Annual European Union greenhouse gas inventory 1990–2018 and inventory report 2020

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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 present report is the official inventory submission of the European Union for 2020 under the UNFCCC and also under the Kyoto Protocol (KP).

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). Due to this lag in reporting, the 2020 inventory report does not yet reflect the effects of the COVID-19 pandemic.

The UK left the EU on February 1, 2020, but applies EU law until the end of the transition period. Moreover, key provisions of Regulation (EU) No 525/2013 ("Mechanism for Monitoring and Reporting GHG") and of Decision No 406/2009/EC ("Effort Sharing") apply to the United Kingdom also in respect of greenhouse gases emitted during 2019 and 2020. Article 5 of Commission Regulation (EU) No 389/2013 ("EU registry") applies to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol[1]. The European Union, its Member States, Iceland and the United Kingdom (UK) fulfil their quantified emission limitation and reduction commitments for the second commitment period to the Kyoto Protocol, reflected in the Doha Amendment, jointly. 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'.

The EU, Iceland and the UK jointly report their national greenhouse gases emissions during the second commitment period of the Kyoto Protocol. The present report and the inventory presented here refer to the EU GHG inventory under the UNFCCC (scope EU-27+UK) and the Kyoto Protocol (scope EU-27+ISL+UK = EU-KP). This report, therefore, presents the totals of the EU-27 plus Iceland, plus the United Kingdom (EU-KP). For reasons of clarity, please note that in some cases the terms 'Member States' and 'EU' and 'Union' may be used. As a general rule, these terms also refer to Iceland and the United Kingdom.The EU should not be held liable for any remaining errors caused by the CRF Reporter software 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

[1] Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community (2019/C 384 I/01), Article 96(5).

reporting GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC[2].

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;
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 Monitoring Mechanism Regulation sets out the reporting rules on GHG emissions to meet the requirements arising from international climate agreements, it 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 countries making up the EU-27 plus Iceland plus the UK. Energy data from Eurostat are used for the reference approach for CO_2 emissions from fossil fuels, developed by the Intergovernmental Panel on Climate Change (IPCC).

The main institutions involved in the compilation of the EU GHG inventory are the Member States plus Iceland and the UK, 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 Mitigation and Energy (ETC/CME), Eurostat, and the Joint Research Centre (JRC).

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

1. Member States/countries 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/CME, 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.

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

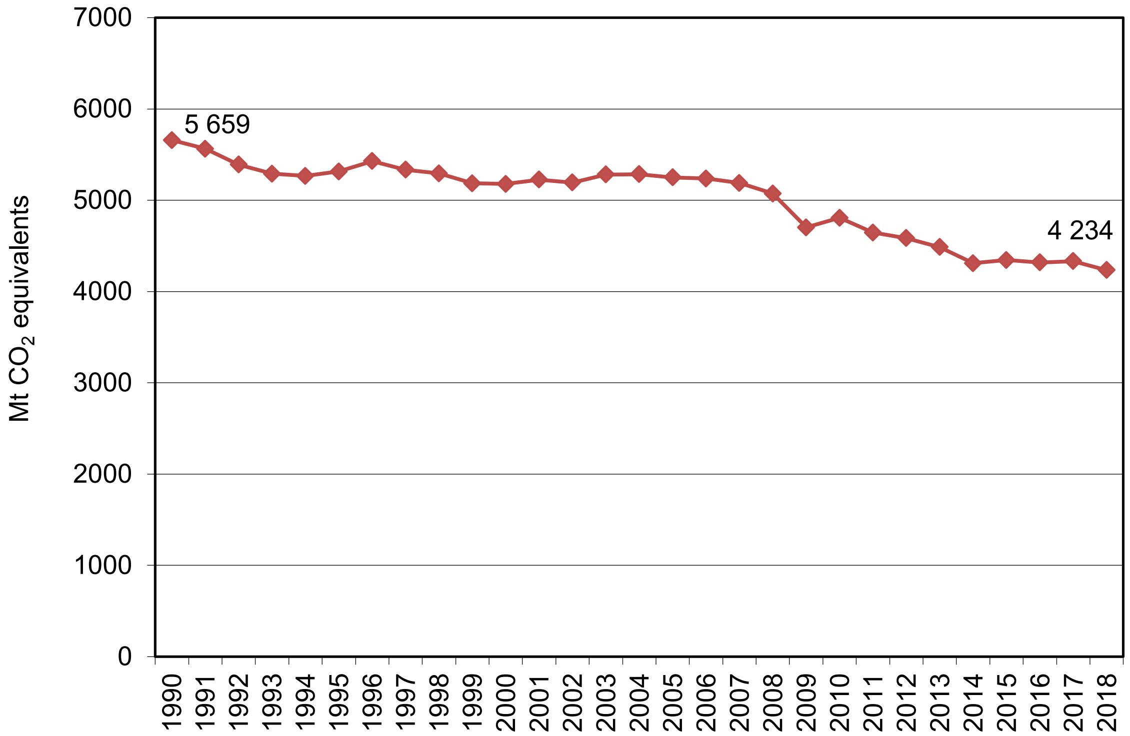
4. The EEA and its ETC/CME review final inventory submissions from Member States and their responses to the initial checks, and prepare the final EU GHG inventory and inventory report by 15 April so that they can be submitted to the UNFCCC.
5. A resubmission is prepared by 27 May if needed.

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-KP amounted to 4 234 million tonnes CO_2 equivalent in 2018 (including indirect CO_2 emissions). All GHG emission totals provided in this report include indirect CO_2 emissions[3].

In 2018, total GHG emissions were 25.2% (1 425 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 2.3 % (99 million tonnes CO_2 equivalent) between 2017 and 2018 (Figure ES. 1).

Figure ES. 1 EU-27, Iceland and the United Kingdom (EU-KP) GHG emissions (excl. LULUCF)



Notes: **The GHG emissions data shown in this figure include indirect CO_2 emissions, 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 100-year global warming potentials are those from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and are included in Annex III of UNFCCC Decision 24/CP.19.**

[3] 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 these emissions. The CRF tables include national totals, including and excluding indirect CO_2 emissions.

1.1 Main trends by source category, 1990-2018

Total GHG emissions (excluding LULUCF and excluding international aviation) decreased by 1425 million tonnes since 1990 (or 25.2 %) reaching their lowest level during this period in 2018 (4234 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 above 60 % alongside a decrease in emissions of 25 % over the period (-23 %, when including international aviation).

The reduction in greenhouse gas emissions over the 28-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fossil fuels and improvements in energy efficiency, as well as to structural changes in the economy and the economic recession. These have resulted in a lower energy intensity of the economy and in a lower carbon intensity of energy production and consumption in 2018 compared to 1990. 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 2018, 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, iron and steel production (including energy-related emissions) 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.

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 2018, the use of solid and liquid fuels in thermal power 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 28 years.

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 reduced adipic and nitric acid production. 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 over 50% of the total net reduction in the EU-KP of the past 28 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 2018.

For a more detailed analysis of GHG emissions trends in the EU, see the EEA report 'Trends and drivers of EU greenhouse gas emissions', to be published alongside the EU GHG inventory submission, and available at https://www.eea.europa.eu/themes/climate/eu-greenhouse-gas-inventory

Table ES. 1 Overview of EU-KP source categories whose emissions increased or decreased by more than 20 million tonnes CO_2 equivalent in the period 1990–2018

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO2 from 1.A.3.b)	172
Refrigeration and Air conditioning (HFCs from 2.F.1)	86
Aluminium Production (PFCs from 2.C.3)	-21
Cement Production (CO2 from 2.A.1)	-25
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-25
Fluorochemical Production (HFCs from 2.B.9)	-27
Fugitive Emissions from Oil and Natural Gas (CH4 from 1.B.2)	-38
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-41
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-44
Nitric Acid Production (N2O from 2.B.2)	-46
Adipic Acid Production (N2O from 2.B.3)	-57
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-61
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-68
Managed Waste Disposal Sites (CH4 from 5.A.1)	-72
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-115
Fuels used Residential Sector (CO2 from 1.A.4.b)	-134
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-248
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-497
Total	**-1425**

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, 2017–2018

Total GHG emissions (excluding LULUCF) decreased in 2018 by 98.7 million tonnes, or 2.3 % compared to 2017, to reach 4234 Mt CO_2 equivalent in 2018. This decrease in emissions came along with an increase in GDP of 2.0 %. Germany and France accounted for more than half of the net reduction in GHG emissions in absolute terms in the EU-KP in 2018.

At EU level, two thirds of the net reduction in GHG emissions in 2018 took place in main activity producers of heat and electricity, including combined heat and power. Emissions from solid fuels decreased by almost 50 million tonnes compared to 2017. Natural gas input to power stations also decreased, with emissions 14 million tonnes below 2017 levels. In addition, the use of renewable energy sources in electricity generation increased again in 2018, thus underpinning the ongoing decarbonisation trend in the sector.

Although less substantial than in the power sector, GHG emissions in 2018 also decreased in residential buildings, refrigeration and air conditioning, petroleum refining and agricultural soils. In particular, it is worth highlighting that HFC emissions from refrigeration and air conditioning have decreased for the fourth consecutive year since 2014. It is also worth mentioning that CO_2 emissions from road transportation remained stable in 2018 compared to 2017, after four consecutive years of increases since 2013. This was due to lower diesel consumption in passenger cars, where emissions decreased for the first time since 2012. The overall 2.3% net decrease in total GHG emissions in 2018 was partly offset by higher emissions from manufacturing industries and construction.

In terms of fuels, there was a significant decrease in the use of fossil fuels for energy combustion, including solid fuels particularly, but also of gaseous (natural gas) and liquid fossil fuels. Based on Eurostat data, there was a decline in nuclear energy in 2018 in parallel with a strong increase in the use of renewable energy sources, both in terms of primary and final energy.

Overall, the energy intensity of the economy and the carbon intensity of energy production and consumption improved again in 2018. These were largely driven by lower transformation losses and better energy efficiency, on the one hand, and by the higher share of renewables in the fuel mix compared to fossil fuels, on the other.

Table ES. 2 shows the source categories making the largest contribution to the change in GHG emissions in the EU between 2017 and 2018.

Table ES. 2 Overview of EU-KP plus Iceland source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2017–2018

Source category	Million tonnes (CO_2 equivalents)
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	3
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-3
Petroleum Refining (CO2 from 1.A.1.b)	-4
Refrigeration and Air conditioning (HFCs from 2.F.1)	-6
Fuels used Residential Sector (CO2 from 1.A.4.b)	-9
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-65
Total	**-99**

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 countries, illustrating where the main changes occurred.

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

	1990 (million tonnes)	2018 (million tonnes)	2017 - 2018 (million tonnes)	Change 2017 - 2018 (%)	Change 1990-2018 (%)
Austria	78.5	79.0	-3.1	-3.7%	0.6%
Belgium	146.4	118.5	0.5	0.4%	-19.1%
Bulgaria	101.8	57.8	-3.9	-6.3%	-43.2%
Croatia	31.9	23.8	-1.2	-5.0%	-25.4%
Cyprus	5.7	8.8	-0.2	-1.8%	55.0%
Czechia	199.1	128.1	-1.6	-1.3%	-35.6%
Denmark	70.8	48.2	-0.1	-0.3%	-31.9%
Estonia	40.3	20.0	-0.9	-4.5%	-50.4%
Finland	71.2	56.4	1.0	1.8%	-20.8%
France	548.3	444.8	-18.7	-4.0%	-18.9%
Germany	1249.5	858.4	-35.9	-4.0%	-31.3%
Greece	103.3	92.2	-3.4	-3.5%	-10.7%
Hungary	94.0	63.2	-0.6	-0.9%	-32.7%
Ireland	55.5	60.9	-0.1	-0.1%	9.9%
Italy	516.1	427.5	-3.8	-0.9%	-17.2%
Latvia	26.3	11.7	0.5	4.4%	-55.5%
Lithuania	48.0	20.3	-0.4	-1.7%	-57.8%
Luxembourg	12.7	10.5	0.3	3.0%	-17.2%
Malta	2.6	2.2	0.0	1.4%	-14.9%
Netherlands	221.7	188.2	-5.1	-2.7%	-15.1%
Poland	475.1	412.9	-1.8	-0.4%	-13.1%
Portugal	58.6	67.4	-3.2	-4.6%	15.0%
Romania	248.0	116.1	-0.8	-0.7%	-53.2%
Slovakia	73.5	43.3	-0.1	-0.3%	-41.0%
Slovenia	18.6	17.5	0.1	0.8%	-6.0%
Spain	289.4	334.3	-6.0	-1.8%	15.5%
Sweden	71.2	51.8	-0.9	-1.8%	-27.3%
United Kingdom	794.2	462.1	-9.4	-2.0%	-41.8%
EU-27+UK	**5652.2**	**4226.0**	**-98.8**	**-2.3%**	**-25.2%**
Iceland	3.7	4.9	0.0	0.4%	30.1%
United Kingdom (KP)	797.0	465.2	-9.3	-2.0%	-41.6%
EU-KP	**5658.7**	**4233.9**	**-98.7**	**-2.3%**	**-25.2%**

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

Table ES. 4 gives an overview of the main trends in the EU-KP GHG emissions and removals for the period 1990–2018. By far the most important GHG is CO_2, which accounted for 81 % of total EU-KP emissions in 2018, excluding LULUCF. In 2018, EU CO_2 emissions excluding LULUCF were 3 440 million tonnes, which was 23 % below 1990 levels. Compared to 2017, CO_2 emissions decreased by 2.3 %. CH_4 and N_2O emissions also decreased by around 2 % during that time.

Table ES. 4 Overview of EU-KP GHG emissions and removals from 1990 to 2018 in million tonnes CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net CO_2 emissions/removals	4 203	3 920	3 854	3 985	3 487	3 610	3 467	3 406	3 315	3 162	3 208	3 195	3 241	3 151
CO_2 emissions (without LULUCF)	4 475	4 221	4 186	4 322	3 840	3 960	3 812	3 754	3 663	3 489	3 526	3 508	3 521	3 440
CH_4	741	679	619	558	512	501	491	488	477	469	469	464	465	456
N_2O	397	360	320	302	265	255	251	249	249	252	253	253	257	252
HFCs	29	44	55	78	98	105	106	109	112	114	111	108	106	99
PFCs	26	17	12	7	4	4	4	4	4	3	4	4	4	4
Unspecified mix of HFCs and PFCs	6	6	2	1	1	1	0	1	1	1	1	1	1	2
SF_6	11	15	11	8	6	6	6	6	6	6	6	6	7	7
NF_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**5 413**	**5 042**	**4 873**	**4 939**	**4 374**	**4 482**	**4 326**	**4 262**	**4 163**	**4 008**	**4 051**	**4 031**	**4 080**	**3 970**
Total (without CO2 from LULUCF)	**5 685**	**5 343**	**5 205**	**5 276**	**4 727**	**4 831**	**4 671**	**4 610**	**4 511**	**4 335**	**4 369**	**4 344**	**4 360**	**4 259**
Total (without LULUCF)	**5 659**	**5 315**	**5 178**	**5 250**	**4 702**	**4 807**	**4 646**	**4 584**	**4 487**	**4 310**	**4 345**	**4 318**	**4 333**	**4 234**

Notes: CO_2 emissions include indirect CO_2. Please note that historical data may have changed from last year's Inventory Report due to recalculations

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-KP GHG emissions in the main source categories for the period 1990–2018. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 78 % of total EU emissions in 2018. 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-KP GHG emissions (in million tonnes CO_2-equivalent) in the main source and sink categories for the period 1990 to 2018

GHG SOURCE AND SINK	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1. Energy	4 350	4 090	4 023	4 134	3 714	3 812	3 662	3 619	3 526	3 342	3 382	3 361	3 367	3 284
2. Industrial Processes	516	498	455	468	379	396	392	379	377	384	379	376	382	374
3. Agriculture	547	475	464	442	431	427	427	425	429	436	438	438	442	436
4. Land-Use, Land-Use Change and Forestry	-245	-273	-304	-310	-328	-325	-320	-322	-324	-303	-294	-287	-252	-264
5. Waste	241	248	233	204	177	169	163	159	153	147	145	141	140	138
6. Other	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
Total (with net CO_2 emissions/removals)	**5 413**	**5 042**	**4 873**	**4 939**	**4 374**	**4 482**	**4 326**	**4 262**	**4 163**	**4 008**	**4 051**	**4 031**	**4 080**	**3 970**
Total (without LULUCF)	**5 659**	**5 315**	**5 178**	**5 250**	**4 702**	**4 807**	**4 646**	**4 584**	**4 487**	**4 310**	**4 345**	**4 318**	**4 333**	**4 234**

Notes: CO_2 emissions include indirect CO_2

ES-5 SUMMARY OF EU MEMBER STATE EMISSION TRENDS

Table ES. 6 gives an overview of countries' contributions to EU GHG emissions for the period 1990–2018. Countries show large variations in GHG emissions trends.

Table ES. 6 Overview of countries' contributions to total EU GHG emissions, excluding LULUCF, from 1990 to 2018 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	78	79	80	92	80	85	82	80	80	76	79	79	82	79
Belgium	146	154	150	146	127	134	124	121	121	115	119	118	118	118
Bulgaria	102	75	60	64	58	61	66	61	56	59	62	59	62	58
Croatia	32	23	26	30	28	28	28	26	24	24	24	24	25	24
Cyprus	5.7	7.1	8.5	9.4	9.8	9.5	9.2	8.6	7.9	8.3	8.3	8.8	9.0	8.8
Czechia	197	157	149	148	137	140	138	134	129	127	128	130	129	127
Denmark	70	78	70	66	63	63	58	53	55	51	48	50	48	48
Estonia	40	20	17	19	17	21	21	20	22	21	18	20	21	20
Finland	71	72	70	70	68	76	68	62	63	59	55	58	55	56
France	548	543	553	555	505	512	483	484	485	454	458	459	464	445
Germany	1249	1121	1043	993	909	942	919	924	942	902	906	909	894	858
Greece	103	109	126	136	125	119	116	112	103	99	95	92	96	92
Hungary	94	75	73	75	64	65	63	60	57	57	61	61	64	63
Ireland	55	59	68	70	62	61	57	58	58	57	59	61	61	61
Italy	516	529	552	587	503	514	501	482	447	426	439	436	431	428
Latvia	26	13	11	11	11	12	11	11	11	11	11	11	11	12
Lithuania	48	22	20	23	20	21	21	21	20	20	20	20	21	20
Luxembourg	13	10	10	13	12	12	12	12	11	11	10	10	10	11
Malta	2.6	2.7	2.8	3.0	2.9	3.0	3.0	3.2	2.9	2.9	2.3	1.9	2.2	2.2
Netherlands	221	231	219	214	201	213	199	195	195	187	195	195	193	188
Poland	475	447	396	404	394	413	412	405	401	388	392	400	415	413
Portugal	59	69	82	86	73	69	67	65	64	64	68	66	70	67
Romania	248	187	143	151	128	124	129	126	116	116	116	114	117	116
Slovakia	74	53	49	51	46	46	46	43	43	41	42	42	43	43
Slovenia	19	19	19	20	20	20	20	19	18	17	17	18	17	18
Spain	289	329	389	443	373	359	358	351	325	327	338	327	340	334
Sweden	71	73	68	67	58	64	60	57	56	54	54	53	53	52
United Kingdom	794	748	712	691	596	611	563	580	566	526	508	483	471	462
EU-27+UK	**5648**	**5305**	**5168**	**5240**	**4692**	**4797**	**4637**	**4575**	**4477**	**4301**	**4335**	**4308**	**4323**	**4224**
Iceland	3.7	3.6	4.2	4.1	5.0	4.9	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.9
United Kingdom (KP)	797	751	715	695	599	614	566	583	569	529	511	486	474	465
EU-KP	**5654**	**5312**	**5175**	**5247**	**4700**	**4805**	**4644**	**4582**	**4485**	**4309**	**4343**	**4316**	**4331**	**4232**

The overall EU GHG emission trend is dominated by the three largest emitters, Germany (20 %), the United Kingdom (11 %) and France (11 %), accounting for over forty percent of total EU-KP GHG emissions in 2018. Germany and the United Kingdom, the two ccountries with the highest absolute reductions, achieved total domestic GHG emission reductions of 723 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 141 % between 1990 and 2018 and GHG emissions from international shipping increased by 35 % during the same period. In 2018 international aviation accounted for 167 million tonnes CO_2 equivalent and international shipping for 150 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 countries, 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', Iceland's and UK's GHG inventories in 2020, total EU GHG emissions (excluding LULUCF) for 2017 were 0.001% higher than those reported in the 2018 GHG inventories. Total EU emissions in 1990, reported in 2020 GHG inventories, were 0.03 % lower than the 1990 emissions reported in 2019 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

1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY

The present report is the official inventory submission of the European Union for 2020 under the UNFCCC and the Kyoto Protocol (KP).

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 UK left the EU on February 1, 2020, but applies EU law until the end of the transition period, December 31, 2020. Key provisions of Regulation (EU) No 525/2013 ("Mechanism for Monitoring and Reporting GHG") and of Decision No 406/2009/EC ("Effort Sharing") apply to the United Kingdom also in respect of greenhouse gases emitted during 2019 and 2020. Article 5 of Commission Regulation (EU) No 389/2013 ("EU registry") applies to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol.

In addition, the European Union, its Member States, Iceland and the United Kingdom (UK) have agreed to fulfil their quantified emission limitation and reduction commitments for the second commitment period to the Kyoto Protocol, reflected in the Doha Amendment, jointly. The Union, its Member States, the United Kingdom 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', the United Kingdom's 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'.

In this context, the EU, Iceland and the UK jointly report their national greenhouse gases emissions during the second commitment period of the Kyoto Protocol. As described above, the present report is under the UNFCCC and the Kyoto Protocol and as such the inventory presented here corresponds to the EU GHG inventory under both scopes. This report, therefore, refers to the totals of the EU-27 plus Iceland, plus the United Kingdom (EU-KP). For reasons of clarity, please note that in some cases the terms 'Member States' and ''EU' and 'Union' may be used. As a general rule, these terms also include Iceland and the United Kingdom.

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 2020 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[4] (hereafter referred to as the Monitoring Mechanism Regulation or MMR). Decision No 280/2004/EC has been revised in 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-27 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 and Sweden.. 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 27 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

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

EU legislation for reduction of GHG emissions[5]. 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
- data in accordance with UNFCCC reporting requirements on their anthropogenic emissions of carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxides (NOx) 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[6]. According to the MMR and its implementing decision the reporting requirements are exactly the same as for the UNFCCC, regarding content and format. The

[5] 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).

[6] 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).

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[7]) 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 Climate Change Mitigation and Energy (ETC/CME) as well as the following other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC) [8].

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

[8] 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

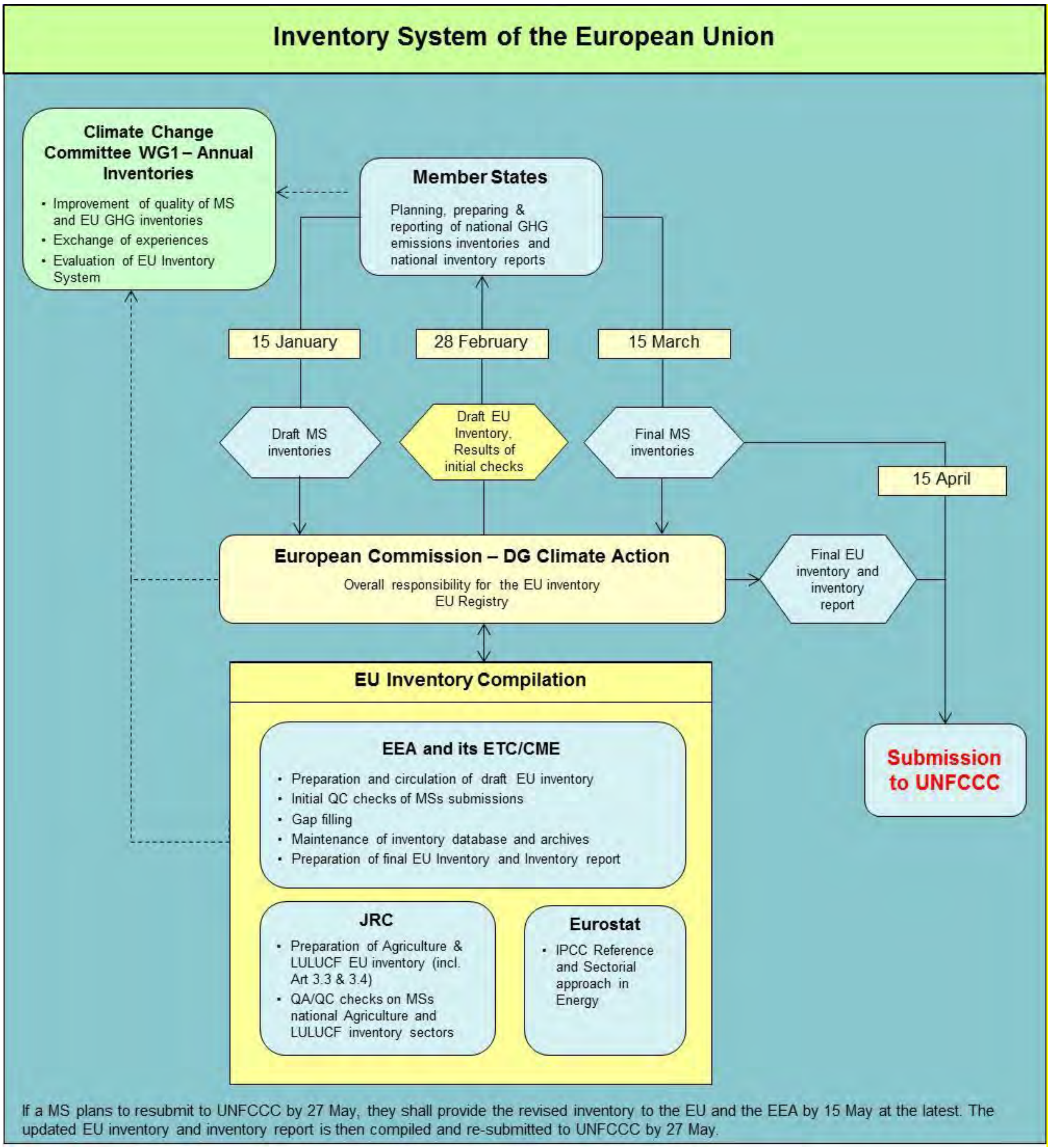


Table 1.1 shows the main institutions and persons involved in the compilation and submission of the EU inventory.

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

Belgium	Peter Wittoeck Federal Department of the Environment
Bulgaria	Detelina Petrova Executive Environment Agency dpetrova@moew.government.bg
Croatia	Ms Vlatka Palčić and Tatjana Obučina Ministri of Environment and Energy vlatka.palcic@mzoe.hr Ms Iva Švedek Ekonerg - Energy and Environmental Protection Institute iva.svedek@ekonerg.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	Kristi Põlluveer Ministry of the Environment Adviser, Climate Department kristi.polluveer@envir.ee Cris-Tiina Türkson Adviser, Estonian Environmental Research Centre Cris-Tiina.Turkson@klab.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
Hungary	Mr. Gábor KIS-KOVÁCS Hungarian Meteorological Service kiskovacs.g@met.hu
Iceland	Ásta Karen Helgadóttir, Environment Agency of Iceland asta.helgadottir@umhverfisstofnun.is
Ireland	Paul Duffy Environmental Protection Agency p.duffy@epa.ie
Italy	M. Contaldi, R. de Lauretis, D. Romano 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	Mr Saviour Vassallo Malta Resources Authority – Climate Change Unit Saviour.vassallo@mra.org.mt
Netherlands	Margreet van Zanten National Institute for Public Health and the Environment margreet.van.zanten@rivm.nlmailto:
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	Janka Szemesova Department of Emissions and Biofuels, Slovak Hydrometeorological Institute janka.szemesova@shmu.sk
Slovenia	Tajda Mekinda Majaron Environmental Agency of the Republic of Slovenia tajda.mekinda-majaron@gov.si
Spain	Maj Britt Larka Abellán Dirección General de Calidad y Evaluación Ambiental y Medio Natural Ministerio de Agricultura, 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	Neil Lambert Department for Business, Energy and Industrial Strategy UK Greenhouse Gas Inventory team neil.lambert@beis.gov.uk
European Commission	Andreas Pilzecker European Commission, DG Climate Action Andreas.PILZECKER@ec.europa.eu

European Environment Agency (EEA)	Ricardo Fernandez, Claire Qoul, Melanie Sporer European Environment Agency Ricardo.Fernandez@eea.europa.eu, Claire.Qoul@eea.europa.eu, melanie.sporer@eea.europa.eu
European Topic Centre on Climate Change Mitigation and Energy (ETC/CME)	Nicole Mandl, Michaela Gager, Elisabeth Rigler European Topic Centre on Climate Change Mitigation and Energy, Umweltbundesamt nicole.mandl@umweltbundesamt.at, michaela.gager@umweltbundesamt.at, Elisabeth.rigler@umweltbundesamt.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, Directorate D – Sustainable Resources 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/CME 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[9] (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/).

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 Climate Change Mitigation and Energy (ETC/CME), which is an international consortium working with the EEA under a framework partnership agreement. The activities of the EEA's ETC/CME are further deployed in the next paragraph.

1.2.1.4 The European Topic Centre on Climate Change Mitigation and Energy

The EEA's European Topic Centre on Climate Change Mitigation and Energy (ETC/CME) was established by a contract between the lead organisation Vito (vision on technology) in Belgium and EEA for the years 2019-2021, continuing the work of the previous ETC on part of the work of the previous ETC on Air Pollution and Climate change Mitigation, which ended in 2018.

The EEA's ETC/CME involves 11 organisations and institutions in nine European countries. The technical annex of the work plan for the EEA's ETC/CME and a yearly action plan defines the specific tasks of the EEA's ETC/CME partner organisations with regard to the preparation of the EU inventory and inventory report. Environment Agency Austria is the task leader for the compilation of the EU annual inventory and inventory report in the EEA's ETC/CME. The specific tasks undertaken by EEA's ETC/CME in this task include:

- Implementation of the quality assurance and quality control (QA/QC) procedures of the EU GHG inventory national system for the compilation and submission of the Union GHG inventory to the UNFCCC. Initial QA/QC checks of Member States' submissions are performed in cooperation with Eurostat, and the JRC, and documented in the EEA review tool
- Performing the first step of the annual Effort Sharing Decision (ESD) review and identifying significant issues according to Art. 29 and 30 of the Commission Implementing Regulation (EU) No 749/2014 (MMR Implementing Regulation).
- Consultation with Member States in order to clarify data and other information provided;

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

- 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/CME 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/CME, Eurostat and the JRC perform initial checks of the submitted data up to 28 February. The ETC/CME 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.
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)

Element	Who	When	What
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/CME 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-27 Member States, Iceland and the United Kingdom (EU-KP) submissions in 2020 that were taken into account for the compilation EU GHG inventory.

Table 1.3 Date, mode and content of submission of EU-27 Member States, Iceland and the United Kingdom (EU-KP) in 2020 that were taken into account for the compilation of EU GHG inventory

MS	date	Sub-mission mode	XML	CRF	NIR
AUT	15.04.2020	CDR	AUT_2020_2_14042020_1323566823656198599147111.xml	1990-2018	x
BEL	14.04.2020	CDR	BEL_2020_1_09042020_1326214259475774596432253.xml	1990-2018	x
BGR	15.04.2020	CDR	BGR_2020_1_12042020_0751114449497920614047651.xml	1988-2018	x
CYP	15.04.2020	CDR	CYP_2020_3_14042020_2155596108535216176956322.xml	1990-2018	x
CZE	14.04.2020	CDR	CZE_2020_1_30032020_1652482201294829901486537.xml	1990-2018	x
DEU	21.04.2020	CDR	DEU_2020_1_19032020_1014054776578236132200802.xml	1990-2018	
DEU	21.04.2020	CDR			x
DNM	08.05.2020	CDR	DNM_2020_5_27042020_1313043796415518835388566.xml	1990-2018	x
ESP	13.03.2020	CDR	ESP_2020_1_06032020_1827374439037440702550662.xml	1990-2018	x
EST	14.04.2020	CDR	EST_2020_1_09042020_1124122423715812433561972.xml	1990-2018	x
FIN	15.04.2020	CDR	FIN_2020_4_15042020_2149577048616023702669361.xml	1990-2018	x
FRK	17.03.2020	CDR	FRK_2020_1_13032020_1521112128519854698038752.xml	1990-2019	x
GBK	14.03.2020	CDR	GBK_2020_1_13032020_1757246616956401435812859.xml	1990-2018	x
GRC	14.03.2020	CDR	GRC_2020_1_12032020_1838544925581189471457366.xml	1990-2018	x
HRV	16.04.2020	CDR	HRV_2020_1_16042020_1928307129467655796220113.xml	1990-2018	x
HUN	26.03.2020	CDR	HUN_2020_3_13032020_1433323581365193121841217.xml	1990-2018	
HUN	19.03.2020	CDR			x
IRL	13.03.2020	CDR	IRL_2020_3_06032020_152221487284355541236653.xml	1990-2018	x
ITA	10.04.2020	CDR	ITA_2020_1_10042020_1938173149611270340774647.xml	1990-2018	x
LTU	24.04.2020	CDR	LTU_2020_1_15042020_1719091874090694159965282.xml	1990-2018	x
LUX	15.04.2020	CDR	LUX_2020_1_11032020_1602085850199700850186307.xml	1990-2018	x
LVA	07.05.2020	CDR	LVA_2020_2_09042020_1352478869328790094419027.xml	1990-2018	x
MLT	13.04.2020	CDR	MLT_2020_2_06042020_1442381376460054512151036.xml	1990-2018	x
NLD	07.05.2020	CDR	NLD_2020_2_10042020_0924452774663454683189694.xml	1990-2018	
NLD	28.04.2020	CDR			x
POL	15.04.2020	CDR	POL_2020_1_14042020_1241278294710808930298418.xml	1988-2018	x
PRT	13.03.2020	CDR	PRT_2020_1_12032020_1932203533178210289713731.xml	1990-2018	x
ROU	06.05.2020	CDR	ROU_2020_9_23042020_1630163381212698463731250.xml	1989-2018	x
SVK	13.03.2020	CDR	SVK_2020_3_09032020_1715531526236745005075646.xml	1990-2018	x
SVN	15.04.2020	CDR	SVN_2020_5_13042020_185554651531311218831100.xml	1986-2018	x
SWE	12.03.2020	CDR	SWE_2020_3_11032020_1002487940389948684359483.xml	1990-2018	x
ISL	14.04.2020	CDR	ISL_2020_1_08042020_1332395729648668707030788.xml	1990-2018	x

Table 1.4 gives an overview on people involved in the compilation of the EU GHG inventory submission in 2020 and their individual responsibilities in this process.

Table 1.4 Responsibility list for the compilation of the EU GHG inventory submission in 2020

	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
Commission	Andreas.PILZECKER (DG Clima) Andreas.PILZECKER@ec.europa.eu	X		Chapter 13 Changes national system	**QA NIR:** Executive summary, chapter 1				
	Francesca LANZA (DG Clima) Francesca.LANZA@ec.europa.eu			Chapter 12 Kyoto units, Chapter 14 Changes to registry, EU-SEF Tables					
	BogdanVoinea (DG Clima) Bogdan.VOINEA@ext.ec.europa.eu			Chapter 14 Changes to registry, EU-SEF Tables					
	Adrian Leip (JRC) adrian.leip@ec.europa.eu			sector 3				sector 3	sector3
	Alexander De- Meij (JRC) Alexander.DE-MEIJ@ext.ec.europa.eu			sector 3				sector 3	
	Janka Szemesova (JRC) janka.szemesova@shmu.sk				**QA NIR:** sector 3			sector 3	
	Giacomo Grassi (JRC) giacomo.grassi@ec.europa.eu				**QA NIR:** sector 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-CME	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				X			sector3
	Melanie Sporer (EEA) melanie.sporer@eea.europa.eu					X			

	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
	Herdis Gudbrandsdottir (EEA) herdis.gudbrandsdottir@eea.europa.eu			Data checks					
	Michaela Gager (ETC-CME; UBA-V) michaela.gager@umweltbundesamt.at		Data manager						
	Günther Schmidt (ETC-CME; UBA-V) guether.schmidt@umweltbundesamt.at		Data manager		**QA NIR:** sector 1				
	Nicole Mandl (ETC-CME, UBA-V) nicole.mandl@umweltbundesamt.at		X	Executive summary, chapter 1, trend chapter			X	cross-cutting issues	cross-cutting issues
	Marion Pinterits (ETC-CME; UBA-V) marion.pinterits@umweltbundesamt.at		X	1B, 1C, chapter 10			X	1B, 1C	
	Georg Wartecker (ETC-CME; UBA-V) georg.wartecker@umweltbundesamt.at			Project support					
	Elisabeth Kampel (ETC-CME) e.kampel@klarfakt.com			Project support					
	Eva Krtkova (ETC-CME;CHMI) eva.krtkova@chmi.cz			1A2, 1A4, 1A5				1A2, 1A4, 1A5	
	Markéta Müllerová (ETC-CME; CHMI) marketa.mullerova@chmi.cz			1A2, 1A4, 1A5				1A2, 1A4, 1A5	
	Céline GUEGUEN (ETC-CME) celine.gueguen2@gmail.com			sector 5				sector 5	
	Coralie JEANNOT (ETC-CME; CITEPA) coralie.jeannot@citepa.org			EU ETS				EU ETS	
	Julien Vincent (ETC-CME; CITEPA) julien.vincent@citepa.org			1A1				1A1	1B, 1C, 1AB
	Giorgos Mellios (ETC-CME; Emisia) giorgos.m@emisia.com			1A3 + bunkers, comparison with Eurocontrol					1A3 + bunkers
	Matina Kastori (ETC-CME; Emisia) matina.k@emisia.com			1A3 + bunkers, comparison with Eurocontrol				1A3 + bunkers	
	Barbara Gschrey (ETC-CME; Oeko Recherche) b.gschrey@oekorecherche.de			F-gases 2E, 2F, 2G1-2				F-gases 2E, 2F, 2G1-2	

	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
	Kristina Kaar (ETC-CME; Oeko Recherche) kristina.kaar@oekorecherche.de			F-gases 2E, 2F, 2G1-3				F-gases 2E, 2F, 2G1-3	
	Lorenz Moosmann (ETC-CME; Oeko) l.moosmann@oeko.de			sectors 2A, 2B, Chapter 15				2A, 2B	
	Lukas Emele (ETC-CME; Oeko) l.emele@oeko.de			sectors 2A, 2B, Chapter 15				2A, 2B, Chapter 15	
	Bernd Gugele (ETC-CME, UBA-V) bernd.gugele@umweltbundesamt.at			1A Reference approach	**QA NIR:** sector 1			1A Reference approach	1A1, 1A2, 1A4, 1A5
	Bradley Matthews (ETC-CME, UBA-V) bradley.matthews@umweltbundesamt.at			uncertainties,					
	Maria Purzner (ETC-CME; UBA-V) maria.purzner@umweltbundesamt.at			2C, 2D, 2G3-2G4, 2H				2C, 2D, 2G3-2G4, 2H	sector 2 f-gases only
	Ils Moorkens (ETC-CME; VITO) ils.moorkens@vito.be				**QA NIR:** sector 2				sector 2 (excl. f-gases)
	Kaat Jespers (ETC-CME; 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 procedures for the EU inventory and ensures that the objectives of the QA/QC programme are implemented in the design of the QA/QC manual defining general and specific QC procedures for the EU GHG inventory submission. The European Environment Agency (EEA) is responsible for the annual implementation of these 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/CME, 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 during 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[10]) 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/CME transfers the national data from the xml-files into the ETC/CME CRF aggregator database. The ETC/CME 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/CME 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

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

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 layout checks. 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 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/CME 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 for more information.

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

Since 2012, six 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, 2020 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 SF6. 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, 2018 and 2019 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 Member States are subject to step 2 for which significant issues are identified during step 1.

- In 2017 15 MS were subject to step 2; the final review reports include 70 recommendations, 16 revised estimates provided by the Member States and four technical corrections calculated by the review team.
- In 2018 eleven MS were subject to step 2; the final review reports include 34 recommendations, ten revised estimates provided by the Member States and one technical correction calculated by the review team.

- In 2019 13 MS were subject to step 2. In addition Norway and Iceland participated in step 2 on a voluntary basis. The final review reports include 56 recommendations, 16 revised estimates provided by the Member States and four technical correction calculated by the review team.

The 3rd comprehensive review will be organised in 2020. All 27 EU Member States + UK, Iceland and Norway will be reviewed by a team of 28 reviewers. On the basis of the GHG inventories reviewed in 2020, the European Commission will fix the base year and the greenhouse gas emissions targets for 2030, and the trajectory years for 2021-2029. The review will cover the years 2005 and 2016-2018, all gases and all sectors apart from LULUCF.

Capacity building activities based on the ESD reviews

After the ESD review in autumn, each year capacity building workshops/webinars are organised 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.

In 2018 four webinars were organized following the sectors Energy, IPPU, Agriculture, and Waste on four days. The IPPU webinar was split into two sessions following the (group of) subcategories of the ESD review 2018: (1) IPPU excluding F-gases and (2) IPPU F-gases. Overall experts from 23 Member States plus Iceland and Norway registered for the webinars. In total 110 experts registered for one or more webinars. During the webinars in 2018 the status of all open issues from previous webinars was presented and discussed. Seven out of eight follow-up issues from 2017 have been resolved and closed during 2018.

In 2019 four webinars were organized following the sectors Energy, IPPU, Agriculture, and Waste on four days. Overall 109 experts from 21 Member States registered for one or more webinars.

As a result of the capacity building webinars guidance documents have been developed in order to support the Member States in improving their inventories. By May 2020 18 guidance documents are available: four for the Energy Sector; six for the IPPU Sector; four for the Agriculture Sector; four for the Waste Sector.

Apart from the capacity building webinars open to all Member States the ESD project team carried out additional capacity building targeted at specific countries in 2018 and 2019. In this context the experts:

- Provided support via e-mail for four MS related to the sectors energy, transport, F-gases, agriculture and waste;
- Organized five in-country visits in the sectors energy, transport, F-gases, agriculture and waste.

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.

In 2019 the European Union did not undergo an UNFCCC inventory review.

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 and inventory report 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
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	28-29 May, Varese, Italy
JRC technical workshop on LULUCF reporting under the Kyoto Protocol	16-17 May 2018, Arona, Italy
Joint Workshop of the Eurostat 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
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP)	02-03 May 2016, Stresa, Italy

Workshop/expert meeting	Date and venue
and the EU LULUCF Decision No 529/2013	
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.
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

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-KP GHG inventory is compiled on the basis of the inventories of the 27 Member States, Iceland and the United Kingdom. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the 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 on the basis of Eurostat energy data (see Section 3.6) and the key category analysis (Section 1.5) is separately performed at EU level[11].

Since Member States use different national methodologies, national activity data or country-specific emission factors in accordance with IPCC and UNFCCC guidelines, these methodologies are reflected in the EU GHG inventory data. The EU believes that it is consistent with the UNFCCC reporting guidelines and the IPCC good practice guidance to use different methodologies for one source category across the EU especially if this helps to reduce uncertainty 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 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-27, Iceland and the United Kingdom

Table 1.7 Manual changes in the CRF Reporter

Year	Sector	Source category	Parameter	Manual changes / inclusion in the CRF Reporter
1990-2018	Energy	1 AB, 1AC, 1AD	All	Enter Reference Approach data from Eurostat

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

Year	Sector	Source category	Parameter	Manual changes / inclusion in the CRF Reporter
2013-2018	Energy	1.A.2, 1.B.2, 2.C.1, 2.C.2, 2.C.7	CO_2, CH_4, N_2O, NOx, NMVOC and CO	Shift differences due to SWE confidential data into 'Other fossil fuels' within the same sub-category, if the total emissions of the sub-category are available. Otherwise shift differences to 'Other' sub-category.
1990-2018	IPPU	2.B, 2.C, 2.E, 2.F, 2.G, 2.H	f gases	Enter country-specific f gases
1990-2018	IPPU	2.C.7, 2.G.4, 2.H	CO_2, CH_4, N_2O, NOx, NMVOC, SO2	Enter country-specific emissions and recovery data.
2018	IPPU	2.A.1, 2.A.2,	AD	Replace aggregated activity ('AD') data with gap-filled AD provided by sector experts
1990-2018	IPPU	2.A, 2.B, 2.C, 2.D, 2.G	AD	Replace aggregated AD with notation key 'NE' if an aggregation does not make sense due to inhomogeneous AD
1990-2018	Agriculture	3	CH_4, N_2O, NMVOC	Enter aggregated data from JRC
1990-2018	Agriculture	3	AD	Correct additional information with aggregated data from JRC
1990-2018	LULUCF	4G	All	Enter aggregated data (approach B)
1990-2018	KP.LULUCF		All	Incorporate aggregated data and comments from JRC

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_CME\Intern\0 ETC CME 2020\1.3.1.1 EU GHG inventory

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 emissions for which higher tiers are used in the EU 27, Iceland and the United Kingdom 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 (excluding LULUCF)

Source category gas	Share of higher Tier
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	97%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	93%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	97%
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	97%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	96%
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	99%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	92%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	97%
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	99%
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	99%
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	99.9%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	92%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	92%
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	98%
1.A.2.c Chemicals: Liquid Fuels (CO_2)	93%
1.A.2.c Chemicals: Solid Fuels (CO_2)	99%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	91%
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)	96%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	95%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	60%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	93%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	98%
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	98%
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	71%
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	99%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	99%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	96%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	98%
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	93%
1.A.3.b Road Transportation: Diesel Oil (CO_2)	89%
1.A.3.b Road Transportation: Diesel Oil (N_2O)	100%
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	87%
1.A.3.b Road Transportation: Gasoline (CH_4)	99%

Source category gas	Share of higher Tier
1.A.3.b Road Transportation: Gasoline (CO_2)	92%
1.A.3.b Road Transportation: Gasoline (N_2O)	100%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	97%
1.A.3.b Road Transportation: Other Fuels (CO_2)	--
1.A.3.c Railways: Liquid Fuels (CO_2)	74%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	84%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	71%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	93%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	92%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	98%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	100%
1.A.4.b Residential: Biomass (CH_4)	54%
1.A.4.b Residential: Gaseous Fuels (CO_2)	93%
1.A.4.b Residential: Liquid Fuels (CO_2)	88%
1.A.4.b Residential: Solid Fuels (CH_4)	7%
1.A.4.b Residential: Solid Fuels (CO_2)	99%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	88%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	87%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	97%
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	99%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	47%
1.B.1.a Coal Mining and Handling: Operation (CH_4)	71%
1.B.2.a Oil: Operation (CH_4)	63%
1.B.2.a Oil: Operation (CO_2)	89%
1.B.2.b Natural Gas: Operation (CH_4)	80%
1.B.2.c Venting and Flaring: Operation (CO_2)	81%
2.A.1 Cement Production (CO_2)	100%
2.A.2 Lime Production (CO_2)	99.97%
2.A.4 Other Process Uses of Carbonates (CO_2)	99.87%
2.B.1 Ammonia Production (CO_2)	97%
2.B.2 Nitric Acid Production (N_2O)	98.7%
2.B.3 Adipic Acid Production (N_2O)	100%
2.B.8 Petrochemical and Carbon Black Production (CO_2)	86%
2.B.9 Fluorochemical Production (HFCs)	100%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	100%
2.B.10 Other chemical industry (CO_2)	81%
2.C.1 Iron and Steel Production (CO_2)	96%
2.C.3 Aluminium Production (PFCs)	100%
2.D.3 Other non energy products (CO_2)	91%
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	85%
2.F.2 Foam Blowing Agents: no classification (HFCs)	95%
2.F.4 Aerosols: no classification (HFCs)	90%
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	99%
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	100%

Source category gas	Share of higher Tier
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	92%
3.A.4 Enteric Fermentation: Other livestock (CH_4)	64%
3.B.1 CH_4 Emissions: Farming (CH_4)	96%
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	97%
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	39%
3.D.2 Agricultural Soils: Farming (N_2O)	28%
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)	56%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	57%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	25%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	45%

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 data set on verified installation-specific emissions for the sectors covered by the scheme. For 2018 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 2018 (Member States and United Kingdom)

Main activity	Activity code	Number of entities	Verified emissions (Mt CO_2-eq.)
Combustion of fuels	20	7 373	1 081
Refining of mineral oil	21	135	122
Production of coke	22	20	11
Metal ore roasting or sintering	23	9	3
Production of pig iron or steel	24	245	122
Production or processing of ferrous metals	25	239	11
Production of primary aluminium	26	23	5
Production of secondary aluminium	27	33	1
Production or processing of non-ferrous metals	28	84	7
Production of cement clinker	29	257	120
Production of lime, or calcination of dolomite/magnesite	30	292	32
Manufacture of glass	31	366	18
Manufacture of ceramics	32	1 054	15
Manufacture of mineral wool	33	50	2
Production or processing of gypsum or plasterboard	34	39	1
Production of pulp	35	170	5
Production of paper or cardboard	36	579	22
Production of carbon black	37	18	2
Production of nitric acid	38	37	4
Production of adipic acid	39	3	0.11

Main activity	Activity code	Number of entities	Verified emissions (Mt CO_2-eq.)
Production of glyoxal and glyoxylic acid	40	1	0.01
Production of ammonia	41	29	21
Production of bulk chemicals	42	357	37
Production of hydrogen and synthesis gas	43	42	8
Production of soda ash and sodium bicarbonate	44	14	3
Capture of greenhouse gases under Directive 2009/31/EC	45	2	0.0003
Transport of greenhouse gases under Directive 2009/31/EC	46	1	0.0014
Other activity opted-in under Art. 24	99	256	1
All stationary installations		11 729	1 655

Source: EEA, 2020 (EU ETS data viewer)

1.4.1.2 Mapping table between EU ETS activities and CRF categories

The table below indicates the mapping between the EU ETS activities and the IPCC/CRF categories, with supporting comments. Such table is 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)	• 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

EU ETS activity	CRF category	Comment
	1.A.4.a Commercial/ Institutional 1.A.4.c Agriculture/ Forestry / Fisheries 1.B Fugitive emissions from fuels	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 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

EU ETS activity	CRF category	Comment
		• 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 fuels and other energy industries	• 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 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 Al2O3 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.

EU ETS activity	CRF category	Comment
		• 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.
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.
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	2.A.4 Other process uses of carbonates	• Emissions are included in EU ETS only for installations with a production capacity exceeding 75 tonnes per

EU ETS activity	CRF category	Comment
firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain	1.A.2.f Non-metallic minerals	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 cardboard a production capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • Combustion related emissions from EU ETS 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

EU ETS activity	CRF category	Comment
		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 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.

EU ETS activity	CRF category	Comment
		• 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
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
47 Geological storage of greenhouse gases in a storage site permitted under Directive 2009/31/EC	1.C.2 Injection and storage	• Consistent with scope of inventory (currently no emissions reported under the EU ETS)
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 2020

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 2020 to the European Commission, all Member States indicated that they used EU ETS data at least for QA/QC purposes (Table 1.11). 25 Member States indicated to directly use the verified emissions reported by installations under the EU ETS (depending of the sectors). All Member States used EU ETS data to improve country-specific emission factors. And all Member States reported that they used activity data (e.g. fuel use) provided under the EU ETS in the national inventory (depending of the sectors).

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 2020 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) 2020: 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 submitted by the 28 countries and the European Union to the UNFCCC and to the UNECE. The main objective of the WP is to assist EU countries 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/CME assist DG CLIMA regarding the technical requirements.

To support the inventory process for the submission in 2020, in November 2019 the countries received fuel and emissions data for the years 2005 to 2018 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 countries on a regular basis. In November 2018 one webinar took place to exchange information between EUROCONTROL and countries on the data provided.

In the course of the ‘initial checks’ of countries inventories in the first months of 2020 the comparison between Tier 3b calculations from EUROCONTROL and time series of countries inventories has been conducted with most actual inventories from countries. In case of considerable differences between countries results and those from EUROCONTROL, the European Environment Agency and its ETC/CME asked countries via the EMRT about possible reasons. In addition, the European Environment Agency provided the countries with a comparison between EUROCONTROL data and countries data on fuel consumption of civil and international aviation for the years 2017 and 2018, 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 countries. Under a new framework contract with DG CLIMA, EUROCONTROL will provide data for the year 2019 and eventually recalculate time series for the period 2005 to 2018 in case of considerable changes in the model.

Comparing emissions reported by countries 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 countries.

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 Union level, every Member State provides a national key category analysis which is independent from the assessment at Union level. The Union key category analysis is not intended to replace the key category analysis by Member States. The key category analysis at Union 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 Union 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-27, Iceland and the United Kingdom, 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 2018. The assessment was carried out for emissions excluding LULUCF and including LULUCF.
  The key category analysis excluding LULUCF resulted in the identification of 93 key categories for the EU cover 96 % of total EU GHG emissions in 2018 (see Annex I). The key category analysis including LULUCF resulted in 102 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-KP key category in terms of level and trend.

Table 1.12 Key categories for the EU-27, Iceland and the United Kingdom (Gg CO_2 equivalents)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2018		1990	2018
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107724	217622	T	L	L
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	178084	27031	T	L	L
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10729	41090	T	L	L
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	8508	8361	0	L	L
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1126162	640562	T	L	L
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5275	25042	T	0	L
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	110902	85522	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17369	18726	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91167	31298	T	L	L
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	31 736	19 745	T	L	L
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8 787	1 406	T	L	0
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	140 878	77 065	T	L	L
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3 836	7 052	T	0	L
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8 141	1 352	T	0	0
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	55 144	39 357	0	L	L
1.A.2.c Chemicals: Liquid Fuels (CO_2)	40 698	22 245	T	L	L
1.A.2.c Chemicals: Solid Fuels (CO_2)	15 336	8 576	0	L	L
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13 067	18 766	T	L	L
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11 338	1 721	T	L	0
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	7 982	2 376	T	0	0
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19 284	31 362	T	L	L
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	19 745	3 344	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12 648	4 546	T	L	0
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27 315	31 449	T	L	L
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	44 730	22 729	T	L	L
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1 422	14 701	T	0	L
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	57 559	17 126	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	94 404	93 707	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	105 940	49 572	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93 817	14 338	T	L	L
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13332	16431	T	L	L
1.A.3.b Road Transportation: Diesel Oil (CO_2)	302993	634867	T	L	L
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1867	7801	T	0	L
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	503	4000	T	0	0
1.A.3.b Road Transportation: Gasoline (CH_4)	6201	854	T	0	0
1.A.3.b Road Transportation: Gasoline (CO_2)	406611	232520	T	L	L
1.A.3.b Road Transportation: Gasoline (N_2O)	4938	832	T	0	0
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7328	15807	T	0	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2018		1990	2018
1.A.3.b Road Transportation: Other Fuels (CO_2)	0	2717	T	0	0
1.A.3.c Railways: Liquid Fuels (CO_2)	12981	5756	T	L	L
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17692	13957	0	L	L
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10372	5908	0	L	L
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	66 422	109 931	T	L	L
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	83 428	36 849	T	L	L
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	758	6 104	T	0	L
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	47 183	4 269	T	L	0
1.A.4.b Residential: Biomass (CH_4)	9 398	10 289	T	L	L
1.A.4.b Residential: Gaseous Fuels (CO_2)	183 819	240 761	T	L	L
1.A.4.b Residential: Liquid Fuels (CO_2)	181 765	94 274	T	L	L
1.A.4.b Residential: Solid Fuels (CH_4)	9 310	2 820	T	L	0
1.A.4.b Residential: Solid Fuels (CO_2)	136 137	36 000	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12 477	11 348	0	L	L
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	71 887	61 239	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9 721	3 926	T	L	0
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5945	9	T	0	0
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14216	4027	T	L	0
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97099	29063	T	L	L
1.B.2.a Oil: Operation (CH_4)	6767	1133	T	0	0
1.B.2.a Oil: Operation (CO_2)	9451	11813	T	L	L
1.B.2.b Natural Gas: Operation (CH_4)	50935	21178	T	L	L
1.B.2.c Venting and Flaring: Operation (CO_2)	8728	6832	0	L	L
2.A.1 Cement Production (CO_2)	102729	77970	T	L	L
2.A.2 Lime Production (CO_2)	25241	19641	0	L	L
2.A.4 Other Process Uses of Carbonates (CO_2)	11824	10200	0	L	L
2.B.1 Ammonia Production (CO_2)	33353	23548	0	L	L
2.B.2 Nitric Acid Production (N_2O)	49606	3410	T	L	0
2.B.3 Adipic Acid Production (N_2O)	57555	392	T	L	0
2.B.8 Petrochemical and Carbon Black Production (CO_2)	14813	15387	T	L	L
2.B.9 Fluorochemical Production (HFCs)	29033	2022	T	L	0
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	53	T	0	0
2.B.10 Other chemical industry (CO_2)	6432	12251	T	0	L
2.C.1 Iron and Steel Production (CO_2)	95404	64484	T	L	L
2.C.3 Aluminium Production (PFCs)	21277	613	T	L	0
2.D.3 Other non energy products (CO_2)	8215	5844	0	L	L
2.F.1 Refrigeration and Air conditioning (HFCs)	85	86322	T	0	L
2.F.2 Foam Blowing Agents (HFCs)	0	3278	T	0	0
2.F.4 Aerosols (HFCs)	2	4322	T	0	0
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	80,109	59,788	0	L	L
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	89,710	78,222	T	L	L
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	28,682	20,308	0	L	L
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6,814	6,609	0	0	L
3.B.1 CH_4 Emissions: Farming (CH_4)	52,433	41,107	0	L	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2018		1990	2018
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	29,574	22,030	0	L	L
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	157,614	132,553	T	L	L
3.D.2 Agricultural Soils: Farming (N_2O)	37,134	29,652	0	L	L
4.A.1 Forest Land remaining Forest Land (CO_2)	-359654	-332111	T	L	L
4.A.2 Land converted to Forest Land (CO_2)	-39301	-41497	T	L	L
4.B.1 Cropland remaining Cropland (CO_2)	26493	15429	T	L	L
4.B.2 Land converted to Cropland (CO_2)	46951	42467	T	L	L
4.C.1 Grassland remaining Grassland (CO_2)	46225	28968	T	L	L
4.C.2 Land converted to Grassland (CO_2)	-20521	-26633	0	L	L
4.D.1 Wetlands: Land Use (CO_2)	7907	9578	T	0	L
4.E.2 Settlements: Land Use (CO_2)	34467	43140	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-31462	-44621	T	L	L
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	157755	85508	T	L	L
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	30443	13129	T	L	L
5.B.1 Waste Composting: Waste (CH_4)	628	3688	T	0	0
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	24503	11624	T	L	L
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8265	6846	0	L	L
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	11319	7969	0	L	L

Note: EU totals for 2018 in sector Energy and IPPU may not include data for Sweden due to confidential reporting.

1.6 General uncertainty evaluation

The EU-KP 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)

$$Trend_{n,x} = E_{n,x}(t) - E_{n,x}(0) \quad (1)$$

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 correlations between years have a much larger effect on trend uncertainty than correlations 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 the 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-KP. The lowest level uncertainty estimates are for fuel combustion activities (0.8 %) and the highest estimates are for Agriculture (45.1 %). Overall level uncertainty estimates including LULUCF of all EU-KP GHG emissions is calculated at 5.5 %. If LULUCF is excluded, the total level uncertainty is lower at 5.0 %.

With regard to trend uncertainty estimates the lowest uncertainty estimates are for fuel combustion activities (+/-0.4 percentage points) and the the highest estimates are for Waste (19.1 percentage points). Overall trend uncertainty (including LULUCF) of all EU-KP GHG and Iceland emissions is estimated to be 1.2 percentage points.

These results of the Tier 1 analysis of the trend and level uncertainties are similar to the results of the previous year. However, substantial decreases in the level uncertainties of LULUCF and Waste are worthy of note. The 2018 level uncertainty for LULUCF was estimated at 22.4 % compared to the 2017 level uncertainty of 34.3 % reported in the previous year. This reduction is due mainly to the smaller level uncertainty in the subcategory 4A Forest land, which has decreased from 20 to 12 %. Forest land is of course the dominant subsector in LULUCF, contributing 139 % of the total EU LULUCF net removals in 2018. This reduced uncertainty appears to be partially due to Germany's revised uncertainty estimate. Germany's Forest land contributes that largest removals to the EU subsector total and in this year's submission Germany revised its combined level uncertainty down from 41 to 11 %. For Waste, the 2018 level uncertainty was estimated at 31.7 % compared to the 2017 level uncertainty of 51.5 % reported in the previous year. This reduction in sector uncertainty has been due in large part to the reduced level uncertainty in N_2O emissions from Wastewater treatment and discharge. This subsector contributes ca. 5 % of total Waste GHG emissions and is associated with very large relative uncertainties. At EU level the 2018 level uncertainty of these emissions was estimated at 451 % compared to the 899 % level uncertainty reported in the previous submission. The reduced level uncertainty reflects to some extent the revised uncertainty estimate of Spain. Spain is the second largest contributor to these subsector emissions and has revised its level uncertainty from 4900 % in the previous year down to 1400 %. More detailed uncertainty estimates for the source categories are provided in Chapters 3-7.

Table 1.15 Tier 1 uncertainty estimates of EU-Member States, Iceland and the United Kingdom GHG emissions (in CO_2 equivalents) for the main sectors

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	4 298 831	3 196 347	-25.6%	0.8%	0.4%
1.B Fugitive emissions	all	206 755	82 208	-60.2%	27.6%	8.4%
2. Industrial processes	all	537 916	358 514	-33.4%	11.7%	4.8%
3. Agriculture	all	555 423	437 562	-21.2%	45.1%	2.4%
5. Waste	all	240 311	137 140	-42.9%	31.7%	19.1%
4. LULUCF	all	-215 309	-255 810	18.8%	22.4%	15.0%
Total (incl LULUCF)	**all**	**5 623 926**	**3 955 960**	**-29.7%**	**5.5%**	**1.2%**
Total (excl LULUCF)	**all**	**5 839 235**	**4 211 771**	**-27.9%**	**5.0%**	**1.0%**

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-KP countries on uncertainty estimates in their national inventory reports 2019 and presents summarised results of these estimates.

Table 1.16 Overview of uncertainty estimates available from EU Member States, Iceland and the United Kingdom

Member State	Austria		Belgium	Bulgaria		Croatia			Cyprus	Czechia		Denmark	
Citation	NIR April 2020, pp.66-70		NIR April 2020, pp.49-51	NIR April 2020, pp.50-51		NIR May 2020, pp.49-50			NIR March 2020, p.52-53	NIR April 2020, pp.44		NIR May 2020, pp.60-66	
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 (Annex 2)		Yes (Annex 2)	Yes (Annex 2)		Yes (Annex 2)			Yes (Annex 2)	Yes (Annex 2)		Yes (pp.60-66)	
Years and sectors included	emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF	emissions: 2018; trends: 1988-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF			emissions: 2018; trends: 1990-2018*; excluding LULUCF	emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018 trends: 1990-2018*; 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 2 (i .L.)	Tier 2 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2												5.20%	2.30%
CH_4												14.3%	
N_2O												36.0%	
F-gases												43.5%	
Total	15.95%	4.80%	3.72%	65.69%	17.33%	57.10%	-13.57% +62.34%	-5.70% +8.04%	9.46%	5.57%	3.76%	5.7%	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 2 (i .L.)	Tier 2 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2												1.60%	1.40%
CH_4												11.70%	
N_2O												9.50%	
F-gases												73.7%	
Total	2.99%	2.28%	2.31%	11.90%	2.63%	8.11%	-19.81% +40.95%	-6.67% +7.04%	2.19%	4.68%	2.36%	1.80%	1.80%

Member State	Estonia		Finland				France		Germany				Greece		Hungary	Ireland	
Citation	NIR April 2020, p.45		NIR April 2020, pp.45-47				NIR March 2020, pp.81-83		NIR April 2020, pp.130-133				NIR March 2020, pp.69-73		NIR March 2020, pp.28	NIR Apr. 2020, pp.24-26	
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 (pp.24-26)	
Years and sectors included	emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF				emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF				emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; excluding LULUCF	emissions: 2018; trends: 1990-2018; 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 (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.)
CO_2													3.0%	2.5%	2.5%	11.59%	1.29%
CH_4													31.8%	31.9%	20.8%	2.00%	2.05%
N_2O													105.5%	105.9%	144.8%	2.72%	2.89%
F-gases													269.8%	269.8%	12.8%	0.40%	0.43%
Total	10.65%	5.22%	±25%	±4%	-18% +24%	-3% +4%	11.6%	10.5%	3.28%	3.55%	-2,58% +2,92%	-2.08% +2,40%	13.1%	12.5%	11.6%	12.08%	3.79%
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 (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.)
CO_2																10.62%	1.68%
CH_4																1.04%	0.92%
N_2O																0.76%	0.78%
F-gases																0.58%	0.63%
Total	4.10%	2.16%	±29%	±5%	-23% +32%	-4% +4%	2.2%	2.0%	3.82%	3.84%	-12,54% +13,11%	-10,88% +11,54%	12.5%	11.4%	2.8%	10.72%	2.30%

Member State	Italy		Latvia		Lithuania		Luxembourg		Malta	Netherlands			Poland	
Citation	NIR April 2020, pp.45-47		NIR May 2020, pp.62-63		NIR April 2020, pp.41-42		NIR April 2020, pp.93-98		NIR April 2020, pp.48	NIR April 2020, pp.52-57			NIR April 2020, p.26	
Method used	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 1)		Yes (Annex 2)		Yes (Annex 2)		Yes (pp.93-98)		Yes (pp. 48)	Yes (Annex 2)			Yes (Annex 8)	
Years and sectors included	emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF	emissions: 2018; trends: 1990-2018*; including LULUCF			emissions: 2018; trends: 1988-2018; 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											2%	3%	4.3%	1.8%
CH_4											9%	9%	22.2%	22.2%
N_2O											38%	26%	48.1%	49.5%
F-gases											35%	27%		
Total	4.5%	2.9%	21%	7%	21.4%	9.9%	4.12%	3.85%	5.00%	3%	3%	3%	5.4%	4.0%
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											2%		2.60%	2.00%
CH_4											5%		25.20%	25.20%
N_2O											6%		42.10%	42.90%
F-gases											9%			
Total	3.6%	2.3%	13%	2%	4.6%	1.9%	3.52%	3.29%	5.62%	2%	2%		4.60%	4.30%

Member State	Portugal		Romania		Slovakia		Slovenia		Spain		Sweden		UK		Iceland	
Citation	NIR March 2020, pp."1-23"		NIR May 2020, pp.108-110		NIR April 2020, p.39		NIR April 2020, pp.31-32		NIR March 2020, pp.79 - 80		NIR March 2020, pp.66-68		NIR March 2020, p.97		NIR April 2020, p.16	
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 H)		Yes (Annex 2)		Yes (Annex 3)		Yes (Annex 2)		Yes (Annex 6)		Yes (Annex 7)		Yes (Annex 2)		Yes (Annex 2)	
Years and sectors included	emissions: 2018; trends: 1990-2018; including LULUCF **		emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1986-2018; including LULUCF		emissions: 2018; trends: 1990-2018 *; including LULUCF		emissions: 2018; trends: 1990-2018; including LULUCF		emissions: 2018; trends: 1990-2018 *; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF	
Uncertainty (%)	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 (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	6.80%		23.7%	17.3%	8.15%	3.21%	6.35%	5.77%	11.8%	8.8%	75.00%	4.70%	2.90%	3.0%	40.1%	7.9%
Uncertainty in trend (%)	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 (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	4.50%		2.9%	2.2%	3.34%	1.26%	5.85%	2.53%	1.7%	1.1%	27.26%	1.80%	1.70%	-43.0%	18.6%	8.2%

*Note: *Base year for F.gases is 1995*

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.

1.7.1 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 “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 12 mandatory categories have “NE” visible in the CRF tables for 2018.

Table 1.17 Overview of the number of NE visible in the EU CRF tables for 2018

Sector	Number of NE visible in the EU CRF for the year 2018 for mandatory categories (MS reporting NE)
Energy	2 (CZE, GBK, POL)
IPPU	9 (CZE, ESP, PRT, ROU, SWE)
Agriculture	0
Waste	1 (CZE, GBK)

1.7.2 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 2020 only two MS made use of this option; for the year 2018 Croatia reported CO_2, CH_4 and N_2O emission from 1D2 as confidential (Multilateral operations), while Sweden reported correct sector totals for all sectors but in the sectors Energy and IPPU on a less aggregated level the country reported 13 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 2020.

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. If Member States report confidential data the notation key “C” will be shown in the comments of the relevant cell in the CRF tables only.

In 2018 no “C”s were shown in the comments of the relevant cells in the CRF tables.

1.7.3 Data gaps and gap-filling

1.7.3.1 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/CME 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[12].

1.7.3.2 Gap filling of emissions in GHG inventory submissions 2019

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

1.7.3.3 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.

1.7.3.4 Gap filling of activity data in GHG inventory submissions 2020

Applying the rules mentioned above activity data of the following categories have been gap-filled in this inventory submission for the year 2018:

- Clinker Production 2A1
- Lime Production 2A2

1.7.4 Geographical coverage of the European Union inventory

Table 1.18 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 of the Party to the UNFCCC or the Kyoto Protocol. For three countries/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 inventory is the sum of the Member States' inventories, the EU inventory covers the same geographical area as the inventories of the 27 Member States, Iceland and the United Kingdom 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 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 1.18).

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

Table 1.18 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
Czechia	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-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-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 are those that derive from the legal territory of the Netherlands. This includes a 12-mile zone out from the coastline and inland water bodies. It excludes Aruba, Curaçao and Sint Maarten, which are constituent countries of the Kingdom of the Netherlands. It also excludes Bonaire, Saba and Sint Eustatius, which since 10 October 2010 have been public bodies (openbare lichamen) with their own legislation that is not applicable to the European part of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included	√	√	√	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 areas.	√	√	√	PRT
Romania	Romania	√	√	√	ROU
Slovakia	Slovakia	√	√	√	SVK

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Slovenia	Slovenia	√	√	√	SVN
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla	√	√	√	ESP
Sweden	Sweden	√	√	√	SWE
European Union	EU-27+GBE		√	√	EUA
Iceland	Iceland	√		√	
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 Union and Iceland	EU-27, Iceland and the relevant UK's Overseas Territories and Crown Dependencies (GBK).	√			EUC

1.7.5 Completeness of the European Union submission

1.7.5.1 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 1.19 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 1.19 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	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

1.7.5.2 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.

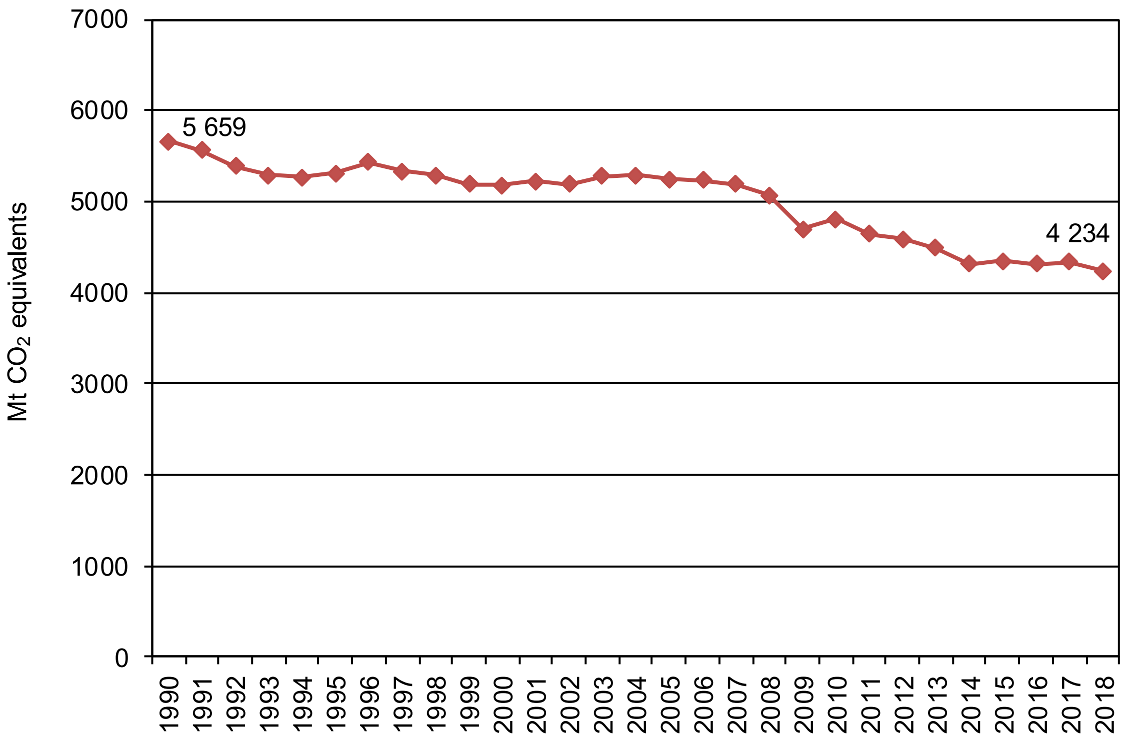
2 EU GREENHOUSE GAS EMISSION TRENDS

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

2.1 Aggregated greenhouse gas emissions

In 2018, total GHG emissions in the EU-KP, without LULUCF, were 25.2 % (-1 425million tonnes CO_2 equivalents) below 1990. Emissions decreased by 2 % (99 million tonnes CO_2 equivalents) between 2017 and 2018 (Figure 2.1).

Figure 2.1 EU-KP GHG emissions 1990–2018 (excl. LULUCF)



Notes: GHG emission data for the EU-KP 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, 1990-2018

Total GHG emissions in the EU:KP (excluding LULUCF and excluding international aviation) decreased by 1425 million tonnes since 1990 (or 25.2 %) reaching their lowest level during this period in 2018 (4234 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 above 60 % alongside a decrease in emissions of 25 % over the period (-23 %, when including international aviation).

The reduction in greenhouse gas emissions over the 28-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fossil fuels and improvements in energy efficiency, as well as to structural changes in the economy and the economic recession. These have resulted in a lower energy intensity of the economy and in a lower carbon intensity of energy production and consumption in 2018 compared to 1990. 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 2018, 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, iron and steel production (including energy-related emissions) 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 2018, the use of solid and liquid fuels in thermal power 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 28 years. 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 reduced acidic and nitric acid production. 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 over 50% of the total net reduction in the EU-KP of the past 28 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 2018.

Table 2.1 Overview of EU source categories whose emissions increased or decreased by more than 20 Million tonnes CO_2 equivalent in the period 1990-2018

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO2 from 1.A.3.b)	172
Refrigeration and Air conditioning (HFCs from 2.F.1)	86
Aluminium Production (PFCs from 2.C.3)	-21
Cement Production (CO2 from 2.A.1)	-25
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-25
Fluorochemical Production (HFCs from 2.B.9)	-27
Fugitive Emissions from Oil and Natural Gas (CH4 from 1.B.2)	-38
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-41
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-44
Nitric Acid Production (N2O from 2.B.2)	-46
Adipic Acid Production (N2O from 2.B.3)	-57
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-61
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-68
Managed Waste Disposal Sites (CH4 from 5.A.1)	-72
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-115
Fuels used Residential Sector (CO2 from 1.A.4.b)	-134
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-248
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-497
Total	**-1425**

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, 2017-2018

Total GHG emissions (excluding LULUCF) decreased in 2018 by 98.7 million tonnes, or 2.3 % compared to 2017, to reach 4234 Mt CO_2 equivalent in 2018. This decrease in emissions came along with an increase in GDP of 2.0 %. Germany and France accounted for more than half of the net reduction in GHG emissions in absolute terms in the EU-KP in 2018.

At EU level, two thirds of the net reduction in GHG emissions in 2018 took place in main activity producers of heat and electricity, including combined heat and power. Emissions from solid fuels decreased by almost 50 million tonnes compared to 2017. Natural gas input to power stations also decreased, with emissions 14 million tonnes below 2017 levels. In addition, the use of renewable energy sources in electricity generation increased again in 2018, thus underpinning the ongoing decarbonisation trend in the sector.

Although less substantial than in the power sector, GHG emissions in 2018 also decreased in residential buildings, refrigeration and air conditioning, petroleum refining and agricultural soils. In particular, it is worth highlighting that HFC emissions from refrigeration and air conditioning have decreased for the fourth consecutive year since 2014. It is also worth mentioning that CO_2 emissions from road transportation remained stable in 2018 compared to 2017, after four consecutive years of increases since 2013. This was due to lower diesel consumption in passenger cars, where emissions decreased for the first time since 2012. The overall 2.3% net decrease in total GHG emissions in 2018 was partly offset by higher emissions from manufacturing industries and construction.

In terms of fuels, there was a significant decrease in the use of fossil fuels for energy combustion, including solid fuels particularly, but also of gaseous (natural gas) and liquid fossil fuels. Based on Eurostat data, there was a decline in nuclear energy in 2018 in parallel with a strong increase in the use of renewable energy sources, both in terms of primary and final energy.

Overall, the energy intensity of the economy and the carbon intensity of energy production and consumption improved again in 2018. These were largely driven by lower transformation losses and better energy efficiency, on the one hand, and by the higher share of renewables in the fuel mix compared to fossil fuels, on the other.

Table 2.2 shows the source categories making the largest contribution to the change in GHG emissions in the EU between 2017 and 2018.

Table 2.2 Overview of EU-KP source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2017–2018

Source category	Million tonnes (CO_2 equivalents)
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	3
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-3
Petroleum Refining (CO2 from 1.A.1.b)	-4
Refrigeration and Air conditioning (HFCs from 2.F.1)	-6
Fuels used Residential Sector (CO2 from 1.A.4.b)	-9
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-65
Total	**-99**

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 countries, illustrating where main changes occurred.

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

	1990 (million tonnes)	2018 (million tonnes)	2017 - 2018 (million tonnes)	Change 2017 - 2018 (%)	Change 1990-2018 (%)
Austria	78.5	79.0	-3.1	-3.7%	0.6%
Belgium	146.4	118.5	0.5	0.4%	-19.1%
Bulgaria	101.8	57.8	-3.9	-6.3%	-43.2%
Croatia	31.9	23.8	-1.2	-5.0%	-25.4%
Cyprus	5.7	8.8	-0.2	-1.8%	55.0%
Czechia	199.1	128.1	-1.6	-1.3%	-35.6%
Denmark	70.8	48.2	-0.1	-0.3%	-31.9%
Estonia	40.3	20.0	-0.9	-4.5%	-50.4%
Finland	71.2	56.4	1.0	1.8%	-20.8%
France	548.3	444.8	-18.7	-4.0%	-18.9%
Germany	1249.5	858.4	-35.9	-4.0%	-31.3%
Greece	103.3	92.2	-3.4	-3.5%	-10.7%
Hungary	94.0	63.2	-0.6	-0.9%	-32.7%
Ireland	55.5	60.9	-0.1	-0.1%	9.9%
Italy	516.1	427.5	-3.8	-0.9%	-17.2%
Latvia	26.3	11.7	0.5	4.4%	-55.5%
Lithuania	48.0	20.3	-0.4	-1.7%	-57.8%
Luxembourg	12.7	10.5	0.3	3.0%	-17.2%
Malta	2.6	2.2	0.0	1.4%	-14.9%
Netherlands	221.7	188.2	-5.1	-2.7%	-15.1%
Poland	475.1	412.9	-1.8	-0.4%	-13.1%
Portugal	58.6	67.4	-3.2	-4.6%	15.0%
Romania	248.0	116.1	-0.8	-0.7%	-53.2%
Slovakia	73.5	43.3	-0.1	-0.3%	-41.0%
Slovenia	18.6	17.5	0.1	0.8%	-6.0%
Spain	289.4	334.3	-6.0	-1.8%	15.5%
Sweden	71.2	51.8	-0.9	-1.8%	-27.3%
United Kingdom	794.2	462.1	-9.4	-2.0%	-41.8%
EU-27+UK	**5652.2**	**4226.0**	**-98.8**	**-2.3%**	**-25.2%**
Iceland	3.7	4.9	0.0	0.4%	30.1%
United Kingdom (KP)	797.0	465.2	-9.3	-2.0%	-41.6%
EU-KP	**5658.7**	**4233.9**	**-98.7**	**-2.3%**	**-25.2%**

2.2 Emission trends by gas

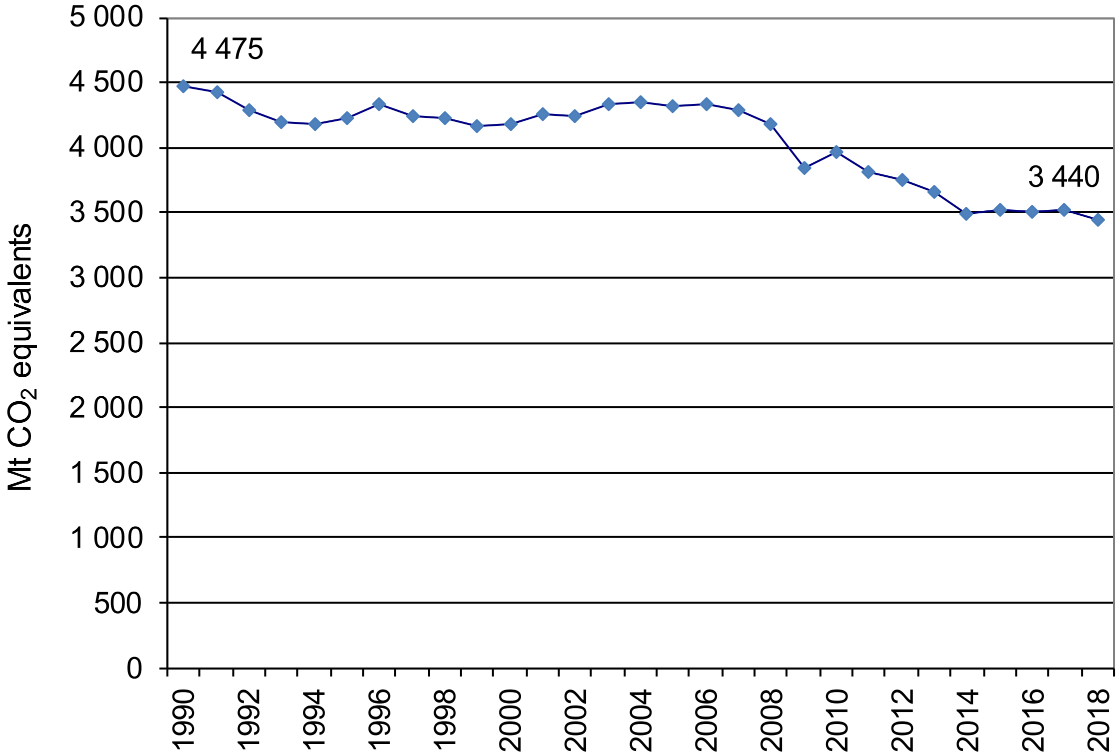
Table 2.4, Figure 2.2 and Figure 2.3 give an overview of the main trends in EU-KP GHG emissions and removals for 1990–2018. In the EU-KP the most important GHG is CO_2, accounting for 81 % of total EU-KP emissions in 2018 excluding LULUCF. In 2018, CO_2 emissions excluding LULUCF were 3 440 Mt, which was 23 % below 1990 levels. Compared to 2017, CO_2 emissions, N_2O emissions and CH_4 emissions decreased each by 2 %.

Table 2.4 Overview of EU-KP GHG emissions and removals from 1990 to 2018 in CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net CO_2 emissions/removals	4 203	3 920	3 854	3 985	3 487	3 610	3 467	3 406	3 315	3 162	3 208	3 195	3 241	3 151
CO_2 emissions (without LULUCF)	4 475	4 221	4 186	4 322	3 840	3 960	3 812	3 754	3 663	3 489	3 526	3 508	3 521	3 440
CH_4	741	679	619	558	512	501	491	488	477	469	469	464	465	456
N_2O	397	360	320	302	265	255	251	249	249	252	253	253	257	252
HFCs	29	44	55	78	98	105	106	109	112	114	111	108	106	99
PFCs	26	17	12	7	4	4	4	4	4	3	4	4	4	4
Unspecified mix of HFCs and PFCs	6	6	2	1	1	1	0	1	1	1	1	1	1	2
SF_6	11	15	11	8	6	6	6	6	6	6	6	6	7	7
NF_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**5 413**	**5 042**	**4 873**	**4 939**	**4 374**	**4 482**	**4 326**	**4 262**	**4 163**	**4 008**	**4 051**	**4 031**	**4 080**	**3 970**
Total (without CO2 from LULUCF)	**5 685**	**5 343**	**5 205**	**5 276**	**4 727**	**4 831**	**4 671**	**4 610**	**4 511**	**4 335**	**4 369**	**4 344**	**4 360**	**4 259**
Total (without LULUCF)	**5 659**	**5 315**	**5 178**	**5 250**	**4 702**	**4 807**	**4 646**	**4 584**	**4 487**	**4 310**	**4 345**	**4 318**	**4 333**	**4 234**

Notes: CO_2 emissions include indirect CO_2

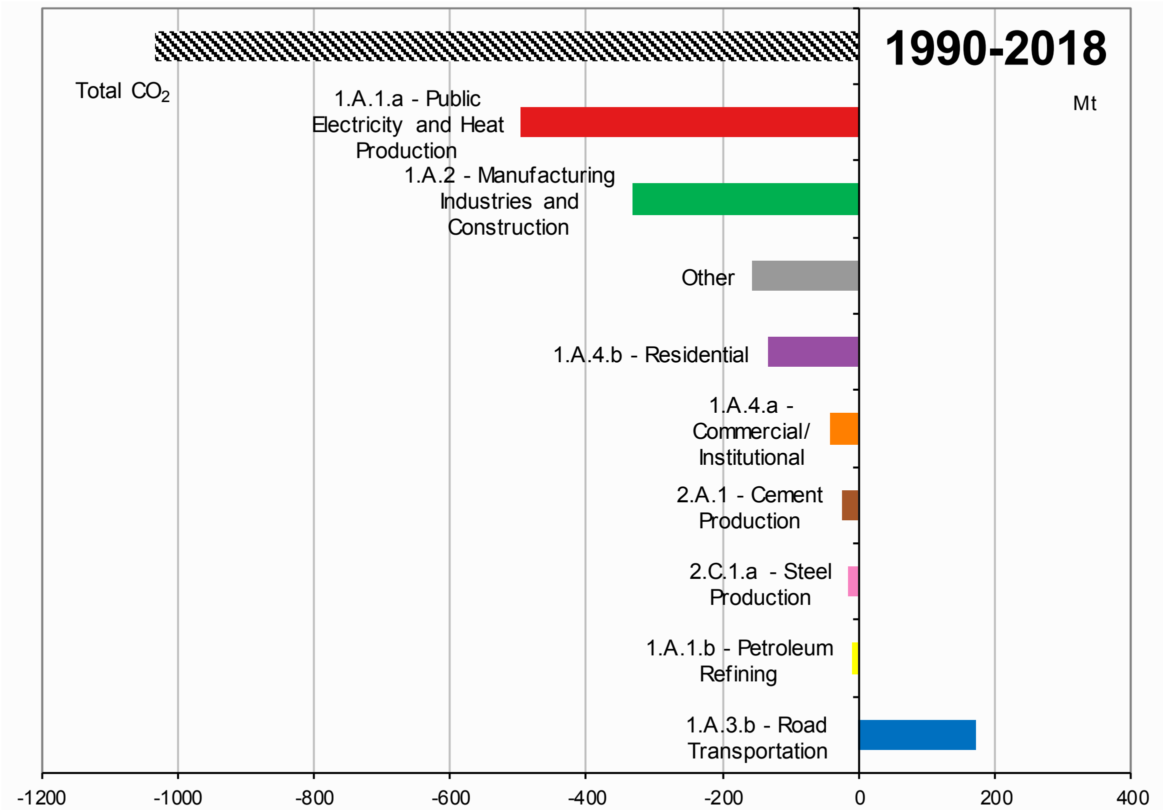
Figure 2.2 CO_2 emissions 1990 to 2018 (Mt)



Notes: CO_2 emissions include indirect CO_2

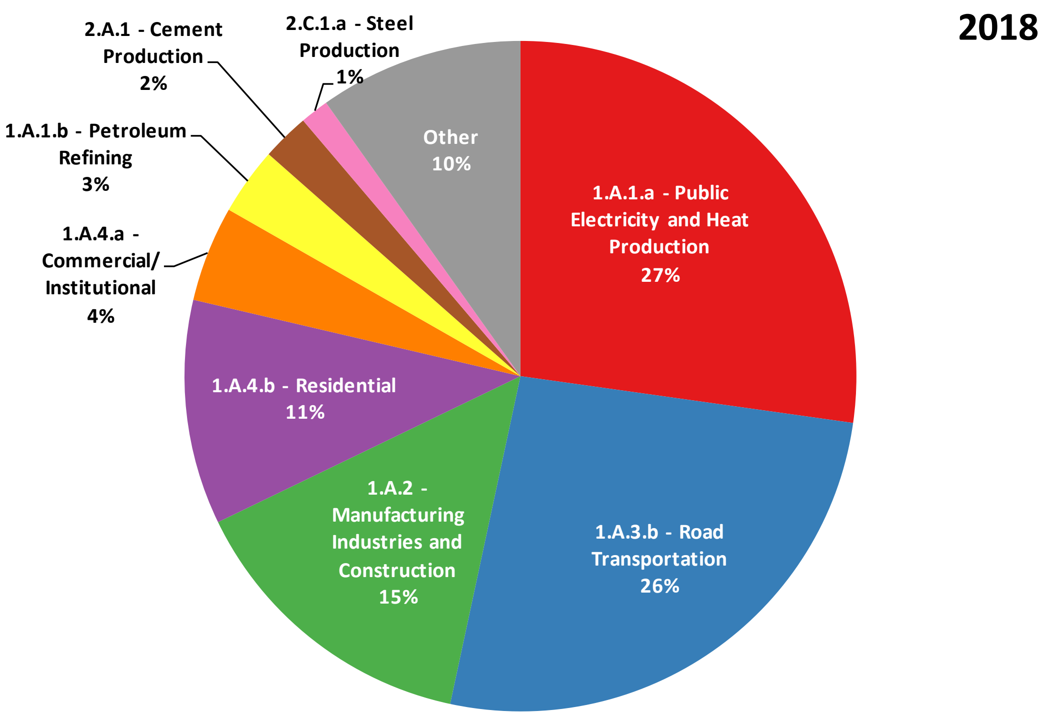
The largest key source categories for CO_2 emissions (Figure 2.3) have been reduced between 1990 and 2018 with the exception of 1.A.3.b Road transportation, which accounts for 26 % of CO_2 emissions in 2018.

Figure 2.3 *Absolute change of CO_2 emissions by large key source categories 1990 to 2018 in CO_2 equivalents (Mt) for EU-KP*



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 2018 for EU-KP*



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

CH_4 emissions account for 11 % of total EU GHG emissions in 2018 and decreased by 38 % since 1990 to 456 Mt CO_2 equivalents in 2018 (Figure 2.5). The two largest key sources are enteric fermentation and anaerobic waste (Figure 2.7). They account for 54 % of CH_4 emissions in 2018.

Figure 2.5 CH_4 emissions 1990 to 2018 in CO_2 equivalents (Mt)

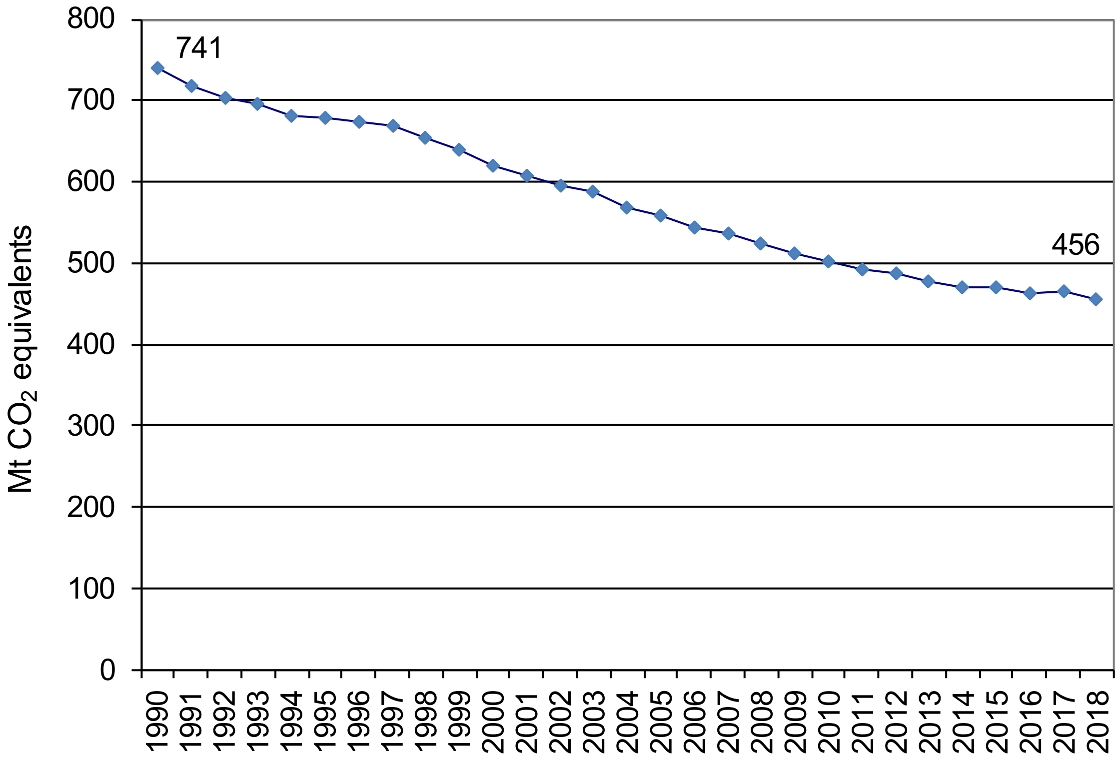
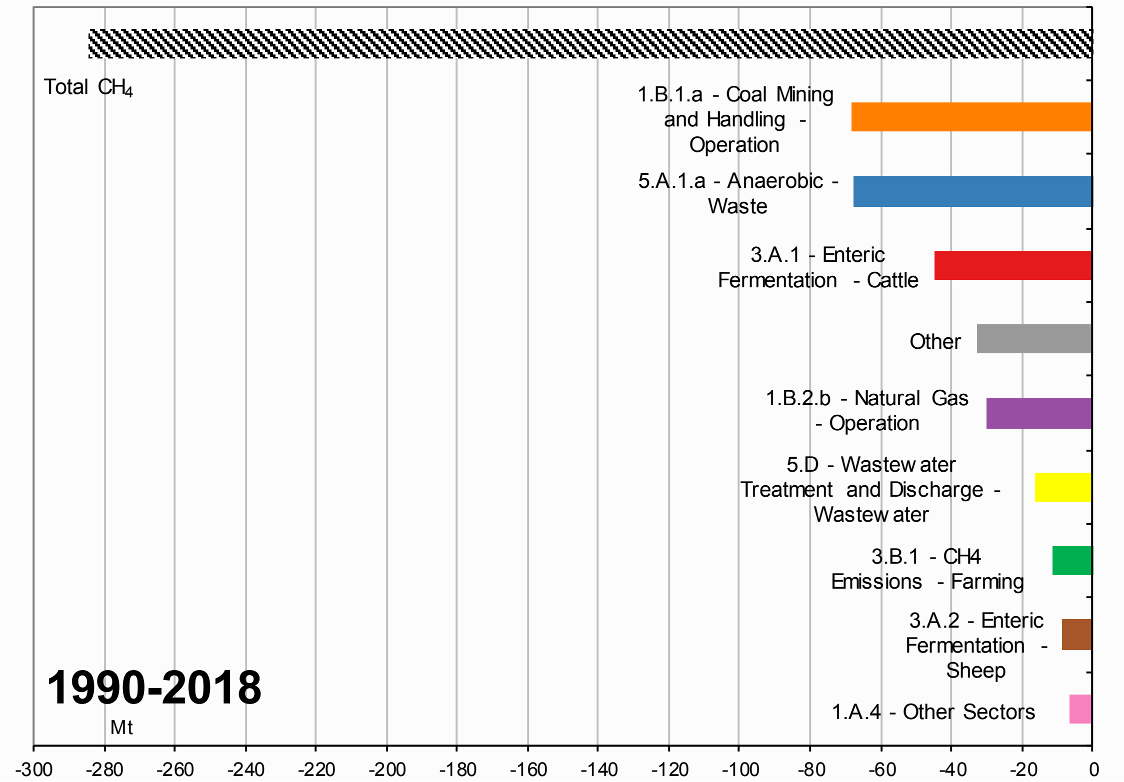


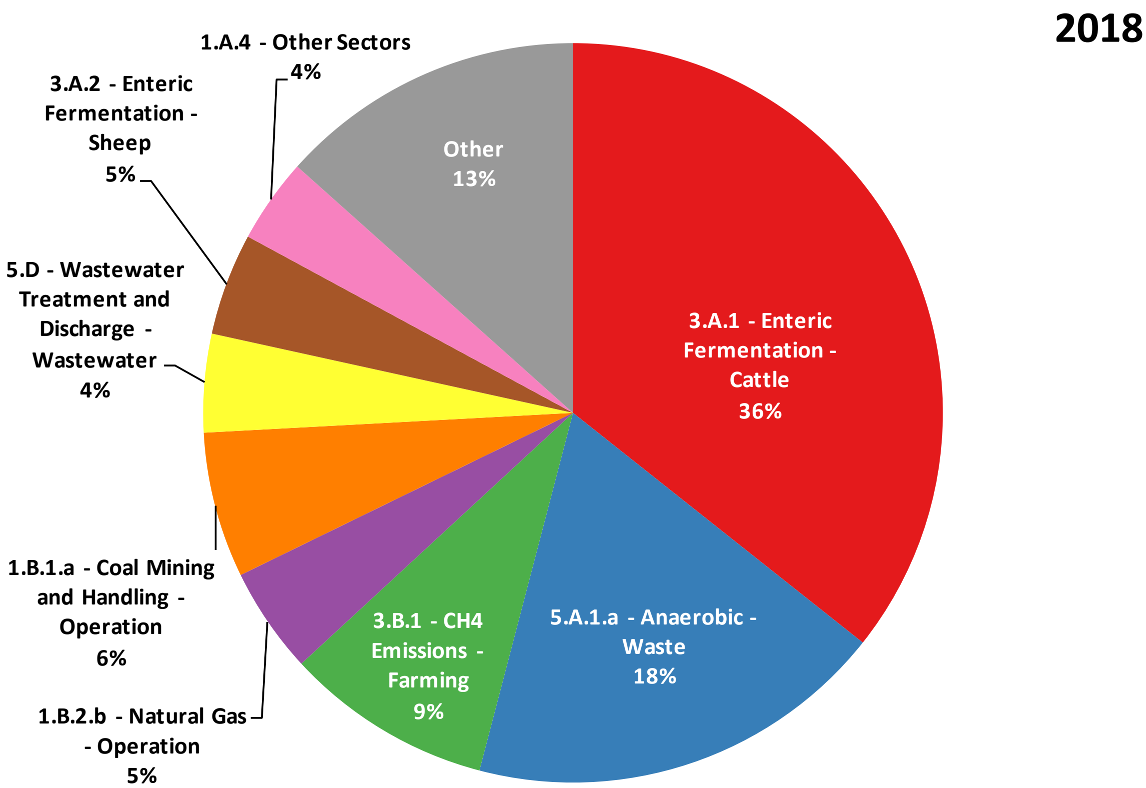
Figure 2.6 shows that the main reasons for declining CH_4 emissions were reductions in anaerobic waste and coal mining.

Figure 2.6 Absolute change of CH_4 emissions by large key source categories 1990 to 2018 in CO_2 equivalents (Mt) for EU-KP



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 2018 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

N_2O emissions are responsible for 6 % of total EU GHG emissions and decreased by 37 % to 252 Mt CO_2 equivalents in 2018 (Figure 2.8). N_2O emissions derive mainly from the agriculture sector. The two largest key sources account for about 65 % of N_2O emissions in 2018 (Figure 2.10). 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 2018 in CO_2 equivalents (Mt)

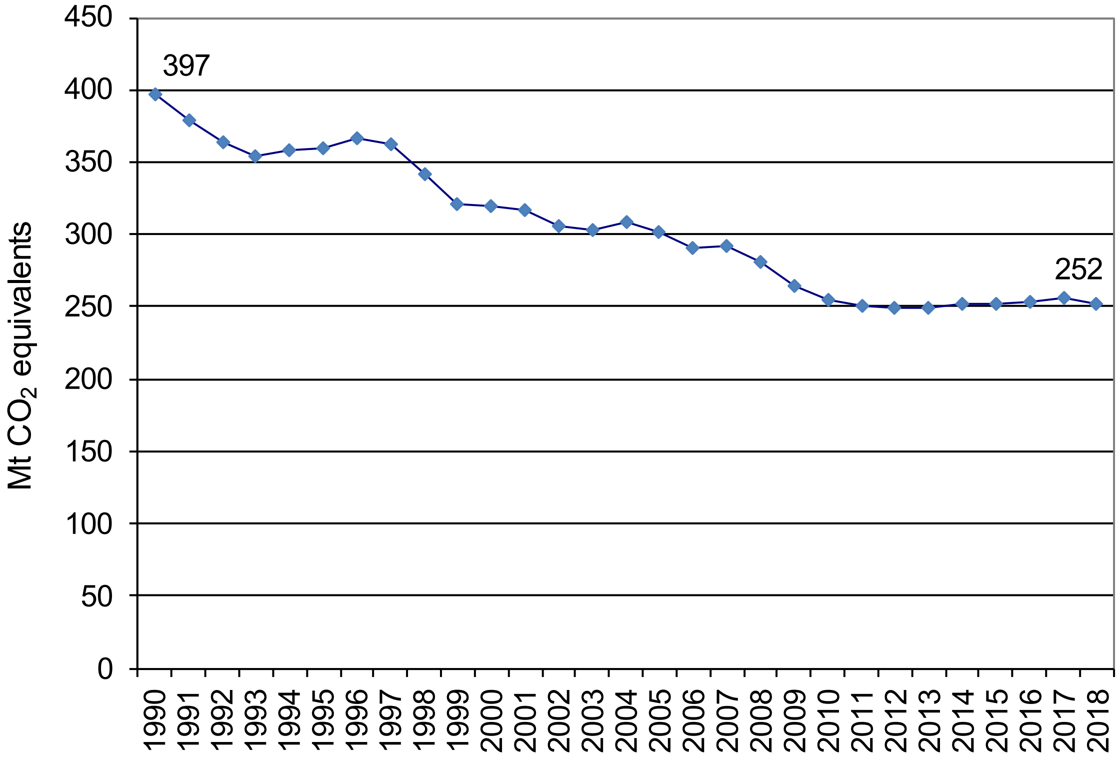
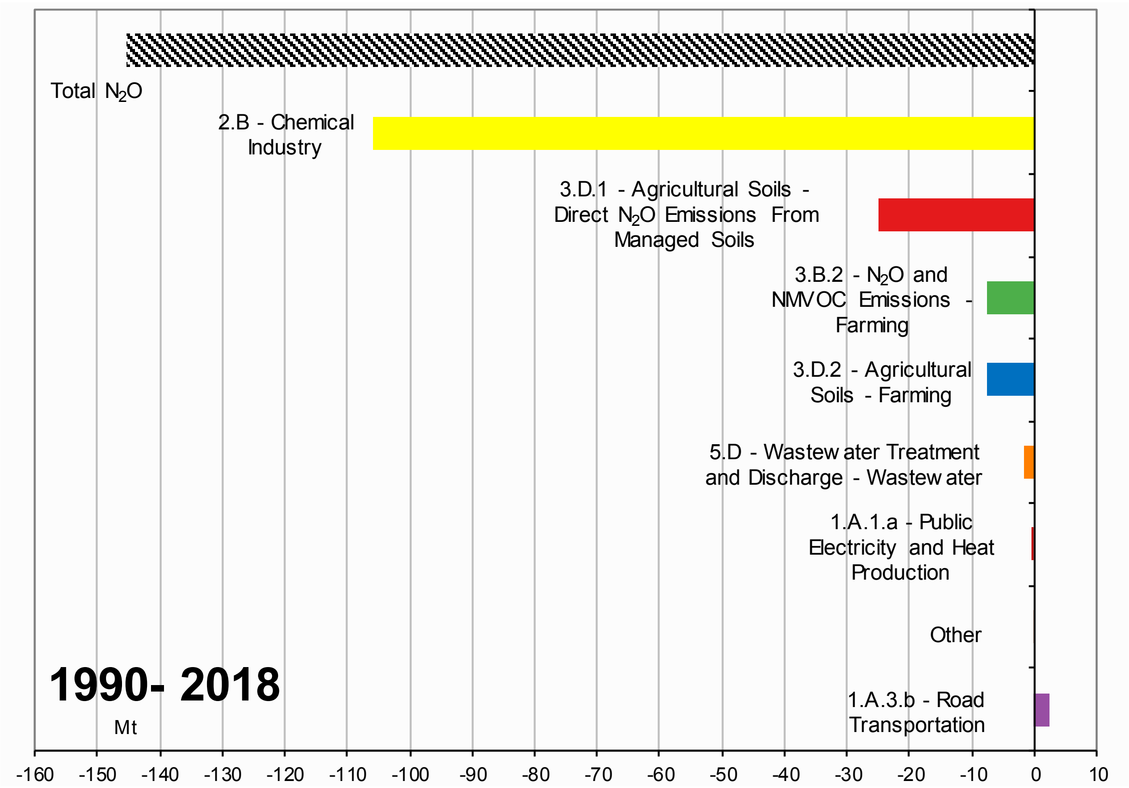
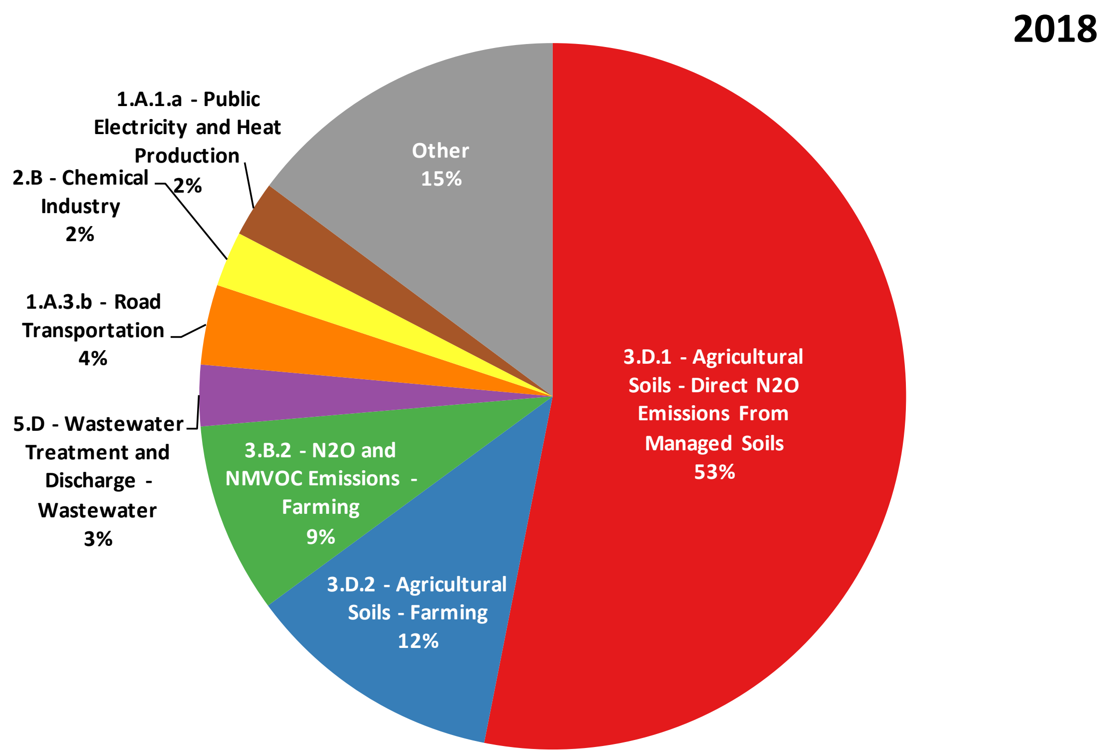


Figure 2.9 Absolute change of N_2O emissions by large key source categories 1990 to 2018 in CO_2 equivalents (Mt) for EU-KP



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 2018 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

Fluorinated gas emissions account for 2.6 % of total EU GHG emissions. In 2018, emissions amounted to 111 Mt CO_2 equivalents, which was 52 % above 1990 levels (Figure 2.11). Refrigeration and air conditioning, the largest key category, accounts for 78 % of fluorinated gas emissions in 2018. Figure 2.12 reveals that HFCs from refrigeration and air conditioning showed large increases between 1990 and 2018. 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 2018 in CO_2 equivalents (Mt)

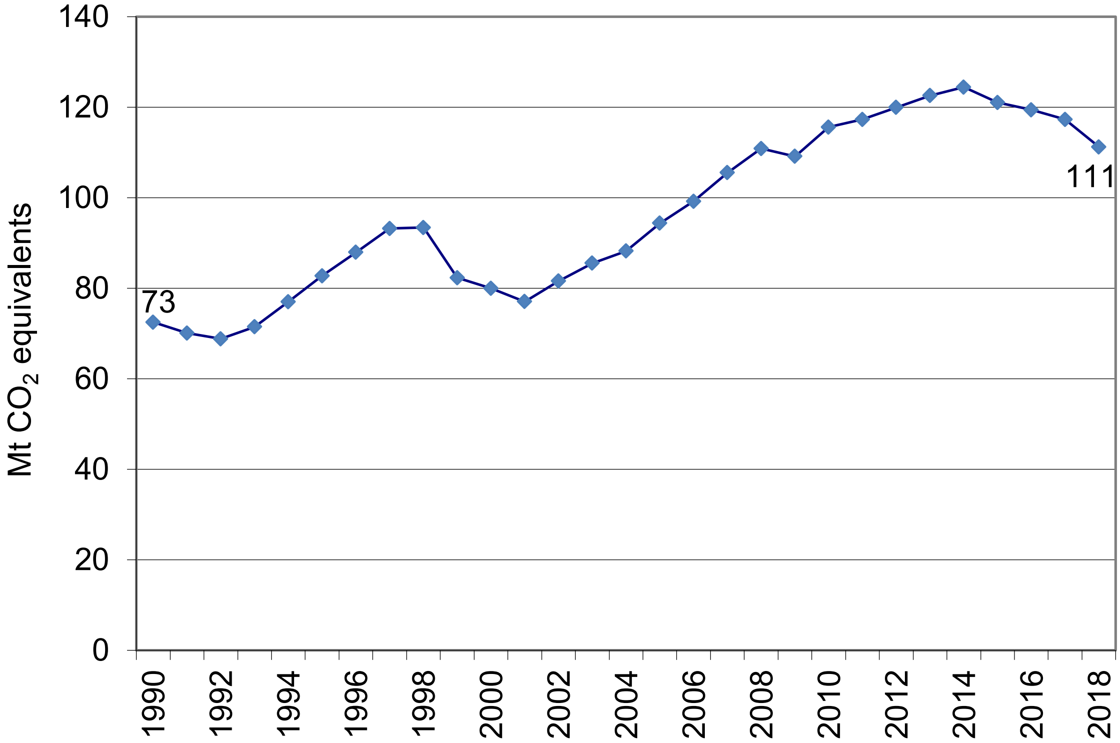
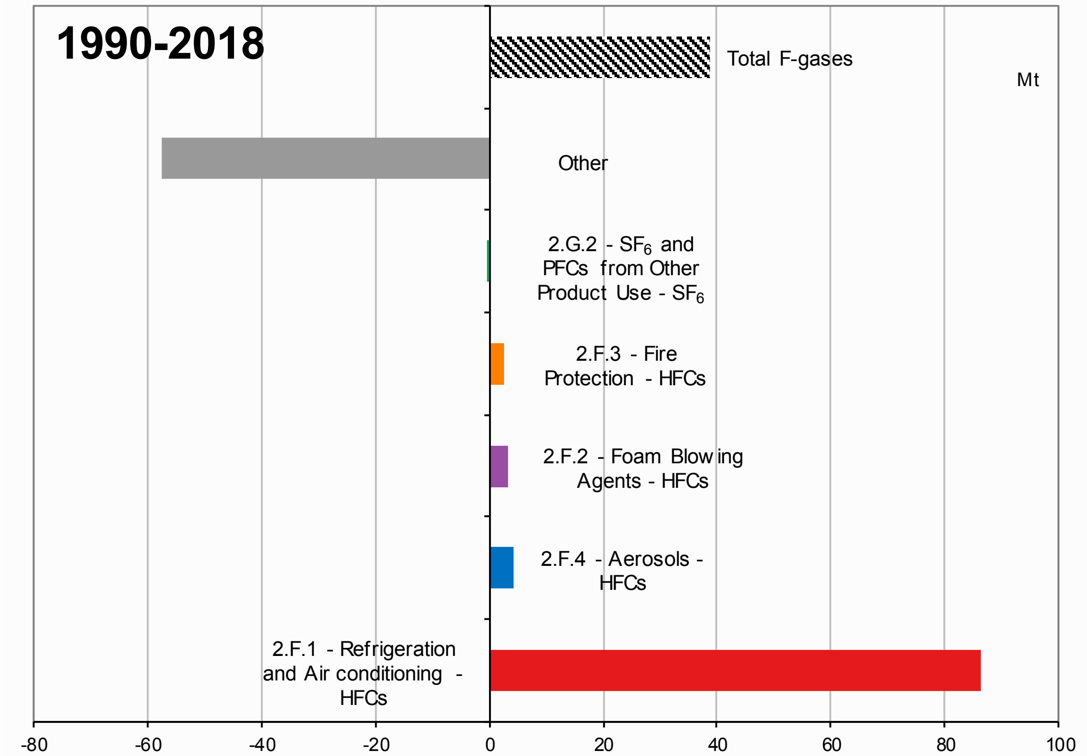
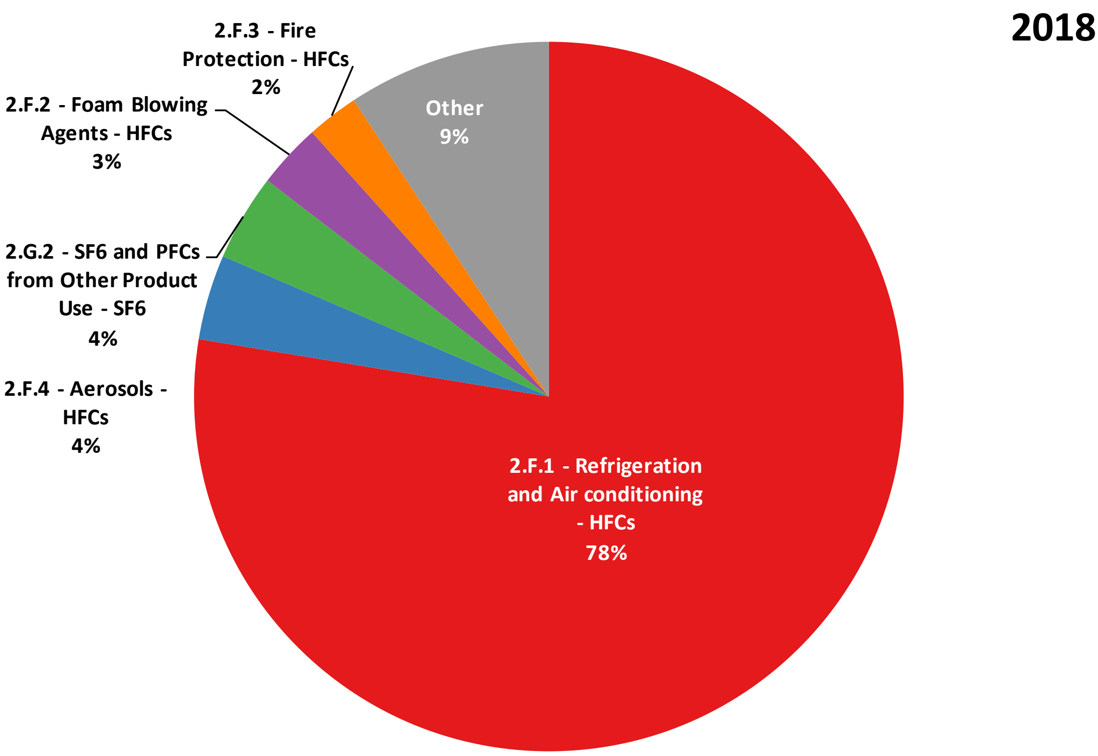


Figure 2.12 Absolute change of fluorinated gas emissions by large key source categories 1990 to 2018 in CO_2 equivalents (Mt) for EU-KP



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 2018 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

2.3 Emission trends by source

Table 2.5 gives an overview of EU-KP emissions in the main source categories for 1990–2018. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 78 % of total emissions in 2018. 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) and chapter 9 on indirect CO_2 emissions.

Table 2.5 Overview of EU-KP GHG emissions (in million tonnes CO_2 equivalent) in the main source and sink categories for the period 1990 to 2018

GHG SOURCE AND SINK	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1. Energy	4 350	4 090	4 023	4 134	3 714	3 812	3 662	3 619	3 526	3 342	3 382	3 361	3 367	3 284
2. Industrial Processes	516	498	455	468	379	396	392	379	377	384	379	376	382	374
3. Agriculture	547	475	464	442	431	427	427	425	429	436	438	438	442	436
4. Land-Use, Land-Use Change and Forestry	-245	-273	-304	-310	-328	-325	-320	-322	-324	-303	-294	-287	-252	-264
5. Waste	241	248	233	204	177	169	163	159	153	147	145	141	140	138
6. Other	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
Total (with net CO_2 emissions/removals)	**5 413**	**5 042**	**4 873**	**4 939**	**4 374**	**4 482**	**4 326**	**4 262**	**4 163**	**4 008**	**4 051**	**4 031**	**4 080**	**3 970**
Total (without LULUCF)	**5 659**	**5 315**	**5 178**	**5 250**	**4 702**	**4 807**	**4 646**	**4 584**	**4 487**	**4 310**	**4 345**	**4 318**	**4 333**	**4 234**

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-KP emissions for 1990–2018. Countries show large variations in GHG emission trends.

Table 2.6 Overview of countries contributions to total EU GHG emissions, excluding LULUCF, including indirect CO_2 emissions, from 1990 to 2018 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	78	79	80	92	80	85	82	80	80	76	79	79	82	79
Belgium	146	154	150	146	127	134	124	121	121	115	119	118	118	118
Bulgaria	102	75	60	64	58	61	66	61	56	59	62	59	62	58
Croatia	32	23	26	30	28	28	28	26	24	24	24	24	25	24
Cyprus	6	7	8	9	10	10	9	9	8	8	8	9	9	9
Czechia	199	158	151	149	138	141	139	135	130	128	129	131	130	128
Denmark	71	79	71	67	63	64	58	54	55	51	49	51	48	48
Estonia	40	20	17	19	17	21	21	20	22	21	18	20	21	20
Finland	71	72	70	70	68	76	68	62	63	59	55	58	55	56
France	548	543	553	555	505	512	483	484	485	454	458	459	464	445
Germany	1249	1121	1043	993	909	942	919	924	942	902	906	909	894	858
Greece	103	109	126	136	125	119	116	112	103	99	95	92	96	92
Hungary	94	75	73	75	64	65	63	60	57	57	61	61	64	63
Ireland	55	59	68	70	62	61	57	58	58	57	59	61	61	61
Italy	516	529	552	587	503	514	501	482	447	426	439	436	431	428
Latvia	26	13	11	11	11	12	11	11	11	11	11	11	11	12
Lithuania	48	22	20	23	20	21	21	21	20	20	20	20	21	20
Luxembourg	13	10	10	13	12	12	12	12	11	11	10	10	10	11
Malta	3	3	3	3	3	3	3	3	3	3	2	2	2	2
Netherlands	222	232	220	215	202	214	200	196	195	188	196	195	193	188
Poland	475	447	396	404	394	413	412	405	401	388	392	400	415	413
Portugal	59	69	82	86	73	69	68	66	64	64	68	66	71	67
Romania	248	187	143	151	128	124	129	126	116	116	116	114	117	116
Slovakia	74	53	49	51	46	46	46	43	43	41	42	42	43	43
Slovenia	19	19	19	20	20	20	20	19	18	17	17	18	17	18
Spain	289	329	389	443	373	359	358	351	325	327	338	327	340	334
Sweden	71	73	68	67	58	64	60	57	56	54	54	53	53	52
United Kingdom	794	748	712	691	596	611	563	580	566	526	508	483	471	462
EU-27+UK	5652	5309	5170	5243	4694	4799	4639	4577	4479	4303	4337	4310	4325	4226
Iceland	4	4	4	4	5	5	5	5	5	5	5	5	5	5
United Kingdom (KP)	797	751	715	695	599	614	566	583	569	529	511	486	474	465
EU-KP	5659	5315	5178	5250	4702	4807	4646	4584	4487	4310	4345	4318	4333	4234

The overall EU GHG emission trend is dominated by the three largest emitters Germany (20 %), the United Kingdom (11 %) and France (11 %), accounting for over forty percent of total EU GHG emissions in 2018. Germany and the United Kingdom, the two countries with the highest absolute reductions, achieved total domestic GHG emission reductions of 723 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.

France's emissions were 19 % below 1990 levels in 2018. France achieved large reductions in N_2O emissions in 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 2018. Italian GHG emissions increased since 1990 primarily from road transport, electricity and heat production and petrol refining.

Italy, Poland and Spain were the fourth, fifth and six largest emitters in the EU-KP with a share in total GHG emissions of 10 %, 10 % and 8 %, respectively.

Italy's GHG emissions were 17 % below 1990 levels in 2018. However, Italian emissions decreased significantly since 2007 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 and again in 2018

Poland's GHG emissions were 13 % below 1990 levels in 2018. 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 increased emissions by 16 % between 1990 and 2018. 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-KP between 1990 and 2018. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-92 %) followed by, CO (-73 %), NMVOC (-64 %). and NO_x (-64 %).

Table 2.7 Overview of EU-KP indirect GHG and SO_2 emissions for 1990–2018(kt)

	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NO_X	17996	15491	13415	12338	9994	9967	9408	9107	8706	8350	8179	7862	7763	6563
CO	65120	52883	40739	32204	26698	27292	24955	25047	24024	21978	22152	21670	21429	17708
NMVOC	17992	14518	11880	9907	8355	8323	7887	7757	7506	7300	7258	7209	7291	6464
SO_2	24180	15628	9616	7365	4571	4334	4187	3919	3487	3236	3142	2680	2668	1936

Table 2.8 shows the NO_x emissions of the EU-KP countries between 1990 and 2018. The largest emitters, Germany, France, the United Kingdom and Spain made up 54 % of total NO_x emissions in 2018. All countries reduced their NO_x emissions between 1990 and 2018.

Table 2.9 shows the CO emissions between 1990 and 2018. The largest emitters, France, Germany, Italy, Romania and the UK that made up 60 % of the total CO emissions in 2018, reduced their emissions from 1990 levels substantially. Also all other countries reduced emissions.

Table 2.10 shows the NMVOC emissions of the EU-KP countries between 1990 and 2018. The largest emitters France, Germany, Italy and the UK that made up 59 % of the total NMVOC emissions in 2018, reduced their emissions from 1990 levels, together with most other countries.

Table 2.11 shows the SO_2 emissions of the EU-KP countries between 1990 and 2018. The largest emitters, Bulgaria, Germany and Spain that made up 44 % of the total SO_2 emissions in 2018, reduced their emissions from 1990 levels substantially, together with all other countries.

Table 2.8 Overview of Member States' contributions to EU-KP NOx emissions for 1990–2018 (kt)

Member State	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	216	197	210	244	200	201	192	187	186	178	175	168	160	149
Belgium	410	380	342	317	240	245	227	214	206	197	196	185	174	174
Bulgaria	257	172	144	157	135	309	149	136	121	128	136	128	131	122
Croatia	101	75	82	81	72	64	61	55	54	51	51	51	50	46
Cyprus	17	20	23	22	20	19	22	22	17	18	16	15	15	15
Czechia	728	370	280	271	235	229	217	205	190	185	179	171	167	161
Denmark	302	289	225	204	154	149	139	128	124	114	113	113	110	105
Estonia	96	50	44	41	38	45	44	41	38	40	39	40	41	42
Finland	298	266	235	200	171	179	164	155	151	143	132	128	124	120
France	2094	1926	1758	1552	1220	1199	1136	1103	1087	998	966	921	902	847
Germany	2887	2214	1912	1641	1455	1473	1455	1438	1438	1393	1364	1333	1284	1198
Greece	315	320	350	401	371	315	293	243	243	236	233	230	250	169
Hungary	244	190	187	178	149	146	136	128	126	124	125	118	120	120
Ireland	173	172	175	170	123	117	105	107	109	108	111	111	109	109
Italy	2127	1991	1512	1296	972	951	906	859	791	771	735	715	675	672
Latvia	96	51	41	44	38	39	37	37	36	35	35	33	33	34
Lithuania	156	74	63	68	62	64	60	63	61	59	60	60	56	56
Luxembourg	41	35	41	54	33	33	33	30	27	25	22	20	18	1
Malta	7	9	10	10	8	9	8	9	8	9	8	6	6	5
Netherlands	587	486	400	348	292	288	273	264	258	245	243	232	221	212
Poland	1090	1053	852	869	856	888	872	836	796	747	725	742	804	NO,IE,
Portugal	251	285	283	269	208	192	176	163	160	157	160	154	157	152
Romania	485	397	384	329	275	253	258	280	238	230	228	213	208	204
Slovakia	135	113	108	104	88	86	78	76	74	75	73	68	67	66
Slovenia	72	72	59	56	50	49	48	46	44	39	35	36	35	34
Spain	1421	1466	1475	1464	1086	1011	1001	946	851	845	858	815	818	773
Sweden	277	252	214	183	153	157	149	143	141	139	135	132	129	127
United Kingdom	3067	2516	1961	1724	1248	1219	1132	1156	1097	1025	988	892	864	817
EU-27+UK	**17950**	**15441**	**13367**	**12296**	**9955**	**9929**	**9371**	**9070**	**8670**	**8313**	**8140**	**7830**	**7728**	**6528**
Iceland	31	34	33	28	28	26	24	24	23	22	23	21	21	22
United Kingdom (KP)	3083	2531	1977	1739	1260	1232	1145	1170	1110	1040	1004	904	878	830
EU-KP	**17996**	**15491**	**13415**	**12338**	**9994**	**9967**	**9408**	**9107**	**8706**	**8350**	**8179**	**7862**	**7763**	**6563**

Table 2.9 Overview of Member States' contributions to EU-KP CO emissions for 1990–2018 (kt)

Member State	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	1248	967	720	623	560	575	558	558	562	527	539	536	528	489
Belgium	1387	1108	926	753	427	497	394	344	519	319	372	360	292	292
Bulgaria	831	559	305	229	184	180	186	167	153	144	149	154	153	135
Croatia	553	443	453	416	338	327	304	289	278	245	267	258	252	234
Cyprus	43	38	30	26	19	18	17	15	14	14	14	14	13	12
Czechia	2054	1562	1072	921	900	924	893	878	880	851	836	835	834	831
Denmark	727	652	475	425	359	351	308	291	277	252	257	247	244	237
Estonia	237	177	165	133	129	129	113	116	111	113	111	117	113	113
Finland	730	646	573	493	430	442	399	396	377	373	357	366	358	351
France	10381	9051	6580	5257	3795	4176	3507	3167	3209	2676	2675	2713	2667	2525
Germany	13716	7435	5241	3959	3312	3642	3568	3314	3270	3110	3175	3036	3065	2934
Greece	1276	1103	1050	897	702	633	618	683	572	577	551	490	487	271
Hungary	1408	960	825	682	518	520	527	542	535	457	442	433	420	360
Ireland	389	324	241	214	155	141	130	123	117	110	107	100	87	77
Italy	6797	7071	4748	3494	3147	3114	2471	2703	2529	2288	2303	2227	2333	2080
Latvia	457	316	237	227	200	162	164	164	145	135	113	111	117	119
Lithuania	455	280	181	174	173	155	170	165	156	148	142	140	137	136
Luxembourg	466	211	43	38	29	28	26	27	26	24	20	21	22	0
Malta	20	20	14	11	9	8	7	6	7	7	6	6	9	5
Netherlands	1225	888	815	734	667	670	646	629	605	590	585	575	563	559
Poland	3641	4659	3356	3089	2939	3077	2781	2787	2658	2387	2343	2456	2543	O,IE,NA
Portugal	796	825	678	517	396	395	364	350	330	313	320	307	322	281
Romania	2349	2332	3645	2502	2379	2169	2103	2910	2095	2052	2157	1998	1713	1617
Slovakia	1041	678	546	557	412	453	421	429	400	337	352	358	367	301
Slovenia	305	283	191	165	134	132	129	124	123	103	108	111	106	99
Spain	4076	3189	2717	2061	1722	1808	1791	1551	1771	1609	1697	1677	1686	1669
Sweden	1090	946	673	531	457	446	427	399	389	378	365	362	357	337
United Kingdom	7326	6079	4161	3004	2085	2003	1824	1803	1803	1716	1673	1542	1526	1520
EU-27+UK	**65024**	**52801**	**40659**	**32130**	**26579**	**27176**	**24846**	**24930**	**23909**	**21853**	**22036**	**21552**	**21313**	**17586**
Iceland	70	62	64	61	111	109	103	110	108	119	112	114	113	119
United Kingdom (KP)	7352	6099	4176	3017	2093	2010	1831	1810	1809	1721	1677	1546	1529	1523
EU-KP	**65120**	**52883**	**40739**	**32204**	**26698**	**27292**	**24955**	**25047**	**24024**	**21978**	**22152**	**21670**	**21429**	**17708**

Table 2.10 Overview of Member States' contributions to EU-KP NMVOC emissions for 1990–2018 (kt)

Member State	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	334	246	179	157	135	135	129	127	121	114	111	110	111	107
Belgium	326	273	212	172	138	138	126	123	120	113	111	110	109	109
Bulgaria	159	126	96	86	76	75	75	76	71	71	79	73	73	73
Croatia	160	112	95	109	92	88	83	78	74	67	69	70	68	69
Cyprus	13	13	20	25	22	22	16	16	14	12	13	14	16	16
Czechia	537	382	304	256	247	245	233	228	225	219	217	213	213	211
Denmark	220	220	191	158	139	136	131	129	127	119	122	118	118	120
Estonia	48	32	29	26	23	23	22	23	23	25	26	27	27	27
Finland	228	199	175	143	111	113	104	101	96	94	89	89	87	84
France	2857	2467	2027	1543	1154	1164	1090	1044	1036	1018	994	975	979	952
Germany	4033	2407	1841	1512	1267	1384	1273	1279	1235	1196	1166	1160	1165	1140
Greece	267	250	251	238	191	181	173	174	166	164	164	153	155	122
Hungary	308	216	201	175	153	149	153	155	154	145	148	145	145	139
Ireland	146	138	118	116	110	106	104	105	108	103	104	105	110	110
Italy	1965	2022	1600	1361	1202	1137	1045	1036	1008	940	917	901	947	913
Latvia	85	63	53	53	46	44	44	44	43	43	41	39	40	40
Lithuania	101	65	55	50	46	47	44	44	41	41	39	39	37	37
Luxembourg	26	20	15	15	12	11	11	12	11	11	10	10	10	8
Malta	2	2	2	2	1	2	2	2	3	3	3	3	4	4
Netherlands	404	266	197	148	137	137	138	136	134	129	128	128	125	116
Poland	706	825	732	721	748	712	694	676	633	631	641	672	686	NO,IE,I
Portugal	243	235	235	195	158	160	150	146	145	150	151	148	150	153
Romania	208	164	228	245	246	244	231	239	227	224	220	219	220	215
Slovakia	308	209	175	158	138	139	134	129	112	93	102	101	96	86
Slovenia	65	63	54	48	40	39	37	35	34	32	32	33	32	32
Spain	1048	987	980	827	646	645	620	597	581	585	604	618	632	638
Sweden	359	273	220	202	179	175	172	164	156	153	154	146	139	134
United Kingdom	2822	2230	1584	1156	889	864	845	831	801	796	795	781	790	803
EU-27+UK	**17977**	**14504**	**11868**	**9896**	**8346**	**8315**	**7879**	**7749**	**7498**	**7292**	**7250**	**7201**	**7283**	**6456**
Iceland	10	10	9	7	6	6	6	6	5	6	6	6	6	6
United Kingdom (KP)	2828	2234	1588	1159	892	866	847	833	804	799	798	783	793	805
EU-KP	**17992**	**14518**	**11880**	**9907**	**8355**	**8323**	**7887**	**7757**	**7506**	**7300**	**7258**	**7209**	**7291**	**6464**

Table 2.11 Overview of Member States' contributions to EU-KP SO2 emissions for 1990–2018 (Gg)

Member State	1990	1995	2000	2005	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	74	47	32	26	15	16	15	15	14	14	14	13	13	12
Belgium	365	258	172	142	74	60	53	47	43	40	41	39	37	37
Bulgaria	446	377	334	373	383	411	493	429	369	393	428	379	410	360
Croatia	168	77	60	58	56	35	29	25	17	14	16	15	12	10
Cyprus	32	40	48	38	18	22	21	16	14	17	13	16	17	18
Czechia	1755	1059	233	208	169	164	168	160	145	134	129	115	110	97
Denmark	178	146	32	26	15	15	14	12	12	10	10	10	10	11
Estonia	222	103	80	64	45	73	64	30	26	31	24	28	32	36
Finland	250	105	81	69	60	67	60	51	48	43	42	40	35	33
France	1303	985	653	484	310	292	254	248	229	185	177	159	157	153
Germany	5443	1751	650	477	395	405	389	372	360	339	336	311	301	289
Greece	511	521	563	585	411	231	168	142	131	114	112	107	106	99
Hungary	829	614	427	43	30	30	34	31	29	26	24	23	28	23
Ireland	183	163	144	73	33	27	25	23	24	17	15	14	13	12
Italy	1784	1323	756	410	237	218	196	178	147	132	124	117	115	110
Latvia	100	49	18	9	7	4	4	4	4	4	4	3	4	4
Lithuania	185	74	38	27	19	18	20	17	15	13	15	15	13	13
Luxembourg	14	8	2	2	1	1	1	1	1	1	1	0	1	0
Malta	10	11	10	12	7	8	8	8	6	5	2	2	1	0
Netherlands	187	126	71	62	37	34	34	34	30	29	30	27	26	25
Poland	2652	2141	1411	1171	811	874	836	803	768	724	711	591	583	NO,IE,I
Portugal	318	322	295	190	72	63	57	52	48	43	46	46	47	45
Romania	798	697	494	603	453	362	340	278	218	191	154	101	85	80
Slovakia	149	130	117	86	63	68	67	57	52	44	67	26	28	20
Slovenia	200	123	93	39	10	10	11	10	9	7	5	4	4	4
Spain	2117	1819	1422	1229	307	261	296	299	233	252	270	228	235	212
Sweden	103	72	45	37	27	29	26	26	24	21	18	19	18	17
United Kingdom	3765	2453	1286	772	433	450	415	460	396	322	250	179	174	159
EU-27+UK	**24142**	**15592**	**9567**	**7317**	**4496**	**4249**	**4100**	**3828**	**3412**	**3168**	**3077**	**2626**	**2615**	**1879**
Iceland	24	22	39	43	72	82	84	87	72	65	61	52	50	54
United Kingdom (KP)	3779	2466	1296	778	436	453	418	463	399	325	254	181	177	162
EU-KP	**24180**	**15628**	**9616**	**7365**	**4571**	**4334**	**4187**	**3919**	**3487**	**3236**	**3142**	**2680**	**2668**	**1936**

3 ENERGY (CRF SECTOR 1)

This chapter starts with an overview on emission trends in CRF Sector 1 Energy. For each EU-KP key category as well as other important subsector specific categories, overview tables are presented including the countries' 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-KP. Total GHG emissions from this sector decreased by 25% from 4350 Mt in 1990 to 3284 Mt in 2018 (Figure 3.1). In 2018, emissions decreased by 2 % compared to 2017.

The most important energy-related gas is CO_2 that makes up 75% of the total EU-KP greenhouse gas emissions in 2018. 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-KP GHG emissions in CO_2 equivalents (Mt) for 1990–2018

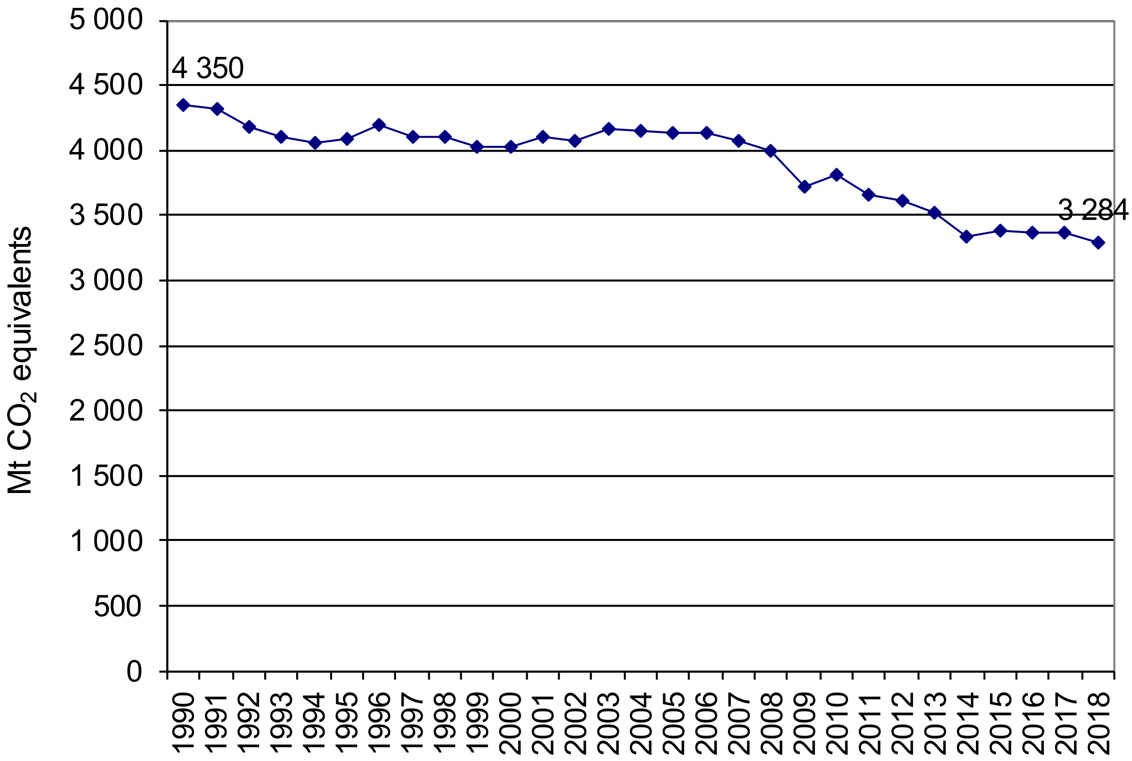
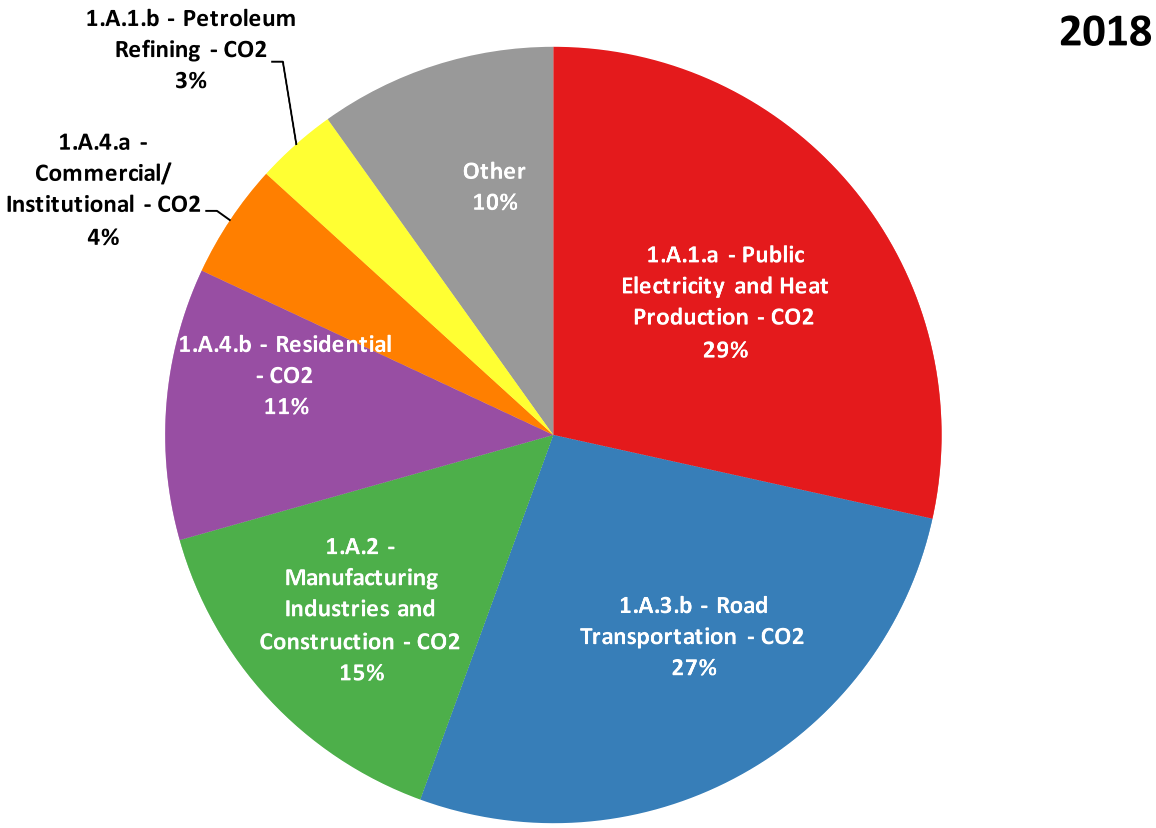


Figure 3.2 shows the share of the largest key categories in the sector Energy in 2018. The first chart illustrates that the three largest key categories account for 71 % and the largest six for 90 % of emissions in the whole sector 1. The two largest categories of the energy sector alone are responsible for 56 % of the total EU-KP emissions in 2018.

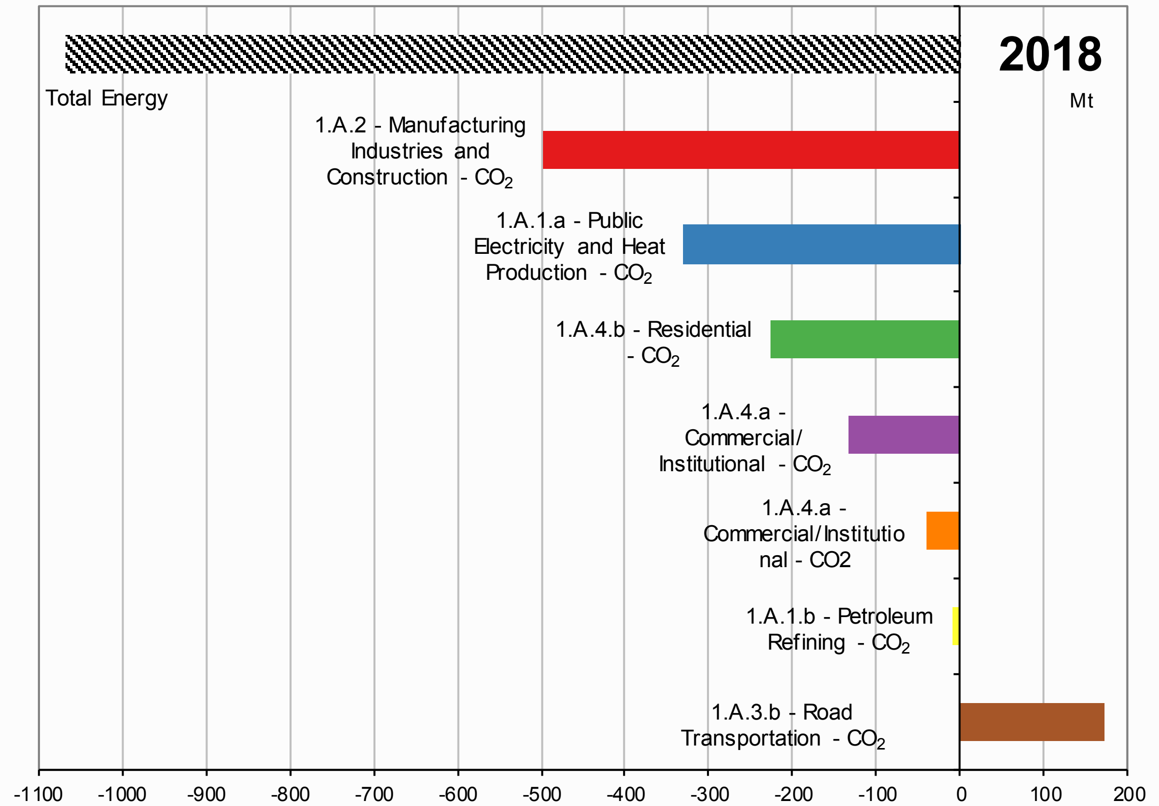
Figure 3.2 CRF Sector 1 Energy: Share of largest key source categories in 2018



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 shows the absolute change of GHG emissions of these large key categories for the years 1990-2018. 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 2018. The decreases in Public Electricity and Heat Production and Manufacturing Industries as well as the increases in Road Transportation occurred in almost all countries. 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 1990-2018



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: 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.2.g Other Manufacturing Industries and Constructions: Other 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.a Oil: Operation (CH_4)
- 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 nine 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 countries. 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 Czechia 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

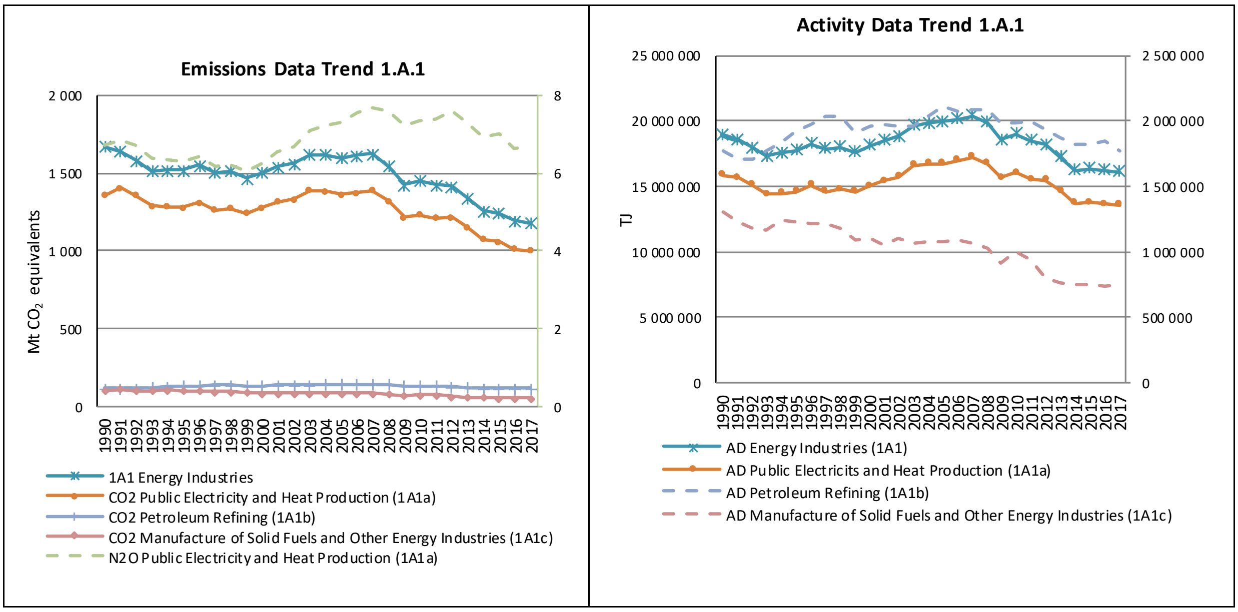
Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107724	217622	T	L	L	97%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	178084	27031	T	L	L	93%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10729	41090	T	L	L	97%
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	8508	8361	0	L	L	97%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1126162	640562	T	L	L	96%
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5275	25042	T	0	L	99%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	110902	85522	T	L	L	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17369	18726	T	L	L	92%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91167	31298	T	L	L	97%

Figure 3.4 shows the trends in emissions in Energy Industries for the EU-KP between 1990 and 2018, 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 33.7%, between 1990 and 2018. This was mainly due to a decrease of CO_2eq emission from Public Electricity and Heat Production (- 494.2 Mt CO_2eq) followed by -61 Mt CO_2eq of the manufacturing of solid fuels and -10 Mt CO_2eq from petroleum refining.

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 country. Between 1990 and 2018, greenhouse gas emissions from energy industries increased in four countries and fell in 25. The highest absolute increase was accounted for by the Netherlands with 6.8 Mt CO_2e respectively 12.7%. The United Kingdom, Germany and Poland, followed by Romania and Italy account for the largest part of reductions (-434 Mt CO_2eq). The change in the EU-KP was a net decrease of about 565 Mt CO_2eq. The table shows the emissions of GHG, N_2O and CH_4 separately expressed in CO_2eq. 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-KP greenhouse gas emissions from energy industries, this sector is clearly dominated by Germany, Poland, Italy and the United Kingdom. The first two combined are responsible for 41%, all four countries represent 58% and the top six countries account for 70% of the EU-KP's greenhouse gas emissions from energy industries.

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

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	14 034	10 098	13 984	9 973	42	100	8	25
Belgium	30 060	20 026	29 860	19 831	180	167	20	28
Bulgaria	36 540	23 540	36 402	23 409	124	112	13	18
Croatia	7 071	3 938	7 049	3 908	17	22	5	8
Cyprus	1 767	3 354	1 761	3 342	4	8	2	3
Czechia	56 855	51 072	56 594	50 800	245	238	17	33
Denmark	26 252	11 461	26 150	11 264	86	86	16	112
Estonia	29 130	13 798	29 105	13 736	18	42	8	20
Finland	18 969	18 679	18 843	18 366	116	282	10	32
France	66 219	41 464	65 835	41 147	318	276	66	41
Germany	427 353	295 192	423 906	290 119	3 167	2 394	280	2 679
Greece	43 253	38 266	43 094	38 149	145	104	14	14
Hungary	20 917	13 088	20 840	13 004	67	59	9	25
Ireland	11 223	10 550	11 145	10 398	71	142	7	10
Italy	137 502	95 805	136 798	95 282	477	400	227	123
Latvia	6 244	1 933	6 228	1 894	11	24	5	15
Lithuania	13 553	2 448	13 522	2 387	21	38	10	23
Luxembourg	36	224	33	216	1	5	1	3
Malta	1 766	698	1 759	697	6	0	1	0
Netherlands	53 365	60 137	53 148	59 767	148	265	69	104
Poland	235 395	163 364	234 294	162 542	1 018	726	82	96
Portugal	16 411	17 869	16 357	17 705	49	150	6	15
Romania	70 944	24 277	70 723	24 174	183	92	38	12
Slovakia	18 966	7 431	18 893	7 379	65	37	8	15
Slovenia	6 375	4 800	6 348	4 774	25	23	2	3
Spain	78 918	72 236	78 578	71 486	289	511	51	240
Sweden	9 928	9 423	9 792	9 126	120	249	17	48
United Kingdom	236 333	94 973	234 729	93 844	1 399	748	204	381
EU-27+UK	**1 675 378**	**1 110 143**	**1 665 769**	**1 098 719**	**8 413**	**7 298**	**1 196**	**4 126**
Iceland	14	2	14	2	0	0	0	0
United Kingdom (KP)	237 024	95 715	235 418	94 583	1 401	750	205	382
EU-KP	**1 676 084**	**1 110 888**	**1 666 471**	**1 099 461**	**8 415**	**7 300**	**1 197**	**4 128**

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-KP greenhouse gas inventory. Differences in the intensity of greenhouse gas emissions of heat and electricity production between the countries are to a large extent explained by the mix of fuels or technologies, which are used. Some countries rely more on coal than on gas. At the EU-KP level, 43% 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 about 30% in 2018 and biomass which has been constantly increasing with a share of 12% in 2018. These shares are constant since 2017.

As can be seen in Figure 3.5 Germany, Poland, Italy and the United Kingdom contribute 58.5% of the total CO_2 emissions in sector 1.A.1 Energy industries in the year 2018. The relatively low share of greenhouse gas emissions from energy industries in France can be partly explained by the use of nuclear and hydro energy for power generation.

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

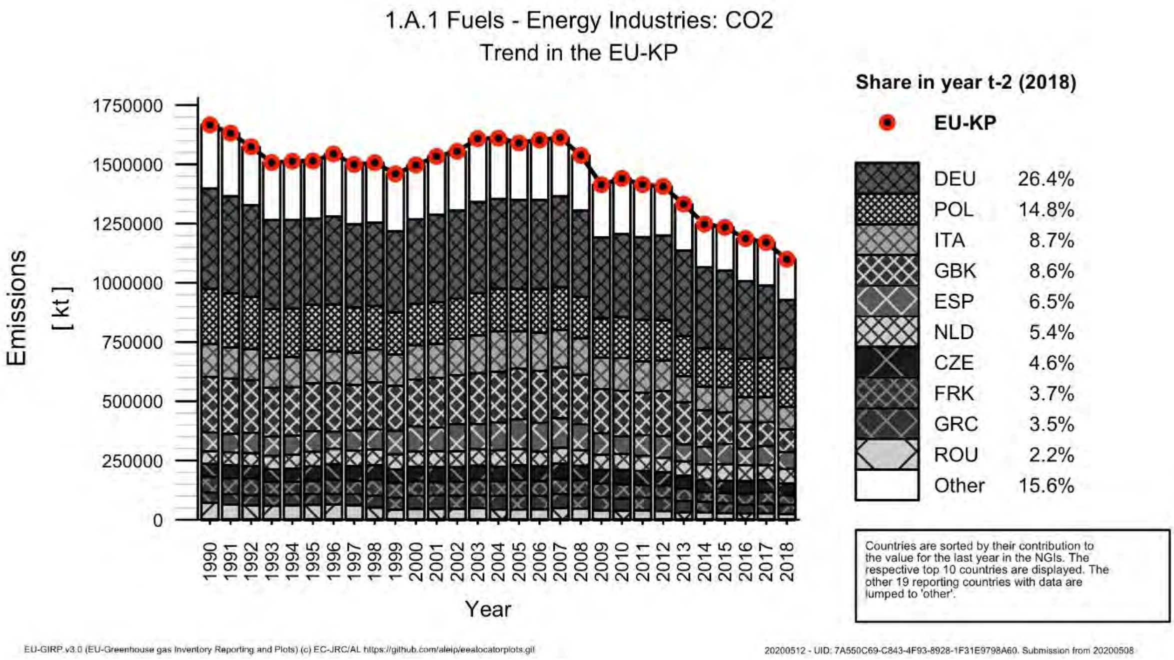


Table 3.3 provides information on the countries' contribution to EU-KP recalculations in CO_2 from 1.A.1 Energy Industries for 1990 and 2017 as well as the main explanations for the largest recalculations in absolute terms.

Table 3.3 1.A.1 Energy Industries: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2017		Main explanations for Major Changes
	kt CO_2	%	kt CO_2	%	
Austria	-66	-0.5	-227	-2.1	Revised energy balance. Revised EF for MSW and Industrial Waste.
Belgium	0.5	0.002	-118	-0.6	Update of the Flemish energy balance; Update of methodology for the incinerator for the Brussels region.
Bulgaria	-	-	-	-	-
Croatia	-	-	-	-	-
Cyprus	-	-	-	-	-
Czechia	-	-	7	0.01	Updated activity data for natural gas.
Denmark	0.4	0.002	-11	-0.1	See NIR
Estonia	-151	-0.5	-1	-0.01	Emissions in the categories 1A1a and 1A1c were recalculated due to improvements in the calculation method of oil shale carbon balance.
Finland	-	-	-27	-0.2	Erroneous fuel code (fossil vs. biogenic fuel) corrected.
France	-154	-0.2	47	0.1	Recalculation of coke production impacting

	1990		2017		Main explanations for Major Changes
	kt CO_2	%	kt CO_2	%	
					consumptions anf thus, CO_2 emissions
Germany	-	-	-1 549	-0.5	Update waste incineration through final waste statistics, revision of waste model, from 2008 Correction of fuel inputs for lignite drying, from 2006 (1.A.1.c) Correction of biomass due to first-time direct use of AGEE stat data, from 2003 (1.A stationary) Revision EF (CO_2) for natural gas, from 2016 (1.A)
Greece	-	-	-	-	-
Hungary	56	0.3	-107	-0.8	Emissions from flared coke oven gas and blast furnace gas were reallocated to the categories 1.B.1.b and 2.C, respectively.
Ireland	-	-	173	1.5	Revised WtE emissions.
Italy	351	0.3	-10	-0.01	Update of complete time series of liquid fuel consumption according to data officially submitted to EUROSTAT
Latvia	-	-	-	-	-
Lithuania	-	-	0.004	0.0002	Energy balance update.
Luxembourg	-	-	-1	-0.3	Energy balance update.
Malta	397	29.2	-6	-0.8	NCV update for 1990-2004; Use of ETS data; energy balance update.
Netherlands	-	-	-0.25	-0.0004	Energy balance update.
Poland	-773	-0.3	535	0.3	Update of the activity data according to Eurostat database and introduction of CO_2 CS EFs for fuel oil.
Portugal	63	0.4	3	0.02	1990-2003: new methodology applied for coke prduction. 2017: update of the EB data
Romania	-	-	3 031	12.7	The CO_2 emission factors for 2017 for lignite fuel and coke_oven_coke fuel have been updated because the Country Specific Emission Factor values for 2017 year have been updated. It was identified an error for net calorific value for natural gas fuel for 1997 year and for patent fuel for 1990-1995 period for specific calorific values. From the coke_oven_coke consumption we subtracted the quantity of the graphite electrodes and are reported in the Industrial Processes and Product Use sector (IPPU), in the 2C1 Iron and Steel category, in according to the 2006 IPCC methodology. In this case the CO_2 emissions are updated for 1990-2017 period.
Slovakia	10	0.1	128	1.7	Based on improvement plant a detail analysis of the municipal waste incineration was performed. The activity data were compared against several independent sources and the composition of waste was improved based on data from IPCC waste model.
Slovenia	-	-	-	-	-
Spain	6	0.01	15	0.0	Correction of a mistake for one public electricity plant in the CO_2 emission factor and fuel characteristics for natural gas between 2014 and 2017. Update of natural gas consumption by the data provider for the year 2017 in stationary engines in natural gas regasification plants. Correction of duplicated consumptions for hydrogen production plants reported by refineries. New estimations for district heating plants according to new information available. Reallocation of the corresponding consumptions and emissions from 1A4bi to 1A1aiii categories.
Sweden	-	-	64	0.7	The CO_2 EF for the iron and steel industry was corrected. One facility's EF for CO_2 from household waste combustion was corrected. In addition, a revision of the average EF for plants not including the fraction of biomass in the EU-ETS was corrected since 2015

	1990		2017		Main explanations for Major Changes
	kt CO_2	%	kt CO_2	%	
United Kingdom	-35	-0.02	-205	-0.2	Revision to remove double count for reported emissions from a specific oil and gas extraction installation. Revisions to fuel use statistics (DUKES)
EU27+UK	-294	-0.02	1 742	0.1	-
Iceland	0.0	0.0	0.55	30.9	For previous submissions AD had been calculated based on electricity producion and an efficiency factor. For this submission sales statistics for fuel sold for electricity production and heating was used.
United Kingdom (KP)					NA
EU-KP	-294	-0.0	1 771	0.2	-

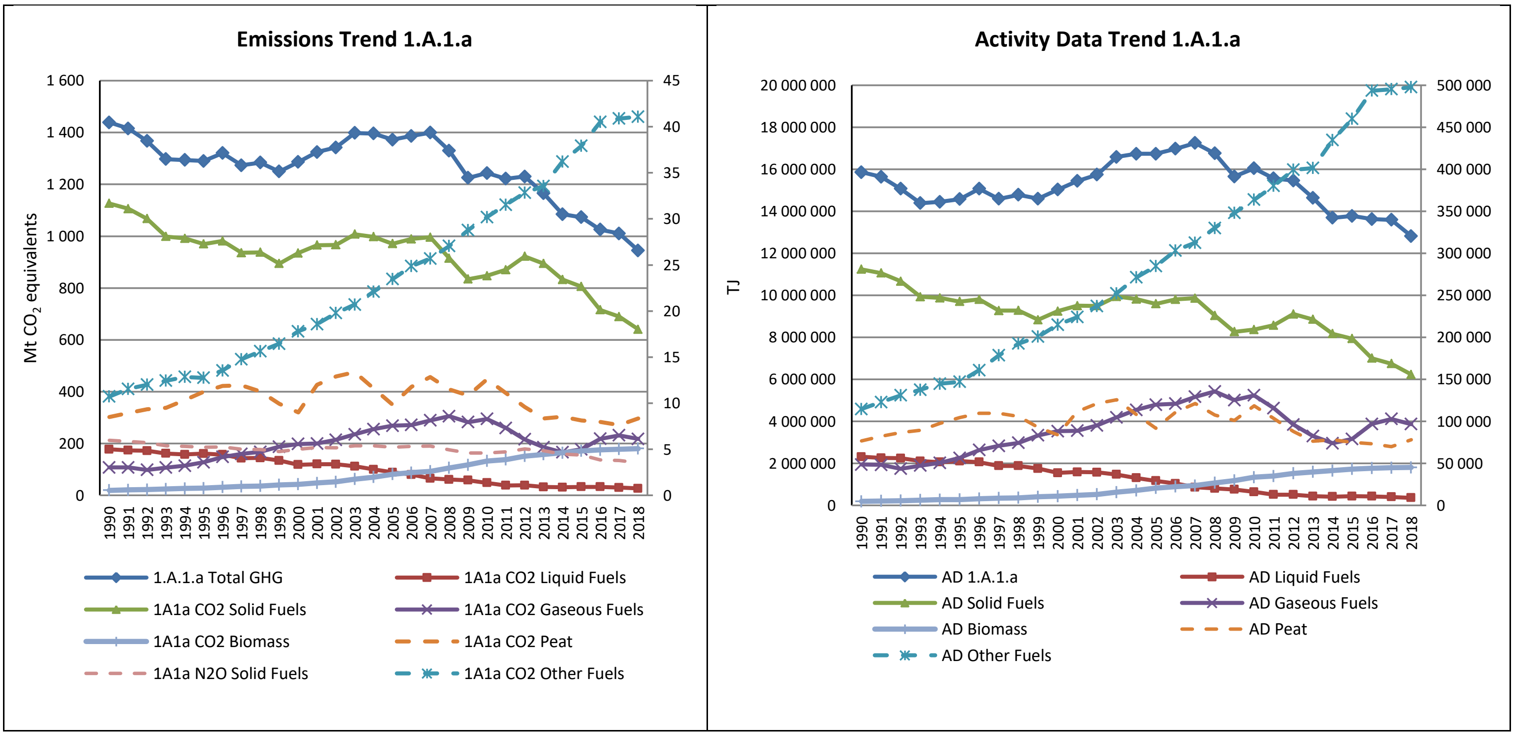
3.2.1.1 **Public Electricity and Heat Production (1.A.1.a) (EU-KP)**

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-KP accounting for 24% of total greenhouse gas emissions in 2018 and for 85% of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2018, CO_2 emissions from electricity and heat production decreased by 34% in the EU-KP.

Figure 3.6 shows the trends in emissions originating from the production of public electricity and heat by fuel in the EU-KP between 1990 and 2018 as well as the underlying activity data[13].

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 19.2% in the EU-KP between 1990 and 2018. Solid fuels still represent 48.6% of the fuel used in public conventional thermal power plants, although its combustion has been declining by 44.6% between 1990 and 2018. Gaseous fuels have increased very rapidly, by a factor of almost 3 between 1990 and 2010, declined until 2014 and now see a new increased use in the last years. In 2018 its share amounts to 30.1% of all the fuels used for the production of heat and electricity in the EU-KP. Liquid fuels still account for some 2.8%, 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: its share in the fuel mix is now at 14.0%.

Table 3.4 shows emissions arising from the production of public heat and electricity by country. Carbon dioxide emissions amount to 98.9% of greenhouse gas emissions from public electricity and heat production. These emissions increased in four Countries and fell in 25 compared to 1990. Of the four countries where emissions were higher in 2018 than in 1990, almost 72% of the increase was accounted for by the Netherlands alone. Of the countries, where emissions fell, 68.3% of the total

[13] 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.

reduction was accounted for by the United Kingdom (28.1%), Germany (15.5%), Poland (15.8%) and Romania (9.5%). The change in the EU-KP between 1990 and 2018 was a net decrease of 496 Mt CO_2 respectively of 34.6%.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	11 079	7 841	6 909	0.7%	-4 170	-38%	-932	-12%	T1,T2	CS,D
Belgium	23 537	15 018	15 177	1.6%	-8 360	-36%	159	1%	T1,T3	D,PS
Bulgaria	35 179	26 678	22 564	2.4%	-12 614	-36%	-4 113	-15%	T1,T2	CS,D
Croatia	3 729	2 896	2 385	0.3%	-1 344	-36%	-510	-18%	T1,T2	CS,D
Cyprus	1 676	3 288	3 342	0.4%	1 667	99%	55	2%	CS	CS
Czechia	54 585	45 066	44 524	4.8%	-10 061	-18%	-542	-1%	T1,T2	CS,D
Denmark	24 697	9 080	9 113	1.0%	-15 585	-63%	33	0%	T1,T2,T3	CS,D,PS
Estonia	29 027	13 176	12 172	1.3%	-16 854	-58%	-1 004	-8%	T1,T2,T3	CS,D,PS
Finland	16 453	15 277	16 428	1.8%	-26	0%	1 150	8%	T3	CS,D,PS
France	49 161	39 365	31 929	3.4%	-17 232	-35%	-7 436	-19%	T2,T3	CS,PS
Germany	338 451	276 488	261 533	28.0%	-76 918	-23%	-14 955	-5%	CS	CS
Greece	40 617	34 876	33 174	3.5%	-7 443	-18%	-1 702	-5%	T1,T2	D,PS
Hungary	17 892	11 948	11 051	1.2%	-6 841	-38%	-897	-8%	T1,T2,T3	CS,D,PS
Ireland	10 876	11 231	9 958	1.1%	-919	-8%	-1 273	-11%	T1,T3	CS,D,PS
Italy	108 527	77 810	69 950	7.5%	-38 578	-36%	-7 861	-10%	T3	CS
Latvia	6 083	1 465	1 842	0.2%	-4 240	-70%	377	26%	T1,T2	CS,D
Lithuania	12 003	1 077	1 020	0.1%	-10 983	-92%	-57	-5%	T1,T2,T3	CS,D,PS
Luxembourg	33	236	216	0.0%	182	547%	-21	-9%	T2	CS
Malta	1 759	718	697	0.1%	-1 061	-60%	-20	-3%	T2	CS
Netherlands	40 027	51 387	47 658	5.1%	7 631	19%	-3 729	-7%	CS,T2	CS,D
Poland	227 279	156 836	155 050	16.6%	-72 229	-32%	-1 786	-1%	T1,T2	CS,D
Portugal	14 355	18 141	15 496	1.7%	1 141	8%	-2 645	-15%	T1,T3	D,PS
Romania	66 280	22 452	20 248	2.2%	-46 032	-69%	-2 204	-10%	T1,T2	CS,D
Slovakia	14 700	4 877	4 712	0.5%	-9 988	-68%	-164	-3%	T2	CS
Slovenia	6 096	4 889	4 774	0.5%	-1 322	-22%	-115	-2%	T1,T2	CS,D,PS
Spain	65 575	68 019	58 987	6.3%	-6 589	-10%	-9 032	-13%	T1,T2	,D,OTH,PS
Sweden	7 714	6 597	6 708	0.7%	-1 005	-13%	111	2%	T2	CS
United Kingdom	203 116	72 595	66 308	7.1%	-136 808	-67%	-6 287	-9%	T1,T2	CS,D
EU-27+UK	**1 430 505**	**999 324**	**933 925**	**100%**	**-496 581**	**-35%**	**-65 400**	**-7%**	**-**	**-**
Iceland	14	2	2	0.0%	-11	-83%	0	2%	T1	D
United Kingdom (KP)	203 804	73 254	67 047	7.2%	-136 757	-67%	-6 207	-8%	T1,T2	CS,D
EU-KP	**1 431 208**	**999 986**	**934 666**	**100%**	**-496 541**	**-35%**	**-65 320**	**-7%**	**-**	**-**

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

N_2O emissions currently represent 0.7% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2018, emissions decreased by 7% (Table 3.5). The largest decline in emissions from this source category was reported by the United Kingdom (-697 kt CO_2eq) and Poland (-285 kt CO_2eq). The biggest increase occurred in Spain (225 kt CO_2eq).

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

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	40	99	95	1.5%	55	140%	-4	-4%	T1	D
Belgium	53	94	92	1.4%	39	74%	-2	-2%	T1,T3	D
Bulgaria	123	108	112	1.7%	-11	-9%	3	3%	T1	D
Croatia	13	20	21	0.3%	8	58%	1	5%	T1	D
Cyprus	4	8	8	0.1%	4	99%	0	1%	T1	D
Czechia	242	224	220	3.4%	-22	-9%	-4	-2%	T1	D
Denmark	79	78	78	1.2%	-1	-1%	0	0%	T1,T2,T3	CS,D
Estonia	18	43	40	0.6%	23	127%	-3	-6%	T1,T2	CS,D
Finland	100	233	262	4.1%	161	161%	29	12%	T3	CS
France	289	300	270	4.2%	-19	-7%	-30	-10%	T2,T3	D,PS
Germany	2 407	2 287	2 189	34.1%	-219	-9%	-98	-4%	T2	CS
Greece	142	104	99	1.5%	-42	-30%	-5	-5%	T1	D
Hungary	63	59	57	0.9%	-5	-8%	-2	-3%	T1	D
Ireland	71	140	141	2.2%	70	99%	1	1%	T1,T2	D
Italy	308	270	250	3.9%	-58	-19%	-21	-8%	T3	CR,D
Latvia	11	22	24	0.4%	13	118%	1	5%	T1	D
Lithuania	19	37	36	0.6%	17	94%	-1	-3%	T1	D
Luxembourg	1	4	5	0.1%	4	242%	1	27%	T1	D
Malta	6	1	0	0.0%	-5	-93%	0	-40%	T2	CS
Netherlands	133	265	246	3.8%	113	85%	-19	-7%	D,T1	D
Poland	1 002	730	718	11.2%	-285	-28%	-12	-2%	T1	D
Portugal	46	176	148	2.3%	103	225%	-27	-16%	T1	D
Romania	179	98	88	1.4%	-91	-51%	-10	-10%	T1	D
Slovakia	59	35	34	0.5%	-25	-42%	0	-1%	T1	D
Slovenia	25	23	23	0.4%	-2	-9%	0	-2%	T1	D
Spain	274	571	499	7.8%	225	82%	-72	-13%	T1,T2	D,OTH
Sweden	118	245	248	3.9%	130	110%	3	1%	T2	CS
United Kingdom	1 110	398	412	6.4%	-698	-63%	14	3%	T1,T2	CS,D
EU-27+UK	**6 931**	**6 671**	**6 414**	**100%**	**-517**	**-7%**	**-257**	**-4%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-82%	0	0%	T1	D
United Kingdom (KP)	1 112	400	414	6.5%	-697	-63%	14	3%	T1,T2	CS,D
EU-KP	**6 933**	**6 673**	**6 416**	**100%**	**-517**	**-7%**	**-257**	**-4%**	**-**	**-**

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 2018, emissions increased by 420%. The biggest increase was reported by Germany (2331 kt CO_2eq), which is also responsible for 69.7% of the emissions EU-KP in 2018.

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

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	6	23	22	0.6%	16	260%	-1	-6%	T1,T2	CS,D
Belgium	11	25	24	0.7%	13	110%	-1	-3%	T1,T3	D
Bulgaria	12	8	18	0.5%	6	46%	10	126%	T1	D
Croatia	3	6	7	0.2%	4	106%	1	16%	T1	D
Cyprus	2	3	3	0.1%	2	96%	0	1%	T1	D
Czechia	15	33	32	0.9%	16	104%	-1	-4%	T1	D
Denmark	15	100	110	3.1%	95	639%	10	10%	T1,T2,T3	CS,D
Estonia	8	20	19	0.5%	11	147%	-2	-8%	T1,T2	CS,D
Finland	9	28	31	0.9%	22	246%	2	9%	T3	CS
France	14	43	36	1.0%	22	165%	-7	-16%	T2	D
Germany	172	2 531	2 503	69.7%	2 331	1354%	-28	-1%	T2	CS
Greece	13	12	11	0.3%	-1	-9%	-1	-5%	T1	D
Hungary	7	25	24	0.7%	17	234%	0	-1%	T1	D
Ireland	6	9	10	0.3%	4	56%	1	13%	T1,T2	D
Italy	95	108	103	2.9%	8	9%	-5	-5%	T3	CR,D
Latvia	5	14	15	0.4%	10	222%	1	5%	T1	D
Lithuania	9	23	23	0.6%	14	154%	-1	-3%	T1	D
Luxembourg	1	2	3	0.1%	2	244%	1	26%	T1	D
Malta	1	0	0	0.0%	-1	-73%	0	-20%	T2	CS
Netherlands	39	84	83	2.3%	44	111%	-1	-1%	T1,T2	CS,D
Poland	75	89	91	2.5%	16	22%	3	3%	T1	D
Portugal	4	15	14	0.4%	10	245%	-1	-8%	T1	D
Romania	36	11	10	0.3%	-26	-73%	-2	-14%	T1	D
Slovakia	6	13	13	0.4%	8	131%	0	1%	T1	D
Slovenia	2	3	3	0.1%	1	65%	0	0%	T1	D
Spain	21	72	69	1.9%	49	235%	-2	-3%	T1,T2	CR,CS,D
Sweden	16	46	47	1.3%	31	200%	1	3%	T2	CS
United Kingdom	88	243	266	7.4%	178	202%	23	10%	T1,T2	CS,D
EU-27+UK	**690**	**3 590**	**3 591**	**100%**	**2 901**	**420%**	**1**	**0%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-82%	0	0%	T1	D
United Kingdom (KP)	89	244	267	7.4%	178	201%	23	10%	T1,T2	CS,D
EU-KP	**691**	**3 591**	**3 593**	**100%**	**2 901**	**420%**	**1**	**0%**	**-**	**-**

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-KP, emissions fell by 85% respectively by 151 Mt CO_2 between 1990 and 2018 (Table 3.7).

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 252	284	110	0.4%	-1 142	-91%	-173	-61%		CS
Belgium	663	78	58	0.2%	-604	-91%	-20	-25%	T1, T3	D, PS
Bulgaria	3 245	498	60	0.2%	-3 186	-98%	-439	-88%	T1,T2	CS,D
Croatia	2 142	133	20	0.1%	-2 123	-99%	-113	-85%	T1	D
Cyprus	1 676	3 288	3 342	12.4%	1 667	99%	55	2%	CS	CS
Czechia	1 174	128	103	0.4%	-1 071	-91%	-26	-20%	T1	D, CS
Denmark	953	149	127	0.5%	-827	-87%	-23	-15%	T1,T2,T3	CS,D,PS
Estonia	4 897	203	165	0.6%	-4 732	-97%	-38	-19%	T2	CS
Finland	1 234	704	587	2.2%	-647	-52%	-117	-17%	T3	CS/PS/D
France	8 219	4 183	3 601	13.3%	-4 618	-56%	-582	-14%	T2,T3	CS,PS
Germany	8 637	1 361	1 249	4.6%	-7 388	-86%	-111	-8%	CS	CS
Greece	5 416	4 029	3 628	13.4%	-1 787	-33%	-401	-10%	T2	CS, PS
Hungary	1 448	79	59	0.2%	-1 389	-96%	-20	-25%	T1, T2	D, CS
Ireland	1 087	105	109	0.4%	-978	-90%	4	3%	T1,T3	CS,D,PS
Italy	64 597	1 430	886	3.3%	-63 711	-99%	-544	-38%	T3	CS
Latvia	3 079	3	6	0.0%	-3 073	-100%	3	115%	T1, T2	CS, D
Lithuania	6 021	87	92	0.3%	-5 929	-98%	6	7%	T1, T2, T3	CS, PS, D
Luxembourg	NO	2	1	0.0%	1	∞	0	-24%	T1/T2	D/CS
Malta	1 049	165	17	0.1%	-1 032	-98%	-149	-90%	T1, T2	CS, D
Netherlands	233	591	745	2.8%	512	219%	154	26%	CS,T2	CS,D
Poland	5 198	1 345	1 252	4.6%	-3 946	-76%	-93	-7%	T1	D
Portugal	6 434	692	692	2.6%	-5 742	-89%	0	0%	T1	D
Romania	20 356	627	705	2.6%	-19 652	-97%	77	12%	T1,T2	CS,D
Slovakia	1 033	12	12	0.0%	-1 022	-99%	0	1%	T2	CS
Slovenia	272	25	24	0.1%	-248	-91%	-1	-6%	T1	D
Spain	6 087	8 586	7 724	28.6%	1 637	27%	-863	-10%	T2	CS/PS
Sweden	1 277	284	376	1.4%	-901	-71%	92	32%	T2	CS
United Kingdom	19 716	800	753	2.8%	-18 963	-96%	-47	-6%	T1, T2	CS, D
EU-27+UK	**177 394**	**29 872**	**26 503**	**98%**	**-150 891**	**-85%**	**-3 369**	**-11%**		
Iceland	14	2	2	0.0%	-11	-83%	0	2%	T1	D
United Kingdom (KP)	20 393	1 247	1 279	4.7%	-19 114	-94%	32	3%	T1, T2	CS, D
EU-KP	**178 084**	**30 321**	**27 031**	**100%**	**-151 053**	**-85%**	**-3 290**	**-11%**		

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

Table 3.7 also shows that about 93 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 3.7 shows the contribution to the emission trend for liquid fuels by the main countries. In 2018 Spain, Greece, France and Cyprus are responsible for about 68% 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 36.2% of the emissions in this category and now in 2018 only for 3.2%.

Figure 3.7 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Emission trend and share for CO_2

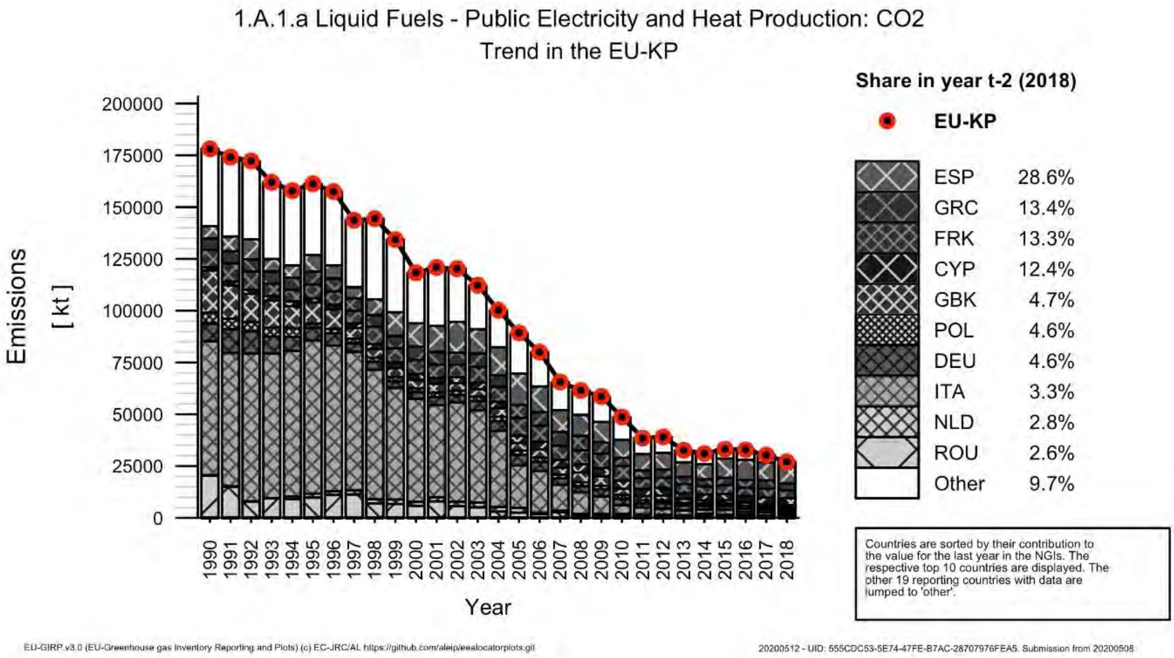
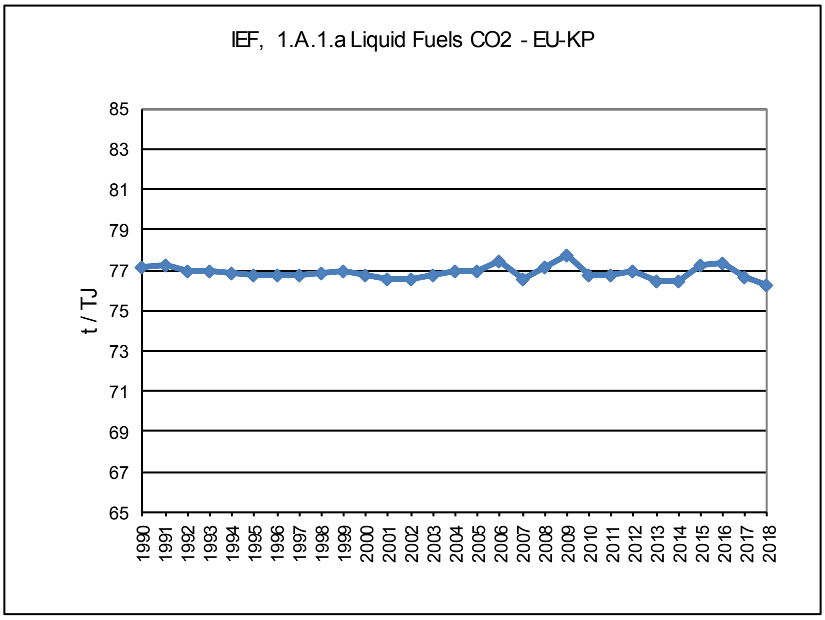
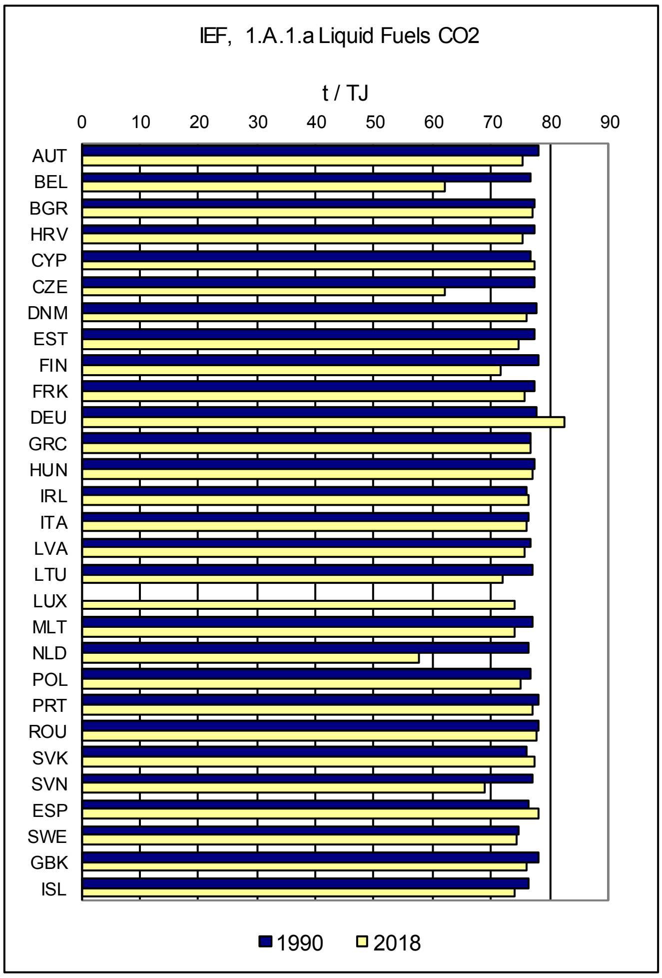


Figure 3.8 (on the next page) shows the implied emission factors for CO_2 emissions from liquid fuels used in public electricity and heat production. The IEFs in most countries range between 76 and 79 t/TJ on the entire time-series. The average IEF within the EU-KP is 76.3 t/TJ in 2018. Germany has the highest IEF in 2018, which is explained by the relatively large share of petroleum coke used in main activity producer CHP plants. The CO_2 country-specific 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 from Netherlands is one of the lowest among the countries in the year 2018. The low IEF 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). The same explanation can be given for Czech Republic which consumes a high share of Refinery gas with an EF of about 55 t CO_2/TJ).

Figure 3.8 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 68% of all greenhouse gas emissions from public electricity and heat production. Within the EU-KP, emissions fell by 43% between 1990 and 2018 (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, Germany as well as in Poland. Over the past 28 years United Kingdom, Germany and Poland account for 68.6 % of the decline in the EU-KP.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	6 247	1 344	1 367	0.2%	-4 880	-78%	23	2%	T3	PS
Belgium	19 434	5 128	4 947	0.8%	-14 488	-75%	-181	-4%	T3	PS
Bulgaria	25 638	24 314	20 658	3.2%	-4 980	-19%	-3 656	-15%	T1,T2	CS,D
Croatia	595	1 215	1 141	0.2%	545	92%	-74	-6%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	52 368	42 001	41 541	6.5%	-10 827	-21%	-460	-1%	T1, T2	D, CS
Denmark	22 225	5 736	5 835	0.9%	-16 390	-74%	99	2%	T1,T2,T3	CS,D,PS
Estonia	21 966	12 072	11 171	1.7%	-10 794	-49%	-901	-7%	T2/T3	CS/PS
Finland	9 281	7 653	7 619	1.2%	-1 662	-18%	-34	0%	T3	CS/PS/D
France	37 410	15 374	11 481	1.8%	-25 929	-69%	-3 894	-25%	T2,T3	CS,PS
Germany	307 246	227 970	215 722	33.7%	-91 524	-30%	-12 249	-5%	CS	CS
Greece	35 201	24 734	23 280	3.6%	-11 921	-34%	-1 454	-6%	T1,T2	D,PS
Hungary	12 266	6 942	6 433	1.0%	-5 833	-48%	-509	-7%	T1, T2, T3	D, CS, PS
Ireland	4 845	3 391	1 907	0.3%	-2 938	-61%	-1 484	-44%	T1,T3	CS,D,PS
Italy	27 756	28 279	24 933	3.9%	-2 823	-10%	-3 346	-12%	T3	CS
Latvia	197	11	11	0.0%	-186	-94%	0	4%	T2	CS
Lithuania	174	7	7	0.0%	-167	-96%	0	0%	T1, T2, T3	CS, PS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	710	NO	NO	-	-710	-100%	-	-	NA	NA
Netherlands	25 862	29 284	26 035	4.1%	173	1%	-3 249	-11%	CS,T2	CS,D
Poland	220 132	150 267	147 375	23.0%	-72 757	-33%	-2 893	-2%	T1/T2	D/CS
Portugal	7 921	11 574	10 149	1.6%	2 228	28%	-1 426	-12%	T3	PS
Romania	25 123	17 523	15 434	2.4%	-9 689	-39%	-2 088	-12%	T1,T2	CS,D
Slovakia	11 542	3 299	3 157	0.5%	-8 385	-73%	-142	-4%	T2, T3	CS
Slovenia	5 712	4 598	4 487	0.7%	-1 225	-21%	-111	-2%	T3	PS
Spain	58 931	44 179	38 473	6.0%	-20 458	-35%	-5 705	-13%	T2	PS
Sweden	4 231	2 937	2 727	0.4%	-1 504	-36%	-210	-7%	T2	CS
United Kingdom	183 150	19 589	14 672	2.3%	-168 478	-92%	-4 917	-25%	T2	CS
EU-27+UK	**1 126 162**	**689 422**	**640 562**	**100%**	**-485 600**	**-43%**	**-48 860**	**-7%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	183 150	19 589	14 672	2.3%	-168 478	-92%	-4 917	-25%	T2	CS
EU-KP	**1 126 162**	**689 422**	**640 562**	**100%**	**-485 600**	**-43%**	**-48 860**	**-7%**		

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

Table 3.8 also shows that about 96 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 3.9 shows the trend of emissions for solid fuels for main contributing countries. In 2018 Germany has the largest share of emissions from solid fuels in the EU-KP (33.7%), followed by Poland (23.0%) and then by a clear margin Czech Republic (6.5%) and Spain (6.0%).

Figure 3.9 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Emission trend and share for CO_2

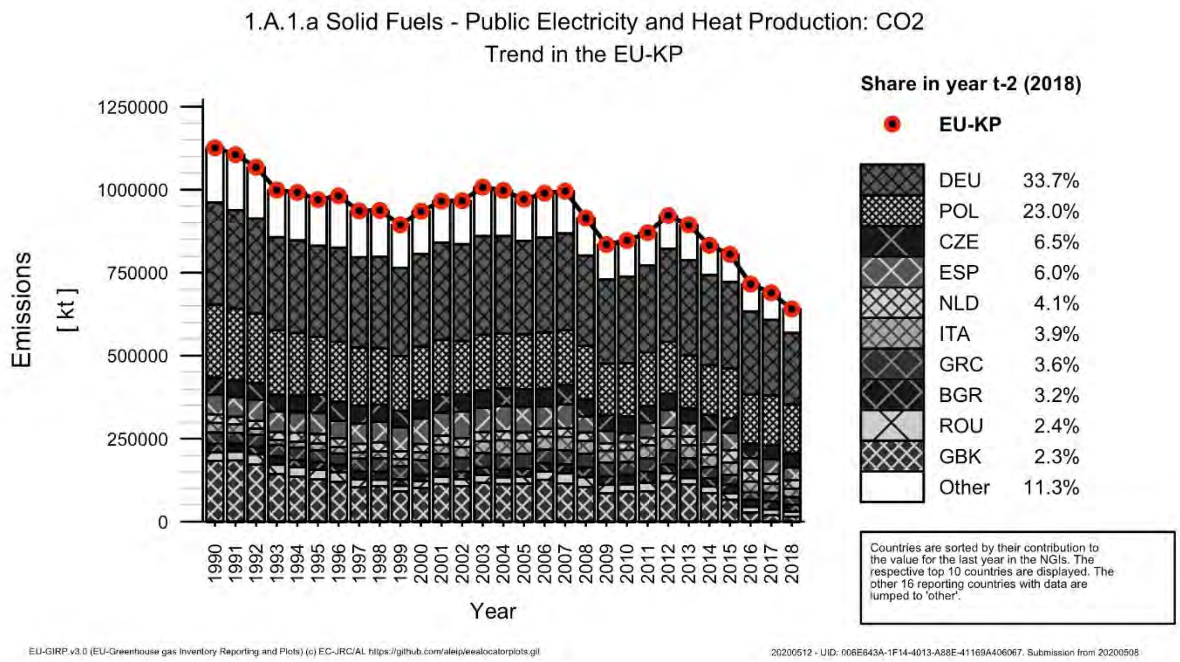
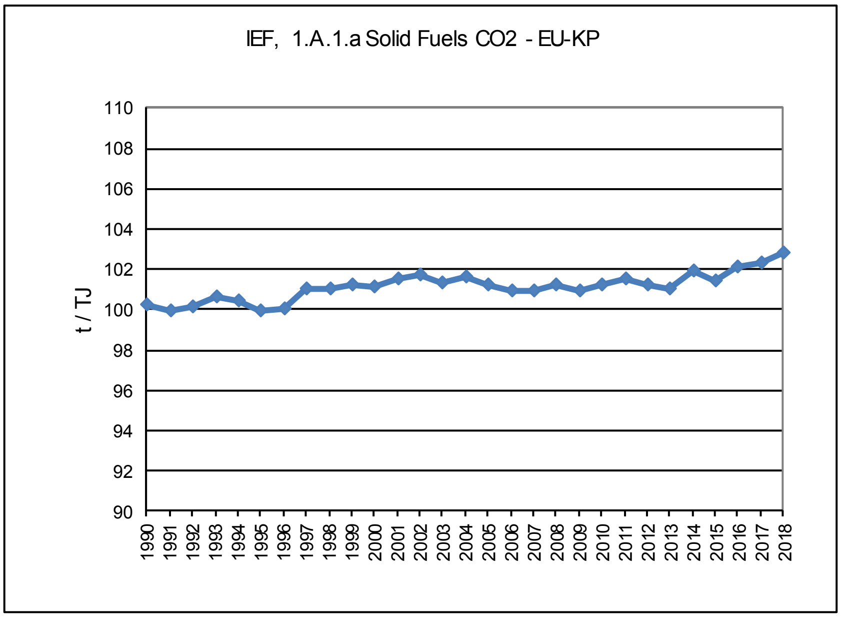
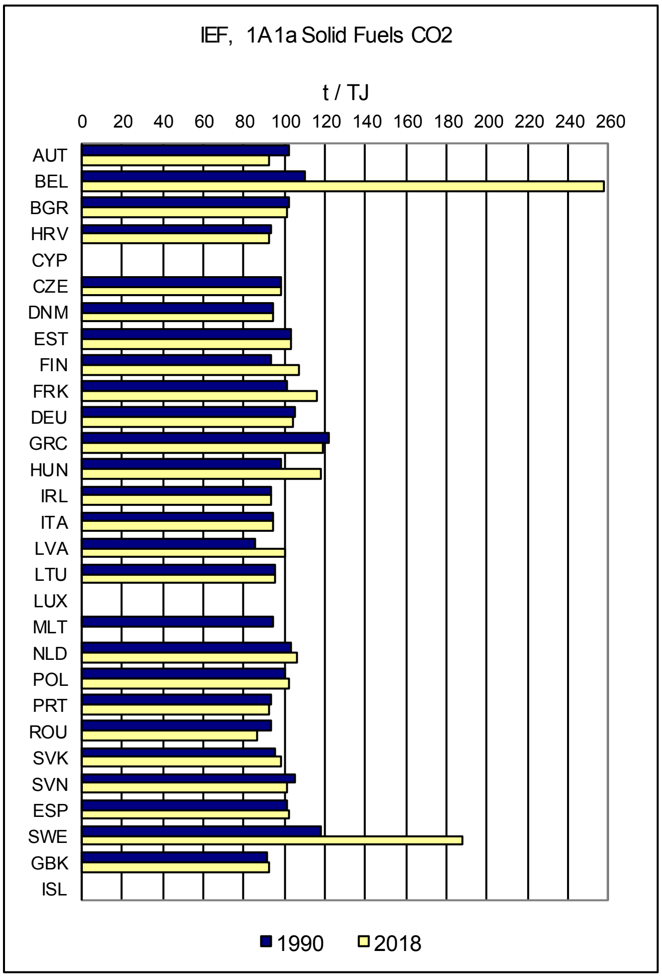


Figure 3.10 (on the next page) shows the relevant implied emission factors for solid fuels. The EU-KP implied emission factor has remained fairly stable between 100 t/TJ and 102 t/TJ on the entire time-series with a slight increase the last three years (102.9 t/TJ in 2018). The comparatively high IEF 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. This is the same observation for Hungary which consumes domestic lignite with very low NCV as well as blast furnace gas. 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 since 2015 can be observed. The reason for this strong increase lies in the large decrease of the consumption of coals and at the same time an increase in energy consumption of blast furnace gas.

Figure 3.10 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 23 % of all greenhouse gas emissions from public electricity and heat generation in 2018. Emissions increased by 102 % in the EU-KP between 1990 and 2018 (Table 3.9). The United Kingdom and Italy together were responsible for about 66.5% of the increase in the last 28 years.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	3 294	5 124	4 396	2.0%	1 101	33%	-728	-14%	T2	CS
Belgium	2 766	7 755	8 188	3.8%	5 423	196%	433	6%	T1, T3	D, PS
Bulgaria	6 295	1 865	1 847	0.8%	-4 449	-71%	-19	-1%	T1,T2	CS,D
Croatia	991	1 548	1 225	0.6%	234	24%	-323	-21%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 019	2 685	2 632	1.2%	1 613	158%	-53	-2%	T1, T2	D, CS
Denmark	980	1 624	1 576	0.7%	596	61%	-48	-3%	T1,T2,T3	CS,D,PS
Estonia	1 977	600	568	0.3%	-1 410	-71%	-32	-5%	T2	CS
Finland	1 989	1 739	2 282	1.0%	294	15%	543	31%	T3	CS
France	974	13 420	9 909	4.6%	8 935	917%	-3 510	-26%	T2,T3	CS,PS
Germany	18 447	32 919	31 485	14.5%	13 037	71%	-1 434	-4%	CS	CS
Greece	IE,NO	6 113	6 265	2.9%	6 265	∞	153	2%	T1,T2	D,PS
Hungary	4 148	4 681	4 321	2.0%	173	4%	-359	-8%	T1, T2	D, CS
Ireland	1 881	5 016	5 129	2.4%	3 248	173%	113	2%	T1,T3	CS,D,PS
Italy	16 030	47 900	43 928	20.2%	27 898	174%	-3 971	-8%	T3	CS
Latvia	2 658	1 452	1 816	0.8%	-842	-32%	364	25%	T2	CS
Lithuania	5 797	786	703	0.3%	-5 093	-88%	-82	-10%	T1, T2	CS, D
Luxembourg	NO	141	118	0.1%	118	∞	-22	-16%	T1/T2	D/CS
Malta	NO	552	681	0.3%	681	∞	128	23%	NA	NA
Netherlands	13 330	18 539	18 021	8.3%	4 691	35%	-518	-3%	CS,T2	CS,D
Poland	1 197	4 625	5 594	2.6%	4 396	367%	969	21%	T2	CS
Portugal	NO	5 376	4 181	1.9%	4 181	∞	-1 194	-22%	T3/T2	PS/D
Romania	20 801	4 302	4 109	1.9%	-16 692	-80%	-193	-4%	T1,T2	CS,D
Slovakia	2 089	1 412	1 387	0.6%	-702	-34%	-25	-2%	T2	CS
Slovenia	112	250	246	0.1%	134	119%	-4	-2%	T2	CS
Spain	447	13 587	11 301	5.2%	10 854	2428%	-2 286	-17%	T2	CS/PS
Sweden	486	286	405	0.2%	-81	-17%	119	41%	T2	CS
United Kingdom	16	47 250	45 134	20.7%	45 118	282738%	-2 116	-4%	T1, T2	CS, D
EU-27+UK	**107 724**	**231 546**	**217 448**	**100%**	**109 724**	**102%**	**-14 098**	**-6%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16	47 424	45 308	20.8%	45 292	283829%	-2 116	-4%	T1, T2	CS, D
EU-KP	**107 724**	**231 720**	**217 622**	**100%**	**109 898**	**102%**	**-14 098**	**-6%**		

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

Table 3.9 also shows that about 97 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 seven EU-KP the consumption of gaseous fuels was lower in 2018 than in 1990. Cyprus and Iceland are not utilising gaseous fuels for public electricity and heat production. In the other 20 countries, gas consumption has increased of the last 28 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 about 40% in 2017 compared to 2014. 2018 presents a decrease of 6% compared to 2017. Figure 3.11 shows the trend of emissions from gaseous fuels by the main contributing countries which are the United Kingdom (20.8%), Italy (20.2%) and Germany (14.5%). 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.

Figure 3.11 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Emission trend and share for CO_2

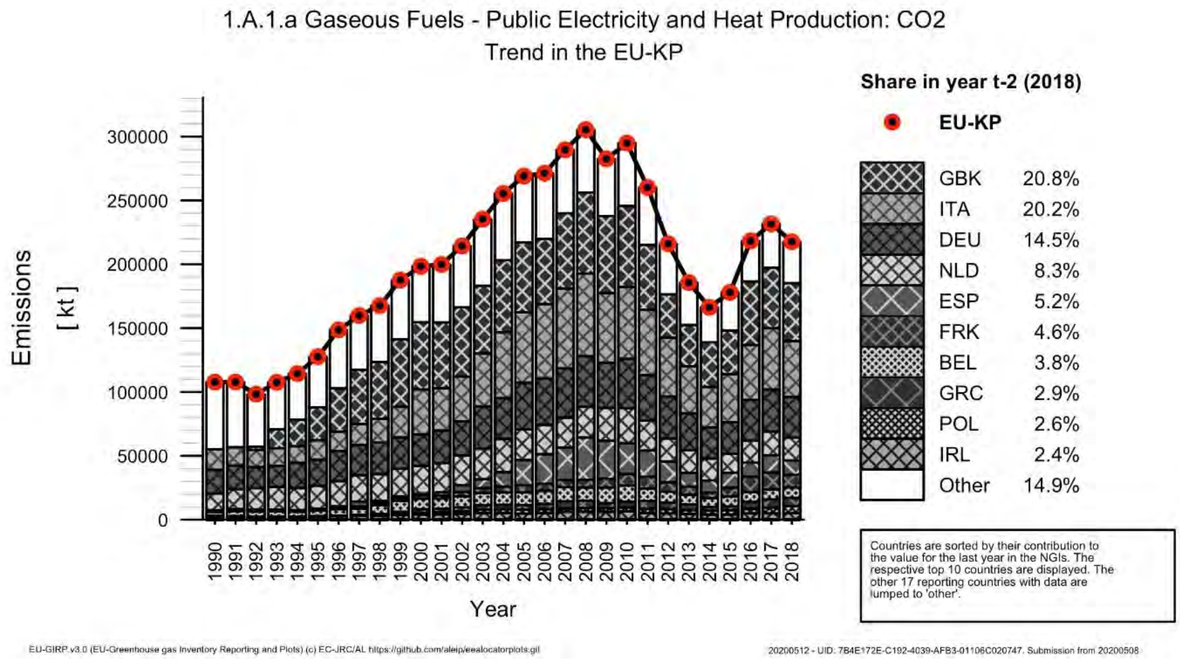
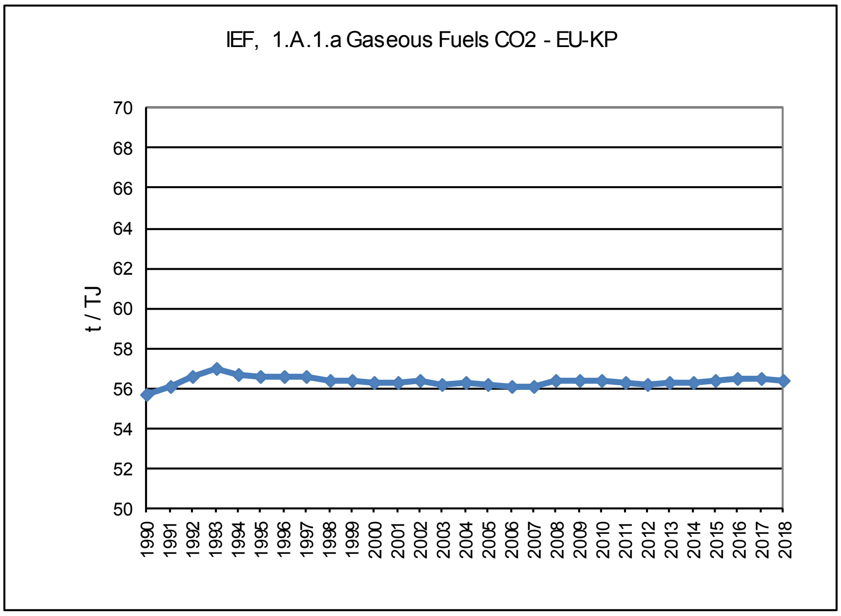
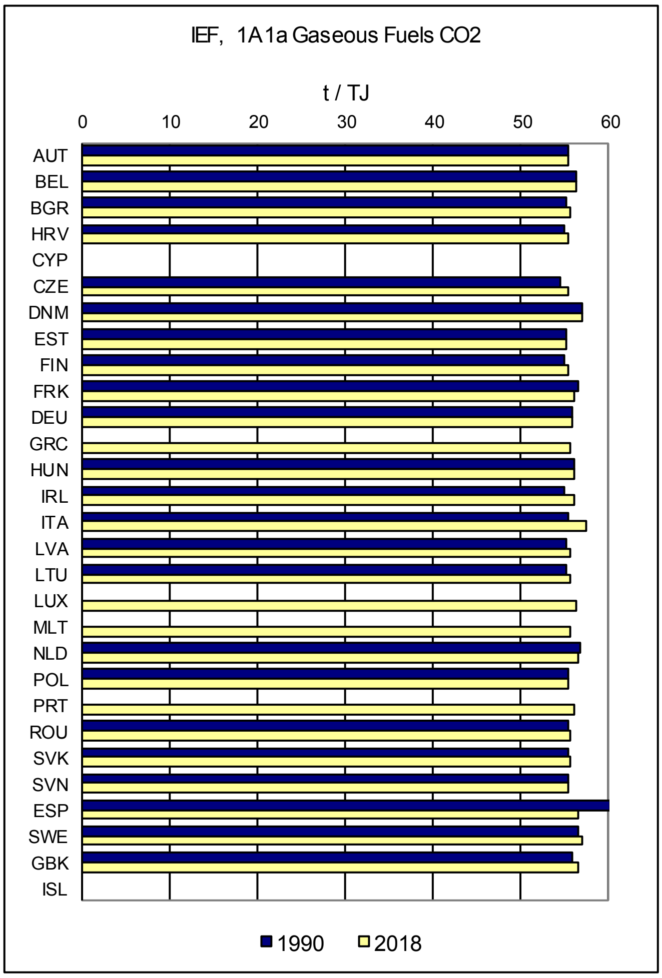


Figure 3.12 (on the next page) shows the implied emission factors from gaseous fuels for CO_2. The EU-KP implied emission factor has remained fairly stable (56.4 t/TJ in 2018) which is very close to the default emission factor of natural gas (56.1 t/TJ). The slight increase in the EU-KP factor observed in the early 1990s can be explained by the higher UK's gas share in the EU-KP and by an increase in the UK's implied emission factor. In the early 1990s, the IEF for Spain is also high. It is explained by the total CO_2 emissions allocation amongst fuels which does not impact total CO_2 emissions. 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 3.12 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 2018, the share of CO_2 emissions from other fuels amounts to 4.3 % 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, hazardous waste, bulky waste and waste sludge (Table 3.10). Emissions increased by 283 % at EU-KP level between 1990 and 2018 and increased in all countries except for Latvia. Germany alone is responsible for 30% of the increase in the whole EU-KP over the last 28 years.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	286	1 089	1 036	2.5%	750	262%	-53	-5%	T2	CS
Belgium	674	2 057	1 984	4.8%	1 309	194%	-73	-4%	T3	PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	24	251	248	0.6%	224	932%	-3	-1%	T1	D
Denmark	539	1 570	1 574	3.8%	1 036	192%	4	0%	T1,T2,T3	CS,D,PS
Estonia	NO	140	138	0.3%	138	∞	-2	-1%	T3	PS
Finland	1	578	609	1.5%	608	60781%	31	5%	T3	CS
France	2 558	6 388	6 938	16.9%	4 380	171%	550	9%	T2,T3	CS,PS
Germany	4 121	14 238	13 077	31.8%	8 956	217%	-1 161	-8%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	30	246	237	0.6%	207	691%	-9	-4%	T1, T2, T3	D, CS, PS
Ireland	NO	363	605	1.5%	605	∞	242	67%	T1,T3	CS,D,PS
Italy	143	202	202	0.5%	59	41%	0	0%	T3	CS
Latvia	3	NO	NO	-	-3	-100%	-	-	T1	D
Lithuania	NO	162	180	0.4%	180	∞	18	11%	T1, T2	CS, D
Luxembourg	33	94	96	0.2%	63	188%	2	2%	T1/T2	D/CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	601	2 972	2 857	7.0%	2 255	375%	-116	-4%	CS,T2	CS,D
Poland	753	599	830	2.0%	77	10%	231	39%	T1	D
Portugal	NO	498	473	1.2%	473	∞	-25	-5%	T2	D/CS
Romania	NO	NO	NO	-	-	-	-	-	T1,T2	CS,D
Slovakia	36	154	157	0.4%	121	340%	2	1%	T2	CS
Slovenia	NO	15	17	0.0%	17	∞	2	12%	T1	D
Spain	110	1 667	1 488	3.6%	1 378	1252%	-178	-11%	T2	CS/PS
Sweden	570	2 610	2 555	6.2%	1 985	348%	-55	-2%	T2	CS
United Kingdom	234	4 956	5 749	14.0%	5 515	2359%	793	16%	T1, T2	CS, D
EU-27+UK	**10 717**	**40 849**	**41 051**	**100%**	**30 334**	**283%**	**201**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	T1	D
United Kingdom (KP)	246	4 994	5 789	14.1%	5 543	2252%	794	16%	T1, T2	CS, D
EU-KP	**10 729**	**40 888**	**41 090**	**100%**	**30 361**	**283%**	**202**	**0%**		

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

Table 3.10 also shows that more than 97 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 3.13 illustrates clearly the strong increase of emissions caused by other fuels over the past 28 years. The largest emitters of other fuels in 2018 were Germany (31.8%), France (16.9%) and the United Kingdom (14.1%). Together these three countries accounted for 62.8% of the total EU-KP emissions in this category.

Figure 3.13 1.A.1.a Public Electricity and Heat Production, Other Fuels: Emission trend and share for CO_2

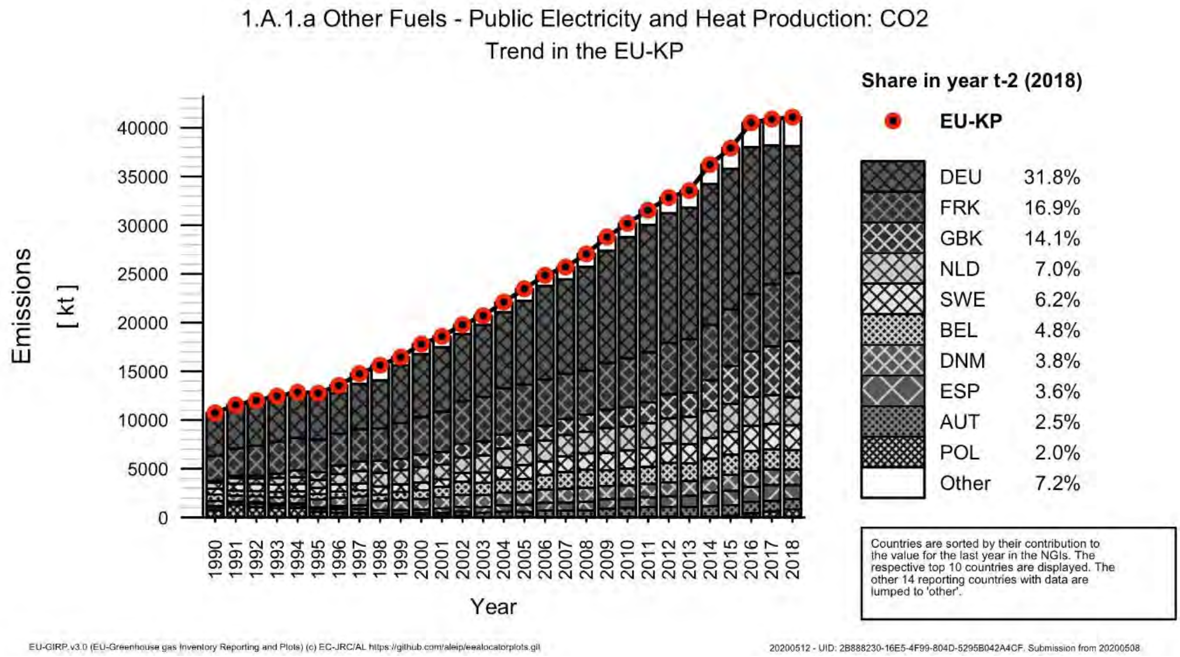
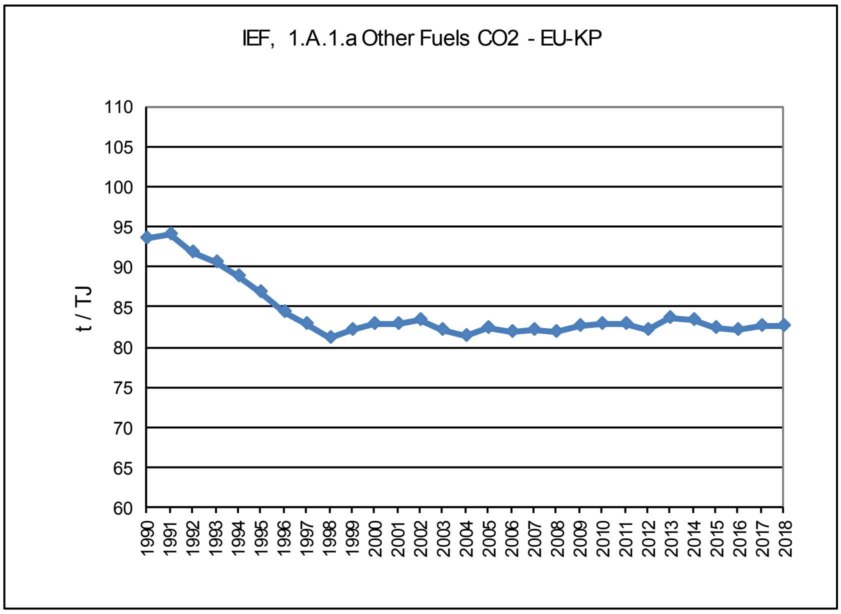
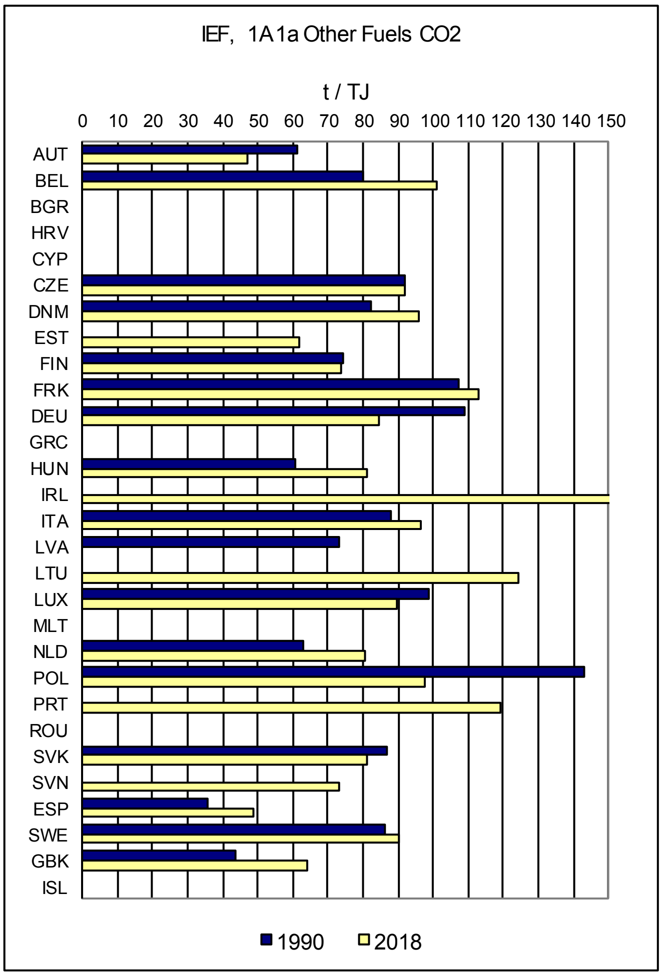


Figure 3.14 (on the next page) shows the implied emission factors of the category other fuels from CO_2. The EU-KP implied emission factor has gradually fallen until 1998, then levelled out between 80 and 85 t/TJ on the entire time-series. In Germany, the IEF declined continuously between 1990 and 2018 (from 109 to 84.6 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 countries' IEFs.

Figure 3.14 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 0.9% 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 6 countries report emissions from peat combustion. Within the EU-KP, emissions declined by 2% respectively 0.15 Mt CO_2 between 1990 and 2018 (Table 3.11).

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		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
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	187	162	130	1.6%	-57	-30%	-32	-20%	T1/T2	D/CS
Finland	3 950	4 603	5 331	63.8%	1 381	35%	727	16%	T3	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	3 065	2 355	2 208	26.4%	-857	-28%	-147	-6%	T1,T3	CS,D,PS
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	146	NO	9	0.1%	-137	-94%	9	∞	T1, T2	CS, D
Lithuania	11	36	38	0.5%	27	246%	3	7%	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	1 150	480	645	7.7%	-505	-44%	165	34%	T2	CS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**8 508**	**7 636**	**8 361**	**100%**	**-147**	**-2%**	**725**	**9%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**8 508**	**7 636**	**8 361**	**100%**	**-147**	**-2%**	**725**	**9%**		

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

Table 3.11 also shows that about 97 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 3.15 illustrates the trend of peat emissions throughout the last 28 years, which is predominately influenced by the emission fluctuation over the years by Finland. Several parameters such as weather conditions greatly influence the peat consumption: in Finland, peat represents 5% of electricity production and is the third most important energy source in district heat production. In 2018, the growth in peat use was affected by the exceptional weather conditions during the heating season at the start of the year and the resulting growth in demand. In 2018, the two largest emitters, Finland and Ireland, are responsible for 90.2% of the total emissions in this category.

Figure 3.15 1.A.1.a Public Electricity and Heat Production, Peat: Emission trend and share for CO_2

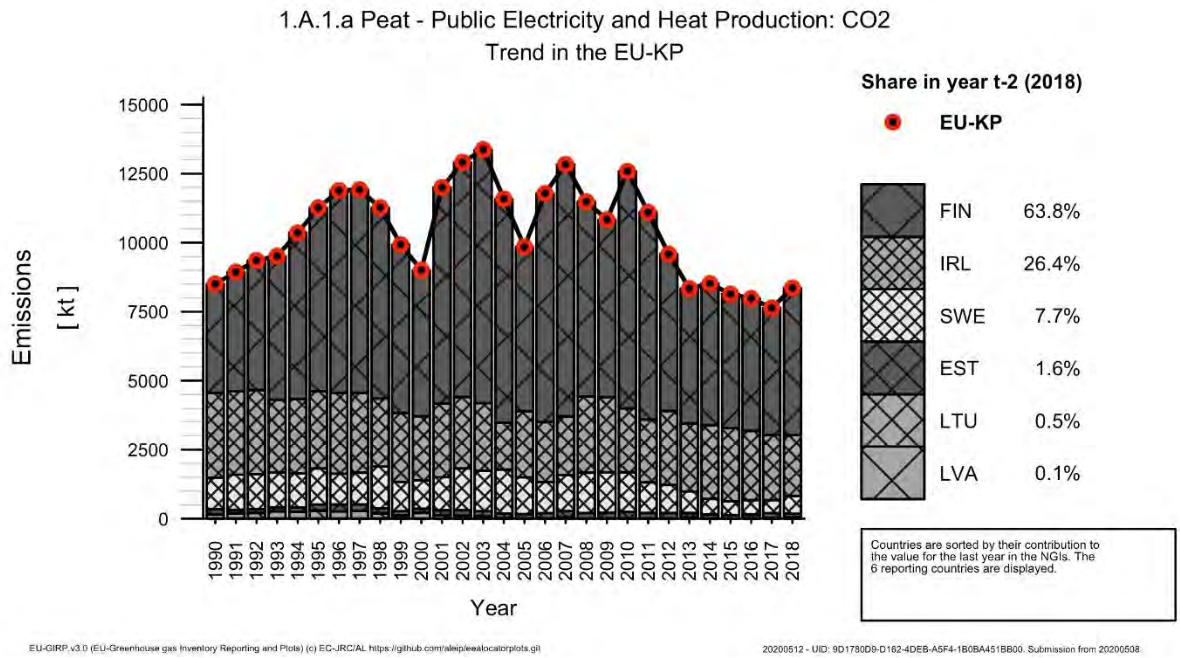
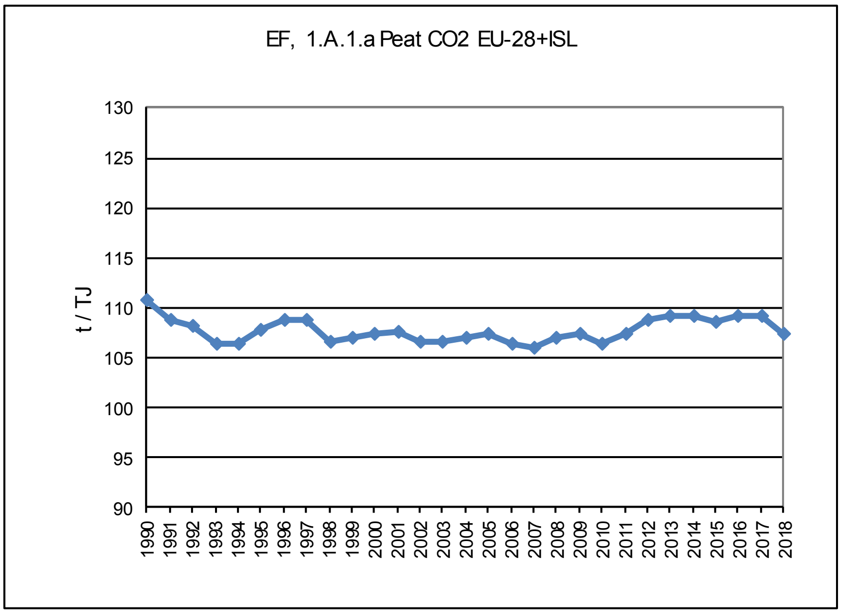
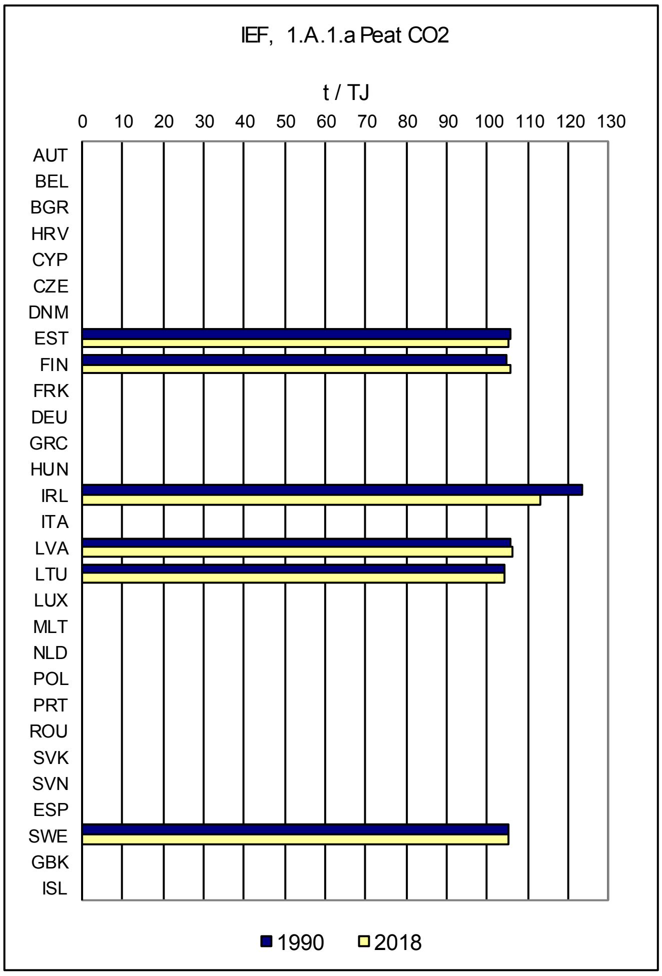


Figure 3.16 shows the implied emission factors of peat from CO_2. The EU-KP implied emission factor amounts to 107.4 t/TJ in 2018 and has been quite stable over the last 28 years. It is mainly influenced by the IEF of the two largest emitters (Finland and Ireland). The default emission factor for peat 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 (112.9 t/TJ) for three milled peat power plants in use.

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




IEF, 1.A.1.a Peat CO2
t / TJ
0 10 20 30 40 50 60 70 80 90 100 110 120 130
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
2018

3.2.1.2 **Petroleum Refining (1.A.1.b) (EU-KP)**

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.

Total emissions from Petroleum Refining are accounting for 2.8% of total greenhouse gas emissions in year 2018. Between 1990 and 2018, EU-KP CO_2 emissions decreased by 8% (Table 3.12). Emissions in 2018 were above 1990 levels in 10 countries, 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. In contrast France and the United Kingdom report the largest decreases together accounting for almost half of the decrease in emissions in this period. The decrease at European level can be explained by the reduction of Liquid fuels consumptions (-19% for sector 1A-Liquid fuels between 2000 and 2018).

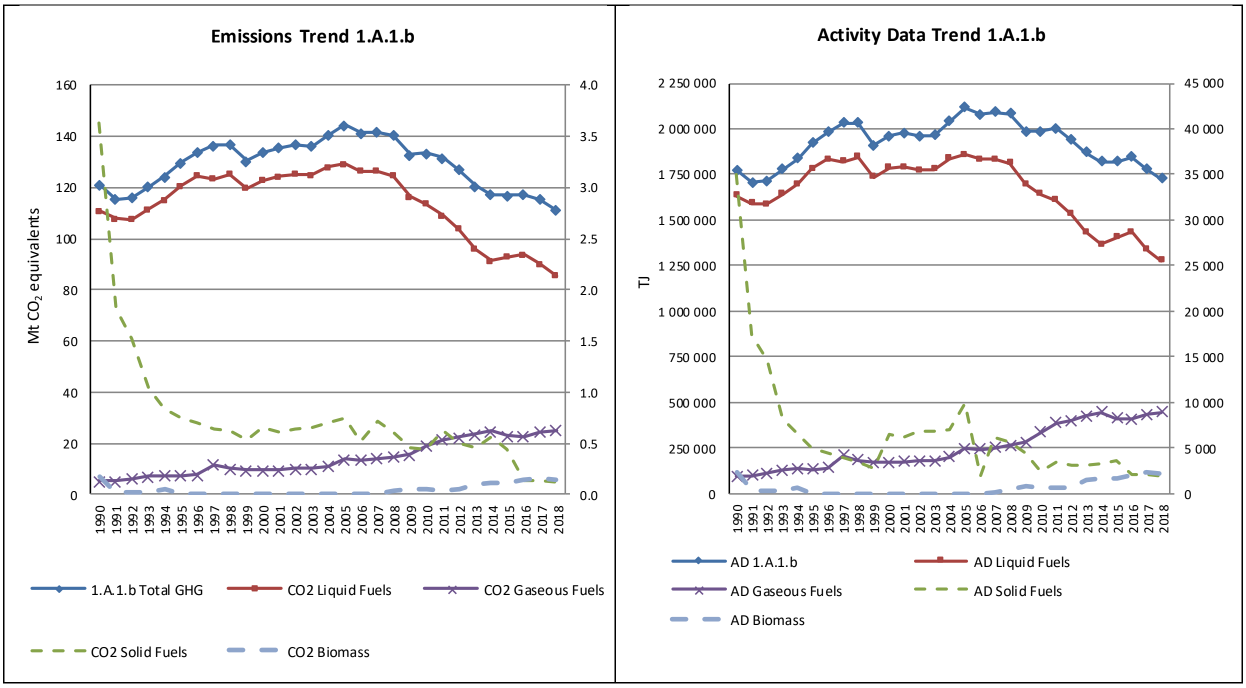
Table 3.12 1.A.1.b Petroleum Refining: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	2 394	2 739	2 824	2.5%	430	18%	86	3%	T2	CS
Belgium	4 299	4 689	4 502	4.1%	203	5%	-187	-4%	CS,T3	PS
Bulgaria	861	873	839	0.8%	-22	-3%	-34	-4%	T1,T2	CS,D
Croatia	2 446	1 351	1 317	1.2%	-1 129	-46%	-33	-2%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	493	539	505	0.5%	12	3%	-34	-6%	T1,T2	CS,D
Denmark	908	932	891	0.8%	-17	-2%	-40	-4%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 042	1 645	1 641	1.5%	-401	-20%	-4	0%	T3	CS,PS
France	11 935	6 831	6 224	5.6%	-5 711	-48%	-607	-9%	T2,T3	CS,PS
Germany	20 166	20 032	18 885	17.0%	-1 281	-6%	-1 147	-6%	CS	CS
Greece	2 375	4 904	4 930	4.4%	2 555	108%	26	1%	T2	PS
Hungary	2 376	1 510	1 584	1.4%	-792	-33%	74	5%	T3	PS
Ireland	168	311	322	0.3%	153	91%	11	4%	T3	CS,PS
Italy	15 821	20 618	19 691	17.8%	3 870	24%	-927	-4%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 380	1 312	1.2%	-197	-13%	-68	-5%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	11 010	9 031	9 105	8.2%	-1 905	-17%	74	1%	T2	CS,D
Poland	2 169	4 654	4 354	3.9%	2 184	101%	-300	-6%	T1,T2	CS,D
Portugal	1 861	2 472	2 209	2.0%	348	19%	-263	-11%	T2	CR,D,PS
Romania	4 297	2 100	1 805	1.6%	-2 493	-58%	-295	-14%	T1,T2	CS,D
Slovakia	2 873	1 469	1 485	1.3%	-1 389	-48%	15	1%	T3	PS
Slovenia	170	NO	NO	-	-170	-100%	-	-	NA	NA
Spain	10 858	11 263	11 353	10.2%	495	5%	90	1%	T2,T3	PS
Sweden	1 778	1 952	2 056	1.9%	278	16%	104	5%	T2	CS
United Kingdom	17 831	13 560	13 049	11.8%	-4 783	-27%	-512	-4%	T2	CS
EU-27+UK	**120 730**	**114 855**	**110 884**	**100%**	**-9 846**	**-8%**	**-3 971**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 831	13 560	13 049	11.8%	-4 783	-27%	-512	-4%	T1,T2	CS
EU-KP	**120 730**	**114 855**	**110 884**	**100%**	**-9 846**	**-8%**	**-3 971**	**-3%**	**-**	**-**

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

Figure 3.17 shows the trends in activity data and the associated emissions originating from the refining of petroleum by fuel in the EU-KP between the years 1990 and 2018. Fuel used for petroleum refining decreased by 2.6% in the EU-KP between 1990 and 2018. In the year 2018, liquid fuels represent 73.8% of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part (25.8%) of the activity data. Gaseous fuels use is almost five times higher in 2018 compared to 1990. There remains a small amount of solid fuels used accounting for 0.11% in petroleum refining; in Germany (lignite and coke oven gas) and Poland (hard coal and lignite) as well as 0.13 of biomass and 0.11 % of other fuels use.

Figure 3.17 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 76.8% of all greenhouse gas emissions from petroleum refining in 2018. Emissions decreased by 23% between 1990 and 2018 (Table 3.13). Greece had the largest emission increases accounting for 56.1% of the whole increase between 1990 and 2018. In contrast the United Kingdom and France report the largest decreases together accounting for 46.3% of the whole decrease in emissions in this period.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 958	2 342	2 435	2.8%	478	24%	93	4%	T2	CS
Belgium	4 285	3 377	2 663	3.1%	-1 622	-38%	-713	-21%	CS,T3	PS
Bulgaria	793	796	730	0.9%	-63	-8%	-66	-8%	T1	D
Croatia	2 432	934	856	1.0%	-1 577	-65%	-78	-8%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	176	322	304	0.4%	129	73%	-18	-6%	T1	CS,D
Denmark	908	932	862	1.0%	-46	-5%	-69	-7%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 383	1 456	1 383	1.6%	0	0%	-73	-5%	T3	CS,PS
France	11 413	5 253	4 839	5.7%	-6 575	-58%	-415	-8%	T2,T3	CS,PS
Germany	15 417	17 184	15 457	18.1%	40	0%	-1 727	-10%	CS	CS
Greece	2 375	4 904	4 930	5.8%	2 555	108%	26	1%	T2	PS
Hungary	1 683	1 024	981	1.1%	-702	-42%	-43	-4%	T3	PS
Ireland	168	295	309	0.4%	140	83%	14	5%	T3	CS,PS
Italy	15 662	16 252	15 749	18.4%	87	1%	-503	-3%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 377	1 310	1.5%	-200	-13%	-67	-5%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 968	6 613	6 253	7.3%	-3 715	-37%	-360	-5%	T2	CS,D
Poland	1 326	2 141	2 288	2.7%	962	73%	147	7%	T1,T2	CS,D
Portugal	1 861	1 327	1 153	1.3%	-709	-38%	-175	-13%	T2	CR,D,PS
Romania	4 297	1 555	1 361	1.6%	-2 936	-68%	-194	-12%	T2	CS
Slovakia	2 786	1 236	1 236	1.4%	-1 550	-56%	-1	0%	T3	PS
Slovenia	43	NO	NO	-	-43	-100%	-	-	NA	NA
Spain	10 812	7 861	8 002	9.4%	-2 810	-26%	141	2%	T2,T3	PS
Sweden	1 778	1 815	1 941	2.3%	164	9%	126	7%	T2	CS
United Kingdom	17 782	11 094	10 480	12.3%	-7 302	-41%	-614	-6%	T2	CS
EU-27+UK	**110 902**	**90 090**	**85 522**	**100%**	**-25 380**	**-23%**	**-4 568**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 782	11 094	10 480	12.3%	-7 302	-41%	-614	-6%	T2	CS
EU-KP	**110 902**	**90 090**	**85 522**	**100%**	**-25 380**	**-23%**	**-4 568**	**-5%**	**-**	**-**

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

Table 3.13 also shows that more than 97 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 fr 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 3.18 illustrates that Italy, Germany and the United Kingdom are the countries contributing most in terms of CO_2 emissions in 2018. It also can be seen that the trend for liquid fuels was continuously decreasing since the year 2008 with a stabilization between 2014 and 2016.

Figure 3.18 1.A.1.b Petroleum Refining, Liquid Fuels: Emission trend and share for CO_2

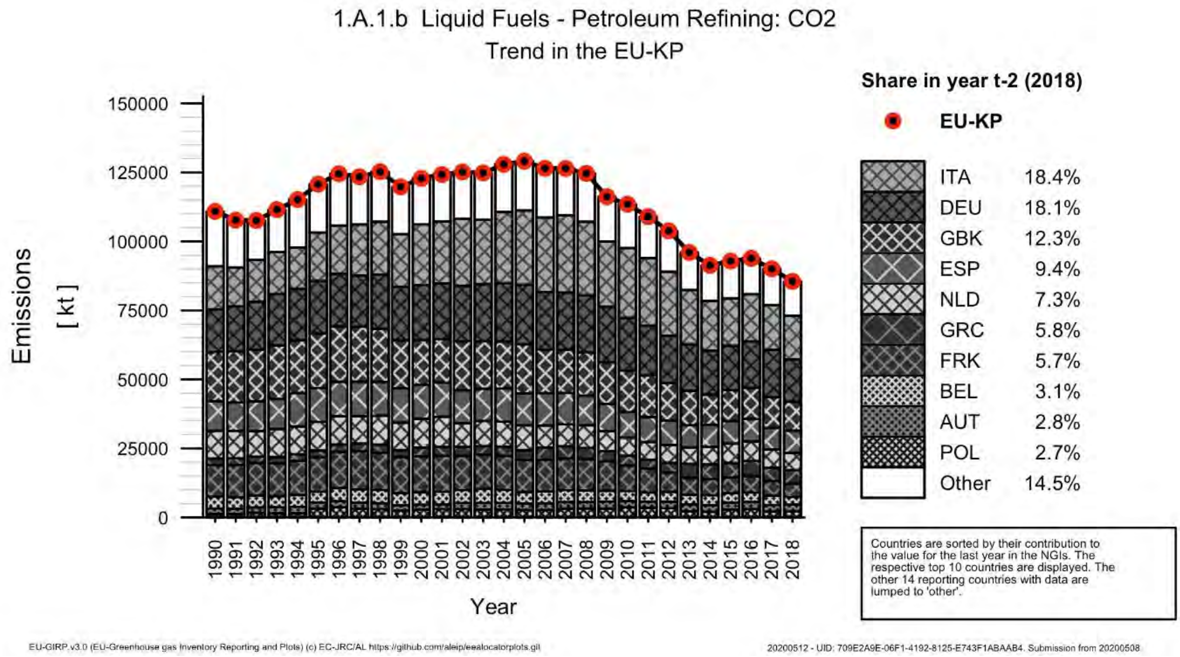
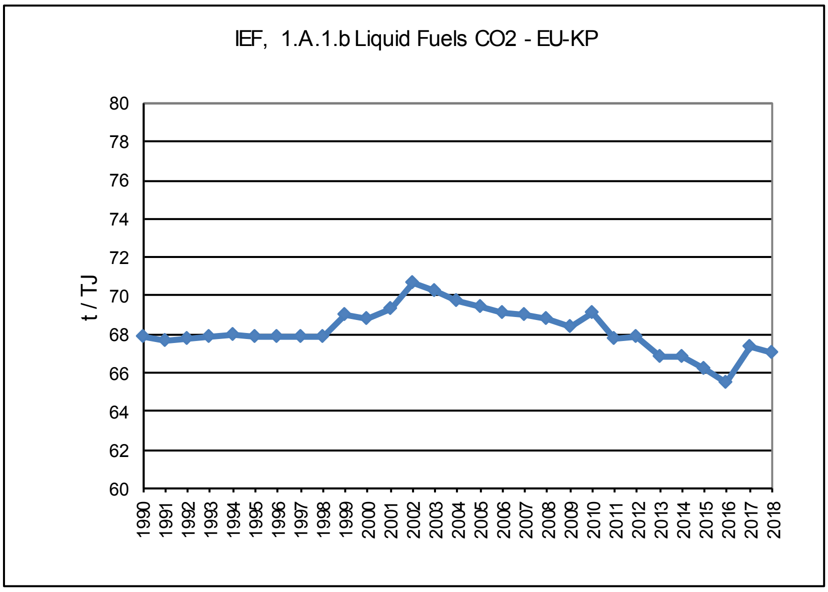
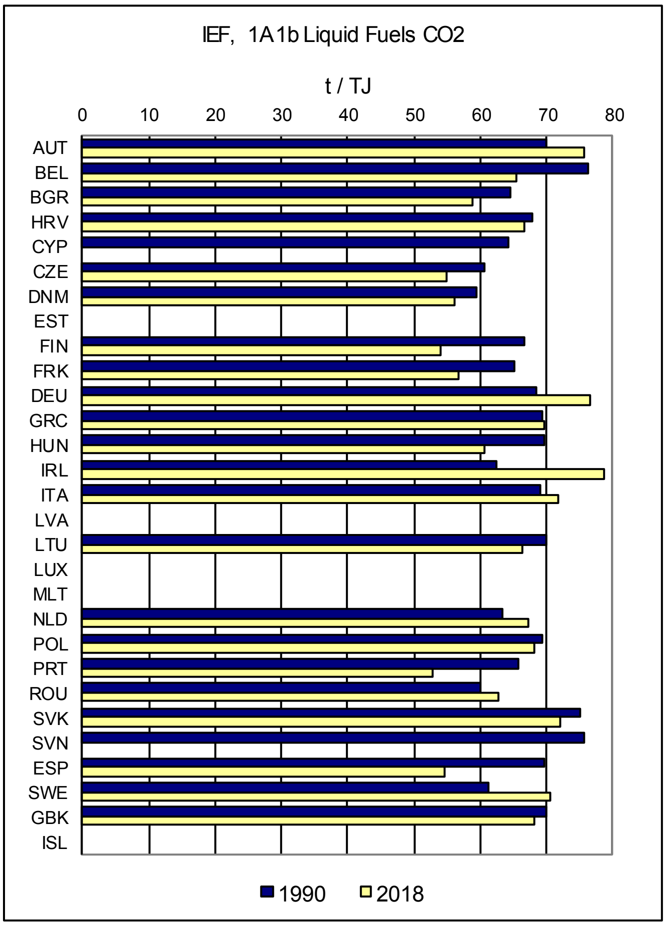


Figure 3.19 (on the next page) shows the emission factors for CO_2 emissions from liquid fuels. The EU-KP implied emission factor shows variations around 68 t/TJ over the time series and amounts 67 t/TJ in 2018. In general, the fluctuating IEF is due to the annual variations of fuel consumption with different carbon content. The IEF declining trend observed since 2002 is due to the higher share of refinery gas in the energy mix.

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 highest IEF in 2018 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.

Figure 3.19 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 2018. There are only two countries reporting emissions in the EU-KP in 2018 (Poland and Germany). Thereof only Poland reports increasing emissions between 1990 and 2018. Poland is now responsible for the majority of emissions in 2018 in the EU-KP. Over the whole times series emissions fell by 97% on average (Table 3.14).

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		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
Czechia	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	NO	NO	-	-486	-100%	-	-	NA	NA
Germany	3 131	47	47	41.1%	-3 084	-99%	0	-1%	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	84	67	58.9%	63	1480%	-16	-20%	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-27+UK	**3 633**	**131**	**114**	**100%**	**-3 519**	**-97%**	**-17**	**-13%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**3 633**	**131**	**114**	**100%**	**-3 519**	**-97%**	**-17**	**-13%**	**-**	**-**

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

Table 3.14 also shows that 94 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 3.20 illustrates the trend of emissions in 1.A.1.b for solid fuels for the past 28 years. The use of solid fuels in petroleum refining has declined drastically since 1990. Emissions are down by 97%. Germany is responsible for the strong declining trend in the 1990s and due to the recent overall trend, Poland is now responsible for 58.9% of the total emissions in the EU-KP for this category in 2018.

Figure 3.20 1.A.1.b Petroleum Refining, Solid Fuels: Emission trend and share for CO_2

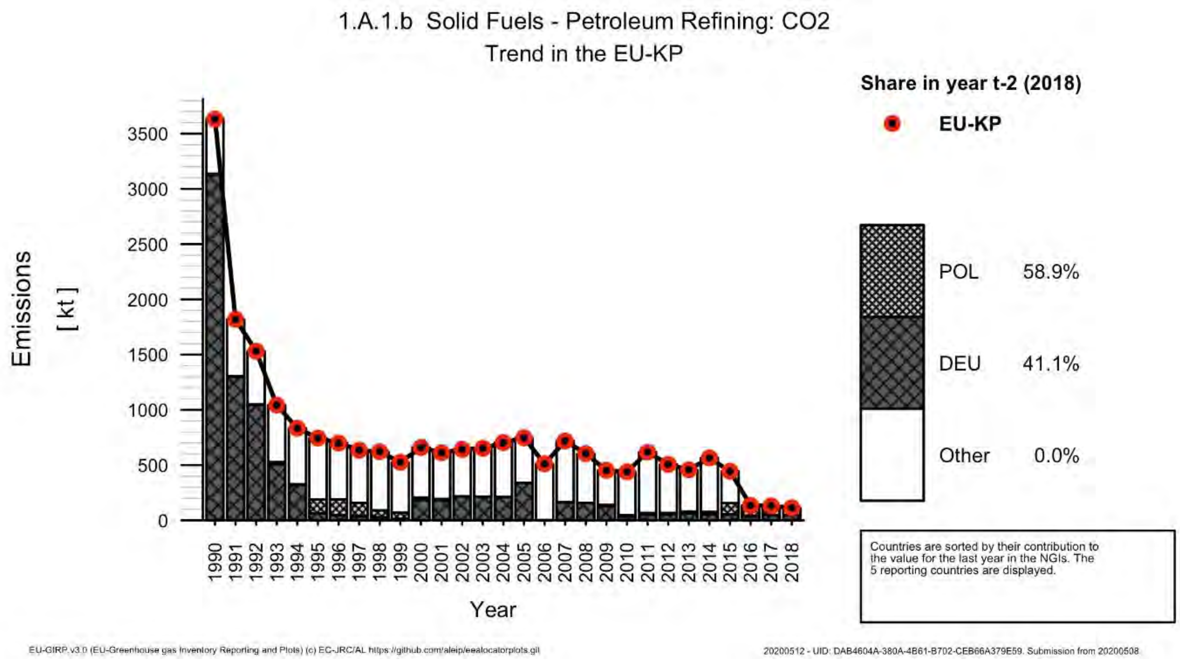
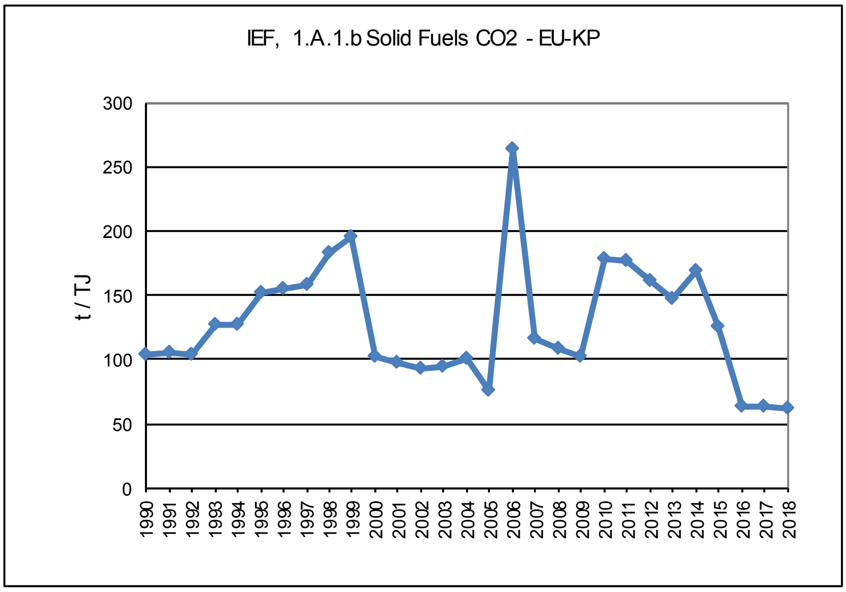
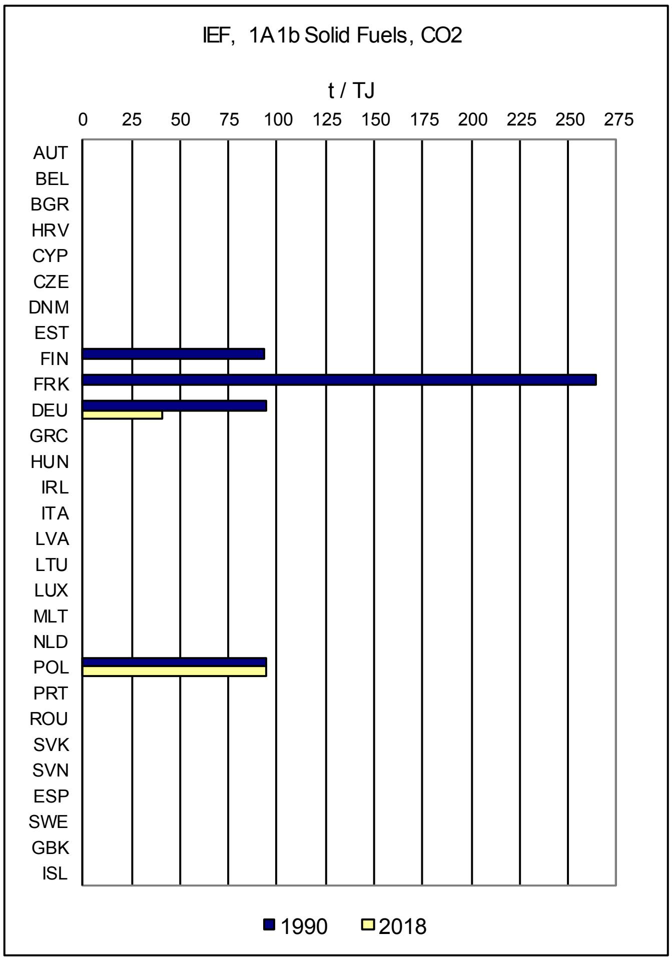


Figure 3.21 (on the next page) shows the relevant implied emission factors. The EU-KP implied emission factor showed strong fluctuations and amounts 61.47 t/TJ in 2018. One explanation for this is the low number of countries reporting this category. Apart from that, the variation in the EU-KP factor 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-KP 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-KP 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-KP level during these years. For 2006 Germany reports only negligible amounts of solid fuel use in petroleum refining. Therefore, the EU-KP IEF was almost entirely dominated by the high French IEF in this year. The drop in the implied emission factor since 2014 can be explained by the increased weight of Poland with their lower IEF (compared to France). Since there is no more solid fuel consumption in France in 2017, the average IEF is driven by Poland and Germany which have similar CO_2 EF.

Figure 3.21 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 2018, CO_2 emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 22.5% of total greenhouse gas emissions from 1.A.1.b. Emissions in the EU-KP increased by 375% between 1990 and 2018 (Table 3.15). Only five countries reduced their emissions: Austria, Czech Republic, Finland, Hungary and Slovenia over the whole time series. Italy, Poland, Spain and the United Kingdom together account for 57.9% of the total increase between 1990 and 2018.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	437	397	389	1.6%	-48	-11%	-7	-2%	T2	CS
Belgium	14	1 170	1 709	6.8%	1 695	12203%	539	46%	CS,T3	PS
Bulgaria	69	77	109	0.4%	41	59%	32	42%	T2	CS
Croatia	14	417	462	1.8%	448	3215%	45	11%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	317	217	201	0.8%	-116	-37%	-16	-7%	T2	CS
Denmark	NO	NO	29	0.1%	29	∞	29	∞	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	648	189	258	1.0%	-389	-60%	70	37%	T3	CS
France	36	1 536	1 385	5.5%	1 349	3728%	-151	-10%	T2,T3	CS,PS
Germany	1 444	2 801	3 381	13.5%	1 937	134%	580	21%	CS	CS
Greece	NO	IE	IE	-	-	-	-	-	NA	NA
Hungary	693	486	603	2.4%	-90	-13%	117	24%	T3	PS
Ireland	NO	16	13	0.1%	13	∞	-3	-17%	T3	CS,PS
Italy	159	4 366	3 942	15.7%	3 783	2375%	-424	-10%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	4	3	0.0%	3	∞	-1	-27%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 042	2 418	2 852	11.4%	1 810	174%	434	18%	T2	CS
Poland	92	2 429	1 998	8.0%	1 906	2061%	-431	-18%	T2	CS
Portugal	NO	1 145	1 056	4.2%	1 056	∞	-89	-8%	T2	CR,D,PS
Romania	NO	545	444	1.8%	444	∞	-101	-19%	T2	CS
Slovakia	88	233	249	1.0%	161	184%	16	7%	T3	PS
Slovenia	127	NO	NO	-	-127	-100%	-	-	NA	NA
Spain	46	3 342	3 275	13.1%	3 229	7023%	-67	-2%	T2,T3	PS
Sweden	NO	137	114	0.5%	114	∞	-22	-16%	T2	CS
United Kingdom	49	2 466	2 568	10.3%	2 519	5107%	102	4%	T2	CS
EU-27+UK	**5 275**	**24 390**	**25 042**	**100%**	**19 767**	**375%**	**652**	**3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	49	2 466	2 568	10.3%	2 519	5107%	102	4%	T2	CS
EU-KP	**5 275**	**24 390**	**25 042**	**100%**	**19 767**	**375%**	**652**	**3%**	**-**	**-**

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

Table 3.15 also shows that about 99 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS.

Figure 3.22 illustrates the trend of increasing emissions from gaseous fuels in category 1.A.1.b in the last 28 years. As can be seen the six largest contributors to CO_2 emissions in this sector account together for 72% of the total emissions in this category. Emissions have increased by 3% between 2017 and 2018 and are at the same level as in 2014.

Figure 3.22 1.A.1.b Petroleum Refining, Gaseous Fuels: Emission trend and share for CO_2

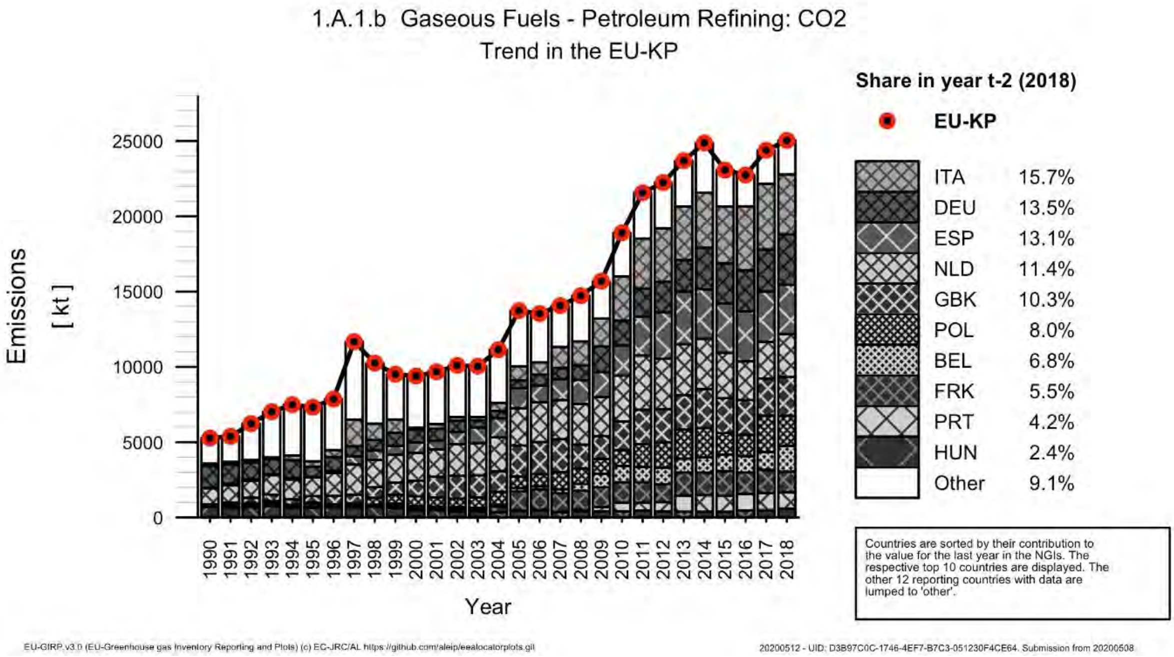
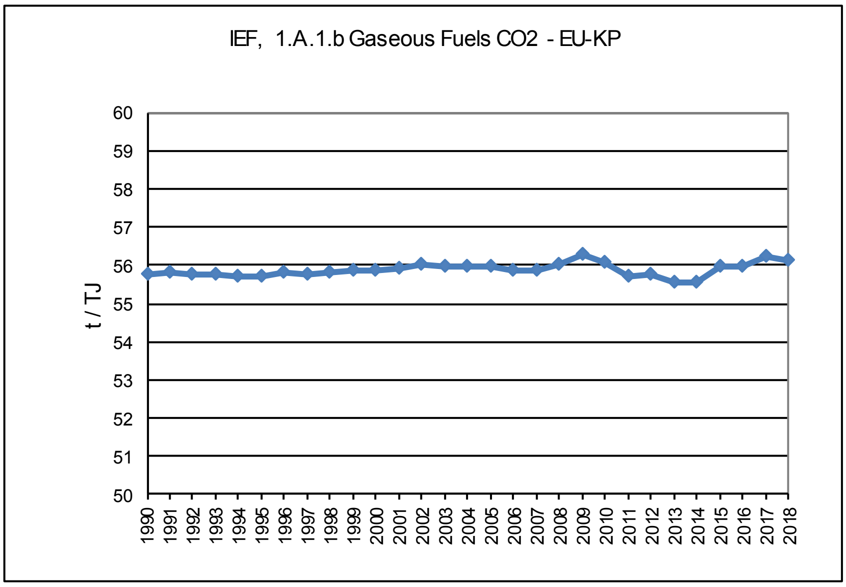
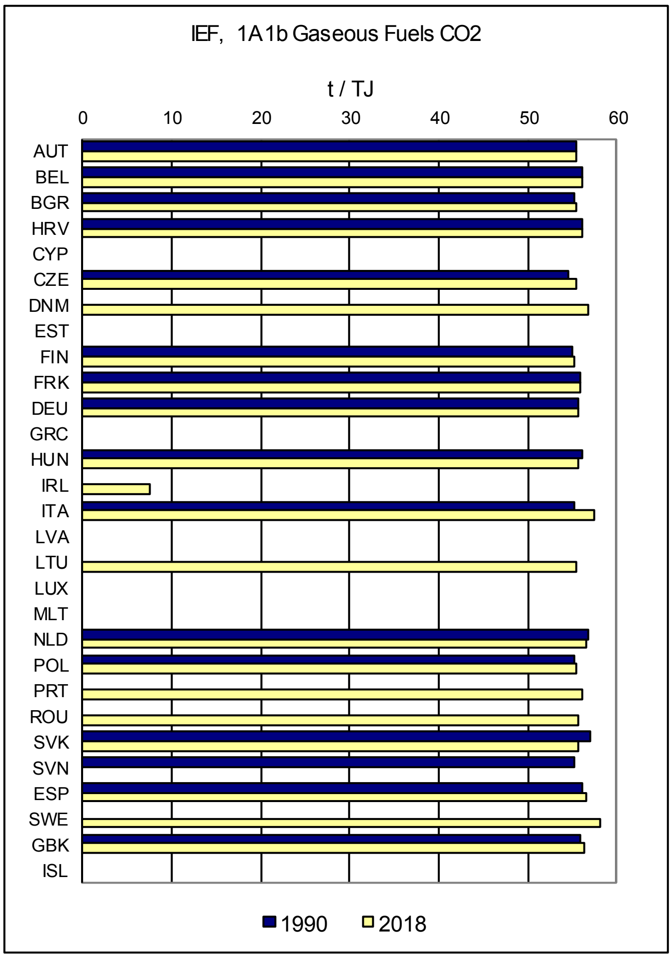


Figure 3.23 (on the next page) shows the implied emission factors for CO_2 emissions from gaseous fuels. The EU-KP implied emission factor has remained broadly stable around 56 t/TJ on the entire time-series. The very low IEF from Ireland is due to inconsistencies between CO_2 emissions originating from ETS data and activity data derived from the energy balance which aggregates different types of gases. This impacts only the IEF as total fuel reported under ETS is very similar to total fuel reported in the energy balance.

Figure 3.23 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-KP)**

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 1.4% of total EU-KP greenhouse gas emissions in 2018. Between 1990 and 2018, CO_2 emissions fell by 53% in the EU-KP (Table 3.16). The United Kingdom, Germany, the Czech Republic and Italy together are responsible for 66% of the total EU-KP emissions in 2018. Germany is responsible for almost 92% of the whole decrease in this category between 1990 and 2018.

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

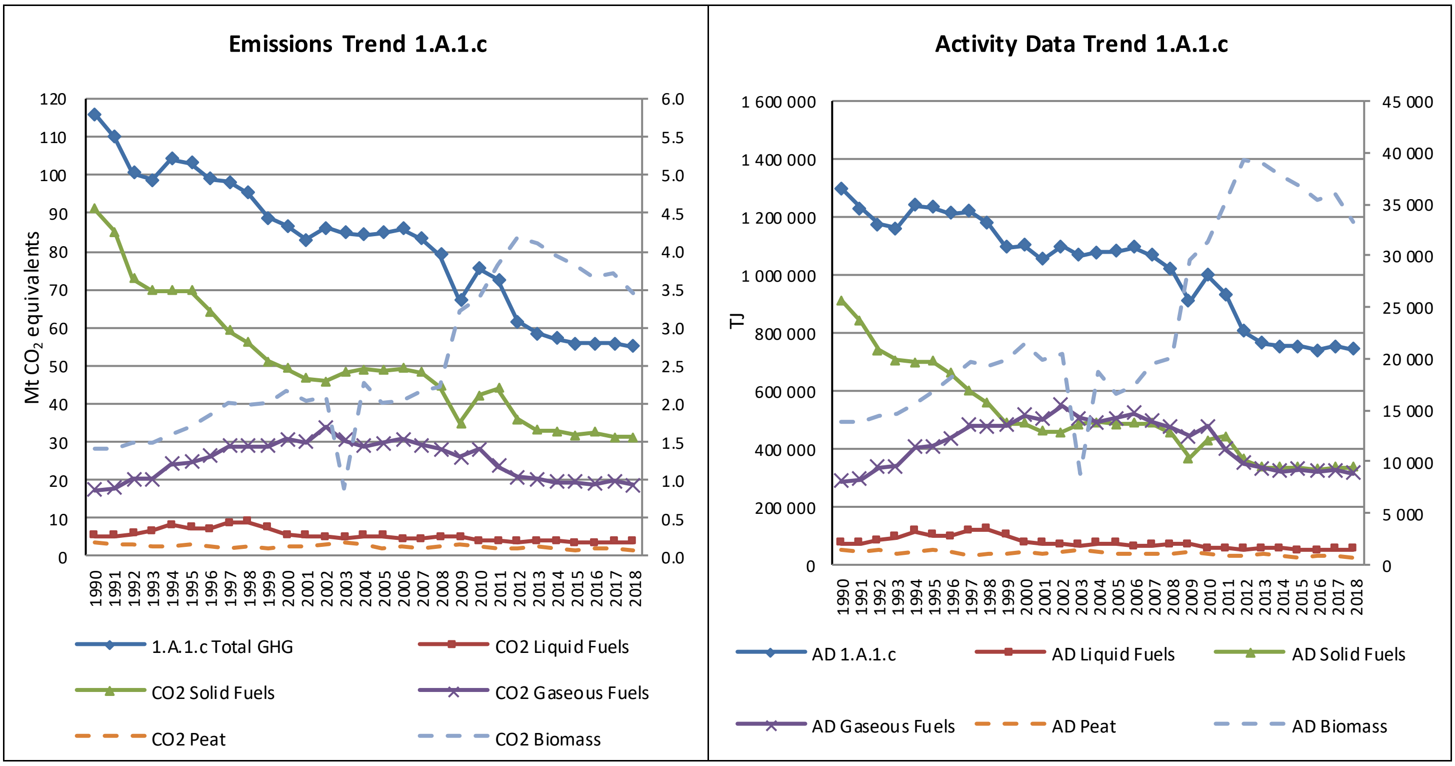
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	510	259	240	0.4%	-270	-53%	-20	-8%	T2	CS
Belgium	2 024	151	152	0.3%	-1 872	-92%	1	1%	T3	PS
Bulgaria	362	4	6	0.0%	-357	-98%	2	48%	T1,T2	CS,D
Croatia	873	218	205	0.4%	-668	-77%	-13	-6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 516	5 889	5 771	10.7%	4 255	281%	-118	-2%	T1,T2	CS,D
Denmark	545	1 364	1 260	2.3%	715	131%	-104	-8%	T2,T3	CS,PS
Estonia	78	1 467	1 564	2.9%	1 485	1895%	97	7%	T3	PS
Finland	347	325	297	0.6%	-50	-14%	-29	-9%	T3	CS
France	4 738	3 091	2 994	5.6%	-1 744	-37%	-96	-3%	T2	CS
Germany	65 289	9 810	9 701	18.0%	-55 588	-85%	-109	-1%	CS	CS
Greece	102	37	45	0.1%	-57	-56%	8	22%	T2	PS
Hungary	573	305	370	0.7%	-203	-35%	65	21%	T1,T2,T3	CS,D,PS
Ireland	100	129	119	0.2%	19	19%	-10	-8%	T3	CS
Italy	12 449	5 777	5 641	10.5%	-6 807	-55%	-135	-2%	T3	CS
Latvia	145	46	52	0.1%	-94	-64%	6	13%	T2	CS
Lithuania	9	53	54	0.1%	45	484%	1	2%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 110	2 654	3 004	5.6%	893	42%	350	13%	T2	CS
Poland	4 846	3 080	3 138	5.8%	-1 708	-35%	58	2%	T1,T2	CS,D
Portugal	141	NO	NO	-	-141	-100%	-	-	NA	NA
Romania	146	2 296	2 121	3.9%	1 975	1352%	-175	-8%	T1,T2	CS,D
Slovakia	1 319	1 218	1 182	2.2%	-137	-10%	-37	-3%	T2	CS
Slovenia	82	0	0	0.0%	-82	-100%	0	94%	T2	CS
Spain	2 144	1 251	1 146	2.1%	-998	-47%	-105	-8%	T1,T2	,D,OTH,PS
Sweden	300	393	362	0.7%	62	20%	-31	-8%	T2	CS
United Kingdom	13 782	15 081	14 487	26.9%	705	5%	-594	-4%	T1,T2	CS,D
EU-27+UK	**114 533**	**54 900**	**53 910**	**100%**	**-60 623**	**-53%**	**-990**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	13 782	15 081	14 487	26.9%	705	5%	-594	-4%	T1,T2	CS,D
EU-KP	**114 533**	**54 900**	**53 910**	**100%**	**-60 623**	**-53%**	**-990**	**-2%**	**-**	**-**

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

Figure 3.24 shows the trends in emissions from this source category by fuel in the EU-KP between 1990 and 2018. The largest part of greenhouse gas emissions from the manufacture of solid fuels can be accounted to CO_2 emissions from solid (57%) and gaseous (34%) 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 42.8% in the EU-KP between 1990 and 2018. The strongest decline was reported for solid fuels (-63%), followed by liquid fuels (-27.9%). On the other hand, gaseous fuels and biomass increased in the period 1990 to 2018. In the year 2018 solid fuels and gaseous fuels represented 45.4% and 42.7% respectively of all fuel used. Almost no other fossil fuels and peat are used in this category; together accounting for less than 0.1% of the total fuel used in 2018.

Figure 3.24 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 57% of total greenhouse gas emissions from 1.A.1.c in 2018. Emissions in the EU-KP declined by 66% since 1990. This was mainly driven by a strong decline in emissions in Germany (-51 762 kt CO_2), which amounts to about 86.5% of the total decline in this category.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	1 969	151	152	0.5%	-1 817	-92%	1	1%	T3	PS
Bulgaria	274	2	1	0.0%	-273	-99%	-1	-29%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 352	5 865	5 749	18.4%	4 397	325%	-116	-2%	T1, T2	D, CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	78	1 467	1 564	5.0%	1 485	1895%	97	7%	T3	PS
Finland	347	325	297	0.9%	-50	-14%	-29	-9%	T3	CS
France	4 054	3 091	2 994	9.6%	-1 060	-26%	-96	-3%	T2	CS
Germany	61 101	9 511	9 339	29.8%	-51 762	-85%	-173	-2%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	220	180	263	0.8%	43	20%	84	47%	T1, T2, T3	D, CS, PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	10 891	4 802	4 739	15.1%	-6 152	-56%	-64	-1%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	916	1 031	1 449	4.6%	533	58%	418	41%	T2	CS
Poland	4 009	2 088	2 197	7.0%	-1 812	-45%	109	5%	T1/T2	D/CS
Portugal	91	NO	NO	-	-91	-100%	-	-	T1	D
Romania	NO	1	0	0.0%	0	∞	-1	-79%	T1,T2	CS,D
Slovakia	1 319	1 174	1 144	3.7%	-175	-13%	-31	-3%	T2	CS
Slovenia	37	NO	NO	-	-37	-100%	-	-	NA	NA
Spain	1 864	273	243	0.8%	-1 620	-87%	-30	-11%	T1/T2	D/CS/PS
Sweden	300	393	362	1.2%	62	20%	-31	-8%	T2	CS
United Kingdom	2 344	775	805	2.6%	-1 540	-66%	30	4%	T1, T2	CS, D
EU-27+UK	**91 167**	**31 130**	**31 298**	**100%**	**-59 870**	**-66%**	**168**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 344	775	805	2.6%	-1 540	-66%	30	4%	T1, T2	CS, D
EU-KP	**91 167**	**31 130**	**31 298**	**100%**	**-59 870**	**-66%**	**168**	**1%**		

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

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 97 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 one third of the 1990 levels. The decline in emissions (see Figure 3.25 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 2018 were Germany, the Czech Republic and Italy, jointly responsible for 63.3% of all EU-KP emissions in this category.

Figure 3.25 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Emission trend and share for CO_2

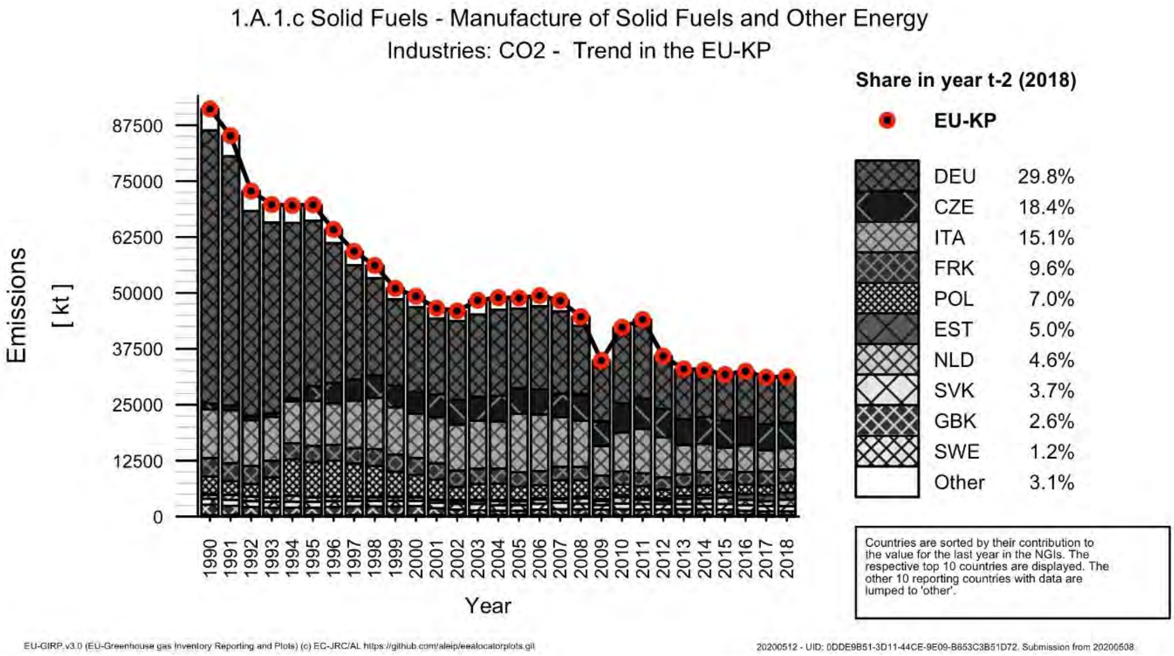
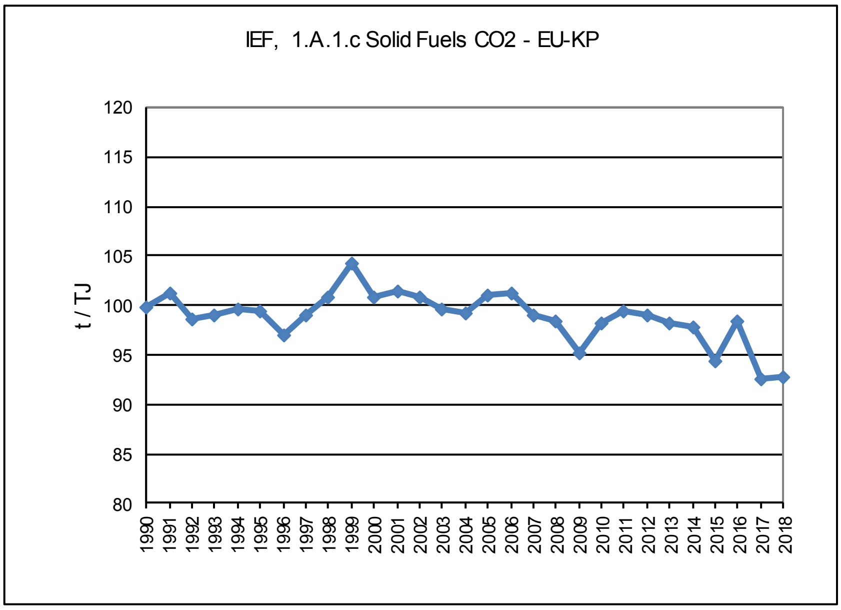
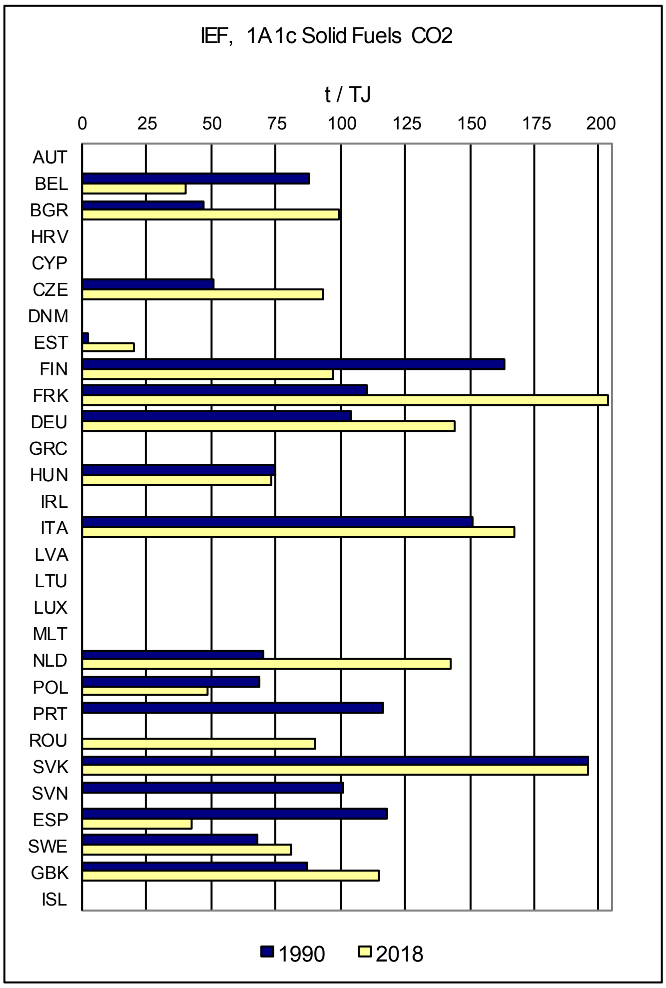


Figure 3.26 shows the relevant implied emission factors for solid fuels. The EU-KP implied emission factor amounted to 92.7 t/TJ in 2018: it is the lowest with 2017 of the entire time-series. This drop can be partly explained by the decrease of 8% of IEF of Italy (third emitter with 15.1%) since 2016.

In general, the 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 the carbon in the oil shale is subtracted from the carbon of shale oil, semi-coke gas, gasoil and black ash.

Figure 3.26 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 34.1% of total greenhouse gas emissions from this category in 2018. Emissions in the EU-KP increased by 8% (Table 3.18 below) between the years 1990 and 2018. After a strong increase 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 57.7% of emissions in 2018 in the EU-KP. The top three countries (United Kingdom, the Netherlands and Romania) together account for 73.4% of emissions in this category.

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

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	506	259	240	1.3%	-267	-53%	-20	-8%	T2	CS
Belgium	51	NO	NO	-	-51	-100%	-	-	NA	NA
Bulgaria	NO	1	1	0.0%	1	∞	0	-28%	T1,T2	CS,D
Croatia	833	218	205	1.1%	-628	-75%	-13	-6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	5	3	0.0%	3	∞	-2	-34%	T1, T2	D, CS
Denmark	545	1 364	1 260	6.7%	715	131%	-104	-8%	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	287	351	1.9%	-2 271	-87%	64	22%	CS	CS
Greece	102	37	45	0.2%	-57	-56%	8	22%	T2	PS
Hungary	313	125	106	0.6%	-207	-66%	-19	-15%	T1, T3	D, PS
Ireland	IE	30	41	0.2%	41	∞	11	35%	T3	CS
Italy	615	974	903	4.8%	287	47%	-72	-7%	T3	CS
Latvia	45	24	29	0.2%	-16	-36%	4	18%	T2	CS
Lithuania	NO	39	41	0.2%	41	∞	1	3%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 184	1 623	1 555	8.3%	370	31%	-69	-4%	T2	CS
Poland	684	887	832	4.4%	148	22%	-54	-6%	T2	CS
Portugal	NO	NO	NO	-	-	-	-	-	T1	D
Romania	NO	1 548	1 418	7.6%	1 418	∞	-130	-8%	T1,T2	CS,D
Slovakia	NO	44	38	0.2%	38	∞	-6	-14%	T2	CS
Slovenia	42	0	0	0.0%	-42	-100%	0	94%	T2	CS
Spain	89	936	858	4.6%	768	862%	-79	-8%	T2	CS
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom	9 206	11 424	10 801	57.7%	1 594	17%	-624	-5%	T1, T2	CS, D
EU-27+UK	**17 369**	**19 829**	**18 726**	**100%**	**1 357**	**8%**	**-1 103**	**-6%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	9 206	11 424	10 801	57.7%	1 594	17%	-624	-5%	T1, T2	CS, D
EU-KP	**17 369**	**19 829**	**18 726**	**100%**	**1 357**	**8%**	**-1 103**	**-6%**		

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

Note: Estonia includes the emissions from 1.A.1.c in 1A1a.
Sweden includes emissions from 1.A.1.c in 1.A.2.g

Table 3.18 also shows that 92 % of EU-KP emissions are calculated using higher tier methods. Many countries 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 3.27 illustrates the emission trend for gaseous fuels split by countries over the last 28 years. Although the emissions in the year 2018 compared to 1990 increased by 8% over the whole time series, there was a strong increase in the 1990s and a decline after 2009. The increase in EU-KP 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 57.7% of the total EU-KP emissions in this category in 2018.

Figure 3.27 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Emission trend and share for CO_2

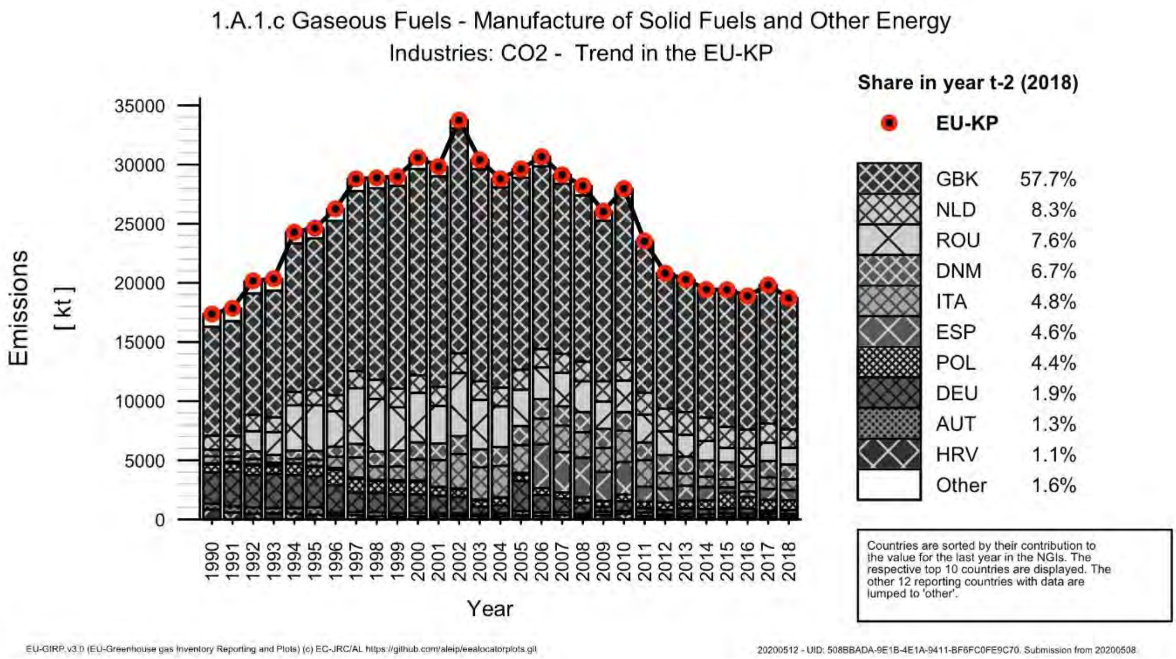
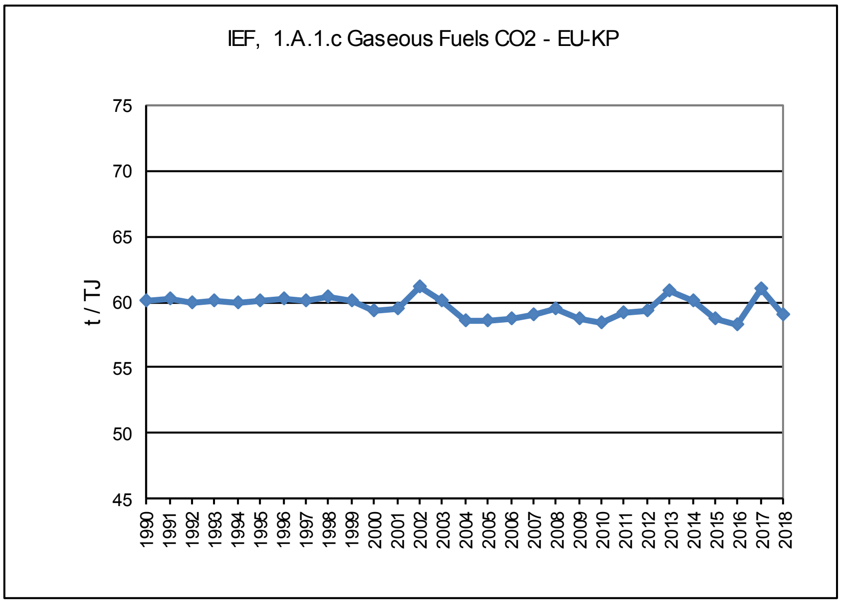
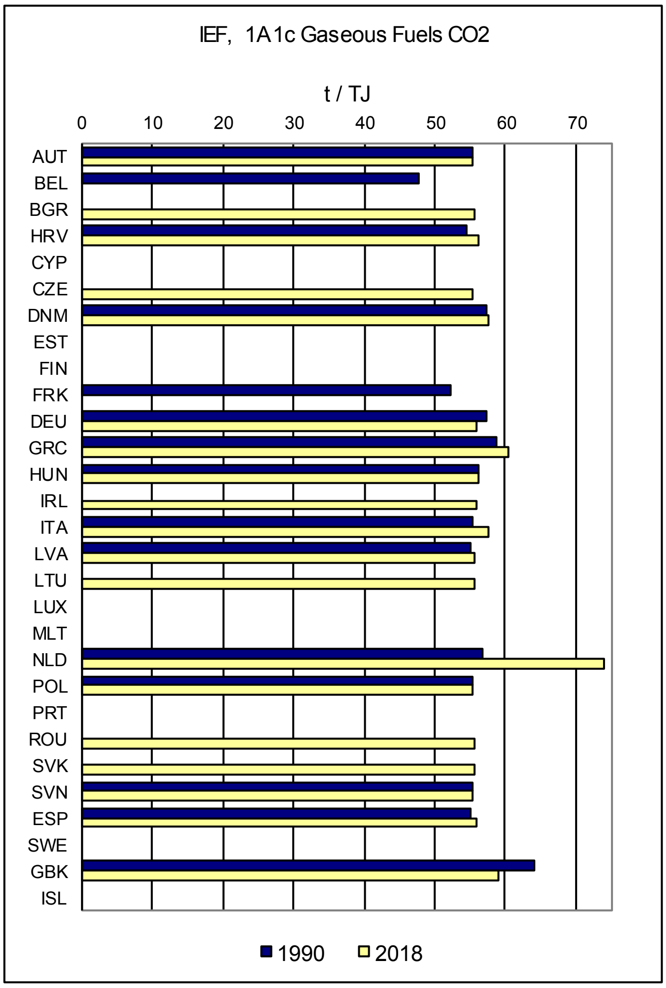


Figure 3.28 (on the next page) shows the implied emission factors for gaseous fuels. The EU-KP implied emission factor amounts 59 t/TJ in 2018 and remained fairly stable around 60 t/TJ over the last 28 years. The IPCC default values range between 54.3 t/TJ (lower) and 58.3 t/TJ (upper). The EU-KP IEF is dominated by the IEF of the United Kingdom and the Netherlands, which are comparatively high. 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. 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 IEF in other sectors. The IEF of the Netherlands is comparatively high. The inter-annual variability in the EFs for CO_2 and CH_4 emissions from gas combustion is mainly

due to a change in the statistics to estimate Activity Data which are not consistent with emissions reported in the AERs of individual companies. This leads to high IEF but it does not influence total emissions: this issue is under investigation.

Figure 3.28 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 1.A.2.)

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 1.A.2.. Emissions from category 1.A.2. 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 countries report emissions arising from off-road and other mobile machinery used in industry (e.g. construction machinery) under category 1.A.2.g. 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 subcategories 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 specific tier methods used for each 1.A.2. key source category emission estimates. It can be seen, that most countries use Tier 2 methodology for emission estimates.

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

Methods and method combinations	Share of emissions which are estimated by the specific Tier method'
CS	3%
T1	17%
T1,T2	17%
T1,T3	4%
T2	46%
T2,T3	3%
T3	7%
T1,T2,T3	3%
CS,T1,T3	1%

Information about methodology used by countries for calculating emissions from category 1.A.2.g is not included in submission files for specific fuels but only as overall methodology information.

Table 3.20: Key categories for sector 1.A.2. (Table excerpt)

Source category gas	kt CO_2 equivalent		Trend	Level		Share of higher Tiers [%]
	1990	2018		1990	2018	

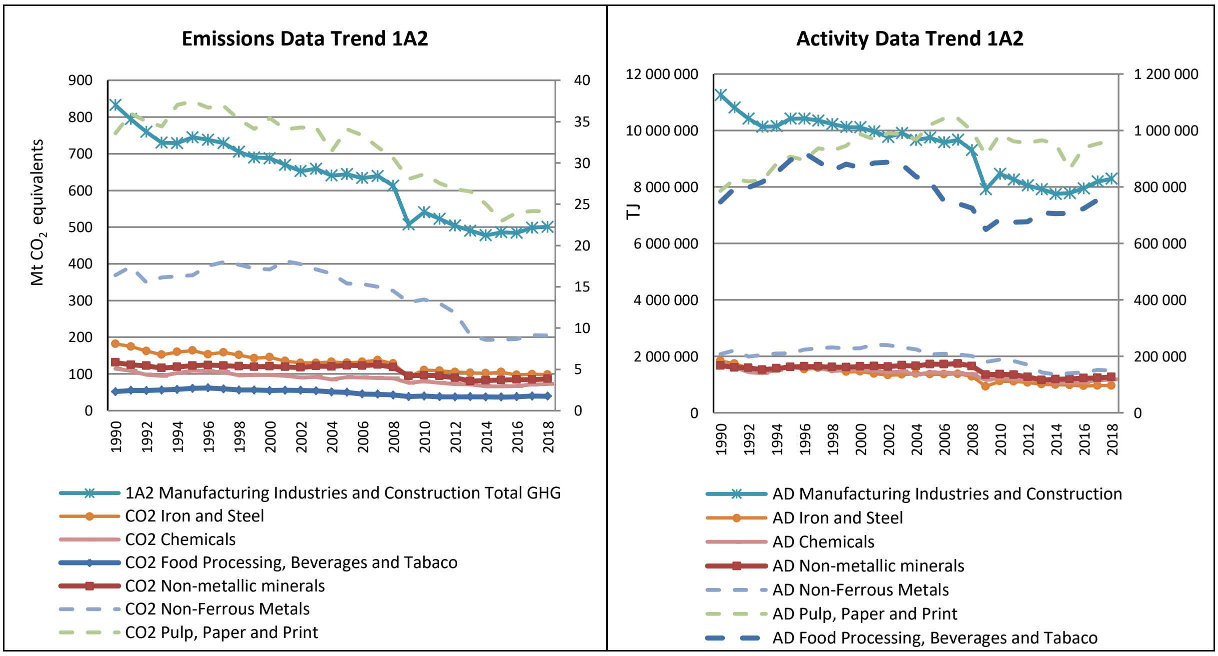
Source category gas	kt CO_2 equivalent		Trend	Level		Share of higher Tiers [%]
	1990	2018		1990	2018	
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	31 736	19 745	T	L	L	99
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8 787	1 406	T	L	0	99
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	140 878	77 065	T	L	L	99.9
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3 836	7 052	T	0	L	92
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8 141	1 352	T	0	0	92
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	55 144	39 357	0	L	L	98
1.A.2.c Chemicals: Liquid Fuels (CO_2)	40 698	22 245	T	L	L	93
1.A.2.c Chemicals: Solid Fuels (CO_2)	15 336	8 576	0	L	L	99
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13 067	18 766	T	L	L	91
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11 338	1 721	T	L	0	89
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	7 982	2 376	T	0	0	96
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19 284	31 362	T	L	L	95
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	19 745	3 344	T	L	0	60
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12 648	4 546	T	L	0	93
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27 315	31 449	T	L	L	98
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	44 730	22 729	T	L	L	98
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1 422	14 701	T	0	L	71
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	57 559	17 126	T	L	L	99
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	94 404	93 707	T	L	L	99
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	105 940	49 572	T	L	L	96
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93 817	14 338	T	L	L	98

In 2018, category 1.A.2. contributed to 500 975 kt CO_2 equivalents of which 98.7% share belongs to CO_2 emissions, 0.8% to N_2O emissions and 0.5% to CH_4 emissions.

Figure 3.29 shows the emission trends within source category 1.A.2., which is dominated by CO_2 from category 1.A.2.g Other which contributes to total kt CO_2 equivalents emissions by 33% followed by 1.A.2.a Iron and steel contributing by 20%, 1.A.2.f Non-metallic Minerals contributing by 17%, 1.A.2.c Chemicals by 14%, 1.A.2.e Food processing, beverages and tobacco by 8%, 1.A.2.d Pulp, paper and print by 5% and 1.A.2.b Non-ferrous metals by 2%. Some Member States do not allocate emissions to all sub-categories under 1.A.2., which is one reason for 1.A.2.g being the largest sub-category within 1.A.2. source category.

Greece reports the rest of industrial sector emissions in category 1.A.2.f instead of category 1.A.2.g for whole time series. Germany reports some fuels of subcategories 1.A.2.a-1.A.2.e as included elsewhere (Notation key 'IE') and reports the specific emissions and activity data under 1.A.2.g. For the years 2013 to 2018 Sweden makes excessive use of confidential reporting (Notation key 'C'), which implies that sub-categories include emissions without providing detailed fuel specific emissions (1.A.2.a, 1.A.2.b, 1.A.2.c, 1.A.2.d, 1.A.2.e, 1.A.2.f and 1.A.2.g for 2013 and 1.A.2.a, 1.A.2.f and 1.A.2.). However, all Swedish confidential emissions are included in the total emissions of 1.A.2. and have been included in 'other fossil fuels' of the EU inventory.

Figure 3.29: 1.A.2. Manufacturing Industries and Construction: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Table 3.21 summarizes information by countries on GHG emissions and CO_2 emissions from 1.A.2. Manufacturing Industries and Construction in 1990 and 2018. The highest share on total kt CO_2 equivalent emissions (above the average share calculated for EU-KP) has Germany (26%), Italy (11%), France (10%), United Kingdom (10%), Spain (9%), Poland (6%) and Netherlands (6%). Together those countries contribute to 78% of total emissions from 1.A.2.

Table 3.21: 1.A.2. Manufacturing Industries and Construction: Member States, United Kingdom and Iceland contributions to total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)
Austria	9 844	10 933	9 762	10 788
Belgium	23 220	13 811	23 074	13 594
Bulgaria	17 765	4 270	17 666	4 228
Croatia	5 529	2 421	5 502	2 411
Cyprus	515	557	512	551
Czechia	47 113	9 959	46 824	9 867
Denmark	5 428	3 966	5 362	3 880
Estonia	2 507	688	2 498	676
Finland	13 429	6 862	13 246	6 683
France	78 794	51 431	78 082	50 707
Germany	186 709	130 124	185 108	128 961
Greece	9 405	5 125	9 338	5 049
Hungary	13 623	5 337	13 587	5 295
Ireland	3 962	4 741	3 943	4 715
Italy	91 203	53 936	89 697	52 887
Latvia	3 963	762	3 902	710
Lithuania	6 165	1 266	6 108	1 247
Luxembourg	6 266	1 164	6 250	1 153
Malta	53	43	53	43
Netherlands	34 549	28 004	34 446	27 897
Poland	42 836	31 728	42 621	31 427
Portugal	8 946	7 559	8 788	7 396
Romania	49 243	12 165	49 138	12 098
Slovakia	16 097	7 633	16 027	7 581
Slovenia	3 151	1 828	3 119	1 802
Spain	45 271	46 408	44 918	45 255
Sweden	10 900	6 911	10 739	6 743
United Kingdom	95 680	51 041	95 248	50 687
EU-27+UK	**832 164**	**500 675**	**825 556**	**494 330**
Iceland	377	150	362	138
United Kingdom (KP)	95 789	51 191	95 356	50 836
EU-KP	**832 649**	**500 975**	**826 026**	**494 617**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The difference between EU-27+UK and EU-KP is not only Iceland but also the different geographical coverage of the UK included in the EU-27+UK submission (GBE). The EU-27+UK numbers are the numbers submitted under the UNFCCC and include the EU territory for the UK. The EU-KP numbers are the numbers submitted under the Kyoto Protocol and include the Kyoto Protocol territory of the UK (GBK).

CO_2 emissions from 1.A.2. Manufacturing Industries and Construction is the fourth largest sector in the EU-KP accounting for 15% of total GHG emissions from Energy sector in 2018. Between 1990 and 2018, CO_2 emissions from 1.A.2. Manufacturing Industries and Construction declined by 40%. Decrease of total emissions is caused by decrease of fossil fuel consumption in category 1.A.2. Manufacturing Industries and Construction.

A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass CO_2 emissions by 110% and an increase of other fossil fuels CO_2 emissions by 180% have been recorded in 2018 compared to 1990.

Between 1990 and 2018, CO_2 emissions were significantly reduced by Latvia (82%), Luxembourg (82%), Lithuania (80%), Czechia (79%), Bulgaria (76%), Romania (75%) and Estonia (73%) compared to the level of CO_2 emissions in 1990. Only Austria, Cyprus, Ireland and Spain report emission increases.

The main reason for the decline of emissions in Latvia for 1990 to 2001 could be explained with recession of Soviet Union and following reformations and reorganizations within Latvia after that. Decrease of emissions in 2006 to 2008 were influenced by the features of national economy development when in-country industrial production already started to diminish due to increasing costs of the production and dominance of imported products. Crisis in national economy in the second part of 2008 also caused a significant decrease in total emissions. The main reasons for the large decline in Czechia 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 main reason for the decline of emissions in Germany (30%) was the restructuring of the industry and efficiency improvements after German reunification.

Table 3.22 provides information on countries recalculations in CO_2 from 1.A.2. Manufacturing Industries for 1990 and 2017 and explanations for the recalculations in absolute terms. The largest recalculations in 1990 were reported by Italy and Portugal. The largest recalculations in 2017 were reported by the Germany, Italy and Spain. The reasons for year 2017 revisions are mostly changes in activity data/revised energy balances.

Table 3.22: 1.A.2. Manufacturing Industries and Construction: Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2017		Explanations for Changes
	kt CO_2	%	kt CO_2	%	
Austria	-56	-0.6	-332	-3.0	Revised energy balance. Revised EF for Industrial Waste (non ETS).
Belgium	-11	-0.0	43	0.3	Optimization of the model to calculate the off-road emissions (OFFREM-model) in the category 1A2gvii (all regions). Brussels-Capital region: Energy consumption data of stationary combustion in the industry were revised for the period 2014-2017. Walloon region: In 1A2gviii, from 1990 to 2013, recalculation of the gasoil consumptions as there was a double counting of the consumption with the gasoil used in the sector 1A2gvii (offroad in industry). Flemish region: For the year 2017 a correction was made for heavy fuel oil for the aggregated group of big companies with an energy-audit. A number of companies were re-allocated to another sector from the year 2017 on.
Bulgaria	-	-	-1.7	-0.0	Correction of computation error in category 1.A.2.g.viii – Other fossil fuels.
Croatia	-	-	21	0.9	In 1.A.2.gviii small part of liquid fosil fuels were not added from energy balance by mistake in previous submission.
Cyprus	-	-	-37	-5.7	Revised Activity Data (Energy balance)
Czechia	-	-	-112	-1.1	Updated activity data for natural gas and solid fuels.
Denmark	-3.7	-0.1	-38	-1.0	For stationary combustion plants, the emission estimates for the years 1990-2017 have been updated according to the latest energy statistics published by the Danish Energy Agency.

	1990		2017		Explanations for Changes
	kt CO_2	%	kt CO_2	%	
Estonia	-	-	16	2.6	Emissions in the categories 1.A.2.b, 1.A.2.c, 1.A.2.d, 1.A.2.e, 1.A.2.f and 1.A.2.g were recalculated due to updates in the past energy balances done by Statistics Estonia.
Finland	-232	-1.7	-181	-2.7	Reallocation of certain non-road machinery.
France	347	0.4	-740	-1.5	Revision of consumption in the SDES energy balance for all fuels Update of the emission factor for domestic heating oil over the years 1990 to 2017 1.A.2.e Dehydration of alfalfa: taking into account the consumption of sites in bottom up: impact on total consumption and on emissions.
Germany	-	-	-3493	-2.6	Recalculation of blast furnace gas due to rounding differences, 2014 (1.A.2.a) Recalculations after updating production data in accordance with the BGS sheet supplied, 2017 (1.A.2.a)
Greece	-	-	-	-	
Hungary	-	-	47	1.0	Latest IEA/Eurostat energy statistics.
Ireland	-	-	-99	-2.1	Revised fuel consumption in the national energy balance for fuels and years; natural gas (2009, 2013, 2015), fuel oil, biomass and non-renewable wastes (2017) resulted in recalculations for these years.
Italy	-2016	-2.2	1298	2.6	Update of complete time series of liquid fuel consumption according to data officially submitted to EUROSTAT
Latvia	-	-	0.0	0.0	Calculated CO_2 emissions from Industrial waste (tyre combustion) in sector CRF 1.A.2.f were corrected.
Lithuania	-	-	-4.4	-0.4	Correction of activity data for other bituminous coal in 1.A.2.c Chemicals industry based on information provided by Statistics Lithuania; correction of CO_2 emission factor for heating and other gasoil based on measurements performed by AB "ORLEN Lietuva"; correction of activity data for industrial waste (hazardous waste) based on information provided by UAB "Toksika" in Non-specified industry (1.A.2.g.viii).
Luxembourg	-0.1	-0.0	3.1	0.3	Revision of AD: energy balance revised, modified allocation of fuels to road vs. offroad sectors due to switch from HBEFA3.3 to HBEFA4.1.
Malta	0.0	0.0	20	58.7	Biomass values updated.
Netherlands	-12	-0.0	-59	-0.2	Model update for NRMM.
Poland	-148	-0.3	2.7	0.0	Update of the activity data according to Eurostst database and introduction of CO_2 CS EFs for fuel oil.
Portugal	-870	-9.0	-23	-0.3	Iron and Steel (1.A.2.a): Major methodological changes for the iron and steel sector in 1990-2001.
Romania	-755	-1.5	25	0.2	Update of the activity data according to Eurostst database and intoduction of CO_2 CS EFs for fuel oil.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	186	0.4	1049	2.5	Update of CO_2 EF for natural gas for the year 2017 according to country-specific characteristics Correction of a mistake in the activity data used in one glass production plant Correction of a mistake in the consumption of gas oil. In the activity of reheating furnaces, linked to the steel produced in electric arc furnaces (EAF), a lack of gas oil consumption data has been detected and therefore included. Correction of a mistake in the CO_2 EF for residual oil. In the activity of reheating furnaces, linked to the steel produced in electric arc furnaces (EAF), a mistake has been detected in the CO_2 emission factors for residual oil (23H2) and has therefore been corrected. An SO2 emission factor has also been included for the residual oil (23H2). Reallocation of one fraction of emissions in the magnesite production activity from non-ferrous metals category to mineral industry category

	1990		2017		Explanations for Changes
	kt CO_2	%	kt CO_2	%	
					Reallocation of one fraction of emissions in the magnesite production activity from non-ferrous metals category to mineral industry category Correction of the CO_2 EF for natural gas for the year 2017 applied in one part of one chemical plant Update of CO_2 EF for natural gas for the year 2017 according to country-specific characteristics for some activities not previously updated in past Inventory editions Update of CO_2 EF for natural gas in some parts of some cement plants according to country-specific natural gas characteristics Recalculation due to new activity data added referring combustion in pulp, paper and print (1.A.2.d). Update of emissions due to the addition of direct information from chemical plants Update of natural gas consumption for the year 2017 in the tiles and bricks sector Update of CO_2 EF for natural gas according to country-specific fuel characteristics for some metal production plants Recalculations due to the energy balance performed by the Inventory for consistency with energy statistics Correction of a mistake. A lack of CO_2 emissions has been detected in the activity of "reheating furnaces" in 2017 in one of the integrated steel plants, so they have been included.
Sweden	48	0.5	-56	-0.8	Increased fuel consumption and hence emissions in the model for NRMM due to adjustment of different parameters in the model. One chemical facility was reallocated from IPPU to Energy sector.
United Kingdom	-364	-0.4	988	1.9	Revisions to fuel use statistics (DUKES). Revisions to emission factors for Iron and Steel combustion.
EU27+UK	**-3 887**	**-0.5**	**-1 665**	**-0.3**	
Iceland	-0.0	-0.0	-10	-5.8	Some fuels that were previously put in category 1.A.2. have been moved to 1A5 because it is unknown how those fuels are used.
United Kingdom (KP)					NA
EU-KP	**-3 887**	**-0.5**	**-1 681**	**-0.3**	

3.2.2.1 **Iron and Steel (1.A.2.a)**

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.a Iron and Steel.

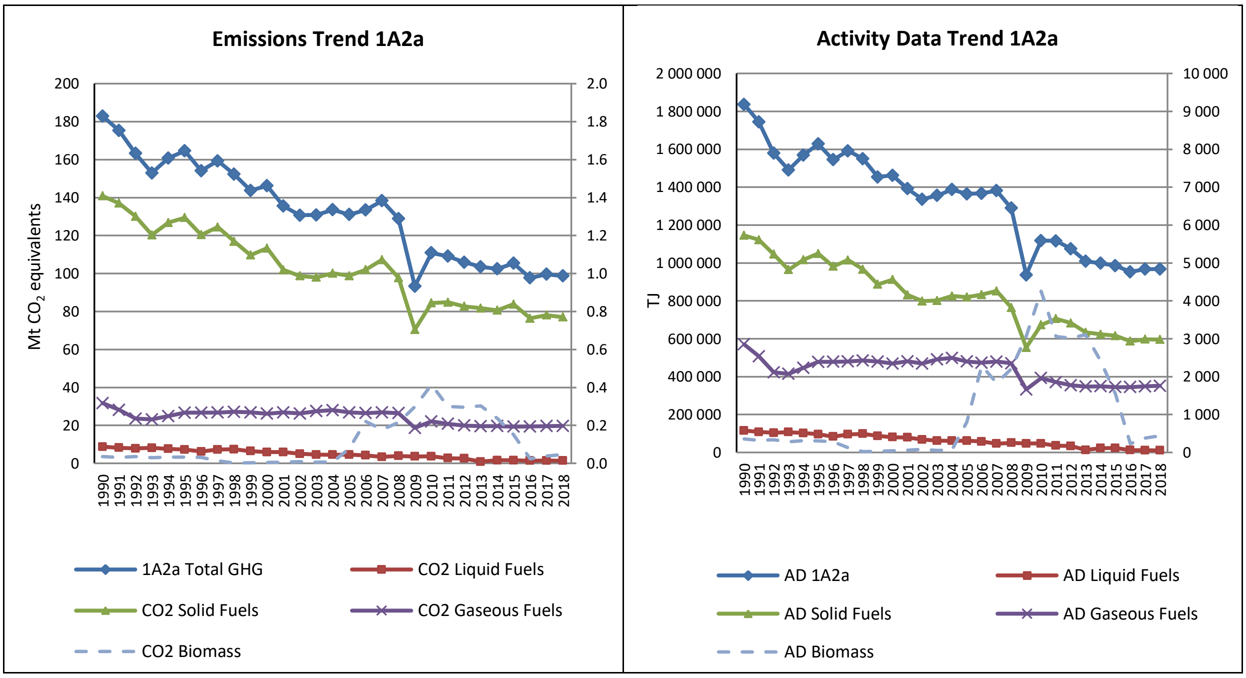
Category 1.A.2.a (more specifically CO_2 emissions from use of gaseous, liquid and solid fuels) was identified as a key category by level and trend and thus next description is concerned only to CO_2 emissions. CO_2 emissions trend and activity data trends can be observed in *Figure 3.30*. Detailed data related to countries CO_2 emissions and percentage differences is depicted in Table 3.23. CO_2 emissions have almost 100% share on total emissions from 1.A.2.a. The strong increase of emissions (20%) observed between 2009 and 2010 correlates with crude steel production which was higher by 25% in 2010. Between 1990 and 2018 CO_2 emissions decreased by 46%. Small decrease of CO_2 emissions (1%) is reported between 2017 and 2018.

Total CO_2 emissions from 1.A.2.a amounted to 98 241 kt CO_2 eq. in 2018. The trend of total CO_2 emissions for 1990 to 2018 from category 1.A.2.a is depicted in *Figure 3.30*. Total CO_2 emissions decreased by 46% since 1990, mainly due to improved efficiency of restructured iron and steel plants and ongoing consequences of the economic crisis in 2009. Total CO_2 emissions decreased by 1% between 2017 and 2018. CO_2 emissions from 1.A.2.a Iron and Steel accounted for 20% of 1.A.2. source category. The share of liquid fuels on CO_2 emissions from 1.A.2.a decreased from 5% in 1990 to 1.5% in 2018. The share of solid fuels on CO_2 emissions from 1.A.2.a increased from 73% in 1990 to 78.5% on 2018. The share of gaseous fuels on CO_2 emissions from 1.A.2.a increased from 17% in 1990 to 20% in 2018.

Almost all Member States reported lower level of CO_2 emissions in 2017 compared to 1990 except of Germany, Slovakia and Iceland. Highest share on total EU-KP emissions has Germany (37%) followed by France (14%) and Italy (10%). Most rapid decrease of emissions compared to 1990 can be observed for Latvia (99.9%), Ireland (99%), Bulgaria (95%), Luxembourg (95%) and Hungary (91%). Emissions are reported as 'NO' (not occurring) for Estonia, Lithuania and Malta. Cyprus reports emissions as 'NO, IE' (not occurring, included elsewhere).

A main driver of category 1.A.2.a CO_2 emissions is crude steel production which decreased from about 192 million tonnes in 1990 to 168 million tonnes in 2018 (www.worldsteel.org (Steel Statistical Yearbook)) as well as blast furnace iron production (BFI), which decreased from about 126 million tonnes to 91 million tonnes in 2018 (www.worldsteel.org).

Figure 3.30: 1.A.2.a Iron and Steel: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Table 3.23: 1.A.2.a Iron and Steel: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Information
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	2 062	1 606	1 722	1.8%	-340	-16%	116	7%	T1,T2	CS,D
Belgium	5 662	1 212	1 266	1.3%	-4 396	-78%	54	4%	T1,T3	D,PS
Bulgaria	2 705	119	130	0.1%	-2 576	-95%	11	9%	T2	CS
Croatia	NO,IE	37	54	0.1%	54	∞	17	47%	T1	D
Cyprus	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Czechia	14 861	2 063	2 020	2.1%	-12 841	-86%	-43	-2%	T1,T2	CS,D
Denmark	125	105	107	0.1%	-19	-15%	2	2%	T1,T2,T3	CS,D
Estonia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Finland	2 499	882	905	0.9%	-1 594	-64%	23	3%	T3	CS,PS
France	21 714	13 267	13 922	14.2%	-7 792	-36%	655	5%	T2,T3	CS,PS
Germany	35 269	37 590	36 534	37.2%	1 264	4%	-1 056	-3%	CS	CS
Greece	447	103	91	0.1%	-357	-80%	-12	-11%	T2	CS,PS
Hungary	2 341	196	207	0.2%	-2 133	-91%	11	6%	T1,T2	CS,D
Ireland	175	2	2	0.0%	-173	-99%	0	0%	T2	CS
Italy	24 410	9 327	10 008	10.2%	-14 402	-59%	681	7%	T2	CS
Latvia	389	0	0	0.0%	-389	-100%	0	-31%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	5 404	269	285	0.3%	-5 120	-95%	15	6%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	5 599	5 423	5 035	5.1%	-563	-10%	-388	-7%	T2	CS
Poland	16 247	5 912	5 459	5.6%	-10 788	-66%	-452	-8%	T1,T2	CS,D
Portugal	373	93	98	0.1%	-275	-74%	5	5%	T2	CR,D,PS
Romania	7 059	1 237	924	0.9%	-6 134	-87%	-312	-25%	T1,T2	CS,D
Slovakia	2 682	3 088	3 424	3.5%	742	28%	336	11%	T2	CS
Slovenia	421	215	209	0.2%	-212	-50%	-6	-3%	T1,T2	CS,D
Spain	8 340	5 677	5 650	5.8%	-2 690	-32%	-27	0%	T1,T2,T3	,D,OTH,PS
Sweden	1 705	1 377	1 342	1.4%	-363	-21%	-35	-3%	T2	CS
United Kingdom	21 563	9 393	8 845	9.0%	-12 718	-59%	-548	-6%	T2	CS
EU-27+UK	**182 053**	**99 193**	**98 239**	**100%**	**-83 814**	**-46%**	**-953**	**-1%**	**-**	**-**
Iceland	0	1	1	0.0%	1	322%	0	6%	T1	D
United Kingdom (KP)	21 563	9 393	8 845	9.0%	-12 718	-59%	-548	-6%	T2	CS
EU-KP	**182 053**	**99 194**	**98 241**	**100%**	**-83 813**	**-46%**	**-953**	**-1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Cyprus reports an 'IE' for liquid fuels (included in 1.A.2.b) 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.

1.A.2.a Iron and Steel - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.a amounted 1 406 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 84% and compared to 2017 by 3%. Category has 0.3% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 91% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.24. Czechia, Estonia, Hungary, Malta, Ireland, Lithuania and Netherlands report emissions as 'NO' (not occurring). Cyprus reports emissions as 'IE' (included elsewhere), consumption of fuels and emissions are included in 1.A.2.b Non-ferrous metals category. Two Member States and Iceland use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Liquid Fuels (CO_2)). All countries reported lower level of emissions in 2018 than in 1990 (except of Iceland, but it should be noted that the share of Iceland emissions on total EU-KP emissions is only 0.1%).

Table 3.24: 1.A.2.a Iron and Steel, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	76	7	6	0.4%	-70	-92%	-1	-16%	T2	CS
Belgium	885	16	16	1.1%	-869	-98%	0	-1%	T1,T3	D,PS
Bulgaria	37	1	1	0.0%	-37	-98%	0	-17%	NA	NA
Croatia	IE	9	7	0.5%	7	∞	-2	-23%	T1	D
Cyprus	IE	IE	IE	-	-	-	-	-	NA	NA
Czechia	427	NO	NO	-	-427	-100%	-	-	NA	NA
Denmark	14	3	3	0.2%	-12	-82%	0	-4%	T1,T2	CS,D
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	305	304	263	18.7%	-42	-14%	-41	-14%	T3	CS
France	1 394	206	192	13.7%	-1 202	-86%	-13	-6%	T2,T3	CS,PS
Germany	916	17	15	1.1%	-901	-98%	-1	-8%	CS	CS
Greece	447	37	30	2.1%	-418	-93%	-8	-20%	T2	PS
Hungary	392	NO	NO	-	-392	-100%	-	-	NA	NA
Ireland	16	NO	NO	-	-16	-100%	-	-	NA	NA
Italy	156	2	1	0.0%	-155	-100%	-1	-55%	T2	CS
Latvia	92	0	0	0.0%	-92	-100%	0	0%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	48	3	3	0.2%	-45	-93%	0	2%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19	NO	NO	-	-19	-100%	-	-	NA	NA
Poland	870	19	18	1.2%	-853	-98%	-1	-5%	T1,T2	CS,D
Portugal	109	0	0	0.0%	-109	-100%	0	191%	T2	CR,D,PS
Romania	NO	17	2	0.2%	2	∞	-14	-85%	T2	CS
Slovakia	164	2	1	0.1%	-163	-99%	-1	-38%	T2	CS
Slovenia	54	5	5	0.4%	-49	-91%	0	2%	T1	D
Spain	1 070	151	132	9.4%	-938	-88%	-20	-13%	T1,T2,T3	CS,D,PS
Sweden	831	616	662	47.1%	-169	-20%	46	7%	T2	CS
United Kingdom	462	38	49	3.5%	-413	-89%	10	26%	T2	CS
EU-27+UK	**8 787**	**1 452**	**1 405**	**100%**	**-7 382**	**-84%**	**-47**	**-3%**	**-**	**-**
Iceland	0	1	1	0.1%	1	322%	0	6%	T1	D
United Kingdom (KP)	462	38	49	3.5%	-413	-89%	10	26%	T2	CS
EU-KP	**8 787**	**1 453**	**1 406**	**100%**	**-7 381**	**-84%**	**-47**	**-3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Cyprus reports an 'IE' for liquid fuels (included in 1.A.2.b) 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 3.31 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Sweden (47%), Finland (19%), France (14%) and Spain (9%), which together have 89% share on EU-KP emissions.

Figure 3.31: 1.A.2.a Iron and Steel, Liquid fuels: Emission trend and share for CO_2

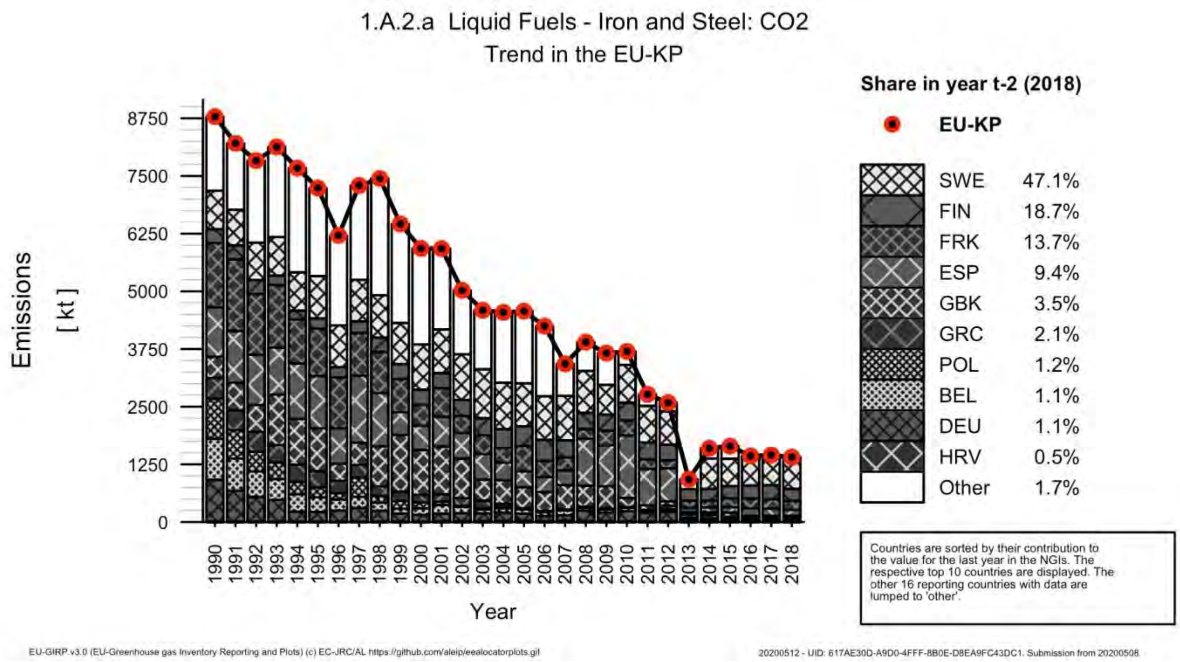
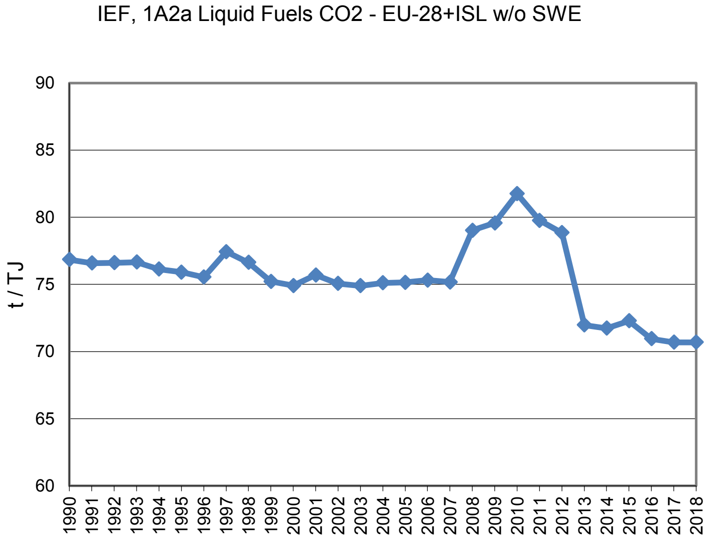


Figure 3.32 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. Between 1990 and 2015 the IEF includes Swedish data; since 2016 Swedish activity data is not reflected in the EU CRF because of confidentiality (however Swedish emissions are included in the EU CRF). Therefore, the EU IEF is much higher in the years 2016-2018 than in the years before. The high CO_2 IEF reported for 2008–2012 is mainly due to the contribution of Spain's CO_2 emissions to the EU total (up to 36 %, in 2010) and its high CO_2 IEF (ranging from 92.4 to 96.1 t/TJ) for those years. The EU CO_2 IEF equaled 70.7 t/TJ in 2018 excluding Sweden.

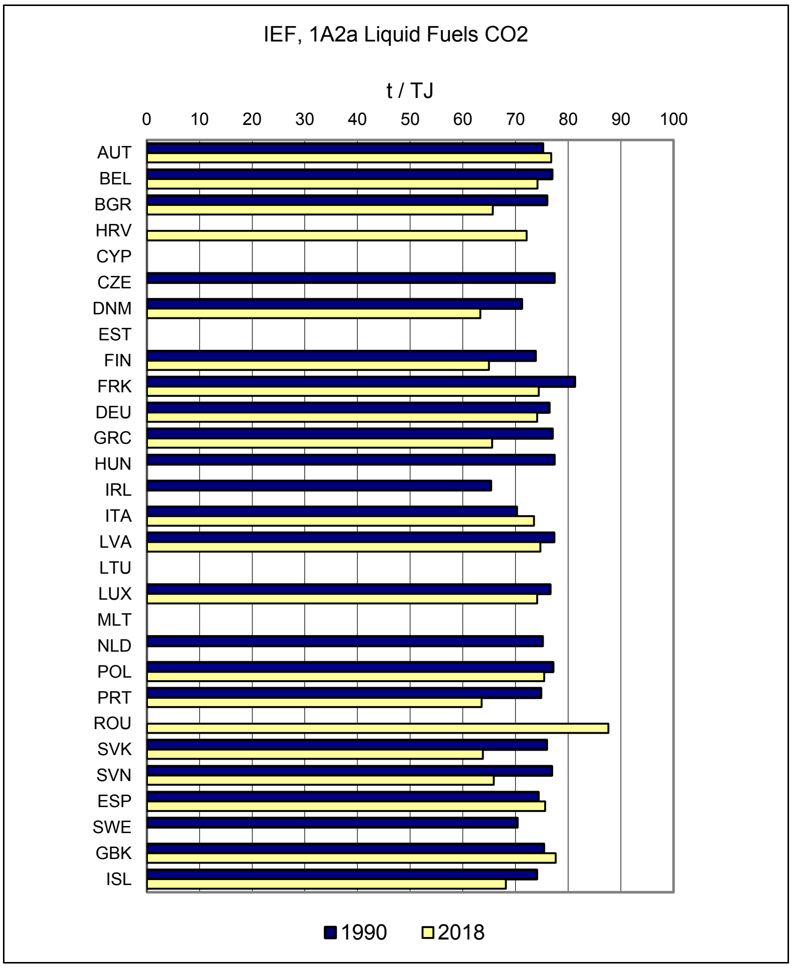
Figure 3.32: 1.A.2.a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



Note: The EU IEF for CO_2 emissions of category 1.A.2.a. liquid fuels displayed in this graph does not include data from SWE due to reported confidential data.

Figure 3.33 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. Since 2015 Romania reports relatively high CO_2 IEF compared to other countries (CO_2 IEF is lower than IPCC upper default value). The comparatively high 2018 CO_2 IEF of Romania is caused by high share of petrol coke included in this category. For year 2018, Sweden reports activity data as C (‘confidential’) and thus CO_2 IEF is not depicted in Figure 3.33.

Figure 3.33: 1.A.2.a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1.A.2.a Iron and Steel - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.a amounted 77 065 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 45% and decreased compared to 2017 by 1%. Category has 16% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 48% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.25. Cyprus, Denmark, Estonia, Greece, Ireland, Latvia, Lithuania, Luxembourg, Malta, Portugal and Iceland report emissions as ‘NO’ (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of the Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.9% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2018 than in 1990 (except of Germany with a 43% share on total EU-KP emissions in 2018 and Slovakia with a 4% share on total EU-KP emissions in 2018).

Table 3.25: 1.A.2.a Iron and Steel, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 335	497	522	0.7%	-814	-61%	24	5%	T2	CS
Belgium	3 284	25	17	0.0%	-3 267	-99%	-8	-31%	T3	PS
Bulgaria	1 631	0	0	0.0%	-1 631	-100%	0	-61%	NA	NA
Croatia	IE	1	12	0.0%	12	∞	11	1183%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	13 709	1 566	1 495	1.9%	-12 213	-89%	-71	-5%	T2	CS,D
Denmark	5	NO	NO	-	-5	-100%	-	-	NA	NA
Estonia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Finland	2 084	451	488	0.6%	-1 596	-77%	37	8%	T3	CS,PS
France	17 506	10 534	11 101	14.4%	-6 405	-37%	567	5%	T2,T3	CS,PS
Germany	29 912	34 301	33 339	43.3%	3 427	11%	-962	-3%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	625	83	64	0.1%	-560	-90%	-18	-22%	T1,T2	CS,D
Ireland	115	NO	NO	-	-115	-100%	-	-	NA	NA
Italy	19 955	5 432	6 053	7.9%	-13 902	-70%	621	11%	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	4 781	4 405	5.7%	-508	-10%	-376	-8%	T2	CS
Poland	11 870	4 579	4 055	5.3%	-7 815	-66%	-524	-11%	T1,T2	CS,D
Portugal	264	NO	NO	-	-264	-100%	-	-	NA	NA
Romania	394	81	152	0.2%	-242	-62%	70	87%	T1,T2	CS,D
Slovakia	2 296	2 959	3 236	4.2%	940	41%	277	9%	T2	CS
Slovenia	57	28	29	0.0%	-28	-50%	1	3%	T1	D
Spain	6 475	3 759	3 656	4.7%	-2 819	-44%	-103	-3%	T1,T2,T3	CS,PS
Sweden	849	581	528	0.7%	-321	-38%	-53	-9%	T2	CS
United Kingdom	18 638	8 433	7 912	10.3%	-10 725	-58%	-521	-6%	T2	CS
EU-27+UK	**140 878**	**78 090**	**77 065**	**100%**	**-63 813**	**-45%**	**-1 025**	**-1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	18 638	8 433	7 912	10.3%	-10 725	-58%	-521	-6%	T2	CS
EU-KP	**140 878**	**78 090**	**77 065**	**100%**	**-63 813**	**-45%**	**-1 025**	**-1%**	**-**	**-**

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 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Germany (43%), France (14%), United Kingdom (10%), Italy (8%) and Netherlands (6%), which together have 81% share on EU-KP emissions.

Figure 3.34: 1.A.2.a Iron and Steel, solid fuels: Emission trend and share for CO_2

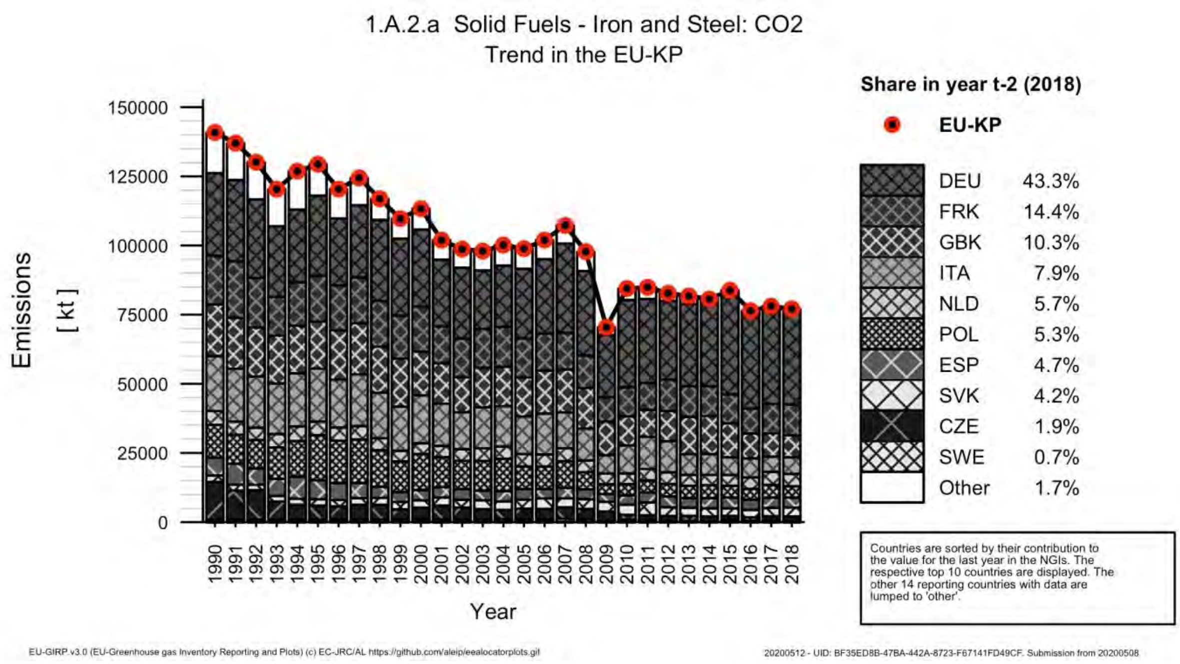


Figure 3.35 shows implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF fluctuate during the whole time series. Lowest CO_2 IEF was calculated for year 2011 and since that CO_2 IEF has increasing but still fluctuating trend. The main reason for the increase in the CO_2 IEF between 2012 and 2013 is Italy's decrease in CO_2 emissions. For these years, the share of Germany's CO_2 emissions in the EU total increased from 27% to 29%, and Germany's CO_2 IEF was one of the highest reported, increasing from 155.17 t/TJ in 2012 to 158.47 t/TJ in 2013. CO_2 IEF equaled to 129.33 t/TJ in 2018.

Figure 3.35: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

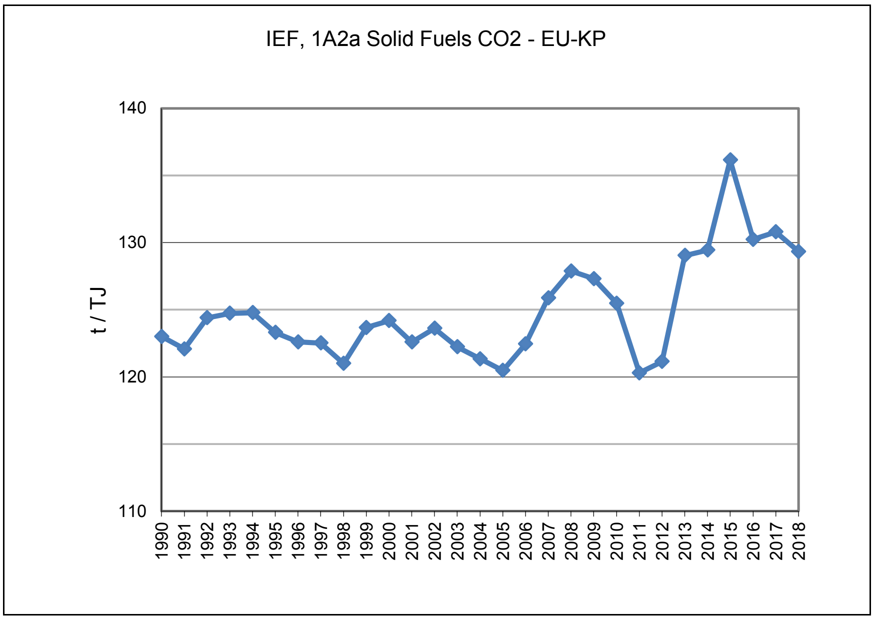
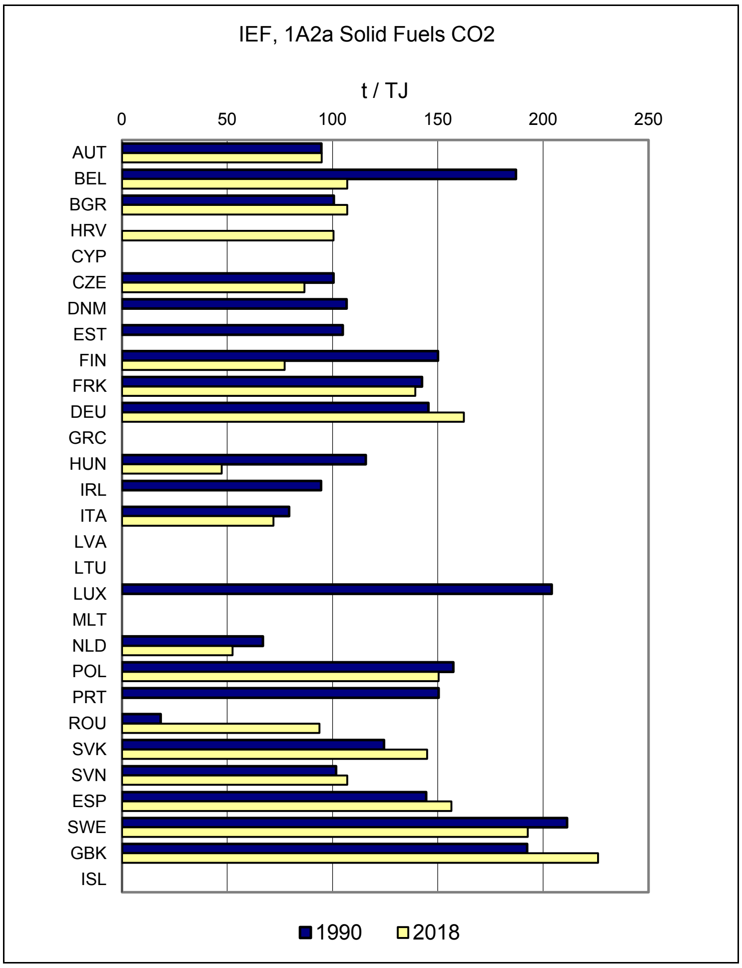


Figure 3.36 shows comparison of CO_2 IEF used by Member States, United Kingdom and Iceland for emission estimates in 1990 and 2018. The high variation of the CO_2 IEFs across MS is due to usage of derived coal gases which have significant lower (coke oven gas) or higher carbon content (blast furnace gas) than coal.

Figure 3.36: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1.A.2.a Iron and Steel - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.a amounted 19 745 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 38% and increased compared to 2017 by 1%. Category has 4% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 38% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.26. Cyprus, Estonia, Lithuania, Malta and Iceland report emissions as 'NO' (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Gaseous Fuels (CO_2)). Austria, Finland, Spain and Sweden report higher level of emissions in 2018 than in 1990. Highest increase of emissions (505%) is calculated for Sweden with a 0.8% share on total EU-KP emissions in 2018.

Table 3.26: 1.A.2.a Iron and Steel, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	650	1 101	1 194	6.0%	544	84%	93	8%	T2	CS
Belgium	1 493	1 167	1 228	6.2%	-265	-18%	61	5%	T1,T3	D,PS
Bulgaria	1 037	118	129	0.7%	-908	-88%	11	10%	T2	CS
Croatia	IE	27	35	0.2%	35	∞	8	31%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	724	496	524	2.7%	-200	-28%	28	6%	T2	CS
Denmark	106	102	104	0.5%	-2	-2%	2	2%	T3	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	110	128	154	0.8%	44	40%	26	21%	T3	CS
France	2 806	2 520	2 614	13.2%	-192	-7%	94	4%	T2,T3	CS,PS
Germany	4 442	3 272	3 180	16.1%	-1 262	-28%	-93	-3%	CS	CS
Greece	NO	65	61	0.3%	61	∞	-4	-6%	T2	CS
Hungary	1 324	113	143	0.7%	-1 181	-89%	30	26%	T1	D
Ireland	44	2	2	0.0%	-41	-95%	0	0%	T2	CS
Italy	4 299	3 894	3 954	20.0%	-345	-8%	61	2%	T2	CS
Latvia	236	0	0	0.0%	-235	-100%	0	-33%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	397	266	281	1.4%	-116	-29%	15	6%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	667	642	630	3.2%	-37	-6%	-12	-2%	T2	CS
Poland	2 924	1 314	1 387	7.0%	-1 537	-53%	73	6%	T2	CS
Portugal	NO	93	98	0.5%	98	∞	5	5%	T2	CR,D,PS
Romania	6 665	1 135	766	3.9%	-5 899	-89%	-369	-32%	T2	CS
Slovakia	221	127	187	0.9%	-35	-16%	60	47%	T2	CS
Slovenia	310	182	175	0.9%	-134	-43%	-7	-4%	T2	CS
Spain	795	1 767	1 862	9.4%	1 067	134%	95	5%	T2,T3	CS,PS
Sweden	25	181	152	0.8%	127	505%	-28	-16%	T2	CS
United Kingdom	2 463	922	884	4.5%	-1 579	-64%	-38	-4%	T2	CS
EU-27+UK	**31 736**	**19 634**	**19 745**	**100%**	**-11 990**	**-38%**	**112**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 463	922	884	4.5%	-1 579	-64%	-38	-4%	T2	CS
EU-KP	**31 736**	**19 634**	**19 745**	**100%**	**-11 990**	**-38%**	**112**	**1%**	**-**	**-**

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 3.37 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Italy (20%), Germany (16%), France (13%), Spain (9%), Poland (7%), Belgium (6%), Austria (6%) and United Kingdom (5%) which together have 83% share on EU-KP emissions.

Figure 3.37: 1.A.2.a Iron and Steel, Gaseous fuels: Emission trend and share for CO_2

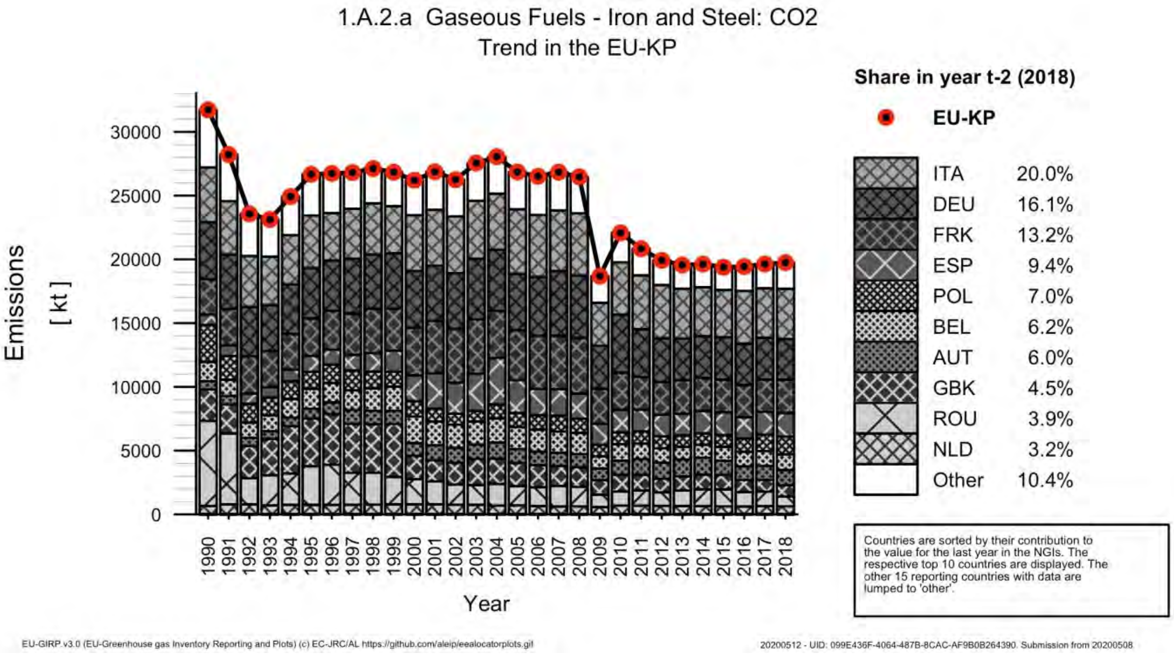


Figure 3.38 shows implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that the CO_2 IEF is fluctuating but the fluctuation is not as noticeable as in the case of CO_2 IEF calculated for solid fuels. The increased CO_2 IEF factor from 2008 onwards was mainly 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. Since 2016, CO_2 IEF has decreasing trend. CO_2 IEF equaled to 56.21 t/TJ in 2018.

Figure 3.38: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

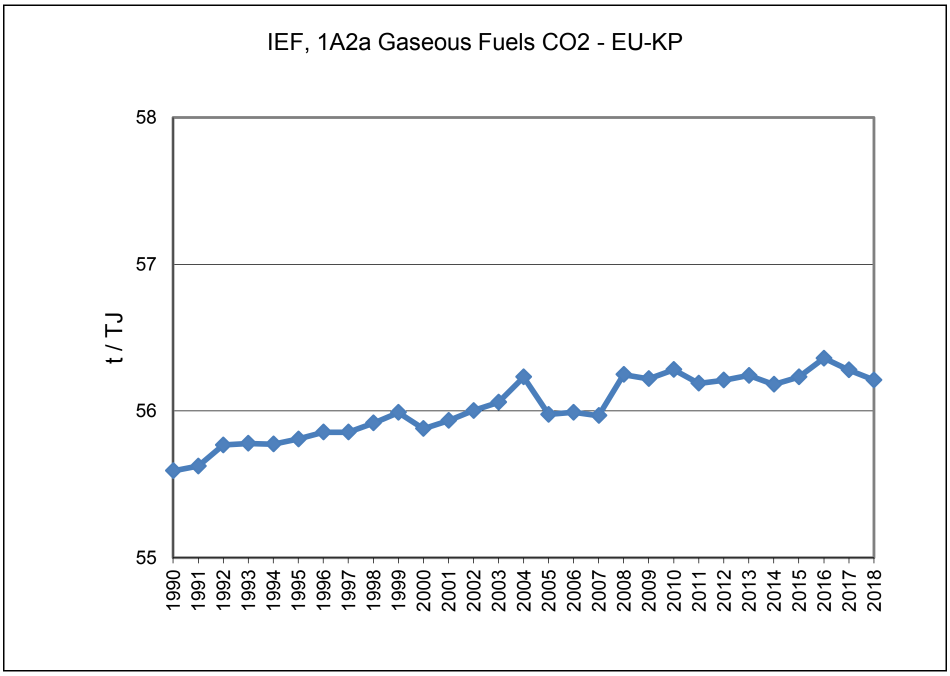
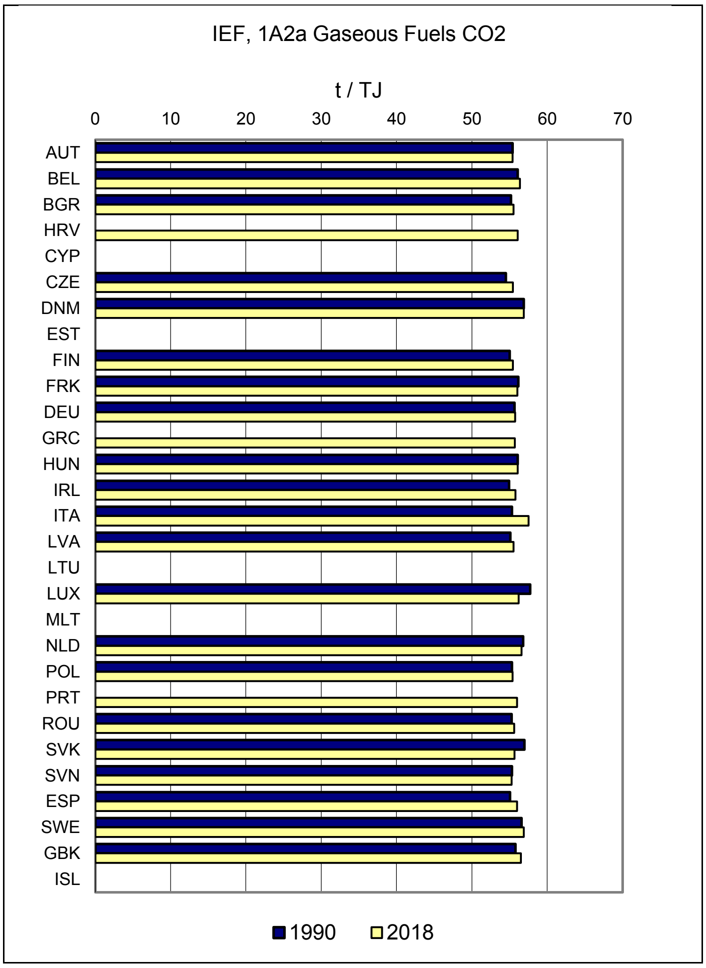


Figure 3.39 shows comparison of implied emission factors (CO_2 IEFs) used by countries for emission estimates in 1990 and 2018. No significant differences between CO_2 IEF used by EU-KP are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2018 are occurring.

Figure 3.39: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



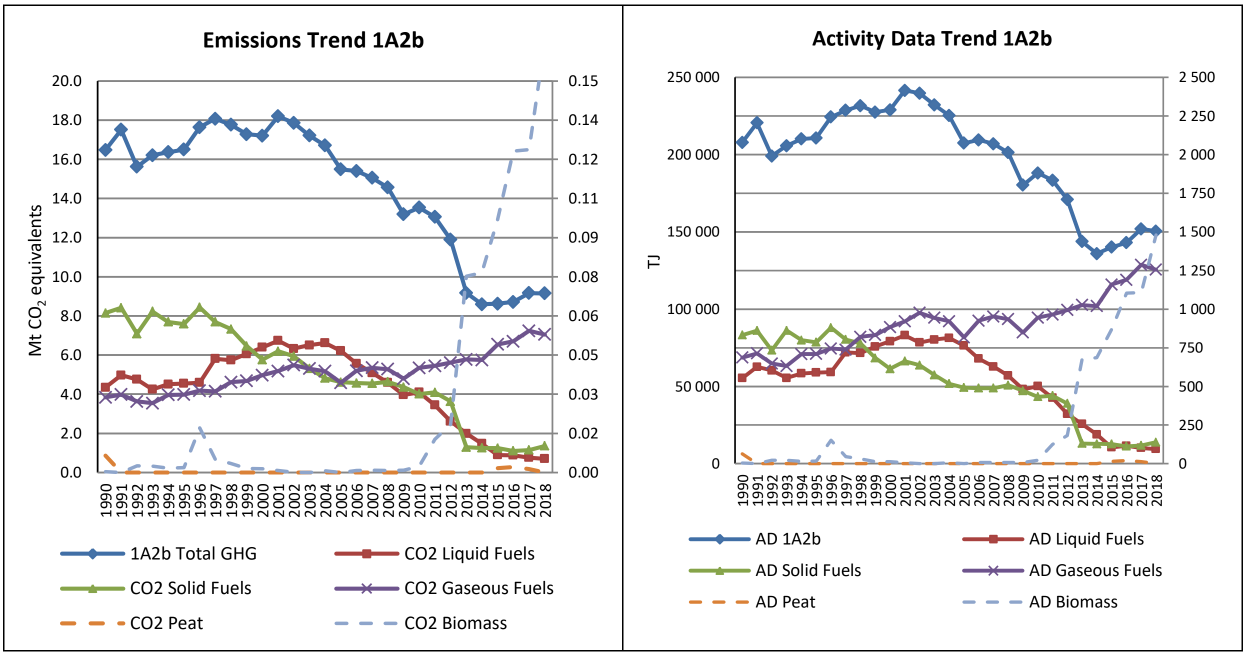
3.2.2.2 **Non Ferrous Metals (1.A.2.b)**

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.b Non Ferrous Metals.

Total CO_2 emissions from 1.A.2.b amounted to 9 108 kt CO_2 eq. in 2018. The trend of total emissions for 1990 to 2018 from category 1.A.2.b is depicted in Figure 3.40. Total CO_2 emissions decreased by 44% since 1990 and decreased by less than 1% between 2017 and 2018. Total CO_2 emissions from 1.A.2.b Non Ferrous Metals accounted for 2% of 1.A.2. source category.

Figure 12 shows the emission trend within the category 1.A.2.b, which is dominated by CO_2 emissions from gaseous fuels in 2018. The share of liquid fuels on CO_2 emissions from 1.A.2.b decreased from 27% in 1990 to 8% in 2018. The share of solid fuels on CO_2 emissions from 1.A.2.b decreased from 50% in 1990 to 15% in 2018. The share of gaseous fuels on CO_2 emissions from 1.A.2.b increased from 23% in 1990 to 77% in 2018.

Figure 3.40: 1.A.2.b Non-ferrous Metals: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table.3.27. Denmark, Estonia, Lithuania, Malta, Portugal and Romania report emissions as ‘NO’ (not occurring) or ‘IE’ (included elsewhere). For Portugal and Romania, emissions from non-ferrous metals are included in 1.A.2.a Iron and steel production. Seven Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Austria.

Table.3.27: 1.A.2.b Non-ferrous Metals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	132	297	329	3.6%	197	150%	32	11%	T1,T2	CS,D
Belgium	629	483	490	5.4%	-139	-22%	7	1%	T1	D
Bulgaria	299	176	205	2.3%	-94	-31%	29	16%	T1,T2	CS,D
Croatia	NO,IE	21	27	0.3%	27	∞	6	30%	T1	D
Cyprus	5	2	2	0.0%	-3	-55%	0	1%	T1	D
Czechia	102	168	153	1.7%	51	50%	-16	-9%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	5	NO	-	-	-	-5	-100%	NA	NA
Finland	338	98	113	1.2%	-225	-67%	16	16%	T3	CS,D
France	2 439	734	751	8.2%	-1 688	-69%	17	2%	T2,T3	CS,PS
Germany	1 377	163	151	1.7%	-1 225	-89%	-11	-7%	CS	CS
Greece	582	759	322	3.5%	-261	-45%	-438	-58%	T2	CS,PS
Hungary	239	195	189	2.1%	-50	-21%	-6	-3%	T1	D
Ireland	809	1 402	1 406	15.4%	597	74%	4	0%	T1,T2,T3	CS,D
Italy	730	1 073	1 134	12.5%	404	55%	61	6%	T2	CS
Latvia	NO	1	1	0.0%	1	∞	0	3%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	28	54	49	0.5%	21	73%	-5	-9%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	214	175	168	1.8%	-45	-21%	-6	-4%	T2	CS
Poland	1 053	1 138	1 252	13.7%	199	19%	114	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	123	94	1.0%	-1 162	-92%	-29	-23%	T2	CS
Slovenia	439	127	123	1.4%	-315	-72%	-4	-3%	T1,T2	CS,D
Spain	1 192	1 119	1 309	14.4%	117	10%	190	17%	T1,T2,T3	CS,D,PS
Sweden	128	101	100	1.1%	-28	-22%	-1	-1%	T2	CS
United Kingdom	4 319	719	732	8.0%	-3 587	-83%	13	2%	T2	CS
EU-27+UK	**16 381**	**9 132**	**9 100**	**100%**	**-7 281**	**-44%**	**-33**	**0%**	**-**	**-**
Iceland	14	8	8	0.1%	-5	-40%	0	6%	T1	D
United Kingdom (KP)	4 319	719	732	8.0%	-3 587	-83%	13	2%	T2	CS
EU-KP	**16 395**	**9 140**	**9 108**	**100%**	**-7 287**	**-44%**	**-32**	**0%**	**-**	**-**

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

1.A.2.b Non-Ferrous Metals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.b amounted 703 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 84% and compared to 2017 decreased by 7%. Category has 0.1% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 83% compared to 1990. The category was not identified as a key category for this submission but it was identified in previous submissions and thus the description of the category is still included in the reporting.

Detailed data related to the EU-KP submissions are depicted in *Table 3.28*. Czechia, Denmark, Estonia, Hungary, Latvia, Lithuania, Luxemburg, Malta and Netherlands report emissions as 'NO' (not occurring). Portugal and Romania report emissions as 'IE' (included elsewhere). Five Member States and Iceland use for emission estimates Tier 1 methodology (approximately 82% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2018 than in 1990 (except of Italy).

Table 3.28: 1.A.2.b Non-ferrous Metals, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	35	18	6	0.9%	-29	-82%	-12	-65%	T2	CS
Belgium	220	52	46	6.6%	-174	-79%	-6	-11%	T1	D
Bulgaria	199	36	51	7.2%	-149	-75%	14	39%	T1	D
Croatia	IE	2	4	0.5%	4	∞	1	49%	T1	D
Cyprus	5	2	2	0.3%	-3	-55%	0	1%	T1	D
Czechia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	0	NO	-	-	-	0	-100%	NA	NA
Finland	174	73	81	11.5%	-93	-53%	8	11%	T3	CS
France	647	49	42	6.0%	-605	-93%	-7	-14%	T2,T3	CS,PS
Germany	144	107	97	13.8%	-47	-33%	-10	-10%	CS	CS
Greece	582	23	17	2.5%	-565	-97%	-6	-25%	T2	PS
Hungary	143	3	NO	-	-143	-100%	-3	-100%	NA	NA
Ireland	766	23	27	3.8%	-739	-96%	4	17%	T1,T3	CS,D
Italy	18	42	31	4.5%	14	77%	-11	-25%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	15	NO	NO	-	-15	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	62	51	36	5.1%	-27	-43%	-15	-30%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	23	6	4	0.6%	-19	-81%	-2	-32%	T2	CS
Slovenia	120	18	19	2.6%	-102	-85%	0	1%	T1	D
Spain	931	156	146	20.7%	-785	-84%	-11	-7%	T1,T2,T3	CS,D,PS
Sweden	110	84	83	11.8%	-27	-24%	-1	-2%	T2	CS
United Kingdom	133	2	2	0.3%	-131	-98%	0	16%	T2	CS
EU-27+UK	**4 332**	**751**	**695**	**99%**	**-3 638**	**-84%**	**-56**	**-7%**	**-**	**-**
Iceland	14	8	8	1.2%	-5	-40%	0	6%	T1	D
United Kingdom (KP)	133	2	2	0.3%	-131	-98%	0	16%	T2	CS
EU-KP	**4 346**	**759**	**703**	**100%**	**-3 643**	**-84%**	**-56**	**-7%**	**-**	**-**

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

Figure 3.41 shows CO_2 emissions trend as well as the share of the Member States with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Spain (21%), Germany (14%), Sweden (12%), Finland (12%), Bulgaria (7%), Belgium (7%) and France (6%) which together have 78% share on EU-KP emissions.

Figure 3.41: 1.A.2.b Non-ferrous Metals, liquid fuels: Emission trend and share for CO_2

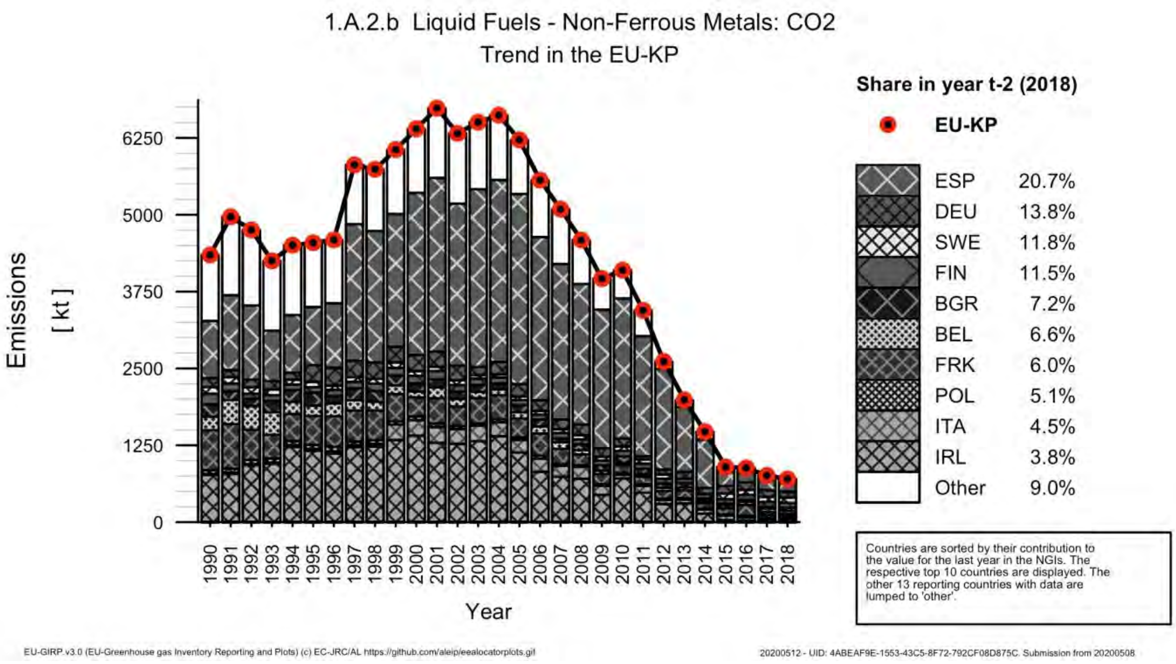


Figure 3.42 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF fluctuated at the beginning of the time series and since 2013 shows major fluctuations. The peak in the 2015 implied emission factor, as presented in the figure below, occurs because Sweden reported activity data as confidential. CO_2 IEF equaled to 74.13 t/TJ in 2018.

Figure 3.42: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

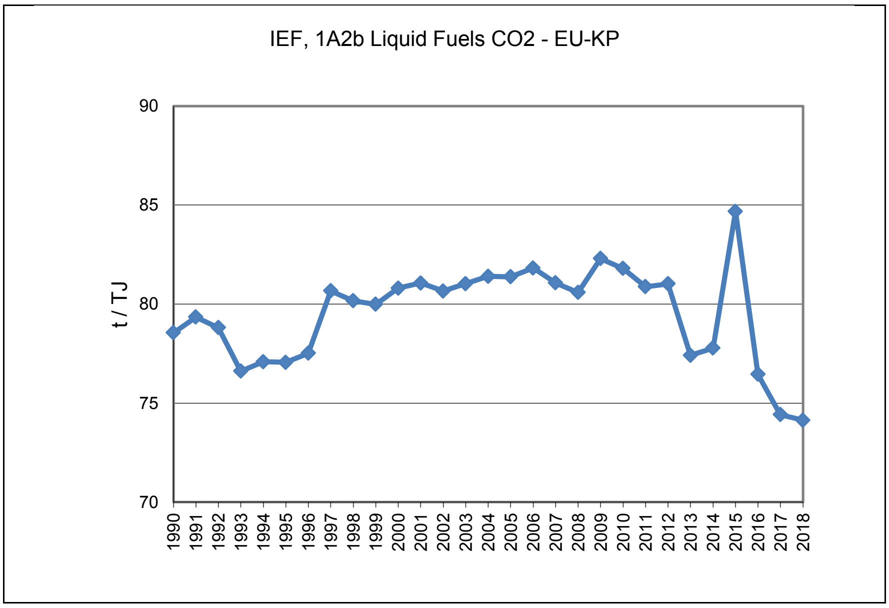
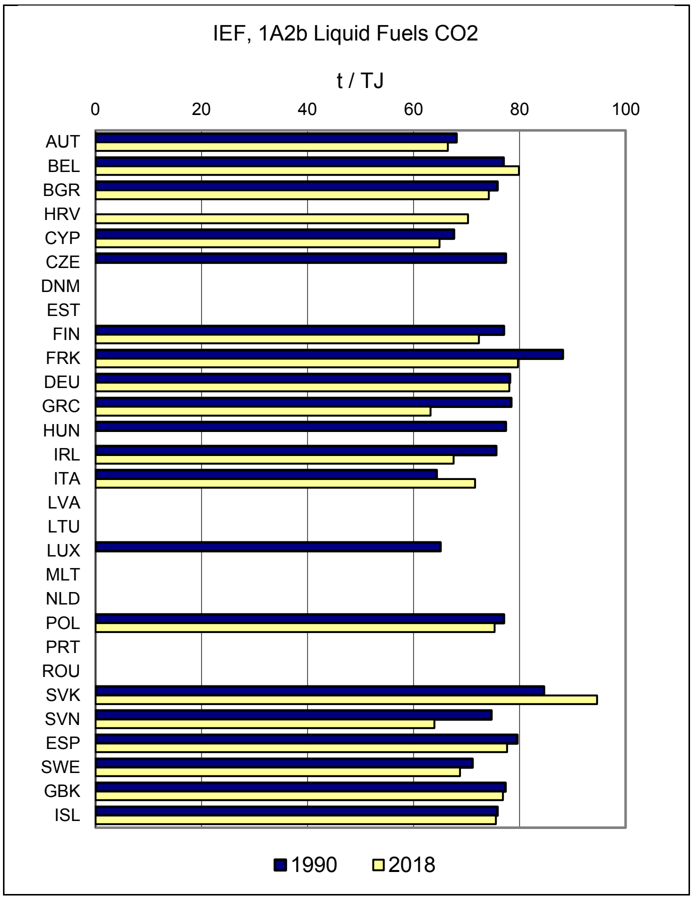


Figure 3.43 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. Particularly higher implied CO_2 emission factors are due to the use of petrol coke, which has significantly higher carbon content than liquid oil products.

Figure 3.43: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.b Non-Ferrous Metals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.b amounted 1 352 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 83% and compared to 2017 increased by 18%. Category has 0.3% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 83% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.29. Eleven countries and Iceland report emissions as 'NO' (not occurring). Greece, Portugal and Romania report emissions as 'IE' (included elsewhere). Belgium uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 92% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2018 than in 1990 (except of Poland with a 57% share on total EU-KP emissions in 2018).

Table 3.29: 1.A.2.b Non-ferrous Metals, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	22	11	10	0.8%	-11	-52%	-1	-9%	T2	CS
Belgium	147	101	102	7.6%	-45	-31%	1	1%	T1	D
Bulgaria	76	49	51	3.8%	-26	-34%	2	5%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	46	16	14	1.0%	-32	-69%	-1	-9%	T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	2	NO	-	-	-	-2	-100%	NA	NA
Finland	155	21	29	2.2%	-126	-81%	9	41%	T3	CS
France	1 038	2	2	0.1%	-1 036	-100%	0	8%	T2,T3	CS,PS
Germany	1 233	55	54	4.0%	-1 178	-96%	-1	-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	NO	133	9.9%	-18	-12%	133	∞	T2	CS
Latvia	NO	NO	0	0.0%	0	∞	0	∞	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	673	668	775	57.3%	102	15%	107	16%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	73	IE	IE	-	-73	-100%	-	-	NA	NA
Slovakia	798	46	26	1.9%	-773	-97%	-21	-45%	T2	CS
Slovenia	154	6	6	0.4%	-149	-96%	0	-3%	T1,T2	CS,D
Spain	188	64	49	3.6%	-139	-74%	-16	-25%	T1,T2	CS,D
Sweden	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom	3 366	104	101	7.5%	-3 264	-97%	-2	-2%	T2	CS
EU-27+UK	**8 141**	**1 145**	**1 352**	**100%**	**-6 789**	**-83%**	**207**	**18%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 366	104	101	7.5%	-3 264	-97%	-2	-2%	T2	CS
EU-KP	**8 141**	**1 145**	**1 352**	**100%**	**-6 789**	**-83%**	**207**	**18%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. Romania includes emissions under 1.A.2.a.
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 **3.44*** shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (57%), Italy (10%), Belgium (8%) and United Kingdom (7%) which together have 82% share on EU-KP emissions.

The reason for the strong decrease of the emissions in 2013 is the reallocation of the UK power plant. Since then, emissions from this plant are reported under 1.A.1.a.

Figure 3.44: 1.A.2.b Non-ferrous Metals, solid fuels: Emission trend and share for CO_2

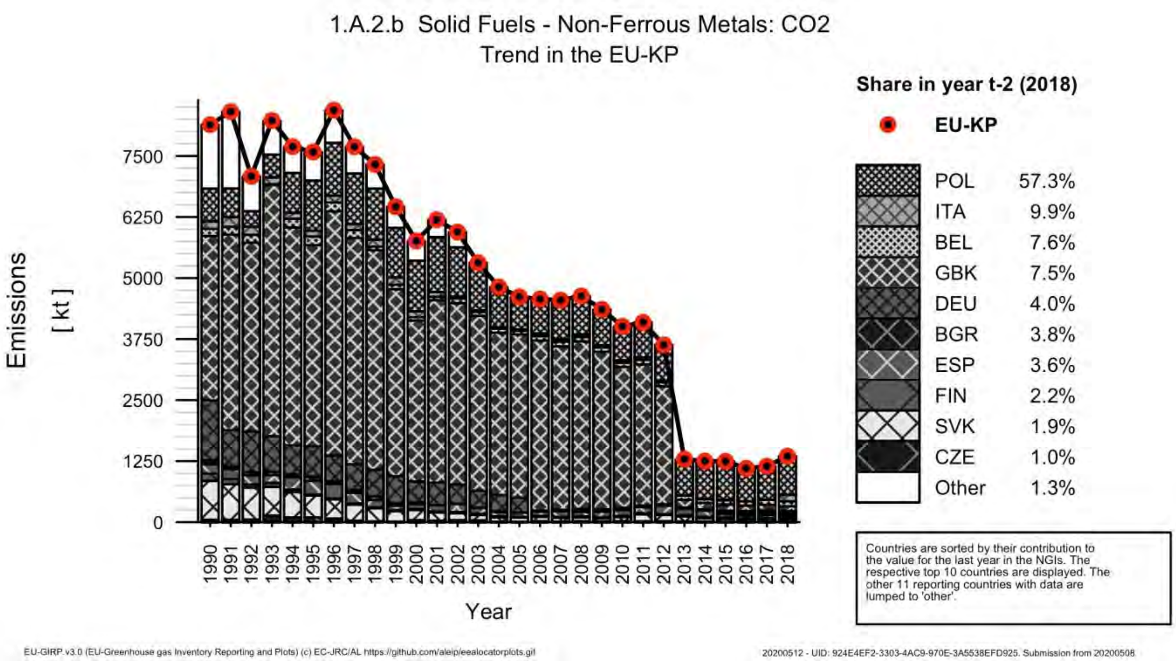


Figure 3.45 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. Since the beginning of the time series, the CO_2 IEF had relatively decreasing trend. In 2013 CO_2 IEF increased rapidly. The reason for the increase of the CO_2 IEF in 2013 is the reallocation of the UK power plant. As the UK IEF is lower than the EU average the declining weight of the UK in EU emissions leads to an increase in the IEF of the EU. CO_2 IEF equaled to 97.33 t/TJ in 2018.

Figure 3.45: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

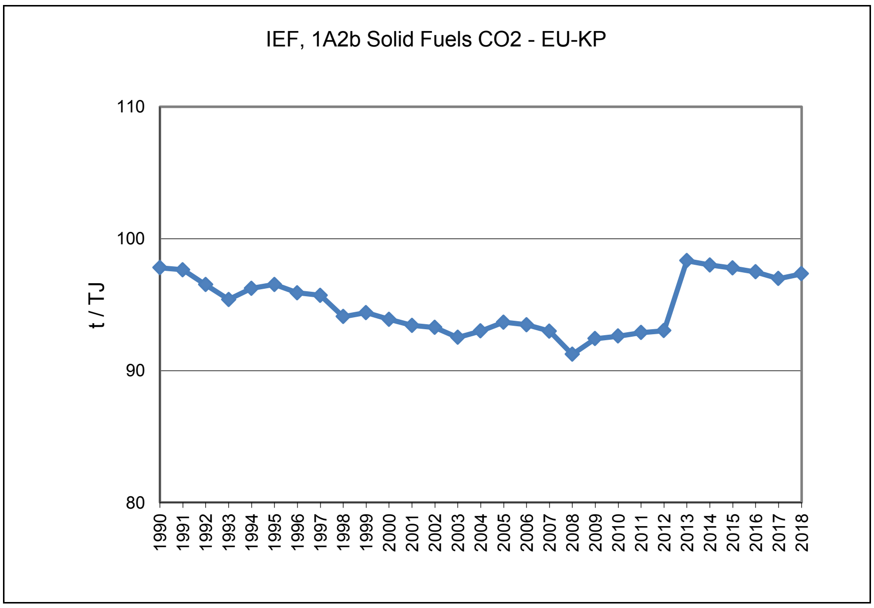
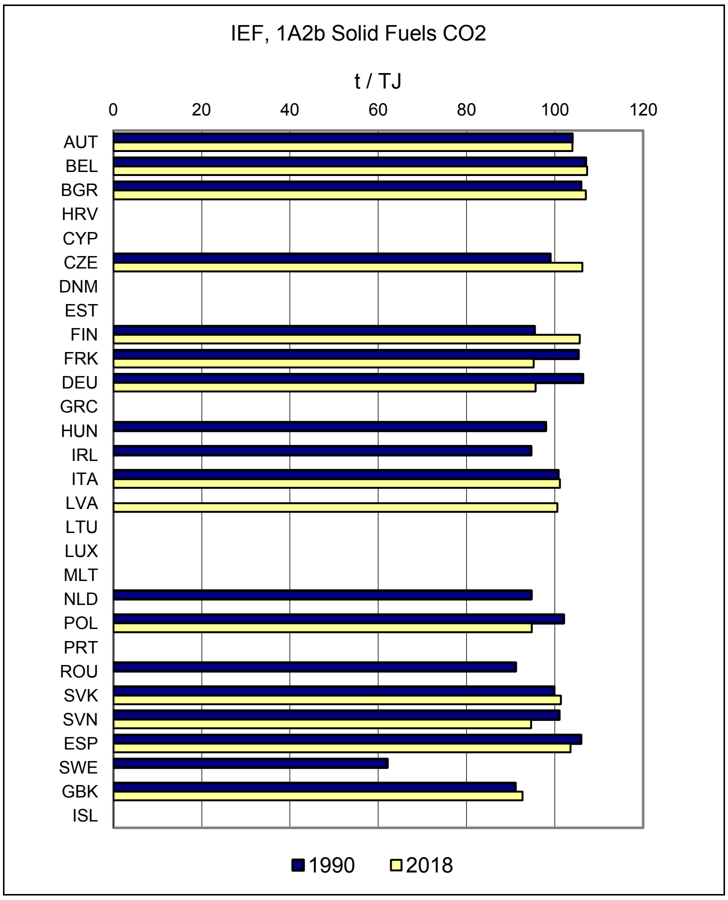


Figure 3.46 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018.

Figure 3.46: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.b Non-Ferrous Metals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.b amounted 7 052 kt in 2018 for EU-KP. CO_2 emissions increased compared to year 1990 by 84% and compared to year 2017 decreased by 3%. Category has 1.4% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption increased by 83% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.30. Cyprus, Denmark, Estonia Lithuania, Malta and Iceland report emissions as 'NO' (not occurring). Germany, Portugal and Romania report emissions as 'IE' (included elsewhere). For Germany, emissions from gaseous fuels from this category are reported in 1.A.2.g Other. Three Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 92% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Gaseous Fuels (CO_2)). Five countries reported lower level of emissions in 2018 than in 1990. Most rapid increase of emissions was reported by Ireland (3475%); Ireland has also the highest share on total CO_2 emissions from 1.A.2.b – Gaseous Fuels (CO_2).

Table 3.30: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	75	266	312	4.4%	237	316%	46	17%	T2	CS
Belgium	261	330	341	4.8%	81	31%	12	4%	T1	D
Bulgaria	23	91	104	1.5%	80	343%	12	14%	T2	CS
Croatia	IE	18	23	0.3%	23	∞	5	27%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	53	153	138	2.0%	85	161%	-14	-9%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	3	NO	-	-	-	-3	-100%	NA	NA
Finland	NO	3	3	0.0%	3	∞	0	4%	T3	CS
France	754	683	707	10.0%	-48	-6%	23	3%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	736	304	4.3%	304	∞	-432	-59%	T2	CS
Hungary	87	192	189	2.7%	102	117%	-3	-1%	T1	D
Ireland	39	1 378	1 379	19.5%	1 340	3475%	0	0%	T2	CS
Italy	561	1 031	969	13.7%	409	73%	-62	-6%	T2	CS
Latvia	NO	1	1	0.0%	1	∞	0	-4%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	13	54	49	0.7%	36	267%	-5	-9%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	213	175	168	2.4%	-45	-21%	-6	-4%	T2	CS
Poland	254	419	441	6.3%	187	73%	22	5%	T2	CS
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	435	70	65	0.9%	-370	-85%	-6	-8%	T2	CS
Slovenia	164	103	99	1.4%	-64	-39%	-4	-3%	T2	CS
Spain	73	898	1 114	15.8%	1 041	1422%	216	24%	T2,T3	CS,PS
Sweden	10	17	17	0.2%	6	58%	0	0%	T2	CS
United Kingdom	819	613	628	8.9%	-191	-23%	15	2%	T2	CS
EU-27+UK	**3 836**	**7 234**	**7 052**	**100%**	**3 216**	**84%**	**-182**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	819	613	628	8.9%	-191	-23%	15	2%	T2	CS
EU-KP	**3 836**	**7 234**	**7 052**	**100%**	**3 216**	**84%**	**-182**	**-3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Portugal includes emissions under 1.A.2.g Romania includes emissions under 1.A.2.a. Germany reported emissions under 1.A.2.g other (unspecified industrial power plants) because of confidential data.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.47 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Ireland (20%), Spain (16%), Italy (14%), France (10%), United Kingdom (9%), Poland (6%) and Belgium (5%) which together have 79% share on EU-KP emissions.

Figure 3.47: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Emission trend and share for CO_2

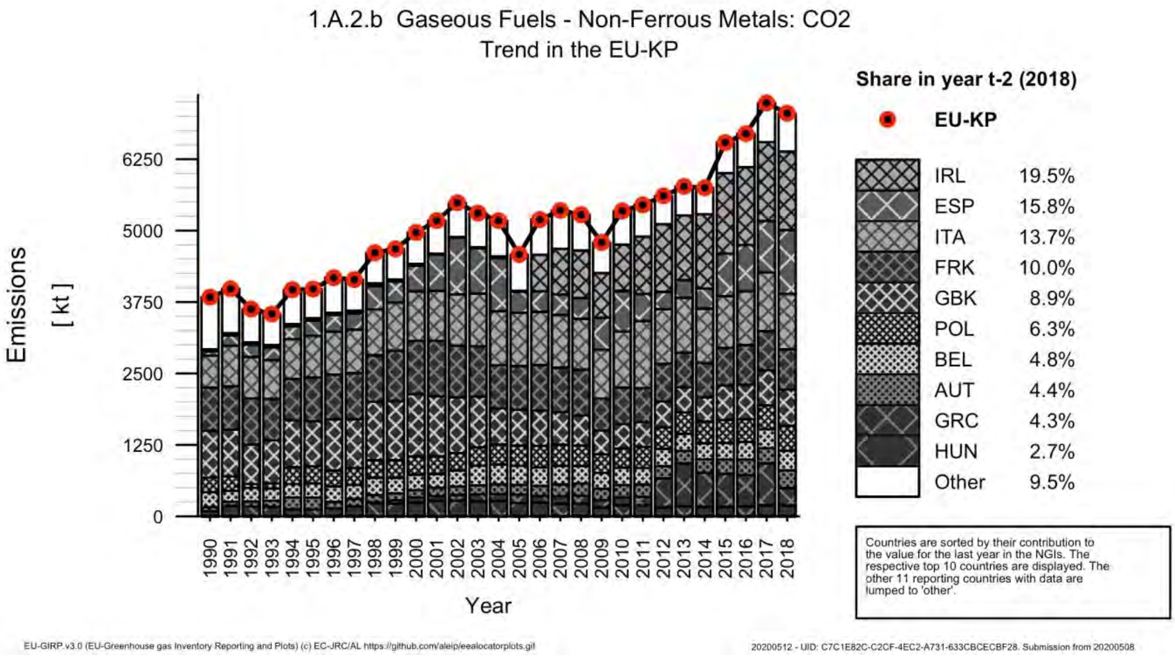


Figure 3.48 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen that CO_2 IEF has stable trend for the whole time series. CO_2 IEF equaled to 56.17 t/TJ in 2018.

Figure 3.48: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

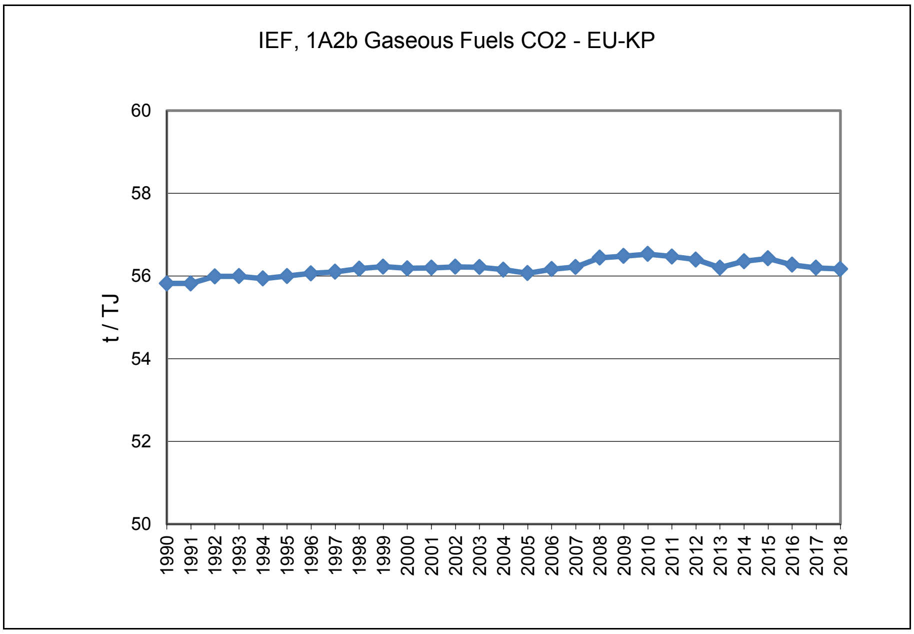
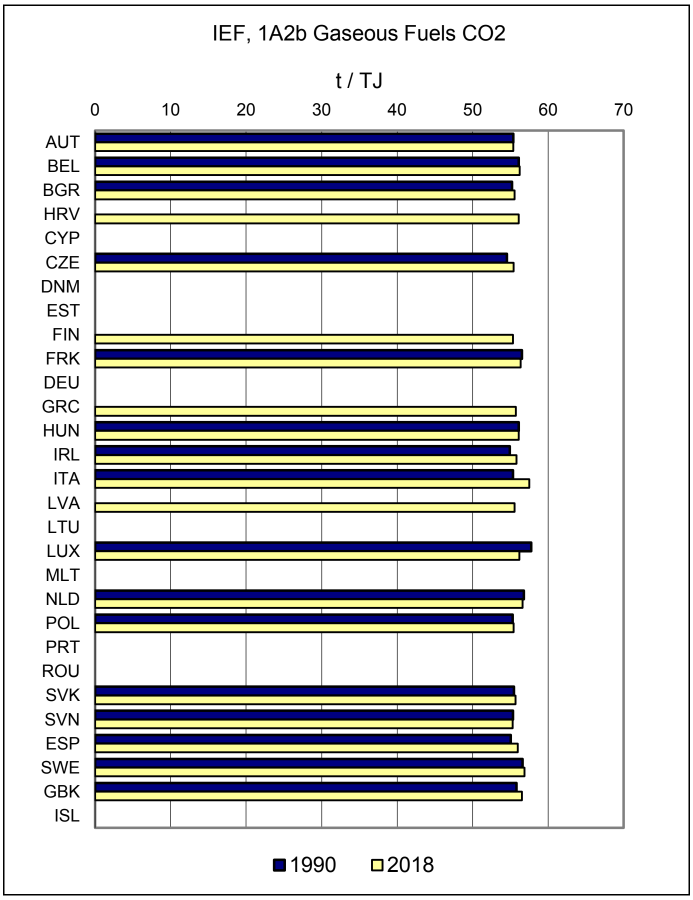


Figure 3.49 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. No significant differences between CO_2 IEF used by EU-KP are occurring and also no significant differences between CO_2 IEF used in 1990 and 2018 are occurring.

Figure 3.49: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



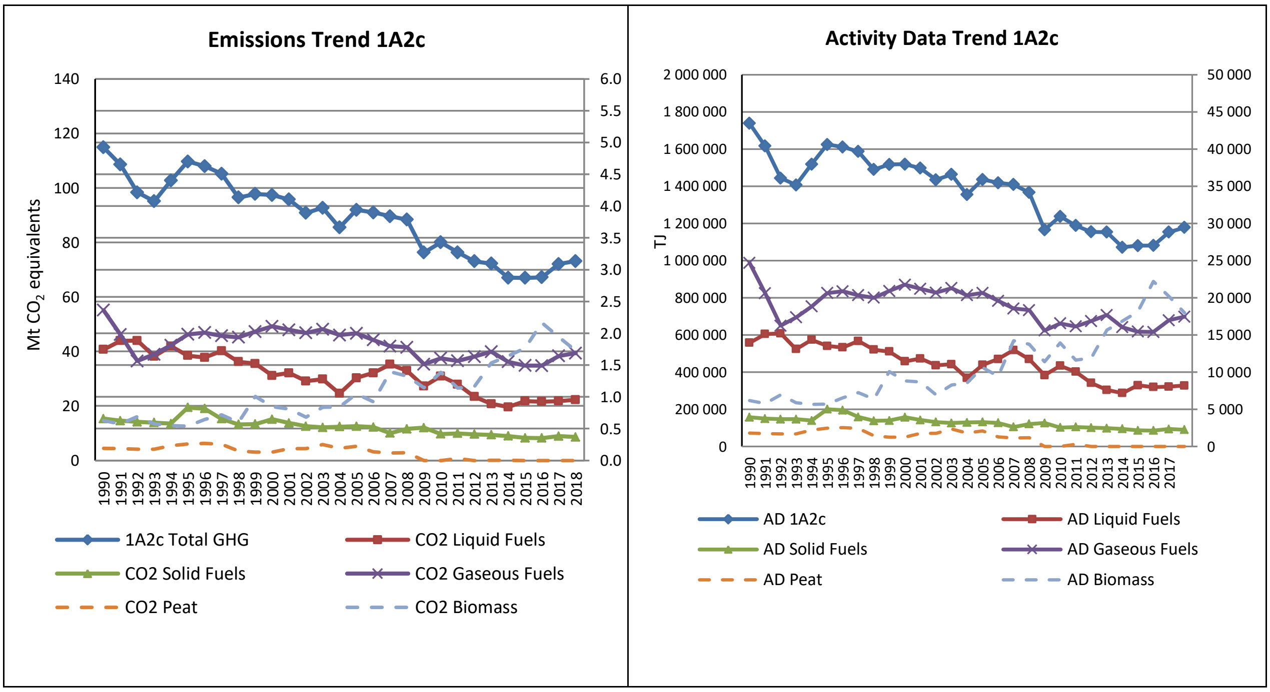
3.2.2.3 **Chemicals (1.A.2.c)**

This chapter provides information about European emission trend, Member States and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.c Chemicals.

Total CO_2 emissions from 1.A.2.c amounted to 72 501 kt CO_2 eq. in 2018. The trend of total CO_2 emissions for 1990 to 2018 from category 1.A.2.c is depicted in Figure 3.50. CO_2 emissions decreased by 37% since 1990 and increased by 1% between 2017 and 2018. CO_2 emissions from 1.A.2.c Chemicals accounted for 14% of 1.A.2. source category.

Figure 12 shows the emission trend within the category 1.A.2.c, which is dominated by CO_2 emissions from gaseous fuels in 2018. The share of liquid fuels on CO_2 emissions from 1.A.2.c decreased from 36% in 1990 to 31% in 2018. The share of solid fuels on CO_2 emissions from 1.A.2.c slightly decreased from 13% in 1990 to 12% in 2018. The share of gaseous fuels on CO_2 emissions from 1.A.2.c increased from 48% in 1990 to 54% in 2018.

Figure 3.50: 1.A.2.c Chemicals: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table 3.31. Germany, Malta and Iceland report emissions as 'NO' (not occurring) or 'IE' (included elsewhere). For Germany, emissions from this category are reported in 1.A.2.g Other. Six Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Cyprus (but it should be noted that the share of Cyprus emissions on total EU-KP emissions is minor compared to for example Poland, Sweden and Austria which reported significant increase of emissions and have also high share on total EU-KP emissions).

Table 3.31: 1.A.2.c Chemicals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	847	1 625	1 470	2.0%	623	74%	-155	-10%	T1,T2	CS,D
Belgium	4 786	3 625	3 614	5.0%	-1 172	-24%	-11	0%	T1,T3	D,PS
Bulgaria	967	1 013	1 527	2.1%	560	58%	514	51%	T1,T2	CS,D
Croatia	NO,IE	332	280	0.4%	280	∞	-53	-16%	T1	D
Cyprus	2	7	8	0.0%	6	255%	1	17%	T1	D
Czechia	2 996	1 878	1 850	2.6%	-1 146	-38%	-28	-2%	T1,T2	CS,D
Denmark	315	349	351	0.5%	36	11%	2	1%	T1,T2,T3	CS,D
Estonia	806	20	13	0.0%	-793	-98%	-7	-37%	T2	CS
Finland	1 245	676	741	1.0%	-505	-41%	65	10%	T3	CS,D
France	16 045	10 818	10 603	14.6%	-5 442	-34%	-216	-2%	T2,T3	CS,PS
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Greece	808	266	478	0.7%	-329	-41%	212	80%	T2	CS
Hungary	1 540	426	392	0.5%	-1 148	-75%	-34	-8%	T1,T3	D,PS
Ireland	410	273	292	0.4%	-118	-29%	19	7%	T2	CS
Italy	21 361	11 229	11 517	15.9%	-9 844	-46%	289	3%	T2	CS
Latvia	294	34	38	0.1%	-255	-87%	4	13%	T2	CS
Lithuania	399	274	288	0.4%	-111	-28%	14	5%	T2	CS
Luxembourg	170	135	135	0.2%	-34	-20%	0	0%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	17 276	14 513	13 923	19.2%	-3 353	-19%	-590	-4%	T2	CS,D
Poland	4 003	6 561	6 276	8.7%	2 273	57%	-285	-4%	T1,T2	CS,D
Portugal	1 346	1 097	1 072	1.5%	-274	-20%	-24	-2%	T1,T3	D,PS
Romania	17 871	1 848	1 963	2.7%	-15 909	-89%	115	6%	T1,T2	CS,D
Slovakia	2 652	514	525	0.7%	-2 127	-80%	11	2%	T2	CS
Slovenia	209	68	64	0.1%	-146	-70%	-4	-6%	T1,T2	CS,D
Spain	5 361	7 965	9 133	12.6%	3 772	70%	1 168	15%	T1,T2	CS,D,PS
Sweden	629	505	555	0.8%	-74	-12%	50	10%	T2	CS
United Kingdom	12 056	5 439	5 394	7.4%	-6 661	-55%	-45	-1%	T2	CS
EU-27+UK	**114 395**	**71 490**	**72 501**	**100%**	**-41 895**	**-37%**	**1 011**	**1%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	12 056	5 439	5 394	7.4%	-6 661	-55%	-45	-1%	T2	CS
EU-KP	**114 403**	**71 490**	**72 501**	**100%**	**-41 902**	**-37%**	**1 011**	**1%**	**-**	**-**

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

1.A.2.c Chemicals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.c amounted 22 245 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 45% and compared to 2017 increased by 2%. Category has 4% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 41% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.32. Estonia, Malta and Iceland report emissions as 'NO' (not occurring). Seven Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 93% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c – Liquid Fuels (CO_2)). Bulgaria, Cyprus, Netherland, Poland and Sweden reported higher level of emissions in 2018 than in 1990.

Table 3.32: 1.A.2.c Chemicals, Liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	97	56	31	0.1%	-66	-68%	-24	-44%	T2	CS
Belgium	1 852	318	327	1.5%	-1 525	-82%	9	3%	T1	D
Bulgaria	857	595	964	4.3%	108	13%	369	62%	T1	D
Croatia	IE	9	10	0.0%	10	∞	2	18%	T1	D
Cyprus	2	7	8	0.0%	6	255%	1	17%	T1	D
Czechia	175	117	140	0.6%	-35	-20%	23	20%	T1	D
Denmark	198	0	0	0.0%	-198	-100%	0	-12%	T1,T2	CS,D
Estonia	13	11	NO	-	-13	-100%	-11	-100%	NA	NA
Finland	731	560	626	2.8%	-105	-14%	66	12%	T3	CS
France	6 263	3 313	3 047	13.7%	-3 216	-51%	-266	-8%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	639	47	66	0.3%	-573	-90%	19	41%	T2	CS
Hungary	380	6	3	0.0%	-377	-99%	-3	-52%	T1	D
Ireland	131	80	85	0.4%	-46	-35%	5	7%	T2	CS
Italy	13 126	5 916	6 368	28.6%	-6 758	-51%	452	8%	T2	CS
Latvia	270	9	11	0.1%	-259	-96%	3	28%	T2	CS
Lithuania	69	3	3	0.0%	-66	-96%	0	-2%	T2	CS
Luxembourg	112	3	3	0.0%	-110	-97%	0	2%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 493	7 796	7 699	34.6%	1 206	19%	-97	-1%	T2	CS,D
Poland	308	792	770	3.5%	462	150%	-22	-3%	T1,T2	CS,D
Portugal	1 308	701	535	2.4%	-772	-59%	-166	-24%	T1,T3	D,PS
Romania	NO	598	708	3.2%	708	∞	110	18%	T1,T2	D
Slovakia	51	5	2	0.0%	-49	-95%	-2	-47%	T2	CS
Slovenia	32	10	10	0.0%	-21	-68%	0	1%	T1	D
Spain	2 852	445	366	1.6%	-2 485	-87%	-79	-18%	T1,T2	CS,D
Sweden	341	308	356	1.6%	15	4%	48	16%	T2	CS
United Kingdom	4 392	101	106	0.5%	-4 286	-98%	5	5%	T2	CS
EU-27+UK	**40 690**	**21 805**	**22 245**	**100%**	**-18 445**	**-45%**	**441**	**2%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	4 392	101	106	0.5%	-4 286	-98%	5	5%	T2	CS
EU-KP	**40 698**	**21 805**	**22 245**	**100%**	**-18 453**	**-45%**	**441**	**2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany and Malta are included in 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 3.51 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen, that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Netherland (35%), Italy (29%), France (14%) which together have 77% share on EU-KP emissions.

Figure 3.51: 1.A.2.c Chemicals, Liquid fuels: Emission trend and share for CO_2

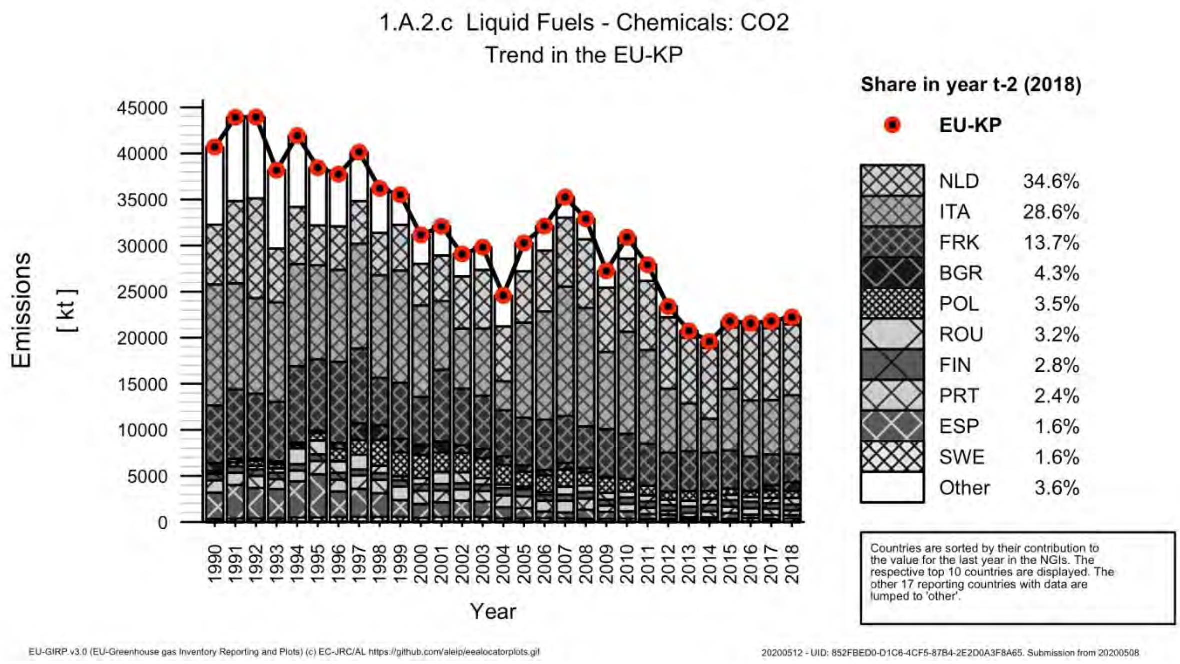


Figure 3.52 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF fluctuates over the time period with decreasing trend. CO_2 IEF equaled to 67.80 t/TJ in 2018. The main reason for the declining trend of the IEF is the growing weight in EU emissions of the Netherlands (with a lower IEF) and the decreasing weight of Italy (with a higher IEF).

Figure 3.52: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

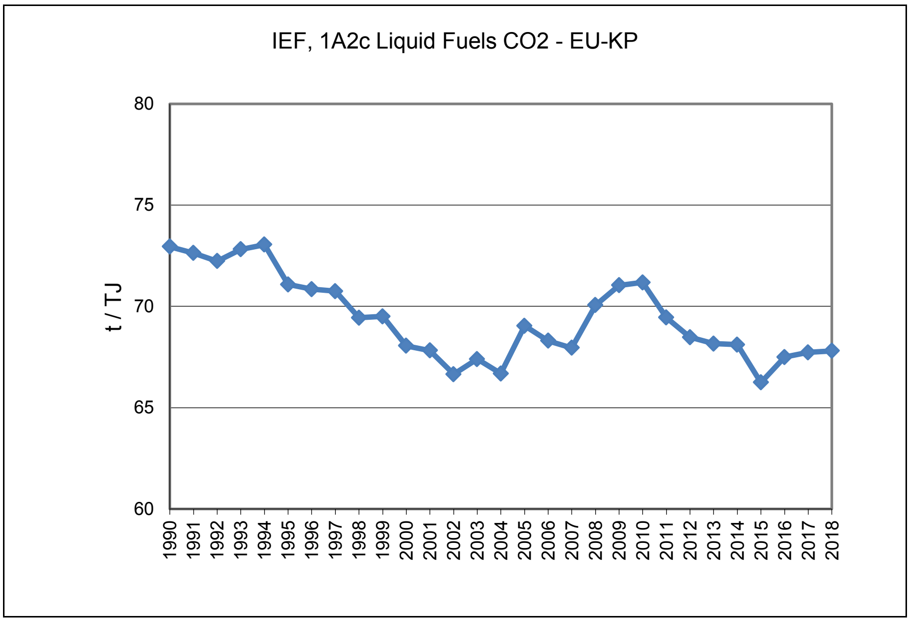
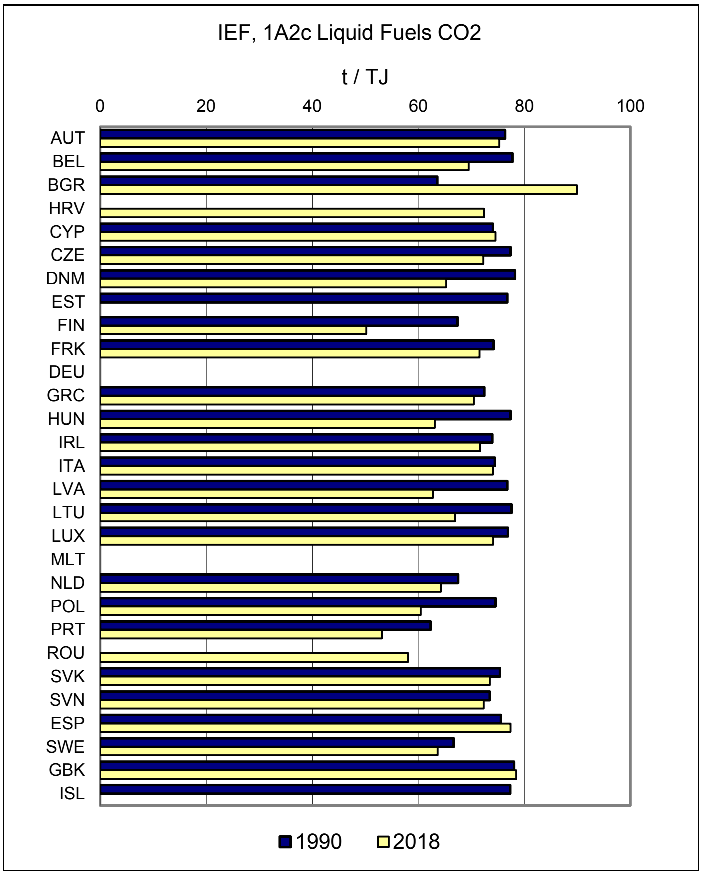


Figure 3.53 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. The main reason for the differences of IEFs across countries is differences in the fuel mix.

Figure 3.53: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.c Chemicals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.c amounted 8 576 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 44% and compared to 2017 decreased by 4%. Category has 2% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 43% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.33. Thirteen Member States and Iceland report emissions as 'NO' (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c – Solid Fuels (CO_2)). Four Member States reported higher level of emissions in 2018 than in 1990. Noticeable increase of emissions compared to year 1990 can be observed for the Austria, Bulgaria, Denmark and Poland. Poland has the highest share on total EU-KP emissions. Rapid increase of emissions in Bulgaria is linked with increased consumption of solid fuels in this category.

Table 3.33: 1.A.2.c Chemicals, Solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	106	207	120	1.4%	14	13%	-87	-42%	T2	CS
Belgium	402	3	3	0.0%	-398	-99%	0	1%	T1	D
Bulgaria	80	143	249	2.9%	169	210%	106	74%	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 487	1 189	1 141	13.3%	-1 346	-54%	-48	-4%	T2	CS,D
Denmark	6	53	54	0.6%	48	738%	1	2%	T1	D
Estonia	626	NO	NO	-	-626	-100%	-	-	NA	NA
Finland	214	NO	NO	-	-214	-100%	-	-	NA	NA
France	2 521	1 489	1 371	16.0%	-1 150	-46%	-118	-8%	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	NO	6	0.1%	-633	-99%	6	∞	T2	CS
Latvia	NO	NO	0	0.0%	0	∞	0	∞	T2	CS
Lithuania	NO	0	NO	-	-	-	0	-100%	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	1 012	4 834	4 613	53.8%	3 600	356%	-221	-5%	T1,T2	CS,D
Portugal	39	NO	NO	-	-39	-100%	-	-	NA	NA
Romania	581	126	141	1.6%	-440	-76%	15	12%	T1,T2	CS,D
Slovakia	1 584	70	64	0.8%	-1 519	-96%	-6	-8%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	691	615	635	7.4%	-56	-8%	19	3%	T1,T2	CS,D,PS
Sweden	127	28	32	0.4%	-96	-75%	3	12%	T2	CS
United Kingdom	2 794	163	146	1.7%	-2 648	-95%	-17	-11%	T2	CS
EU-27+UK	**15 336**	**8 921**	**8 576**	**100%**	**-6 760**	**-44%**	**-345**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 794	163	146	1.7%	-2 648	-95%	-17	-11%	T2	CS
EU-KP	**15 336**	**8 921**	**8 576**	**100%**	**-6 760**	**-44%**	**-345**	**-4%**	**-**	**-**

Emissions of Germany are included in 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 3.54 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (54%), France (16%) and Czechia (13%) which together have 83% share on EU-KP emissions.

Figure 3.54: 1.A.2.c Chemicals, Solid fuels: Emission trend and share for CO_2

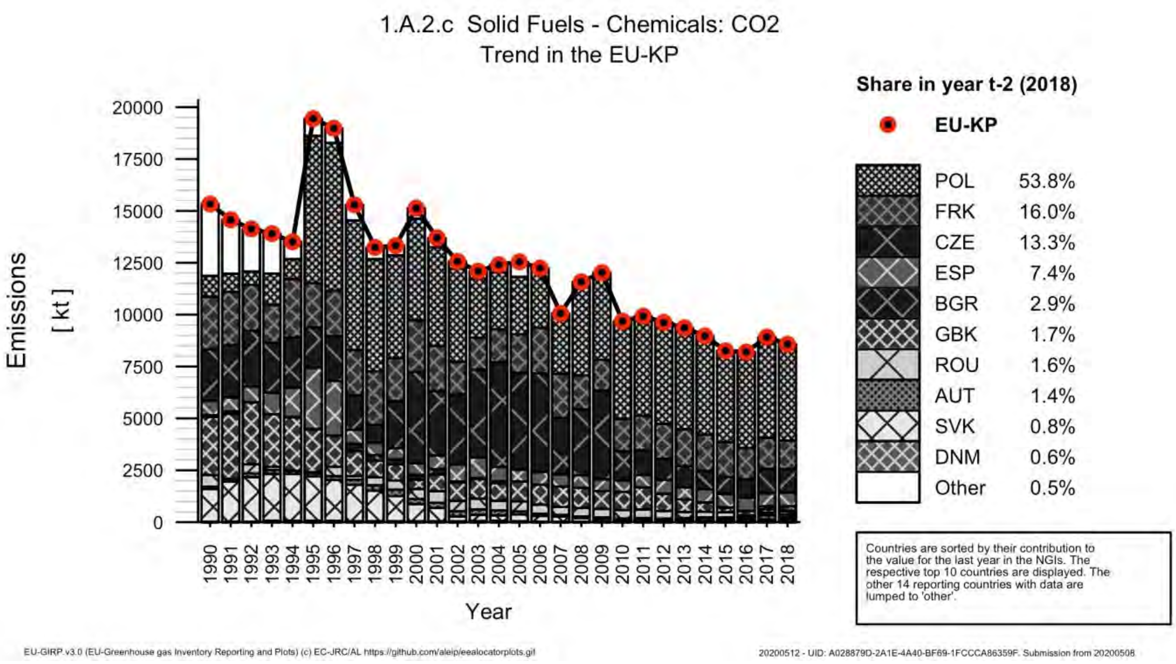


Figure 3.55 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that since 2010 CO_2 IEF fluctuates only slightly. CO_2 IEF equaled to 95.04 t/TJ in 2018.

Figure 3.55: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

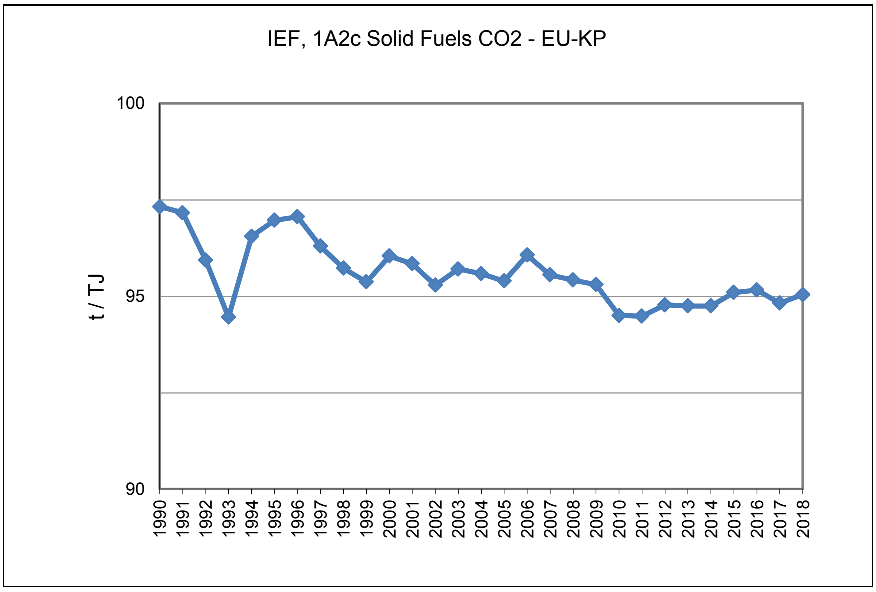
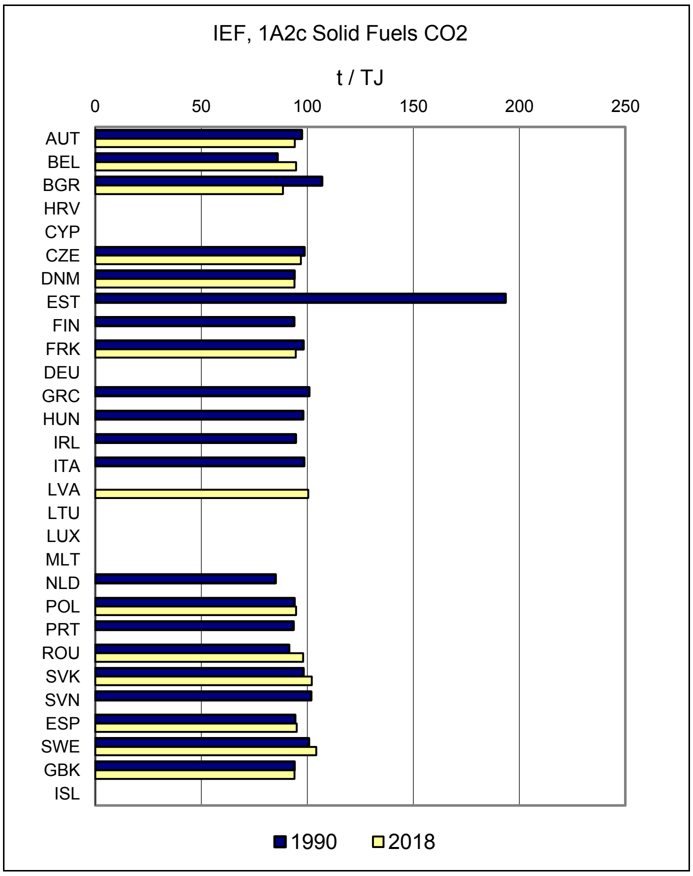


Figure 3.56 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. The high CO_2 IEF factor for Estonia is caused by the use of oil shale generator gas which had high carbon content. Since the Italy's 2018 CO_2 IEF is erroneous value, it is not included in the graph.

Figure 3.56: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



Note: The Italian CO_2 IEF in 2018 is erroneous, thus it is not included in the graph

1.A.2.c Chemicals – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.c amounted 39 357 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 29% and compared to 2017 increased by 3%. Category has 8% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 29% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.34. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 98% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c –Gaseous Fuels (CO_2)). Ten Member States and United Kingdom reported higher level of emissions in 2018 than in 1990. Noticeable higher level of emissions in 2018 compared to 1990 was reported by Bulgaria and Spain.

Table 3.34: 1.A.2.c Chemicals, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	519	1 137	1 113	2.8%	594	115%	-24	-2%	T2	CS
Belgium	2 532	3 290	3 270	8.3%	737	29%	-20	-1%	T1,T3	D,PS
Bulgaria	30	275	314	0.8%	283	938%	39	14%	T2	CS
Croatia	IE	324	269	0.7%	269	∞	-54	-17%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	334	573	569	1.4%	235	70%	-3	-1%	T2	CS
Denmark	110	296	297	0.8%	186	169%	1	0%	T3	CS
Estonia	167	9	13	0.0%	-154	-92%	4	41%	T2	CS
Finland	99	103	108	0.3%	9	9%	5	5%	T3	CS
France	6 787	4 188	4 289	10.9%	-2 497	-37%	101	2%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	219	412	1.0%	412	∞	193	88%	T2	CS
Hungary	1 064	419	388	1.0%	-677	-64%	-31	-8%	T1	D
Ireland	207	193	207	0.5%	0	0%	14	7%	T2	CS
Italy	7 595	5 313	5 143	13.1%	-2 452	-32%	-170	-3%	T2	CS
Latvia	24	25	27	0.1%	3	13%	2	6%	T2	CS
Lithuania	331	271	285	0.7%	-46	-14%	14	5%	T2	CS
Luxembourg	57	132	133	0.3%	75	131%	0	0%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 696	6 717	6 224	15.8%	-3 472	-36%	-493	-7%	T2	CS
Poland	293	722	841	2.1%	548	187%	119	17%	T2	CS
Portugal	NO	395	537	1.4%	537	∞	141	36%	T1,T3	D,PS
Romania	17 290	1 068	1 041	2.6%	-16 250	-94%	-27	-3%	T2	CS
Slovakia	989	420	443	1.1%	-547	-55%	23	6%	T2	CS
Slovenia	176	58	54	0.1%	-122	-70%	-4	-7%	T2	CS
Spain	1 819	6 904	8 131	20.7%	6 313	347%	1 228	18%	T2	CS
Sweden	155	109	109	0.3%	-45	-29%	1	1%	T2	CS
United Kingdom	4 870	5 175	5 142	13.1%	272	6%	-33	-1%	T2	CS
EU-27+UK	**55 144**	**38 332**	**39 357**	**100%**	**-15 787**	**-29%**	**1 025**	**3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 870	5 175	5 142	13.1%	272	6%	-33	-1%	T2	CS
EU-KP	**55 144**	**38 332**	**39 357**	**100%**	**-15 787**	**-29%**	**1 025**	**3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany are included in 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 3.57 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Spain (21%), Netherlands (16%), Italy (13%), United Kingdom (13%), France (11%) and Belgium (8%) which together have 82% share on EU-KP emissions.

Figure 3.57: 1.A.2.c Chemicals, Gaseous fuels: Emission trend and share for CO_2

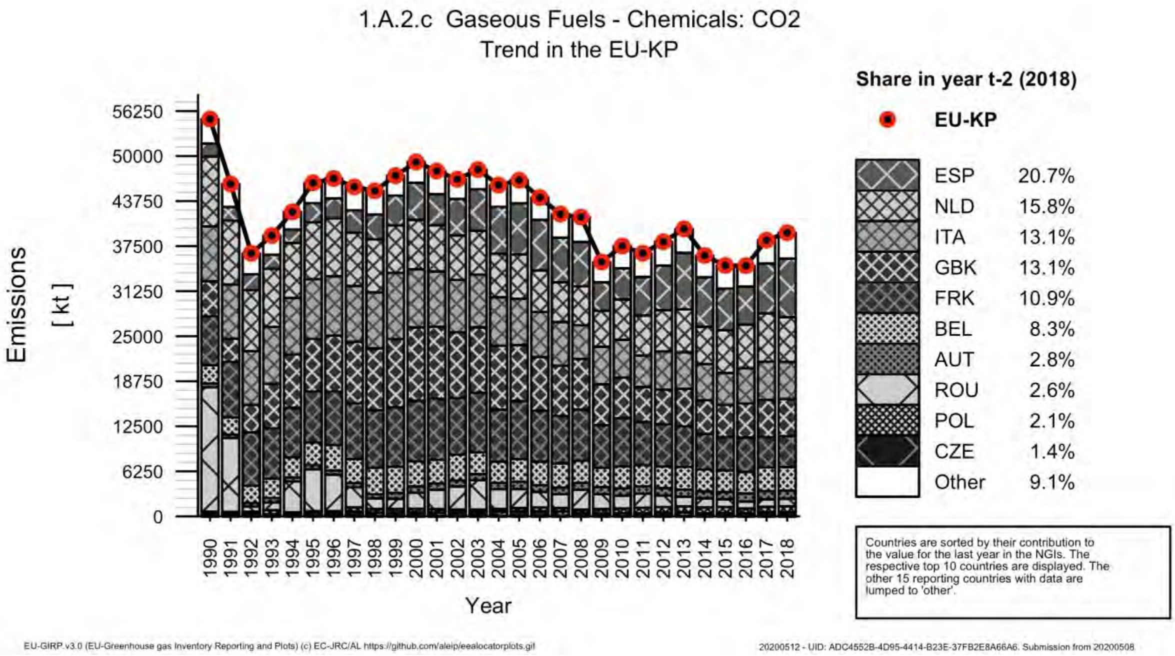


Figure 3.58 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF shows stable trend for the whole time series. CO_2 IEF equaled to 56.36 t/TJ in 2018.

Figure 3.58: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

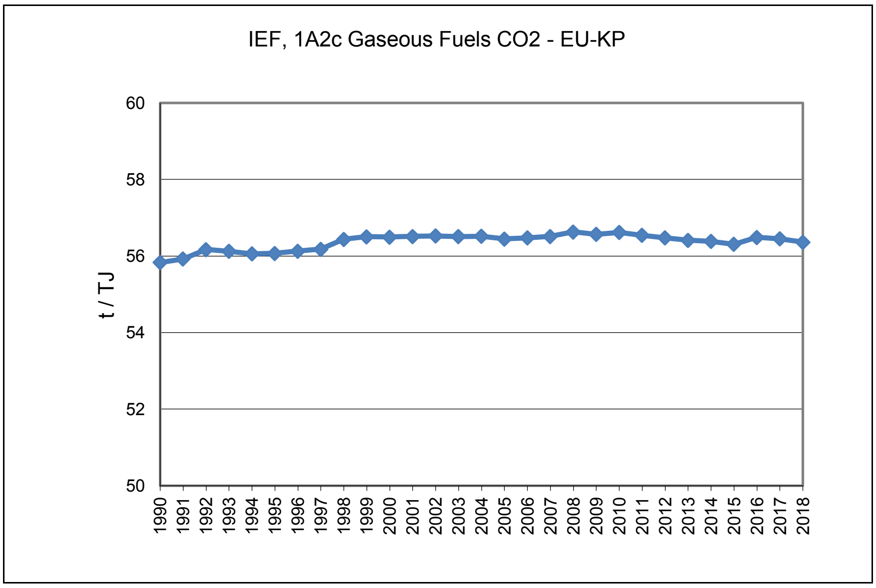
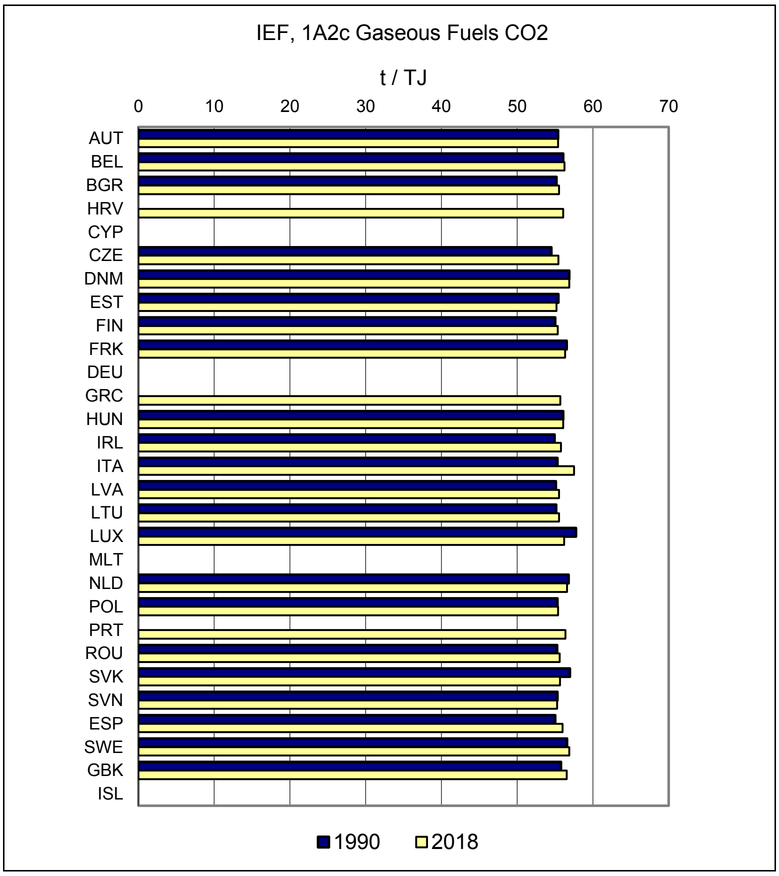


Figure 3.59 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. No significant differences between CO_2 IEF used by EU-KP are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2018 are occurring.

Figure 3.59: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



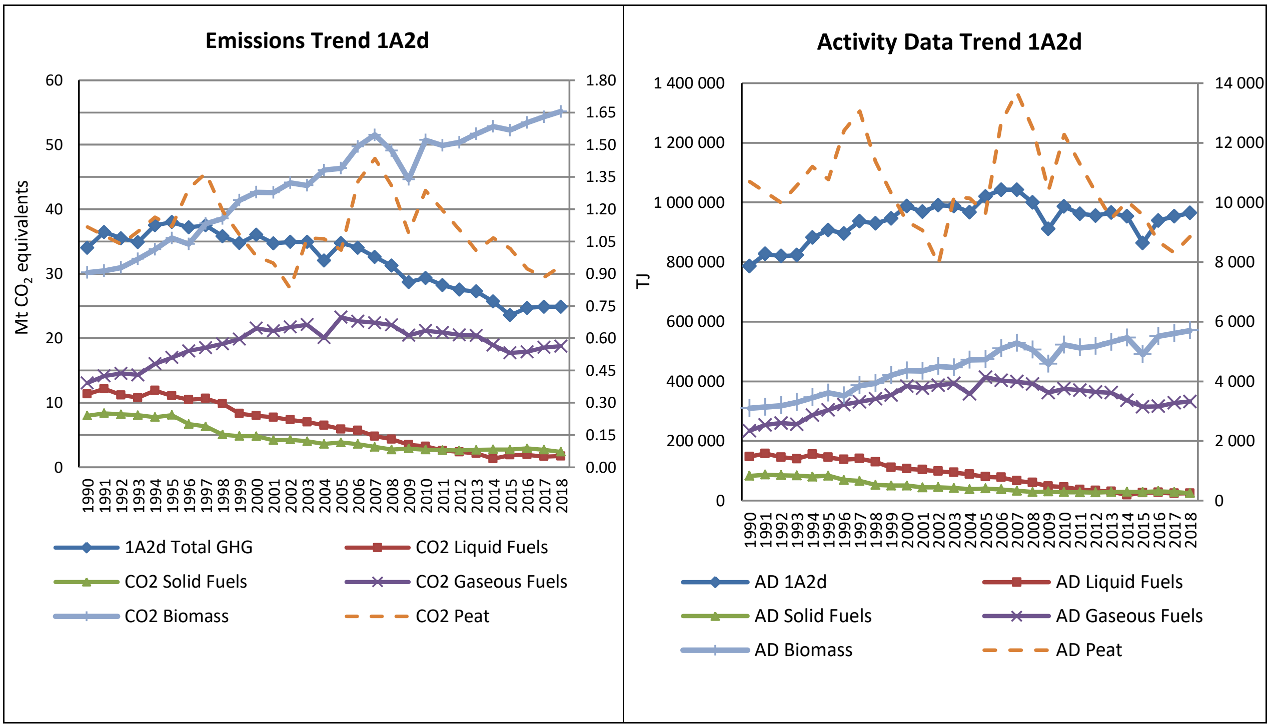
3.2.2.4 **Pulp, Paper and Print (1.A.2.d)**

This chapter provides information about European emission trend, Member States and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.d Pulp, Paper and Print.

Total CO_2 emissions from 1.A.2.d amounted to 24 134 kt CO_2 eq. in 2018. The trend of total emissions for 1990 to 2018 from category 1.A.2.d is depicted in Figure **3.60**. Total CO_2 emissions decreased by 28% since 1990 and almost didn't change between 2017 and 2018. CO_2 emissions from 1.A.2.d Pulp, Paper and Print accounted for 5% of 1.A.2. source category.

Figure 12 shows the emission trend within the category 1.A.2.d, which is dominated by CO_2 emissions from gaseous fuels in 2018. The share of liquid fuels on CO_2 emissions from 1.A.2.d decreased from 34% in 1990 to 7% in 2018. The share of solid fuels on CO_2 emissions from 1.A.2.d decreased from 24% in 1990 to 10% in 2018. The share of gaseous fuels on CO_2 emissions from 1.A.2.d increased from 39% in 1990 to 78% in 2018. 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 3.60: 1.A.2.d Pulp, Paper and Print: Total and CO_2 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.

Detailed data related to the EU-KP submissions are depicted in Table 3.35. Malta and Iceland report emissions as ‘NO’ (not occurring). Seven Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The most significant increase of CO_2 emissions was reported by Bulgaria, Hungary and Poland.

Table 3.35: 1.A.2.d Pulp, Paper and Print: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	2 208	1 811	1 923	8.0%	-285	-13%	112	6%	T1,T2	CS,D
Belgium	644	561	512	2.1%	-132	-21%	-49	-9%	T1,T3	D,PS
Bulgaria	16	106	107	0.4%	91	586%	1	1%	T1,T2	CS,D
Croatia	NO,IE	97	93	0.4%	93	∞	-4	-4%	T1	D
Cyprus	5	3	3	0.0%	-2	-46%	0	-5%	T1	D
Czechia	2 285	401	409	1.7%	-1 877	-82%	8	2%	T1,T2	CS,D
Denmark	330	38	79	0.3%	-251	-76%	41	107%	T1,T2,T3	CS,D
Estonia	NO	13	41	0.2%	41	∞	28	226%	T1,T2	CS,D
Finland	5 330	2 487	2 556	10.6%	-2 773	-52%	70	3%	T3	CS,D
France	4 026	2 200	2 280	9.4%	-1 746	-43%	79	4%	T2	CS
Germany	4	4	7	0.0%	3	80%	3	70%	CS	CS
Greece	306	77	91	0.4%	-215	-70%	14	19%	T2	CS
Hungary	74	478	425	1.8%	350	472%	-54	-11%	T1,T3	D,PS
Ireland	28	16	17	0.1%	-11	-40%	1	5%	T2	CS
Italy	3 089	4 994	4 888	20.3%	1 799	58%	-106	-2%	T2	CS
Latvia	168	6	6	0.0%	-162	-96%	0	1%	T2	CS
Lithuania	255	33	43	0.2%	-212	-83%	10	29%	T2	CS
Luxembourg	NO,IE	5	5	0.0%	5	∞	1	13%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 669	900	797	3.3%	-872	-52%	-103	-11%	T2	CS
Poland	284	1 486	1 312	5.4%	1 028	361%	-174	-12%	T1,T2	CS,D
Portugal	754	1 129	1 307	5.4%	553	73%	177	16%	T1	D
Romania	NO	234	156	0.6%	156	∞	-78	-33%	T1,T2	CS,D
Slovakia	2 329	377	346	1.4%	-1 984	-85%	-32	-8%	T2	CS
Slovenia	380	306	309	1.3%	-71	-19%	3	1%	T1,T2,T3	CS,D,PS
Spain	2 600	4 204	4 214	17.5%	1 613	62%	10	0%	T1,T2,T3	CS,D,PS
Sweden	2 189	736	777	3.2%	-1 412	-64%	41	6%	T2	CS
United Kingdom	4 623	1 457	1 433	5.9%	-3 190	-69%	-24	-2%	T2	CS
EU-27+UK	**33 596**	**24 158**	**24 134**	**100%**	**-9 461**	**-28%**	**-24**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 623	1 457	1 433	5.9%	-3 190	-69%	-24	-2%	T2	CS
EU-KP	**33 596**	**24 158**	**24 134**	**100%**	**-9 461**	**-28%**	**-24**	**0%**	**-**	**-**

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

1.A.2.d Pulp, Paper and Print – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.d amounted 1 721 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 85% and compared to 2017 increased by 4%. Category has 0.3% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 83% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.36. Estonia, Malta, Netherland and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Six Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 89% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2018 than in 1990 (except of Poland, which has 7% share on total EU-KP emissions in 2018).

Table 3.36: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	853	17	14	0.8%	-839	-98%	-3	-19%	T2	CS
Belgium	235	14	9	0.5%	-225	-96%	-5	-33%	T1,T3	D,PS
Bulgaria	16	3	1	0.1%	-14	-91%	-1	-47%	NA	NA
Croatia	IE	6	3	0.2%	3	∞	-3	-53%	T1	D
Cyprus	5	3	3	0.2%	-2	-46%	0	-5%	T1	D
Czechia	461	7	10	0.6%	-451	-98%	3	46%	T1	CS,D
Denmark	81	4	4	0.2%	-78	-96%	0	-6%	T1,T2	CS,D
Estonia	NO	1	NO	-	-	-	-1	-100%	NA	NA
Finland	1 138	336	354	20.6%	-784	-69%	19	6%	T3	CS
France	1 354	93	90	5.2%	-1 264	-93%	-3	-3%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	302	50	48	2.8%	-254	-84%	-2	-3%	T2	CS
Hungary	19	6	3	0.2%	-16	-84%	-3	-52%	T1	D
Ireland	28	8	9	0.5%	-20	-69%	1	7%	T2	CS
Italy	1 017	37	35	2.1%	-981	-97%	-2	-5%	T2	CS
Latvia	16	0	0	0.0%	-16	-99%	0	-25%	T2	CS
Lithuania	69	1	4	0.2%	-65	-95%	3	467%	T2	CS
Luxembourg	IE	0	0	0.0%	0	∞	0	2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	106	133	119	6.9%	13	12%	-14	-10%	T1,T2	CS,D
Portugal	754	163	159	9.3%	-594	-79%	-3	-2%	T1	D
Romania	NO	1	1	0.0%	1	∞	0	64%	T1,T2	CS,D
Slovakia	985	3	3	0.2%	-982	-100%	0	2%	T2	CS
Slovenia	98	2	7	0.4%	-90	-92%	6	313%	T1	D
Spain	1 247	166	176	10.2%	-1 071	-86%	10	6%	T1,T2,T3	CS,D,PS
Sweden	1 786	596	660	38.4%	-1 126	-63%	64	11%	T2	CS
United Kingdom	769	6	8	0.5%	-761	-99%	1	23%	T2	CS
EU-27+UK	**11 338**	**1 654**	**1 721**	**100%**	**-9 617**	**-85%**	**66**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	769	6	8	0.5%	-761	-99%	1	23%	T2	CS
EU-KP	**11 338**	**1 654**	**1 721**	**100%**	**-9 617**	**-85%**	**66**	**4%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany are included in 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 3.61 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Sweden (38%), Finland (21%) Spain (10%), Portugal (9%), Poland (7%) and France (5%) which together have 91% share on EU-KP emissions.

Figure 3.61: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Emission trend and share for CO_2

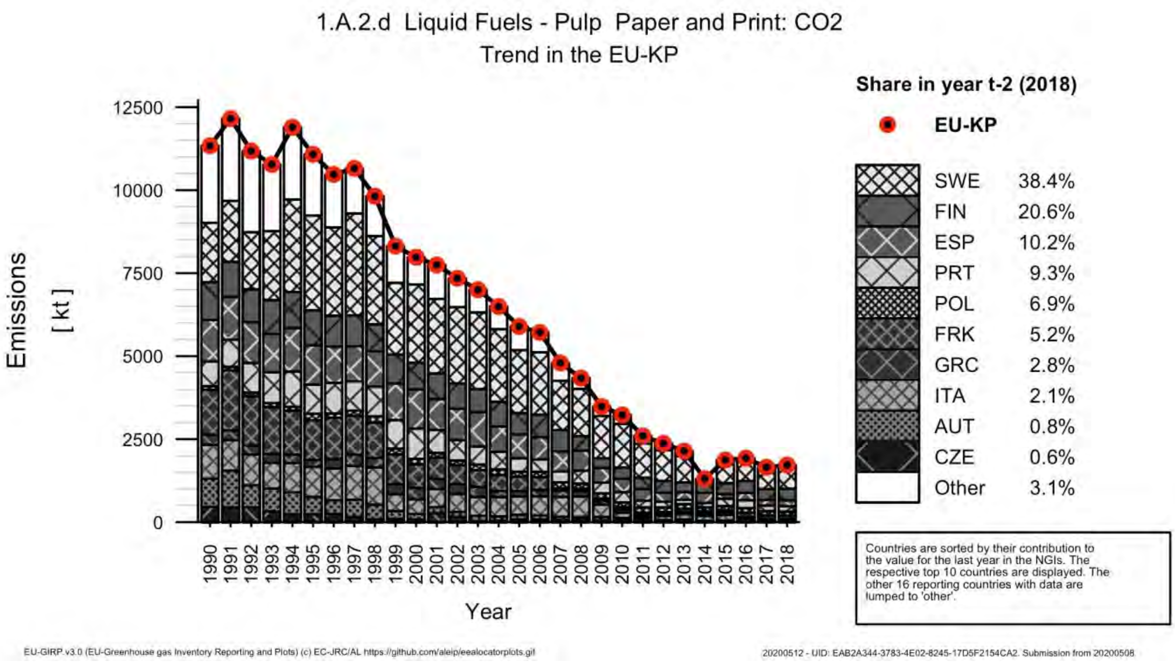


Figure.3.62 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF is decreasing during whole time period, which is caused by increasing consumption of Liquified Petroleum Gas with lower CO_2 IEF and decreasing consumption of Heavy Fuel Oil with higher CO_2 IEF. Slight fluctuation occurred during few last years. CO_2 IEF equaled to 69.75 t/TJ in 2018.

Figure.3.62: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

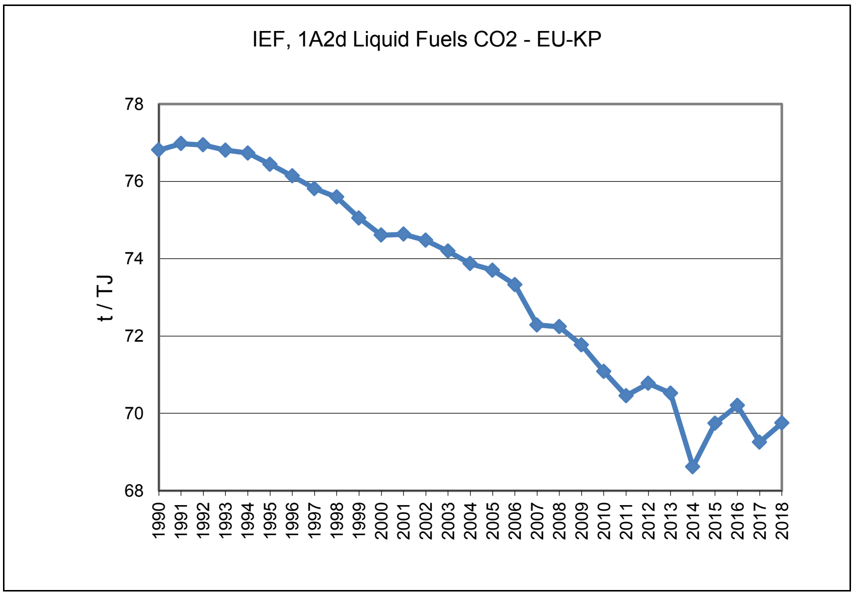
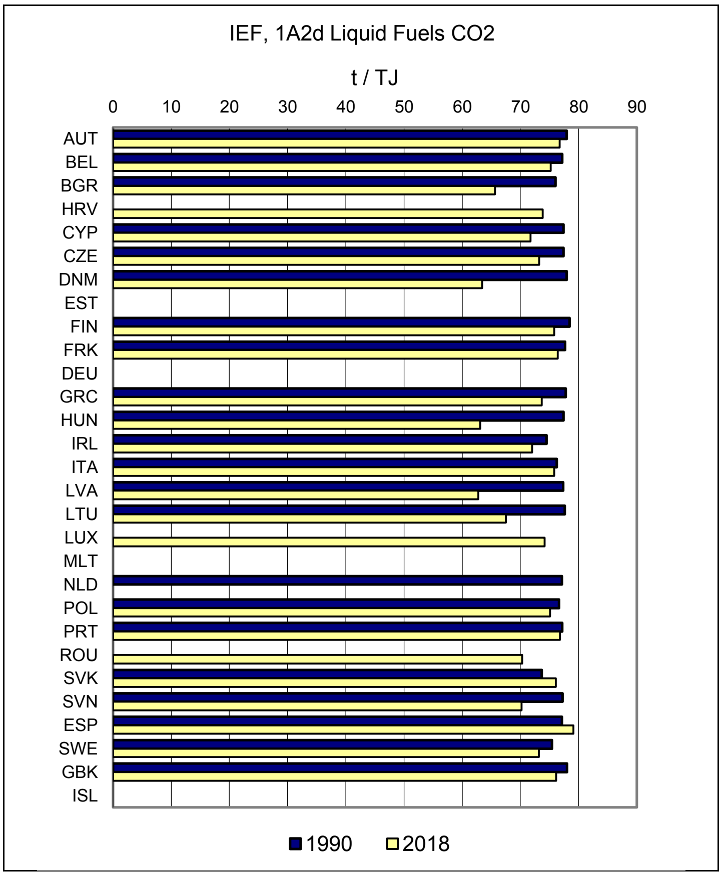


Figure.3.63 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. No major differences between countries CO_2 IEF occur.

Figure.3.63: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.d Pulp, Paper and Print - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.d amounted 2 376 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 70% and compared to 2017 by 12%. Category has 0.5% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 70% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table **3.37**. Fifteen Member States and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Belgium uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 96% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2018 than in 1990 (except of Hungary and Poland, which together has 40% share on EU-KP emissions).

Table 3.37: 1.A.2.d Pulp, Paper and Print, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	398	387	371	15.6%	-27	-7%	-16	-4%	T2	CS
Belgium	128	102	91	3.8%	-37	-29%	-11	-11%	T1	D
Bulgaria	NO	6	5	0.2%	5	∞	-1	-16%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 646	126	134	5.6%	-1 512	-92%	8	6%	T2	CS,D
Denmark	125	NO	NO	-	-125	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 318	230	181	7.6%	-1 136	-86%	-49	-21%	T3	CS
France	583	83	92	3.9%	-491	-84%	10	12%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	4	NO	NO	-	-4	-100%	-	-	NA	NA
Hungary	6	335	281	11.8%	276	4951%	-54	-16%	T3	PS
Ireland	NO	0	NO	-	-	-	0	-100%	NA	NA
Italy	6	NO	NO	-	-6	-100%	-	-	NA	NA
Latvia	2	NO	NO	-	-2	-100%	-	-	NA	NA
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	173	828	665	28.0%	493	285%	-163	-20%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	1 142	184	152	6.4%	-990	-87%	-31	-17%	T2	CS
Slovenia	172	108	107	4.5%	-65	-38%	0	0%	T3	PS
Spain	277	1	NO	-	-277	-100%	-1	-100%	NA	NA
Sweden	265	15	29	1.2%	-235	-89%	14	93%	T2	CS
United Kingdom	1 732	289	265	11.2%	-1 466	-85%	-23	-8%	T2	CS
EU-27+UK	**7 982**	**2 694**	**2 376**	**100%**	**-5 607**	**-70%**	**-318**	**-12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 732	289	265	11.2%	-1 466	-85%	-23	-8%	T2	CS
EU-KP	**7 982**	**2 694**	**2 376**	**100%**	**-5 607**	**-70%**	**-318**	**-12%**	**-**	**-**

Emissions of Germany are included in 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 3.64 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen, that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (28%), Austria (16%), Hungary (12%) and United Kingdom (11%) which together have 67% share on EU-KP emissions.

Figure 3.64: 1.A.2.d Pulp, Paper and Print, Solid fuels: Emission trend and share for CO_2

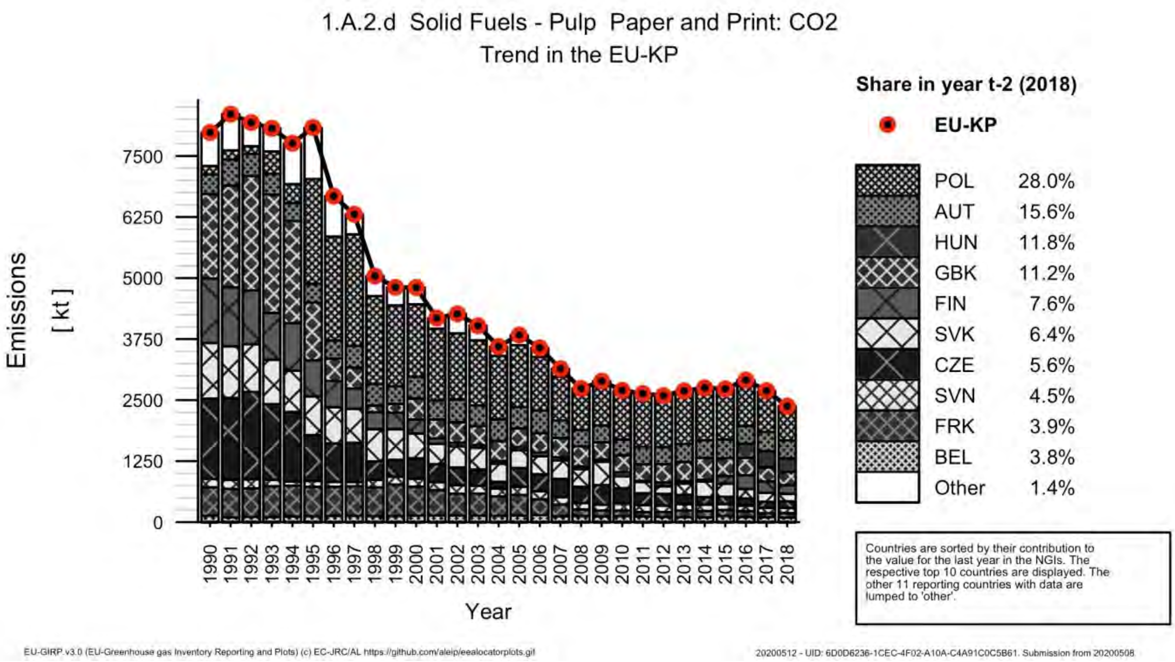


Figure 3.65 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF equaled to 94.15 t/TJ in 2018.

Figure 3.65: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

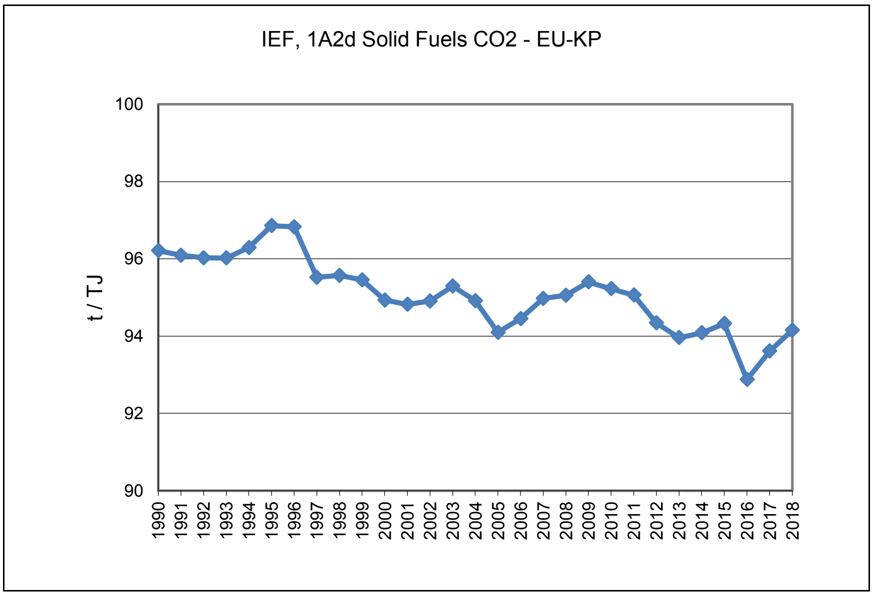
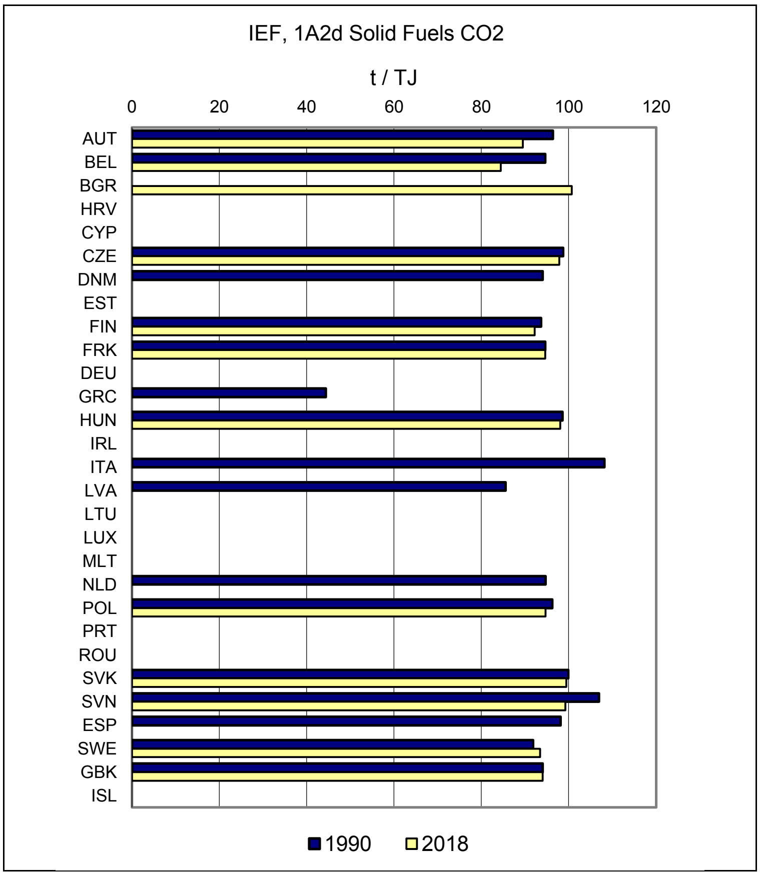


Figure 3.66 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018.

Figure 3.66: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.d Pulp, Paper and Print - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.d amounted 18 766 kt in 2018 for EU-KP. CO_2 emissions increased compared to year 1990 by 44% and compared to 2017 by 1%. Category has 4% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption increased by 42% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.38. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Four Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 91% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Gaseous Fuels (CO_2)). Seven Member States and United Kingdom reported lower level of emissions in 2018 than in 1990, the rest of Member States reported increase of emissions compared to 1990. Most rapid increase of emissions compared to 1990 was reported by Hungary, Italy, Poland and Spain.

Table 3.38: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	943	1 384	1 517	8.1%	574	61%	132	10%	T2	CS
Belgium	282	352	314	1.7%	32	11%	-39	-11%	T1	D
Bulgaria	NO	97	100	0.5%	100	∞	3	3%	T2	CS
Croatia	IE	91	90	0.5%	90	∞	-1	-1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	179	268	265	1.4%	86	48%	-3	-1%	T2	CS
Denmark	124	35	76	0.4%	-49	-39%	41	119%	T3	CS
Estonia	NO	12	41	0.2%	41	∞	29	242%	T2	CS
Finland	1 757	963	1 009	5.4%	-747	-43%	46	5%	T3	CS
France	2 089	2 006	2 075	11.1%	-14	-1%	69	3%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	27	43	0.2%	43	∞	16	60%	T2	CS
Hungary	50	107	113	0.6%	63	126%	6	6%	T1	D
Ireland	NO	8	8	0.0%	8	∞	1	7%	T2	CS
Italy	2 066	4 957	4 852	25.9%	2 786	135%	-104	-2%	T2	CS
Latvia	150	6	6	0.0%	-144	-96%	0	2%	T2	CS
Lithuania	187	33	39	0.2%	-148	-79%	7	20%	T2	CS
Luxembourg	IE	5	5	0.0%	5	∞	1	14%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 659	900	797	4.2%	-862	-52%	-103	-11%	T2	CS
Poland	6	483	476	2.5%	470	8436%	-7	-1%	T2	CS
Portugal	NO	967	1 147	6.1%	1 147	∞	181	19%	T1	D
Romania	NO	226	146	0.8%	146	∞	-80	-36%	T2	CS
Slovakia	203	173	181	1.0%	-21	-11%	9	5%	T2	CS
Slovenia	110	197	194	1.0%	85	77%	-2	-1%	T2	CS
Spain	1 077	4 036	4 037	21.5%	2 961	275%	1	0%	T2,T3	CS,PS
Sweden	66	69	75	0.4%	9	14%	6	9%	T2	CS
United Kingdom	2 122	1 162	1 160	6.2%	-962	-45%	-2	0%	T2	CS
EU-27+UK	**13 067**	**18 561**	**18 766**	**100%**	**5 699**	**44%**	**205**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 122	1 162	1 160	6.2%	-962	-45%	-2	0%	T2	CS
EU-KP	**13 067**	**18 561**	**18 766**	**100%**	**5 699**	**44%**	**205**	**1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Emissions of Germany are included in 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 3.67 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Italy (26%), Spain (22%), France (11%), Austria (8%), United Kingdom (6%), Portugal (6%), Finland (5%) and Netherland (4%) which together have 88% share on EU-KP emissions.

Figure 3.67: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Emission trend and share for CO_2

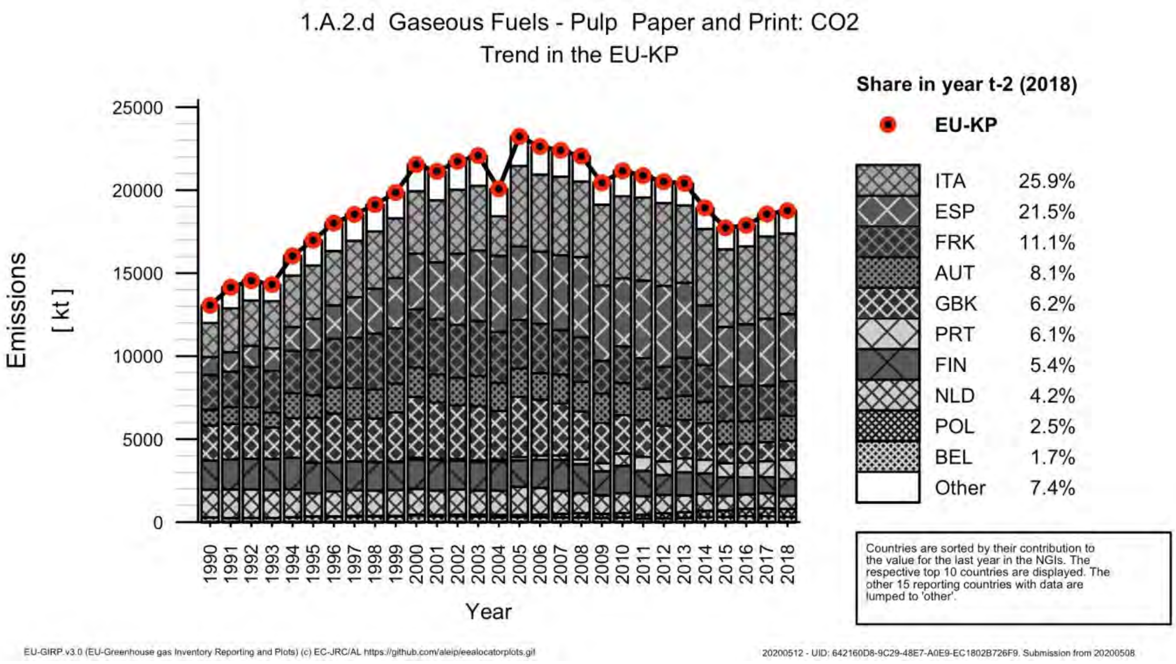


Figure 3.68 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF shows relatively stable trend without major fluctuations for whole time series with slightly increasing trend. The main reason for increasing trend of the CO_2 IEF is the growing weight in EU emissions of Italy and Spain; their CO_2 IEFs have been slightly growing since 1990. CO_2 IEF equaled to 56.52 t/TJ in 2018.

Figure 3.68: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

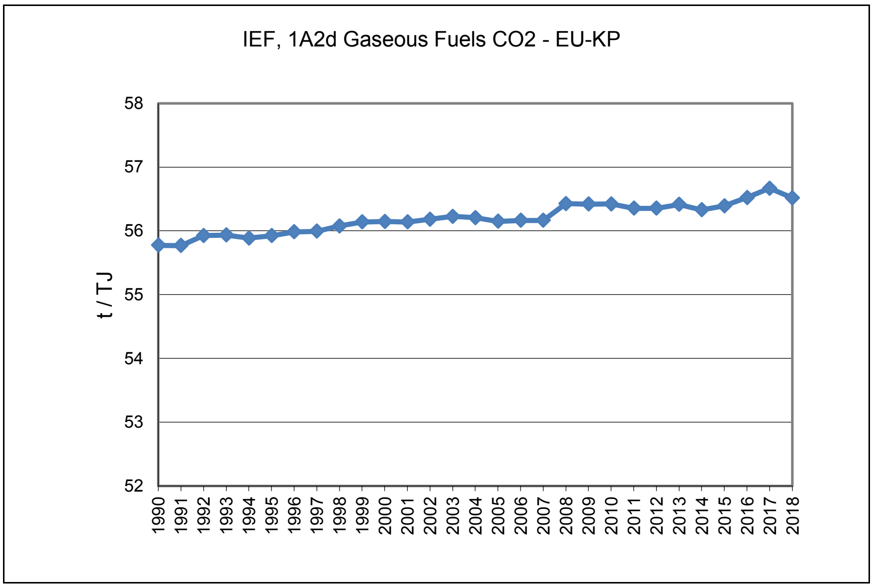
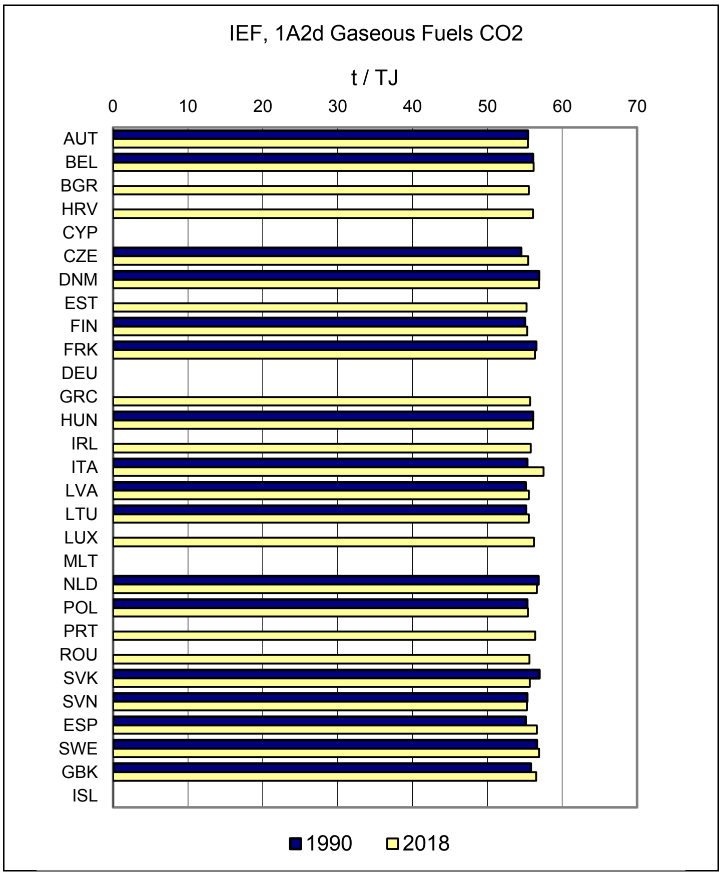


Figure 3.69 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen, that no major differences between CO_2 IEF used by countries occur, also no major differences between 1990 and 2018 CO_2 IEFs occur.

Figure 3.69: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



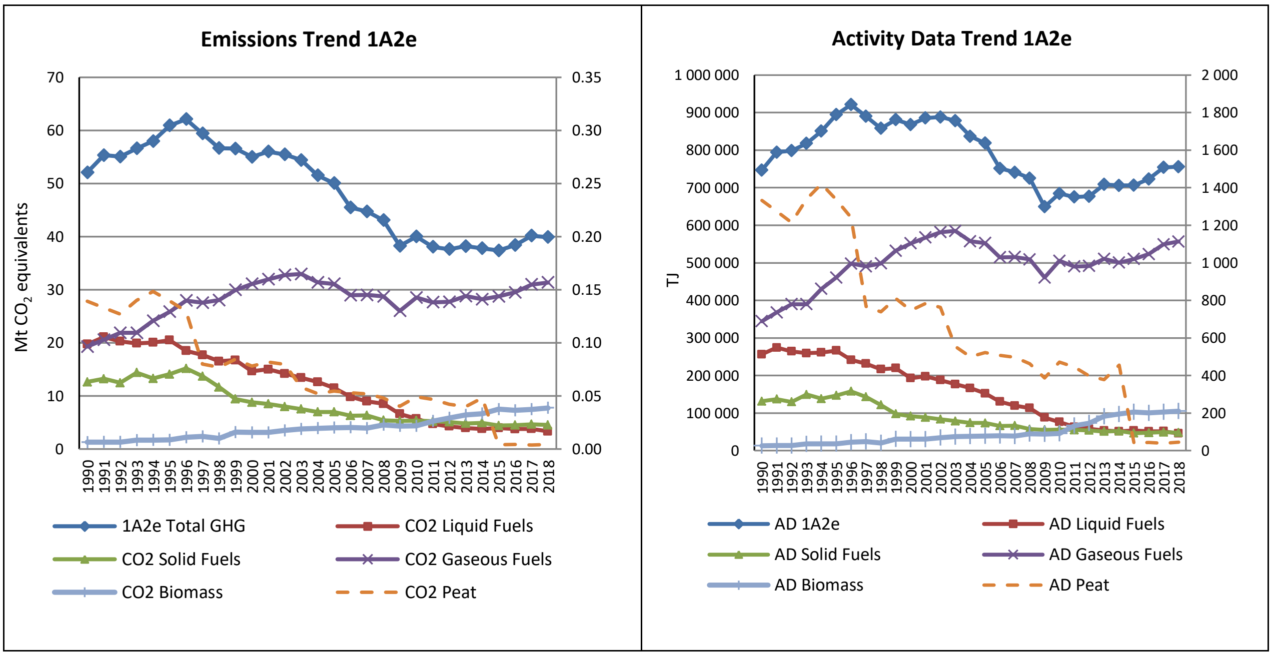
3.2.2.5 **Food Processing, Beverages and Tobacco (1.A.2.e)**

This chapter provides information about European emission trend, Member States, Iceland and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.e Food Processing, Beverages and Tobacco.

Total CO_2 emissions from 1.A.2.e amounted to 39 294 kt CO_2 eq. in 2018. The trend of total CO_2 emissions for 1990 to 2018 from category 1.A.2.e is depicted in Figure 3.70. Total CO_2 emissions decreased by 24% since 1990 and by 1% between 2017 and 2018. CO_2 emissions from 1.A.2.e Food Processing, Beverages and Tobacco accounted for 8% of 1.A.2. source category.

Figure 3.70 shows the emission trend within the category 1.A.2.e, which is dominated by CO_2 emissions from gaseous fuels in 2018. The share of liquid fuels on CO_2 emissions from 1.A.2.e decreased from 38% in 1990 to 9% in 2018. The share of solid fuels on CO_2 emissions from 1.A.2.e decreased from 24% in 1990 to 12% in 2018. The share of gaseous fuels on CO_2 emissions from 1.A.2.e increased from 37% in 1990 to 80% in 2018.

Figure 3.70: 1.A.2.e Food Processing, Beverages and Tobacco: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table 3.39. Malta reports emissions as 'NO' (not occurring). Four Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Romania which has 2% share on total EU-KP emissions.

Table 3.39: 1.A.2.e Food Processing, Beverages and Tobacco: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	870	806	773	2.0%	-96	-11%	-33	-4%	T1,T2	CS,D
Belgium	3 023	2 299	2 365	6.0%	-659	-22%	65	3%	T1,T3	D,PS
Bulgaria	454	240	238	0.6%	-215	-47%	-2	-1%	T1,T2	CS,D
Croatia	NO,IE	358	334	0.9%	334	∞	-24	-7%	T1	D
Cyprus	73	71	66	0.2%	-7	-10%	-5	-8%	T1	D
Czechia	2 988	1 032	984	2.5%	-2 004	-67%	-48	-5%	T1,T2	CS,D
Denmark	1 540	1 033	1 031	2.6%	-509	-33%	-2	0%	T1,T2,T3	CS,D
Estonia	457	14	7	0.0%	-449	-98%	-7	-48%	T2	CS
Finland	828	151	128	0.3%	-700	-85%	-23	-15%	T3	CS,D
France	8 631	7 173	7 130	18.1%	-1 501	-17%	-43	-1%	T2	CS
Germany	2 016	187	185	0.5%	-1 831	-91%	-2	-1%	CS	CS
Greece	917	637	608	1.5%	-309	-34%	-29	-5%	T1,T2	CS,D,PS
Hungary	1 888	722	826	2.1%	-1 062	-56%	104	14%	T1,T2	CS,D
Ireland	1 017	865	896	2.3%	-122	-12%	30	4%	T1,T2	CS,D
Italy	3 870	3 699	3 512	8.9%	-358	-9%	-188	-5%	T2	CS
Latvia	835	91	91	0.2%	-743	-89%	0	0%	T1,T2	CS,D
Lithuania	676	247	253	0.6%	-423	-63%	6	3%	T2	CS
Luxembourg	8	26	27	0.1%	19	229%	1	5%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4 009	3 731	3 693	9.4%	-316	-8%	-38	-1%	T2	CS
Poland	3 715	4 154	4 586	11.7%	870	23%	432	10%	T1,T2	CS,D
Portugal	830	782	737	1.9%	-94	-11%	-45	-6%	T1	CR,D
Romania	110	893	779	2.0%	669	609%	-114	-13%	T1,T2	CS,D
Slovakia	1 140	324	323	0.8%	-818	-72%	-1	0%	T2	CS
Slovenia	221	88	109	0.3%	-111	-51%	21	24%	T1,T2	CS,D
Spain	3 004	5 425	4 901	12.5%	1 897	63%	-524	-10%	T1,T2	CS,D
Sweden	948	336	322	0.8%	-626	-66%	-15	-4%	T2	CS
United Kingdom	7 628	4 139	4 365	11.1%	-3 264	-43%	225	5%	T2	CS
EU-27+UK	**51 697**	**39 526**	**39 268**	**100%**	**-12 429**	**-24%**	**-258**	**-1%**	**-**	**-**
Iceland	128	20	26	0.1%	-102	-80%	6	28%	T1	D
United Kingdom (KP)	7 628	4 139	4 365	11.1%	-3 264	-43%	225	5%	T2	CS
EU-KP	**51 825**	**39 546**	**39 294**	**100%**	**-12 531**	**-24%**	**-252**	**-1%**	**-**	**-**

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

1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.e amounted 3 344 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 83% and compared to 2017 by 12%. Category has 0.7% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 82% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.40. Estonia, Malta and Netherlands report emissions as 'NO' (not occurring). Nine Member States and Iceland use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 60% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Liquid Fuels (CO_2)). All countries reported lower level of emissions in 2018 than in 1990 (except for Luxembourg and Poland which together have 7% share on EU-KP emissions).

Table 3.40: 1.A.2.e Food Processing, Beverages and Tobacco, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	345	48	33	1.0%	-312	-90%	-15	-30%	T2	CS
Belgium	1 689	87	59	1.8%	-1 630	-96%	-28	-32%	T1	D
Bulgaria	409	30	26	0.8%	-384	-94%	-5	-15%	T1	D
Croatia	IE	50	52	1.5%	52	∞	2	4%	T1	D
Cyprus	73	71	66	2.0%	-7	-10%	-5	-8%	T1	D
Czechia	472	18	18	0.5%	-454	-96%	0	-1%	T1	CS,D
Denmark	675	205	180	5.4%	-495	-73%	-25	-12%	T1,T2	CS,D
Estonia	437	5	NO	-	-437	-100%	-5	-100%	NA	NA
Finland	365	71	46	1.4%	-319	-87%	-25	-36%	T3	CS
France	3 005	219	122	3.6%	-2 883	-96%	-97	-44%	T2	CS
Germany	908	19	18	0.5%	-891	-98%	-2	-10%	CS	CS
Greece	863	491	490	14.7%	-372	-43%	-1	0%	T2	CS
Hungary	463	23	23	0.7%	-440	-95%	0	0%	T1	D
Ireland	433	376	401	12.0%	-31	-7%	26	7%	T1,T2	CS,D
Italy	1 424	274	201	6.0%	-1 222	-86%	-73	-27%	T2	CS
Latvia	565	13	11	0.3%	-554	-98%	-2	-14%	T2	CS
Lithuania	174	42	31	0.9%	-143	-82%	-11	-26%	T2	CS
Luxembourg	4	12	12	0.4%	8	184%	0	4%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	165	NO	NO	-	-165	-100%	-	-	NA	NA
Poland	232	241	237	7.1%	4	2%	-5	-2%	T1,T2	CS,D
Portugal	829	216	213	6.4%	-616	-74%	-3	-1%	T1	CR,D
Romania	NO	145	95	2.8%	95	∞	-50	-34%	T1,T2	CS,D
Slovakia	359	1	1	0.0%	-357	-100%	0	30%	T2	CS
Slovenia	146	25	25	0.7%	-121	-83%	0	0%	T1	D
Spain	2 251	949	819	24.5%	-1 431	-64%	-130	-14%	T1	D
Sweden	596	135	119	3.5%	-478	-80%	-16	-12%	T2	CS
United Kingdom	2 735	21	23	0.7%	-2 712	-99%	2	9%	T2	CS
EU-27+UK	**19 617**	**3 787**	**3 321**	**99%**	**-16 296**	**-83%**	**-465**	**-12%**	**-**	**-**
Iceland	128	17	22	0.7%	-106	-83%	5	32%	T1	D
United Kingdom (KP)	2 735	21	23	0.7%	-2 712	-99%	2	9%	T2	CS
EU-KP	**19 745**	**3 804**	**3 344**	**100%**	**-16 402**	**-83%**	**-460**	**-12%**	**-**	**-**

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 3.71 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Spain (25%), Greece (15%), Ireland (12%), Poland (7%), Portugal (6%), Italy (6%) and Denmark (5%) which together have 76% share on EU-KP emissions.

Figure 3.71: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Emission trend and share for CO_2

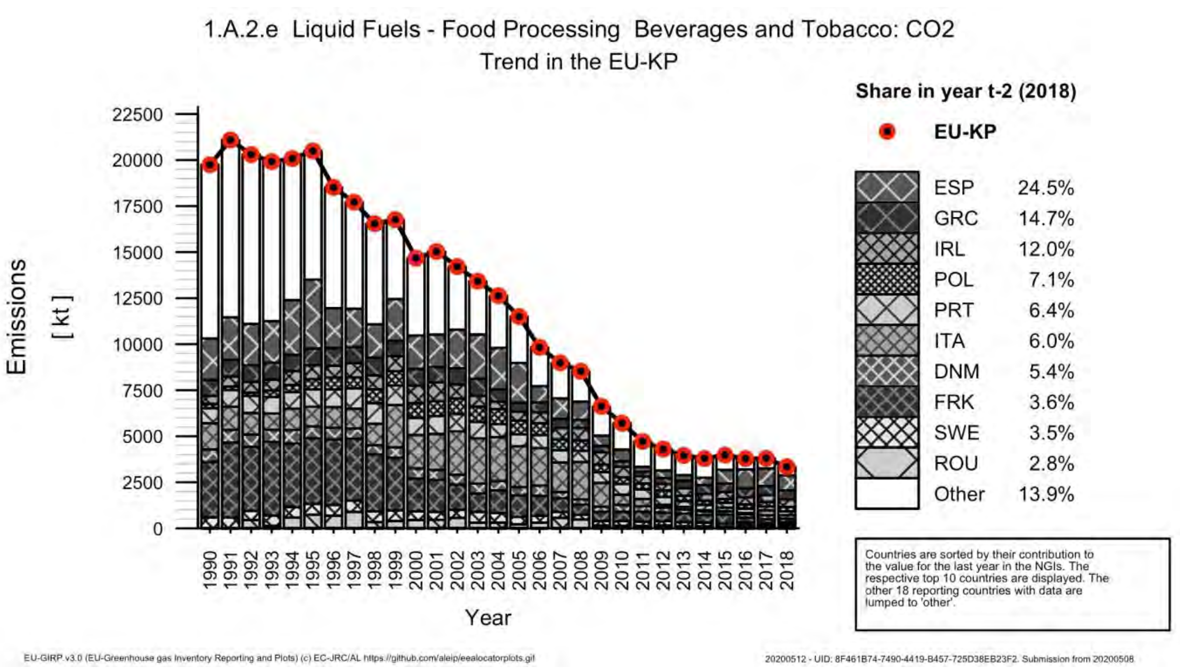


Figure 3.72 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that whole time series CO_2 IEF has decreasing trend with minor fluctuation between 2014 and 2018. CO_2 IEF equaled to 73.16 t/TJ in 2018.

Figure 3.72: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

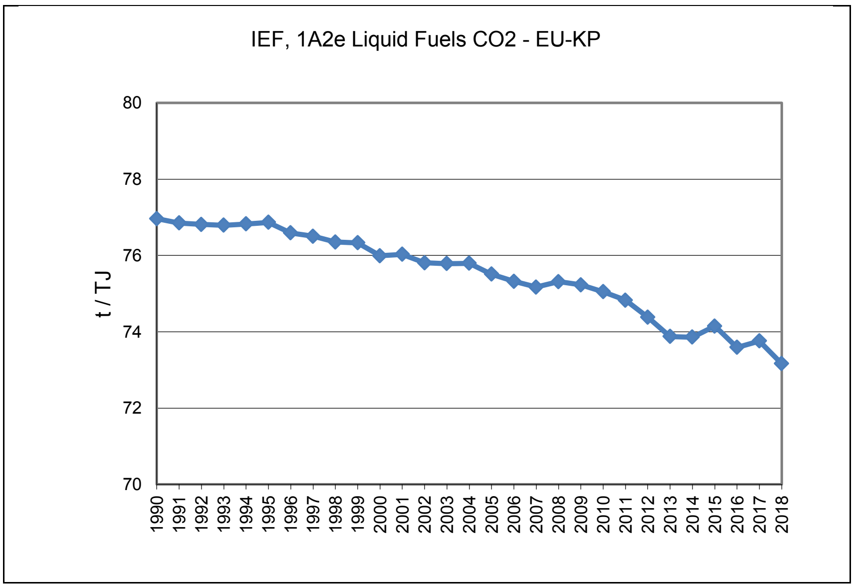
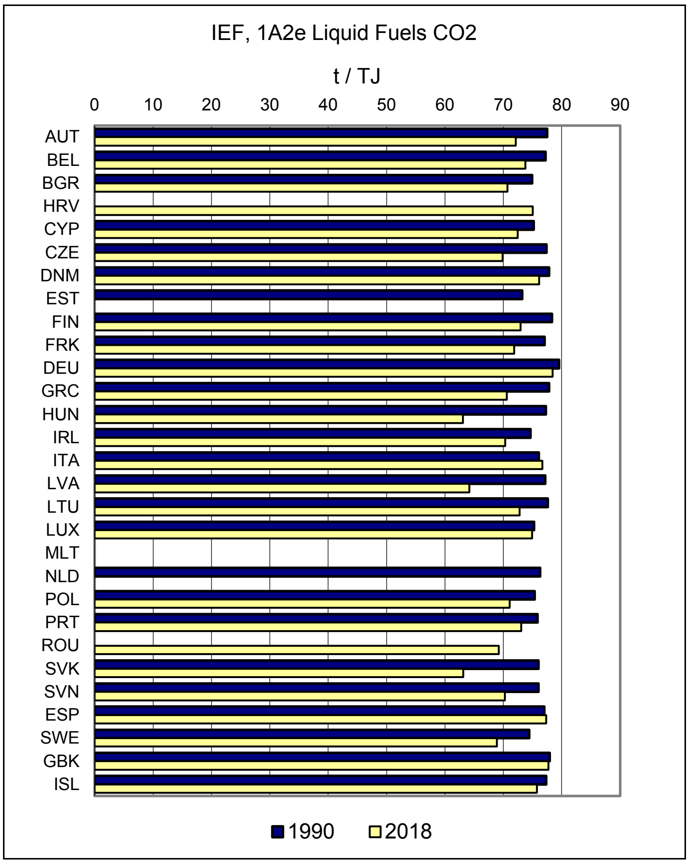


Figure 3.73 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen that no major differences between CO_2 IEF used by countries occur. Also no major differences between CO_2 IEF calculated in 1990 and 2018 occur.

Figure 3.73: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emissions for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.e Food Processing Beverages and Tobacco - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.e amounted 4 546 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 64% and compared to 2017 by 3%. Category has 0.9% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 64% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.41. Cyprus, Estonia, Luxembourg, Malta, Portugal, Slovenia and Iceland report emissions as 'NO' (not occurring). Four Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 93% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Solid Fuels (CO_2)). All countries reported lower level of emissions in 2018 than in 1990.

Table 3.41: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	18	18	14	0.3%	-4	-22%	-4	-22%	T2	CS
Belgium	651	98	118	2.6%	-532	-82%	20	20%	T1	D
Bulgaria	33	3	3	0.1%	-30	-91%	0	-10%	T1,T2	CS,D
Croatia	IE	86	62	1.4%	62	∞	-24	-28%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 789	200	201	4.4%	-1 588	-89%	1	0%	T2	CS,D
Denmark	399	122	121	2.7%	-278	-70%	-1	-1%	T1	D
Estonia	5	NO	NO	-	-5	-100%	-	-	NA	NA
Finland	257	67	71	1.6%	-185	-72%	4	6%	T3	CS
France	2 138	1 092	948	20.9%	-1 189	-56%	-144	-13%	T2	CS
Germany	1 108	168	167	3.7%	-941	-85%	0	0%	CS	CS
Greece	54	5	0	0.0%	-54	-99%	-4	-93%	T2	PS
Hungary	185	6	9	0.2%	-175	-95%	3	49%	T1,T2	CS,D
Ireland	292	85	73	1.6%	-218	-75%	-11	-13%	T2	CS
Italy	87	17	14	0.3%	-74	-84%	-3	-20%	T2	CS
Latvia	95	4	2	0.0%	-93	-98%	-2	-58%	T2	CS
Lithuania	33	10	9	0.2%	-25	-74%	-2	-16%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	227	127	127	2.8%	-100	-44%	0	0%	T2	CS
Poland	3 374	2 253	2 336	51.4%	-1 038	-31%	83	4%	T1,T2	CS,D
Portugal	1	NO	NO	-	-1	-100%	-	-	NA	NA
Romania	110	35	3	0.1%	-107	-97%	-32	-92%	T1	D
Slovakia	312	47	45	1.0%	-267	-86%	-3	-5%	T2	CS
Slovenia	9	NO	NO	-	-9	-100%	-	-	NA	NA
Spain	94	25	19	0.4%	-75	-80%	-6	-24%	T1,T2	CS,D
Sweden	90	11	8	0.2%	-82	-91%	-3	-29%	T2	CS
United Kingdom	1 289	202	195	4.3%	-1 094	-85%	-8	-4%	T2	CS
EU-27+UK	**12 648**	**4 683**	**4 546**	**100%**	**-8 103**	**-64%**	**-137**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 289	202	195	4.3%	-1 094	-85%	-8	-4%	T2	CS
EU-KP	**12 648**	**4 683**	**4 546**	**100%**	**-8 103**	**-64%**	**-137**	**-3%**	**-**	**-**

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 3.74 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (51%) and France (21%) which together have 72% share on EU-KP emissions.

Figure 3.74: 1.A.2.e Food Processing, Beverages and Tobacco, solid fuels: Emission trend and share for CO_2

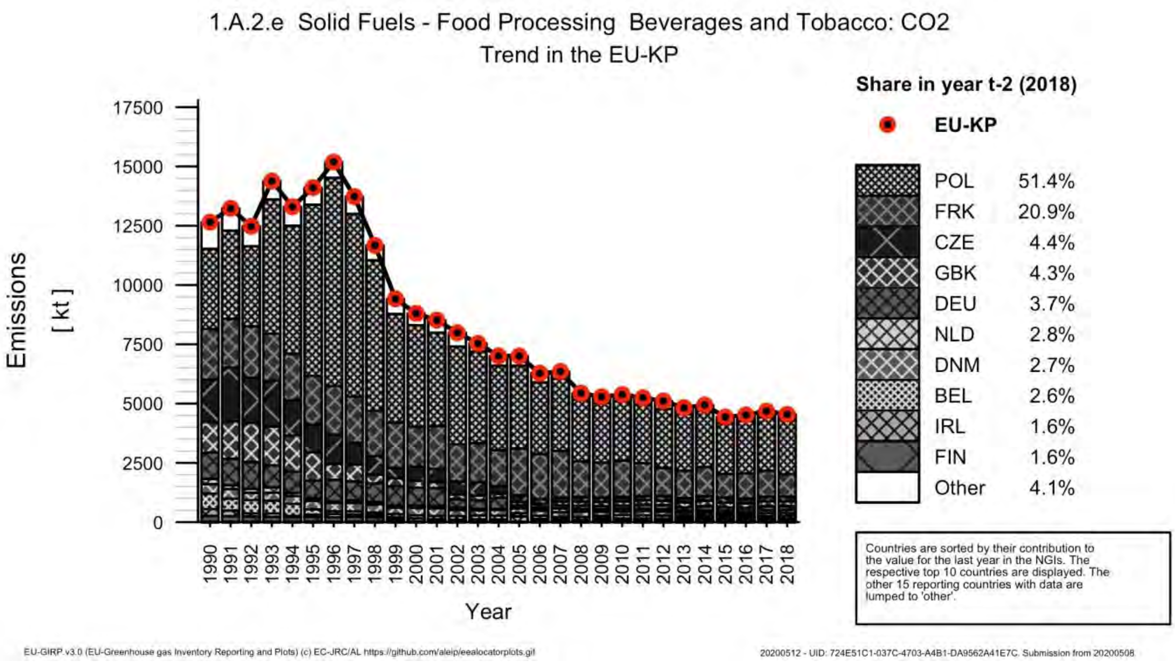


Figure 3.75 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF is relatively stable during whole time period with slightly decreasing trend. CO_2 IEF equaled to 95.08 t/TJ in 2018.

Figure 3.75: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

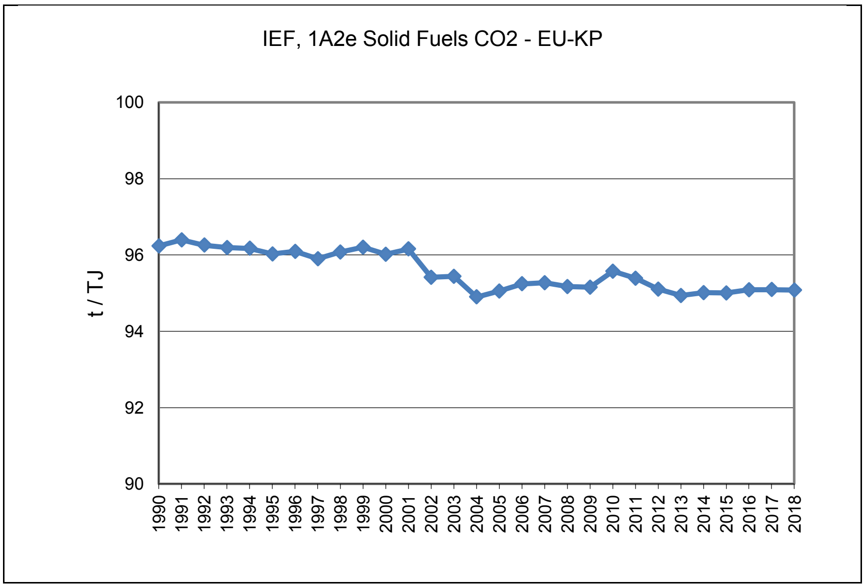
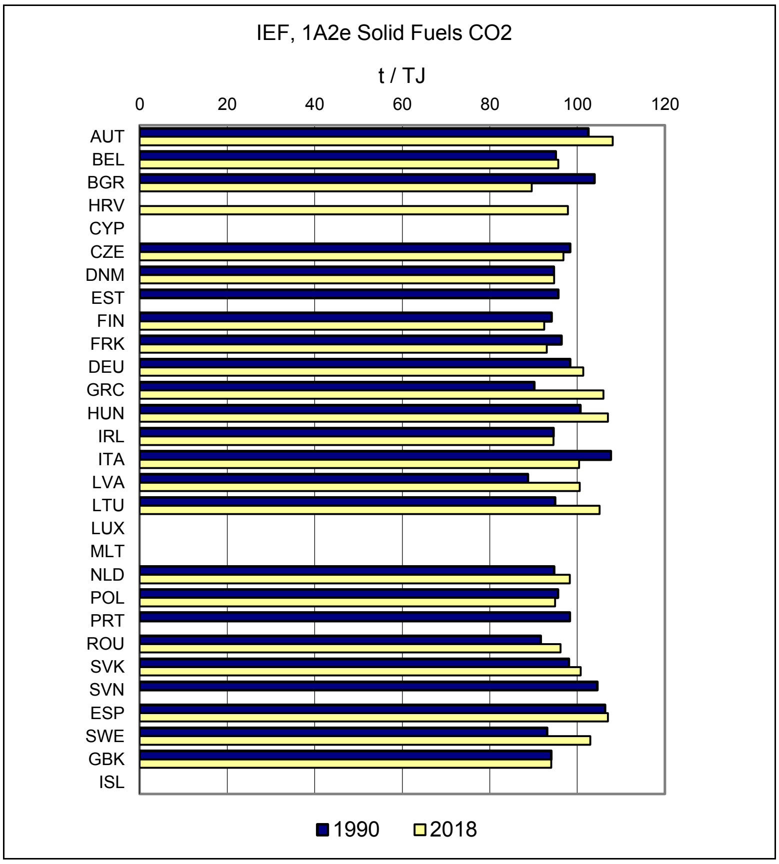


Figure 3.76 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen, that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2018 occur.

Figure 3.76: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.e Food Processing Beverages and Tobacco - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.e amounted 31 362 kt in 2018 for EU-KP. CO_2 emissions increased compared to year 1990 by 63% and compared to 2017 by 1%. Category has 6% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption increased by 62% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.42. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). For confidentiality reasons Germany reports emissions in 1.A.2.g. Emissions of Malta are included in 1.A.2.g. Three Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 95% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Gaseous Fuels (CO_2)). Eight Member States reported lower level of emissions in 2018 than in 1990, the rest of countries reported increase of emissions.

Table 3.42: 1.A.2.e Food Processing, Beverages and Tobacco, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	507	740	726	2.3%	219	43%	-14	-2%	T2	CS
Belgium	684	2 114	2 187	7.0%	1 503	220%	74	3%	T1,T3	D,PS
Bulgaria	11	207	210	0.7%	199	1738%	3	1%	T2	CS
Croatia	IE	223	220	0.7%	220	∞	-3	-1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	727	815	766	2.4%	39	5%	-48	-6%	T2	CS
Denmark	466	706	730	2.3%	264	57%	24	3%	T3	CS
Estonia	15	10	7	0.0%	-7	-50%	-2	-24%	T2	CS
Finland	67	13	11	0.0%	-56	-84%	-2	-15%	T3	CS
France	3 488	5 850	6 051	19.3%	2 562	73%	200	3%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	141	117	0.4%	117	∞	-24	-17%	T2	CS
Hungary	1 239	692	793	2.5%	-446	-36%	101	15%	T1	D
Ireland	293	402	418	1.3%	124	42%	15	4%	T2	CS
Italy	2 359	3 408	3 297	10.5%	938	40%	-112	-3%	T2	CS
Latvia	175	72	77	0.2%	-99	-56%	4	6%	T2	CS
Lithuania	469	193	212	0.7%	-257	-55%	19	10%	T2	CS
Luxembourg	4	14	14	0.0%	11	280%	1	5%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 617	3 604	3 566	11.4%	-51	-1%	-38	-1%	T2	CS
Poland	109	1 659	2 013	6.4%	1 904	1747%	354	21%	T2	CS
Portugal	NO	567	524	1.7%	524	∞	-43	-8%	T1	D
Romania	NO	688	658	2.1%	658	∞	-30	-4%	T2	CS
Slovakia	470	276	277	0.9%	-193	-41%	1	0%	T2	CS
Slovenia	65	63	84	0.3%	19	28%	21	34%	T2	CS
Spain	660	4 451	4 063	13.0%	3 403	516%	-388	-9%	T2	CS
Sweden	254	178	195	0.6%	-58	-23%	17	10%	T2	CS
United Kingdom	3 605	3 916	4 147	13.2%	543	15%	231	6%	T2	CS
EU-27+UK	**19 284**	**31 001**	**31 362**	**100%**	**12 078**	**63%**	**361**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 605	3 916	4 147	13.2%	543	15%	231	6%	T2	CS
EU-KP	**19 284**	**31 001**	**31 362**	**100%**	**12 078**	**63%**	**361**	**1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Emissions of Germany included in 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 3.77 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has France (19%), United Kingdom (13%), Spain (13%), Netherlands (11%), Italy (11%), Belgium (7%) and Poland (6%) which together have 81% share on EU-KP emissions.

Figure 3.77: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Emission trend and share for CO_2

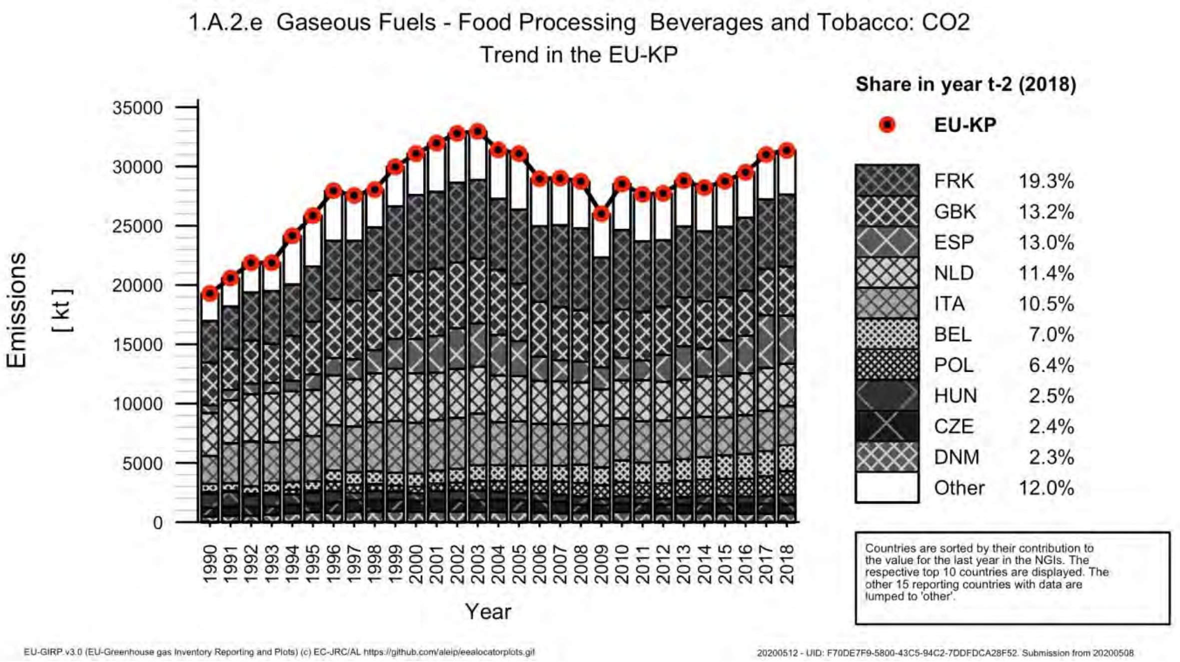


Figure 3.78 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018 which is stable during whole time period. CO_2 IEF equaled to 56.32 t/TJ in 2018.

Figure 3.78: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

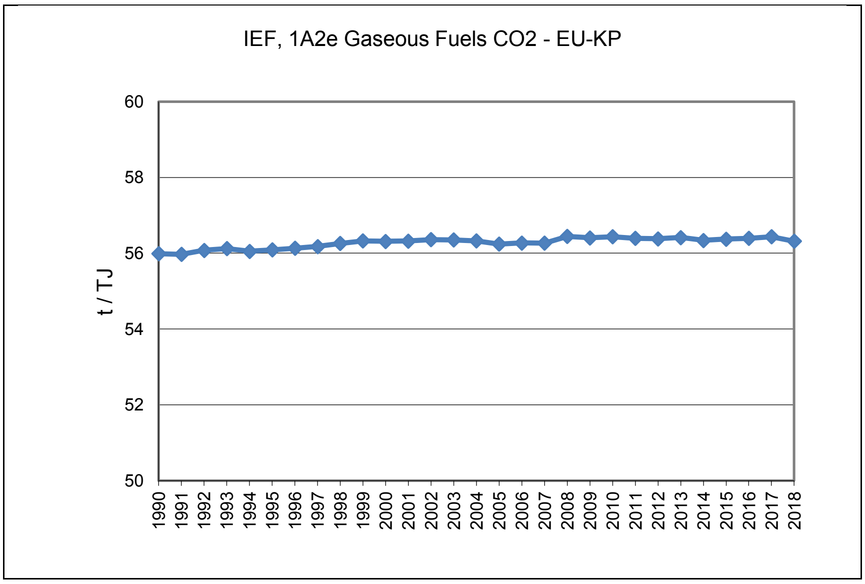
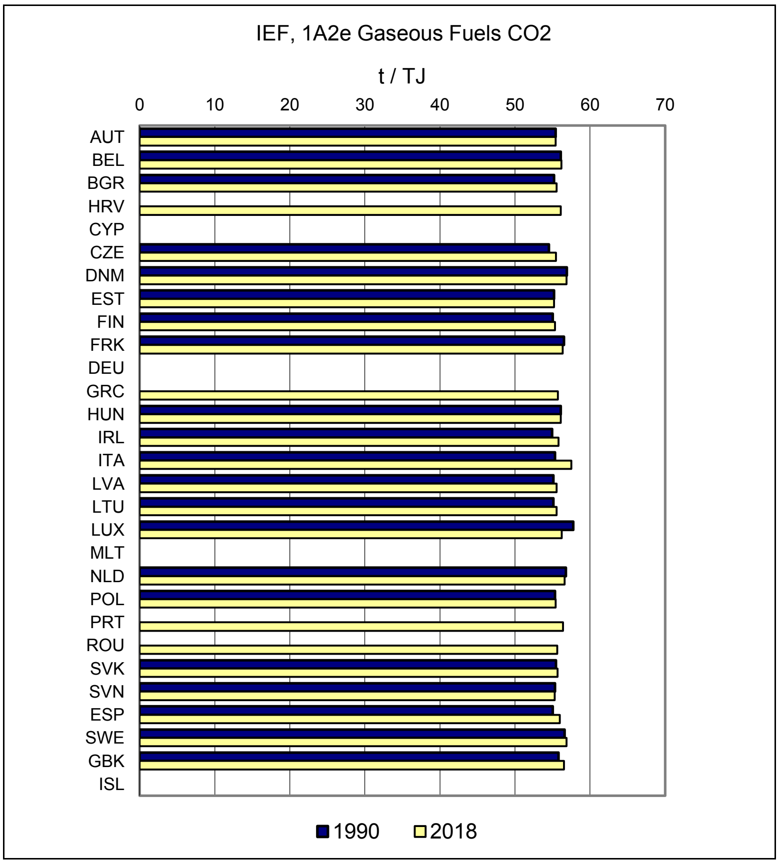


Figure 3.79 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen, that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2018 occur.

Figure 3.79: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



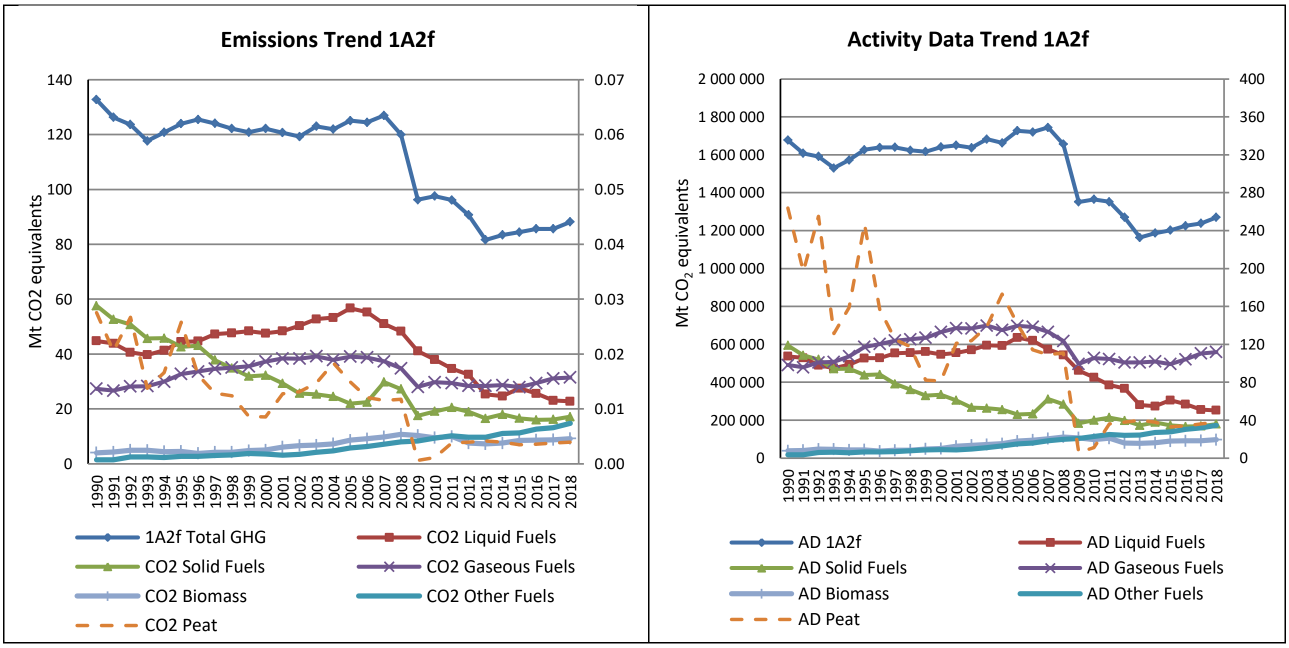
3.2.2.6 **Non-metallic Minerals (1.A.2.f)**

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.f Non-metallic Minerals.

Total CO_2 emissions from 1.A.2.f amounted to 86 914 kt CO_2 eq. in 2018. The trend of total emissions for 1990 to 2018 from category 1.A.2.f is depicted in Figure 3.80. Total CO_2 emissions decreased by 34% since 1990 and increased by 3% between 2017 and 2018. The sharp decline in 2009 is due to the economic crisis and sharp decline in building activity. CO_2 emissions from 1.A.2.f Non-metallic Minerals accounted for 17% of 1.A.2. source category.

Figure 3.80 shows the emission trend within the category 1.A.2.f, which is dominated by CO_2 emissions from gaseous fuels in 2018. The share of liquid fuels on CO_2 emissions from 1.A.2.f decreased from 34% in 1990 to 26% in 2018. The share of solid fuels on CO_2 emissions from 1.A.2.f decreased from 44% in 1990 to 20% in 2018. The share of gaseous fuels on CO_2 emissions from 1.A.2.f increased from 21% in 1990 to 36% in 2018.

Figure 3.80: 1.A.2.f Non-metallic Minerals: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table.3.43. Malta reports emissions as 'NO' (not occurring). Six Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emission was reported by Romania (1113%) which has 4% share on total EU-KP emissions.

Table.3.43: 1.A.2.f Non-metallic Minerals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 669	1 636	1 694	1.9%	25	1%	58	4%	T1,T2	CS,D
Belgium	5 525	3 341	3 489	4.0%	-2 037	-37%	148	4%	T1,T3	D,PS
Bulgaria	2 646	1 194	1 146	1.3%	-1 500	-57%	-49	-4%	T1,T2	CS,D
Croatia	NO,IE	105	101	0.1%	101	∞	-4	-4%	T1	D
Cyprus	380	475	420	0.5%	41	11%	-55	-12%	CS,T1	CS,D
Czechia	4 527	2 601	2 488	2.9%	-2 039	-45%	-113	-4%	T1,T2	CS,D
Denmark	1 292	1 435	1 395	1.6%	102	8%	-41	-3%	T1,T2,T3	CS,D,PS
Estonia	952	421	397	0.5%	-555	-58%	-25	-6%	T1,T2,T3	CS,D,PS
Finland	1 368	672	595	0.7%	-773	-56%	-77	-11%	T3	CS,D
France	14 517	8 334	8 485	9.8%	-6 032	-42%	151	2%	T2,T3	CS,PS
Germany	18 507	13 388	13 705	15.8%	-4 802	-26%	317	2%	CS	CS
Greece	6 278	3 875	3 459	4.0%	-2 819	-45%	-415	-11%	T1,T2	CS,D,PS
Hungary	2 326	1 132	1 214	1.4%	-1 112	-48%	82	7%	T1,T2,T3	CS,D,PS
Ireland	819	1 227	1 296	1.5%	477	58%	69	6%	T1,T2,T3	CS,D,PS
Italy	21 008	11 553	11 858	13.6%	-9 150	-44%	305	3%	T2	CS
Latvia	598	264	331	0.4%	-267	-45%	67	25%	T1,T2	CS,D,PS
Lithuania	3 210	403	446	0.5%	-2 764	-86%	43	11%	T2,T3	CS,PS
Luxembourg	537	394	391	0.4%	-146	-27%	-3	-1%	T1,T2	CS,D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 298	1 222	1 289	1.5%	-1 008	-44%	67	6%	T2	CS
Poland	10 340	8 731	9 556	11.0%	-783	-8%	825	9%	T1,T2	CS,D
Portugal	3 288	2 733	2 611	3.0%	-677	-21%	-122	-4%	T1,T3	D,PS
Romania	265	2 661	3 209	3.7%	2 944	1113%	548	21%	T1,T2	CS,D
Slovakia	3 408	1 311	1 496	1.7%	-1 913	-56%	185	14%	T2	CS
Slovenia	296	442	465	0.5%	169	57%	23	5%	T1,T2,T3	CS,D,PS
Spain	16 525	11 138	11 661	13.4%	-4 864	-29%	522	5%	T1,T2	CS,D,PS
Sweden	1 826	1 222	1 194	1.4%	-632	-35%	-27	-2%	T1,T2	CS
United Kingdom	6 600	2 540	2 524	2.9%	-4 076	-62%	-16	-1%	T2	CS
EU-27+UK	**131 004**	**84 448**	**86 914**	**100%**	**-44 090**	**-34%**	**2 466**	**3%**	**-**	**-**
Iceland	50	0	0	0.0%	-50	-99%	0	-2%	T1	D
United Kingdom (KP)	6 600	2 540	2 524	2.9%	-4 076	-62%	-16	-1%	T2	CS
EU-KP	**131 054**	**84 448**	**86 914**	**100%**	**-44 140**	**-34%**	**2 466**	**3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. 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.

1.A.2.f Non-metallic Minerals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.f amounted 22 729 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 48% and compared to 2017 by 2%. Category has 5% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 53% compared to 1990. One of the reasons for the decline is increase in the use of waste as a fuel.

Detailed data related to the EU-KP submissions are depicted in Table **3.44**. Sweden reports emissions as 'C' (confidential) since 2016 in order to comply with the Public Access to Information and Secrecy Act of the Swedish law. This decision was made based on the results of the internal review. Estonia, Malta and Netherlands report emissions as 'NO' (not occuring). Five Member States and Iceland use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 98% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Liquid Fuels (CO_2)). Four Member States reported higher level of emissions in 2018 than in 1990.

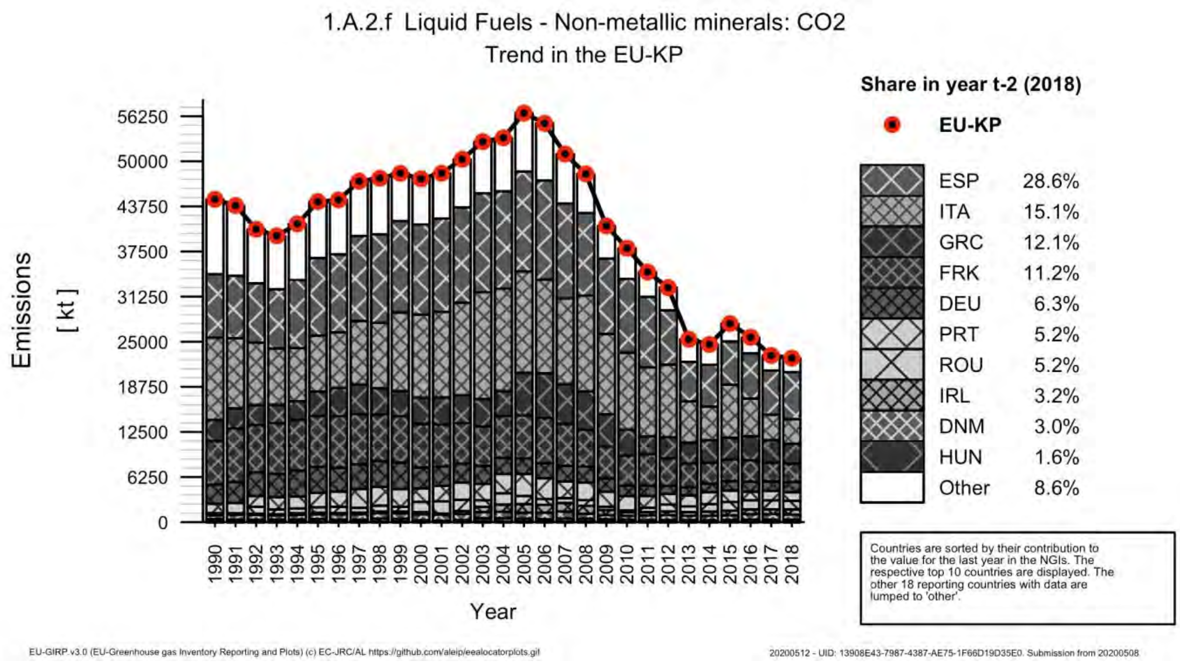
Table 3.44: 1.A.2.f Non-metallic Minerals , liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	508	136	132	0.6%	-376	-74%	-4	-3%	T2	CS
Belgium	1 509	202	208	0.9%	-1 300	-86%	6	3%	T1,T3	D,PS
Bulgaria	666	339	307	1.4%	-359	-54%	-32	-9%	T1	D
Croatia	IE	1	1	0.0%	1	∞	0	50%	T1	D
Cyprus	148	374	269	1.2%	121	82%	-105	-28%	CS	CS
Czechia	1 029	19	46	0.2%	-983	-95%	27	140%	T1	CS,D
Denmark	481	768	674	3.0%	193	40%	-94	-12%	T1,T2	CS,D
Estonia	140	3	NO	-	-140	-100%	-3	-100%	NA	NA
Finland	437	250	251	1.1%	-186	-43%	1	0%	T3	CS
France	6 049	2 571	2 547	11.2%	-3 502	-58%	-24	-1%	T2,T3	CS,PS
Germany	2 663	1 318	1 440	6.3%	-1 223	-46%	122	9%	CS	CS
Greece	2 914	3 177	2 741	12.1%	-173	-6%	-436	-14%	T2	PS
Hungary	423	338	367	1.6%	-56	-13%	29	9%	T1,T2	CS,D
Ireland	312	670	717	3.2%	405	130%	47	7%	T1,T2	CS,D
Italy	11 375	3 489	3 424	15.1%	-7 951	-70%	-65	-2%	T2	CS
Latvia	267	4	1	0.0%	-265	-99%	-3	-66%	T1,T2	CS,D
Lithuania	2 750	12	7	0.0%	-2 743	-100%	-5	-40%	T2	CS
Luxembourg	23	9	9	0.0%	-14	-59%	0	2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	468	15	NO	-	-468	-100%	-15	-100%	NA	NA
Poland	394	281	329	1.4%	-66	-17%	47	17%	T1,T2	CS,D
Portugal	1 318	1 327	1 182	5.2%	-136	-10%	-145	-11%	T1,T3	D,PS
Romania	NO	1 224	1 181	5.2%	1 181	∞	-42	-3%	T1,T2	CS,D
Slovakia	1 219	204	206	0.9%	-1 013	-83%	2	1%	T2	CS
Slovenia	63	112	122	0.5%	59	93%	10	9%	T1	D
Spain	8 819	6 148	6 495	28.6%	-2 323	-26%	347	6%	T1,T2	CS,D
Sweden	625	C	C	-	-625	-100%	-	-	T1	CS
United Kingdom	127	89	71	0.3%	-56	-44%	-18	-20%	T2	CS
EU-27+UK	**44 103**	**23 081**	**22 729**	**100%**	**-21 374**	**-48%**	**-352**	**-2%**	**-**	**-**
Iceland	2	0	0	0.0%	-2	-81%	0	-2%	T1	D
United Kingdom (KP)	127	89	71	0.3%	-56	-44%	-18	-20%	T2	CS
EU-KP	**44 105**	**23 081**	**22 729**	**100%**	**-21 376**	**-48%**	**-352**	**-2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Malta 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.3.81 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Spain (29%), Italy (15%), Greece (12%), France (11%), Germany (6%), Portugal (5%) and Romania (5%) which together have 84% share on EU-KP emissions.

Figure.3.81: 1.A.2.f Non-metallic Minerals, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden.

Figure.3.82 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF increased more obvious compared to CO_2 IEF calculated for 1990. The high CO_2 IEF in recent years is caused mainly due to the increased consumption of petrol coke in cement kilns. The strong decrease in 2012 is caused by big decrease of Italy's CO_2 IEF which has a strong influence on total EU-KP CO_2 IEF. CO_2 IEF equaled to 90.42 t/TJ in 2018.

Figure.3.82: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

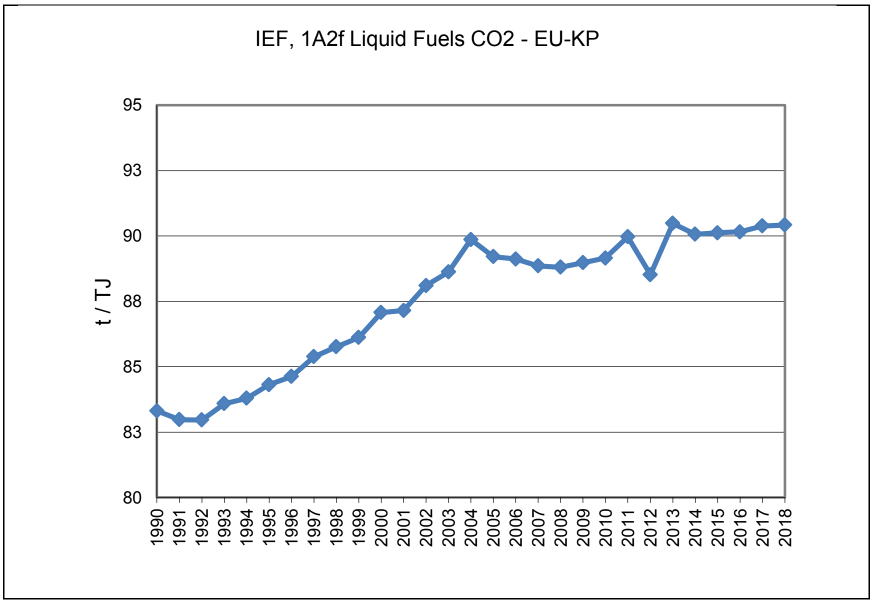
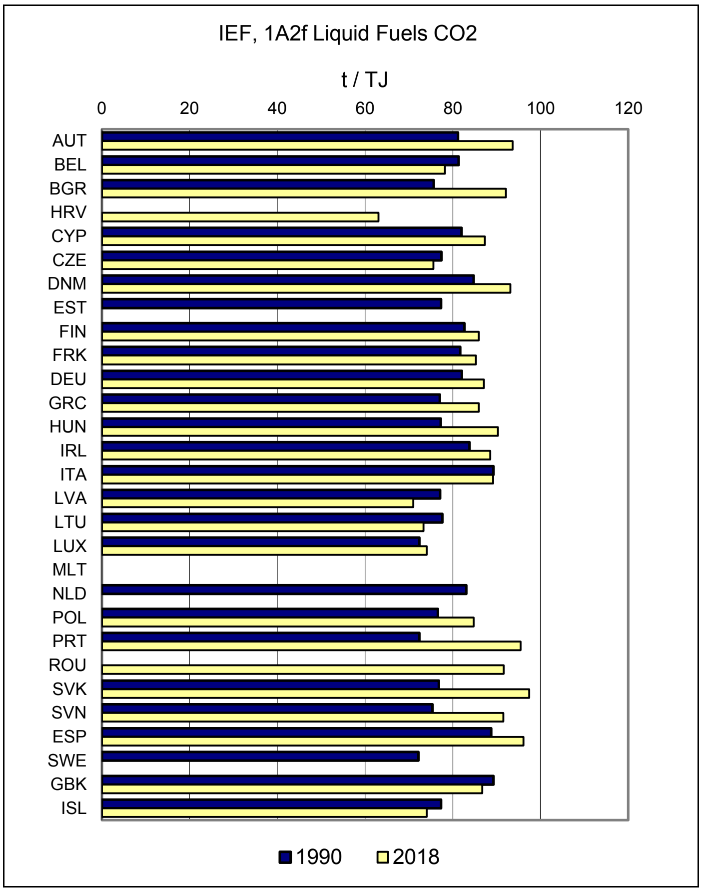


Figure 3.83 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. The CO_2 IEF is in many cases higher in 2018 than in 1990 which reflects reasons for relatively high CO_2 IEF mentioned above.

Figure 3.83: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.f amounted 17 126 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 70% and compared to 2017 increased by 6%. Category has 3% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption decreased by 70% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.45. Croatia, Malta and Iceland report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). Luxembourg uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Solid Fuels (CO_2)). All countries reported lower level of emissions in 2018 than in 1990 (except of Latvia and Lithuania, but it should be noted that the share of their emissions on total EU-KP emissions is together only 3%).

Table 3.45: 1.A.2.f Non-metallic Minerals, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	535	211	230	1.3%	-305	-57%	19	9%	T2	CS
Belgium	2 466	1 548	1 655	9.7%	-811	-33%	108	7%	T1,T3	D,PS
Bulgaria	295	209	203	1.2%	-92	-31%	-6	-3%	T1,T2	CS,D
Croatia	IE	NO	NO	-	-	-	-	-	NA	NA
Cyprus	232	12	54	0.3%	-178	-77%	42	361%	CS	CS
Czechia	2 209	788	752	4.4%	-1 456	-66%	-35	-5%	T2	CS,D
Denmark	574	248	252	1.5%	-322	-56%	4	2%	T1,T3	D,PS
Estonia	756	171	182	1.1%	-574	-76%	10	6%	T1,T2	CS,D
Finland	806	309	236	1.4%	-570	-71%	-73	-24%	T3	CS
France	4 276	816	879	5.1%	-3 397	-79%	63	8%	T2,T3	CS,PS
Germany	12 053	4 876	4 835	28.2%	-7 218	-60%	-40	-1%	CS	CS
Greece	3 364	154	457	2.7%	-2 907	-86%	304	198%	T2	PS
Hungary	230	135	118	0.7%	-112	-49%	-17	-13%	T1,T2	D,PS
Ireland	375	319	344	2.0%	-30	-8%	25	8%	T2	CS
Italy	3 690	767	918	5.4%	-2 772	-75%	152	20%	T2	CS
Latvia	15	91	130	0.8%	115	758%	39	43%	T2	CS
Lithuania	60	328	370	2.2%	311	521%	42	13%	T2	CS
Luxembourg	312	152	135	0.8%	-177	-57%	-17	-11%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	346	197	209	1.2%	-137	-40%	12	6%	T2	CS
Poland	8 576	2 398	2 603	15.2%	-5 973	-70%	205	9%	T1,T2	CS,D
Portugal	1 958	NO	1	0.0%	-1 957	-100%	1	∞	T1,T3	D,PS
Romania	265	193	211	1.2%	-54	-20%	17	9%	T1,T2	CS,D
Slovakia	1 474	451	546	3.2%	-928	-63%	95	21%	T2	CS
Slovenia	113	49	47	0.3%	-66	-58%	-2	-3%	T1,T3	D,PS
Spain	5 221	158	183	1.1%	-5 038	-96%	25	16%	T1,T2	CS,D
Sweden	1 135	C	C	-	-1 135	-100%	-	-	T2	CS
United Kingdom	6 174	1 580	1 573	9.2%	-4 601	-75%	-7	0%	T2	CS
EU-27+UK	**56 375**	**16 160**	**17 126**	**100%**	**-39 249**	**-70%**	**966**	**6%**	**-**	**-**
Iceland	48	NO	NO	-	-48	-100%	-	-	NA	NA
United Kingdom (KP)	6 174	1 580	1 573	9.2%	-4 601	-75%	-7	0%	T2	CS
EU-KP	**56 423**	**16 160**	**17 126**	**100%**	**-39 297**	**-70%**	**966**	**6%**	**-**	**-**

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 3.84 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Germany (28%), Poland (15%), Belgium (10%), United Kingdom (9%), Italy (5%), France (5%) and Czechia (4%) which together have 77% share on EU-KP emissions.

Figure 3.84: 1.A.2.f Non-metallic Minerals, solid fuels: Emission trend and share for CO_2

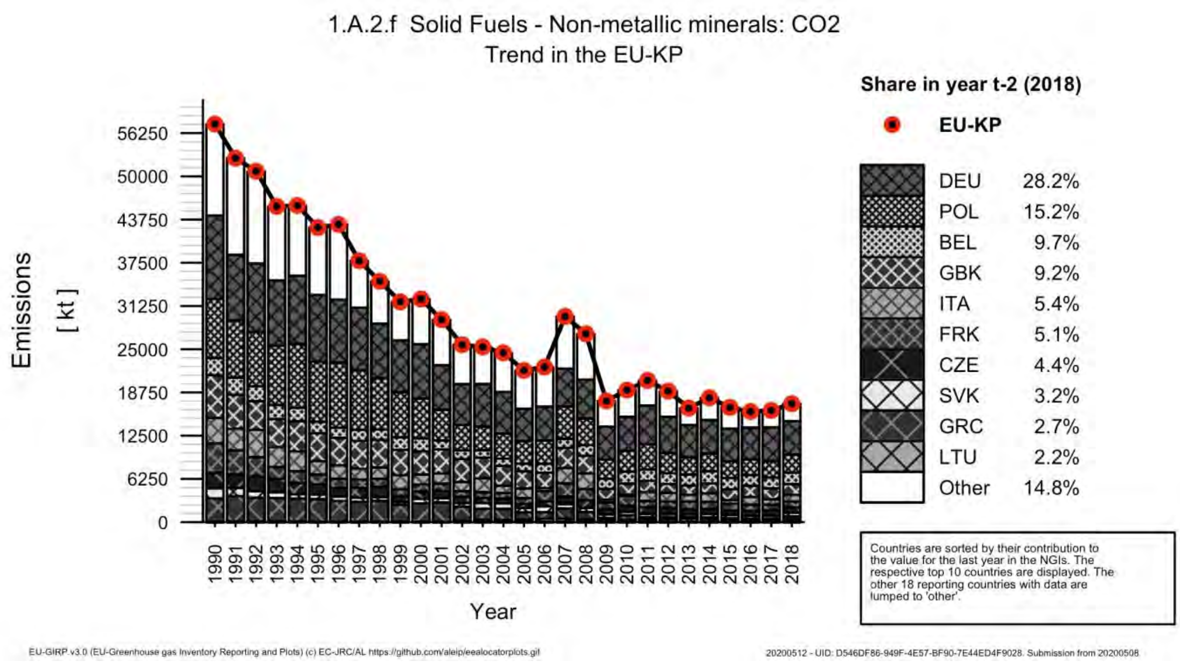


Figure 3.85 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF equaled to 95.68 t/TJ in 2018.

Figure 3.85: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

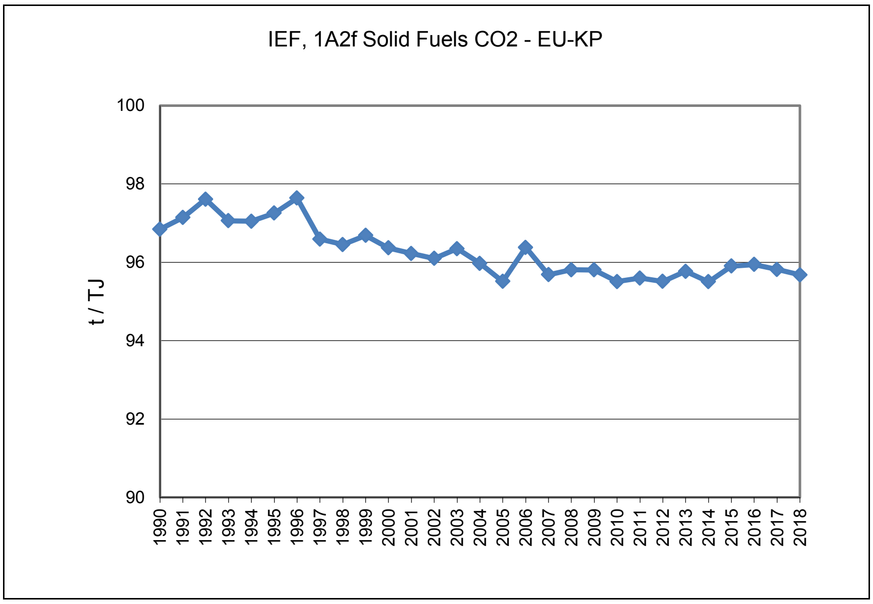
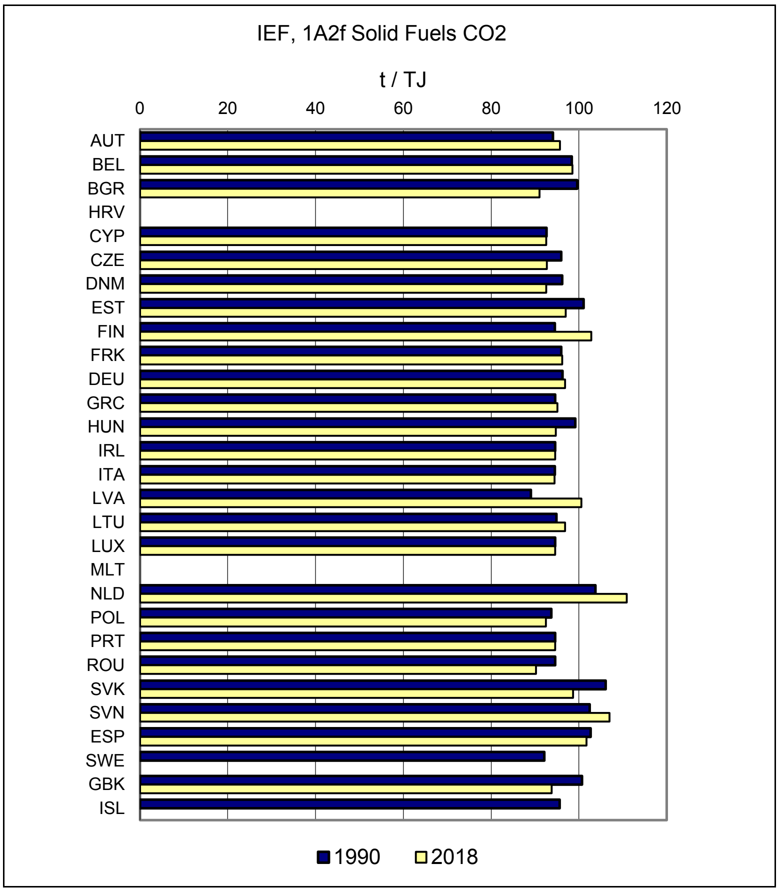


Figure 3.86 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen, that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2018 occur.

Figure 3.86: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.f amounted 31 449 kt in 2018 for EU-KP. CO_2 emissions increased compared to year 1990 by 15% and compared to 2017 by 1%. Category has 6% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption increased by 14% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.46. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Three Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 98% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Gaseous Fuels (CO_2)). Nine Member States reported higher level of emissions in 2018 than in 1990.

Table 3.46: 1.A.2.f Non-metallic Minerals, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	559	667	670	2.1%	112	20%	3	0%	T2	CS
Belgium	1 364	1 268	1 255	4.0%	-109	-8%	-14	-1%	T1,T3	D,PS
Bulgaria	1 684	646	635	2.0%	-1 049	-62%	-11	-2%	T2	CS
Croatia	IE	104	100	0.3%	100	∞	-4	-4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 289	1 391	1 323	4.2%	34	3%	-67	-5%	T2	CS
Denmark	237	266	271	0.9%	34	14%	5	2%	T3	CS
Estonia	46	30	24	0.1%	-22	-48%	-6	-19%	T2	CS
Finland	126	49	54	0.2%	-71	-57%	5	11%	T3	CS
France	3 869	3 689	3 821	12.2%	-47	-1%	133	4%	T2,T3	CS,PS
Germany	3 265	4 585	4 580	14.6%	1 315	40%	-5	0%	CS	CS
Greece	NO	462	133	0.4%	133	∞	-330	-71%	T2	CS
Hungary	1 673	456	474	1.5%	-1 199	-72%	18	4%	T1	D
Ireland	132	39	42	0.1%	-91	-68%	3	7%	T2	CS
Italy	5 943	6 851	7 024	22.3%	1 081	18%	173	3%	T2	CS
Latvia	316	71	69	0.2%	-247	-78%	-3	-4%	T2	CS
Lithuania	382	55	56	0.2%	-327	-85%	1	1%	T2	CS
Luxembourg	201	158	159	0.5%	-42	-21%	1	1%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 484	1 009	1 080	3.4%	-403	-27%	71	7%	T2	CS
Poland	1 359	2 470	2 390	7.6%	1 030	76%	-80	-3%	T2	CS
Portugal	NO	1 108	1 151	3.7%	1 151	∞	43	4%	T1,T3	D,PS
Romania	NO	629	852	2.7%	852	∞	224	36%	T2	CS
Slovakia	542	343	435	1.4%	-107	-20%	91	27%	T2	CS
Slovenia	115	180	179	0.6%	64	56%	-1	0%	T2	CS
Spain	2 366	4 175	4 288	13.6%	1 922	81%	113	3%	T2	CS
Sweden	65	120	116	0.4%	51	77%	-4	-3%	T1	CS
United Kingdom	297	268	269	0.9%	-28	-10%	1	0%	T2	CS
EU-27+UK	**27 315**	**31 089**	**31 449**	**100%**	**4 134**	**15%**	**360**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	297	268	269	0.9%	-28	-10%	1	0%	T2	CS
EU-KP	**27 315**	**31 089**	**31 449**	**100%**	**4 134**	**15%**	**360**	**1%**	**-**	**-**

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 3.87 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Italy (22%), Germany (15%), Spain (14%), France (12%), Poland (8%), Czechia (4%) and Belgium (4%) which together have 78% share on EU-KP emissions.

Figure 3.87: 1.A.2.f Non-metallic Minerals, gaseous fuels: Emission trend and share for CO_2

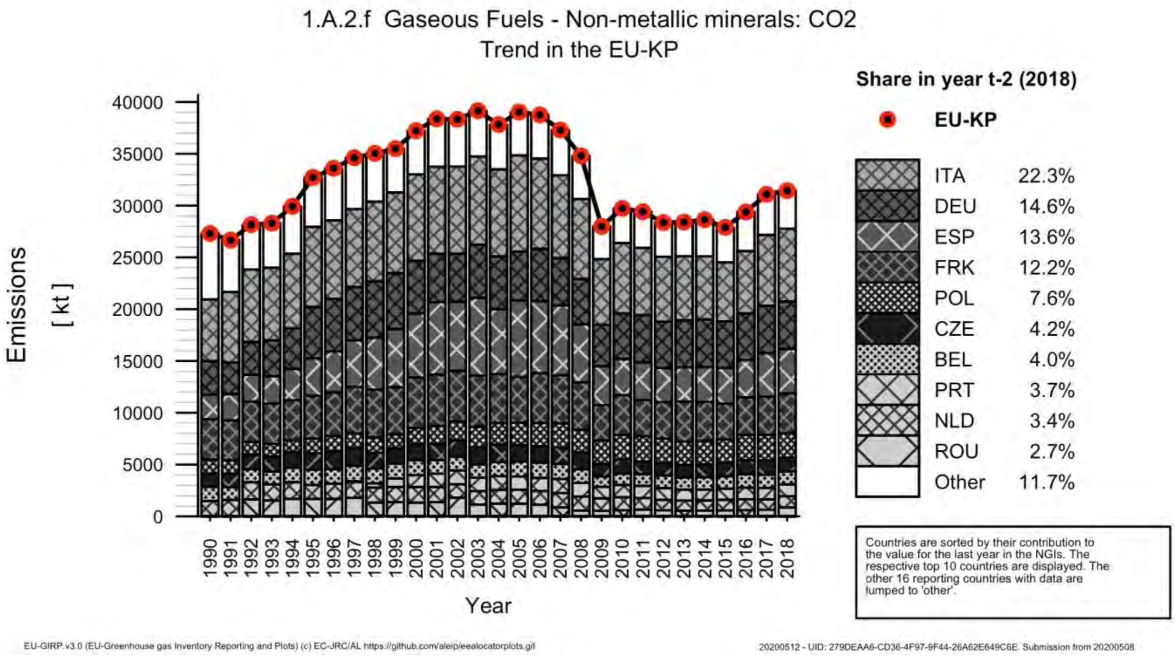


Figure 3.88 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF is stable during whole time period with slightly increasing trend. CO_2 IEF equaled to 56.26 t/TJ in 2018.

Figure 3.88: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

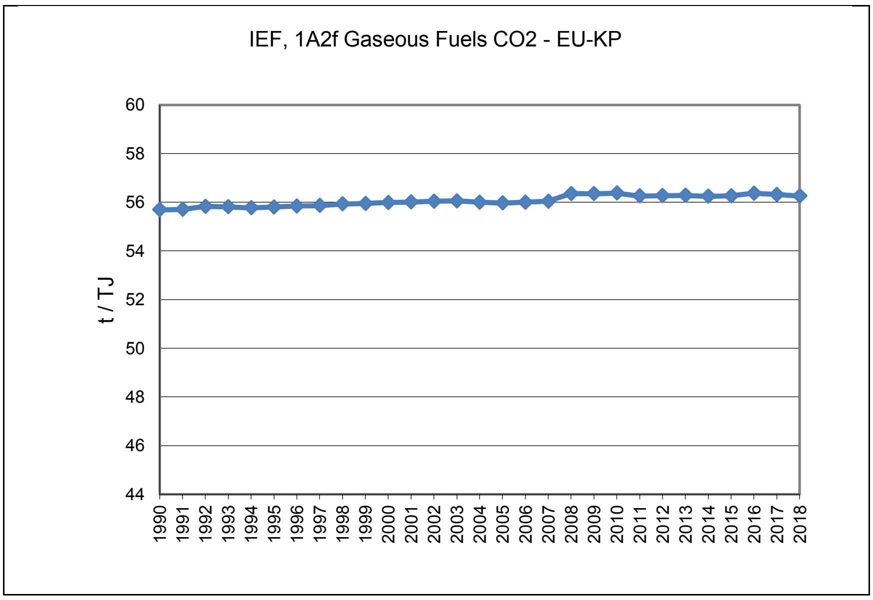
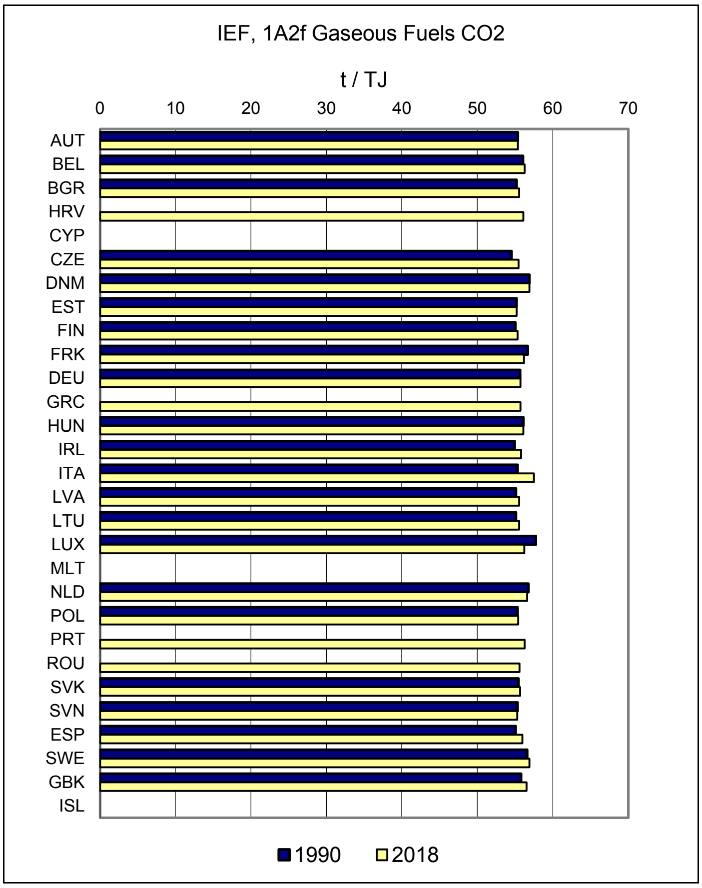


Figure 3.89 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen, that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2018 occur.

Figure 3.89: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals – Other Fossil Fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1.A.2.f amounted 14 701 kt in 2018 for EU-KP. CO_2 emissions increased compared to year 1990 by 934% and compared to 2017 by 12%. Category has 3% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption increased by 972% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.47. Bulgaria, Croatia, Malta, Netherlands and Iceland report emissions as 'NO' (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 71% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Other Fossil Fuels (CO_2)). All countries reported higher level of emissions in 2018 than in 1990. Most countries 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 could be waste tyres, waste oil/lubricants, solvents, plastics waste and paper waste.

Table 3.47: 1.A.2.f Non-metallic Minerals, other fossil fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	67	622	662	4.5%	595	884%	40	6%	T2	CS
Belgium	186	323	370	2.5%	184	99%	48	15%	T1,T3	D,PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	89	97	0.7%	97	∞	8	9%	T1	D
Czechia	NO	403	366	2.5%	366	∞	-37	-9%	T2	CS
Denmark	NO	154	198	1.3%	198	∞	44	29%	T2	CS
Estonia	NO	217	191	1.3%	191	∞	-26	-12%	T3	PS
Finland	NO	64	55	0.4%	55	∞	-10	-15%	T3	CS
France	323	1 259	1 237	8.4%	914	283%	-21	-2%	T2,T3	CS,PS
Germany	526	2 609	2 849	19.4%	2 323	442%	240	9%	CS	CS
Greece	NO	81	128	0.9%	128	∞	47	58%	T2	PS
Hungary	NO	202	254	1.7%	254	∞	52	26%	T3	PS
Ireland	NO	199	193	1.3%	193	∞	-6	-3%	T3	PS
Italy	NO	446	492	3.3%	492	∞	46	10%	T2	CS
Latvia	NO	98	131	0.9%	131	∞	33	34%	T2	PS
Lithuania	NO	4	9	0.1%	9	∞	5	131%	T3	PS
Luxembourg	NO	75	88	0.6%	88	∞	12	16%	T1,T2	D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	10	3 582	4 236	28.8%	4 226	43458%	654	18%	T1	D
Portugal	12	298	277	1.9%	265	2170%	-21	-7%	T1,T3	D,PS
Romania	NO	614	964	6.6%	964	∞	350	57%	T2	CS
Slovakia	173	312	308	2.1%	136	78%	-4	-1%	T2	CS
Slovenia	5	101	116	0.8%	112	2383%	15	15%	T1,T3	D,PS
Spain	120	658	695	4.7%	575	481%	37	6%	T2	CS,PS
Sweden	NO	163	173	1.2%	173	∞	10	6%	T2	CS
United Kingdom	1	603	611	4.2%	610	60930%	8	1%	T2	CS
EU-27+UK	**1 422**	**13 176**	**14 701**	**100%**	**13 278**	**934%**	**1 525**	**12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1	603	611	4.2%	610	60930%	8	1%	T2	CS
EU-KP	**1 422**	**13 176**	**14 701**	**100%**	**13 278**	**934%**	**1 525**	**12%**	**-**	**-**

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

Figure 3.90 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (29%), Germany (19%), France (8%), Romania (7%), Spain (5%) and Austria (5%) which together have 72% share on EU-KP emissions.

Figure 3.90: 1.A.2.f Non-metallic Minerals, other fossil fuels: Emission trend and share for CO_2

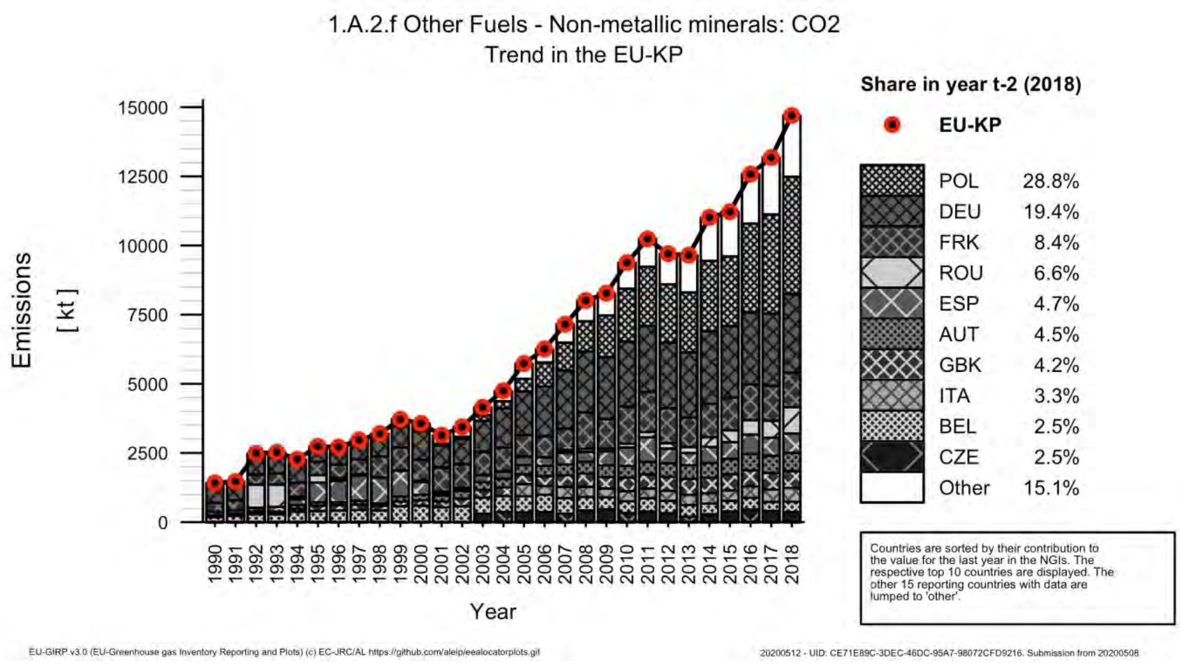


Figure 3.91 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF is fluctuating during whole time period, the lowest CO_2 IEF was calculated for 2002 and since then CO_2 IEF is increasing. CO_2 IEF equaled to 85.04 t/TJ in 2018.

Figure 3.91: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

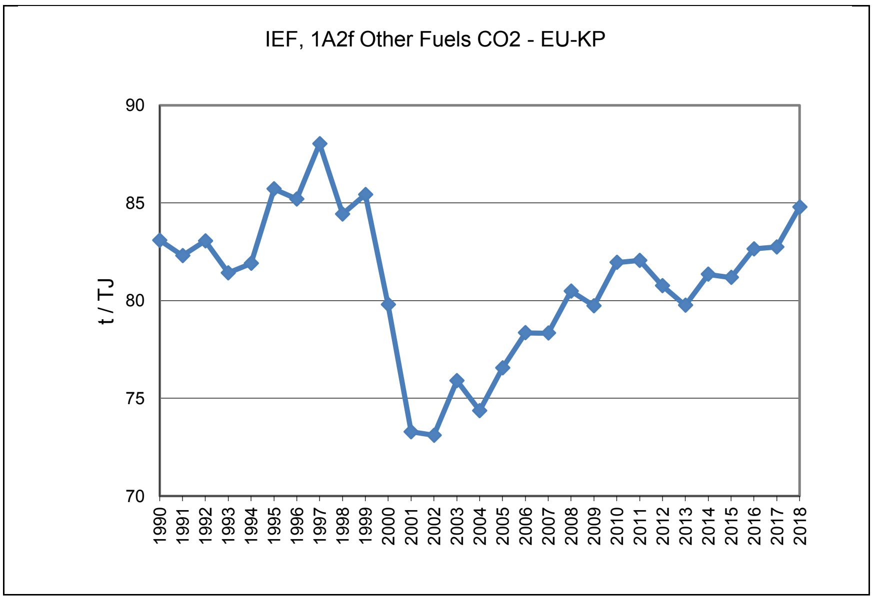
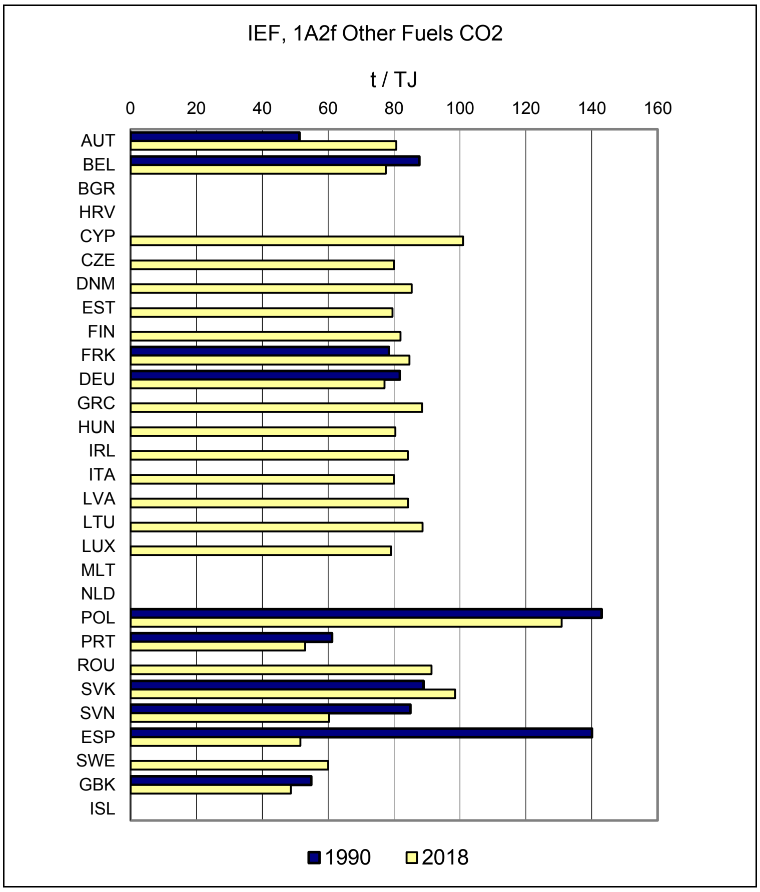


Figure 3.92 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. Poland applies the default IPCC CO_2 emission factor (or a factor which is close to it) which is significantly higher than the country specific values used by almost all other countries. The comparatively low implied emission factor reported by almost all countries is mainly due to incineration of industrial waste.

Figure 3.92: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



3.2.2.7 **Other (1.A.2.g)**

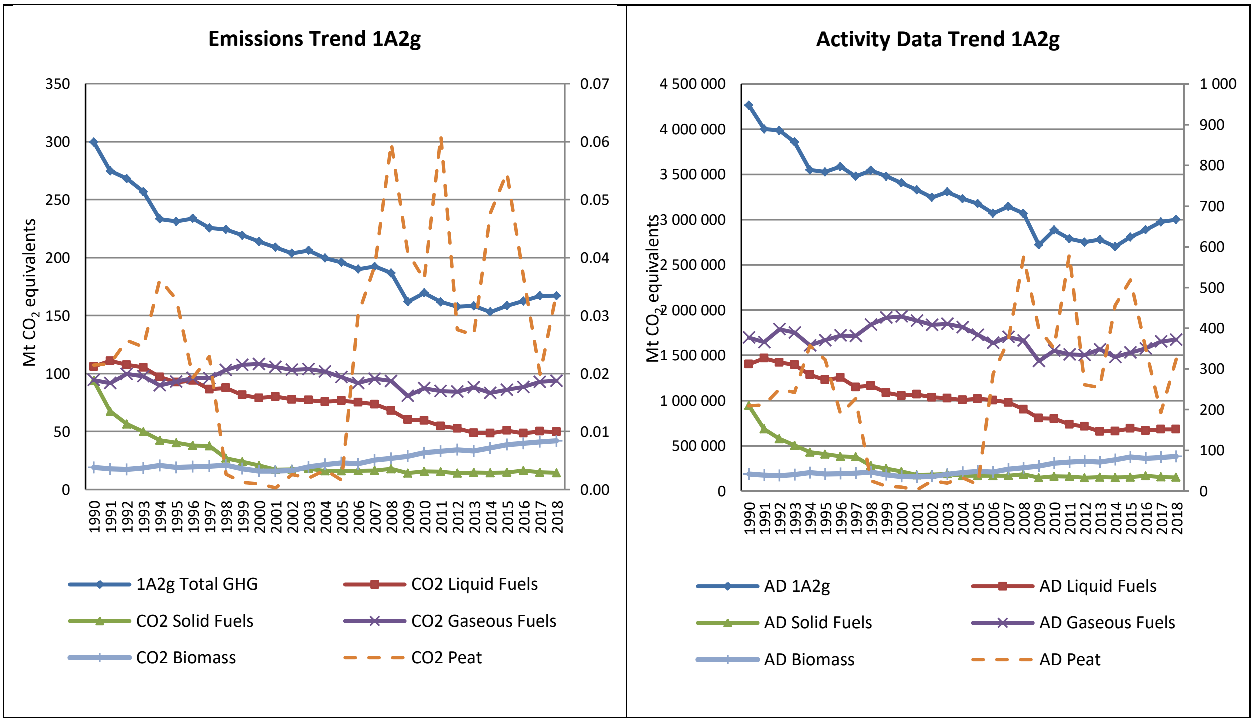
This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.g Other.

This category includes emissions from stationary combustion but also may include emissions from mobile sources (e.g. construction machinery). Some countries use this category to report emissions which cannot be allocated to the categories 1.A.2.a to 1.A.2.f due to lack of detailed data, e.g. IEA data provides fuel consumption of Industrial Auto-producers (Electricity, CHP, Heat) for total industry only. This category is dominated by Germany; Germany reports all emissions from power and heat production in industry under this category.

Total CO_2 emissions from 1.A.2.g amounted to 164 426 kt CO_2 eq. in 2018. The trend of total CO_2 emissions for 1990 to 2018 from category 1.A.2.g is depicted in Figure 3.93. Total CO_2 emissions decreased by 45% since 1990 and almost didn’t change between 2017 and 2018. CO_2 emissions from 1.A.2.g Other accounted for 33% of 1.A.2. source category.

Figure 3.93 shows the emission trend within the category 1.A.2.g, 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.

Figure 3.93: 1.A.2.g Other: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table **3.48**. Greece report data as 'IE' (included elsewhere). Six Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emission was reported by Luxembourg (152%), but it should be noted that Luxembourg has minor share (approximately 0.2%) on total EU-KP emissions.

Table 3.48: 1.A.2.g Other: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 974	2 787	2 876	1.7%	902	46%	90	3%	T1,T2,T3	CS,D
Belgium	2 805	1 867	1 859	1.1%	-946	-34%	-8	0%	CS,T1,T3	D
Bulgaria	10 579	716	875	0.5%	-9 705	-92%	159	22%	T1,T2	CS,D
Croatia	5 502	1 480	1 523	0.9%	-3 979	-72%	43	3%	T1	D
Cyprus	48	60	52	0.0%	4	8%	-8	-13%	T1	D
Czechia	19 064	2 071	1 964	1.2%	-17 100	-90%	-107	-5%	T1,T2	CS,D
Denmark	1 759	966	918	0.6%	-842	-48%	-48	-5%	M,T1,T2,T3	CS,D
Estonia	280	161	218	0.1%	-61	-22%	57	35%	T1,T2	CS,D
Finland	1 639	1 531	1 644	1.0%	5	0%	113	7%	T3	CS,D
France	10 710	7 449	7 537	4.6%	-3 173	-30%	88	1%	T2	CS
Germany	127 935	79 528	78 380	47.7%	-49 555	-39%	-1 148	-1%	CS,T1	CS,D
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	5 180	1 805	2 043	1.2%	-3 137	-61%	238	13%	T1,T2	CS,D
Ireland	684	754	806	0.5%	123	18%	52	7%	T1,T2	CS,D
Italy	15 229	9 543	9 970	6.1%	-5 259	-35%	427	4%	T2	CS
Latvia	1 618	226	241	0.1%	-1 378	-85%	14	6%	T1,T2	CS,D
Lithuania	1 567	208	217	0.1%	-1 350	-86%	9	4%	T1,T2	CS,D
Luxembourg	103	250	260	0.2%	157	152%	11	4%	T1,T2	CS,D
Malta	53	54	43	0.0%	-9	-18%	-10	-19%	T1	D
Netherlands	3 382	2 975	2 991	1.8%	-390	-12%	16	1%	T2	CS
Poland	6 979	2 860	2 986	1.8%	-3 993	-57%	126	4%	T1,T2	CS,D
Portugal	2 196	1 580	1 572	1.0%	-624	-28%	-8	-1%	T1	D
Romania	23 761	4 769	5 067	3.1%	-18 694	-79%	299	6%	T1,T2	CS,D
Slovakia	2 560	1 346	1 373	0.8%	-1 187	-46%	27	2%	T2	CS
Slovenia	1 153	410	523	0.3%	-630	-55%	112	27%	T1,T2	CS,D
Spain	7 896	7 949	8 388	5.1%	492	6%	439	6%	T1,T2,T3	CS,D,M,PS
Sweden	3 314	2 439	2 453	1.5%	-861	-26%	14	1%	T1,T2	CS
United Kingdom	38 461	28 325	27 395	16.7%	-11 066	-29%	-930	-3%	T1,T2,T3	CS,D
EU-27+UK	**296 431**	**164 108**	**164 174**	**100%**	**-132 256**	**-45%**	**66**	**0%**	**-**	**-**
Iceland	162	127	102	0.1%	-60	-37%	-25	-20%	T1	D
United Kingdom (KP)	38 569	28 469	27 544	16.8%	-11 026	-29%	-925	-3%	T1,T2,T3	CS,D
EU-KP	**296 701**	**164 380**	**164 426**	**100%**	**-132 275**	**-45%**	**46**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
Greece includes emissions of 1.A.2.g in category 1.A.2.f

1.A.2.g Other – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.g amounted 49 572 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 52% and compared to 2017 by 1%. Category has 10% share on total CO_2 equivalent emissions from category 1.A.2..

Detailed data related to the EU-KP submissions are depicted in Table.3.49. Sweden reports emissions as 'C' (confidential). Greece includes emissions of 1.A.2.g in category 1.A.2.f. All countries reported lower level of emissions in 2018 than in 1990 (except of Austria, Cyprus and Luxembourg which together have 3% share on EU-KP emissions).

Table.3.49: 1.A.2.g Other, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	866	1 362	1 360	2.7%	494	57%	-2	0%
Belgium	1 568	720	739	1.5%	-829	-53%	19	3%
Bulgaria	8 632	216	306	0.6%	-8 327	-96%	89	41%
Croatia	2 158	982	985	2.0%	-1 173	-54%	3	0%
Cyprus	48	60	52	0.1%	4	8%	-8	-13%
Czechia	2 935	108	141	0.3%	-2 794	-95%	32	30%
Denmark	1 145	619	629	1.3%	-516	-45%	10	2%
Estonia	188	135	179	0.4%	-9	-5%	44	32%
Finland	1 480	1 241	1 331	2.7%	-150	-10%	90	7%
France	5 913	3 951	3 923	7.9%	-1 990	-34%	-28	-1%
Germany	30 317	16 143	15 256	30.8%	-15 061	-50%	-888	-5%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	1 900	655	825	1.7%	-1 075	-57%	170	26%
Ireland	512	383	413	0.8%	-99	-19%	29	8%
Italy	5 707	2 126	2 427	4.9%	-3 280	-57%	301	14%
Latvia	1 066	139	143	0.3%	-923	-87%	4	3%
Lithuania	812	66	69	0.1%	-743	-91%	4	5%
Luxembourg	59	190	197	0.4%	138	232%	7	4%
Malta	53	54	43	0.1%	-9	-18%	-10	-19%
Netherlands	1 630	1 459	1 621	3.3%	-9	-1%	162	11%
Poland	1 028	639	719	1.5%	-309	-30%	80	12%
Portugal	2 147	606	592	1.2%	-1 555	-72%	-15	-2%
Romania	4 805	1 162	1 057	2.1%	-3 748	-78%	-105	-9%
Slovakia	66	17	15	0.0%	-51	-77%	-2	-9%
Slovenia	647	136	189	0.4%	-458	-71%	53	39%
Spain	5 788	2 586	2 667	5.4%	-3 121	-54%	81	3%
Sweden	3 107	C	C	-	-3 107	-100%	-	-
United Kingdom	21 091	14 123	13 443	27.1%	-7 649	-36%	-681	-5%
EU-27+UK	**102 563**	**49 881**	**49 321**	**99%**	**-53 242**	**-52%**	**-560**	**-1%**
Iceland	162	127	102	0.2%	-60	-37%	-25	-20%
United Kingdom (KP)	21 200	14 268	13 592	27.4%	-7 608	-36%	-676	-5%
EU-KP	**102 833**	**50 152**	**49 572**	**100%**	**-53 261**	**-52%**	**-580**	**-1%**

Greece includes emissions of 1.A.2.g in category 1.A.2.f
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 3.94 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Germany (31%), United Kingdom (27%), France (8%), Spain (5%) and Italy (5%) which together have 76% share on EU-KP emissions.

Figure 3.94: 1.A.2.g Other, liquid fuels: Emission trend and share for CO_2

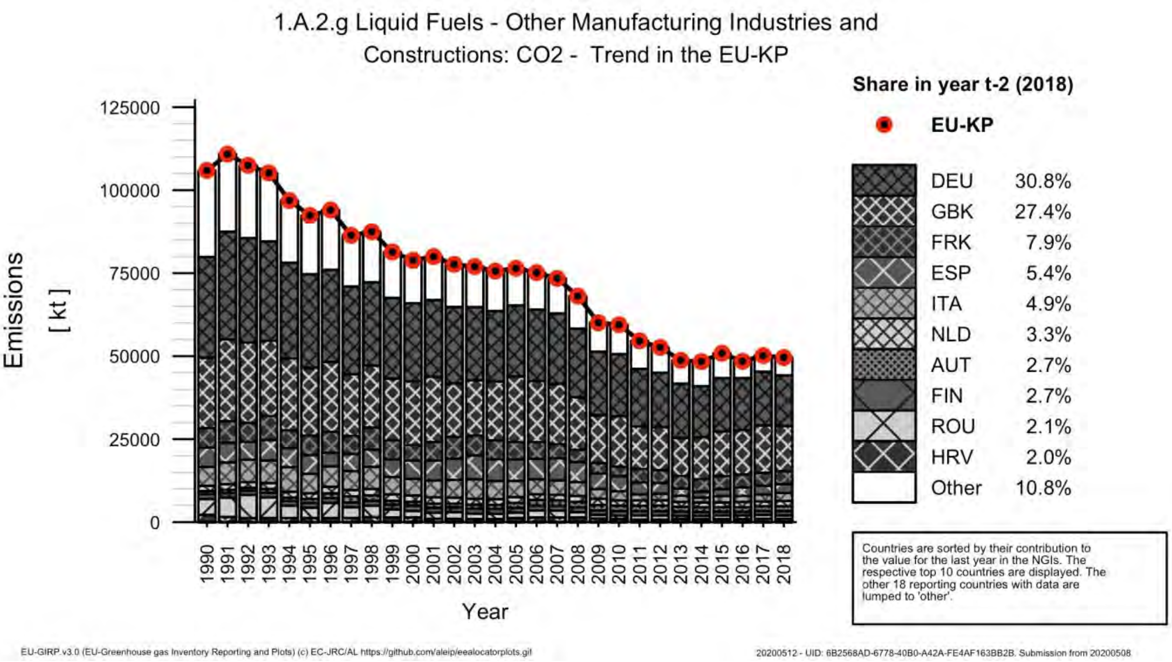


Figure 3.95 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF has decreasing trend since 2008. CO_2 IEF equaled to 72.87 t/TJ in 2018.

Figure 3.95: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

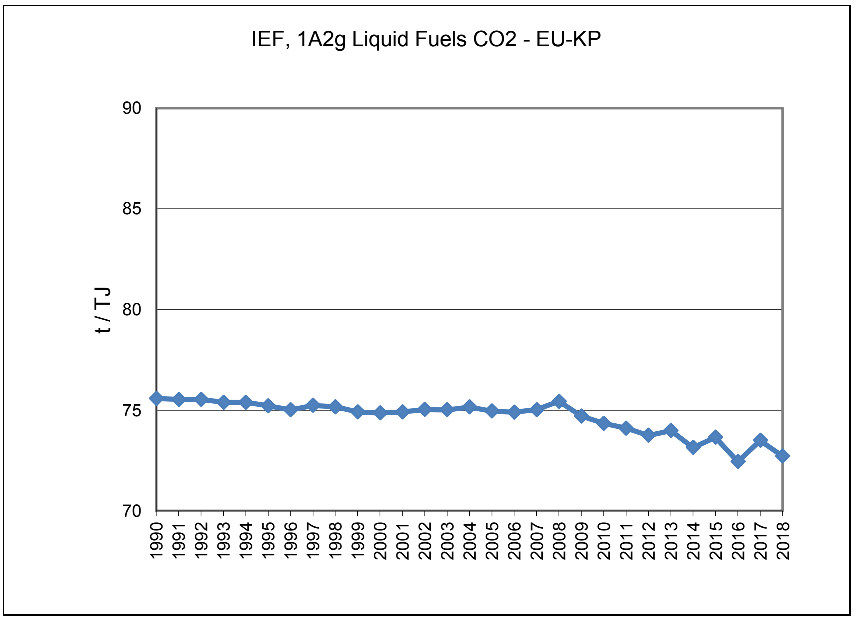
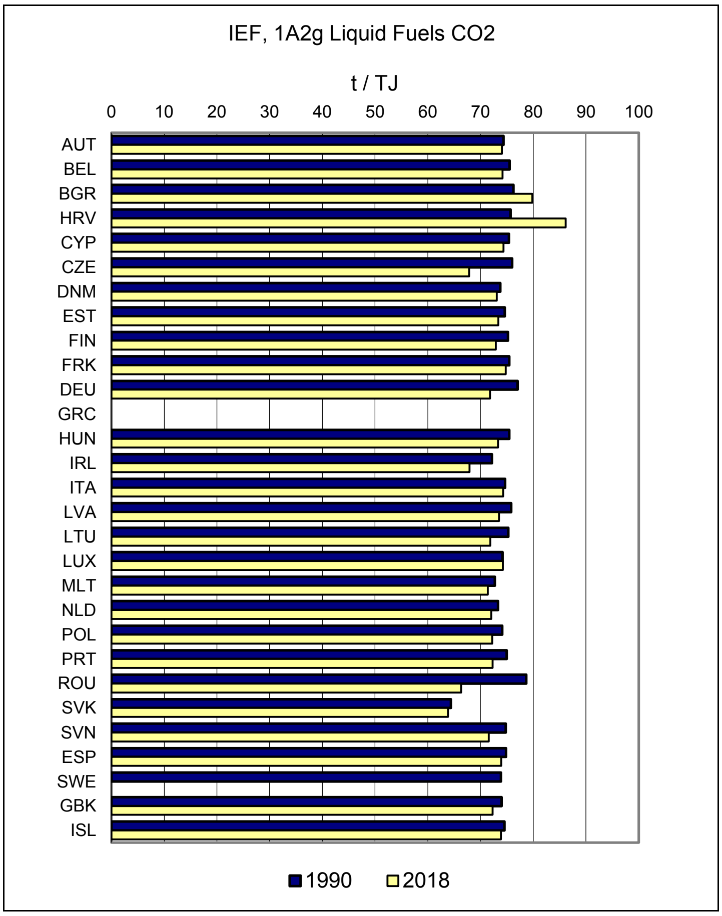


Figure 3.96 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018.

Figure 3.96: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.g amounted 14 338 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 85% and compared to 2017 by 3%. Category has 3% share on total CO_2 equivalent emissions from category 1.A.2..

Detailed data related to the EU-KP submissions are depicted in Table 3.50. Cyprus, Estonia, Ireland, Malta, Spain and Iceland report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). All countries reported lower level of emissions in 2018 than in 1990 (except of Italy and Netherlands which together have 4% share on EU-KP emissions).

Table 3.50: 1.A.2.g Other, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	91	2	0	0.0%	-91	-100%	-2	-96%
Belgium	33	18	18	0.1%	-15	-45%	0	2%
Bulgaria	1 858	24	56	0.4%	-1 802	-97%	32	131%
Croatia	1 703	236	216	1.5%	-1 486	-87%	-19	-8%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	13 750	112	102	0.7%	-13 648	-99%	-10	-9%
Denmark	324	54	65	0.5%	-259	-80%	10	19%
Estonia	38	1	NO	-	-38	-100%	-1	-100%
Finland	8	0	0	0.0%	-8	-99%	0	-37%
France	737	2	2	0.0%	-735	-100%	0	2%
Germany	57 580	10 567	10 380	72.4%	-47 200	-82%	-187	-2%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	677	15	27	0.2%	-651	-96%	11	73%
Ireland	14	1	NO	-	-14	-100%	-1	-100%
Italy	396	325	511	3.6%	115	29%	186	57%
Latvia	25	4	3	0.0%	-23	-89%	-1	-18%
Lithuania	79	5	5	0.0%	-74	-94%	-1	-13%
Luxembourg	20	19	18	0.1%	-2	-11%	-1	-6%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	42	96	71	0.5%	29	70%	-25	-26%
Poland	5 082	723	722	5.0%	-4 359	-86%	0	0%
Portugal	49	23	21	0.1%	-28	-57%	-2	-7%
Romania	5 313	12	1	0.0%	-5 312	-100%	-12	-95%
Slovakia	1 422	497	523	3.7%	-899	-63%	26	5%
Slovenia	89	0	0	0.0%	-89	-100%	0	-88%
Spain	248	NO	NO	-	-248	-100%	-	-
Sweden	94	C	C	-	-94	-100%	-	-
United Kingdom	4 145	2 014	1 596	11.1%	-2 549	-61%	-418	-21%
EU-27+UK	**93 723**	**14 752**	**14 338**	**100%**	**-79 385**	**-85%**	**-414**	**-3%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	4 145	2 014	1 596	11.1%	-2 549	-61%	-418	-21%
EU-KP	**93 723**	**14 752**	**14 338**	**100%**	**-79 385**	**-85%**	**-414**	**-3%**

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 1.A.2.g in category 1.A.2.f

Figure.3.97 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Germany (72%), United Kingdom (11%) and Poland (5%) which together have 89% share on EU-KP emissions.

Figure.3.97: 1.A.2.g Other, solid fuels: Emission trend and share for CO_2

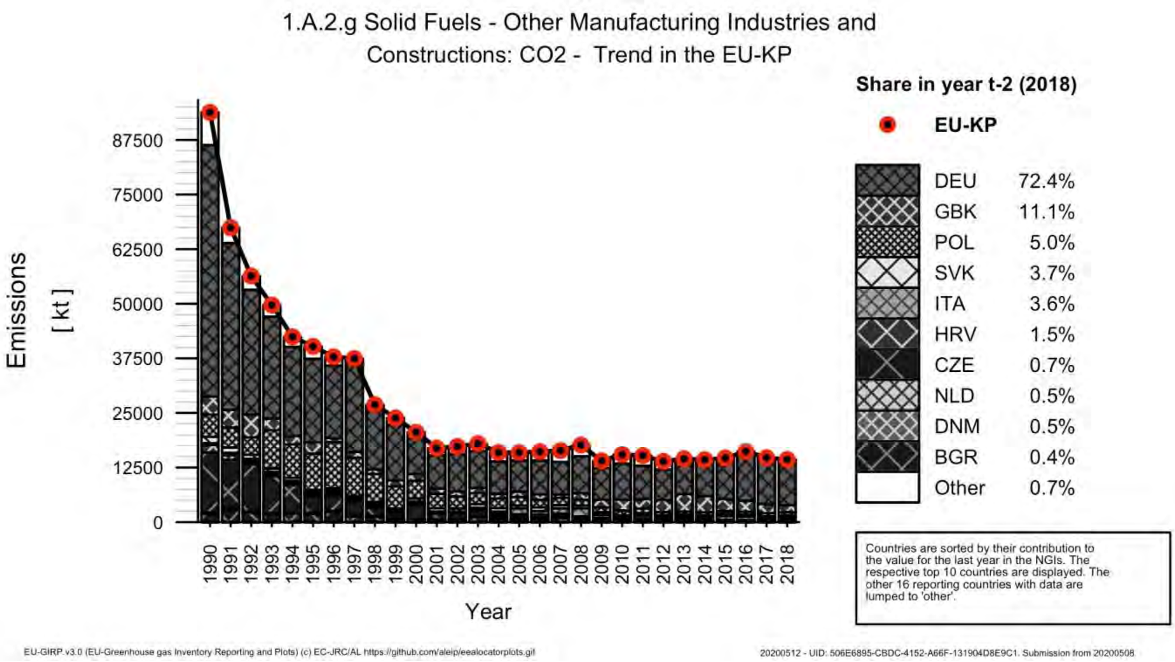


Figure 3.98 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. It can be seen, that CO_2 IEF has started decreasing since 2016.CO_2 IEF equaled to 94.89 t/TJ in 2018.

Figure 3.98: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

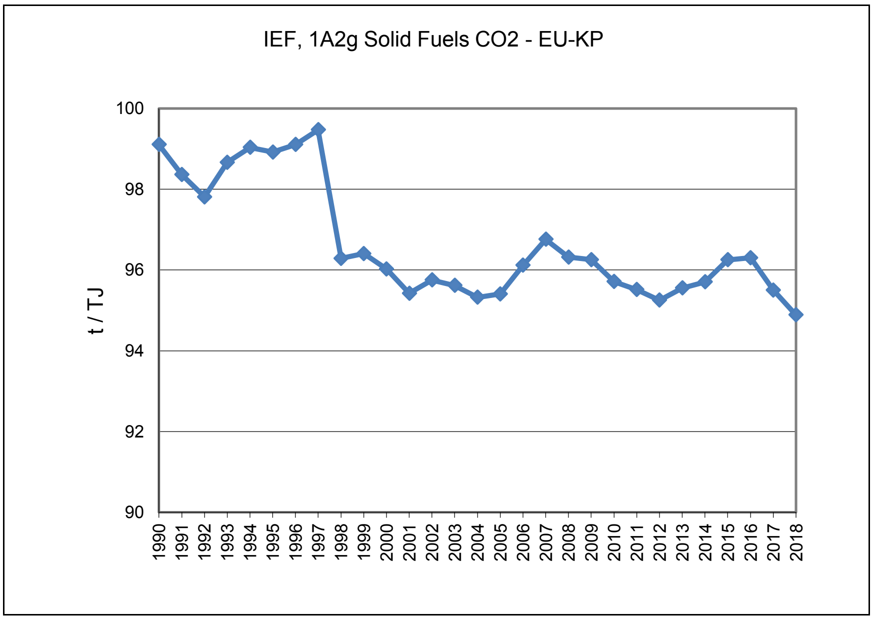
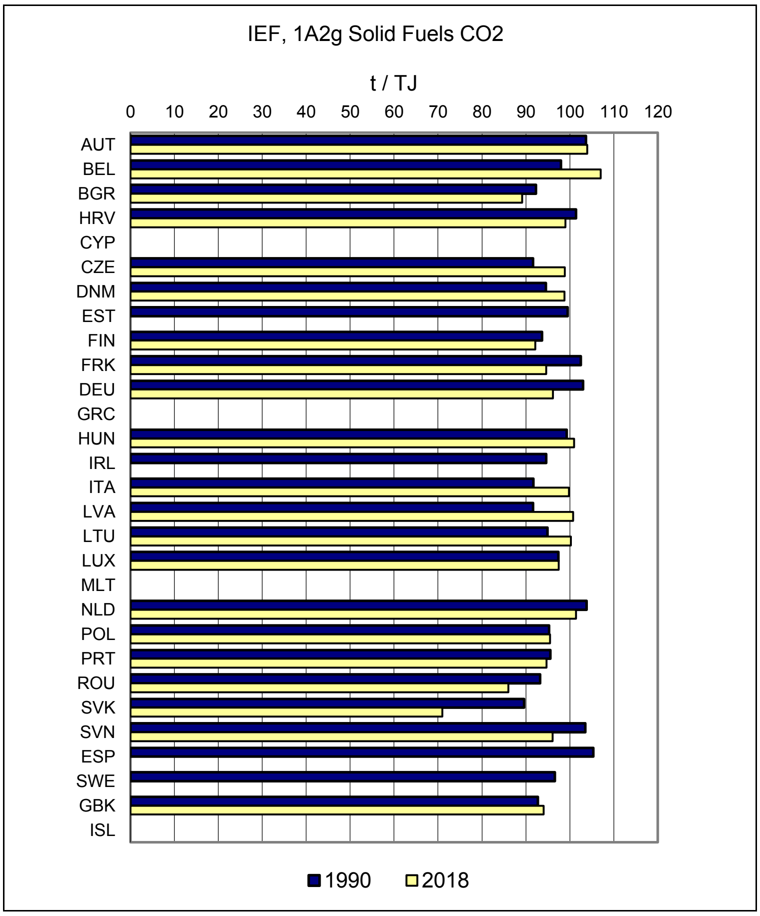


Figure 68 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018.

Figure 3.99: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.g amounted 93 707 kt in 2018 for EU-KP. CO_2 emissions decreased compared to year 1990 by 1% and compared to 2017 increased by 1%. Category has 19% share on total CO_2 equivalent emissions from category 1.A.2..

Detailed data related to the EU-KP submissions are depicted in Table 3.51. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Greece includes emissions of 1.A.2.g in category 1.A.2.f. Seven Member States reported higher level of emissions in 2018 than in 1990.

Table 3.51: 1.A.2.g Other, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	1 014	1 390	1 481	1.6%	467	46%	91	7%
Belgium	1 204	1 091	1 085	1.2%	-119	-10%	-6	-1%
Bulgaria	89	358	377	0.4%	288	324%	20	5%
Croatia	1 641	193	205	0.2%	-1 436	-88%	11	6%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	2 379	1 850	1 721	1.8%	-658	-28%	-130	-7%
Denmark	289	293	224	0.2%	-65	-23%	-69	-23%
Estonia	54	23	39	0.0%	-15	-28%	16	66%
Finland	41	31	37	0.0%	-4	-11%	6	19%
France	4 051	3 467	3 583	3.8%	-468	-12%	116	3%
Germany	37 693	49 093	48 999	52.3%	11 306	30%	-94	0%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	2 603	1 135	1 191	1.3%	-1 411	-54%	57	5%
Ireland	158	369	394	0.4%	236	149%	24	7%
Italy	9 126	7 092	7 032	7.5%	-2 094	-23%	-60	-1%
Latvia	527	84	95	0.1%	-432	-82%	11	13%
Lithuania	677	127	132	0.1%	-545	-81%	4	4%
Luxembourg	24	40	45	0.0%	21	89%	5	12%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1 710	1 420	1 299	1.4%	-411	-24%	-121	-9%
Poland	865	1 482	1 529	1.6%	663	77%	46	3%
Portugal	NO,IE	947	954	1.0%	954	∞	7	1%
Romania	13 643	3 593	4 008	4.3%	-9 635	-71%	415	12%
Slovakia	1 071	831	834	0.9%	-237	-22%	3	0%
Slovenia	417	269	327	0.3%	-90	-22%	58	22%
Spain	1 860	5 363	5 721	6.1%	3 861	208%	358	7%
Sweden	113	88	83	0.1%	-30	-27%	-5	-6%
United Kingdom	13 155	12 148	12 313	13.1%	-842	-6%	165	1%
EU-27+UK	**94 404**	**92 778**	**93 707**	**100%**	**-697**	**-1%**	**929**	**1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	13 155	12 148	12 313	13.1%	-842	-6%	165	1%
EU-KP	**94 404**	**92 778**	**93 707**	**100%**	**-697**	**-1%**	**929**	**1%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece includes emissions of 1.A.2.g in category 1.A.2.f
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure 3.100 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Germany (52%), United Kingdom (13%), Italy (8%), Spain (6%) and Romania (4%) which together have 83% share on EU-KP emissions.

Figure 3.100: 1.A.2.g Other, gaseous fuels: Emission trend and share for CO_2

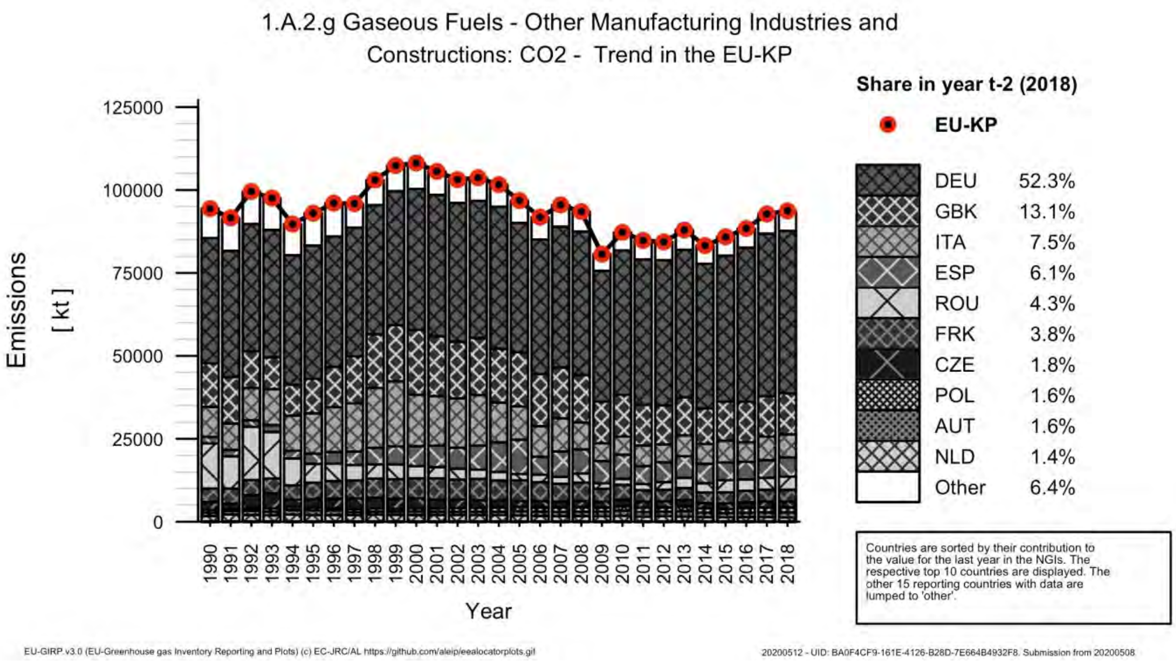


Figure 3.101 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF is relatively stable during reporting period and equaled to 56.02 t/TJ in 2018.

Figure 3.101: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

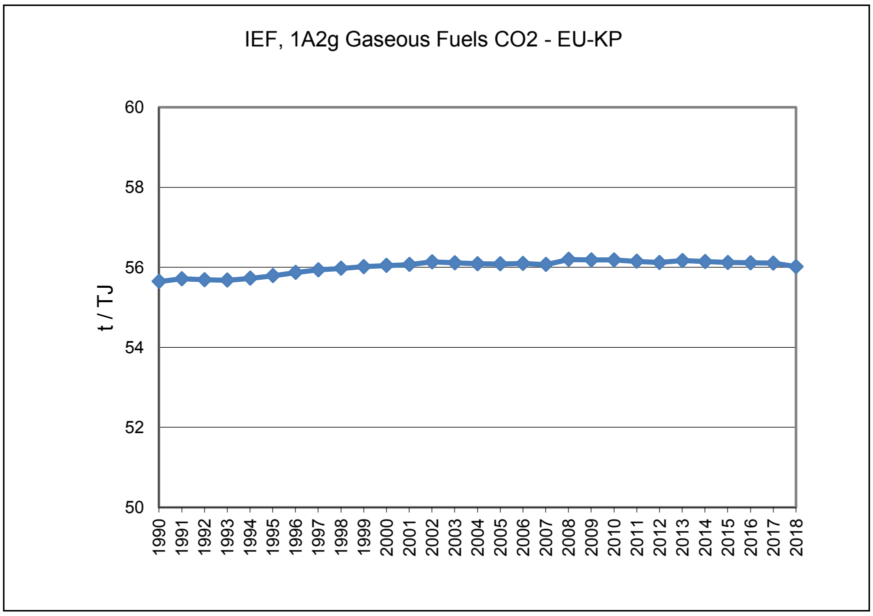
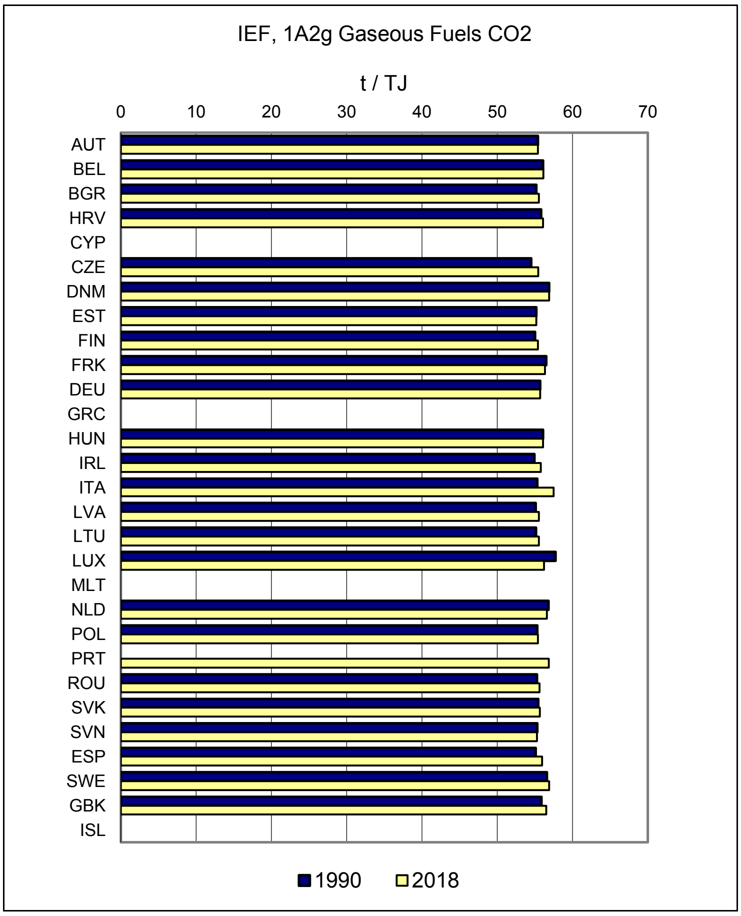


Figure 3.102 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. It can be seen, that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2018 occur.

Figure 3.102: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Other fossil fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1.A.2.g amounted 4 419 kt in 2018 for EU-KP. CO_2 emissions increased compared to year 1990 by 75% and compared to 2017 by 2%. Category has 1% share on total CO_2 equivalent emissions from category 1.A.2..

Detailed data related to the EU-KP submissions are depicted in Table 3.52. Twelve Member States and Iceland report emissions as 'NO' (not occurring). All Member States reported higher level of emissions in 2018 than in 1990, only United Kingdom reported lower level of emissions.

Table 3.52: 1.A.2.g Other, other fossil fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	3	33	36	0.8%	32	937%	3	9%
Belgium	NO	38	17	0.4%	17	∞	-20	-54%
Bulgaria	NO	118	136	3.1%	136	∞	18	15%
Croatia	NO	69	117	2.6%	117	∞	48	69%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	1	NO	NO	-	-1	-100%	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	88	243	245	5.5%	157	179%	1	1%
France	10	29	29	0.7%	19	196%	0	0%
Germany	2 344	3 725	3 745	84.8%	1 400	60%	20	1%
Greece	-	-	-	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	8	10	0.2%	10	∞	1	17%
Luxembourg	NO	1	1	0.0%	1	∞	0	3%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3	15	15	0.3%	12	385%	0	1%
Portugal	NO,IE	3	4	0.1%	4	∞	1	18%
Romania	NO	1	2	0.0%	2	∞	1	72%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	5	7	0.2%	7	∞	2	31%
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	14	13	0.3%	13	∞	0	-2%
United Kingdom	70	39	43	1.0%	-27	-38%	4	11%
EU-27+UK	**2 519**	**4 341**	**4 419**	**100%**	**1 899**	**75%**	**78**	**2%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	70	39	43	1.0%	-27	-38%	4	11%
EU-KP	**2 519**	**4 341**	**4 419**	**100%**	**1 899**	**75%**	**78**	**2%**

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 3.103 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen, that the highest share on total CO_2 emissions has Germany (85%) for 2018.

Figure 3.103: 1.A.2.g Other, other fossil fuels: Emission trend and share for CO_2

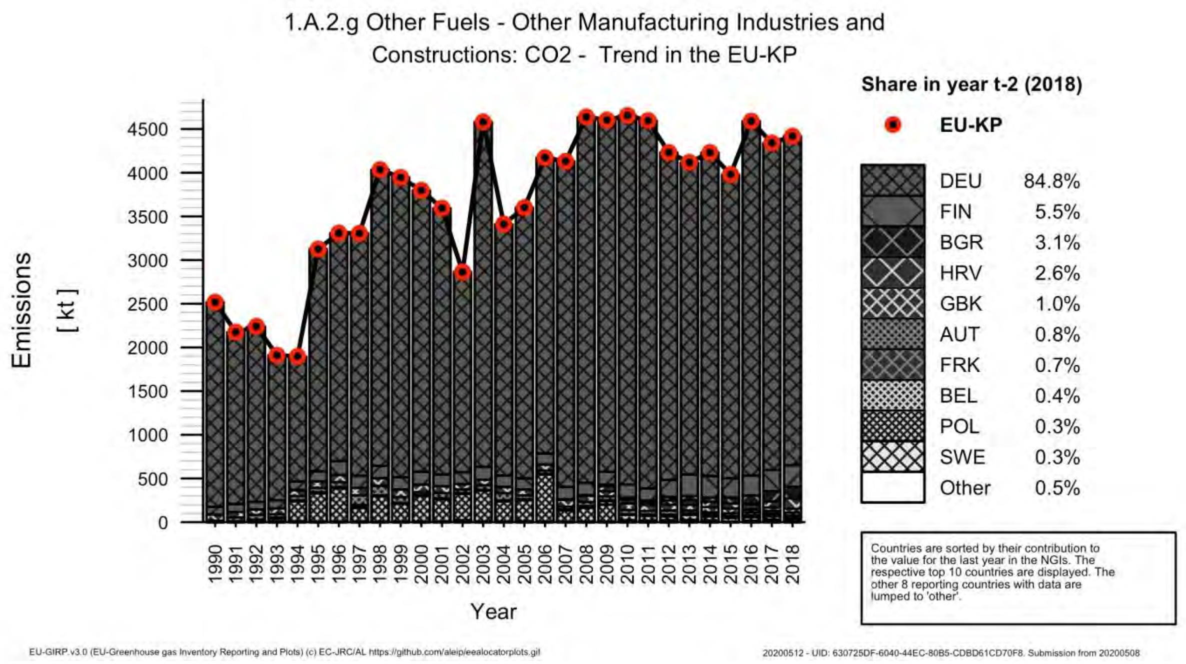


Figure 3.104 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2018. CO_2 IEF equaled to 75.53 t/TJ in 2018.

Figure 3.104: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

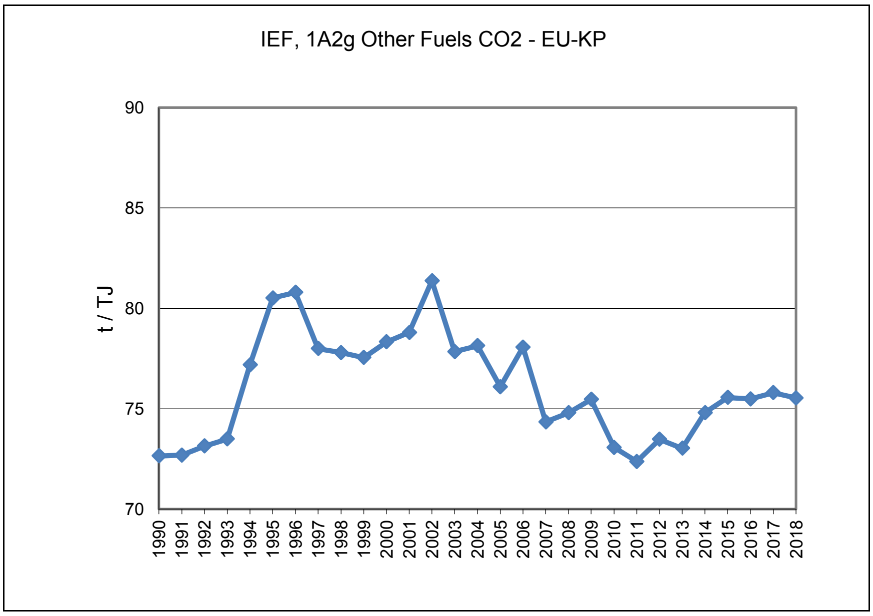
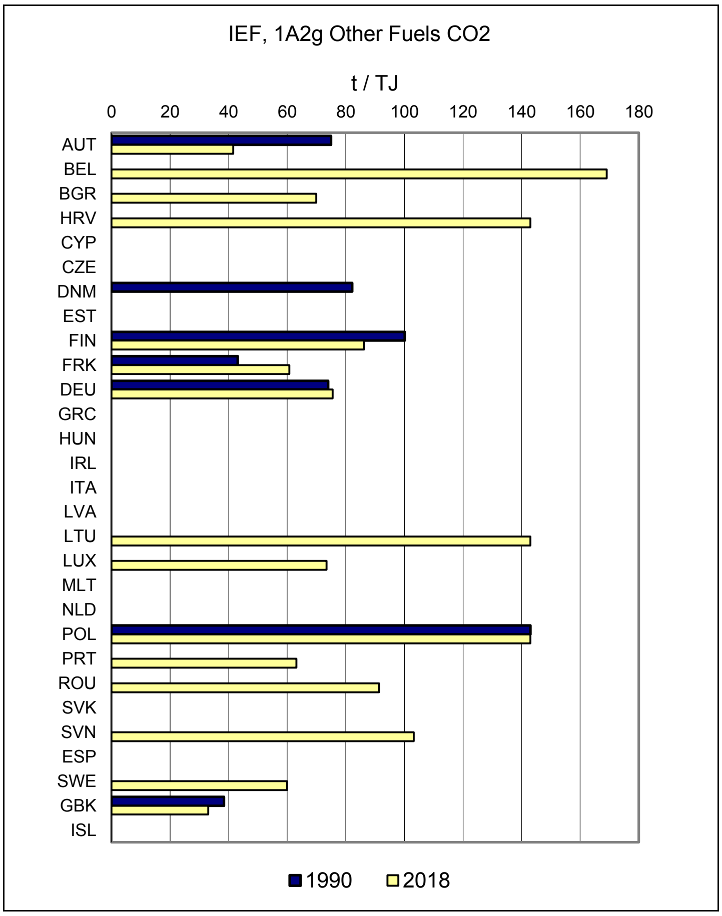


Figure 3.105 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2018. The comparatively low implied emission factor of Austria is mainly due to reporting of wood waste with high biomass content. In the United Kingdom, low implied emission factor is mainly due to use of waste solvents.

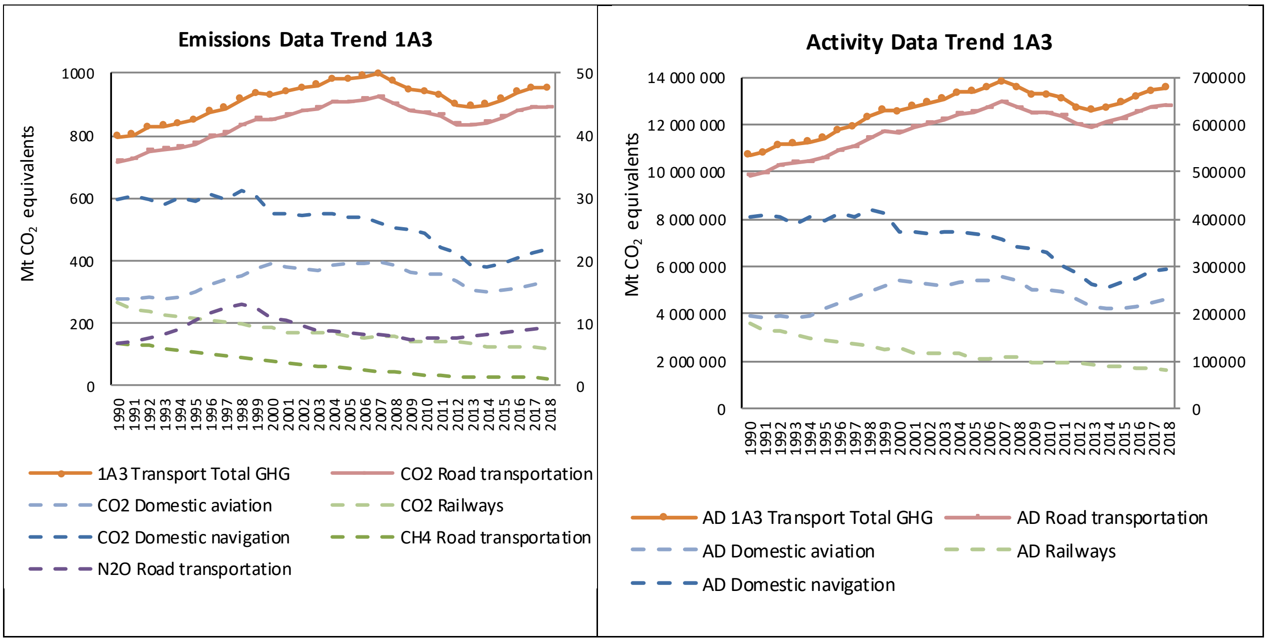
Figure 3.105: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



3.2.3 Transport (CRF Source Category 1A3) (EU-KP)

Greenhouse gas emissions from 1A3 Transport are shown in Figure 3.106. CO_2 emissions from this source category account for 22.2 %, CH_4 for 0.03 %, N_2O for 0.29 % of total GHG emissions (without LULUCF). Between 1990 and 2018, GHG from transport increased by 20 % in the EU-KP.

Figure 3.106 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 3.53 summarizes the share of countries using higher tier methods for calculating emissions for the key categories of the transport categories. If the information on tier methods used is not available in the following tables of each subsector, the countries NIRs were reviewed so as to calculate the share of higher tiers. As presented, most countries use higher tiers, whereas the lower percentage is observed for 1A3d Domestic navigation: residual fuel oil, where most countries 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. In all cases, France, Germany, Italy, Spain and United Kingdom are mainly influencing the share of higher tiers.

Table 3.53 Key category analysis for the EU (1A3 sector excerpt): Key source categories for level and trend analyses and share of countries emissions using higher tier methods

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13332	16431	T	L	L	93 %
1.A.3.b Road Transportation: Diesel Oil (CO_2)	302993	634867	T	L	L	89 %
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1867	7801	T	0	L	100 %
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	503	4000	T	0	0	87 %
1.A.3.b Road Transportation: Gasoline (CH_4)	6201	854	T	0	0	99 %
1.A.3.b Road Transportation: Gasoline (CO_2)	406611	232520	T	L	L	92 %
1.A.3.b Road Transportation: Gasoline (N_2O)	4938	832	T	0	0	100 %
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7328	15807	T	0	L	97 %
1.A.3.b Road Transportation: Other Fuels (CO_2)	0	2717	T	0	0	--
1.A.3.c Railways: Liquid Fuels (CO_2)	12981	5756	T	L	L	74 %
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17692	13957	0	L	L	84 %
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10372	5908	0	L	L	71 %

Table 3.54 shows total GHG, CO_2, CH_4 and N_2O emissions from 1A3 Transport.

Table 3.54 1A3 Transport: Countries' contributions to CO_2 emissions, CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	13 976	24 426	13 777	24 142	125	262	74	21
Belgium	20 931	26 251	20 613	25 954	177	279	141	18
Bulgaria	6 605	9 701	6 426	9 590	107	89	71	22
Croatia	3 883	6 428	3 787	6 340	55	61	41	27
Cyprus	1 245	2 067	1 214	2 051	24	13	7	4
Czechia	11 485	19 055	11 219	18 824	190	207	76	24
Denmark	10 751	13 437	10 573	13 285	99	141	79	10
Estonia	2 468	2 405	2 407	2 377	38	24	23	3
Finland	12 097	11 656	11 824	11 557	161	86	113	13
France	122 770	132 179	120 759	130 514	972	1 520	1 039	145
Germany	164 978	163 620	161 807	161 664	1 498	1 728	1 673	227
Greece	14 507	17 448	14 124	17 130	272	246	110	72
Hungary	8 865	13 930	8 673	13 759	124	148	69	23
Ireland	5 147	12 225	5 031	12 084	67	130	49	11
Italy	102 177	104 263	100 299	103 096	972	967	906	199
Latvia	3 041	3 354	2 940	3 298	81	52	20	4
Lithuania	5 822	6 111	5 685	5 997	84	95	53	19
Luxembourg	2 617	6 029	2 589	5 961	16	64	13	3
Malta	331	663	326	652	3	6	3	5
Netherlands	28 010	31 486	27 709	31 161	105	260	196	66
Poland	20 774	65 303	20 275	64 464	329	701	170	139
Portugal	10 818	17 248	10 619	17 068	102	157	98	23
Romania	12 439	18 435	12 059	18 178	285	223	94	34
Slovakia	6 824	7 739	6 693	7 640	100	91	30	8
Slovenia	2 728	5 824	2 666	5 748	36	71	26	5
Spain	58 659	90 269	57 752	89 215	524	962	383	92
Sweden	18 748	16 472	18 416	16 295	177	158	155	18
United Kingdom	121 352	122 031	118 663	120 722	1 441	1 212	1 248	97
EU-27+UK	**794 048**	**950 056**	**778 926**	**938 767**	**8 164**	**9 956**	**6 958**	**1 333**
Iceland	623	1 047	611	1 037	6	8	6	2
United Kingdom (KP)	122 169	122 854	119 464	121 537	1 449	1 218	1 256	98
EU-KP	**795 488**	**951 926**	**780 338**	**940 619**	**8 178**	**9 971**	**6 972**	**1 336**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.55 provides information on the contribution of countries to EU-KP recalculations in CO_2 from 1A3 Transport for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table 3.55 1A3 Transport: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-0	-0.0	-5	-0.0	Revised biofuel share in road diesel
Belgium	59	0.3	237	0.9	Revision of off-road model, The emissions from machinery used in harbours, airports and transhipment companies are allocated to the category 1A3e (instead of category 1A4a before)
Bulgaria	-	-	35	0.4	A complete recalculation has been performed, introducing the new COPERT version 5.3 In order to apply the new version, an updated vehicle distribution matrix has been developed.
Croatia	-0	-0.0	0	0.0	Switch to COPERT 5 for all calculations
Cyprus	3	0.2	5	0.2	Revised energy balance
Czechia	1	0.0	56	0.3	Updated activity data following transport performace data change

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Denmark	-1	-0.0	-34	-0.3	Fuel consumption factors for vans are now further split into vehicle weight classes based on fuel consumption factor data from the European model Handbook of Emission Factors. Updated navigation emission factors as a function of engine load.
Estonia	-8	-0.3	-15	-0.6	Recalculations to reflect the actual LPG consumption in the 1A3b sector and improve the data consistency through out the timeline. Emissons in 1A3a were recalculated due to improved the calc. method.
Finland	0	0.0	-17	-0.1	Correction of activity data in LNG use in Navigation. Fuel properties have been checked and revised.
France	-52	-0.0	-104	-0.1	Update of the CNG energy balance (and average annual registration of km), update of the diesel PCI
Germany	60	0.0	1 062	0.6	Revision of model TREMOD Aviation (1.A.3.a, 1.D.1.a), TREMOD (1.A.3.b, 1.A.3.c, 1.A.3.d) and TREMOD MM (1.A.2.g vii, 1.A.4.a ii, b ii, c ii)
Greece	-	-	-0	-0.0	The total statistical fuel conusmption is used for each fuel type. However, statistical fuel consumption data do not exist for each vehicle category and, hence, we attribute the fuel used to each vehicle category by using the estimated vehicle*kms travelled and the corresponding fuel consumption coefficients. In this case, we have found a mistake in the application of the above approach and, therefore, we conducted a recalculation to correct it, resulting in a different fuel consumption split to each vehicle category and in different CO_2 emissions.
Hungary	-5	-0.1	15	0.1	Latest energy statistics + CO_2 from fossil part of FAME biodiesel has been added to diesel oil emissions+CS EF in railways
Ireland	-4	-0.1	24	0.2	The new methodology uses the actual number of kilometers travelled by buses and coaches, taken from operator's annual reports divided by the known fleet. This change in bus methodology required that the mileage and fuel be rebalanced for the years 2013 to 2017 for all vehicle categories which resulted in a recalculation for these years.
Italy	-14	-0.0	1 374	1.4	Blend share correction for road transport fuels in COPERT5
Latvia	-1	-0.0	-1	-0.0	Recalculations have been done due to switch from COPERT 5.2 model version to COPERT 5.3 model version and corrected distribution of vehicles fleet by sub-classes. CO_2 emissions from biodiesel (FAME) fuel that are of fossil origin has been calculated.
Lithuania	-21	-0.4	-52	-0.9	Emissions correction for road transportation according to updated activity data on diesel oil and gasoline. Recalculations in category 1.A.3.e.i have been done due to elimination of natural gas consumed in support of the pipeline operation through venting in order to avoid double counting with fugitive emissions. Activity data and emissions from fuel used in ports for loading ships with various cranes and other means of transport were included in 1.A.3.e.ii.
Luxembourg	2	0.1	-2	-0.0	Revision of AD: energy balance revised and modified allocation of fuels to road vs. offroad sectors due to switch from HBEFA3.3 to HBEFA4.1
Malta	-0	-0.1	-2	-0.4	Recalculations in aviation to harmonise national aviation emissions from 2005 onwards (EUROCONTROL), addition of CO_2 emissions from urea in road transport
Netherlands	-9	-0.0	58	0.2	Revised energy balance and model update for fossil part in biofuels
Poland	-104	-0.5	-16	-0.0	AD data and the method of calculation from COPERT 5.2 to COPERT 5.3 was changed
Portugal	596	5.9	41	0.2	Road Transport (1A3b): Allocation of petrol and diesel consumption from 1A4
Romania	-	-	-	-	-

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Slovakia	-	-	-57	-0.8	Update of the COPERT model version and introducing of the CO_2 correction factor to the emissions calculation led to changes in GHG emissions in the category 1.A.3.b.i (Cars). This recalculation resulted into redistribution of fuel consumption and in a shift of CO_2, CH_4 and N_2O emissions between vehicle categories.
Slovenia	-	-	6	0.1	Emissions from fossil part of biodiesel have been included.
Spain	4	0.0	241	0.3	AD update of the entire consumption series according to AD provided by the source, new estimations of commercial/institutional mobile machinery (1A4aii) and update of fuel specifications (WTT study and Fuel Quality Directive 98/70/CE)
Sweden	-270	-1.4	279	1.7	New survey of monthly fuels, which only ask about the total amount of fuel for naviagtion and not split up by national and international
United Kingdom	15	0.0	172	0.1	Minor changes due to improvement of fuel consumption factors relating to rail locomotives and real drive cycles. Revisions to fuel use statistics (DUKES).
EU27+UK	**249**	**0.0**	**3 301**	**0.4**	
Iceland	11	1.8	10	1.0	Changes in methodology, emissions are calculated with COPERT
United Kingdom (KP)					NA
EU-KP	**260**	**0.0**	**3 316**	**0.4**	

Table 3.57 provides information on the contribution of countries to EU-KP recalculations in CH_4 from 1A3 Transport for 1990 and 2018.

Table 3.56 1A3 Transport: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	6	8.7	9	87.1	Revised emission factors in the transport-model (switch to HBEFA 4.1)
Belgium	20	16.7	2	9.7	Revision of off-road model, The emissions from machinery used in harbours, airports and transhipment companies are allocated to the category 1A3e (instead of category 1A4a before)
Bulgaria	0	0.2	0	0.4	A complete recalculation has been performed, introducing the new COPERT version 5.3 In order to apply the new version, an updated vehicle distribution matrix has been developed.
Croatia	0	0.1	17	148.2	Switch to COPERT 5 for all calculations
Cyprus	-0	-0.3	-0	-2.5	Revised energy balance
Czechia	0	0.1	1	3.9	Updated activity data following transport performace data change
Denmark	-0	-0.1	0	0.1	Fuel consumption factors for vans are now further split into vehicle weight classes based on fuel consumption factor data from the European model Handbook of Emission Factors. Updated navigation emission factors as a function of engine load.
Estonia	-0	-0.6	-0	-1.1	Recalculations to reflect the actual LPG consumption in the 1A3b sector and improve the data consistency through out the timeline. Emissons in 1A3a were recalculated due to improved the calc. method.
Finland	0	0.0	-2	-13.4	Correction of activity data in LNG use in Navigation.
France	1	0.1	1	0.7	Update of the CNG energy balance (and average annual registration of km), update of the CH_4 GPLc

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					emission factor, update of the diesel PCI
Germany	344	25.9	89	61.7	Revision of model TREMOD Aviation (1.A.3.a, 1.D.1.a), TREMOD (1.A.3.b, 1.A.3.c, 1.A.3.d) and TREMOD MM (1.A.2.g vii, 1.A.4.a ii, b ii, c ii)
Greece	-	-	-2	-3.2	The total statistical fuel conusmption is used for each fuel type. However, statistical fuel consumption data do not exist for each vehicle category and, hence, we attribute the fuel used to each vehicle category by using the estimated vehicle*kms travelled and the corresponding fuel consumption coefficients. In this case, we have found a mistake in the application of the above approach and, therefore, we conducted a recalculation to correct it, resulting in a different fuel consumption split to each vehicle category and in different CO_2 emissions.
Hungary	-0	-0.1	-0	-0.5	Latest energy statistics
Ireland	-0	-0.0	-0	-0.2	The new methodology uses the actual number of kilometers travelled by buses and coaches, taken from operator's annual reports divided by the known fleet. This change in bus methodology required that the mileage and fuel be rebalanced for the years 2013 to 2017 for all vehicle categories which resulted in a recalculation for these years.
Italy	-44	-4.6	-3	-1.5	Correction of blend share for road transport fuels
Latvia	1	4.1	-0	-8.1	Recalculations have been done due to switch from COPERT 5.2 model version to COPERT 5.3 model version and corrected distribution of vehicles fleet by sub-classes
Lithuania	-0	-0.0	0	1.7	Emissions correction for road transportation according to updated activity data on diesel oil and gasoline. Recalculations in category 1.A.3.e.i have been done due to elimination of natural gas consumed in support of the pipeline operation through venting in order to avoid double counting with fugitive emissions. Activity data and emissions from fuel used in ports for loading ships with various cranes and other means of transport were included in 1.A.3.e.ii.
Luxembourg	1	11.3	2	215.5	Revision of methodology: switch from HBEFA3.3 to HBEFA4.1
Malta	-0	-2.8	0	11.1	Recalculations in aviation to harmonise national aviation emissions from 2005 onwards (EUROCONTROL)
Netherlands	-0	-0.0	2	3.6	Revised energy balance
Poland	-15	-8.0	-3	-2.3	AD data and the method of calculation from COPERT 5.2 to COPERT 5.3 was changed
Portugal	2	2.2	-0	-1.9	Road Transports (1A3b): Update of Activity Data
Romania	-	-	-	-	-
Slovakia	-	-	0	4.8	Update of the COPERT model version and introducing of the CO_2 correction factor to the emissions calculation led to changes in GHG emissions in the category 1.A.3.b.i (Cars). This recalculation resulted into redistribution of fuel consumption and in a shift of CO_2, CH_4 and N_2O emissions between vehicle categories.
Slovenia	-	-	-	-	-
Spain	-0	-0.1	-0	-0.5	AD update of the entire consumption series according to AD provided by the source, new estimations of commercial/institutional mobile machinery (1A4aii) and update of fuel specifications (WTT study and Fuel Quality Directive 98/70/CE)
Sweden	-0	-0.1	1	4.3	Increase in gasoline and decrease of diesel consumption decrease
United Kingdom	-0	-0.0	-1	-1.1	Minor changes due to improvement of fuel consumption factors relating to rail locomotives and

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					real drive cycles.
EU27+UK	**316**	**4.8**	**112**	**9.0**	
Iceland	2	44.7	-1	-43.1	Changes in methodology, emissions are calculated with COPERT
United Kingdom (KP)					NA
EU-KP	**318**	**4.8**	**110**	**8.8**	

Table 3.57 provides information on the contribution of countries to EU-KP recalculations in N_2O from 1A3 Transport for 1990 and 2018.

Table 3.57 1A3 Transport: Contribution of countries to EU-KP recalculations in N_2O for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-5	-3.6	42	20.1	Revised emission factors in the transport-model (switch to HBEFA 4.1)
Belgium	-41	-18.8	5	1.8	Revision of off-road model, The emissions from machinery used in harbours, airports and transhipment companies are allocated to the category 1A3e (instead of category 1A4a before)
Bulgaria	-	-	-0	-0.0	A complete recalculation has been performed, introducing the new COPERT version 5.3 In order to apply the new version, an updated vehicle distribution matrix has been developed.
Croatia	2	3.1	-0	-0.1	Switch to COPERT 5 for all calculations
Cyprus	-0	-0.1	-0	-3.0	Revised energy balance
Czechia	-0	-0.0	-9	-4.2	Updated activity data following transport performace data change
Denmark	-1	-0.5	-1	-0.7	Fuel consumption factors for vans are now further split into vehicle weight classes based on fuel consumption factor data from the European model Handbook of Emission Factors. Updated navigation emission factors as a function of engine load.
Estonia	-0	-0.3	-0	-0.3	Recalculations to reflect the actual LPG consumption in the 1A3b sector and improve the data consistency through out the timeline. Emissons in 1A3a were recalculated due to improved the calc. method.
Finland	-0	-0.0	-0	-0.0	Correction of activity data in LNG use in Navigation.
France	2	0.2	-17	-1.1	Update of the CNG energy balance (and average annual registration of km), update of the diesel PCI
Germany	307	25.8	78	4.7	Revision of model TREMOD Aviation (1.A.3.a, 1.D.1.a), TREMOD (1.A.3.b, 1.A.3.c, 1.A.3.d) and TREMOD MM (1.A.2.g vii, 1.A.4.a ii, b ii, c ii)
Greece	-	-	-23	-8.8	The total statistical fuel conusmption is used for each fuel type. However, statistical fuel consumption data do not exist for each vehicle category and, hence, we attribute the fuel used to each vehicle category by using the estimated vehicle*kms travelled and the corresponding fuel consumption coefficients. In this case, we have found a mistake in the application of the above approach and, therefore, we conducted a recalculation to correct it, resulting in a different fuel consumption split to each vehicle category and in different CO_2 emissions.
Hungary	0	0.2	0	0.1	Latest energy statistics + CO_2 from fossil part of FAME biodiesel has been added to diesel oil emissions+CS EF in railways
Ireland	-0	-0.1	0	0.2	The new methodology uses the actual number of kilometers travelled by buses and coaches, taken from

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					operator's annual reports divided by the known fleet. This change in bus methodology required that the mileage and fuel be rebalanced for the years 2013 to 2017 for all vehicle categories which resulted in a recalculation for these years.
Italy	19	2.0	60	6.8	Correction of blend share for road transport fuels
Latvia	1	1.1	2	3.3	Recalculations have been done due to switch from COPERT 5.2 model version to COPERT 5.3 model version and corrected distribution of vehicles fleet by sub-classes
Lithuania	5	6.1	42	88.5	Emissions correction for road transportation according to updated activity data on diesel oil and gasoline. Recalculations in category 1.A.3.e.i have been done due to elimination of natural gas consumed in support of the pipeline operation through venting in order to avoid double counting with fugitive emissions. Activity data and emissions from fuel used in ports for loading ships with various cranes and other means of transport were included in 1.A.3.e.ii.
Luxembourg	-3	-14.8	9	18.4	Revision of methodology: switch from HBEFA3.3 to HBEFA4.1
Malta	1	83.3	1	17.2	Recalculations in aviation to harmonise national aviation emissions from 2005 onwards (EUROCONTROL)
Netherlands	-0	-0.0	6	2.5	Revised energy balance
Poland	-6	-1.7	-48	-6.8	AD data and the method of calculation from COPERT 5.2 to COPERT 5.3 was changed
Portugal	3	3.4	-3	-1.7	Road Transports (1A3b): Update of Activity Data
Romania	-	-	-	-	-
Slovakia	-	-	-0	-0.0	Update of the COPERT model version and introducing of the CO_2 correction factor to the emissions calculation led to changes in GHG emissions in the category 1.A.3.b.i (Cars). This recalculation resulted into redistribution of fuel consumption and in a shift of CO_2, CH_4 and N_2O emissions between vehicle categories.
Slovenia	-	-	-	-	-
Spain	-0	-0.0	1	0.1	AD update of the entire consumption series according to AD provided by the source, new estimations of commercial/institutional mobile machinery (1A4aii) and update of fuel specifications (WTT study and Fuel Quality Directive 98/70/CE)
Sweden	-3	-1.5	3	2.0	Updates in HBEFA model
United Kingdom	0	0.0	1	0.1	Minor changes due to improvement of fuel consumption factors relating to rail locomotives and real drive cycles.
EU27+UK	**282**	**3.6**	**150**	**1.5**	
Iceland	-10	-61.7	-31	-80.0	Changes in methodology, emissions are calculated with COPERT
United Kingdom (KP)					NA
EU-KP	**273**	**3.4**	**119**	**1.2**	

3.2.3.1 **Domestic Aviation (1A3a) (EU-KP)**

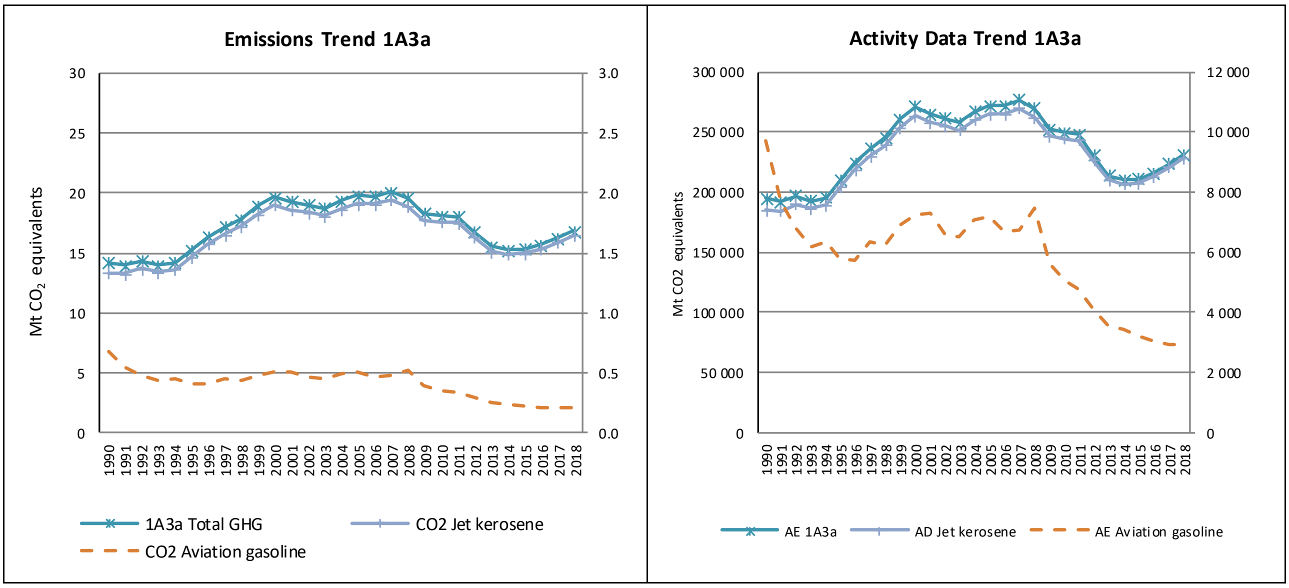
This source category includes emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. It should be noted that emissions from military aviation should be reported under category 1A5b Other Mobile, which is the case for most countries. Croatia and Ireland have stated in their NIR that emissions from military aviation are reported under category

1A3a, since it is not possible to split the fuel use between these two sub-categories (but the fuel used for military purposes is small compared to the fuel used for civil domestic aviation).Bulgaria and Iceland do not report emissions under category 1A5b in the CRF file and relevant information is not included in the NIR. During the ESD checks Iceland informed the EU that there is no military in Iceland, thus emissions from military aviation are not occurring. This information will be added to the ISL NIR for next submission. Bulgaria informed the EU that emissions from military aviation have been included in the inventory. Due to confidentiality issues, they have no access to the exact quantities of jet kerosene used for military aviation, but have been assured by the National Statistics Institute, that jet kerosene reported for domestic aviation also includes jet kerosene for military purposes.

CO_2 emissions from 1A3a Domestic Aviation account for 2 % of total transport-related GHG emissions in 2018. Between 1990 and 2018, CO_2 emissions from domestic aviation increased by 19 % in the EU-KP (Table 3.58, Figure 3.107).

CO_2 emissions from Jet Kerosene account for 99 % of total CO_2 emissions from 1A3a Domestic Aviation. Between 2017 and 2018, CO_2 emissions from domestic aviation increased by 3 % in the EU-KP (Table 3.58, Figure 3.107).

Figure 3.107 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 countries France, Germany, Italy and Spain alone contributed 75.5 % to the emissions from this source. Thirteen countries in total increased emissions from civil aviation between 1990 and 2018 (Table 3.58). Based on the following table Germany and Italy used also T1 method for calculation emissions, but they 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 93%.

Table 3.58 1A3a Civil Aviation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	32	42	46	0.3%	14	44%	4	8%	T2,T3	CS
Belgium	15	11	19	0.1%	5	31%	8	68%	T1	D
Bulgaria	135	62	53	0.3%	-82	-61%	-9	-15%	T1,T2	D
Croatia	7	31	32	0.2%	25	381%	0	1%	T1	D
Cyprus	26	1	1	0.0%	-25	-97%	0	8%	T1	D
Czechia	139	10	10	0.1%	-129	-93%	0	1%	T1	D
Denmark	205	137	133	0.8%	-72	-35%	-4	-3%	CR,M,T2	CS
Estonia	6	4	4	0.0%	-1	-27%	0	14%	T2	D
Finland	385	194	216	1.3%	-170	-44%	21	11%	T1	CS
France	4 384	4 939	5 221	31.4%	837	19%	282	6%	T3	M
Germany	2 280	1 980	1 993	12.0%	-288	-13%	13	1%	CS,T1,T2	CS,D,M
Greece	323	404	421	2.5%	98	30%	18	4%	T2,T3	D
Hungary	4	4	4	0.0%	1	20%	1	13%	T1,T2	CS,D
Ireland	48	17	17	0.1%	-31	-65%	-1	-4%	M,T3	CS
Italy	1 493	2 221	2 318	13.9%	825	55%	97	4%	T1,T2	CS
Latvia	0	4	4	0.0%	4	5465%	-1	-18%	T1	D
Lithuania	8	1	2	0.0%	-6	-76%	0	34%	T1	CS
Luxembourg	0	1	1	0.0%	0	163%	0	-3%	T1	D
Malta	1	0	1	0.0%	0	-39%	0	70%	T1,T3	M
Netherlands	85	32	32	0.2%	-53	-62%	0	0%	T1	CS,D
Poland	65	134	134	0.8%	69	106%	0	0%	T1	D
Portugal	178	502	498	3.0%	320	180%	-4	-1%	T1,T3	D
Romania	25	148	166	1.0%	141	568%	19	13%	T1,T2	D,OTH
Slovakia	4	3	3	0.0%	-1	-24%	-1	-17%	T3	D
Slovenia	1	2	2	0.0%	1	90%	0	19%	T1	D
Spain	1 664	2 805	3 030	18.2%	1 366	82%	225	8%	T3	D
Sweden	673	545	523	3.1%	-150	-22%	-22	-4%	T1	D
United Kingdom	1 540	1 658	1 540	9.3%	0	0%	-119	-7%	T3	CS
EU-27+UK	**13 726**	**15 892**	**16 422**	**99%**	**2 696**	**20%**	**530**	**3%**	**-**	**-**
Iceland	32	23	25	0.1%	-7	-23%	2	7%	T1	D
United Kingdom (KP)	1 795	1 856	1 729	10.4%	-66	-4%	-127	-7%	T3	CS
EU-KP	**14 013**	**16 113**	**16 636**	**100%**	**2 623**	**19%**	**523**	**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 2018 CO_2 emissions resulting from jet kerosene within the category 1A3a were responsible for 99 % of CO_2 emissions in 1A3a. Within the EU-KP the emissions increased between 1990 and 2018 by 23 % (Table 3.59). By far the largest absolute increase occurred in Spain. Between 2017 and 2018, EU-KP emissions increased by 3 %.

Table 3.59 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	24	35	39	0.2%	15	61%	4	11%	T3	CS
Belgium	12	9	18	0.1%	6	52%	9	99%	T1	D
Bulgaria	114	60	51	0.3%	-62	-55%	-9	-15%	T2	D
Croatia	6	30	30	0.2%	24	385%	0	1%	T1	D
Cyprus	26	1	1	0.0%	-25	-97%	0	8%	T1	D
Czechia	1	1	1	0.0%	-1	-43%	0	20%	T1	D
Denmark	197	135	130	0.8%	-67	-34%	-5	-4%	CR,M,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	377	193	213	1.3%	-164	-43%	21	11%	T1	CS
France	4 278	4 885	5 166	31.4%	887	21%	281	6%	T3	M
Germany	2 110	1 952	1 966	12.0%	-144	-7%	14	1%	CS,T2	CS,M
Greece	311	397	415	2.5%	104	33%	19	5%	T3	D
Hungary	1	1	2	0.0%	0	37%	1	50%	T2	CS
Ireland	45	15	15	0.1%	-30	-68%	0	-3%	M,T3	CS
Italy	1 459	2 213	2 307	14.0%	848	58%	94	4%	T1,T2	CS
Latvia	0	4	3	0.0%	3	5819%	-1	-20%	T1	D
Lithuania	7	0	0	0.0%	-7	-94%	0	200%	T1	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	0	1	0.0%	0	-40%	0	80%	T1,T3	M
Netherlands	73	29	30	0.2%	-43	-59%	0	1%	T1	D
Poland	40	123	122	0.7%	81	201%	-2	-1%	T1	D
Portugal	176	501	497	3.0%	321	183%	-3	-1%	T3	D
Romania	25	145	163	1.0%	138	555%	18	12%	T2	OTH
Slovakia	4	3	3	0.0%	-1	-23%	-1	-18%	T3	D
Slovenia	NO	1	1	0.0%	1	∞	0	4%	T1	D
Spain	1 638	2 795	3 020	18.4%	1 382	84%	225	8%	T3	D
Sweden	658	541	519	3.2%	-139	-21%	-21	-4%	T1	D
United Kingdom	1 477	1 624	1 508	9.2%	31	2%	-115	-7%	T3	CS
EU-27+UK	**13 061**	**15 691**	**16 221**	**99%**	**3 159**	**24%**	**529**	**3%**	**-**	**-**
Iceland	27	22	24	0.1%	-3	-11%	2	8%	T1	D
United Kingdom (KP)	1 721	1 819	1 696	10.3%	-25	-1%	-123	-7%	T3	CS
EU-KP	**13 332**	**15 909**	**16 431**	**100%**	**3 099**	**23%**	**523**	**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 2018 (Figure 3.109). Table **3.59** shows that the majority of emissions from Domestic Aviation jet kerosene were calculated using a higher tier method (93%) as presented in Table 6.1. Based on the table above, Italy, which is one of the major contributors to this category, mentions to use also T1 method. As stated in the NIR, T1 method is used for calculating emissions for N_2O and not CO_2 emissions. Thus, it was included in the share of the high tier methods calculation for CO_2 emissions. In Figure 3.108 the IEF is depicted, showing a mean value of around 72 t/TJ.

Figure 3.109 1A3a Civil Aviation, Jet Kerosene: Emission trend and share for CO_2

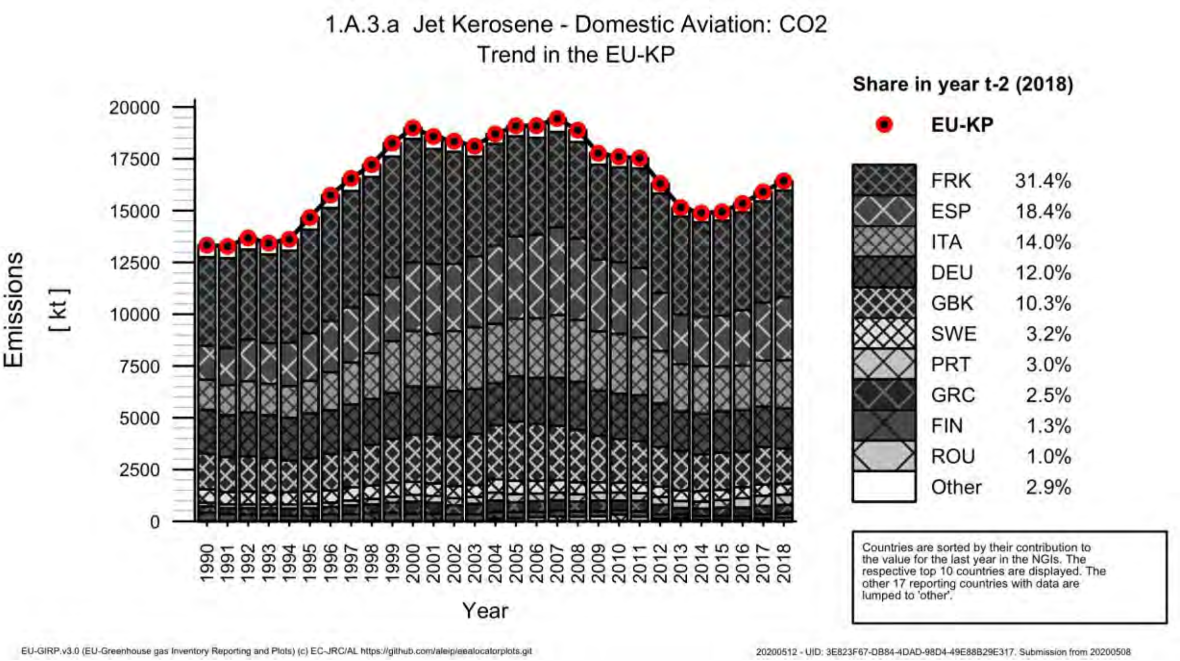
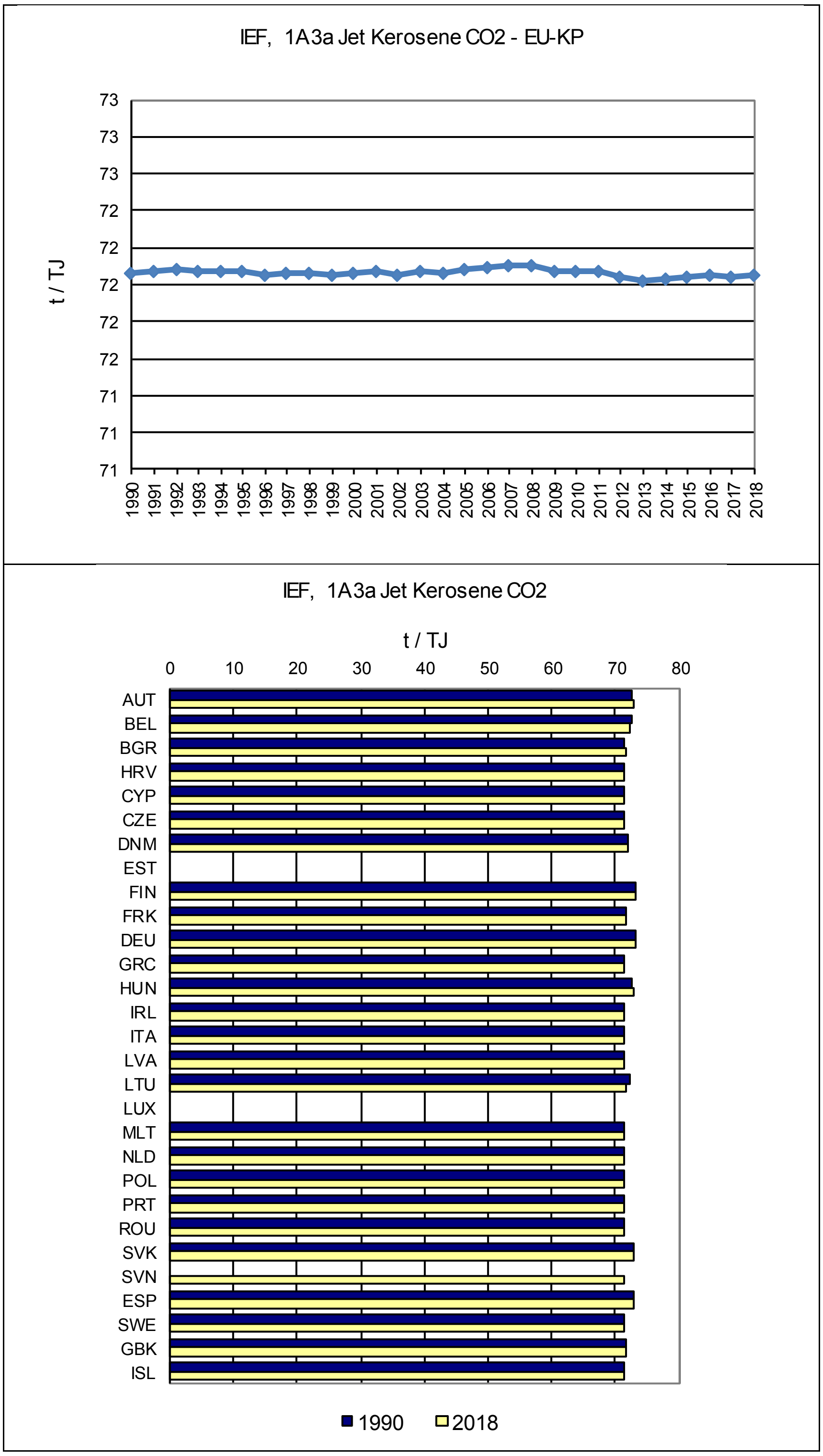


Figure 3.110 1A3a Civil Aviation, Jet Kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.2 **Road Transportation (1A3b) (EU-KP)**

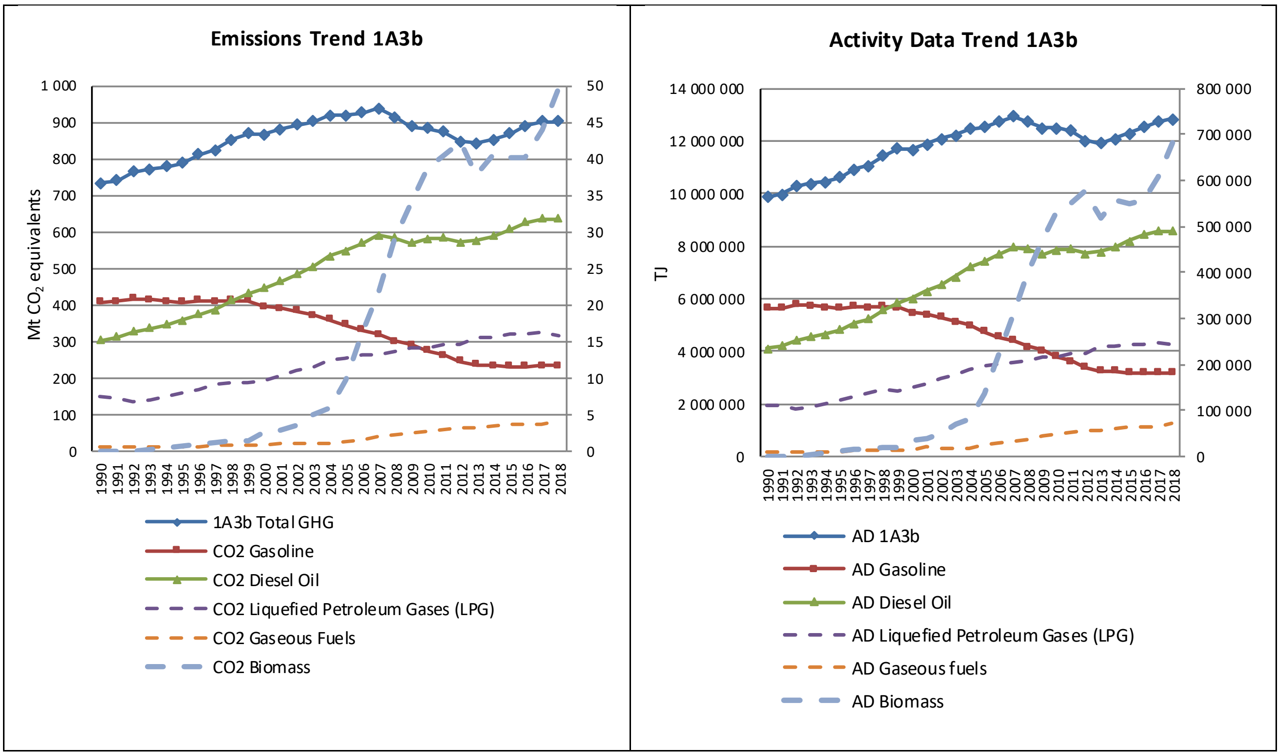
CO_2 emissions from 1A3b Road Transportation

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-KP accounting for 21 % of total GHG emissions in 2018. Between 1990 and 2018, CO_2 emissions from road transportation increased by 24 % in the EU-KP (Table 3.60). 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 but also to the increased use of biofuels. The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 30 % between 1990 and 2018.

Figure 3.111 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 increase of diesel show the gradual switch from gasoline to diesel passenger cars in several EU-KP countries.

Figure 3.111 1A3b Road Transport: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The countries Germany, France, Italy, Spain and the United Kingdom contributed most to the CO_2 emissions from this source (64 %). All countries, except Finland (0%) and Sweden (-13%), show increased emissions from road transportation between 1990 and 2018. 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 in the EU. The countries with the highest increases in absolute terms were Poland, Spain, France and Austria. The countries with the lowest increase in relative terms were United Kingdom and Germany (Table 3.60).

Table 3.60 1A3b Road Transport: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	13 328	23 238	23 407	2.6%	10 079	76%	169	1%	T1,T2	CS,D
Belgium	19 680	24 926	25 060	2.8%	5 380	27%	134	1%	M,T2	CS,M
Bulgaria	5 780	8 878	9 177	1.0%	3 396	59%	298	3%	T2	CR
Croatia	3 506	6 343	6 113	0.7%	2 607	74%	-230	-4%	T1	D
Cyprus	1 186	2 079	2 048	0.2%	862	73%	-31	-1%	T1,T2	D,M
Czechia	10 253	18 138	18 495	2.1%	8 243	80%	358	2%	T2	M
Denmark	9 357	12 012	12 307	1.4%	2 950	32%	294	2%	CR,M,T2	CS
Estonia	2 226	2 327	2 333	0.3%	107	5%	6	0%	T1,T2	CS,D
Finland	10 804	10 687	10 852	1.2%	48	0%	165	2%	T2	CS
France	114 063	125 911	123 216	13.8%	9 153	8%	-2 695	-2%	T3	M
Germany	151 898	161 453	155 813	17.5%	3 914	3%	-5 640	-3%	CS,M,T2,T3	CS,D
Greece	11 793	14 534	14 593	1.6%	2 799	24%	59	0%	T1,T2,T3	CS,D
Hungary	7 826	12 707	13 444	1.5%	5 618	72%	737	6%	T1,T2	CS,D
Ireland	4 690	11 395	11 553	1.3%	6 863	146%	158	1%	T2,T3	CS,M
Italy	92 316	92 769	95 796	10.8%	3 480	4%	3 027	3%	T2	CS,M
Latvia	2 402	3 090	3 107	0.3%	705	29%	18	1%	T1,T2	CS,D
Lithuania	5 247	5 407	5 756	0.6%	509	10%	348	6%	T1,T2	CS,D
Luxembourg	2 563	5 578	5 953	0.7%	3 390	132%	375	7%	T1,T2	CS,D
Malta	300	554	559	0.1%	259	86%	5	1%	T1,T3	M
Netherlands	26 451	29 721	29 982	3.4%	3 532	13%	261	1%	T1,T2	CS
Poland	18 436	61 200	63 047	7.1%	44 612	242%	1 847	3%	T2	D
Portugal	10 001	16 208	16 277	1.8%	6 276	63%	70	0%	NE,T2	NE,OTH
Romania	10 366	17 066	17 605	2.0%	7 239	70%	539	3%	T1,T3	D,OTH
Slovakia	4 503	7 094	7 255	0.8%	2 752	61%	161	2%	T2	CS,D
Slovenia	2 600	5 441	5 719	0.6%	3 119	120%	278	5%	M	M
Spain	50 433	81 789	82 663	9.3%	32 230	64%	874	1%	T1,T2	CS,D,M
Sweden	16 979	15 241	14 828	1.7%	-2 151	-13%	-413	-3%	T2	CS
United Kingdom	107 891	113 026	111 497	12.5%	3 606	3%	-1 529	-1%	T1,T3	CS,OTH
EU-27+UK	**716 876**	**888 812**	**888 455**	**100%**	**171 579**	**24%**	**-357**	**0%**	**-**	**-**
Iceland	520	944	969	0.1%	450	87%	25	3%	T1	D
United Kingdom (KP)	108 364	113 555	112 043	12.6%	3 679	3%	-1 512	-1%	OTH,T1,T3	CS,OTH
EU-KP	**717 869**	**890 286**	**889 971**	**100%**	**172 102**	**24%**	**-315**	**0%**	**-**	**-**

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

In Table 3.61 the fuel share is presented per country. It is clear that diesel oil accounts for 67 % for EU-KP and gasoline for 25 %. The highest LPG consumption is observed in Bulgaria (14 %) and Poland (9 %). The share of biomass is around 5 % for EU-KP with Sweden having the highest percentage (22 %).

Table 3.61 1A3b Road Transport: Countries' share of different fuel in the total consumption

Country	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Austria	19.2%	75.5%	0.1%	0.2%	5.0%
Belgium	18.7%	75.0%	0.7%	0.2%	5.5%
Bulgaria	15.1%	62.9%	14.4%	2.5%	5.1%
Croatia	25.4%	69.2%	3.9%	0.2%	1.3%
Cyprus	53.4%	45.2%	0.1%	NO	1.3%
Czechia	24.9%	67.8%	1.6%	1.0%	4.8%
Denmark	30.8%	64.1%	0.0003%	0.3%	4.9%
Estonia	33.4%	63.2%	1.1%	NO	2.2%
Finland	31.8%	58.8%	NO, NA	0.08%	9.3%
France	16.9%	75.6%	0.2%	0.2%	7.1%
Germany	31.5%	62.5%	0.6%	0.3%	5.1%

Country	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Greece	47.0%	44.2%	4.9%	0.3%	3.7%
Hungary	30.9%	64.2%	0.5%	0.2%	4.2%
Ireland	20.8%	75.4%	0.05%	NO	3.7%
Italy	22.8%	65.3%	5.4%	2.6%	3.8%
Latvia	17.6%	73.6%	5.3%	0.005%	3.3%
Lithuania	11.7%	78.5%	5.5%	0.4%	3.6%
Luxembourg	16.0%	78.2%	0.02%	NO	5.8%
Malta	42.4%	54.1%	0.3%	NO	3.2%
Netherlands	39.1%	54.6%	1.1%	0.6%	4.6%
Poland	20.1%	64.8%	9.3%	0.4%	5.3%
Portugal	19.5%	75.2%	0.7%	0.3%	4.3%
Romania	22.5%	70.8%	1.6%	NO	5.1%
Slovakia	20.2%	71.5%	1.8%	0.2%	6.3%
Slovenia	22.4%	73.0%	0.8%	0.2%	3.7%
Spain	17.4%	76.2%	0.2%	0.6%	5.5%
Sweden	33.6%	44.2%	NO, IE	0.2%	22.1%
United Kingdom	31.2%	65.2%	0.2%	IE	3.4%
EU-27 + UK	**25%**	**67%**	**2%**	**0.6%**	**5.4%**
Iceland	39.5%	55.0%	NO, NA	NO	5.5%
EU-KP	**25%**	**67%**	**2%**	**0.6%**	**5.3%**

1A3b Road Transportation – Gaseous Fuels (CO_2)

CO_2 emissions from Gaseous fuels account for 0,5 % of CO_2 emissions from 1A3b Road Transport in 2018 (Table 3.62). Between 2017 and 2018 CO_2 emissions from Gaseous fuels have increased by 12 %, between 1990 and 2018 emissions show an increase of 695% in EU-KP. Most countries showed increased emissions, whereas eight countries 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 3.62 1A3b Road Transport, gaseous fuels: countries contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	NO	39	38	1.0%	38	∞	-1	-3%
Belgium	NO,IE	23	37	0.9%	37	∞	15	65%
Bulgaria	NO	176	184	4.6%	184	∞	8	5%
Croatia	NO	10	10	0.2%	10	∞	0	0%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	130	146	3.7%	146	∞	17	13%
Denmark	0	21	27	0.7%	27	173004%	6	27%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	NO,NA	5	7	0.2%	7	∞	2	42%
France	0	202	237	5.9%	237	66511%	36	18%
Germany	NA	295	353	8.8%	353	∞	58	20%
Greece	NO	33	39	1.0%	39	∞	6	19%
Hungary	0	21	23	0.6%	22	7400%	2	11%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	483	2 043	2 066	51.7%	1 583	328%	22	1%
Latvia	17	NO,NA	0	0.0%	-17	-99%	0	∞
Lithuania	NO	18	18	0.4%	18	∞	0	-1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	138	149	3.7%	149	∞	12	8%
Poland	NO	27	189	4.7%	189	∞	163	611%
Portugal	NO	35	38	1.0%	38	∞	3	9%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	13	10	0.2%	10	∞	-3	-24%
Slovenia	NO	8	8	0.2%	8	∞	0	2%
Spain	NO	300	392	9.8%	392	∞	93	31%
Sweden	3	43	27	0.7%	24	823%	-17	-39%
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-27+UK	**503**	**3 579**	**4 000**	**100%**	**3 497**	**695%**	**421**	**12%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-KP	**503**	**3 579**	**4 000**	**100%**	**3 497**	**695%**	**421**	**12%**

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 countries Germany, France, Italy and Spain contributed most to the CO_2 emissions from this source (76 %). All countries, except for Latvia, show increased emissions from road transportation between 1990 and 2018. The countries with the highest increases in absolute terms were Italy, Germany and Spain.

In Figure 3.112 it is depicted that the share of gaseous fuels is constantly increasing from 1990 to 2018. The reason for this increase is the increasing activity data and corresponing emissions of Italy, which is a high contributor to this source category. The IEF is depicted and the mean value is around 56 t/TJ. The increase in the IEF value is mainly due to the correspodning increase in the IEF of Italy. As already mentioned, Italy dominates EU emissions, thus the IEF of EU almost follows the increasing trend of the IEF of Italy from 1990 to 2018.

Figure 3.112: 1A3b Road Transport, gaseous fuels: Emission trend and share for CO_2

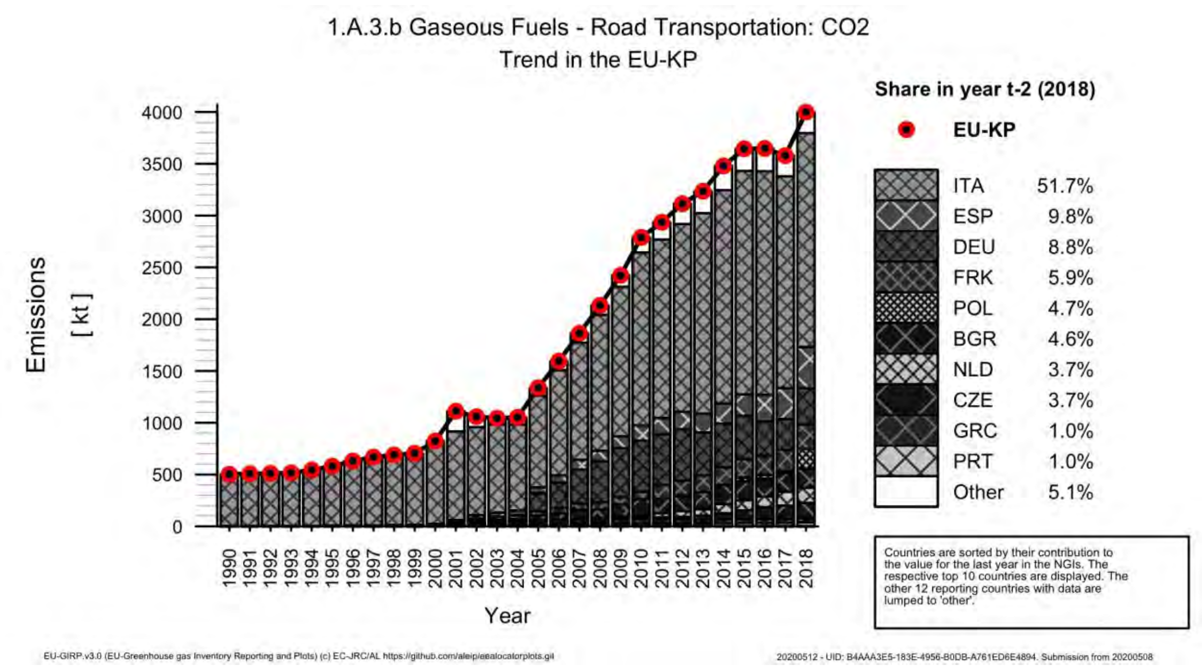
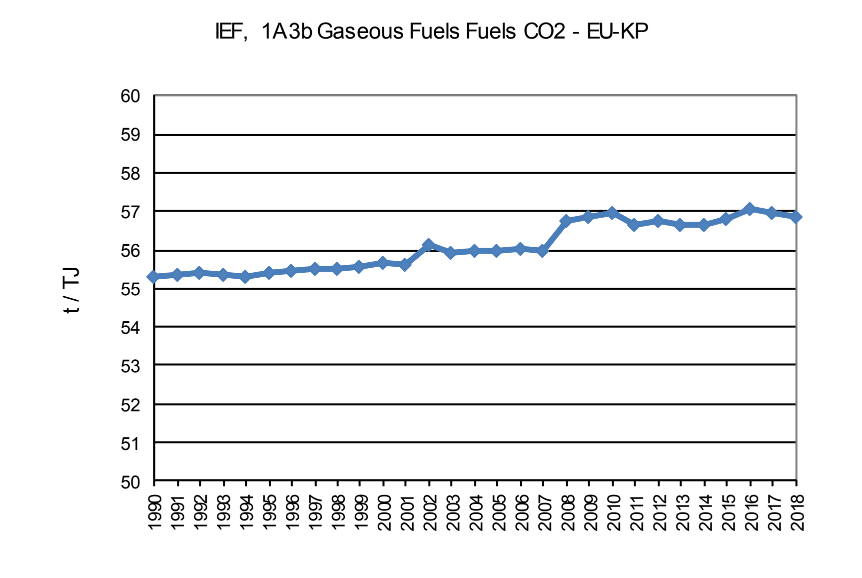
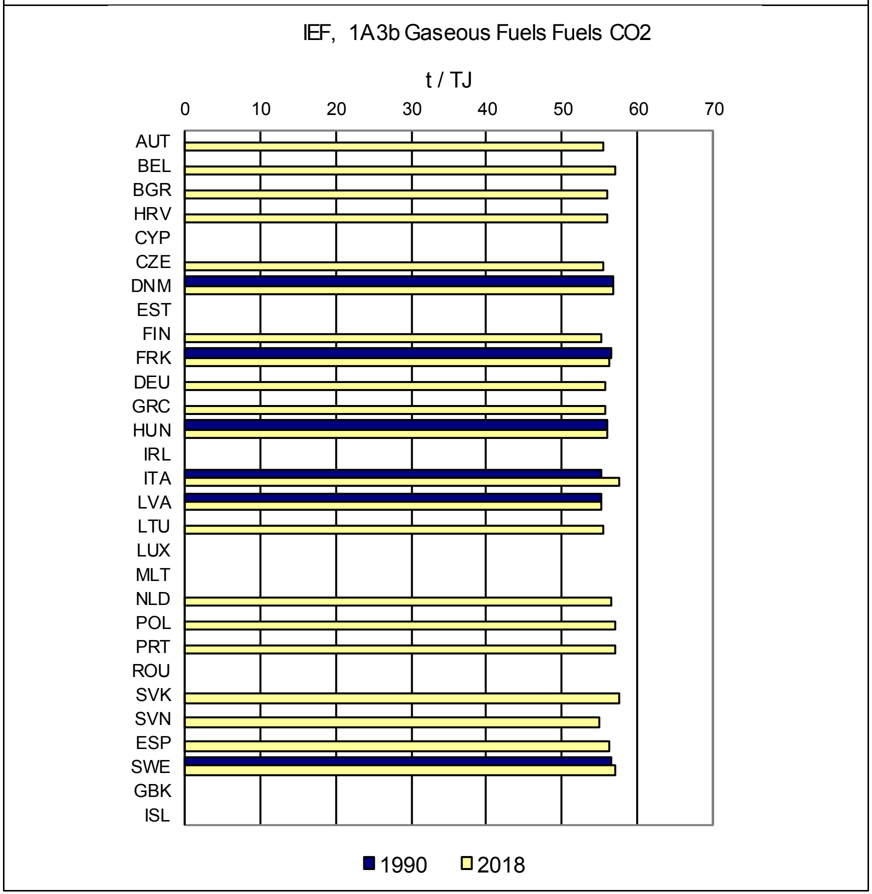


Figure 3.113 1A3b Road Transport, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





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 2018 (Table 3.63). All countries show increased emissions from Diesel oil between 1990 and 2018. Countries with the highest increase in per cent were Slovenia, Iceland, Ireland and Poland. Some of these increases are due to fuel bought in the respective countries but consumed abroad (fuel tourism).

Table 3.63 1A3b Road Transport, diesel oil: countries contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	5 378	18 381	18 444	2.9%	13 066	243%	64	0%
Belgium	11 027	20 355	19 938	3.1%	8 911	81%	-416	-2%
Bulgaria	1 539	5 846	6 278	1.0%	4 739	308%	433	7%
Croatia	1 159	4 572	4 383	0.7%	3 224	278%	-190	-4%
Cyprus	669	955	953	0.2%	284	42%	-3	0%
Czechia	6 655	13 055	13 324	2.1%	6 669	100%	269	2%
Denmark	4 436	8 032	8 308	1.3%	3 872	87%	276	3%
Estonia	697	1 511	1 525	0.2%	829	119%	15	1%
Finland	4 923	6 880	7 102	1.1%	2 178	44%	222	3%
France	54 622	103 344	99 898	15.7%	45 276	83%	-3 446	-3%
Germany	54 478	105 519	101 946	16.1%	47 469	87%	-3 573	-3%
Greece	4 264	6 514	6 738	1.1%	2 474	58%	224	3%
Hungary	2 388	8 551	9 147	1.4%	6 759	283%	596	7%
Ireland	1 914	8 720	9 123	1.4%	7 208	377%	402	5%
Italy	47 808	63 343	65 864	10.4%	18 056	38%	2 521	4%
Latvia	623	2 359	2 403	0.4%	1 781	286%	44	2%
Lithuania	2 134	4 429	4 738	0.7%	2 605	122%	309	7%
Luxembourg	1 269	4 642	4 933	0.8%	3 664	289%	291	6%
Malta	119	339	312	0.0%	193	162%	-27	-8%
Netherlands	13 012	17 042	17 105	2.7%	4 093	31%	63	0%
Poland	8 769	42 897	43 951	6.9%	35 182	401%	1 054	2%
Portugal	5 625	12 765	12 866	2.0%	7 240	129%	101	1%
Romania	3 648	12 847	13 414	2.1%	9 766	268%	567	4%
Slovakia	3 123	5 404	5 604	0.9%	2 482	79%	200	4%
Slovenia	904	4 149	4 397	0.7%	3 492	386%	248	6%
Spain	24 555	66 530	66 594	10.5%	42 039	171%	64	0%
Sweden	4 223	8 605	8 410	1.3%	4 187	99%	-194	-2%
United Kingdom	32 772	77 275	76 375	12.0%	43 603	133%	-899	-1%
EU-27+UK	**302 734**	**634 859**	**634 074**	**100%**	**331 341**	**109%**	**-785**	**0%**
Iceland	116	521	567	0.1%	451	389%	47	9%
United Kingdom (KP)	32 916	77 498	76 601	12.1%	43 685	133%	-897	-1%
EU-KP	**302 993**	**635 603**	**634 867**	**100%**	**331 874**	**110%**	**-736**	**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 UK account for 65 % of CO_2 emissions from diesel oil in 2018 (In Figure 3.116 the IEF is depicted and the mean value is around 74 t/TJ. For some countries 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. The case of Romania was investigated and it was concluded that the value of the IEF depends also on the country specific values for the Net Calorific Value (NCV). Investigations are still on-going.

Figure 3.114 1A3b Road Transport, Diesel Oil: Emission trend and share for CO_2

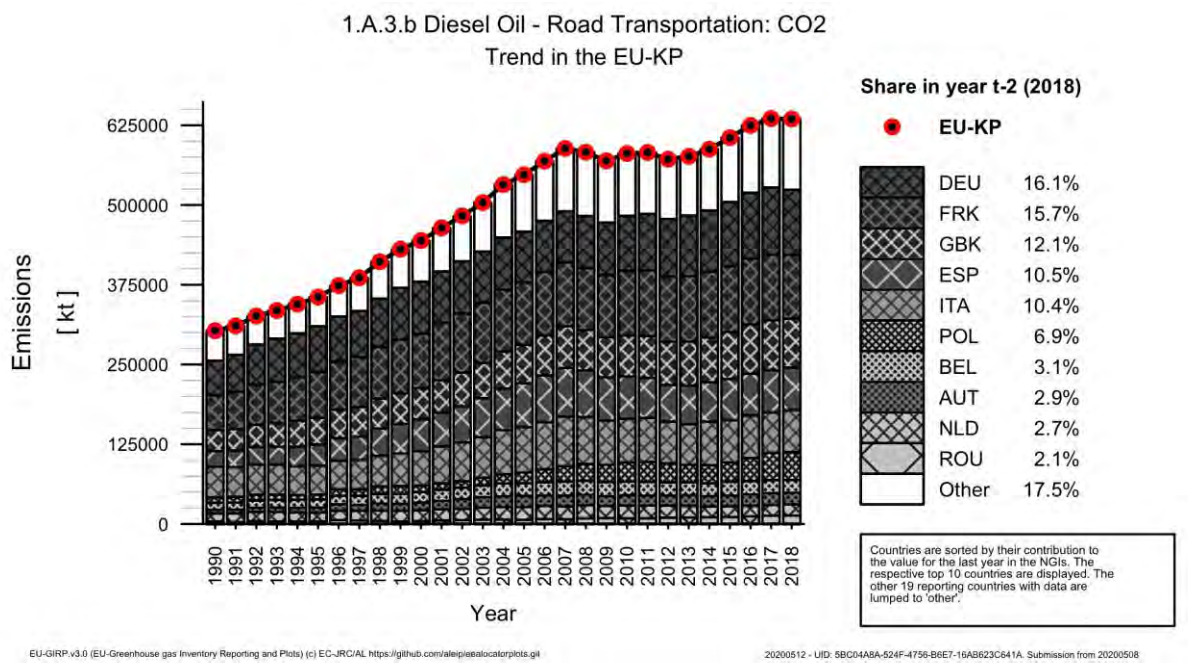
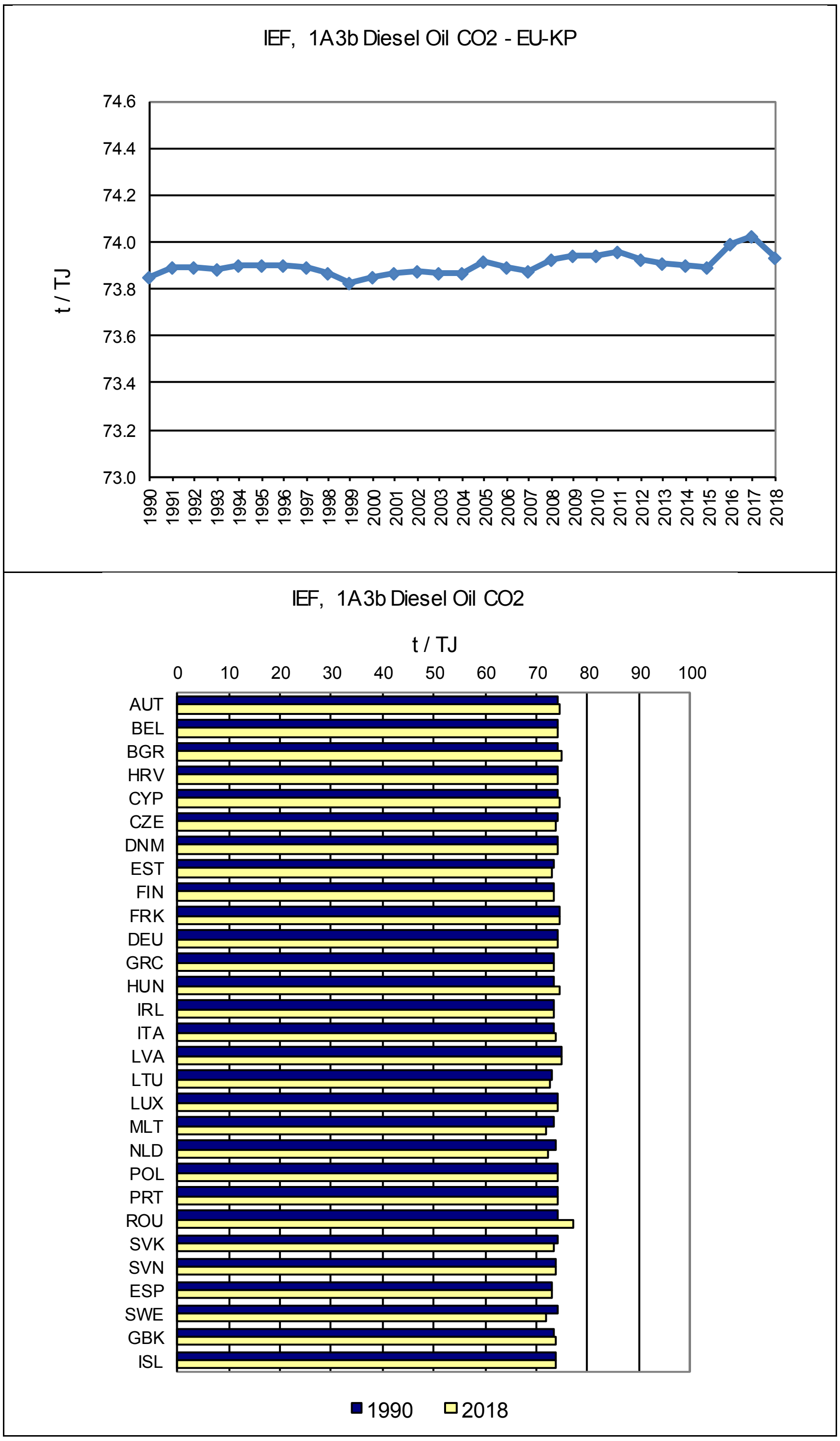


Figure 3.115 1A3b Road Transport, Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – Gasoline (CO_2)

Between 1990 and 2018, CO_2 emissions from gasoline decreased by 43 % in the EU-KP Table 3.64.

Table 3.64 1A3b Road Transport, gasoline: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	7 924	4 723	4 836	2.1%	-3 087	-39%	113	2%
Belgium	8 482	4 317	4 835	2.1%	-3 647	-43%	518	12%
Bulgaria	4 241	1 517	1 435	0.6%	-2 807	-66%	-82	-5%
Croatia	2 347	1 551	1 508	0.6%	-839	-36%	-44	-3%
Cyprus	517	1 124	1 094	0.5%	577	112%	-30	-3%
Czechia	3 598	4 664	4 748	2.0%	1 150	32%	84	2%
Denmark	4 911	3 929	3 942	1.7%	-970	-20%	13	0%
Estonia	1 529	797	782	0.3%	-747	-49%	-15	-2%
Finland	5 880	3 802	3 743	1.6%	-2 137	-36%	-59	-2%
France	59 279	20 885	21 734	9.3%	-37 545	-63%	850	4%
Germany	97 217	54 174	52 150	22.4%	-45 067	-46%	-2 024	-4%
Greece	7 438	7 310	7 167	3.1%	-272	-4%	-143	-2%
Hungary	5 404	4 065	4 212	1.8%	-1 192	-22%	147	4%
Ireland	2 758	2 647	2 404	1.0%	-353	-13%	-242	-9%
Italy	39 949	22 100	22 721	9.8%	-17 228	-43%	621	3%
Latvia	1 722	572	548	0.2%	-1 174	-68%	-23	-4%
Lithuania	3 053	623	682	0.3%	-2 371	-78%	59	9%
Luxembourg	1 282	917	1 000	0.4%	-282	-22%	84	9%
Malta	180	212	245	0.1%	65	36%	32	15%
Netherlands	10 799	12 168	12 364	5.3%	1 565	14%	196	2%
Poland	9 667	12 736	13 240	5.7%	3 573	37%	504	4%
Portugal	4 370	3 256	3 228	1.4%	-1 143	-26%	-28	-1%
Romania	6 591	3 982	3 944	1.7%	-2 646	-40%	-38	-1%
Slovakia	1 380	1 552	1 517	0.7%	136	10%	-35	-2%
Slovenia	1 695	1 237	1 262	0.5%	-434	-26%	24	2%
Spain	25 794	14 652	15 270	6.6%	-10 524	-41%	618	4%
Sweden	12 753	6 591	6 391	2.7%	-6 362	-50%	-200	-3%
United Kingdom	75 117	35 459	34 796	15.0%	-40 321	-54%	-663	-2%
EU-27+UK	**405 878**	**231 560**	**231 797**	**100%**	**-174 080**	**-43%**	**237**	**0%**
Iceland	404	423	402	0.2%	-1	0%	-21	-5%
United Kingdom (KP)	75 446	35 765	35 117	15.1%	-40 329	-53%	-648	-2%
EU-KP	**406 611**	**232 289**	**232 520**	**100%**	**-174 091**	**-43%**	**231**	**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 63 % for CO_2 emissions from gasoline in 2018. In Figure 3.116 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. After communiucation with Germany, it was explained that in order to keep inventory data consistent with the NEB, the NCV of gasoline was decreased, thus the energy related emission factor increased. For some countries 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 3.117 1A3b Road Transport, Gasoline: Emission trend and share for CO_2

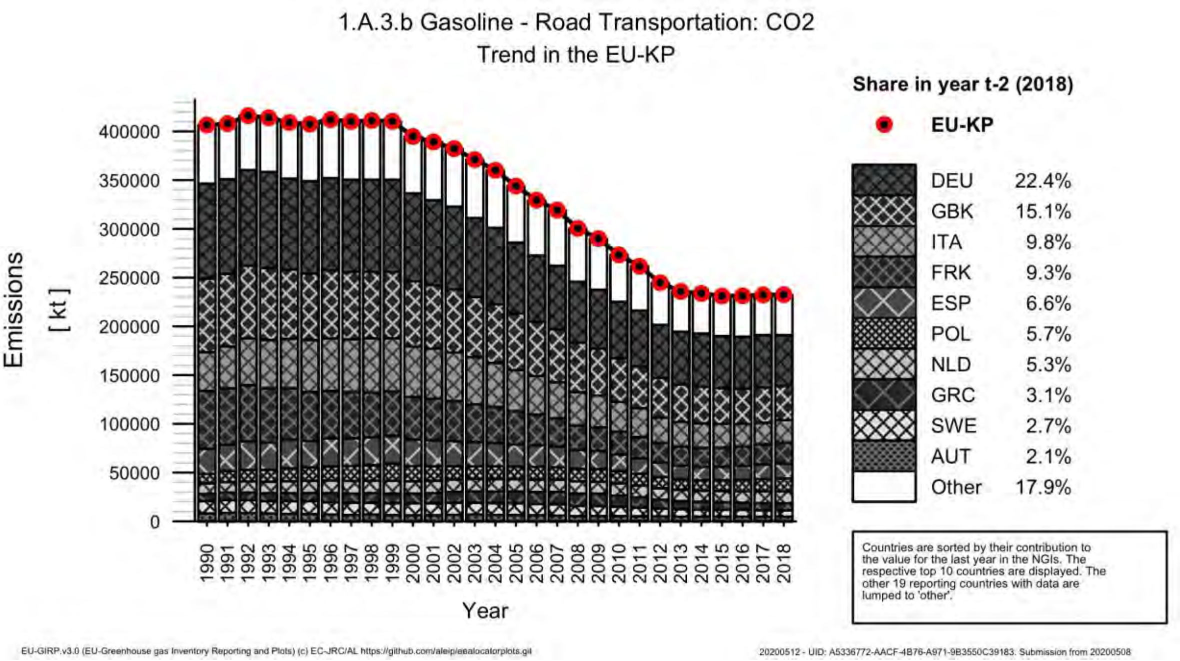
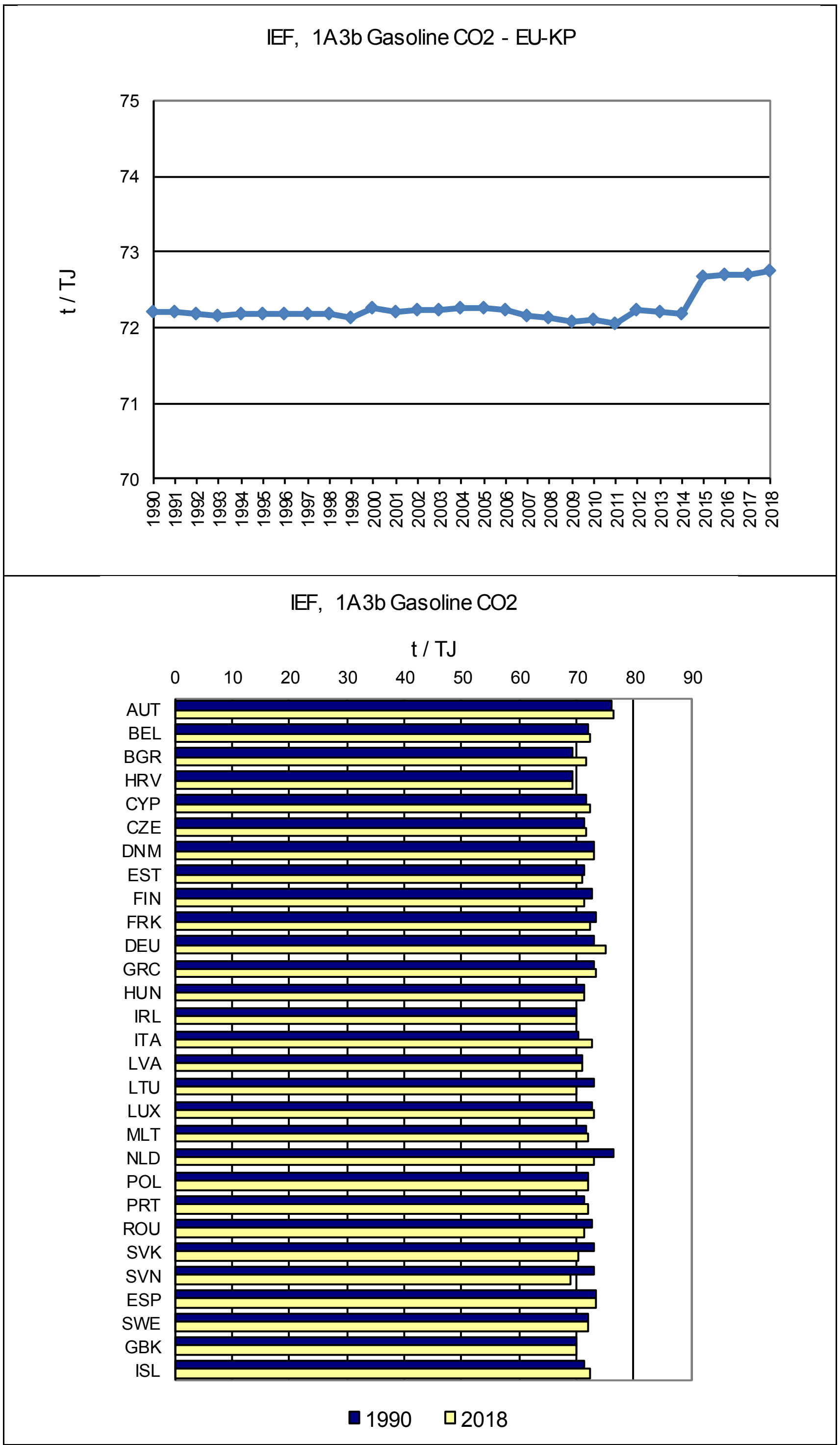


Figure 3.118 1A3b Road Transport, Gasoline: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – LPG (CO_2)

Between 1990 and 2018, CO_2 emissions from LPG increased by 116 % in the EU-KP. Three countries report emissions as ‘Not occurring’. Between 2017 and 2018 EU-KP emissions decreased by 2 % (Table 3.67).

Table 3.65 1A3b Road Transport, LPG: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	26	31	24	0.2%	-3	-9%	-7	-23%
Belgium	169	162	152	1.0%	-18	-10%	-10	-6%
Bulgaria	NO	1 318	1 258	8.0%	1 258	∞	-60	-5%
Croatia	NO	209	208	1.3%	208	∞	-1	0%
Cyprus	NO	NO	1	0.0%	1	∞	1	∞
Czechia	NO	290	278	1.8%	278	∞	-12	-4%
Denmark	9	0	0	0.0%	-9	-100%	0	-24%
Estonia	1	19	23	0.1%	23	3877%	4	21%
Finland	NO,NA	NO,NA	NO,NA	-	-	-	-	-
France	150	193	174	1.1%	24	16%	-20	-10%
Germany	9	1 020	900	5.7%	891	9850%	-120	-12%
Greece	91	677	648	4.1%	558	615%	-28	-4%
Hungary	NO	70	61	0.4%	61	∞	-9	-13%
Ireland	19	6	5	0.0%	-14	-73%	-1	-18%
Italy	4 026	5 046	4 885	30.9%	859	21%	-162	-3%
Latvia	37	153	145	0.9%	108	291%	-8	-5%
Lithuania	60	326	305	1.9%	245	408%	-20	-6%
Luxembourg	11	2	1	0.0%	-10	-91%	-1	-47%
Malta	NO	2	2	0.0%	2	∞	0	-15%
Netherlands	2 640	343	309	2.0%	-2 331	-88%	-34	-10%
Poland	NO,IE	5 471	5 546	35.1%	5 546	∞	75	1%
Portugal	0	110	108	0.7%	108	170977%	-2	-2%
Romania	NO	237	246	1.6%	246	∞	9	4%
Slovakia	NO	126	125	0.8%	125	∞	-1	-1%
Slovenia	NO	42	41	0.3%	41	∞	-1	-2%
Spain	79	154	187	1.2%	109	138%	33	22%
Sweden	0	2	NO,IE	-	0	-100%	-2	-100%
United Kingdom	NO	198	173	1.1%	173	∞	-25	-13%
EU-27+UK	**7 328**	**16 208**	**15 807**	**100%**	**8 480**	**116%**	**-400**	**-2%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	198	173	1.1%	173	∞	-25	-13%
EU-KP	**7 328**	**16 208**	**15 807**	**100%**	**8 480**	**116%**	**-400**	**-2%**

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 31 % and Poland for 35 % of CO_2 emissions from LPG in 2018 whereas France, Germany, Spain and the United Kingdom account for only 9 % of CO_2 emissions Table 3.65 .

1.A.3.b Road Transportation: Other Fuels (CO_2)

This category covers the CO_2 emissions from the fossil part of biofuels. According to the 2006 IPCC GLs (volume 2, chapter 3, section 'CO_2 emissions from biofuels' in page 3.17*): it is important to assess the biofuel origin so as to identify and separate fossil from biogenic feedstocks". In other words, a part of the carbon of biofuels (and the associated CO_2 emissions) may have a fossil origin. The IPCC GLs provide some examples about biofuels' fossil part: "biodiesel made from coal methanol with animal feedstocks has a non-zero fossil fuel fraction and is therefore not fully carbon neutral. Ethanol from the fermentation of agricultural products will generally be purely biogenic (carbon neutral), except in some cases, such as fossil-fuel derived methanol. Products which have undergone further chemical transformation may contain substantial amounts of fossil carbon ranging from about 5-10 percent in the fossil methanol used for biodiesel production upwards to 46 percent in ethyl-tertiary-butyl-ether (ETBE) from fossil isobutene (ADEME/DIREM, 2002). Some processes may generate biogenic by-products such as glycol or glycerine, which may then be used elsewhere*.

For this reason, all countries are encouraged to calculate these emissions and include them in the CRF under "Other fossil fuels". Based on Table 3.66 10 countries report these emissions as Not occurring or Not applicable. Sweden calculates these emissions and they are included under "fossil" diesel in the CRF tables. After communication with Sweden in next year's submission, these emissions will be reported separately. France, Germany, Italy, Spain and United Kingdom contribute the most to this category, with a share of 82%.

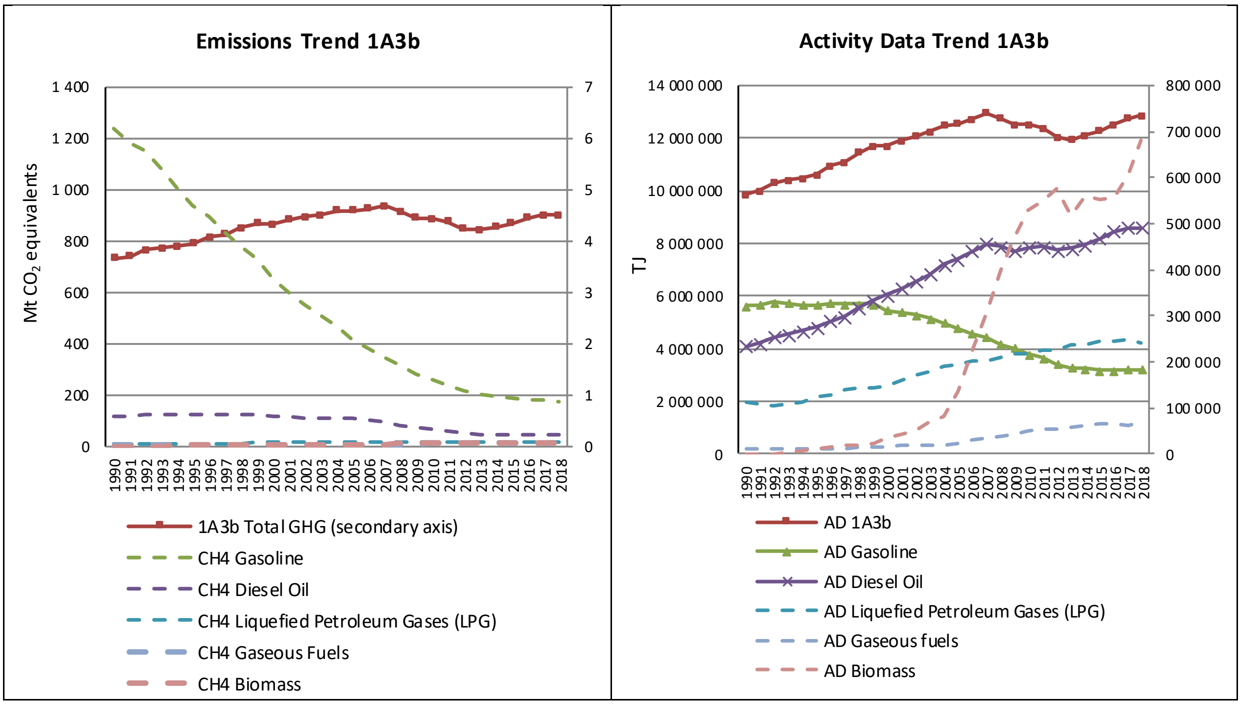
Table 3.66 1A3b Road Transport, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	NO	64	64	2.4%	64	∞	0	0%
Belgium	NO	70	97	3.6%	97	∞	28	40%
Bulgaria	NO	22	22	0.8%	22	∞	-1	-2%
Croatia	NO	0	4	0.2%	4	∞	4	4763%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	NO	30	30	1.1%	30	∞	0	0%
Estonia	NO	0	2	0.1%	2	∞	2	7946%
Finland	NA	NA	NA	-	-	-	-	-
France	NO	1 279	1 164	42.8%	1 164	∞	-115	-9%
Germany	NA	439	458	16.9%	458	∞	19	4%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	22	22	0.8%	22	∞	-1	-3%
Italy	NO	202	239	8.8%	239	∞	37	18%
Latvia	NO	0	5	0.2%	5	∞	5	2056%
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	17	18	0.7%	18	∞	1	6%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	30	54	2.0%	54	∞	24	81%
Poland	NO	70	121	4.5%	121	∞	51	72%
Portugal	NO	40	35	1.3%	35	∞	-4	-11%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	6	12	0.4%	12	∞	6	96%
Spain	NO	152	218	8.0%	218	∞	66	44%
Sweden	-	-	-	-	-	-	-	-
United Kingdom	NO	93	152	5.6%	152	∞	59	63%
EU-27+UK	**NA,NO**	**2 536**	**2 717**	**100%**	**2 717**	∞	**181**	**7%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	93	152	5.6%	152	∞	59	63%
EU-KP	**NA,NO**	**2 536**	**2 717**	**100%**	**2 717**	∞	**181**	**7%**

CH_4 emissions from 1A3b Road Transportation

CH_4 emissions from 1A3b Road Transportation account for 0.03 % of total EU-KP GHG emissions in 2018 Figure 3.122 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 3.119 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 2018 by 82 % (Table 3.67). All countries, except for Malta (increase by 61 %) showed a decrease in CH_4 emissions from 1990 to 2018. Between 2017 and 2018, CH_4 emissions decreased by 2 % in EU-KP. In the same time period, the largest decrease in relative terms was reported by Ireland, and Sweden.

Table 3.67 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	73	19	20	1.6%	-53	-72%	1	7%	T3	CS
Belgium	140	17	18	1.4%	-123	-87%	1	3%	M,T3	CS,M
Bulgaria	70	23	22	1.7%	-48	-69%	-1	-6%	T2	CR
Croatia	41	28	26	2.1%	-14	-36%	-2	-7%	T1,T3	CR,D
Cyprus	7	4	4	0.3%	-3	-47%	0	-7%	T1,T2	D,M
Czechia	75	26	24	1.9%	-51	-68%	-2	-6%	T3	M
Denmark	78	10	9	0.7%	-69	-88%	-1	-5%	CR,M,T3	CR
Estonia	23	3	3	0.3%	-19	-85%	0	-4%	T1,T3	CS,D
Finland	107	10	9	0.7%	-97	-91%	-1	-8%	T3	CR
France	1 016	119	118	9.5%	-897	-88%	-1	-1%	T3	M
Germany	1 660	224	218	17.6%	-1 442	-87%	-5	-2%	CS,M,T2,T3	CS,M
Greece	107	70	68	5.5%	-39	-36%	-2	-3%	M,T1	D,M
Hungary	67	23	23	1.9%	-44	-65%	0	-1%	T1,T3	D,M
Ireland	48	11	10	0.8%	-39	-80%	-1	-12%	T3	M
Italy	869	189	180	14.6%	-689	-79%	-8	-4%	T3	M
Latvia	19	4	3	0.3%	-16	-82%	0	-3%	T1,T2	CR,D,M
Lithuania	52	19	19	1.5%	-33	-63%	0	1%	T1,T3	CR,D
Luxembourg	12	3	3	0.3%	-9	-72%	0	9%	T3	M
Malta	3	5	5	0.4%	2	61%	0	11%	T1,T3	M
Netherlands	193	64	62	5.0%	-131	-68%	-1	-2%	T3	CS
Poland	168	134	138	11.1%	-30	-18%	4	3%	T3	D
Portugal	96	22	21	1.7%	-74	-78%	-1	-5%	T3	OTH
Romania	90	34	33	2.7%	-57	-63%	-1	-4%	T1,T3	D,OTH
Slovakia	29	8	8	0.6%	-21	-73%	0	-6%	T3	D
Slovenia	26	5	5	0.4%	-20	-80%	0	0%	M	M
Spain	369	81	83	6.7%	-287	-78%	2	3%	T3	M
Sweden	152	16	14	1.1%	-138	-91%	-2	-11%	M,T2	CS,D
United Kingdom	1 236	92	87	7.0%	-1 149	-93%	-4	-5%	T3	CS
EU-27+UK	**6 827**	**1 262**	**1 236**	**100%**	**-5 591**	**-82%**	**-26**	**-2%**	**-**	**-**
Iceland	6	1	1	0.1%	-4	-73%	0	-1%	T3	D
United Kingdom (KP)	1 244	93	88	7.1%	-1 155	-93%	-4	-5%	T3	CS
EU-KP	**6 839**	**1 265**	**1 239**	**100%**	**-5 600**	**-82%**	**-26**	**-2%**	**-**	**-**

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 2018, CH_4 emissions from gasoline decreased by 86 % in the EU-KP. All countries reported decreasing emissions, apart from Malta (increase by 70 %). Between 2017 and 2018 EU-KP emissions decreased by 3 % (Table 3.68). The largest decreases in per cent were reported by Ireland (-13 %), Sweden and Bulgaria (-11 %).

Table 3.68 1A3b Road Transport, gasoline: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	69	9	9	1.0%	-60	-87%	0	-3%
Belgium	116	12	13	1.5%	-103	-89%	1	7%
Bulgaria	66	7	7	0.8%	-59	-90%	-1	-11%
Croatia	38	24	23	2.7%	-15	-40%	-2	-7%
Cyprus	5	3	3	0.3%	-3	-47%	0	-8%
Czechia	57	18	17	1.9%	-40	-71%	-1	-8%
Denmark	69	8	7	0.9%	-61	-89%	0	-5%
Estonia	21	3	3	0.3%	-18	-87%	0	-3%
Finland	93	7	7	0.8%	-86	-93%	-1	-8%
France	899	85	86	10.1%	-813	-90%	1	1%
Germany	1 614	159	149	17.4%	-1 465	-91%	-10	-6%
Greece	97	53	51	6.0%	-47	-48%	-2	-5%
Hungary	61	16	15	1.8%	-46	-75%	0	-3%
Ireland	44	9	8	0.9%	-36	-82%	-1	-13%
Italy	736	131	125	14.7%	-611	-83%	-6	-5%
Latvia	16	2	2	0.2%	-15	-89%	0	-1%
Lithuania	44	6	6	0.7%	-38	-86%	1	9%
Luxembourg	12	1	1	0.1%	-11	-91%	0	-1%
Malta	3	4	5	0.6%	2	70%	1	13%
Netherlands	156	53	51	6.0%	-106	-68%	-2	-4%
Poland	146	66	67	7.8%	-79	-54%	0	1%
Portugal	83	15	15	1.7%	-68	-82%	-1	-4%
Romania	81	22	21	2.5%	-60	-74%	-1	-4%
Slovakia	21	5	5	0.5%	-16	-78%	0	-6%
Slovenia	24	4	4	0.5%	-20	-83%	0	-4%
Spain	321	59	61	7.2%	-260	-81%	2	3%
Sweden	149	13	12	1.4%	-137	-92%	-1	-11%
United Kingdom	1 149	84	81	9.5%	-1 068	-93%	-3	-3%
EU-27+UK	**6 189**	**880**	**851**	**100%**	**-5 338**	**-86%**	**-29**	**-3%**
Iceland	5	1	1	0.1%	-4	-77%	0	-1%
United Kingdom (KP)	1 155	85	82	9.6%	-1 073	-93%	-3	-3%
EU-KP	**6 201**	**882**	**854**	**100%**	**-5 347**	**-86%**	**-29**	**-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 2018 (Figure 3.120). In Figure **3**.121 the IEF is depicted and the IEF decreased from 40 kg/TJ in 1990 to 10 kg/TJ in 2018. All countries show a similar trend in both the IEF and emission values, which is also linked to the decreasing trend of the corresponding activity data. CH_4 emissions and consequently CH_4 IEF have reduced along the time series due to the introduction of abatement devices on vehicles, in agreement with the legislation emission limits. The increased IEF of Malta for 2018 will be corrected in the next submission.

Figure 3.120 1A3b Road Transport, gasoline: Emission trend and share for CH_4 emission

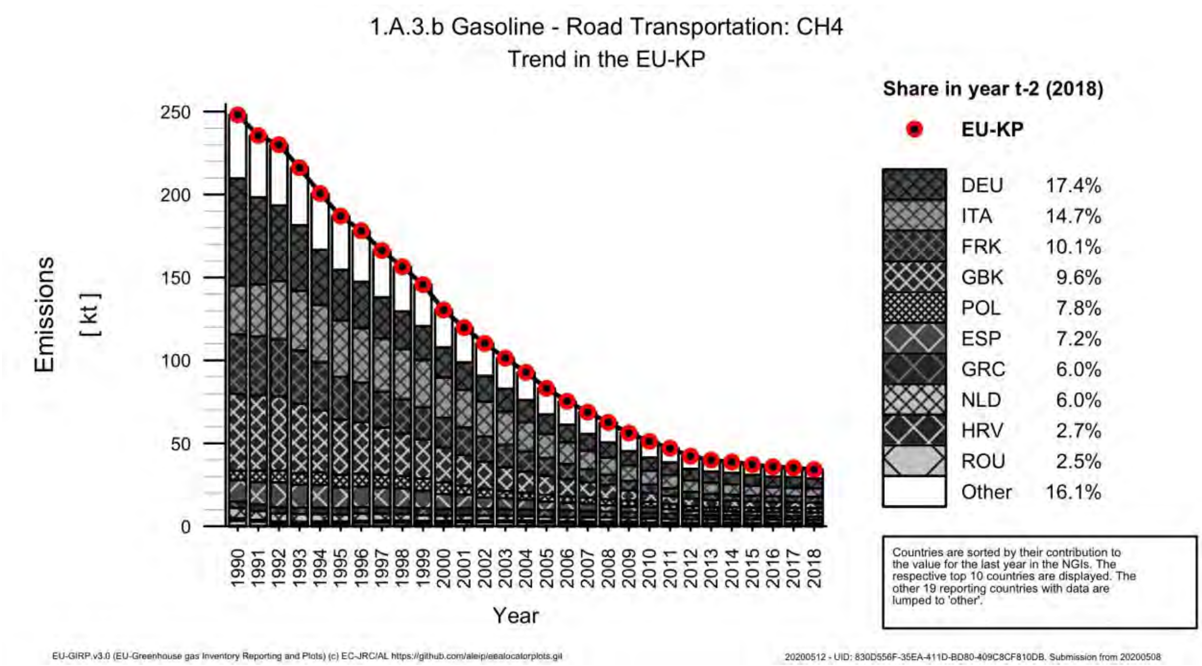
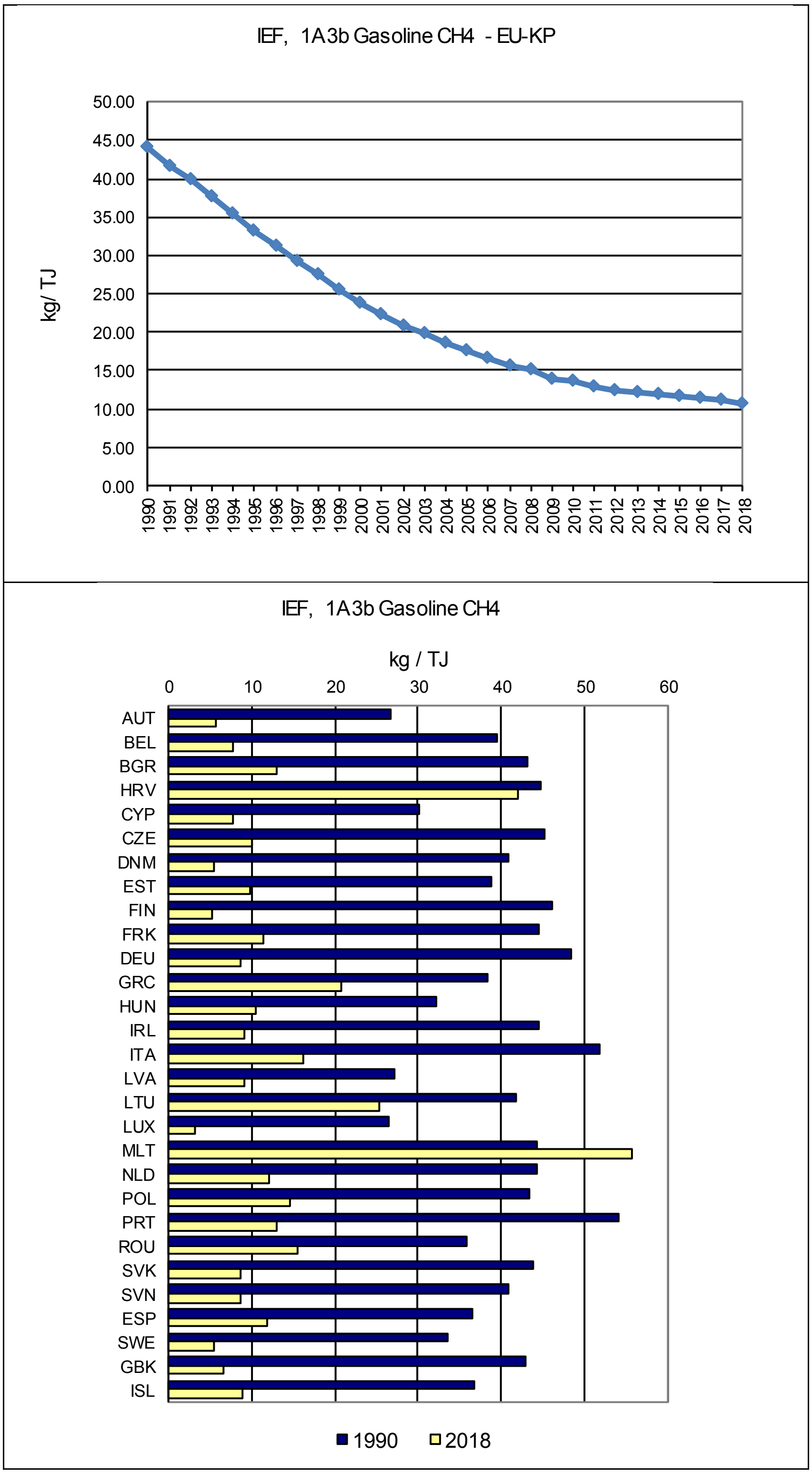


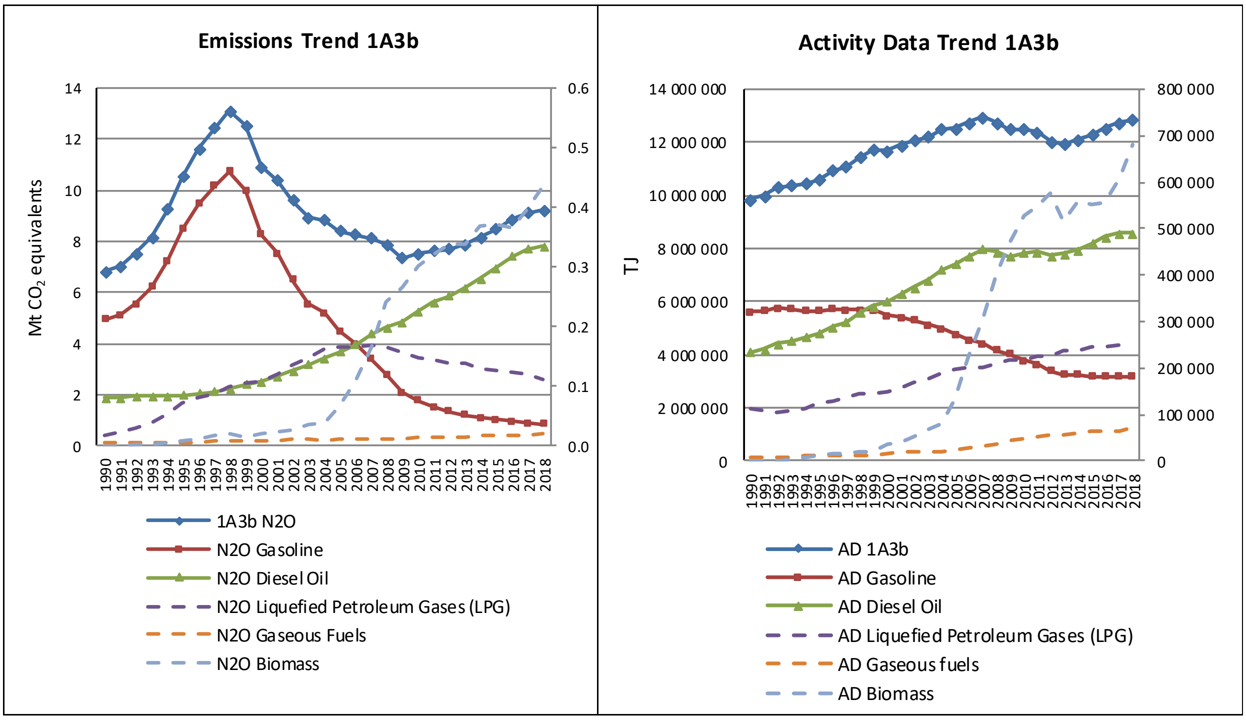
Figure 3.121 1A3b Road Transport, Gasoline: Implied Emission Factors for CH_4 (in kg/TJ)



N_2O emissions from 1A3b Road Transportation

N_2O emissions from 1A3b Road Transportation account for 1% of total EU-KP Transport GHG emissions in 2018. Figure 3.122 gives an overview of the N_2O trend caused by different fuels. The trend is mainly dominated by emissions resulting from diesel oil, LPG and biomass in the recent years.

Figure 3.122   1A3b Road Transport: N_2O Emissions Trend



Data displayed as dashed line refers to the secondary axis.

N_2O emissions increased between 1990 and 2018 by 35 % (Table 3.70). 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-KP 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.). The emission factors included in COPERT are in line with the EMEP/EEA Guidebook 2016 and they decrease for every technology generation (similar approach as the HBEFA).

The treatment of N_2O emission factors in the COPERT model was as follows: N_2O 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 3.69.

Table 3.69: 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	
Version: 5.2.0	Date: August 2018
METHODOLOGY: New L-category vehicles added (ATVs and diesel mini cars) with corresponding CH_4 and N_2O emission factors.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.3.0	Date: September 2019
METHODOLOGY: Corrected CH_4 Hot Emission Factor for PC, LCV vehicles and revised Euro 6 LCV NOx emissions factors.	
Reference: http://emisia.com/products/copert/versions	

Table 3.70 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	106	243	255	2.8%	150	141%	12	5%	T3	CS
Belgium	156	271	268	2.9%	112	71%	-3	-1%	M,T3	CS,M
Bulgaria	54	81	85	0.9%	31	58%	3	4%	T2	CR
Croatia	40	56	54	0.6%	14	35%	-2	-3%	T1,T3	CR,D
Cyprus	24	13	12	0.1%	-11	-47%	0	-1%	T1,T2	D,M
Czechia	100	174	175	1.9%	75	75%	1	1%	T3	M
Denmark	88	130	133	1.4%	45	51%	3	2%	CR,M,T3	CR
Estonia	21	20	21	0.2%	-1	-3%	1	4%	T1,T3	CS,D
Finland	154	79	81	0.9%	-72	-47%	2	3%	T3	CR
France	915	1 501	1 460	15.9%	546	60%	-41	-3%	T3	M
Germany	1 420	1 681	1 676	18.2%	256	18%	-5	0%	CS,M,T2,T3	CS,M
Greece	117	120	122	1.3%	4	4%	2	1%	M,T1	D,M
Hungary	61	125	133	1.4%	72	119%	8	6%	T1,T3	D,M
Ireland	51	112	114	1.2%	64	126%	3	3%	T3	M
Italy	843	874	890	9.7%	47	6%	16	2%	T3	M
Latvia	20	29	30	0.3%	10	47%	0	2%	T1,T2	CR,D,M
Lithuania	43	68	71	0.8%	28	64%	3	5%	T1,T3	CR,D
Luxembourg	15	59	64	0.7%	48	313%	5	8%	T3	M
Malta	2	5	5	0.1%	3	101%	0	-2%	T1,T3	M
Netherlands	98	254	251	2.7%	153	156%	-3	-1%	T1,T2	CS
Poland	174	631	662	7.2%	488	281%	31	5%	T3	D
Portugal	78	144	147	1.6%	69	89%	3	2%	OTH,T3	OTH
Romania	227	180	187	2.0%	-40	-18%	7	4%	T1,T3	D,OTH
Slovakia	56	78	80	0.9%	24	42%	2	3%	T3	D
Slovenia	29	62	68	0.7%	39	138%	5	8%	M	M
Spain	468	885	913	9.9%	445	95%	28	3%	T3	M
Sweden	154	134	138	1.5%	-15	-10%	4	3%	M,T1,T2	CS,D
United Kingdom	1 306	1 093	1 103	12.0%	-203	-16%	11	1%	T3	CR,CS
EU-27+UK	**6 820**	**9 102**	**9 199**	**100%**	**2 379**	**35%**	**97**	**1%**	-	-
Iceland	5	7	8	0.1%	2	48%	0	5%	T3	D
United Kingdom (KP)	1 311	1 096	1 107	12.0%	-204	-16%	11	1%	T3	CR,CS
EU-KP	**6 829**	**9 113**	**9 210**	**100%**	**2 381**	**35%**	**98**	**1%**	-	-

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 85 % of N_2O emissions from 1A3b "Road Transportation" in 2018. Between 1990 and 2018 N_2O emissions from Diesel oil increased in all countries, except for Finland (decrease by 7 %) and Cyprus (decrease by 45 %); within the EU-KP the emission increased by 318 %. The largest increase in absolute terms was reported by France and Germany. Between 2017 and 2018, EU-KP emissions rose by 2 % (Table 3.71).

Table 3.71 1A3b Road Transport, diesel oil: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	12	216	227	2.9%	215	1772%	11	5%
Belgium	59	243	240	3.1%	181	306%	-3	-1%
Bulgaria	13	50	55	0.7%	43	342%	6	12%
Croatia	11	44	43	0.6%	32	284%	-1	-1%
Cyprus	13	7	7	0.1%	-6	-45%	0	1%
Czechia	61	138	141	1.8%	80	133%	4	3%
Denmark	31	109	113	1.4%	82	265%	4	4%
Estonia	7	16	18	0.2%	10	145%	1	7%
Finland	65	57	61	0.8%	-5	-7%	4	7%
France	256	1 270	1 234	15.8%	978	382%	-35	-3%
Germany	143	1 479	1 480	19.0%	1 337	936%	0	0%
Greece	39	59	62	0.8%	23	60%	3	6%
Hungary	21	95	103	1.3%	82	387%	8	8%
Ireland	15	96	101	1.3%	86	568%	5	5%
Italy	344	700	714	9.1%	370	107%	14	2%
Latvia	7	24	25	0.3%	18	257%	1	6%
Lithuania	24	61	64	0.8%	39	162%	3	4%
Luxembourg	3	54	58	0.7%	55	2183%	4	8%
Malta	0	4	3	0.0%	2	613%	-1	-20%
Netherlands	23	195	197	2.5%	174	743%	2	1%
Poland	77	454	478	6.1%	400	518%	23	5%
Portugal	29	112	116	1.5%	86	296%	4	3%
Romania	31	134	143	1.8%	112	364%	9	6%
Slovakia	41	64	67	0.9%	25	60%	3	4%
Slovenia	9	57	59	0.8%	50	571%	2	4%
Spain	195	823	848	10.9%	653	336%	25	3%
Sweden	14	117	123	1.6%	109	805%	6	5%
United Kingdom	321	997	1 014	13.0%	693	216%	17	2%
EU-27+UK	**1 865**	**7 673**	**7 792**	**100%**	**5 927**	**318%**	**120**	**2%**
Iceland	1	5	6	0.1%	5	510%	0	10%
United Kingdom (KP)	322	1 000	1 017	13.0%	694	215%	17	2%
EU-KP	**1 867**	**7 680**	**7 801**	**100%**	**5 933**	**318%**	**120**	**2%**

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 68 % of N_2O emissions from diesel oil in 2018 (Figure 3.123). In Figure 3.125 the IEF is depicted and the EU IEF increased from 1.5 kg/TJ in 1990 to about 3 kg/TJ in 2018. A similar situation, increase in the values of the IEF, is observed for almost all countries. In most cases the IEF is country specific, thus a variation in the values of the IEF through the timeseries is observed. These IEF depend on the vehicle age, on the vehicle size and on driving conditions. Additionally, N_2O IEF for certain categories, such as heavy duty trucks and buses, have been increasing with more recent Euro standards (Euro IV-VI). All the above can lead to increased emission factors over the years.

Figure 3.123 1A3b Road Transport, diesel oil: Emission trend and share for N_2O emission

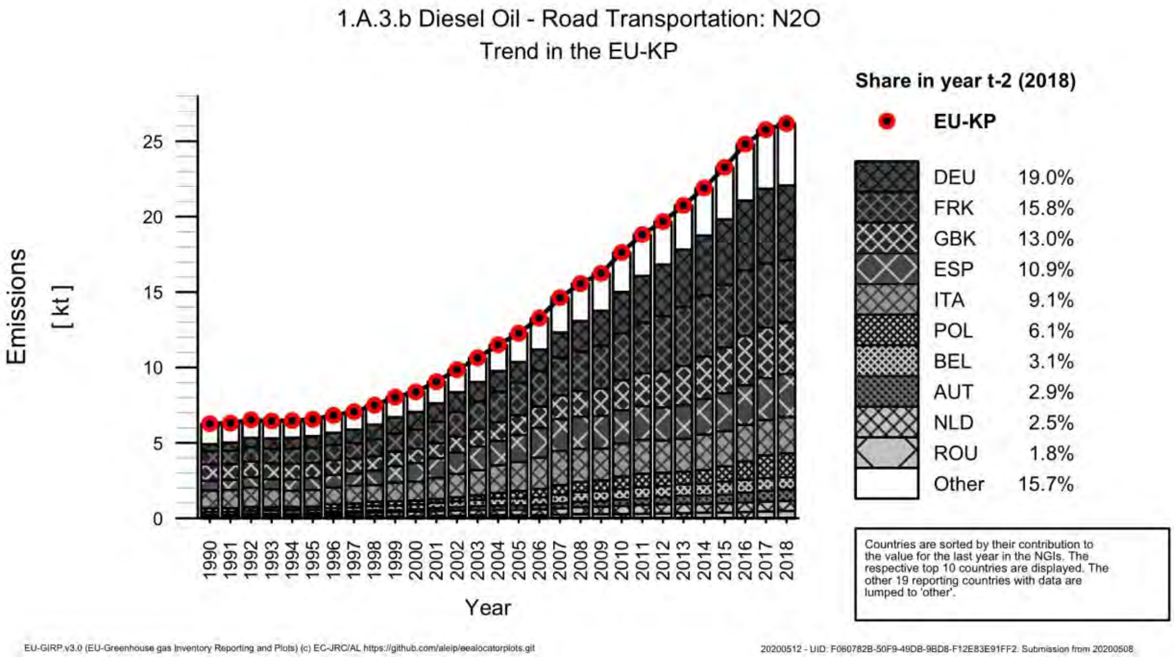
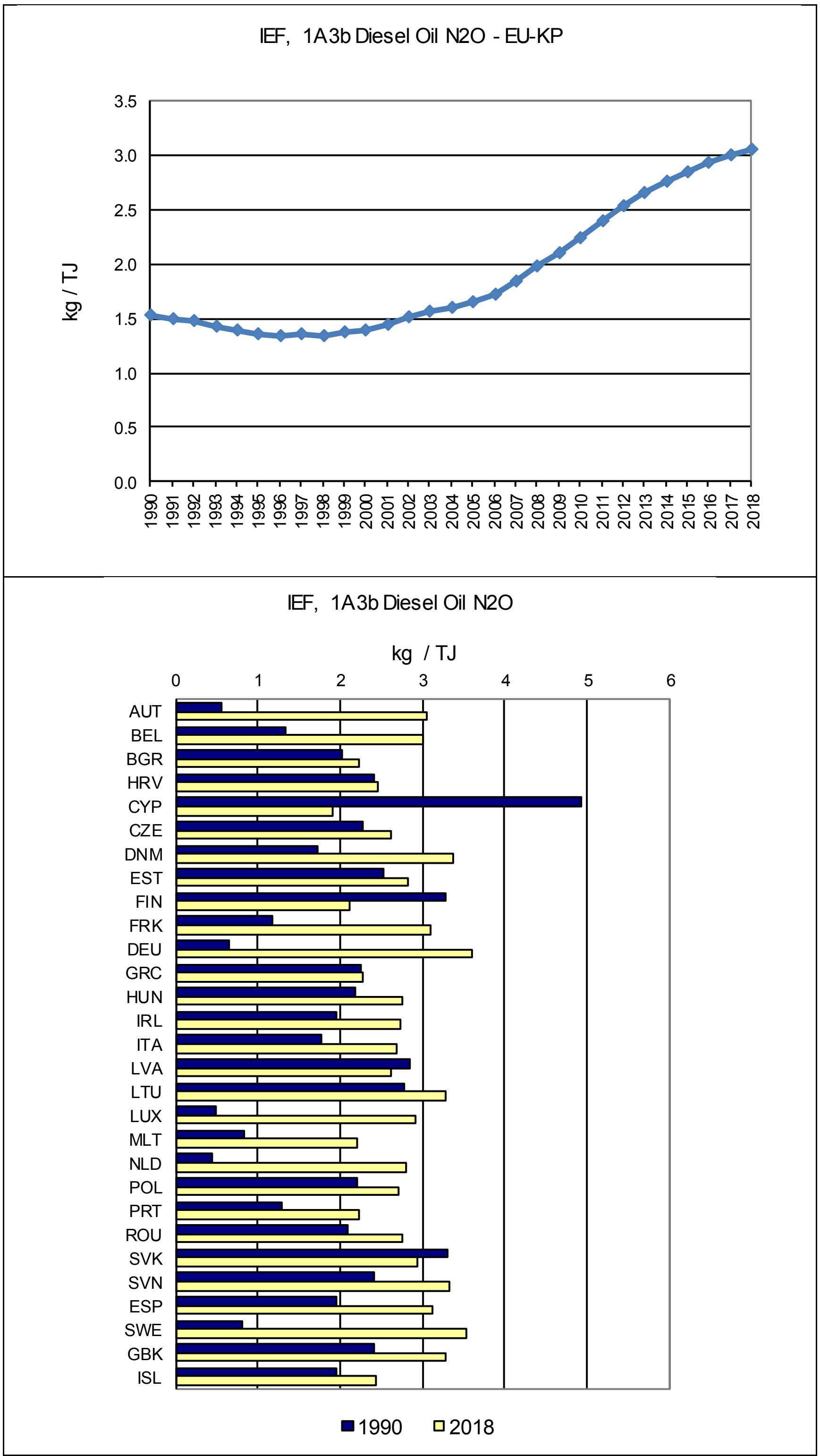


Figure 3.124 1A3b Road Transport, Diesel Oil: Implied Emission Factors for N_2O (in kg/TJ)



1A3b Road Transportation – Gasoline (N_2O)

N_2O emissions from Gasoline account for 9 % of N_2O emissions from 1A3b Road Transportation in 2018. Between 1990 and 2018, N_2O emissions from gasoline decreased by 83 % in the EU-KP 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 2017 and 2018, almost all countries (except for Belgium, Lithuania, Luxembourg, Malta, Slovenia and Spain), showed a decreasing trend. The EU-KP total N_2O emissions dropped by 6 % (Table 3.72).

Table 3.72 1A3b Road Transport, gasoline: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	93	11	10	1.2%	-83	-89%	-1	-5%
Belgium	97	10	11	1.3%	-87	-89%	0	2%
Bulgaria	41	11	10	1.2%	-31	-76%	-1	-12%
Croatia	29	10	9	1.1%	-20	-69%	-1	-10%
Cyprus	10	5	5	0.6%	-5	-52%	0	-4%
Czechia	39	23	21	2.5%	-19	-48%	-2	-10%
Denmark	57	13	12	1.4%	-45	-80%	-1	-10%
Estonia	14	3	3	0.4%	-11	-78%	0	-10%
Finland	88	13	12	1.5%	-76	-86%	-1	-9%
France	659	105	100	12.0%	-559	-85%	-5	-5%
Germany	1 277	113	102	12.2%	-1 176	-92%	-11	-10%
Greece	78	51	49	5.9%	-29	-37%	-1	-2%
Hungary	39	24	22	2.7%	-17	-44%	-1	-5%
Ireland	35	11	9	1.0%	-27	-76%	-2	-20%
Italy	494	104	100	12.1%	-394	-80%	-3	-3%
Latvia	12	3	2	0.2%	-10	-84%	-1	-33%
Lithuania	19	5	6	0.7%	-13	-68%	1	12%
Luxembourg	13	2	2	0.2%	-11	-87%	0	4%
Malta	2	1	2	0.3%	0	0%	1	40%
Netherlands	58	48	38	4.5%	-20	-35%	-10	-21%
Poland	96	95	92	11.1%	-4	-5%	-3	-3%
Portugal	49	25	23	2.8%	-26	-53%	-2	-7%
Romania	196	29	27	3.3%	-169	-86%	-2	-5%
Slovakia	15	7	7	0.8%	-8	-56%	-1	-9%
Slovenia	20	1	2	0.2%	-18	-92%	0	18%
Spain	273	54	55	6.6%	-218	-80%	0	1%
Sweden	140	13	11	1.4%	-128	-92%	-2	-13%
United Kingdom	985	95	89	10.7%	-896	-91%	-6	-6%
EU-27+UK	**4 931**	**885**	**829**	**100%**	**-4 101**	**-83%**	**-55**	**-6%**
Iceland	4	2	2	0.2%	-3	-62%	0	-6%
United Kingdom (KP)	988	96	90	10.8%	-898	-91%	-6	-6%
EU-KP	**4 938**	**887**	**832**	**100%**	**-4 107**	**-83%**	**-55**	**-6%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

France, Germany, Italy, Spain and the United Kingdom accounted for 54 % of N_2O emissions (Figure **3.126**). In Figure 3.125 the IEF is depicted and it is clear that high variability exists for all countries through the whole time series.

Figure 3.126 1A3b Road Transport, Gasoline: Emission trend and share for N_2O emissions

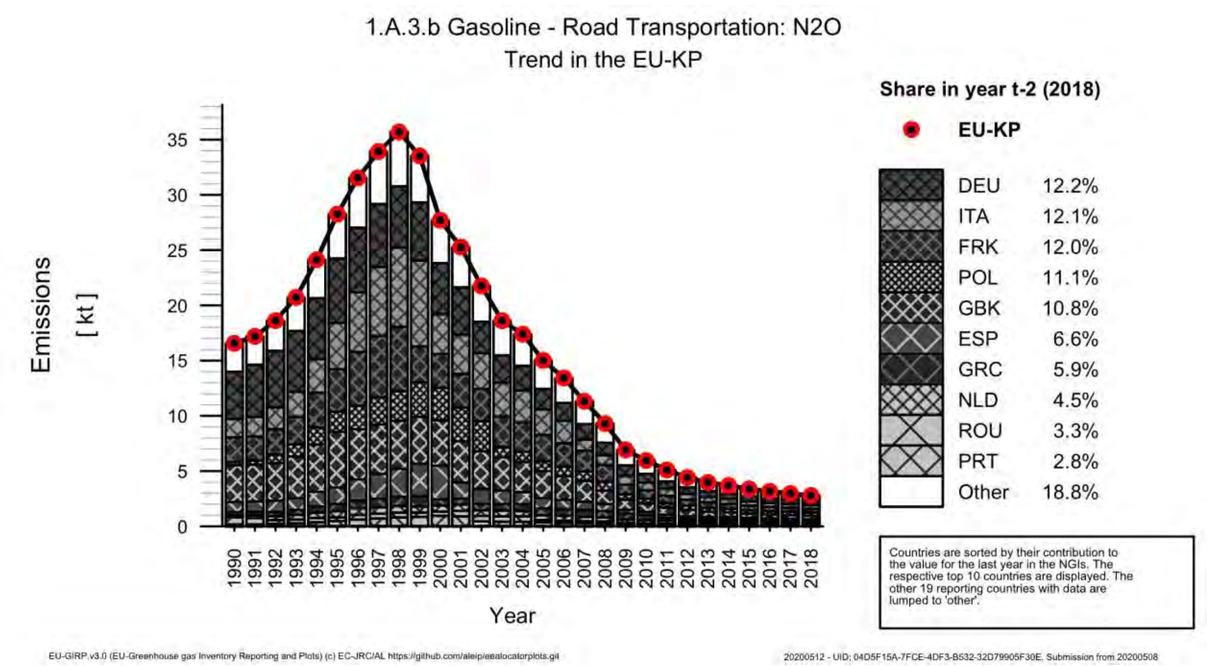
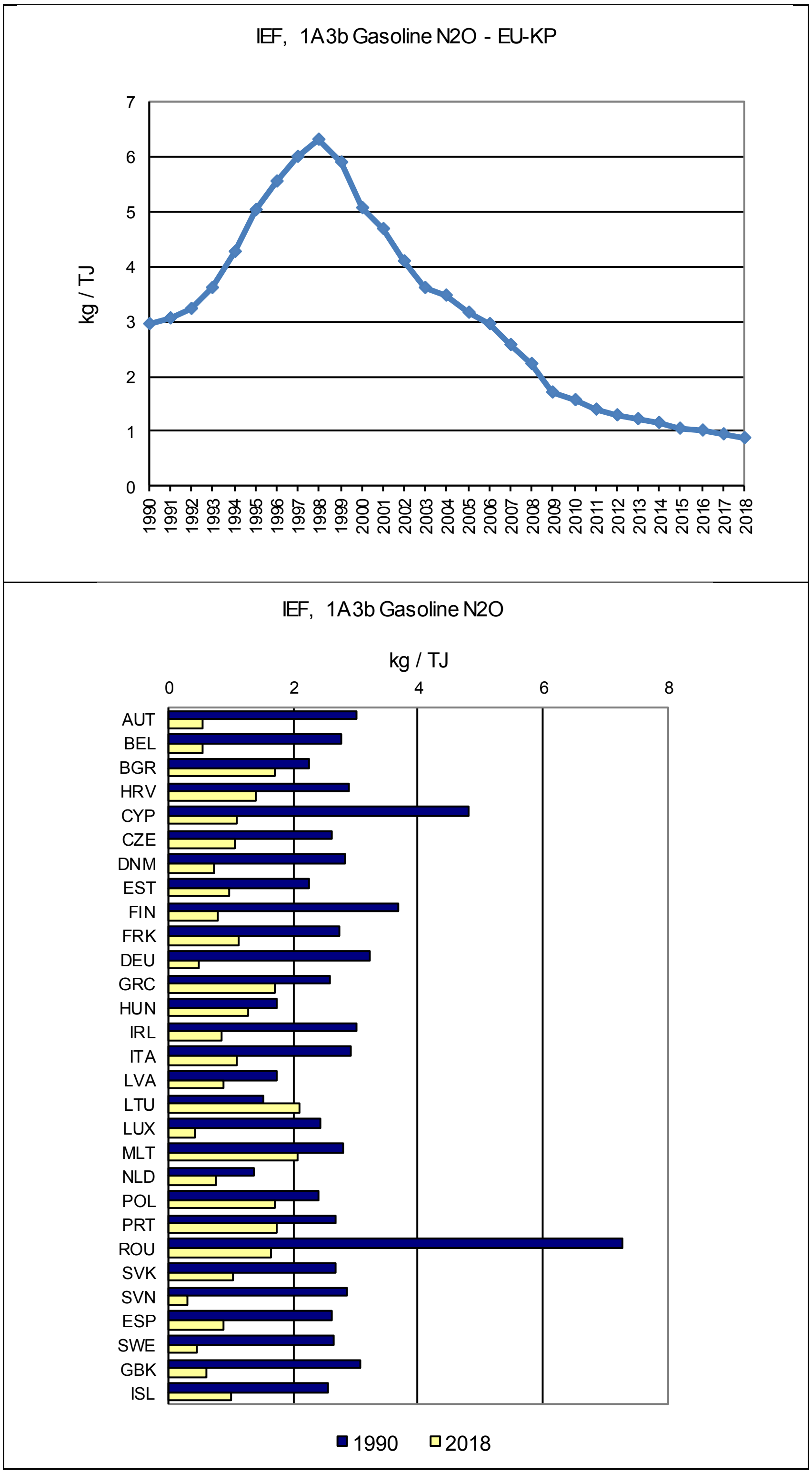


Figure 3.127 1A3b Road Transport, Gasoline: Implied Emission Factors for N_2O (in kg/TJ)

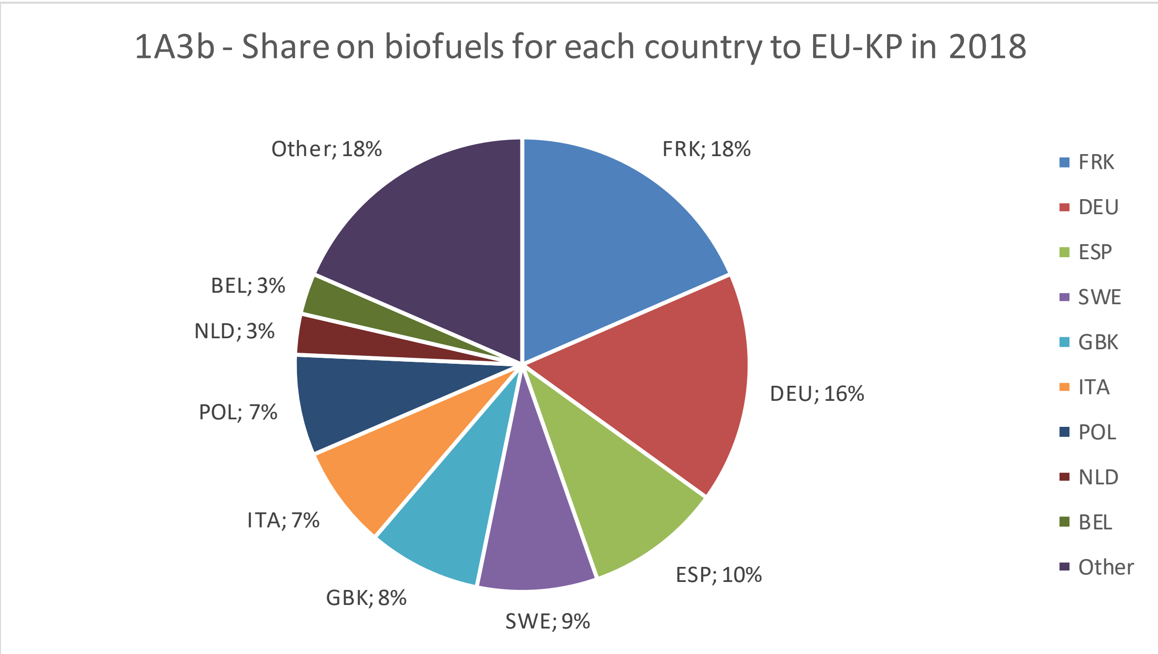


1A3b Road Transportation – Activity Data Biofuels

According to the European Directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EG), countries 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. Countries 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.

Figure 3.128 shows the share on biofuels for each country to EU-KP in 2018. In this figure only the 9 countries, which contribute the most, are presented, whereas all remaining countries are presented together in category "Other" in this figure. France reports most of total amount of biofuels (18 % of total EU-KP activity in 2018), followed by Germany (16 %). All countries report biofuels activity under 1A3b for 2018.

Figure 3.128 1A3b Road Transport, Biofuels: Share on biofuels for each country



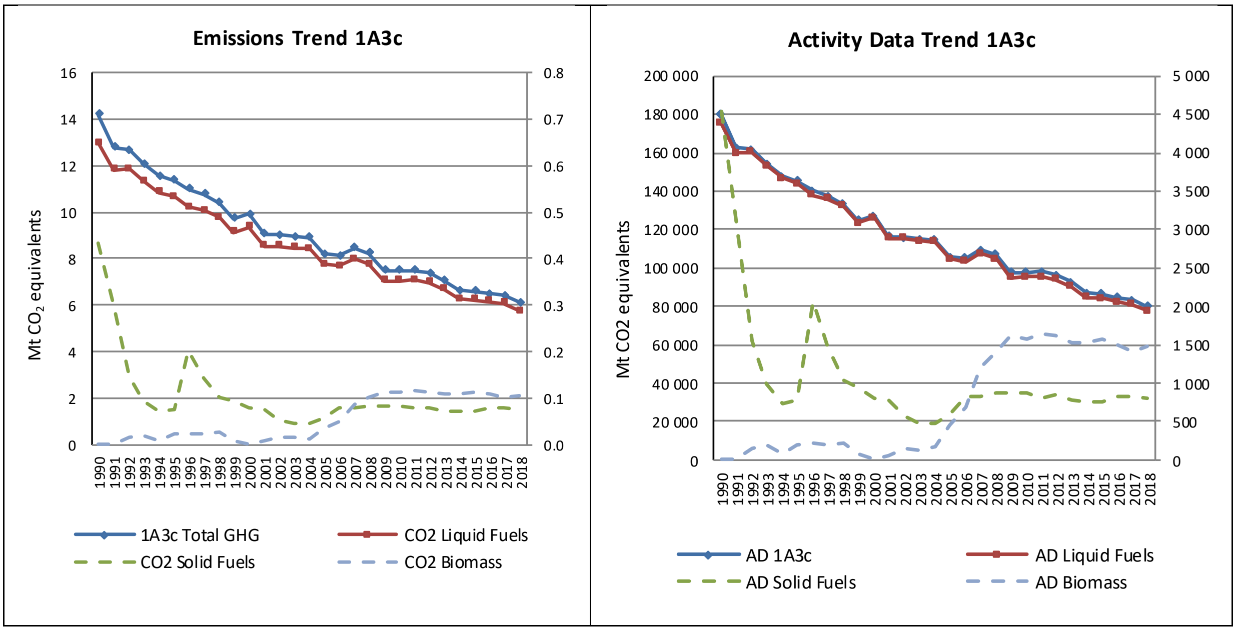
Based on information collected from NIRs, all countries report emissions from lubricants combusted in two-stroke engines under the transport category. Exceptions are Austria, which mentions that "Lubricants used for 2-stroke engines were not estimated, as there are hardly any 2-stroke engines in use in Austria", Finland, which states that "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 aggregation and allocation should not result in an over- or underestimation of the emissions" and Iceland, which mentions "Currently available activity data does not allow to separate lubricants mixed in with other fuel in 2-stroke engines from lubricants used for their lubricating properties, however the amount of lubricant used as 2-stroke engine fuel is likely to be very small. Thus, we attribute all emissions from lubricants to this category (2D1), and none to combustion in the energy sector.

3.2.3.3 **Railways (1A3c) (EU-KP)**

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 0.14 % of total EU-KP GHG emissions in 2018. Between 1990 and 2018, CO_2 emissions from rail transportation decreased by 56 % in the EU-KP. The total trend is dominated by CO_2 emissions from liquid fuels (Figure 3.129). The emissions from this key category are due to fossil fuel consumption in rail transport, which decreased by 56 % between 1990 and 2018.

Figure 3.129 1A3c Railways: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The countries, France, Germany, Spain and the United Kingdom contributed most to the emissions from this source (56 %). Between 1990 and 2018, Germany had by far the highest decreases in absolute terms (Table 3.73).

Table 3.73 1A3c Railways: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	178	116	93	1.6%	-85	-48%	-24	-20%	T1,T2	CS,D
Belgium	222	78	76	1.3%	-146	-66%	-2	-2%	T3	CS,D
Bulgaria	323	42	34	0.6%	-289	-89%	-7	-18%	T1	D
Croatia	140	56	47	0.8%	-94	-67%	-9	-16%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	281	276	4.7%	-492	-64%	-5	-2%	T1	D
Denmark	297	244	224	3.8%	-73	-25%	-20	-8%	CR,T2	CS
Estonia	154	50	25	0.4%	-129	-84%	-25	-51%	T2	CS
Finland	191	63	63	1.1%	-129	-67%	-1	-1%	T2	CS
France	1 078	409	408	7.0%	-670	-62%	-1	0%	T1	OTH
Germany	2 901	874	846	14.5%	-2 055	-71%	-28	-3%	CS,M,T1	CS,D,M
Greece	199	122	116	2.0%	-83	-42%	-6	-5%	T1,T2	CS
Hungary	533	133	133	2.3%	-400	-75%	0	0%	T2	CS
Ireland	133	116	117	2.0%	-16	-12%	1	1%	T2	CS
Italy	613	104	138	2.4%	-475	-77%	35	33%	T2	CS
Latvia	537	164	167	2.9%	-370	-69%	3	2%	T1,T2	CS,D
Lithuania	350	165	187	3.2%	-163	-47%	21	13%	T1,T2	CS,D
Luxembourg	25	7	7	0.1%	-18	-72%	0	6%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	88	84	69	1.2%	-19	-22%	-15	-18%	T2	CS
Poland	1 624	268	322	5.5%	-1 301	-80%	54	20%	T1	D
Portugal	177	31	30	0.5%	-147	-83%	-1	-3%	T1	D
Romania	452	371	280	4.8%	-172	-38%	-90	-24%	T1,T2	CS,D
Slovakia	372	84	83	1.4%	-289	-78%	-1	-2%	T1	D
Slovenia	65	29	26	0.5%	-39	-60%	-3	-9%	T1	D
Spain	422	244	252	4.3%	-170	-40%	8	3%	T1	D
Sweden	101	41	44	0.8%	-57	-56%	3	7%	T2	CS
United Kingdom	1 472	1 965	1 774	30.4%	302	21%	-191	-10%	T1,T2	CS
EU-27+UK	**13 416**	**6 141**	**5 837**	**100%**	**-7 578**	**-56%**	**-304**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 472	1 965	1 774	30.4%	302	21%	-191	-10%	T1,T2	CS
EU-KP	**13 416**	**6 141**	**5 837**	**100%**	**-7 578**	**-56%**	**-304**	**-5%**	**-**	**-**

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 2018, CO_2 emissions from liquid fuels decreased by 56 % in the EU-KP. Between 2017 and 2018, EU-KP emissions decreased by 5 % (Table 3.74).

Table 3.74 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	171	116	92	1.6%	-79	-46%	-24	-20%	T2	CS
Belgium	222	78	76	1.3%	-146	-66%	-2	-2%	T3	CS,D
Bulgaria	323	42	34	0.6%	-289	-89%	-7	-18%	T1	D
Croatia	119	56	47	0.8%	-72	-61%	-9	-16%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	277	274	4.8%	-494	-64%	-3	-1%	T1	D
Denmark	297	244	224	3.9%	-73	-25%	-20	-8%	CR,T2	CS
Estonia	143	50	25	0.4%	-118	-83%	-25	-51%	T2	CS
Finland	191	63	63	1.1%	-129	-67%	-1	-1%	T2	CS
France	1 078	408	407	7.1%	-672	-62%	-1	0%	T1	OTH
Germany	2 847	840	811	14.1%	-2 036	-71%	-28	-3%	CS,M	CS,M
Greece	199	122	116	2.0%	-83	-42%	-6	-5%	T2	CS
Hungary	528	133	133	2.3%	-395	-75%	0	0%	T2	CS
Ireland	133	116	117	2.0%	-16	-12%	1	1%	T2	CS
Italy	613	104	138	2.4%	-475	-77%	35	33%	T2	CS
Latvia	537	164	167	2.9%	-370	-69%	3	2%	T2	CS
Lithuania	350	165	187	3.2%	-163	-47%	21	13%	T1,T2	CS,D
Luxembourg	25	7	7	0.1%	-18	-72%	0	6%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	88	84	69	1.2%	-20	-22%	-15	-18%	T2	CS
Poland	1 319	268	322	5.6%	-997	-76%	54	20%	T1	D
Portugal	177	31	30	0.5%	-147	-83%	-1	-3%	T1	D
Romania	420	371	280	4.9%	-139	-33%	-90	-24%	T1,T2	CS,D
Slovakia	372	84	83	1.4%	-289	-78%	-1	-2%	T1	D
Slovenia	65	28	26	0.4%	-39	-60%	-3	-9%	T1	D
Spain	422	244	252	4.4%	-170	-40%	8	3%	T1	D
Sweden	101	41	44	0.8%	-57	-56%	3	7%	T2	CS
United Kingdom	1 472	1 924	1 733	30.1%	261	18%	-191	-10%	T2	CS
EU-27+UK	**12 981**	**6 059**	**5 756**	**100%**	**-7 225**	**-56%**	**-302**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 472	1 924	1 733	30.1%	261	18%	-191	-10%	T2	CS
EU-KP	**12 981**	**6 059**	**5 756**	**100%**	**-7 225**	**-56%**	**-302**	**-5%**	**-**	**-**

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 62 % of CO_2 emissions from liquid fuels in 2018 (Figure 3.131).

Table 3.74 shows that the majority of CO_2 emissions from the combustion of liquid fuels in railways were calculated using a higher tier method (74.3%). From the calculation of the higher tier methods, countries 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 3.130 the IEF is depicted where the mean value is around 74 t/TJ. In 2016 and 2017 the IEF showed a slight increase, mainly due to the increased value of the IEF of Romania. The fluctuations in the IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined.

Figure 3.131 1A3c Railways, Liquid Fuels: Emission trend and share for CO_2

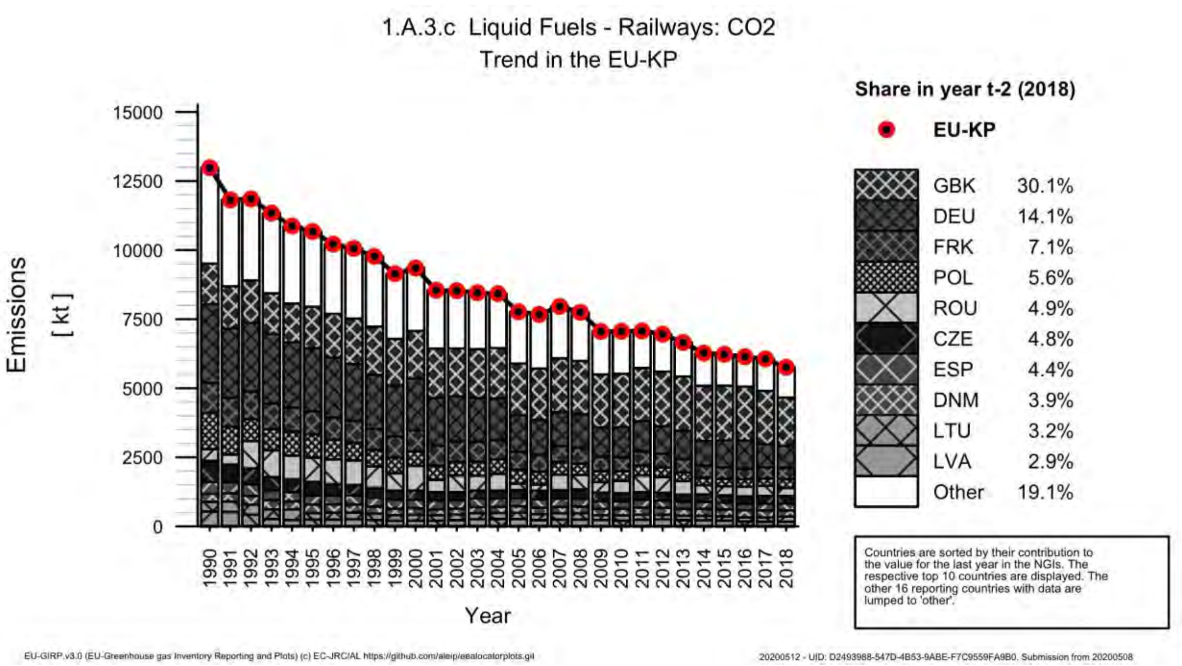
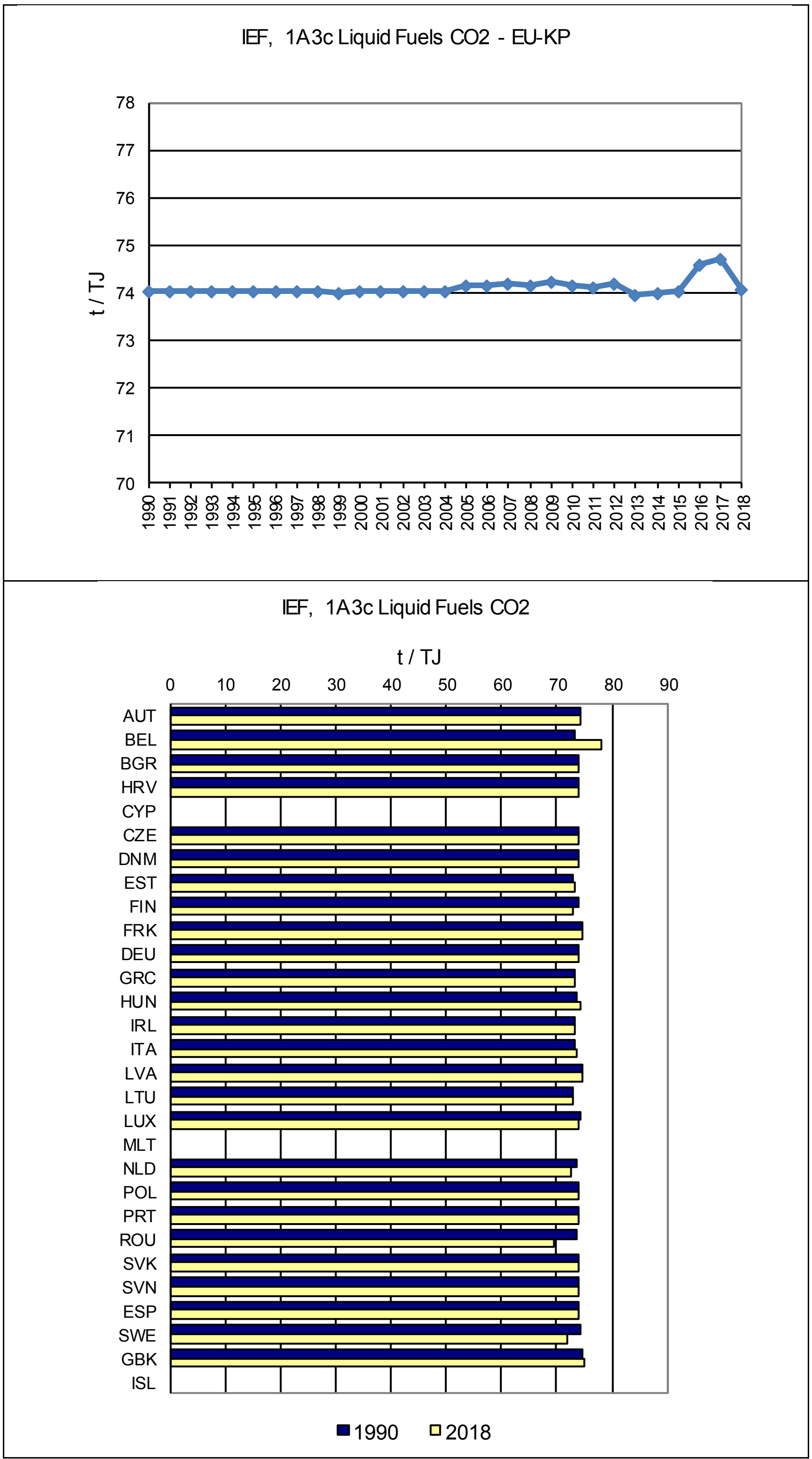


Figure 3.132 1A3c Railways, Liquid Fuels: Implied Emission Factors for CO_2 (in t/TJ)

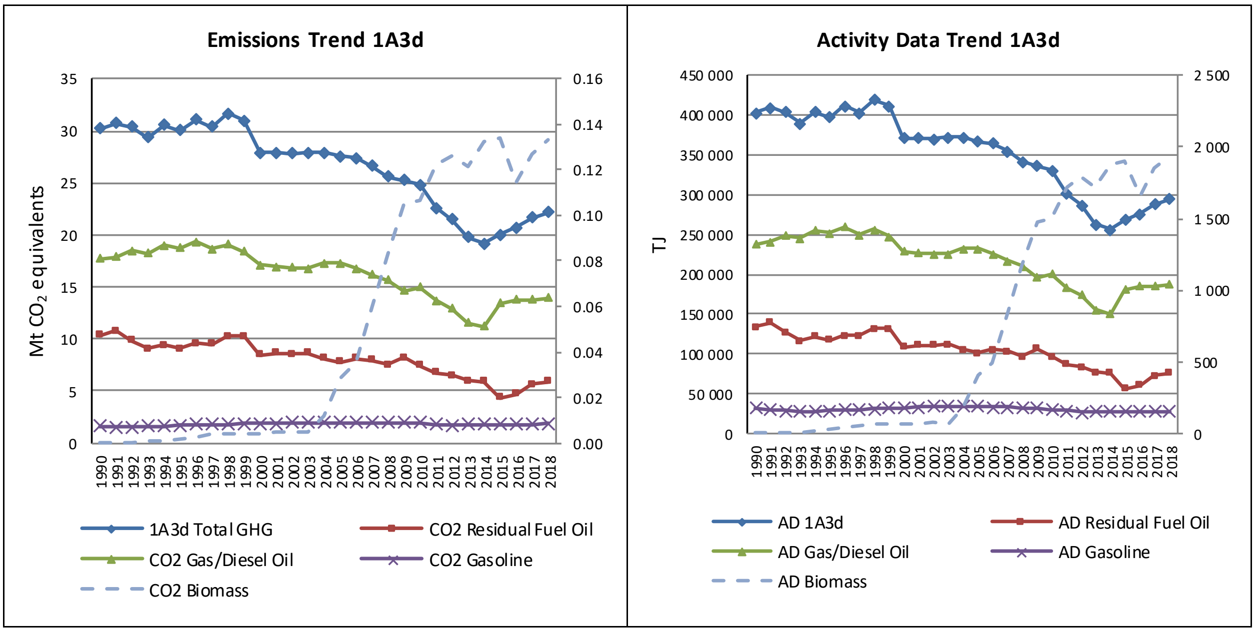


3.2.3.4 **Domestic Navigation (1A3d) (EU-KP)**

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 0.51 % of total EU-KP GHG emissions in 2018. Between 1990 and 2018, CO_2 emissions from navigation decreased by 27 % in the EU-KP (Table 3.75). 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 3.133).

Figure 3.133 1A3d Domestic Navigation: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

Five countries (Germany, Greece, Italy, Spain and the United Kingdom) contributed the most to the emissions from this source (75 %). Most countries (17 in total) had decreasing emissions from navigation between 1990 and 2018. The countries with the highest decreases in absolute terms were Germany, United Kingdom and Spain (Table 3.75).

Table 3.75 1A3d Domestic Navigation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	15	10	10	0.0%	-5	-35%	0	-1%	T1,T2	CS,D
Belgium	362	403	401	1.8%	40	11%	-2	0%	T1,T3	CS,D
Bulgaria	56	7	7	0.0%	-50	-88%	0	0%	T1	D
Croatia	134	140	149	0.7%	15	11%	9	7%	T1	D
Cyprus	2	2	2	0.0%	0	-2%	0	4%	T1	D
Czechia	54	13	10	0.0%	-44	-82%	-3	-25%	T1	D
Denmark	714	631	621	2.9%	-93	-13%	-9	-2%	CR,M,T2	CS
Estonia	22	17	16	0.1%	-6	-29%	-2	-11%	T2	CS
Finland	441	420	419	1.9%	-23	-5%	-1	0%	T2	CS
France	1 023	1 287	1 293	5.9%	270	26%	5	0%	T1	CS
Germany	3 645	1 661	1 690	7.8%	-1 955	-54%	29	2%	CS,T1	CS,D,M
Greece	1 809	1 844	2 000	9.2%	191	11%	157	8%	T1	CS
Hungary	209	16	16	0.1%	-193	-92%	0	0%	T1	D
Ireland	85	233	258	1.2%	173	203%	25	11%	T2	CS
Italy	5 470	3 915	4 052	18.6%	-1 418	-26%	137	4%	T1,T2	CS
Latvia	1	14	20	0.1%	19	1910%	6	42%	T1,T2	CS,D
Lithuania	15	17	15	0.1%	-1	-5%	-2	-13%	T1	CS
Luxembourg	1	1	1	0.0%	0	-14%	0	-2%	T1,T2	CS,D
Malta	25	70	92	0.4%	67	272%	22	31%	T1,T3	CS,D
Netherlands	743	987	987	4.5%	244	33%	0	0%	T2	CS
Poland	151	22	11	0.1%	-139	-92%	-10	-47%	T1	D
Portugal	263	268	263	1.2%	0	0%	-5	-2%	T2	D
Romania	1 151	131	122	0.6%	-1 029	-89%	-9	-7%	T2	CS
Slovakia	0	5	3	0.0%	3	11269%	-2	-45%	T1	D
Slovenia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Spain	5 214	3 035	3 129	14.4%	-2 086	-40%	94	3%	T1	D
Sweden	443	677	725	3.3%	282	64%	47	7%	T2	CS
United Kingdom	7 536	5 306	5 331	24.5%	-2 205	-29%	26	0%	T2	CS
EU-27+UK	**29 584**	**21 131**	**21 641**	**99%**	**-7 943**	**-27%**	**510**	**2%**	**-**	**-**
Iceland	60	32	43	0.2%	-16	-28%	12	37%	T1	D
United Kingdom (KP)	7 608	5 440	5 410	24.9%	-2 198	-29%	-30	-1%	T2	CS
EU-KP	**29 717**	**21 297**	**21 763**	**100%**	**-7 953**	**-27%**	**466**	**2%**	**-**	**-**

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 27 % of CO_2 emissions from 1A3d Navigation in 2018. Between 1990 and 2018, CO_2 emissions from residual fuel oil decreased by 43 % in the EU-KP. The countries with the highest decrease in absolute terms were Romania, United Kingdom and Germany. 17 countries reported emissions as 'Not Occurring' (Table 3.76) for 2018, 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 3.76 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		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
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	357	136	118	2.0%	-239	-67%	-18	-13%	CR,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	123	34	34	0.6%	-89	-73%	0	0%	T2	CS
France	159	51	56	1.0%	-103	-65%	5	10%	T1	CS
Germany	935	1	23	0.4%	-912	-98%	22	3887%	CS	CS,M
Greece	746	1 045	1 146	19.4%	401	54%	102	10%	T1	CS
Hungary	3	NO	NO	-	-3	-100%	-	-	NA	NA
Ireland	63	NO	NO	-	-63	-100%	-	-	NA	NA
Italy	2 576	1 741	1 771	30.0%	-805	-31%	30	2%	T1,T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	5	NO	NO	-	-5	-100%	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	70	NO	NO	-	-70	-100%	-	-	NA	NA
Portugal	190	194	190	3.2%	0	0%	-4	-2%	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	1 254	1 596	1 596	27.0%	342	27%	0	0%	T1	D
Sweden	239	197	392	6.6%	152	64%	194	98%	T2	CS
United Kingdom	2 581	566	542	9.2%	-2 038	-79%	-23	-4%	T2	CS
EU-27+UK	**10 331**	**5 559**	**5 867**	**99%**	**-4 464**	**-43%**	**308**	**6%**	**-**	**-**
Iceland	22	NO	16	0.3%	-6	-27%	16	∞	T1	D
United Kingdom (KP)	2 599	645	567	9.6%	-2 032	-78%	-78	-12%	T2	CS
EU-KP	**10 372**	**5 639**	**5 908**	**100%**	**-4 464**	**-43%**	**270**	**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 76 % of CO_2 emissions from residual fuel oil in 2018 (Figure 3.135).

Table **3.76** shows that the majority of CO_2 emissions from the combustion of residual fuel oil in navigation were calculated using a higher tier method (71%). Spain was 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 and Greece also includes in the NIR that country specific EF for CO_2 emissions were used. In Figure 3.134 the IEF is depicted where the mean value is around 78 t/TJ.

Figure 3.135 1A3d Navigation, Residual Fuel Oil: Emission trend and share for CO_2

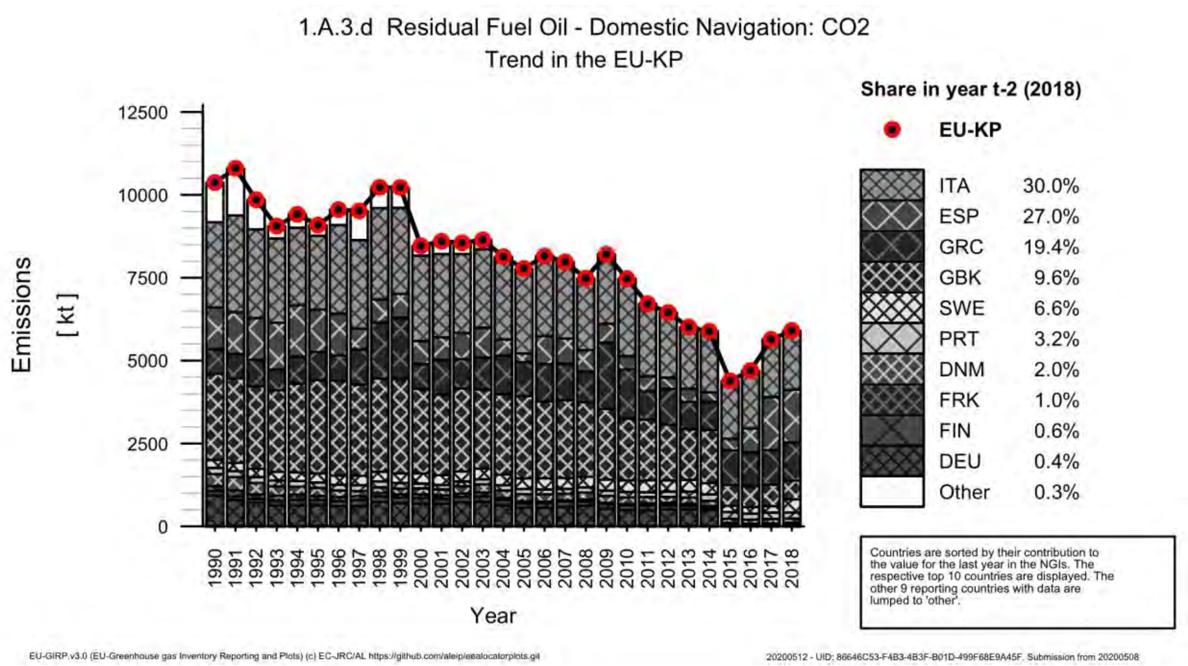
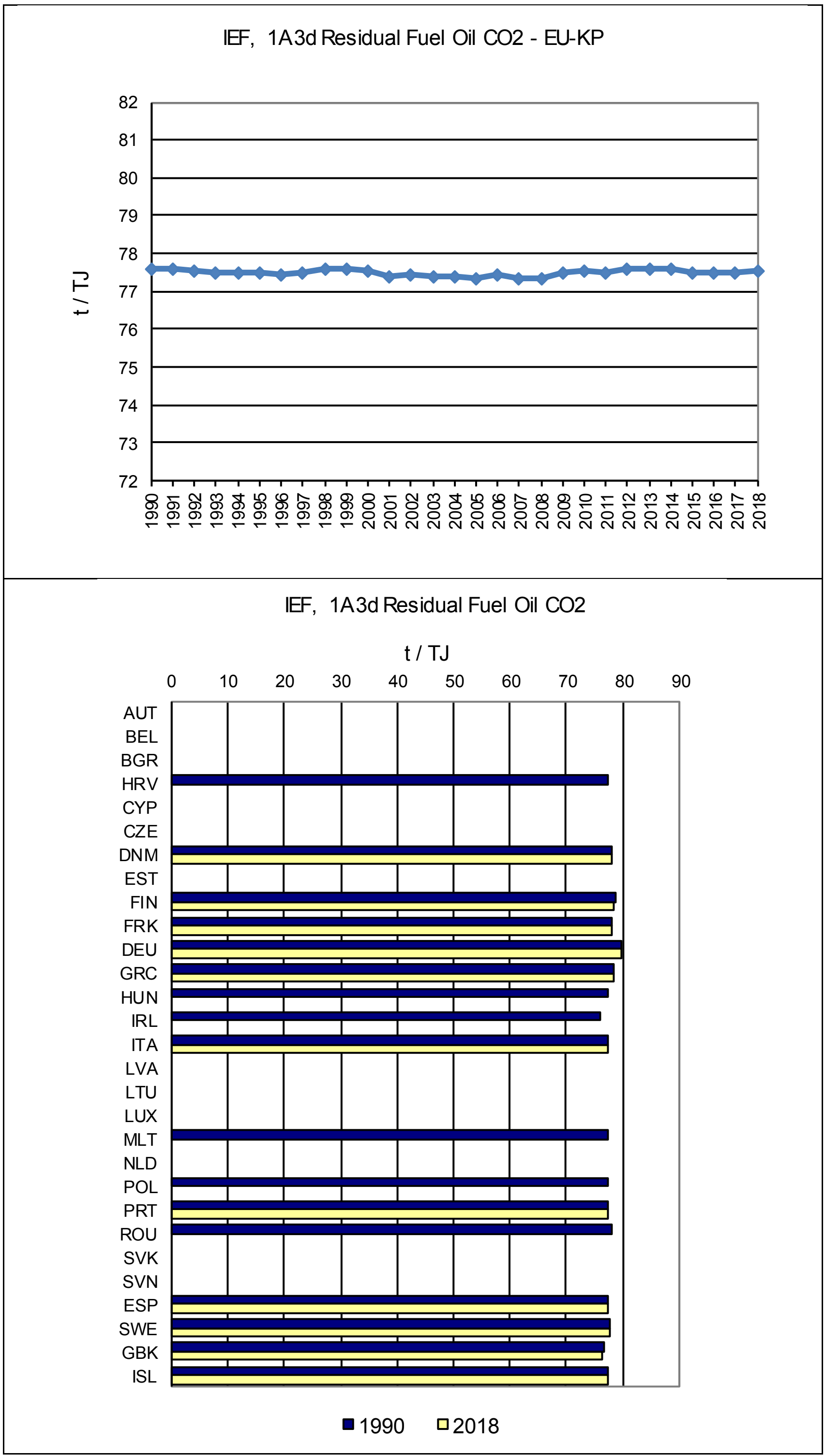


Figure 3.136 1A3d Navigation, Residual Fuel Implied Emission Factors for CO_2 (in t/TJ)



1A3d Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from Gas/Diesel oil account for 64 % of CO_2 emissions from 1A3d Navigation in 2018 (Table 3.77). The CO_2 emissions from Gas/Diesel oil decreased by 21 % between 1990 and 2018.

Table 3.77 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			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	5	3	3	0.0%	-3	-48%	0	-3%	T2	CS
Belgium	362	403	401	2.9%	40	11%	-2	0%	T1,T3	CS,D
Bulgaria	56	7	7	0.0%	-50	-88%	0	0%	T1	D
Croatia	128	140	149	1.1%	22	17%	9	7%	T1	D
Cyprus	2	2	2	0.0%	0	-2%	0	4%	T1	D
Czechia	54	13	10	0.1%	-44	-82%	-3	-25%	T1	D
Denmark	358	490	498	3.6%	141	39%	8	2%	CR,M,T2	CS
Estonia	22	17	16	0.1%	-6	-29%	-2	-11%	T2	CS
Finland	186	259	258	1.8%	71	38%	-1	0%	T2	CS
France	327	360	368	2.6%	41	13%	8	2%	T1	CS
Germany	2 710	1 658	1 665	11.9%	-1 045	-39%	7	0%	CS	CS,M
Greece	1 063	799	854	6.1%	-209	-20%	55	7%	T1	CS
Hungary	28	16	16	0.1%	-13	-44%	0	0%	T1	D
Ireland	22	233	258	1.8%	235	1059%	25	11%	T2	CS
Italy	2 326	1 855	1 962	14.1%	-364	-16%	107	6%	T1,T2	CS
Latvia	1	14	20	0.1%	19	2298%	6	44%	T2	CS
Lithuania	15	17	15	0.1%	-1	-5%	-2	-13%	T1	CS
Luxembourg	1	1	1	0.0%	0	0%	0	-2%	T2	CS
Malta	19	69	90	0.6%	71	365%	21	31%	T1,T3	CS,D
Netherlands	698	922	922	6.6%	224	32%	1	0%	T2	CS
Poland	81	22	11	0.1%	-70	-86%	-10	-47%	T1	D
Portugal	73	75	73	0.5%	0	0%	-2	-2%	T2	D
Romania	125	130	120	0.9%	-5	-4%	-10	-8%	T2	CS
Slovakia	0	5	3	0.0%	3	11250%	-2	-46%	T1	D
Slovenia	IE	IE	IE	-	-	-	-	-	NA	NA
Spain	3 960	1 439	1 533	11.0%	-2 427	-61%	94	7%	T1	D
Sweden	127	346	199	1.4%	72	57%	-147	-42%	T2	CS
United Kingdom	4 851	4 384	4 423	31.7%	-428	-9%	39	1%	T2	CS
EU-27+UK	**17 600**	**13 677**	**13 876**	**99%**	**-3 724**	**-21%**	**198**	**1%**	**-**	**-**
Iceland	37	32	27	0.2%	-10	-28%	-5	-14%	T1	D
United Kingdom (KP)	4 905	4 439	4 477	32.1%	-428	-9%	38	1%	T2	CS
EU-KP	**17 692**	**13 763**	**13 957**	**100%**	**-3 735**	**-21%**	**193**	**1%**	**-**	**-**

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 2018 (Figure 3.138).

Table 3.77 shows that the majority of CO_2 emissions from the combustion of gas/diesel oil in navigation were calculated using a higher tier method (84%). Spain was 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 and Greece also includes in the NIR that country specific EF for CO_2 emissions were used. In Figure 3.137 the IEF is depicted where the mean value is around 74 t/TJ. It should be noted that Slovenia reported emission as "Included elsewere" and more specifically under Road transport, since no separate data are available.

Figure 3.138 1A3d Navigation, Gas/Diesel Oil: Emission trend and share for CO_2

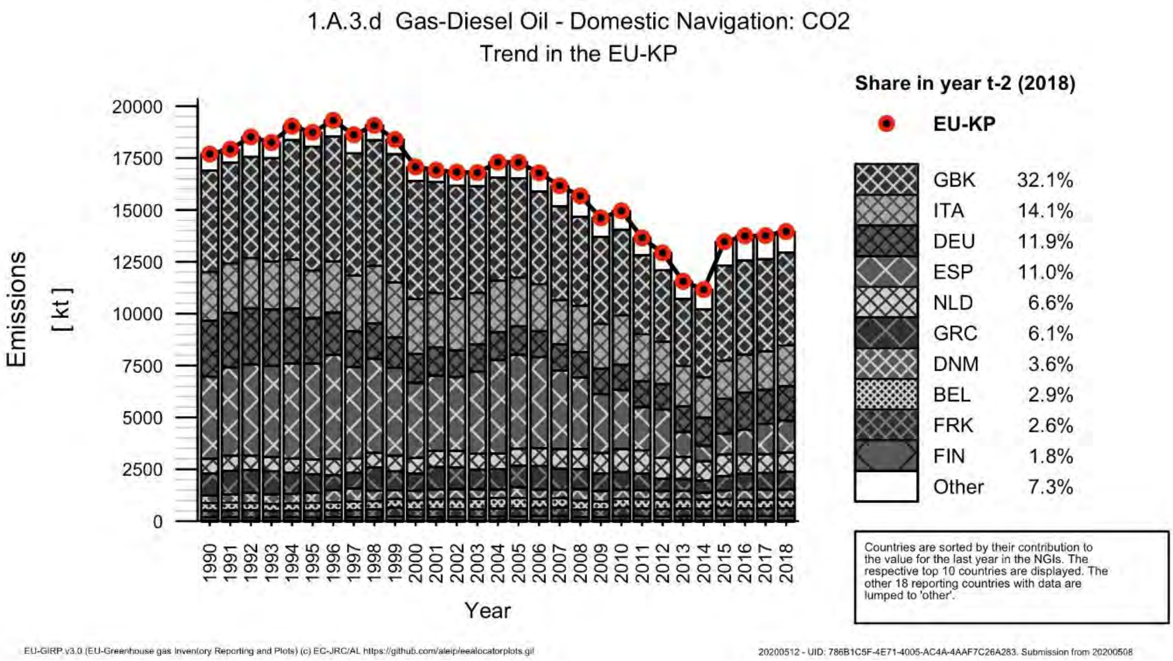
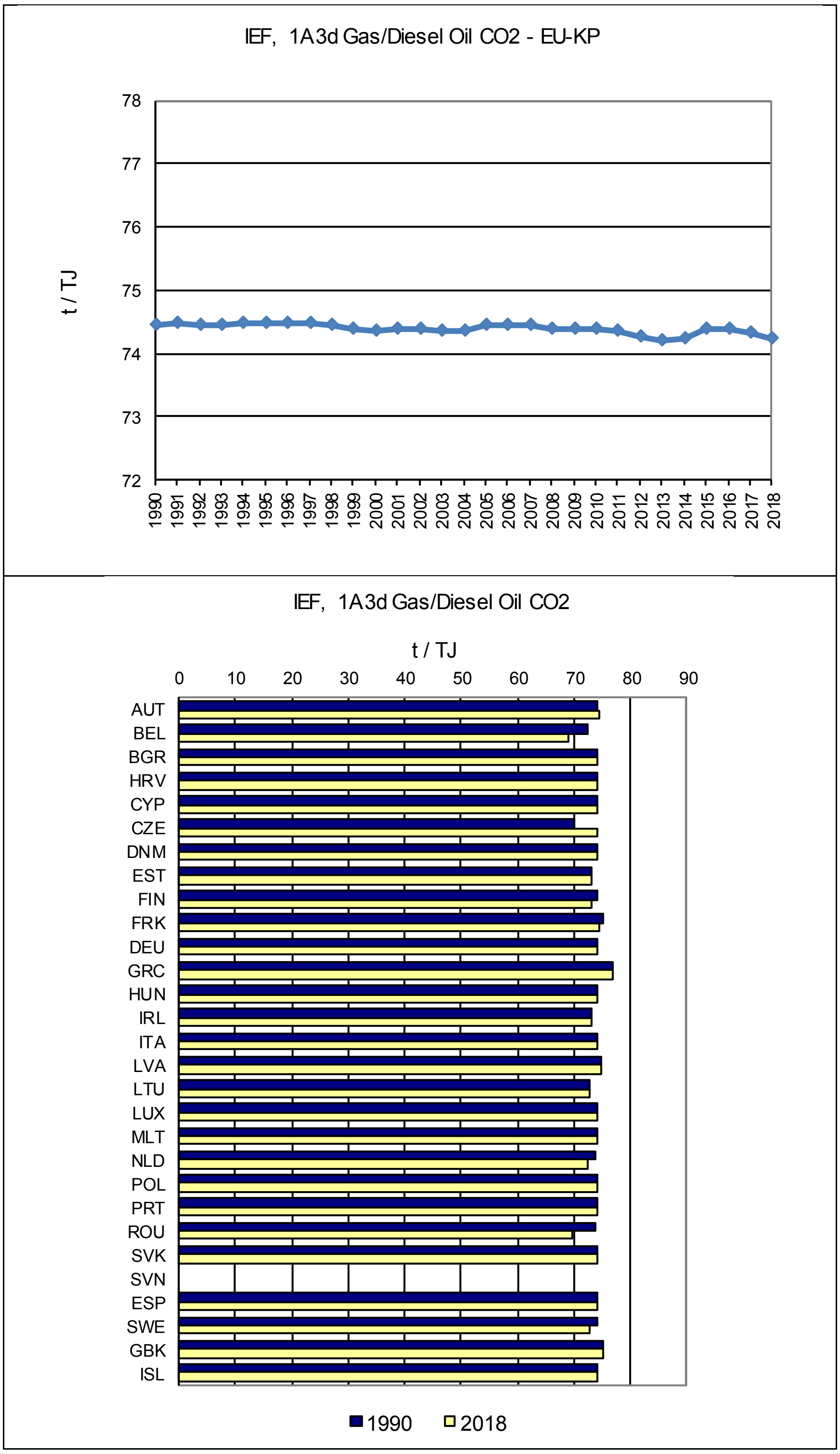


Figure 3.139 1A3d Navigation, Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.5 **Other (1A3e) (EU-KP)**

CO_2 emissions from 1A3e Other account for only 0.15 % of total EU-KP GHG emissions in 2018. 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 24 % between 1990 and 2018.

Germany contributed 21 % and Poland 15 % to the EU-KP emissions from this source in 2018 (Table 3.78). Between 1990 and 2018 the EU-KP emissions increased by 20 %. Seven countries 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 these sectors in the Energy Balance.

Table 3.78 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	224	634	587	9.2%	363	162%	-47	-7%	T2	CS
Belgium	334	348	396	6.2%	62	19%	48	14%	CS,T3	D
Bulgaria	132	397	319	5.0%	188	143%	-78	-20%	T2	CS
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	5	33	33	0.5%	27	505%	0	0%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2	3	8	0.1%	6	251%	5	181%	T1	CS
France	212	366	376	5.9%	165	78%	10	3%	T2	CS
Germany	1 083	1 249	1 323	20.6%	240	22%	74	6%	CS	CS
Greece	NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	100	135	161	2.5%	61	60%	27	20%	T1	D
Ireland	74	127	140	2.2%	66	89%	13	10%	T2	CS
Italy	407	757	792	12.4%	385	95%	35	5%	T2	CS
Latvia	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Lithuania	64	46	37	0.6%	-27	-42%	-8	-18%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	342	96	90	1.4%	-252	-74%	-5	-5%	T2	CS
Poland	NO	864	949	14.8%	949	∞	85	10%	T1	D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	66	3	4	0.1%	-62	-94%	1	22%	T1,T2	CS,D
Slovakia	1 814	319	296	4.6%	-1 518	-84%	-23	-7%	T2	CS
Slovenia	NO	5	1	0.0%	1	∞	-4	-83%	T2	CS
Spain	19	132	141	2.2%	122	638%	9	7%	T1	CS,D
Sweden	219	177	176	2.7%	-43	-20%	-1	-1%	T2	CS
United Kingdom	225	566	581	9.1%	356	159%	16	3%	T3	CS
EU-27+UK	**5 323**	**6 257**	**6 412**	**100%**	**1 088**	**20%**	**155**	**2%**	**-**	**-**
Iceland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom (KP)	225	566	581	9.1%	356	159%	16	3%	T3	CS
EU-KP	**5 323**	**6 257**	**6 412**	**100%**	**1 088**	**20%**	**155**	**2%**	**-**	**-**

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 1.A.4.)

Category 1.A.4. 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 1.A.4.c includes emissions from domestic inland, coastal, deep sea and international fishing. Emissions from transportation of agricultural goods are reported under category 1.A.3 Transport. The emissions reported under 1.A.4. can be generally defined as heat production processes for internal consumption.

The main driving force for CO_2 emissions in the 1.A.4. is energy consumption is the combustion for purposes of space heating. The fluctuations in consumption can be ascribed to difference in cold winter periods. The trend in eventually decreasing CO_2 emissions is a result of higher standards for new buildings and of successful execution of energy-efficiency-oriented modernization of existing buildings.

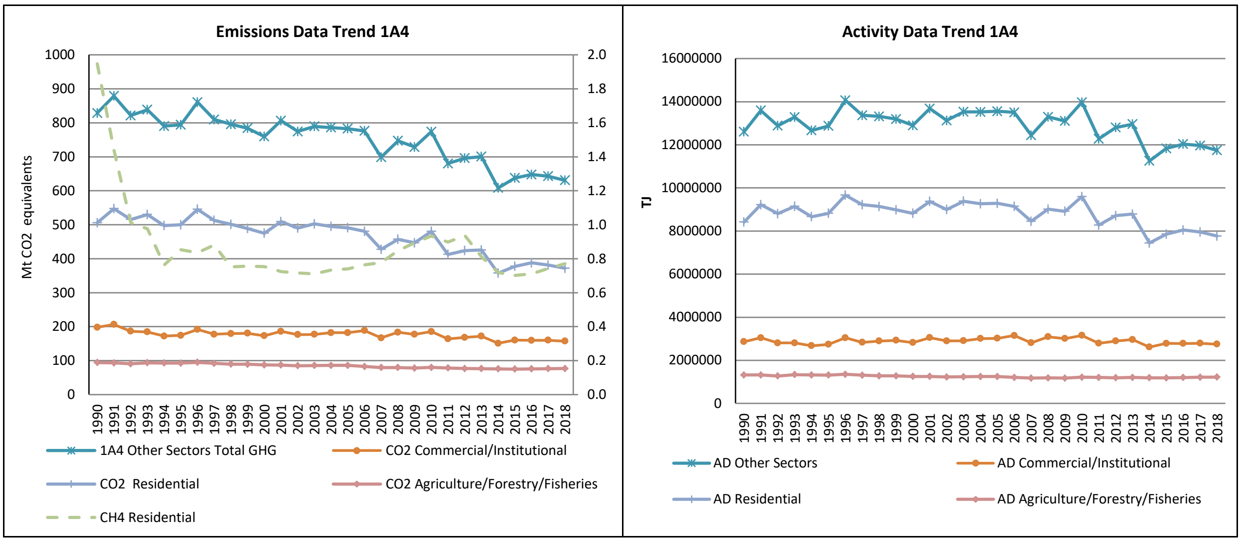
The following enumeration shows the correspondence of 1.A.4. sub categories and ISIC 3.1 rev codes:

- 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.c Agriculture/Forestry/Fishing: ISIC categories 05, 11, 12, 1302

In 2018 category 1.A.4. contributed to 630 940 kt CO_2 equivalents of which 96.1% CO_2, 2.7% CH_4 and 1.2% N_2O.

Figure 3.140 shows the trend of total GHG emissions within source category 1.A.4. and the dominating sources which are CO_2 emissions from 1.A.4.b Residential and from 1.A.4.a Commercial/Residential. The emission trends of the large key sources show larger fluctuations between 1990 and 2018. Between 1990 and 2018, emissions from 1.A.4. decreased by 24%. From 2017 to 2018 emissions decreased by 2% (-12 Mt CO_2 equivalents) which is mainly due to a decrease of category 1.A.4.b CO_2 emissions which decreased by 2% and category 1.A.4.a CO_2 emissions which also decreased by 2%. The trend of 1.A.4.a CO_2 emissions in the year 2018 is mostly influenced by Germany (-32.1 Mt CO_2), and Czechia (-7.1 Mt CO_2). The decrease of 1.A.4.b CO_2 emissions in the year 2018 is mostly influenced by Germany (-45.9 Mt CO_2) and France (-13.3 Mt CO_2).

Figure 3.140 1.A.4. Other Sectors: Total, CO_2 and CH_4 emission trends



Data displayed as dashed line refers to the secondary axis.

In 2018 GHG emissions from source category 1.A.4. accounted for 16 % of total GHG emissions. This source category includes twelve key sources which contributed to 98% of total 1.A.4. GHG emissions in 2018. The following list shows the key sources and their contribution to total 1.A.4. GHG emissions for the year 2018:

1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2) - 16.7%

1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)- 6.4%

1.A.4.a Commercial/Institutional: Other Fuels (CO_2) - 0.7%

1.A.4.a Commercial/Institutional: Solid Fuels (CO_2) - 0.6%

1.A.4.b Residential: Biomass (CH_4) - 1.7%

1.A.4.b Residential: Gaseous Fuels (CO_2) -37.9%

1.A.4.b Residential: Liquid Fuels (CO_2) - 16.1%

1.A.4.b Residential: Solid Fuels (CH_4) - 0.4%

1.A.4.b Residential: Solid Fuels (CO_2) - 5.7%

1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2) - 1.7%

1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2) - 9.3%

1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2) - 0.6%

The following table shows the share of higher tier methods used for each key source of category 1.A.4.. It comprises all methods and method combinations as reported by member states for any of the 1.A.4. key sources.

Table 3.79: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1.A.4. (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2018		1990	2018	
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	66 422	109 931	T	L	L	93
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	83 428	36 849	T	L	L	92
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	758	6 104	T	0	L	98
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	47 183	4 269	T	L	0	100
1.A.4.b Residential: Biomass (CH_4)	9 398	10 289	T	L	L	54
1.A.4.b Residential: Gaseous Fuels (CO_2)	183 819	240 761	T	L	L	93
1.A.4.b Residential: Liquid Fuels (CO_2)	181 765	94 274	T	L	L	88
1.A.4.b Residential: Solid Fuels (CH_4)	9 310	2 820	T	L	0	7
1.A.4.b Residential: Solid Fuels (CO_2)	136 137	36 000	T	L	L	99
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12 477	11 348	0	L	L	88
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	71 887	61 239	T	L	L	87
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9 721	3 926	T	L	0	97

The following table shows the assumptions made when estimating the share of higher tiers in a category.

Table 3.80: Assumptions made when estimating the share of higher Tier methods for 1.A.4..

Methods and method of EF combinations	Share of emissions which are estimated with a 'higher Tier method'
CS	13.5%
T1	0.6%
T1,T2	37.4%
T1, T3	0.0%
T2	13.2%
T2, T3	0.0%
T3	0.0%
D	4.5%
CS,D	72.4%
CS, T1, T3	4.0%
T1, T2, T3	22.0%
Other combination, i.e. including CS, CR or M	13.5%

Table 3.81 shows total GHG, CO_2 and CH_4 emissions from 1.A.4. Other sectors. Between 1990 and 2018 CO_2 emissions from 1.A.4. Other Sectors decreased by 24%, CH_4 decreased by 27% and N_2O emissions decreased by 1%.

Table 3.81 1.A.4. 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 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	14 223	8 815	13 516	8 401	515	268
Belgium	28 171	24 705	27 824	24 174	256	418
Bulgaria	8 133	1 838	7 654	1 446	286	304
Croatia	4 218	3 205	3 719	2 747	358	336
Cyprus	434	479	430	472	2	6
Czechia	33 807	13 146	31 954	12 098	1 676	909
Denmark	9 263	4 274	9 042	4 052	157	134
Estonia	2 038	632	1 881	462	103	126
Finland	7 743	3 865	7 487	3 593	169	207
France	102 542	82 788	96 264	80 171	4 793	1 196
Germany	208 173	122 070	203 012	120 610	4 185	1 017
Greece	8 653	5 417	8 066	5 120	239	219
Hungary	22 169	12 326	21 211	11 740	858	492
Ireland	10 586	8 986	10 031	8 763	451	146
Italy	78 603	83 173	75 721	78 382	1 141	2 325
Latvia	5 842	1 537	5 418	1 285	268	172
Lithuania	7 300	1 539	6 903	1 338	210	160
Luxembourg	1 360	1 664	1 343	1 647	11	12
Malta	265	131	264	130	1	1
Netherlands	39 486	33 967	38 864	32 547	572	1 371
Poland	56 922	57 684	53 441	53 187	2 805	3 393
Portugal	4 111	4 532	3 463	4 154	431	216
Romania	10 847	11 630	10 418	10 357	384	992
Slovakia	11 502	4 827	11 067	4 587	389	180
Slovenia	1 867	1 307	1 646	1 153	161	108
Spain	26 331	39 971	25 292	38 635	828	1 046
Sweden	11 323	2 543	11 045	2 387	115	64
United Kingdom	111 587	92 428	109 606	91 121	1 588	1 052
EU-27+UK	**827 498**	**629 479**	**796 581**	**604 758**	**22 953**	**16 869**
Iceland	794	560	785	554	3	1
United Kingdom (KP)	112 091	93 157	110 103	91 843	1 592	1 054
EU-KP	**828 796**	**630 767**	**797 863**	**606 035**	**22 960**	**16 872**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.82 provides information on the contribution of Member States to EU-KP recalculations in CO_2 from 1.A.4. Other sectors for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table 3.82 1.A.4. Other Sectors: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-33	-0.2	228	2.6	Revised energy balance
Belgium	34	0.1	1 706	7.6	Revision of the energy balances in each region + 1240 kt CO_2 from revision gasoil consumption in the energy balance in the walloon region following the Belgium biennal survey; Flemish region: +462,46 kt CO_2: +171 kt CO_2 in 1.A.4.ai; +228 kt CO_2 in 1.A.4.bi and +49 kt CO_2 in 1.A.4.ci due to update energy balance
Bulgaria	-	-	-	-	

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Croatia	-	-	-	-	
Cyprus	0	0.0	7	1.4	Revised activity data (energy balance)
Czechia	-	-	130	1.0	Updated activity data
Denmark	-0.9	-0.0	11	0.3	Data for both reference approach and national approach have been updated according to the latest energy statistics.
Estonia	-	-	-23	-4.5	
Finland	233	3.2	178	5.0	
France	-139	-0.1	-314	-0.4	
Germany	-	-	-8 681	-6.4	Revision of model TREMOD MM (1.A.4.a ii, b ii, c ii)
Greece	-	-	-	-	
Hungary	-	-	-75	-0.6	Latest IEA/Eurostat energy statistics, revised methodology for waste incineration
Ireland	-	-	-0.8	-0.0	
Italy	-	-	-165	-0.2	
Latvia	-	-	-13	-1.0	
Lithuania	-	-	0.1	0.0	Correction of CO_2 emission factor for heating and other gasoil based on measurements performed by AB "ORLEN Lietuva". Correction of CH_4 emission factor for other solid biomass taking into account newest available information in internationally referenced sources and EFs from neighbouring countries appropriate to Lithuania's national circumstances in 1.A.4.a.i and 1.A.4.c.i.
Luxembourg	-0.8	-0.1	5.7	0.3	revision of AD: energy balance revised, modified allocation of fuels to road vs. offroad sectors due to switch from HBEFA3.3 to HBEFA4.1
Malta	68	35	-67	-31	Biomass values updated
Netherlands	-23	-0.1	-35	-0.1	
Poland	-170	-0.3	309	0.6	Update of the activity data according to Eurostat database and introduction of CO_2 CS EFs for fuel oil.
Portugal	-600	-15	46	1.2	Other Sectors (1.A.4.): Activity data corrections - Fuel consumption.
Romania	879	9.2	1	0.0	The CO_2 emission factor value for 2017 year for lignit fuel and coke_oven_coke fuel have been updated because the Country Specific Emission Factor values for 2017 year have been updated. It was identified an error for net calorific value for natural gas fuel for 1997 year and for patent fuel for 1990-1995 period for specific calorific values. From the coke_oven_coke consumption we substracted the quantity of the graphite electrodes and are reported in the Industrial Processes and Product Use sector (IPPU), in the 2C1 Iron and Steel category, in according to the 2006 IPCC methodology. In this case the CO_2 emissions are updated for 1990-2017 period.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-21	-0.1	-1 018	-2.6	New estimates have been made. Following the ERT recommendation (CLRTAP STAGE-3 2014, 68 and 69) separate estimates have been made for the 1.A.4.a.ii sub-sector Update of natural gas consumption for residential, commercial and institutional categories according to updated information contained in national energy statistics Uddate of activity data for years "n-1" and "n-2"(Forest Statistical Yearbook, consumption years: "n-1" and "n-2"). Update of activity data for year "n-1" (1.A.4.ciii)
Sweden	76	0.7	-102	-3.8	
United Kingdom	-42	-0.0	-269	-0.3	
EU27+UK	262	0.0	-8 142	-1.3	
Iceland	-0.0	-0.0	0.2	0.0	
United Kingdom (KP)					NA

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
EU-KP	197	0.0	-8 250	-1.3	

Table 3.83 provides information on the contribution of Member States to EU-KP recalculations in CH_4 from 1.A.4. Other sectors for 1990 and 2017.

Table 3.83 1.A.4. Other Sectors: Contribution of MS to EU-KP recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	22	4.4	17	6.2	Revised energy balance
Belgium	-0.1	-0.1	6.0	1.5	Revision of the energy balances in each region + 1240 kt CO_2 from revision gasoil consumption in the energy balance in the walloon region following the Belgium biennal survey; Flemish region: +462,46 kt CO_2: +171 kt CO_2 in 1.A.4.ai; +228 kt CO_2 in 1.A.4.bi and +49 kt CO_2 in 1.A.4.ci due to update energy balance
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	1	26.4	Revised activity data (energy balance)
Czechia	-	-	2	0.2	Updated activity data
Denmark	-2.8	-1.7	-6.2	-4.3	Data for both reference approach and national approach have been updated according to the latest energy statistics.
Estonia	-	-	0.1	0.1	
Finland	-54	-24	24	13	
France	13	0.3	-64	-4.8	
Germany	-	-	-140	-12	Revision of model TREMOD MM (1.A.4.a ii, b ii, c ii)
Greece	135	130	113	95	
Hungary	-	-	-1	-0.1	Latest IEA/Eurostat energy statistics, revised methodology for waste incineration
Ireland	-	-	0	0.0	
Italy	-	-	-0	-0.0	
Latvia	48	22	34	25	
Lithuania	-	-	0	0.1	Correction of CO_2 emission factor for heating and other gasoil based on measurements performed by AB "ORLEN Lietuva". Correction of CH_4 emission factor for other solid biomass taking into account newest available information in internationally referenced sources and EFs from neighbouring countries appropriate to Lithuania's national circumstances in 1.A.4.a.i and 1.A.4.c.i.
Luxembourg	-	-	-1	-8.2	revision of AD: energy balance revised, modified allocation of fuels to road vs. offroad sectors due to switch from HBEFA3.3 to HBEFA4.1
Malta	-0	-35	-1	-41	Biomass values updated
Netherlands	-0	-0.0	-19	-1.3	
Poland	-6	-0.2	22	0.6	Update of the activity data according to Eurostat database and introduction of CO_2 CS EFs for fuel oil.
Portugal	17	4.1	-29	-12	Other Sectors (1.A.4.): Activity data corrections - Fuel consumption.
Romania	68	21	0.0	0.0	The CO_2 emission factor value for 2017 year for lignit fuel and coke_oven_coke fuel have been updated because the Country Specific Emission Factor values for 2017 year have been updated. It was identified an error for net calorific value for natural gas fuel for 1997 year and for patent fuel for 1990-1995 period for specific calorific values. From the coke_oven_coke consumption we substracted the quantity of the graphite electrodes and are reported in the Industrial Processes and Product Use sector (IPPU), in the 2C1 Iron and Steel category, in according to the 2006 IPCC methodology. In this case the CO_2 emissions are updated for 1990-2017 period.

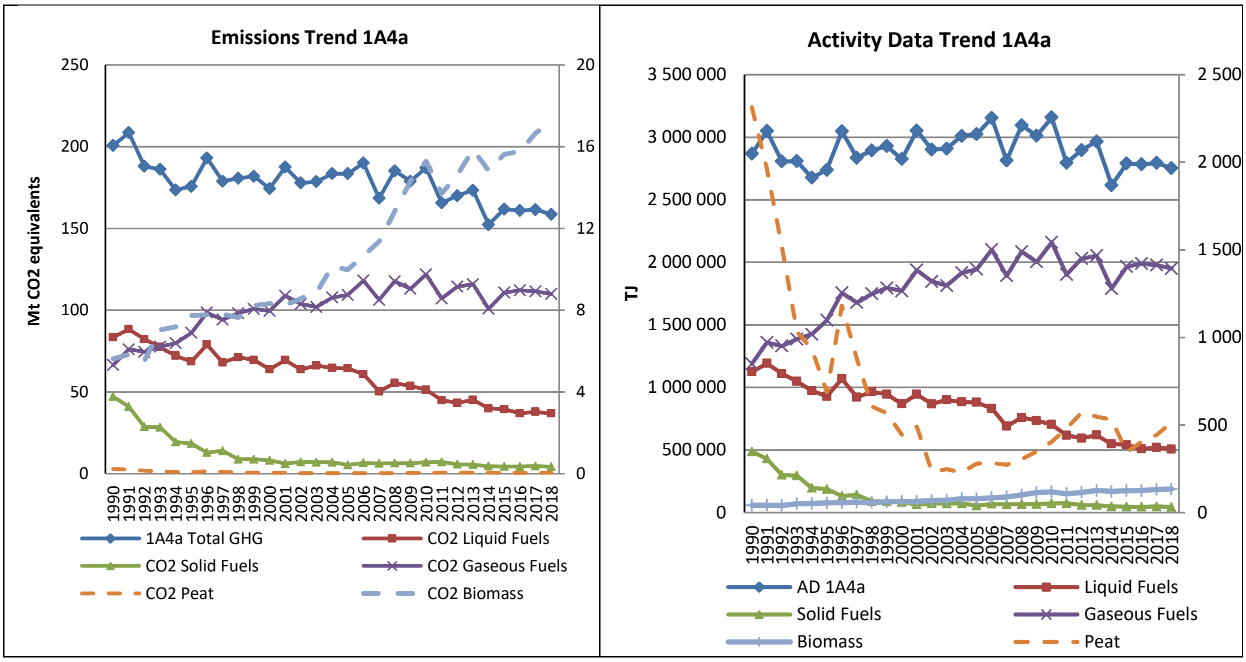
	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Slovakia	-	-	-	-	
Slovenia	14	9.2	-27	-18	
Spain	-0	-0.0	6.6	0.6	New estimates have been made. Following the ERT recommendation (CLRTAP STAGE-3 2014, 68 and 69) separate estimates have been made for the 1.A.4.a.ii sub-sector Update of natural gas consumption for residential, commercial and institutional categories according to updated information contained in national energy statistics Uddate of activity data for years "n-1" and "n-2"(Forest Statistical Yearbook, consumption years: "n-1" and "n-2"). Update of activity data for year "n-1" (1.A.4.ciii)
Sweden	-2	-1.5	-44	-38	
United Kingdom	23	1.5	15	1.6	
EU27+UK	274	1.2	-89	-0.5	
Iceland	0	0.0	-0	-0.0	
United Kingdom (KP)					NA
EU-KP	274	1.2	-90	-0.5	

3.2.4.1 Commercial/Institutional (1.A.4.a)

CO_2 emissions from 1.A.4.a Commercial/Institutional accounted for 5% of total GHG emissions from 1.A Fuel Combustion in 2018. The subcategory 1.A.4.a. includes all combustion sources that utilize heat combustion for heating production halls and operational buildings in institutions, commercial facilities, services and trade.

Figure 3.141 shows the emission trend within the category 1.A.4.a, which is mainly dominated by CO_2 emissions from gaseous and liquid fuels. Between 1990 and 2018 CO_2 emissions decreased by 21% (see also the Table 3-70), mainly due to decreases in CO_2 emissions from solid (-91%) and liquid (-56%) fuels while CO_2 emissions from gaseous fuels increased by 66% and show a fluctuating trend since 2006. Between 2017 and 2018 the GHG emissions decreased by 2%, mainly driven by the decreases in solid and liquid fuels.

Figure 3.141 1.A.4.a Commercial/Institutional: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

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 1.A.4.a decreased by 4% between 1990 and 2018 and biomass consumption increased by 223%.

France, Germany, Italy and the United Kingdom contributed the most to the CO_2 emissions from this source (67%) (in case for EU-27 + UK). The Member States with the highest increases in absolute terms were Spain and Italy. The Member States with the highest reduction in absolute terms were Germany and Czechia (Table 3.84).

Table 3.84 1.A.4.a 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	2 300	1 388	1 305	0.8%	-995	-43%	-83	-6%	T1,T2	CS,D
Belgium	4 292	5 641	5 685	3.6%	1 393	32%	44	1%	T1	D
Bulgaria	3 117	341	314	0.2%	-2 803	-90%	-27	-8%	T1,T2	CS,D
Croatia	855	627	627	0.4%	-227	-27%	1	0%	T1	D
Cyprus	75	111	109	0.1%	33	44%	-2	-2%	T1	D
Czechia	9 907	3 095	2 778	1.8%	-7 129	-72%	-318	-10%	T1,T2	CS,D
Denmark	1 460	719	698	0.4%	-762	-52%	-21	-3%	M,T1,T2,T3	CS,D
Estonia	48	73	76	0.0%	28	60%	3	4%	T1,T2	CS,D
Finland	2 476	1 198	1 180	0.8%	-1 296	-52%	-18	-1%	T1,T2,T3	CS,D
France	29 934	29 704	28 124	17.9%	-1 810	-6%	-1 580	-5%	T1,T2	CS,D
Germany	64 106	34 734	31 985	20.3%	-32 121	-50%	-2 749	-8%	CS,T1,T2,T3	CS,D
Greece	519	711	683	0.4%	165	32%	-27	-4%	T1,T2	CS,D
Hungary	2 757	2 981	2 864	1.8%	107	4%	-117	-4%	T1,T2	CS,D
Ireland	2 232	1 962	2 093	1.3%	-138	-6%	131	7%	T2	CS
Italy	11 815	23 135	24 804	15.8%	12 989	110%	1 669	7%	T2	CS
Latvia	2 696	381	386	0.2%	-2 310	-86%	5	1%	T1,T2	CS,D
Lithuania	3 059	331	343	0.2%	-2 716	-89%	12	4%	T2	CS
Luxembourg	639	562	592	0.4%	-47	-7%	30	5%	T1,T2	CS,D
Malta	165	89	71	0.0%	-94	-57%	-17	-20%	T1	D
Netherlands	8 293	7 706	7 476	4.8%	-817	-10%	-230	-3%	T2	CS,D
Poland	9 715	7 378	6 912	4.4%	-2 802	-29%	-465	-6%	T1,T2	CS,D
Portugal	704	1 135	1 213	0.8%	509	72%	78	7%	T1,T2	CS,D
Romania	NO	2 166	2 207	1.4%	2 207	∞	41	2%	T1,T2	CS
Slovakia	4 148	1 596	1 444	0.9%	-2 703	-65%	-152	-10%	T2	CS
Slovenia	503	363	305	0.2%	-198	-39%	-57	-16%	T1,T2	CS,D
Spain	3 812	12 083	12 472	7.9%	8 661	227%	389	3%	T1,T2	CS,D,OTH
Sweden	2 900	729	695	0.4%	-2 205	-76%	-34	-5%	T1,T2	CS
United Kingdom	25 400	19 101	19 728	12.5%	-5 672	-22%	627	3%	T2	CS
EU-27+UK	**197 926**	**160 040**	**157 171**	**100%**	**-40 755**	**-21%**	**-2 869**	**-2%**	**-**	**-**
Iceland	16	1	1	0.0%	-16	-96%	0	-13%	T1	D
United Kingdom (KP)	25 483	19 133	19 762	12.6%	-5 720	-22%	629	3%	T1,T2	CS
EU-KP	**198 025**	**160 072**	**157 206**	**100%**	**-40 819**	**-21%**	**-2 866**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4. a Commercial/Institutional – Liquid Fuels (CO_2)

In 2018 CO_2 emissions from liquid fuels had a share of 23% within source category 1.A.4.a (compared to 42% in 1990). Between 1990 and 2018, CO_2 emissions decreased by 56% (Table 3.85). Only four Member States increased the use of liquid fuels in the time series, the highest absolute increase is noted for Poland. It is important to note, however, that Poland hasn't been using the liquid fuels at the beginning of 90's. The highest absolute decreases were achieved in Germany and France. Generally, in number of Member States, there is apparent strong decrease from 2006 to 2007 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. Between 2017 and 2018 EU-KP CO_2 emissions decreased by 3%. According to the methodology as described in chapter 3.2.4 about 92% of EU27+UK emissions are calculated by using higher tier methods in 2018.

Table 3.85 1.A.4.a Commercial/Institutional, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 420	577	502	1.4%	-918	-65%	-76	-13%	T2	T2
Belgium	2 315	1 229	1 260	3.4%	-1 054	-46%	31	3%	T1	T1
Bulgaria	2 986	105	77	0.2%	-2 909	-97%	-29	-27%	T1	T1
Croatia	526	176	152	0.4%	-374	-71%	-24	-13%	T1	T1
Cyprus	75	111	109	0.3%	33	44%	-2	-2%	T1	T1
Czechia	2 000	58	43	0.1%	-1 957	-98%	-15	-27%	T1	T1
Denmark	1 055	257	270	0.7%	-785	-74%	13	5%	T1,T2	T1,T2
Estonia	19	14	15	0.0%	-4	-20%	1	6%	-	-
Finland	2 423	1 112	1 103	3.0%	-1 320	-54%	-9	-1%	T2	T2
France	20 476	10 648	10 103	27.4%	-10 373	-51%	-546	-5%	-	-
Germany	28 133	12 934	12 231	33.2%	-15 902	-57%	-703	-5%	CS	CS
Greece	499	358	346	0.9%	-152	-31%	-12	-3%	T2	T2
Hungary	1 124	93	114	0.3%	-1 010	-90%	21	23%	T1	T1
Ireland	1 870	786	818	2.2%	-1 053	-56%	31	4%	T2	T2
Italy	1 530	1 531	1 524	4.1%	-6	0%	-7	0%	-	-
Latvia	1 017	101	97	0.3%	-920	-90%	-4	-4%	T2	T2
Lithuania	1 166	9	5	0.0%	-1 161	-100%	-4	-43%	T2	T2
Luxembourg	469	349	353	1.0%	-116	-25%	4	1%	T2	T2
Malta	165	89	71	0.2%	-94	-57%	-17	-20%	T1	T1
Netherlands	433	385	361	1.0%	-73	-17%	-24	-6%	T2	T2
Poland	IE,NO	1 325	1 355	3.7%	1 355	∞	29	2%	T1,T2	T1,T2
Portugal	704	350	425	1.2%	-279	-40%	75	22%	T1	T1
Romania	NO	258	299	0.8%	299	∞	41	16%	T1,T2	T1,T2
Slovakia	384	29	25	0.1%	-359	-94%	-4	-14%	T2	T2
Slovenia	270	254	265	0.7%	-6	-2%	10	4%	T1	T1
Spain	3 284	3 678	3 850	10.4%	565	17%	172	5%	T2	T2
Sweden	2 814	545	504	1.4%	-2 311	-82%	-41	-8%	T1	T1
United Kingdom	6 183	490	540	1.5%	-5 643	-91%	50	10%	T2	T2
EU-27+UK	**83 340**	**37 851**	**36 815**	**100%**	**-46 524**	**-56%**	**-1 036**	**-3%**		
Iceland	7	1	1	0.0%	-6	-89%	0	-13%	T1	T1
United Kingdom (KP)	6 265	521	573	1.6%	-5 691	-91%	52	10%	T2	T2
EU-KP	**83 428**	**37 883**	**36 849**	**100%**	**-46 579**	**-56%**	**-1 034**	**-3%**		

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 3.142 and Figure **3.143** show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, France and Spain; together they cause 71% of the CO_2 emissions from liquid fuels in

1.A.4.a. Fuel consumption decreased by 56% between 1990 and 2018. The CO_2 implied emission factor for liquid fuels was 72.75 t/TJ in 2018.

Figure 3.142 1.A.4.a Commercial/Institutional, liquid fuels: Emission trend and share for CO_2

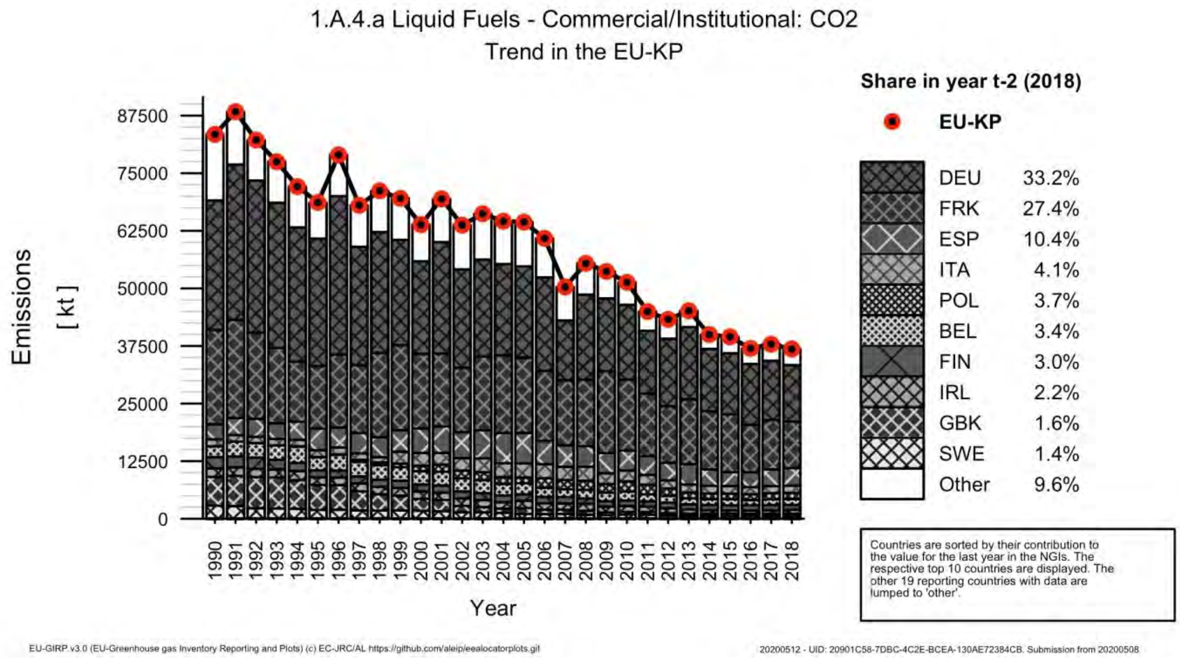
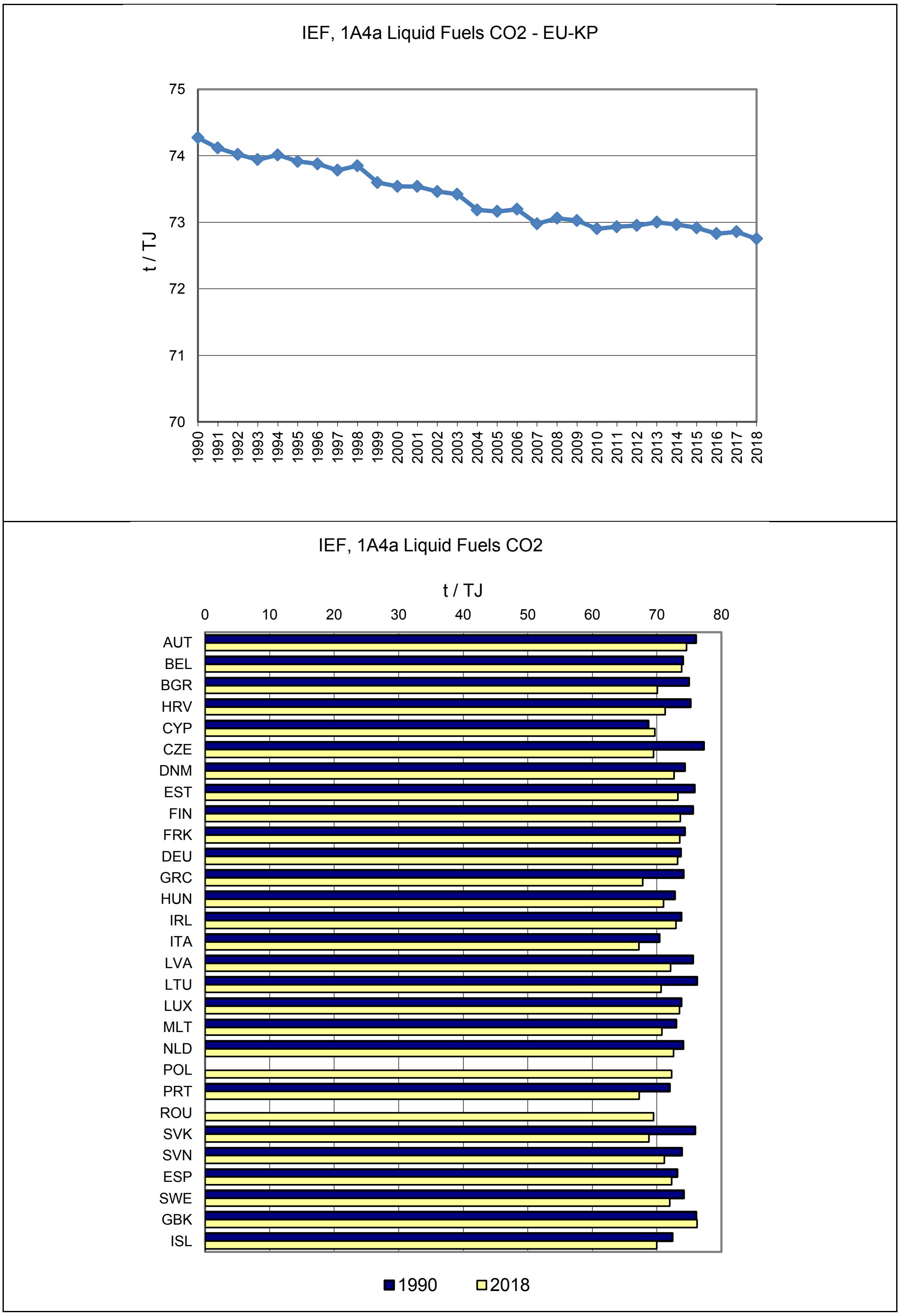


Figure 3.143 1.A.4.a Commercial/Institutional, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Solid Fuels (CO_2)

In 2018, CO_2 from solid fuels had a share of 3% within source category 1.A.4.a (compared to 24% in 1990). Between 1990 and 2018 CO_2 emissions decreased by 91% (Table 3.86). Twelve Member States and Island report emissions as 'Not occurring' in 2018; all other Member States reduced emissions between 1990 and 2018 except Spain and Romania. Between 2017 and 2018 CO_2 emissions decreased by 9%. According to the methodology as described in chapter 3.2.1 about nearly 100% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.86 1.A.4.a Commercial/Institutional, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	91	NO	NO	-	-91	-100%	-	-	NA	NA
Belgium	9	0	0	0.0%	-9	-100%	0	0%	T1	T1
Bulgaria	89	16	10	0.2%	-79	-89%	-6	-36%	T1,T2	T1,T2
Croatia	88	0	0	0.0%	-88	-100%	0	-72%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	6 237	131	91	2.1%	-6 146	-99%	-40	-30%	T2	T2
Denmark	8	NO	NO	-	-8	-100%	-	-	NA	NA
Estonia	5	1	5	0.1%	0	11%	4	523%	-	-
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	719	738	405	9.5%	-313	-44%	-333	-45%	-	-
Germany	22 426	60	55	1.3%	-22 371	-100%	-4	-7%	CS	CS
Greece	20	NO,IE	NO,IE	-	-20	-100%	-	-	NA	NA
Hungary	475	6	6	0.2%	-468	-99%	0	2%	T1,T2	T1,T2
Ireland	3	NO	NO	-	-3	-100%	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	1 276	20	17	0.4%	-1 259	-99%	-3	-17%	T2	T2
Lithuania	1 173	132	132	3.1%	-1 041	-89%	0	0%	T2	T2
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	101	9	8	0.2%	-94	-92%	-1	-10%	T2	T2
Poland	8 881	2 642	2 481	58.1%	-6 400	-72%	-161	-6%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	2	0.1%	2	∞	2	∞	NA	NA
Slovakia	1 729	270	267	6.2%	-1 462	-85%	-3	-1%	T2	T2
Slovenia	203	NO	NO	-	-203	-100%	-	-	NA	NA
Spain	147	548	683	16.0%	537	366%	135	25%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	3 502	106	104	2.4%	-3 398	-97%	-2	-2%	T2	T2
EU-27+UK	**47 182**	**4 678**	**4 268**	**100%**	**-42 914**	**-91%**	**-411**	**-9%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 503	107	105	2.5%	-3 398	-97%	-2	-2%	T2	T2
EU-KP	**47 183**	**4 679**	**4 269**	**100%**	**-42 914**	**-91%**	**-411**	**-9%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.144 and Figure 3.145 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland and Spain in 2018; together they cause 74% of the CO_2 emissions from solid fuels in 1.A.4.a. Fuel consumption in the EU27+UK decreased by 91% between 1990 and 2018. The CO_2 implied emission factor for solid fuels was 96.44 t/TJ in 2018. 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 3.144 1.A.4.a Commercial/Institutional, solid fuels: Emission trend and share for CO_2

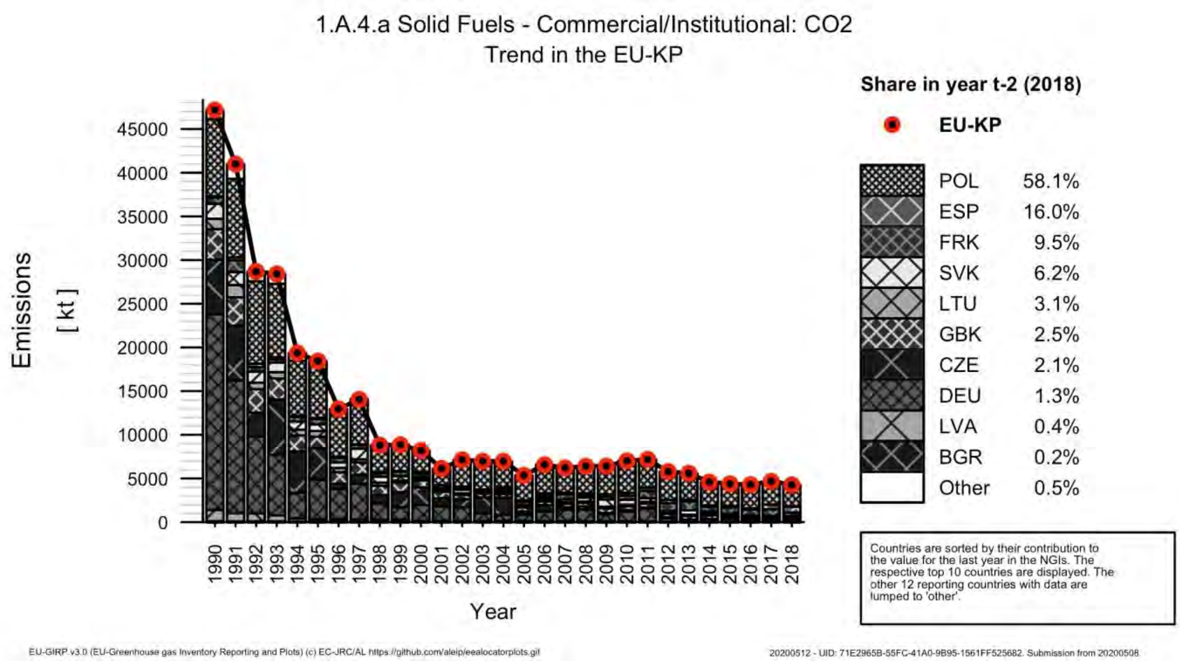
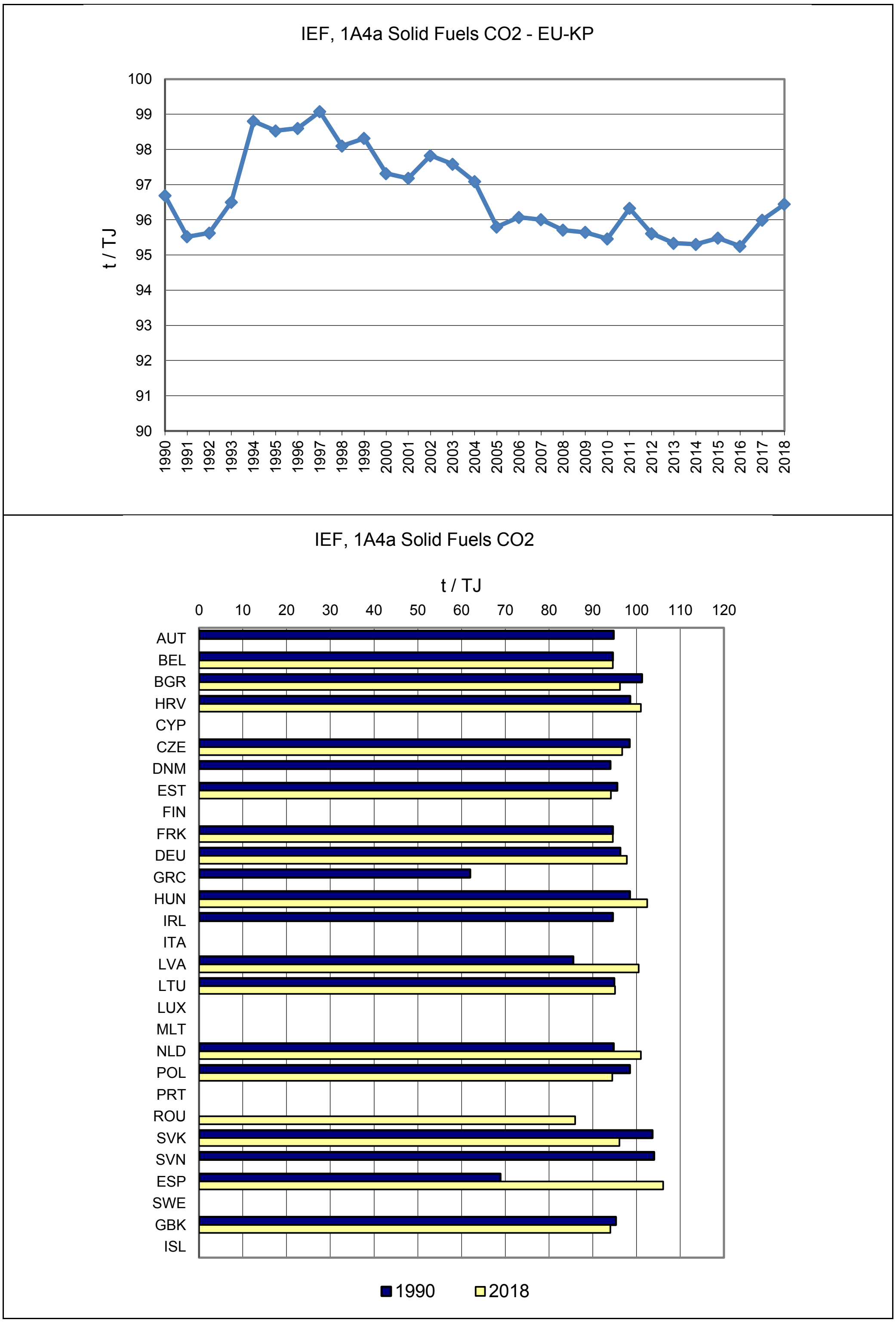


Figure 3.145 1.A.4.a Commercial/Institutional, solid fuels: of Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Gaseous Fuels (CO_2)

In 2018 CO_2 from gaseous fuels had a share of 70% within source category 1.A.4.a (compared to 34% in 1990). Between 1990 and 2018, the emissions increased by 66% (Table 3.87). All Member States except of Latvia, Lithuania, the Netherlands and Slovakia reported increasing emissions. The highest absolute increases occurred in France, Italy, Spain and Germany. Between 2017 and 2018 CO_2

emissions decreased by 1%. According to the methodology as described in chapter 3.2.4 about 93% of EU27+UK emissions are calculated by using higher tier methods in 2018.

Table 3.87 1.A.4.a Commercial/Institutional, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	707	805	797	0.7%	90	13%	-8	-1%	T2	T2
Belgium	1 939	4 279	4 299	3.9%	2 360	122%	21	0%	T1	T1
Bulgaria	42	220	227	0.2%	185	441%	7	3%	T2	T2
Croatia	241	450	475	0.4%	234	97%	24	5%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 670	2 906	2 644	2.4%	974	58%	-263	-9%	T2	T2
Denmark	363	452	428	0.4%	65	18%	-24	-5%	T3	T3
Estonia	20	58	56	0.1%	35	172%	-2	-3%	-	-
Finland	37	71	63	0.1%	25	67%	-8	-11%	T2	T2
France	8 740	18 315	17 614	16.0%	8 874	102%	-701	-4%	-	-
Germany	13 547	21 739	19 697	17.9%	6 151	45%	-2 042	-9%	CS	CS
Greece	IE,NO	353	337	0.3%	337	∞	-15	-4%	T2	T2
Hungary	1 158	2 788	2 634	2.4%	1 476	127%	-154	-6%	T1	T1
Ireland	223	1 176	1 276	1.2%	1 052	471%	100	9%	T2	T2
Italy	9 755	15 900	17 460	15.9%	7 705	79%	1 560	10%	-	-
Latvia	336	259	269	0.2%	-67	-20%	10	4%	T2	T2
Lithuania	708	160	170	0.2%	-538	-76%	10	6%	T2	T2
Luxembourg	170	213	239	0.2%	69	41%	26	12%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 758	7 312	7 107	6.5%	-652	-8%	-206	-3%	T2	T2
Poland	762	3 364	3 050	2.8%	2 288	300%	-314	-9%	T2	T2
Portugal	NO	785	788	0.7%	788	∞	3	0%	T2	T2
Romania	NO	1 894	1 894	1.7%	1 894	∞	0	0%	T2	T2
Slovakia	2 035	1 297	1 153	1.0%	-882	-43%	-144	-11%	T2	T2
Slovenia	29	109	41	0.0%	12	40%	-68	-63%	T2	T2
Spain	381	7 858	7 939	7.2%	7 558	1986%	81	1%	T2	T2
Sweden	86	184	192	0.2%	105	122%	7	4%	T1	T1
United Kingdom	15 716	18 505	19 084	17.4%	3 369	21%	579	3%	T2	T2
EU-27+UK	**66 422**	**111 452**	**109 931**	**100%**	**43 508**	**66%**	**-1 521**	**-1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	15 716	18 505	19 084	17.4%	3 369	21%	579	3%	T2	T2
EU-KP	**66 422**	**111 452**	**109 931**	**100%**	**43 508**	**66%**	**-1 521**	**-1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.146 and Figure 3.147 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, United Kingdom, France and Italy; together they cause 67% of the CO_2 emissions from gaseous fuels in 1.A.4.a. Fuel combustion rose by 66% between 1990 and 2018. The CO_2 implied emission factor for gaseous fuels was 56.34 t/TJ in 2018.

Figure 3.146 1.A.4.a Commercial/Institutional, gaseous fuels: Emission trend and share for CO_2

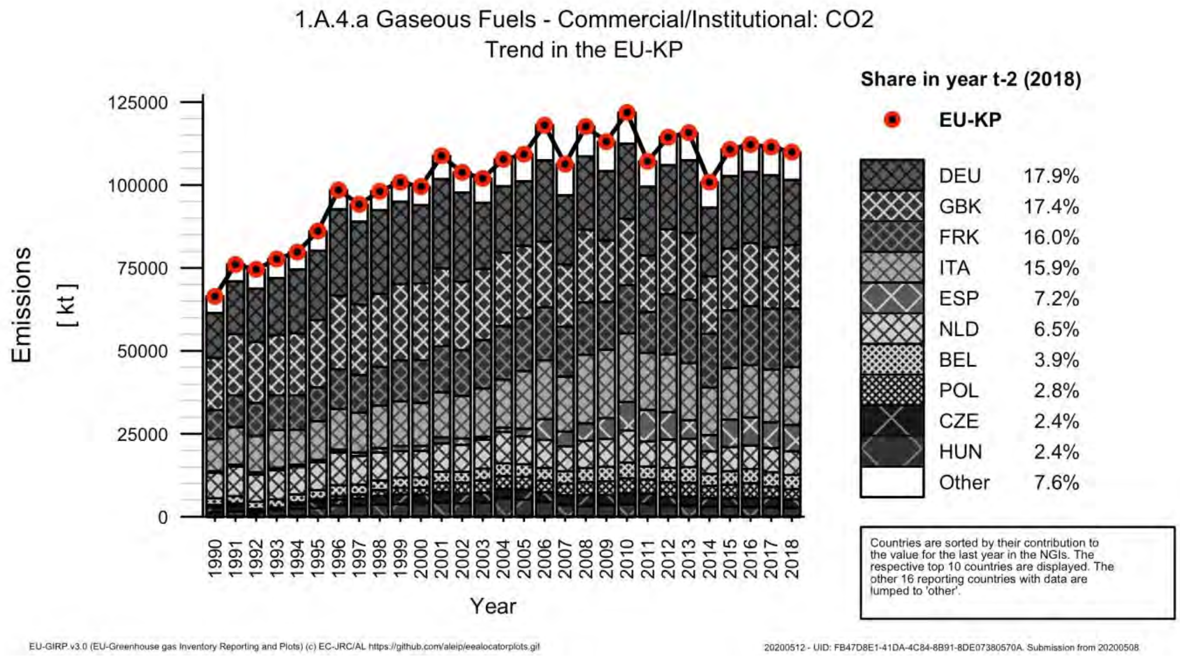
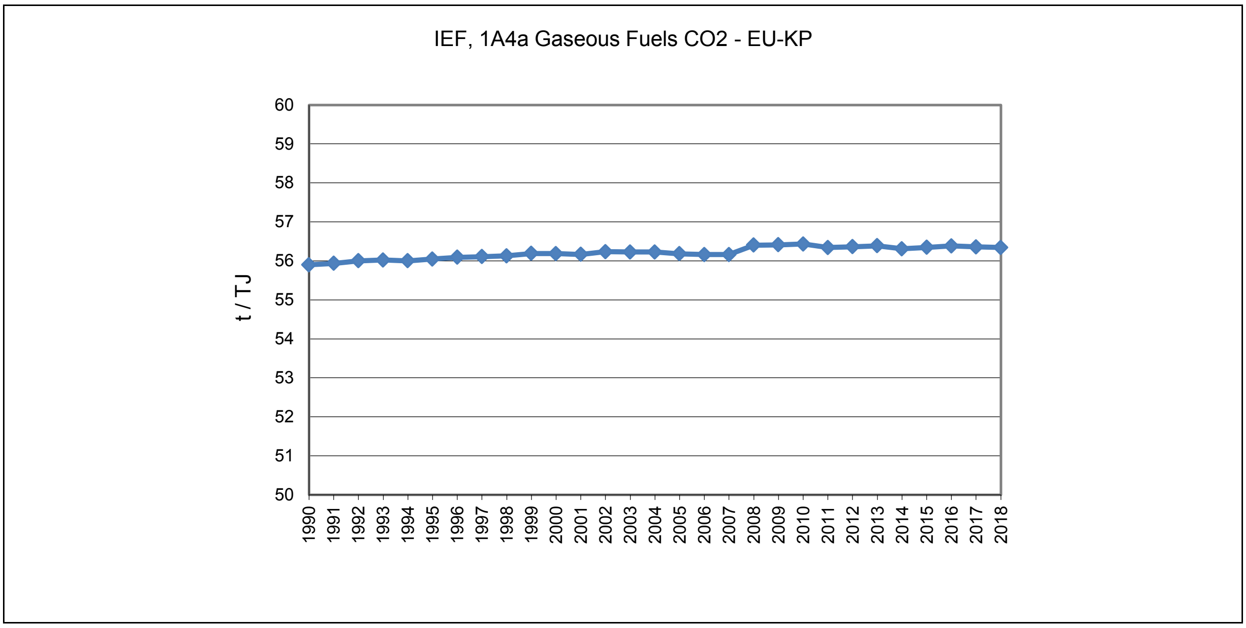
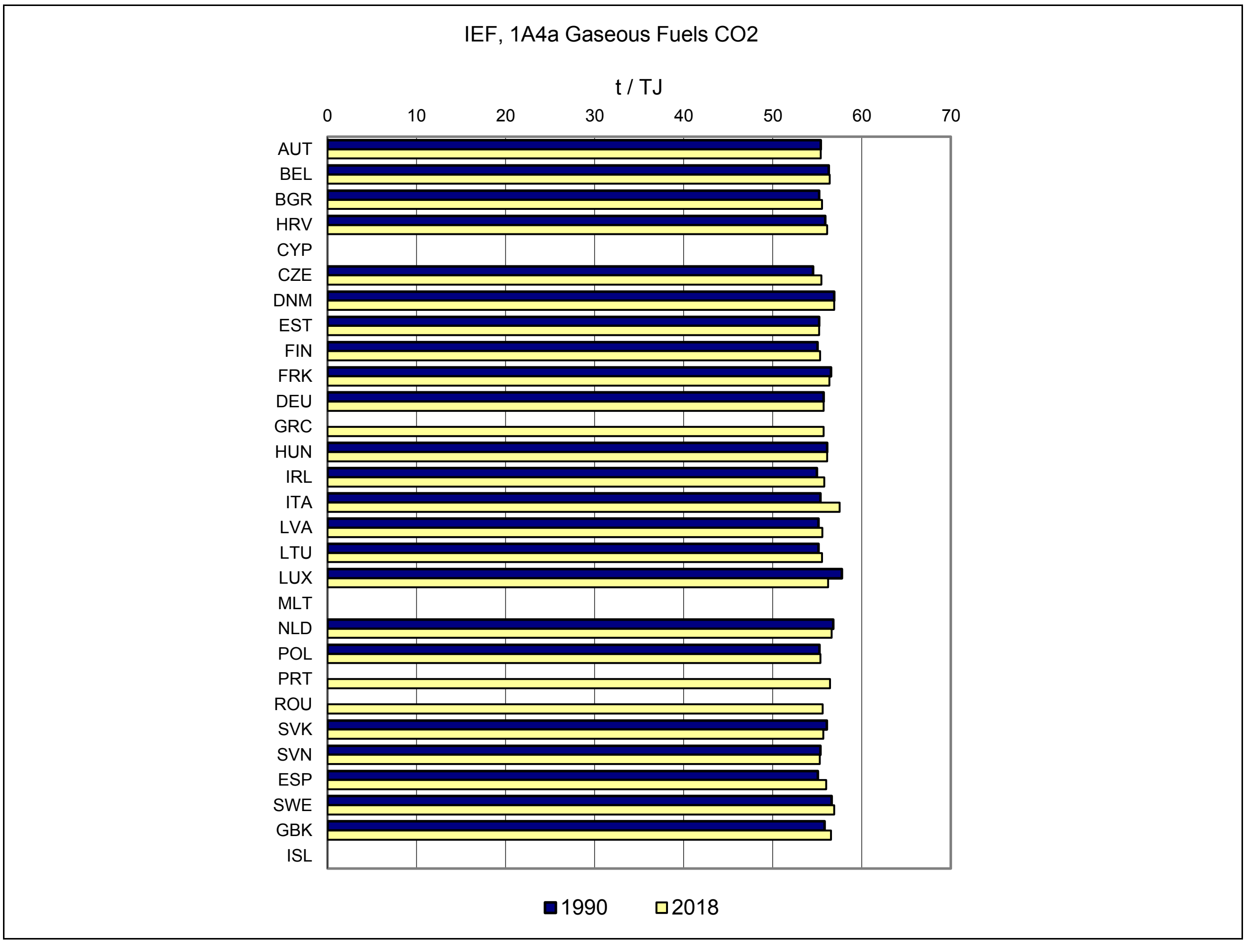


Figure 3.147 1.A.4.a Commercial/Institutional, gaseous fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.a 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 2018, CO_2 from other fossil fuels had a share of 4% within category 1.A.4.a. Between 1990 and 2018 CO_2 increased by 716% (Table 3.88). 18 Member States and Iceland report emissions as 'Not occurring' in 2018; between 2017 and 2018 CO_2 increased by 2%. Level of emissions is strongly driven by Italy. In this category Italy includes all emissions due to the non-renewable part of wastes used in electricity generation. According to the methodology as described in chapter 3.2.4 about 97.5% of EU27+UK emissions are calculated by using higher tier methods in 2018.

Table 3.88: 1.A.4.a Commercial/Institutional, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	83	6	7	0.1%	-77	-92%	1	15%	T2	T2
Belgium	29	134	126	2.1%	96	332%	-8	-6%	T1	T1
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	34	10	NO	-	-34	-100%	-10	-100%	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	0	NO	NO	-	0	-100%	-	-	NA	NA
France	NO	3	2	0.0%	2	∞	-1	-23%	-	-
Germany	NO,NA	2	1	0.0%	1	∞	0	-5%	NA	NA
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	NO	94	109	1.8%	109	∞	16	17%	T2	T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	530	5 704	5 820	95.3%	5 290	998%	116	2%	-	-
Latvia	NO	0	0	0.0%	0	∞	0	33%	T1	T1
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	1	1	0.0%	1	∞	0	68%	NA	NA
Poland	72	46	26	0.4%	-46	-63%	-20	-43%	T1	T1
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	14	11	0.2%	11	∞	-3	-20%	T2	T2
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-27+UK	**748**	**6 012**	**6 104**	**100%**	**5 356**	**716%**	**92**	**2%**		
Iceland	10	NO	NO	-	-10	-100%	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**758**	**6 012**	**6 104**	**100%**	**5 346**	**705%**	**92**	**2%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'

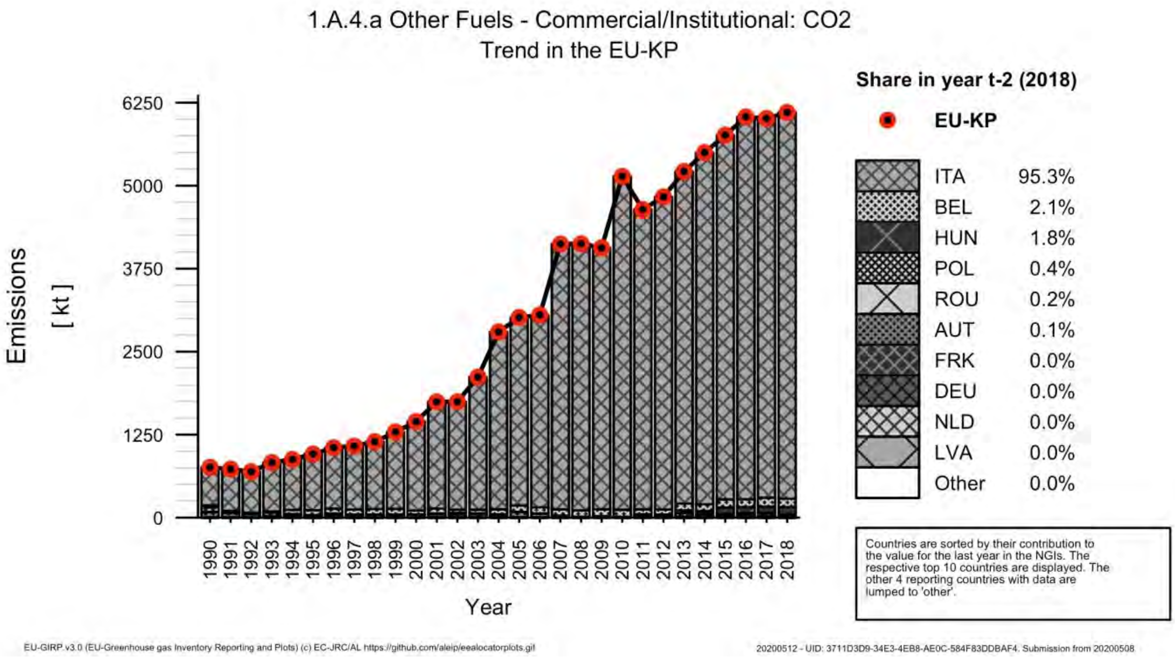


Figure 3.149 shows CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Italy; it causes 95% of the CO_2 emissions from other fuels in 1.A.4.a. The CO_2 implied emission factor for other fossil

fuels was 97.43 t/TJ in 2018. The comparatively high implied emission factor is a calculated value from a mass balance calculation method and data from energy statistics.

Figure 3.148 1.A.4.a Commercial/Institutional, other fuels: Emission trend and share for CO_2

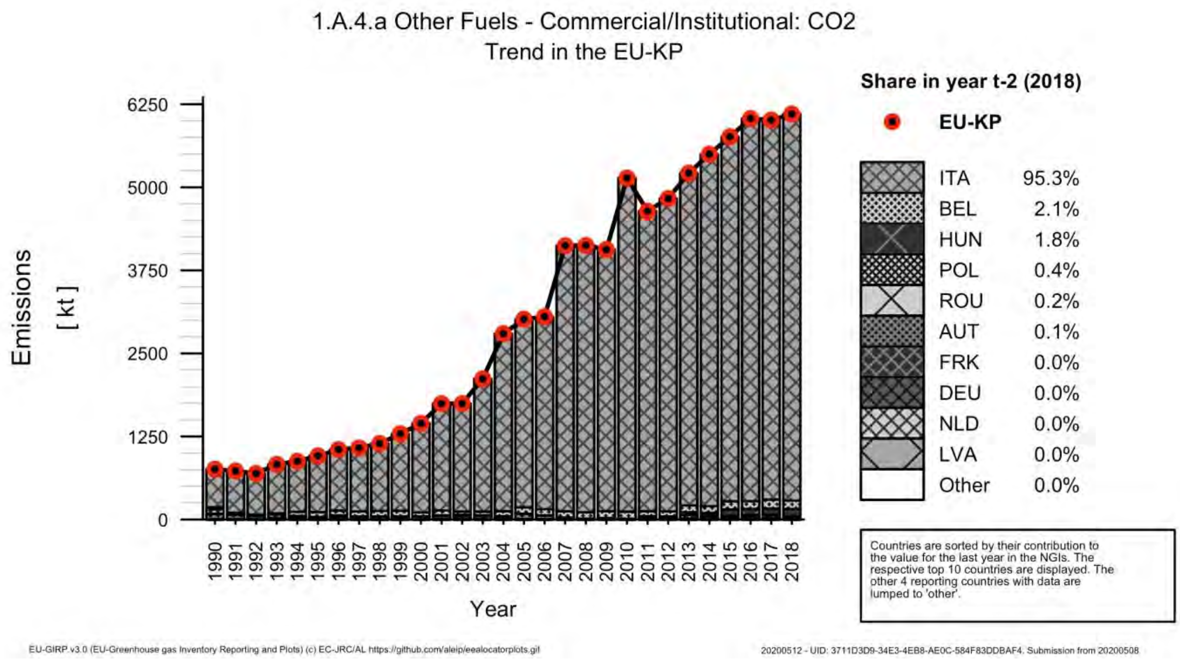
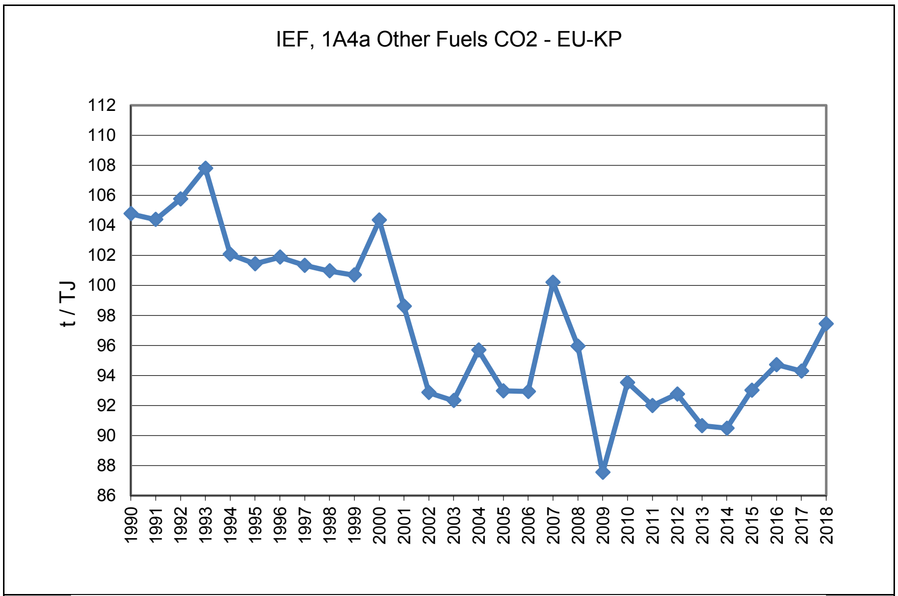
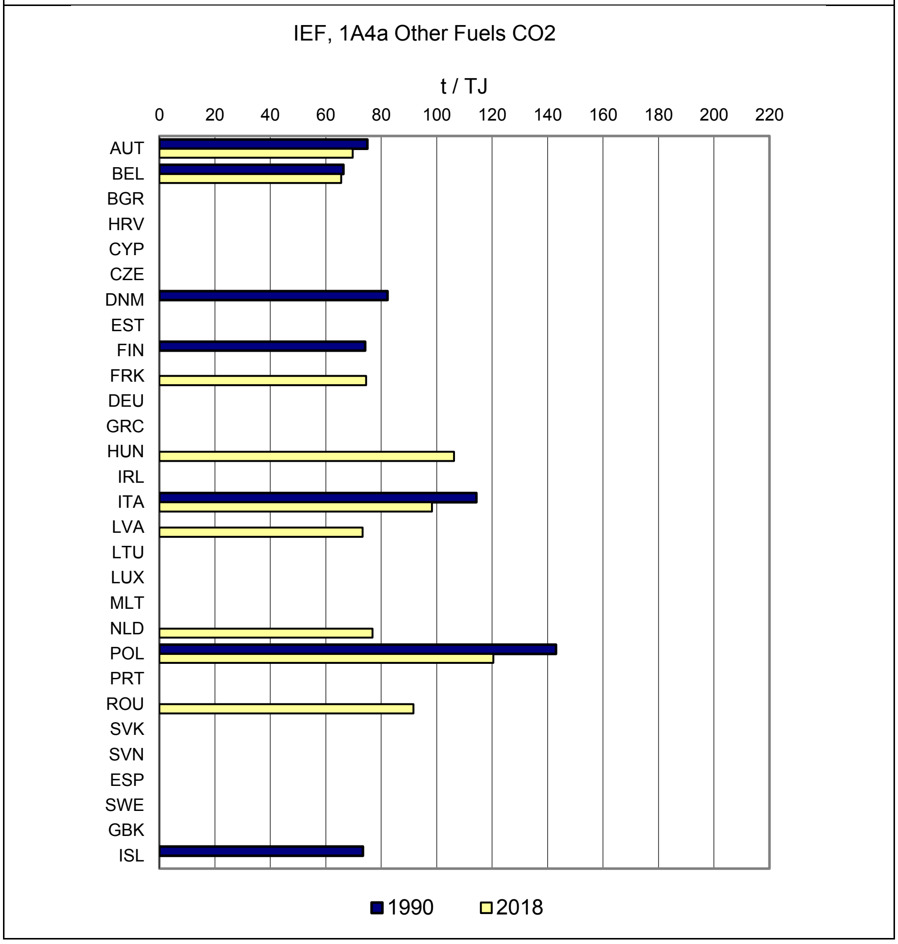


Figure 3.149 1.A.4.a Commercial/Institutional, other fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)





3.2.4.2 **Residential (1.A.4.b)**

CO_2 emissions from 1.A.4.b Residential account for 12% of total GHG emissions from 1A Fuels Combustion in 2018.

Figure 3.150 shows the emission trend within the category 1.A.4.b, which is mainly dominated by CO_2 emissions from liquid and gaseous fuels. Total GHG emissions decreased by 26% since 1990, although CO_2 emissions from gaseous fuels increased strongly (+31%) which was counterbalanced by decreasing emissions from liquid and solid fuels. From 2017 to 2018 CO_2 emissions decreased by 2% and energy consumption decreased by 7% which is correlating with the trend in EU-KP heating degree days (-3%). Biomass consumption reached a share of 23% in the year 2018 (in whole 1.A.4.) while the share of solid fuels consumption dropped to 5%.

Trend in fuel consumption is usually decreasing, although some of the countries have a slight increase for 1.A.4.b in 2018. Same trend is apparent for heating degree days, where most of the countries also experienced decreasing trend except of Spain, Portugal and United Kingdom. The following Table **3.89: EU-27+UK heating degree days 2017 and 2018** and 1.A.4.b trend in total fuel consumption. presents the (15°/18°) heating degree days in 2017 and 2018 for EU-27+UK Member States and the energy consumption-weighted calculated values for EU-27+UK as well as the trend in 1.A.4.b total fuel consumption.

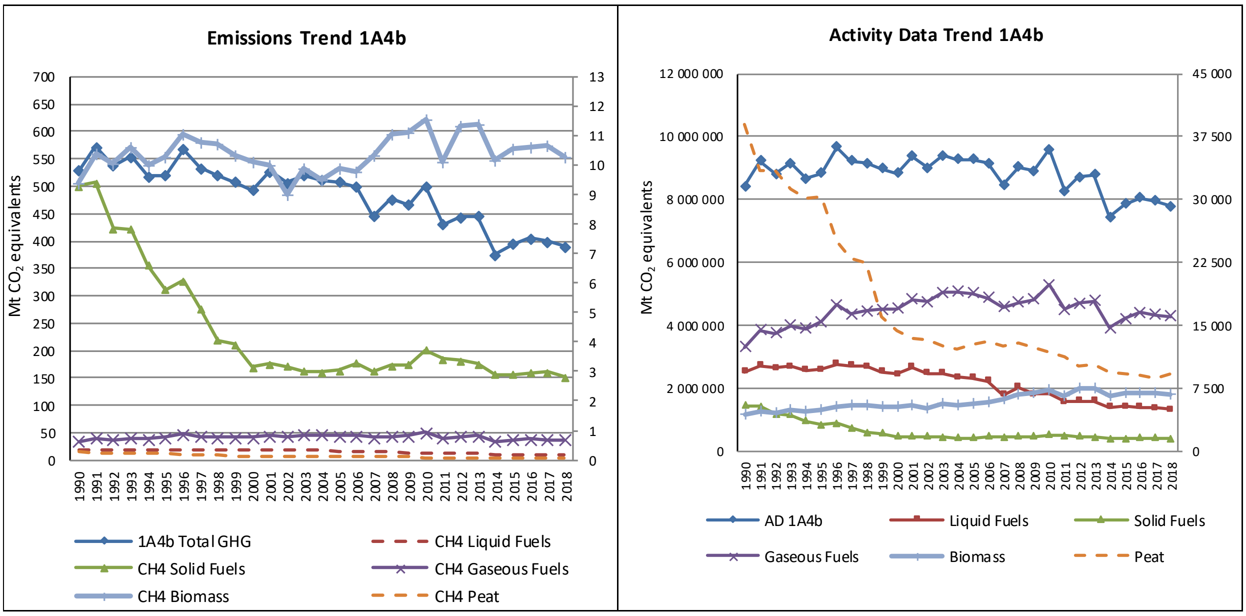
Table 3.89: EU-27+UK heating degree days 2017 and 2018 and 1.A.4.b trend in total fuel consumption.

	2017	2018	Trend 2017 – 2018 [%]	Trend fuel consumption 1.A.4.b [%]
Austria	3503	3196	-9	-9
Belgium	2580	2514	-3	-1
Bulgaria	2533	2358	-7	-6
Croatia	2331	2148	-8	-5
Cyprus	721	477	-34	-17
Czech Republic	3310	2996	-9	-3
Denmark	3117	3051	-2	1
Estonia	4208	4065	-3	0
Finland	5524	5364	-3	-3
France	2338	2184	-7	-5
Germany	2964	2776	-6	-4
Greece	1658	1383	-17	-12
Hungary	2742	2472	-10	-9
Ireland	2670	2756	3	8
Italy	1878	1754	-7	-4
Latvia	4016	3891	-3	5
Lithuania	3830	3696	-4	1
Luxembourg	2870	2670	-7	-7
Malta	485	366	-25	-6
Netherlands	2544	2527	-1	-1
Poland	3290	3125	-5	-2
Portugal	1055	1305	24	1
Romania	2916	2749	-6	1
Slovakia	3280	2922	-11	-12
Slovenia	2833	2584	-9	-8
Spain	1598	1800	13	1
Sweden	5220	5163	-1	-12

	2017	2018	Trend 2017 – 2018 [%]	Trend fuel consumption 1.A.4.b [%]
United Kingdom	2865	2936	2	5
EU27+UK (weighted)	3 032	2 938	-3	-2

Source: EEA 2020

Figure 3.150 1.A.4.b 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 1.A.4.b Residential

Between 1990 and 2018, CO_2 emissions from households decreased by 26% in the EU-KP (Table 3.90). 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 7% between 1990 and 2018, with a fuel shift from coal and oil to natural gas and biomass. Overall, the recently mild winters are apparent on the lower amount of fuel combustion.

Between 1990 and 2018, the largest CO_2 reduction in absolute terms was reported by Germany. Only three Member States show increases in their emissions. One reason for the performance of the Nordic countries 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 2017 and 2018 the largest increase in the emissions is reported by Ireland and Lithuania, followed by Romania and United Kingdom.

Table 3.90 1.A.4.b 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	9 963	6 860	6 257	1.7%	-3 706	-37%	-603	-9%	T1,T2	CS,D
Belgium	20 496	16 421	16 266	4.4%	-4 230	-21%	-155	-1%	CS,T1,T3	D
Bulgaria	2 887	833	674	0.2%	-2 213	-77%	-159	-19%	T1,T2	CS,D
Croatia	2 029	1 566	1 478	0.4%	-551	-27%	-88	-6%	T1	D
Cyprus	300	349	284	0.1%	-15	-5%	-65	-18%	T1	D
Czechia	18 375	8 762	8 115	2.2%	-10 260	-56%	-647	-7%	T1,T2	CS,D
Denmark	4 988	1 894	1 872	0.5%	-3 116	-62%	-22	-1%	M,T1,T2,T3	CS,D
Estonia	1 338	177	170	0.0%	-1 168	-87%	-7	-4%	T1,T2	CS,D
Finland	3 148	1 205	1 111	0.3%	-2 037	-65%	-94	-8%	T1,T2,T3	CS,D
France	55 012	44 294	41 688	11.2%	-13 324	-24%	-2 607	-6%	T1,T2	CS,D
Germany	128 636	86 619	82 695	22.2%	-45 941	-36%	-3 923	-5%	CS,T1,T2	CS
Greece	4 654	4 696	3 973	1.1%	-681	-15%	-723	-15%	T1,T2	CS,D
Hungary	15 798	7 937	7 399	2.0%	-8 399	-53%	-538	-7%	T1,T2	CS,D
Ireland	7 052	5 599	6 048	1.6%	-1 004	-14%	449	8%	T2	CS
Italy	55 554	47 704	46 152	12.4%	-9 403	-17%	-1 552	-3%	T2	CS
Latvia	1 143	464	467	0.1%	-677	-59%	3	1%	T1,T2	CS,D
Lithuania	2 361	751	791	0.2%	-1 571	-67%	40	5%	T2	CS
Luxembourg	670	1 125	1 032	0.3%	362	54%	-93	-8%	T1,T2	CS,D
Malta	95	43	40	0.0%	-55	-57%	-3	-7%	T1	D
Netherlands	20 735	16 501	16 391	4.4%	-4 344	-21%	-110	-1%	T1,T2	CS,D
Poland	35 222	35 916	35 142	9.4%	-81	0%	-775	-2%	T1,T2	CS,D
Portugal	1 640	1 748	1 784	0.5%	144	9%	37	2%	T1,T2	CS,D
Romania	8 424	6 529	6 767	1.8%	-1 658	-20%	237	4%	T1,T2	CS,D
Slovakia	6 773	3 092	2 809	0.8%	-3 964	-59%	-283	-9%	T2	CS
Slovenia	809	677	630	0.2%	-178	-22%	-47	-7%	T1,T2	CS,D
Spain	12 802	14 561	14 691	3.9%	1 889	15%	130	1%	T2	CS,D,OTH
Sweden	6 317	528	472	0.1%	-5 845	-93%	-55	-10%	T1,T2	CS
United Kingdom	78 228	63 749	66 363	17.8%	-11 866	-15%	2 613	4%	T1,T2,T3	CS,D
EU-27+UK	**505 450**	**380 599**	**371 560**	**100%**	**-133 891**	**-26%**	**-9 039**	**-2%**	**-**	**-**
Iceland	31	11	7	0.0%	-23	-76%	-4	-33%	T1,T2	D
United Kingdom (KP)	78 457	64 155	66 779	18.0%	-11 677	-15%	2 625	4%	T1,T2,T3	CS,D
EU-KP	**505 709**	**381 015**	**371 984**	**100%**	**-133 725**	**-26%**	**-9 031**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Liquid Fuels (CO_2)

In 2018 CO_2 from liquid fuels had a share of 25% within source category 1.A.4.b (compared to 36% in 1990). Between 1990 and 2018 emissions decreased by 48% (Table 3.91). Germany, Italy and France show the highest absolute decreases. Only two Member States and United Kingdom reported increasing emissions since 1990. Between 2017 and 2018 EU-KP CO_2 emissions decreased by 4%. 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 88% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.91 1.A.4.b Residential, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	5 605	3 362	3 043	3.2%	-2 562	-46%	-320	-10%	T2	T2
Belgium	12 806	8 418	8 274	8.8%	-4 532	-35%	-144	-2%	T1	T1
Bulgaria	158	66	58	0.1%	-99	-63%	-8	-12%	T1	T1
Croatia	1 137	428	372	0.4%	-764	-67%	-56	-13%	T1	T1
Cyprus	300	349	284	0.3%	-15	-5%	-65	-18%	-	-
Czechia	239	130	145	0.2%	-94	-39%	15	12%	T1	T1
Denmark	3 928	491	518	0.5%	-3 411	-87%	27	6%	T1,T2	T1,T2
Estonia	544	42	40	0.0%	-504	-93%	-2	-4%	-	-
Finland	3 024	1 129	1 039	1.1%	-1 984	-66%	-90	-8%	T2	T2
France	31 195	14 896	13 720	14.6%	-17 475	-56%	-1 176	-8%	-	-
Germany	56 382	34 891	32 740	34.7%	-23 642	-42%	-2 151	-6%	CS	CS
Greece	4 565	3 836	3 185	3.4%	-1 380	-30%	-651	-17%	T2	T2
Hungary	3 540	217	220	0.2%	-3 320	-94%	3	1%	T1	T1
Ireland	1 175	2 894	3 168	3.4%	1 993	170%	274	9%	T2	T2
Italy	28 444	6 060	6 418	6.8%	-22 026	-77%	357	6%	T2	T2
Latvia	332	163	161	0.2%	-171	-51%	-1	-1%	T2	T2
Lithuania	397	159	166	0.2%	-231	-58%	7	4%	T2	T2
Luxembourg	474	489	457	0.5%	-17	-4%	-32	-7%	T2	T2
Malta	95	43	40	0.0%	-55	-57%	-3	-7%	T1	T1
Netherlands	778	181	179	0.2%	-599	-77%	-2	-1%	T2	T2
Poland	110	1 616	1 649	1.7%	1 538	1393%	32	2%	T1,T2	T1,T2
Portugal	1 640	1 153	1 137	1.2%	-503	-31%	-16	-1%	T1	T1
Romania	922	754	791	0.8%	-131	-14%	37	5%	T1,T2	T1,T2
Slovakia	93	23	20	0.0%	-73	-78%	-3	-13%	T2	T2
Slovenia	439	401	373	0.4%	-66	-15%	-28	-7%	T1	T1
Spain	9 855	7 568	7 906	8.4%	-1 949	-20%	338	4%	T2	T2
Sweden	6 231	436	389	0.4%	-5 842	-94%	-46	-11%	T1	T1
United Kingdom	7 128	7 354	7 407	7.9%	280	4%	53	1%	T2	T2
EU-27+UK	**181 536**	**97 551**	**93 902**	**100%**	**-87 634**	**-48%**	**-3 649**	**-4%**		
Iceland	31	11	7	0.0%	-23	-76%	-4	-33%	T1,T2	T1,T2
United Kingdom (KP)	7 326	7 709	7 772	8.2%	446	6%	63	1%	T2	T2
EU-KP	**181 765**	**97 916**	**94 274**	**100%**	**-87 491**	**-48%**	**-3 642**	**-4%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.151 and Figure 3.152 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States and UK with the highest contributions. The largest emissions are reported by Germany and France; together they cause 49% of the CO_2 emissions from liquid fuels in 1.A.4.b. Fuel consumption in the EU-KP decreased by 48% between 1990 and 2018. The CO_2 implied emission factor for liquid fuels was 72.12 t/TJ in 2018. Within the MS there is variation of specific fuels used, which is causing also the fluctuation of the IEF. Most often Residual fuel oil, LPG and other kerosene are used.

Figure 3.151 1.A.4.b Residential, liquid fuels: Emission trend and share for CO_2

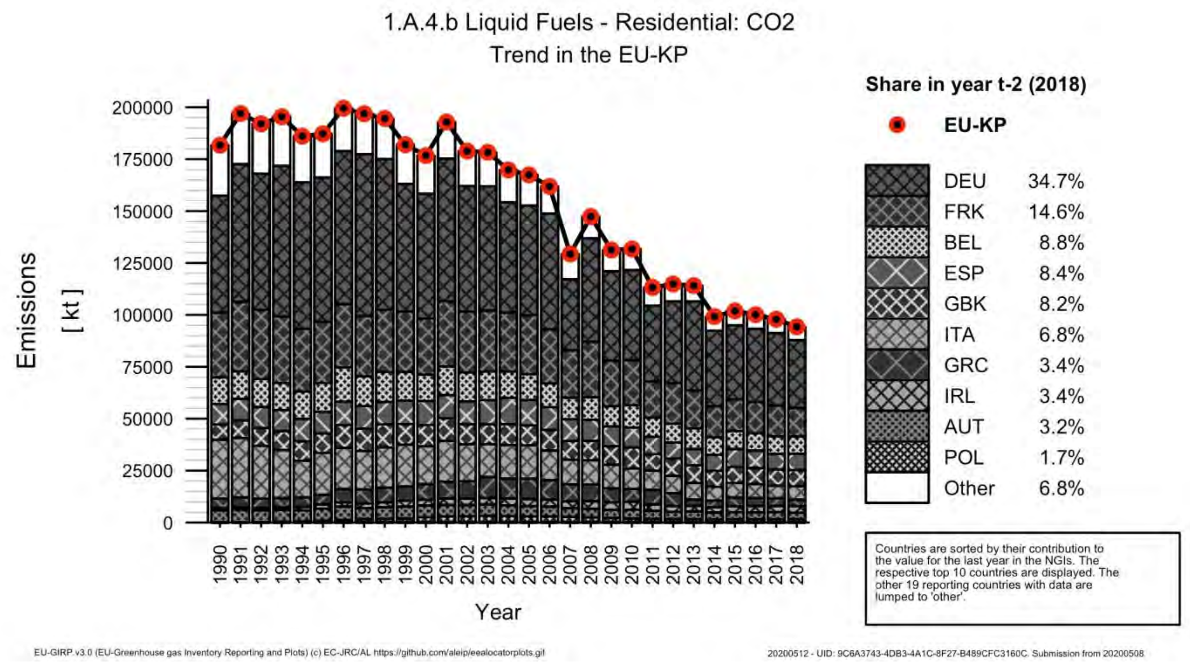
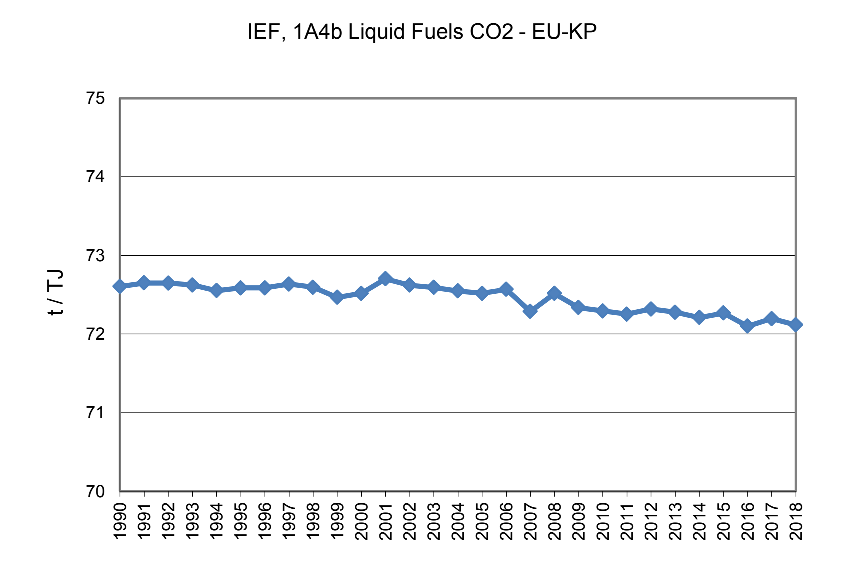
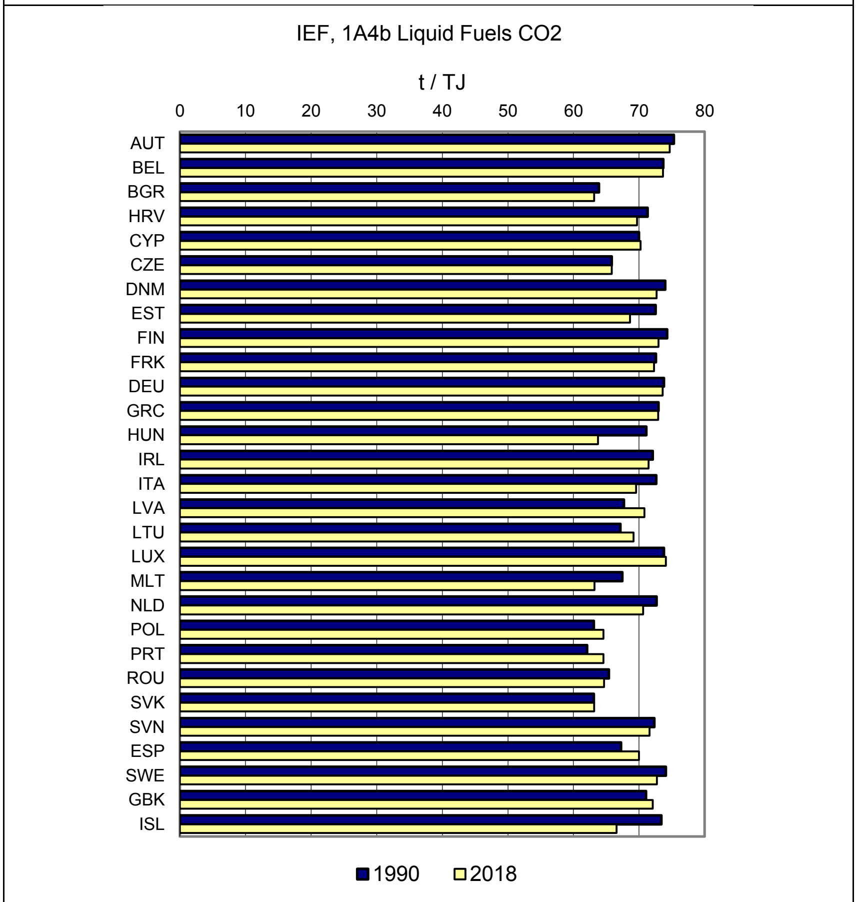


Figure 3.152 1.A.4.b Residential, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.b Residential –Solid Fuels (CO_2)

In 2018 CO_2 from solid fuels had a share of 10% within source category 1.A.4.b (compared to 27% in 1990). Between 1990 and 2018 CO_2 emissions decreased by 74% (Table 3.92). All Member States reported decreasing emissions with the highest reductions in absolute terms in Germany, the United Kingdom and Czechia. Between 2017 and 2018 CO_2 emissions decreased by 5%. Iceland, Cyprus, Denmark, Italy, Malta, Portugal and Sweden report emissions as 'Not occurring' in 2018. According to the methodology as described in chapter 3.2.4 about 99% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.92 1.A.4.b Residential, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	2 511	89	79	0.2%	-2 431	-97%	-10	-11%	T2	T2
Belgium	1 796	114	118	0.3%	-1 678	-93%	5	4%	T1	T1
Bulgaria	2 730	609	436	1.2%	-2 294	-84%	-173	-28%	T1,T2	T1,T2
Croatia	436	12	8	0.0%	-428	-98%	-4	-30%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	16 038	3 966	3 598	10.0%	-12 440	-78%	-368	-9%	T2	T2
Denmark	72	NO	NO	-	-72	-100%	-	-	NA	NA
Estonia	338	10	5	0.0%	-333	-98%	-5	-50%	-	-
Finland	33	1	1	0.0%	-33	-98%	0	-10%	T2	T2
France	3 449	738	405	1.1%	-3 044	-88%	-333	-45%	-	-
Germany	40 661	2 068	1 988	5.5%	-38 673	-95%	-80	-4%	CS	CS
Greece	89	18	15	0.0%	-74	-83%	-3	-19%	T2	T2
Hungary	8 107	614	409	1.1%	-7 698	-95%	-205	-33%	T1,T2	T1,T2
Ireland	2 483	602	628	1.7%	-1 856	-75%	26	4%	T2	T2
Italy	899	NO	NO	-	-899	-100%	-	-	NA	NA
Latvia	548	41	28	0.1%	-520	-95%	-14	-33%	T2	T2
Lithuania	1 440	166	165	0.5%	-1 275	-89%	-2	-1%	T2	T2
Luxembourg	26	2	1	0.0%	-25	-96%	-1	-38%	T1	T1
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	61	5	4	0.0%	-57	-93%	0	-10%	T2	T2
Poland	28 362	25 892	25 240	70.1%	-3 122	-11%	-652	-3%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	2 275	128	122	0.3%	-2 153	-95%	-6	-5%	T1,T2	T1,T2
Slovakia	5 122	322	242	0.7%	-4 880	-95%	-80	-25%	T2	T2
Slovenia	345	0	0	0.0%	-344	-100%	0	-25%	T1	T1
Spain	2 035	390	337	0.9%	-1 698	-83%	-53	-14%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	16 254	2 225	2 171	6.0%	-14 083	-87%	-54	-2%	T2	T2
EU-27+UK	**136 107**	**38 011**	**36 000**	**100%**	**-100 108**	**-74%**	**-2 012**	**-5%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16 283	2 225	2 171	6.0%	-14 113	-87%	-54	-2%	T2	T2
EU-KP	**136 137**	**38 011**	**36 000**	**100%**	**-100 137**	**-74%**	**-2 012**	**-5%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.153 and Figure 3.154 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland, and Czechia; together they cause 80% of the CO_2 emissions from solid fuels in 1.A.4.b. Fuel consumption in the EU-KP decreased by 74% between 1990 and 2018. The CO_2 implied emission factor for solid fuels was 94.74 t/TJ in 2018. 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 3.153 1.A.4.b Residential, solid fuels: Emission trend and share for CO_2

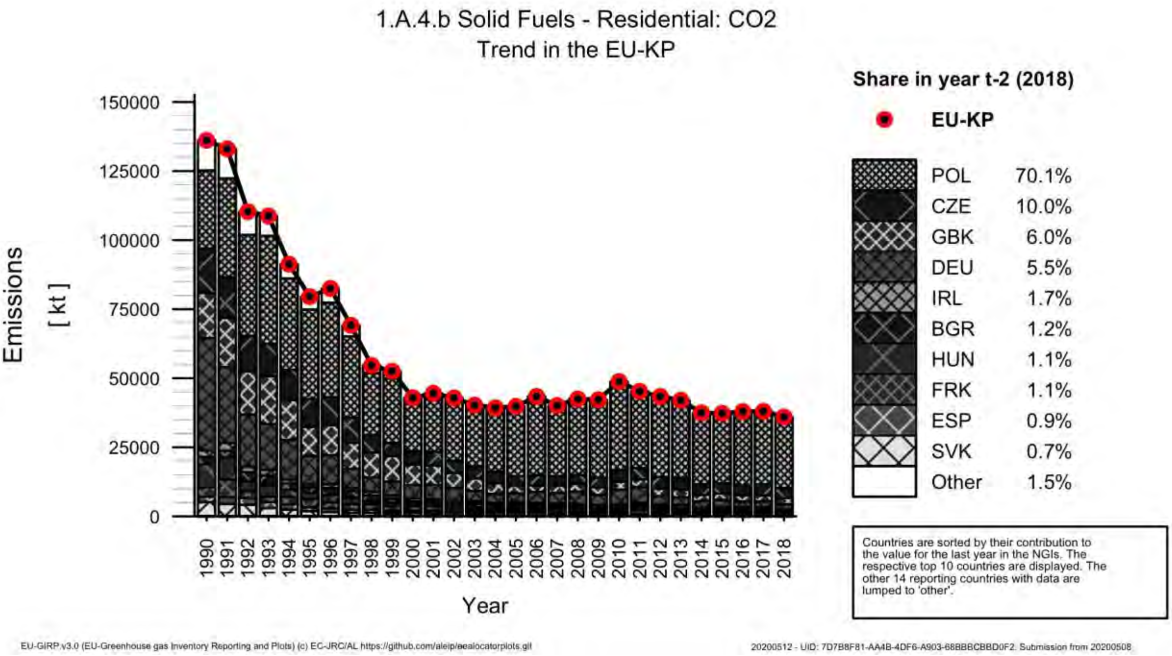
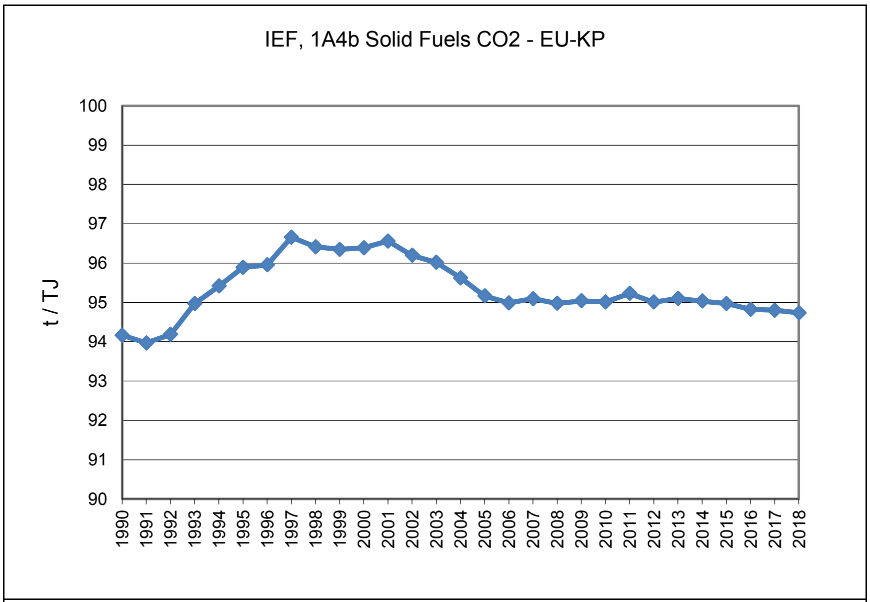
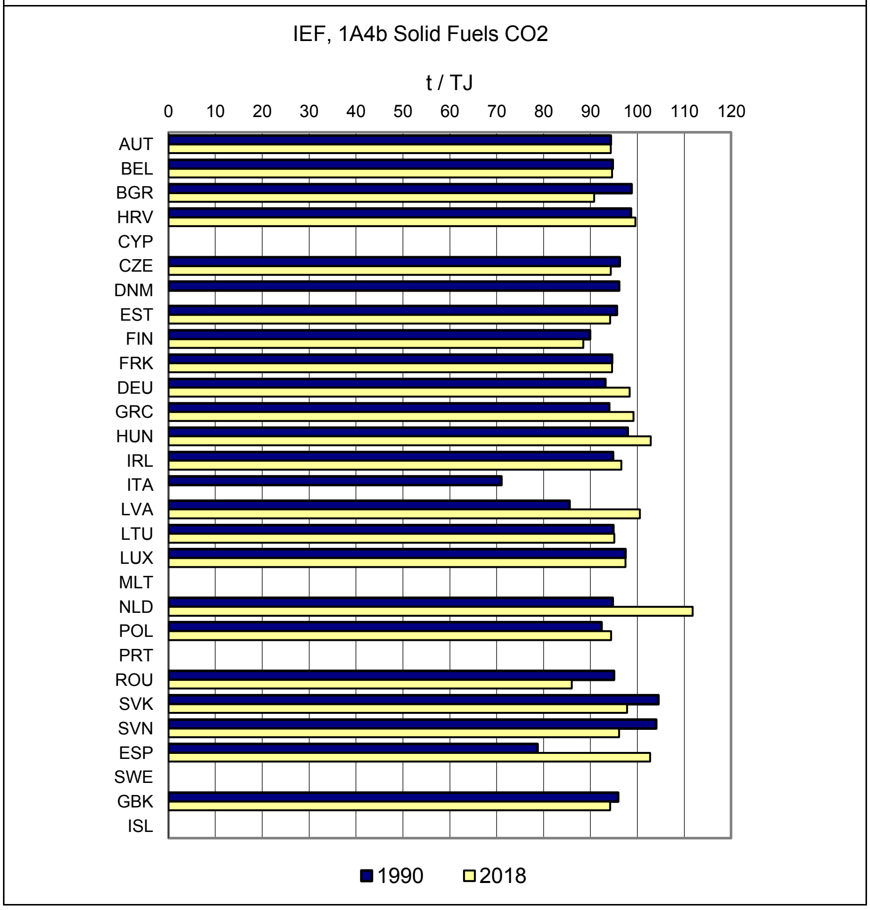


Figure 3.154 1.A.4.b Residential, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.b Residential – Gaseous Fuels (CO_2)

In 2018, CO_2 from gaseous fuels had a share of 65% within source category 1.A.4.b (compared to 36% in 1990). Between 1990 and 2018, the emissions increased by 31% (Table 3.93). All Member States except Lithuania, the Netherlands and Sweden reported increasing emissions from the gaseous fuels combustion. The highest absolute increase occurred in Germany and Italy. Between 2017 and 2018 EU-KP emissions decreased by 1%. According to the methodology as described in chapter 3.2.4 about 93% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.93 1.A.4.b Residential, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 847	3 408	3 134	1.3%	1 287	70%	-274	-8%	T2	T2
Belgium	5 894	7 889	7 873	3.3%	1 980	34%	-16	0%	T1	T1
Bulgaria	NO	158	180	0.1%	180	∞	22	14%	T2	T2
Croatia	456	1 125	1 097	0.5%	642	141%	-28	-2%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	2 098	4 665	4 372	1.8%	2 274	108%	-293	-6%	T2	T2
Denmark	988	1 403	1 354	0.6%	366	37%	-49	-4%	T3	T3
Estonia	117	124	124	0.1%	8	6%	0	0%	-	-
Finland	25	60	56	0.0%	30	120%	-4	-7%	T2	T2
France	20 368	28 649	27 553	11.4%	7 185	35%	-1 096	-4%	-	-
Germany	31 564	49 659	47 967	19.9%	16 402	52%	-1 692	-3%	CS	CS
Greece	IE,NO	842	773	0.3%	773	∞	-69	-8%	T2	T2
Hungary	4 152	7 106	6 770	2.8%	2 619	63%	-336	-5%	T1	T1
Ireland	270	1 296	1 411	0.6%	1 141	423%	115	9%	T2	T2
Italy	26 211	41 643	39 734	16.5%	13 523	52%	-1 909	-5%	T2	T2
Latvia	221	260	278	0.1%	57	26%	18	7%	T2	T2
Lithuania	509	358	383	0.2%	-126	-25%	25	7%	T2	T2
Luxembourg	170	635	574	0.2%	404	238%	-60	-10%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19 896	16 316	16 208	6.7%	-3 688	-19%	-108	-1%	T2	T2
Poland	6 750	8 408	8 253	3.4%	1 503	22%	-155	-2%	T2	T2
Portugal	NO	595	648	0.3%	648	∞	53	9%	T2	T2
Romania	5 228	5 647	5 853	2.4%	625	12%	206	4%	T2	T2
Slovakia	1 559	2 747	2 547	1.1%	988	63%	-201	-7%	T2	T2
Slovenia	25	276	257	0.1%	232	923%	-19	-7%	T2	T2
Spain	913	6 603	6 448	2.7%	5 536	607%	-155	-2%	T2	T2
Sweden	86	92	83	0.0%	-3	-4%	-9	-10%	T1	T1
United Kingdom	54 475	54 165	56 780	23.6%	2 305	4%	2 615	5%	T2	T2
EU-27+UK	**183 819**	**244 130**	**240 709**	**100%**	**56 890**	**31%**	**-3 420**	**-1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	54 475	54 216	56 832	23.6%	2 357	4%	2 616	5%	T2	T2
EU-KP	**183 819**	**244 180**	**240 761**	**100%**	**56 942**	**31%**	**-3 419**	**-1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.155 shows CO_2 emissions for EU-KP and the Member States as well as the share of the Member States and UK with the highest contributions. The largest emissions are reported by the United Kingdom, Germany, Italy and France; together they cause 71.5% of the CO_2 emissions from gaseous fuels in 1.A.4.b. Fuel consumption in the EU-KP rose by 31% between 1990 and 2018. The CO_2 implied emission factor for gaseous fuels was 56.36 t/TJ in 2018.

Figure 3.155 1.A.4.b Residential, gaseous fuels: Emission trend and share for CO_2

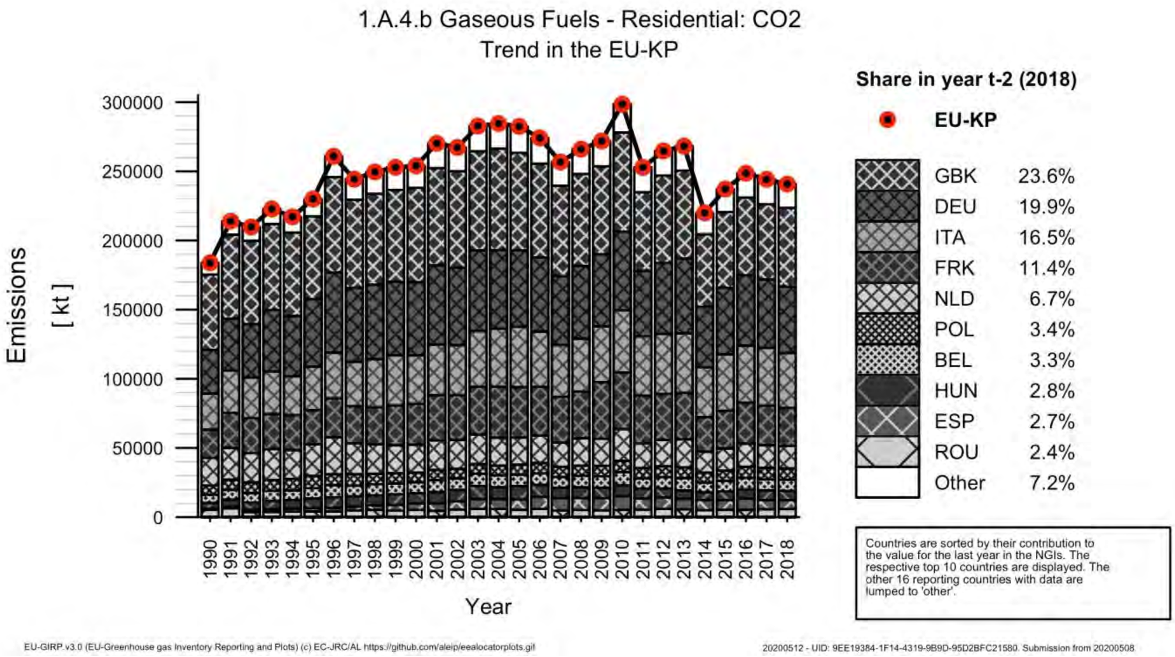
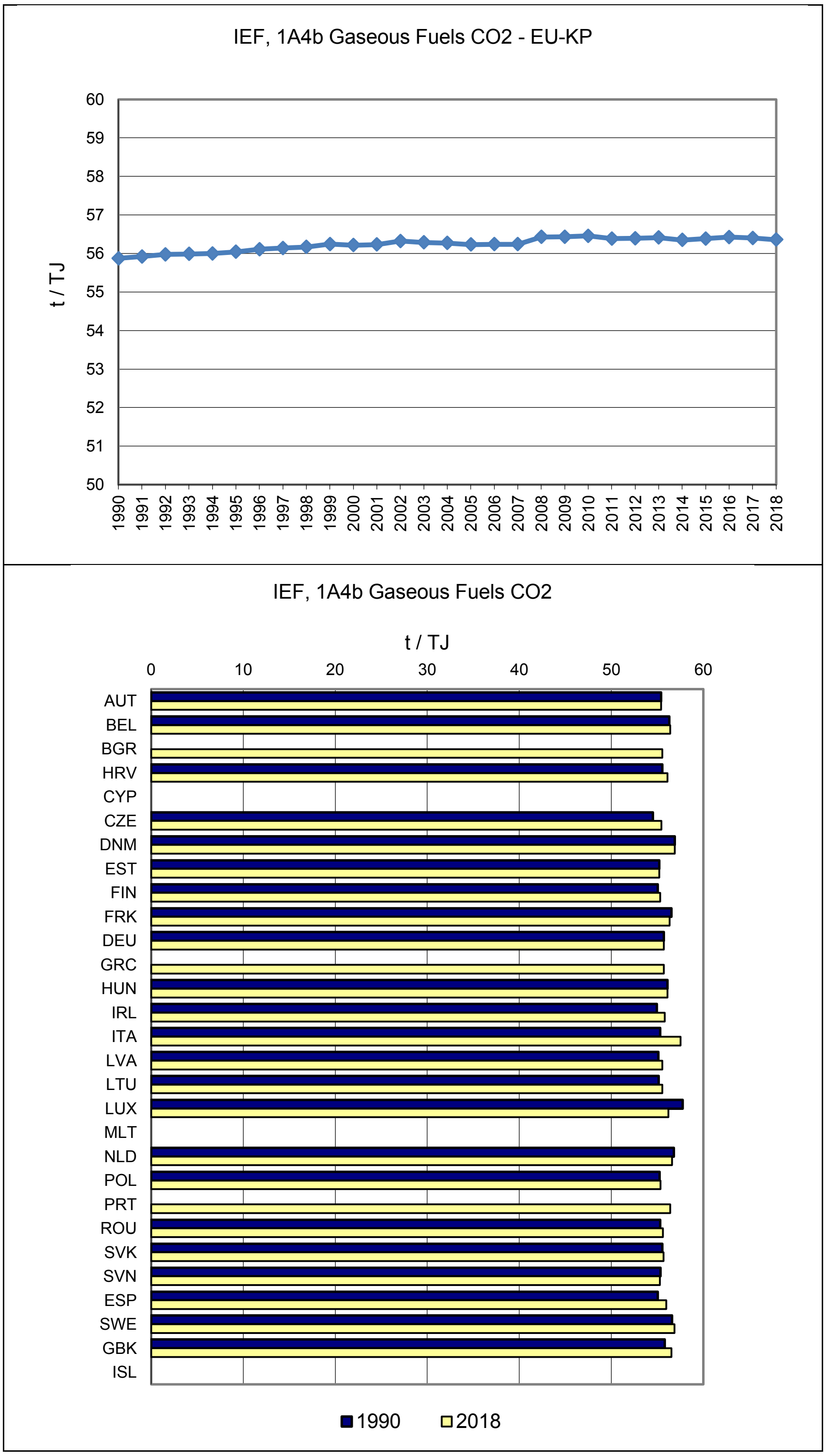


Figure 3.156   1.A.4.b Residential, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



CH_4 emissions from 1.A.4.b Residential

CH_4 emissions mainly occur from incomplete biomass and coal combustion. CH_4 emissions from 1.A.4.b Residential accounted for 57% of total CH_4 emissions and 0.4% of total GHG emissions in 1A in 2018. Between 1990 and 2018, CH_4 emissions from households decreased by 30% in the EU-KP (Table 3.94). France and Germany reported the highest decrease in emissions while Italy reported the highest increase in emissions. Between 2017 and 2018 CH_4 emissions decreased by 4%.

Table 3.94 1.A.4.b 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	462	231	211	1.5%	-251	-54%	-20	-9%	T1,T2,T3	CS,D
Belgium	234	266	266	1.9%	32	14%	0	0%	CS,T1,T3	CR,D
Bulgaria	262	289	268	1.9%	7	3%	-20	-7%	T1	D
Croatia	354	347	331	2.4%	-23	-7%	-16	-5%	T1	D
Cyprus	2	5	4	0.0%	2	124%	-1	-14%	T1	D
Czechia	1 515	898	891	6.3%	-624	-41%	-7	-1%	T1	D
Denmark	120	99	95	0.7%	-25	-21%	-4	-5%	M,T1,T2,T3	CS,D,OTH
Estonia	95	124	124	0.9%	29	31%	0	0%	T1	D
Finland	154	199	195	1.4%	41	27%	-4	-2%	T1,T2,T3	CR,CS,D
France	4 679	1 188	1 102	7.8%	-3 577	-76%	-86	-7%	T1,T2	CS,D
Germany	2 484	745	718	5.1%	-1 766	-71%	-27	-4%	T2,T3	CS,M
Greece	229	221	209	1.5%	-20	-9%	-12	-5%	T1	D
Hungary	829	572	471	3.4%	-357	-43%	-101	-18%	T1	D
Ireland	443	127	133	0.9%	-309	-70%	6	5%	T1	D
Italy	1 095	2 317	2 146	15.3%	1 052	96%	-170	-7%	T2	CR
Latvia	197	130	135	1.0%	-62	-31%	5	4%	T1,T2	CS,D
Lithuania	175	147	145	1.0%	-30	-17%	-2	-1%	T1,T2	CS,D
Luxembourg	9	10	11	0.1%	1	15%	0	2%	T1,T3	D,M
Malta	0	1	1	0.0%	0	90%	0	-2%	T1	D
Netherlands	454	417	415	3.0%	-39	-9%	-2	0%	T1,T2	CS,D
Poland	2 441	2 903	2 838	20.2%	397	16%	-65	-2%	T1	D
Portugal	428	214	213	1.5%	-215	-50%	-2	-1%	T1,T2	D,OTH
Romania	374	983	975	6.9%	601	161%	-8	-1%	T1,T2	D
Slovakia	378	199	158	1.1%	-220	-58%	-41	-21%	T1	D
Slovenia	142	118	106	0.8%	-35	-25%	-12	-10%	T1,T2	CS,D
Spain	794	859	858	6.1%	63	8%	-2	0%	T2	D
Sweden	103	62	53	0.4%	-50	-48%	-9	-14%	M,T1	CS
United Kingdom	1 510	917	973	6.9%	-537	-36%	56	6%	T1,T2,T3	CS,D
EU-27+UK	**19 961**	**14 590**	**14 046**	**100%**	**-5 915**	**-30%**	**-543**	**-4%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-82%	0	-42%	T1,T2	D
United Kingdom (KP)	1 513	918	975	6.9%	-538	-36%	56	6%	T1,T2,T3	CS,D
EU-KP	**19 965**	**14 591**	**14 048**	**100%**	**-5 917**	**-30%**	**-543**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Biomass (CH_4)

In 2018 CH_4 from biomass had a share of 73% within source category on the total emissions from 1.A.4.b (compared to 47% in 1990). Between 1990 and 2018 CH_4 emissions increased by 9% (Table 3.95). France reported the highest absolute decrease, while CH_4 emissions of Italy increased significantly. Between 2017 and 2018, CH_4 emissions decreased by 4%. According to the methodology as described in chapter 3.2.4 about 54% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.95 1.A.4.b Residential, biomass: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	242	211	192	1.9%	-50	-20%	-18	-9%	T1,T2	T1,T2
Belgium	97	233	232	2.3%	135	138%	-1	0%	T1	T1
Bulgaria	54	239	232	2.3%	178	328%	-7	-3%	T1	T1
Croatia	316	343	327	3.2%	10	3%	-16	-5%	T1	T1
Cyprus	1	4	3	0.0%	2	234%	0	-12%	-	-
Czechia	324	572	595	5.8%	271	83%	23	4%	T1	T1
Denmark	110	97	92	0.9%	-18	-16%	-5	-5%	T1,T3	T1,T3
Estonia	40	123	123	1.2%	83	206%	0	0%	-	-
Finland	137	191	188	1.8%	51	37%	-3	-2%	T2	T2
France	4 252	1 009	956	9.3%	-3 296	-78%	-53	-5%	-	-
Germany	280	541	521	5.1%	241	86%	-19	-4%	T2	T2
Greece	220	218	207	2.0%	-14	-6%	-12	-5%	T1	T1
Hungary	186	510	425	4.1%	238	128%	-85	-17%	T1	T1
Ireland	14	9	9	0.1%	-5	-36%	0	5%	T1	T1
Italy	996	2 263	2 094	20.4%	1 098	110%	-169	-7%	T2	T2
Latvia	145	125	132	1.3%	-13	-9%	6	5%	T2	T2
Lithuania	58	128	125	1.2%	67	114%	-3	-2%	T2	T2
Luxembourg	5	7	8	0.1%	3	58%	1	7%	T1	T1
Malta	NO	0	0	0.0%	0	∞	0	-1%	T1	T1
Netherlands	96	123	123	1.2%	27	28%	0	0%	T1	T1
Poland	258	823	810	7.9%	553	215%	-13	-2%	T1	T1
Portugal	425	212	211	2.0%	-214	-50%	-2	-1%	T2	T2
Romania	181	958	950	9.2%	769	425%	-8	-1%	T1	T1
Slovakia	36	170	135	1.3%	99	275%	-35	-21%	T1	T1
Slovenia	115	116	104	1.0%	-11	-9%	-12	-10%	T2	T2
Spain	651	794	796	7.7%	144	22%	2	0%	T2	T2
Sweden	96	59	50	0.5%	-46	-48%	-9	-15%	T1	T1
United Kingdom	62	595	650	6.3%	588	952%	55	9%	T1	T1
EU-27+UK	**9 398**	**10 672**	**10 289**	**100%**	**891**	**9%**	**-384**	**-4%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	62	595	650	6.3%	588	952%	55	9%	T1	T1
EU-KP	**9 398**	**10 672**	**10 289**	**100%**	**891**	**9%**	**-384**	**-4%**		

Abbreviations explained in the Chapter 'Units and abbreviation'.

Figure 3.157 and

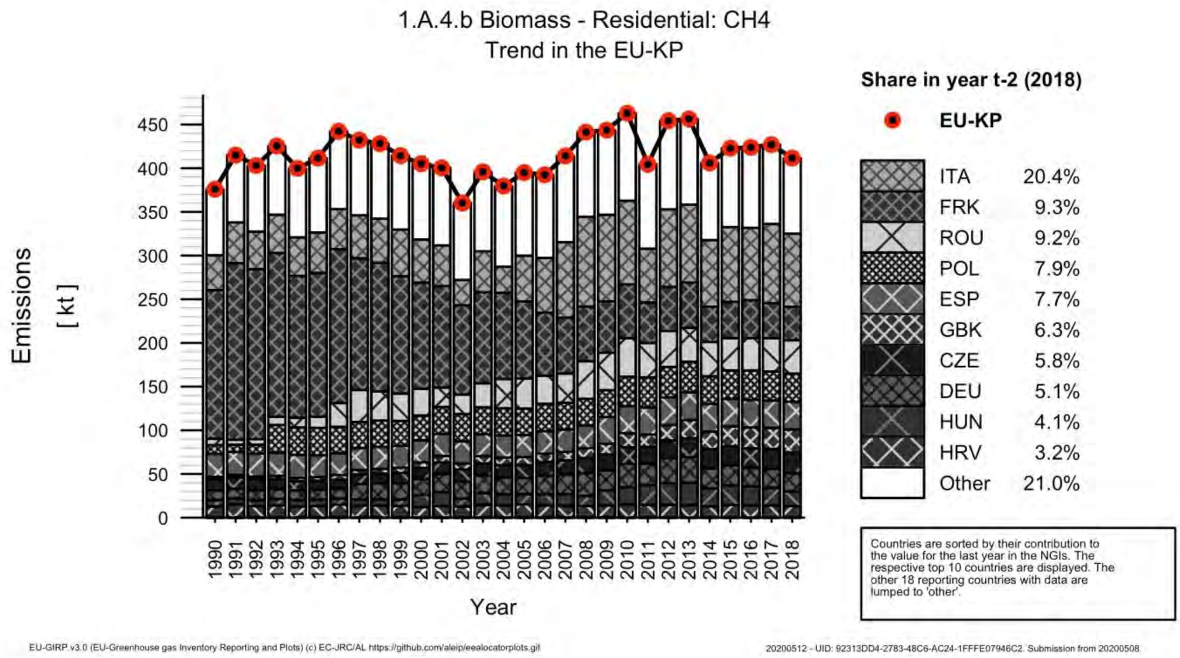


Figure 3.158 show CH_4 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Italy, France

and Romania; together they cause 39% of the CH_4 emissions from biomass fuels in 1.A.4.b. Biomass fuel consumption in the EU-KP rose by 58% between 1990 and 2018. The CH_4 implied emission factor for biomass fuels was 228.82 kg/TJ in 2018.

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 3.157 1.A.4.b Residential, biomass: Emission trend and share for CH_4

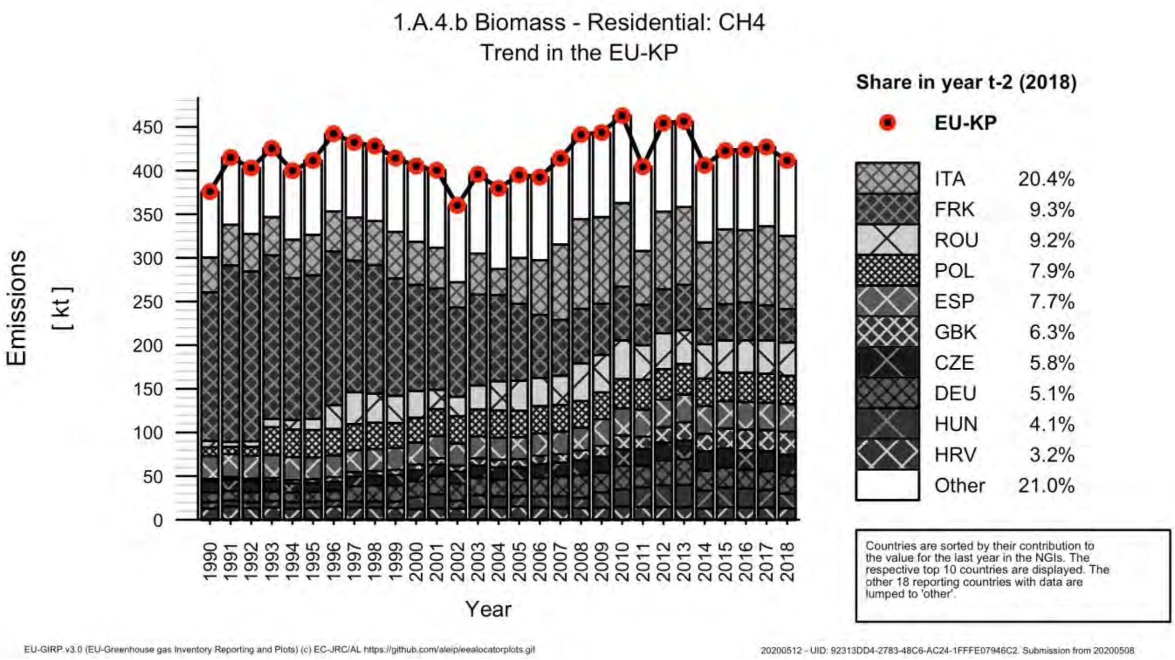
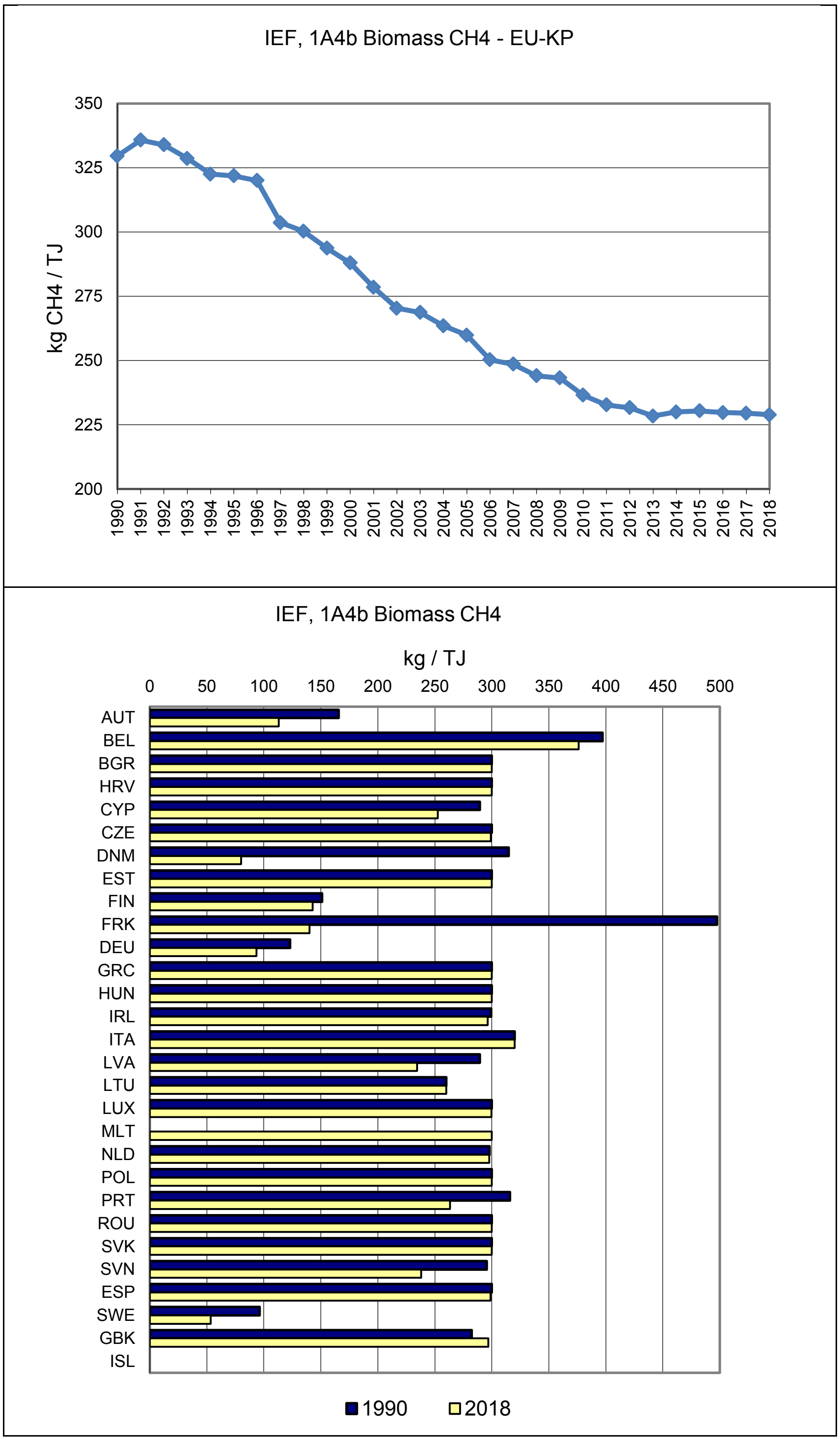


Figure 3.158 1.A.4.b Residential, biomass: Implied Emission Factors for CH_4 (in kg/TJ)



1.A.4.b Residential – Solid Fuels (CH_4)

In 2018 CH_4 from solid fuels had a share of 20% within source category 1.A.4.b (compared to 47% in 1990). Between 1990 and 2018 CH_4 emissions decreased by 70% (Table 3.96). All Member States reported decreasing emissions since 1990 with Germany and the United Kingdom showing the largest absolute decreases. Between 2017 and 2018 CH_4 emissions decreased by 5 %. According to the methodology as described in chapter 3.2.4 about 7% of EU-KP emissions are calculated by using higher tier methods in 2017.

Table 3.96: 1.A.4.b Residential, solid fuels: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	200	7	6	0.2%	-193	-97%	-1	-11%	T1,T2	T1,T2
Belgium	110	8	8	0.3%	-101	-92%	0	5%	T1	T1
Bulgaria	207	50	36	1.3%	-171	-83%	-14	-28%	T1	T1
Croatia	33	1	1	0.0%	-33	-98%	0	-30%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	1 186	315	286	10.1%	-900	-76%	-29	-9%	T1	T1
Denmark	6	NO	NO	-	-6	-100%	-	-	T1,T3	T1,T3
Estonia	26	1	0	0.0%	-26	-98%	0	-50%	-	-
Finland	3	0	0	0.0%	-3	-98%	0	-10%	T2	T2
France	273	59	32	1.1%	-241	-88%	-26	-45%	-	-
Germany	2 168	128	123	4.4%	-2 045	-94%	-5	-4%	T2	T2
Greece	7	1	1	0.0%	-6	-84%	0	-19%	T1	T1
Hungary	621	44	30	1.1%	-591	-95%	-15	-33%	T1	T1
Ireland	197	47	49	1.7%	-148	-75%	2	4%	T1	T1
Italy	10	NO	NO	-	-10	-100%	-	-	T2	T2
Latvia	48	3	2	0.1%	-46	-96%	-1	-33%	T2	T2
Lithuania	114	13	13	0.5%	-101	-89%	0	-1%	T2	T2
Luxembourg	2	0	0	0.0%	-2	-96%	0	-38%	T1	T1
Malta	NO	NO	NO	-	-	-	-	-	T1	T1
Netherlands	0	0	0	0.0%	0	-46%	0	-10%	T1	T1
Poland	2 168	2 058	2 006	71.1%	-162	-7%	-52	-3%	T1	T1
Portugal	NO	NO	NO	-	-	-	-	-	T2	T2
Romania	179	11	11	0.4%	-169	-94%	0	-2%	T1	T1
Slovakia	339	23	18	0.6%	-321	-95%	-5	-23%	T1	T1
Slovenia	25	0	0	0.0%	-25	-100%	0	-25%	T2	T2
Spain	116	28	25	0.9%	-91	-79%	-4	-14%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	T1	T1
United Kingdom	1 271	177	173	6.1%	-1 098	-86%	-4	-2%	T1	T1
EU-27+UK	**9 308**	**2 975**	**2 820**	**100%**	**-6 488**	**-70%**	**-155**	**-5%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 273	177	173	6.1%	-1 100	-86%	-4	-2%	T1	T1
EU-KP	**9 310**	**2 975**	**2 820**	**100%**	**-6 491**	**-70%**	**-155**	**-5%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.157 and

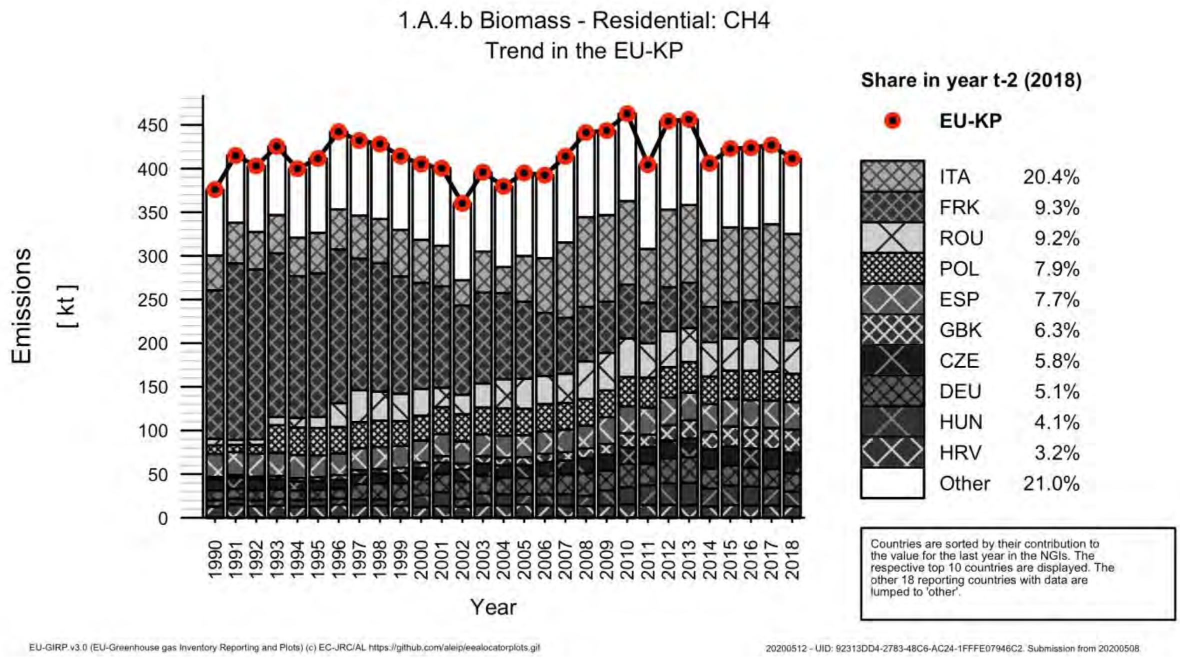


Figure 3.158 show CH_4 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland with a share of 71% of total CH_4 emissions from solid fuels in 1.A.4.b. Solid fuel consumption in the EU-KP decreased by 74% between 1990 and 2018. The CH_4 implied emission factor for solid fuels was 296.8 kg/TJ in 2018.

Figure 3.159: 1.A.4.b Residential, solid fuels: Emission trend and share for CH_4

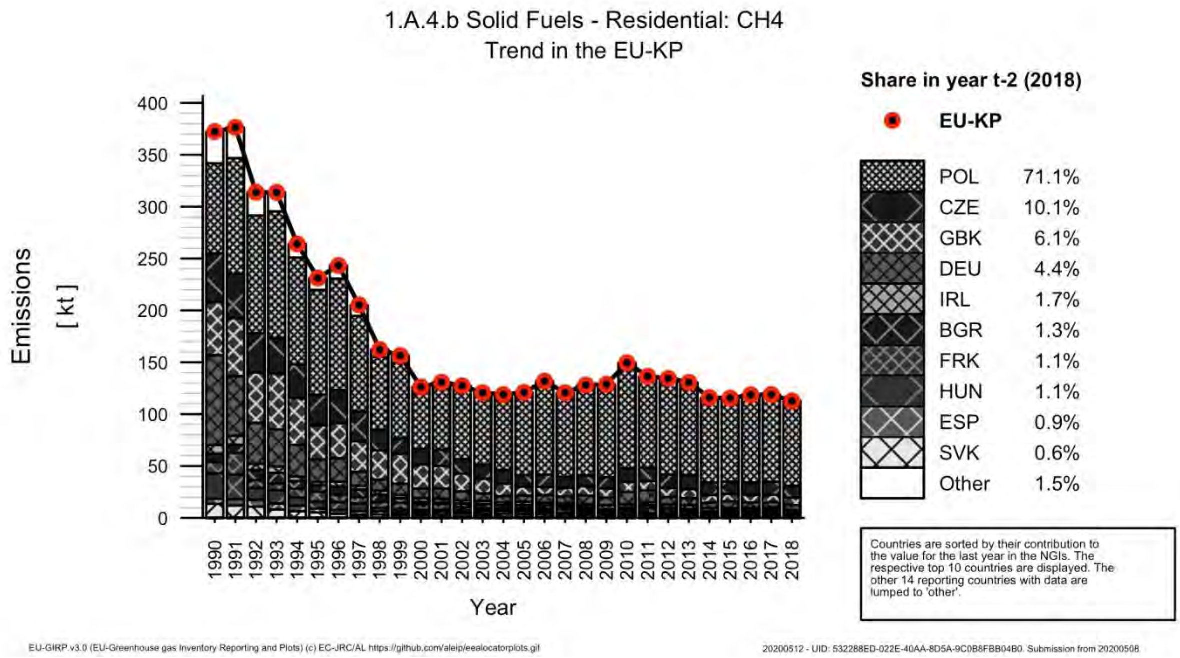
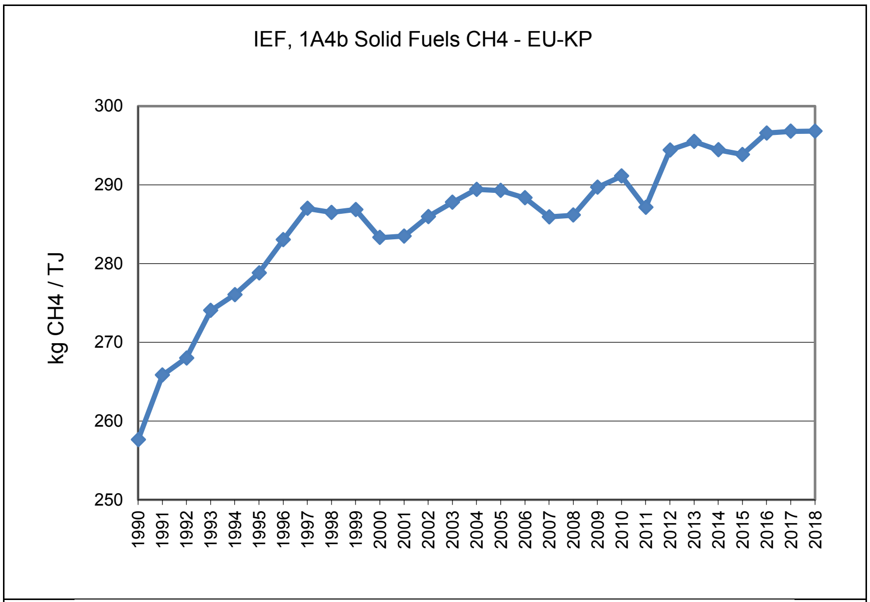
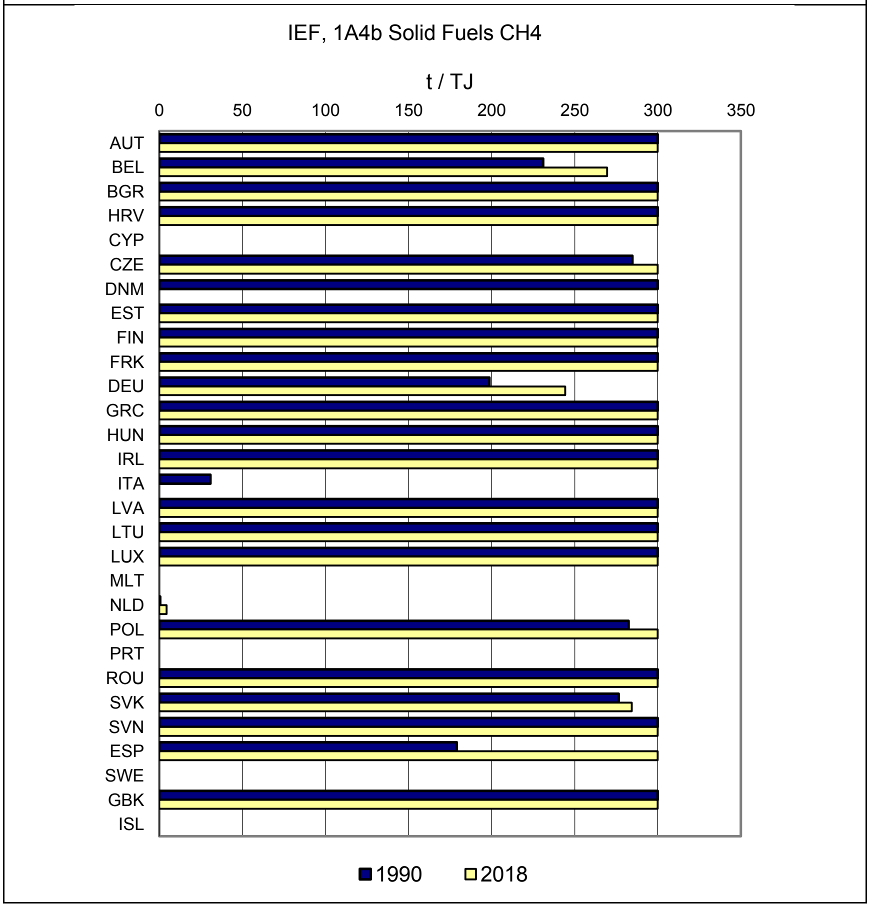


Table 3.97: 1.A.4.b Residential, solid fuels: Implied Emission Factors for CH_4 (in kg/TJ)





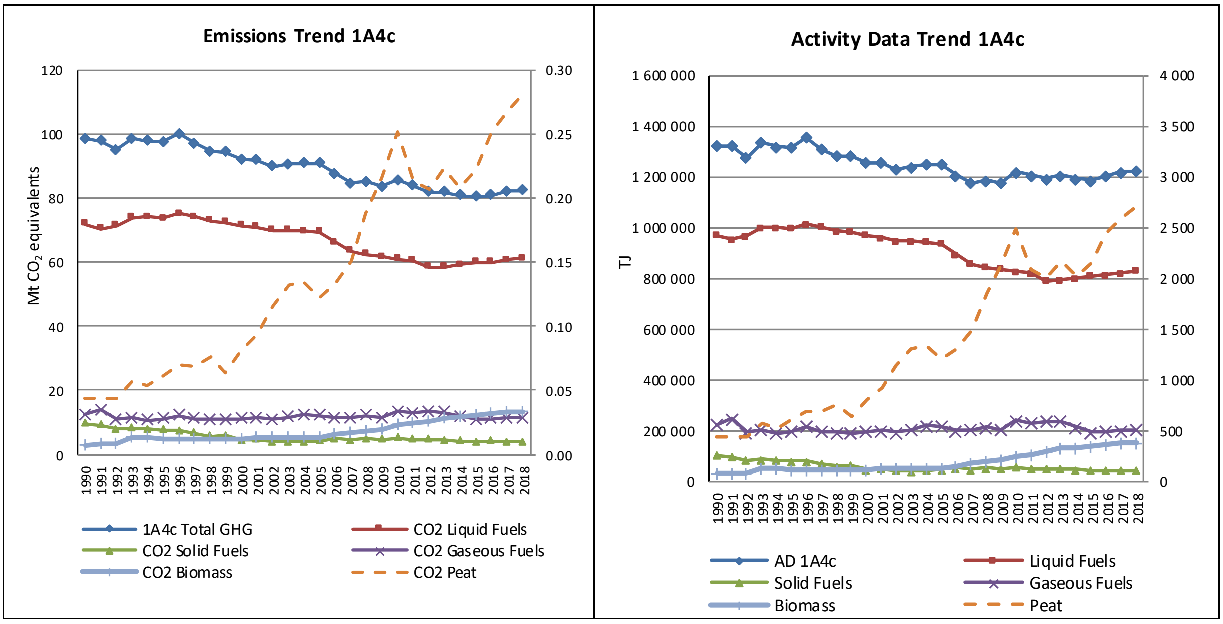
3.2.4.3 **Agriculture/Forestry/Fisheries (1.A.4.c)**

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1.A.4.c by fuels. CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries accounted for 2.4% of total EU-KP GHG emissions in 1A Fuel Combustion in 2018. Between 1990 and

2018, CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries decreased by 17% in the EU-KP (Table 3.98).

Figure 3.160 shows the emission trend within source category 1.A.4.c, which is mainly dominated by CO_2 emissions from liquid fuels. Total GHG emissions decreased by 16%, mainly due to decreases in CO_2 emissions from liquid fuels (-15%).

Figure 3.160 1.A.4.c 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 2018. Spain and Poland were the Member States with the highest increase in absolute terms between 1990 and 2018, while the highest decreases were achieved in Czechia, Germany and Greece.

Table 3.98 1.A.4.c 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 252	841	839	1.1%	-413	-33%	-2	0%	D,NO,T1,T2,T3	CS,D,NO
Belgium	3 036	2 159	2 223	2.9%	-814	-27%	64	3%	CS,T1,T3	D
Bulgaria	1 649	433	457	0.6%	-1 192	-72%	24	6%	T1,T2	CS,D
Croatia	835	629	642	0.8%	-194	-23%	13	2%	T1	D
Cyprus	55	84	79	0.1%	23	42%	-5	-6%	T1	D
Czechia	3 672	1 212	1 206	1.6%	-2 466	-67%	-6	-1%	T1,T2	CS,D
Denmark	2 595	1 501	1 482	1.9%	-1 112	-43%	-18	-1%	CR,M,T1,T2,T3	CS,D
Estonia	495	235	216	0.3%	-279	-56%	-19	-8%	T1,T2	CS,D
Finland	1 863	1 366	1 302	1.7%	-561	-30%	-64	-5%	T1,T2,T3	CS,D
France	11 318	10 433	10 359	13.5%	-959	-8%	-74	-1%	T1,T2	CS,D
Germany	10 270	6 242	5 930	7.7%	-4 340	-42%	-312	-5%	CS,T1,T2,T3	CS,D
Greece	2 893	458	463	0.6%	-2 430	-84%	5	1%	T1,T2	CS,D,NO
Hungary	2 655	1 398	1 478	1.9%	-1 178	-44%	80	6%	T1,T2	CS,D
Ireland	747	576	622	0.8%	-125	-17%	46	8%	T1,T2	CS,D
Italy	8 352	7 029	7 426	9.7%	-925	-11%	398	6%	T2	CS
Latvia	1 579	438	433	0.6%	-1 146	-73%	-6	-1%	T1,T2	CS,D
Lithuania	1 483	210	204	0.3%	-1 279	-86%	-6	-3%	T2	CS
Luxembourg	34	23	23	0.0%	-11	-32%	0	2%	T1,T2	CS,D
Malta	4	16	18	0.0%	14	368%	2	12%	T1	D
Netherlands	9 836	8 843	8 680	11.3%	-1 156	-12%	-163	-2%	T1,T2	CS,D
Poland	8 504	10 916	11 133	14.5%	2 629	31%	217	2%	T1,T2	CS,D
Portugal	1 119	1 140	1 156	1.5%	37	3%	16	1%	NO,T1,T2	CS,D,NO
Romania	1 994	1 242	1 384	1.8%	-611	-31%	142	11%	T1,T2	CS,D
Slovakia	146	387	334	0.4%	187	128%	-53	-14%	T1,T2	CS,D
Slovenia	334	217	217	0.3%	-117	-35%	0	0%	T1	D
Spain	8 678	11 328	11 472	14.9%	2 793	32%	143	1%	T1,T2,T3	S,D,M,OTH
Sweden	1 827	1 319	1 219	1.6%	-608	-33%	-100	-8%	T1,T2	CS
United Kingdom	5 978	5 044	5 030	6.5%	-948	-16%	-14	0%	T1,T2,T3	CS,D
EU-27+UK	**93 205**	**75 719**	**76 028**	**99%**	**-17 177**	**-18%**	**308**	**0%**	-	-
Iceland	738	529	546	0.7%	-192	-26%	17	3%	T1	D
United Kingdom (KP)	6 164	5 308	5 302	6.9%	-862	-14%	-6	0%	T1,T2,T3	CS,D
EU-KP	**94 129**	**76 512**	**76 845**	**100%**	**-17 284**	**-18%**	**334**	**0%**	-	-

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.c Agriculture/Forestry/Fisheries – Liquid Fuels (CO_2)

In 2018 CO_2 from liquid fuels had a share of 80% within source category 1.A.4.c (compared to 76% in 1990). Between 1990 and 2018 CO_2 decreased by 15% (Table 3.99). Seven Member States reported increasing emissions with the highest increases in absolute terms in Poland. Between 2017 and 2018 EU-KP emissions increased by 1%. According to the methodology as described in chapter 3.2.4 87% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.99 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	1 181	780	783	1.3%	-397	-34%	4	0%	T2	T2
Belgium	2 757	1 073	1 067	1.7%	-1 690	-61%	-6	-1%	T1	T1
Bulgaria	1 498	359	387	0.6%	-1 111	-74%	28	8%	T1	T1
Croatia	788	582	596	1.0%	-192	-24%	14	2%	T1	T1
Cyprus	55	84	79	0.1%	23	42%	-5	-6%	T1	T1
Czechia	1 536	1 033	1 058	1.7%	-478	-31%	24	2%	T1	T1
Denmark	2 231	1 344	1 349	2.2%	-882	-40%	6	0%	T1,T2	T1,T2
Estonia	476	230	216	0.4%	-259	-55%	-14	-6%	T1,T2	T1,T2
Finland	1 778	1 143	1 082	1.8%	-695	-39%	-61	-5%	T1	T1
France	10 996	9 906	9 767	15.9%	-1 229	-11%	-140	-1%	T1,T2	T1,T2
Germany	6 926	5 543	5 296	8.6%	-1 631	-24%	-247	-4%	CS	CS
Greece	2 882	455	461	0.8%	-2 421	-84%	6	1%	T2	T2
Hungary	2 085	1 109	1 222	2.0%	-863	-41%	113	10%	T1	T1
Ireland	747	576	622	1.0%	-125	-17%	46	8%	T1,T2	T1,T2
Italy	8 300	6 701	7 097	11.6%	-1 203	-14%	396	6%	T2	T2
Latvia	701	403	404	0.7%	-297	-42%	1	0%	T2	T2
Lithuania	1 173	149	144	0.2%	-1 029	-88%	-5	-3%	T2	T2
Luxembourg	34	22	23	0.0%	-12	-34%	0	1%	NA	NA
Malta	4	16	18	0.0%	14	368%	2	12%	T1	T1
Netherlands	2 507	1 624	1 581	2.6%	-926	-37%	-43	-3%	T1,T2	T1,T2
Poland	4 724	6 998	7 333	12.0%	2 609	55%	335	5%	T1,T2	T1,T2
Portugal	1 119	1 115	1 134	1.9%	15	1%	19	2%	T1	T1
Romania	9	943	1 057	1.7%	1 048	11194%	115	12%	T1,T2	T1,T2
Slovakia	104	313	269	0.4%	164	158%	-44	-14%	T2	T2
Slovenia	334	217	217	0.4%	-117	-35%	0	0%	NA	NA
Spain	8 635	11 150	11 116	18.2%	2 481	29%	-34	0%	T2,T3	T2,T3
Sweden	1 638	1 305	1 205	2.0%	-432	-26%	-100	-8%	T1	T1
United Kingdom	5 747	4 857	4 838	7.9%	-908	-16%	-18	0%	T2	T2
EU-27+UK	**70 963**	**60 030**	**60 421**	**99%**	**-10 541**	**-15%**	**391**	**1%**		
Iceland	738	529	546	0.9%	-192	-26%	17	3%	NA	NA
United Kingdom (KP)	5 933	5 121	5 110	8.3%	-822	-14%	-10	0%	T2	T2
EU-KP	**71 887**	**60 823**	**61 239**	**100%**	**-10 648**	**-15%**	**417**	**1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.161 and

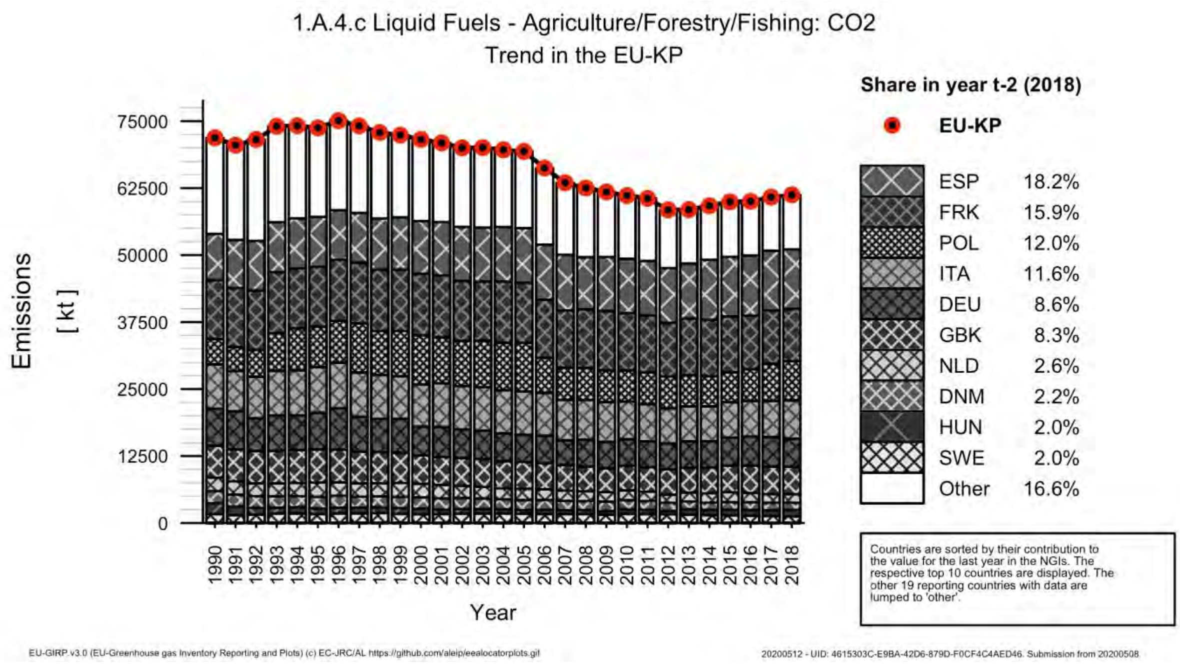


Figure 3.162 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by Spain and France; together they cause 34% of the CO_2 emissions from liquid fuels in 1.A.4.c. Fuel consumption in the EU-KP decreased by 15% between 1990 and 2018. The CO_2 implied emission factor for liquid fuels was 73.94 t/TJ in 2018.

Figure 3.161 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Emission trend and share for CO_2

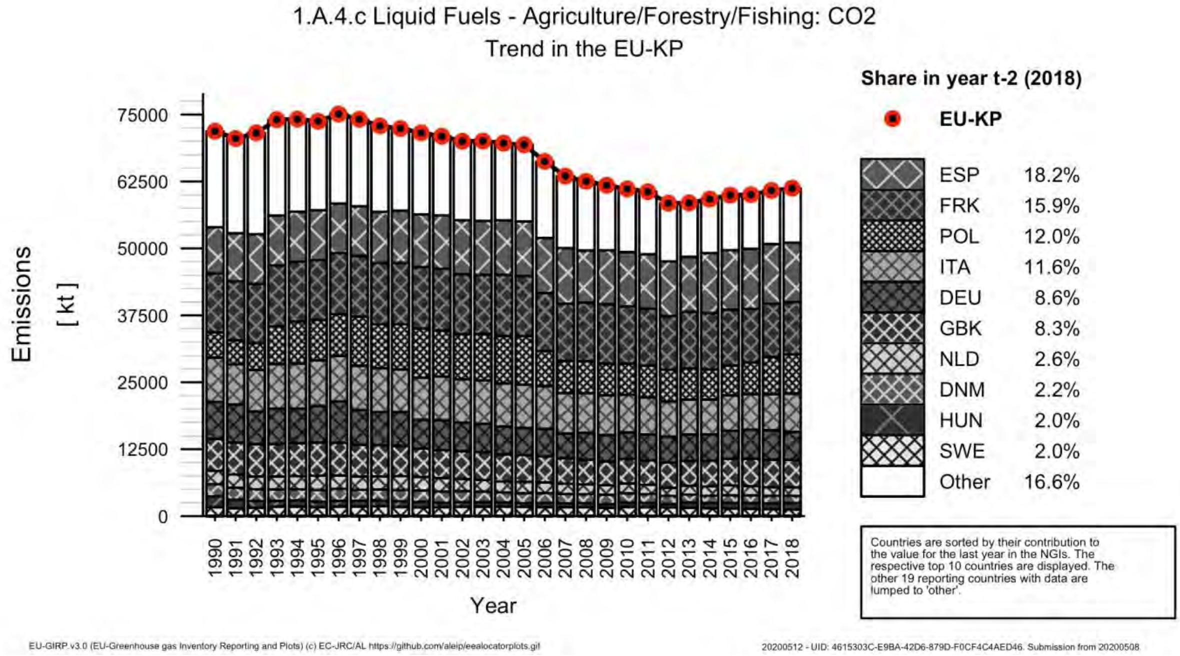
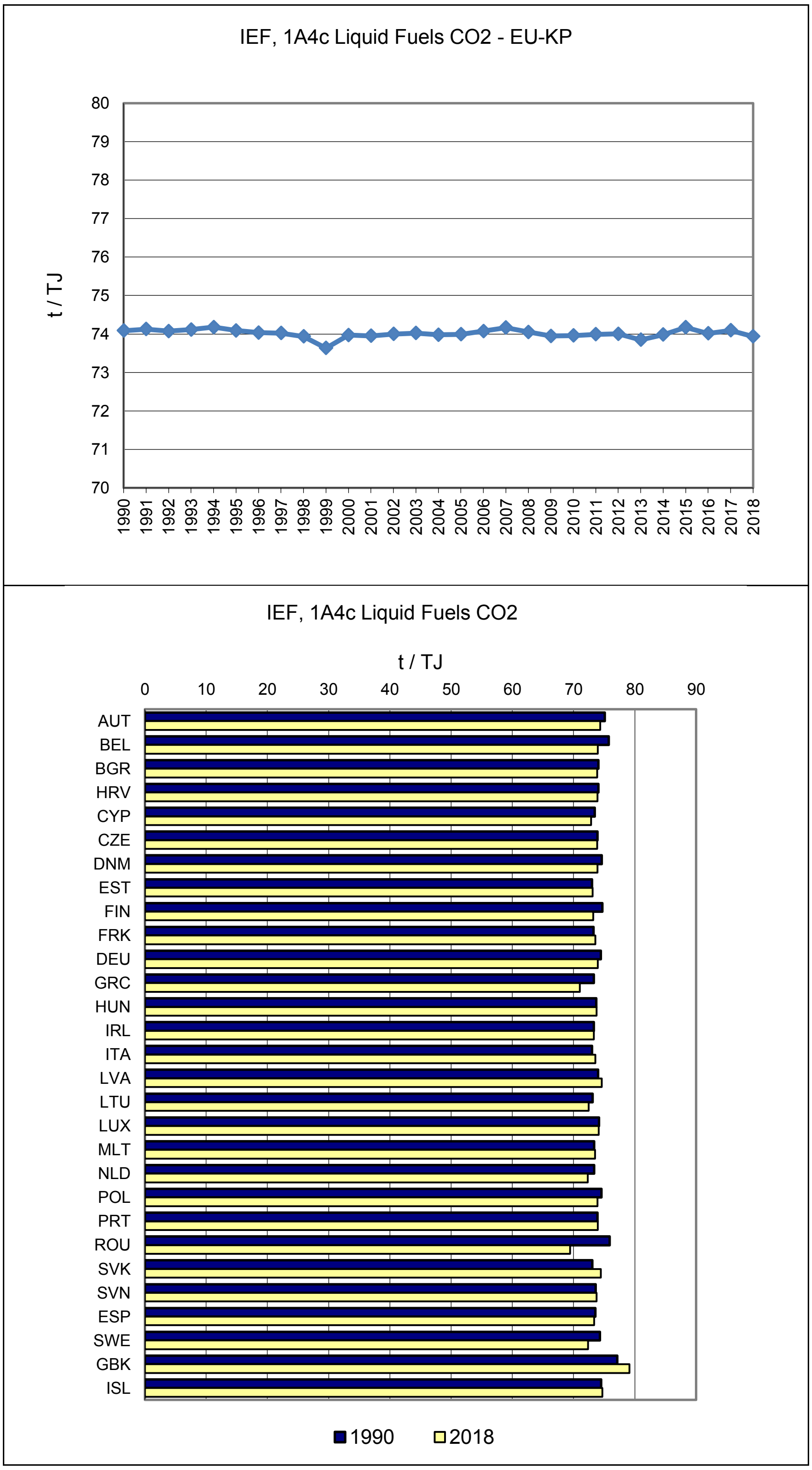


Figure 3.162 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



Different IEF for Romania is caused by the specific methodology of the MS. Default emission factors for the fuels which are not reported under EU-ETS, are used. For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS analysis, Tier 2 methodology is used. The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those provided in correspondence with this activity in the Energy

Balance, and for the concerned fuels, the national weighted averages values derived from the EU-ETS reports, are used.

1.A.4.c Agriculture/Forestry/Fisheries – Solid Fuels (CO_2)

In 2018 CO_2 from solid fuels had a share of 5% within source category 1.A.4.c (compared to 10% in 1990). Between 1990 and 2018 CO_2 decreased by 60% (Table 3.100). Fourteen member states, Iceland and United Kingdom reported CO_2 emissions from this source category as 'Not occurring' in 2018. All Member States except Slovakia reported decreasing emissions between 1990 and 2018. Between 2017 and 2018 EU-KP emissions decreased by 3%, mainly due to decrease reported by Denmark. 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 97% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.100 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	51	3	2	0.1%	-49	-95%	0	-11%	T2	T2
Belgium	212	65	65	1.7%	-147	-69%	0	0%	T1	T1
Bulgaria	151	39	37	0.9%	-114	-76%	-2	-6%	T1,T2	T1,T2
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 730	26	25	0.6%	-1 705	-99%	-1	-3%	T2	T2
Denmark	237	42	34	0.9%	-203	-86%	-8	-19%	T1	T1
Estonia	16	4	NO	-	-16	-100%	-4	-100%	NA	NA
Finland	13	7	6	0.1%	-8	-57%	-1	-18%	T3	T3
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	2 861	10	9	0.2%	-2 852	-100%	-1	-7%	CS	CS
Greece	11	3	2	0.1%	-9	-78%	-1	-28%	T2	T2
Hungary	134	1	4	0.1%	-130	-97%	2	174%	T1,T2	T1,T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	92	0	NO	-	-92	-100%	0	-100%	NA	NA
Lithuania	148	9	9	0.2%	-139	-94%	0	2%	T2	T2
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	3 755	3 834	3 731	95.0%	-25	-1%	-104	-3%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	65	0	0	0.0%	-64	-99%	0	1121%	NA	NA
Slovakia	1	2	2	0.1%	1	47%	0	-9%	T2	T2
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-27+UK	**9 721**	**4 045**	**3 926**	**100%**	**-5 796**	**-60%**	**-119**	**-3%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-KP	**9 721**	**4 045**	**3 926**	**100%**	**-5 796**	**-60%**	**-119**	**-3%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.163 and Figure **3.164** show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. Poland contributes to 95% of emissions in 2018. Fuel consumption in the EU-KP decreased by 59% between 1990 and 2018. The CO_2 implied emission factor for solid fuels was 94.5 t/TJ in 2018.

Figure 3.163 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Emission trend and share for CO_2

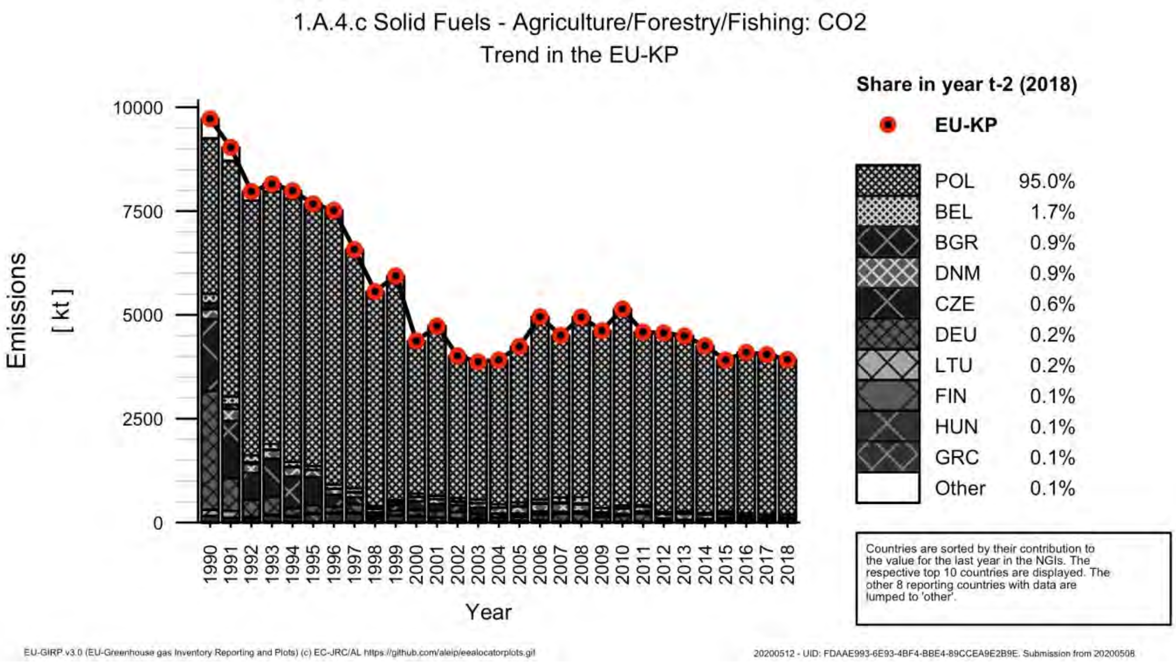
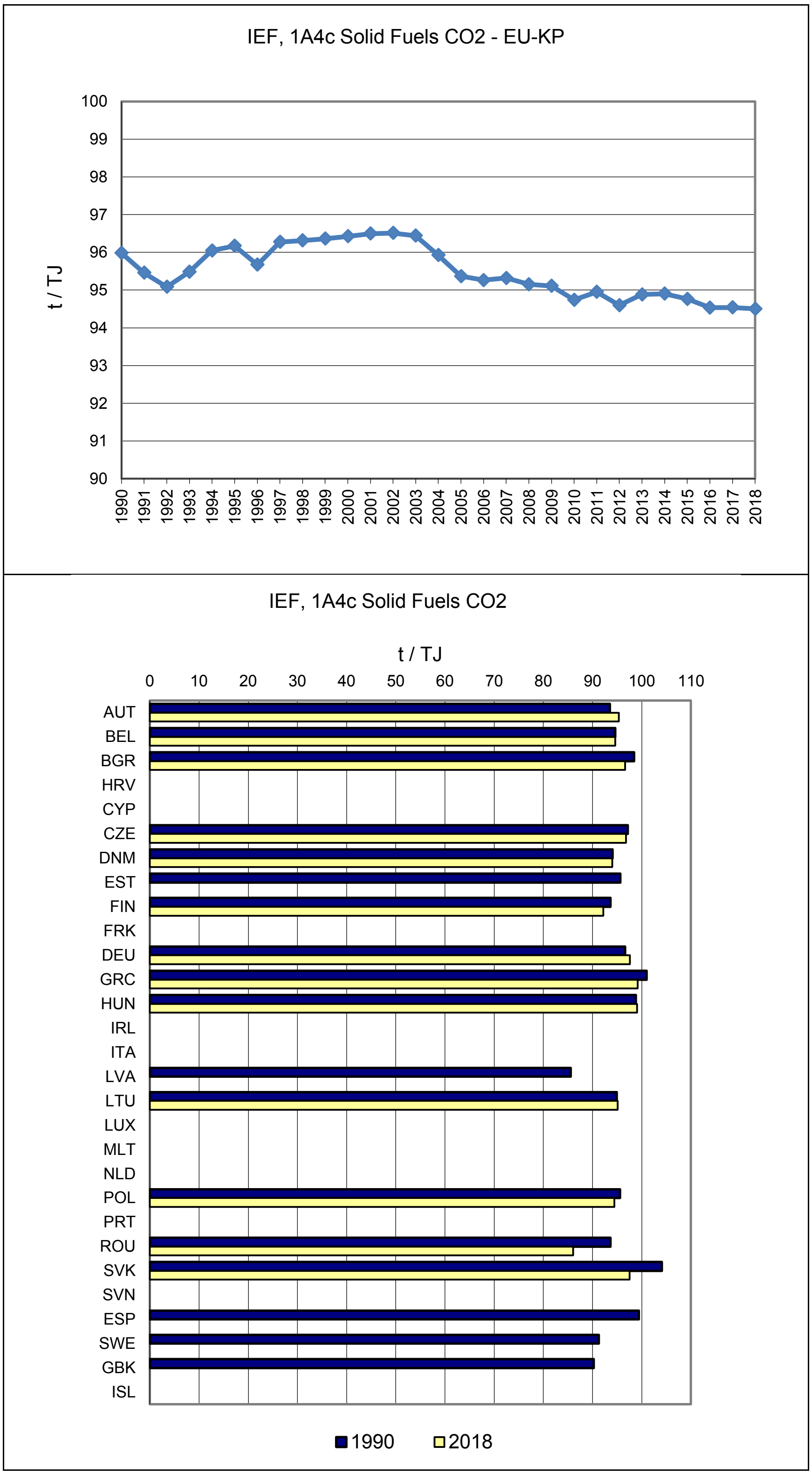


Figure 3.164 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries –Gaseous Fuels (CO_2)

In 2018, CO_2 from gaseous fuels had a share of 15% within source category 1.A.4.c (compared to 13% in 1990). Between 1990 and 2018 CO_2 emissions decreased by 9% (Table 3.101). The highest increase occurred in Bulgaria (+16651%). Between 2017 and 2018 EU-KP emissions neither increased nor decreased. This source of emissions 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 88% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.101 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	20	56	51	0.4%	30	150%	-6	-10%	T2	T2
Belgium	68	1 021	1 091	9.6%	1 023	1511%	70	7%	T1	T1
Bulgaria	0	35	33	0.3%	33	16651%	-2	-5%	T2	T2
Croatia	48	47	46	0.4%	-2	-4%	-1	-2%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	405	152	123	1.1%	-283	-70%	-30	-19%	T2	T2
Denmark	126	115	99	0.9%	-27	-22%	-16	-14%	T3	T3
Estonia	4	1	NO	-	-4	-100%	-1	-100%	NA	NA
Finland	32	2	2	0.0%	-30	-93%	0	-7%	T2	T2
France	322	492	559	4.9%	237	73%	66	13%	T1,T2	T1,T2
Germany	483	677	613	5.4%	131	27%	-64	-9%	CS	CS
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	437	288	252	2.2%	-185	-42%	-35	-12%	T1	T1
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	52	328	329	2.9%	278	539%	1	0%	T2	T2
Latvia	782	35	28	0.2%	-754	-96%	-6	-18%	T2	T2
Lithuania	162	51	49	0.4%	-114	-70%	-2	-4%	T2	T2
Luxembourg	NO	0	0	0.0%	0	∞	0	12%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 329	7 217	7 096	62.5%	-234	-3%	-121	-2%	T1,T2	T1,T2
Poland	25	84	70	0.6%	45	183%	-14	-17%	T2	T2
Portugal	NO	25	22	0.2%	22	∞	-3	-13%	T2	T2
Romania	1 920	247	260	2.3%	-1 660	-86%	13	5%	T2	T2
Slovakia	41	72	63	0.6%	22	55%	-9	-12%	T2	T2
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	6	179	356	3.1%	350	5681%	177	99%	T2	T2
Sweden	33	14	14	0.1%	-19	-57%	0	-2%	T1	T1
United Kingdom	182	187	192	1.7%	10	6%	4	2%	T2	T2
EU-27+UK	**12 477**	**11 325**	**11 348**	**100%**	**-1 129**	**-9%**	**23**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	182	187	192	1.7%	10	6%	4	2%	T2	T2
EU-KP	**12 477**	**11 325**	**11 348**	**100%**	**-1 129**	**-9%**	**23**	**0%**		

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 3.165 and

Figure 3.166 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. The largest emissions are reported by the Netherlands, accounting for 63% of the CO_2 emissions from gaseous fuels in 1.A.4.c. Fuel consumption in the EU-KP decreased by 9% between 1990 and 2018. The CO_2 implied emission factor for gaseous fuels was 56.46 t/TJ in 2018.

Figure 3.165 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Emission trend and share for CO_2

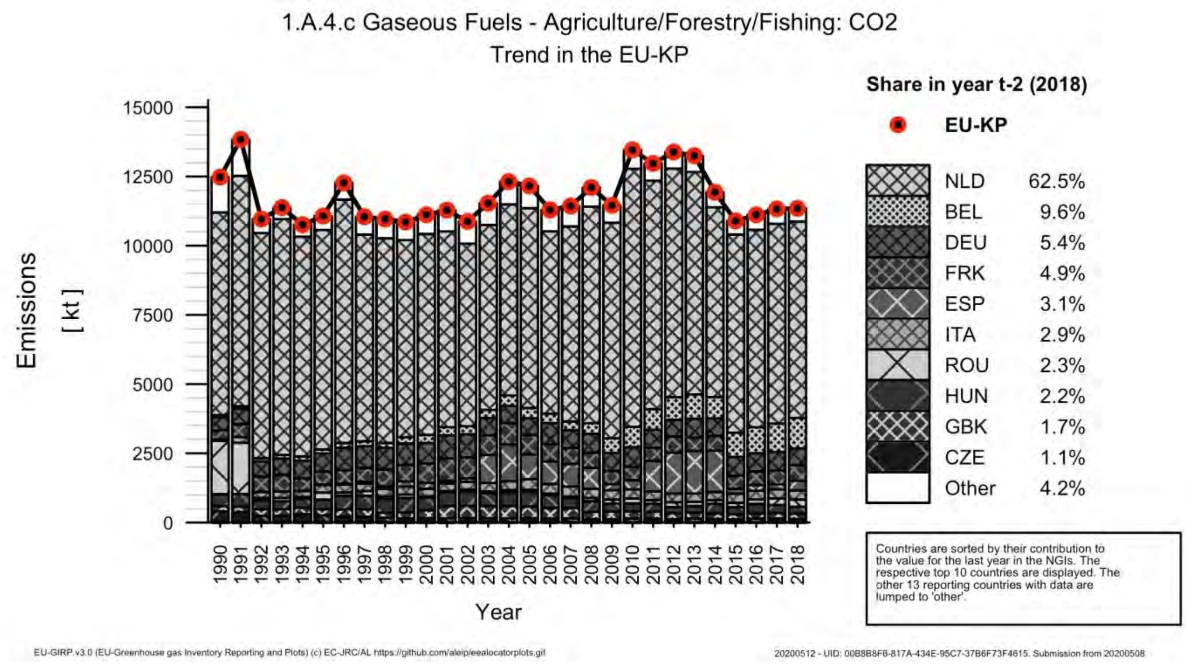
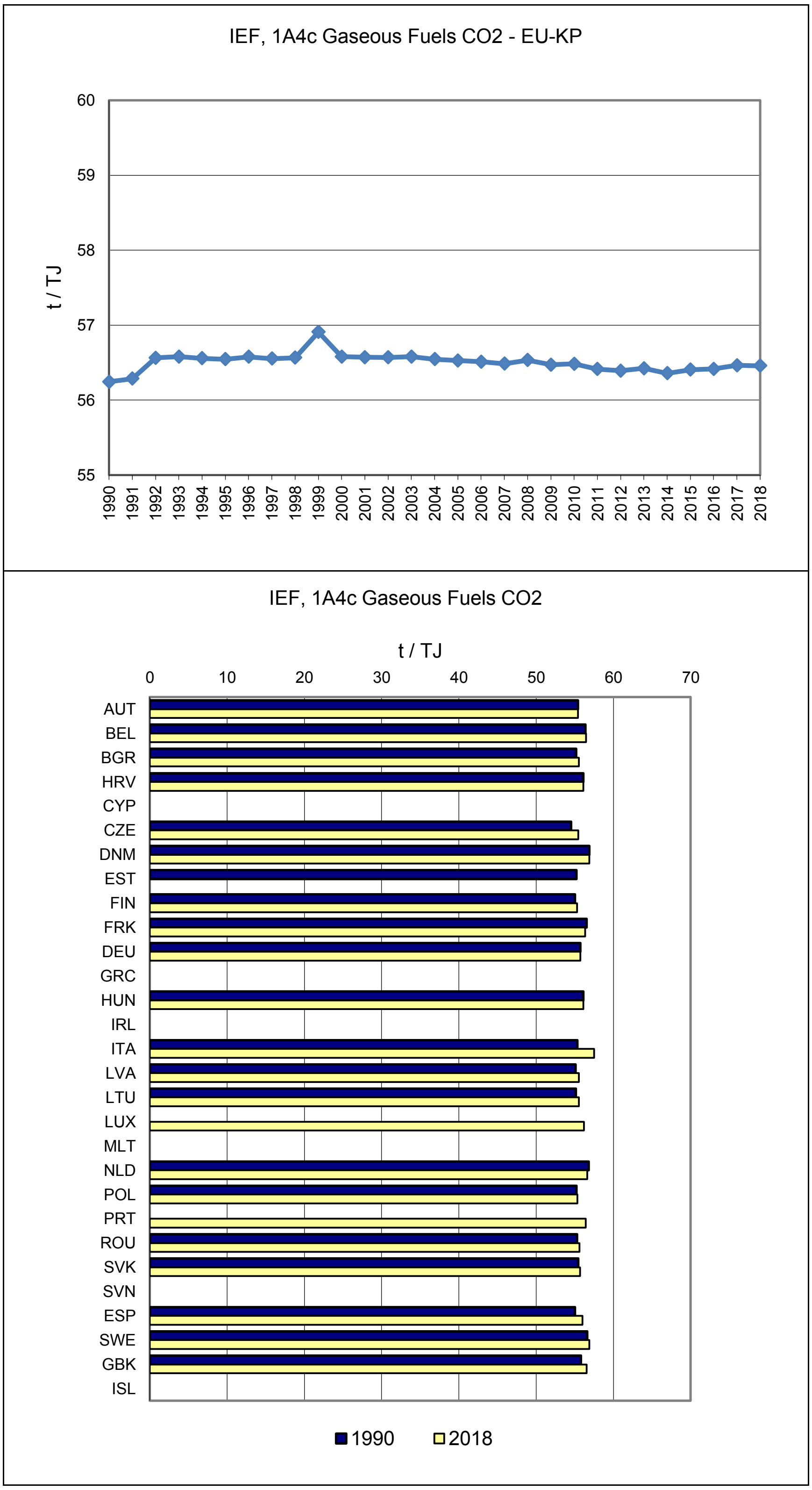


Figure 3.166 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.2.5 Other (CRF Source Category 1.A.5.)

Source category 1.A.5. Other includes emissions from stationary and mobile military fuel use including air craft. In 2018 category 1.A.5. contributed to 6203 kt CO_2 equivalents of which 98.8% CO_2, 0.1% CH_4 and 1% N_2O.

Table 3.102: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1.A.5. (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2018		1990	2018	
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5945	9	T	0	0	99%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14216	4027	T	L	0	47%

Table 3.103 provides an overview of Member States' source allocation to Source Category 1.A.5. Other as reported in CRF Table1.A(a)s4.

Table 3.103 1.A.5. Other: Member States' allocation of sources

Member State	Source allocation to 1.A.5. Other
Austria	Stationary: Emissions are 'Not occurring' Mobile: Military use
Belgium	Stationary: Emissions are 'Not occurring' Mobile: Military use
Bulgaria	Stationary: Emissions are 'Not occurring' Mobile: Emissions are 'Not occurring'
Croatia	Emissions are 'Not occurring' or 'Included elsewhere', Data on disaggregated level are not available
Cyprus	Stationary: Emissions reported from Liquid Fuels Mobile: aviation component
Czechia	Mobile; Other mobile sources not included elsewhere (not included under 1.A.4.cii). Agriculture and Forestry and Fishing, includes emissions from aviation besides the public air transport, it is consumption of aviation fuels in the army in the state institutions (aerial vehicles from Integrated rescue system), or private air transport
Estonia	Mobile: Military use
Denmark	Mobile: Military use, Recreational crafts
Finland	Stationary: Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: other non-specified: Emissions are ‚Included elsewhere', CO_2, CH_4 and N_2O emissions and fuel consumptions of all fuels from category 1.A.5.b is reported in 1.A.5.a due to confidentiality
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' (under 1.A.4.c)
Iceland	Emissions are 'Not occurring'
Italy	Stationary: Emissions are 'Not occurring' Mobile Other mobile sources not included elsewhere (not included under 1.A.4.cii).
Latvia	Mobile Other mobile sources not included elsewhere (not included under 1.A.4.cii).
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' (under 1.A.4.c) Mobile: Emissions are 'Not occurring'

Member State	Source allocation to 1.A.5. Other
Portugal	Stationary (no further specification): Emissions are reported for 1990-1994 and 'Not occurring' from 1995 on. Mobile: Military aviation
Romania	Stationary Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Emissions are 'Included elsewhere', under 1.A.5.a
Slovakia	Stationary: Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Military use Jet Kerosene, Gasoline, Diesel Oil
Slovenia	Stationary: Emissions are 'Not occurring' Mobile: Military use of fuels
Spain	Stationary Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Military use of fuels
Sweden	Stationary: Emissions are 'Not occurring' Mobile: Military use
United Kingdom	Stationary: Emissions are 'Included elsewhere' (under 1.A.4.c) Mobile: Military aviation and naval shipping

Figure 3.167 shows the total trend within source category 1.A.5. and the dominating emission sources: CO_2 emissions from 1.A.5.b Mobile and from 1.A.5.a Stationary. Total GHG emissions of source category 1.A.5. decreased by 74% between 1990 and 2018. Germany has the most influence to the overall trend, it reports minus 94% of 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 26% to CO_2 emissions in 2018. The United Kingdom reports military aircraft and naval vessels within this category.

Figure 3.167 1.A.5. Other: Total and CO_2 emission and activity trends

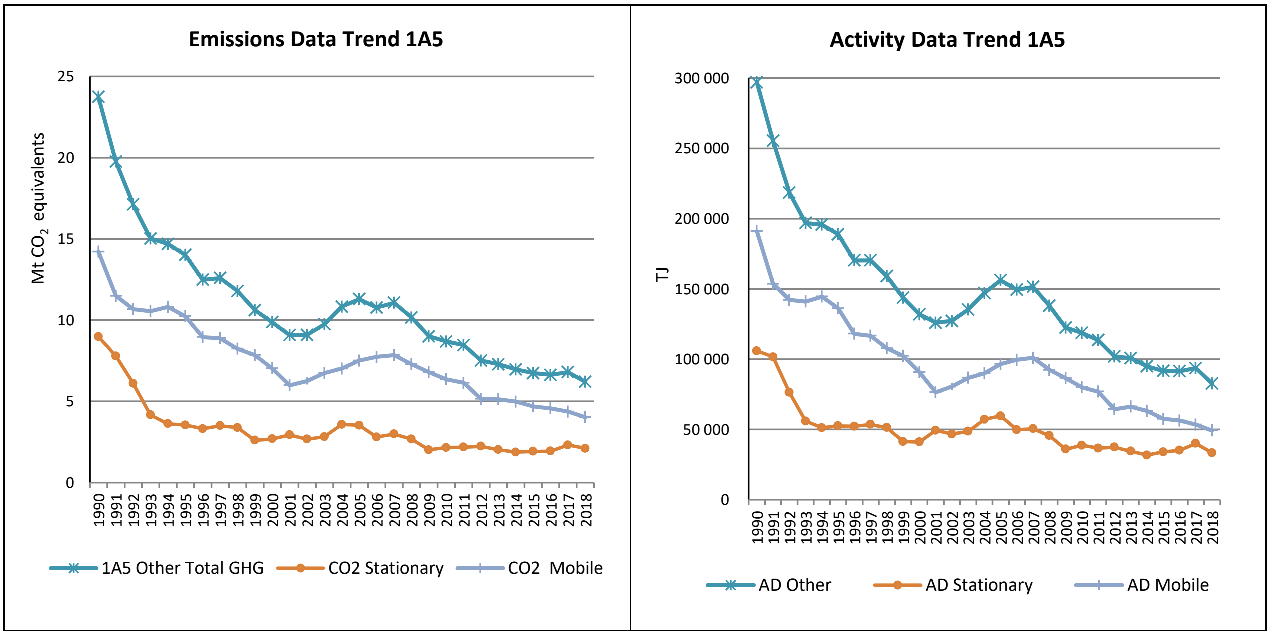


Table 3.104 shows total GHG and CO_2 emissions by Member State from 1.A.5. CO_2 emissions from 1.A.5 Other accounted for 0.19% of total EU-KP GHG emissions in 2018 in 1A. Between 1990 and 2018, CO_2 emissions from this source decreased by 74% in the EU-KP. Between 1990 and 2018 the

largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after German reunification.

Table 3.104 1.A.5. Other: Member States' contributions to CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)
Austria	36	52	35	51
Belgium	174	107	172	106
Bulgaria	NO	NO	NO	NO
Croatia	IE,NO	IE,NO	NO,IE	NO,IE
Cyprus	11	24	11	24
Czechia	194	322	192	312
Denmark	170	218	167	215
Estonia	44	50	43	50
Finland	1 143	955	1 131	946
France	IE,NO	IE,NO	NO,IE	NO,IE
Germany	12 138	752	11 797	748
Greece	IE,NO	124	NO,IE	123
Hungary	15	29	15	28
Ireland	IE	IE	IE	IE
Italy	1 143	351	1 071	341
Latvia	NE,NO	20	NO,NE	20
Lithuania	0	20	0	20
Luxembourg	3	0	3	0
Malta	3	3	3	3
Netherlands	320	154	314	152
Poland	IE,NO	IE,NO	NO,IE	NO,IE
Portugal	97	59	96	59
Romania	1 220	619	1 212	617
Slovakia	479	89	476	88
Slovenia	32	4	32	4
Spain	301	451	298	447
Sweden	862	170	845	167
United Kingdom	5 353	1 628	5 293	1 609
EU-27+UK	**23 738**	**6 202**	**23 206**	**6 130**
Iceland	IE,NO	1	NO,IE	1
United Kingdom (KP)	5 353	1 628	5 293	1 609
EU-KP	**23 738**	**6 203**	**23 206**	**6 131**

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 1.A.4.a and that emissions from 1.A.5.b military are included in 1.A.3
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.105 provides information on the contribution of Member States to EU27+UK recalculations in CO_2 from 1.A.5 Other for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table 3.1051.A.5 Other: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

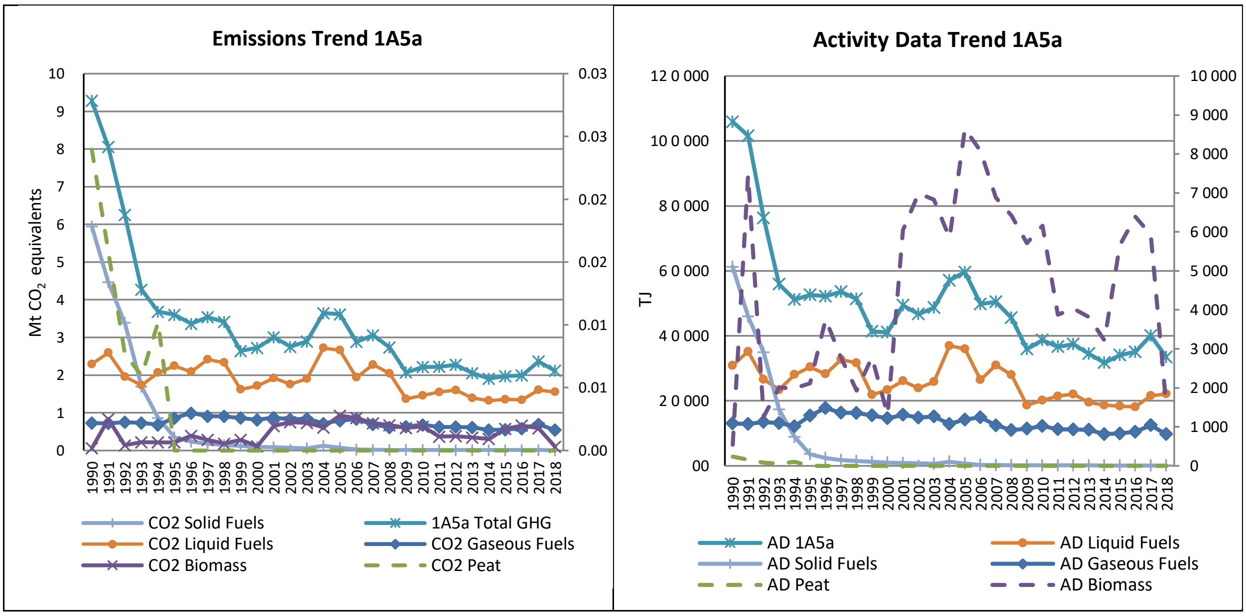
Member State	1990		2017		Main explanations
	kt CO_2		kt CO_2		
Austria	-	-	-	-	
Belgium	0.2	0.1	-1.6	-1.6	Updated data
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-1.5	-6.5	Updated data
Czechia	-	-	-	-	

Member State	1990		2017		Main explanations
	kt CO_2		kt CO_2		
Denmark	-	-	-	-	
Estonia	-	-	-0.2	-0.4	Updated data
Finland	-1.0	-0.1	15	1.3	Corrections of other sectors are reflected here
France	-	-	-	-	
Germany	-	-	-7.5	-0.9	Updated data
Greece	-	-	-	-	
Hungary	0.2	1.7	0.4	1.7	Updated data
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	0.0	0.0	
Lithuania	-	-	-	-	
Luxembourg	-0	-0.0	0.0	0.0	
Malta	-	-	0.0	1.3	Updated data
Netherlands	-	-	-	-	
Poland	-	-	-	-	
Portugal	-8.4	-8.0	-	-	
Romania	-	-	-	-	
Slovakia	0.0	0.0	0.0	0.0	
Slovenia	-	-	-	-	
Spain	0.1	0.0	0.4	0.1	
Sweden	-1.3	-0.2	-2.2	-1.2	Updated data
United Kingdom	-	-	29	1.9	Updated data
EU27+UK	-10	-0.0	32	0.5	
Iceland	-	-	0.2	100.0	Updated data
United Kingdom (KP)					NA
EU-KP	-10	-0.0	32	0.5	

3.2.5.1 Stationary (1.A.5.a)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1.A.5.a by fuels. CO_2 emissions from 1.A.5.a Stationary accounted for 0.1% of total GHG emissions in 1A in 2018. Figure 3.168 shows the emission trend within the categories 1.A.5.a, 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 77%, mainly due to decreases in emissions from solid fuels (-100%) and liquid fuels (-32%).

Figure 3.168 1.A.5.a Stationary: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Only five Member States (Cyprus, Finland, Germany, Romania and Slovakia) reported emissions from this key source in 2018 (Table 3.106). Between 1990 and 2018 Germany reported the highest absolute decrease. Luxembourg reported emissions for 1990 - 2003. This led to an EU-KP decrease of 77% in GHG emissions. Between 2017 and 2018 CO_2 emissions decreased by 9%.

Table 3.106 1.A.5.a 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		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	11	18	19	0.9%	8	76%	2	10%	T1	D
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 131	1 117	946	45.0%	-185	-16%	-171	-15%	T2	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	6 227	475	444	21.1%	-5 783	-93%	-30	-6%	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	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	1 212	646	617	29.3%	-595	-49%	-29	-4%	T1,T2	CS,D
Slovakia	406	55	76	3.6%	-330	-81%	20	37%	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-27+UK	**8 989**	**2 310**	**2 102**	**100%**	**-6 887**	**-77%**	**-208**	**-9%**	**-**	**-**
Iceland	NO,IE	0	1	0.0%	1	∞	1	307%	T1	D
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-	NA	NA
EU-KP	**8 989**	**2 310**	**2 103**	**100%**	**-6 887**	**-77%**	**-207**	**-9%**	**-**	**-**

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 1.A.4.ai 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 1.A.4.a.
Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a.

1.A.5.a Stationary – Solid Fuels (CO_2)

In 2018 CO_2 from solid fuels had a share of 0.4% within source category 1.A.5.a (compared to 66% in 1990). Between 1990 and 2018, CO_2 decreased by nearly 100% (Table 3.107). In 2018 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 1.A.4.ai 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 1.A.4.a.

Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a.

According to the methodology as described in chapter 3.2.1 about 99% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.107 1.A.5.a Stationary, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	NO	NO	NO	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	1	NO	NO	-	-1	-100%	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	4 553	7	7	77.4%	-4 546	-100%	-1	-9%
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	NO	NO	NO	-	-	-	-	-
Romania	1 174	NO	NO	-	-1 174	-100%	-	-
Slovakia	216	2	2	22.6%	-214	-99%	0	-18%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-
Sweden	NO	NO	NO	-	-	-	-	-
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-27+UK	**5 945**	**10**	**9**	**100%**	**-5 936**	**-100%**	**-1**	**-11%**
Iceland	IE	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-KP	**5 945**	**10**	**9**	**100%**	**-5 936**	**-100%**	**-1**	**-11%**

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 3.169 shows CO_2 emissions for EU27+UK and the Member States. Germany accounts for 77% of EU-KP CO_2 emissions from this source category. Fuel combustion in the EU-KP decreased by 100% between 1990 and 2018. The CO_2 implied emission factor for solid fuels was 99 t/TJ in 2018.

Figure 3.169 1.A.5.a Stationary, solid fuels: Emission trend and share for CO_2

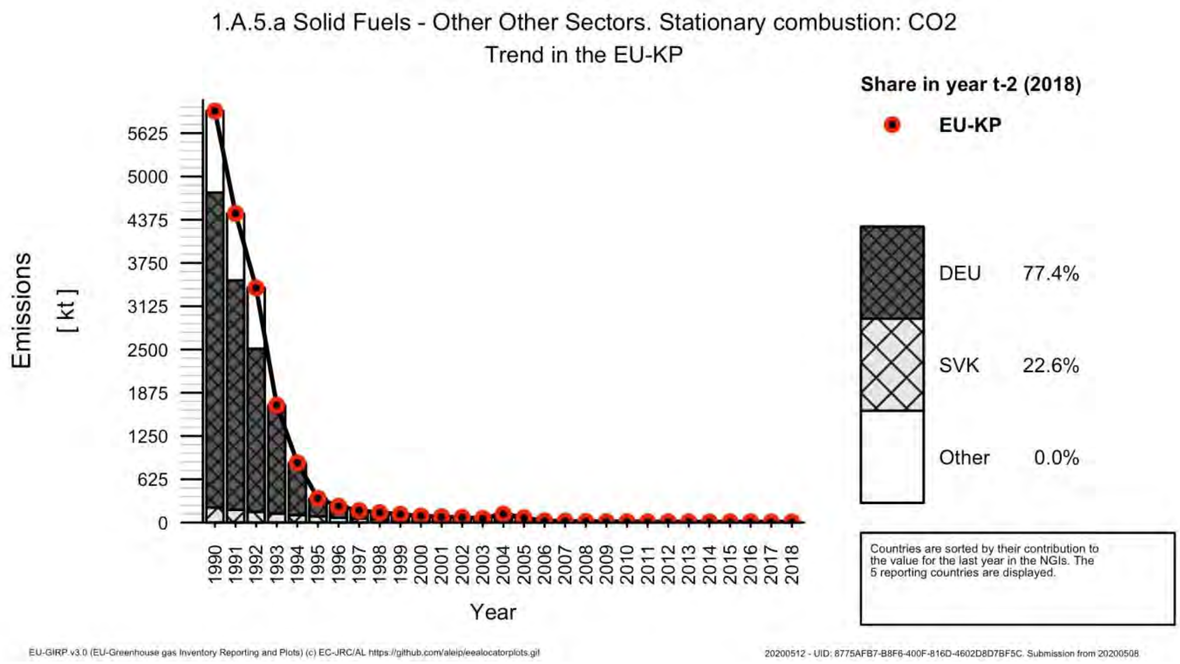
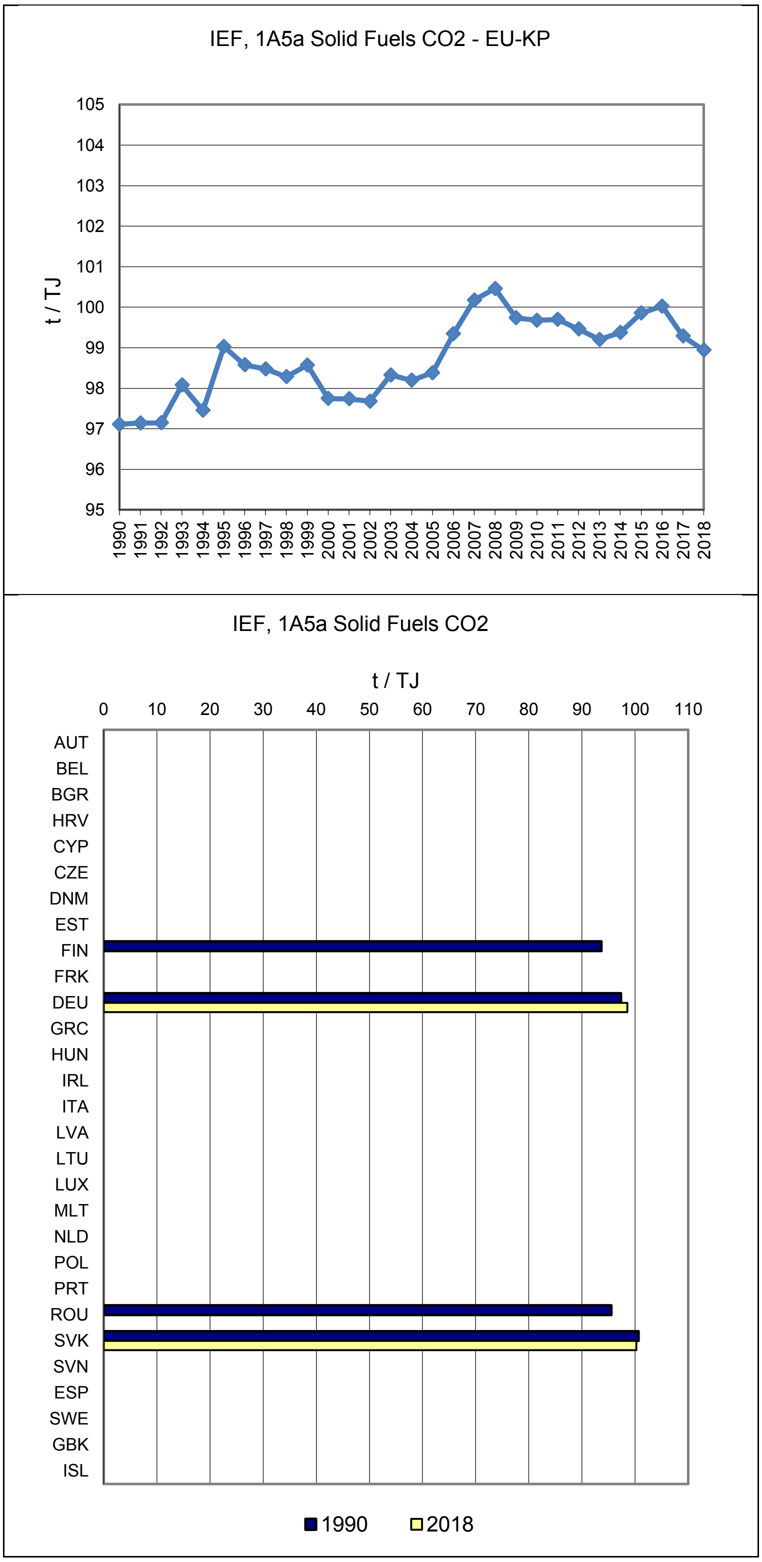


Figure 3.170 1.A.5.a Stationary, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

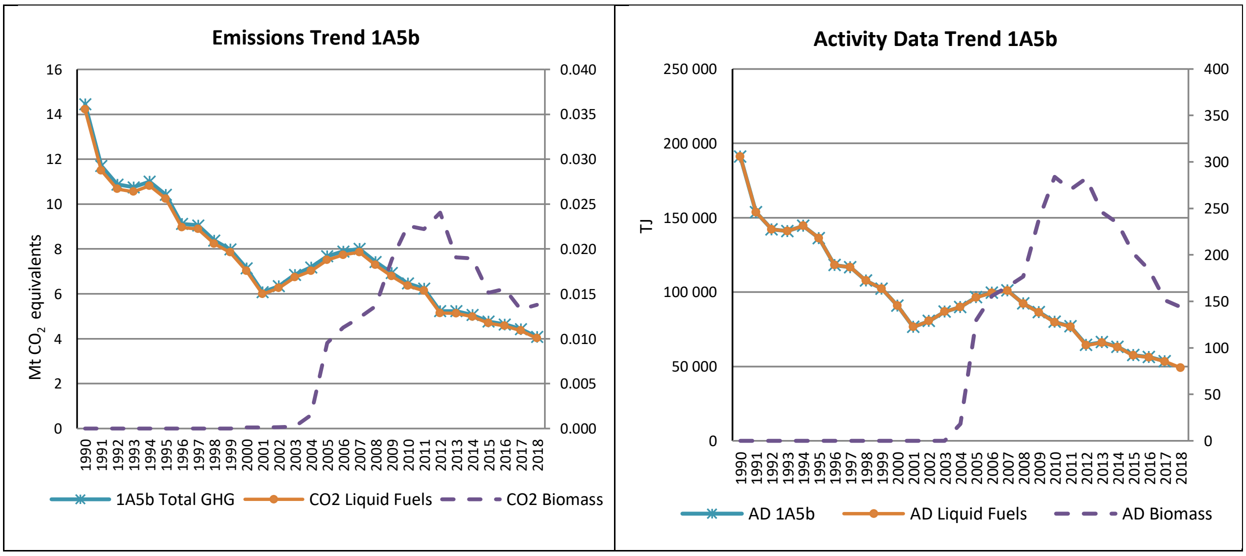


3.2.5.2 **Mobile (1.A.5.b)**

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1.A.5.b by fuels. CO_2 emissions from 1.A.5.b Mobile accounted for 0.1% of total EU-KP GHG emissions in 1A in 2018. Figure 3.171 shows the emission trend within the category

1.A.5.b, which is dominated by CO_2 emissions from liquid fuels. Total CO_2 emissions decreased by 72%.

Figure 3.171 1.A.5.b Mobile: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Seven Member States and Iceland reported emissions as 'Not occurring' or 'Included elsewhere'. The United Kingdom had the highest emissions in 2018 and – together with Germany - decreased the most in absolute terms between 1990 and 2018. Between 2017 and 2018 Czechia had the highest absolute decrease. The EU-KP emissions decreased by 8% between 2017 and 2018.

Often, "included elsewhere" indicates, that the country reports these emissions under 1.A.4.c.ii Off-road vehicles and other machinery or, in some cases, under 1.A.3 Transport. Croatia reports emissions from military aviation in category 1.A.3.a and emissions from military naval vessels under category 1.A.3.d. Ireland reports that emissions from mobile military sources are included in 1.A.3.

Table 3.108 1.A.5.b Mobile: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	35	50	51	1.3%	16	45%	1	1%	T1,T2	CS,D
Belgium	172	105	106	2.6%	-66	-38%	1	1%	CS,T1,T3	D
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Cyprus	NO	4	5	0.1%	5	∞	1	17%	T1	D
Czechia	192	449	312	7.8%	120	63%	-137	-31%	T1	D
Denmark	167	302	215	5.3%	48	29%	-87	-29%	CR,M,T2	CS
Estonia	43	56	50	1.2%	6	14%	-6	-11%	T2	CS
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Germany	5 570	366	304	7.5%	-5 267	-95%	-62	-17%	CS,D,M	CS,D,M
Greece	NO,IE	182	123	3.1%	123	∞	-59	-32%	T1	D
Hungary	15	25	28	0.7%	14	95%	3	13%	T2	CS
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 071	326	341	8.5%	-730	-68%	15	5%	T2	CS
Latvia	NO,NE	13	20	0.5%	20	∞	7	51%	T1	D
Lithuania	0	26	20	0.5%	20	5515%	-5	-21%	T2	CS
Luxembourg	0	0	0	0.0%	0	-11%	0	0%	T1,T2	CS,D
Malta	3	4	3	0.1%	1	31%	0	-11%	T1,T3	CS,D
Netherlands	314	148	152	3.8%	-162	-52%	3	2%	T2	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	96	44	59	1.5%	-37	-39%	15	34%	T1	D
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	70	10	12	0.3%	-58	-82%	2	24%	T1,T2	D
Slovenia	32	4	4	0.1%	-28	-88%	0	-5%	T1	D
Spain	298	482	447	11.1%	149	50%	-35	-7%	T1,T2	CS,D,M
Sweden	845	182	167	4.1%	-678	-80%	-15	-8%	NA	NA
United Kingdom	5 293	1 587	1 609	40.0%	-3 684	-70%	22	1%	T1	CS
EU-27+UK	**14 216**	**4 365**	**4 028**	**100%**	**-10 188**	**-72%**	**-337**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 293	1 587	1 609	40.0%	-3 684	-70%	22	1%	T1	CS
EU-KP	**14 216**	**4 365**	**4 028**	**100%**	**-10 188**	**-72%**	**-337**	**-8%**	**-**	**-**

Finland reports emissions from military activities in category 1.A.5.a 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'.

1.A.5.b Mobile – Liquid Fuels (CO_2)

In 2018, CO_2 from liquid fuels had a share of 99% within source category 1.A.5.b (compared to 100% in 1990). Between 1990 and 2018 CO_2 decreased by 72% (Table 3.109). Twenty one Member States and United Kingdom reported emissions in 2018 while other Member States report emissions as 'Not occurring' or 'Included Elsewhere'. The highest decrease in absolute terms was achieved in Germany (-95%) and the United Kingdom (-70%), while Czechia, Greece and Spain had the largest increases.

According to the methodology as described in chapter 3.2.1 about 47% of EU-KP emissions are calculated by using higher tier methods in 2018.

Table 3.109 1.A.5.b Mobile, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	35	50	51	1.3%	16	45%	1	1%
Belgium	172	105	106	2.6%	-66	-38%	1	1%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NO	4	5	0.1%	5	∞	1	17%
Czechia	192	449	312	7.8%	120	63%	-137	-31%
Denmark	167	302	215	5.3%	48	29%	-87	-29%
Estonia	43	56	50	1.2%	6	14%	-6	-11%
Finland	IE	IE	IE	-	-	-	-	-
France	IE	IE	IE	-	-	-	-	-
Germany	5 570	366	303	7.5%	-5 267	-95%	-62	-17%
Greece	IE	182	123	3.1%	123	∞	-59	-32%
Hungary	15	25	28	0.7%	14	95%	3	13%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	1 071	326	341	8.5%	-730	-68%	15	5%
Latvia	NE	13	20	0.5%	20	∞	7	51%
Lithuania	0	26	20	0.5%	20	5515%	-5	-21%
Luxembourg	0	0	0	0.0%	0	-11%	0	0%
Malta	3	4	3	0.1%	1	31%	0	-11%
Netherlands	314	148	152	3.8%	-162	-52%	3	2%
Poland	NO	NO	NO	-	-	-	-	-
Portugal	96	44	59	1.5%	-37	-39%	15	34%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	70	10	12	0.3%	-58	-82%	2	24%
Slovenia	32	4	4	0.1%	-28	-88%	0	-5%
Spain	298	482	447	11.1%	149	50%	-35	-7%
Sweden	845	182	167	4.1%	-678	-80%	-15	-8%
United Kingdom	5 293	1 587	1 609	40.0%	-3 684	-70%	22	1%
EU-27+UK	**14 216**	**4 364**	**4 027**	**100%**	**-10 189**	**-72%**	**-337**	**-8%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	5 293	1 587	1 609	40.0%	-3 684	-70%	22	1%
EU-KP	**14 216**	**4 364**	**4 027**	**100%**	**-10 189**	**-72%**	**-337**	**-8%**

Finland reports emissions from military activities in category 1.A.5.a 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 **3.108** as emissions from this source only occur in liquid fuels*
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.172 shows CO_2 emissions for EU-KP and the Member States. The largest emissions are reported by United Kingdom, Spain and Italy; together they cause 59.6% of the CO_2 emissions from liquid fuels in 1.A.5.b. Fuel consumption in the EU-KP decreased by 72% between 1990 and 2018. The CO_2 implied emission factor for liquid fuels was 81.3 t/TJ in 2018. 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 2018.

Figure 3.172 1.A.5.b Mobile, liquid fuels: Emission trend and share for CO_2

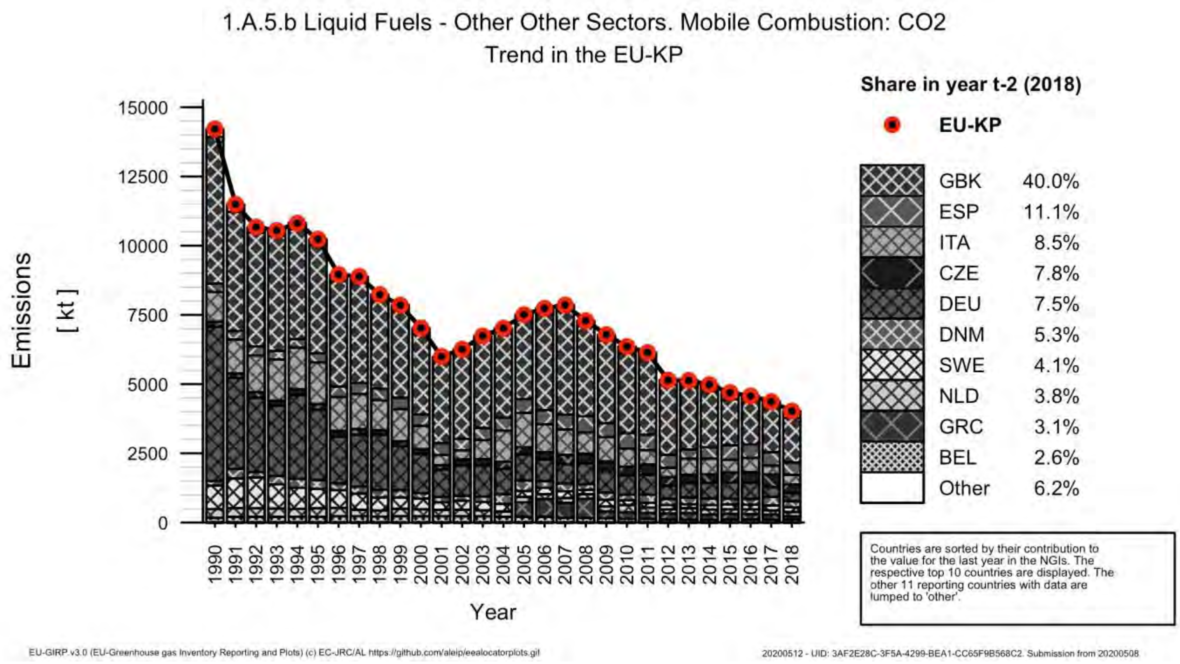
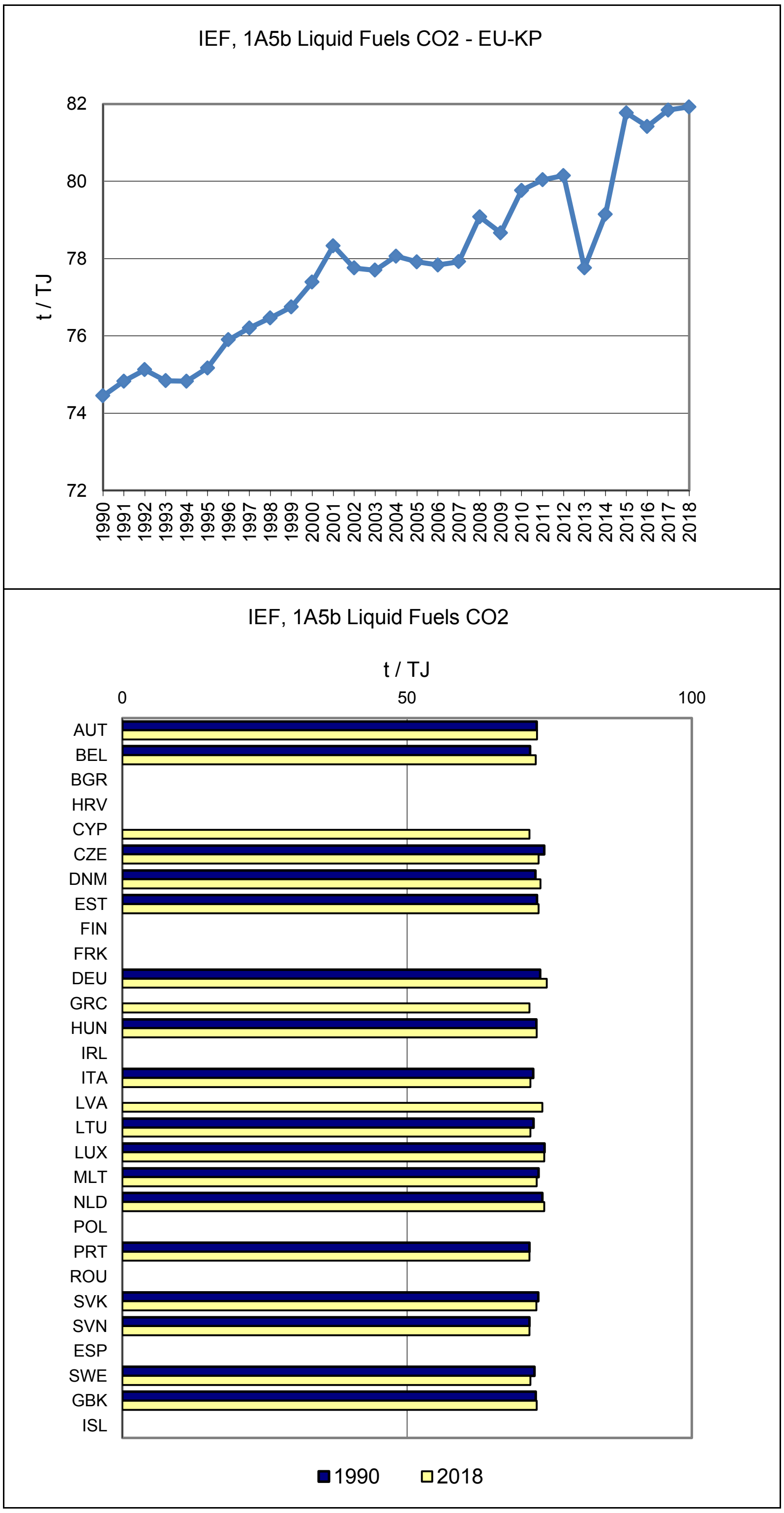


Figure 3.173 1.A.5.b Mobile, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

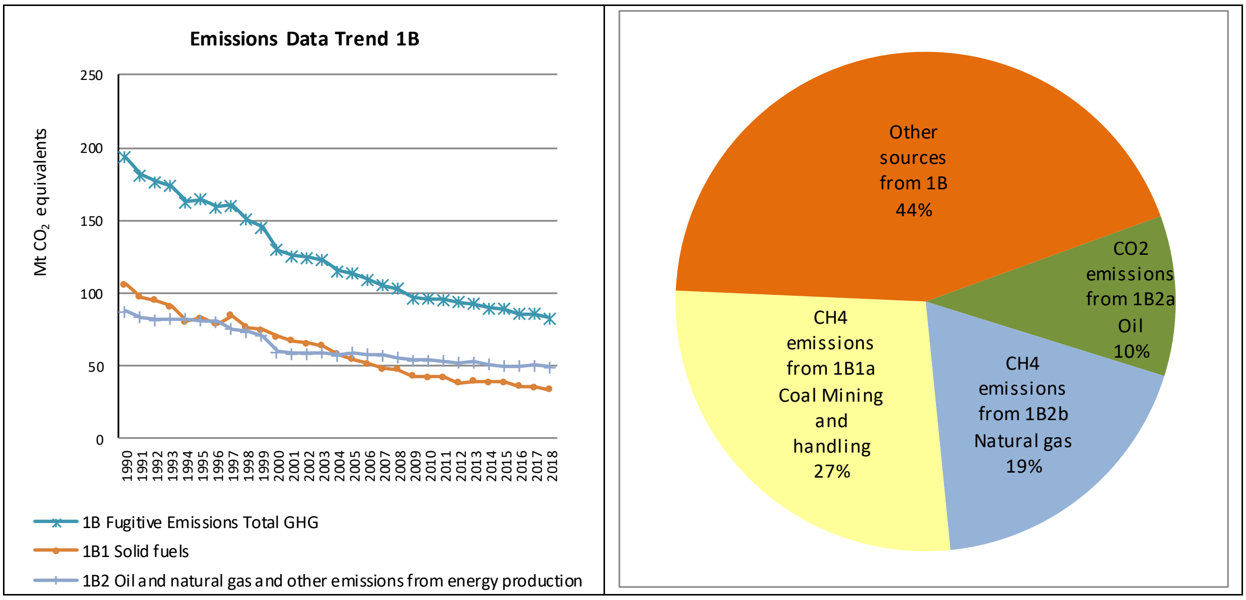


3.2.6 Fugitive emissions from fuels (CRF Source Category 1.B)

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 2018, in terms of CO_2 equivalents, about 68% of emissions from source category 1.B were fugitive CH_4 emissions while 32% were fugitive CO_2 emissions. Together, they represent 2 % of total GHG emissions in the EU-KP. Fugitive GHG emissions have been steadily declining (Figure 3.174). Between 1990 and 2018, the total fugitive GHG emissions decreased by 57 %. This was mainly due to the decrease in underground mining activities: CH_4 emissions from underground mining activities have decreased by 73 % since 1990 (Figure 3.177) and decreases in CH_4 emissions from category 1B1a i underground mines are responsible for 59 % of the total decrease of fugitive emissions. Between 1990 and 2018, GHG emissions from 1.B.1 Solid Fuels decreased by 68 % Figure 3.175), while emissions from 1.B.2 Oil and Natural Gas decreased only by 44 % (Figure 3.175). While emissions from 1.B.1 Solid Fuels and 1.B.2 Oil and Natural Gas each were responsible for roughly 55 % (1.B.1) and 45% (1.B.2) of total fugitive emissions in 1990, fugitive emissions from 1.B.1 Solid Fuels represented only 41 % of total fugitive emissions in 2018 (Figure 3.174).

Figure 3.174 1.B Fugitive Emission from Fuel: GHG Emissions trend and proportion of fugitive emissions within source category



Fugitive emissions includes five key sources:

Table 3.110: Key source categories for level and trend analyses and share of countries emissions using higher tier methods in sector 1.B (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97099	29063	T	L	L	71%
1.B.2.a Oil: Operation (CH_4)	6767	1133	T	0	0	63%
1.B.2.a Oil: Operation (CO_2)	9451	11813	T	L	L	89%
1.B.2.b Natural Gas: Operation (CH_4)	50935	21178	T	L	L	80%
1.B.2.c Venting and Flaring: Operation (CO_2)	8728	6832	0	L	L	81%

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 3.174).

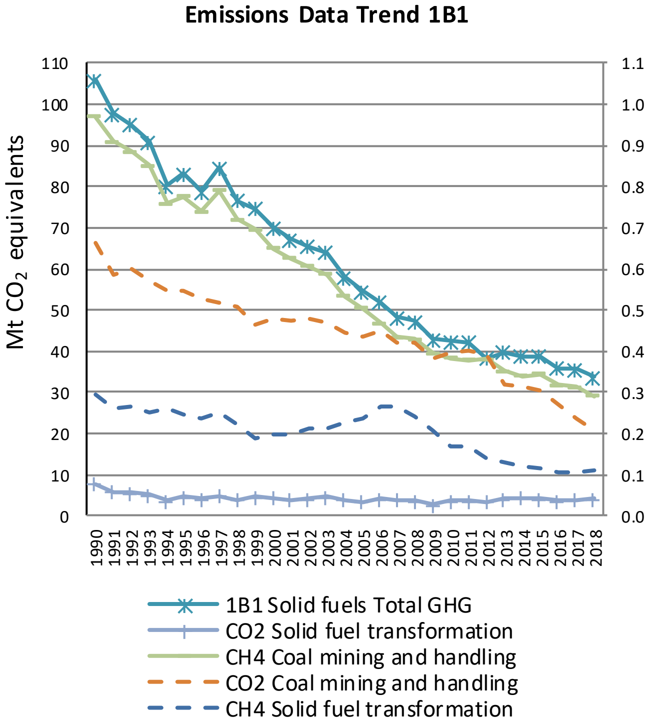
3.2.6.1 **Fugitive emissions from Solid Fuels (1.B.1)**

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 countries (Denmark, Estonia, Finland, Latvia and Lithuania) have peat extraction but no coal mining.

In 2018 fugitive emissions from solid fuels accounted for 0.8 % of the total GHG emissions in the EU-KP and 41 % of total fugitive emissions:

- 86 % 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.
- 12 % 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 3.175   1.B.1 Fugitive Emissions from Solid Fuels: Trend



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

In 2018 four countries, Poland, Germany, Czechia and Romania represented 90 % of total fugitive GHG emissions from solid fuels (Table 3.111).

Table 3.111 1.B.1 Fugitive Emissions from Solid Fuels: Countries Contribution

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	333	NA,IE,NO	NO,IE,NA	NO,IE,NA	333	NO,IE,NA
Belgium	433	41	0	NO	432	41
Bulgaria	2 011	928	64	25	1 946	903
Croatia	60	NA,NO	NO	NO	60	NO
Cyprus	NO	NO	NO	NO	NO	NO
Czechia	10 779	2 714	456	99	10 323	2 615
Denmark	NO	NO	NO	NO	NO	NO
Estonia	NO	NO	NO	NO	NO	NO
Finland	NO	NO	NO	NO	NO	NO
France	4 810	18	NO,NA	NO,NA	4 810	18
Germany	27 386	2 283	1 833	665	25 553	1 618
Greece	1 130	795	NO	NO	1 130	795
Hungary	1 061	38	7	8	1 055	31
Ireland	56	19	NO	NO	56	19
Italy	132	34	0	NO,NA	132	34
Latvia	NA,NO	NA,NO	NO	NO	NO	NO
Lithuania	NO	NO	NO	NO	NO	NO
Luxembourg	NO	NO	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	121	82	110	77	11	5
Poland	25 356	19 470	4 188	2 996	21 167	16 474
Portugal	143	16	3	NO	140	16
Romania	5 867	5 708	NA,NO	NO,NA	5 867	5 708
Slovakia	699	249	19	19	680	230
Slovenia	461	351	101	131	361	220
Spain	1 638	83	18	7	1 620	75
Sweden	5	4	5	4	0	0
United Kingdom	23 525	776	1 699	307	21 827	469
EU-27+UK	**106 007**	**33 608**	**8 503**	**4 339**	**97 504**	**29 270**
Iceland	NO	NO	NO	NO	NO	NO
United Kingdom (KP)	23 525	776	1 699	307	21 827	469
EU-KP	**106 007**	**33 608**	**8 503**	**4 339**	**97 504**	**29 270**

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.

Nearly all fugitive CH_4 emissions from solid fuels originate from coal mining and handling (1B1a). Between 1990 and 2018 these emissions decreased by 70% (Table 3.112). Large reductions (in absolute terms) were observed in Czechia, Germany and in the United Kingdom (Table 3.111).

CH_4 recovery from coal mining

The UK, which has a share of 98% of all reported CH_4 recovery in 2018 in category 1.B.1.a.1iii (Abandoned underground mines) in the EU GHG inventory, reports emissions from the utilisation of colliery methane under sectors 1A1ciii and 1A2gvii, of which almost all in 1A1ciii.

Romania has a share of 2% of all reported CH_4 recovery in category 1.B.1.a.1i (Mining activities) in the EU in 2018. The recovered CH_4 from Lupeni mines and Vulcan mine are used for energy purposes for the housework of the workers colonies and these information are included in '1.B.1.a Coal Mining and Handling, 1.B. 1.a.1 Underground Mines, 1.B.1.a.1.i Mining Activities, Recovery / Flaring CH_4' category.

Slovakia has reported CH_4 recovery in category 1.B.1.a.1 only for the reporting years 2007-2014. Emissions from cogeneration of mine gas is reported as other biogas from one facility in the category 1.A.1.c – Manufactured of Solid Fuels and Other Energy Industries.

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 0.7 % of total GHG emissions in 2018 and for 35 % of all fugitive emissions in the EU-KP. CH_4 emissions from this source decreased by 70 % in the EU-KP between 1990 and 2018 and also a decrease by -7 % between 2017 and 2018 due to decreases in Germany, the Czech Republic, Poland and Romania (Table 3.112). In 2018 Poland, Romania, Germany and Czechiaaccounted together for 90 % of CH_4 emissions from 1.B.1.a. They had substantially reduced their emissions between 1990 and 2018 due to the decline of coal mining (Figure 3.90).

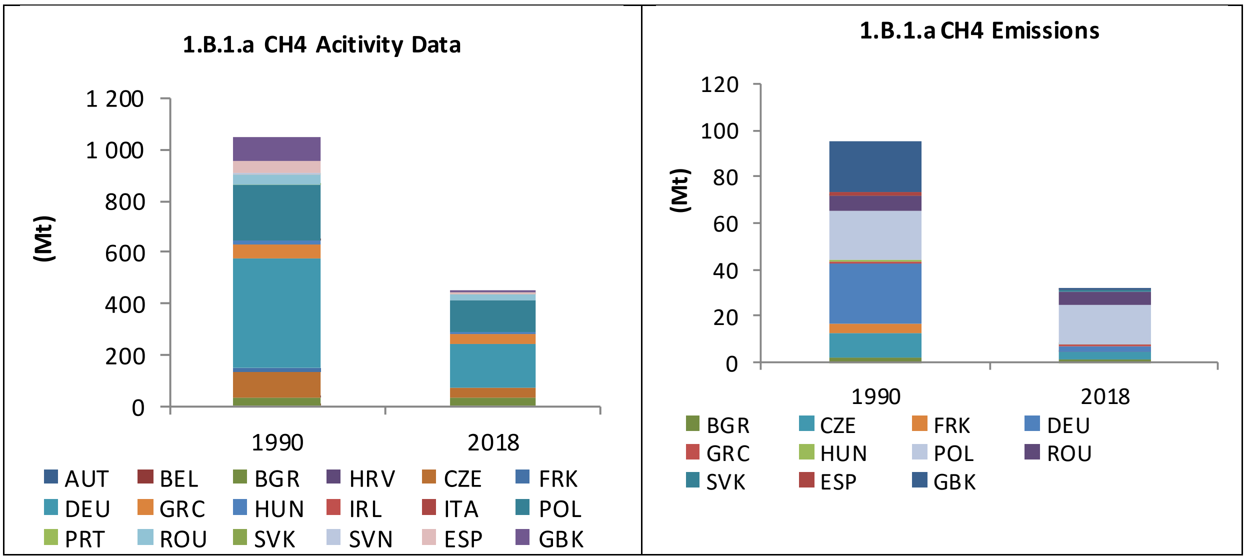
Table **3.112** shows that 71 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (BRG, CZE, HUN, POL, ROU) only emissions from subcategories of sector 1.B.1.a were taken into account, where the countries actually apply a higher tier method, according to the IPCC 2006 Guidelines.

Table 3.112 1.B.1.a Coal Mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	333	NO,NA	NO,NA	-	-333	-100%	-	-	NA	NA
Belgium	396	41	41	0.1%	-355	-90%	0	-1%	D	D
Bulgaria	1 931	1 048	902	3.1%	-1 029	-53%	-146	-14%	T1,T2	CS,D
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	10 322	2 896	2 609	9.0%	-7 714	-75%	-287	-10%	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	2 434	1 565	5.4%	-23 929	-94%	-868	-36%	T2,T3	CS
Greece	1 130	822	795	2.7%	-335	-30%	-27	-3%	T1	D
Hungary	1 055	30	30	0.1%	-1 025	-97%	0	0%	T1,T2	CS,D
Ireland	56	19	19	0.1%	-37	-66%	0	-2%	T1	D
Italy	53	13	10	0.0%	-43	-81%	-3	-22%	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	21 054	16 891	16 375	56.3%	-4 680	-22%	-516	-3%	T1,T2	D
Portugal	140	16	16	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 825	5 957	5 708	19.6%	-117	-2%	-249	-4%	T1,T2	D
Slovakia	680	272	227	0.8%	-453	-67%	-45	-17%	T1,T2	CS
Slovenia	361	230	220	0.8%	-141	-39%	-10	-4%	T2,T3	CS,D,PS
Spain	1 620	82	75	0.3%	-1 545	-95%	-7	-8%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 809	481	462	1.6%	-21 347	-98%	-19	-4%	T2,T3	CS
EU-27+UK	**97 099**	**31 240**	**29 063**	**100%**	**-68 036**	**-70%**	**-2 177**	**-7%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 809	481	462	1.6%	-21 347	-98%	-19	-4%	T2,T3	CS
EU-KP	**97 099**	**31 240**	**29 063**	**100%**	**-68 036**	**-70%**	**-2 177**	**-7%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
According to the MS NIR Poland calculates emissions from this source with a Tier3 approach

Figure 3.176 1.B.1.a Coal Mining and Handling: Contribution of countries to CH_4 emission and activity data



CH_4 from Underground mines (1.B.1.a.1)

In 2018 84% of fugitive emissions from coal mines were due to underground mines. Within the EU-KP coal mining in underground mines decreased substantially between 1990 and 2018 (-73 %) (Table **3.113** and Figure 3.177). Largest decreases of CH_4 emissions in absolute terms were observed in Germany (-94 %) 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 2020). 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 2017 (GBE NIR 2020).

Poland and Germany, which are contributing 62% and 6% of methane emissions to this source, respectively, apply a Tier 3 method based on direct measurements and calculations. (POL NIR 2020; DEU NIR 2020). Romania has a share of 21% of CH_4 emissions from this source, applying a Tier 1 methodology of the 2006 IPCC Guidelines (ROU NIR 2020). A Tier 2 method including country specific emission factors is applied by the Czechia, which is contributing 5% of methane emissions to this source (CZE NIR 2020) (Table **3.113**). For detailed information on countries methodologies please see Annex III.

Table 3.113 1.B.1.a.1 Coal Mining – underground mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Information
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	299	NO,NA	NO,NA	-	-299	-100%	-	-	NA	NA
Belgium	396	41	41	0.2%	-355	-90%	0	-1%	D	D
Bulgaria	1 325	304	244	1.0%	-1 081	-82%	-60	-20%	T1,T2	CS,D
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	7 544	1 513	1 230	5.0%	-6 314	-84%	-283	-19%	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	2 387	1 520	6.2%	-23 877	-94%	-867	-36%	T3	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	1 055	29	29	0.1%	-1 026	-97%	-1	-2%	T1	D
Ireland	56	19	19	0.1%	-37	-66%	0	-2%	T1	D
Italy	20	13	10	0.0%	-10	-50%	-3	-22%	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	19 583	15 559	15 099	62.0%	-4 483	-23%	-460	-3%	T1,T2	D
Portugal	140	16	16	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 282	5 412	5 205	21.4%	-77	-1%	-208	-4%	T1,T2	D
Slovakia	680	272	227	0.9%	-453	-67%	-45	-17%	T1,T2	CS
Slovenia	361	230	220	0.9%	-141	-39%	-10	-4%	T2,T3	CS,D,PS
Spain	1 620	72	69	0.3%	-1 550	-96%	-3	-4%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 616	449	435	1.8%	-21 182	-98%	-14	-3%	T2,T3	CS
EU-27+UK	**90 164**	**26 326**	**24 373**	**100%**	**-65 791**	**-73%**	**-1 953**	**-7%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 616	449	435	1.8%	-21 182	-98%	-14	-3%	T2,T3	CS
EU-KP	**90 164**	**26 326**	**24 373**	**100%**	**-65 791**	**-73%**	**-1 953**	**-7%**	**-**	**-**

Note: According to the MS NIR Poland calculates emissions from this source with a Tier3 approach (POL NIR, 2020)

Figure 3.177 1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for EU-KP and the emitting countries of CH_4

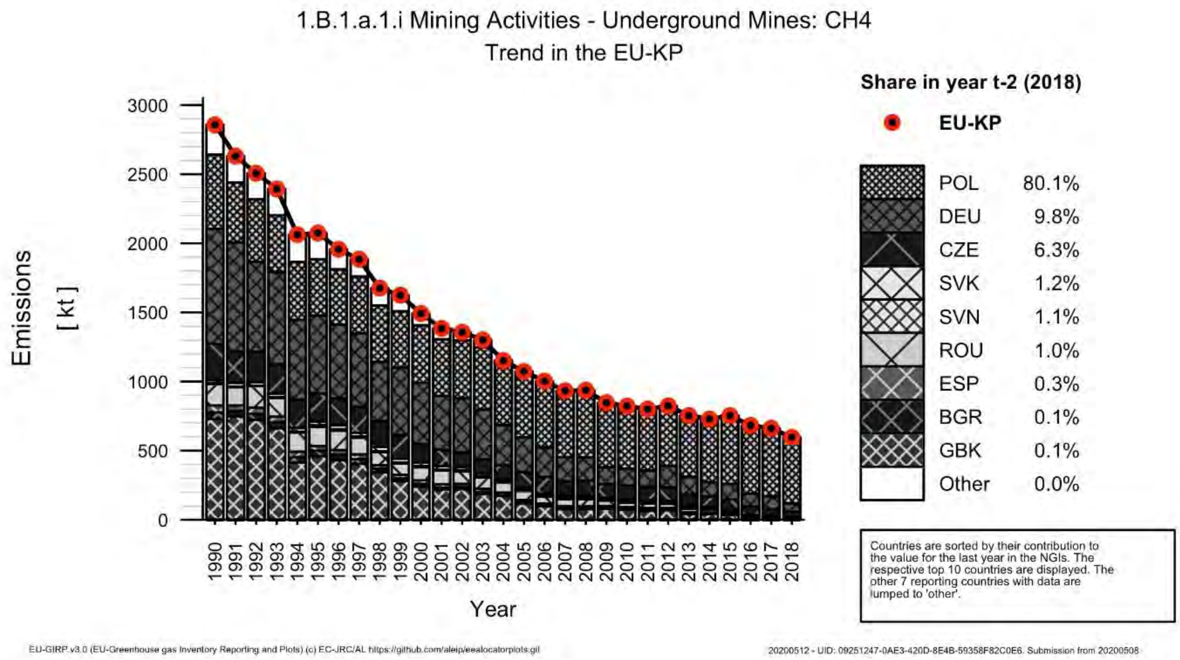
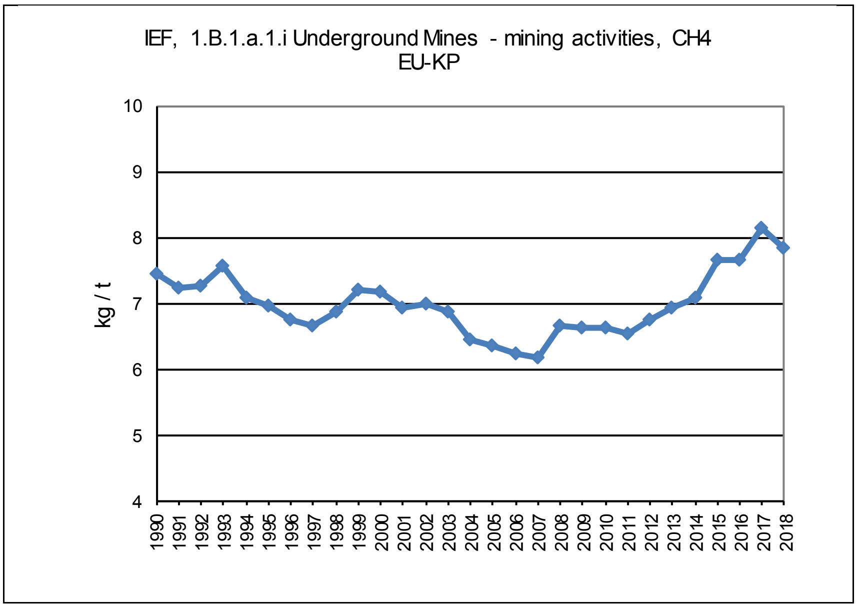
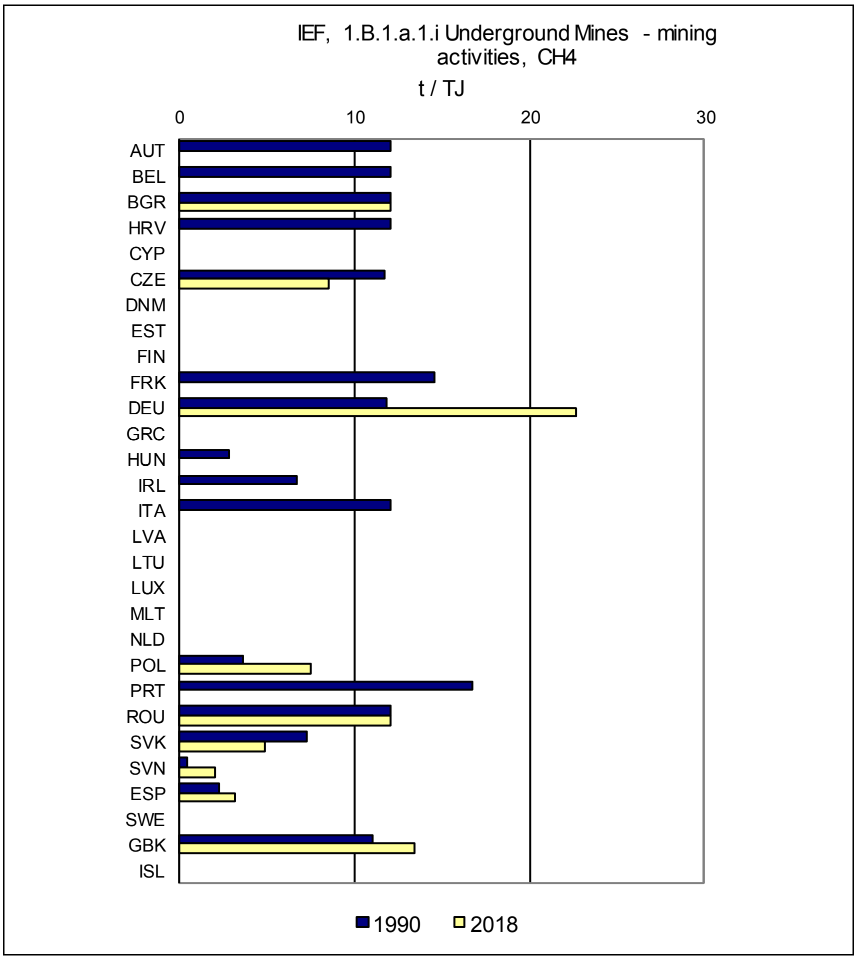


Figure 3.178 shows the implied emission factor of EU-KP and also the implied emission factor for each Member State for CH_4 emissions in 1B1a1i – underground mines, mining activities, which are responsible for 51 % of total GHG emissions from 1.B.1.a.1. Germany is calculating emissions from this source applying a Tier 3 methodology, which results in a higher emission factor, compared to the IEF of other countries (see DEU NIR 2020).

Figure 3.178: 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 2018, only 16% of emissions from coal mining originate from surface mining. Overall, the coal production from surface mines decreased by 32 % between 1990 and 2018 (Table **3.114** and Figure 3.179).

Czechia shows largest decreases of methane emissions in absolute terms between 1990 and 2018 (-1 400 kt CO_2 equ.), which is caused by the closure of mines (CZE NIR 2020).

Together, Czechia 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, 7 % of total emissions from coal mining arise from category 1.B.1.a.2, the share in Czechia is 51%. For detailed information on countries methodologies please see Annex III. (Table **3.114**).

Table 3.114 1.B.1.a.2 Coal Mining – surface mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	34	NO	NO	-	-34	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	606	743	658	14.0%	52	9%	-86	-12%	T1,T2	D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 778	1 383	1 379	29.4%	-1 400	-50%	-4	0%	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	47	46	1.0%	-52	-53%	-1	-3%	T2	CS
Greece	1 130	822	795	16.9%	-335	-30%	-27	-3%	T1	D
Hungary	NO	0	1	0.0%	1	∞	0	164%	T2	CS
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	1 472	1 332	1 275	27.2%	-196	-13%	-56	-4%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	544	544	503	10.7%	-40	-7%	-41	-8%	T1	D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1	10	6	0.1%	5	652%	-4	-41%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	193	32	27	0.6%	-165	-86%	-5	-15%	T2	CS
EU-27+UK	**6 935**	**4 914**	**4 690**	**100%**	**-2 245**	**-32%**	**-224**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	193	32	27	0.6%	-165	-86%	-5	-15%	T2	CS
EU-KP	**6 935**	**4 914**	**4 690**	**100%**	**-2 245**	**-32%**	**-224**	**-5%**	**-**	**-**

Figure 3.179 1.B.1.a.2.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4

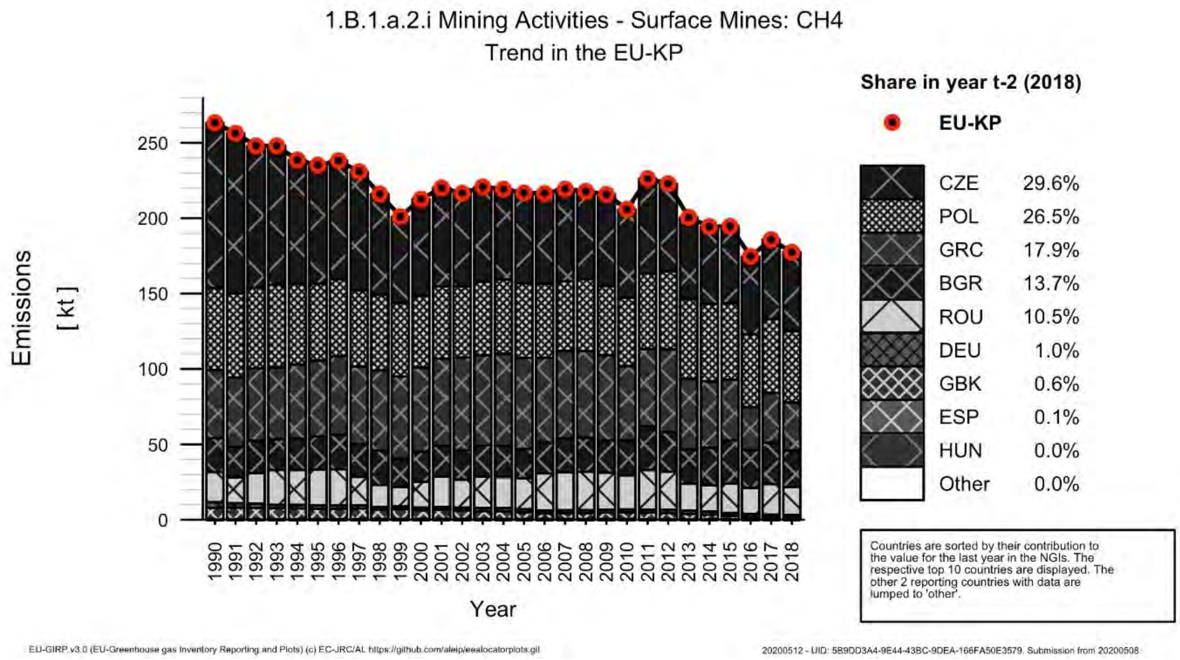
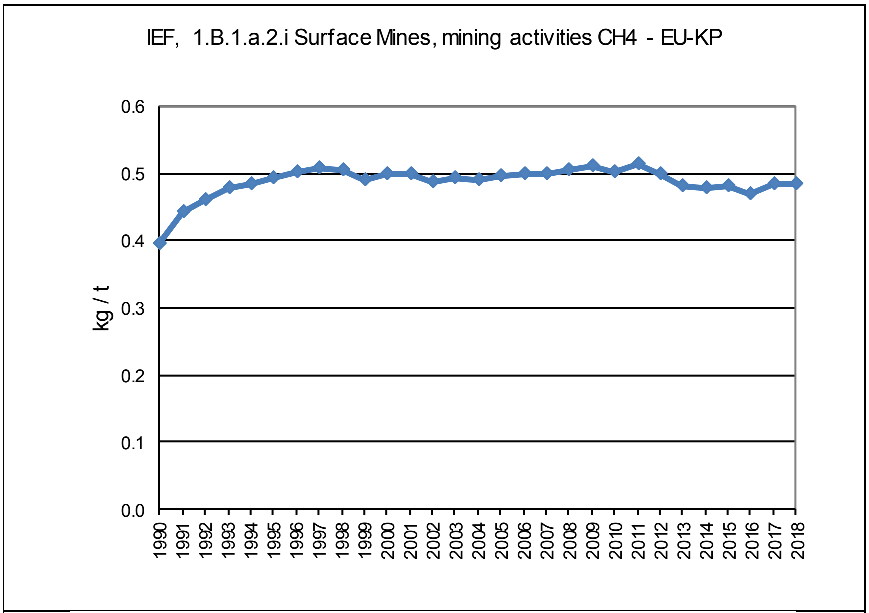
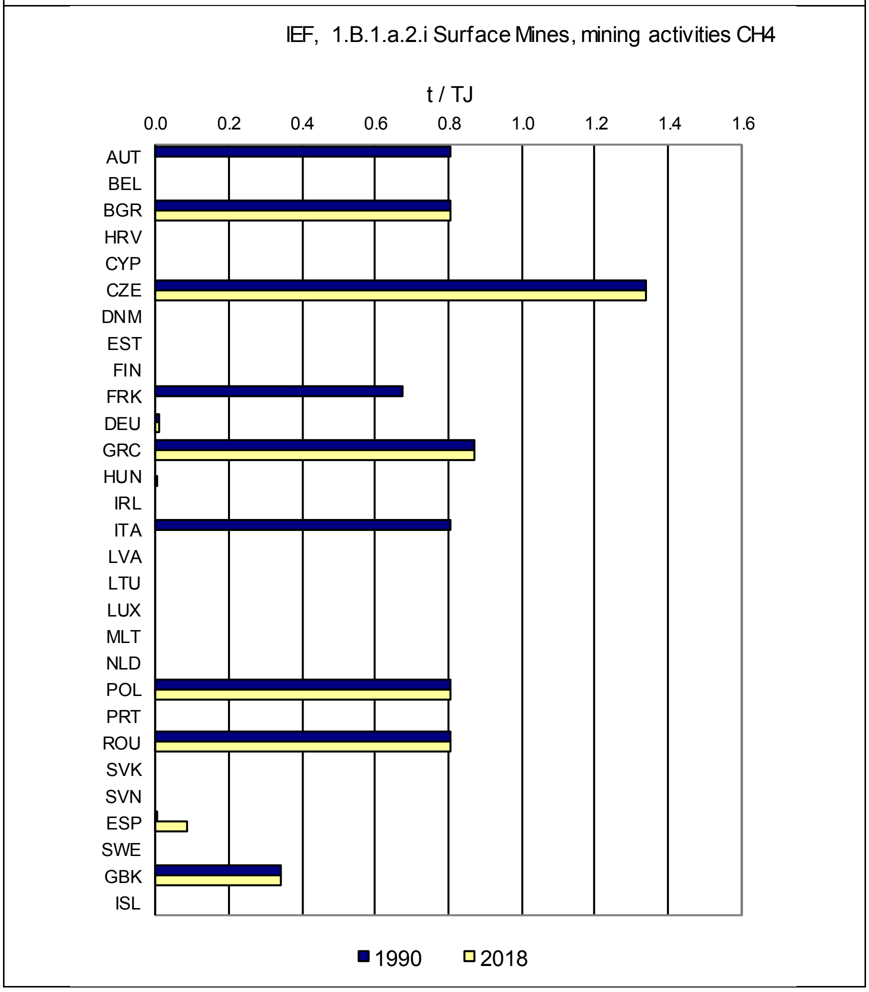


Figure **3.174** shows the Implied Emission factor of EU-KP and also the implied Emission factor for each Member State for CH_4 emissions in 1.B.1.a.2.i – mining activities from surface mines, which are responsible for 94 % of total GHG emissions from 1.B.1.a.2.

Czechia applies the high default emission factor from the IPCC 2006 Guidelines, which explains the outlier in Figure 3.180 (lower figure). Germany's low emission factor is caused by the application of a Tier 2 method with a country specific emission factor for CH_4 emissions from this source (0.016m3 CH_4/t). According to the German NIR, emission factors from the IPCC 2006 Guidelines cannot be applied to German lignite, as it does not exceed a temperature of 50°C during the coalification process, while significant methane releases occur only at temperatures higher than 80°C (for detailed information see Annex III of the EU GHG inventory and German NIR, 2020).

Figure 3.180: 1.B.1.a.2.i Mining activities – Surface mines - Overview of outliers of Implied Emission Factors for CH_4 (in kg/t)





Emissions from Other (1.B.1.c)

Poland and Sweden both report CH_4 and CO_2 emissions in this sector. Sweden additionally reports N_2O emissions. The description of the subcategories is presented in Table 3.115.

Table 3.115 Description of subcategories in sector 1.B.1c for CO_2- and CH_4-emissions for reporting countries

Member state	Emission	Subcategory
Poland	CO_2, CH_4	emissions from Coke Oven Gas Subsystem
Sweden	CO_2, CH_4, N_2O	Flaring of gas

Table 3.116 provides information on the contribution of countries to EU-KP recalculations in CH_4 from 1.B.1 Solid fuels for 1990 and 2017.

Table 3.116 1.B.1 Fugitive Emissions from Solid Fuels: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-1	-2.2	No information provided.
Bulgaria	-100	-4.9	205	24.3	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	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	1	0.1	Updated activity data
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	-0.01	-0.04	Improvement of completeness.
Germany	-	-	-	-	
Greece	-	-	-	-	
Hungary	166	18.6	-22	-41.8	Revision of abandoned coal mines
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-0.002	-0.00001	0.00007	0.0000004	No information provided
Portugal	-29	-16.9	-1	-3.8	Update on CH_4 emission factor for Underground Mining.
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	10	14.6	Correction of a mistake in the consumption of one fuel for coal open mines
Sweden	-	-	-	-	
United Kingdom	-0.0	-0.0	0.002	0.0003	No significant recalculations.
EU27+UK	37	0.0	193	0.6	
Iceland	-	-	-	-	

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
United Kingdom (KP)					
EU-KP	37	0.04	193	0.6	

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 1.2 % of the total GHG emissions in 2018 and for 59 % (Figure 3.181) of all fugitive emissions in the EU-KP.

Of all fugitive emissions from oil and natural gas, in 2018:

- 43 % were CH_4 emissions from natural gas (exploration, production, processing, transport and distribution)
- 24 % were CO_2 emissions from oil (exploration, production, transport, refining and storage and distribution)
- 14% were CO_2 emissions from venting and flaring
- 9% were CH_4 emissions from venting and flaring
- 5 % were CH_4 emissions due to Other emissions

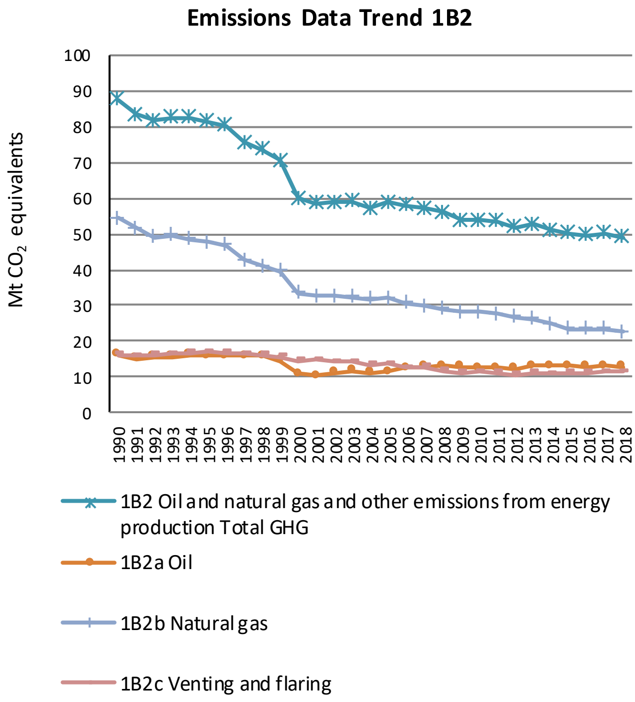
This source category includes four key categories:

Table 3.117: Key source categories for level and trend analyses and share of countries emissions using higher tier methods in sector 1.B.2 (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
1.B.2.a Oil: Operation (CH_4)	6767	1133	T	0	0	63%
1.B.2.a Oil: Operation (CO_2)	9451	11813	T	L	L	89%
1.B.2.b Natural Gas: Operation (CH_4)	50935	21178	T	L	L	80%
1.B.2.c Venting and Flaring: Operation (CO_2)	8728	6832	0	L	L	81%

Fugitive emissions from oil and natural gas occur in all countries but Malta (Table 3.118). Total greenhouse gas emissions from 1.B.2 decreased by 44 % between 1990 and 2018 (Figure **3.181**). This trend was mainly due to the reduction of fugitive CH_4 emissions from natural gas activities, which decreased by 59 % over that period.

Figure 3.181 1.B.2-Fugitive Emissions Oil and Natural Gas: Trend



In 2018, 54% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: Germany, Italy, Poland and the United Kingdom. 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 3.118).

Table 3.118 1.B.2 Fugitive emissions from oil and natural gas: Countries' contributions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	369	370	102	127	NA,NO,IE	NO,IE,NA	266	243
Belgium	805	619	85	121	NO,IE,NA	NO,IE,NA	720	498
Bulgaria	219	921	61	687	0	1	158	233
Croatia	970	450	601	267	1	0	369	184
Cyprus	1	0	0	0	NO,NE	NO	0	0
Czechia	1 082	608	2	5	0	0	1 080	603
Denmark	517	364	341	232	53	41	123	90
Estonia	50	16	0	0	NO	NO	50	16
Finland	123	121	111	91	1	1	11	29
France	6 189	4 090	4 362	3 008	26	14	1 801	1 069
Germany	10 310	6 242	2 008	1 342	2	1	8 300	4 900
Greece	79	132	43	11	0	0	36	120
Hungary	1 834	771	478	140	1	0	1 354	631
Ireland	49	62	0	0	NO	0	49	62
Italy	12 794	6 765	4 047	2 295	12	9	8 735	4 460
Latvia	248	91	0	0	NO	NO	248	91
Lithuania	289	523	24	254	0	0	265	269
Luxembourg	19	31	0	0	NO	NO	19	31
Malta	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	2 707	1 498	775	1 027	NO,IE,NA	NO,IE,NA	1 932	471
Poland	1 130	4 539	46	1 851	0	1	1 084	2 687
Portugal	124	1 187	119	1 128	2	3	2	56
Romania	25 366	4 171	1 177	552	3	1	24 186	3 618
Slovakia	1 714	1 342	5	1	0	0	1 708	1 341
Slovenia	50	39	0	0	0	0	50	39
Spain	1 910	3 966	1 749	3 784	0	0	162	182
Sweden	424	878	331	821	1	1	92	57
United Kingdom	18 198	9 236	5 778	4 279	41	38	12 379	4 920
EU-27+UK	**87 570**	**49 032**	**22 243**	**22 022**	**145**	**111**	**65 182**	**26 899**
Iceland	62	160	61	156	NA,NO	NO,NA	1	3
United Kingdom (KP)	18 198	9 236	5 778	4 279	41	38	12 379	4 920
EU-KP	**87 632**	**49 192**	**22 304**	**22 178**	**145**	**111**	**65 183**	**26 902**

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 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-KP GHG emissions in 2018 and for 14 % of all fugitive emissions. Between 1990 and 2018, CO_2 emissions from this source increased by 25 % in the EU-KP (Table 3.119). By contrast, during the same period 1990-2018, CH_4 emissions of this source category were reduced by 83 %.

Together France, Italy and Spain accounted for 64 % of the EU-KP total CO_2 emissions of 1.B.2.a 'Fugitive CO_2 emissions from oil' (Table 3.119, Figure 3.182). 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 2020). For detailed information on countries methodologies please see Annex III. Table **3.119** shows that 89 % of EU-KP CO_2 emissions from this source are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (FRK, ITA, LTU, ROU, ESP) only emissions from subcategories of sector 1.B.2.a were taken into account for the calculation, where the countries 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 higher method, according to the IPCC 2006 Guidelines.

During the period 1990-2018, the largest decreases in CO_2 emissions (in absolute terms) were observed in Italy, Romania, France and the United Kingdom. (Table 3.119). Decreasing CO_2 emissions in Italy are mainly driven by the reduction in crude oil losses in refineries (ITA NIR 2020). In the UK, CO_2 emissions from this source decline mainly due to a decrease of 87% of CO_2 emissions in oil exploration (1.B.2.a.1).

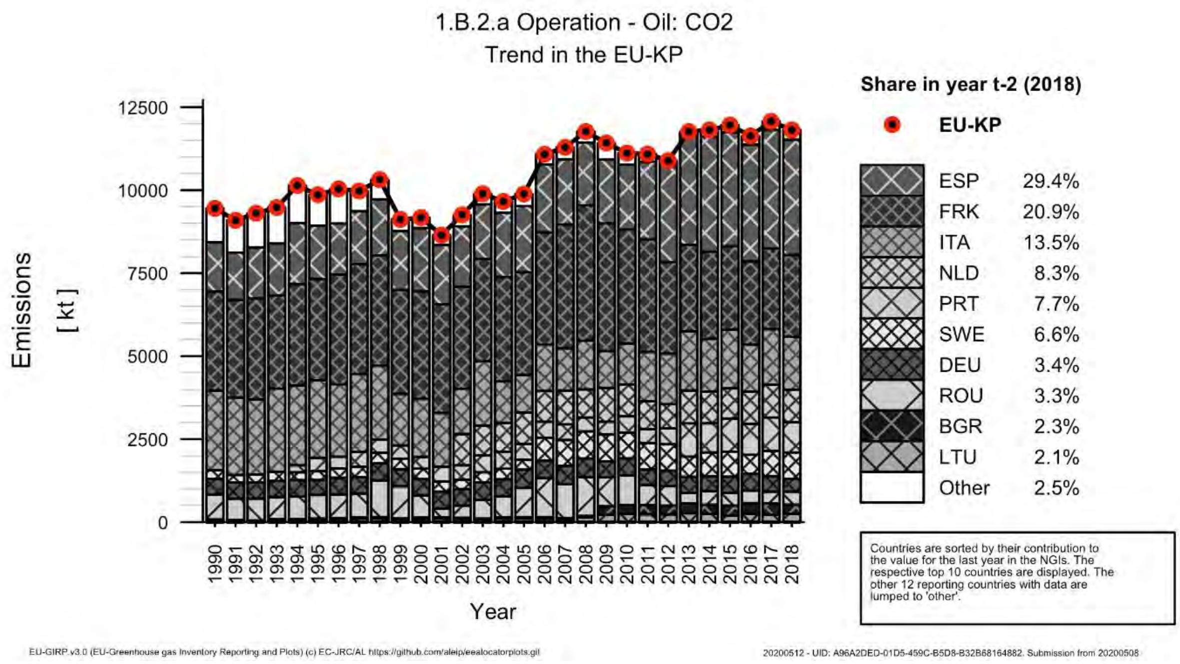
Largest increases between 1990-2018 are reported in the Netherlands, Portugal and Spain (Table 3.119). In all three countries, increases are mainly driven by increases in CO_2 emissions from subcategory 1.B.2.a.4 (Oil – Refining/Storage).

Table 3.119 1.B.2.a Fugitive CO_2 emissions from oil: Countries' contributions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	0.004	0.004	0.005	0.00004%	0.001	23%	0.0004	9%	T1	D
Belgium	0.01	0.02	0.02	0.0002%	0.005	32%	-0.001	-3%	T1	D
Bulgaria	60	337	272	2.3%	212	353%	-65	-19%	T1	D
Croatia	158	44	43	0.4%	-115	-73%	-1	-2%	T1	D
Cyprus	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Czechia	0.02	0.04	0.04	0.0003%	0.02	102%	0.001	2%	T1	D
Denmark	5	0.004	0.003	0.00003%	-5	-100%	-0.001	-16%	T3	D,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	2 983	2 436	2 470	20.9%	-513	-17%	34	1%	T1,T2,T3	CS,D,PS
Germany	478	474	398	3.4%	-80	-17%	-76	-16%	T2	CS
Greece	0.00004	0.00001	0.00001	0.0%	-0.00003	-73%	0	46%	T1	D
Hungary	5	1	1	0.005%	-5	-89%	0	1%	T1	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	2 402	1 671	1 592	13.5%	-810	-34%	-79	-5%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	23	222	251	2.1%	228	979%	30	13%	T1,T3	D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	991	983	8.3%	983	5462059%	-8	-1%	CS,T1	D,PS
Poland	0.1	0.2	0.3	0.002%	0.2	363%	0.01	4%	T1	CS
Portugal	0	999	912	7.7%	912	188296%	-87	-9%	D	D
Romania	746	359	388	3.3%	-358	-48%	30	8%	T1,T2	CS,D
Slovakia	0.03	0.01	0.01	0.0001%	-0.02	-75%	-0.0003	-5%	T1	CS
Slovenia	0.03	0.06	0.07	0.001%	0.04	175%	0.005	8%	T1	D
Spain	1 477	3 568	3 472	29.4%	1 995	135%	-95	-3%	T1,T2	D,PS
Sweden	255	756	783	6.6%	528	207%	27	4%	T3	PS
United Kingdom	859	217	247	2.1%	-612	-71%	30	14%	T2	CS,PS
EU-27+UK	**9 451**	**12 074**	**11 813**	**100%**	**2 362**	**25%**	**-262**	**-2%**	**-**	**-**
Iceland	0.003	0.005	0.005	0.00004%	0.002	77%	0.0004	9%	T1	D
United Kingdom (KP)	859	217	247	2.1%	-612	-71%	30	14%	T2	CS,PS
EU-KP	**9 451**	**12 074**	**11 813**	**100%**	**2 362**	**25%**	**-262**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.182 1.B.2.a Oil: Emission trend and share for the emitting countries of CO_2



CH_4 from Oil (1.B.2.a)

CH_4 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.03 % of total EU-KP GHG emissions in 2018 and for 1.4 % of all fugitive emissions. Between 1990 and 2018, CH_4 emissions from this source decreased by 83 % in the EU-KP (Table 3.119).

Together Romania, Italy, Poland, Germany and the UK accounted for 74 % of the EU-KP total CH_4 emissions of 1.B.2.a 'Fugitive CH_4 emissions from oil' (Table 3.120). In Romania main contributions to CH_4 emissions come from subcategory 1.B.2.a.2 (Oil – Production). From 1990 to 2000 CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2020). This also explains the outlier in *Figure 3.183*. 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 countries methodologies please see Annex III.

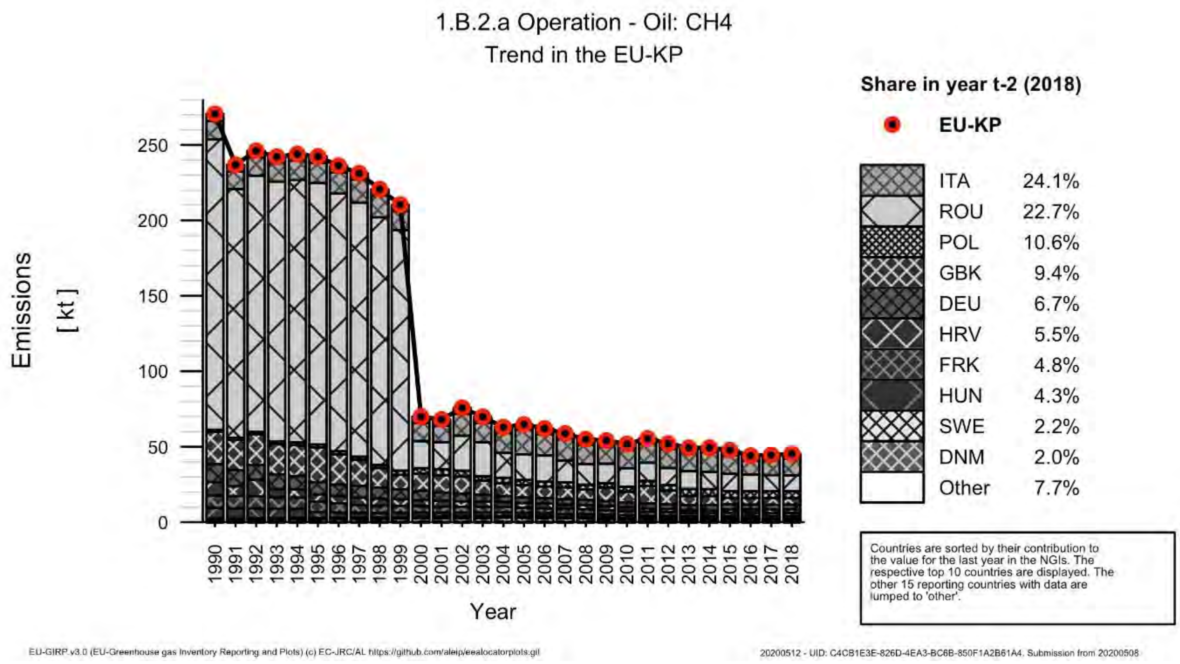
During the period 1990-2018, the largest decreases in CH_4 emissions (in absolute terms) were observed in the United Kingdom and Romania, caused by significant decreases in oil production (-95% in Romania, -80% in the UK). In the same period of time emissions increased most in Poland due to an increase of 402% in oil production (Table 3.120).

Table 3.120 1.B.2.a Fugitive CH_4 emissions from oil: Countries' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	8	8	0.7%	1	14%	1	11%	T1	D
Belgium	11	8	8	0.7%	-4	-33%	0	1%	CS,D	CS,D
Bulgaria	12	8	7	0.6%	-5	-42%	-1	-12%	T1	D
Croatia	220	63	62	5.5%	-159	-72%	-1	-1%	T1	D
Cyprus	0	NO,NE	NO,NE	-	0	-100%	-	-	NA	NA
Czechia	23	7	6	0.6%	-16	-72%	0	-3%	T1,T2	CS,D
Denmark	31	25	23	2.0%	-9	-27%	-2	-9%	T2,T3	,D,OTH,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	6	9	9	0.8%	3	46%	0	1%	T1	D
France	206	53	54	4.8%	-152	-74%	1	2%	T1,T2,T3	CS,D,PS
Germany	301	77	76	6.7%	-225	-75%	-1	-1%	T2	CS
Greece	10	15	16	1.4%	6	61%	0	2%	T1	D
Hungary	179	43	48	4.3%	-130	-73%	5	12%	T1	CS
Ireland	0	0	0	0.0%	0	68%	0	-5%	T1	D
Italy	310	248	273	24.1%	-37	-12%	24	10%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	4	3	3	0.3%	-1	-31%	0	-6%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	20	14	16	1.4%	-4	-21%	2	13%	T1,T1b	D
Poland	34	115	120	10.6%	86	253%	6	5%	T1	CS
Portugal	2	2	2	0.2%	0	20%	0	-12%	CR,OTH	CR,OTH
Romania	4 811	261	257	22.7%	-4 554	-95%	-4	-2%	T1	D
Slovakia	15	8	8	0.7%	-7	-49%	0	-3%	T1	CS
Slovenia	0	NO,NA	NO,NA	-	0	-100%	-	-	NA	NA
Spain	4	3	3	0.3%	-1	-16%	0	1%	T1	D
Sweden	25	26	25	2.2%	1	3%	-1	-3%	T1,T2	CS,D,PS
United Kingdom	534	113	106	9.4%	-428	-80%	-7	-6%	T2	CS,PS
EU-27+UK	**6 767**	**1 110**	**1 132**	**100%**	**-5 635**	**-83%**	**22**	**2%**	**-**	**-**
Iceland	0	1	1	0.1%	0	62%	0	12%	T1	D
United Kingdom (KP)	534	113	106	9.4%	-428	-80%	-7	-6%	T2	CS,PS
EU-KP	**6 767**	**1 111**	**1 133**	**100%**	**-5 634**	**-83%**	**22**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.183: 1.B.2.a Oil: Emission trend and share for the emitting countries of CH_4



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 0.5 % of total EU-KP GHG emissions in 2018 and for 26 % of all fugitive emissions in the EU-KP. Between 1990 and 2018, CH_4 emissions from this source decreased by -58 % Table 3.121.

In 2018, 71% of the EU-KP CH_4 emissions from 1.B.2.b were emitted by four countries: Germany, Italy, Romania and the United Kingdom (Table 3.121, Figure 3.184). 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. From 1990 to 2000 CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2020). This also explains the outlier in Figure **3.184**. For detailed information on countries methodologies please see Annex III. Table **3.121** shows that 80 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (AUT, FIN, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the countries 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 higher Tier method, according to the IPCC 2006 Guidelines.

The emission decreases between 1990 and 2018 observed in Romania (-86 %), the United Kingdom (-65 %), Germany (-40 %) and in Italy (-50 %) contributed most significantly to the overall reduction in the EU-KP between 1990 and 2018. 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 and the change of methodology (Romania).

Table 3.121 1.B.2.b Fugitive CH_4 emissions from natural gas: Countries' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	259	281	235	1.1%	-24	-9%	-47	-17%	T1,T2	CS,D
Belgium	709	507	490	2.3%	-219	-31%	-17	-3%	CS	CS
Bulgaria	146	227	226	1.1%	80	55%	-1	0%	T1	D
Croatia	148	138	122	0.6%	-27	-18%	-16	-12%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 045	574	569	2.7%	-476	-46%	-5	-1%	T1,T2	CS
Denmark	61	49	43	0.2%	-18	-29%	-6	-12%	T2,T3	CS,D
Estonia	50	16	16	0.1%	-34	-67%	0	2%	T1	D
Finland	4	21	20	0.1%	16	370%	-1	-5%	T1,T2	CS,D,PS
France	1 520	1 045	991	4.7%	-529	-35%	-55	-5%	T2,T3	CS,PS
Germany	7 997	4 837	4 823	22.8%	-3 175	-40%	-15	0%	T2,T3	CS
Greece	9	87	78	0.4%	69	749%	-9	-10%	T1	D
Hungary	818	437	421	2.0%	-397	-49%	-16	-4%	T1	CS
Ireland	20	46	48	0.2%	27	134%	2	5%	T3	CS,PS
Italy	8 236	4 471	4 120	19.5%	-4 116	-50%	-351	-8%	T2	CS
Latvia	177	140	84	0.4%	-93	-53%	-55	-40%	T3	CS
Lithuania	261	297	265	1.3%	5	2%	-31	-11%	T2	CS
Luxembourg	19	31	31	0.1%	12	60%	0	-1%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	421	256	257	1.2%	-164	-39%	1	0%	T3	CS
Poland	753	1 189	1 208	5.7%	455	60%	19	2%	T1	D
Portugal	NO	51	52	0.2%	52	∞	1	3%	CR,NO,OTH	CR,NO,OTH
Romania	16 762	2 388	2 409	11.4%	-14 353	-86%	21	1%	T1	D
Slovakia	1 103	917	856	4.0%	-248	-22%	-61	-7%	T1	CS
Slovenia	42	34	33	0.2%	-9	-21%	-1	-2%	T1	D
Spain	136	128	148	0.7%	11	8%	20	16%	CS,T1	CS,D
Sweden	67	34	31	0.1%	-36	-54%	-3	-8%	T2,T3	CS,PS
United Kingdom	10 168	3 765	3 602	17.0%	-6 566	-65%	-163	-4%	T2,T3	CS,PS
EU-27+UK	**50 935**	**21 966**	**21 178**	**100%**	**-29 757**	**-58%**	**-788**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	10 168	3 765	3 602	17.0%	-6 566	-65%	-163	-4%	T2,T3	CS,PS
EU-KP	**50 935**	**21 966**	**21 178**	**100%**	**-29 757**	**-58%**	**-788**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.184 1.B.2.b Natural Gas: Emission trend and share for the emitting countries of CH_4

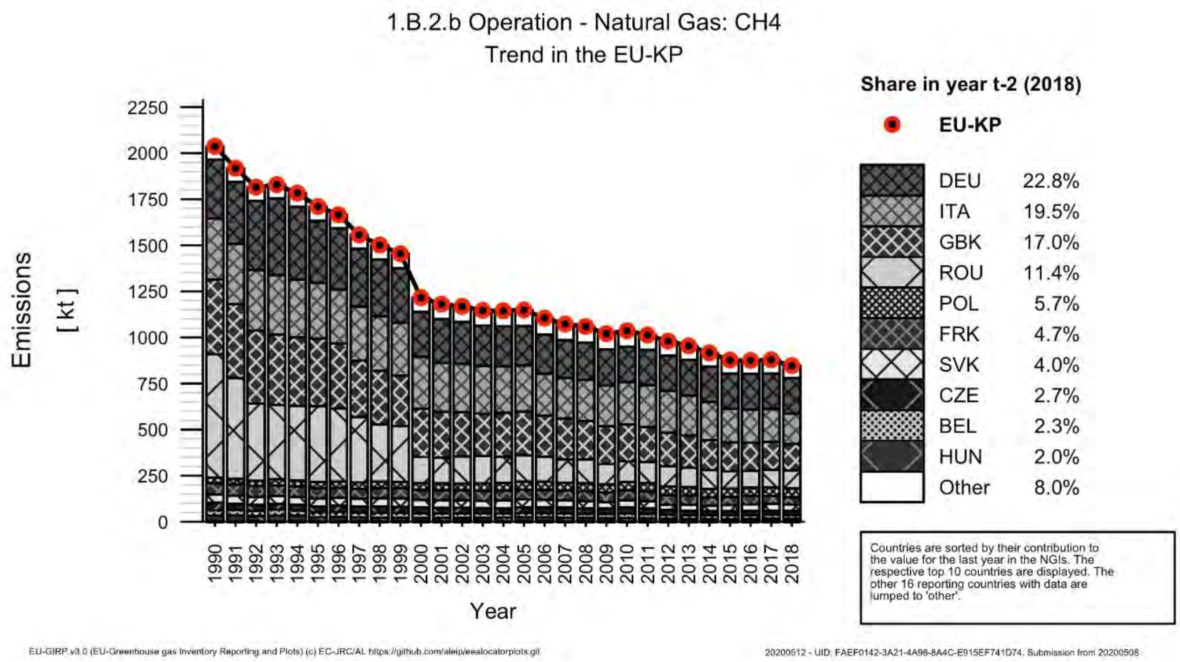


Table 3.122 and

1.B.2.a Fugitive CO2 and CH4 Emissions from Oil			1990								
Member State		GHG source category	Activity data: Description	Activity data: Unit	Activity data: Value	CO2 IEF (kg/unit)	CH4 IEFr (kg/unit)	CO2 emissions (kt)	CH4 emissions (kt)	Activity data: Description	Activity data: Unit
AUT	Austria	Oil						0	0.29		
		1. Exploration	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt
		2. Production	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt
		3. Transport	1000 m3 crude oil	Mt	7 993	0.5	5	0.004	0.04	1000 m3 crude oil	Mt
		4. Refining and storage	Mt crude oil Input	Mt	8	NA,NO	31 663	NA	0.25	Mt crude oil Input	Mt
		5. Distribution of oil products	Mt gasoline	Mt	3	NA,NO	NA	NA	NA	Mt gasoline	Mt
		6. Other		Mt	NO	NO	NO	NO	NO		Mt
BEL	Belgium	Oil						0	0.46		
		1. Exploration		PJ	NO	NO	NO	NO	NO		PJ
		2. Production		PJ	NO	NO	NO	NO	NO		PJ
		3. Transport		PJ	1 051	14	150	0.01	0.16		PJ
		4. Refining and storage		PJ	1 251	NA,NO	238	NA	0.30		PJ
		5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ
		6. Other		PJ	NO	NO	NO	NO	NO		PJ
BGR	Bulgaria	Oil						60	0.50		
		1. Exploration	Indigenous production	103m3	70	4 400	20	0	0.00	Indigenous production	103m3
		2. Production	Indigenous production	103m3	70	44 990	2 910	3.15	0.20	Indigenous production	103m3
		3. Transport	Indigenous production	103m3	70	2	25	0.0002	0.002	Indigenous production	103m3
		4. Refining and storage	Refinery intake	103m3	9 667	5 850	30	57	0.29	Refinery intake	103m3

1.B.2.a Fugitive CO2 and CH4 Emissions from Oil			1990								
Member State		GHG source category	Activity data			CO2 IEF (kg/unit)	CH4 IEFr (kg/unit)	CO2 emissions (kt)	CH4 emissions (kt)	Activity data	
			Description	Unit	Value					Description	Unit
		5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO
		6. Other		NO	NO	NO	NO	NO	NO		NO
CYP	Cypress	**Oil**						**NO,NE**	**0.02**		
		1. Exploration		NO	NO	NO	NO	NO	NO		NO
		2. Production		NO	NO	NO	NO	NO	NO		NO
		3. Transport			NE	NO,NE	NE	NE	NE		
		4. Refining and storage	Crude Oil refined (10^3 m3)	NO	743	NO,NE	22	NE	0.02	Crude Oil refined (10^3 m3)	NO
		5. Distribution of oil products		NE	NE	NO,NE	NE	NE	NE		NE
		6. Other		NO	NO	NO	NO	NO	NO		NO
CZE	Czech Republic	**Oil**						**0.02**	**0.91**		
		1. Exploration	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE	(e.g. number of wells drilled)	PJ
		2. Production	(e.g. PJ of oil produced)	PJ	2	7 473	5 897	0.02	0.01	(e.g. PJ of oil produced)	PJ
		3. Transport	(e.g. PJ oil loaded in tankers)	PJ	306	13	145	0.004	0.04	(e.g. PJ oil loaded in tankers)	PJ
		4. Refining and storage	(e.g. PJ oil refined)	PJ	306	NE,NO	2 779	NE	0.85	(e.g. PJ oil refined)	PJ
		5. Distribution of oil products	(e.g. PJ oil refined)	PJ	306	NE,NO	NE	NE	NE	(e.g. PJ oil refined)	PJ
		6. Other	(NO)	PJ	NO	NO	NO	NO	NO	(NO)	PJ
DEU	Germany	**Oil**						**478**	**12.05**		
		1. Exploration	Number of wells drilled	number	12	0.5	64	0.00001	0.00	Number of wells drilled	number
		2. Production	oil produced	t	3 605 667	0.1	0.3	0.5	1.08	oil produced	t
		3. Transport	oil transported	t	87 702 887	NO,NA	0.01	NA	0.59	oil transported	t
		4. Refining and storage	oil refined	t	214 116 000	2	0.0	477	10.38	oil refined	t
		5. Distribution of oil products	oil products distributed	t	89 461 000	NO,NA	NA	NA	NA	oil products distributed	t
		6. Other			NO	NO	NO	NO	NO		
DNM	Denmark	**Oil**						**5**	**1.26**		
		1. Exploration	Oil explored	m3	1 930	2 433	0	5	0.00	Oil explored	m3
		2. Production	Oil produced	10^3 m3	6 999	0	1	0	0.00	Oil produced	10^3 m3
		3. Transport	Oil loaded	Mg	3 390 120	NO,NA	0	NA	0.03	Oil loaded	Mg
		4. Refining and storage	Oil refined	Mg	7 263 000	0	0	0	1.22	Oil refined	Mg
		5. Distribution of oil products	Gasoline distribution	Mg	1 734 295	NA	NA	NA	NA	Gasoline distribution	Mg
		6. Other	Other	m3	NO	NO	NO	NO	NO	Other	m3
ESP	Spain	**Oil**						**1477**	**0.16**		
		1. Exploration	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA	Crude oil produced	Tg
		2. Production	Crude oil produced	Tg	1	58	705	0.00005	0.00	Crude oil produced	Tg
		3. Transport	Transport of crude oil	Tg	57	66	729	0.004	0.04	Transport of crude oil	Tg
		4. Refining and	Oil refined	Tg	54	27 571 240	2 107	1477	0.11	Oil refined	Tg

1.B.2.a Fugitive CO2 and CH4 Emissions from Oil			1990								
Member State		GHG source category	Activity data			CO2 IEF (kg/unit)	CH4 IEFr (kg/unit)	CO2 emissions (kt)	CH4 emissions (kt)	Activity data	
			Description	Unit	Value					Description	Unit
		storage									
		5. Distribution of oil products	Oil products	Tg	NA	NO,NA	NA	NA	NA	Oil products	Tg
		6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
EST	Estonia	**Oil**						**NO,NE**	**NO,NE**		
		1. Exploration	Exploration	NA	NO	NO	NO	NO	NO	Exploration	NA
		2. Production	Production	NA	NO	NO	NO	NO	NO	Production	NA
		3. Transport	Transport	NA	NO	NO	NO	NO	NO	Transport	NA
		4. Refining and storage	Refining/Storage	NA	NO	NO	NO	NO	NO	Refining/Storage	NA
		5. Distribution of oil products	Distribution of oil products	kt	NE	NE	NE	NE	NE	Distribution of oil products	kt
		6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA
FIN	Finland	**Oil**						**NO**	**0.25**		
		1. Exploration		NA	NO	NO	NO	NO	NO		NA
		2. Production		NO	NO	NO	NO	NO	NO		NO
		3. Transport		NO	NO	NO	NO	NO	NO		NO
		4. Refining and storage	kt oil refined	kt	9 884	NO	25	NO	0.25	kt oil refined	kt
		5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO
		6. Other		NO	NO	NO	NO	NO	NO		NO
FRK	France	**Oil**						**2983**	**8.23**		
		1. Exploration	Oil produced	PJ	127	252 097	5 373	32	0.68	Oil produced	PJ
		2. Production	Oil produced	PJ	127	7 201	54 578	1	6.93	Oil produced	PJ
		3. Transport	Oil loaded	PJ	5 189	7	73	0.03	0.38	Oil loaded	PJ
		4. Refining and storage	Oil refined	PJ	3 194	923 744	75	2950	0.24	Oil refined	PJ
		5. Distribution of oil products	Oil refined	PJ	3 785	NA	NA	NA	NA	Oil refined	PJ
		6. Other	NO	PJ	NO	NO	NO	NO	NO	NO	PJ
GBK	United Kingdom	**Oil**						**859**	**21.35**		
		1. Exploration	Exploration drilling: fuel use	t	234 422	3 185	16	747	3.67	Exploration drilling: fuel use	t
		2. Production	Oil produced	PJ	3 981	28 256	3 550	112	14.13	Oil produced	PJ
		3. Transport	Oil loading	t	222 791 650	NO	0.02	NO	3.40	Oil loading	t
		4. Refining and storage	Refinery throughput	PJ	3 862	NO	37	NO	0.14	Refinery throughput	PJ
		5. Distribution of oil products		NA	NO	NO	NO	NO	NO		NA
		6. Other		NA	NO	NO	NO	NO	NO		NA
GRC	Greece	**Oil**						**0.00004**	**0.39**		
		1. Exploration			NE	NO,NE	NE	NE	NE		
		2. Production		kt	773	0.1	1	0.00004	0.00		kt
		3. Transport		kt	773	NO,NE	27	NE	0.02		kt
		4. Refining and storage		kt	14 411	IE,NO	26	IE	0.37		kt
		5. Distribution of oil products		kt	2 450	NA,NO	NA	NA	NA		kt

1.B.2.a Fugitive CO2 and CH4 Emissions from Oil			1990								
Member State		GHG source category	Activity data			CO2 IEF (kg/unit)	CH4 IEFr (kg/unit)	CO2 emissions (kt)	CH4 emissions (kt)	Activity data	
			Description	Unit	Value					Description	Unit
		6. Other			NO	NO	NO	NO	NO		
HRV	Croatia	**Oil**						**158**	**8.82**		
		1. Exploration	total oil production	1000 m3	3 135	9 102	194	29	0.61	total oil production	1000 m3
		2. Production	total oil production	1000 m3	3 135	41 225	2 546	129	7.98	total oil production	1000 m3
		3. Transport	total oil transported by pipelines	1000 m3	9 949	0.49	5	0.00	0.05	total oil transported by pipelines	1000 m3
		4. Refining and storage	oil refined	1000 m3	7 978	NO,NA	22	NA	0.17	oil refined	1000 m3
		5. Distribution of oil products	product transported	NA	NA	NO,NA	NA	NA	NA	product transported	NA
		6. Other		NO	NO	NO	NO	NO	NO		NO
HUN	Hungary	**Oil**						**5**	**7.14**		
		1. Exploration		NA	IE	IE,NO	IE	IE	IE		NA
		2. Production	conventional oil production (thousand m3)	1000 m3	2 269	2 150	3 000	5	6.81	conventional oil production (thousand m3)	1000 m3
		3. Transport	Oil transported by pipeline (thousand m3)	1000 m3	10 432	25	13	0.3	0.13	Oil transported by pipeline (thousand m3)	1000 m3
		4. Refining and storage	Oil refined (thousand m3)	1000 m3	9 357	NA,NO	22	NA	0.20	Oil refined (thousand m3)	1000 m3
		5. Distribution of oil products		NA	NA	NA,NO	NA	NA	NA		NA
		6. Other		NO	NO	NO	NO	NO	NO		NO
IRL	Ireland	**Oil**						**NO**	**0.01**		
		1. Exploration		PJ	NO	NO	NO	NO	NO		PJ
		2. Production		PJ	NO	NO	NO	NO	NO		PJ
		3. Transport		PJ	NO	NO	NO	NO	NO		PJ
		4. Refining and storage		PJ	77	NO	110	NO	0.01		PJ
		5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ
		6. Other		PJ	NO	NO	NO	NO	NO		PJ
ISL	Iceland	**Oil**						**0.003**	**0.02**		
		1. Exploration			NO	NO	NO	NO	NO		
		2. Production			NO	NO	NO	NO	NO		
		3. Transport			NO	NO	NO	NO	NO		
		4. Refining and storage			NO	NO	NO	NO	NO		
		5. Distribution of oil products	oil distributed	TJ	27 981	0.1	1	0.003	0.02	oil distributed	TJ
		6. Other			NO	NO	NO	NO	NO		
ITA	Italy	**Oil**						**2402**	**12.39**		
		1. Exploration	Wells drilled	Number	6	1 900	112	0.01	0.00	Wells drilled	Number
		2. Production	Oil produced	Gg	4 668	320	2 049	1	9.56	Oil produced	Gg
		3. Transport	Oil transported	Gg	94 600	1	6	0.1	0.58	Oil transported	Gg

1.B.2.a Fugitive CO2 and CH4 Emissions from Oil			1990									
Member State		GHG source category	Activity data			CO2 IEF (kg/unit)	CH4 IEFr (kg/unit)	CO2 emissions (kt)	CH4 emissions (kt)	Activity data	
			Description	Unit	Value					Description	Unit
		4. Refining and storage	Oil refined	Gg	93 711	25 615	24	2400	2.24	Oil refined	Gg
		5. Distribution of oil products	Oil distributed	NA	NA	NA	NA	NA	NA	Oil distributed	NA
		6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA
LTU	Lithuania	**Oil**						**23.3**	**0.17**		
		1. Exploration	Oil produced	thous. m3	14	9 102	194	0.1	0.00	Oil produced	thous.m3
		2. Production	Oil produced, thous.m3	thous. m3	14	0.1	2	0.000 002	0.00	Oil produced, thous.m3	thous.m3
		3. Transport	Oil transported, thous.m3	thous. m3	25 577	0.5	5	0.01	0.14	Oil transported, thous.m3	thous.m3
		4. Refining and storage	Oil refined	thous. m3	11 181	NO	3	NO	0.03	Oil refined	thous.m3
		5. Distribution of oil products		NA	NA	NO,NA	NA	NA	NA		NA
		6. Other	Refinery gas	kt	8	2 870 000	NO	23	NO	Refinery gas	kt
LUX	Luxembourg	**Oil**						**NO**	**NO**		
		1. Exploration	number of wells drilled	NA	NO	NO	NO	NO	NO	number of wells drilled	NA
		2. Production	oil produced	NA	NO	NO	NO	NO	NO	oil produced	NA
		3. Transport	oil loaded in tankers	NA	NO	NO	NO	NO	NO	oil loaded in tankers	NA
		4. Refining and storage	oil refined	NA	NO	NO	NO	NO	NO	oil refined	NA
		5. Distribution of oil products	oil refined	ktoe	1 577	NO	NO	NO	NO	oil refined	ktoe
		6. Other	other n.i.e.	NA	NO	NO	NO	NO	NO	other n.i.e.	NA
LVA	Latvia	**Oil**						**NO,NA**	**NO,NA**		
		1. Exploration	Exploration	kt	NO	NO	NO	NO	NO	Exploration	kt
		2. Production	Production	kt	NO	NO	NO	NO	NO	Production	kt
		3. Transport	Transport	kt	NO	NO	NO	NO	NO	Transport	kt
		4. Refining and storage	Refining/Storage	kt	NO	NO	NO	NO	NO	Refining/Storage	kt
		5. Distribution of oil products	Distribution of Oil Products	kt	609	NO,NA	NA	NA	NA	Distribution of Oil Products	kt
		6. Other	Other	kt	NO	NO	NO	NO	NO	Other	kt
MLT	Malta	**Oil**						**NO**	**NO**		
		1. Exploration	number of wells drilled	NO	NO	NO	NO	NO	NO	number of wells drilled	NO
		2. Production	oil produced	NO	NO	NO	NO	NO	NO	oil produced	NO
		3. Transport	oil loaded in tankers	NO	NO	NO	NO	NO	NO	oil loaded in tankers	NO
		4. Refining and storage	oil refined	NO	NO	NO	NO	NO	NO	oil refined	NO
		5. Distribution of oil products	Gasoline	NO	NO	NO	NO	NO	NO	Gasoline	NO
		6. Other	Other Petroleum Product	NO	NO	NO	NO	NO	NO	Other Petroleum Product	NO
NLD	Netherlands	**Oil**						**0.02**	**0.81**		
		1. Exploration		PJ	IE	NO,IE	IE	IE	IE		PJ
		2. Production		PJ	IE	NO,IE	IE	IE	IE		PJ

1.B.2.a Fugitive CO2 and CH4 Emissions from Oil			1990								
Member State		GHG source category	Activity data			CO2 IEF (kg/unit)	CH4 IEFr (kg/unit)	CO2 emissions (kt)	CH4 emissions (kt)	Activity data	
			Description	Unit	Value					Description	Unit
		3. Transport		Mg	33 912	1	6	0.02	0.20		Mg
		4. Refining and storage		PJ	2 077	NO,IE	296	IE	0.61		PJ
		5. Distribution of oil products		PJ	NE	NA	NA	NA	NA		PJ
		6. Other		PJ	NO	NO	NO	NO	NO		PJ
POL	Poland	Oil						0	1.36		
		1. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA
		2. Production	Production	PJ	7	7 309	101 205	0	0.67	Production	PJ
		3. Transport	oil ltransported by pipeline	Gg	13 286	1	6	0	0.08	oil ltransported by pipeline	Gg
		4. Refining and storage	oil refined	PJ	531	NA	1 153	NA	0.61	oil refined	PJ
		5. Distribution of oil products	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRT	Portugal	Oil						0.5	0.07		
		1. Exploration		NO	NO	NO	NO	NO	NO		NO
		2. Production		NO	NO	NO	NO	NO	NO		NO
		3. Transport		Mt	0.01	490	5 400 000	0.00001	0.07		Mt
		4. Refining and storage		Mt	0.04	10 894 328	6	0.5	0.00		Mt
		5. Distribution of oil products		Mt	0.001	NO	NO	NO	NO		Mt
		6. Other		NO	NO	NO	NO	NO	NO		NO
ROU	Romania	Oil						746	192.45		
		1. Exploration	oil produced	PJ	322	2 245 932	47 534	724	15.32	oil produced	PJ
		2. Production	oil produced	PJ	322	69 542	547 400	22	176.40	oil produced	PJ
		3. Transport	oil refined	PJ	975	14	151	0.01	0.15	oil refined	PJ
		4. Refining and storage	oil refined	PJ	962	IE,NO	609	IE	0.59	oil refined	PJ
		5. Distribution of oil products	oil refined	PJ	NO	NO	NO	NO	NO	oil refined	PJ
		6. Other	oil refined	kt	NO	NO	IE	NO	IE	oil refined	kt
SVK	Slovakia	Oil						0.03	0.59		
		1. Exploration		NO	NO	NO	NO	NO	NO		NO
		2. Production	Production	kt	73	260	3 600	0.02	0.26	Production	kt
		3. Transport	Transfer	kt	13 581	0.5	5	0.01	0.07	Transfer	kt
		4. Refining and storage	Refining/Storage	kt	6 221	NE	41	NE	0.26	Refining/Storage	kt
		5. Distribution of oil products		NA	NE	NO,NE	NE	NE	NE		NA
		6. Other		NA	NO	NO	NO	NO	NO		NA
SVN	Slovenia	Oil						0.03	0.01		
		1. Exploration	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3
		2. Production	Conventional oil produced	1000 m3	3	0.04	1	0.0000001	0.00	Conventional oil produced	1000 m3
		3. Transport	Consumption of LPG	1000 m3	58	430	NA	0.03	NA	Consumption of LPG	1000 m3
		4. Refining and storage	Oil refined	1000 m3	626	NO,NA	22	NA	0.01	Oil refined	1000 m3

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990								
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data	
			Description	Unit	Value					Description	Unit
		5. Distribution of oil products	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3
		6. Other	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3
SWE	Sweden	**Oil**						**255**	**0.99**		
		1. Exploration	Consumption of feedstock	TJ	NA	NA	NA	38	0.00	Consumption of feedstock	TJ
		2. Production	Oil production		NO	NO	NO	NO	NO	Oil production	
		3. Transport	Transported amount of oil	PJ	725	NE	745	NE	0.54	Transported amount of oil	PJ
		4. Refining and storage	Consumption of crude oil	Mt	17	12 497 656	25 612	217	0.44	Consumption of crude oil	Mt
		5. Distribution of oil products	Distribution of oil products		NE	NA	NA	NA	NA	Distribution of oil products	
		6. Other			NO	NO	NO	NO	NO		

Table 3.123 provide an overview on activity data description and emission factors for all countries for sector 1.B.2.a and 1.B.2.b. CRF Tables do not include activity data for sector 1.B.2 because countries use different types of activity data which cannot be aggregated.

Table 3.122: 1.B.2.a Fugitive CO_2- and CH_4 emissions from natural gas: Information on activity data, emission factors by Member State

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
AUT	Austria	**Oil**						**0**	**0.29**						**0**	**0.34**
		1. Exploration	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt	0.69	NO,IE	IE	IE	IE
		2. Production	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt	0.69	NO,IE	IE	IE	IE
		3. Transport	1000 m3 crude oil	Mt	7 993	0.5	5	0.004	0.04	1000 m3 crude oil	Mt	9 800	0.49	5	0	0.05
		4. Refining and storage	Mt crude oil Input	Mt	8	NA,NO	31 663	NA	0.25	Mt crude oil Input	Mt	9	NO,NA	31663	NA	0.28
		5. Distribution of oil products	Mt gasoline	Mt	3	NA,NO	NA	NA	NA	Mt gasoline	Mt	2	NO,NA	NA	NA	NA
		6. Other		Mt	NO	NO	NO	NO	NO		Mt	NO	NO	NO	NO	NO
BEL	Belgium	**Oil**						**0**	**0.46**						**0.02**	**0.30**
		1. Exploration		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		2. Production		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		3. Transport		PJ	1 051	14	150	0.01	0.16		PJ	1 382	14	150	0.02	0.21
		4. Refining and storage		PJ	1 251	NA,NO	238	NA	0.30		PJ	1 454	NO,NA	66	NA	0.10
		5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		6. Other		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
BGR	Bulgaria	**Oil**						**60**	**0.50**						**272**	**0.29**
		1. Exploration	Indigenous production	103m3	70	4 400	20	0	0.00	Indigenous production	103m3	26	4400	20	0	0.00
		2. Production	Indigenous production	103m3	70	44 990	2 910	3.15	0.20	Indigenous production	103m3	26	44990	2910	1	0.08
		3. Transport	Indigenous production	103m3	70	2	25	0.0002	0.002	Indigenous production	103m3	26	2	25	0	0.00
		4. Refining and storage	Refinery intake	103m3	9 667	5 850	30	57	0.29	Refinery intake	103m3	6 853	39503	31	271	0.21
		5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
CYP	Cypress	**Oil**						**NO,NE**	**0.02**						**NO,NE**	**NO,NE**
		1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		3. Transport			NE	NO,NE	NE	NE	NE			NO	NO	NO	NO	NO
		4. Refining and storage	Crude Oil refined (10^3 m3)	NO	743	NO,NE	22	NE	0.02	Crude Oil refined (10^3 m3)	NO	NO	NO	NO	NO	NO
		5. Distribution of oil products		NE	NE	NO,NE	NE	NE	NE		NE	NE	NO,NE	NE	NE	NE
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
CZE	Czech Republic	**Oil**						**0.02**	**0.91**						**0.04**	**0.26**
		1. Exploration	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE
		2. Production	(e.g. PJ of oil produced)	PJ	2	7 473	5 897	0.02	0.01	(e.g. PJ of oil produced)	PJ	5	7576	4702	0.04	0.02
		3. Transport	(e.g. PJ oil loaded in tankers)	PJ	306	13	145	0.004	0.04	(e.g. PJ oil loaded in tankers)	PJ	322	13	146	0.004	0.05
		4. Refining and storage	(e.g. PJ oil refined)	PJ	306	NE,NO	2 779	NE	0.85	(e.g. PJ oil refined)	PJ	322	NO,NE	585	NE	0.19
		5. Distribution of oil products	(e.g. PJ oil refined)	PJ	306	NE,NO	NE	NE	NE	(e.g. PJ oil refined)	PJ	322	NO,NE	NE	NE	NE
		6. Other	(NO)	PJ	NO	NO	NO	NO	NO	(NO)	PJ	NO	NO	NO	NO	NO
DEU	Germany	**Oil**						**478**	**12.05**						**398**	**3.05**
		1. Exploration	Number of wells drilled	number	12	0.5	64	0.00001	0.00	Number of wells drilled	number	19	0.48	64	0.00001	0.00
		2. Production	oil produced	t	3 605 667	0.1	0.3	0.5	1.08	oil produced	t	2 070 076	0.12	0.02	0.25	0.04
		3. Transport	oil transported	t	87 702 887	NO,NA	0.01	NA	0.59	oil transported	t	104 500 000	NO,NA	0.01	NA	0.57
		4. Refining and storage	oil refined	t	214 116 000	2	0.0	477	10.38	oil refined	t	87 700 000	5	0.03	398	2.44
		5. Distribution of oil products	oil products distributed	t	89 461 000	NO,NA	NA	NA	NA	oil products distributed	t	78 807 281	NO,NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
DNM	Denmark	**Oil**						**5**	**1.26**						**0.003**	**0.91**
		1. Exploration	Oil explored	m3	1 930	2 433	0	5	0.00	Oil explored	m3	NO	NO	NO	NO	NO
		2. Production	Oil produced	10^3 m3	6 999	0	1	0	0.00	Oil produced	10^3 m3	6 629	0.04	1	0.0003	0.00
		3. Transport	Oil loaded	Mg	3 390 120	NO,NA	0	NA	0.03	Oil loaded	Mg	2 806 716	NO,NA	0	NA	0.05
		4. Refining and storage	Oil refined	Mg	7 263 000	0	0	0	1.22	Oil refined	Mg	7 542 000	0.0004	0.11	0.003	0.85
		5. Distribution of oil products	Gasoline distribution	Mg	1 734 295	NA	NA	NA	NA	Gasoline distribution	Mg	1 317 071	NA	NA	NA	NA
		6. Other	Other	m3	NO	NO	NO	NO	NO	Other	m3	NO	NO	NO	NO	NO
ESP	Spain	**Oil**						**1477**	**0.16**						**3472**	**0.13**
		1. Exploration	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA
		2. Production	Crude oil produced	Tg	1	58	705	0.00005	0.00	Crude oil produced	Tg	0	57.48	706	0.00001	0.00
		3. Transport	Transport of crude oil	Tg	57	66	729	0.004	0.04	Transport of crude oil	Tg	74	45.13	497	0.003	0.04
		4. Refining and storage	Oil refined	Tg	54	27 571 240	2 107	1477	0.11	Oil refined	Tg	60	57827895	1561	3472	0.09
		5. Distribution of oil products	Oil products	Tg	NA	NO,NA	NA	NA	NA	Oil products	Tg	NA	NO,NA	NA	NA	NA
		6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EST	Estonia	**Oil**						**NO,NE**	**NO,NE**						**NO,NE**	**NO,NE**
		1. Exploration	Exploration	NA	NO	NO	NO	NO	NO	Exploration	NA	NO	NO	NO	NO	NO
		2. Production	Production	NA	NO	NO	NO	NO	NO	Production	NA	NO	NO	NO	NO	NO
		3. Transport	Transport	NA	NO	NO	NO	NO	NO	Transport	NA	NO	NO	NO	NO	NO
		4. Refining and storage	Refining/Storage	NA	NO	NO	NO	NO	NO	Refining/Storage	NA	NO	NO	NO	NO	NO
		5. Distribution of oil products	Distribution of oil products	kt	NE	NE	NE	NE	NE	Distribution of oil products	kt	NE	NE	NE	NE	NE
		6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
FIN	Finland	**Oil**						**NO**	**0.25**						**NO**	**0.37**
		1. Exploration		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
		2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		3. Transport		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		4. Refining and storage	kt oil refined	kt	9 884	NO	25	NO	0.25	kt oil refined	kt	14 386	NO	25	NO	0.37
		5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
FRK	France	**Oil**						**2983**	**8.23**						**2470**	**2.16**
		1. Exploration	Oil produced	PJ	127	252 097	5 373	32	0.68	Oil produced	PJ	33	252097	5373	8	0.17
		2. Production	Oil produced	PJ	127	7 201	54 578	1	6.93	Oil produced	PJ	33	7201	54578	0.23	1.77
		3. Transport	Oil loaded	PJ	5 189	7	73	0.03	0.38	Oil loaded	PJ	3 032	6	65	0.02	0.20
		4. Refining and storage	Oil refined	PJ	3 194	923 744	75	2950	0.24	Oil refined	PJ	2 325	1058699	6	2462	0.01
		5. Distribution of oil products	Oil refined	PJ	3 785	NA	NA	NA	NA	Oil refined	PJ	3 630	NA	NA	NA	NA
		6. Other	NO	PJ	NO	NO	NO	NO	NO	NO	PJ	NO	NO	NO	NO	NO
GBK	United Kingdom	**Oil**						**859**	**21.35**						**247**	**4.24**
		1. Exploration	Exploration drilling: fuel use	t	234 422	3 185	16	747	3.67	Exploration drilling: fuel use	t	29 883	3200	25	96	0.75
		2. Production	Oil produced	PJ	3 981	28 256	3 550	112	14.13	Oil produced	PJ	2 242	67447	1237	151	2.77
		3. Transport	Oil loading	t	222 791 650	NO	0.02	NO	3.40	Oil loading	t	68 945 316	NO	0	NO	0.71
		4. Refining and storage	Refinery throughput	PJ	3 862	NO	37	NO	0.14	Refinery throughput	PJ	2 560	NO	2	NO	0.01
		5. Distribution of oil products		NA	NO	NO	NO	NO	NO		NA				NO	NO
		6. Other		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
GRC	Greece	**Oil**						**0.00004**	**0.39**						**0.00001**	**0.63**
		1. Exploration			NE	NO,NE	NE	NE	NE			NE	NO,NE	NE	NE	NE

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
		2. Production		kt	773	0.1	1	0.00004	0.00		kt	206	0.05	1	0.00001	0.00
		3. Transport		kt	773	NO,NE	27	NE	0.02		kt	206	NO,NE	27	NE	0.01
		4. Refining and storage		kt	14 411	IE,NO	26	IE	0.37		kt	24 327	NO,IE	26	IE	0.62
		5. Distribution of oil products		kt	2 450	NA,NO	NA	NA	NA		kt	2 297	NO,NA	NA	NA	NA
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
HRV	Croatia	**Oil**						**158**	**8.82**						**43**	**2.48**
		1. Exploration	total oil production	1000 m3	3 135	9 102	194	29	0.61	total oil production	1000 m3	851	9102	194	8	0.17
		2. Production	total oil production	1000 m3	3 135	41 225	2 546	129	7.98	total oil production	1000 m3	851	41225	2546	35	2.17
		3. Transport	total oil transported by pipelines	1000 m3	9 949	0.49	5	0.00	0.05	total oil transported by pipelines	1000 m3	9 943	0.49	5	0.005	0.05
		4. Refining and storage	oil refined	1000 m3	7 978	NO,NA	22	NA	0.17	oil refined	1000 m3	4 175	NO,NA	22	NA	0.09
		5. Distribution of oil products	product transported	NA	NA	NO,NA	NA	NA	NA	product transported	NA	NA	NO,NA	NA	NA	NA
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
HUN	Hungary	**Oil**						**5**	**7.14**						**1**	**1.93**
		1. Exploration		NA	IE	IE,NO	IE	IE	IE		NA	IE	NO,IE	IE	IE	IE
		2. Production	conventional oil production (thousand m3)	1000 m3	2 269	2 150	3 000	5	6.81	conventional oil production (thousand m3)	1000 m3	929	130	1801	0.1	1.67
		3. Transport	Oil transported by pipeline (thousand m3)	1000 m3	10 432	25	13	0.3	0.13	Oil transported by pipeline (thousand m3)	1000 m3	9 006	47	10	0.4	0.09
		4. Refining and storage	Oil refined (thousand m3)	1000 m3	9 357	NA,NO	22	NA	0.20	Oil refined (thousand m3)	1000 m3	8 091	NO,NA	22	NA	0.18

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
		5. Distribution of oil products		NA	NA	NA,NO	NA	NA	NA		NA	NA	NO,NA	NA	NA	NA
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
IRL	Ireland	**Oil**						**NO**	**0.01**						**NO**	**0.01**
		1. Exploration		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		2. Production		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		3. Transport		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		4. Refining and storage		PJ	77	NO	110	NO	0.01		PJ	129	NO	110	NO	0.01
		5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		6. Other		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
ISL	Iceland	**Oil**						**0.003**	**0.02**						**0**	**0.03**
		1. Exploration			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		2. Production			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		3. Transport			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		4. Refining and storage			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		5. Distribution of oil products	oil distributed	TJ	27 981	0.1	1	0.003	0.02	oil distributed	TJ	45 409	0.11	1	0.005	0.03
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
ITA	Italy	**Oil**						**2402**	**12.39**						**1592**	**10.91**
		1. Exploration	Wells drilled	Number	6	1 900	112	0.01	0.00	Wells drilled	Number	NO	NO	NO	NO	NO
		2. Production	Oil produced	Gg	4 668	320	2 049	1	9.56	Oil produced	Gg	4 684	321	1872	2	8.77
		3. Transport	Oil transported	Gg	94 600	1	6	0.1	0.58	Oil transported	Gg	115 685	0.56	6	0.06	0.72
		4. Refining and storage	Oil refined	Gg	93 711	25 615	24	2400	2.24	Oil refined	Gg	78 878	20158	18	1590	1.43
		5. Distribution of oil products	Oil distributed	NA	NA	NA	NA	NA	NA	Oil distributed	NA	NA	NA	NA	NA	NA
		6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
LTU	Lithuania	**Oil**						**23.3**	**0.17**						**251**	**0.12**
		1. Exploration	Oil produced	thous. m3	14	9 102	194	0.1	0.00	Oil produced	thous.m3	54	9101.90	194	0	0.01
		2. Production	Oil produced, thous.m3	thous. m3	14	0.1	2	0.000002	0.00	Oil produced, thous.m3	thous.m3	54	0.11	2	0.00001	0.00
		3. Transport	Oil transported, thous.m3	thous. m3	25 577	0.5	5	0.01	0.14	Oil transported, thous.m3	thous.m3	14 450	0.49	5	0.01	0.08
		4. Refining and storage	Oil refined	thous. m3	11 181	NO	3	NO	0.03	Oil refined	thous.m3	11 359	NO	3	NO	0.03
		5. Distribution of oil products		NA	NA	NO,NA	NA	NA	NA		NA	NA	NO,NA	NA	NA	NA
		6. Other	Refinery gas	kt	8	2 870 000	NO	23	NO	Refinery gas	kt	85	2943989.29	NO	251	NO
LUX	Luxembourg	**Oil**						**NO**	**NO**						**NO**	**NO**
		1. Exploration	number of wells drilled	NA	NO	NO	NO	NO	NO	number of wells drilled	NA	NO	NO	NO	NO	NO
		2. Production	oil produced	NA	NO	NO	NO	NO	NO	oil produced	NA	NO	NO	NO	NO	NO
		3. Transport	oil loaded in tankers	NA	NO	NO	NO	NO	NO	oil loaded in tankers	NA	NO	NO	NO	NO	NO
		4. Refining and storage	oil refined	NA	NO	NO	NO	NO	NO	oil refined	NA	NO	NO	NO	NO	NO
		5. Distribution of oil products	oil refined	ktoe	1 577	NO	NO	NO	NO	oil refined	ktoe	2 902	NO	NO	NO	NO
		6. Other	other n.i.e.	NA	NO	NO	NO	NO	NO	other n.i.e.	NA	NO	NO	NO	NO	NO
LVA	Latvia	**Oil**						**NO,NA**	**NO,NA**						**NO,NA**	**NO,NA**
		1. Exploration	Exploration	kt	NO	NO	NO	NO	NO	Exploration	kt	NO	NO	NO	NO	NO
		2. Production	Production	kt	NO	NO	NO	NO	NO	Production	kt	NO	NO	NO	NO	NO
		3. Transport	Transport	kt	NO	NO	NO	NO	NO	Transport	kt	NO	NO	NO	NO	NO
		4. Refining and storage	Refining/Storage	kt	NO	NO	NO	NO	NO	Refining/Storage	kt	NO	NO	NO	NO	NO
		5. Distribution of oil products	Distribution of Oil	kt	609	NO,NA	NA	NA	NA	Distribution of Oil Products	kt	183	NO,NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
			Products													
		6. Other	Other	kt	NO	NO	NO	NO	NO	Other	kt	NO	NO	NO	NO	NO
MLT	Malta	**Oil**						**NO**	**NO**						**NO**	**NO**
		1. Exploration	number of wells drilled	NO	NO	NO	NO	NO	NO	number of wells drilled	NO	NO	NO	NO	NO	NO
		2. Production	oil produced	NO	NO	NO	NO	NO	NO	oil produced	NO	NO	NO	NO	NO	NO
		3. Transport	oil loaded in tankers	NO	NO	NO	NO	NO	NO	oil loaded in tankers	NO	NO	NO	NO	NO	NO
		4. Refining and storage	oil refined	NO	NO	NO	NO	NO	NO	oil refined	NO	NO	NO	NO	NO	NO
		5. Distribution of oil products	Gasoline	NO	NO	NO	NO	NO	NO	Gasoline	NO	NO	NO	NO	NO	NO
		6. Other	Other Petroleum Product	NO	NO	NO	NO	NO	NO	Other Petroleum Product	NO	NO	NO	NO	NO	NO
NLD	Netherlands	**Oil**						**0.02**	**0.81**						**983**	**0.64**
		1. Exploration		PJ	IE	NO,IE	IE	IE	IE		PJ	IE	NO,IE	IE	IE	IE
		2. Production		PJ	IE	NO,IE	IE	IE	IE		PJ	IE	NO,IE	IE	IE	IE
		3. Transport		Mg	33 912	1	6	0.02	0.20		Mg	40 821	0.53	6	0.02	0.24
		4. Refining and storage		PJ	2 077	NO,IE	296	IE	0.61		PJ	2 456	400229	165	983	0.41
		5. Distribution of oil products		PJ	NE	NA	NA	NA	NA		PJ	NE	NO,NA	NA	NA	NA
		6. Other		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
POL	Poland	**Oil**						**0**	**1.36**						**0.26**	**4.82**
		1. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		2. Production	Production	PJ	7	7 309	101 205	0	0.67	Production	PJ	43	5675	78581	0.24	3.36
		3. Transport	oil ltransported by pipeline	Gg	13 286	1	6	0	0.08	oil ltransported by pipeline	Gg	28 262	0.57	6	0.02	0.18
		4. Refining and storage	oil refined	PJ	531	NA	1 153	NA	0.61	oil refined	PJ	1 143		1121		1.28
		5. Distribution of oil products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
		6. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRT	Portugal	**Oil**						**0.5**	**0.07**						**912**	**0.08**
		1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		3. Transport		Mt	0.01	490	5 400 000	0.00001	0.07		Mt	0	490	5400000	0.00001	0.08
		4. Refining and storage		Mt	0.04	10 894 328	6	0.5	0.00		Mt	0	14057427847	5	912	0.00
		5. Distribution of oil products		Mt	0.001	NO	NO	NO	NO		Mt	0	NO	NO	NO	NO
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
ROU	Romania	**Oil**						**746**	**192.45**						**388**	**10.30**
		1. Exploration	oil produced	PJ	322	2 245 932	47 534	724	15.32	oil produced	PJ	146	258306	5506	38	0.80
		2. Production	oil produced	PJ	322	69 542	547 400	22	176.40	oil produced	PJ	146	7946	62435	1	9.13
		3. Transport	oil refined	PJ	975	14	151	0.01	0.15	oil refined	PJ	493	13	149	0.01	0.07
		4. Refining and storage	oil refined	PJ	962	IE,NO	609	IE	0.59	oil refined	PJ	479	NO,IE	612	IE	0.29
		5. Distribution of oil products	oil refined	PJ	NO	NO	NO	NO	NO	oil refined	PJ	NO	NO	NO	NO	NO
		6. Other	oil refined	kt	NO	NO	IE	NO	IE	oil refined	kt	118	2964977	IE	350	IE
SVK	Slovakia	**Oil**						**0.03**	**0.59**						**0.01**	**0.30**
		1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		2. Production	Production	kt	73	260	3 600	0.02	0.26	Production	kt	7	260	3600	0.002	0.03
		3. Transport	Transfer	kt	13 581	0.5	5	0.01	0.07	Transfer	kt	9 460	0.49	5	0.005	0.05
		4. Refining and storage	Refining/Storage	kt	6 221	NE	41	NE	0.26	Refining/Storage	kt	5 457	NE	41	NE	0.22
		5. Distribution of oil products		NA	NE	NO,NE	NE	NE	NE		NA	NE	NO,NE	NE	NE	NE
		6. Other		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
SVN	Slovenia	**Oil**						**0.03**	**0.01**						**0**	**NO,NA**
		1. Exploration	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2018						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEFr (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
			Description	Unit	Value					Description	Unit	Value				
		2. Production	Conventional oil produced	1000 m3	3	0.04	1	0.0000001	0.00	Conventional oil produced	1000 m3	NO	NO	NO	NO	NO
		3. Transport	Consumption of LPG	1000 m3	58	430	NA	0.03	NA	Consumption of LPG	1000 m3	161	430	NA	0.07	NA
		4. Refining and storage	Oil refined	1000 m3	626	NO,NA	22	NA	0.01	Oil refined	1000 m3	NO	NO,NA	NO	NA	NO
		5. Distribution of oil products	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
		6. Other	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
SWE	Sweden	**Oil**						**255**	**0.99**						**783**	**1.01**
		1. Exploration	Consumption of feedstock	TJ	NA	NA	NA	38	0.00	Consumption of feedstock	TJ	NA	C,NA	C	C	C
		2. Production	Oil production		NO	NO	NO	NO	NO	Oil production		NO	NO	NO	NO	NO
		3. Transport	Transported amount of oil	PJ	725	NE	745	NE	0.54	Transported amount of oil	PJ	838	NE	745	NE	0.62
		4. Refining and storage	Consumption of crude oil	Mt	17	12 497 656	25 612	217	0.44	Consumption of crude oil	Mt	C	C,NA	C	C	C
		5. Distribution of oil products	Distribution of oil products		NE	NA	NA	NA	NA	Distribution of oil products		NE	NA	NA	NA	NA
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO

Table 3.123 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					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
AUT	Austria	**Natural Gas**					**10.36**					**9.39**
		1. Exploration	Mm3 natural gas	Mm3	248.09	IE	IE	Mm3 natural gas	Mm3	237.62	IE	IE
		2. Production	Mm3 natural gas	Mm3	1288.00	4478.94	5.77	Mm3 natural gas	Mm3	969.00	3938.08	3.82
		3. Processing	Mm3 natural gas	Mm3	1288.00	NA	NA	Mm3 natural gas	Mm3	969.00	NA	NA
		4. Transmission and storage	km pipeline length	km	3628.00	718.43	2.61	km pipeline length	km	7247.80	562.11	4.07
		5. Distribution	km distribution network length	km	11672.00	170.22	1.99	km distribution network length	km	30088.55	49.74	1.50
		6. Other	Mm3 natural gas stored	Mm3	1500.00	NO	NO	Mm3 natural gas stored	Mm3	6168.15	NO	NO
BEL	Belgium	**Natural Gas**					**28.35**					**19.60**
		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	27925.24	203.37	5.68		PJ	31327.90	165.75	5.19
		5. Distribution		PJ	27925.24	811.78	22.67		PJ	31327.90	460.02	14.41
		6. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
BGR	Bulgaria	**Natural Gas**					**5.84**					**9.03**
		2. Exploration	Indigenous production	106m3	14.00	60.00	0.00	Indigenous production	106m3	32.94	60.00	0.00
		3. Production	Indigenous production	106m3	14.00	2540.00	0.04	Indigenous production	106m3	32.94	2540.00	0.08
		4. Processing	Indigenous production	106m3	14.00	570.00	0.01	Indigenous production	106m3	32.94	570.00	0.02
		5. Transmission and storage	Pipeline length	km	1469.00	2123.34	3.12	Pipeline length	km	2788.00	2113.22	5.89
		6. Distribution	Pipeline length	km	50.00	230.00	0.01	Pipeline length	km	4916.00	230.00	1.13
		7. Other	Natural gas consumption at energy and industrial plants	106m3	6610.22	403.27	2.67	Natural gas consumption at energy and industrial plants	106m3	2597.25	734.46	1.91
CYP		**Natural Gas**					**NO**					**NO**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (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**					**22.76**
		2. Exploration		PJ	NE	NE	NE		PJ	NE	NE	NE
		3. Production	(e.g. PJ gas produced)	PJ	7.84	39365.45	0.31	(e.g. PJ gas produced)	PJ	7.70	38144.93	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	1372.06	4495.43	6.17
		6. Distribution	(e.g. PJ gas consumed)	PJ	55.77	517563.35	28.86	(e.g. PJ gas consumed)	PJ	128.44	126923.59	16.30
		7. Other	(e.g. PJ gas consumed)	PJ	29.68	IE	IE	(e.g. PJ gas consumed)	PJ	199.41	IE	IE
DEU	Germany	**Natural Gas**					**319.90**					**192.90**
		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	6303119.14	0.04	0.24
		5. Processing	gas produced	1000 m³	15262000.00	0.35	5.34	gas produced	1000 m³	6303119.14	0.02	0.10
		6. Transmission and storage	lenght of transmission pipelines	km	22696.00	1998.74	45.36	lenght of transmission pipelines	km	34996.00	2194.73	76.81
		7. Distribution	lenght of distribution pipelines	km	282612.00	828.87	234.25	lenght of distribution pipelines	km	493949.00	176.06	86.96
		8. Other	gas consumed	TJ	893519.00	32.62	29.15	gas consumed	TJ	1231559.00	23.38	28.79
DNM	Denmark	**Natural Gas**					**2.43**					**1.73**
		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	4031.00	380.00	1.53
		5. Processing	Gas produced	10^6 m3	5137.00	NA	NA	Gas produced	10^6 m3	4031.00	NA	NA
		6. Transmission and storage	Gas transmission	10^6 m3	2739.00	69.45	0.19	Gas transmission	10^6 m3	4363.00	6.29	0.03

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		7. Distribution	Gas distributed	10^6 m3	1749.06	145.93	0.26	Gas distributed	10^6 m3	2411.33	69.65	0.17
		8. Other	Incl. In transmission	m3	NO	NO	NO	Incl. In transmission	m3	NO	NO	NO
ESP	Spain	**Natural Gas**					**5.46**					**5.90**
		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	92.09	2239.11	0.21
		5. Processing	Mm3 gas produced	Mm3	1314.69	150.00	0.20	Mm3 gas produced	Mm3	92.09	150.00	0.01
		6. Transmission and storage	PJ gas (NCV)	PJ	198.07	5897.84	1.17	PJ gas (NCV)	PJ	1131.00	1569.02	1.77
		7. Distribution	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	205.47	16959.73	3.48	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	1146.64	3406.14	3.91
		8. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EST	Estonia	**Natural Gas**					**2.01**					**0.66**
		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	16.80	2217.60	0.04
		8. Distribution	Amount of natural gas distributed	PJ	51.23	36960.00	1.89	Amount of natural gas distributed	PJ	16.80	36960.00	0.62
		9. Other	Other	NA	NO	NO	NO	Other	NA	NO	NO	NO
FIN	Finland	**Natural Gas**					**0.17**					**0.80**
		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	NO	NO
		7. Transmission and storage	PJ gas consumed	PJ	91.58	1856.22	0.17	PJ gas consumed	PJ	88.20	3840.14	0.34
		8. Distribution	PJ gas distributed	NO	NO	NO	NO	PJ gas distributed	NO	8.35	55076.63	0.46

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		9. Other		NO	NO	NO	NO		NO	NO	NO	NO
FRK	France	**Natural Gas**					**60.81**					**39.64**
		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	6.07	303.96	0.00
		7. Transmission and storage	Gas consumed	PJ	1091.00	24425.57	26.65	Gas consumed	PJ	1541.49	10570.97	16.30
		8. Distribution	Gas consumed	PJ	1091.00	30640.07	33.43	Gas consumed	PJ	1541.49	15141.53	23.34
		9. Other	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
GBK	United Kingdom	**Natural Gas**					**406.73**					**144.10**
		5. Exploration	Exploration drilling: fuel use	t	225517.62	15.66	3.53	Exploration drilling: fuel use	t	46659.57	45.00	2.10
		6. Production	Gas produced	PJ	1709.37	IE	IE	Gas produced	PJ	1457.43	IE	IE
		7. Processing	Gas produced	PJ	1709.37	12756.73	21.81	Gas produced	PJ	1457.43	1635.99	2.38
		8. Transmission and storage	Natural gas supply	GWh	387730.56	23.58	9.14	Natural gas supply	GWh	514041.01	6.56	3.37
		9. Distribution	Natural gas supply	GWh	387730.56	960.08	372.25	Natural gas supply	GWh	514041.01	265.04	136.24
		10. Other		NA	NO	NO	NO		NA	NO	NO	NO
GRC	Greece	**Natural Gas**					**0.37**					**3.13**
		5. Exploration			NE	NE	NE			NE	NE	NE
		6. Production		mil_m3	123.00	1930.00	0.24		mil_m3	11.53	1930.00	0.02
		7. Processing		mil_m3	123.00	IE	IE		mil_m3	11.53	IE	IE
		8. Transmission and storage		mil m3	123.00	298.00	0.04		mil m3	4829.60	298.00	1.44
		9. Distribution		mil m3	86.24	1100.00	0.09		mil m3	1519.59	1100.00	1.67
		10. Other			IE	IE	IE			IE	IE	IE
HRV	Croatia	**Natural Gas**					**5.92**					**4.86**
		5. Exploration	Natural gas production	1000000 m3	1982.30	194.00	0.38	Natural gas production	1000000 m3	1230.10	194.00	0.24
		6. Production	gas produced	1000000 m3	1982.30	1340.76	2.66	gas produced	1000000 m3	1230.10	1340.76	1.65
		7. Processing	gas produced	1000000 m3	1982.30	592.00	1.17	gas produced	1000000 m3	1230.10	592.00	0.73

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		8. Transmission and storage	marketable gas	1000000 m3	2686.60	480.00	1.29	marketable gas	1000000 m3	2770.50	480.00	1.33
		9. Distribution	utility sales	1000000 m3	379.30	1100.00	0.42	utility sales	1000000 m3	832.50	1100.00	0.92
		10. Other		NO	NO	NO	NO		NO	NO	NO	NO
HUN	Hungary	**Natural Gas**					**32.72**					**16.84**
		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	1905.00	1340.00	2.55
		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	589.75	935.14	0.55
		9. Transmission and storage	Marketable gas (million m3)	million m3	11278.00	674.50	7.61	Marketable gas (million m3)	million m3	14651.00	298.00	4.37
		10. Distribution	Utility sales (million m3)	million m3	9491.95	1800.00	17.09	Utility sales (million m3)	million m3	8517.51	1100.00	9.37
		11. Other		NO	NO	NO	NO		NO	NO	NO	NO
IRL	Ireland	**Natural Gas**					**0.82**					**1.92**
		6. Exploration	Natural gas exploration	PJ	IE	IE	IE	Natural gas exploration	PJ	IE	IE	IE
		7. Production		PJ	78.58	0.32	0.00		PJ	115.22	36.53	0.00
		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	78.93	10385.64	0.82		PJ	208.05	9203.29	1.91
		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

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
ITA	Italy	**Natural Gas**					**329.45**					**164.80**
		6. Exploration	Wells explored	Number	36.00	158.15	0.01	Wells explored	Number	2.00	334.43	0.00
		7. Production	Gas produced	Mm3	17296.39	1726.36	29.86	Gas produced	Mm3	5553.20	905.93	5.03
		8. Processing	Gas produced	Mm3	17296.39	773.26	13.37	Gas produced	Mm3	5553.20	405.75	2.25
		9. Transmission and storage	Gas transported	Mm3	45683.58	822.12	37.56	Gas transported	Mm3	72820.00	391.17	28.48
		10. Distribution	Gas distributed	Mm3	20632.00	12051.86	248.65	Gas distributed	Mm3	33183.40	3888.27	129.03
		11. Other	other	NA	NO	NO	NO	other	NA	NO	NO	NO
LTU	Lithuania	**Natural Gas**					**10.42**					**10.61**
		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	2.69	952271.00	2.56
		11. Distribution	Natural gas leakages	kt	8.65	977699.00	8.46	Natural gas leakages	kt	8.42	952271.00	8.02
		12. Other	Natural gas leakages	NO	NO	NO	NO	Natural gas leakages	NO	0.03	952271.00	0.03
LUX	Luxembourg	**Natural Gas**					**0.77**					**1.24**
		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	28792.80	13.06	0.38
		11. Distribution	gas consumed	TJ	17933.32	30.07	0.54	gas consumed	TJ	28792.80	29.92	0.86
		12. Other	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
LVA	Latvia	**Natural Gas**					**7.09**					**3.37**
		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	12236.00	0.68	0.01

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		11. Distribution	Distribution	m3	694188.00	0.69	0.48	Distribution	m3	731446.00	0.65	0.48
		12. Other	Other	m3	12435406.00	0.52	6.53	Other	m3	4418828.00	0.65	2.88
MLT	Malta	**Natural Gas**					**NO**					**NO**
		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**					**10.27**
		8. Exploration		NA	NA	IE	IE		NA	NA	IE	IE
		9. Production		mln m3	72131.00	IE	IE		mln m3	36735.00	IE	IE
		10. Processing		PJ	IE	IE	IE		PJ	IE	IE	IE
		11. Transmission and storage		PJ	2648.08	4121.34	10.91		PJ	3042.00	1548.98	4.71
		12. Distribution		10^3 km	99.98	59294.88	5.93		10^3 km	125.32	44335.78	5.56
		13. Other		PJ	NA	NO	NO		PJ	IE	NO	NO
POL	Poland	**Natural Gas**					**30.13**					**48.32**
		8. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		9. Production	Production	PJ	99.56	74346.49	7.40	Production	PJ	143.33	71342.44	10.23
		10. Processing		PJ	99.56	33294.30	3.31		PJ	143.33	31949.01	4.58
		11. Transmission and storage	gas consumed	PJ	374.21	15515.79	5.81	gas consumed	PJ	673.17	14888.86	10.02
		12. Distribution	gas consumed	PJ	374.21	35557.02	13.31	gas consumed	PJ	673.17	34120.30	22.97
		13. Other	NA	PJ	374.21	808.11	0.30	NA	PJ	673.17	775.46	0.52
PRT	Portugal	**Natural Gas**					**NO**					**2.09**
		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

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		12. Transmission and storage		toe NG Transmitted	NO	NO	NO		toe NG Transmitted	5039.77	10.89	0.05
		13. Distribution		toe NG Distributed	NO	NO	NO		toe NG Distributed	1754.87	1157.15	2.03
		14. Other		NO	NO	NO	NO		NO	NO	NO	NO
ROU	Romania	**Natural Gas**					**670.47**					**96.35**
		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	10277.68	1340.00	13.77
		11. Processing	gas produced and processed	106m3	28336.00	250.00	7.08	gas produced and processed	106m3	10277.68	590.00	6.06
		12. Transmission and storage	gas produced	106m3	35667.00	633.00	22.58	gas produced	106m3	13145.27	247.51	3.25
		13. Distribution	gas supplied	106m3	35667.00	1800.00	64.20	gas supplied	106m3	11794.23	1100.00	12.97
		14. Other	gas consumed	PJ	899.10	257135.36	231.19	gas consumed	PJ	295.84	203793.29	60.29
SVK	Slovakia	**Natural Gas**					**44.14**					**34.23**
		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	93.00	2300.00	0.21
		11. Processing		mil m3	444.00	1030.00	0.46		mil m3	93.00	1030.00	0.10
		12. Transmission and storage	Transfer	mil m3	73600.00	480.00	35.33	Transfer	mil m3	59700.00	480.00	28.66
		13. Distribution	Distribution	mil m3	6666.00	1100.00	7.33	Distribution	mil m3	4777.99	1100.00	5.26
		14. Other	Storage	mil m3	1.00	25.00	0.00	Storage	mil m3	423.00	25.00	0.01
SVN	Slovenia	**Natural Gas**					**1.70**					**1.33**
		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	16027.00	1.34	0.02
		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	890206.03	0.37	0.33
		14. Distribution	Utility sale	1000 m3	892000.60	1.10	0.98	Utility sale	1000 m3	890206.03	1.10	0.98
		15. Other	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
SWE	Swed	**Natural Gas**					**2.69**					**1.24**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2018				
Member State		GHG source category	Activity data			IEF (kg/unit)	CH_4 emissions (kt)	Activity data			IEF (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		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	1.16
		15. Other			NO	NO	NO			NO	NO	NO

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 0.2% of total EU-KP GHG emissions in 2018 and for 8 % of all fugitive emissions in the EU-KP. Between 1990 and 2018 CO_2 emissions from this source decreased by 22%.

All but four countries (Austria, Estonia, Luxembourg, Malta) - are reporting CO_2 emissions in this category.

In 2018, 55% of the EU-KP CO_2 emissions from 1.B.2.c were emitted by the UK (Table 3.124) 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. 81 % of EU-KP emissions are calculated using higher tier methods. In cases where countries 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 countries 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 higher Tier method, according to the IPCC 2006 Guidelines.

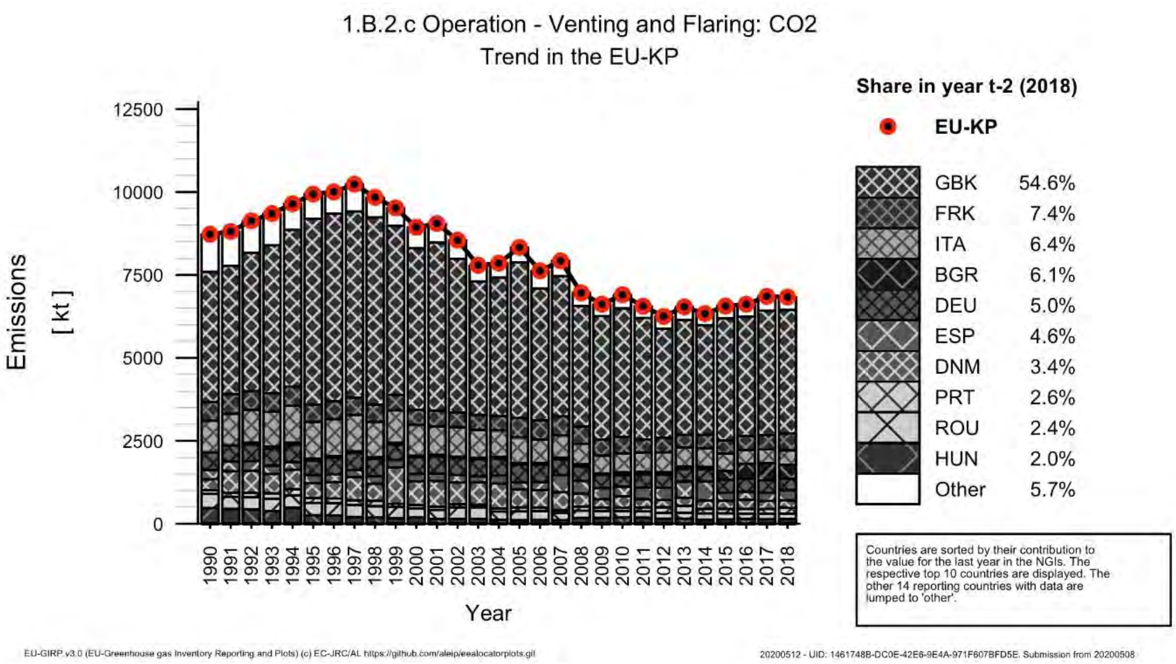
The emission decreases between 1990 and 2018 observed in the Netherlands (-94%), Italy (-54%), Germany (-37%), Hungary (-71%) and Romania (-62 %) contributed most significantly to the overall reduction in the EU-KP between 1990 and 2018.

Table 3.124: 1.B.2.c Fugitive CO_2 emissions from Other emissions: Countries' contributions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	84	98	121	1.8%	37	44%	22	23%	T3	PS
Bulgaria	NO,IE	510	413	6.1%	413	∞	-97	-19%	T1	D
Croatia	0.002	0.0001	0.0002	0.000002%	-0.002	-93%	0.00003	20%	T1	D
Cyprus	0.04	0.1	0.1	0.001%	0.02	66%	-0.00001	0%	T1	D
Czechia	2	4	5	0.1%	3	126%	0.1	3%	T1	D
Denmark	328	240	232	3.4%	-96	-29%	-8	-3%	T3	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	111	147	91	1.3%	-20	-18%	-56	-38%	CS	CS
France	560	431	505	7.4%	-55	-10%	74	17%	T1,T2,T3	CS,D,PS
Germany	544	384	342	5.0%	-202	-37%	-42	-11%	T2	CS
Greece	43	7	10	0.2%	-32	-75%	3	45%	T1	D
Hungary	471	132	139	2.0%	-333	-71%	6	5%	T1,T3	CS
Ireland	NO	5	0.2	0.003%	0	∞	-5	-96%	CS,T3	CS,PS
Italy	956	420	437	6.4%	-518	-54%	17	4%	T1	D
Latvia	0.003	0.002	0.001	0.00001%	0	-65%	-0.001	-47%	T3	CS
Lithuania	1	3	2	0.03%	2	283%	-0.4	-17%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	774	54	44	0.6%	-730	-94%	-10	-18%	T2	PS
Poland	44	73	75	1.1%	32	73%	3	4%	T1	D
Portugal	118	147	176	2.6%	58	49%	29	20%	NO	NO
Romania	424	164	161	2.4%	-263	-62%	-3	-2%	T1	D
Slovakia	5	1	1	0.0%	-4	-84%	-0.2	-21%	T1	CS
Slovenia	0.2	0.01	0.02	0.0003%	-0.2	-88%	0.01	71%	T1	D
Spain	272	246	311	4.6%	39	14%	66	27%	CS,T1,T2	CS,D,PS
Sweden	73	39	37	0.5%	-36	-49%	-1	-4%	T2,T3	CS,PS
United Kingdom	3 920	3 749	3 729	54.6%	-191	-5%	-20	-1%	T2	CS,PS
EU-27+UK	**8 728**	**6 853**	**6 832**	**100%**	**-1 896**	**-22%**	**-21**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 920	3 749	3 729	54.6%	-191	-5%	-20	-1%	T2	CS,PS
EU-KP	**8 728**	**6 853**	**6 832**	**100%**	**-1 896**	**-22%**	**-21**	**0%**	**-**	**-**

Note: Austria includes CO_2 emissions from venting and flaring in 1.A.1b Petroleum refining

Figure 3.185: 1.B.2.c Venting and Flaring: Emission trend and share for the emitting countries of CO_2



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.

Seven countries report CO_2 emissions in this sector, four are reporting CH_4 emissions and three countries also report N_2O emissions. The description of the subcategories is presented in Table 3.125

Table 3.125 Description of subcategories in sector 1.B.2.d for CO_2-, N_2O- and CH_4-emissions for reporting Countries

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
Poland	CO_2	Underground storage of gas
Portugal	CO_2	Geothermal
United Kingdom	N_2O	Natural gas exploration: N_2O emissions

Table 3.126 and Table 3.127 provide information on the contribution of countries to EU-KP recalculations in CO_2 and CH_4 from 1.B.2 'Oil and natural gas' for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table 3.1261.B.2 Fugitive CO_2 emissions from Oil and natural gas: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-	-	0.0002	0.0002	No explanation provided
Bulgaria	56	1 367.8	44	5.5	For the 2020 submission a complete recalculation of the Fugitive emission sector has been performed, applying the updated methodologies and the default emission factors from 2019 Refinement to the 2006 IPCC Guidelines.
Croatia	-0.001	-0.0001	0.001	0.0004	Data provider for oil transport has changed. Data from CBS used for emission calculation.
Cyprus	-	-	-0	-0.2	No explanation provided.
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	0.004	0.0001	1	0.04	1.B.2.a: Update of "Quantity of crude oil transported by pipelines" for 2017 (CPDP). 1.B.2.b+1.B.2.c: improved accuracy
Germany	-226	-10.1	-138	-8.1	new emission factors for refining and storage (1.B.2.a) Differentiation of inherent and energy-related CO_2 from sour gas processing (1.B.2.b) Consideration of emissions from cleaning natural gas pipelines (1.B.2.b)
Greece	-	-	-	-	
Hungary	0.3	0.1	4	2.8	Both EF and AD data have been revised for gas distribution
Ireland	-0.03	-83.7	-0.1	-1.8	Fugitive emissions from Natural Gas in 1.B.2. were

	1990		2017		
	kt CO_2	%	kt CO_2	%	
					recalculated as the methodology for Natural Gas transmission, storage and distribution were updated using country specific information provided by Gas Networks Ireland. This resulted in an average recalculation of -6.6 per cent in years from 1990-2017.
Italy	34	0.9	0.1	0.01	
Latvia	-	-	-	-	
Lithuania	23	3 199	221	6 767.8	Correction of CO_2 emissions from 1.B.2.a.1 Oil exploration (servicing) due to calculation error.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-0.00005	-0.0001	-0.001	-0.0001	Update of the activity data according to Euroststdatabase.
Portugal	-	-	2	0.2	Fugitive Emissions from Oil (1B2a): Update of Activity Data; Other - Geothermal (1.B.2.d) Update geothermal energy production data.
Romania	-	-	0.05	0.01	CO_2 emissions were recalculated for 2017, 1B2b4 category, taking into account updated of AD for 2017 in Energy Balance 2018; (1.B.2.a.2) and (1.B.2.c.1) categories: recalculations of the CO_2 emissions for the 1992 - 2017 period have been made due to an errors transcription in CRF application have been identified.
Slovakia	-	-	-	-	
Slovenia	0.02	7.1	0.04	51.7	Correction of an error in the calculation.
Spain	-0.1	-0.01	-16	-0.4	Recalculations due to a methodological up-grading by the source in the distribution of natural gas. Correction of duplicated consumptions for hydrogen production plants reported by refineries
Sweden	48	17.2	0.02	0.003	Updates as a result of a development project.
United Kingdom	0.00001	0.0000002	-45	-1.1	Removal of duplicate emission estimates for three upstream oil and gas facilities.
EU27+UK	-64	-0.3	73	0.3	
Iceland	-0.00003	-0.00005	-	-	
United Kingdom (KP)					
EU-KP	-64	-0.3	73	0.3	

Table 3.127 1.B.2 Fugitive CH_4 emissions from Oil and natural gas: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-0.002	-0.0004	No explanation provided.
Bulgaria	-112	-41.4	16	7.4	For the 2020 submission a complete recalculation of the Fugitive emission sector has been performed, applying the updated methodologies and the default emission factors from 2019 Refinement to the 2006 IPCC Guidelines.
Croatia	-0.2	-0.05	0.4	0.2	Data provider for oil transport has changed. Data from CBS used for emission calculation
Cyprus	0.3	223.3	-0.0002	-0.2	No explanation provided
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-0.1	-0.2	Activity data for fugitive CH_4 emissions from oil refining were corrected
France	8	0.5	4	0.3	1.B.2.a: Update of "Quantity of crude oil transported by

	1990		2017		
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					pipelines" for 2017 (CPDP). 1.B.2.b+1.B.2.c: improved accuracy
Germany	-45	-0.5	-95	-1.9	new emission factors for refining and storage (1.B.2.a) Differentiation of inherent and energy-related CO_2 from sour gas processing (1.B.2.b) Consideration of emissions from cleaning natural gas pipelines (1.B.2.b)
Greece	-	-	-	-	
Hungary	83	6.5	-165	-20.3	Both EF and AD data have been revised for gas distribution. Most notably: activity data for gas distribution (utility sales) has been revised.
Ireland	-0	-1.0	-18	-24.7	Fugitive emissions from Natural Gas in 1.B.2. were recalculated as the methodology for Natural Gas transmission, storage and distribution were updated using country specific information provided by Gas Networks Ireland. This resulted in an average recalculation of -6.6 per cent in years from 1990-2017.
Italy	16	0.2	86	1.8	Update of activity data of methane distributed at city level
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-0.001	-0.0001	-0.3	-0.01	Update of the activity data according to Eurostst database.
Portugal	-	-	0.02	0.04	Fugitive Emissions from Oil (1B2a): Update of Activity Data.
Romania	-	-	-0.02	-0.001	CH_4 emissions were recalculated for 2017, 1B2b4 category, taking into account updated of AD for 2017 in Energy Balance 2018; (1.B.2.c.1) category: recalculations of the CH_4 emissions for the 1992 - 2017 period have been made due to an errors transcription in CRF application have been identified.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-318	-66.3	-558	-78.2	Recalculations due to a methodological up-grading by the source in the distribution of natural gas
Sweden	0.03	0.03	-0.3	-0.5	Updates as a result of a development project.
United Kingdom	34	0.3	3	0.1	Revision to installation-level estimates for upstream oil and gas facilities.
EU27+UK	-334	-0.5	-728	-2.6	
Iceland	-	-	-	-	
United Kingdom (KP)					NA
EU-KP	-334	-0.5	-728	-2.6	

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 captured CO_2 emissions in this category for the years 1993 to 2018.

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.

Captured CO_2 emissions reported in 1C 'CO_2 capture and storage' correspond to 0.003 % of total EU-KP GHG emissions in 2018. The emissions captured increased between 1993 and 2018 by 15 007%.

3.2.8 Energy – non-key categories

Table 3.128 Aggregeted GHG emission from non-key categories in the energ sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.a Public Electricity and Heat Production: Biomass (CH_4)	51.5	2 294.1	2 282.8	0.07%	2 231	4331%	-11	0%
1.A.1.a Public Electricity and Heat Production: Biomass (N_2O)	159.4	1 499.9	1 539.6	0.05%	1 380	866%	40	3%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CH_4)	161.6	958.7	975.5	0.03%	814	504%	17	2%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (N_2O)	150.8	746.2	667.9	0.02%	517	343%	-78	-10%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CH_4)	166.8	30.2	27.2	0.00%	-140	-84%	-3	-10%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (N_2O)	431.2	87.7	78.5	0.00%	-353	-82%	-9	-10%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CH_4)	35.9	147.1	157.4	0.00%	121	338%	10	7%
1.A.1.a Public Electricity and Heat Production: Other Fuels (N_2O)	86.3	442.0	452.8	0.01%	366	425%	11	2%
1.A.1.a Public Electricity and Heat Production: Peat (CH_4)	7.9	8.9	9.4	0.00%	1	18%	1	6%
1.A.1.a Public Electricity and Heat Production: Peat (N_2O)	119.2	107.1	122.7	0.00%	4	3%	16	15%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CH_4)	267.4	152.4	140.3	0.00%	-127	-48%	-12	-8%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (N_2O)	5 986.3	3 790.1	3 555.0	0.11%	-2 431	-41%	-235	-6%
1.A.1.b Petroleum Refining: Biomass (CH_4)	1.9	0.1	0.1	0.00%	-2	-97%	-0.01	-10%
1.A.1.b Petroleum Refining: Biomass (N_2O)	3.5	1.2	1.2	0.00%	-2	-65%	-0.02	-1%
1.A.1.b Petroleum Refining: Gaseous Fuels (CH_4)	5.7	21.2	22.6	0.00%	17	297%	1	7%
1.A.1.b Petroleum Refining: Gaseous Fuels (N_2O)	135.3	56.8	59.6	0.00%	-76	-56%	3	5%
1.A.1.b Petroleum Refining: Liquid Fuels (CH_4)	74.1	52.1	49.7	0.00%	-24	-33%	-2	-5%
1.A.1.b Petroleum Refining: Liquid Fuels (N_2O)	305.8	295.2	283.6	0.01%	-22	-7%	-12	-4%
1.A.1.b Petroleum Refining: Other Fuels (CH_4)	5.8	0.0	0.0	0.00%	-6	-99%	0.001	4%
1.A.1.b Petroleum Refining: Other Fuels (CO_2)	920.7	244.1	205.7	0.01%	-715	-78%	-38	-16%
1.A.1.b Petroleum Refining: Other Fuels (N_2O)	9.7	0.1	0.04	0.00%	-10	-100%	-0.012	-22%
1.A.1.b Petroleum Refining: Solid Fuels (CH_4)	0.5	0.03	0.03	0.00%	-1	-95%	-0.005	-15%
1.A.1.b Petroleum Refining: Solid Fuels (N_2O)	29.9	0.6	0.5	0.00%	-29	-98%	-0.083	-14%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (CH_4)	82.2	174.9	163.6	0.00%	81	99%	-11	-6%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (N_2O)	3.8	51.7	49.5	0.00%	46	1193%	-2	-4%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels	161.1	215.6	269.2	0.01%	108	67%	54	25%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
(CH_4)								
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (N_2O)	216.5	284.4	280.6	0.01%	64	30%	-4	-1%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CH_4)	14.0	11.1	10.7	0.00%	-3	-23%	-0.4	-3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CO_2)	5 365.6	3 840.4	3 807.1	0.12%	-1 559	-29%	-33	-1%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (N_2O)	75.7	65.8	65.0	0.00%	-11	-14%	-1	-1%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CH_4)	4.9	0.004	0.01	0.00%	-5	-100%	0.004	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CO_2)	456.1	0.8	1.7	0.00%	-454	-100%	1	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (N_2O)	9.1	0.01	0.01	0.00%	-9	-100%	0	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CH_4)	0.1	0.04	0.03	0.00%	0	-41%	0	-22%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CO_2)	175.5	99.9	77.9	0.00%	-98	-56%	-22	-22%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (N_2O)	0.7	0.4	0.3	0.00%	0	-54%	0	-23%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CH_4)	155.6	20.6	19.0	0.00%	-137	-88%	-2	-8%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (N_2O)	692.1	144.9	143.0	0.00%	-549	-79%	-2	-1%
1.A.2.a Iron and Steel: Biomass (CH_4)	0.3	0.2	0.3	0.00%	0	3%	0	18%
1.A.2.a Iron and Steel: Biomass (N_2O)	0.4	1.0	1.1	0.00%	1	153%	0	9%
1.A.2.a Iron and Steel: Gaseous Fuels (CH_4)	19.1	14.6	16.5	0.00%	-3	-13%	2	13%
1.A.2.a Iron and Steel: Gaseous Fuels (N_2O)	126.1	46.5	133.5	0.00%	7	6%	87	187%
1.A.2.a Iron and Steel: Liquid Fuels (CH_4)	12.6	0.6	0.6	0.00%	-12	-95%	-0.05	-9%
1.A.2.a Iron and Steel: Liquid Fuels (N_2O)	28.8	10.4	10.2	0.00%	-19	-65%	-0.28	-3%
1.A.2.a Iron and Steel: Other Fuels (CH_4)	3.7	0.04	0.05	0.00%	-4	-99%	0.01	17%
1.A.2.a Iron and Steel: Other Fuels (CO_2)	652.3	17.0	24.1	0.00%	-628	-96%	7	42%
1.A.2.a Iron and Steel: Other Fuels (N_2O)	5.9	0.1	0.1	0.00%	-6	-98%	0	16%
1.A.2.a Iron and Steel: Solid Fuels (CH_4)	347.4	151.0	145.8	0.00%	-202	-58%	-5	-3%
1.A.2.a Iron and Steel: Solid Fuels (N_2O)	332.4	169.3	171.3	0.01%	-161	-48%	2	1%
1.A.2.b Non-Ferrous Metals: Biomass (CH_4)	0.003	0.8	1.1	0.00%	1	35710%	0.3	34%
1.A.2.b Non-Ferrous Metals: Biomass (N_2O)	0.005	1.4	1.8	0.00%	2	36399%	0.4	32%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CH_4)	2.4	6.1	16.1	0.00%	14	582%	10	165%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (N_2O)	5.1	9.1	9.2	0.00%	4	81%	0.17	2%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CH_4)	3.9	0.6	0.5	0.00%	-3	-86%	-0.05	-8%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (N_2O)	12.3	3.3	3.1	0.00%	-9	-75%	-0.22	-7%
1.A.2.b Non-Ferrous Metals: Other Fuels (CH_4)	0.3	0.01	0.003	0.00%	0	-99%	-0.003	-53%
1.A.2.b Non-Ferrous Metals: Other Fuels (CO_2)	64.9	1.4	0.7	0.00%	-64	-99%	-1	-49%
1.A.2.b Non-Ferrous Metals: Other Fuels (N_2O)	0.5	0.02	0.01	0.00%	-1	-98%	-0.01	-44%
1.A.2.b Non-Ferrous Metals: Peat (CH_4)	0.002	0.02	0.0	0.00%	0	-100%	-0.02	-100%
1.A.2.b Non-Ferrous Metals: Peat (CO_2)	6.5	1.3	0.0	0.00%	-7	-100%	-1	-100%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.b Non-Ferrous Metals: Peat (N_2O)	0.04	0.004	0.0	0.00%	-0.04	-100%	-0.004	-100%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CH_4)	10.2	2.4	2.6	0.00%	-8	-75%	0.2	8%
1.A.2.b Non-Ferrous Metals: Solid Fuels (N_2O)	48.2	5.1	6.0	0.00%	-42	-88%	1	17%
1.A.2.c Chemicals: Biomass (CH_4)	1.6	10.4	9.9	0.00%	8	539%	0	-4%
1.A.2.c Chemicals: Biomass (N_2O)	8.4	23.7	21.4	0.00%	13	154%	-2	-10%
1.A.2.c Chemicals: Gaseous Fuels (CH_4)	51.9	312.3	377.5	0.01%	326	627%	65	21%
1.A.2.c Chemicals: Gaseous Fuels (N_2O)	47.9	48.6	53.3	0.00%	5	11%	5	10%
1.A.2.c Chemicals: Liquid Fuels (CH_4)	45.7	21.8	22.3	0.00%	-23	-51%	1	2%
1.A.2.c Chemicals: Liquid Fuels (N_2O)	161.3	68.9	73.3	0.00%	-88	-55%	4	6%
1.A.2.c Chemicals: Other Fuels (CH_4)	15.2	9.1	8.6	0.00%	-7	-44%	0	-5%
1.A.2.c Chemicals: Other Fuels (CO_2)	3 033.7	2 431.8	2 322.4	0.07%	-711	-23%	-109	-5%
1.A.2.c Chemicals: Other Fuels (N_2O)	27.1	21.2	20.3	0.00%	-7	-25%	-1	-5%
1.A.2.c Chemicals: Peat (CH_4)	0.1	0.0	0.0001	0.00%	0	-100%	0.0001	100%
1.A.2.c Chemicals: Peat (CO_2)	191.1	0.0	0.1	0.00%	-191	-100%	0.1	100%
1.A.2.c Chemicals: Peat (N_2O)	3.8	0.0	0.0	0.00%	-4	-100%	0.0004	100%
1.A.2.c Chemicals: Solid Fuels (CH_4)	32.9	23.4	22.4	0.00%	-11	-32%	-1	-4%
1.A.2.c Chemicals: Solid Fuels (N_2O)	83.9	41.9	40.3	0.00%	-44	-52%	-2	-4%
1.A.2.d Pulp, Paper and Print: Biomass (CH_4)	46.5	116.6	119.1	0.00%	73	156%	3	2%
1.A.2.d Pulp, Paper and Print: Biomass (N_2O)	198.2	375.0	379.8	0.01%	182	92%	5	1%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CH_4)	32.8	118.2	121.4	0.00%	89	270%	3	3%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (N_2O)	29.8	47.4	47.7	0.00%	18	60%	0.4	1%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CH_4)	13.1	6.9	6.8	0.00%	-6	-48%	-0.1	-2%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (N_2O)	37.9	7.1	14.1	0.00%	-24	-63%	7	98%
1.A.2.d Pulp, Paper and Print: Other Fuels (CH_4)	0.1	1.7	1.8	0.00%	2	1328%	0	5%
1.A.2.d Pulp, Paper and Print: Other Fuels (CO_2)	90.9	366.3	336.4	0.01%	246	270%	-30	-8%
1.A.2.d Pulp, Paper and Print: Other Fuels (N_2O)	0.5	4.0	4.0	0.00%	3	668%	0	0%
1.A.2.d Pulp, Paper and Print: Peat (CH_4)	0.6	0.6	0.6	0.00%	0	6%	0	7%
1.A.2.d Pulp, Paper and Print: Peat (CO_2)	1 117.6	882.7	935.5	0.03%	-182	-16%	53	6%
1.A.2.d Pulp, Paper and Print: Peat (N_2O)	9.8	6.8	7.3	0.00%	-2	-25%	1	8%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CH_4)	17.3	6.6	5.8	0.00%	-11	-66%	-1	-12%
1.A.2.d Pulp, Paper and Print: Solid Fuels (N_2O)	45.5	32.9	25.9	0.00%	-20	-43%	-7	-21%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (CH_4)	7.1	223.7	227.0	0.01%	220	3119%	3	1%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (N_2O)	18.0	91.9	95.5	0.00%	77	431%	4	4%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CH_4)	20.3	222.2	210.5	0.01%	190	938%	-12	-5%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (N_2O)	18.7	37.5	36.6	0.00%	18	95%	-1	-3%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CH_4)	18.8	3.8	3.4	0.00%	-15	-82%	-0.4	-10%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (N_2O)	79.2	15.1	13.3	0.00%	-66	-83%	-2	-12%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CH_4)	0.01	0.3	0.3	0.00%	0.3	3000%	-0.04	-11%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CO_2)	8.3	54.4	37.7	0.00%	29	354%	-17	-31%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (N_2O)	0.0	0.5	0.5	0.00%	0.4	1148%	-0.08	-15%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CH_4)	0.3	0.002	0.002	0.00%	-0.3	-99%	0.0003	17%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CO_2)	139.1	3.8	4.5	0.00%	-135	-97%	1	17%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (N_2O)	1.5	0.02	0.02	0.00%	-1	-99%	0.003	17%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CH_4)	31.7	11.4	11.1	0.00%	-21	-65%	-0.3	-3%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (N_2O)	67.7	23.3	22.7	0.00%	-45	-66%	-1	-3%
1.A.2.f Non-metallic minerals: Biomass (CH_4)	19.2	44.8	49.5	0.00%	30	157%	5	11%
1.A.2.f Non-metallic minerals: Biomass (N_2O)	55.3	103.2	112.4	0.00%	57	103%	9	9%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CH_4)	23.2	54.4	62.3	0.00%	39	168%	8	15%
1.A.2.f Non-metallic minerals: Gaseous Fuels (N_2O)	136.8	147.2	150.8	0.00%	14	10%	4	2%
1.A.2.f Non-metallic minerals: Liquid Fuels (CH_4)	52.3	24.7	25.1	0.00%	-27	-52%	0	1%
1.A.2.f Non-metallic minerals: Liquid Fuels (N_2O)	712.3	343.9	337.2	0.01%	-375	-53%	-7	-2%
1.A.2.f Non-metallic minerals: Other Fuels (CH_4)	4.3	73.5	82.1	0.00%	78	1821%	9	12%
1.A.2.f Non-metallic minerals: Other Fuels (N_2O)	13.9	187.6	207.2	0.01%	193	1386%	20	10%
1.A.2.f Non-metallic minerals: Peat (CH_4)	0.013	0.002	0.002	0.00%	-0.01	-86%	0.0001	6%
1.A.2.f Non-metallic minerals: Peat (CO_2)	27.5	3.8	4.0	0.00%	-24	-86%	0.2	6%
1.A.2.f Non-metallic minerals: Peat (N_2O)	0.1	0.02	0.02	0.00%	0	-86%	0.001	6%
1.A.2.f Non-metallic minerals: Solid Fuels (CH_4)	136.4	30.9	33.1	0.00%	-103	-76%	2	7%
1.A.2.f Non-metallic minerals: Solid Fuels (N_2O)	509.1	143.8	153.4	0.00%	-356	-70%	10	7%
1.A.2.g Other Manufacturing Industries and Constructions: Biomass (CH_4)	105.1	223.6	224.2	0.01%	119	113%	1	0%
1.A.2.g Other Manufacturing Industries and Constructions: Biomass (N_2O)	213.3	448.2	430.9	0.01%	218	102%	-17	-4%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CH_4)	81.7	383.3	399.4	0.01%	318	389%	16	4%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (N_2O)	166.2	288.1	289.4	0.01%	123	74%	1	0%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CH_4)	138.0	67.9	66.0	0.00%	-72	-52%	-2	-3%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (N_2O)	1 221.9	854.2	881.8	0.03%	-340	-28%	28	3%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CH_4)	12.0	4.7	5.1	0.00%	-7	-58%	0	8%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CO_2)	2 519.3	4 340.6	4 418.6	0.13%	1 899	75%	78	2%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (N_2O)	29.2	51.4	52.5	0.00%	23	80%	1	2%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (CH_4)	0.1	0.04	0.05	0.00%	0	-13%	0	18%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (CO_2)	21.5	19.9	33.9	0.00%	12	58%	14	70%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (N_2O)	0.2	0.1	0.3	0.00%	0	3%	0	121%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CH_4)	117.2	14.3	13.2	0.00%	-104	-89%	-1	-8%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (N_2O)	739.7	193.1	193.8	0.01%	-546	-74%	1	0%
1.A.3.a Domestic Aviation: Aviation Gasoline (CH_4)	2.8	1.1	1.0	0.00%	-2	-64%	0	-6%
1.A.3.a Domestic Aviation: Aviation Gasoline (CO_2)	681.1	204.4	204.8	0.01%	-476	-70%	0	0%
1.A.3.a Domestic Aviation: Aviation Gasoline (N_2O)	9.5	3.6	3.8	0.00%	-6	-61%	0	3%
1.A.3.a Domestic Aviation: Jet Kerosene (CH_4)	14.3	7.3	7.5	0.00%	-7	-48%	0	2%
1.A.3.a Domestic Aviation: Jet Kerosene (N_2O)	125.8	142.2	146.0	0.00%	20	16%	4	3%
1.A.3.b Road Transportation: Biomass (CH_4)	0.1	44.9	46.9	0.00%	47	68984%	2	4%
1.A.3.b Road Transportation: Biomass (N_2O)	0.1	396.2	435.3	0.01%	435	307368%	39	10%
1.A.3.b Road Transportation: Diesel Oil (CH_4)	582.4	208.6	204.3	0.01%	-378	-65%	-4	-2%
1.A.3.b Road Transportation: Gaseous Fuels (CH_4)	11.1	57.6	65.8	0.00%	55	492%	8	14%
1.A.3.b Road Transportation: Gaseous Fuels (N_2O)	4.8	18.6	21.3	0.00%	16	343%	3	15%
1.A.3.b Road Transportation: Gasoline (N_2O)	4 938.5	887.3	831.9	0.03%	-4 107	-83%	-55	-6%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CH_4)	43.9	67.6	64.5	0.00%	21	47%	-3	-5%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (N_2O)	18.1	119.5	110.9	0.00%	93	512%	-9	-7%
1.A.3.b Road Transportation: Other Fuels (CH_4)	0.0	3.7	3.2	0.00%	3	100%	-1	-14%
1.A.3.b Road Transportation: Other Fuels (CO_2)	0.0	2 536.4	2 717.5	0.08%	2 717	100%	181	7%
1.A.3.b Road Transportation: Other Fuels (N_2O)	0.0	10.8	10.4	0.00%	10	100%	0	-4%
1.A.3.b Road Transportation: Other Liquid Fuels (CH_4)	0.9	0.1	0.1	0.00%	-1	-89%	0	-2%
1.A.3.b Road Transportation: Other Liquid Fuels (CO_2)	434.0	70.5	59.1	0.00%	-375	-86%	-11	-16%
1.A.3.b Road Transportation: Other Liquid Fuels (N_2O)	0.4	0.1	0.1	0.00%	0	-70%	0	2%
1.A.3.c Railways: Biomass (CH_4)	0.0	0.2	0.2	0.00%	0	100%	0	4%
1.A.3.c Railways: Biomass (N_2O)	0.0	2.6	2.9	0.00%	3	100%	0	9%
1.A.3.c Railways: Liquid Fuels (CH_4)	19.5	6.2	6.2	0.00%	-13	-68%	0	0%
1.A.3.c Railways: Liquid Fuels (N_2O)	768.7	266.3	264.4	0.01%	-504	-66%	-2	-1%
1.A.3.c Railways: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0	100%	0	3%
1.A.3.c Railways: Other Fuels (CO_2)	0.0	4.5	4.6	0.00%	5	100%	0	3%
1.A.3.c Railways: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0	100%	0	2%
1.A.3.c Railways: Solid Fuels (CH_4)	0.2	1.0	1.0	0.00%	1	324%	0	0%
1.A.3.c Railways: Solid Fuels (CO_2)	434.6	77.9	76.3	0.00%	-358	-82%	-2	-2%
1.A.3.c Railways: Solid Fuels (N_2O)	2.1	0.3	0.3	0.00%	-2	-88%	0	-3%
1.A.3.d Domestic Navigation: Biomass (CH_4)	0.0	2.3	2.4	0.00%	2	100%	0	7%
1.A.3.d Domestic Navigation: Biomass (N_2O)	0.0	1.1	1.2	0.00%	1	100%	0	5%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CH_4)	24.0	16.5	17.1	0.00%	-7	-29%	1	3%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (N_2O)	285.6	229.0	235.6	0.01%	-50	-18%	7	3%
1.A.3.d Domestic Navigation: Gaseous Fuels (CH_4)	0.0	0.1	0.0	0.00%	0	100%	0	-22%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.d Domestic Navigation: Gaseous Fuels (CO_2)	0.0	5.5	4.3	0.00%	4	100%	-1	-23%
1.A.3.d Domestic Navigation: Gaseous Fuels (N_2O)	0.0	0.0	0.0	0.00%	0	100%	0	-23%
1.A.3.d Domestic Navigation: Gasoline (CH_4)	44.9	38.0	38.1	0.00%	-7	-15%	0	0%
1.A.3.d Domestic Navigation: Gasoline (CO_2)	1 646.9	1 810.8	1 830.3	0.06%	183	11%	20	1%
1.A.3.d Domestic Navigation: Gasoline (N_2O)	7.5	10.8	11.0	0.00%	4	47%	0	2%
1.A.3.d Domestic Navigation: Other Fuels (CH_4)	0.0	1.3	1.1	0.00%	1	100%	0	-9%
1.A.3.d Domestic Navigation: Other Fuels (CO_2)	0.0	43.0	37.7	0.00%	38	100%	-5	-12%
1.A.3.d Domestic Navigation: Other Fuels (N_2O)	0.0	0.2	0.2	0.00%	0	100%	0	-14%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CH_4)	0.1	0.3	0.0	0.00%	0	-70%	0	-86%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CO_2)	5.6	35.9	25.8	0.00%	20	361%	-10	-28%
1.A.3.d Domestic Navigation: Other Liquid Fuels (N_2O)	0.0	0.2	0.1	0.00%	0.1	303%	-0.1	-31%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CH_4)	15.7	11.1	11.3	0.00%	-4	-28%	0.3	2%
1.A.3.d Domestic Navigation: Residual Fuel Oil (N_2O)	102.8	48.3	51.2	0.00%	-52	-50%	3	6%
1.A.3.e Other Transportation: Gaseous Fuels (CH_4)	9.9	9.6	11.4	0.00%	2	15%	2	18%
1.A.3.e Other Transportation: Gaseous Fuels (CO_2)	4 543.4	5 206.9	5 332.4	0.16%	789	17%	126	2%
1.A.3.e Other Transportation: Gaseous Fuels (N_2O)	23.6	25.8	27.3	0.00%	4	16%	2	6%
1.A.3.e Other Transportation: Liquid Fuels (CH_4)	1.1	0.6	0.5	0.00%	-1	-52%	-0.03	-6%
1.A.3.e Other Transportation: Liquid Fuels (CO_2)	725.3	1 049.8	1 079.2	0.03%	354	49%	29	3%
1.A.3.e Other Transportation: Liquid Fuels (N_2O)	22.3	15.2	16.2	0.00%	-6	-27%	1	6%
1.A.3.e Other Transportation: Solid Fuels (CH_4)	0.4	0.0	0.0	0.00%	0	-100%	0	0%
1.A.3.e Other Transportation: Solid Fuels (CO_2)	54.7	0.0	0.0	0.00%	-55	-100%	0	0%
1.A.3.e Other Transportation: Solid Fuels (N_2O)	0.7	0.0	0.0	0.00%	-1	-100%	0	0%
1.A.4.a Commercial/Institutional: Biomass (CH_4)	174.4	348.0	373.4	0.01%	199	114%	25	7%
1.A.4.a Commercial/Institutional: Biomass (N_2O)	46.9	173.7	181.6	0.01%	135	287%	8	5%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CH_4)	127.2	271.7	277.4	0.01%	150	118%	6	2%
1.A.4.a Commercial/Institutional: Gaseous Fuels (N_2O)	106.6	178.4	182.5	0.01%	76	71%	4	2%
1.A.4.a Commercial/Institutional: Liquid Fuels (CH_4)	165.6	80.9	81.9	0.00%	-84	-51%	1	1%
1.A.4.a Commercial/Institutional: Liquid Fuels (N_2O)	332.7	120.0	118.2	0.00%	-215	-64%	-2	-1%
1.A.4.a Commercial/Institutional: Other Fuels (CH_4)	9.4	28.4	25.8	0.00%	16	173%	-3	-9%
1.A.4.a Commercial/Institutional: Other Fuels (N_2O)	18.1	160.3	163.7	0.00%	146	804%	3	2%
1.A.4.a Commercial/Institutional: Peat (CH_4)	0.7	0.3	0.3	0.00%	0	-62%	0	5%
1.A.4.a Commercial/Institutional: Peat (CO_2)	233.7	45.9	53.2	0.00%	-180	-77%	7	16%
1.A.4.a Commercial/Institutional: Peat (N_2O)	1.1	0.3	0.3	0.00%	-1	-73%	0	12%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.4.a Commercial/Institutional: Solid Fuels (CH_4)	1 470.6	13.4	12.2	0.00%	-1 458	-99%	-1	-9%
1.A.4.a Commercial/Institutional: Solid Fuels (N_2O)	166.6	23.2	24.0	0.00%	-143	-86%	1	3%
1.A.4.b Residential: Biomass (N_2O)	1 726.1	2 892.9	2 757.2	0.08%	1 031	60%	-136	-5%
1.A.4.b Residential: Gaseous Fuels (CH_4)	631.4	695.3	690.4	0.02%	59	9%	-5	-1%
1.A.4.b Residential: Gaseous Fuels (N_2O)	280.8	396.5	385.2	0.01%	104	37%	-11	-3%
1.A.4.b Residential: Liquid Fuels (CH_4)	338.8	183.3	180.7	0.01%	-158	-47%	-3	-1%
1.A.4.b Residential: Liquid Fuels (N_2O)	652.5	260.6	255.0	0.01%	-398	-61%	-6	-2%
1.A.4.b Residential: Other Fuels (CH_4)	0.0	0.4	0.4	0.00%	0.4	100%	-0.1	-15%
1.A.4.b Residential: Other Fuels (CO_2)	0.0	12.2	10.9	0.00%	11	100%	-1	-10%
1.A.4.b Residential: Other Fuels (N_2O)	0.0	0.1	0.1	0.00%	0.1	100%	-0.01	-13%
1.A.4.b Residential: Peat (CH_4)	286.0	64.6	67.8	0.00%	-218	-76%	3	5%
1.A.4.b Residential: Peat (CO_2)	3 987.9	895.3	938.5	0.03%	-3 049	-76%	43	5%
1.A.4.b Residential: Peat (N_2O)	17.0	3.8	3.9	0.00%	-13	-77%	0.2	5%
1.A.4.b Residential: Solid Fuels (N_2O)	1 106.3	233.4	220.8	0.01%	-886	-80%	-13	-5%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (CH_4)	96.3	649.0	645.2	0.02%	549	570%	-4	-1%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (N_2O)	20.4	184.2	184.9	0.01%	165	809%	1	0%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CH_4)	77.6	1 062.2	1 000.3	0.03%	923	1190%	-62	-6%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (N_2O)	8.5	8.6	8.4	0.00%	-0.1	-1%	-0.2	-2%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CH_4)	209.4	98.0	97.3	0.00%	-112	-54%	-1	-1%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (N_2O)	3 451.2	3 244.8	3 349.7	0.10%	-101	-3%	105	3%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CH_4)	0.0	0.1	0.1	0.00%	0.1	100%	-0.02	-10%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CO_2)	0.0	50.9	51.7	0.00%	52	100%	1	2%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (N_2O)	0.0	3.5	3.6	0.00%	4	100%	0.03	1%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CH_4)	0.7	6.5	7.4	0.00%	7	916%	1	15%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CO_2)	43.4	268.3	280.7	0.01%	237	547%	12	5%
1.A.4.c Agriculture/Forestry/Fishing: Peat (N_2O)	0.5	2.7	2.7	0.00%	2	455%	0.03	1%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CH_4)	663.2	311.4	302.9	0.01%	-360	-54%	-9	-3%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (N_2O)	38.2	19.2	18.6	0.00%	-20	-51%	-1	-3%
1.A.5.a Other Other Sectors: Biomass (CH_4)	0.3	34.7	1.6	0.00%	1	360%	-33	-95%
1.A.5.a Other Other Sectors: Biomass (N_2O)	0.3	5.6	0.4	0.00%	0.2	69%	-5	-92%
1.A.5.a Other Other Sectors: Gaseous Fuels (CH_4)	0.4	0.5	0.2	0.00%	-0.2	-53%	-0.3	-59%
1.A.5.a Other Other Sectors: Gaseous Fuels (CO_2)	726.6	694.9	540.4	0.02%	-186	-26%	-154	-22%
1.A.5.a Other Other Sectors: Gaseous Fuels (N_2O)	1.2	2.1	1.2	0.00%	0	3%	-1	-40%
1.A.5.a Other Other Sectors: Liquid Fuels (CH_4)	3.1	2.4	2.5	0.00%	-1	-21%	0.1	3%
1.A.5.a Other Other Sectors: Liquid Fuels (CO_2)	2 294.0	1 605.2	1 553.6	0.05%	-740	-32%	-52	-3%
1.A.5.a Other Other Sectors: Liquid Fuels (N_2O)	10.7	7.5	7.5	0.00%	-3	-30%	0	-1%

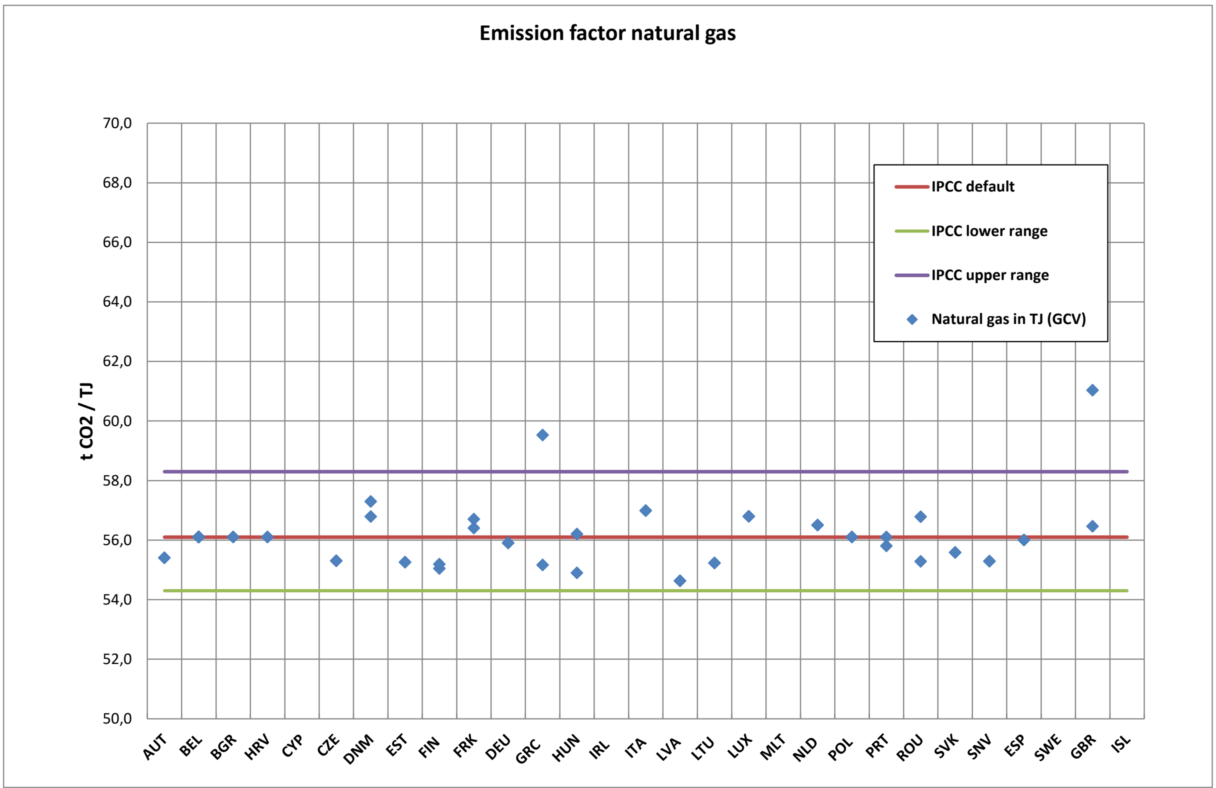
EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.5.a Other Other Sectors: Peat (CH_4)	0.3	0.0	0.0	0.00%	0	-100%	0	0%
1.A.5.a Other Other Sectors: Peat (CO_2)	24.0	0.0	0.0	0.00%	-24	-100%	0	0%
1.A.5.a Other Other Sectors: Peat (N_2O)	0.1	0.0	0.0	0.00%	0	-100%	0	0%
1.A.5.a Other Other Sectors: Solid Fuels (CH_4)	253.4	0.3	0.3	0.00%	-253	-100%	-0.02	-6%
1.A.5.a Other Other Sectors: Solid Fuels (N_2O)	20.9	0.1	0.04	0.00%	-21	-100%	-0.01	-17%
1.A.5.b Other Other Sectors: Biomass (CH_4)	0.0	0.02	0.02	0.00%	0.02	100%	-0.001	-3%
1.A.5.b Other Other Sectors: Biomass (N_2O)	0.0	0.05	0.05	0.00%	0.05	100%	-0.002	-4%
1.A.5.b Other Other Sectors: Liquid Fuels (CH_4)	41.9	5.1	4.6	0.00%	-37	-89%	-1	-10%
1.A.5.b Other Other Sectors: Liquid Fuels (N_2O)	199.7	63.6	53.8	0.00%	-146	-73%	-10	-15%
1.A.5.b Other Other Sectors: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0	100%	0.0	-9%
1.A.5.b Other Other Sectors: Other Fuels (CO_2)	0.0	0.8	0.8	0.00%	1	100%	0.04	6%
1.A.5.b Other Other Sectors: Other Fuels (N_2O)	0.0	0.00002	0.00002	0.00%	0	100%	0.0	-3%
1.B.1.a Coal Mining and Handling: Operation (CO_2)	664.2	238.3	205.7	0.01%	-458	-69%	-33	-14%
1.B.1.b Solid Fuel Transformation: Operation (CH_4)	291.9	104.5	107.7	0.00%	-184	-63%	3	3%
1.B.1.b Solid Fuel Transformation: Operation (CO_2)	7 832.4	3 889.5	4 058.8	0.12%	-3 774	-48%	169	4%
1.B.1.b Solid Fuel Transformation: Operation (N_2O)	0.1	0.02	0.01	0.00%	0	-87%	-0.01	-34%
1.B.1.c Other Solid fuel operation: Operation (CH_4)	113.0	98.8	99.3	0.00%	-14	-12%	1	1%
1.B.1.c Other Solid fuel operation: Operation (CO_2)	6.9	80.7	74.3	0.00%	67	973%	-6	-8%
1.B.1.c Other Solid fuel operation: Operation (N_2O)	0.003	0.003	0.003	0.00%	-0.0004	-13%	-0.0004	-13%
1.B.2.a Oil: Operation (CH_4)	6 767.2	1 111.1	1 132.9	0.03%	-5 634	-83%	22	2%
1.B.2.a Oil: Operation (N_2O)	28.3	11.8	12.0	0.00%	-16	-58%	0.2	1%
1.B.2.b Natural Gas: Operation (CO_2)	3 381.5	1 380.2	1 308.5	0.04%	-2 073	-61%	-72	-5%
1.B.2.c Venting and Flaring: Operation (CH_4)	7 374.1	4 454.6	4 510.7	0.14%	-2 863	-39%	56	1%
1.B.2.c Venting and Flaring: Operation (N_2O)	103.7	93.6	89.8	0.00%	-14	-13%	-4	-4%
1.B.2.d Other emissions from energy production: Operation (CH_4)	107.0	87.1	80.8	0.00%	-26	-24%	-6	-7%
1.B.2.d Other emissions from energy production: Operation (CO_2)	743.7	2 273.9	2 225.4	0.07%	1 482	199%	-48	-2%
1.B.2.d Other emissions from energy production: Operation (N_2O)	12.6	9.9	9.6	0.00%	-3	-24%	-0.3	-3%

3.3 Methodological issues and uncertainties (EU-KP)

The previous section presented for each EU-KP 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 is 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.

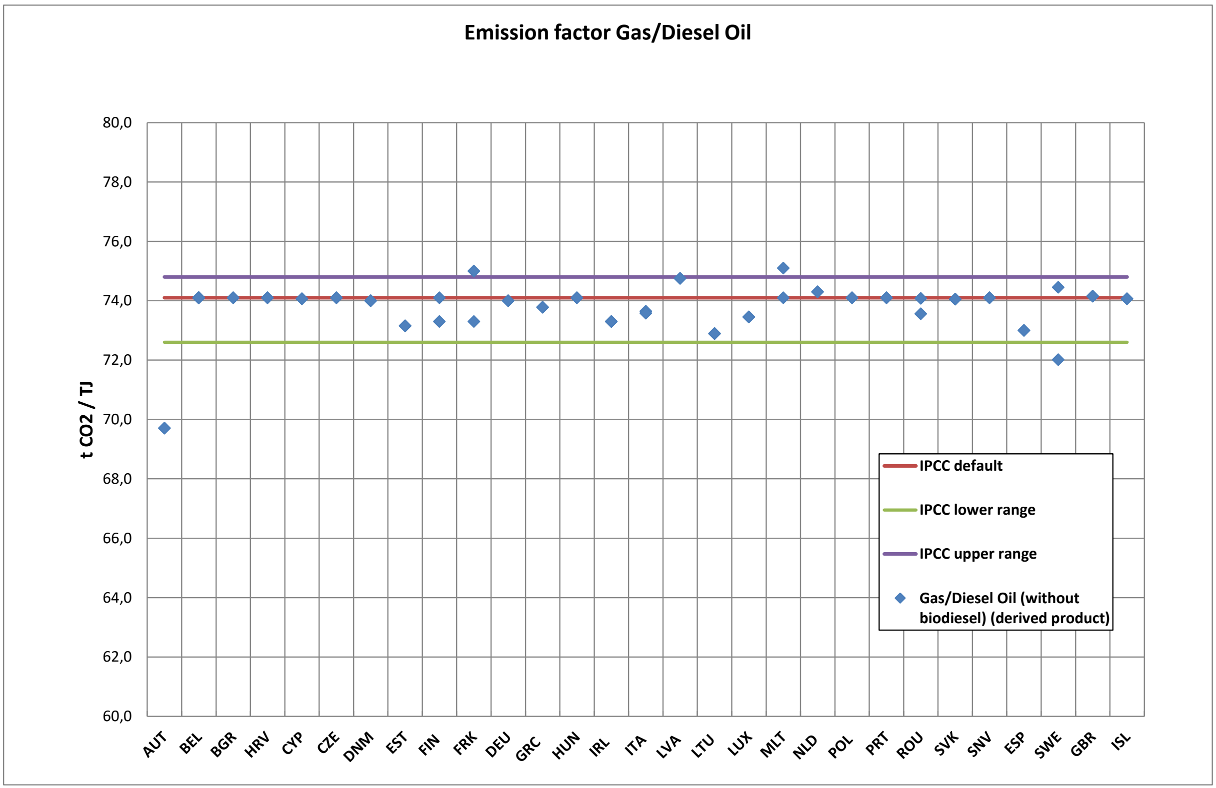
Figure 3.186 Emission factors used by Member States for natural gas



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).

Figure 3.187 Emission factors used by Member States for gas/diesel oil



AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.

Figure 3.188 Emission factors used by Member States for LPG

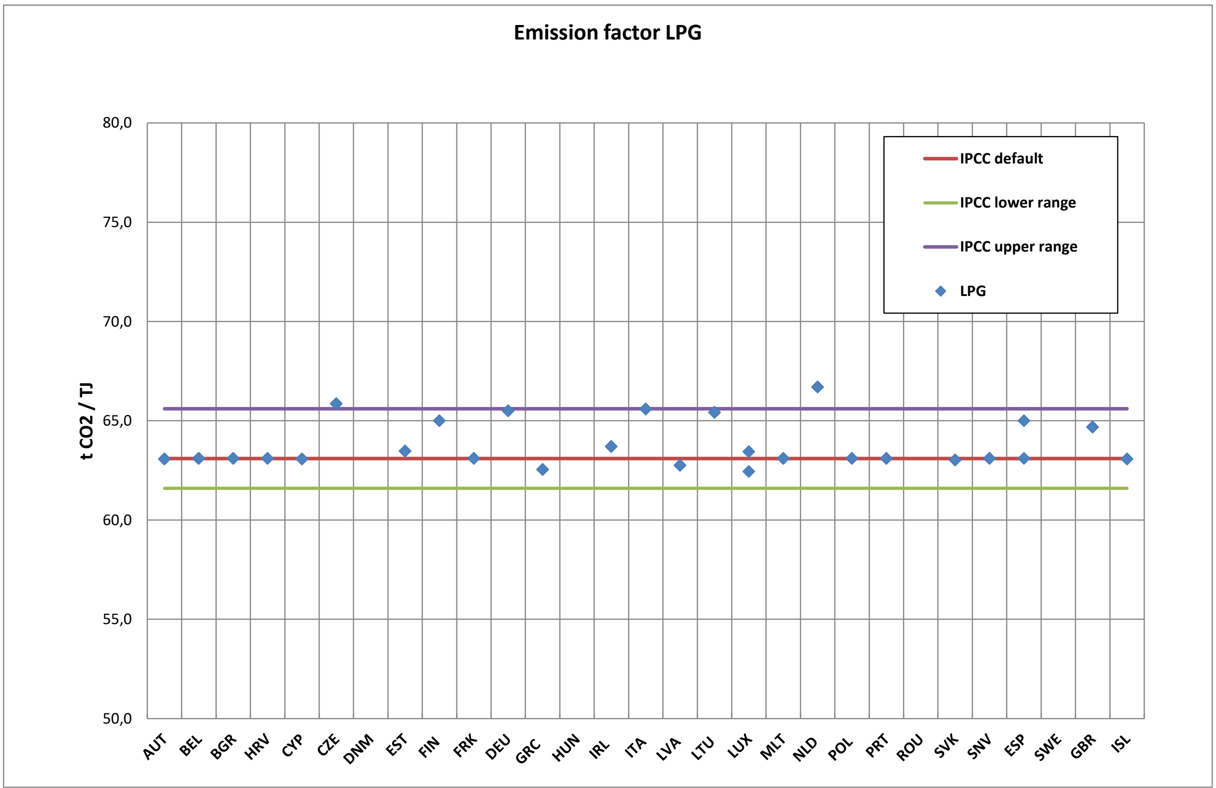
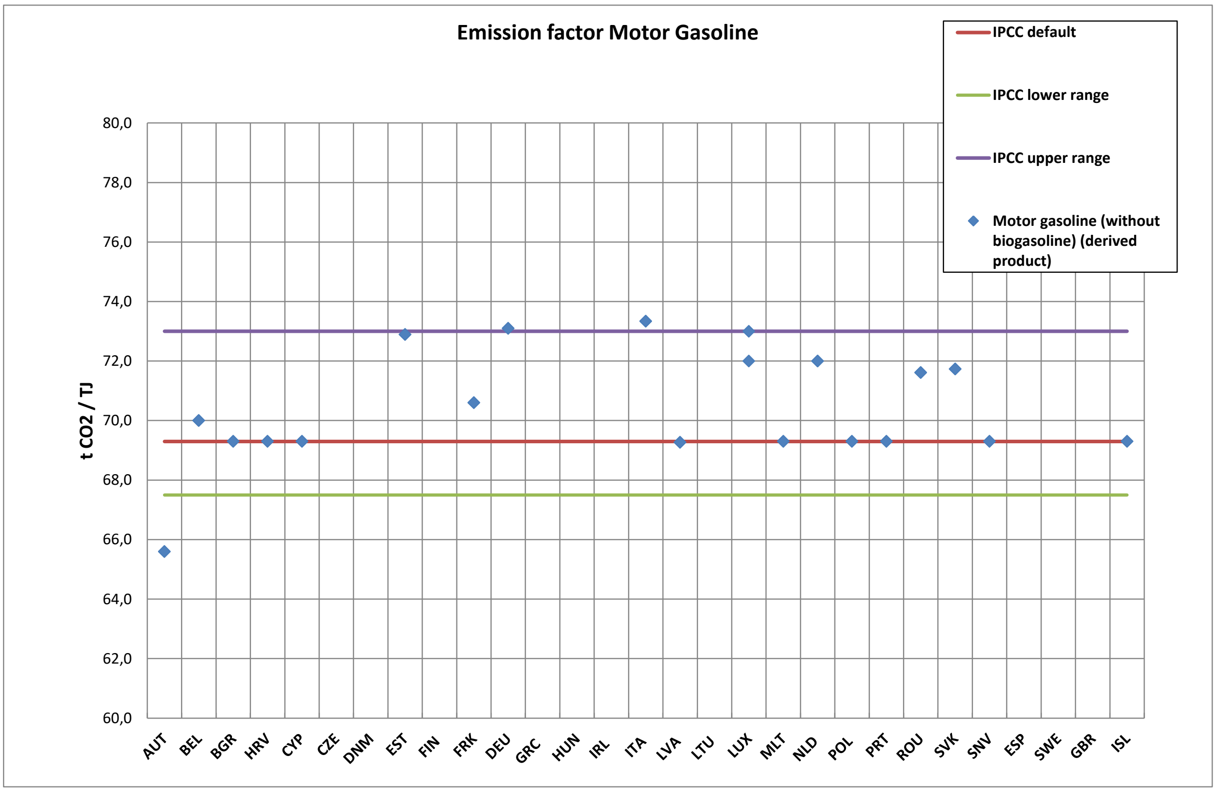


Figure 3.189 Emission factors used by Member States for natural gasoline



AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.

Figure 3.190 Emission factors used by Member States for jet kerosene

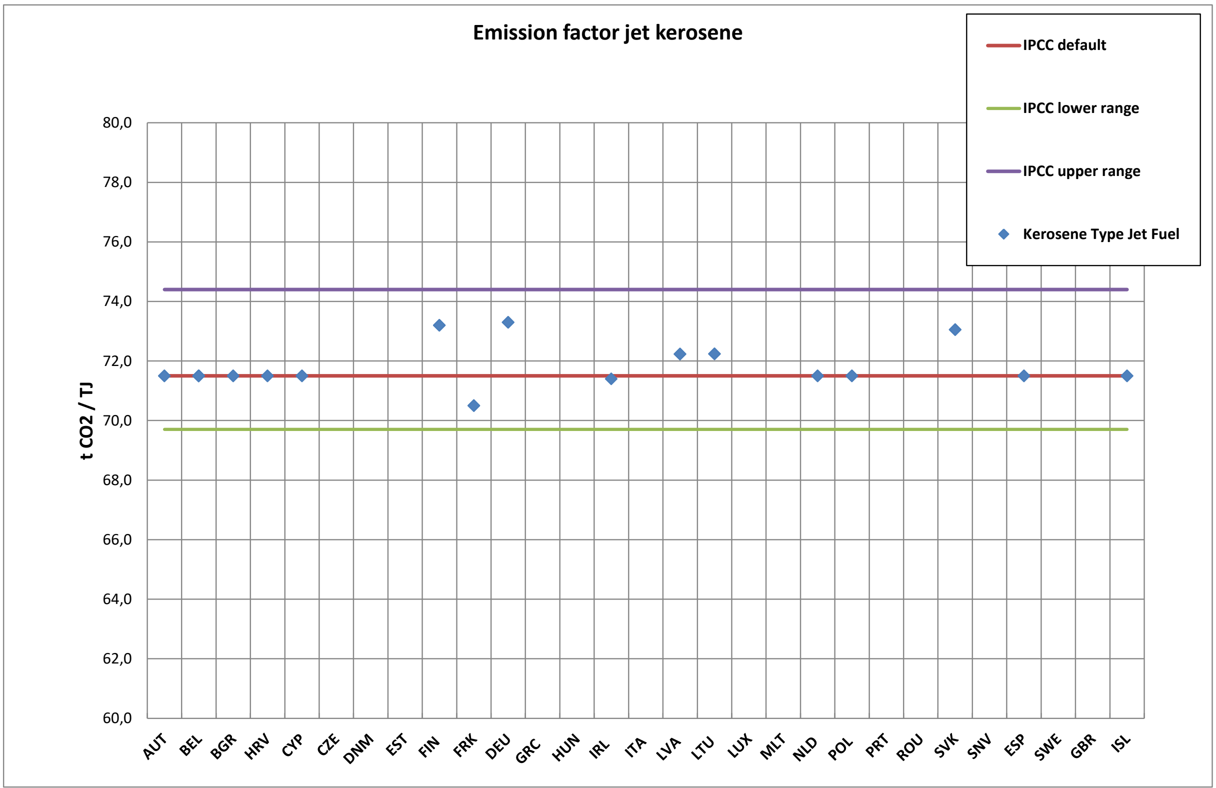
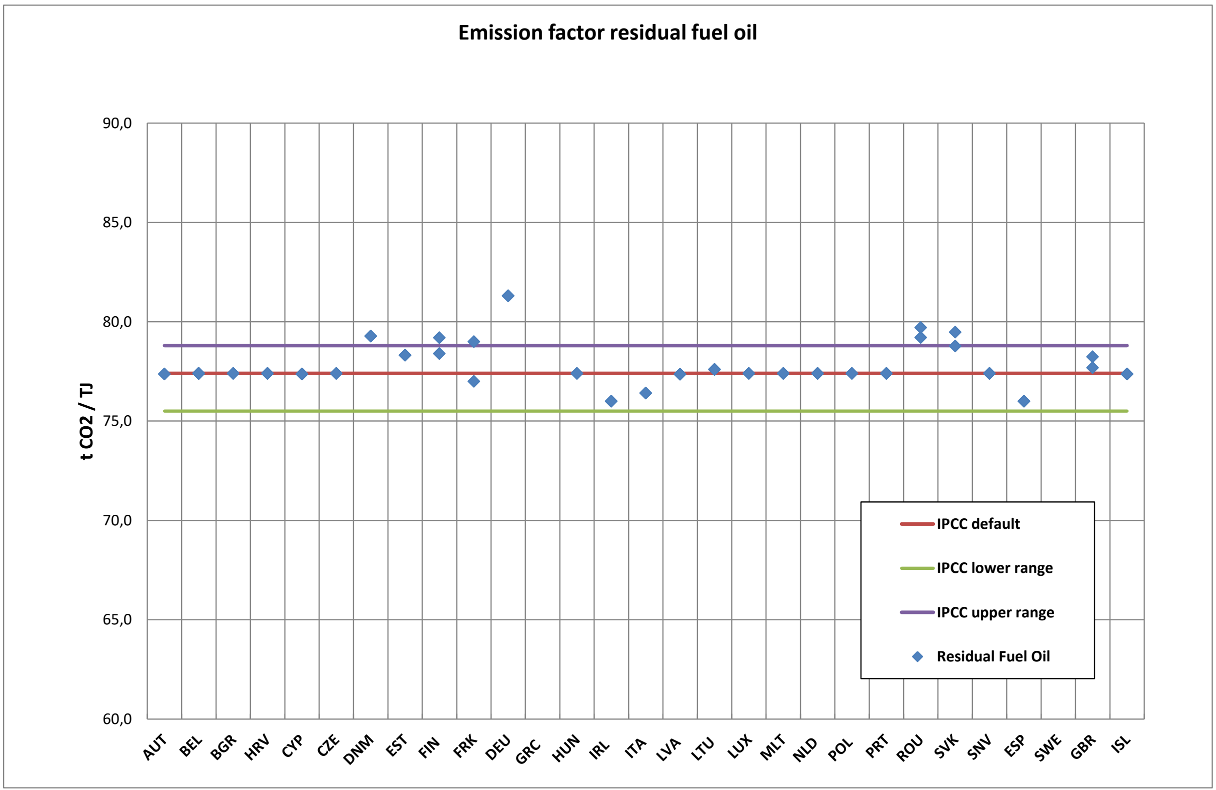


Figure 3.191 Emission factors used by Member States for residual fuel oil



<u>DEU:</u> This is the value for heavy residual fuel oil.

<u>ROU:</u> 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.

Figure 3.192 Emission factors used by Member States for petroleum coke

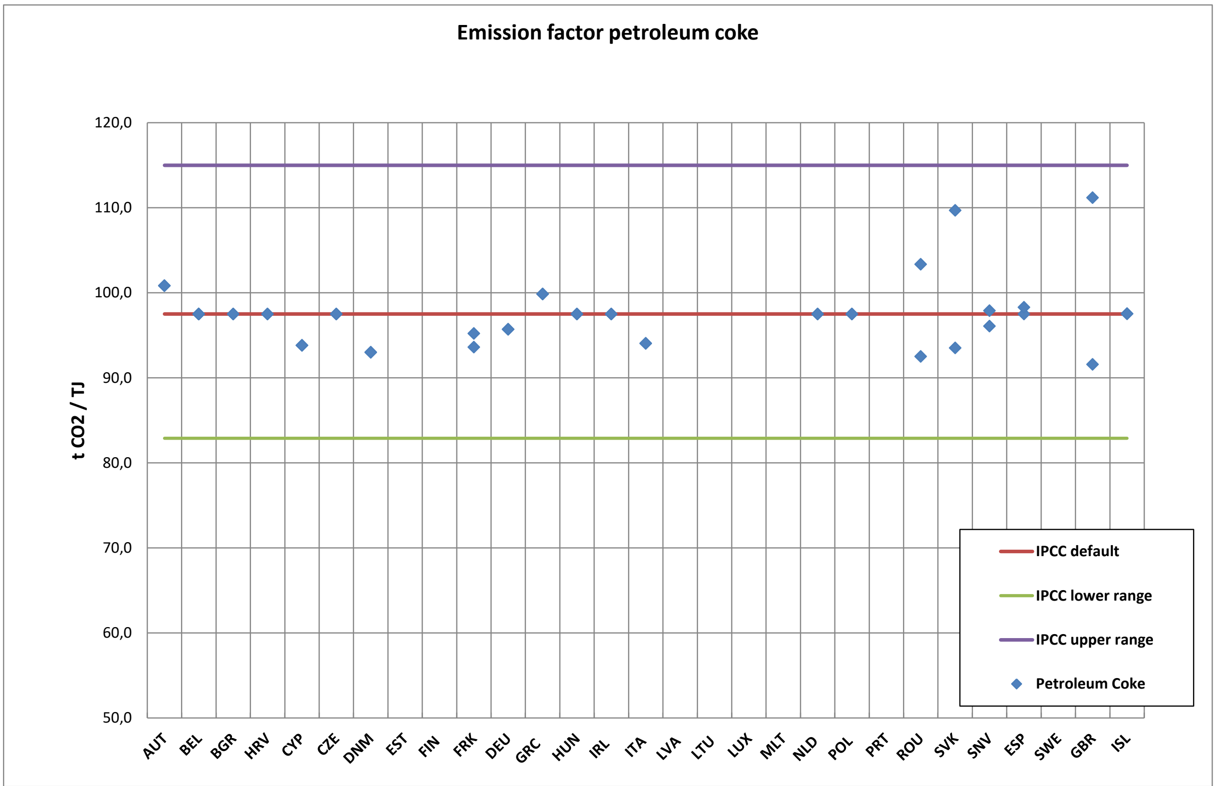


Figure 3.193 Emission factors used by Member States for refinery gas

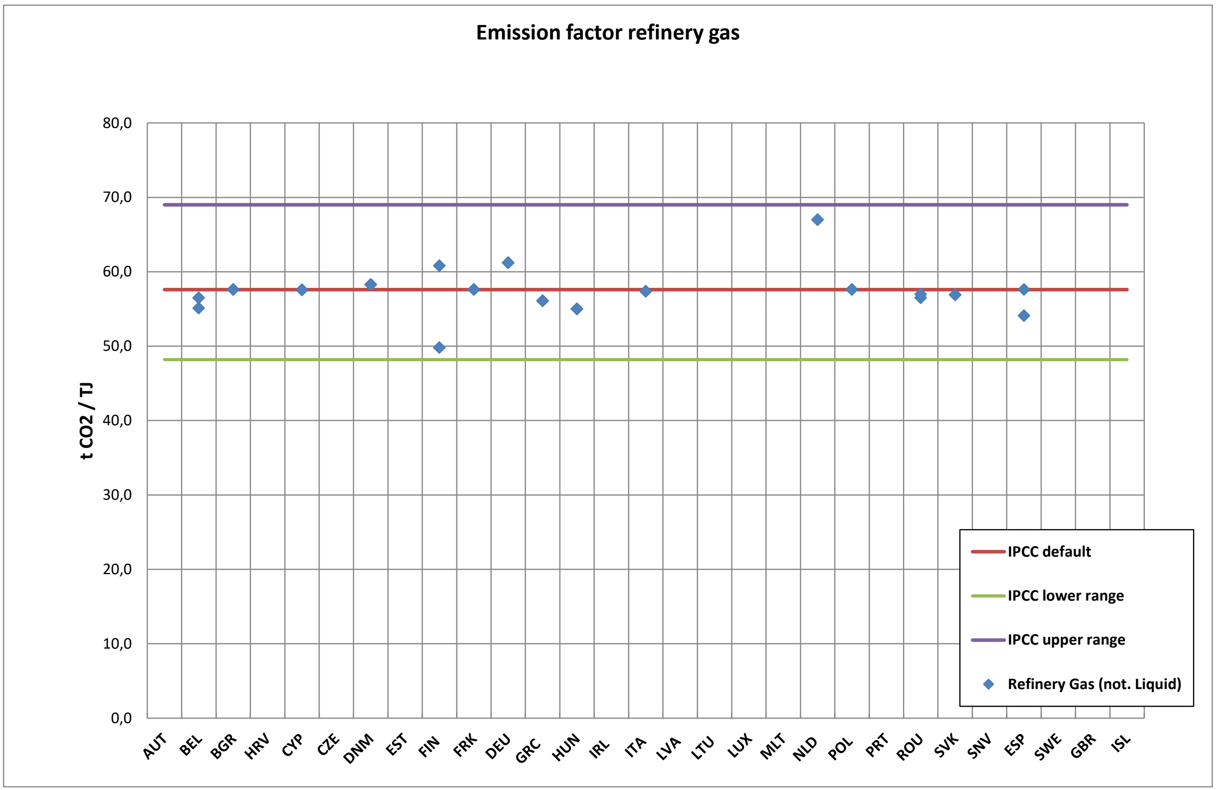


Figure 3.194 Emission factors used by Member States for bituminous coal

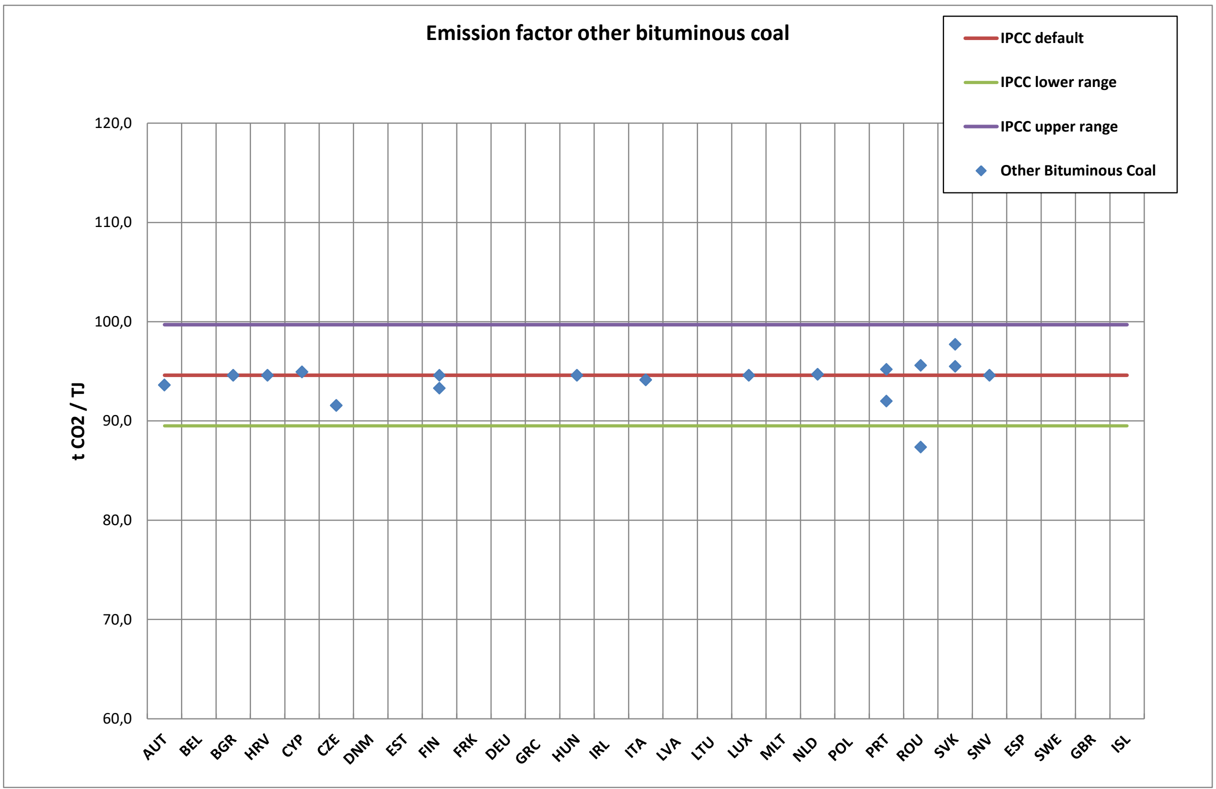
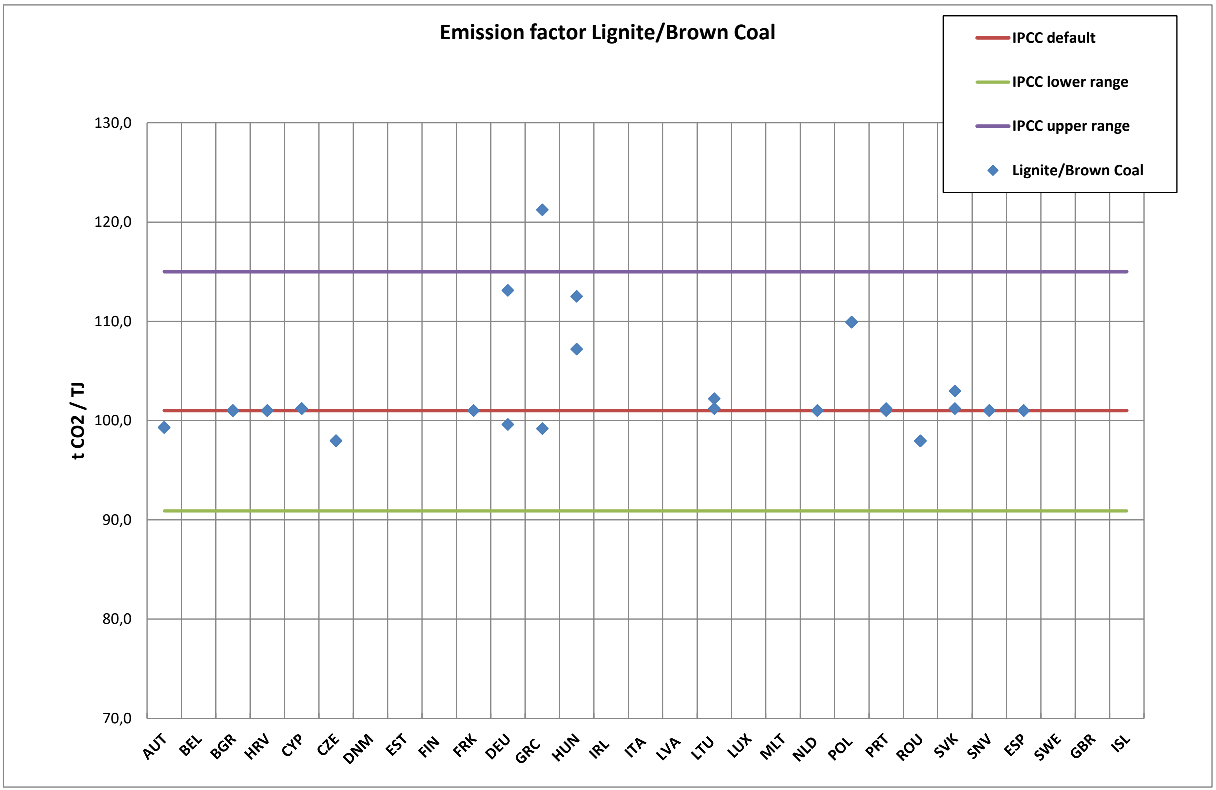


Figure 3.195 Emission factors used by Member States for lignite



__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.

Figure 3.196 Emission factors used by Member States for coking coal

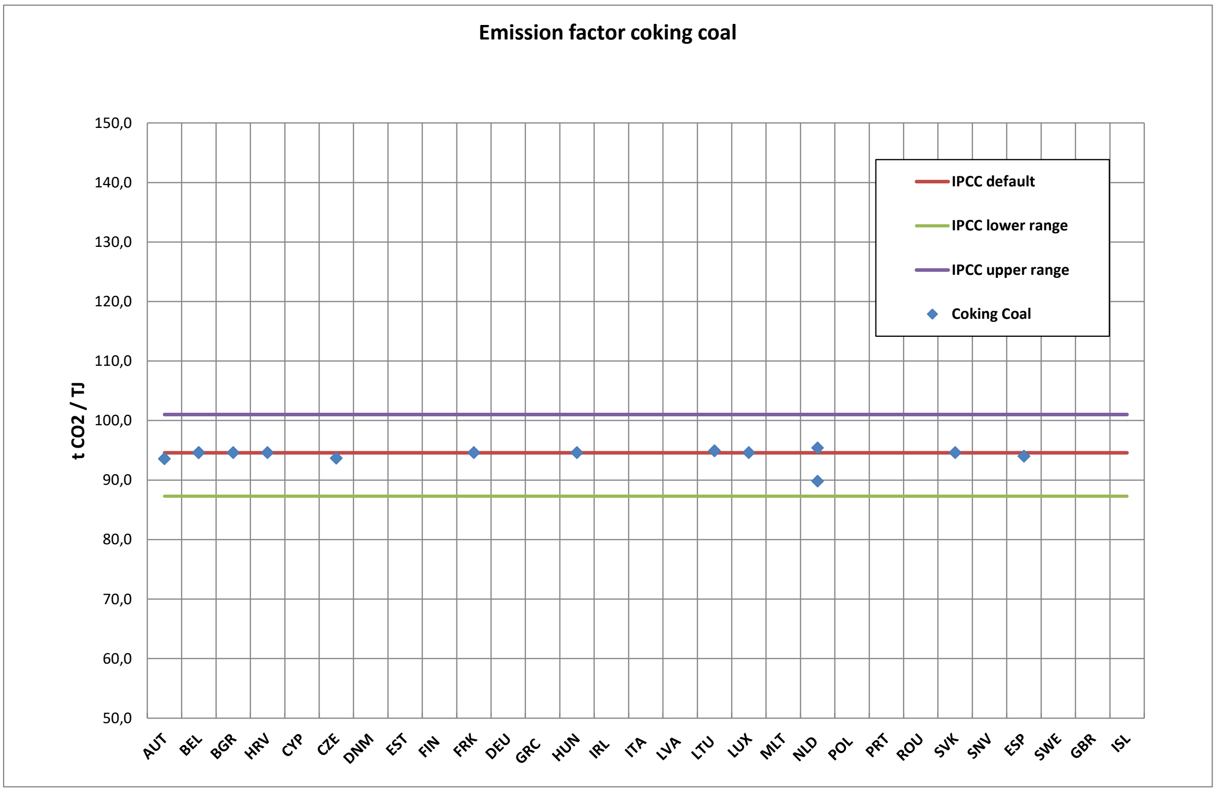


Figure 3.197 Emission factors used by Member States for coke oven coke

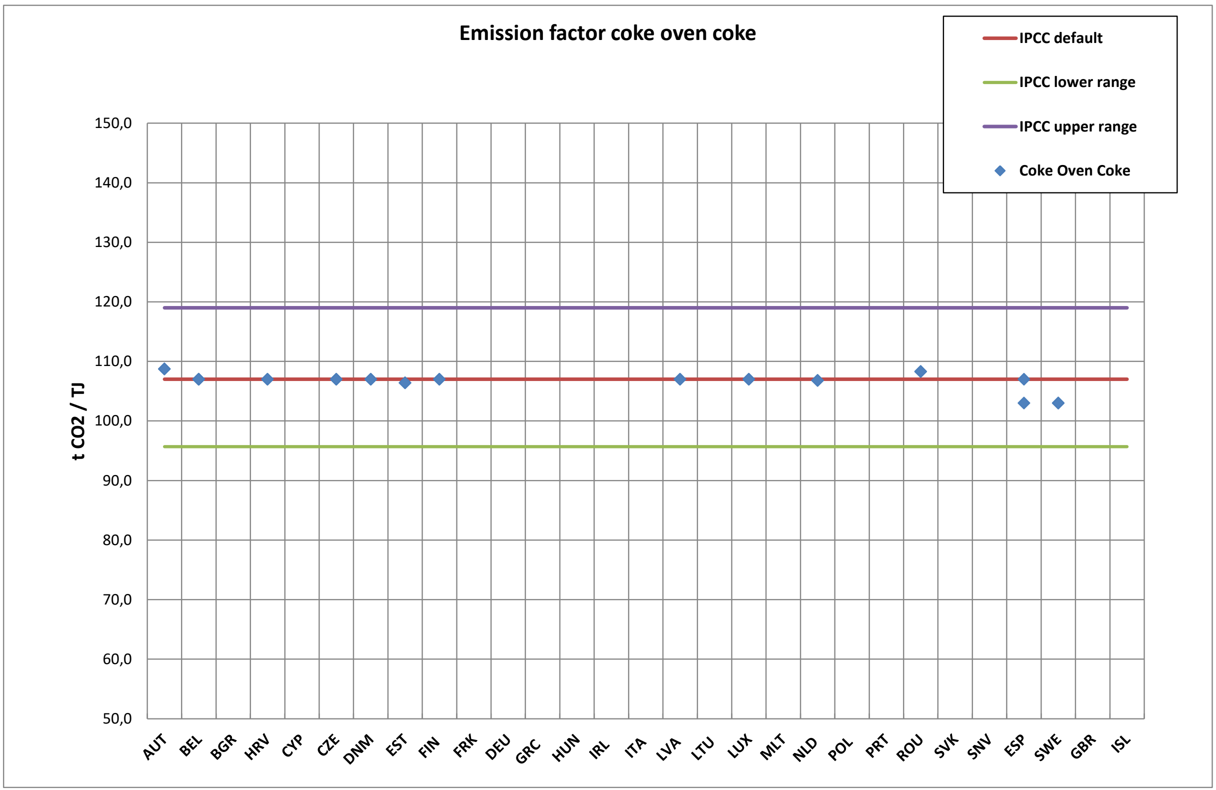
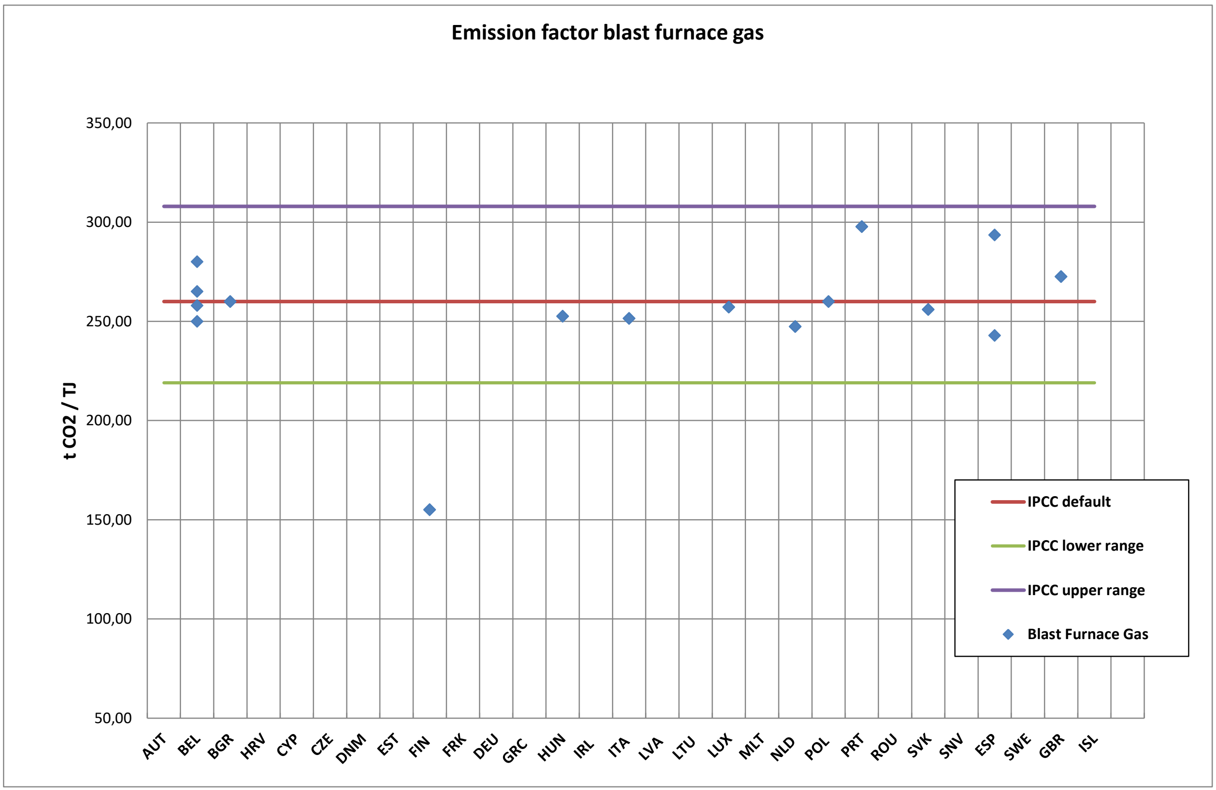


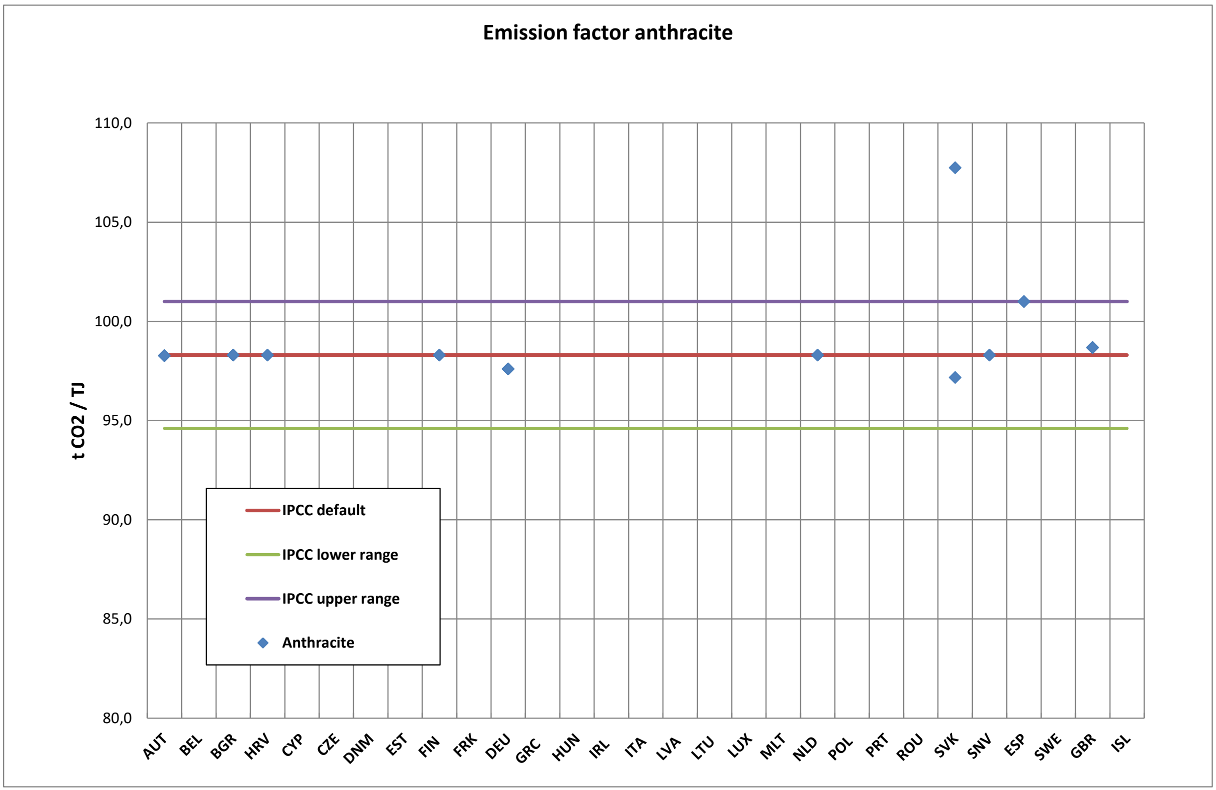
Figure 3.198 Emission factors used by Member States for blast furnace gas



* BEL: Highest value max. Wallonia, lowest value min. Flanders

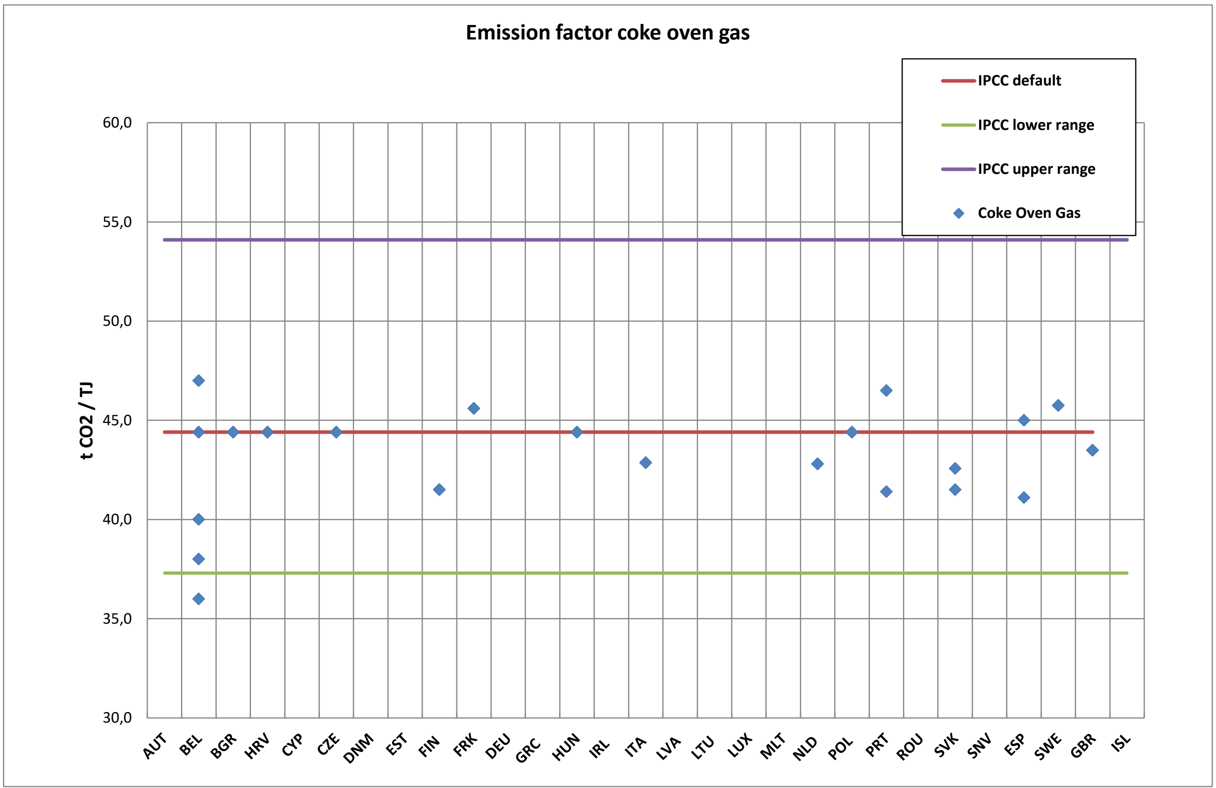
FIN: Because the number of plants is very small, we have to aggregate certain fuel types to more general categories. In this case, blast furnace gas includes actually two types of gas. One is more like carbon monoxide (EF 155), and the other actual blast furnace gas (EF around 265). Both EF values (or 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').

Figure 3.199 Emission factors used by Member States for anthracite



SVK: The higher value is used for 1A2a, the lower value for 1A1a.

Figure 3.200 Emission factors used by Member States for coke oven gas



* BEL: Highest value max. Wallonia, lowest value min. Wallonia

Table 3.129 shows the total EU-KP 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 CO_2 from 1A2d and the lowest for CO_2 from 1A2c. 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-KP see Chapter 1.6.

Table 3.129 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	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	587 608	428 891	-27.0%	2.6%	0.01%
1.A.1.a Public electricity and heat production	CH_4	245	2 618	968.4%	62.7%	6.2%
1.A.1.a Public electricity and heat production	N_2O	2 842	2 681	-5.7%	32.7%	0.1%
1.A.1.b Petroleum refining	CO_2	53 514	48 457	-9.4%	4.1%	0.02%
1.A.1.b Petroleum refining	CH_4	19	16	-18.3%	19.4%	0.1%
1.A.1.b Petroleum refining	N_2O	230	132	-42.6%	24.9%	0.2%
1.A.1.c Manufacture of solid fuels and other energy industries	CO_2	74 328	18 467	-75.2%	5.0%	0.04%
1.A.1.c Manufacture of solid fuels and other energy industries	CH_4	102	168	65.0%	144.6%	1.0%
1.A.1.c Manufacture of solid fuels and other energy industries	N_2O	670	156	-76.8%	22.9%	0.2%
1.A.2.a Iron and Steel	CO_2	51 557	40 069	-22.3%	5.3%	0.0%
1.A.2.a Iron and Steel	CH_4	70	64	-8.6%	26.6%	0.02%
1.A.2.a Iron and Steel	N_2O	220	201	-8.3%	221.6%	0.8%
1.A.2.b Non-ferrous Metals	CO_2	2 615	2 176	-16.8%	8.3%	0.01%
1.A.2.b Non-ferrous Metals	CH_4	3	2	-16.5%	62.9%	0.1%
1.A.2.b Non-ferrous Metals	N_2O	20	10	-52.2%	93.1%	0.3%
1.A.2.c Chemicals	CO_2	29 660	6 188	-79.1%	1.7%	0.02%
1.A.2.c Chemicals	CH_4	19	18	-5.9%	71.0%	0.4%
1.A.2.c Chemicals	N_2O	31	29	-7.8%	399.6%	1.8%
1.A.2.d Pulp, Paper and Print	CO_2	3 010	1 502	-50.1%	3.4%	0.03%
1.A.2.d Pulp, Paper and Print	CH_4	15	19	28.8%	38.8%	0.1%
1.A.2.d Pulp, Paper and Print	N_2O	77	97	25.8%	77.2%	0.3%
1.A.2.e Food Processing, Beverages and Tobacco	CO_2	7 766	3 908	-49.7%	1.7%	0.02%
1.A.2.e Food Processing, Beverages and Tobacco	CH_4	11	12	6.1%	66.6%	0.5%
1.A.2.e Food Processing, Beverages and Tobacco	N_2O	40	12	-68.9%	202.2%	0.7%
1.A.2.f Non-metallic minerals	CO2	28 352	21 868	-22.9%	2.7%	0.01%
1.A.2.f Non-metallic minerals	CH4	67	42	-37.4%	31.7%	0.2%
1.A.2.f Non-metallic minerals	N2O	237	190	-19.7%	55.8%	0.3%
1.A.2.g Other	CO_2	170 267	86 521	-49.2%	3.3%	0.01%
1.A.2.g Other	CH_4	194	244	25.9%	29.9%	0.1%
1.A.2.g Other	N_2O	1 164	716	-38.5%	31.7%	0.1%
1.A.3.a Domestic aviation	CO_2	7 908	8 637	9.2%	12.6%	0.03%
1.A.3.a Domestic aviation	CH_4	11	5	-57.7%	67.7%	0.3%
1.A.3.a Domestic aviation	N_2O	73	62	-15.1%	152.4%	0.3%
1.A.3.c Railways	CO_2	7 848	2 868	-63.5%	4.5%	0.03%
1.A.3.c Railways	CH_4	10	4	-60.3%	79.5%	0.3%
1.A.3.c Railways	N_2O	500	192	-61.6%	123.7%	0.5%
1.A.3.d Domestic navigation	CO_2	21 778	14 407	-33.8%	19.9%	0.1%
1.A.3.d Domestic navigation	CH_4	24	22	-10.2%	88.2%	0.2%
1.A.3.d Domestic navigation	N_2O	306	228	-25.6%	212.2%	0.3%
1.A.3.e Other transportation	CO_2	4 334	3 550	-18.1%	2.5%	0.02%
1.A.3.e Other transportation	CH_4	7	7	-0.2%	66.3%	0.1%
1.A.3.e Other transportation	N_2O	21	19	-8.4%	123.8%	0.5%
1.A.4.a Commercial/Institutional	CO_2	82 101	48 407	-41.0%	5.9%	0.03%
1.A.4.a Commercial/Institutional	CH_4	1 576	170	-89.2%	71.0%	1.5%
1.A.4.a Commercial/Institutional	N_2O	272	139	-49.1%	121.4%	0.3%
1.A.4.b Residential	CO_2	186 757	123 414	-33.9%	6.4%	0.02%
1.A.4.b Residential	CH_4	4 059	2 758	-32.1%	67.3%	0.6%
1.A.4.b Residential	N_2O	1 018	642	-37.0%	125.8%	0.4%
1.A.4.c Agriculture/forestry/fishing	CO_2	35 460	22 204	-37.4%	5.9%	0.02%
1.A.4.c Agriculture/forestry/fishing	CH_4	457	1 344	194.4%	42.0%	0.9%
1.A.4.c Agriculture/forestry/fishing	N_2O	664	351	-47.2%	124.3%	0.2%
1.A.5 Other	CO_2	23 705	3 938	-83.4%	19.5%	0.1%
1.A.5 Other	CH_4	301	7	-97.5%	139.3%	1.5%
1.A.5 Other	N_2O	184	38	-79.1%	353.1%	1.7%
1.A (where no subsector data were submitted)	*all*	607 188	*355 569*	*-41.4%*	*1.4%*	*1.3%*
1.A.1 (where no subsector data were submitted)	*all*	*680 870*	*455 388*	*-33.1%*	*1.5%*	*0.6%*
1.A.2 (where no subsector data were submitted)	*all*	*444 546*	*262 647*	*-40.9%*	*1.9%*	*0.9%*
1.A.3 (where no subsector data were submitted)	*all*	*251 266*	*304 247*	*21.1%*	*3.0%*	*1.0%*
1.A.4 (where no subsector data were submitted)	*all*	*432 371*	*320 492*	*-25.9%*	*3.0%*	*1.4%*
Total - 1.A (where no subsector data were submitted)	**all**	**607 188**	**355 569**	**-41.4%**	**1.4%**	**1.3%**
Total - 1.A.1	**all**	**1 400 429**	**956 974**	**-31.7%**	**1.4%**	**0.5%**
Total - 1.A.2	**all**	**739 940**	**426 536**	**-42.4%**	**1.4%**	**0.6%**
Total - 1.A.3	**all**	**782 349**	**933 364**	**19.3%**	**1.6%**	**0.6%**
Total - 1.A.4	**all**	**744 734**	**519 920**	**-30.2%**	**2.5%**	**1.1%**
Total - 1.A.5	**all**	**24 190**	**3 984**	**-83.5%**	**4.8%**	**3.4%**
Total - 1.A	**all**	**4 298 831**	**3 196 347**	**-25.6%**	**0.8%**	**0.4%**

Note: Emissions are in kt 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 3.130 shows the total EU-KP 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 CO_2 from 1B1; the highest trend uncertainties were estimated for N_2O from 1B1, the lowest for CO_2 and CH_4 from 1B1 and CO_2 from 1B2. Uncertainties analysis show very similar results as in 2017.

Table 3.130 1B Fugitive Emissions: Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.B.1 Solid Fuels	CO_2	8 279	4 306	-48.0%	12.3%	0.1%
1.B.1 Solid Fuels	CH_4	101 630	28 418	-72.0%	74.7%	0.1%
1.B.1 Solid Fuels	N_2O	0.1	0.0	-87.1%	118.0%	1.0%
1.B.2. Oil and Natural Gas and other emissions from energy production	CO_2	18 313	19 570	6.9%	16.2%	0.1%
1.B.2. Oil and Natural Gas and other emissions from energy production	CH_4	64 342	22 217	-65.5%	28.4%	0.2%
1.B.2. Oil and Natural Gas and other emissions from energy production	N_2O	133	102	-23.6%	448.6%	0.8%
1.B (werhe no subsector data were submitted)	*all*	*14 057*	*7 594*	*-46.0%*	*51.8%*	*16.5%*
Total - 1.B	**all**	**206 755**	**82 208**	**-60.2%**	**27.6%**	**8.4%**

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 3.131 shows the total EU-KP 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 1A3b. With regard to trend N_2O from 1A3e 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 3.131 1A3 Transport: Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.3.a Domestic aviation	CO_2	7 908	8 637	9.2%	12.6%	0.03%
1.A.3.a Domestic aviation	CH_4	11	5	-57.7%	67.7%	0.3%
1.A.3.a Domestic aviation	N_2O	73	62	-15.1%	152.4%	0.3%
1.A.3.b Road transport	CO_2	479 522	593 133	23.7%	1.8%	0.01%
1.A.3.b Road transport	CH_4	4 378	715	-83.7%	23.8%	0.2%
1.A.3.b Road transport	N_2O	4 361	5 267	20.8%	39.1%	0.3%
1.A.3.c Railways	CO_2	7 848	2 868	-63.5%	4.5%	0.03%
1.A.3.c Railways	CH_4	10	4	-60.3%	79.5%	0.3%
1.A.3.c Railways	N_2O	500	192	-61.6%	123.7%	0.5%
1.A.3.d Domestic navigation	CO_2	21 778	14 407	-33.8%	19.9%	0.1%
1.A.3.d Domestic navigation	CH_4	24	22	-10.2%	88.2%	0.2%
1.A.3.d Domestic navigation	N_2O	306	228	-25.6%	212.2%	0.3%
1.A.3.e Other transportation	CO_2	4 334	3 550	-18.1%	2.5%	0.02%
1.A.3.e Other transportation	CH_4	7	7	-0.2%	66.3%	0.1%
1.A.3.e Other transportation	N_2O	21	19	-8.4%	123.8%	0.5%
Total - 1.A.3	**all**	**782 349**	**933 364**	**19.3%**	**1.6%**	**0.6%**
Total - 1.A	**all**	**4 298 831**	**3 196 347**	**-25.6%**	**0.8%**	**0.4%**

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 3.132 summarizes the main checks carried out on Member States' submissions.

Table 3.132 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 the years 2005, 2016, 2017 and 2018 (ESD) 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 the years 2005, 2016, 2017 and 2018 (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 the years 2005, 2016, 2017 and 2018 7 (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 the years 2005, 2016, 2017 and 2018 (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 the years 2005, 2016 and 2017 Focus on EU key categories
Follow-up from 2018	Check if issues that were classified as "Unresolved" or "Partly resolved" in 2019 have been resolved by Member States in 2020.
Implementation of UNFCCC and ESD review recommendations	Check if recommendations from 2016 and 2017 UNFCCC review reports have been implemented by Member States. Check if recommendations from ESD review 2019 have been implemented by Member States.
Reporting of non-energy use of fossil fuels	Check plausibility of reporting in CRF table 1A(d) as compares reporting in CRF table 1A(b), 1A(c) and the IPPU sector.

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 for the 2020 targets 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 2020 a comprehensive review is carried out for all countries.

In addition, every year after the ESD review capacity building activities are organized. In 2019 the energy-related webinar had 51 participants from 20 EU Member States. Main issues discussed at the webinar were:

- Main findings from ESD review 2019

- Status of the 1A3d Maritime transport issue
- Explanation of step 1 checks
- Country-specific CO_2 emissions from transport

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, 2018, 2019 and 2020 and during the initial checks 2015, 2016, 2017, 2018, 2019 and 2020 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[14]. 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

[14] 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.

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.

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 countries and the European Union to the UNFCCC and to the UNECE. EU countries 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/CME is preparing comparisons between EUROCONTROL results and countries 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 2019 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 2018 by EU countries 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 inventory data submitted by countries for the time series 2005 to 2018 has been prepared by the European Environment Agency and its ETC/CME in February 2020. Results have been shared with countries 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, countries 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 countries in EUROCONTROL calculations than in inventories. In addition, most countries 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. Kerosene consumption in 2018 resulting from EUROCONTROL calculations is 4 % lower for both domestic and international aviation compared to the aggregation of countries results from inventories. The domestic split (as the share of kerosene consumption for domestic aviation on total kerosene consumption) for the 28 countries is identical between EU inventory and EUROCONTROL results. Obviously both the reporting of the countries but also the calculation of EUROCONTROL improved considerably during the years. The development of kerosene consumption along the time series 2005 to 2018 for the 28 countries 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 countries results.

Absolute differences in kerosene consumption are partly higher for single countries. The reasons for these differences are mainly due to the fact, that respective countries 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 countires, either for checking purposes but also by using the numbers directly in inventory calculations. In the course of the ‘initial checks’ 2016, 2017, 2018, 2019 and 2020 an intensive discussion with countries took place to understand the reasons for differences on countries 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.

In Table 3.133 an overview is given, how Eurocontrol data has been used by countries, as it has been mentioned in their NIR 2020 (or even previous versions, in case no updated information was found in NIR 2020).

Table 3.133 Use of Eurocontrol data by countries in their national inventory reports

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
Austria					
Belgium			Airport related data for distribution in regions	In Flamish region for international flights. In Wallonia, for N_2O and CH_4	NA
Bulgaria			LTO per aircraft type for the period 1996-2018		
Cyprus				For domestic and international flights	Trend of domestic share from Eurocontrol data has been applied to years 1990-2004
Czechia					
Germany	yes				

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
Denmark			List of aircraft types provided by Eurocontrol used		
Spain				For domestic and international flights	An adaptation model has been applied to link results based on national statistic with Eurocontrol results (2005-2018).
Estonia					
Finland				For domestic flights from 2005 onwards	For the years before 2005, the own model (ILMI) has been used. ILMI was implemented by Finavia and calculated emissions partly until the year 2008, since 2010 the model was not updated. No specific adaptation.
France					
United Kingdom			EMEP/EEA Eurocontrol cruise factors for generic aircraft are used		
Greece				For domestic and international flights	To keep timeseries consistency, emissions from 1990-2005 have been recalculated taking into account only international aviation fuel consumption and by applying Tier 1 methodology.
Croatia					
Hungary				For domestic flights	Fuel use (and consequently the emissions) of the years before 2005 have been adapted with built-in extrapolation procedures: The same share of kerosene use from Eirocontrol result 2005-2015 for domestic flights has been applied for the years 1985-2004.
Iceland	yes	It is planned to assess the use of the Eurocontrol dataset for estimating emissions from the aviation subsectors.			
Ireland				The fuel consumption is estimated using a Tier 3b approach based on origin and destination data for domestic air travel provided by EUROCONTROL	For the years 1990 to 2004, the number of flights for each airport was estimated based on domestic passenger and aircraft movement statistics as well as the relationship between all Irish airports and Dublin airport which is the principal destination of all domestic flights.
Italy				domestic	Emissions from aviation have been recalculated from 1990 on the basis of information on activity data and emission factors provided by Eurocontrol. A linear interpolation took place between 1999 (the year of a Tier 3 calculation) and 2005 for fuel consumption factors and emission factors.
Lithuania					
Luxembourg					
Latvia	Yes (2008-2018)				
Malta				For domestic aviation (from 2005	Data was extracted from the EUROCONTROL model for the whole

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
				until 2018)	timeseries from 2005 until 2018. This was done in order to harmonise any discrepancies that might have occurred. From 2005 onwards, EUROCONTROL data is being used, the timeseries is more coherent and any increases in emissions is well recorded.
Netherlands					
Poland				For the share of domestic flights	A 5-years average from Eurocontrol data for years 2005-2009 has been assumed for the years 1988-2004.
Portugal					
Romania					
Slovakia				For domestic and international flights	For the years 1990-2004 summary information from the Eurocontrol database was used (emission factors and domestic share).
Slovenia				For domestic flights	Only a small amount of domestic flights has been recorded by Eurocontrol. No adaptation took place for the years 1990-2004
Sweden					

Three countries report a comparison or a verification of their results with EUROCONTROL data and one country mention possible improvements in future submissions using this data. Four countries mention the indirect use of this data, using emissions factors or LTO information. Twelve countries report direct use of EUROCONTROL data and most of them informed about related adaptation process to ensure time-series consistency. Comparing to last year, one country (Ireland) moved from using EUROCONTROL data for comparison, to calculate fuel consumption using data for domestic air travel as provided by EUROCONTROL.

3.5 Sector-specific improvements

The improvements implemented in 2020 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 are included in included in Table 10.7 in chapter 10.

3.6 Sector-specific recalculations

Table 3.134 shows that in the energy sector the largest recalculations in absolute terms in 1990 and in 2017 were made for CO_2. In relative terms, the largest recalculations in 1990 were made for N_2O (+1.0 %) and in 2017 for CH_4 (-1.0 %).

Table 3.134 Sector 1 Energy: Recalculations of total GHG emissions and recalculations of GHG emissions for the years 1990 and 2017 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	
	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
Total emissions and removals	-8 529	-0.2%	1 287	0.2%	-3 960	-1.0%	65	0.2%	171	0.7%	7	0.1%	-229	-3.8%	7	40.7%
Energy	-2 880	-0.1%	260	0.1%	295	1.0%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2017																
Total emissions and removals	-3 715	-0.1%	-665	-0.1%	277	0.1%	832	0.8%	296	9.1%	-100	-1.5%	-580	-34.8%	12	25.0%
Energy	-4 697	-0.1%	-819	-1.0%	191	0.7%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NO: not occurring

Table 3.135 provides an overview of Member States' contributions to EU-KP recalculations. In absolute terms, Germany had the most influence on CO_2 recalculations in the EU-KP for 2017. Explanations for recalculations by Member State are provided in Chapters 3.2 and 10.1.

Table 3.135 Sector 1 Energy: Contribution of Member States to EU-KP recalculations for 1990 and 2017 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2017							
	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	-154	28	-5	NO	NO	NO	NO	NO	-337	25	53	NO	NO	NO	NO	NO
Belgium	83.4	17.4	-50.1	NO	NO	NO	NO	NO	1 866	6	8	NO	NO	NO	NO	NO
Bulgaria	120.7	-212.2	0.2	NO	NO	NO	NO	NO	107	221	0.1	NO	NO	NO	NO	NO
Croatia	0.0	-0.1	1.7	NO	NO	NO	NO	NO	21	17	-0.02	NO	NO	NO	NO	NO
Cyprus	2.5	0.3	-0.02	NO	NO	NO	NO	NO	-26	1	-0.1	NO	NO	NO	NO	NO
Czechia	0.6	0.1	-0.01	NO	NO	NO	NO	NO	81	5	-9	NO	NO	NO	NO	NO
Denmark	-4.9	-2.9	-0.5	NO	NO	NO	NO	NO	-73	-6	15	NO	NO	NO	NO	NO
Estonia	-159.5	-0.1	-0.1	NO	NO	NO	NO	NO	-24	1	3	NO	NO	NO	NO	NO
Finland	0.0	-54.3	1.0	NO	NO	NO	NO	NO	-32	23	5	NO	NO	NO	NO	NO
France	1.0	24.4	5.7	NO	NO	NO	NO	NO	-1 110	-62	74	NO	NO	NO	NO	NO
Germany	-166.5	298.2	308.5	NO	NO	NO	NO	NO	-12 805	-472	-8	NO	NO	NO	NO	NO
Greece	0.0	135.0	21.5	NO	NO	NO	NO	NO	0	111	-5	NO	NO	NO	NO	NO
Hungary	52.1	248.8	0.3	NO	NO	NO	NO	NO	-106	-188	0.4	NO	NO	NO	NO	NO
Ireland	-4.4	-0.5	-0.04	NO	NO	NO	NO	NO	97	-18	-0.4	NO	NO	NO	NO	NO
Italy	-1 645.4	-30.3	-2.0	NO	NO	NO	NO	NO	2 498	85	74	NO	NO	NO	NO	NO
Latvia	-0.8	49.1	0.9	NO	NO	NO	NO	NO	-14	34	0.2	NO	NO	NO	NO	NO
Lithuania	2.1	-0.01	4.9	NO	NO	NO	NO	NO	165	1	42	NO	NO	NO	NO	NO
Luxembourg	1.2	1.3	-2.7	NO	NO	NO	NO	NO	6	1	9	NO	NO	NO	NO	NO
Malta	465.2	-0.2	2.4	NO	NO	NO	NO	NO	-56	-1	-1	NO	NO	NO	NO	NO
Netherlands	-42.7	-2.8	-0.6	NO	NO	NO	NO	NO	-37	-19	3	NO	NO	NO	NO	NO
Poland	-310.0	-45.4	-53.2	NO	NO	NO	NO	NO	833	8	-63	NO	NO	NO	NO	NO
Portugal	-851.5	-10.4	37.8	NO	NO	NO	NO	NO	70	-30	29	NO	NO	NO	NO	NO
Romania	123.8	67.6	4.0	NO	NO	NO	NO	NO	3 057	1	15	NO	NO	NO	NO	NO
Slovakia	10.1	-0.4	-0.7	NO	NO	NO	NO	NO	72	1	1	NO	NO	NO	NO	NO
Slovenia	0.0	13.6	2.4	NO	NO	NO	NO	NO	6	-27	0.0002	NO	NO	NO	NO	NO
Spain	174.9	-320.0	0.9	NO	NO	NO	NO	NO	271	-493	1	NO	NO	NO	NO	NO
Sweden	-98.1	-1.7	-2.7	NO	NO	NO	NO	NO	182	-45	1	NO	NO	NO	NO	NO
United Kingdom	-425.7	57.0	30.5	NO	NO	NO	NO	NO	671	3	-24	NO	NO	NO	NO	NO
EU27+UK	-2 825.6	258.9	305.3	NO	NO	NO	NO	NO	-4 618	-818	221	NO	NO	NO	NO	NO
Iceland	10.6	1.7	-9.6	NO	NO	NO	NO	NO	1	-1	-30	NO	NO	NO	NO	NO
United Kingdom (KP)	-490.9	56.8	29.4	NO	NO	NO	NO	NO	590	2	-25	NO	NO	NO	NO	NO
EU-KP	-2 880.2	260.5	294.7	NO	NO	NO	NO	NO	-4 697	-819	191	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-KP)

The IPCC reference approach for CO_2 from fossil fuels for the EU-KP is based on Eurostat energy data (Eurostat database, February 2019) 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-KP as a whole.

The Eurostat data for the EU-KP 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-KP 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 29 countries, 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-KP2018 inventory submission, and reported in table 1.A(b), corresponds to the sum of its 29 countries.
- 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 2020.
- 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-KP CO_2 emissions calculated with the IPCC reference approach and the sectoral approach (Table 3.136). The percentage differences for both energy consumption and CO_2 emissions are very similar to previous submissions.

Table 3.136 Comparison of reference approach and sectoral approach for EU-KP

[1. Energy][1.AC Comparison of CO2 Emissions from Fuel Combustion]	Unit	1990	2000	2005	2010	2015	2016	2017	2018
Fuel consumption									
Sectoral approach	PJ	51 845	51 111	53 329	49 765	43 529	43 828	44 038	43 125
Apparent energy consumption (excluding non-energy use, reductants and feedstocks)	PJ	51 557	50 517	52 826	49 276	42 948	43 363	43 907	43 086
Energy consumption difference	%	-0,6	-1,2	-0,9	-1,0	-1,3	-1,1	-0,3	-0,1
CO2 emissions									
Reference approach	kt	4 003 357	3 733 745	3 875 048	3 575 476	3 162 677	3 157 484	3 179 655	3 115 265
Sectoral approach	kt	4 093 904	3 836 956	3 966 831	3 659 885	3 239 352	3 221 537	3 226 464	3 146 863
Difference	%	-2,2	-2,7	-2,3	-2,3	-2,4	-2,0	-1,5	-1,0

Table 3.137 provides an overview for EU-KP on differences between the Eurostat and national reference approach for apparent consumption in TJ for 2018. For EU-KP 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)

Clarification of the large difference in total liquid fuels for Estonia is ongoing.

Table 3.137 Comparison between Eurostat and national reference approach for apparent consumption for EU-KP for 2018 (CRF 1.A) [15]

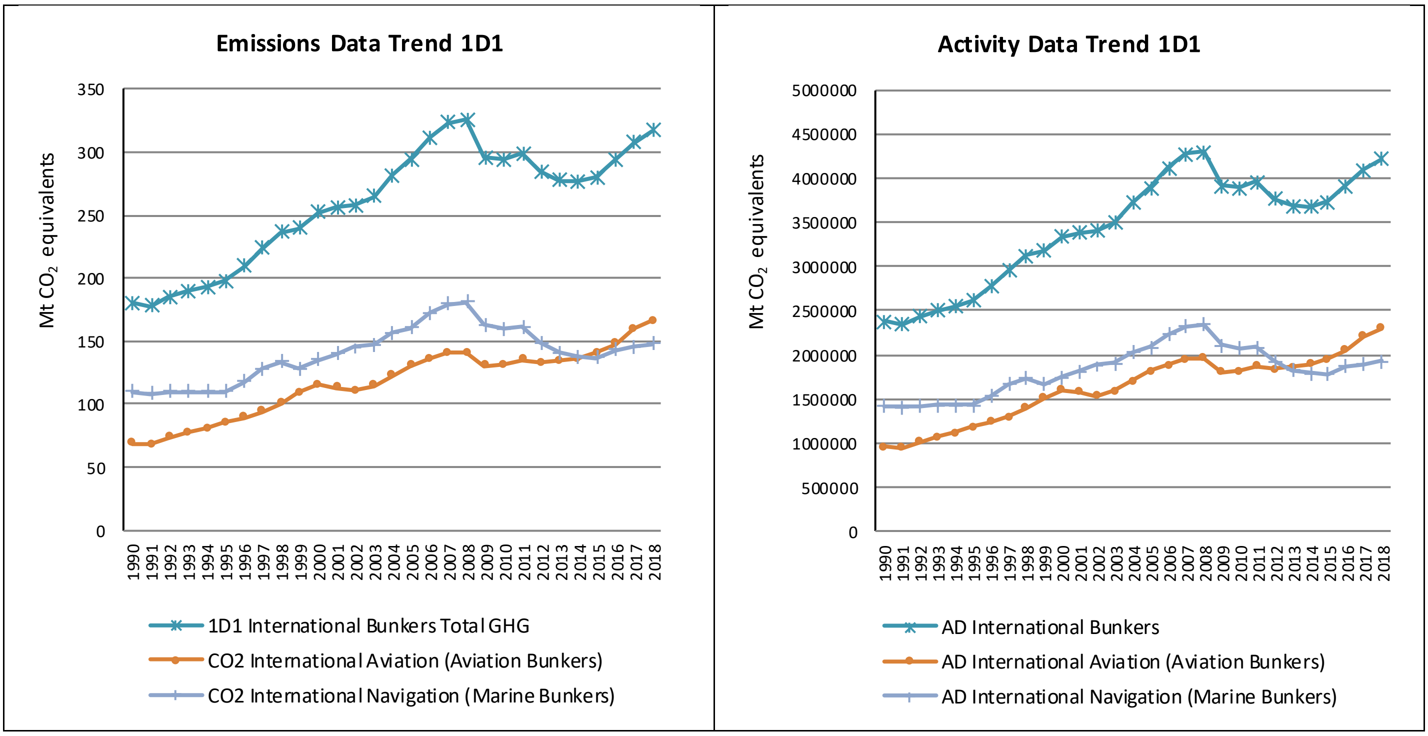
	Total gaseous			Total liquid			Total solid		
	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %
AT	309 600	309 600	0,0%	487 817	497 419	2,0%	114 013	114 980	0,8%
BE	624 160	624 529	0,1%	885 919	885 919	0,0%	128 588	129 678	0,8%
BG	109 365	109 365	0,0%	181 905	182 405	0,3%	226 955	228 042	0,5%
CY	- -	- -	0,0%	84 951	85 799	1,0%	570	582	2,1%
CZ	285 502	286 158	0,2%	392 773	387 662	-1,3%	653 328	652 511	-0,1%
DE	3 079 476	3 078 880	0,0%	4 111 030	4 057 626	-1,3%	2 919 815	2 904 081	-0,5%
DK	111 932	111 932	0,0%	255 673	256 014	0,1%	71 901	65 642	-8,7%
EE	17 317	17 312	0,0%	2 558	48 826	1808,8%	196 016	196 863	0,4%
ES	1 133 874	1 142 693	0,8%	2 208 111	2 131 430	-3,5%	483 925	442 497	-8,6%
FI	90 950	91 118	0,2%	340 561	342 269	0,5%	115 317	111 380	-3,4%
FR	1 537 636	1 539 948	0,2%	2 973 172	2 962 426	-0,4%	378 901	356 827	-5,8%
GR	172 380	172 380	0,0%	425 700	450 653	5,9%	191 088	207 010	8,3%
HR	95 970	95 970	0,0%	132 642	135 853	2,4%	15 339	15 330	-0,1%
HU	346 407	346 407	0,0%	327 130	327 070	0,0%	88 773	88 135	-0,7%
IE	187 887	187 579	-0,2%	263 572	263 202	-0,1%	30 405	30 339	-0,2%
IS	- -	0	0,0%	24 753	24 765	0,0%	4 588	4 446	-3,1%
IT	2 491 707	2 492 003	0,0%	2 131 663	2 230 537	4,6%	357 620	358 350	0,2%
LT	74 345	74 346	0,0%	123 715	124 010	0,2%	7 239	7 238	0,0%
LU	28 622	28 622	0,0%	96 381	96 361	0,0%	1 764	1 763	-0,1%
LV	48 946	49 024	0,2%	59 764	59 775	0,0%	1 894	1 898	0,2%
MT	12 264	12 264	0,0%	12 457	11 929	-4,2%	- -	- -	0,0%
NL	1 286 567	1 286 900	0,0%	1 146 546	1 103 367	-3,8%	343 838	343 800	0,0%
PL	675 084	673 171	-0,3%	1 245 225	1 253 426	0,7%	2 050 145	2 051 515	0,1%
PT	210 281	210 139	-0,1%	369 834	366 820	-0,8%	112 885	112 820	-0,1%
RO	412 105	412 105	0,0%	401 413	399 350	-0,5%	211 306	211 437	0,1%
SE	41 894	44 084	5,2%	417 700	373 489	-10,6%	84 211	79 675	-5,4%
SI	30 342	30 342	0,0%	101 278	101 718	0,4%	47 372	47 262	-0,2%
SK	170 699	171 395	0,4%	156 530	158 057	1,0%	139 798	139 386	-0,3%
UK	2 840 713	2 846 962	0,2%	2 523 897	2 538 420	0,6%	339 643	336 357	-1,0%
EU-KP	16 426 025	16 445 231	0,1%	21 884 671	21 856 596	-0,1%	9 317 235	9 239 841	-0,8%

[15] Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

3.8 International bunker fuels (EU-KP)

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 countries[16]. Between 1990 and 2018, greenhouse gas emissions from international bunker fuels increased by 76 % in the EU-KP. CO_2 emissions from "Marine bunkers" account for 47 % of total greenhouse gas emissions from international bunkers in 2018, CO_2 from "Aviation bunkers" accounts for 52 % (Figure 3.201).

Figure 3.201 1D1 International bunker fuels: GHG emission trend and activity data



3.8.1 Aviation bunkers (EU-KP)

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 4 % of total GHG emissions in 2018 but are not included in the national total of GHG emissions (Table 3.138).

The countries France, Germany, Spain and the United Kingdom contributed more than 60 % to the EU-KP emissions from this source. All countries (expect for Lithuania and Romania) increased emissions from Aviation bunkers between 1990 and 2018.

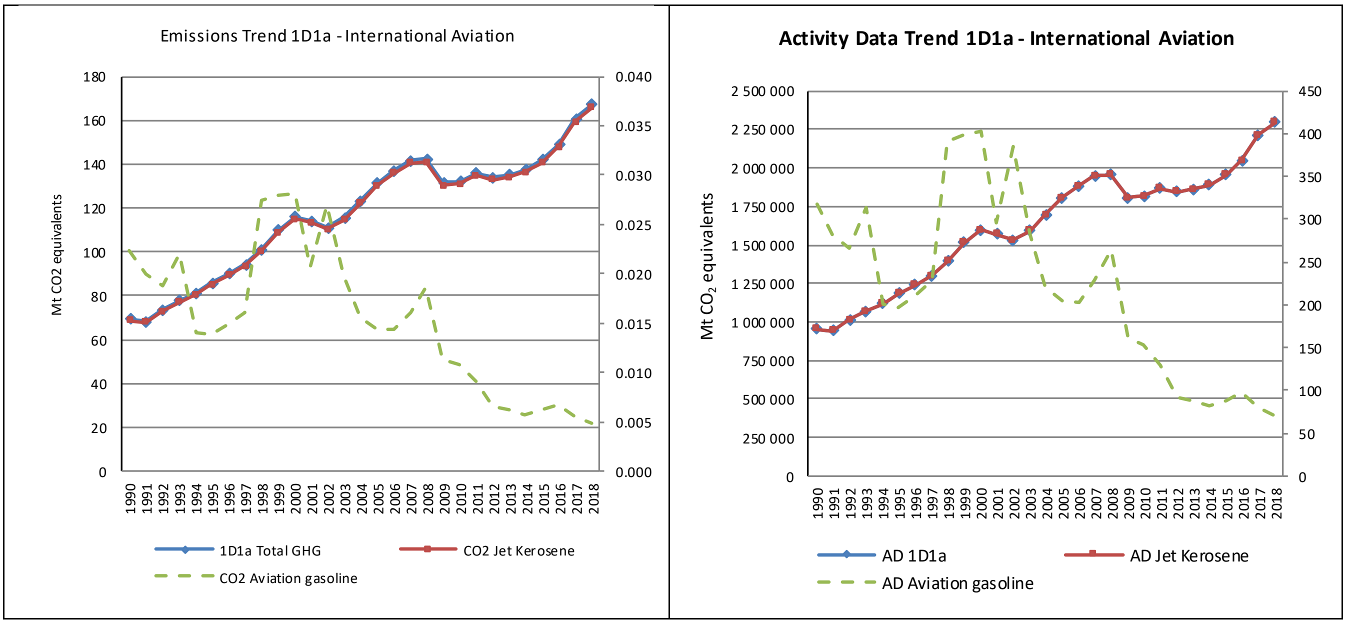
[16] The definitions in Tables 2.8 and 2.9 of the IPCC good practice guidance are based on activities within 'one country". This means domestic aviation is defined for individual countries. The decision tree in Figure 2.8 of the IPCC good practice guidance considers 'national fuel statistics' for domestic 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 countries 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 3.138 1D1a Aviation bunkers: Countries' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	886	2 246	2 530	1.5%	1 644	186%	284	13%
Belgium	3 125	4 799	5 144	3.1%	2 019	65%	345	7%
Bulgaria	713	718	772	0.5%	59	8%	54	8%
Croatia	497	449	560	0.3%	63	13%	111	25%
Cyprus	718	998	1 037	0.6%	319	44%	39	4%
Czechia	524	1 074	1 238	0.7%	714	136%	164	15%
Denmark	1 774	2 906	3 045	1.8%	1 271	72%	140	5%
Estonia	107	179	209	0.1%	102	95%	29	16%
Finland	1 008	2 097	2 388	1.4%	1 381	137%	291	14%
France	8 537	17 249	17 825	10.8%	9 288	109%	576	3%
Germany	12 053	29 192	30 062	18.1%	18 009	149%	870	3%
Greece	2 475	3 435	3 858	2.3%	1 383	56%	424	12%
Hungary	505	680	841	0.5%	336	67%	161	24%
Ireland	1 073	3 038	3 280	2.0%	2 207	206%	242	8%
Italy	4 285	11 166	11 645	7.0%	7 361	172%	479	4%
Latvia	221	426	467	0.3%	246	111%	41	10%
Lithuania	399	318	378	0.2%	-21	-5%	60	19%
Luxembourg	386	1 682	1 801	1.1%	1 415	366%	118	7%
Malta	197	428	472	0.3%	275	139%	44	10%
Netherlands	4 604	12 014	12 158	7.3%	7 554	164%	144	1%
Poland	638	2 495	2 976	1.8%	2 339	367%	482	19%
Portugal	1 533	3 836	4 120	2.5%	2 588	169%	285	7%
Romania	790	1 006	411	0.2%	-379	-48%	-594	-59%
Slovakia	67	165	184	0.1%	117	175%	19	12%
Slovenia	49	74	101	0.1%	53	107%	28	38%
Spain	4 731	16 926	17 806	10.7%	13 075	276%	880	5%
Sweden	1 335	2 753	2 788	1.7%	1 453	109%	35	1%
United Kingdom	15 337	35 872	36 297	21.9%	20 961	137%	425	1%
EU-27+UK	**68 565**	**158 222**	**164 396**	**99%**	**95 831**	**140%**	**6 174**	**4%**
Iceland	219	1 147	1 293	0.8%	1 073	489%	146	13%
United Kingdom (KP)	15 270	35 888	36 318	21.9%	21 047	138%	429	1%
EU-KP	**68 718**	**159 385**	**165 709**	**100%**	**96 990**	**141%**	**6 324**	**4%**

CO_2 emissions from jet kerosene account for 99 % of total emissions from "Aviation bunkers" in 2018 (Figure 3.202). All countries but Lithuania and Romania increased emissions from jet kerosene between 1990 and 2018. Countries with the highest increase between 1990 and 2018 in percent were Luxembourg, Spain and Poland.

Figure 3.202 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 3.203 provides an overview of emissions for EU-KP and the contribution of each country to EU-KP emissions. The United Kingdom, Germany, France and Spain are the countries that contributed most to the EU-KP emissions. Fuel combustion of EU-KP increased by 141 % between 1990 and 2018.

In the IEF is depicted, showing a mean value of around 72 t/TJ for 2018.

Figure 3.203 Aviation bunkers, Jet kerosene: Emission trend and share for CO_2

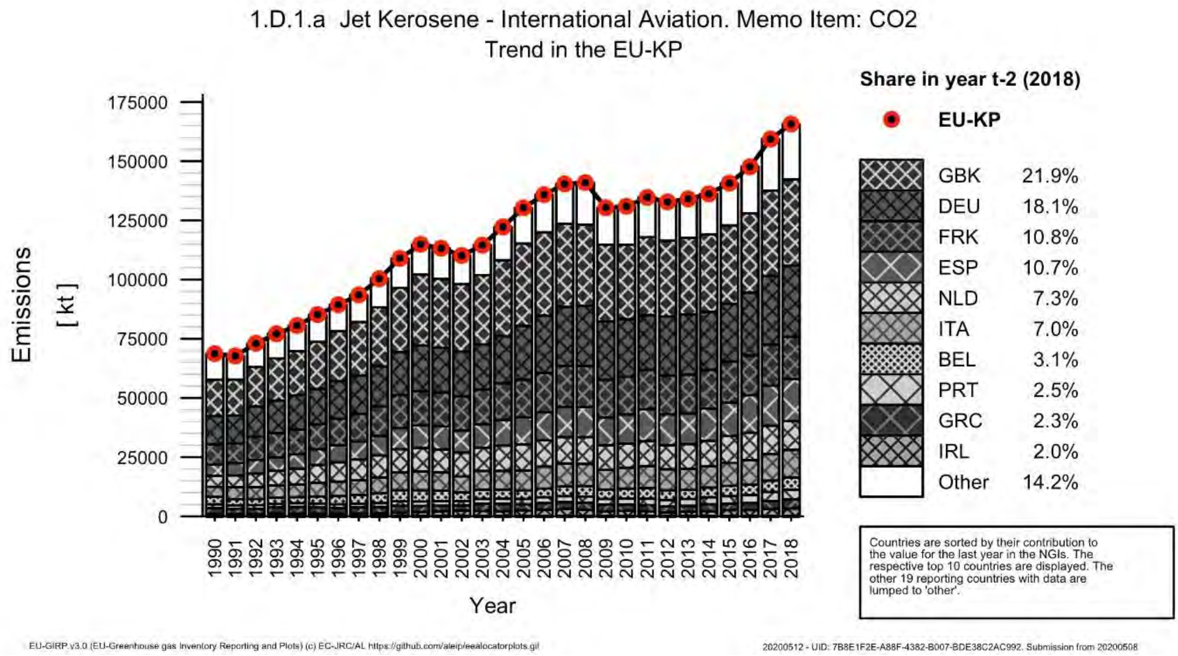
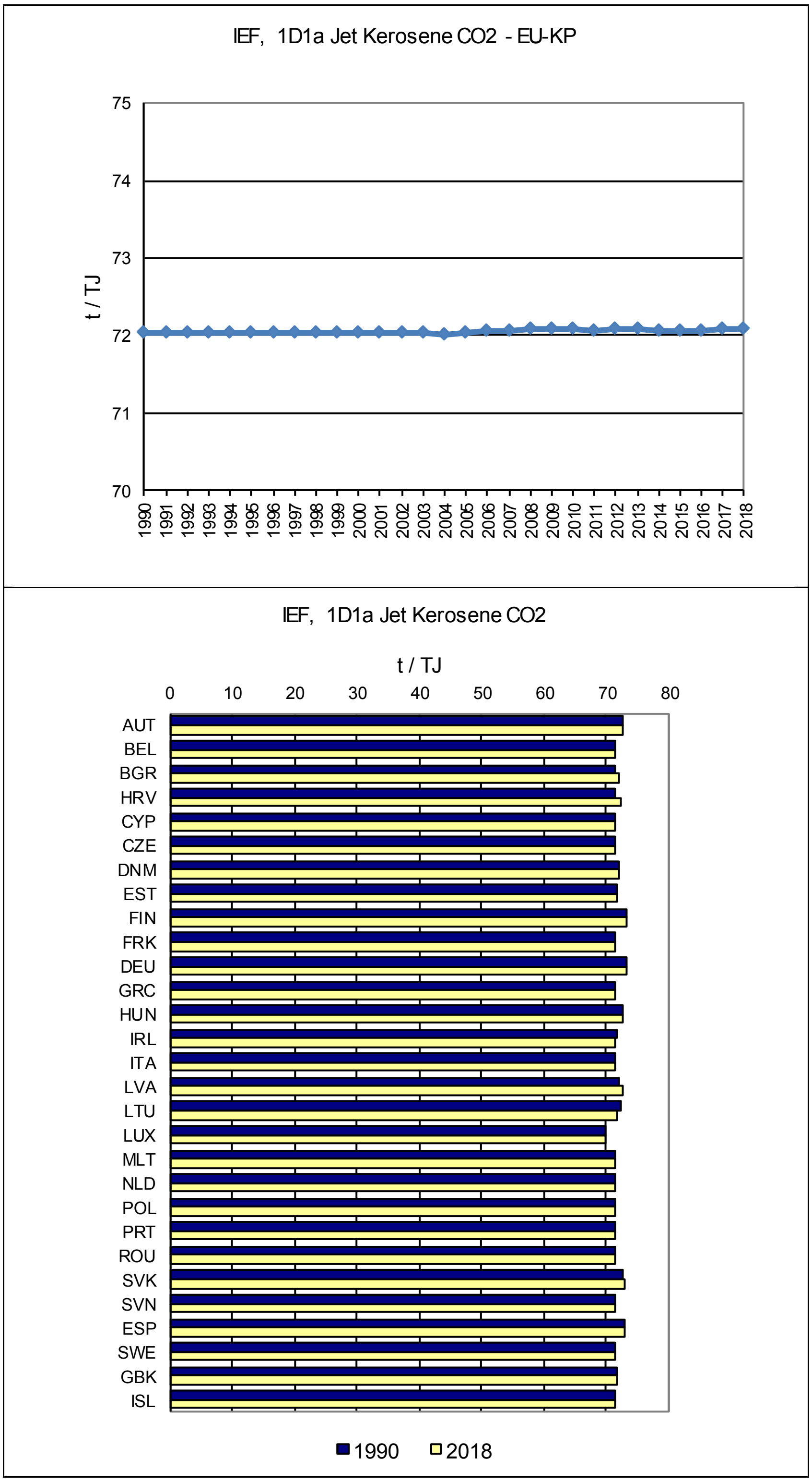


Figure 3.204: *1D1a Aviation bunkers – Jet kerosene: Implied Emission Factors for CO_2 (in t/TJ)*



3.8.2 Marine bunkers (EU-KP)

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 2018 and are also not included in the national total of GHG emissions. Between 1990 and 2018, CO_2 emissions from Marine bunkers increased by 35 % in the EU-KP (Table 3.139).

The Netherlands, Spain and Belgium contributed most to the emissions from this source (59 %) in 2018. Between 1990 and 2018, most countries (17 in total) increased emissions from Marine bunkers. The countries with the highest increase in absolute terms were Belgium, Spain and Malta. 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 3.139 1D1b Marine bunkers: Countries' contributions to CO_2 emissions

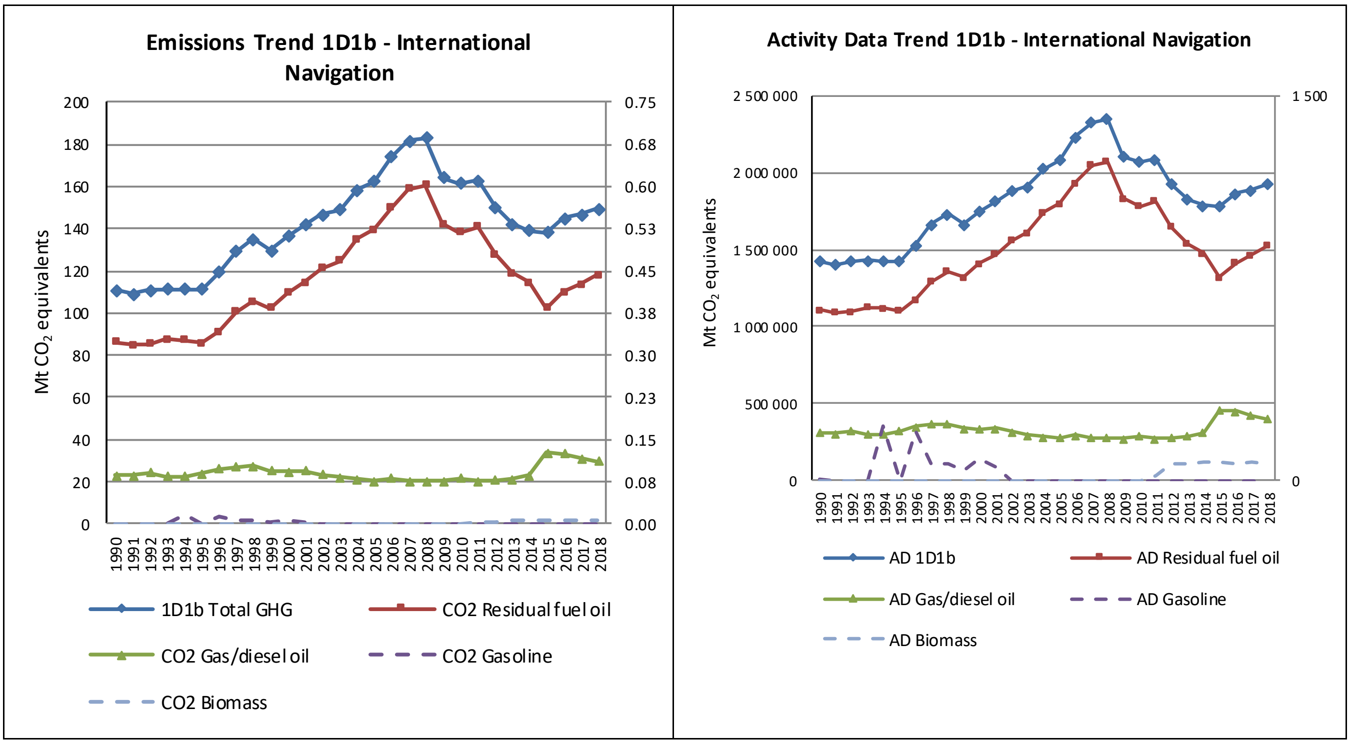
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	49	60	44	0.0%	-5	-11%	-16	-27%
Belgium	13 313	24 435	30 269	20.5%	16 957	127%	5 834	24%
Bulgaria	183	250	257	0.2%	74	41%	7	3%
Croatia	147	20	65	0.0%	-82	-56%	45	224%
Cyprus	183	805	857	0.6%	674	369%	53	7%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	3 012	1 507	1 727	1.2%	-1 285	-43%	220	15%
Estonia	552	984	934	0.6%	381	69%	-50	-5%
Finland	1 832	1 097	1 014	0.7%	-818	-45%	-83	-8%
France	7 968	5 588	6 291	4.3%	-1 677	-21%	703	13%
Germany	6 405	6 449	4 280	2.9%	-2 125	-33%	-2 168	-34%
Greece	8 106	6 967	7 137	4.8%	-969	-12%	170	2%
Hungary	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Ireland	57	480	499	0.3%	443	780%	20	4%
Italy	4 454	7 113	5 859	4.0%	1 405	32%	-1 254	-18%
Latvia	1 515	828	120	0.1%	-1 395	-92%	-708	-86%
Lithuania	302	554	636	0.4%	334	111%	82	15%
Luxembourg	0	0	0	0.0%	0	72%	0	-13%
Malta	895	6 924	7 161	4.8%	6 266	700%	236	3%
Netherlands	34 947	37 288	35 841	24.2%	894	3%	-1 446	-4%
Poland	1 265	836	848	0.6%	-417	-33%	12	1%
Portugal	1 400	2 536	2 657	1.8%	1 257	90%	121	5%
Romania	NO	90	54	0.0%	54	∞	-36	-40%
Slovakia	65	18	11	0.0%	-54	-83%	-8	-41%
Slovenia	NO,NA	500	666	0.5%	666	∞	167	33%
Spain	11 659	21 465	21 395	14.5%	9 737	84%	-70	0%
Sweden	2 340	7 314	8 342	5.6%	6 002	257%	1 027	14%
United Kingdom	8 915	10 833	10 818	7.3%	1 903	21%	-15	0%
EU-27+UK	**109 564**	**144 940**	**147 783**	**100%**	**38 219**	**35%**	**2 842**	**2%**
Iceland	19	212	242	0.2%	222	1152%	29	14%
United Kingdom (KP)	8 886	10 796	10 791	7.3%	1 905	21%	-5	0%
EU-KP	**109 555**	**145 116**	**147 998**	**100%**	**38 443**	**35%**	**2 882**	**2%**

Austria, Croatia, Denmark, Finland, France, Germany, Greece, Latvia, Poland and Slovakia decreased their emissions. Czechia and Hungary reported in 1990 and/or 2018 notation keys. All other countries reported increased emissions from residual oil between 1990 and 2018. Countries with the highest increase in percent were Ireland, Malta and Cyprus.

CO_2 emissions from residual fuel oil account for 79 % of total emissions from "Marine bunkers" in 2018 (Figure 3.205). Between 1990 and 2018, CO_2 emissions from residual fuel oil increased by 37 % in the EU-KP.

CO_2 emissions from gas/diesel oil account for 20 % of total emissions from "Marine bunkers" in 2018. Between 1990 and 2018, CO_2 emissions from gas/diesel oil increased by 28 % in the EU-KP.

Figure 3.205 1D1b Marine bunkers: Trend of CO_2 Emissions and Activity Data



Data displayed as dashed line refers to the secondary axis.

Table 3.138 and Table 3.139 provide an overview of emissions for residual oil and gas/diesel oil for EU-KP and those countries contributing most to EU-KP emissions.

Figure 3.206 Marine bunkers, residual fuel oil: Emission trend and share for CO_2

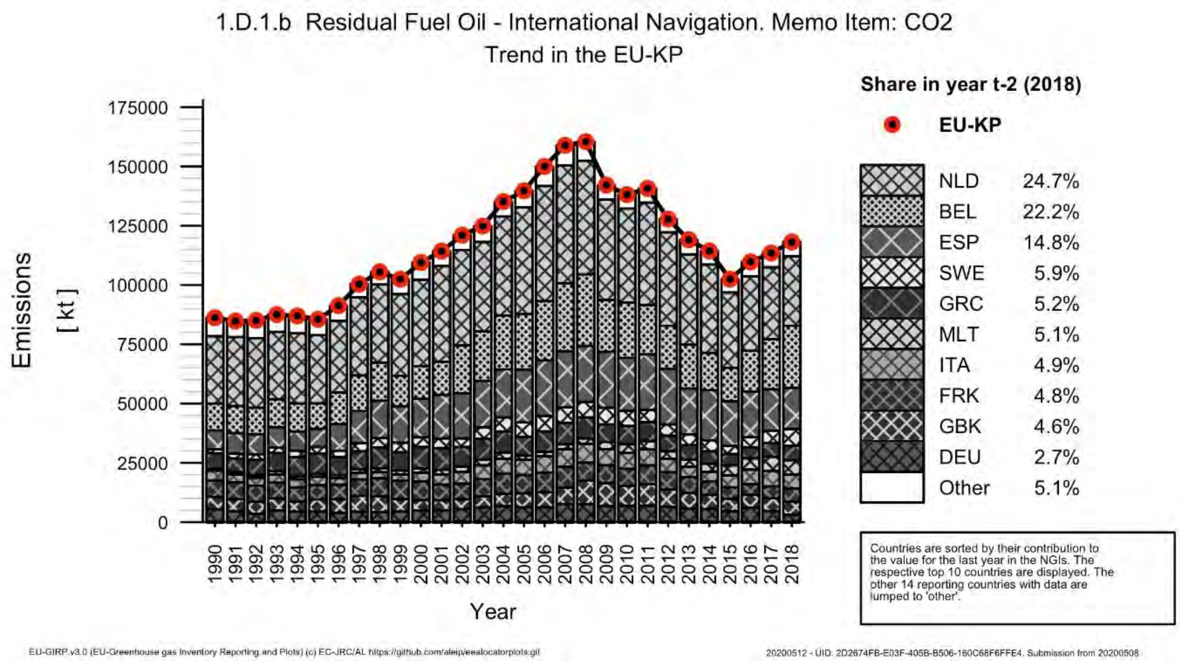
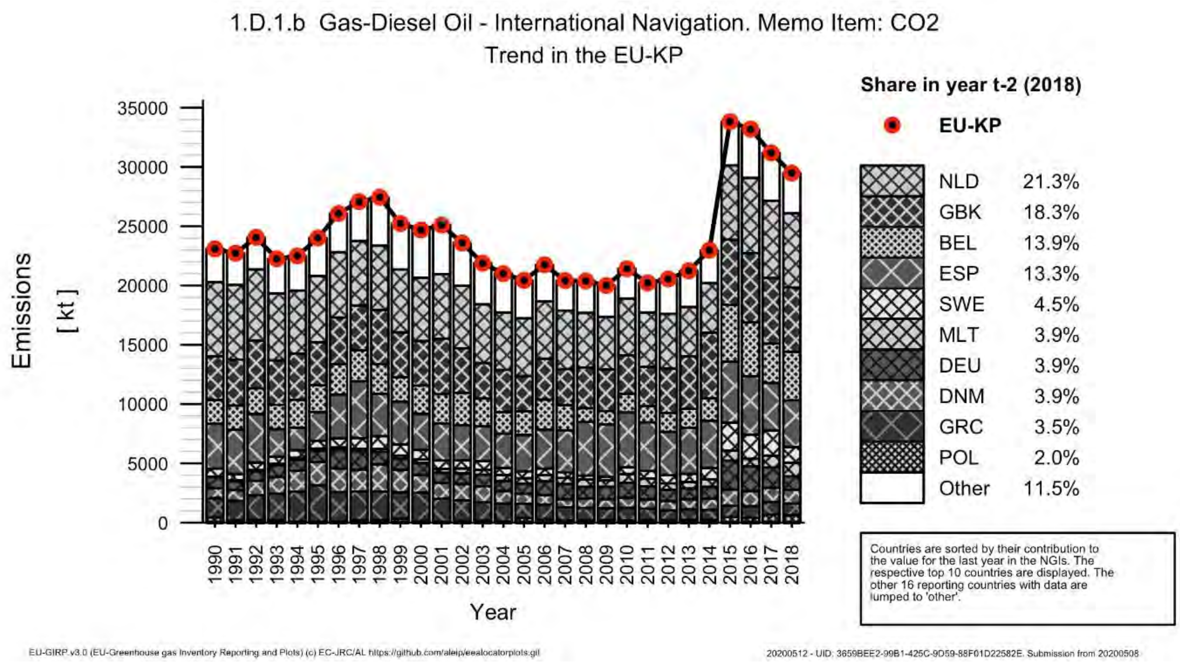


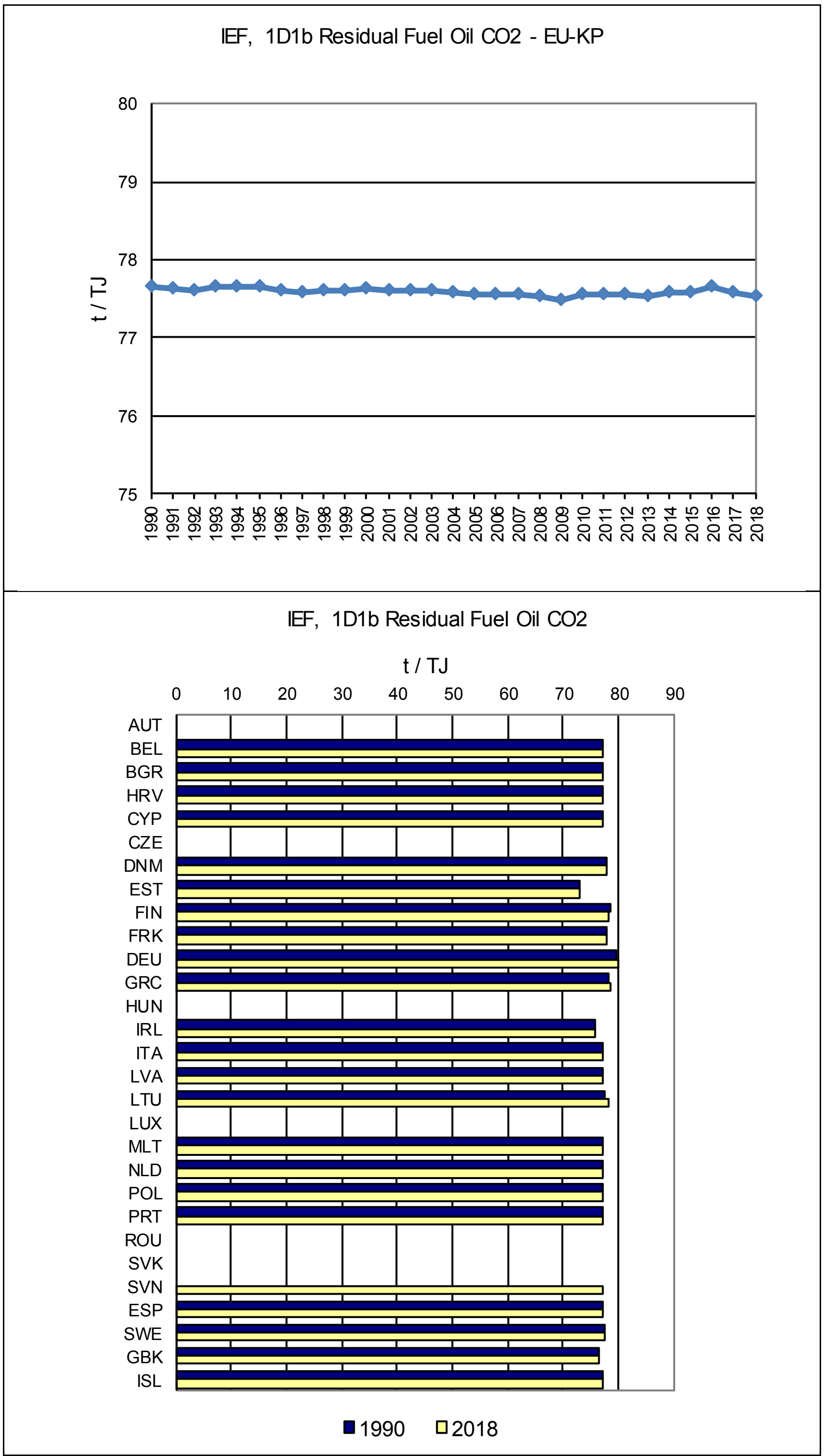
Figure 3.207 Marine bunkers, gas/diesel oil: Emission trend and share for CO_2



3.8.2.1 **Marine Bunkers – Residual Oil (CO_2)**

Combustion of residual oil in the EU-KP increased by 37 % between 1990 and 2018. In *Figure 3.208* the IEF is depicted, with a mean value of 77.6 t/TJ.

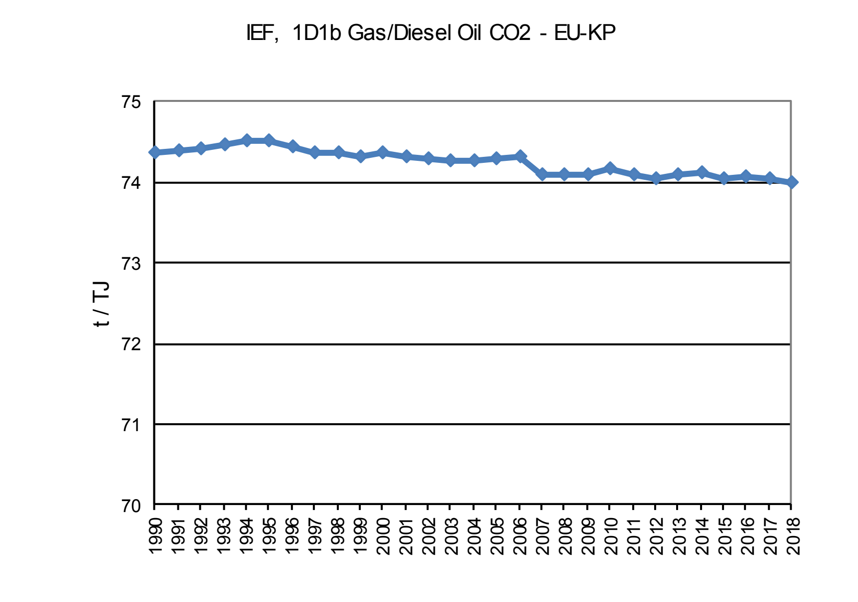
Figure 3.208 *1D1b Marine bunkers – Residual Oil: Implied Emission Factors for CO_2 (in t/TJ)*

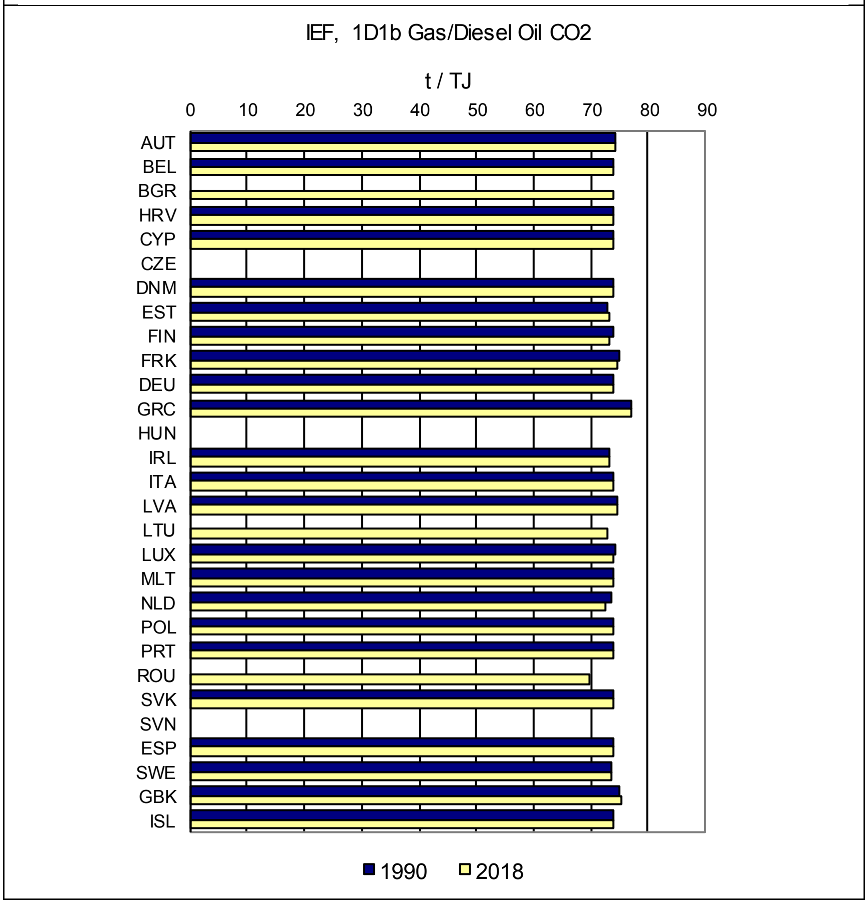


3.8.2.2 **Marine Bunkers – Gas/Diesel Oil (CO_2)**

Combustion of gas/diesel oil in the EU-KP increased by 28 % between 1990 and 2018. In *Figure 3.209* the IEF is depicted, with a mean value of 74.4 t/TJ.

Figure 3.209: 1D1b Marine bunkers – Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)





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 **3.140** shows the fuels that were used for the purpose of non-energy use in the EU-KP in 2018. It shows that 72 % 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 accounts for 13 % of non-energy use of fuels and is mainly used for feedstock in ammonia production. Coke oven / gas coke accounts for 9 % of NEU of fuels and is mainly used as reductant in the metal industry.

Table 3.140 Fuel quantity for non-energy use in TJ and % for the EU-KP

Fuel			TJ	%
Liquid fossil	Primary fuels	Crude oil	860	0%
		Natural gas liquids	72 600	1%
		Gasoline	103 111	2%
		Jet kerosene	1	0%
		Other kerosene	2 025	0%
		Gas/diesel oil	122 532	2%
		Residual fuel oil	80 719	2%
		Liquefied petroleum gases (LPG)	572 730	11%
		Ethane	52 525	1%
		Naphtha	1 547 215	30%
		Bitumen	627 930	12%
		Lubricants	201 235	4%
		Petroleum coke	60 963	1%
		Refinery feedstocks	12 690	0%
		Other oil	255 100	5%
Other liquid fossil			5 267	0%
Liquid fossil totals			**3 717 502**	**72%**
Solid fossil	Primary fuels	Anthracite	34 555	1%
		Coking coal	134 763	3%
		Other bituminous coal	90 639	2%
		Sub-bituminous coal	8 325	
		Lignite	375	0%
		Oil shale and tar sand	7 972	0%
		Coke oven/gas coke	460 725	9%
		Coal tar	27 002	1%
Solid fossil totals			**764 356**	**15%**
Gaseous fossil		Natural gas (dry)	692 668	13%
Gaseous fossil totals			**692 668**	**13%**
Waste (non-biomass fraction)			219	0%
Total			**5 174 526**	**100%**

Table **3.141**shows the associated CO_2 emissions from the NEU reported in the inventory for the year 2018. It shows that 44% of the CO_2 emissions stem from solid fuels, 26% from liquid fuels and 30 % from natural gas. It has to be noted that the reporting in CRF table 1A(d) is still not fully coherent and work is ongoing between the EU and its Member States in order to improve the reporting in this table.

Table 3.141 CO_2 emissions from the NEU reported in the inventory kt CO_2 and % for the EU-KP

Fuel			kt	%
Liquid fossil	Primary fuels	Crude oil	16	0%
		Other kerosene	0,2	0%
		Gas/diesel oil	2	0%
		Residual fuel oil	139	0%
		Liquefied petroleum gases (LPG)	3 356	3%
		Naphtha	12 616	12%
		Bitumen	3 589	3%
		Lubricants	2 797	3%
		Petroleum coke	3 733	3%
		Other oil	1 813	2%
Other liquid fossil			123	0%
Liquid fossil totals			28 183	**26%**
Solid fossil	Primary fuels	Anthracite	3 514	3%
		Coking coal	12 219	11%
		Other bituminous coal	8 138	8%
		Sub-bituminous Coal	779	
		Lignite	9	0%
		Coke oven/gas coke	23 014	21%
		Coal tar	98	0%
Solid fossil totals			**47 771**	**44%**
Gaseous fossil		Natural gas (dry)	32 003	30%
Gaseous fossil totals			**32 003**	**30%**
Waste (non-biomass fraction)			37	0%
Total			**107 957**	**100%**

Table **3.142** shows the recalculations of non-energy use of fuels for the year 2017. A major recalculation can be seen for non-energy use of solid fuels which needs to be further analysed. Across all fuels recalculations were at 2%. Most recalculations at fuel level were due to revisions in the energy balance.

Table 3.142 Recalculations of fuel quantity for non-energy use of fuels for the inventory year 2017

FUEL+A6:G38 TYPE			ACTIVITY DATA AND RELATED INFORMATION			
			Fuel quantity for NEU (TJ)		Difference in TJ	Difference in %
			2019	2020		
Liquid fossil fossil	Primary fuels	Crude oil	932	932	0	0%
		Orimulsion	IE,NO	IE,NO	0	-
		Natural gas liquids	90 100	90 100	0	0%
	Secondary fuels	Gasoline	300	300	0	-
		Jet kerosene	1	1	0	-
		Other kerosene	2 327	2 327	0	0%
		Shale oil	NO	NO	0	-
		Gas/diesel oil	140 253	140 340	87	0%
		Residual fuel oil	84 670	84 670	0	0%
		Liquefied petroleum gases (LPG)	522 887	548 007	25 119	5%
		Ethane	59 813	59 890	77	0%
		Naphtha	1 760 410	1 776 683	16 272	1%
		Bitumen	578 327	602 857	24 530	4%
		Lubricants	217 823	204 000	-13 823	-6%
		Petroleum coke	70 625	62 392	-8 234	-12%
		Refinery feedstocks	13 014	13 014	0	0%
		Other oil	298 943	285 379	-13 563	-5%
Other liquid fossil			4 800	4 798	-2	0%
Liquid fossil totals			**3 845 225**	**3 875 687**	**30 463**	**1%**
Solid fossil	Primary fuels	Anthracite	47 727	33 794	-13 933	-29%
		Coking coal	137 644	145 014	7 370	5%
		Other bituminous coal	99 059	94 819	-4 240	-4%
		Sub-bituminous Coal	IE,NO	7 592	7 592	-
		Lignite	378	378	0	0%
		Oil shale and tar sand	5 595	7 769	2 174	39%
	Secondary fuels	BKB and patent fuel	NA,NO	NA,NO	0	-
		Coke oven/gas coke	407 594	466 314	58 720	14%
		Coal tar(7)	26 699	26 699	0	0%
Other solid fossil					0	-
		Other			0	-
Solid fossil totals			**724 696**	**782 379**	**57 683**	**8%**
Gaseous fossil		Natural gas (dry)	729 423	727 631	-1 792	0%
Other gaseous fossil			NA,NO	NA,NO	0	-
Gaseous fossil totals			**729 423**	**727 631**	**-1 792**	**0%**
Waste (non-biomass fraction)			482	482	0	0%
Other fossil fuels			NA,NO	NA,NO	0	-
Other fossil fuels totals			NA,NO	NA,NO	0	-
Total fossil fuels			**5 299 343**	**5 385 697**	**86 354**	**2%**

Table 3.143 provides information on feedstocks and non-energy use of fuels from Member States' NIRs.

Table 3.143 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

<table>
<tr><td>Greece</td><td>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.</td><td>National Inventory Report, Chapter 3.2.3</td></tr>
<tr><td>Hungary</td><td>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.</td><td>National Inventory Report, Chapter 3.2.3</td></tr>
<tr><td>Ireland</td><td>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).</td><td>National Inventory Report, Chapter 3.2.3</td></tr>
</table>

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 Union 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-KP GHG (without LULUCF) emissions in 2018. The most important GHGs from this sector are CO_2 (6 % of total GHG emissions), HFCs (2 %) and N_2O (0.3 %). 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 28 % from 516 Mt in 1990 to 374 Mt in 2018 (Figure 4.1). In 2018, the emissions decreased by 2 % compared to 2018. 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.4 Aerosols/ Metered Dose Inhalers (HFCs)

Figure 4.1: CRF Sector 2 Industrial Processes and Product Use: EU-KP GHG emissions for 1990–2018 in CO_2 equivalents (Mt)

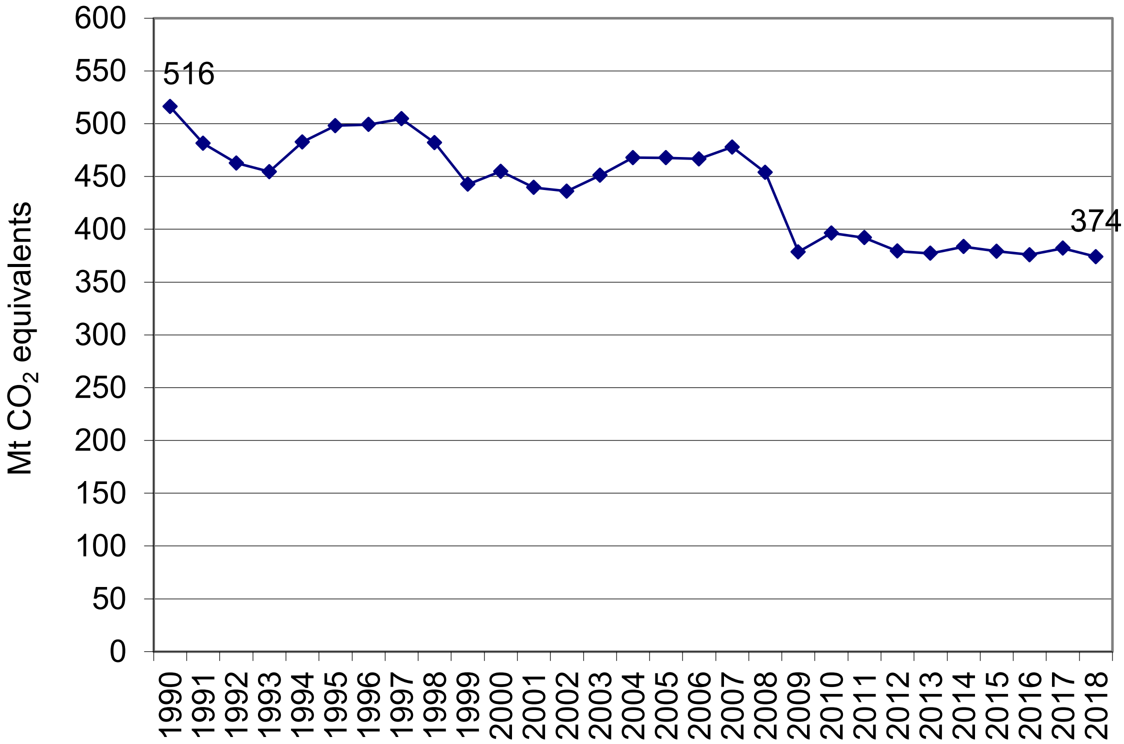
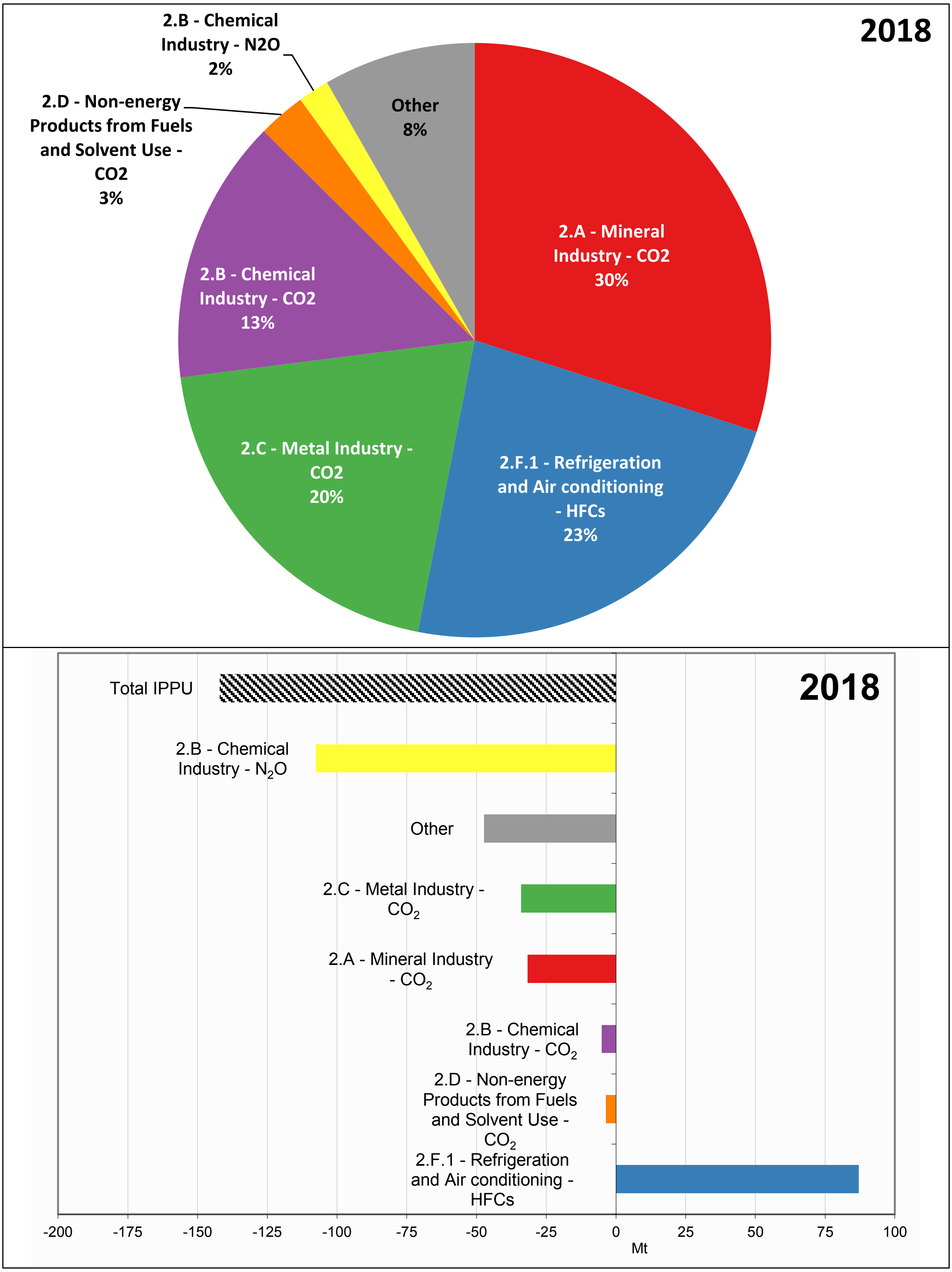


Figure 4.2: CRF Sector 2 Industrial processes and Product Use: Share of largest key categories in 2018 and absolute change of GHG emissions by large key categories 1990–2018 in CO_2 equivalents (Mt)



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

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 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
2.A.1 Cement Production (CO_2)	102729	77970	T	L	L	100%
2.A.2 Lime Production (CO_2)	25241	19641	0	L	L	99.97%
2.A.4 Other Process Uses of Carbonates (CO_2)	11824	10200	0	L	L	99.87%

This sector is dominated by cement production which contributes nearly 70% of mineral industry 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 approx. 18% of the sector where CO_2 is 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 9% of the sector and is composed of several sources with independent estimation methods. The remaining 4% of emissions is from 2A3 Glass production. The share of higher tiers used is complete or almost complete for each of the three key categories.

While mineral sector emissions decreased after the 2009 economic crisis they increased again between 2013 and 2014 and from 2016 to 2018. Nevertheless, mineral industry emissions have fallen by 23% since 1990. (Figure **4.3**). Eight countries (Cyprus, Croatia, Denmark, Ireland, Latvia, Netherlands, Poland and Sweden), have higher Mineral industry CO_2 emissions in 2018 compared to 1990 (Table 4.2).

Figure 4.3 2A Mineral industry CO_2 emissions

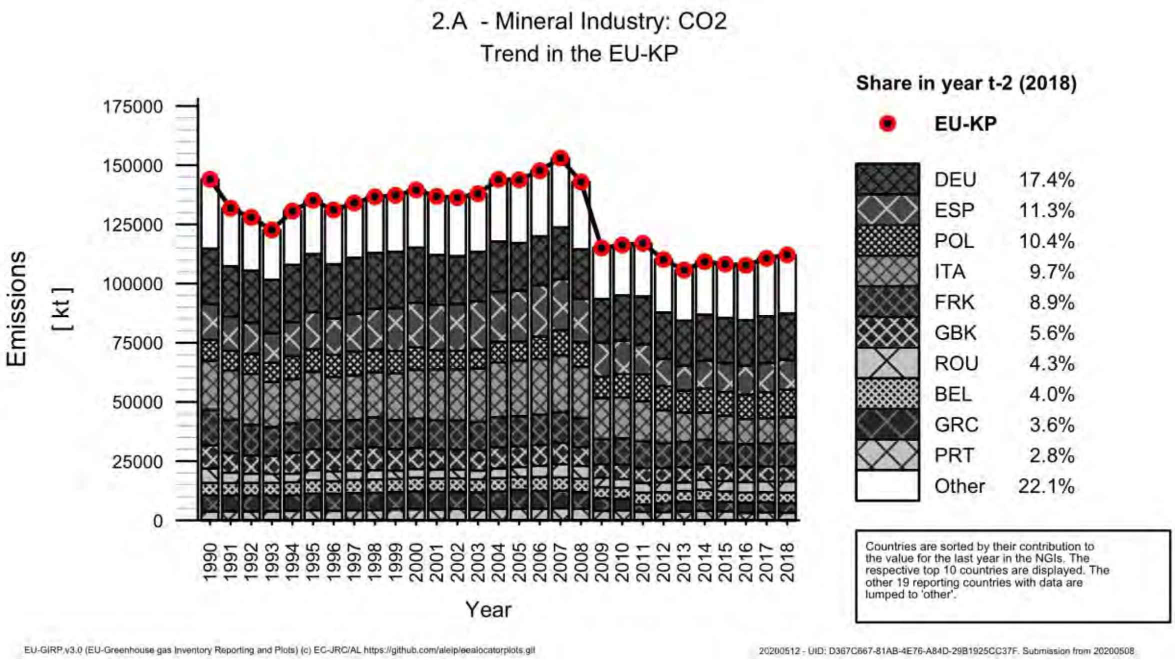


Table 4.2 2A Mineral industry: Member States total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)
Austria	3 092	2 908	3 092	2 908
Belgium	5 319	4 451	5 319	4 451
Bulgaria	3 278	2 479	3 278	2 479
Croatia	1 307	1 365	1 307	1 365
Cyprus	717	863	717	863
Czechia	4 082	3 078	4 082	3 078
Denmark	1 082	1 298	1 082	1 298
Estonia	614	363	614	363
Finland	1 218	1 061	1 218	1 061
France	14 972	9 939	14 972	9 939
Germany	23 522	19 562	23 522	19 562
Greece	6 775	4 008	6 775	4 008
Hungary	2 890	1 362	2 890	1 362
Ireland	1 117	2 095	1 117	2 095
Italy	20 720	10 900	20 720	10 900
Latvia	537	562	537	562
Lithuania	2 130	539	2 130	539
Luxembourg	623	434	623	434
Malta	1	0	1	0
Netherlands	1 411	1 495	1 411	1 495
Poland	8 855	11 651	8 855	11 651
Portugal	3 696	3 171	3 696	3 171
Romania	6 083	4 776	6 083	4 776
Slovakia	2 714	2 280	2 714	2 280
Slovenia	694	541	694	541
Spain	15 119	12 657	15 119	12 657
Sweden	1 672	2 030	1 672	2 030
United Kingdom	9 760	6 279	9 760	6 279
EU-27+UK	**144 003**	**112 148**	**144 003**	**112 148**
Iceland	52	1	52	1
United Kingdom (KP)	9 760	6 279	9 760	6 279
EU-KP	**144 056**	**112 148**	**144 056**	**112 148**

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 countries' contribution to EU-KP recalculations in CO_2 from 2A Mineral industry for 1990 and 2017 as well as the explanations for recalculations provided by the countries.

Table 4.3 2A Mineral industry: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	42	1.3	2	0.1	Revised EF, CKD correction factor has been revised for the period 1988-2008 due to ERT recommendation. Recalculations have been performed based on provided data for CaO and MgO for the years 2016 and 2017.
Croatia	-4	-0.3	-6	-0.4	Revised activity data from ceramics industry were used in emission calculation.
Cyprus	-	-	-	-	
Czechia	-	-	0	0.0	Activity data were updated in category 2.A.4.d.
Denmark	-0	-0.0	1	0.1	Inclusion of data from one flue gas desulphurisation plant in 2017 that were missing in the previous submission. In addition, CO_2 emissions from production of expanded clay products from one company were recalculated for the entire time series based on collaboration with the company.
Estonia	-	-	-	-	
Finland	-	-	-0	-0.0	Activity data of soda ash use were corrected.
France	-0	-0.0	248	2.7	2A2 Lime production: Recalculation of national lime production in 2017, resulting in a change in the ratio of CO_2 emissions via declared bypass dust / national production, used to calculate CO_2 emissions via bypass dust. Recalculation of quicklime, slaked lime and magnesium lime in 2017 impacting emissions.
Germany	0	0.0	-439	-2.2	Correction of activity data in the lime industry, extrapolation 2013 to 2017 (2.A.2).
Greece	-	-	11	0.3	Update of activity data in 2.A.2 lime production.
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-13	-0.6	-1	-0.2	Recalculation in lime production due to correction of the emission factor for high-calcium lime production and change of default correction factor for hydrated lime to national correction factor.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-	-	20	0.2	Activity data correction on glass production (2.A.3)
Portugal	11	0.3	2	0.1	Update of activity data under 2.A.4.a.
Romania	-	-	-0	-0.0	Under 2.A.1, correction of an error in the CaO and MgO contents reported by one clinker plant for 2017; under 2.A.4.b, update of activity data reported by one operator; under 2.A.4.d, update of activity data from two flue gas desulphurisation installations.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	0	0.0	-2	-0.0	Correction of a mistake in the activity data from two dolomite production plants.

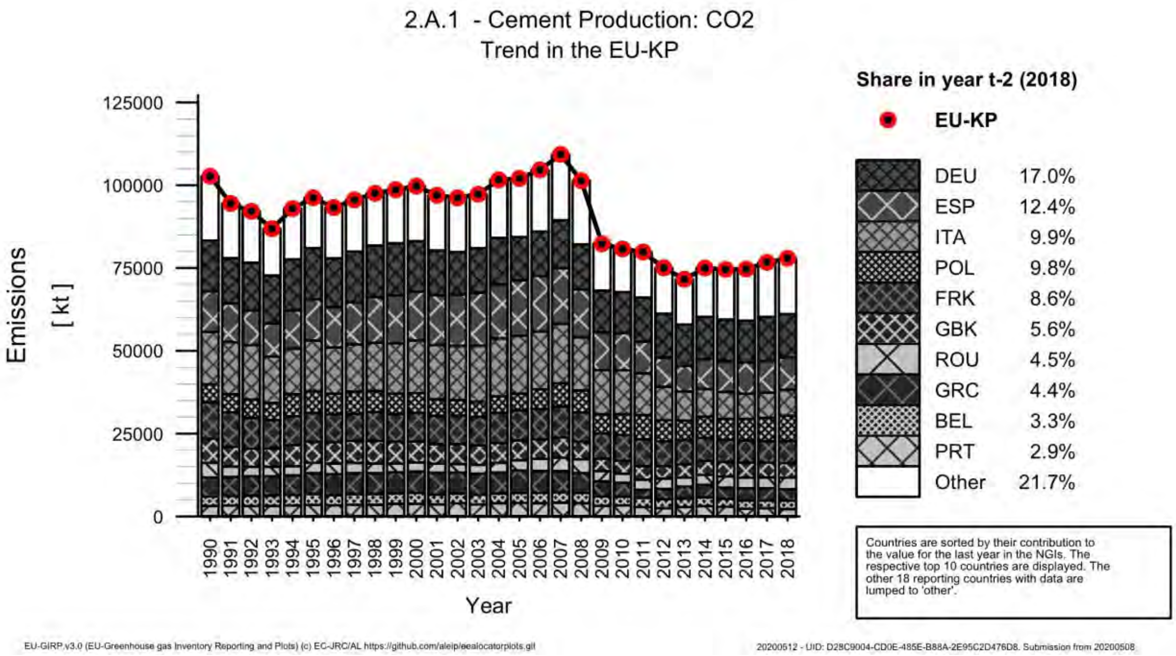
	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Sweden	0	0.0	0	0.0	Correction of activity data under 2.A.4.b; addition of a facility producing carbonate products under 2.A.4.d.
United Kingdom	-44	-0.4	37	0.6	Correction to methodology for early time series for lime production (2A2)
EU27+UK	**-8**	**-0.0**	**-127**	**-0.1**	
Iceland	-0	-0.0	0	0.0	Minimal change related to rounding (<0.0001 t)
United Kingdom (KP)					NA
EU-KP	**36**	**0.0**	**-164**	**-0.2**	

(*) 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 1.9% of total EU-KP (without LULUCF) emissions in 2018 and were 24% below 1990 levels. This source is a key category of CO_2 emissions in terms of emissions level.

Figure 4.4 2A1 Cement production: EU-KP CO_2 emissions



Germany, Spain and Italy were the largest emitters accounting for respectively 17.0%, 12.4% and 9.9% of cement related emissions. (Figure 4.4 and Table 4.4). Cement production saw 1.6% increase in overall emissions in 2018 compared to 2017. The number of countries with increases outweighed the number of countries with decreases. The three countries with the largest absolute growth (2017-2018) were Poland, Belgium and Spain. The three countries with the largest absolute reductions were Portugal, Greece and Germany.

Table 4.4 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	2 033	1 710	1 827	2.3%	-207	-10%	116	7%	T3	PS
Belgium	2 824	2 291	2 534	3.3%	-289	-10%	243	11%	T3	PS
Bulgaria	2 142	1 239	1 224	1.6%	-919	-43%	-16	-1%	T2	PS
Croatia	1 093	1 287	1 211	1.6%	117	11%	-77	-6%	T2,T3	PS
Cyprus	668	919	843	1.1%	176	26%	-76	-8%	CS	CS
Czechia	2 489	1 728	1 868	2.4%	-622	-25%	139	8%	T3	PS
Denmark	882	1 194	1 160	1.5%	277	31%	-34	-3%	T3	PS
Estonia	483	307	298	0.4%	-185	-38%	-9	-3%	T2	PS
Finland	729	604	602	0.8%	-127	-17%	-2	0%	T3	PS
France	10 937	6 483	6 701	8.6%	-4 236	-39%	218	3%	T2,T3	CS,PS
Germany	15 297	13 408	13 228	17.0%	-2 069	-14%	-180	-1%	T2	CS
Greece	5 762	3 685	3 419	4.4%	-2 342	-41%	-266	-7%	CS	PS
Hungary	1 751	783	882	1.1%	-869	-50%	99	13%	T3	PS
Ireland	884	1 840	1 916	2.5%	1 032	117%	76	4%	T3	PS
Italy	15 846	7 711	7 757	9.9%	-8 089	-51%	45	1%	T2	CS,PS
Latvia	346	437	551	0.7%	206	59%	114	26%	T2	PS
Lithuania	1 668	450	511	0.7%	-1 157	-69%	61	14%	T2	PS
Luxembourg	570	373	372	0.5%	-198	-35%	-1	0%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	298	220	0.3%	-195	-47%	-78	-26%	CS	PS
Poland	5 453	6 996	7 655	9.8%	2 202	40%	659	9%	T2	CS
Portugal	3 176	2 531	2 251	2.9%	-926	-29%	-280	-11%	T3	OTH
Romania	4 445	3 310	3 505	4.5%	-940	-21%	195	6%	CS,T2	PS
Slovakia	1 464	1 367	1 347	1.7%	-118	-8%	-20	-1%	T2	PS
Slovenia	470	410	450	0.6%	-20	-4%	40	10%	T2	CS
Spain	12 279	9 449	9 667	12.4%	-2 612	-21%	219	2%	T2	CS
Sweden	1 272	1 484	1 607	2.1%	335	26%	123	8%	T3	PS
United Kingdom	7 295	4 410	4 364	5.6%	-2 931	-40%	-46	-1%	T3	CS
EU-27+UK	**102 677**	**76 706**	**77 970**	**100%**	**-24 708**	**-24%**	**1 264**	**2%**	**-**	**-**
Iceland	52	NO	NO	-	-52	-100%	-	-	NA	NA
United Kingdom (KP)	7 295	4 410	4 364	5.6%	-2 931	-40%	-46	-1%	T3	CS
EU-KP	**102 729**	**76 706**	**77 970**	**100%**	**-24 759**	**-24%**	**1 264**	**2%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece uses a country-specific method and reports "CS" accordingly. Following a recommendation by the expert review team, the following supplementary information is provided: The level of complexity of the method applied by Greece is Tier 3 (T3).

Table 4.5 shows information on methods, activity data, and emission factors for CO_2 emissions from 2A1 Cement production for 1990 and 2018. All cement production emissions are estimated with higher Tier methods and most countries use plant-specific emission factors.

The implied emission factors per tonne of clinker produced in 2018 range from 0.50 t CO_2/t of clinker produced for Slovakia and Luxembourg to 0.59 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 2018 the EU-KP 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 Activity Data Description	1990 Activity Data (kt)	1990 Implied Emission Factor (t/t)	1990 CO2 Emission (kt)	2018 Activity Data Description	2018 Activity Data (kt)	2018 Implied Emission Factor (t/t)	2018 CO2 Emission (kt)	Method	Emission Factor Information
Austria	Clinker production	3 694	0.55	2 033	Clinker production	3 552	0.51	1 827	T3	PS
Belgium	Clinker production	5 292	0.53	2 824	Clinker production	4 605	0.55	2 534	T3	PS
Bulgaria	Clinker production	3 987	0.54	2 142	Clinker production	2 297	0.53	1 224	T2	PS
Croatia	Clinker production	2 062	0.53	1 093	Clinker production	2 326	0.52	1 211	T2,T3	PS
Cyprus	Clinker production	1 249	0.53	668	Clinker production	1 593	0.53	843	CS	CS
Czech Republic	Clinker production	4 726	0.53	2 489	Clinker production	3 514	0.53	1 868	T3	PS
Denmark	Clinker production	1 406	0.63	882	Clinker production	2 141	0.54	1 160	T3	PS
Estonia	Clinker production	790	0.61	483	Clinker production	505	0.59	298	T2	PS
Finland	Clinker production	1 470	0.50	729	Clinker production	1 187	0.51	602	T3	PS
France	Clinker production	20 854	0.52	10 937	Clinker production	12 845	0.52	6 701	T2,T3	CS,PS
Germany	Clinker production	28 863	0.53	15 297	Clinker production	24 958	0.53	13 228	T2	CS
Greece	Clinker production	10 645	0.54	5 762	Clinker production	6 548	0.52	3 419	CS	PS
Hungary	Clinker production	3 210	0.55	1 751	Clinker production	C	C	882	T3	PS
Ireland	Clinker production	1 610	0.55	884	Clinker production	3 513	0.55	1 916	T3	PS
Italy	Clinker production	29 786	0.53	15 846	Clinker production	14 820	0.52	7 757	T2	CS,PS
Latvia	Clinker production	669	0.52	346	Clinker production	1 074	0.51	551	T2	PS
Lithuania	Clinker production	3 058	0.55	1 668	Clinker production	952	0.54	511	T2	PS
Luxembourg	Clinker production	1 048	0.54	570	Clinker production	747	0.50	372	T2	CS,PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	Clinker production	770	0.54	416	Clinker production	433	0.51	220	CS	PS
Poland	Clinker production	10 309	0.53	5 453	Clinker production	14 221	0.54	7 655	T2	CS
Portugal	Clinker production	6 128	0.52	3 176	Clinker production	4 294	0.52	2 251	T3	OTH
Romania	Clinker production	8 379	0.53	4 445	Clinker production	6 696	0.52	3 505	CS,T2	PS
Slovakia	Clinker production	2 836	0.52	1 464	Clinker production	2 696	0.50	1 347	T2	PS
Slovenia	Clinker production	891	0.53	470	Clinker production	873	0.52	450	T2	CS
Spain	Clinker production	23 212	0.53	12 279	Clinker production	18 460	0.52	9 667	T2	CS
Sweden	Clinker production	2 348	0.54	1 272	Clinker production	2 958	0.54	1 607	T3	PS
United Kingdom	Clinker production	13 199	0.55	7 295	Clinker production	7 734	0.56	4 364	T3	CS
EU-27+UK		**NE**	**NE**	**102 677**	-	**147 208**	**0.53**	**77 970**	-	-
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	7 734	0.56	4 364	T3	CS
EU-KP		**NE**	**NE**	**102 729**	-	**147 208**	**0.53**	**77 970**	-	-

Abbreviations are explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Some countries report activity data and IEF as confidential for this category. Values for the EU-27+UK and EU-KP have therefore been gap filled for 2018.

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for 0.5% of total EU-KP (without LULUCF) emissions in 2018. Between 1990 and 2018, CO_2 emissions from this source decreased by 22%.

Lime production CO_2 emissions saw a 1.2% increase in overall emissions in 2018 compared to 2017. The number of countries with increases outweighed the number of countries with decreases. The largest increases were 127kt in France and 62kt in Portugal. The largest decreases occurred in Finland and Sweden (Table 4.6).

Emissions from lime production have been fairly stable since the recovery from the 2009 economic crisis. Germany, France and Italy are the largest emitters contributing approx. 24.6%, 11.7% and 9.5% of the total respectively (Figure 4.5).

Figure 4.5 2A2 Lime production: EU-KP CO_2 emissions

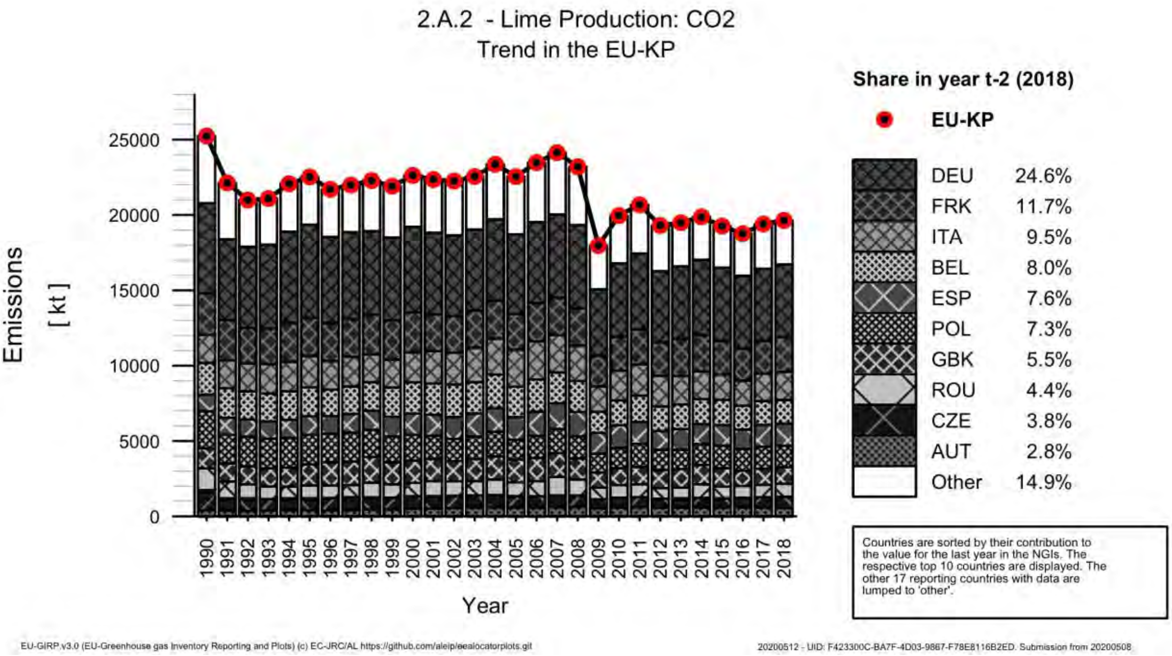


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Table 4.6 2A2 Lime production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	396	583	544	2.8%	148	37%	-39	-7%	T3	PS
Belgium	2 097	1 579	1 563	8.0%	-534	-25%	-16	-1%	T3	PS
Bulgaria	390	224	252	1.3%	-139	-36%	28	13%	T2	D
Croatia	157	82	89	0.5%	-68	-43%	7	8%	T3	PS
Cyprus	5	3	5	0.0%	0	0%	2	68%	T1	D
Czechia	1 337	674	749	3.8%	-587	-44%	76	11%	T3	PS
Denmark	105	51	37	0.2%	-69	-65%	-14	-27%	T2	CS,PS
Estonia	130	55	55	0.3%	-75	-58%	-1	-1%	T2	PS
Finland	401	397	309	1.6%	-92	-23%	-87	-22%	T3	CS
France	2 750	2 166	2 292	11.7%	-458	-17%	127	6%	T2,T3	CS,PS
Germany	5 987	4 775	4 832	24.6%	-1 155	-19%	56	1%	T2	D
Greece	404	173	210	1.1%	-194	-48%	37	21%	CS	PS
Hungary	614	171	173	0.9%	-441	-72%	2	1%	T3	PS
Ireland	214	199	177	0.9%	-37	-17%	-22	-11%	T3	PS
Italy	1 877	1 832	1 869	9.5%	-9	0%	37	2%	T2	CS,PS
Latvia	122	NO	NO	-	-122	-100%	-	-	NA	NA
Lithuania	210	20	2	0.0%	-209	-99%	-18	-92%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	NO	NO	-	-1	-100%	-	-	NA	NA
Netherlands	163	226	230	1.2%	67	41%	4	2%	CS	D
Poland	2 461	1 480	1 427	7.3%	-1 035	-42%	-53	-4%	T2	CS
Portugal	206	353	415	2.1%	208	101%	62	18%	T3	OTH
Romania	1 450	838	868	4.4%	-582	-40%	30	4%	T2	CS,D
Slovakia	795	508	523	2.7%	-272	-34%	15	3%	T2	PS
Slovenia	200	58	61	0.3%	-139	-69%	3	5%	T3	CS
Spain	1 108	1 443	1 485	7.6%	377	34%	42	3%	T3	PS
Sweden	331	465	388	2.0%	57	17%	-77	-16%	T3	D
United Kingdom	1 329	1 052	1 089	5.5%	-240	-18%	37	3%	T3	CS
EU-27+UK	**25 241**	**19 404**	**19 641**	**100%**	**-5 599**	**-22%**	**238**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 329	1 052	1 089	5.5%	-240	-18%	37	3%	T3	CS
EU-KP	**25 241**	**19 404**	**19 641**	**100%**	**-5 599**	**-22%**	**238**	**1%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations are explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece and the Netherlands use country-specific methods and report "CS" accordingly. Following a recommendation by the expert review team, the level of complexity (IPCC tier) is provided in addition: The level of complexity of the methods applied by Greece and the Netherlands is Tier 3 (T3).

Table 4.7 shows information on the methods and emission factors for CO_2 emissions from 2A2 Lime production for 1990 and 2018. 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 also report production 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 2018 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 in 2018 range from 0.67 for France to 0.81 for Finland. The IEFs for three countries (Netherlands, Portugal and the United Kingdom) stand out because they report activity as Limestone used and Carbonate used. Of the twenty-five countries which report lime production emissions, all but one use higher tier methodologies (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

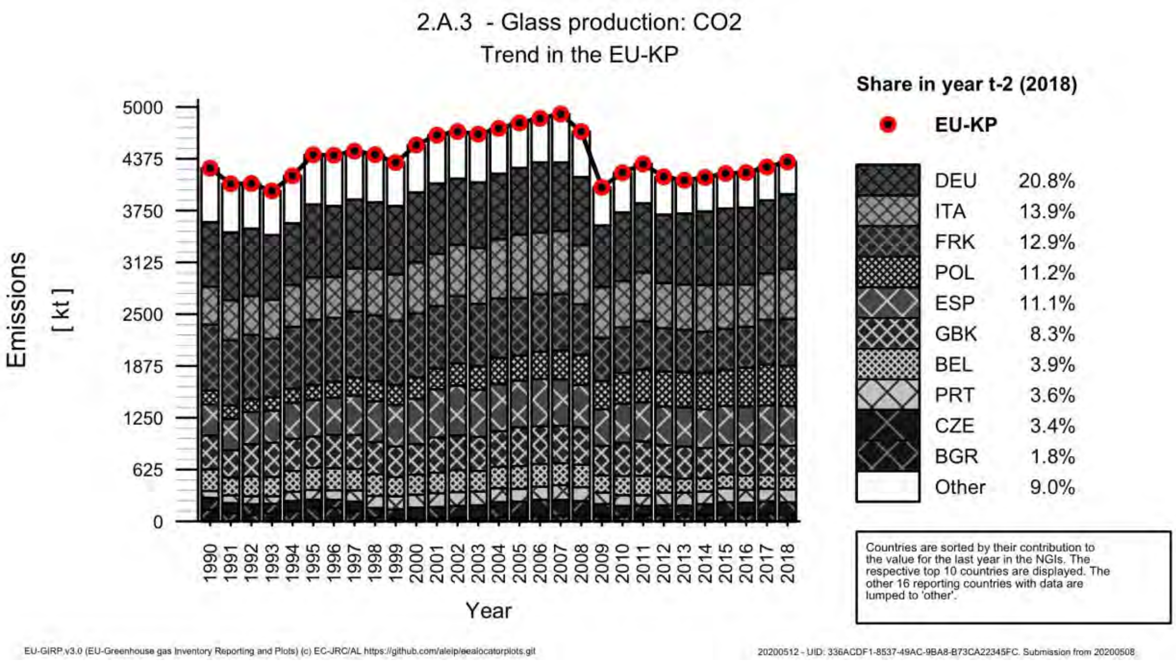
Member State	1990				2018				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Lime Production	513	0.77	396	Lime Production	735	0.74	544	T3	PS
Belgium	Lime Production	2 660	0.79	2 097	Lime Production	1 991	0.78	1 563	T3	PS
Bulgaria	Lime Production	490	0.80	390	Lime Production	323	0.78	252	T2	D
Croatia	Lime Production	219	0.72	157	Lime Production	115	0.77	89	T3	PS
Cyprus	Lime Production	7	0.73	5	Lime Production	7	0.73	5	T1	D
Czech Republic	Lime Production	1 823	0.73	1 337	Lime Production	986	0.76	749	T3	PS
Denmark	Lime Production	134	0.79	105	Lime Production	46	0.79	37	T2	CS,PS
Estonia	Lime Production	185	0.70	130	Lime Production	76	0.72	55	T2	PS
Finland	Lime Production	488	0.82	401	Lime Production	384	0.81	309	T3	CS
France	Lime Production	3 589	0.77	2 750	Lime Production	3 445	0.67	2 292	T2,T3	CS,PS
Germany	Lime Production	7 927	0.76	5 987	Lime Production	6 438	0.75	4 832	T2	D
Greece	Lime Production	491	0.82	404	Lime Production	267	0.79	210	CS	PS
Hungary	Lime Production	831	0.74	614	Lime Production	234	0.74	173	T3	PS
Ireland	Lime Production	255	0.84	214	Lime Production	238	0.74	177	T3	PS
Italy	Lime Production	2 583	0.73	1 877	Lime Production	2 518	0.74	1 869	T2	CS,PS
Latvia	Lime Production	225	0.54	122	Lime Production	NO	NO,NA	NO	NA	NA
Lithuania	Lime Production	288	0.73	210	Lime Production	2	0.78	2	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	525	0.44	230	CS	D
Poland	Lime Production	3 464	0.71	2 461	Lime Production	1 941	0.74	1 427	T2	CS
Portugal	Carbonate used	462	0.45	206	Carbonate used	999	0.42	415	T3	OTH
Romania	Lime Production	2 025	0.72	1 450	Lime Production	1 165	0.75	868	T2	CS,D
Slovakia	Lime Production	1 076	0.74	795	Lime Production	669	0.78	523	T2	PS
Slovenia	Lime Production	275	0.73	200	Lime Production	81	0.75	61	T3	CS
Spain	Lime Production	1 601	0.69	1 108	Lime Production	2 103	0.71	1 485	T3	PS
Sweden	Lime Production	439	0.75	331	Lime Production	520	0.75	388	T3	D
United Kingdom	Carbonate used	2 982	0.45	1 329	Carbonate used	2 443	0.45	1 089	T3	CS
EU-27+UK		**NE**	**NE**	**25 241**		**26 633**	**0.74**	**19 641**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Carbonate used	2 982	0.45	1 329	Carbonate used	2 443	0.45	1 089	T3	CS
EU-KP		**NE**	**NE**	**25 241**		**26 633**	**0.74**	**19 641**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Not all countries show lime production as the activity data for this emissions category. Gap-filled values are shown against Lime production for EU activity and the EU IEF for 2018.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece and the Netherlands use country-specific methods and report "CS" accordingly. Following a recommendation by the expert review team, the level of complexity (IPCC tier) is provided in addition: The level of complexity of the methods applied by Greece and the Netherlands is Tier 3 (T3).

4.2.1.3 2A3 Glass production

CO_2 emissions from 2A3 Glass production contributed to only 0.1% of total EU-KP (without LULUCF) emissions in 2018. As can be seen in Figure 4.6, emissions in 2018 were similar to 1990 levels (just 2% higher). CO_2 emissions from glass production in 2018 increased by 1.4% on 2017 levels.

Figure 4.6 2A3 Glass production: EU-KP CO_2 emissions



In 2018, Germany was responsible for 20.8%, Italy for 13.9% and France for 12.9% of the emissions from this source. The largest absolute reduction in annual emissions compared to 1990 has been seen in France (-235kt or 30%) and the largest absolute increase in Poland (+318kt or +188%)

Table 4.8 2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	39	38	38	0.9%	0	-1%	0	0%	T3	PS
Belgium	263	164	169	3.9%	-94	-36%	4	3%	T3	CS,PS
Bulgaria	138	86	79	1.8%	-59	-43%	-6	-7%	T1	CS
Croatia	43	32	30	0.7%	-13	-29%	-1	-4%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	143	155	148	3.4%	5	3%	-7	-5%	T3	PS
Denmark	16	9	10	0.2%	-6	-37%	2	20%	T3	PS
Estonia	1	10	10	0.2%	8	681%	0	-2%	T3	PS
Finland	21	3	3	0.1%	-18	-86%	0	14%	T3	CS
France	797	536	562	12.9%	-235	-30%	26	5%	T2,T3	CS,PS
Germany	780	883	903	20.8%	123	16%	21	2%	T2	CS
Greece	20	18	17	0.4%	-3	-15%	0	-2%	CS	CS
Hungary	77	48	44	1.0%	-33	-43%	-5	-10%	T3	CS,PS
Ireland	13	NO	NO	-	-13	-100%	-	-	NA	NA
Italy	453	561	604	13.9%	150	33%	43	8%	T2	CS,PS
Latvia	0	1	1	0.0%	0	110%	0	2%	T3	D,PS
Lithuania	12	6	7	0.2%	-4	-38%	2	29%	T2	D
Luxembourg	54	64	63	1.4%	9	17%	-1	-2%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	80	71	1.6%	-71	-50%	-8	-11%	CS	CS
Poland	169	494	487	11.2%	318	188%	-8	-2%	T2	D
Portugal	84	154	157	3.6%	73	87%	2	2%	T3	OTH
Romania	150	53	51	1.2%	-99	-66%	-3	-5%	T2	CS,D
Slovakia	8	15	16	0.4%	8	103%	1	5%	T3	PS
Slovenia	3	11	12	0.3%	9	263%	1	12%	T3	D
Spain	374	472	480	11.1%	106	28%	8	2%	T3	CS,D,PS
Sweden	54	17	16	0.4%	-38	-71%	-1	-8%	T3	CS,D
United Kingdom	407	368	360	8.3%	-47	-11%	-8	-2%	T3	CS
EU-27+UK	**4 262**	**4 276**	**4 337**	**100%**	**75**	**2%**	**62**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	407	368	360	8.3%	-47	-11%	-8	-2%	T3	CS
EU-KP	**4 262**	**4 276**	**4 337**	**100%**	**75**	**2%**	**62**	**1%**	**-**	**-**

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 emission factors for CO_2 emissions from 2A3 Glass production for 1990 and 2018.

The table below shows that while most countries report glass production as activity data for glass production some report inputs (carbonate use). A gap-filled IEF was not calculated for EU glass production because the standard deviation of the countries' IEF for glass production was above 50%.

Table 4.9 2A3 Glass production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2018				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn	CO2 Emission (kt)	Activity Data		Implied Emission Factor	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Glass Production	399	0.10	39	Glass Production	487	0.08	38	T3	PS
Belgium	Glass Production	1 993	0.13	263	Glass Production	1 575	0.11	169	T3	CS,PS
Bulgaria	-	818	0.17	138	-	607	0.13	79	T1	CS
Croatia	Glass Production	99	0.44	43	Glass Production	71	0.43	30	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czech Republic	Glass Production	1 237	0.12	143	Glass Production	1 219	0.12	148	T3	PS
Denmark	Glass Production	200	0.08	16	Glass Production	200	0.05	10	T3	PS
Estonia	Glass Production	12	0.10	1	Glass Production	86	0.11	10	T3	PS
Finland	Used Carbonates	45	0.47	21	Used Carbonates	7	0.41	3	T3	CS
France	Glass Production	4 307	0.19	797	Glass Production	3 239	0.17	562	T2,T3	CS,PS
Germany	Glass Production	6 562	0.12	780	Glass Production	7 669	0.12	903	T2	CS
Greece	Glass Production	135	0.15	20	Glass Production	117	0.15	17	CS	CS
Hungary	Glass Production	418	0.18	77	Glass Production	350	0.12	44	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	5 861	0.10	604	T2	CS,PS
Latvia	Glass Production	44	0.01	0	Glass Production	C	C	1	T3	D,PS
Lithuania	Glass Production	66	0.18	12	Glass Production	49	0.15	7	T2	D
Luxembourg	Glass Production	377	0.14	54	Glass Production	422	0.15	63	CS	PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	1 095	0.13	142	-	1 494	0.05	71	CS	CS
Poland	Glass Production	1 058	0.16	169	Glass Production	3 043	0.16	487	T2	D
Portugal	-	615	0.14	84	-	1 962	0.08	157	T3	OTH
Romania	Glass Production	926	0.16	150	Glass Production	394	0.13	51	T2	CS,D
Slovakia	Used Carbonates	18	0.44	8	Used Carbonates	38	0.42	16	T3	PS
Slovenia	Glass Production	25	0.13	3	Glass Production	89	0.13	12	T3	D
Spain	Glass Production	2 866	0.13	374	Glass Production	4 683	0.10	480	T3	CS,D,PS
Sweden	-	NE	NE	54	-	NE	NE	16	T3	CS,D
United Kingdom	Glass Production	1 942	0.21	407	Glass Production	2 203	0.16	360	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**4 262**	**-**	**35 867**	**0.12**	**4 337**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Glass Production	1 942	0.21	407	Glass Production	2 203	0.16	360	T3	CS
EU-KP	**-**	**NE**	**NE**	**4 262**	**-**	**35 867**	**0.12**	**4 337**	**-**	**-**

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. A gap-filled IEF was not calculated for EU glass production because the standard deviation of the IEF of the other countries was above 50%.

4.2.1.4 2A4 Other process uses of carbonates

CO_2 emissions from 2A4 Other process uses of carbonates contributed 0.2% of total EU-KP (without LULUCF) emissions in 2018. Emissions from this sector in 2018 were 14% lower than 1990 levels. Emissions have been reasonably stable since 2014. It is not necessarily useful to compare specific shares of emissions due to the fact that each country's estimates are mostly composed of 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	624	468	499	4.9%	-125	-20%	31	7%	T1,T3	D,PS
Belgium	136	188	185	1.8%	50	37%	-2	-1%	T3	CS,PS
Bulgaria	607	973	924	9.1%	317	52%	-49	-5%	T1,T2	D,PS
Croatia	13	32	35	0.3%	22	165%	3	10%	T2,T3	D,PS
Cyprus	44	13	15	0.1%	-29	-67%	2	15%	CS,T1	CS,D
Czechia	114	299	313	3.1%	199	175%	14	5%	T1,T3	D,PS
Denmark	77	80	91	0.9%	14	18%	11	13%	CS,T3	CS,D
Estonia	NO,IE,NA	3	1	0.0%	1	∞	-2	-65%	T1,T2	D,PS
Finland	67	132	147	1.4%	79	118%	15	11%	T1,T3	CS,D
France	488	392	384	3.8%	-104	-21%	-8	-2%	T1,T2,T3	CS,D,PS
Germany	1 458	696	599	5.9%	-859	-59%	-97	-14%	T1,T2	CS,D
Greece	590	374	361	3.5%	-228	-39%	-13	-3%	CS,T1	CS,D
Hungary	449	254	264	2.6%	-185	-41%	10	4%	T2,T3	CS,D,PS
Ireland	5	1	1	0.0%	-4	-77%	0	-6%	T3	PS
Italy	2 544	712	671	6.6%	-1 873	-74%	-42	-6%	T2	CS,PS
Latvia	69	9	10	0.1%	-59	-86%	0	5%	T1,T2	D,PS
Lithuania	240	16	19	0.2%	-220	-92%	3	18%	T1,T2	CS,D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	12%	0	-30%	NA	NA
Netherlands	690	1 027	974	9.5%	284	41%	-53	-5%	CS,T1,T3	D
Poland	771	1 983	2 083	20.4%	1 311	170%	100	5%	T1,T2	CS,D
Portugal	230	354	349	3.4%	119	52%	-5	-1%	T1,T3	OTH
Romania	38	357	353	3.5%	314	820%	-4	-1%	OTH,T2,T3	D,PS
Slovakia	447	387	394	3.9%	-53	-12%	7	2%	T3	PS
Slovenia	20	18	18	0.2%	-2	-12%	0	0%	T2	D
Spain	1 358	1 029	1 025	10.0%	-333	-25%	-4	0%	T1,T2,T3	CS,D,PS
Sweden	15	18	19	0.2%	4	23%	1	7%	T3	D
United Kingdom	729	457	466	4.6%	-263	-36%	9	2%	T3	CS
EU-27+UK	**11 823**	**10 270**	**10 199**	**100%**	**-1 624**	**-14%**	**-72**	**-1%**	**-**	**-**
Iceland	1	1	1	0.0%	0	30%	0	0%	T3	PS
United Kingdom (KP)	729	457	466	4.6%	-263	-36%	9	2%	T3	CS
EU-KP	**11 824**	**10 271**	**10 200**	**100%**	**-1 624**	**-14%**	**-72**	**-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	2018		1990	2018	
2.B.1 Ammonia Production (CO_2)	33353	23548	0	L	L	96.5%
2.B.2 Nitric Acid Production (N_2O)	49606	3410	T	L	0	98.7%
2.B.3 Adipic Acid Production (N_2O)	57555	392	T	L	0	100%
2.B.8 Petrochemical and Carbon Black Production (CO_2)	14813	15387	T	L	L	86,0%
2.B.9 Fluorochemical Production (HFCs)	29033	2022	T	L	0	100%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	53	T	0	0	100%
2.B.10 Other chemical industry (CO_2)	6432	12251	T	0	L	81.0%

The key category 2B1 Ammonia production accounts for 36.1% of total GHG emissions in the chemical industry, followed by the 2B9 Petrochemical and Carbon Black Production (23.6%), which includes the CO_2 emissions associated with a wide range of petrochemicals including methanol and ethylene and carbon black manufacture. The category 2.B.10 Other chemical industry (18.8%) is the third most important category.

Figure 4.7 shows chemical industry CO_2 emissions while *Table 4.12* presents a summary of emissions of CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents.

Figure 4.7 2B Chemical industry CO_2 emissions

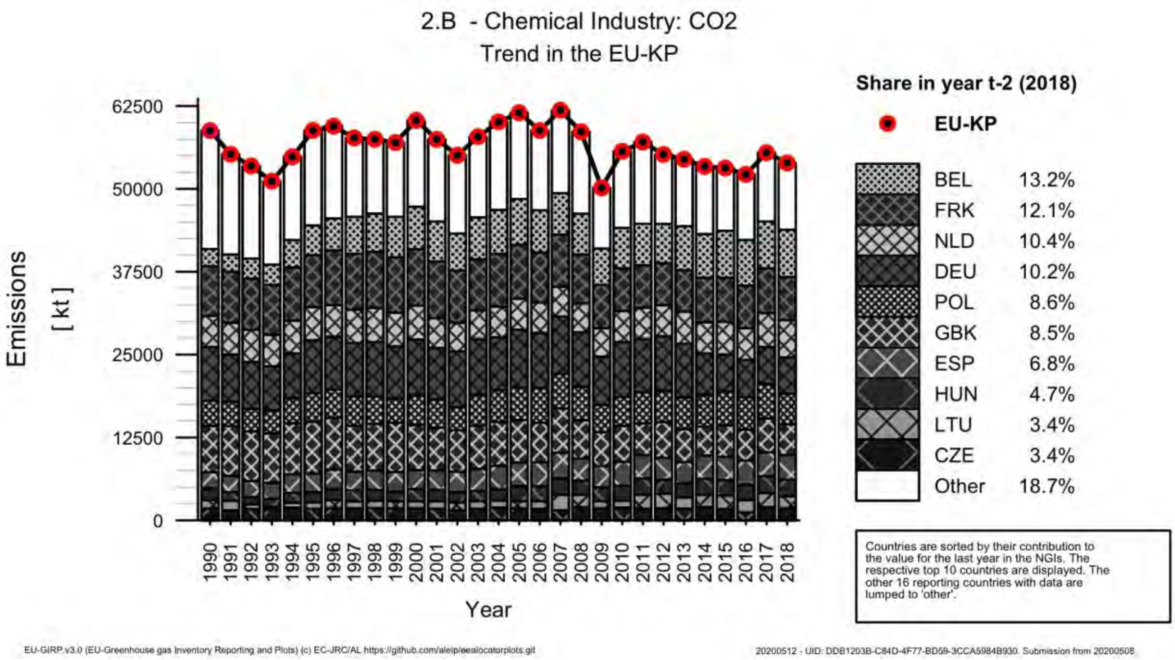


Table 4.12 shows chemical industry CO_2, CH_4, N_2O and total GHG emissions (which includes F-gases) as CO_2e. Between 1990 and 2018 GHG emissions from the chemical industry sector have decreased markedly largely due to the significant reduction in N_2O emissions which have decreased by approx. 94%. The greatest absolute decreases in N_2O emissions over the period have been in France, Germany and the UK.

Table 4.12 2B Chemical industry: EU-KP 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 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	1 555	644	644	542	877	56	35	46
Belgium	10 076	9 686	2 590	7 120	3 807	820	0	7
Bulgaria	4 943	1 456	3 283	1 340	1 647	116	13	NO,NA
Croatia	1 511	563	751	513	754	50	5	NO,NE,IE
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	2 944	2 048	1 783	1 813	1 125	186	36	49
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	1 321	270	1 110	1 592	211	NO,NA	NO,NA
France	36 967	7 647	7 486	6 497	23 708	955	78	38
Germany	35 459	6 670	8 109	5 496	21 335	649	334	470
Greece	2 931	974	681	951	1 066	22	1	NO,NA
Hungary	4 867	2 608	1 759	2 525	3 090	36	18	46
Ireland	1 986	NO	990	NO	995	NO	NO	NO
Italy	10 546	3 248	2 577	1 611	6 418	120	61	4
Latvia	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO
Lithuania	2 176	2 004	1 278	1 828	893	175	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	17 657	7 615	4 713	5 631	7 069	1 352	269	288
Poland	7 378	5 412	3 802	4 620	3 536	744	40	48
Portugal	1 735	491	1 211	429	498	46	26	16
Romania	9 748	1 315	5 563	1 078	4 135	231	50	6
Slovakia	2 020	1 698	878	1 591	1 142	106	0	1
Slovenia	88	58	83	58	NO	NO	4	NO,NA
Spain	8 383	4 223	2 430	3 686	2 829	425	84	112
Sweden	1 414	900	610	868	803	32	1	1
United Kingdom	45 409	4 714	6 986	4 596	23 797	26	222	45
EU-27+UK	**212 965**	**65 297**	**58 786**	**53 905**	**112 118**	**6 360**	**1 283**	**1 177**
Iceland	47	NO	0	NO	46	NO	NO,NA	NO
United Kingdom (KP)	45 409	4 714	6 986	4 596	23 797	26	222	45
EU-KP	**213 012**	**65 297**	**58 787**	**53 905**	**112 165**	**6 360**	**1 283**	**1 177**

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 2017 showing explanations for large recalculations.

Table 4.13 2B Chemical Industry: Contribution of MS to EU recalculated CO_2 emissions for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-6	-0.9	Ammonia production: Updated data on urea use.
Belgium	-	-	-18	-0.3	Re-allocation of emissions partly to category 5.C.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-23	-1.2	Update of activity data following QA/QC,
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	9	0.1	-1	-0.0	Update of plant-specific activity data for 2.B.2 and 2.B.10; update of emission factor for 2.B.8, update of CO_2 recovery data at one plant

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					for 2.B.1.
Germany	-	-	0	0.0	Correction of a data entry error in category 2.B.5.
Greece	-	-	-	-	
Hungary	-	-	50	2.0	Update of reported emissions data under 2.B.8.b.
Ireland	-	-	-	-	
Italy	-	-	0	0.0	Update of activity data reported by an operator under 2.B.5.b.
Latvia	-	-	-	-	
Lithuania	-	-	4	0.2	Recalculation in ammonia production due to recalculation of urea use in agriculture.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-0	-0.0	Minimal change related to rounding (<0.0001 t)
Poland	-	-	-1	-0.0	Carbon content of natural gas used for ammonia production was corrected for 2017.
Portugal	-0	-0.0	1	0.1	Update of activity data under 2.B.8.c and 2.B.8.g.
Romania	-	-	-22	-2.0	Ammonia production: updated data on urea export.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-27	-1.1	-21	-0.6	Emission factor update due to the addition of direct information from chemical plants.
Sweden	**1**	**0.1**	**3**	**0.4**	
United Kingdom	216	3.2	158	3.2	Revision to analysis of EU ETS petrochemical sites, resulting in an increase in estimated emissions from use of process off-gases.
EU27+UK	**199**	**0.3**	**125**	**0.2**	
Iceland	0	0.0	-	-	
United Kingdom (KP)					NA
EU-KP	**-17**	**-0.0**	**-33**	**-0.1**	

(*) contribution of the recalculation as percentage of the total emissions of category 2B for the respective year and MS

Table 4.14 2B Chemical Industry: Contribution of MS to EU recalculated N_2O emissions for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	4	1.8	Updated activity data in category 2.B.4.a.
Denmark	-	-	-	-	
Estonia					

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
	-	-	-	-	
Finland	-	-	-	-	
France	52	0.2	-0	-0.0	HNO3 production and N_2O emissions data were added for three sites already recorded, for the period 1990-1998.
Germany	-	-	6	0.9	Correction of operator-specific N_2O emissions
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-0	-0.0	Update of activity data reported under 2.B.2.
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden	-	-	-	-	
United Kingdom	0	0.0	0	0.2	Estimates for CO_2 from 2.B.8.g have been revised following review of the available EU ETS and other data.
EU27+UK	**52**	**0.0**	**10**	**0.1**	
Iceland	-	-	-	-	
United Kingdom (KP)					NA
EU-KP	**52**	**0.1**	**10**	**0.1**	

4.2.2.1 **2B1 Ammonia production**

In most facilities, 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-KP (without LULUCF) emissions in 2018. Emissions have decreased by almost 30% since 1990, and by 8% from 2017 to 2018.

Figure 4.8 2B1 Ammonia production: CO_2 emissions

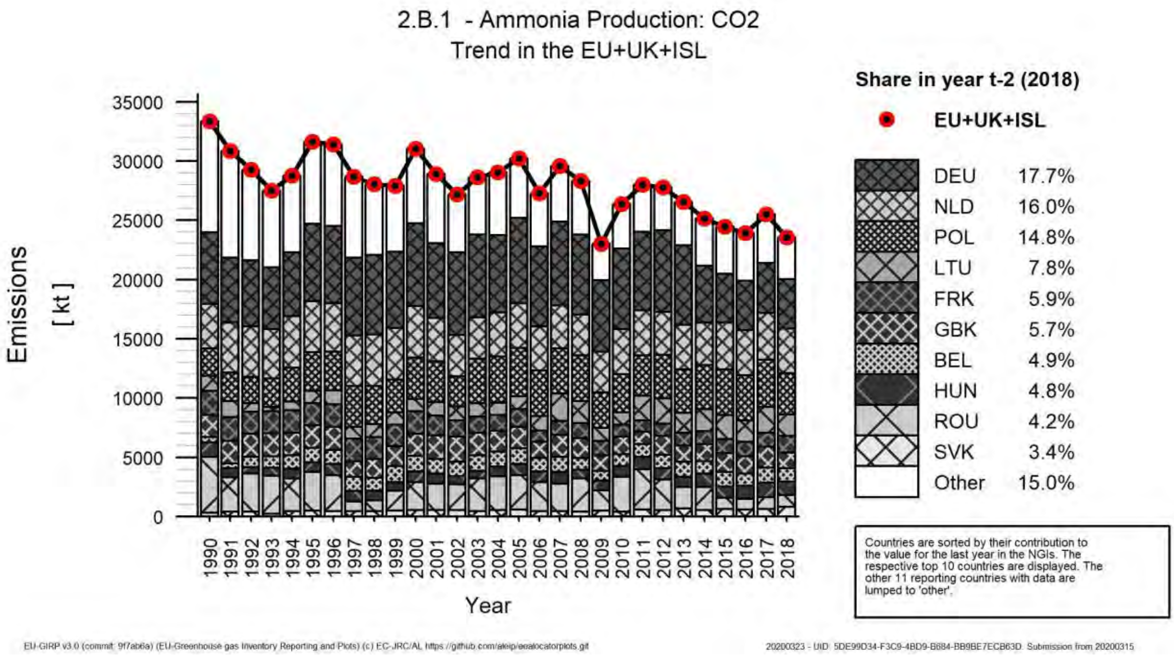


Figure 4.8 and Table 4.15 show that in 2018 Germany was responsible for 17.7% of this category's emissions. The next largest contributors are the Netherlands and Poland which contribute 16.0% and 14.8% respectively.

Bulgaria, Germany, Italy, Ireland and Romania 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 absolute terms in emissions between 1990 and 2018 occurred in Belgium, Lithuania, Poland and Slovakia.

Table 4.15 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	467	466	357	1.5%	-111	-24%	-110	-24%	T2	PS
Belgium	423	1 285	1 146	4.9%	723	171%	-139	-11%	T3	D,PS
Bulgaria	2 508	1 086	784	3.3%	-1 724	-69%	-302	-28%	T2	PS
Croatia	559	567	513	2.2%	-46	-8%	-54	-9%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	991	744	586	2.5%	-405	-41%	-158	-21%	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	1 195	1 378	5.9%	-641	-32%	183	15%	T1,T2,T3	CS,D,PS
Germany	6 025	4 228	4 157	17.7%	-1 868	-31%	-71	-2%	T3	PS
Greece	652	268	245	1.0%	-407	-62%	-23	-9%	T1a	CS
Hungary	1 255	1 217	1 135	4.8%	-120	-10%	-82	-7%	T3	D
Ireland	990	NO	NO	-	-990	-100%	-	-	NA	NA
Italy	1 892	642	679	2.9%	-1 213	-64%	36	6%	T2	PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 254	2 142	1 828	7.8%	575	46%	-313	-15%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 730	3 942	3 757	16.0%	27	1%	-185	-5%	T3	CS
Poland	2 344	4 007	3 485	14.8%	1 140	49%	-522	-13%	T2	CS
Portugal	540	NO	NO	-	-540	-100%	-	-	NA	NA
Romania	4 678	984	998	4.2%	-3 679	-79%	14	1%	T3	PS
Slovakia	332	633	790	3.4%	459	138%	158	25%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	400	348	371	1.6%	-29	-7%	23	6%	T3	PS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 895	1 764	1 339	5.7%	-556	-29%	-425	-24%	T3	CS
EU-27+UK	**33 353**	**25 518**	**23 548**	**100%**	**-9 805**	**-29%**	**-1 970**	**-8%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 895	1 764	1 339	5.7%	-556	-29%	-425	-24%	T3	CS
EU-KP	**33 353**	**25 518**	**23 548**	**100%**	**-9 805**	**-29%**	**-1 970**	**-8%**	**-**	**-**

The method and emission factor information shown here only refers to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

In line with the IPCC guidelines all emissions (energy and non-energy use of feedstocks/fuels) from ammonia production should be reported in category 2B1. In a review of the inventory submission of the European Union, the ERT recommended that the European Union include in the NIR a table that includes the potentially combustion-related EU ETS emission values rather than only the process-related emissions reported for ammonia production. Table 4.16 aligns 2B1. Ammonia production against EU ETS reported emissions for Production of ammonia (EU ETS activity sector code 41). Of the seventeen countries which report emissions under 2B1 Ammonia production thirteen report against EU ETS activity Production of Ammonia and of these only nine report higher levels to the EU ETS than is reported in the inventory. The column labelled 'Potentially combustion related' shows differences between IPPU 2B1 and ETS reported emissions from production of ammonia where the ETS figure is greater.

Table 4.16 2B1 Ammonia production: inventory and relevant EU ETS reported CO_2 emissions for 2018 (kt CO_2 emissions)

Member State	IPPU 2B1. Ammonia production	EU ETS: Production of ammonia	Potentially combustion related [1]	EU ETS: Production of hydrogen and synthesis gas
Austria	357		349	-
Belgium	1 146		-	721
Bulgaria	784		-	-
Croatia	513	706	589	-
Cyprus	NO	-	-	-
Czech Republic	586	692	-	-
Denmark	NO	1 102	-	-
Estonia	NO	-	-	-
Finland	NO	-	-	-
France	1 378	-	204	512
Germany	4 157	-	436	3 090
Greece	245	-	23	-
Hungary	1 135	1 582	-	154
Ireland	NO	4 593	-	-
Italy	679	268	-	576
Latvia	NO	805	-	-
Lithuania	1 828	-	577	-
Luxembourg	NO	-	-	-
Malta	NO	-	-	-
Netherlands	3 757	2 406	-	1 794
Poland	3 485	-	-	-
Portugal	NO	-	-	62
Romania	998	3 607	-	45
Slovakia	790	1 513	451	-
Slovenia	NO	-	-	-
Spain	371	-	356	868
Sweden	NO	1 242	-	-
United Kingdom	1 339	-	33	568
EU-27+UK	**23 548**	**727**	**3 018**	**8 389**
Iceland	NO	-	-	-
United Kingdom (KP)	1 339	1 373	33	568
EU-KP	**23 548**	**20 614**	**3 018**	**8 389**

[1] Potentially combustion related: difference between IPPU 2B1 and EU ETS reported emissions from production of ammonia where the ETS figure is greater.
EU ETS data from: www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

The different scopes, reporting thresholds and reporting obligations mean that it is not possible to make a detailed analysis of the differences visible in Table 4.16. To analyse the consistency between EU ETS and inventory data would require a detailed analysis of the data reported by each ETS installation to the national competent authorities and the allocation to the specific CRF categories, including the methods, activity data and calculation parameters used. Please refer to chapter 1.4.1 on ‘the use of data from EU ETS for the purposes of the national GHG inventories’. See also the mapping table (Table 1.10 in section 1.4.1) between ETS activities and CRF categories (including on ammonia production).

It is worth observing that the EU ETS activity sector: Production of hydrogen and synthesis gas (code 43), does not have a direct counterpart in the inventory and is included here to illustrate the difficulty of comparing UNFCCC and EU ETS reported emissions. Note also that ammonia can be produced using hydrogen supplied by another company and that not all hydrogen producers are obliged to report within the framework of EU ETS.

Table 4.17 shows information on methods applied, activity data, emission factors for CO_2 emissions from 2B1 Ammonia production for 1990 to 2018. Not all countries show ammonia production as activity data for this emissions category but gap-filled values for the EU IEF have not been calculated because the data distribution does not appear to be normal (the standard deviation divided by mean is greater than 50%). In 2018, 96.5% of emissions from ammonia production are estimated with higher Tier methods (Tier 2 or Tier 3).

Table 4.17 2B1 Ammonia production: Information on methods applied, activity data, emission factors for CO_2 emissions

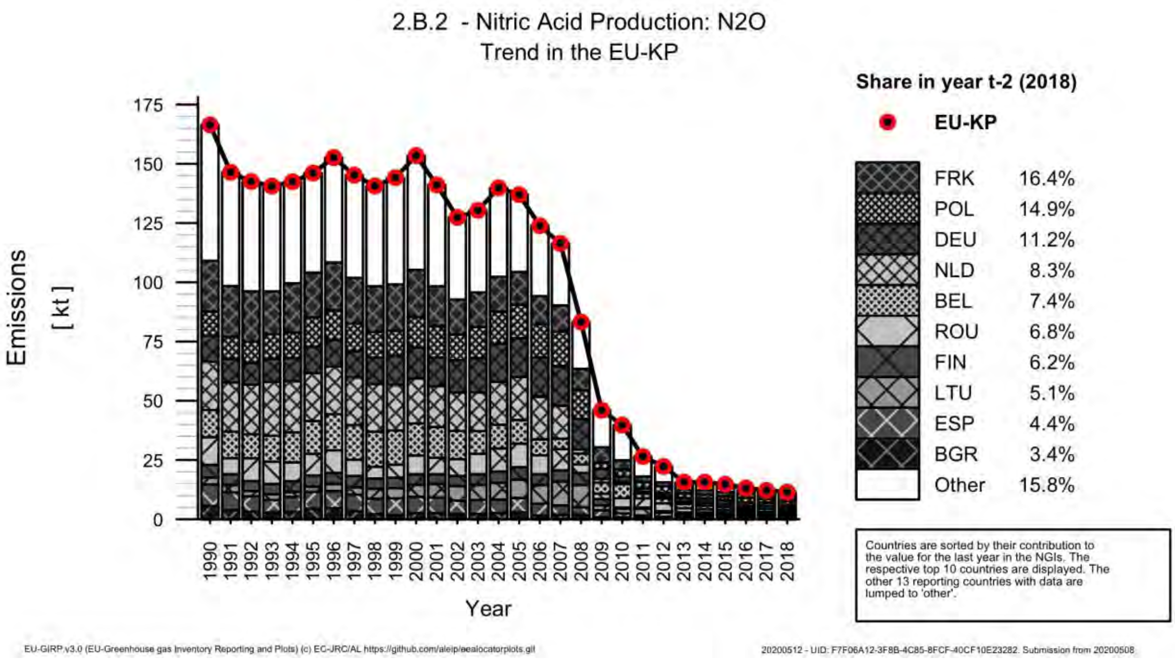
Member State	1990				2018				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Ammonia Production	461	1.22	467	Ammonia Production	405	1.22	357	T2	PS
Belgium	Ammonia Production	360	1.17	423	Ammonia Production	975	1.29	1146	T3	D,PS
Bulgaria	-	C	C	2508	-	C	C	784	T2	PS
Croatia	Ammonia Production	345	2.24	559	Ammonia Production	397	2.00	513	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Ammonia Production	336	3.27	991	Ammonia Production	179	3.27	586	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	1928	1.05	2019	Ammonia Production	1112	1.24	1378	T1,T2,T3	CS,D,PS
Germany	Ammonia Production	2705	2.41	6025	Ammonia Production	3030	1.77	4157	T3	PS
Greece	Ammonia Production	313	2.08	652	Ammonia Production	148	1.65	245	T1a	CS
Hungary	Natural Gas Consumption	25334	0.06	1255	Natural Gas Consumption	20239	0.06	1135	T3	D
Ireland	Natural Gas Feedstocks	430	2.30	990	Natural Gas Feedstocks	NO	NO	NO	NA	NA
Italy	Ammonia Production	1455	1.94	1892	Ammonia Production	611	1.83	679	T2	PS
Latvia	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Lithuania	Ammonia Production	568	2.27	1254	Ammonia Production	948	2.10	1828	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	3730	-	C	C	3757	T3	CS
Poland	Ammonia Production	1532	1.53	2344	Ammonia Production	2535	1.37	3485	T2	CS
Portugal	-	C	C	540	-	C	NO	NO	NA	NA
Romania	Natural Gas Consumption	2101	2.28	4678	Natural Gas Consumption	524	2.27	998	T3	PS
Slovakia	Ammonia Production	360	1.71	332	Ammonia Production	517	1.99	790	T3	PS
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Ammonia Production	573	1.22	400	Ammonia Production	531	1.27	371	T3	PS
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Ammonia Production	1328	1.43	1895	Ammonia Production	876	1.53	1339	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**33353**	**-**	**NE**	**NE**	**23548**	**-**	**-**
Iceland	-	IE	NA,NO	NA	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Ammonia Production	1328	1.43	1895	Ammonia Production	876.301	1.53	1339	T3	CS
EU-KP	**-**	**NE**	**NE**	**33353**	**-**	**NE**	**NE**	**23548**	**-**	**-**

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.

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 6% from 2017 to 2018 and by 93% since 1990. All countries have had marked reductions from this source notably post 2007 when pollution control measures were introduced and post 2013 under EU ETS reporting obligations. N_2O emissions from nitric acid production contributed less than 0.1% of total EU-KP (without LULUCF) emissions in 2018. (Figure **4.9** and Table 4.18). France and the Netherlands have 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 (in 2004) and ceased in Ireland in 2002 due to the insolvency of Irish fertiliser industries.

Figure 4.9 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 6% between 2017 and 2018. Twenty countries reported these emissions in 2018, eight of which reported emissions increases compared to the previous year.

Table 4.18 2B2 Nitric acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	877	39	56	1.7%	-820	-94%	18	46%	T3	PS
Belgium	3 422	371	254	7.4%	-3 168	-93%	-118	-32%	T3	PS
Bulgaria	1 647	93	116	3.4%	-1 532	-93%	22	24%	T3	PS
Croatia	754	99	50	1.5%	-704	-93%	-48	-49%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 050	134	112	3.3%	-938	-89%	-22	-16%	T3	PS
Denmark	1 003	NO	NO	-	-1 003	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 592	231	211	6.2%	-1 380	-87%	-19	-8%	T3	PS
France	6 368	433	560	16.4%	-5 808	-91%	127	29%	T2,T3	CS,D,PS
Germany	3 258	493	382	11.2%	-2 877	-88%	-111	-23%	T3	PS
Greece	1 066	20	22	0.7%	-1 044	-98%	2	12%	CS	CS
Hungary	3 090	48	36	1.1%	-3 053	-99%	-11	-24%	T3	PS
Ireland	995	NO	NO	-	-995	-100%	-	-	NA	NA
Italy	2 005	64	56	1.6%	-1 949	-97%	-8	-12%	T3	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	893	228	175	5.1%	-718	-80%	-52	-23%	T3	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 085	299	282	8.3%	-5 802	-95%	-17	-6%	T2	PS
Poland	3 041	471	509	14.9%	-2 532	-83%	39	8%	T2	CS
Portugal	498	37	46	1.4%	-452	-91%	9	24%	D	PS
Romania	3 473	250	231	6.8%	-3 242	-93%	-19	-8%	T2,T3	D,PS
Slovakia	1 142	105	106	3.1%	-1 036	-91%	1	1%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 704	135	149	4.4%	-2 555	-94%	14	11%	T3	PS
Sweden	782	42	31	0.9%	-752	-96%	-11	-26%	T2	PS
United Kingdom	3 860	37	24	0.7%	-3 836	-99%	-13	-34%	T3	CS
EU-27+UK	**49 606**	**3 628**	**3 410**	**100%**	**-46 195**	**-93%**	**-218**	**-6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 860	37	24	0.7%	-3 836	-99%	-13	-34%	T3	CS
EU-KP	**49 606**	**3 628**	**3 410**	**100%**	**-46 195**	**-93%**	**-218**	**-6%**	**-**	**-**

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 2B2 Nitric acid production for 1990 to 2018. 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 more 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 vast majority of emissions (96.6%) are estimated with higher tier methods (Tier 2 or Tier 3).

Table 4.19 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions

Member State	1990				2018				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factor (t/t)	N2O Emissions (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O Emissions (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Nitric Acid Production	530	0.01	877	Nitric Acid Production	430	0.00	56	T3	PS
Belgium	Nitric Acid Production	1436	0.01	3422	Nitric Acid Production	2042	0.00	254	T3	PS
Bulgaria	-	C	C	1647	-	C	C	116	T3	PS
Croatia	Nitric Acid Production	332	0.01	754	Nitric Acid Production	289	0.00	50	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Nitric Acid Production	530	0.01	1050	Nitric Acid Production	579	0.00	112	T3	PS
Denmark	-	450	0.01	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	0.01	1592	Nitric Acid Production	650	0.00	211	T3	PS
France	Nitric Acid Production	3200	0.01	6368	Nitric Acid Production	1961	0.00	560	T2,T3	CS,D,PS
Germany	Nitric Acid Production	1698	0.01	3258	Nitric Acid Production	2669	0.00	382	T3	PS
Greece	Nitric Acid Production	511	0.01	1066	Nitric Acid Production	190	0.00	22	CS	CS
Hungary	Nitric Acid Production	732	0.01	3090	Nitric Acid Production	790	0.00	36	T3	PS
Ireland	Nitric Acid Production	339	0.01	995	Nitric Acid Production	NO	NO	NO	NA	NA
Italy	Nitric Acid Production	1037	0.01	2005	Nitric Acid Production	447	0.00	56	T3	D,PS
Latvia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Lithuania	Nitric Acid Production	355	0.01	893	Nitric Acid Production	1050	0.00	175	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	282	T2	PS
Poland	Nitric Acid Production	1577	0.01	3041	Nitric Acid Production	2310	0.00	509	T2	CS
Portugal	-	C	C	498	-	C	C	46	D	PS
Romania	Nitric Acid Production	1261	0.01	3473	Nitric Acid Production	C	C	231	T2,T3	D,PS
Slovakia	Nitric Acid Production	401	0.01	1142	Nitric Acid Production	575	0.00	106	T3	PS
Slovenia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Spain	Nitric Acid Production	1329	0.01	2704	Nitric Acid Production	716	0.00	149	T3	PS
Sweden	Nitric Acid Production	374	0.01	782	Nitric Acid Production	269	0.00	31	T2	PS
United Kingdom	Nitric Acid Production	2408	0.01	3860	Nitric Acid Production	1082	0.00	24	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**49606**	**-**	**NE**	**NE**	**3410**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Nitric Acid Production	2408	0.01	3860	Nitric Acid Production	1082	0.00	24	T3	CS
EU-KP	**-**	**NE**	**NE**	**49606**	**-**	**NE**	**NE**	**3410**	**-**	**-**

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-KP (without LULUCF) emissions. Between 1990 and 2018, N_2O emissions from this source decreased by 99% (Figure 4.10 and Table 4.20). The year 2018 saw a strong decrease (-63%) compared to 2017. Emissions in 2017 were relatively high compared to other recent years due to problems with the abatement equipment at an installation in France. Besides France, only Germany and Italy continue to produce adipic acid.

Figure 4.10 2B3 Adipic acid production N_2O emissions

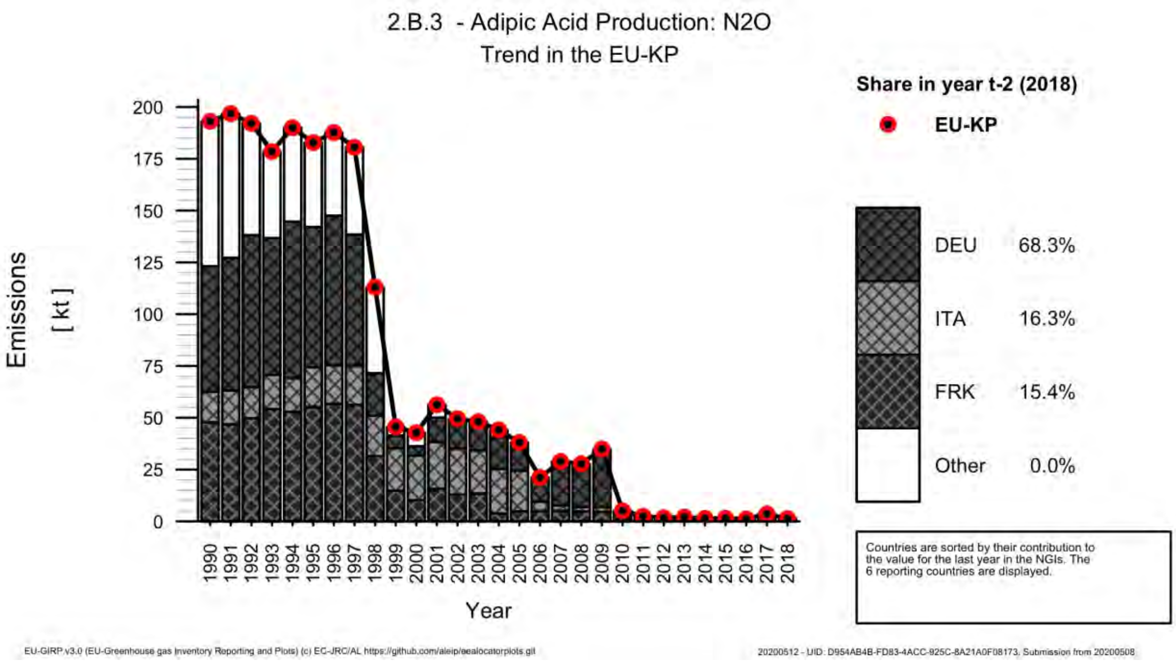


Table 4.20 2B3 Adipic acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
France	14 232	781	60	15.4%	-14 172	-100%	-721	-92%	T2,T3	CS,D,PS
Germany	18 077	207	268	68.3%	-17 809	-99%	61	29%	T3	PS
Italy	4 402	74	64	16.3%	-4 338	-99%	-10	-14%	T3	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-27+UK	**57 555**	**1 062**	**392**	**100%**	**-57 163**	**-99%**	**-670**	**-63%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-KP	**57 555**	**1 062**	**392**	**100%**	**-57 163**	**-99%**	**-670**	**-63%**	**-**	**-**

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

Table 4.21 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B3 Adipic acid production for 1990 to 2018. 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 0.002 t/t for 2018. In 2018 all emissions are estimated with higher Tier methods.

Table 4.21 2B3 Adipic acid production: methods, activity data, emission factors for N_2O emissions

Member State	1990				2018				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factor(t/t)	N2O Emissions (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O Emissions (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Czechia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Estonia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
France	Adipic Acid Production	C	C	14 232	Adipic Acid Production	C	C	60	T2,T3	CS,D,PS
Germany	Adipic Acid Production	C	C	18 077	Adipic Acid Production	C	C	268	T3	PS
Italy	Adipic Acid Production	49	0.30	4 402	Adipic Acid Production	86	0.00	64	T3	D,PS
Latvia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Luxembourg	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
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-27+UK	**-**	**NE**	**NE**	**57 555**	**-**	**NE**	**NE**	**392**	**-**	**-**
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-KP	**-**	**NE**	**NE**	**57 555**	**-**	**NE**	**NE**	**392**	**-**	**-**

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 1990-2018 with this source being a key category of CO_2 emissions in terms of emissions level and trend for EU-KP.

CO_2 emissions from 2B8 Petrochemical and carbon black production remained stable between 2017 and 2018 and contributed 0.36% of total EU-KP (without LULUCF) emissions in 2018. Belgium, the United Kingdom, Spain and Hungary contribute the largest share of emissions, respectively 25.7%, 19.1%, 13.3% and 9.0%. In 2018, EU-KP emissions from this category are 3.9 % higher than in 1990. Trends vary widely between countries, due to increases and decreases in production of the various chemicals over the 28-year period.

Figure 4.11 2B8 Petrochemical and carbon black production: EU-KP CO_2 emissions

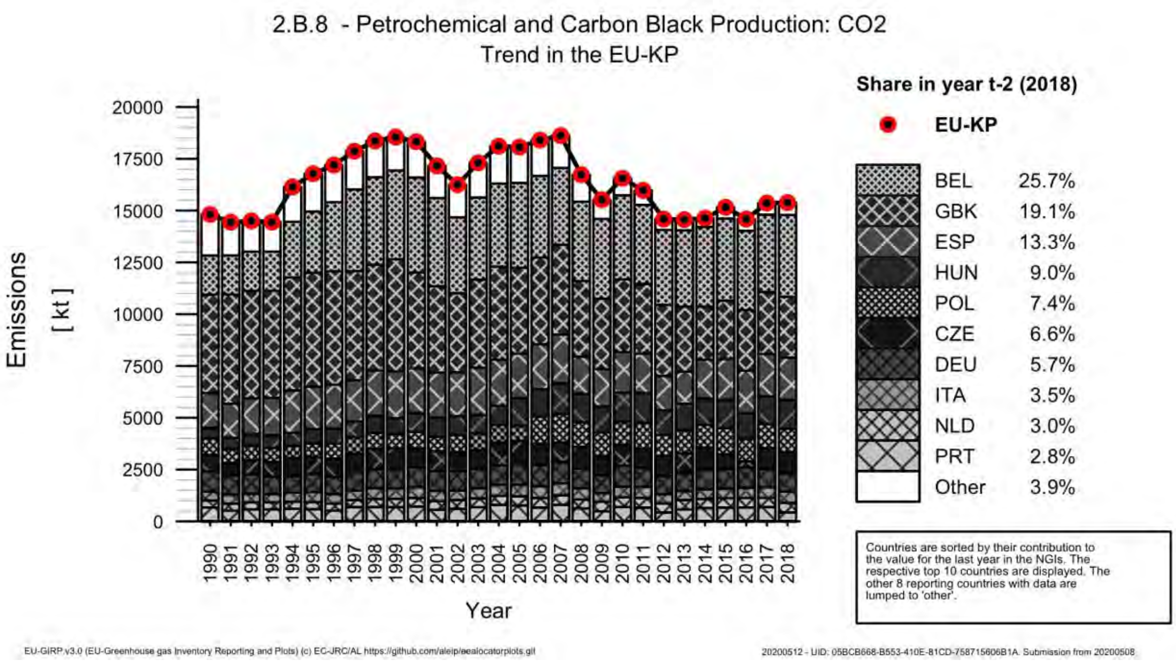


Table 4.22: 2B8 Petrochemical and carbon black production CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Belgium	1 882	3 726	3 949	25.7%	2 066	110%	223	6%	T3	PS
Bulgaria	346	NO,NA	NO,NA	-	-346	-100%	-	-	NA	NA
Croatia	192	NO,IE	NO,IE	-	-192	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	792	1 007	1 020	6.6%	227	29%	12	1%	T1	D,PS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
France	376	204	199	1.3%	-177	-47%	-4	-2%	T1,T2,T3	CS,D,PS
Germany	974	885	880	5.7%	-94	-10%	-5	-1%	T1,T2	CS,D
Greece	29	NO,NA	NO,NA	-	-29	-100%	-	-	NA	NA
Hungary	504	1 337	1 390	9.0%	886	176%	53	4%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	422	495	542	3.5%	120	28%	47	10%	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	459	458	3.0%	123	37%	-1	0%	CS	CS
Poland	806	1 168	1 136	7.4%	329	41%	-32	-3%	T1	D
Portugal	672	683	429	2.8%	-243	-36%	-254	-37%	NO	NO
Romania	574	NO	NO	-	-574	-100%	-	-	NA	NA
Slovakia	429	358	399	2.6%	-29	-7%	42	12%	T2	CS,PS
Slovenia	16	NO	NO	-	-16	-100%	-	-	NA	NA
Spain	1 684	2 035	2 044	13.3%	360	21%	9	0%	T1,T3	D,PS
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-	NA	NA
United Kingdom	4 755	3 005	2 941	19.1%	-1 814	-38%	-64	-2%	CS,T1	CS,D
EU-27+UK	**14 813**	**15 361**	**15 387**	**100%**	**574**	**4%**	**26**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 755	3 005	2 941	19.1%	-1 814	-38%	-64	-2%	CS,T1	CS,D
EU-KP	**14 813**	**15 361**	**15 387**	**100%**	**574**	**4%**	**26**	**0%**	**-**	**-**

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 4.23 Key categories for sector 2B9 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
2.B.9 Fluorochemical Production (HFCs)	29033	2022	T	L	0	100%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	53	T	0	0	100%

In this subcategory, by-product emissions and fugitive emissions are to be reported.

As regards by-product emissions, the generation of HFC-23 as a by-product during the manufacture of HCFC-22 and HFC-32 is particularly relevant due to its high global warming potential of 14,800. HFC-23 is primarily generated during the fluorination of chloroform (trichloromethane, CHCl3 or R20). Since chloroform is a feedstock for chlorodifluoromethane (HCFC-22 or R22), HFC-23 is a by-product during the manufacture of this widely used substance. The HFC-23 yield amounts to 2-3% of the amount of R22 produced. In addition, where R22 is used as an intermediate product or feedstock this may also lead to HFC-23 by-production. This is the case e.g. for some production pathways of difluoromethane (HFC-32 or R32). HFC-32 is increasingly used as a single substance refrigerant but has also been included in a number of frequently used refrigerant blends such as the R407 series (10-30% R32) and R410A (50% R32) for many years. Production of these blends may therefore also involve HFC-23 by-production. (EU Commission, 2015)

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, 20017), in the absence of abatement measures. Before the mid-1990s, ten HCFC-22 plants were operated in Europe. At that time HFC-23 by-product emissions were partly captured and processed but emissions were also 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 were largely reduced.

In fluorochemical manufacture also other fluorinated greenhouse gases can occur as by-products including e.g. CF4, C2F6, C3F8, C4F10, C5F12, C6F14 as well as SF6. The type and amount of these by-product emissions depends on the applied production pathway and installed abatement technology.

Fugitive emissions are also 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 significantly reduced as well.

17 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 4.24: 2B9 Fluorochemical production – HFCs: Countries' 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-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Belgium	NO	NO	1 422	1 620	80.1%	1 620	∞	1 620	∞	197	14%	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO	NO	-	-	-	-	-	-	-	-	-	-	-
Czechia	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	303	154	7.6%	-4 220	-96%	-512	-77%	-149	-49%	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	2	0.1%	-442	-100%	-547	-100%	0	27%	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	NO,NA	NO	-	-	-	-	-	-	-	NA	NA
Netherlands	5 606	7 298	128	247	12.2%	-5 359	-96%	-7 050	-97%	119	93%	T2	CS
Poland	NO	NO	NO	-	-	-	-	-	-	-	-	NA	NA
Portugal	NO,NA	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	17 671	NO	NO	-	-14 387	-100%	-17 671	-100%	-	-	NA	NA
EU-27+UK	**29 033**	**36 165**	**1 855**	**2 022**	**100%**	**-27 011**	**-93%**	**-34 142**	**-94%**	**168**	**9%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	14 387	17 671	NO	NO	-	-14 387	-100%	-17 671	-100%	-	-	NA	NA
EU-KP	**29 033**	**36 165**	**1 855**	**2 022**	**100%**	**-27 011**	**-93%**	**-34 142**	**-94%**	**168**	**9%**	**-**	**-**

Table 4.25: 2B9 Fluorochemical production: Countries' contributions to Unspecified mix of HFC and PFC emissions and information on method applied, activity data and emission factor

	Unspecified mix of HFCs and PFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		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	-	-	-	-	-	-	-	-	-	-	-
Czechia	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	65	53	100.0%	-5 514	-99%	-5 282	-99%	-12	-19%	T3	PS
Greece	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
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	-	-	-	-	-	-	-	-	-	-
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	-	-	-	NA	NA
Portugal	NO,NA	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-27+UK	**5 567**	**5 335**	**65**	**53**	**100%**	**-5 514**	**-99%**	**-5 282**	**-99%**	**-12**	**-19%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-KP	**5 567**	**5 335**	**65**	**53**	**100%**	**-5 514**	**-99%**	**-5 282**	**-99%**	**-12**	**-19%**	**-**	**-**

Table 4.26: 2B Chemical production: Contribution of MS to EU recalculations in HFCs for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	1 422.4	7 323 203.0	Due to new insights in methodologies to calculate the emissions of a unique electro-fluorination plant in Europe, located in Flanders, the emissions of F-gases in this plant were recalculated from 2010 on. A monitoring plan was set up with the responsible authority and an external verification office was involved. The result was that much higher emissions are reported now.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	3.0	1.0	Addition of HFC-365mfc emissions in 2017 from one site resulting from refrigerant production.
Germany	-	-	-	-	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden					
United Kingdom	-	-	-2.5	-100.0	HCFC manufacturing had ceased prior to 2017, so the previously estimated (extrapolated) emissions of HFCs from the production site have been removed from the inventory.
EU27+UK	**-**	**-**	**1 422.8**	**329.3**	
Iceland	-	-	-	-	
United Kingdom (KP)					NA
EU-KP	**-**	**-**	**1 422.8**	**329.3**	

4.2.2.6 **2B10 Other chemical industry**

Fifteen countries reported CO_2, CH_4 or N_2O emissions in this category in 2018 which contributed 15.7 Mt of CO_2e or 0.4% of total EU-KP (without LULUCF) emissions.

Between 1990 and 2018, CO_2 emissions from this source almost doubled (Table 4.28) while CH_4 and N_2O emissions decreased by about 69% and 49% respectively. This category contains a wide range of emissions and sources as shown in the tables below.

Table 4.27 2B10 Other: CO_2, CH_4 and N_2O emissions for 1990 and 2018

Country	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	2018	2018	2018	2018
AUT	10. Other (please specify)	138.56	7.30	NA	145.86	136.92	5.92	NA	142.83
	CO_2 from Nitric Acid Production	0.41	NA	NA	0.41	0.32	NA	NA	0.32
	Other chemical bulk production	138.15	7.30	NA	145.44	136.60	5.92	NA	142.52
BEL	10. Other (please specify)	285.15	NA	27.42	312.56	2025.68	6.72	30.50	2062.90
	Other non-specified	285.15	NA	27.42	312.56	2025.68	6.72	30.50	2062.90
BGR	10. Other (please specify)	IE	NA	NA		NA	NA	NA	
CYP	10. Other (please specify)	NO	NO	NO					
CZE	10. Other (please specify)	IE	NO	NO		207.40	NO	NO	207.40
	Other non energy use in chemical industry	IE	NO	NO		191.76	NO	NO	191.76
	Non selective catalytic reduction	IE	NO	NO		15.64	NO	NO	15.64
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	1.43	NA	NA	1.43
	Production of catalysts	0.57	NA	NA	0.57	1.43	NA	NA	1.43
ESP	10. Other (please specify)	NO,NA	NA	NA		868.82	NA	NA	868.82
	Other No-Specify	NO	NA	NA		868.82	NA	NA	868.82
EST	10. Other (please specify)	868.82	NA	NA	868.823175	NO	NO	NO	
FIN	10. Other (please specify)	177.28	NO	NO	177.28	1109.73	NO	NO	1109.73
	Phosphoric Acid Production	24.54	NO	NO	24.54	36.83	NO	NO	36.83

Country	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	2018	2018	2018	2018
	Hydrogen Production	116.22	NO	NO	116.22	994.26	NO	NO	994.26
	Limestone and Dolomite Use	36.52	NO	NO	36.52	78.63	NO	NO	78.63
	Chemicals Production	NO	NO	NO		NO	NO	NO	
FRK	10. Other (please specify)	4513.66	76.48	534.27	5124.41	4574.74	37.89	68.44	4681.07
GBE	10. Other (please specify)	3683.36	1.63		3685.00	2935.61	1.32		2936.93
	Chemical industry - other	3683.36	1.63		3685.00	2935.61	1.32		2936.93
GRC	10. Other (please specify)	NA,NO	NA	NA		706.37	NA	NA	706.37
	Sulfuric acid	NA	NA	NA		NA	NA	NA	
	Hydrogen production	NO	NA	NA		706.37	NA	NA	706.37
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)	NO	NO	NO		NO	NO	NO	
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	
MLT	10. Other (please specify)	0.17	NA	NA	0.17	0.04	NA	NA	0.04
	Carbide use	0.17	NA	NA	0.17	0.04	NA	NA	0.04
NLD	10. Other (please specify)	583.27	NO	244.19	827.46	1415.73	NO	343.89	1759.63

Country	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	2018	2018	2018	2018
	Other process emissions	583.27	NO	244.19	827.46	1415.73	NO	343.89	1759.63
POL	10. Other (please specify)	NO	NO	NO					
PRT	10. Other (please specify)	1.41	NO		1.41	2.48	NO		2.48
	2.B.10.b Ammonium Sulphate	NO,NA	NO,NA	NO,NA		NO,NA	NO,NA	NO,NA	
	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	NA	NA	NA		NA	NA	NA	
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	332.95	0.15	0.18	333.28
	Hydrogen Production	116.99	0.05	0.06	117.10	332.95	0.15	0.18	333.28
SVN	10. Other (please specify)	17.43	NO	NO	17.43	13.17	NO	NO	13.17
SWE	10. Other (please specify)	598.46	0.71	20.72	619.89	858.27	0.77	1.13	860.17
	Pharmaceutical industry	NA	NE	14.90	14.90	NA	NE	NE	
	Other non-specified	NE	NE	NE		NE	NE	NE	
	Other organic chemical products	520.07	0.63	0.01	520.70	753.33	C	C	753.33
	Base chemicals for plastic industry	37.52	0.00	3.55	41.08	28.66	C	C	28.66
	Other inorganic chemical products	40.87	0.07	2.27	43.21	76.28	0.09	1.12	77.48
	Sulphuric acid production	NE	NA	NA		NE	NA	NA	

Country	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**	**2018**	**2018**	**2018**	**2018**
EU-27+UK		**10985**	**86**	**827**	**11898**	**15189**	**53**	**444**	**15686**
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	
	Fertilizer production	NA	NA	46.49	46.49	NO	NO	NO	
GBK	10. Other (please specify)	3683.36	1.63		3685.00	2935.61	1.32		2936.93
	Chemical industry - other	NO	191.08	2.21	193.29	NO	35.31	1.57	36.88
EU-KP		**10985**	**86**	**873**	**11945**	**15189**	**53**	**444**	**15686**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table **4.28** provides an overview of changes in CO_2 emissions between 1990 and 2018 at an aggregated level. The diverging trends can be explained by various increases and decreases in the production of chemicals between 1990 and 2018. The same holds true for N_2O (Table **4.29**) and CH_4 (***Table*** *4.30*).

Table 4.28 2B10 Other: CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	139	145	137	1.1%	-2	-1%	-8	-5%	T3	PS
Belgium	285	2 040	2 026	16.5%	1 741	610%	-14	-1%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	-	-	-	-	-	-	-	-	-
Czechia	IE	207	207	1.7%	207	∞	1	0%	T1	CS
Denmark	1	1	1	0.0%	1	151%	0	4%	T2	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	177	1 151	1 110	9.1%	932	526%	-41	-4%	CS,T2,T3	CS,PS
France	4 514	5 010	4 575	37.3%	61	1%	-436	-9%	T1,T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA,NO	537	706	5.8%	706	∞	169	32%	T1	CS
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
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	-79%	0	0%	-	-
Netherlands	583	709	1 416	11.6%	832	143%	707	100%	T1	D
Poland	NO	NO	-	-	-	-	-	-	-	-
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	117	378	333	2.7%	216	185%	-45	-12%	T3	CS
Slovenia	17	13	13	0.1%	-4	-24%	1	5%	D	CS
Spain	NO,NA	872	869	7.1%	869	∞	-3	0%	T3	PS
Sweden	598	833	858	7.0%	260	43%	26	3%	T3	PS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**6 432**	**11 894**	**12 251**	**100%**	**5 820**	**90%**	**357**	**3%**	**-**	**-**
Iceland	0	NO	NO	-	0	-100%	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**6 432**	**11 894**	**12 251**	**100%**	**5 819**	**90%**	**357**	**3%**	**-**	**-**

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

Table 4.29 2B10 Other: N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NA	NA	NA	-	-	-	-	-	NA	NA
Belgium	27	53	31	6.8%	3	11%	-23	-43%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	-	-	-	-	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	534	65	68	15.4%	-466	-87%	4	6%	T2,T3	CS,D,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
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	244	387	344	77.2%	100	41%	-44	-11%	T1	CS
Poland	NO	NO	-	-	-	-	-	-	-	-
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.0%	0	191%	0	-12%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	21	6	1	0.3%	-20	-95%	-5	-82%	T2,T3	CS,PS
United Kingdom	2	2	2	0.4%	-1	-29%	0	-2%	T3	CS
EU-27+UK	**829**	**514**	**446**	**100%**	**-383**	**-46%**	**-68**	**-13%**	**-**	**-**
Iceland	46	NO	NO	-	-46	-100%	-	-	NA	NA
United Kingdom (KP)	2	2	2	0.4%	-1	-29%	0	-2%	T3	CS
EU-KP	**875**	**514**	**446**	**100%**	**-430**	**-49%**	**-68**	**-13%**	**-**	**-**

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

Table 4.30: 2B10 Other: CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	7	6	6.8%	-1	-19%	-1	-12%	T3	PS
Belgium	NA	9	7	7.7%	7	∞	-2	-25%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	-	-	-	-	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	76	43	38	43.7%	-39	-50%	-5	-12%	T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
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	-	-	-	-	-	-	-	-
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.2%	0	191%	0	-12%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	1	1	1	0.9%	0	9%	0	-1%	T1,T2,T3	CS,D,PS
United Kingdom	191	52	35	40.7%	-156	-82%	-16	-32%	CS	CS
EU-27+UK	**276**	**111**	**87**	**100%**	**-189**	**-69%**	**-25**	**-22%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	191	52	35	40.7%	-156	-82%	-16	-32%	CS	CS
EU-KP	**276**	**111**	**87**	**100%**	**-189**	**-69%**	**-25**	**-22%**	**-**	**-**

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

Table 4.31 provides an overview of all sources reported under 2B10 Other Chemical Industry for all gases for the year 2018. The largest contributors to the total emissions are France, the United Kingdom and Belgium.

Table 4.31 2B10 Other: Overview of sources reported under this source category for 2018

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
		2018	2018	2018	2018	2018
Austria	10. Other (please specify), CO2 from Nitric Acid Production, Other chemical bulk production	137	0	NA	143	1%
Belgium	10. Other (please specify), Other non-specified	2026	0	0	2063	13%
Bulgaria	10. Other (please specify)	NA	NA	NA	-	-
Croatia	10. Other (please specify)	NO	NO	NO	-	-
Cyprus	10. Other (please specify)				-	-
Czech Republic	10. Other (please specify), Other non energy use in chemical industry, Non selective catalytic reduction	207	NO	NO	207	1%
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	1110	NO	NO	1110	7%
France	10. Other (please specify)	4575	2	0	4681	30%
Germany	10. Other (please specify), Other	NA	NA	IE	-	-
Greece	10. Other (please specify), Sulfuric acid, Hydrogen production	706	NA	NA	706	5%
Hungary	10. Other (please specify)	NO	NO	NO	-	-
Ireland	10. Other (please specify)	NO	NO	NO	-	-
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	1416	NO	1	1760	11%
Poland	10. Other (please specify)				-	-
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	333	0	0	333	2%
Slovenia	10. Other (please specify)	13	NO	NO	13	0%
Spain	10. Other (please specify), Other No-Specify	869	NA	NA	869	6%
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	858	0	0	860	5%
United Kingdom	10. Other (please specify), Chemical industry - other	2936	0.053		2937	19%
EU-27+UK		**15189**	**2**	**1**	**15686**	**100%**
Island	10. Other (please specify), Silicium production, Fertilizer production	NO	NO	NO	-	-
Great Britain	10. Other (please specify), Chemical industry - other	2936	0.053		2937	19%
EU-KP		**15189**	**2**	**1**	**15686**	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.7 Non-key sources

Non key sources in the chemical industry 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 2018 sixteen countries reported emissions from these categories which contributed 4.8 Mt of CO_2 equivalent or 0.1% of total EU-KP (without LULUCF) emissions.

4.2.3 Metal Industry (CRF Source Category 2C)

This source category includes two key sources for level and trend, namely CO_2 emissions from 2C1 Iron and Steel Production and PFC emissions from 2C3 Aluminium Production (*Table 4.32*).

Table 4.32: 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	2018		1990	2018	
2.C.1 Iron and Steel Production (CO_2)	95404	64484	T	L	L	96%
2.C.3 Aluminium Production (PFCs)	21277	613	T	L	0	100%
2.D.3 Other non energy products (CO_2)	8215	5844	0	L	L	91%

Table 4.33Table 4.33 2C Metal Industry: Countries' contributions to total GHG, CO2, HFC, PFC and SF6 emissions

summarises information by countries on total GHG emissions, CO_2, SF_6 and PFC emissions from Metal Production. Between 1990 and 2018, CO_2 emissions from 2C Metal Production decreased by 32% of total EU-KP (without LULUCF). The absolute decrease of GHG emissions was largest in Romania, Belgium, United Kingdom and Germany (in decending order).

Table 4.33 2C Metal Industry: Countries' contributions to total GHG, CO_2, HFC, PFC and SF_6 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2018 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2018 (kt CO2 equivalents)	SF6 emissions in 1990 (kt CO2 equivalents)
Austria	8 177	9 529	6 786	9 524	-	-	1 149	NO	242
Belgium	10 106	4 251	10 092	4 234	-	-	-	-	-
Bulgaria	1 629	186	1 603	186	NA	NA	NA	NA	NA
Croatia	1 581	9	336	9	NO	NO	1 240	NO	NO
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	9 670	6 949	9 655	6 935	NO	NO	NO	NO	NO
Denmark	60	0	30	0	NO	NO	NO	NO	30
Estonia	0	2	0	2	NO	NO	NO	NO	NO
Finland	1 976	2 075	1 976	2 075	NO	-	NO	-	NO
France	10 597	4 577	6 241	4 445	NO	NO	3 567	65	781
Germany	28 188	21 504	25 080	21 248	NA	18	2 889	126	180
Greece	1 203	1 207	1 012	1 108	NO	NO	190	99	NO
Hungary	3 701	1 408	3 317	1 402	NO	NO	376	NO	NO
Ireland	26	NO	26	NO	NO	NO	NO	NO	NO
Italy	6 421	1 731	4 378	1 682	NO	10	1 975	NO	NO
Latvia	70	NO	70	NO	NO	NO	NO	NO	NO
Lithuania	17	2	17	2	NO	NO	NO	NO	NO
Luxembourg	985	114	985	114	-	-	-	-	-
Malta	NO	NO	NO	NO	NO	-	NO	-	NO
Netherlands	3 090	42	452	19	NO	NO	2 638	22	NO
Poland	5 817	2 622	5 652	2 608	NA	NA	142	NO,NA	NA,NO
Portugal	447	75	446	75	NA	NO	NO,NA	NO	NO,NA
Romania	14 218	4 091	11 388	4 082	NO	NO	2 808	5	NA,NO
Slovakia	4 901	4 754	4 586	4 745	NO	NO	315	8	NO
Slovenia	551	218	343	202	NO	NO	208	16	NO
Spain	4 730	3 271	3 537	3 125	NO,NA	NO,NA	1 164	124	NO,NA
Sweden	3 871	2 678	3 260	2 616	NO	0	569	62	23
United Kingdom	9 395	2 541	7 400	2 354	NO	4	1 553	10	387
EU-27+UK	**131 425**	**73 836**	**108 670**	**72 793**	**NA,NO**	**32**	**20 783**	**536**	**1 642**
Iceland	844	1 846	348	1 766	NO	NO	495	76	NO
United Kingdom (KP)	9 395	2 541	7 400	2 354	NO	4	1 553	10	387
EU-KP	**132 270**	**75 682**	**109 018**	**74 559**	**NA,NO**	**32**	**21 277**	**613**	**1 642**

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 4.12: 2C Metal Industry CO_2 – Trend in EU-KP

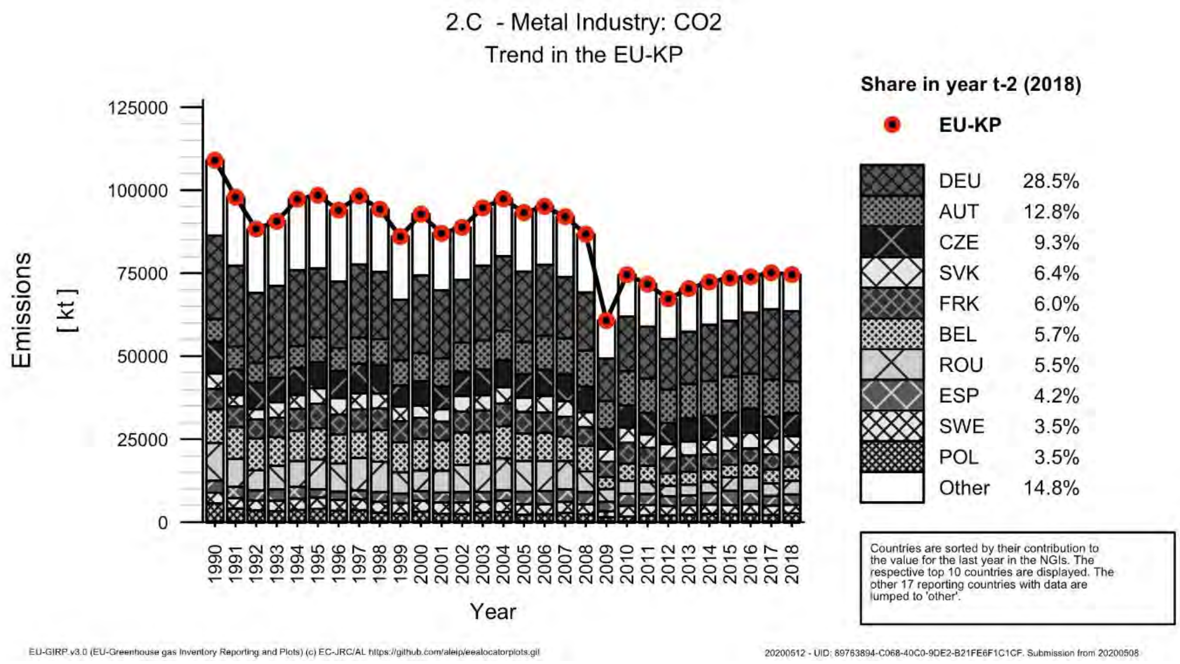


Table 4.34 provides information on the contribution of countries to EU recalculations of CO_2 emissions from 2C Metal Production for 1990 and 2017, including main explanations.

Table 4.34: 2C Metal Production: Contribution of countries to EU recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-0.2	-0.002	Recalculations in the IEA Joint Questionnaire resulted in a changed time series from 2005 onwards (-0.22 kt CO_2 in 2017)
Belgium	-244	-2.4	-	-	Recalculation of CO_2 emissions in 2C1 : the C content of the steel produced in the basic oxygen furnaces was substracted from the total CO_2 emissions in the Waloon region.
Bulgaria	-	-	0.01	0.01	Recalculations have been made due to a technical error in steel production value for the year 2017.
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-23	-0.4	The emission and oxidation factor for other bituminous coal were updated following the change in the data. The change was carried out for years 2014 – 2017; the impact of recalculation is minus 0.4% or 22 kt (in 2014) and 23 kt (in 2018). Thus this change is for the Czech Republic under the threshold of significance, but brings more accurate emission data in the inventory.
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	6	0.1	2.C.1: Blast furnace production of pig iron was changed between 2014 and 2017. This has an impact on CO_2 emissions for blast furnaces. 2.C.3: Updates to the CO_2 EFs of heating oil for the years 1990-2017 and natural gas for the years 1990-2013 lead to recalculations of these emissions.
Germany	-	-	2 018	10.5	Implementation of data of the final energy balance 2017 (2.C.1) Update of the activity rate carried forward in the last year, since the underlying statistics are only provided every two years (2.C.2
Greece	-	-	-1	-0.1	This is a minor recalculation concerning 2.C.2
Hungary	2	0.1	105	8.8	2.C.1.a – Steel production. CO_2 emissions from 2008 EAF steel production was reported years later by one of the EAF companies under the EU ETS. As

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					estimated 2008 emission data were used in the calculated extrapolation for 1985-2006, emission was recalculated for years 1985-2006 and 2008. 2.C.1.b – Pig iron production. Based on IEA and EU ETS data, part of the blast furnace gas produced during the BOF pig iron production was not transferred offsite but was flared, therefore this quantity can not be included in the recovery. CO_2 emissions and recovery was recalculated from 2007 onwards.
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-114	-2.0	-142	-6.3	Corrections in C balance for blast furnaces were introduced in the period 1988-2017 (the changes resulted mainly from Eurostat database update for coke and coal)
Portugal	322	258.6	23	42.3	Following considerable recommendations that resulted from UNFCCC, as well as from CRLTAP reviews, Iron and Steel sector underwent some major methodological changes for this submission. These changes resulted in significant recalculations. For details please refert to NIR p 4-72
Romania	-	-	0	0.0	Recalculations have been made for the 2017 year. An error has been identified in the calculation of CO_2 emissions in EAF. (CRF Category 2.C.1)
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-8	-0.3	CO_2 emissions were recalculated for 2017, due to the fact that the company has corrected the information provided in their questionnaires.
Sweden	0.1	0.003	0.1	0.002	2.C.1.a: Emissions form flaring of pilot fuel has been included for one facility. This affected emissions from 1990 of: CO_2, NOx, NMVOC and CO. 2.C.1.e: Correction of amount carbon bound in product for 2008 and 2012 led to an increase in reported CO_2 emission of 5 kton and 11 kton, respectively. Other corrections resulted in minor changes of reported CO_2 emissions for 2007, 2009, 2010, 2011 and 2013 (± 1.2 kton).
United Kingdom	-1	-0.01	0.4	0.02	There have been a few relatively trivial updates due to revisions to calorific values used in calculating the emission estimates UK energy statistics affecting the carbon balance calculations.
EU27+UK	-35	-0.0	1 979	2.8	
Iceland	0.0004	0.0001	-0.0004	-0.00002	
United Kingdom (KP)					NA
EU-KP	-35	-0.0	1 979	2.7	

In the current submission no recalculations were performed in PFC emissions from 2C – Metal production.

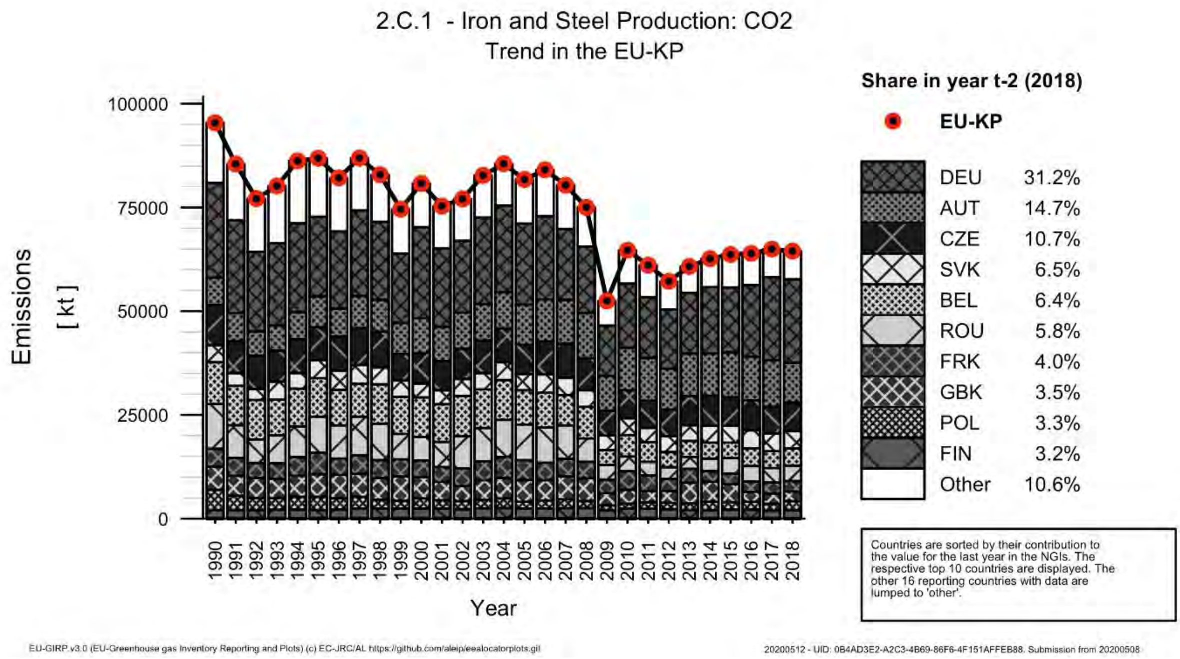
4.2.3.1 **2C1 Iron and steel production**

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. Countries use different methods for the allocation of emissions that are described in Table **4.37**.

CO_2 emissions from 2C1 Iron and Steel Production amounted to approximately 1.5 % of total GHG emissions (without LULUCF) in 2018. Germany accounts for 31.2 % of these emissions in the EU KP. Romania had the largest decrease in absolute terms between 1990 and 2018 while increases were encountered (in order of magnitude) in Austria, Slovenia and (on a small scale) Finland.

The overall emission trend between 1990 and 2018 roughly follows the trend of emissions from Germany that fluctuates due to varying production figures. Between 1990 and 2018, overall CO_2 emissions from iron and steel production decreased by 32% (Table 4.35). Between 2017 and 2018, emissions decreased by 1%.

Figure 4.13 2C1 Iron and Steel Production: CO_2 emissions – Trend in EU-KP



CO_2 emissions from iron and steel industry are reported by all countries except Cyprus, Estonia and Malta. Denmark and Ireland reported emissions from this sector in 1990. All follow higher-tier methods and most use country or plant specific methods (see Table **4.35**).

Table 4.35 2C1 Iron and Steel Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	6 610	11 162	9 495	14.7%	2 885	44%	-1 667	-15%	T1,T3	CS,PS
Belgium	10 034	4 038	4 121	6.4%	-5 912	-59%	84	2%	CS,T3	PS
Bulgaria	1 283	35	35	0.1%	-1 248	-97%	0	1%	T2	CS
Croatia	44	2	9	0.0%	-35	-79%	7	382%	OTH,T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	9 643	6 430	6 923	10.7%	-2 719	-28%	493	8%	CS,T2	CS,D,PS
Denmark	30	NO	NO	-	-30	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	1 884	2 052	3.2%	85	4%	168	9%	CS,T3	CS
France	4 351	2 678	2 565	4.0%	-1 786	-41%	-112	-4%	T2	CS
Germany	22 810	20 078	20 146	31.2%	-2 664	-12%	68	0%	T2	CS
Greece	105	81	91	0.1%	-14	-13%	10	13%	CS	PS
Hungary	3 155	1 302	1 402	2.2%	-1 753	-56%	100	8%	T3	PS
Ireland	26	NO	NO	-	-26	-100%	-	-	NA	NA
Italy	3 124	1 408	1 436	2.2%	-1 688	-54%	28	2%	T2	CR,CS,PS
Latvia	70	NO	NO	-	-70	-100%	-	-	NA	NA
Lithuania	17	2	2	0.0%	-15	-89%	0	-10%	T2	D
Luxembourg	985	107	112	0.2%	-873	-89%	5	4%	CS,T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	44	14	19	0.0%	-24	-56%	5	38%	T2	CS
Poland	4 959	1 663	2 152	3.3%	-2 807	-57%	489	29%	T2,T3	CS
Portugal	440	66	62	0.1%	-377	-86%	-4	-6%	T1,T3	D,PS
Romania	10 781	3 470	3 734	5.8%	-7 047	-65%	264	8%	T3	CS
Slovakia	4 168	4 328	4 188	6.5%	20	0%	-140	-3%	T2	PS
Slovenia	44	58	60	0.1%	16	37%	1	2%	T2	PS
Spain	2 501	1 420	1 614	2.5%	-887	-35%	194	14%	T2	CS,PS
Sweden	2 624	2 230	1 978	3.1%	-646	-25%	-253	-11%	T2,T3	PS
United Kingdom	5 591	2 502	2 286	3.5%	-3 305	-59%	-216	-9%	T2	CS
EU-27+UK	**95 404**	**64 959**	**64 484**	**100%**	**-30 920**	**-32%**	**-474**	**-1%**	**-**	**-**
Iceland	NO	NO,NA	NO,NA	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 591	2 502	2 286	3.5%	-3 305	-59%	-216	-9%	T2	CS
EU-KP	**95 404**	**64 959**	**64 484**	**100%**	**-30 920**	**-32%**	**-474**	**-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 countries 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 emission factors and CO_2 emissions for the various countries and sub-categories are provided in Table **4.37**.

Table 4.36 2C1 Iron and Steel Production: Implied emission factors

Member State	1990				Member State	2018				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**			9495		
	Steel	3921	1.68	6591		Steel	6176	1.53	9455	T1,T3	CS,PS
	Pig Iron	3444	NO,IE	IE		Pig Iron	5263	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			41		
	Electric Furnace Steel	370	0	20		Electric Furnace Steel	721	0	41	T3	PS
Belgium	**Iron and steel production**			10034	**Belgium**	**Iron and steel production**			4121		
	Steel	11570	0.73	8445		Steel	7925	0.51	4020	CS,T3	PS
	Pig Iron	9415	NA,IE	IE		Pig Iron	4754	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	5456	0.02	94	CS,T3	PS
	Pellet	660	NO,IE	IE		Pellet	NO	NO	NO	NA	NA
	Other			IE		Other			8		
	Use of electrodes	NA	NO,IE	IE		Use of electrodes	2149	0	8	CS,T3	PS
Bulgaria	**Iron and steel production**			1283	**Bulgaria**	**Iron and steel production**			35		
	Steel	2180	0.59	1283		Steel	684	0.05	35	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		

Member State	1990				Member State	2018				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)		
Croatia	**Iron and steel production**			44	**Croatia**	**Iron and steel production**			9		
	Steel	424	0.05	20		Steel	136	0.06	9	T3	PS
	Pig Iron	209	0.12	24		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			0		
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			-		
Czechia	**Iron and steel production**			9643	**Czechia**	**Iron and steel production**			6923		
	Steel	8190	IE,NA	IE		Steel	5034	IE,NA	IE	NA	NA
	Pig Iron	6106	IE,NA	IE		Pig Iron	4028	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	5723	IE,NA	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			9643		Other			6923		
	Use of limestone and dolomite	891	1	462		Use of limestone and dolomite	1001	1	847	CS	PS
	Metallurgical coke	7125	1	9180		Metallurgical coke	2542	2	6076	T2	CS,D
Denmark	**Iron and steel production**			30	**Denmark**	**Iron and steel production**			NO		

Member State	1990				Member State	2018				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)		
	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
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
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**			2052		
	Steel	2861	0.69	1967		Steel	4074	0.50	2052	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	793	NO	NO	NA	NA
France	**Iron and steel production**			4351	**France**	**Iron and steel production**			2565		
	Steel	19073	0.09	1715		Steel	15449	0.08	1233	T2	CS
	Pig Iron	14088	0.09	1317		Pig Iron	10471	0.05	473	T2	CS

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2018 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	22000	0.06	1319		Sinter	13304	0.06	810	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			49		
Germany	**Iron and steel production**			22810	**Germany**	**Iron and steel production**			20146		
	Steel	43939	0.52	22810		Steel	42435	0.47	20146	T2	CS
	Pig Iron	32263	NO,IE	IE		Pig Iron	27834	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**			91		
	Steel	999	0.10	105		Steel	1467	0.06	91	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**			3155	**Hungary**	**Iron and steel production**			1402		
	Steel	2963	0.12	348		Steel	1989	0.12	231	T3	PS
	Pig Iron	1697	1.65	2427		Pig Iron	1355	1.58	896	T3	PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	72	5.28	380		Sinter	48	5.69	275	T3	PS
	Pellet	IE	IE	IE		Pellet	IE	IE	IE	NA	NA
	Other			NO		Other			NO		

Member State	1990				Member State	2018				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)		
Iceland	**Iron and steel production**			NO	**Iceland**	**Iron and steel production**			NO,NA		
	Steel	NO	NO	NO		Steel	NO	NO,NA	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			NA		
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**			1436		
	Steel	25467	0.05	1346		Steel	24503	0.04	1033	T2	CR,CS,PS
	Pig Iron	11852	0.15	1778		Pig Iron	4845	0.08	404	T2	CR,CS,PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13577	NO,NA	NA		Sinter	5327	NO,NA	NA	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

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2018 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	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**			2		
	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			17		Other			2		
	Cast Iron	106	0	17		Cast Iron	2	1	2	T2	D
Luxem-bourg	**Iron and steel production**			985	**Luxem-bourg**	**Iron and steel production**			112		
	Steel	3506	0.12	404		Steel	2228	0.05	112	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		

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2018 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
Nether-lands	**Iron and steel production**			44	Nether-lands	**Iron and steel production**			19		
	Steel	5162	0.01	43		Steel	7027	0.00	19	T2	CS
	Pig Iron	NA	NO,IE	IE		Pig Iron	NA	NO,IE	IE	NA	NA
	Direct reduced iron	NO	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			NO		
	Other Iron and Steel Production.Other non-specified	NA	NA	1		Other Iron and Steel Production.Other non-specified	NA	NO	NO	NA	NA
Poland	**Iron and steel production**			4959	Poland	**Iron and steel production**			2152		
	Steel	IE	IE	IE		Steel	IE	IE	IE	NA	NA
	Pig Iron	8657	0.12	1043		Pig Iron	4788	0.16	749	T3	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11779	0.07	841		Sinter	6738	0.05	355	T3	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			3075		Other			1047		
	Basic Oxygen Furnace Steel	7207	0	929		Basic Oxygen Furnace Steel	5418	0	769	T2	CS
	Electric Furnace Steel	2309	0	85		Electric Furnace Steel	4918	0	279	T2	CS
	Open-hearth Steel	3945	1	2060		Open-hearth Steel	NO	NO,NA	NO	NA	NA
Portugal	**Iron and steel production**			440	Portugal	**Iron and steel production**			62		
	Steel	746	0.10	73		Steel	2254	0.03	62	T1,T3	D,PS
	Pig Iron	339	0.88	298		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	344	0.20	69		Sinter	NO	NO	NO	NA	NA

Member State	1990				Member State	2018				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)		
	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**			3734		
	Steel	9959	1.08	10781		Steel	3701	1.01	3734	T3	CS
	Pig Iron	5916	NO,IE	IE		Pig Iron	1979	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	2458	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**			4188		
	Steel	3562	1.17	4150		Steel	4642	0.90	4177	T2	PS
	Pig Iron	17	NO,IE	IE		Pig Iron	0	NO,IE	IE	NA	NA
	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			11		
	EAF production of steel	311	0	18		EAF production of steel	380	0	11	T2	PS
Slovenia	**Iron and steel production**			44	**Slovenia**	**Iron and steel production**			60		
	Steel	632	0.07	44		Steel	667	0.09	60	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**			2501	**Spain**	**Iron and steel production**			1614		

Member State	1990 category	1990 Activity data (kt)	1990 Implied Emission Factor (t/t)	1990 CO_2 Emissions (kt)	Member State	2018 category	2018 Activity data (kt)	2018 Implied Emission Factor (t/t)	2018 CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Steel	13163	0.08	1045		Steel	14794	0.05	699	T2	CS,PS
	Pig Iron	C	C	246		Pig Iron	C	C	344	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	210	T2	CS
	Pellet	IE	IE,NA	IE		Pellet	IE	IE,NA	IE	NA	NA
	Other			672		Other			362		
	Flaring in iron and steel production	C	C	672		Flaring in iron and steel production	C	C	362	T2	PS
Sweden	**Iron and steel production**			2624	**Sweden**	**Iron and steel production**			1978		
	Steel	1755	0.09	156		Steel	1839	C,NA	C	T2	PS
	Pig Iron	2736	0.77	2094		Pig Iron	2915	0.53	1547	T3	PS
	Direct reduced iron	109	1.19	129		Direct reduced iron	108	C,NA	C	T3	PS
	Sinter	1058	0.20	212		Sinter	NO	NO	NO	NA	NA
	Pellet	13079	0.00	33		Pellet	24337	0.00	103	T2	PS
	Other			NO		Other			NO		
United Kingdom	**Iron and steel production**			5591	**United Kingdom**	**Iron and steel production**			2286		
	Steel	17904	0.01	220		Steel	7336	0.01	100	T2	CS
	Pig Iron	12463	0.15	1837		Pig Iron	5588	0.17	925	T2	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	C	3534		Sinter	C	C	1261	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 countries 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”.

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 countries 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 4.37.

Table 4.37 CO_2 Emissions (2018) 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 EU-KP emissions in 2018	Share 2C1
	1A2a	2C1	Combined		
Austria	1 722	9 495	11 217	7%	85%
Belgium	1 266	4 121	5 387	3%	77%
Bulgaria	130	35	165	0%	21%
Croatia	54	9	63	0%	14%
Cyprus	NO,IE	NO	-	-	-
Czech Republic	2 020	6 923	8 943	5%	77%
Denmark	107	NO	107	0%	-
Estonia	NO	NO	-	-	-
Finland	905	2 052	2 957	2%	69%
France	13 922	2 565	16 487	10%	16%
Germany	36 534	20 146	56 679	35%	36%
Greece	91	91	182	0%	50%
Hungary	207	1 402	1 609	1%	87%
Ireland	2	NO	2	0%	-
Italy	10 008	1 436	11 444	7%	13%
Latvia	0	NO	0	0%	-
Lithuania	NO	2	2	0%	100%
Luxembourg	285	112	397	0%	28%
Malta	NO	NO	-	-	-
Netherlands	5 035	19	5 055	3%	0%
Poland	5 459	2 152	7 611	5%	28%
Portugal	98	62	160	0%	39%
Romania	924	3 734	4 659	3%	80%
Slovakia	3 424	4 188	7 612	5%	55%
Slovenia	209	60	269	0%	22%
Spain	5 650	1 614	7 264	4%	22%
Sweden	1 342	1 978	3 320	2%	60%
United Kingdom	8 845	2 286	11 131	7%	21%
EU-27+UK	**98 239**	**64 484**	**162 723**	**100%**	**40%**
Iceland	1	NO,NA	-	-	-
United Kingdom (KP)	8 845	2 286	11 131	7%	21%
EU-KP	**98 241**	**64 484**	**162 723**	**100%**	**40%**

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 **4.37**) varies across countries. This indicates that the boundary between 1A2a and 2C1 is not uniformly interpreted by countries. The eight countries with largest CO_2 emissions from iron and steel production allocate their emissions in the following ways:

- Germany: Approximately 36% 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 (79%) 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 (84%) is reported under 1A2a. Emissions from sinter production are reported under 1A2a.
- Austria: 85% 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 (87%) 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: 77% of emissions are reported under category 2C1. It also includes emissions from limestone and dolomite use.
- Spain: Major share of emissions (78%) is reported under 1A2a, including emissions from coke production.
- Slovakia: 55% of emissions are reported under 2C1. Technological emissions from pig iron (2.C.1.b), steel (2.C.1.a) and emissions from coke electrodes used by the EAF steel production (2.C.1.f) are included in this category.

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 4.38 summarises information by countries 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-KP GHG emissions (without LULUCF) in 2018. Between 1990 and 2018, PFC emissions from this source decreased by 97 %. In 2018, Germany contributed the highest share among the EU-KPs, amounting to 20.6 % of overall emissions, followed by Spain (20.2%), Greece (16.1 %), Iceland (12.5%) and France (10.6%). Of the 12 countries reporting PFC emissions under this category in 2018, seven use plant or country-specifc emission factors.

Table 4.38 2C3 Aluminium Production: Countries' contributions to PFC emissions and information on method applied and emission factor

Member State	PFCs Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		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	-	-	-	-	-	-	-	-	-	-
Czechia	-	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	-	-	-	-	-	-	-	NA	NA
France	3 567	41	65	10.6%	-3 502	-98%	24	57%	T2,T3	CS,PS
Germany	2 889	84	126	20.6%	-2 763	-96%	42	50%	T3	CS
Greece	190	82	99	16.1%	-91	-48%	17	20%	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	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	-	-	-	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	NA	NA
Netherlands	2 638	13	22	3.7%	-2 615	-99%	9	73%	T2	CS
Poland	142	NO	NO	-	-142	-100%	-	-	NA	NA
Portugal	NO,NA	NO	NO	-	-	-	-	-	NA	NA
Romania	2 808	6	5	0.8%	-2 803	-100%	-1	-11%	T2	D,PS
Slovakia	315	9	8	1.3%	-307	-98%	-1	-10%	T2	PS
Slovenia	208	17	16	2.5%	-192	-92%	-2	-11%	T3	D,PS
Spain	1 164	120	124	20.2%	-1 041	-89%	4	3%	T2	D
Sweden	569	36	62	10.0%	-507	-89%	25	71%	T2	D
United Kingdom	1 553	15	10	1.7%	-1 543	-99%	-5	-31%	T2	PS
EU-27+UK	**20 783**	**423**	**536**	**88%**	**-20 246**	**-97%**	**113**	**27%**	**-**	**-**
Iceland	495	68	76	12.5%	-418	-85%	8	12%	T2	D
United Kingdom (KP)	1 553	15	10	1.7%	-1 543	-99%	-5	-31%	T2	PS
EU-KP	**21 277**	**491**	**613**	**100%**	**-20 665**	**-97%**	**122**	**25%**	**-**	**-**

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

All countries reduced their emissions from this source between 1990 and 2018. France, Germany, the Netherlands, and Romania had the largest decreases in absolute terms. The decreasing trend of PFC emissions from this key source between 1990 and 2018 is due to production stop or decline and due to process improvements. The emission peak in 2002 (see Figure 4.14) 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 228, Netherlands: page 146, Sweden: page 265). 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.

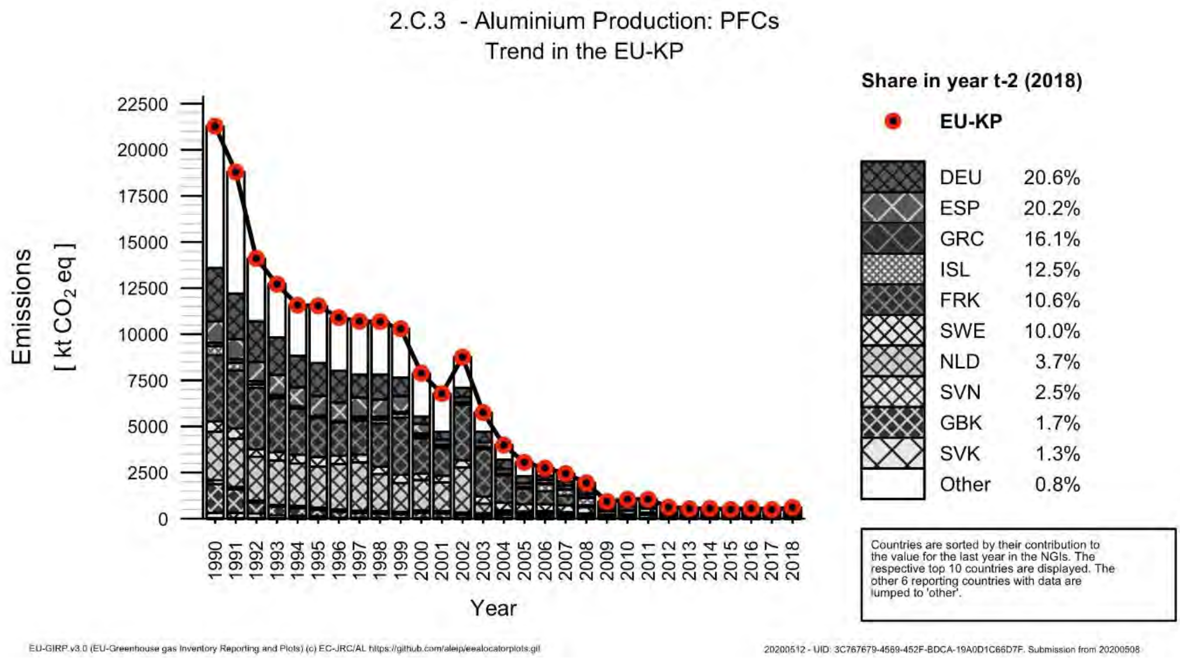
The Netherlands: Estimations of the PFC emissions from primary aluminium production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990‑2018. Emission factors are plant-specific and confidential and are based on measured data.

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 267 of Sweden's NIR 2020.

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 ###. 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 4.14 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 Belgium, 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 ###.

4.2.4 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 4.39 summarises information by countries on total CO_2 emissions. Between 1990 and 2018, CO_2 emissions from 2D non-energy products from fuels and solvent use decreased by 26.4 %. The absolute decrease of CO_2 emissions was largest in France, Germany and Italy (in decending order).

Table 4.39: Key source categories for level and trend analyses and share of countries emissions using higher tier methods for sector 2D (Table excerpt).

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
2.D.3 Other non energy products (CO_2)	8215	5844	0	L	L	91%

Table 4.40: 2D Non-energy products from fuels and solvent use: countries' contributions to total GHG, CO_2, N_2O- and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2018 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	349	142	349	142	NA	NA	NA	NA
Belgium	202	124	202	124	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	169	99	169	99	NO,NA	NO,NA	NO,NA	NO,NA
Croatia	228	83	228	83	NA	NA	NA	NA
Cyprus	9	30	9	30	NE,NA	NE,NA	NE,NA	NE,NA
Czechia	126	154	126	154	NA,NO	NO,NA	NA,NO	NO,NA
Denmark	166	161	166	161	0	0	0	1
Estonia	36	24	36	24	NO	NO	NO	NO
Finland	220	159	218	158	2	1	0	0
France	2 146	1 198	2 143	1 195	1	3	2	0
Germany	2 984	2 035	2 983	2 034	1	1	NA	NA
Greece	130	29	130	29	NA,NO	NO,NA	NA,NO	NO,NA
Hungary	206	105	206	105	NA,NO	NO,NA	NA,NO	NO,NA
Ireland	94	120	94	120	NO	NO	NO	NO
Italy	1 722	1 097	1 722	1 097	NA,NO	NO,NA	NA,NO	NO,NA
Latvia	44	46	44	46	NO,NA	NO,NA	NO,NA	NO,NA
Lithuania	45	31	45	31	NO	NO	NO	NO
Luxembourg	21	32	21	32	NO	NO	NO	NO
Malta	4	5	4	5	NA	NA	NA	NA
Netherlands	187	324	187	324	NO,NA	NO,NA	0	0
Poland	451	781	451	781	NA,NO	NO,NA	NA,NO	NO,NA
Portugal	244	218	243	217	NO	NO	1	1
Romania	1 341	903	1 341	903	NO,NE	NO,NE	NO,NE	NO,NE
Slovakia	207	99	207	99	NO,NA,NE	NO,NE,NA	NO,NA,NE	NO,NE,NA
Slovenia	8	32	8	32	NA	NA	NA	NA
Spain	912	859	912	859	NO,NA	NA	NO,NA	NA
Sweden	393	442	393	442	NA	NA	NA	NA
United Kingdom	553	367	553	367	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-27+UK	**13 195**	**9 698**	**13 188**	**9 691**	**4**	**5**	**3**	**2**
Iceland	7	6	7	6	NE,NA	NO,NE,NA	NE,NA	NO,NE,NA
United Kingdom (KP)	553	367	553	367	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-KP	**13 202**	**9 704**	**13 195**	**9 697**	**4**	**5**	**3**	**2**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.41 provides information on the contribution of countries to EU recalculations of CO_2 emissions from 2D Non-energy products from fuels and solvent use for 1990 and 2017, including main explanations.

Table 4.41: 2D Non-energy products from fuels and solvent use: Contribution of countries to EU recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-8	-5.6	Following in depth QC activities time series inconsistencies in the solvents model were re-moved: this was due to changes of statistical data, concerning ethers and antifreeze, as well as AD for urea used.
Belgium	-12	-5.5	12	11.9	Flemish region: +3,14 kt CO_2 in 2D1: update AD lubricants, also update AD in other regions + update COPERT model to COPERT5,3 with consequences for the categories 2D1 and 2D3

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Bulgaria	-	-	0.01	0.01	The urea consumption has been recalculated due to the revision of the fuel consumption data and the implementation of an updated COPERT 5.2.2 model, which corrected some errors.
Croatia	-4	-1.7	5	7.8	New data for Solvent use sub-category are included for the entire reporting period, mainly due to including new activity in the emission calculation (asphalt blowing in oil refineries) and due to updating the IIR methodology in accordance with revised EMEP/EEA Air Pollutant Emission Inventory Guidebook, 2019. This concerns the time series 1990-2017.
Cyprus	-10	-54.1	6	23.3	Recalculations due to change of factors used for calculation (following 2006 GL), new information on diesel consumption and recalculation of NMVOC emissions.
Czechia	-	-	-1	-0.7	Due to updated activity data and due to use of COPERT 5 model in 1.A.3 the activity data was consequently updated also for the category 2.D.3 Other – Urea Used as catalyst.
Denmark	0.1	0.1	-1	-0.4	Recalculations due to: An update of activity data from Statistics Denmark • Addition of an ethanol category in Statistics Denmark throughout the time series, which account for less than 2% of the ethanol emissions • Adjustments of the reallocation
Estonia	-	-	4	17.2	2004-2017 emissions from NFR category 2D3a Domestic solvent use including fungicides have been recalculated because of recalculation of international trade data.
Finland	-	-	-	-	
France	1	0.05	3	0.2	Recalculations concerning the Solvent sector, due to updated activity data.
Germany	-5	-0.2	-85	-4.0	Change in methodology (subtraction of biogenous waxes) of Parraffin Wax: sector from 1990 onwards.
Greece	50	63.0	-3	-8.3	Lubricant Use: emissions from 2012-2017 were updated die to updated activity data were available regarding from the energy balance. Paraffin Wax Use: update of AD, as import and export of paraffin candles are now taken into account.
Hungary	-4	-1.8	-32	-22.9	Revision of methodology in indirect emissions calculation
Ireland	0	0.4	34	36.4	Parrafin Wax: An average recalculation of 7.5 per cent occurred for all years, 1990-2016, due to a change in ODU factor for candles from 0.9 to 1.0. In 2017 a recalculation of 155 per cent is seen due to a revision in the activity data for candles by the national statistics provider Urea Use: There was a recalculation in fuel balanced mileage in the COPERT model for road transport, which resulted in changes for HDVs; including buses and coaches, from 2006-2017 and in Passenger cars and LDVs for 2015-2017
Italy	12	0.7	-11	-1.1	Significant recalculation occurred along the whole timeseries for CO_2 emissions from Lubricant use (2.D.1) due to the use of updated activity data timeseries and also in 2.D.3.
Latvia	-	-	1	3.6	Urea Use: Recalculation was done for CO_2 emissions in 2.D.3 Urea use due to precised Activity Data. Solvent Use: NMVOC emissions from Solvent use sector were recalculated taking into account that activity data for year 2017 was specified and therefore emissions were recalculated for this year.
Lithuania	-5	-9.9	-25	-46.2	Solvent Use: CO_2 emissions were recalculated due to changes in NMVOC emission calculation methodology. Tier 2 method has been used for subcategories 2D3e Degreasing and 2D3f Dry cleaning since 2002 and since 2005 for 2D3a Domestic solvent use, 2D3d Coating application, 2D3g Chemical products, 2D3h Printing and 2D3i Wool production subcategories.
Luxembourg	-1	-5.9	-1	-2.3	Urea Use: The activity data for the years 2005 to 2017 was updated. Solvent Use: The method for calculating solvent emissions has been modified. The modifications conern Deicing products and take into account the recent guidelines elaborated in the EMEP/EEA air pollutant emission inventory guidebook 2019. While previously, emission from deicing products were calculated alongside all other solvents, in the new approach, emissions from deicing products are calculated separately and the emissions are added to the emissions of SNAP category 0604.
Malta	0	0.0	0	5.9	Urea Use: Urea solution consumption for use in selective catalytic reduction in transport has been included in 2.D.3. Other (Urea for denoxification).

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Netherlands	-0	-0.2	-0	-0.1	Parafin Wax Use: Updated data on parafin use (Candles)
Poland	34	8.2	99	13.7	Solvent use: Update of NMVOC emission
Portugal	-29	-10.6	-33	-13.8	Solvent Use: recalculations due to a methodological revision for 2D3a
Romania	-315	-19.0	13	1.1	Recalculations have been made for the 1990-1994 and 2000-2017 periods. 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)
Slovakia	105	101.7	-16	-14.1	Recalculation of CO_2 and NMVOC in 2.D.3 Other. Methodological changes in CTRLAP and NECD inventories resulted in the recalculation of NMVOC emissions for the whole time series. Recalculation of NMVOC emissions resulted in the recalculation of the respective indirect CO_2 emissions. Recalculation of CO_2 from the urea used in vehicles due the using of new data provided by the update version of the COPERT model for 2014 – 2017 (connected with recalculations in 1.A.3.b – Road Transportation. References to the SVK NIR 2020 IPPU 15-01-2020: Chapters 4.5; 4.10.3 and Annex 4.1.
Slovenia	-	-	-	-	
Spain	4	0.4	4	0.5	New estimates of NMVOC emissions from chemical production of refined olive oil. Affects to NMVOC emissions and hence to indirect CO_2 emissions from NMVOC Update the activity data in the extraction of fat and oil from seeds and plants affecting NMVOC emissions and hence to indirect CO_2 emissions from NMVOC
Sweden	-	-	2	0.5	Updated activity data, and new statistical data became available for all three subsectors of 2.D., which led to recalcultations of the year 2017.
United Kingdom	-0	-0.0	-108	-20.7	Revisions to demand figures within DUKES resulting in downward revisions to total use of petroleum coke within 2D3.
EU27+UK	-179	-1.3	-140	-1.4	
Iceland	-0	-3.2	-0	-0.2	Update of activity data; for some categories under 2D more accurate activity data without interpolation have been retrieved by Statistics Iceland.
United Kingdom (KP)					NA
EU-KP	-179	-1.3	-140	-1.4	

4.2.4.1 **2D3 Other non-energy products from fuels and solvent use**

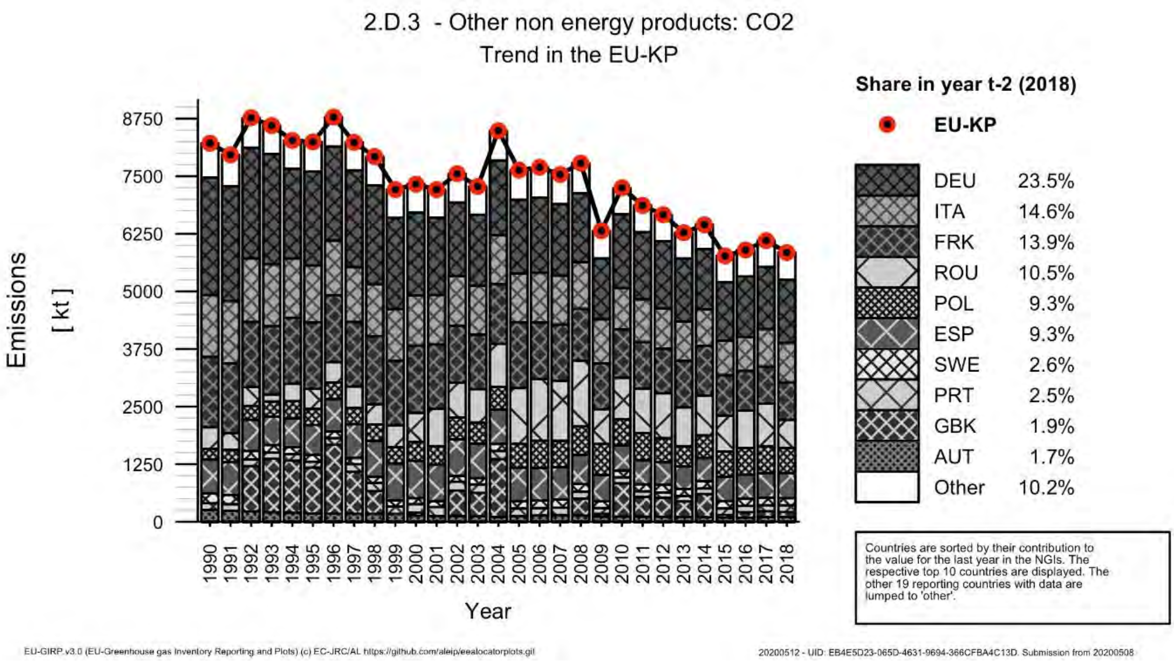
CO_2 emissions from this sector amounted to approximately 0.14% of total GHG emissions (without LULUCF) in 2018. France, Germany, Italy and Romania together account for 63% of all emissions in the EU 27+UK. CO_2 emissions from this sector decreased by 29% since 1990, the biggest reductions in absolute terms occurred in Germany and France (respectively -1 181 and -717 kt). CO_2 emissions decreased in most contries. Belgium, Cyprus, Latvia, Finland, Greece, Luxembourg, Czechia, Poland, Romania and Slovenia showed CO_2 emission increases since 1990. The peak in 2002 is due to an increase of CO_2 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 4.42 2D3 Other non-energy products from fuels and solvent use: countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2	%	kt CO2	%		
Austria	252	98	102	1.7%	-150	-60%	3	3%	T1,T2	CS,D
Belgium	NO,NA	29	30	0.5%	30	∞	1	3%	M,T3	CS,OTH
Bulgaria	87	72	72	1.2%	-15	-18%	-1	-1%	T1,T2	CR,D
Croatia	133	53	63	1.1%	-70	-53%	10	18%	OTH,T1	D
Cyprus	7	25	26	0.4%	18	243%	1	3%	CS,D	CS,D
Czechia	NO,NA	16	17	0.3%	17	∞	0	2%	T1	D
Denmark	94	65	71	1.2%	-24	-25%	6	9%	CS,T2,T3	CS,D,OTH
Estonia	18	20	20	0.3%	1	6%	0	0%	D,T2	D
Finland	NO	10	12	0.2%	12	∞	2	20%	T1	D
France	1 530	811	813	13.9%	-717	-47%	2	0%	T1,T2	CS,D,PS
Germany	2 552	1 355	1 371	23.5%	-1 181	-46%	17	1%	CS,D,M	D
Greece	NO,NA	1	1	0.0%	1	∞	0	16%	D	D
Hungary	120	74	73	1.2%	-47	-39%	-1	-1%	T1,T2	D
Ireland	51	50	51	0.9%	0	0%	1	3%	T1,T2	D
Italy	1 341	811	853	14.6%	-488	-36%	42	5%	CR,CS,T2	R,CS,M,PS
Latvia	21	23	25	0.4%	4	18%	1	6%	CS,D,T1,T2	D,PS
Lithuania	38	12	13	0.2%	-25	-65%	1	10%	T1,T2,T3	CR,D
Luxembourg	14	23	24	0.4%	10	70%	1	5%	CS,M	CS,D
Malta	0	1	1	0.0%	1	2925%	0	-3%	T1	D
Netherlands	NO	21	21	0.4%	21	∞	-1	-4%	T3	CS
Poland	237	587	544	9.3%	306	129%	-44	-7%	T1,T3	D
Portugal	147	136	148	2.5%	1	1%	12	9%	CR,NO,T2	CS,NO,OTH
Romania	466	916	613	10.5%	147	32%	-303	-33%	CR,D	CR,CS,PS
Slovakia	157	66	68	1.2%	-89	-57%	2	3%	CS,T2	CS
Slovenia	NO,NA	5	6	0.1%	6	∞	1	22%	M	M
Spain	728	537	543	9.3%	-186	-26%	6	1%	T1,T2	D
Sweden	217	159	154	2.6%	-63	-29%	-4	-3%	T1,T3	CS,D
United Kingdom	NE,NO	125	108	1.9%	108	∞	-17	-13%	T3	CR,D
EU-27+UK	**8 212**	**6 100**	**5 841**	**100%**	**-2 371**	**-29%**	**-259**	**-4%**	**-**	**-**
Iceland	3	3	3	0.0%	0	10%	0	3%	D	D
United Kingdom (KP)	NO,NE	125	109	1.9%	109	∞	-17	-13%	T3	CR,D
EU-KP	**8 215**	**6 103**	**5 844**	**100%**	**-2 371**	**-29%**	**-259**	**-4%**	**-**	**-**

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

Figure 4.15 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 countries because of the different methods used, and because of the fact that this category is split into many subcategories with varying EFs. Table 4.43 provides an overview of countries' reporting of CO_2 emissions from 2D3.

Table 4.43 2D3 Other non-energy products from fuels and solvent use: Reporting of CO_2 emissions by countries

MS	Category	kt
AUT	3. Other (please specify)	101.88
	Solvent use	66.23
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	35.64
BEL	3. Other (please specify)	30.27
	Solvent use	NA
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	30.27
	Unspecified	NO
BGR	3. Other (please specify)	71.83
	Solvent use	68.73
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Other chemical products	3.09
CYP	Other (please specify)	25.54
	Dry cleaning	0.06
	Coating applications	4.78
	Chemical products	0.02
	Asphalt roofing	0.03
	Domestic solvent use including fungicides	2.31
	Road paving with asphalt	0.00
	Printing	0.50
	Urea-based catalysts	1.47
	Other	16.35

MS	Category	kt
EST	3. Other (please specify)	19.56
	Solvent use	18.37
	Road paving with asphalt	0.04
	Urea based catalysts for motor vehicles	1.15
FIN	3. Other (please specify)	12.34
	Solvent use	NO
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Use of urea-based catalysts	12.34
FRK	3. Other (please specify)	812.96
	Solvent use	303.82
	Road paving with asphalt	NA
	Asphalt roofing	NE
	Other incl. urea use in SCR	509.15
GBE	3. Other (please specify)	108.39
	Solvent use	NE
	Urea use (road transport)	63.49
	Petroleum coke use	44.90
GRC	3. Other (please specify)	0.88
	Solvent use	NA
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Urea used as a catalyst	0.88
HRV	3. Other (please specify)	62.92
	Solvent use	56.29
	Road paving with asphalt	0.02

MS	Category	kt
LTU	3. Other (please specify)	13.31
	Solvent use	11.19
	Road paving with asphalt	0.00
	Asphalt roofing	0.01
	Urea-based catalyst	2.10
LUX	3. Other (please specify)	23.96
	Solvent use	10.87
	Urea-based catalysts	13.09
LVA	3. Other (please specify)	24.62
	Urea use	1.24
	Solvent Use	23.28
	Asphalt roofing	0.05
	Road paving with asphalt	0.05
MLT	3. Other (please specify)	0.70
	Solvent use	NA
	Road paving with asphalt	0.01
NLD	3. Other *(please specify)*	20.68
	Ureum use in SCR	20.68
POL	3. Other (please specify)	543.62
	Solvent use	496.45
	Urea used as catalyst	47.17
PRT	3. Other (please specify)	148.43
	Solvent use	132.04
	Road paving with asphalt	9.01
	Urea-based catalysts	7.38
ROU	3. Other (please specify)	612.53

MS	Category	kt
CZE	3. Other (please specify)	16.53
	Solvent use	NO
	Road paving with asphalt	NA
	Urea used as catalyst	16.53
DEU	3. Other (please specify)	1371.45
	Solvent use	1122.84
	Road paving with asphalt	NE
	Asphalt roofing	NE
	AdBlue	248.62
DNM	3. Other (please specify)	70.62
	Solvent use	60.71
	Road paving with asphalt	0.94
	Asphalt roofing	0.02
	Urea used in catalysts	8.94
ESP	3. Other (please specify)	542.67
	Solvent use	483.90
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea-based catalytic converter	58.77

MS	Category	kt
	Asphalt roofing	0.01
	Urea based CC	6.60
HUN	3. Other (please specify)	72.75
	Other (please specify)	72.75
	Indirect CO_2 from solvents	64.91
	Urea based catalysts	7.84
IRL	3. Other (please specify)	51.20
	Solvent use	41.32
	Urea used as a catalyst	9.89
ITA	3. Other (please specify)	860.51
	Solvent use	781.58
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used in power plants	9.31
	Urea used in engines	69.63

MS	Category	kt
	Solvent use	117.55
	Road paving with asphalt	NE
	Asphalt roofing	NE
	Petroleum coke use	493.58
	Urea use	1.39
SVK	3. Other (please specify)	67.84
	Solvent use	58.18
	Road paving with asphalt	NE
	Asphalt roofing	NE
	Urea catalytic converters	9.66
SVN	3. Other (please specify)	5.83
	Asphalt roofing	NA
	Road paving	NA
	Solvent use	NA
	Urea based catalyst	5.83
SWE	3. Other (please specify)	154.31
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Solvent use	154.31
	Urea used as catalyst	54.64
ISL	Other (please specify)	2.79
	Chemical products	0.01
	Decreasing	0.12
	Dry cleaning	0.00
	Printing	0.33

MS	Category	kt

MS	Category	kt

MS	Category	kt
	Coating applications	0.84
	Organic preservative	0.07
	Creosotes	NO
	Domestic solvent use including fungicide	1.41

4.2.5 Electronics Industry (CRF Source Category 2.E)

2.E Electronics Industry 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), which relates to highly specialized industrial processes.

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.

The gases emitted include in particular PFCs, SF_6 and NF3, HFC emissions occur to relatively small extent only. Attempts have been made in recent years to reduce emissions through process optimization and replacement of certain high-GWP gases, when feasible.

4.2.6 Product uses as substitutes for ODS (CRF Source Category 2.F)

This emission source category relates to the consumption of halocarbons (HFCs and PFCs) in different applications.

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. Due to their high global warming potentials, HFCs are addressed by the so-called MAC Directive, which bans the use of HFCs with a GWP >150 in new passenger cars since 2017, and the EU F-gas Regulation No. 517/2014, which establishes a phase down scheme for HFCs and other measures to limit use and emissions of F-gases.

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 nowadays but mainly in semiconductor manufacture (2.E.1).

The source category 2.F Product uses as substitutes for ODS includes two key categories which occur in all countries: Refrigeration and air conditioning (2.F.1), foam blowing agents (2.F.2) and aerosols (2.F.4), especially MDIs. The use of HFCs as fire extinguishing agents (2.F.3) is common, too, but decreased in recent years due to restrictions at EU level through the F-gas Regulation and national rules.

Table 4.44: Key categories for sector 2F (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	85	86322	T	0	L	85%
2.F.2 Foam Blowing Agents: no classification (HFCs)	0	3278	T	0	0	95%
2.F.4 Aerosols: no classification (HFCs)	2	4322	T	0	0	90%

Table.**4.45** provides information on the contribution of countries to EU-KP recalculations in HFC from 2.F Product uses as substitutes for ODS for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table.4.45 2F Product uses as substitutes for ODS: Contribution of MS to EU recalculations in HFC for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	26	1.5	In the previous inventory refrigerant R-125a was not included in the top down sum for 2.F.1a (commercial refrigeration), 2.F.1.c (industrial refrigeration) and 2.F.1.f (stationary air conditioning). This transcription error was corrected. An update in statistical data on the amount of sold heat pumps. 2.F.3: emissions were recalculated based on new and more detailed information provided by an operator. 2.F.4: the emission factor was corrected.
Belgium	-	-	129	4.6	2.F.1a (commercial refrigeration). Compensation for changes in mobile air conditioning and R22 use in stationary air conditioning; improved calculation of retrofitting R22, R404A and R507 installations. 2.F.1b (domestic refrigeration). Hermetically sealed cooling of small shops, hotels, restaurants added. 2.F.1e (mobile air conditioning). Revised formula for the bank of bus & coach air conditioning. Revised assumptions on stock for bus & coaches and trucks. 2.F.4a (metered dose inhalers): new data, 2.F.4b (technical aerosols): adaptation of German data used as reference.
Bulgaria	-	-	-1	-0.1	2.F.1b (domestic refrigeration) recalculation due to recalculation of the data submitted for 2017 from the NSI of Bulgaria. 2.F.1d (transport refrigeration) recalculation due to technical mistake (the emissions from decommissioning were not included in 2017). 2.F.1e (mobile air conditioning) recalculation due to (1) recalculation in cars sector, concerning the new cars and the use of a new cooling agent since 2014, and (2) a technical mistake in the cars air conditioning (initial emissions). 2.F.1f (stationary air conditioning) recalculation due to technical mistake.
Croatia	-	-	0	0.1	Emission recalculation for HFC-227ea and HFC-236fa from fire protection was performed. Activity data for 2017 is not available, thus linear extrapolation (2012-2016) was performed (in the previous submission, data from the year 2016 were taken for 2017).
Cyprus	16	24.6	38	15.3	2.F.1a (commercial refrigeration) refrigerants R410A, R407C and R507A were added to the calculation of the emissions and annual national GDP values were revised. 2.F.1c (industrial refrigeration) refrigerant R507A was added to the calculation of the emissions and annual national GDP values were revised. 2.F.1d (transport refrigeration) implementation of a new methodology (in 2019 submission changed the methodology (Tier 2a) for calculating emissions from 2.F.1). Regarding 2.F.1d didn't have the data on time to implement the new methodology. For 2020 submission, have the data and apply the new methodology also for 2.F.1d. 2.F.1e new activity data from Statistical Service of Cyprus were used. 2.F.1f annual national GDP values were revised.
Czechia	-	-	-3	-0.1	2.F.1e recalculation of data from COPERT, updated activity data.
Denmark	-	-	14	3.5	Some recalculations were made for HFCs used in refrigeration and air conditioning (2.F.1).
Estonia	-	-	-4	-1.8	Commercial refrigeration data has been recalculated because of double counting of some equipment in stock in 2017.
Finland	-	-	-66	-5.2	Update of refrigerant data in 2.F.1a. Update of lifetime emission factors in 2.F.1f.
France	-	-	-940	-5.1	2F1: Modification of the methodology for calculating fluorinated gas emissions for the fixed air conditioning sectors (air conditioning, chillers, heat pumps). Many parameters, activity data and emission factors were modified following the update of this sector over the entire inventory period. 2F2: Addition of HFC-134a emissions used as blowing agent for polyethylene foams in an application.
Germany	-	-	86	0.8	2.F.1: Recalculation of data on commercial and industrial refrigeration systems and on stationary air-conditioning systems.

	1990		2017		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					2.F.2: Correction of emissions from foams, on the basis of updated statistics.
Greece	-	-	-1	-0.0	2.F.3: updated activity data.
Hungary	-	-	-0	-0.0	2.F.1: the emission from disposal has been changed due to recovery efficiency has been added. 2.F.3: revision of the AD due to a calculation error correlate with lifetime.
Ireland	-1	-100.0	123	10.8	2.F.1: revised AD from data supplier and improvement in calculation methodology. 2.F.4: revised AD due to revision in proxy data (UK inventory emissions).
Italy	-	-	1 114	7.3	Emissions from stationary air conditioning have been revised, with the introduction of emissions from containers of refrigerants; also the amount of gases used for maintenance has been taken into account. An error occurred in the previous estimates was corrected, and from 2016 appliances filled with the new refrigerant R32 were introduced.
Latvia	-	-	2	0.9	2.F.1 and 2.F.2: recalculations were done due to improvedactivity data.
Lithuania	-	-	7	1.0	Recalculations have been done due to mistake in calculations (omitted data) in mobile AC and due to updated activity data for commercial, industrial refrigeration and stationary air-conditioning.
Luxembourg	-	-	-2	-3.1	2.F.1 and 2.F.4: revision of activity data. 2.F.2: revision of emission factors.
Malta	-	-	58	18.7	The estimate of emissions from sub-category 2.F.1f has been revised to include emissions from pre-charged equipment. This revision which addressed a potential problem identified by the Expert Review Team in September 2019 during the review of the 2019 annual submission, was reflected in a complete official resubmission of the CRF tables for 1990-2017. It should, thus, be pointed out that the term "previous submission" is considered to refer to the submission made prior to the identification of the said potential problem.
Netherlands	-	-	-268	-15.8	New activity data for 2.F.1. For mobile air-conditioning, more adequate information became available about the rest volume of HFC in scrapped cars. Therefore, HFC emissions have been changed for the time series from 2005 on.
Poland	-	-	-857	-12.4	Revised parameters (like leakage ratios) for some equipment in refrigeration and air conditioning on the basis of the reporting under F-gas Regulation.
Portugal	-	-	9	0.3	Mobile air-conditioning (2.F.1e): update of vehicle stock data. 2.F.2 and 2.F.4: update of activity data.
Romania	-	-	1	0.1	2.F.1e: recalculations of the HFC emissions have been made due to an error identified in the calculation formula for cars and for bus.
Slovakia	-	-	-	-	
Slovenia	-	-	-18	-5.1	Improved AD and EFs for refrigeration and stationary AC. 2.F.4: improved AD.
Spain	-	-	-1	-0.0	2.F.1: Correction of a mistake in the estimation of HFC-134a used in car manufacturing. 2.F.2: Update of activity data by the source on the use of F-gases as blowing agents. 2.F.4: New information available on the use of HFC152a replacing HFC134a (non-inhalers aerosols), according to the Spanish F-gases registry.
Sweden	-	-	-41	-3.6	2.F.1: Due to a recurring one year lag in the updating of the data from the Products Register from the Swedish Chemicals Agency, data on bulk import and export in 2017 were updated. 2.F.4: Updated number of MDI, removal of standard data for imports of novelty sprays. Banned from 2010 according to EU 517/2014.
United Kingdom	-	-	-2	-0.0	2.F.5: Revision to include latest activity data from EU F-gas Report.
EU27+UK	15	21.1	-596	-0.6	
Iceland	-0	-50.0	-14	-6.8	2.F.1: Adaptation and update of estimation methodology to 2019 Refinement guidelines. 2.F.4: update of activity data.
United Kingdom (KP)					NA
EU-KP	15	20.4	-616	-0.6	

For 2.F Product uses as substitutes for ODS, table 1 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. It should be noted that the amounts reported by Member States as “unspecified mix of

HFCs and PFCs” are not shown in the table but also need to be taken into account in the total greenhouse gas emission estimates.

Table.4.46 2F Product uses as substitutes for ODS in 1990 and 2018: Member States and EU 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 2018 (kt CO2 equivalents)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2018 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2018 (kt CO2 equivalents)
Austria	NO	1 830	NO	1 830	NO	NO,IE
Belgium	NO	2 849	NO	2 849	NO	0
Bulgaria	NO	2 253	NO	2 253	NO	0
Croatia	NO	494	NO	494	NO	NO
Cyprus	80	297	80	297	NO	NO
Czechia	NO	3 737	NO	3 736	NO	1
Denmark	NO	487	NO	487	NO	0
Estonia	NO	231	NO	231	NO	-
Finland	0	1 177	0	1 176	NO	1
France	IE,NO	15 737	NO,IE	15 737	-	-
Germany	NA,IE,NO	10 448	NO,IE,NA	10 443	IE,NA	5
Greece	NO	5 944	NO	5 908	NO	36
Hungary	NO	1 359	NO	1 358	NO	1
Ireland	NO	1 095	NO	1 095	NO	NO
Italy	NO	16 552	NO	16 552	NO	NO
Latvia	NE,NO	239	NO,NE	239	NO	NO
Lithuania	NO	571	NO	571	NO	NO
Luxembourg	0	63	0	63	-	-
Malta	NE,IE,NO	411	NO,NE,IE	411	NO	NO
Netherlands	NO	1 394	NO	1 394	NO	NO
Poland	NO	4 184	NO	4 173	NO	11
Portugal	NA	3 431	NA	3 412	NA	19
Romania	0	2 295	0	2 295	NO	0
Slovakia	NO	703	NO	703	NO	NO
Slovenia	NO	293	NO	293	NO	NO
Spain	NO	6 114	NO	4 558	NO	7
Sweden	6	1 035	6	1 034	NO	0
United Kingdom	0	13 005	0	13 005	NO	NO
EU-27+UK	**87**	**98 228**	**87**	**96 597**	**NA,IE,NO**	**81**
Iceland	0	167	0	167	NO	0
United Kingdom (KP)	0	13 088	0	13 088	NO	NO
EU-KP	**87**	**98 479**	**87**	**96 847**	**NA,IE,NO**	**82**

Abbreviations explained in the Chapter ‘Units and abbreviations’. In 2018 Spain also reported 1550 kt CO_2 equivalents as unspecified mix of HFC and PFC emissions. It is the only country reporting this and therefore no extra column for the mix of HFC and PFC emissions have been included in the table. Pease note that consequently HFC and PFC emissions for the year 2018 do not add up to the total GHG emissions for Spain and EU-27+UK or EU-KP.

F-gas emissions from 2.F Product uses as substitutes for ODS account for 2.4% of total EU-KP GHG emissions (without LULUCF) in 2018. HFC emissions account for the lion’s share of 2.F emissions (98%) and were in 2018 about 1100 times higher than in 1990. The main reason for this is the phase-out of ODS such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halons under the Montreal Protocol and the subsequent 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.4.47 shows the sub-categories of HFC-gas emissions from 2.F Product uses as substitutes for ODS by countries. It highlights that 2.F.1 Refrigeration and Air Conditioning is by far the largest sub-category accounting for 89% (EU-27+UK) of HFC 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 4.4% and 2.F.2 Foam blowing agents approximately 3.3%. Emissions from fire protection relate to 2.7% of HFC emissions from 2.F.1 in 2018.

The EU F-gas Regulation 517/2014 sets out several measures to reduce use and emissions of F-gases with a focus on HFCs. These measures include restrictions of the bulk supply of HFCs on the EU market (the so called HFC phase down) starting from 2015. The following schedule for supply reductions was established: 100% in 2015, 93% in 2016-2017, 63% in 2018-2020, 45% in 2021-2023, 31% in 2024-2026, 24% in 2027-2029, 21% in 2030. This mechanism led to significant price increases for HFCs on the EU market and promoted the uptake of alternatives to HFCs in many applications.

Other important measures of the F-gas Regulation relate to placing on the market bans for certain products (Annex III), for example stationary refrigeration equipment containing high-GWP gases, which were partly implemented by industry ahead of the prohibition dates and possibly due to the price increases under the HFC phase down scheme.

Table.4.47 2F Product uses as substitutes for ODS: Countries' sub-categories of HFC emissions for 2018 (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	**1 830**	1 772	16	13	28	NO	-
Belgium	**2 849**	2 702	54	12	80		NO
Bulgaria	**2 253**	2 218	13	8	13		-
Croatia	**494**	480	NO	5	9	-	-
Cyprus	**297**	288	1	4	3	-	-
Czech Republic	**3 736**	3 703	7	26	NO	0	-
Denmark	**487**	474	1	NO	13	NO	NO
Estonia	**231**	222	2	2	5		0
Finland	**1 176**	1 148	5	NO,IE,NA	23	0	0
France	**15 737**	14 036	323	68	1 265	45	NO,IE
Germany	**10 443**	9 148	897	46	353	IE	-
Greece	**5 908**	5 510	197	156	45	-	-
Hungary	**1 358**	1 189	128	6	35	NO	NO
Ireland	**1 095**	949	NO	32	114	NO	NO
Italy	**16 552**	14 068	614	1 612	257	-	-
Latvia	**239**	233	1	0	5		-
Lithuania	**571**	522	38	3	7	NO	NO
Luxembourg	**63**	57	3	-	3	-	-
Malta	**411**	406	5	0	1	NO	NO
Netherlands	**1 394**	1 219	NO	-	NO	-	175
Poland	**4 173**	3 569	373	103	128	1	-
Portugal	**3 412**	3 284	46	64	18		-
Romania	**2 295**	2 248	2	5	41	NO	NO
Slovakia	**703**	671	2	21	9	NO	NO
Slovenia	**293**	286	2	1	5	NO	-
Spain	**4 558**	4 054	55	118	331	NO	NO
Sweden	**1 034**	980	30	2	23	-	-
United Kingdom	**13 005**	10 652	462	319	1 499	16	57
EU-27+UK	**96 597**	**86 085**	**3 277**	**2 627**	**4 313**	**62**	**232**
United Kingdom (KP)	**13 088**	10 722	463	322	1 507	16	58
Iceland	**167**	166	-		1		-
EU-KP	**96 847**	**86 322**	**3 278**	**2 630**	**4 322**	**62**	**233**

Abbreviations explained in the Chapter 'Units and abbreviations'. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

Table 4.48 to Table.4.51 shows the contribution of each country to EU-KP HFC emissions from 2.F.1 as well as information on the method applied, activity data and emission factor.

Table 4.48 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-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	38	1 689	1 772	2.1%	1 772	∞	1 735	4612%	83	5%	T2	D
Belgium	NO	93	2 751	2 702	3.1%	2 702	∞	2 610	2819%	-48	-2%	T2	CS,D,PS
Bulgaria	NO	3	1 773	2 218	2.6%	2 218	∞	2 214	66533%	445	25%	T2	D
Croatia	NO	29	475	480	0.6%	480	∞	451	1545%	5	1%	T2	D
Cyprus	80	132	279	288	0.3%	208	262%	156	118%	9	3%	T2	D
Czechia	NO	14	3 598	3 703	4.3%	3 703	∞	3 689	26740%	104	3%	T2	CS
Denmark	NO	48	402	474	0.5%	474	∞	426	895%	72	18%	T2	D
Estonia	NO	10	222	222	0.3%	222	∞	212	2134%	0	0%	T2	CS
Finland	0	147	1 164	1 148	1.3%	1 148	10875051%	1 001	680%	-15	-1%	T2	CS,D
France	NO	547	15 093	14 036	16.3%	14 036	∞	13 489	2466%	-1 058	-7%	T2	CS
Germany	NA	589	9 471	9 148	10.6%	9 148	∞	8 558	1452%	-323	-3%	T2	CS,D
Greece	NO	42	5 783	5 510	6.4%	5 510	∞	5 468	12910%	-273	-5%	IE,T2	D,IE
Hungary	NO	25	1 631	1 189	1.4%	1 189	∞	1 163	4567%	-442	-27%	T2	CS,D
Ireland	NO	5	1 118	949	1.1%	949	∞	944	18961%	-170	-15%	T2,T3	CS
Italy	NO	356	13 935	14 068	16.3%	14 068	∞	13 712	3849%	133	1%	T2	CS,D,PS
Latvia	NE	2	232	233	0.3%	233	∞	231	10996%	1	0%	T2	CS,D,OTH
Lithuania	NO	5	675	522	0.6%	522	∞	517	9723%	-153	-23%	T2	CS,D,PS
Luxembourg	0	3	59	57	0.1%	57	79551569%	54	1633%	-2	-4%	T2	CS,M,PS
Malta	NO,IE	0	363	406	0.5%	406	∞	406	21518173%	42	12%	T2	CS
Netherlands	NO	72	1 255	1 219	1.4%	1 219	∞	1 148	1598%	-36	-3%	T2	CS
Poland	NO	154	5 517	3 569	4.1%	3 569	∞	3 414	2211%	-1 948	-35%	T2	D
Portugal	NA	78	3 153	3 284	3.8%	3 284	∞	3 206	4103%	131	4%	NO,T2	D,NO
Romania	NO	2	2 133	2 248	2.6%	2 248	∞	2 246	115977%	115	5%	T2	D
Slovakia	NO	11	706	671	0.8%	671	∞	660	5878%	-35	-5%	T2	CS
Slovenia	NO	3	332	286	0.3%	286	∞	283	9575%	-46	-14%	T1,T2	CS,D
Spain	NO	NO	5 793	4 054	4.7%	4 054	∞	4 054	∞	-1 740	-30%	T2	CS
Sweden	5	128	1 041	980	1.1%	975	19269%	852	665%	-62	-6%	T2	CS,D
United Kingdom	NO	528	11 560	10 652	12.3%	10 652	∞	10 123	1917%	-909	-8%	T2	CS
EU-27+UK	**85**	**3 066**	**92 206**	**86 085**	**100%**	**86 001**	**101573%**	**83 019**	**2707%**	**-6 120**	**-7%**	-	-
Iceland	NO	3	190	166	0.2%	166	∞	164	6036%	-24	-12%	T2	D
United Kingdom (KP)	NO	531	11 631	10 722	12.4%	10 722	∞	10 192	1921%	-909	-8%	T2	CS
EU-KP	**85**	**3 072**	**92 466**	**86 322**	**100%**	**86 237**	**101853%**	**83 251**	**2710%**	**-6 144**	**-7%**	-	-

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

In 2018, HFC emissions from 2.F.1 were more than 28 times higher than in 1995 (Table **4.48** and ***Figure 4.16*** to Figure 4.19) but decreased by 7% compared to 2017 (EU-27+UK).

France, Germany, Italy and the UK were responsible for 55% of total EU-KP emissions from this source in 2018.

Figure 4.16: 2F1 Refrigeration and Air conditioning: EU-KP HFC emissions

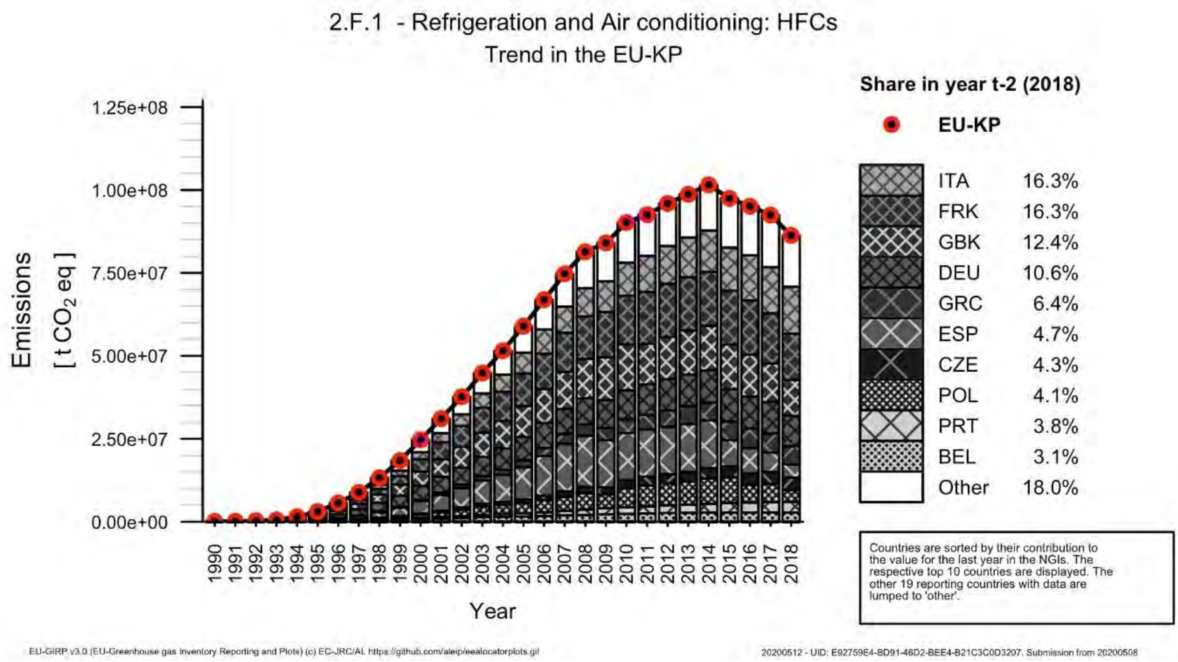


Figure 4.16 shows that emissions in sector 2.F.1 decreased again in 2018.

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. a refrigerant blend commonly used in stationary air conditioning is called “R410A” and is composed of 50% HFC-32 and 50% HFC-125).

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 in 2015, 2016, 2017 and 2018. This is in line with the policies and measures of the EU F-gas Regulation No. 517/2014 and the EU MAC Directive.

Figure 4.17: 2F1a Commercial refrigeration: EU-KP HFC emissions

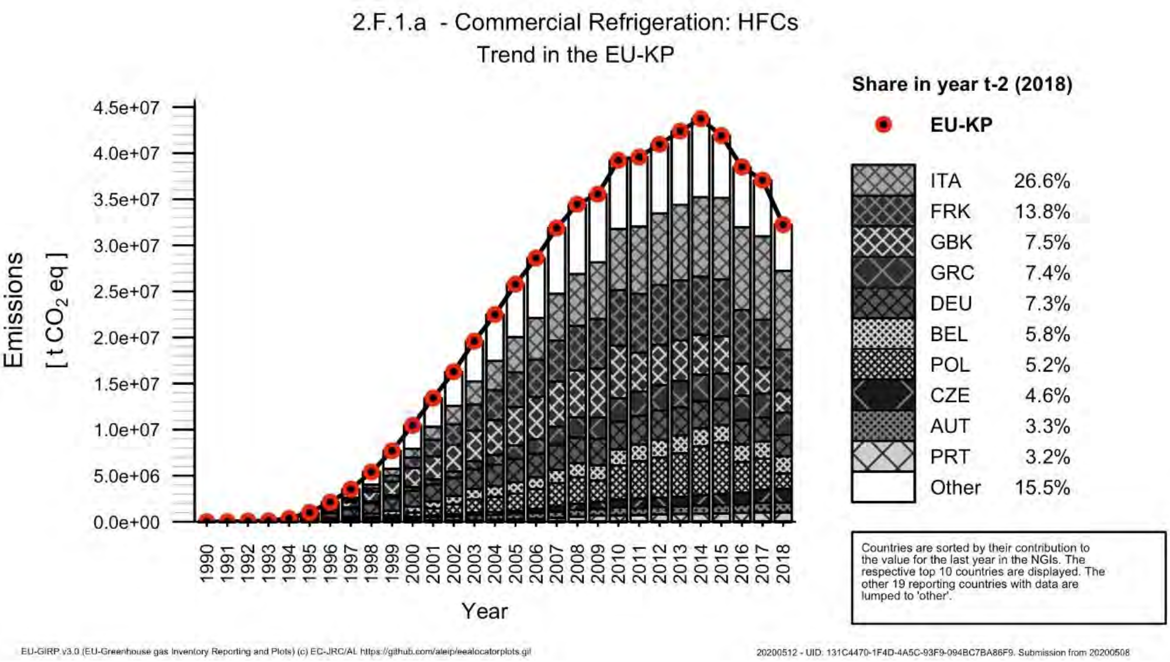


Figure 4.18: 2F1e Mobile air conditioning: EU-KP HFC emissions

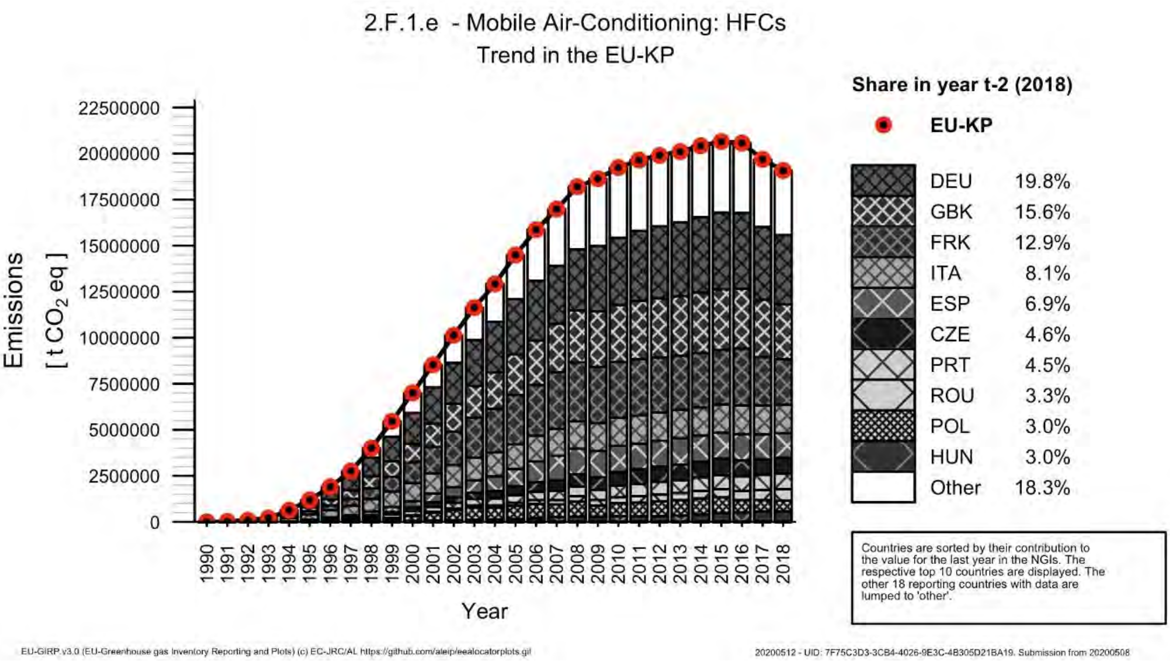


Figure 4.18 shows emission trends for mobile air-conditioning: The EU reported HFC-134a emissions from disposal in the subcategory mobile air conditioning (2.F.1.e) in CRF table 2(II)B-Hs2. The disposal loss factor related to HFC-134a emissions from disposal in mobile air conditioning (2.F.1.e) was 100 per cent for the year1995. HFC-134a was introduced in the early 1990s, and 1995 was the first year in which it was used on a large scale for mobile air conditioning in passenger cars. The very small amounts in 1995 relate to particularities of the inventories of France and Latvia, which run models of

the vehicle stock that assume end of life of a certain share of vehicles each year, in line with a Gaussian normal distribution. Some cars reached their end of life in the first year of widespread use of HFC-134a in mobile air conditioning. Because at that time no measures were in place in these countries to recover the refrigerant during end-of-life treatment, a disposal loss factor of 100 per cent was applied. The 2018 ERT considered the assumption that not every car reaches an average lifespan and that some are disposed of earlier (e.g. owing to damage in an accident) as realistic; and considered acceptable the assumption that in the first year when disposal emissions occurred, there was no recovery of emissions. Emissions from 2.F.1.e decreased in 2017 and 2018. This relates to the introduction of the low-GWP refrigerant R1234yf in air-conditioning systems of new passenger cars. Germany accounts for nearly 20% of emissions from 2.F.1e followed by the UK (15.6%) and France (12.9%).

Figure 4.19: 2F1f Stationary air conditioning: EU-KP HFC emissions

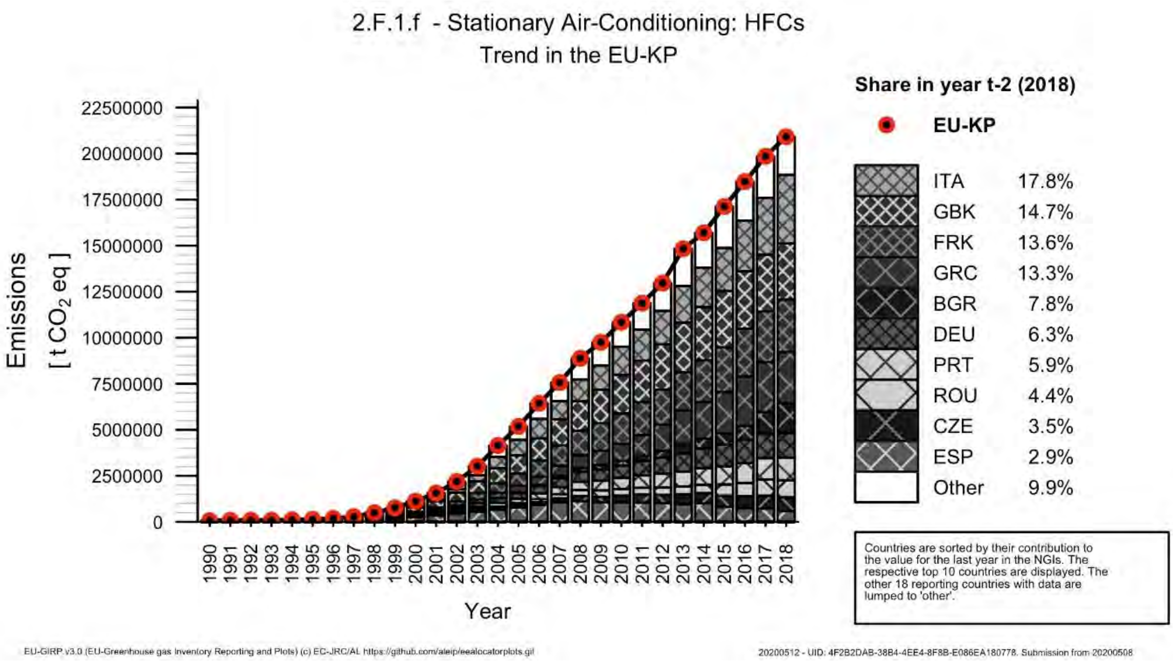


Figure 4.19 shows a consistent trend for sector 2.F.1f with increasing emissions. This development reflects the growing use of air conditioning equipment, in particular in Southern Europe, and the delayed uptake of alternatives to HFCs in this sub-category. It should also be noted that some Member States allocate emissions from 2.F.1f under the 2.F.1a subcategory.

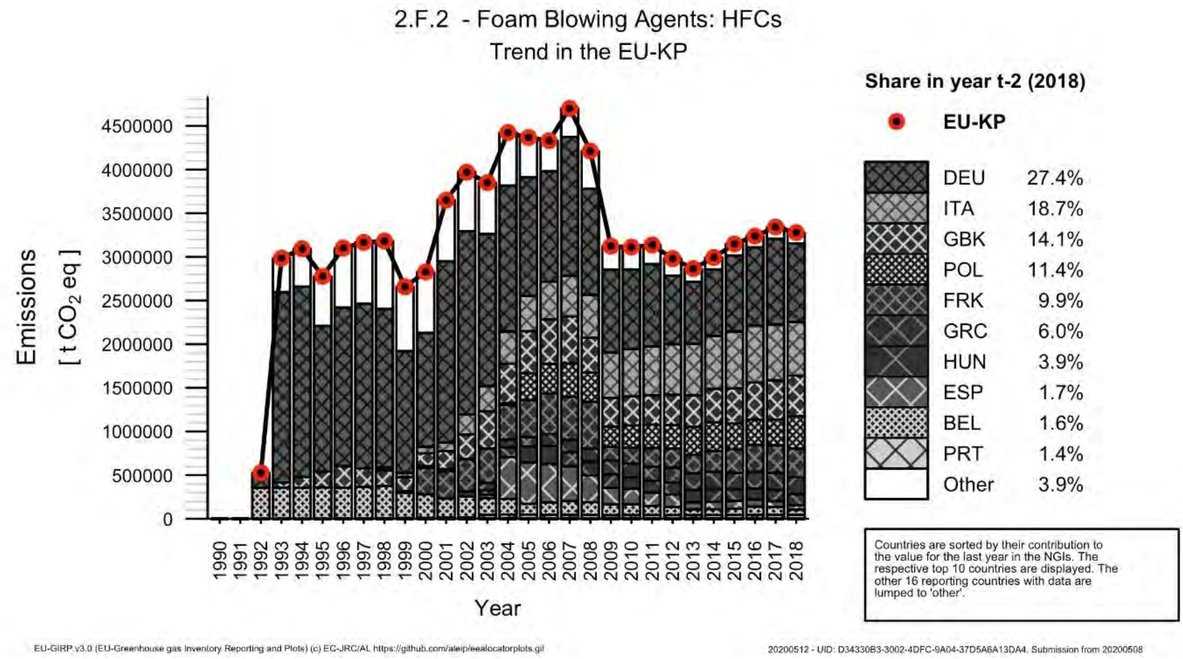
Table 4.49 2F2 Foam Blowing: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	301	17	16	0.5%	16	∞	-284	-95%	0	-1%	T2	D
Belgium	NO	357	87	54	1.6%	54	∞	-303	-85%	-33	-38%	T2	CS,D,PS
Bulgaria	NO	NO	23	13	0.4%	13	∞	13	∞	-10	-42%	T2	D
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO,NE	NO,NE	1	1	0.0%	1	∞	1	∞	0	0%	CS	CS
Czechia	NO	0	13	7	0.2%	7	∞	7	47600%	-6	-48%	NO,T1	D
Denmark	NO	210	1	1	0.0%	1	∞	-209	-100%	0	-2%	NA	NA
Estonia	NO	18	2	2	0.1%	2	∞	-17	-90%	0	-20%	T2	CS
Finland	NO	1	5	5	0.2%	5	∞	5	928%	0	1%	T2	D
France	NO	NO	314	323	9.9%	323	∞	323	∞	9	3%	T2	CS,D
Germany	IE,NA	1 666	985	897	27.4%	897	∞	-769	-46%	-88	-9%	NA	NA
Greece	NO	NO	195	197	6.0%	197	∞	197	∞	2	1%	T2	D
Hungary	NO	NO	128	128	3.9%	128	∞	128	∞	0	0%	T2	CS
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	NO	NO	635	614	18.7%	614	∞	614	∞	-21	-3%	T2	D
Latvia	NO	0	0	1	0.0%	1	∞	0	72%	1	352%	T1a	D,OTH
Lithuania	NO	NO	32	38	1.2%	38	∞	38	∞	6	17%	T2	D
Luxembourg	NO	10	3	3	0.1%	3	∞	-7	-68%	1	20%	T1	CS
Malta	NO	NO	3	5	0.1%	5	∞	5	∞	2	86%	T1	D
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	295	373	11.4%	373	∞	373	∞	78	26%	T2	D
Portugal	NA	1	46	46	1.4%	46	∞	45	6040%	1	2%	T2	D
Romania	NO	NO	3	2	0.1%	2	∞	2	∞	-1	-34%	T2	D
Slovakia	NO	NO	2	2	0.1%	2	∞	2	∞	0	0%	T2	D
Slovenia	NO	30	2	2	0.0%	2	∞	-28	-95%	0	-4%	T2	CS,D
Spain	NO	NO	70	55	1.7%	55	∞	55	∞	-15	-22%	T2	D
Sweden	NO	NO	30	30	0.9%	30	∞	30	∞	0	0%	T2	PS
United Kingdom	NO	184	449	462	14.1%	462	∞	278	151%	13	3%	T2	CS
EU-27+UK	**E,NA,IE,NO**	**2 777**	**3 340**	**3 277**	**100%**	**3 277**	**∞**	**499**	**18%**	**-64**	**-2%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	184	450	463	14.1%	463	∞	279	151%	13	3%	T2	CS
EU-KP	**E,NA,IE,NO**	**2 778**	**3 342**	**3 278**	**100%**	**3 278**	**∞**	**500**	**18%**	**-64**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

In 2018, HFC emissions from 2.F.2 (Table **4.49** and ***Figure 4.20***) decreased slightly by 2% compared to the previous year. The HFC foam blowing agents reported in 2.F.2 are HFC-152a, HFC-134a, HFC-227ea, HFC-245fa and HFC-365mfc. The biggest contributors to emissions from this sector are Germany (27.4%), Italy (18.7%), UK (14.1%) and Poland (11.4%) and those four countries account for 71.6% of the share in EUKP emissions in this sector.

Figure 4.20: 2F2 Foam Blowing Agents: EU-KP HFC emissions



This ***Figure 4.20*** 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 resulted in a drop of emissions from this subcategory in the last ten years. The F-gas Regulation further limits the use of F-gases for this subcategory as the placing on the market of foams containing HFCs with GWP of 150 or more is banned from 2020 for extruded polystyrene (XPS) foams and for other foams from 2023, unless HFCs with higher GWPs are needed to meet national safety requirements (Annex III, point 16).

Table4.50 2F3 Fire protection: Countries' 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-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	13	13	0.5%	13	∞	13	∞	0	0%	T2	D
Belgium	NO	1	13	12	0.5%	12	∞	11	1963%	-1	-4%	T2	CS
Bulgaria	NO	NO	7	8	0.3%	8	∞	8	∞	1	9%	T2	D
Croatia	NO	0	5	5	0.2%	5	∞	5	3935%	0	4%	-	-
Cyprus	NO,NE	0	4	4	0.2%	4	∞	4	57479%	0	0%	CS	CS
Czechia	NO	NO	25	26	1.0%	26	∞	26	∞	1	6%	D	D
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	3	2	0.1%	2	∞	2	∞	0	-9%	T2	CS
Finland	NO	NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-	-	-	NA	NA
France	NO	5	88	68	2.6%	68	∞	64	1388%	-20	-22%	T1	CS
Germany	NA	NA	42	46	1.7%	46	∞	46	∞	3	8%	CS	CS,D
Greece	NO	NO	155	156	5.9%	156	∞	156	∞	1	1%	CS	D
Hungary	NO	NO	7	6	0.2%	6	∞	6	∞	-1	-15%	T1	D
Ireland	NO	NO	32	32	1.2%	32	∞	32	∞	0	0%	T2	CS
Italy	NO	16	1 610	1 612	61.3%	1 612	∞	1 597	10221%	3	0%	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	0%	T1b	D
Luxembourg	-	-	-	-	-	-	-	-	-	-	-	-	-
Malta	NO	NO	2	0	0.0%	0	∞	0	∞	-2	-88%	CS	-
Netherlands	-	-	-	-	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	96	103	3.9%	103	∞	103	∞	7	7%	T2	D
Portugal	NA	NO	51	64	2.4%	64	∞	64	∞	13	26%	T2	D
Romania	NO	NO	5	5	0.2%	5	∞	5	∞	0	0%	-	-
Slovakia	NO	2	22	21	0.8%	21	∞	19	900%	-1	-4%	T1a	CS
Slovenia	NO	NO	1	1	0.0%	1	∞	1	∞	0	1%	T2	CS,D
Spain	NO	1	130	118	4.5%	118	∞	117	12781%	-12	-9%	T1a	CS,D
Sweden	NO	NO	3	2	0.1%	2	∞	2	∞	-2	-55%	T1	CS
United Kingdom	NO	1	322	319	12.1%	319	∞	318	32936%	-3	-1%	T2	CS
EU-27+UK	**NE,NA,NO**	**25**	**2 639**	**2 627**	**100%**	**2 627**	**∞**	**2 602**	**10445%**	**-11**	**0%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	1	324	322	12.2%	322	∞	321	33044%	-3	-1%	T2	CS
EU-KP	**NE,NA,NO**	**25**	**2 641**	**2 630**	**100%**	**2 630**	**∞**	**2 605**	**10453%**	**-11**	**0%**	**-**	**-**

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

In 2018, HFC emissions from 2.F.3 (Table4.50) did hardly change compared to 2015, 2016 and 2017 – but increased dramatically since 1995. This development was caused by the phase-out of ozone depleting substances, especially halons, as fire extinguishing agents under the Montreal Protocol and the subsequent introduction of HFCs and other ODS alternatives as replacements. The HFCs reported in this subcategory are HFC-23 (banned in new equipment in the EU since 2015), HFC-227ea and HFC-236fa. In Denmark, Luxembourg and Iceland HFCs are not used as fire extinguishing agents. Instead, other chemicals or not-in-kind alternatives, e.g. water mist, fluorinated ketones etc., have been applied for many years. In the Netherlands, emissions from this subcategory are included in the 2.F.6 subcategory.

The biggest contributors to this sector are Italy (61.3%), UK (12.2%) and Greece (5.9%), those three countries account for 79.4% of the share in EU-KP emissions in this sector. Relevant increases of emissions from this subcategory compared to 2017 were reported by Portugal (+26 %) and Bulgaria (+9%), while certain decreases were reported by Malta (-88%), Sweden (-55%), France (-22%) and Hungary (-15%).

Figure 4.21: 2F3 Fire Protection, EU-KP: HFC emissions

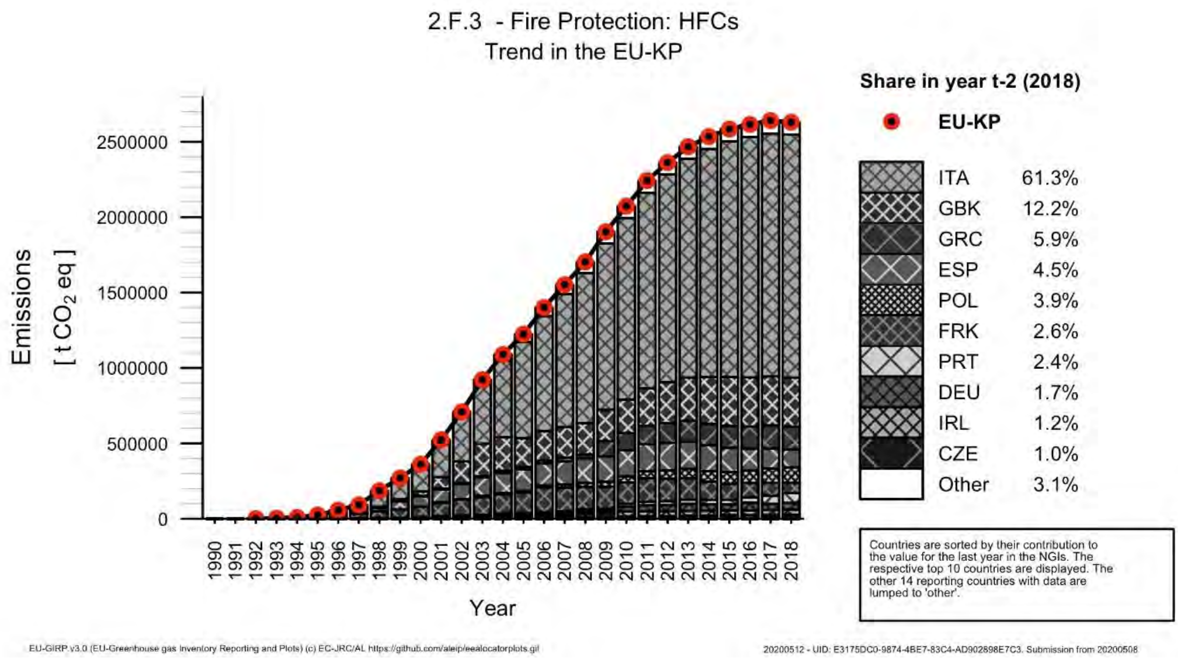


Figure 4.21 illustrates that emissions from fire protection were stable in recent years.

Table.4.51 2F4 Aerosols/ Metered Dose Inhalers: Countries' 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-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	4	27	28	0.7%	28	∞	24	529%	1	4%	T2	D
Belgium	NO	41	83	80	1.9%	80	∞	39	93%	-3	-3%	T2	CS,D,PS
Bulgaria	NO	NO	13	13	0.3%	13	∞	13	∞	0	2%	T2	D
Croatia	NO	NO	9	9	0.2%	9	∞	9	∞	0	0%	NA	NA
Cyprus	NO	0	3	3	0.1%	3	∞	3	25651%	0	0%	CS	CS
Czechia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	16	13	0.3%	13	∞	13	∞	-4	-22%	-	-
Estonia	NO	0	4	5	0.1%	5	∞	4	8982%	0	2%	T2	CS
Finland	NO	2	42	23	0.5%	23	∞	21	1028%	-19	-45%	T2	D
France	NO	623	1 904	1 265	29.3%	1 265	∞	643	103%	-638	-34%	T2	CS,PS
Germany	NO,IE,NA	342	573	353	8.2%	353	∞	10	3%	-221	-38%	CS,T2	CS
Greece	NO	0	45	45	1.0%	45	∞	45	140663%	0	-1%	T2	D
Hungary	NO	12	34	35	0.8%	35	∞	23	196%	1	1%	T2	CS,D
Ireland	NO	38	113	114	2.6%	114	∞	76	201%	1	1%	T1,T2	CS
Italy	NO	NO	207	257	5.9%	257	∞	257	∞	50	24%	T2	CS
Latvia	NO,NE	NO,NE	5	5	0.1%	5	∞	5	∞	0	-2%	T1a	D
Lithuania	NO	1	8	7	0.2%	7	∞	7	783%	0	-1%	T1a	D
Luxembourg	NO	2	3	3	0.1%	3	∞	1	79%	0	13%	T1,T2	CS
Malta	NO,NE	NO,NE	1	1	0.0%	1	∞	1	∞	0	-24%	T1	CS
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	18	128	128	3.0%	128	∞	110	630%	0	0%	T1a,T1b,T2	D
Portugal	NA	27	17	18	0.4%	18	∞	-9	-34%	0	1%	T2	D,NO
Romania	0	1	39	41	0.9%	41	22489%	40	5581%	2	6%	T2	D
Slovakia	NO	NO	9	9	0.2%	9	∞	9	∞	0	-3%	T1a	D
Slovenia	NO	NO	5	5	0.1%	5	∞	5	∞	0	-1%	T1	D
Spain	NO	NO,NA	314	331	7.7%	331	∞	331	∞	17	5%	T2	CS
Sweden	1	7	23	23	0.5%	22	1522%	16	218%	0	0%	T2	D
United Kingdom	IE,NO	660	1 648	1 499	34.7%	1 499	∞	840	127%	-149	-9%	T2	CS
EU-27+UK	**2**	**1 777**	**5 275**	**4 313**	**100%**	**4 312**	**267618%**	**2 537**	**143%**	**-962**	**-18%**	**-**	**-**
Iceland	0	1	1	1	0.0%	1	170%	0	29%	0	-2%	T1a	D
United Kingdom (KP)	NO,IE	662	1 656	1 507	34.9%	1 507	∞	845	128%	-149	-9%	T2	CS
EU-KP	**2**	**1 780**	**5 284**	**4 322**	**100%**	**4 320**	**220852%**	**2 542**	**143%**	**-962**	**-18%**	**-**	**-**

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

In 2018, HFC emissions from 2.F.4 grew by 143% compared to 1995 (Table.**4.51** and ***Figure 4.21***). 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 2.F.4 are HFC-134a (medical and technical aerosols), HFC-227ea (medical aerosols only) and HFC-152a (technical aerosols). Emissions from technical aerosols play a minor role from 2018 onwards as the EU F-gas Regulation bans the placing on the market of technical aerosols containing HFCs with GWP of 150 or more, except when required to meet national safety standards or when used for medical applications since 1 January 2018 (Annex III, point 17). This is reflected in a 18% decrease of EU-KP emissions in 2018 compared to 2017.

UK (34.9%), France (29.3%) and Germany (8.2%) accounted for 72.4% of total EU-KP emissions from this source. A significant relative decrease between 2017 and 2018 was reported by Finland (-45%), Germany (-38%) and France (-34%); the biggest increase was reported by Italy (+24%) and Luxembourg (+13%).(Table.**4.51**). It should be noted that emissions from this subcategory have been decreasing slowly since 2006 despite the growing number of patients in need of MDI treatment in most EU Member States. This is mainly due to increased application of dry powder inhalers and other alternative treatment measures.

Figure 4.22 2F4 Aerosols/Metered Dose Inhalers: EU-KP HFC emissions

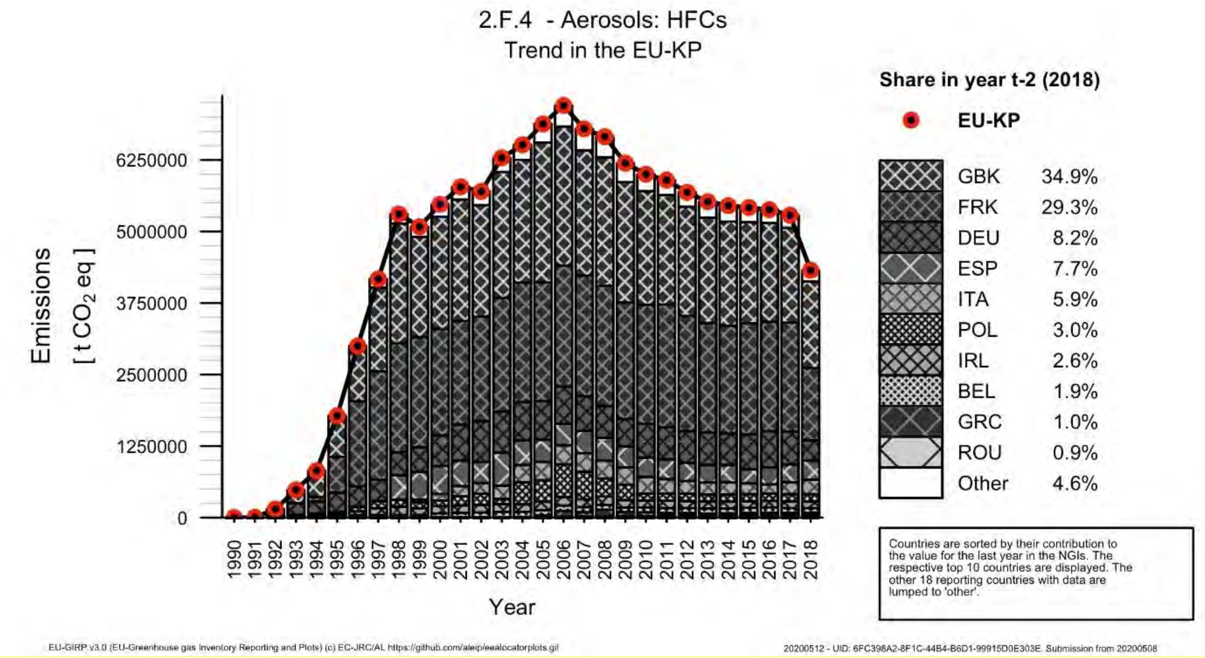


Figure 4.22 shows the significant emission reductions in 2018 compared to previous years.

The subcategories 2.F.5 Solvents and 2.F.6 Other applications are not described in detail in this submission. Emission estimates from 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)

PFCs and SF_6 have been used for certain applications within this category for many decades. SF_6 is a particularly potent greenhouse gas (GWP 22.800) that is used predominantly in insulated switch gear for transportation and distribution of electric power (2.G.1). Emissions also occur from other product use (2.G.2), for example military applications (SF_6), particle accelerators (SF_6), applications of adiabatic properties - shoes and tyres (SF_6, PFCs), sound proof windows (SF_6), medical and cosmetic applications (SF_6, PFCs), other (SF_6, PFCs) etc.

Table.4.52 shows that all Member States report GHG emissions in 2.G Other product manufacture and use for the year 2018. SF_6 emissions from the 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.

Table.4.52 2G Other: Overview of sources reported under this source category for 2018

Country	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-KP Total
AUT	Electrical equipment (SF6); Soundproof windows (SF6); Other (SF6)	NO	NO	348			348	5.0%
BEL	Electrical equipment (SF6); Soundproof windows (SF6); Other (C6F14)	NO	NO	88	NO	NO	88	1.3%
BGR	Electrical equipment (SF6)		NO	18			18	0.3%
HRV	Electrical equipment (SF6)	NO	NO	6	NO	NO	6	0.1%
CYP	Electrical equipment (SF6)		NO	0			0.2	0.0%
CZE	Electrical equipment (SF6); Accelerators (SF6); Soundproof windows (SF6); Other (SF6)			68			68	1.0%
DNM	Electrical equipment (SF6); Soundproof windows (SF6); Other (SF6)	NO,NA	NO,NA	73	NO,NA	NO,NA	73	1.0%
EST	Electrical equipment (SF6); Accelerators (SF6)	NO	NO	3	NO	NO	3	0.0%
FIN	Electrical equipment (SF6)	0	NO,IE	13	0	0	13	0.2%
FRK	Electrical equipment (SF6); Accelerators (SF6); Other (SF6, Unspecified mix of PFCs)	1	531	348			881	12.6%
DEU	Electrical equipment (SF6); Military applications (SF6 => Notation Key C); Accelerators (SF6); Soundproof windows (SF6); Adiabatic properties: shoes and tyres (SF6, C3F8 => Notation Key C); Other (SF6 => partly Notation Key C, C10F18 => Notation Key C); 4. Other (HFC-134a, HFC-245fa => Notation Key C, HFC-365mfc => Notation Key C)	11	IE,NA	3756	NA	NA	3766	53.8%
GRC	Electrical equipment (SF6)		NO	5			5	0.1%
HUN	Electrical equipment (SF6); Other (SF6)	NO	NO	102	NO	NO	102	1.4%

Country	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 equivalent s]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalent s]	Share in EU-KP Total
IRL	Electrical equipment (SF6); Soundproof windows (SF6); Adiabatic properties: shoes and tyres (SF6); Other (SF6)	NO	NO	19	NO	NO	19	0.3%
ITA	Electrical equipment (SF6); Accelerators (SF6)	NO	NO	396	NO	NO	396	5.7%
LVA	Electrical equipment (SF6)	NO	NO	11	NO	NO	11	0.2%
LTU	Electrical equipment (SF6); Accelerators (SF6)	NO	NO	0	NO	NO	0	0.0%
LUX	Electrical equipment (SF6); Soundproof windows (SF6), Other (HFC-43-10mee)	5		10			15	0.2%
MLT	Electrical equipment (SF6), Other (SF6, C3F8)		0.00	0.30			0.30	0.004%
NLD	Other (SF6)	NO	NO	124			124	1.8%
POL	Electrical equipment (SF6)	NA	NA	107	NA	NA	107	1.5%
PRT	Electrical equipment (SF6)	NO	NO	24	NO	NO	24	0.3%
ROU	Electrical equipment (SF6)	NO	NO	62	NO	NO	62	0.9%
SVK	Electrical equipment (SF6)	NO	NO	9	NO	NO	9	0.1%
SVN	Electrical equipment (SF6)	NO	NO	16	NO	NO	16	0.2%
ESP	Electrical equipment (SF6); Accelerators (SF6), Other (SF6)	NO	NO	227	NO	NO	227	3.2%
SWE	Electrical equipment (SF6); Soundproof windows (SF6)		NO	32			32	0.5%
GBE	Electrical equipment (SF6); Military applications (SF6); Accelerators (SF6); Other (CF4, C2F6, C3F8, c-C4F8, SF6)		200	391			590	8%
EU-27+UK	**TOTAL**	16	731	6255	0	0	7002	
GBK	Electrical equipment (SF6); Military applications (SF6); Accelerators (SF6); Other (CF4, C2F6, C3F8, c-C4F8, SF6)		200	391			590	8.4%

Country	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-KP Total
ISL	Electrical equipment (SF6)		NO	3			3	0.05%
EU-KP	**TOTAL**	16	731	6258	0	0	7006	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.23 and Table 4.53 summarize information by Member State on SF_6 emissions for the key source 2.G. Emissions have been relatively stable since 2002 with a small but rather steady increase since 2014. The development of emissions from this category is dominated by the emission trend in Germany (60.1% of SF_6 emissions from EU-KP in 2018), where the disposal of sound proof windows containing SF_6 represents a particularly high emission source.

Table 4.53: 2G - Member States' contributions to SF6 emissions

Member State	SF6 Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2018	Change 1990-2018		Change 1995-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	1995	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	268	353	348	5.6%	217	165%	80	30%	-5	-1%	T2	D
Belgium	135	135	95	88	1.4%	-47	-35%	-47	-35%	-8	-8%	T1,T2	D
Bulgaria	4	5	18	18	0.3%	14	387%	13	267%	0	3%	NO,T2	D,NO
Croatia	10	11	6	6	0.1%	-5	-47%	-6	-50%	0	-3%	T2	CS
Cyprus	0	0	0	0	0.0%	0	542%	0	184%	0	0%	NA	NA
Czechia	84	89	71	68	1.1%	-17	-20%	-21	-24%	-3	-5%	D,T1	D
Denmark	13	70	75	73	1.2%	60	473%	4	5%	-2	-3%	T2,T3	D
Estonia	NO	3	2	3	0.0%	3	∞	-1	-17%	0	5%	T3	CS
Finland	45	27	12	13	0.2%	-32	-71%	-14	-51%	1	5%	T2	CS
France	1 249	1 479	406	348	5.6%	-900	-72%	-1 130	-76%	-58	-14%	T1,T2	CS,D
Germany	4 050	6 072	3 637	3 756	60.0%	-294	-7%	-2 317	-38%	119	3%	CS,D,T3	CS,D
Greece	3	3	5	5	0.1%	2	69%	2	45%	0	-1%	NA	NA
Hungary	12	55	118	102	1.6%	89	718%	47	86%	-17	-14%	T1,T2	D
Ireland	33	38	23	19	0.3%	-14	-42%	-19	-49%	-4	-16%	T1,T2	CS
Italy	294	551	352	396	6.3%	102	35%	-154	-28%	45	13%	CS,T2	CS,PS
Latvia	NO	0	10	11	0.2%	11	∞	10	5982%	0	2%	T1	D
Lithuania	NO	0	1	0	0.0%	0	∞	0	955%	0	-22%	T3	CS
Luxembourg	1	2	10	10	0.2%	9	695%	8	483%	0	3%	D,T1,T3	CS,D,M,PS
Malta	0	1	1	0	0.0%	0	2710%	-1	-79%	-1	-67%	CS	CS,PS
Netherlands	207	261	126	124	2.0%	-83	-40%	-137	-53%	-3	-2%	T1,T3	CS
Poland	NA,NO	13	78	107	1.7%	107	∞	95	756%	29	37%	T1	D
Portugal	NO,NA	14	26	24	0.4%	24	∞	10	70%	-2	-7%	T1	NO
Romania	0	1	54	62	1.0%	62	12950%	61	6249%	8	14%	T2	D
Slovakia	0	10	7	9	0.2%	9	15992%	-1	-8%	2	33%	T3	CS
Slovenia	10	12	16	16	0.3%	6	61%	4	30%	0	0%	T2	CS
Spain	64	100	225	227	3.6%	163	255%	127	127%	1	1%	T2,T3	CS,D
Sweden	79	108	33	32	0.5%	-47	-59%	-76	-70%	-1	-3%	T2,T3	CS,PS
United Kingdom	923	920	400	391	6.2%	-533	-58%	-529	-58%	-9	-2%	CH,T1,T2,T3	CS,D
EU-27+UK	**7 348**	**10 246**	**6 161**	**6 255**	**100%**	**-1 093**	**-15%**	**-3 991**	**-39%**	**94**	**2%**	**-**	**-**
Iceland	1	1	2	3	0.1%	2	197%	2	162%	1	41%	NA	NA
United Kingdom (KP)	923	920	400	391	6.2%	-533	-58%	-529	-58%	-9	-2%	CH,T1,T2,T3	CS,D
EU-KP	**7 349**	**10 248**	**6 164**	**6 258**	**100%**	**-1 091**	**-15%**	**-3 989**	**-39%**	**95**	**2%**	**-**	**-**

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.

Figure 4.23: 2G - Other Product Manufacture and Use: SF6 Trend in the EU-KP

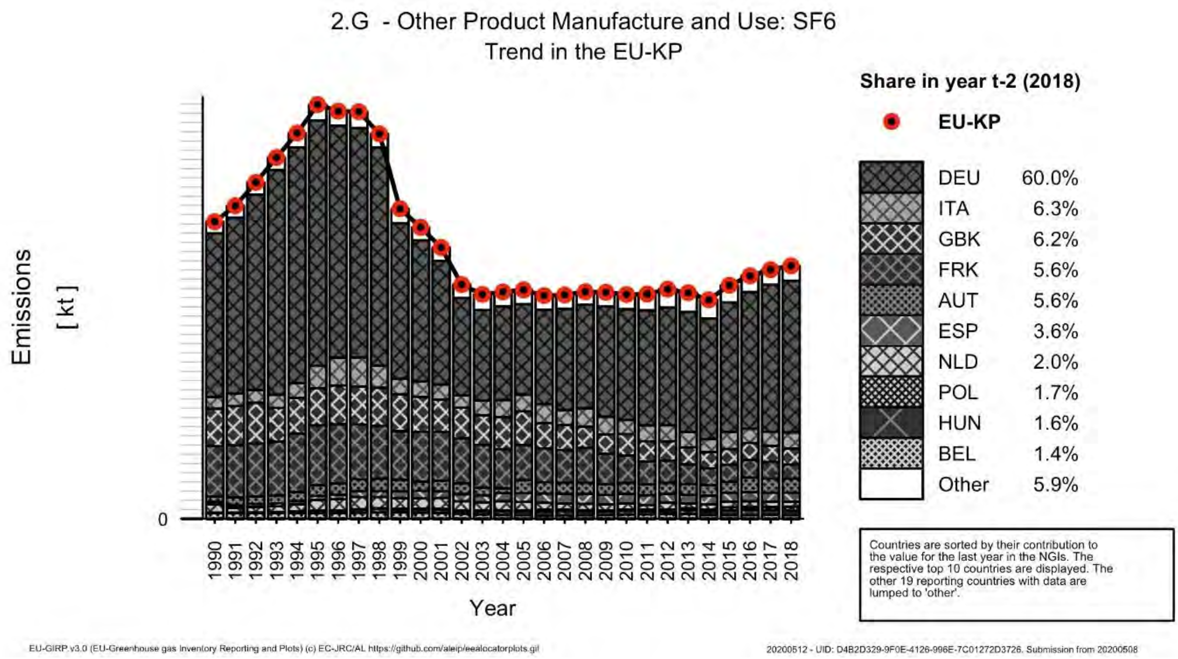


Figure 4.23 shows a stable trend for emissions from SF_6 in sector 2.G in the period 2002-2014, after a considerable decrease since 1995. Since 2014 smaller but steady increases took place (+2% in 2018 compared to 2017).

4.2.8 IPPU – non key categories

Table 4.54: Aggregeted GHG emission from non-key categories in the industrial processes and product use (IPPU) sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
2.A.3 Glass production: no classification (CO_2)	4 262.1	4 275.8	4 337.4	1.16%	75	2%	62	1%
2.B.1 Ammonia Production: no classification (CH_4)	2.1	3.0	2.9	0.00%	1	39%	-0.04	-1%
2.B.1 Ammonia Production: no classification (N_2O)	0.6	0.8	0.8	0.00%	0.2	33%	0.03	4%
2.B.10 Other chemical industry: no classification (CH_4)	275.6	111.5	86.8	0.02%	-189	-69%	-25	-22%
2.B.10 Other chemical industry: no classification (N_2O)	875.4	513.6	445.7	0.12%	-430	-49%	-68	-13%
2.B.3 Adipic Acid Production: no classification (CO_2)	17.7	17.0	18.9	0.01%	1	7%	2	12%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N_2O)	4 128.3	2 190.2	2 111.2	0.56%	-2 017	-49%	-79	-4%
2.B.5 Carbide Production: no classification (CH_4)	5.6	9.4	10.4	0.00%	5	87%	1	11%
2.B.5 Carbide Production: no classification (CO_2)	1 742.5	211.8	234.3	0.06%	-1 508	-87%	23	11%
2.B.6 Titanium Dioxide Production: no classification (CO_2)	179.0	277.8	271.2	0.07%	92	52%	-7	-2%
2.B.7 Soda Ash Production: no classification (CO_2)	2 249.3	2 181.9	2 194.2	0.59%	-55	-2%	12	1%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH_4)	999.2	1 137.2	1 077.2	0.29%	78	8%	-60	-5%
2.B.9 Fluorochemical Production: no classification (PFCs)	4 331.8	1 679.8	1 778.2	0.48%	-2 554	-59%	98	6%
2.B.9 Fluorochemical Production: no classification (SF6)	1 845.5	1.1	1.0	0.00%	-1 845	-100%	-0.05	-5%
2.C.1 Iron and Steel Production: no classification (CH_4)	260.3	124.7	126.3	0.03%	-134	-51%	2	1%
2.C.2 Ferroalloys Production: no classification (CH_4)	27.2	22.0	22.9	0.01%	-4	-16%	1	4%
2.C.2 Ferroalloys Production: no classification (CO_2)	4 868.5	3 500.3	3 488.8	0.93%	-1 380	-28%	-12	0%
2.C.3 Aluminium Production: no classification (CO_2)	4 906.1	4 717.9	4 574.9	1.22%	-331	-7%	-143	-3%
2.C.3 Aluminium Production: no classification (SF6)	13.7	0.1	0.1	0.00%	-14	-99%	0	40%
2.C.4 Magnesium Production: no classification (HFCs)	0.0	38.7	32.2	0.01%	32	100%	-6	-17%
2.C.4 Magnesium Production: no classification (SF6)	847.7	238.9	247.7	0.07%	-600	-71%	9	4%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
2.C.5 Lead Production: no classification (CO_2)	391.0	214.5	208.3	0.06%	-183	-47%	-6	-3%
2.C.6 Zinc Production: no classification (CO_2)	2 961.4	1 087.2	1 088.1	0.29%	-1 873	-63%	1	0%
2.C.7 Other Metal Industry: no classification (CO_2)	486.8	228.0	263.5	0.07%	-223	-46%	36	16%
2.C.7 Other Metal Industry: no classification (N_2O)	44.6	23.4	23.7	0.01%	-21	-47%	0.3	1%
2.C.7 Other Metal Industry: no classification (SF6)	781.0	53.8	57.5	0.02%	-724	-93%	4	7%
2.D.1 Lubricant Use: no classification (CH_4)	1.9	0.3	0.4	0.00%	-2	-81%	0.02	5%
2.D.1 Lubricant Use: no classification (CO_2)	4 303.0	2 706.5	2 732.4	0.73%	-1 571	-36%	26	1%
2.D.1 Lubricant Use: no classification (N_2O)	3.1	3.5	3.6	0.00%	0.4	14%	0.08	2%
2.D.2 Paraffin Wax Use: no classification (CH_4)	0.2	0.4	0.4	0.00%	0.2	113%	-0.01	-4%
2.D.2 Paraffin Wax Use: no classification (CO_2)	677.2	1 165.3	1 120.6	0.30%	443	65%	-45	-4%
2.D.2 Paraffin Wax Use: no classification (N_2O)	0.7	1.6	1.4	0.00%	1	93%	-0.1	-7%
2.D.3 Other non energy products: no classification (CH_4)	1.2	1.5	1.3	0.00%	0.2	14%	-0.2	-13%
2.E.1 Integrated Circuit or Semiconductor: no classification (HFCs)	86.2	60.5	65.8	0.02%	-20	-24%	5	9%
2.E.1 Integrated Circuit or Semiconductor: no classification (NF3)	23.8	60.4	68.3	0.02%	45	187%	8	13%
2.E.1 Integrated Circuit or Semiconductor: no classification (PFCs)	433.4	545.8	522.6	0.14%	89	21%	-23	-4%
2.E.1 Integrated Circuit or Semiconductor: no classification (SF6)	237.7	158.6	146.9	0.04%	-91	-38%	-12	-7%
2.E.4 Heat Transfer Fluid: no classification (HFCs)	0.0	0.05	0.12	0.00%	0	100%	0.1	154%
2.E.4 Heat Transfer Fluid: no classification (PFCs)	8.6	0.0	0.0	0.00%	-9	-100%	0	0%
2.E.5 Other electronics industry: no classification (PFCs)	0.0	1.1	0.0	0.00%	0	0%	-1	-100%
2.F.1 Refrigeration and Air conditioning: no classification (PFCs)	0.0	77.8	70.1	0.02%	70	100%	-8	-10%
2.F.1 Refrigeration and Air conditioning: no classification (Unspecified mix of HFCs and PFCs)	0.0	849.9	1 550.0	0.41%	1 550	100%	700	82%
2.F.3 Fire Protection: no classification (PFCs)	0.0	12.0	11.4	0.00%	11	100%	-1	-5%
2.F.5 Solvents: no classification (HFCs)	0.0	82.4	61.8	0.02%	62	100%	-21	-25%
2.F.6 Other Applications: no classification (HFCs)	0.4	237.1	232.8	0.06%	232	64801%	-4	-2%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
2.G.1 Electrical Equipment: no classification (SF6)	2 855.1	1 862.1	1 862.5	0.50%	-993	-35%	0	0%
2.G.2 SF6 and PFCs from Other Product Use: no classification (PFCs)	322.0	735.1	731.3	0.20%	409	127%	-4	-1%
2.G.2 SF6 and PFCs from Other Product Use: no classification (SF6)	4 494.4	4 301.6	4 396.0	1.18%	-98	-2%	94	2%
2.G.3 N_2O from Product Uses: no classification (N_2O)	3 679.9	3 424.9	3 598.9	0.96%	-81	-2%	174	5%
2.G.4 Other unspecifed product manufacture and use: no classification (CH_4)	56.8	79.0	83.4	0.02%	27	47%	4	6%
2.G.4 Other unspecifed product manufacture and use: no classification (CO_2)	803.9	646.8	621.4	0.17%	-182	-23%	-25	-4%
2.G.4 Other unspecifed product manufacture and use: no classification (HFCs)	0.0	15.8	15.9	0.00%	16	100%	0.04	0%
2.G.4 Other unspecifed product manufacture and use: no classification (N_2O)	45.3	213.4	205.5	0.05%	160	353%	-8	-4%
2.H Other Industrial Process and Product Use: no classification (CH_4)	37.2	14.0	13.5	0.00%	-24	-64%	-0.4	-3%
2.H Other Industrial Process and Product Use: no classification (CO_2)	112.7	114.8	132.7	0.04%	20	18%	18	16%
2.H Other Industrial Process and Product Use: no classification (HFCs)	0.0	2.0	1.9	0.00%	2	17862%	-0.2	-8%
2.H Other Industrial Process and Product Use: no classification (N_2O)	63.8	84.1	85.0	0.02%	21	33%	1	1%
2.H Other Industrial Process and Product Use: no classification (PFCs)	0.2	0.8	0.9	0.00%	1	343%	0.1	14%
2.H Other Industrial Process and Product Use: no classification (SF6)	7.5	12.1	7.1	0.00%	-0.4	-5%	-5	-41%
2.H Other Industrial Process and Product Use: no classification (Unspecified mix of HFCs and PFCs)	273.6	147.6	134.0	0.04%	-140	-51%	-14	-9%

4.3 Methodological issues and uncertainties

The previous section presented for each EU-KP 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 countries and the corresponding IEFs. Some of these tables do include a calculation of EU-level implied emission factors based on a number of countries. 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 countries 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 2018 and only for the EU key categories where the criteria above apply. In 2020 the following categories have been gap-filled:

- Cement Production 2.A.1
- Lime production in 2.A.2

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-KP.
2. These emissions have been divided by the aggregated activity data of those MS in order to derive an IEF for those MS.
3. The total emissions of the EU-KP have been divided by this IEF in order to derive a gap-filled estimate for activity data for EU-KP.

Table **4.55** 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 4.55 Documentation of gap filling of activity data

Category	Geographical coverage	2018			
		Activity data Description	(kt)	IEF (t/t)	Emissions (kt)
2.A.1	EU-27+UK	Clinker production	147208	0.53	77970
	EU-27+UK excl. HUN	Clinker production	145543	0.53	77088
2.A.2	EU-27+UK	Lime Production	26633	0.74	19641
	EU-27+UK excl. NLD, PRT & GBK	Lime Production	24284	0.74	17909

4.3.2 Uncertainty estimates

Table 4.56 shows the total EU-KP 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 PFCs from 2.F (156.3 %) 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-KP see Chapter 1.6.

Table 4.56 Sector 2 Industrial processes: Uncertainty estimates for the EU-KP

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	CO_2	148 361	111 406	-24.9%	3.1%	0.0%
2.A Mineral Industry	CH_4	31	5	-82.7%	100.0%	0.8%
2.A Mineral Industry	N_2O	0	0		0.0%	
2.B Chemical Industry	CO_2	62 486	53 132	-15.0%	5.6%	0.0%
2.B Chemical Industry	CH_4	1 171	1 061	-9.4%	29.2%	0.1%
2.B Chemical Industry	N_2O	116 797	5 745	-95.1%	9.2%	0.2%
2.B Chemical Industry	HFC	35 144	2 022	-94.2%	24.4%	0.1%
2.B Chemical Industry	PFC	4 428	1 778	-59.8%	49.2%	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	1	-99.9%	3.0%	0.2%
2.B Chemical Industry	NF3	0	0		0.0%	0.0%
2.C Metal Industry	CO_2	118 011	72 530	-38.5%	3.2%	0.0%
2.C Metal Industry	CH_4	279	127	-54.6%	15.9%	0.1%
2.C Metal Industry	N_2O	45	24	-46.7%	74.9%	0.3%
2.C Metal Industry	HFC	4 446	37	-99.2%	30.6%	0.5%
2.C Metal Industry	PFC	15 931	608	-96.2%	9.9%	0.1%
2.C Metal Industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.C Metal Industry	SF_6	1 467	218	-85.1%	11.6%	0.2%

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.C Metal Industry	NF3	0	0		0.0%	0.0%
2.D Non-energy products from fuels and solvent use	CO_2	14 086	8 793	-37.6%	38.8%	0.2%
2.D Non-energy products from fuels and solvent use	CH_4	3	2	-35.8%	82.9%	0.4%
2.D Non-energy products from fuels and solvent use	N_2O	4	5	29.2%	75.7%	0.3%
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	58	1 255	2064.2%	23.1%	4.5%
2.E Electronics industry	PFC	540	472	-12.6%	22.9%	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	125	-37.3%	17.3%	0.8%
2.E Electronics industry	NF3	99	64	-35.6%	18.6%	0.1%
2.F Product uses as substitutes for ODS	CO_2	0	2 309		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	4 374	90 053	1959.0%	46.0%	3.3%
2.F Product uses as substitutes for ODS	PFC	21	43	106.5%	156.3%	3.1%
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	808	639	-20.9%	11.8%	0.0%
2.G Other product manufacture and use	CH_4	57	83	46.8%	30.6%	0.2%
2.G Other product manufacture and use	N_2O	3 331	2 911	-12.6%	49.2%	0.1%
2.G Other product manufacture and use	HFC	46	126	174.3%	104.9%	2.4%
2.G Other product manufacture and use	PFC	401	768	91.6%	32.6%	0.2%
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	SF6	3 224	1 986	-38.4%	26.0%	0.1%
2.G Other product manufacture and use	NF3	0	0		0.0%	0.0%
2.H Other	CO_2	98	80	-18.2%	11.4%	0.1%
2.H Other	CH_4	6	8	34.5%	21.1%	0.1%
2.H Other	N_2O	64	85	33.5%	20.9%	0.1%
2.H Other	HFC	0	2	17494.5%	60.7%	106.2%
2.H Other	PFC	0	1	343.3%	60.3%	2.1%

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.H Other	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.H Other	SF6	7	7	-5.2%	60.5%	0.0%
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**	**537 916**	**358 514**	-33.4%	**11.7%**	**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 several arrangements for improving the quality of GHG emissions from industrial processes.: (1) Before and during the compilation of the EU GHG inventory, a number of assessments 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 countries and checks of internal consistency. Table 3.127 (in the Energy chapter), summarizes the main checks carried out on Member States' submissions. Internal reviews are carried out for selected source categories. In 2006 the following source categories were reviewed by countries experts: 2A Mineral Products, 2B Chemical Industry, 2C Iron and Steel Production and Fluorinated Gases, 2E Production of Halocarbons and SF6 and 2F Consumption of Halocarbons and SF6. In 2008, completeness and allocation issues were reviewed by countries experts for all source categories in Industrial Processes. In 2012 a comprehensive review was carried out for all sectors and all EU countries 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. NF3 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 annual ESD reviews in 2017 and 2018. Since 2016, additional focus is put on the introduction of alternatives to F-gases in the quality checks of Member States' submissions. This is relevant in the context of the HFC phase-down under the EU F-gas Regulation.

4.5 Sector Specific Recalculations

Table 4.57 shows that in the industrial processes sector the largest recalculations in absolute terms were made for N_2O and HFCs in 1990 and 2018.

Table 4.57 Recalculations of total GHG emissions and recalculations from industrial processes and product use for 1990 and 2017 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	-8 529	-0.2%	1 287	0.2%	-3 960	-1.0%	65	0.2%	171	0.7%	7	0.1%	-229	-3.8%	7	40.7%
Industrial Processes and Product Use	31	0.0%	-66	-3.8%	-1 966	-1.7%	65	0.2%	171	0.7%	7	0.1%	-229	-3.8%	7	40.7%
2017																
Total emissions and removals	-3 715	-0.1%	-665	-0.1%	277	0.1%	832	0.8%	296	9.1%	-100	-1.5%	-580	-34.8%	12	25.0%
Industrial Processes and Product Use	1 929	0.8%	-85	-5.3%	76	0.7%	832	0.8%	296	9.1%	-100	-1.5%	-580	-34.8%	12	25.0%

Table 4.58 provides an overview of Member States' contributions to EU-KP recalculations.

Table 4.58 Sector 2 Industrial processes: Contribution of Member States to EU-KP recalculations for 1990 and 2017by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2017							
	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	0	0	0	0	0	0	0	-15	0	0	26	0	1	0	0
Belgium	-256	0	3	0	0	0	0	0	-5	0	2	1 551	12	9	0	0
Bulgaria	36	0	0	0	0	0	0	0	-4	0	0	-1	0	0	0	0
Croatia	-8	0	0	0	0	0	0	0	-1	0	7	0	0	-1	0	0
Cyprus	-10	0	7	16	0	0	0	0	6	0	3	38	0	0	0	0
Czechia	0	0	0	0	0	0	0	0	-47	0	4	-3	0	0	0	1
Denmark	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	4	0	0	-4	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0	0	0	-66	-4	-26	0	0
France	9	-5	51	0	0	0	0	0	285	0	0	-937	0	4	0	0
Germany	-5	0	-2 029	50	172	0	-229	7	1 494	1	8	111	167	-75	-584	12
Greece	50	0	0	0	0	0	0	0	8	0	0	-1	0	0	0	0
Hungary	-2	0	0	0	0	2	0	0	124	0	0	0	0	5	0	0
Ireland	0	0	0	-1	0	0	0	0	34	0	0	123	0	0	0	0
Italy	12	0	0	0	0	0	0	0	-11	0	6	1 114	0	0	4	0
Latvia	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0
Lithuania	-18	0	0	0	0	0	0	0	-22	0	0	7	0	0	0	0
Luxembourg	-1	0	0	0	0	0	0	0	-1	0	0	-2	0	0	0	0
Malta	0	0	0	0	0	0	0	0	0	0	0	58	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	-2	-268	0	0	0	0
Poland	-80	0	0	0	0	0	0	0	-24	0	0	-857	0	0	0	0
Portugal	304	-5	0	0	0	0	0	0	-6	-16	0	9	0	0	0	0
Romania	-269	0	0	0	0	0	0	0	22	0	0	1	0	0	0	0
Slovakia	105	0	0	0	0	0	0	0	-16	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	0	0	0	-18	0	0	0	0
Spain	-23	-73	0	0	0	0	0	0	-27	-72	0	-1	0	0	0	0
Sweden	1	0	0	0	0	0			5	0	41	-40	0	-1		
United Kingdom	185	17	0	0	0	5	0	0	124	3	3	-5	122	-16	0	0
EU27+UK	32	-66	-1 968	65	172	7	-229	7	1 929	-85	72	851	296	-100	-580	12
Iceland	0	0	0	0	0	0	0	0	0	0	0	-14	0	0	0	0
United Kingdom (KP)	185	17	3	0	0	5	0	0	124	3	7	-10	122	-16	0	0
EU-KP	31	-66	-1 966	65	171	7	-229	7	1 929	-85	76	832	296	-100	-580	12

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[18].

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)[19].

- "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[20] in 2008 and a Commission Communication on the CAP towards 2020[21] in 2011. The four legislative texts that regulate the post-2013 CAP are (i) Rural Development:

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[18] http://ec.europa.eu/agriculture/envir/index_en.htm

[19] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1782

[20] http://ec.europa.eu/agriculture/healthcheck/index_en.htm

[21] https://ec.europa.eu/agriculture/cap-post-2013_en

Regulation 1305/2013[22]; (ii) "Horizontal" issues such as funding and controls: Regulation 1306/2013[23]; (iii) Direct payments for farmers: Regulation 1307/2013[24]; (iv) Market measures: Regulation 1308/2013[25].

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[26], 2001[27], 2000[28]). 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[29].

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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22 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF

23 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:en:PDF

24 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:en:PDF

25 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0671:0854:en:PDF

26 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.

27 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.

28 EC (2000). Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy. Commission of the European Communities.

29 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[30]) 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 2016/2284/EC[31]) sets upper limits for each country for the total emissions in 2010 of the four pollutants responsible for acidification,

30 http://www.unece.org/env/lrtap/multi_h1.html

eutrophication and ground-level ozone pollution. It has been updated in 2016[32] setting new objectives for EU air policy for 2020 and 2030;

- The Industrial Emission Directive (IED[33][34]), 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-

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31 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1554903780611&uri=CELEX:32016L2284

32 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

33 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

34 http://ec.europa.eu/environment/industry/stationary/index.htm

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 fertilization. In Poland, 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 2018, CO_2, CH_4 and N_2O emissions from CRF sector 3 Agriculture were 47.7%, 72.2%, and 0.27% of total CO_2, CH_4 and N_2O EU-KP emissions, respectively. Total emissions from agriculture were 436 Mt CO_2-eq with contributions from CH_4, N_2O, and CO_2 of 240 Mt CO_2-eq, 186 Mt CO_2-eq and 10.6 Mt CO_2-eq, respectively. Thus, CH_4, N_2O, and CO_2 contributed with 5.1%, 3.9% and 0.22% to total EU-KP GHG emissions. They make 55%, 42.6% and 2.4% of total agricultural emissions.

Figure 5.1 shows the development of total GHG emissions from agriculture from 547 Mt CO_2-eq in 1990 to 436 Mt CO_2-eq in 2018 and the considerably decrease in EU-KP. The reduction of emissions was most pronounced for CO_2 with a decrease of 28.3%, followed by CH_4 with a decrease of 21.7% and N_2O with a decrease of 17.7%. The cut was most pronounced in the first decade with a total reduction of 15.1% between 1990 and 2000, a further decrease by between 2000 and 2005, while remaining constant since 2005 (change -1.2%).

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 countries. Figure 5.3 shows the distribution of agricultural GHG emissions among the different source categories for the year 2018.

Figure 5.1: EU-KP GHG emissions for 1990-2018 from CRF Sector 3: 'Agriculture' in CO_2 equivalents (Mt)

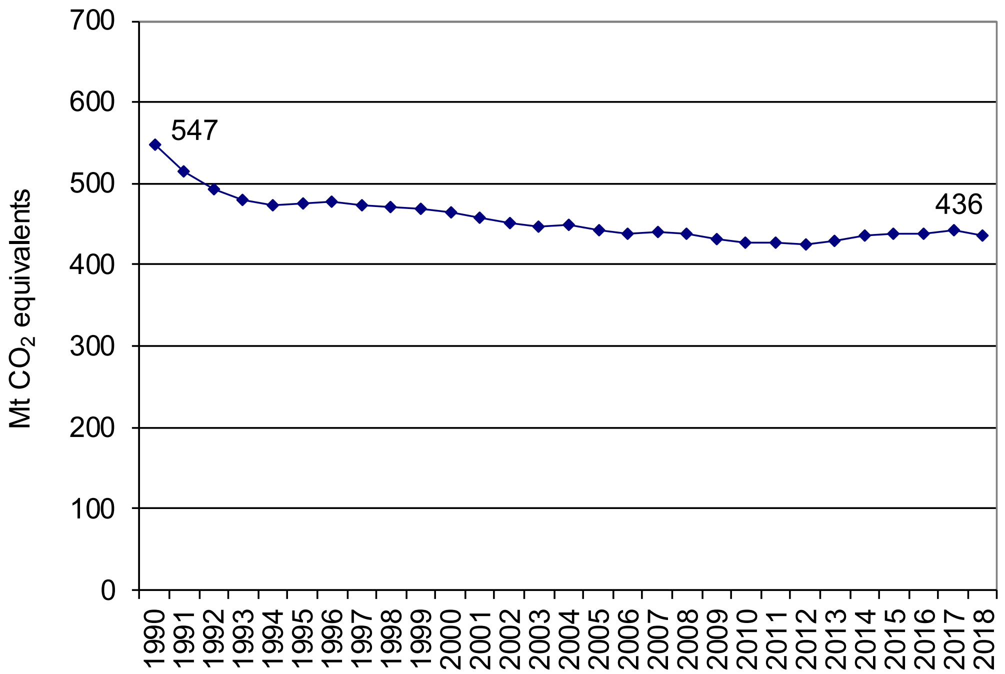


Figure 5.2: **Absolute change of GHG emissions by large key source categories 1990-2018 in CO_2 equivalents (Mt) in CRF Sector 3: 'Agriculture'**

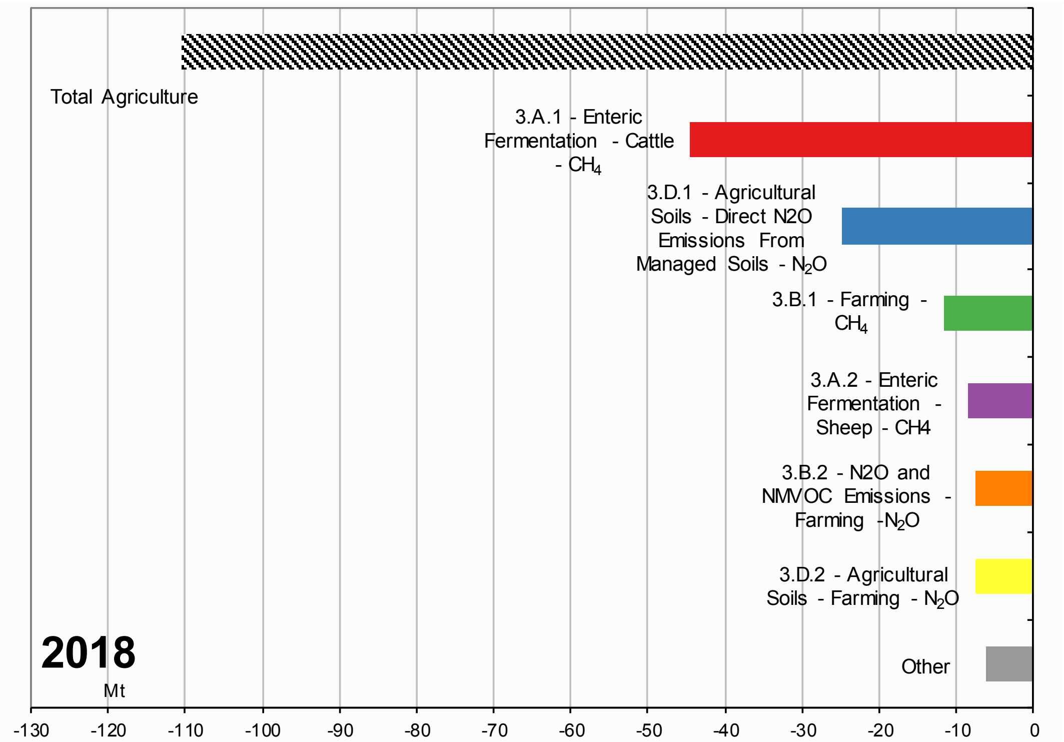
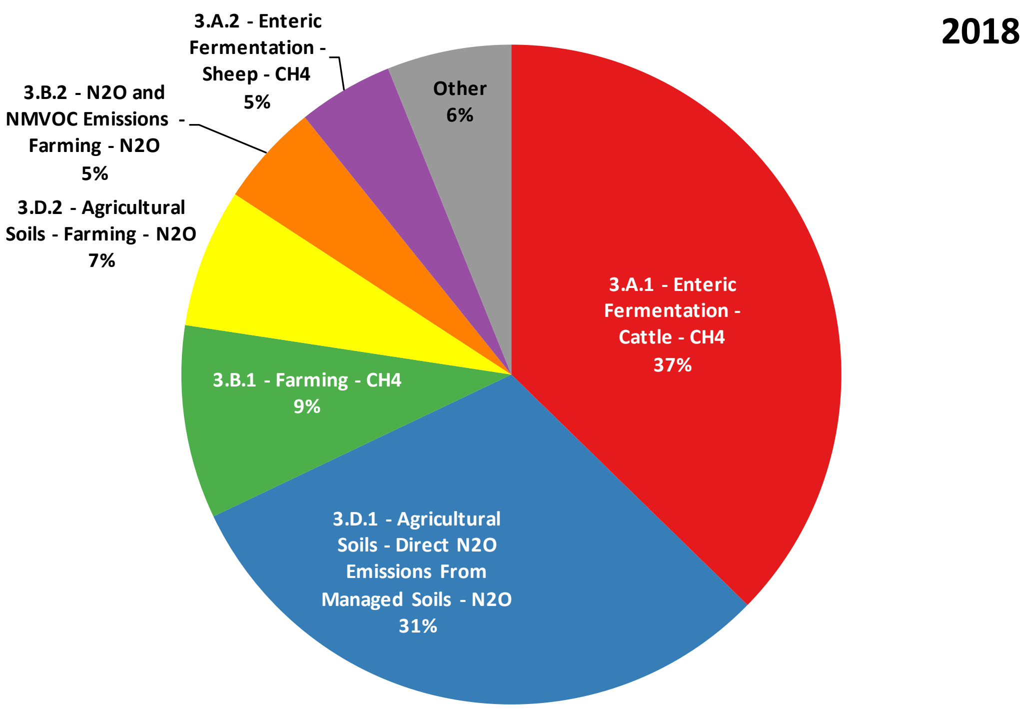


Figure 5.3: **Distribution of agricultural GHG emissions among the different source categories for the year 2018**



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 1990-2018 and 2017-2018. 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 20.5% compared to 1990, and 49% of this reduction is due to sector 3.A. Another important sector in determining long-term emission trends is 3.D.1 which accounts for 22% of the total decrease in agricultural emissions, followed by 3.B.1 (10%), while all the other categories contribute less. The decrease in emissions is due to the decrease in the cattle population (0% between 1990 and 2018) and the decrease in the quantities applied of fertilisers, both synthetic and organic (22.3% and 12.2% decrease, respectively).

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 (2018)	Share of trend 1990-2018	Share of trend 2017-2018
3.A	CH_4	0.45	0.49	0.24
3.B.1	CH_4	0.10	0.10	0.05
3.B.2	N_2O	0.05	0.07	0.01
3.C	CH_4	0.01	0.00	0.02
3.D.1	N_2O	0.31	0.22	0.57
3.D.2	N_2O	0.07	0.07	0.13
3.F	CH_4	0.00	0.01	0.01
3.F	N_2O	0.00	0.00	0.00
3.G	CO_2	0.01	0.04	-0.08
3.H	CO_2	0.01	0.00	0.05
3.I	CO_2	0.00	0.00	0.00

Looking at the data by country in Table 5.2, we can see that the shares of the trend 1990-2018 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 2017 and 2018 (1% of total emissions), with key categories increasing emissions (3.A, 3.B.1, 3.D.1, 3.D.2, 3.I) and some less relevant categories decreasing (3.B.2, 3.C, 3.F, 3.G, 3.H), resulting in an increase of emissions for the whole sector. The greatest relative changes took place in category 3.F, with a 17% decrease of emissions, being the total impact in the general trend, however, only of 2.5% given the low share of these emissions in the total emissions of the sector. The main contributor to the total increase in agricultural emissions from last year is category 3.D.1 (81% of the total trend), followed by 3.D.2 and 3.A (15% and 10%, respectively). The contribution of the other categories is less than 10% of total change.

Table 5.2 Contribution to EU emission trends (2017-2018) per country and emission (%)

Country	3.A	3.B.1	3.B.2	3.D.1	3.D.2	3.G	3.H	Share of total EU emissions from agriculture in 2018
FRK	9.94	-2.44	0.23	15.36	3.27	-1.55	0.20	17.22
DEU	8.20	2.74	1.15	25.44	7.35	-3.60	3.57	14.27
GBK	5.10	0.46	0.23	1.14	0.38	0.18	0.08	9.40
ESP	-1.45	0.93	0.15	2.37	0.59	0.28	1.74	9.13
POL	-4.74	-0.83	-1.47	1.27	-0.15	-0.40	-0.48	7.63
ITA	0.13	1.13	0.76	3.00	0.94	0.04	0.24	6.95
IRL	-0.10	-0.03	0.08	-3.30	-0.27	-2.24	-0.09	4.59
ROU	0.01	2.03	0.31	-11.23	-3.18	0.26	-0.28	4.57
NLD	7.07	1.23	-0.05	2.56	0.23	0.27	NA	4.20
DNM	-0.66	-0.62	-0.21	3.48	0.42	-0.46	0.00	2.54
BEL	-0.25	-0.10	0.09	2.31	0.50	0.00	0.02	2.29
CZE	-1.79	-0.55	-0.48	4.80	1.38	-0.04	-0.03	1.98
GRC	0.49	0.04	0.05	1.10	0.36	NA	0.02	1.79
AUT	0.71	0.13	0.07	0.64	0.13	-0.19	0.11	1.66
HUN	-0.51	-0.17	0.00	-0.10	0.01	0.03	0.00	1.65
PRT	-1.13	-0.02	-0.03	0.12	0.14	0.00	0.09	1.57
SWE	0.21	-0.01	0.01	4.08	0.02	0.00	-0.02	1.56
FIN	0.32	0.04	0.03	0.92	0.21	-0.24	0.01	1.51
BGR	0.40	-0.02	0.04	1.75	0.45	NA	-0.01	1.48
LTU	0.43	0.20	0.10	0.93	0.24	0.01	-0.01	0.99
SVK	0.07	-0.08	-0.10	-1.11	-0.31	-0.09	-0.04	0.63
HRV	1.07	0.42	0.23	-0.22	-0.08	0.00	0.09	0.63
LVA	0.34	0.21	0.15	0.86	0.21	-0.18	-0.01	0.60
SVN	0.08	0.04	0.01	-0.05	-0.02	-0.02	-0.04	0.40
EST	-0.02	-0.01	0.02	0.16	0.01	-0.05	0.00	0.33
LUX	0.07	0.01	0.01	0.06	0.02	-0.04	NA	0.16
ISL	0.25	0.08	0.02	0.20	0.06	-0.04	0.00	0.15
CYP	-0.11	0.01	-0.02	0.01	0.00	NA	0.00	0.11
MLT	0.00	0.00	-0.01	0.00	0.00	NA	NA	0.02
Total	**24.10**	**4.80**	**1.40**	**56.50**	**12.90**	**-8.10**	**5.20**	**100.00**

5.3 Source categories and methodological issues

In this section, we present the information relevant for EU-KP key source categories in the sector 3 Agriculture.

Key source categories identified are:

- CH_4 emissions from source category 3.A.1 - Dairy cattle.
- CH_4 emissions from source category 3.A.1 - Non-dairy cattle.
- CH_4 emissions from source category 3.B.1.1 - Cattle
- CH_4 emissions from source category 3.A.2 - Sheep.
- CH_4 emissions from source category 3.A.4 - Other livestock.
- CH_4 emissions from source category 3.B.1 - Manure management.
- N_2O emissions from source category 3.B.2 - Manure management.
- N_2O emissions from source category 3.D.1 - Direct N_2O emissions from managed soils.
- N_2O emissions from source category 3.D.2 - Indirect emissions from managed 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 two countries (Romania and France) 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 Portugal 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). Emissions in kt CO_2 eq.

Source	Emissions 1990 [kt CO_{2eq}]	Emissions 2018 [kt CO_{2eq}]	Trend	Level 1990	Level 2018	Share higher tiers 1990	Share higher tiers 2018
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	80,109	59,788	0	L	L	0.99	0.99
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	89,710	78,222	T	L	L	1.00	1.00
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	28,682	20,308	0	L	L	0.91	0.92
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6,814	6,609	0	0	L	0.59	0.64
3.B.1 CH_4 Emissions: Farming (CH_4)	52,433	41,107	0	L	L	0.95	0.96
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	29,574	22,030	0	L	L	0.97	0.97

3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	157,614	132,553	T	L	L	0.40	0.39
3.D.2 Agricultural Soils: Farming (N_2O)	37,134	29,652	0	L	L	0.25	0.28

Other source categories are not identified as key source in the analysis at EU-KP 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 EU-KP emissions and to EU-KP 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 4.1% of total EU-KP GHG emissions and 39% of total EU-KP CH_4 emissions. They make 44.5% of total agricultural emissions and 81% 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 countries, Figure 5.5 shows the distribution of CH_4 emissions from enteric fermentation by livestock category in all countries and in the EU-KP. 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 EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2018.

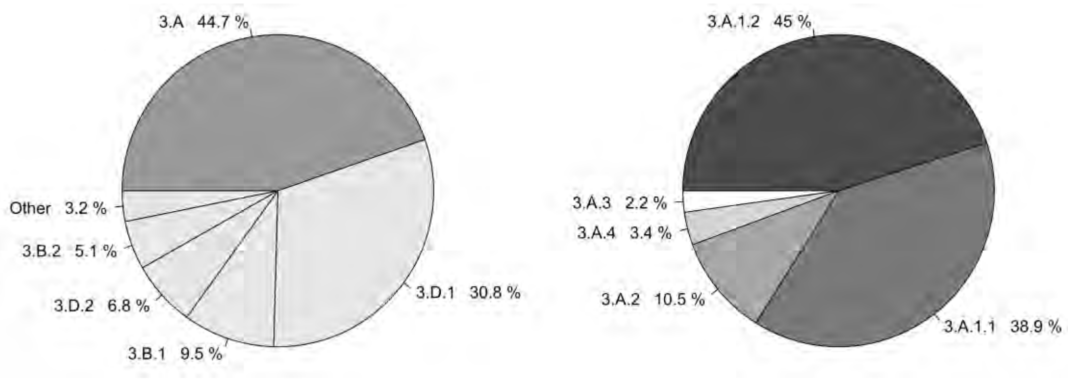
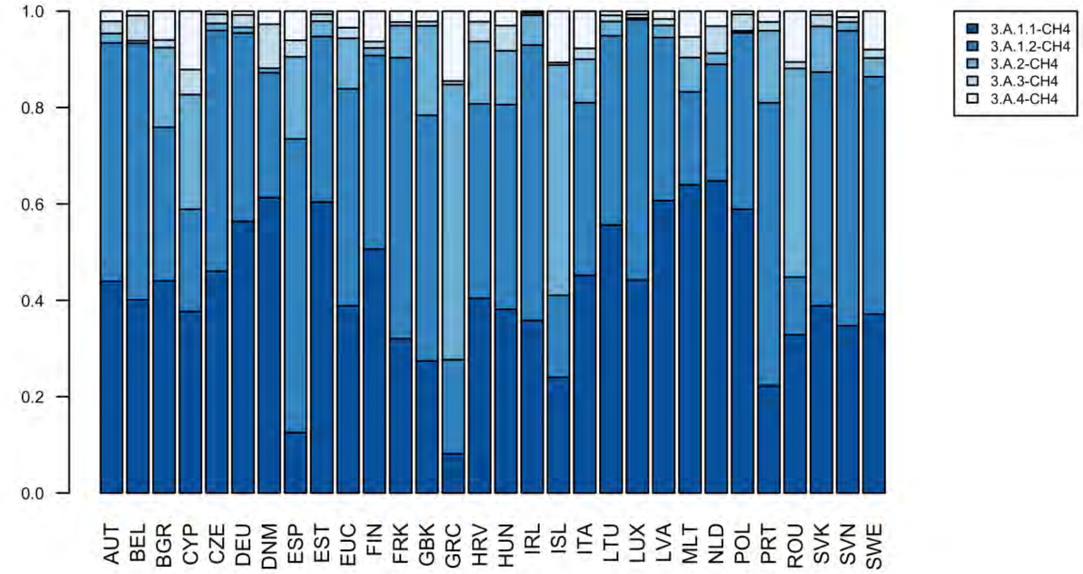


Figure 5.5: Decomposition of emissions in source category 3.A - Enteric Fermentation into its sub-categories by country in the year 2018.



Total GHG and CH_4 emissions by country from 3.A *Enteric Fermentation* are shown in Table 5.4 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). 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 2018, CH_4 emission in this source category decreased by 22% or 54.5 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (69%) and in Germany in absolute terms (10.3 Mt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 0.7%.

Table 5.4 *3.A - Enteric Fermentation: Countries' contributions to total EU-GHG and CH_4 emissions*

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 821	4 157	4 118	2.1%	-703	-15%	-39	-1%	T1,T2	CS,D
Belgium	5 410	4 545	4 558	2.3%	-851	-16%	14	0%	T1,T2	CS,D
Bulgaria	4 805	1 512	1 490	0.8%	-3 314	-69%	-22	-1%	T1,T2	CS,D
Croatia	2 120	1 043	983	0.5%	-1 137	-54%	-60	-6%	T1	D
Cyprus	197	256	262	0.1%	65	33%	6	2%	T1,T2	CS,D
Czechia	5 601	2 939	3 039	1.6%	-2 561	-46%	100	3%	T1,T2	CS,D
Denmark	4 039	3 731	3 767	1.9%	-272	-7%	37	1%	T1,T2	CS,D,OTH
Estonia	1 230	539	540	0.3%	-691	-56%	1	0%	D,T1,T2	CS,D,OTH
Finland	2 417	2 096	2 078	1.1%	-339	-14%	-18	-1%	,OTH,T1,T2	CS,D,OTH
France	38 630	34 755	34 201	17.6%	-4 430	-11%	-554	-2%	T2,T3	CS
Germany	35 353	25 526	25 069	12.9%	-10 284	-29%	-457	-2%	T1,T2,T3	CS,D
Greece	4 024	3 629	3 602	1.9%	-422	-10%	-27	-1%	T1,T2	CS,D
Hungary	3 668	2 022	2 051	1.1%	-1 617	-44%	29	1%	T1,T2	CS,D
Ireland	11 357	11 538	11 543	5.9%	186	2%	5	0%	CS,T1,T2	CS,D
Italy	15 497	14 209	14 202	7.3%	-1 294	-8%	-7	0%	T1,T2	CS,D
Latvia	2 222	869	850	0.4%	-1 372	-62%	-19	-2%	T1,T2	CS,D,OTH
Lithuania	4 291	1 537	1 513	0.8%	-2 778	-65%	-24	-2%	T1,T2	CS,D,OTH
Luxembourg	388	407	403	0.2%	16	4%	-4	-1%	T1,T2	CS,D
Malta	36	32	32	0.0%	-4	-12%	0	0%	T1,T2	CS,D
Netherlands	9 231	8 662	8 268	4.3%	-963	-10%	-394	-5%	T1,T2,T3	CS,D
Poland	21 554	12 794	13 059	6.7%	-8 496	-39%	264	2%	T1,T2	CS,D
Portugal	3 521	3 433	3 496	1.8%	-25	-1%	63	2%	T1,T2	CS,D
Romania	19 492	10 842	10 842	5.6%	-8 650	-44%	0	0%	T2	CS
Slovakia	2 798	999	995	0.5%	-1 803	-64%	-4	0%	T1,T2	CS,D
Slovenia	935	932	927	0.5%	-8	-1%	-4	0%	T1,T2	CS,D
Spain	15 937	17 588	17 669	9.1%	1 732	11%	81	0%	CS,T2	CS
Sweden	3 277	3 019	3 007	1.5%	-270	-8%	-12	0%	CS,T1	CS,D
United Kingdom	25 392	21 458	21 174	10.9%	-4 219	-17%	-285	-1%	T1,T3	CS,D
EU-27+UK	**248 243**	**195 069**	**193 737**	**100%**	**-54 505**	**-22%**	**-1 332**	**-1%**	**-**	**-**
Iceland	326	315	301	0.2%	-25	-8%	-14	-4%	T1,T2	CS,D
United Kingdom (KP)	25 392	21 458	21 174	10.9%	-4 219	-17%	-285	-1%	T1,T3	CS,D
EU-KP	**248 569**	**195 385**	**194 038**	**100%**	**-54 531**	**-22%**	**-1 346**	**-1%**	**-**	**-**

Total GHG and CH_4 emissions by country from *3.A.1 - Cattle Enteric Fermentation* are shown in Table 5.5 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, CH_4 emission in this source category decreased by 21% or 44.5 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (65%) and in Germany in absolute terms (10 Mt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 0.7%.

Table 5.5 3.A.1 - Cattle: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 579	3 885	3 846	2.4%	-734	-16%	-39	-1%	T2	CS
Belgium	5 110	4 239	4 253	2.6%	-857	-17%	14	0%	T2	CS
Bulgaria	2 958	1 161	1 131	0.7%	-1 827	-62%	-30	-3%	T2	CS
Croatia	1 868	851	794	0.5%	-1 074	-57%	-58	-7%	T1	D
Cyprus	101	146	154	0.1%	53	52%	8	6%	T1,T2	CS,D
Czechia	5 318	2 821	2 918	1.8%	-2 400	-45%	97	3%	T2	CS
Denmark	3 662	3 261	3 287	2.0%	-375	-10%	26	1%	T2	CS,D
Estonia	1 172	510	511	0.3%	-661	-56%	2	0%	T2	CS,D
Finland	2 221	1 900	1 887	1.2%	-333	-15%	-13	-1%	T2	CS
France	34 130	31 507	30 898	19.0%	-3 232	-9%	-609	-2%	T2,T3	CS
Germany	33 941	24 370	23 939	14.7%	-10 002	-29%	-431	-2%	T2,T3	CS,D
Greece	1 184	1 022	997	0.6%	-188	-16%	-25	-2%	T2	CS,D
Hungary	2 876	1 621	1 653	1.0%	-1 224	-43%	32	2%	T2	CS
Ireland	10 101	10 709	10 730	6.6%	628	6%	21	0%	CS,T2	CS
Italy	13 164	11 502	11 504	7.1%	-1 660	-13%	3	0%	T2	CS
Latvia	2 118	820	803	0.5%	-1 315	-62%	-17	-2%	T2	CS
Lithuania	4 146	1 457	1 436	0.9%	-2 710	-65%	-21	-1%	T2	CS
Luxembourg	384	400	396	0.2%	13	3%	-4	-1%	T2	CS
Malta	28	27	26	0.0%	-2	-6%	0	-1%	T2	CS
Netherlands	8 195	7 768	7 356	4.5%	-840	-10%	-413	-5%	T2,T3	CS
Poland	19 547	12 228	12 471	7.7%	-7 076	-36%	243	2%	T2	CS
Portugal	2 460	2 785	2 831	1.7%	371	15%	46	2%	T2	CS
Romania	11 213	4 916	4 858	3.0%	-6 355	-57%	-58	-1%	T2	CS
Slovakia	2 517	871	869	0.5%	-1 649	-65%	-3	0%	T2	CS
Slovenia	904	894	890	0.5%	-15	-2%	-4	0%	T2	CS
Spain	10 432	12 781	12 983	8.0%	2 551	24%	202	2%	CS,T2	CS
Sweden	2 884	2 605	2 598	1.6%	-286	-10%	-7	0%	CS	CS
United Kingdom	19 881	16 771	16 596	10.2%	-3 285	-17%	-174	-1%	T3	CS
EU-27+UK	**207 094**	**163 825**	**162 613**	**100%**	**-44 481**	**-21%**	**-1 212**	**-1%**	-	-
Iceland	109	127	124	0.1%	14	13%	-3	-3%	T2	CS
United Kingdom (KP)	19 881	16 771	16 596	10.2%	-3 285	-17%	-174	-1%	T3	CS
EU-KP	**207 204**	**163 952**	**162 736**	**100%**	**-44 467**	**-21%**	**-1 215**	**-1%**	-	-

Total GHG and CH_4 emissions by country from *3.A.2 - Sheep Enteric Fermentation* are shown in Table 5.6 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, CH_4 emission in this source category decreased by 29% or 8.5 Mt CO_2-eq. The decrease was largest in Poland in relative terms (93%) and in Romania in absolute terms (1.9 Mt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 0.1%.

Table 5.6 3.A.2 - Sheep: Countries' contributions to total EU-GHG and CH_4 emissions

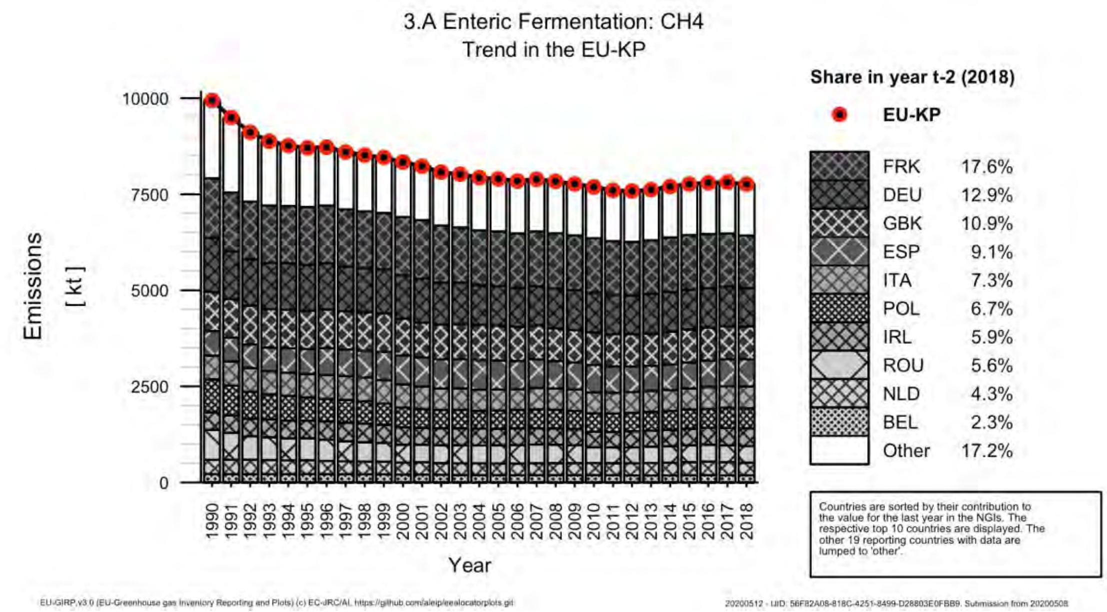
Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	62	80	81	0.4%	19	31%	1	1%	T1	D
Belgium	38	26	26	0.1%	-12	-32%	0	1%	T1	D
Bulgaria	1 454	247	247	1.2%	-1 207	-83%	0	0%	T2	CS
Croatia	150	127	127	0.6%	-23	-15%	0	0%	T1	D
Cyprus	58	64	62	0.3%	4	7%	-2	-3%	T1	D
Czechia	86	43	44	0.2%	-42	-49%	0	1%	T1	D
Denmark	39	34	34	0.2%	-4	-11%	0	0%	T2	D
Estonia	32	18	17	0.1%	-15	-46%	-1	-4%	D,T1	D
Finland	18	33	33	0.2%	15	85%	0	-1%	CS	CS
France	3 533	2 238	2 279	11.2%	-1 253	-35%	41	2%	T2,T3	CS
Germany	518	296	294	1.4%	-225	-43%	-3	-1%	T1	CS,D
Greece	2 054	2 055	2 057	10.1%	3	0%	2	0%	T2	CS,D
Hungary	392	232	229	1.1%	-163	-41%	-3	-1%	T1	D
Ireland	1 176	733	718	3.5%	-459	-39%	-15	-2%	T1	D
Italy	1 504	1 277	1 282	6.3%	-222	-15%	5	0%	T2	CS
Latvia	33	22	21	0.1%	-11	-35%	-1	-4%	T1	D
Lithuania	18	45	45	0.2%	27	146%	0	-1%	T2	CS
Luxembourg	1	1	1	0.0%	0	30%	0	1%	T2	CS
Malta	2	2	2	0.0%	0	-10%	0	11%	T2	CS
Netherlands	340	179	190	0.9%	-151	-44%	11	6%	T1	D
Poland	832	52	55	0.3%	-776	-93%	3	6%	T1	D
Portugal	794	504	523	2.6%	-271	-34%	19	4%	T2	CS
Romania	6 587	4 605	4 695	23.0%	-1 892	-29%	90	2%	T2	CS
Slovakia	179	97	95	0.5%	-84	-47%	-2	-2%	T2	CS
Slovenia	3	17	16	0.1%	14	479%	0	-1%	T1	D
Spain	3 791	3 049	3 009	14.8%	-782	-21%	-40	-1%	CS,T2	CS
Sweden	81	121	117	0.6%	36	45%	-4	-3%	T1	D
United Kingdom	4 936	4 043	3 934	19.3%	-1 002	-20%	-110	-3%	T3	CS
EU-27+UK	**28 711**	**20 242**	**20 234**	**99%**	**-8 477**	**-30%**	**-7**	**0%**	**-**	**-**
Iceland	182	151	144	0.7%	-38	-21%	-7	-5%	T2	CS
United Kingdom (KP)	4 936	4 043	3 934	19.3%	-1 002	-20%	-110	-3%	T3	CS
EU-KP	**28 893**	**20 393**	**20 378**	**100%**	**-8 515**	**-29%**	**-14**	**0%**	**-**	**-**

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 EU-KP by 22% or 54.5 Mt CO_2-eq in the period 1990 to 2018. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.8% of the total. Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Germany, Romania and Poland with a total absolute decrease of 27.4 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 1.7 Mt CO_2-eq.

Figure 5.6: 3.A: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.A.1 - Cattle - Emissions

Emissions in source category *3.A.1 - Cattle* decreased considerably in EU-KP by 21% or 44.5 Mt CO_2-eq in the period 1990 to 2018. The ten countries with the highest emissions accounted together for 83.3% 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 23.4 Mt CO_2-eq. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 3.6 Mt CO_2-eq.

Emissions in source category *3.A.1.1 - Dairy Cattle* decreased strongly in EU-KP by 28% or 29.1 Mt CO_2-eq in the period 1990 to 2018. Figure 5.7 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.9% of the total. Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Poland, Germany and Romania with a total absolute decrease of 14.5 Mt CO_2-eq. The largest increases occurred in the Netherlands and Ireland, with a total absolute increase of 908 kt CO_2-eq.

Emissions in source category *3.A.1.2 - Non-Dairy Cattle* decreased considerably in EU-KP by 15% or 15.4 Mt CO_2-eq in the period 1990 to 2018. Figure 5.8 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 85.1% of the total. Emissions decreased in 22 countries and increased in seven countries. The three countries with the largest decreases were Germany, Romania and the United Kingdom with a total absolute decrease of 9.6 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 4.6 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 EU-KP by 27% or 32.6 million heads in the period 1990 to 2018. The ten countries with the highest population accounted together for 84.3% 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 11.4 million heads. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 2.2 million heads.

Figure 5.7: 3.A.1.1 Dairy Cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

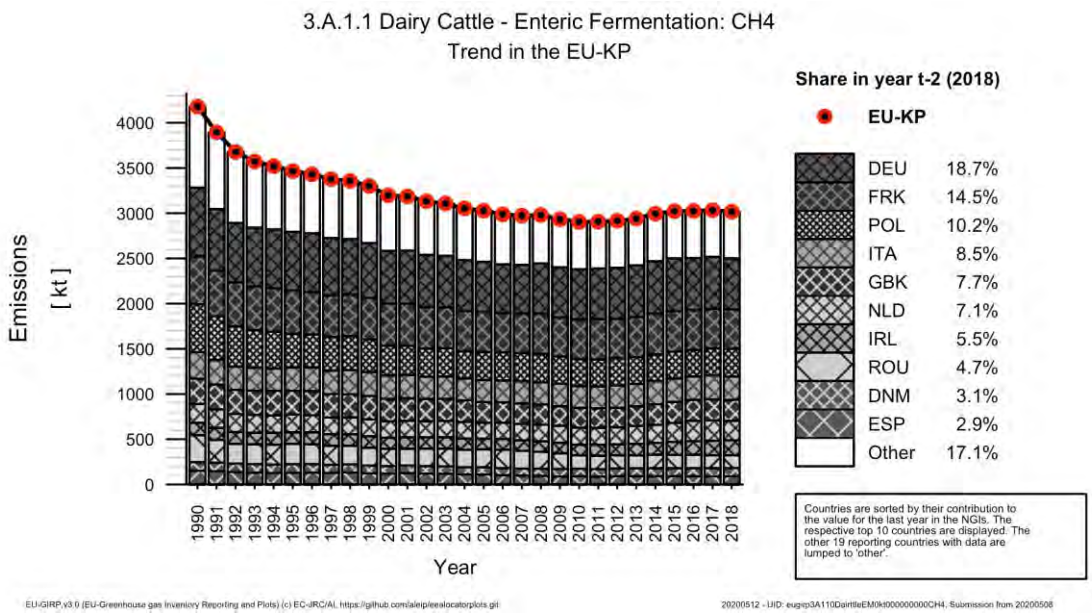


Figure 5.8: 3.A.1.2 Non-Dairy Cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

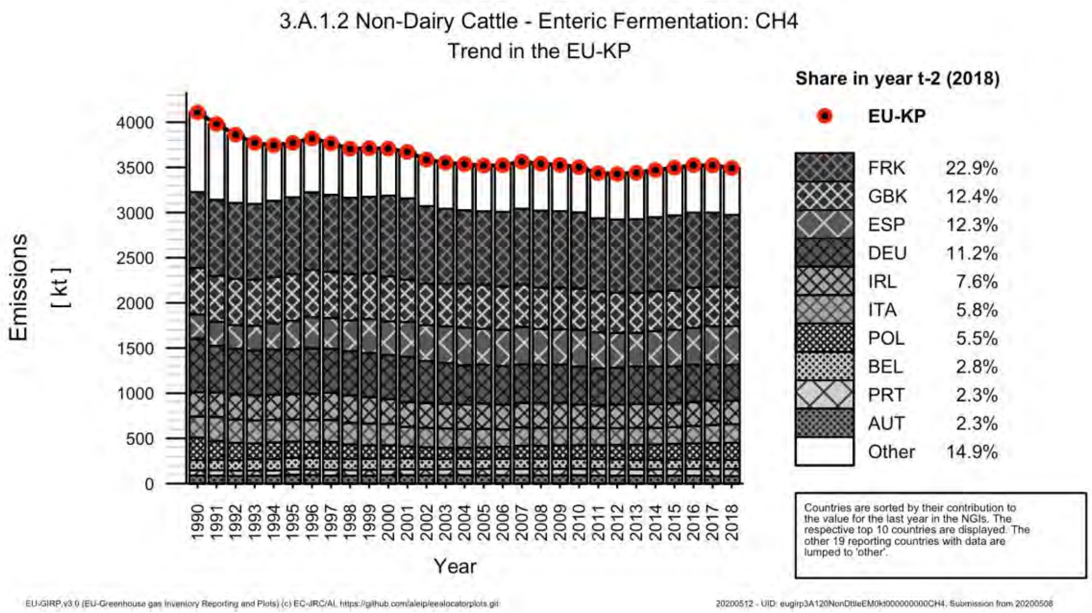


Figure 5.9: 3.A.1 Dairy Cattle: Trend in cattle population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

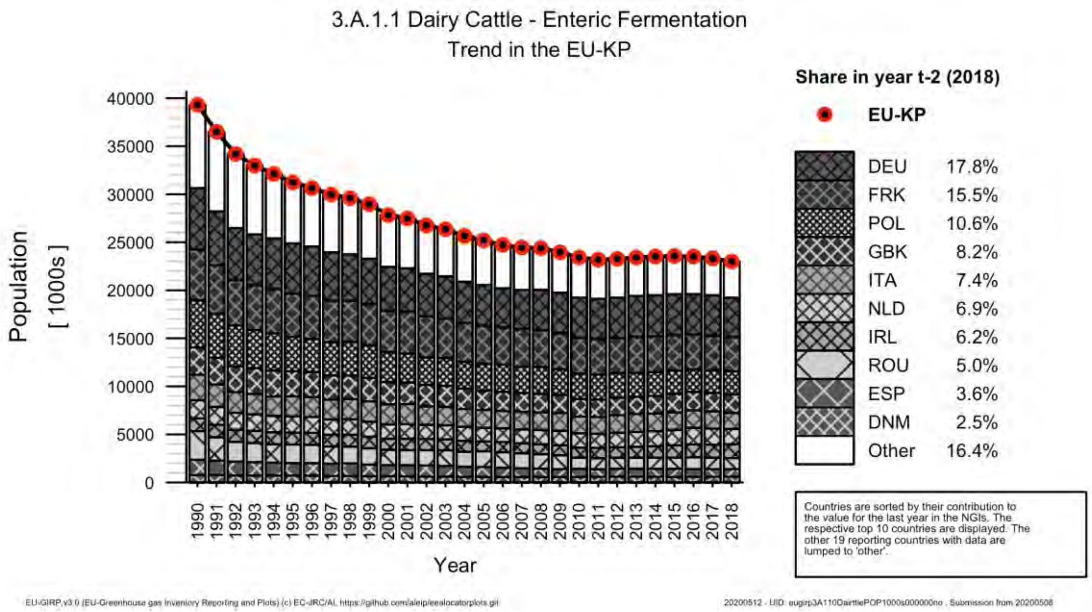
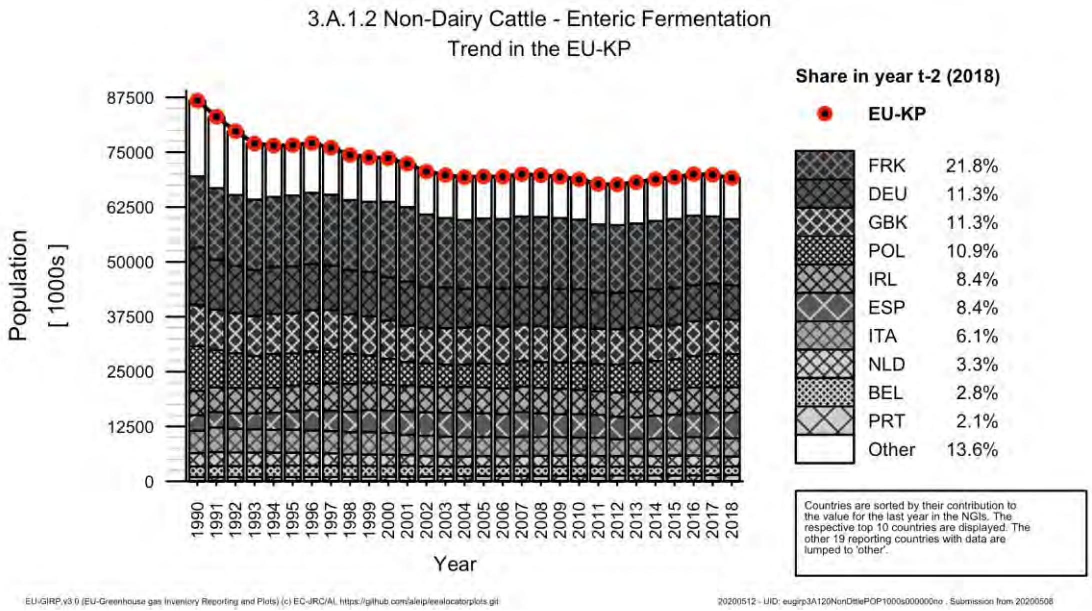


Figure 5.10: 3.A.1 Non-Dairy Cattle: Trend in cattle population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.A.2 - Sheep - Emissions

Emissions in source category *3.A.2 - Sheep* decreased strongly in EU-KP by 29% or 8.5 Mt CO_2-eq in the period 1990 to 2018. Figure 5.11 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 93.4% of the total. Emissions decreased in 21 countries and increased in eight countries. The four countries with the largest decreases were Romania, France, France and Bulgaria with a total absolute decrease of 5.4 Mt CO_2-eq. The five countries with the largest increases were Slovenia, Finland, Austria, Lithuania and Sweden, with a total absolute increase of 111 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 EU-KP by 32% or 47.1 million heads in the period 1990 to 2018. Figure 5.12 shows the trend of sheep population indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 population for the different countries 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 26.1 million heads. The four countries with the largest increases were Slovenia, Austria, Lithuania and Sweden, with a total absolute increase of 452 thousand heads.

Figure 5.11: 3.A.2: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

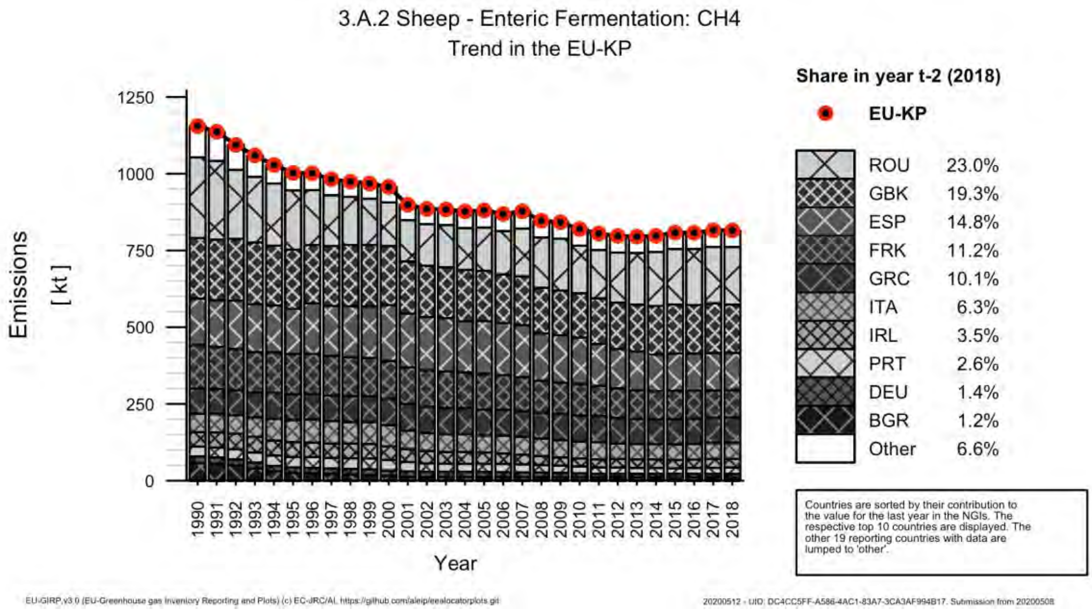
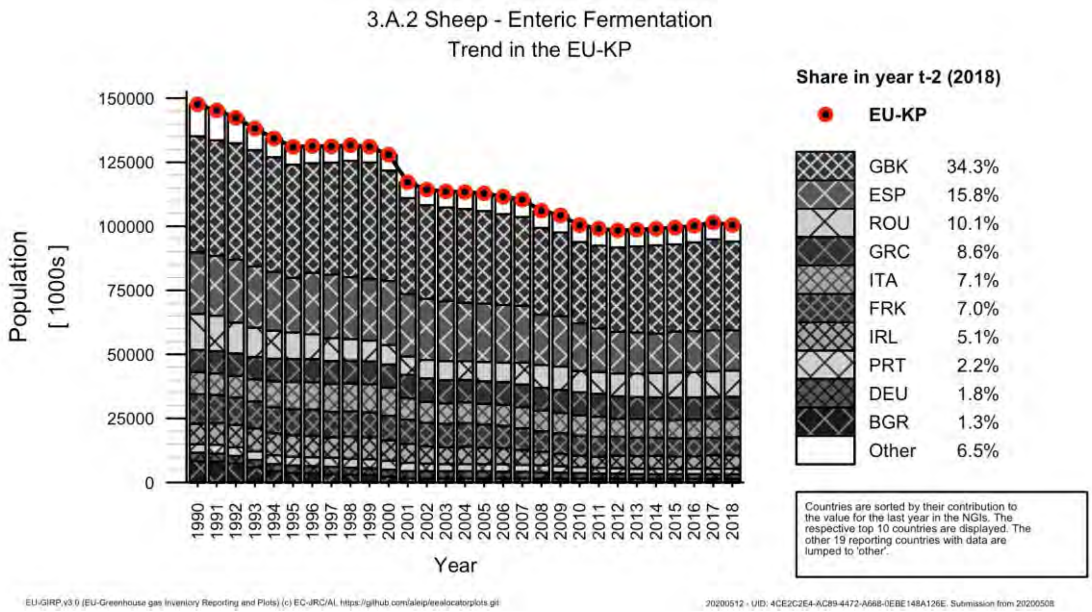


Figure 5.12: 3.A.2: Trend in sheep population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 EU-KP 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 EU-KP moderately between 1990 and 2018 by 7.5% or 5.13 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 2018 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in 26 countries. No data were available for EU-KP. Decreases occurred in Croatia, Portugal and Spain with a mean absolute value of 7 kg/head/year. The four countries with the largest increases were Latvia, the Czech Republic, Malta and Finland with a mean absolute value of 21 kg/head/year.

Table 5.7 3.A.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	71	80	|	Ireland	59	59
Belgium	63	70	|	Iceland	58	61
Bulgaria	74	85	|	Italy	68	78
Cyprus	74	87	|	Lithuania	70	85
Czech Republic	61	82	|	Luxembourg	71	81
Germany	70	80	|	Latvia	59	81
Denmark	65	85	|	Malta	54	75
Spain	81	78	|	Netherlands	67	77
Estonia	62	81	|	Poland	78	80
Finland	65	86	|	Portugal	72	68
France	63	66	|	Romania	84	99
United Kingdom	66	68	|	Slovakia	64	79
Greece	68	74	|	Slovenia	68	75
Croatia	91	77	|	Sweden	67	69
Hungary	71	75	|	**EU-KP**	**69**	**74**

3.A.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.1 - Dairy Cattle* increased in EU-KP considerably between 1990 and 2018 by 23.4% or 24.9 kg/head/year. Figure 5.13 shows the trend of the implied emission factor in EU-KP 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.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The reported implied emission factor increased in all reporting 29 countries. The four countries with the largest increases were the Czech Republic, Malta, Estonia and Finland with a mean absolute value of 51 kg/head/year.

Figure 5.13: 3.A.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

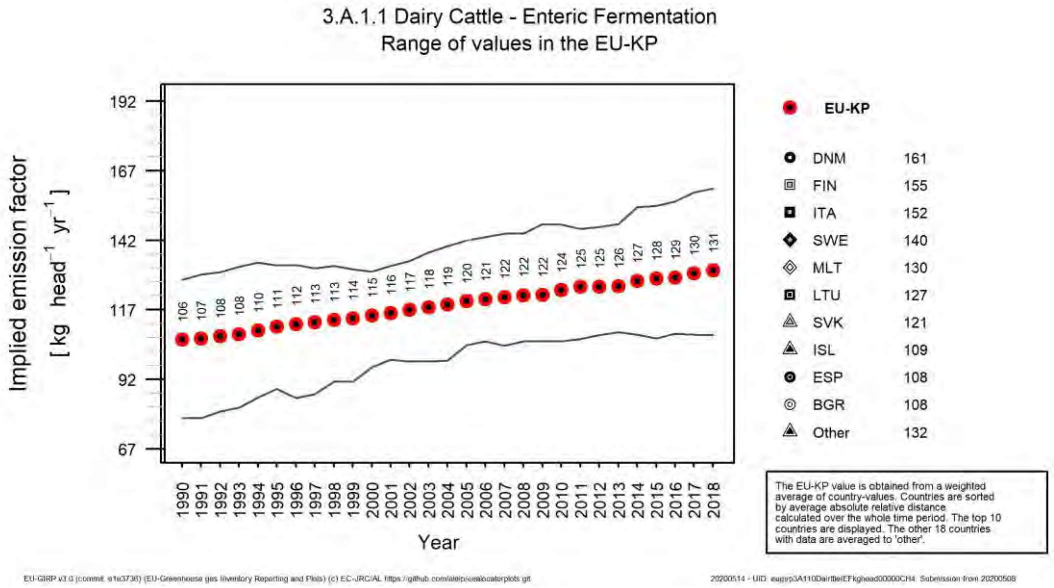


Table 5.8 3.A.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	105	136	|	Ireland	101	116
Belgium	112	149	|	Iceland	90	109
Bulgaria	105	108	|	Italy	111	152
Cyprus	99	124	|	Lithuania	100	127
Czech Republic	97	153	|	Luxembourg	112	149
Germany	120	138	|	Latvia	103	143
Denmark	128	161	|	Malta	78	130
Spain	95	108	|	Netherlands	110	135
Estonia	101	153	|	Poland	108	127
Finland	112	155	|	Portugal	97	131
France	99	123	|	Romania	100	125
United Kingdom	98	123	|	Slovakia	85	121
Greece	93	126	|	Slovenia	92	125
Croatia	117	117	|	Sweden	112	140
Hungary	105	129	|	**EU-KP**	**106**	**131**

3.A.1.1 - Dairy Cattle - Gross energy

The gross energy, a parameter used for calculating CH_4 emissions in source category *3.A.1.1 - Dairy Cattle*, increased in EU-KP strongly between 1990 and 2018 by 29.1% or 71.3 MJ/day. Figure 5.14 shows the trend of the gross energy in EU-KP indicating also the range of values used by the countries. Table 5.9 shows the gross energy in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The reported gross energy increased in all reporting 25 countries. The four countries with the largest increases were Malta, Estonia, Denmark and Finland with a mean absolute value of 112 MJ/day.

Figure 5.14: 3.A.1.1 - Dairy Cattle: Trend in gross energy in the EU-KP and range of values reported by countries

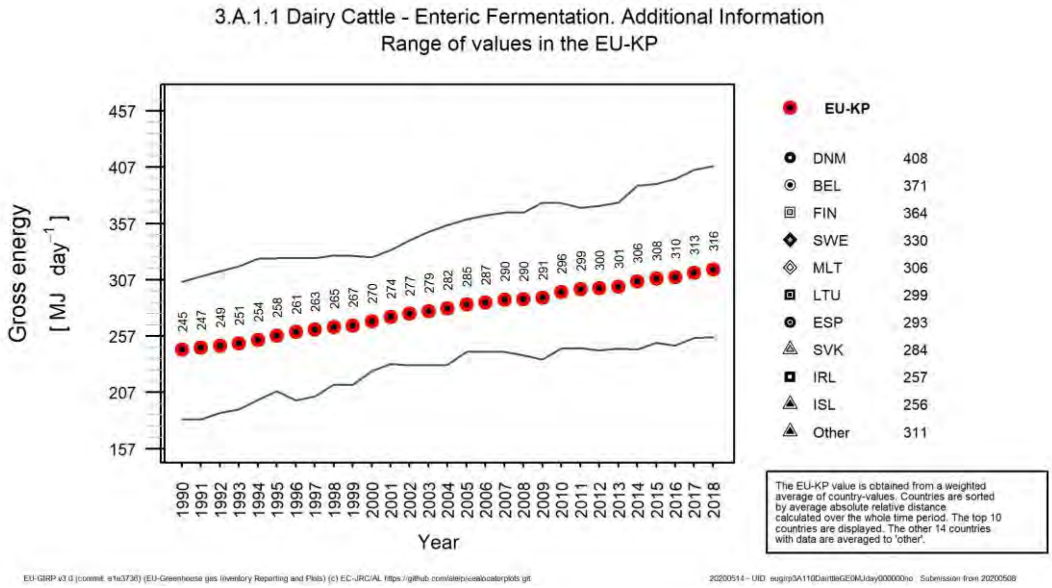


Table 5.9 3.A.1.1 - Dairy Cattle: countries' gross energy (MJ/day)

Country	1990	2018		Country	1990	2018
Austria	247	318	|	Iceland	212	256
Belgium	279	371	|	Italy	261	355
Cyprus	232	290	|	Lithuania	234	299
Germany	259	336	|	Luxembourg	263	350
Denmark	305	408	|	Latvia	242	335
Spain	201	293	|	Malta	183	306
Estonia	237	359	|	Poland	254	297
Finland	263	364	|	Portugal	227	306
United Kingdom	212	289	|	Romania	233	292
Greece	217	296	|	Slovakia	200	284
Croatia	256	275	|	Slovenia	215	294
Hungary	255	317	|	Sweden	271	330
Ireland	222	257	|	**EU-KP**	**245**	**316**

3.A.1.1 - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category *3.A.1.1 - Dairy Cattle*, increased in EU-KP very strongly between 1990 and 2018 by 77.2% or 8.63 kg/head/day.

Figure 5.15 shows the trend of the milk yield in EU-KP indicating also the range of values used by the countries. Table 5.10 shows the milk yield in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The reported milk yield increased in all reporting 27 countries. The four countries with the largest increases were Spain, Estonia, Slovakia and the Czech Republic with a mean absolute value of 14 kg/head/day.

Figure 5.15: 3.A.1.1 - Dairy Cattle: Trend in milk yield in the EU-KP and range of values reported by countries

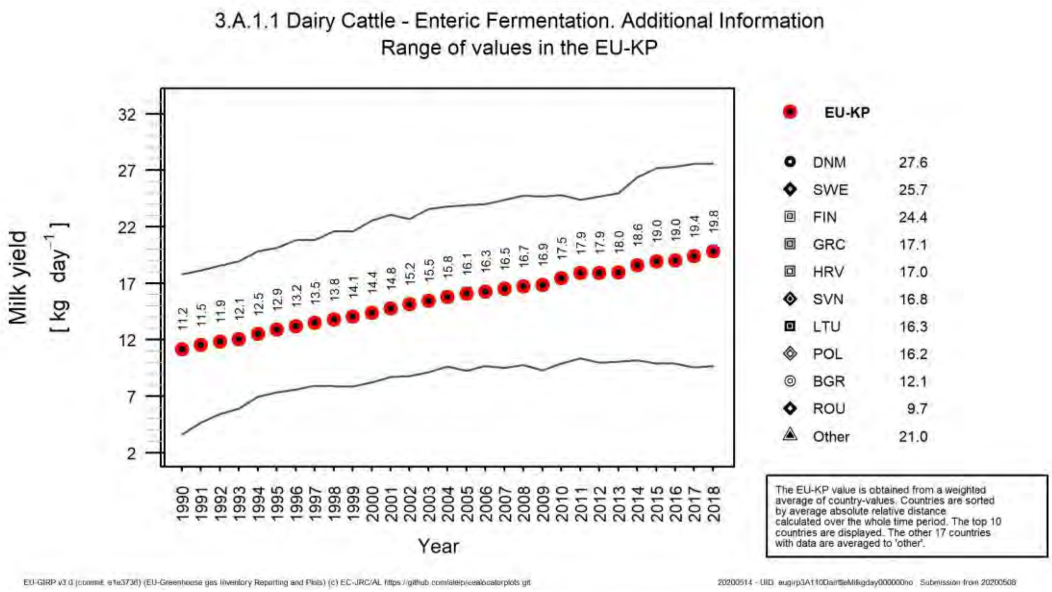


Table 5.10 3.A.1.1 - Dairy Cattle: countries' milk yield (kg/head/day) [35] [36]

Country	1990	2018	Country	1990	2018
Austria	10.4	19.5	Hungary	13.8	22.0
Belgium	11.2	23.1	Ireland	11.5	15.7
Bulgaria	11.1	12.1	Iceland	11.3	17.2
Cyprus	12.2	19.6	Italy	11.5	22.2
Czech Republic	10.7	23.4	Lithuania	10.2	16.3
Germany	12.9	22.1	Latvia	11.3	21.7
Denmark	17.7	27.6	Malta	10.0	17.8
Spain	10.1	24.5	Poland	8.9	16.2
Estonia	11.4	25.4	Portugal	12.2	22.2
Finland	15.7	24.4	Romania	3.6	9.7
France	13.1	19.3	Slovakia	7.0	19.9
United Kingdom	14.1	21.6	Slovenia	7.6	16.8
Greece	7.6	17.1	Sweden	17.8	25.7
Croatia	7.8	17.0	**EU-KP**	**11.2**	**19.8**

[35] Note that the Netherlands does not report milk yield in their CRF, but such data are available in their NIR (see also Annex III).

[36] Note that data from Luxembourg are not included in the plot as they are reported in a different unit.

3.A.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.2 - Non-Dairy Cattle* increased in EU-KP moderately between 1990 and 2018 by 6% or 3.01 kg/head/year. Figure 5.16 shows the trend of the implied emission factor in EU-KP 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.1.2 - Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The implied emission factor decreased in seven countries and increased in 21 countries. It was in 2018 at the level of 1990 in one country. No data were available for EU-KP. The three countries with the largest decreases were the Netherlands, Portugal and Ireland with a mean absolute value of 4 kg/head/year. The three countries with the largest increases were the Czech Republic, Finland and Latvia with a mean absolute value of 15 kg/head/year.

Figure 5.16: 3.A.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

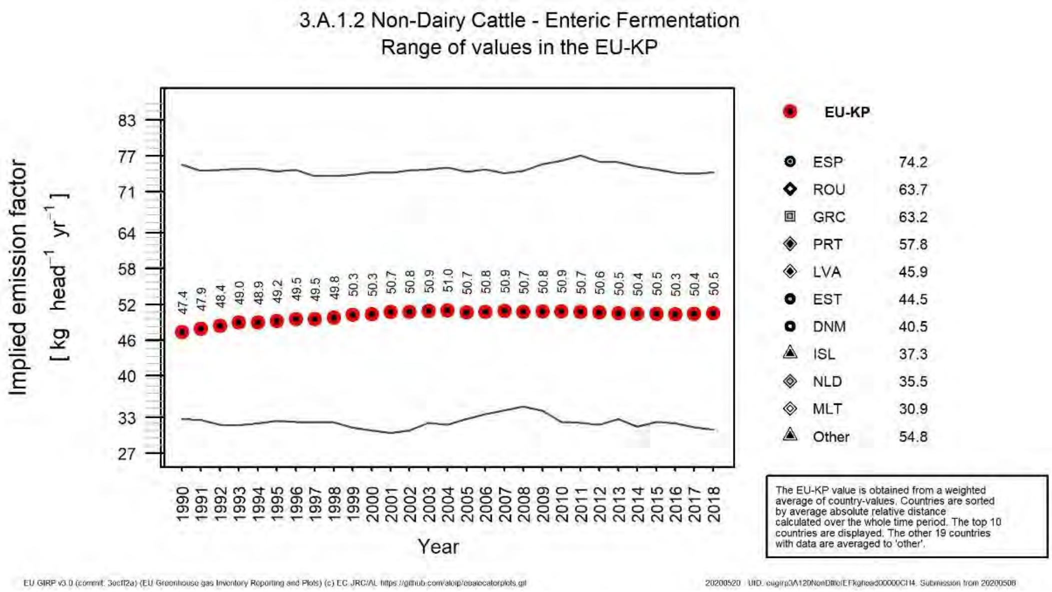


Table 5.11 3.A.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	52	59	|	Ireland	49	45
Belgium	46	50	|	Iceland	35	37
Bulgaria	55	65	|	Italy	46	48
Cyprus	57	57	|	Lithuania	53	57
Czech Republic	42	58	|	Luxembourg	55	59
Germany	45	50	|	Latvia	33	46
Denmark	34	40	|	Malta	34	31
Spain	75	74	|	Netherlands	40	36
Estonia	39	44	|	Poland	49	51
Finland	39	55	|	Portugal	62	58
France	52	53	|	Romania	65	64
United Kingdom	56	55	|	Slovakia	57	62
Greece	57	63	|	Slovenia	50	56
Croatia	57	57	|	Sweden	44	50

Hungary	53	55	**EU-KP**	**50**	**51**

3.A.1.2 - 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.1.2 - Non-Dairy Cattle*, increased in EU-KP slightly between 1990 and 2018 by 4.9% or 5.88 MJ/head/day. Figure 5.17 shows the trend of the average gross energy intake in EU-KP indicating also the range of values used by the countries. Table 5.12 shows the average gross energy intake in source category *3.A.1.2 - Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. Average gross energy intake decreased in seven countries and increased in 21 countries. No data were available for Cyprus and EU-KP. The three countries with the largest decreases were Malta, the Netherlands and Ireland with a mean absolute value of 7 MJ/head/day. The three countries with the largest increases were Finland, the Czech Republic and Latvia with a mean absolute value of 32 MJ/head/day.

Figure 5.17: 3.A.1.2 - Non-Dairy Cattle: Trend in average gross energy intake in the EU-KP and range of values reported by countries

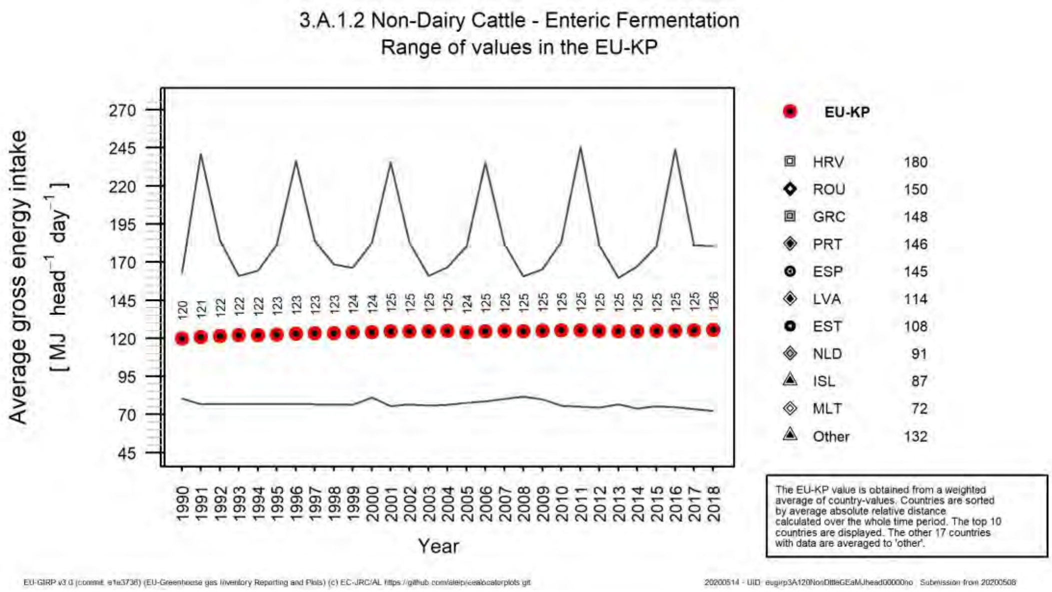


Table 5.12 3.A.1.2 - Non-Dairy Cattle: countries' average gross energy intake (MJ/head/day)

Country	1990	2018	Country	1990	2018
Austria	123	139	Iceland	82	87
Belgium	119	131	Italy	141	144
Bulgaria	129	153	Lithuania	125	131
Czech Republic	116	148	Luxembourg	129	138
Germany	108	119	Latvia	86	114
Denmark	107	130	Malta	80	72
Spain	148	145	Netherlands	99	91
Estonia	97	108	Poland	114	119
Finland	92	128	Portugal	151	146
France	122	125	Romania	153	150
United Kingdom	106	105	Slovakia	136	148

Country	1990	2018		Country	1990	2018
Greece	135	148	|	Slovenia	111	121
Croatia	163	180	|	Sweden	129	140
Hungary	134	138	|	**EU-KP**	**120**	**126**
Ireland	132	126	|			

3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* increased in EU-KP slightly between 1990 and 2018 by 3.6% or 0.281 kg/head/year. Figure 5.18 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in eight countries and increased in eleven countries. It was in 2018 at the level of 1990 in ten countries. No data were available for EU-KP. The three countries with the largest decreases were Slovakia, Portugal and Romania with a mean absolute value of 1 kg/head/year. The three countries with the largest increases were Finland, Spain and Malta with a mean absolute value of 1 kg/head/year.

Figure 5.18: 3.A.2 - Sheep: Trend in implied emission factor in the EU-KP and range of values reported by countries

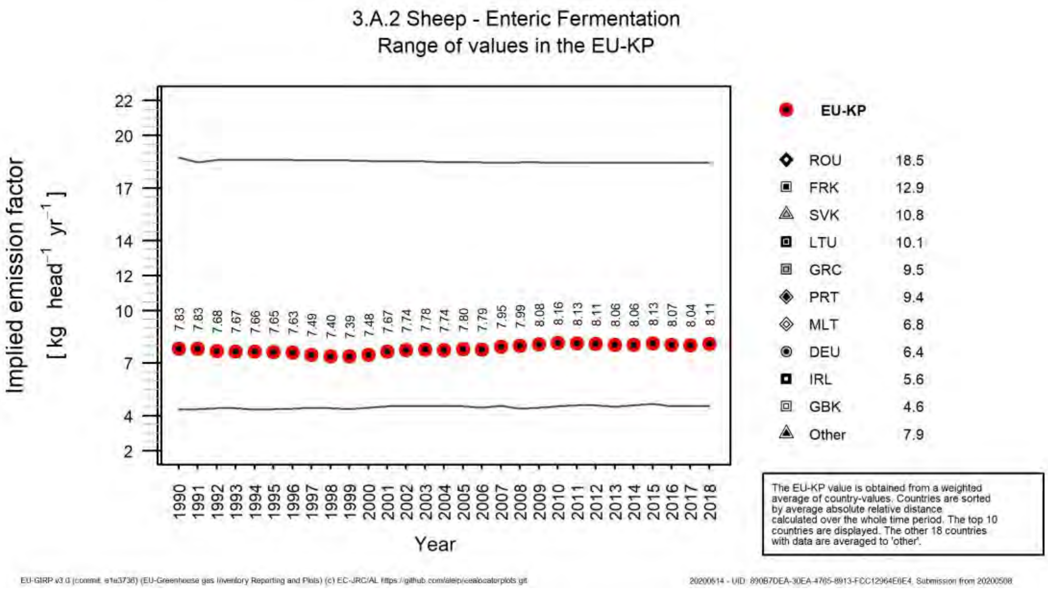


Table 5.13 3.A.2 - Sheep: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	8.0	8.0	|	Ireland	5.9	5.6
Belgium	8.0	8.0	|	Iceland	8.5	8.7
Bulgaria	6.9	7.4	|	Italy	6.9	7.1
Cyprus	8.0	8.0	|	Lithuania	10.2	10.1
Czech Republic	8.0	8.0	|	Luxembourg	7.4	7.8
Germany	6.3	6.4	|	Latvia	8.0	8.0
Denmark	6.7	6.7	|	Malta	6.2	6.8
Spain	6.3	7.6	|	Netherlands	8.0	8.0
Estonia	8.0	8.0	|	Poland	8.0	8.0

Country	1990	2018		Country	1990	2018
Finland	6.8	8.4	|	Portugal	9.7	9.4
France	12.4	12.9	|	Romania	18.7	18.5
United Kingdom	4.4	4.6	|	Slovakia	11.9	10.8
Greece	9.5	9.5	|	Slovenia	8.0	8.0
Croatia	8.0	8.0	|	Sweden	8.0	8.0
Hungary	8.0	8.0	|	**EU-KP**	**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 EU-KP moderately between 1990 and 2018 by 5.5% or 1.06 MJ/head/day. Figure 5.19 shows the trend of the average gross energy intake in EU-KP 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 2018 for all countries and EU-KP. Average gross energy intake decreased in five countries and increased in eight countries. It was in 2018 at the level of 1990 in two countries. No data were available for fifteen countries (Poland, EU-KP, Austria, Belgium, Cyprus, the Czech Republic, Germany, Estonia, Finland, France, France, Croatia, Hungary, Latvia and the Netherlands). The three countries with the largest decreases were Slovakia, Portugal and Romania with a mean absolute value of 1 MJ/head/day. The three countries with the largest increases were Spain, Bulgaria and the United Kingdom 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 EU-KP and range of values reported by countries

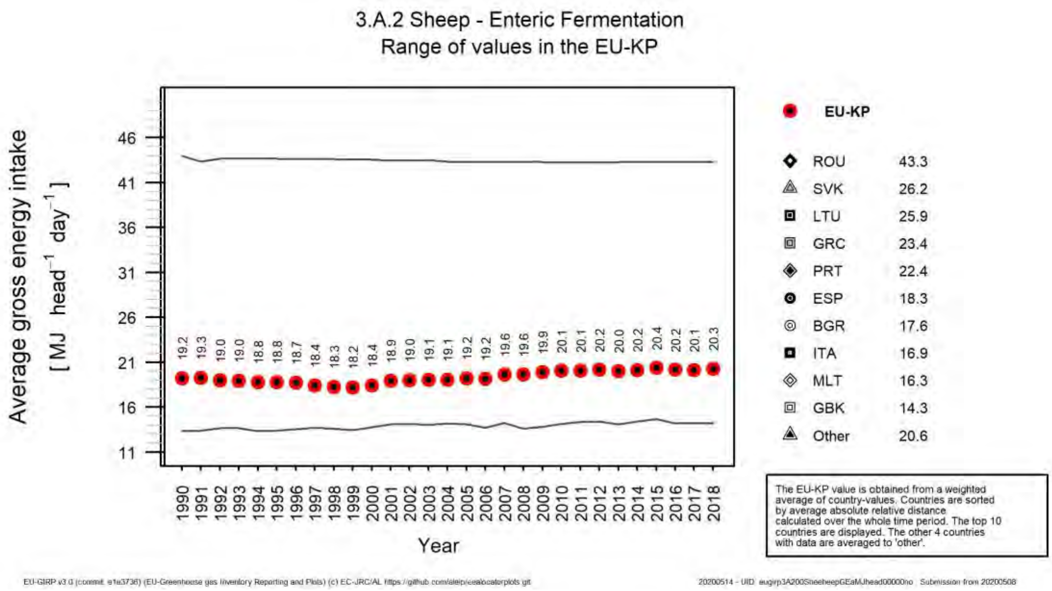


Table 5.14 3.A.2 - Sheep: countries' average gross energy intake (MJ/head/day)

Country	1990	2018		Country	1990	2018
Bulgaria	17	18	|	Lithuania	26	26
Denmark	20	20	|	Luxembourg	19	19
Spain	15	18	|	Malta	16	16
United Kingdom	13	14	|	Portugal	23	22
Greece	23	23	|	Romania	44	43

Ireland	20	20	Slovakia	29	26
Iceland	21	22	Sweden	20	20
Italy	16	17	**EU-KP**	**19**	**20**

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 EU-KP GHG emissions and 8.2% of total EU-KP CH_4 emissions. They make 9.5% 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 countries, Figure 5.21 shows the distribution of CH_4 emissions from manure management by livestock category in all countries and in the EU-KP. 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 EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2018.

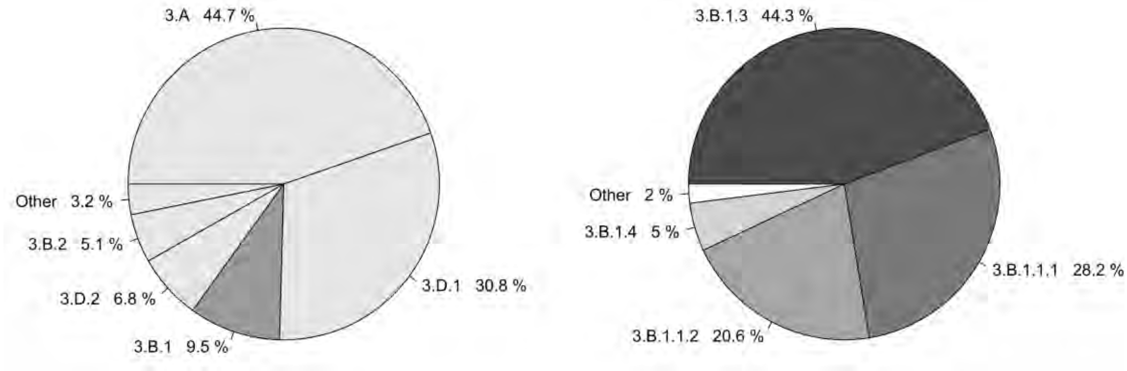
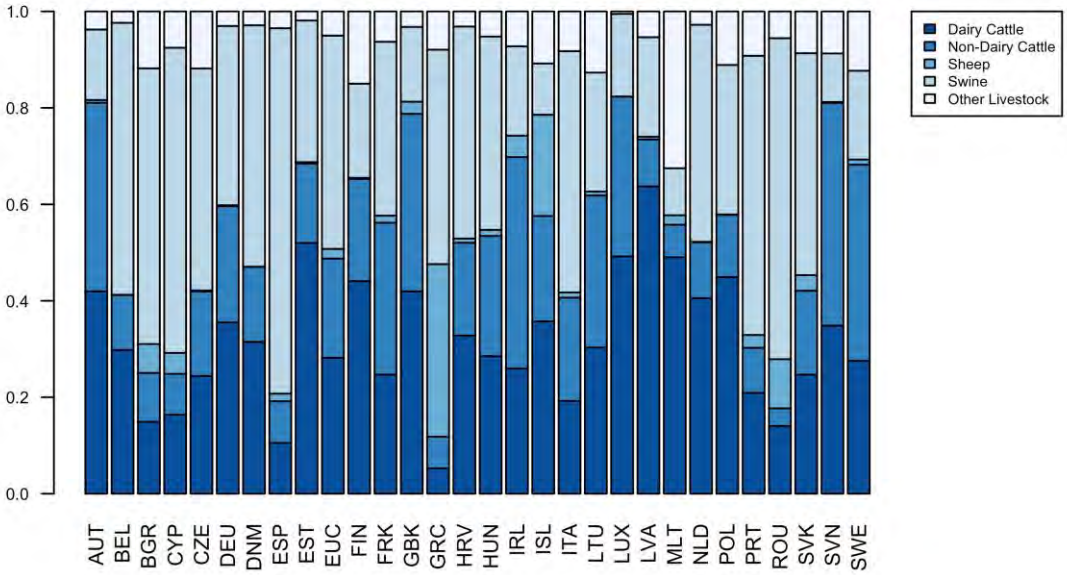


Figure 5.21: Decomposition of emissions in source category 3.B.1 - Manure Management into its sub-categories by country in the year 2018.



Total GHG and CH_4 emissions by country from 3.B.1 *Manure Management* are shown in Table 5.15 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, CH_4 emission in this source category decreased by 22% or 11.5 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 2017 to 2018 emissions in the current category decreased by 0.6%.

Table 5.15 3.B.1 - Manure Management: Countries' contributions to total EU-GHG and CH_4 emissions

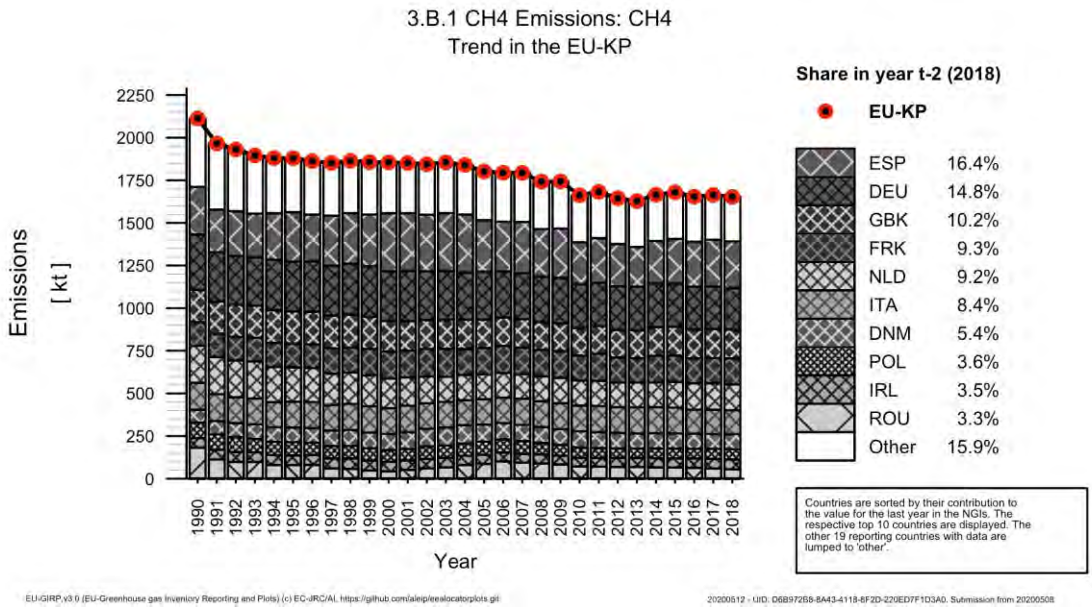
Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	544	552	545	1.3%	1	0%	-7	-1%	T1,T2	CS,D
Belgium	1 299	1 249	1 254	3.0%	-45	-3%	5	0%	T1,T2	CS,D
Bulgaria	715	119	120	0.3%	-595	-83%	1	1%	T1,T2	CS,D
Croatia	426	425	401	1.0%	-25	-6%	-24	-6%	T2	CS,D
Cyprus	69	51	50	0.1%	-19	-28%	-1	-1%	T1,T2	D
Czechia	1 731	502	533	1.3%	-1 198	-69%	31	6%	T1,T2	CS,D
Denmark	1 854	2 185	2 219	5.4%	366	20%	34	2%	CS,T2	CS,D
Estonia	155	135	135	0.3%	-20	-13%	1	1%	D,T1,T2	CS,D
Finland	368	454	451	1.1%	83	23%	-2	-1%	T2	CS
France	3 463	3 690	3 826	9.3%	363	10%	136	4%	T2	CS
Germany	8 100	6 284	6 132	14.8%	-1 968	-24%	-153	-2%	T2	CS,D
Greece	774	626	624	1.5%	-150	-19%	-2	0%	T1,T2	CS,D
Hungary	1 161	644	654	1.6%	-507	-44%	10	1%	T1,T2	CS,D
Ireland	1 406	1 425	1 427	3.5%	21	1%	2	0%	T1,T2	CS,D
Italy	3 948	3 543	3 480	8.4%	-468	-12%	-63	-2%	T1,T2	CS,D
Latvia	190	102	90	0.2%	-100	-53%	-12	-12%	T1,T2	CS,D
Lithuania	666	235	224	0.5%	-442	-66%	-11	-5%	T1,T2	CS,D
Luxembourg	46	61	60	0.1%	14	29%	-1	-1%	T1,T2	CS,D
Malta	5	5	5	0.0%	-1	-11%	0	1%	T1,T2	CS,D
Netherlands	5 442	3 876	3 807	9.2%	-1 635	-30%	-69	-2%	T1,T2	CS,D
Poland	2 278	1 459	1 505	3.6%	-773	-34%	46	3%	T1,T2	CS,D
Portugal	814	724	725	1.8%	-89	-11%	1	0%	T2	CS,D
Romania	4 561	1 492	1 379	3.3%	-3 182	-70%	-113	-8%	T1,T2	CS,D
Slovakia	438	102	107	0.3%	-331	-76%	5	4%	T1,T2	CS,D
Slovenia	342	255	253	0.6%	-89	-26%	-2	-1%	T1,T2	CS,D
Spain	6 982	6 847	6 795	16.4%	-187	-3%	-52	-1%	T1,T2	CS,D
Sweden	245	262	263	0.6%	18	7%	1	0%	T1,T2	CS,D
United Kingdom	4 733	4 227	4 201	10.2%	-531	-11%	-26	-1%	T1,T2,T3	CS,D
EU-27+UK	**52 757**	**41 530**	**41 265**	**100%**	**-11 491**	**-22%**	**-264**	**-1%**	**-**	**-**
Iceland	59	62	57	0.1%	-2	-4%	-5	-8%	T1,T2	CS,D
United Kingdom (KP)	4 733	4 227	4 201	10.2%	-531	-11%	-26	-1%	T1,T2,T3	CS,D
EU-KP	**52 816**	**41 591**	**41 322**	**100%**	**-11 493**	**-22%**	**-269**	**-1%**	**-**	**-**

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 EU-KP by 22% or 11.5 Mt CO_2-eq in the period 1990 to 2018. Figure 5.22 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 84.1% 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 6.8 Mt CO_2-eq. The largest increases occurred in France and France and Denmark, with a total absolute increase of 729 kt CO_2-eq.

Figure 5.22: 3.B.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.B.1.1 - Cattle - Emissions

CH_4 emissions in source category *3.B.1.1 - Cattle* are 0.42% of total EU-KP GHG emissions and 4% of total EU-KP CH_4 emissions. They make 4.6% of total agricultural emissions and 8.4% 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 EU-KP.

Total GHG and CH_4 emissions by country from 3.B.1.1 *Manure Management* are shown in Table 5.16 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, CH_4 emission in this source category decreased by 15% or 3.7 Mt CO_2-eq. The decrease was largest in the Czech Republic in relative terms (74%) and in Germany in absolute terms (1.6 Mt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 1.1%. The ten countries with the highest emissions accounted together for 85.6% of the total. Emissions decreased in sixteen countries and increased in thirteen countries. The three countries with the largest decreases were Germany, the Czech Republic and Italy with a total absolute decrease of 2.8 Mt CO_2-eq. The largest increases occurred in Denmark and the Netherlands, with a total absolute increase of 534 kt CO_2-eq.

Table 5.16 3.B.1.1 - Cattle: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	400	448	442	2.2%	42	11%	-6	-1%	T2	CS
Belgium	489	507	517	2.6%	28	6%	10	2%	T2	CS
Bulgaria	87	31	30	0.1%	-57	-66%	-1	-3%	T2	CS
Croatia	224	219	209	1.0%	-15	-7%	-11	-5%	T2	CS,D
Cyprus	10	12	12	0.1%	3	31%	1	6%	T2	D
Czechia	871	211	224	1.1%	-648	-74%	12	6%	T1,T2	CS
Denmark	886	1 044	1 044	5.2%	158	18%	0	0%	CS,T2	CS,D
Estonia	50	93	93	0.5%	43	86%	0	0%	T2	CS,D
Finland	232	293	295	1.5%	63	27%	1	0%	T2	CS
France	2 104	2 110	2 150	10.7%	45	2%	40	2%	T2	CS
Germany	5 264	3 721	3 655	18.1%	-1 609	-31%	-65	-2%	T2	CS
Greece	95	76	74	0.4%	-21	-22%	-2	-3%	T2	CS,D
Hungary	566	342	349	1.7%	-217	-38%	7	2%	T2	CS
Ireland	1 039	999	996	4.9%	-43	-4%	-3	0%	T2	CS
Italy	1 962	1 434	1 415	7.0%	-547	-28%	-19	-1%	T2	CS
Latvia	111	74	66	0.3%	-45	-40%	-8	-11%	T2	CS
Lithuania	252	137	138	0.7%	-113	-45%	1	1%	T2	CS
Luxembourg	37	49	49	0.2%	12	32%	0	0%	T2	CS
Malta	2	3	3	0.0%	1	26%	0	-1%	T2	CS
Netherlands	1 608	2 054	1 984	9.8%	376	23%	-70	-3%	T2	CS
Poland	1 149	850	870	4.3%	-279	-24%	20	2%	T2	CS
Portugal	199	218	219	1.1%	21	11%	2	1%	T2	CS
Romania	651	247	244	1.2%	-407	-63%	-3	-1%	T2	CS
Slovakia	131	44	45	0.2%	-86	-66%	1	1%	T2	CS
Slovenia	176	208	205	1.0%	29	17%	-3	-1%	T2	CS
Spain	1 652	1 391	1 303	6.5%	-349	-21%	-88	-6%	T2	CS,D
Sweden	156	180	180	0.9%	24	15%	0	0%	T2	CS
United Kingdom	3 397	3 338	3 309	16.4%	-88	-3%	-29	-1%	T3	CS,D
EU-27+UK	**23 800**	**20 332**	**20 118**	**100%**	**-3 681**	**-15%**	**-213**	**-1%**	-	-
Iceland	33	36	33	0.2%	0	-1%	-3	-10%	T2	CS,D
United Kingdom (KP)	3 397	3 338	3 309	16.4%	-88	-3%	-29	-1%	T3	CS,D
EU-KP	**23 833**	**20 368**	**20 151**	**100%**	**-3 682**	**-15%**	**-217**	**-1%**	-	-

Figure 5.23: 3.B.1.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

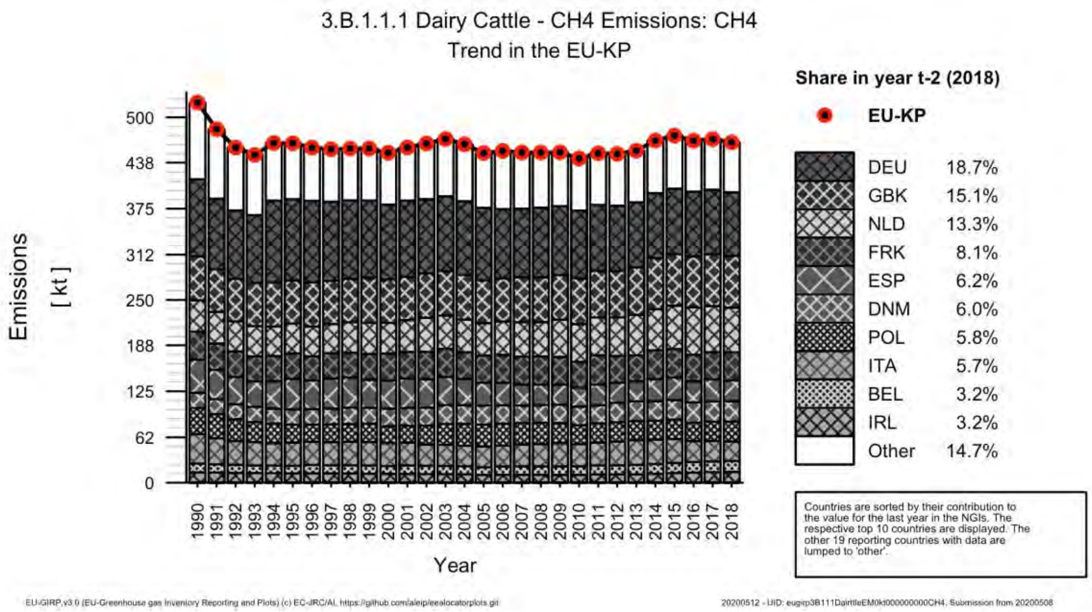
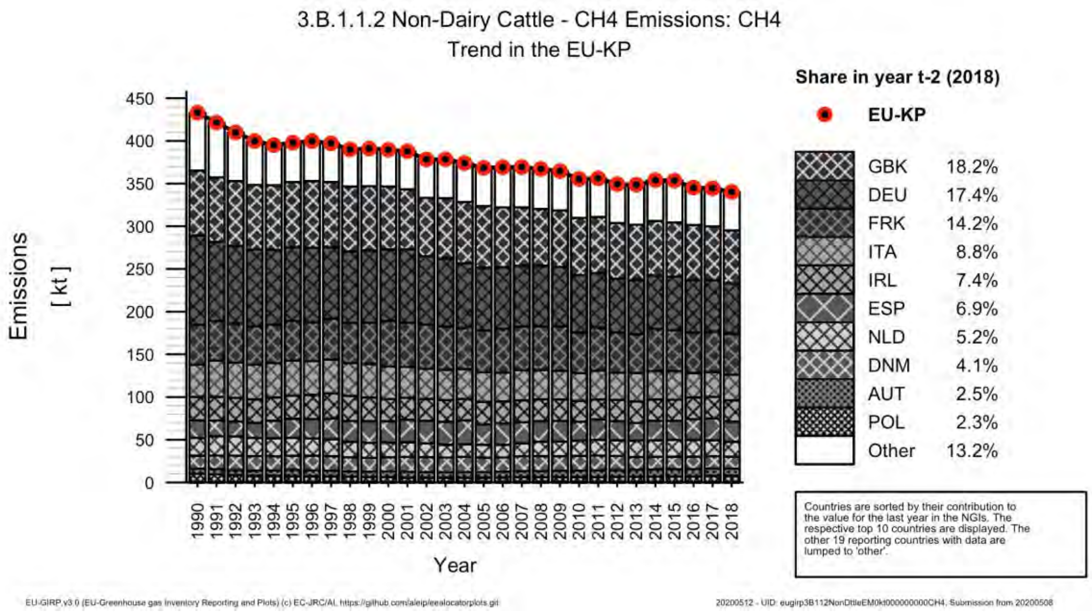


Figure 5.24: 3.B.1.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 0.39% of total EU-KP GHG emissions and 3.6% of total EU-KP CH_4 emissions. They make 4.2% of total agricultural emissions and 7.6% of total agricultural CH_4 emissions.

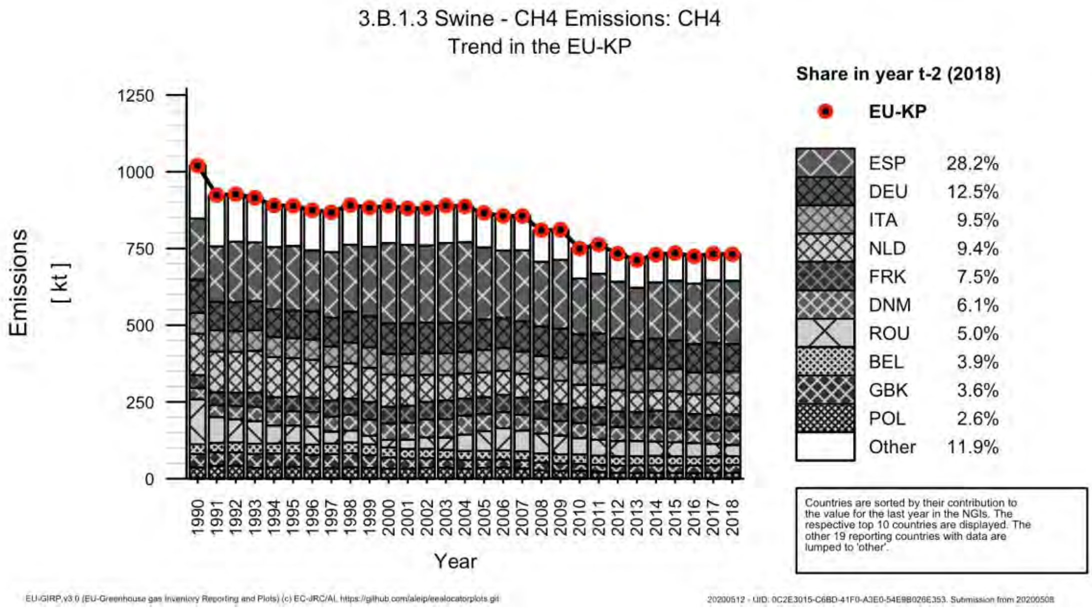
Total GHG and CH_4 emissions by country from 3.B.1.3 *Manure Management* are shown in Table 5.17 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, CH_4 emission in this source category decreased by 28% or 7.2 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 2017 to 2018 emissions in the current category decreased by 0.2%. Figure 5.25 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 88.1% of the total. Emissions decreased in twenty countries and increased in nine 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 Spain, Denmark and France, with a total absolute increase of 661 kt CO_2-eq.

Table 5.17 3.B.1.3 - Swine: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	129	81	80	0.4%	-50	-38%	-2	-2%	T1	D
Belgium	793	713	707	3.9%	-86	-11%	-6	-1%	T2	CS
Bulgaria	543	67	68	0.4%	-475	-87%	1	2%	T2	CS
Croatia	167	189	176	1.0%	9	6%	-12	-7%	T2	CS,D
Cyprus	55	34	32	0.2%	-23	-42%	-2	-6%	T2	D
Czechia	754	235	245	1.3%	-509	-67%	10	4%	T1	D
Denmark	923	1 073	1 111	6.1%	188	20%	38	4%	CS,T2	CS,D
Estonia	97	39	40	0.2%	-57	-59%	1	3%	T2	CS,D
Finland	68	92	88	0.5%	21	31%	-4	-4%	T2	CS
France	1 042	1 280	1 379	7.5%	337	32%	99	8%	T2	CS
Germany	2 685	2 367	2 278	12.5%	-407	-15%	-89	-4%	T2	CS
Greece	398	278	277	1.5%	-121	-30%	0	0%	T1	D
Hungary	500	260	262	1.4%	-238	-48%	2	1%	T2	CS
Ireland	206	261	264	1.4%	58	28%	3	1%	T2	CS,D
Italy	1 703	1 773	1 740	9.5%	37	2%	-33	-2%	T2	CS
Latvia	66	20	19	0.1%	-47	-72%	-1	-6%	T2	CS
Lithuania	329	62	55	0.3%	-274	-83%	-7	-12%	T2	CS
Luxembourg	9	11	10	0.1%	1	16%	-1	-6%	T2	CS
Malta	1	0	0	0.0%	-1	-64%	0	7%	T2	CS,D
Netherlands	3 369	1 707	1 713	9.4%	-1 655	-49%	6	0%	T2	CS
Poland	913	449	467	2.6%	-446	-49%	18	4%	T1	CS
Portugal	506	422	420	2.3%	-86	-17%	-3	-1%	T2	CS
Romania	3 670	1 030	918	5.0%	-2 752	-75%	-112	-11%	T2	CS
Slovakia	288	46	49	0.3%	-239	-83%	4	8%	T2	CS
Slovenia	132	25	25	0.1%	-107	-81%	0	0%	T1	D
Spain	5 012	5 109	5 147	28.2%	135	3%	39	1%	T2	CS,D
Sweden	59	48	48	0.3%	-11	-18%	1	2%	T2	CS
United Kingdom	1 090	646	651	3.6%	-439	-40%	6	1%	T2	D
EU-27+UK	**25 506**	**18 317**	**18 272**	**100%**	**-7 235**	**-28%**	**-45**	**0%**	-	-
Iceland	4	6	6	0.0%	2	35%	0	-7%	T1	D
United Kingdom (KP)	1 090	646	651	3.6%	-439	-40%	6	1%	T2	D
EU-KP	**25 511**	**18 323**	**18 278**	**100%**	**-7 233**	**-28%**	**-46**	**0%**	-	-

Note that some countries 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 countries. For those countries using Tier 1, source category 3.B.1.3 is not a key category.

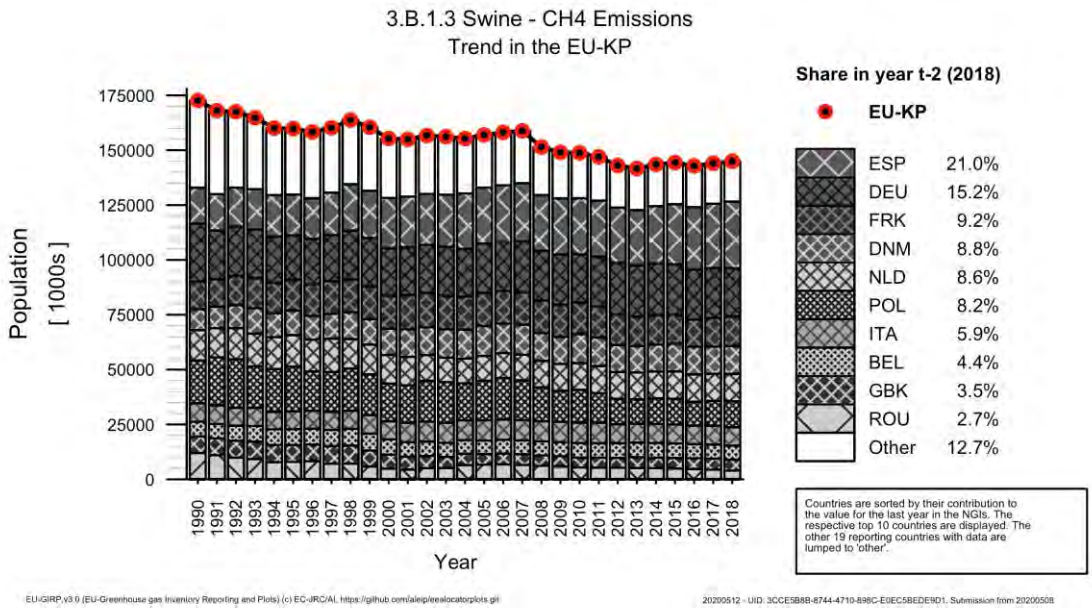
Figure 5.25: 3.B.1.3: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 EU-KP by 16% or 27.7 million heads in the period 1990 to 2018. Figure 5.26 shows the trend of swine population indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 population for the different countries along the inventory period. The ten countries with the highest population accounted together for 87.3% of the total. Population decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were Romania, Poland and Hungary with a total absolute decrease of 21.6 million heads. The largest increases occurred in Denmark and Spain, with a total absolute increase of 17.3 million heads.

Figure 5.26: 3.B.1.3: Trend in swine population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 EU-KP considerably between 1990 and 2018 by 15.7% or 1.24 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 2018 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in 23 countries. No data were available for EU-KP. The largest decreases occurred in Spain and the Czech Republic with a mean absolute value of 4 kg/head/year. The four countries with the largest increases were Estonia, Denmark, Croatia and the Netherlands with a mean absolute value of 10 kg/head/year.

Table 5.18 3.B.1.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	6.2	9.2	|	Ireland	6.1	5.5
Belgium	6.0	8.5	|	Iceland	17.6	16.1
Bulgaria	2.2	2.3	|	Italy	10.1	9.6
Cyprus	7.0	7.0	|	Lithuania	4.2	8.1
Czech Republic	9.9	6.3	|	Luxembourg	6.9	10.1
Germany	10.8	12.2	|	Latvia	3.1	6.7
Denmark	15.8	27.1	|	Malta	3.9	7.4
Spain	12.9	7.9	|	Netherlands	13.1	20.6
Estonia	2.6	14.7	|	Poland	4.6	5.6
Finland	6.8	13.4	|	Portugal	5.8	5.3
France	3.9	4.6	|	Romania	4.9	5.0
United Kingdom	11.2	13.6	|	Slovakia	3.4	4.1
Greece	5.5	5.5	|	Slovenia	13.2	17.2
Croatia	10.9	20.2	|	Sweden	3.6	4.8
Hungary	14.0	15.9	|	**EU-KP**	**7.9**	**9.1**

3.B.1.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle* increased in EU-KP very strongly between 1990 and 2018 by 53% or 7.02 kg/head/year. Figure 5.27 shows the trend of the implied emission factor in EU-KP 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.1.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in 26 countries. No data were available for EU-KP. Decreases occurred in Cyprus, Bulgaria and Ireland with a mean absolute value of 0.2 kg/head/year. The four countries with the largest increases were Estonia, Croatia, Denmark and Finland with a mean absolute value of 23 kg/head/year.

Figure 5.27: **3.B.1.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries**

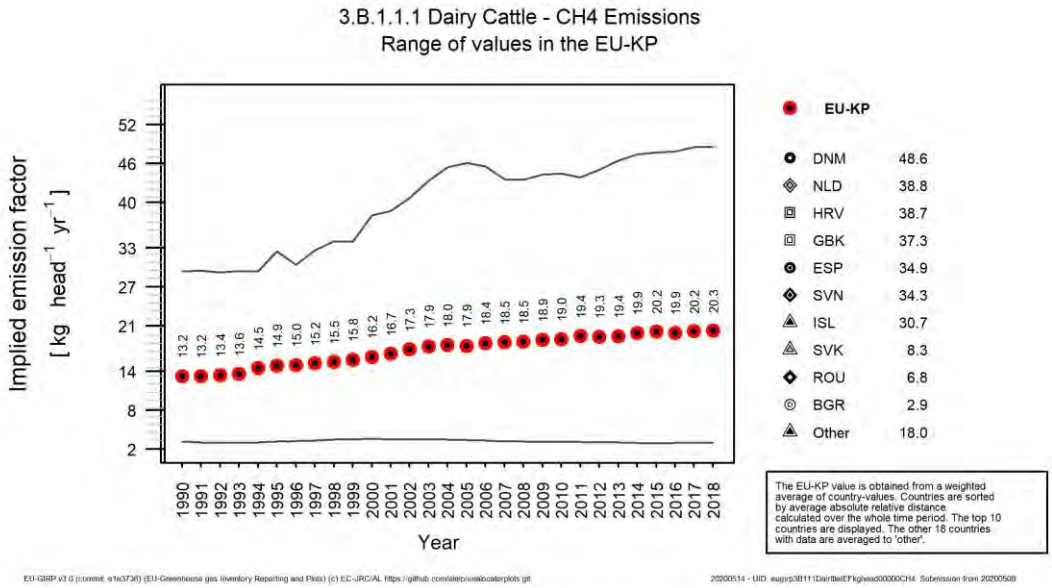


Table 5.19 3.B.1.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	10.8	17.2	|	Ireland	10.6	10.4
Belgium	14.1	30.3	|	Iceland	29.4	30.7
Bulgaria	3.2	2.9	|	Italy	15.2	15.8
Cyprus	10.6	10.3	|	Lithuania	6.0	10.2
Czech Republic	13.9	14.2	|	Luxembourg	12.4	24.7
Germany	16.6	21.2	|	Latvia	6.4	15.9
Denmark	27.2	48.6	|	Malta	6.6	14.7
Spain	28.8	34.9	|	Netherlands	23.1	38.8
Estonia	4.7	33.0	|	Poland	7.3	11.1
Finland	12.4	29.3	|	Portugal	14.6	25.4
France	7.2	10.6	|	Romania	6.5	6.8
United Kingdom	21.0	37.3	|	Slovakia	6.3	8.3
Greece	10.4	14.1	|	Slovenia	21.0	34.3
Croatia	13.9	38.7	|	Sweden	6.6	9.1
Hungary	24.6	30.7	|	**EU-KP**	**13.2**	**20.3**

3.B.1.1.1 - Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle*, increased in EU-KP slightly between 1990 and 2018 by 3.8% or 22.3 kg. Figure 5.28 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.20 shows the typical animal mass in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. Typical animal mass decreased in one country and increased in fourteen countries. It was in 2018 at the level of 1990 in fourteen countries. No data were available for EU-KP. A decrease occurred in France with an absolute value of 8 kg. The largest increase occurred in Finland with an absolute value of 141 kg.

Figure 5.28: **3.B.1.1.1 - Dairy Cattle: Trend in typical animal mass in the EU-KP and range of values reported by countries**

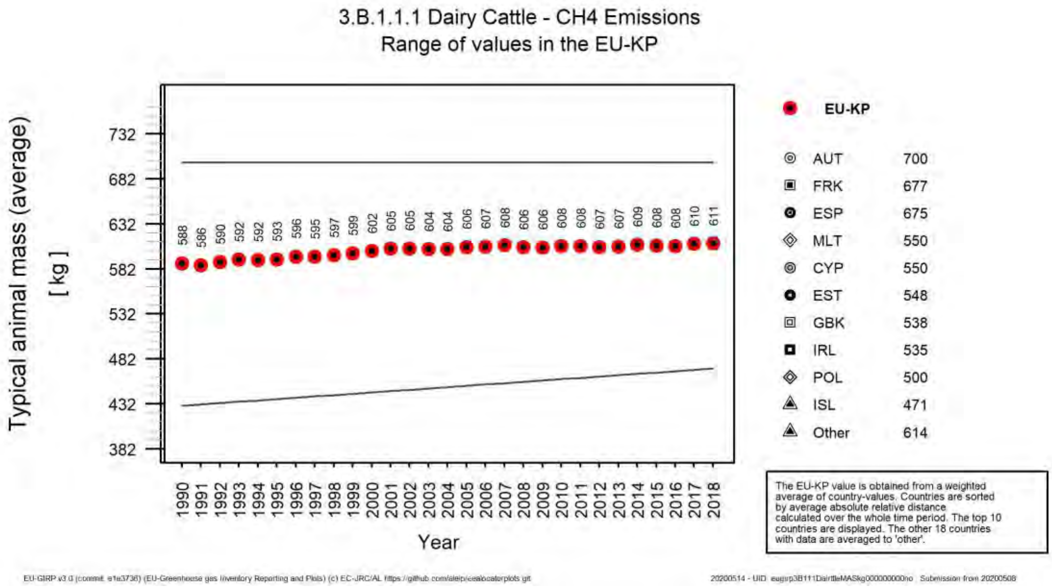


Table 5.20 3.B.1.1.1 - Dairy Cattle: countries' typical animal mass (kg)

Country	1990	2018		Country	1990	2018
Austria	700	700		Ireland	535	535
Belgium	600	600		Iceland	430	471
Bulgaria	588	588		Italy	603	603
Cyprus	550	550		Lithuania	575	627
Czech Republic	520	650		Luxembourg	650	650
Germany	608	655		Latvia	550	570
Denmark	550	580		Malta	550	550
Spain	652	675		Netherlands	555	589
Estonia	545	548		Poland	500	500
Finland	520	661		Portugal	600	600
France	685	677		Romania	650	650
United Kingdom	466	538		Slovakia	589	599
Greece	600	600		Slovenia	510	621
Croatia	563	563		Sweden	650	650
Hungary	633	643		**EU-KP**	**588**	**611**

3.B.1.1.1 - Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle*, increased in EU-KP clearly between 1990 and 2018 by 13.7% or 0.597 kg dm/head/day. Figure 5.29 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.21 shows the VS daily excretion in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. VS daily excretion decreased in one country and increased in 26 countries. It was in 2018 at the level of 1990 in two countries. No data were available for EU-KP. A decrease occurred in Italy with an absolute value of 1 kg dm/head/day.

The four countries with the largest increases were Malta, the Czech Republic, Estonia and Finland with a mean absolute value of 2 kg dm/head/day.

Figure 5.29: **3.B.1.1.1 - Dairy Cattle: Trend in VS daily excretion in the EU-KP and range of values reported by countries**

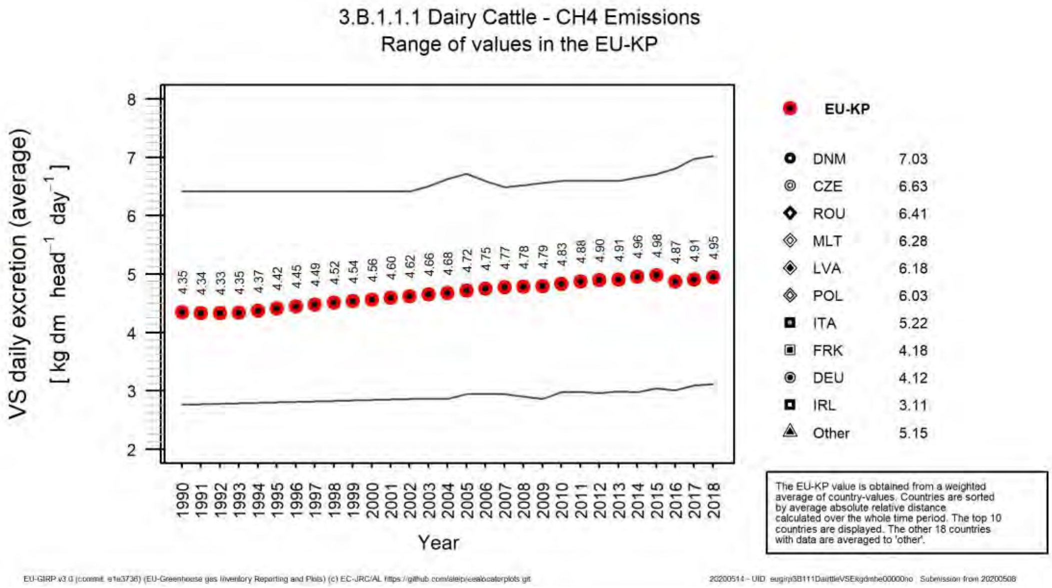


Table 5.21 3.B.1.1.1 - Dairy Cattle: countries' VS daily excretion (kg dm/head/day)

Country	1990	2018	Country	1990	2018
Austria	4.5	5.0	Ireland	2.8	3.1
Belgium	4.0	5.3	Iceland	3.8	4.1
Bulgaria	4.0	4.2	Italy	6.4	5.2
Cyprus	4.5	4.5	Lithuania	4.5	5.8
Czech Republic	4.2	6.6	Luxembourg	4.5	5.9
Germany	3.5	4.1	Latvia	4.7	6.2
Denmark	5.7	7.0	Malta	2.8	6.3
Spain	3.9	5.2	Netherlands	3.8	4.8
Estonia	4.4	6.6	Poland	5.7	6.0
Finland	4.4	6.2	Portugal	3.5	4.8
France	3.5	4.2	Romania	5.1	6.4
United Kingdom	4.0	5.5	Slovakia	3.6	4.4
Greece	3.7	5.0	Slovenia	4.5	5.3
Croatia	5.1	5.1	Sweden	5.1	5.4
Hungary	4.4	5.4	**EU-KP**	**4.4**	**4.9**

3.B.1.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle* decreased in EU-KP slightly between 1990 and 2018 by 1.6% or 0.081 kg/head/year. Figure 5.30 shows the trend of the implied emission factor in EU-KP 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.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The implied emission factor decreased in eleven countries and increased in eighteen countries. No data were available for EU-KP. The largest decreases occurred in the Czech Republic and Spain with a mean absolute value of 3 kg/head/year. The four countries with the largest increases were Denmark, Croatia, Estonia and Lithuania with a mean absolute value of 4 kg/head/year.

Figure 5.30: 3.B.1.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

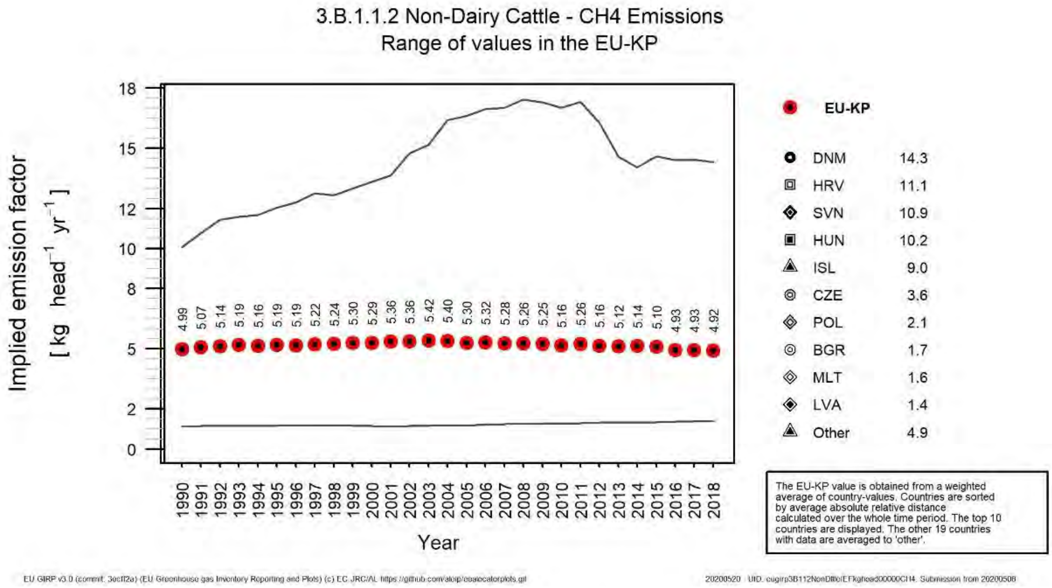


Table 5.22 3.B.1.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	3.7	6.2	|	Ireland	5.0	4.3
Belgium	3.2	3.0	|	Iceland	9.0	9.0
Bulgaria	1.6	1.7	|	Italy	7.5	7.1
Cyprus	4.5	4.4	|	Lithuania	3.3	6.8
Czech Republic	7.9	3.6	|	Luxembourg	4.8	5.4
Germany	8.0	7.5	|	Latvia	1.1	1.4
Denmark	10.1	14.3	|	Malta	1.8	1.6
Spain	5.8	4.0	|	Netherlands	6.9	7.8
Estonia	1.4	5.3	|	Poland	2.0	2.1
Finland	3.7	6.3	|	Portugal	2.2	1.9
France	2.8	3.2	|	Romania	2.9	2.5
United Kingdom	8.2	7.9	|	Slovakia	2.4	2.4
Greece	3.3	3.7	|	Slovenia	7.4	10.9
Croatia	7.0	11.1	|	Sweden	2.1	3.6
Hungary	8.3	10.2	|	**EU-KP**	**5.1**	**4.9**

3.B.1.1.2 - Non-Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle*, increased in EU-KP moderately between 1990 and 2018 by 6.8% or 24.8 kg. Figure 5.31 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.23 shows the typical animal mass in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. Typical animal mass decreased in seven countries and increased in 21 countries. No data were available for Sweden and EU-KP. The three countries with the largest decreases were Cyprus, Malta and the Netherlands with a mean absolute value of 27 kg. The four countries with the largest increases were Bulgaria, Finland, the Czech Republic and Estonia with a mean absolute value of 105 kg.

Figure 5.31: **3.B.1.1.2 - Non-Dairy Cattle: Trend in typical animal mass in the EU-KP and range of values reported by countries**

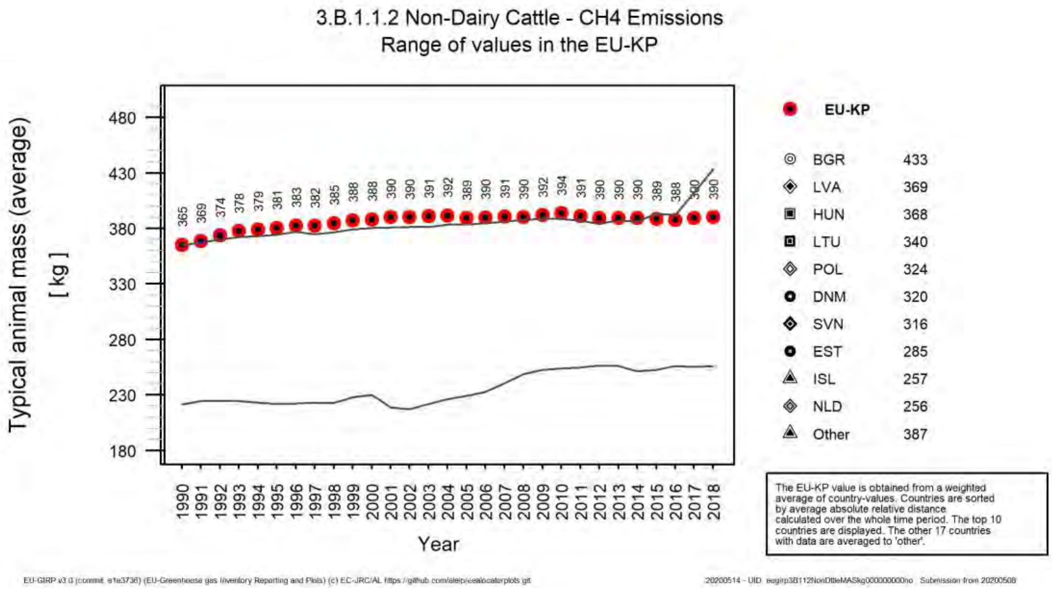


Table 5.23 3.B.1.1.2 - Non-Dairy Cattle: countries' typical animal mass (kg)

Country	1990	2018		Country	1990	2018
Austria	364	413	|	Ireland	362	351
Belgium	381	404	|	Iceland	241	257
Bulgaria	298	433	|	Italy	376	388
Cyprus	359	323	|	Lithuania	327	340
Czech Republic	326	421	|	Luxembourg	422	446
Germany	339	374	|	Latvia	298	369
Denmark	290	320	|	Malta	374	345
Spain	413	418	|	Netherlands	272	256
Estonia	222	285	|	Poland	311	324
Finland	278	403	|	Portugal	399	442
France	431	441	|	Romania	338	337
United Kingdom	426	426	|	Slovakia	331	343
Greece	375	430	|	Slovenia	289	316
Croatia	330	325	|	**EU-KP**	**365**	**390**
Hungary	327	368	|			

3.B.1.1.2 - Non-Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle*, increased in EU-KP barely between 1990 and 2018 by 0.15% or 0.00309 kg dm/head/day. Figure 5.32 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.24 shows the VS daily excretion in source category *3.B.1.1.2*

- *Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. VS daily excretion decreased in nine countries and increased in nineteen countries. It was in 2018 at the level of 1990 in one country. No data were available for EU-KP. The three countries with the largest decreases were Portugal, Italy and Spain with a mean absolute value of 0.4 kg dm/head/day. The four countries with the largest increases were Denmark, the Czech Republic, Finland and Latvia with a mean absolute value of 1 kg dm/head/day.

Figure 5.32: 3.B.1.1.2 - Non-Dairy Cattle: Trend in VS daily excretion in the EU-KP and range of values reported by countries

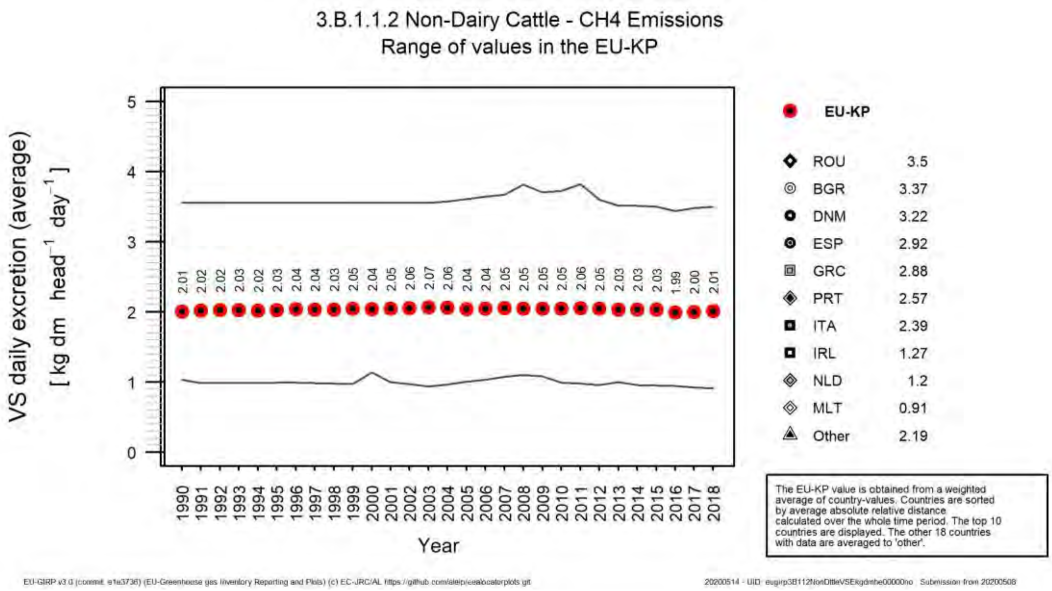


Table 5.24 3.B.1.1.2 - Non-Dairy Cattle: countries' VS daily excretion (kg dm/head/day)

Country	1990	2018		Country	1990	2018
Austria	1.8	2.13	|	Ireland	1.4	1.27
Belgium	1.5	1.60	|	Iceland	1.5	1.57
Bulgaria	2.8	3.37	|	Italy	2.8	2.39
Cyprus	2.7	2.70	|	Lithuania	2.4	2.56
Czech Republic	2.3	2.95	|	Luxembourg	2.2	2.34
Germany	1.4	1.54	|	Latvia	1.7	2.22
Denmark	2.4	3.22	|	Malta	1.0	0.91
Spain	3.2	2.92	|	Netherlands	1.4	1.20
Estonia	2.0	2.22	|	Poland	2.0	1.93
Finland	1.5	2.23	|	Portugal	3.2	2.57
France	1.9	1.91	|	Romania	3.6	3.50
United Kingdom	2.0	1.98	|	Slovakia	2.5	2.67
Greece	2.6	2.88	|	Slovenia	2.1	2.23
Croatia	2.7	2.69	|	Sweden	1.6	1.75
Hungary	2.5	2.63	|	**EU-KP**	**2.0**	**2.01**

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 EU-KP clearly between 1990 and 2018 by 14.7% or 0.866 kg/head/year. Figure 5.33 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in seventeen countries and increased in ten countries. It was in 2018 at the level of 1990 in two countries. No data were available for EU-KP. The four countries with the largest decreases were Croatia, Finland and Hungary with a mean absolute value of 2 kg/head/year. The four countries with the largest increases were Croatia, Finland, Hungary and Estonia 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 EU-KP and range of values reported by countries

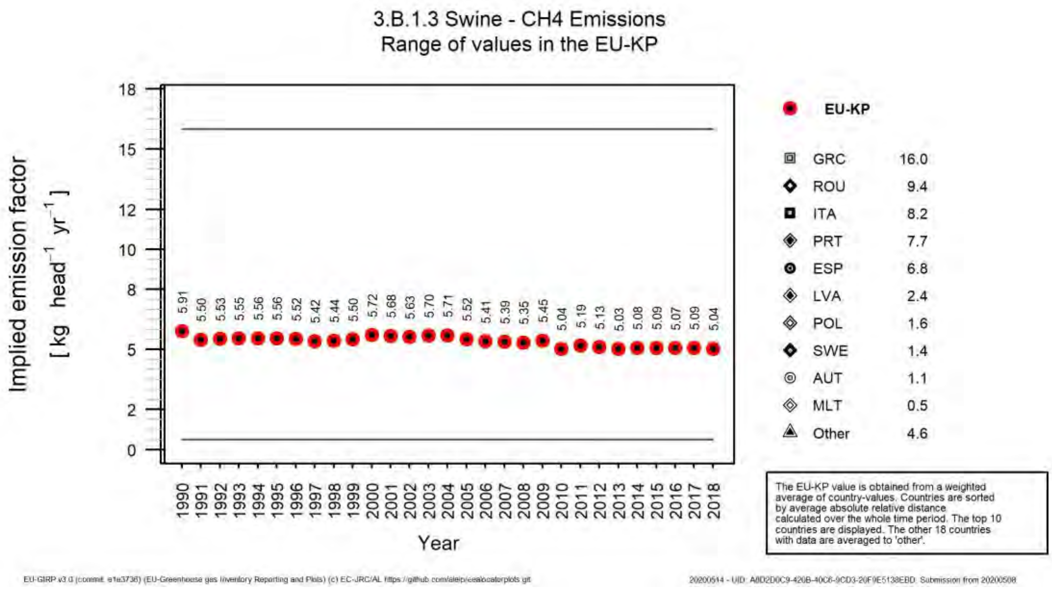


Table 5.25 3.B.1.3 - Swine: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	1.4	1.1	|	Ireland	6.8	6.6
Belgium	4.7	4.5	|	Iceland	6.0	6.0
Bulgaria	5.1	4.4	|	Italy	8.1	8.2
Cyprus	7.9	3.5	|	Lithuania	5.1	3.7
Czech Republic	6.3	6.3	|	Luxembourg	5.8	5.0
Germany	4.1	4.1	|	Latvia	1.9	2.4
Denmark	3.9	3.5	|	Malta	0.5	0.5
Spain	12.2	6.8	|	Netherlands	9.7	5.5
Estonia	4.5	5.5	|	Poland	1.9	1.6
Finland	2.0	3.4	|	Portugal	8.0	7.7
France	3.4	4.1	|	Romania	12.2	9.4
United Kingdom	5.8	5.2	|	Slovakia	4.6	3.1
Greece	16.0	16.0	|	Slovenia	9.0	3.9
Croatia	4.3	6.5	|	Sweden	1.0	1.4
Hungary	2.3	3.7	|	**EU-KP**	**5.9**	**5.0**

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 EU-KP slightly between 1990 and 2018 by 1.2% or 0.827 kg. Figure 5.34 shows the trend of the typical animal mass in EU-KP 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 2018 for all countries and EU-KP. Typical animal mass decreased in thirteen countries and increased in seven countries. It was in 2018 at the level of 1990 in one country. No data were available for nine countries (EU-KP, Austria, Cyprus, Finland, the United Kingdom, the Netherlands, Poland, Slovenia and Sweden). The three countries with the largest decreases were Luxembourg, Latvia and Belgium with a mean absolute value of 10 kg. The three countries with the largest increases were Denmark, Estonia and Hungary with a mean absolute value of 8 kg.

Figure 5.34: 3.B.1.3 - Swine: Trend in typical animal mass in the EU-KP and range of values reported by countries

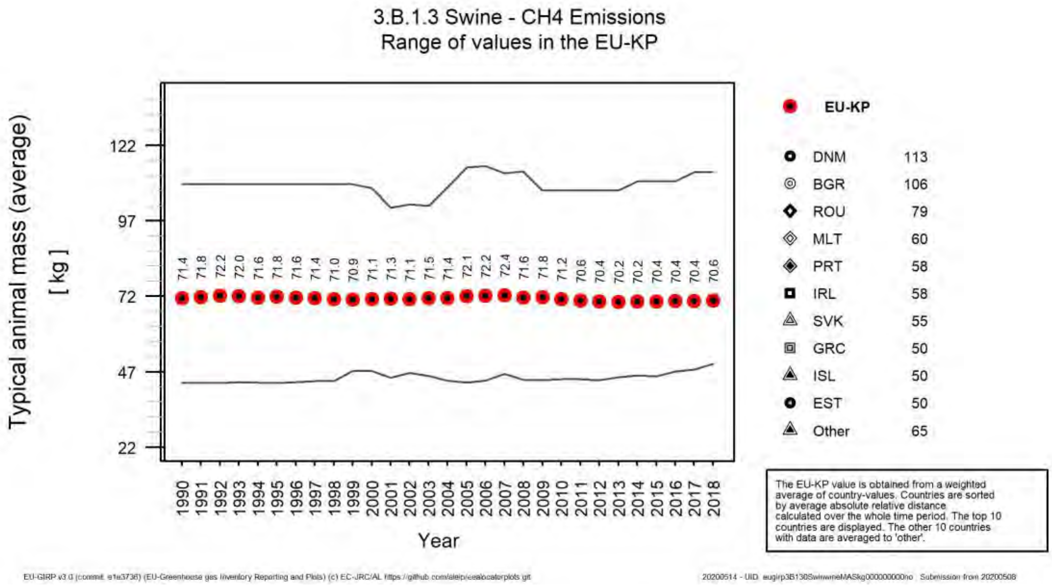


Table 5.26 3.B.1.3 - Swine: countries' typical animal mass (kg)

Country	1990	2018		Country	1990	2018
Belgium	69	63	|	Ireland	63	58
Bulgaria	109	106	|	Iceland	52	50
Czech Republic	62	63	|	Italy	79	81
Germany	67	64	|	Lithuania	65	62
Denmark	98	113	|	Luxembourg	87	75
Spain	64	61	|	Latvia	75	63
Estonia	43	50	|	Malta	59	60
France	64	64	|	Portugal	62	58
Greece	50	50	|	Romania	82	79
Croatia	69	69	|	Slovakia	56	55
Hungary	63	65	|	**EU-KP**	**71**	**71**

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 EU-KP moderately between 1990 and 2018 by 7.5% or 0.0244 kg dm/head/day. Figure 5.35 shows the trend of the VS daily excretion in EU-KP 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 2018 for all countries and EU-KP. VS daily excretion decreased in nineteen countries and increased in five countries. It was in 2018 at the level of 1990 in two countries. No data were available for four countries (Iceland, EU-KP, the Czech Republic and Greece). The three countries with the largest decreases were the Netherlands, Slovakia and Denmark with a mean absolute value of 0.1 kg dm/head/day. The three countries with the largest increases were Germany, Estonia and Sweden with a mean absolute value of 0.038 kg dm/head/day.

Figure 5.35: 3.B.1.3 - Swine: Trend in VS daily excretion in the EU-KP and range of values reported by countries

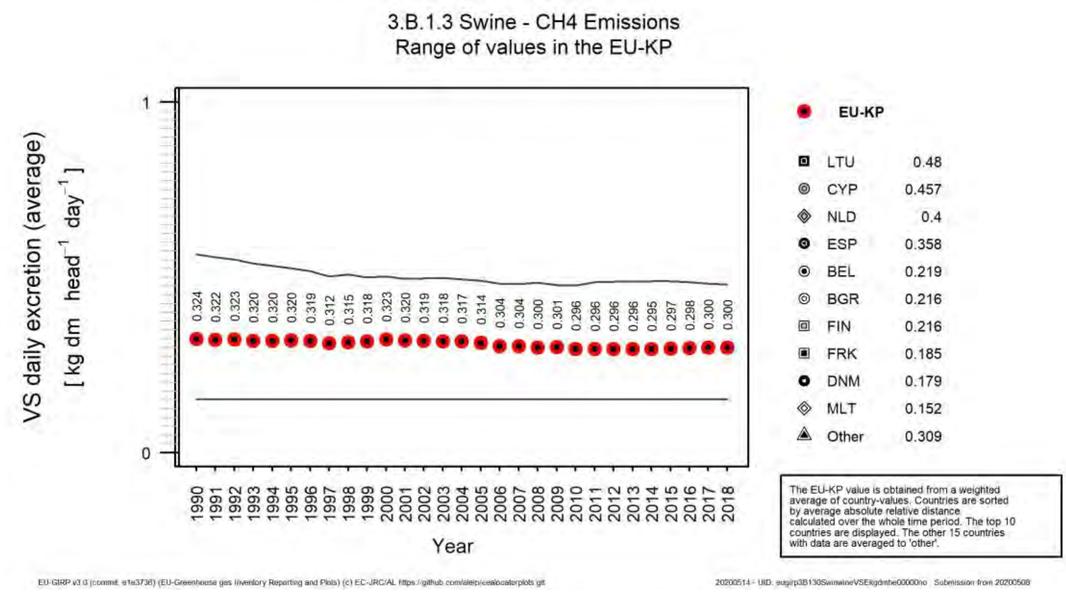


Table 5.27 3.B.1.3 - Swine: countries' VS daily excretion (kg DM/head/day)

Country	1990	2018		Country	1990	2018
Austria	0.30	0.30	|	Italy	0.37	0.33
Belgium	0.23	0.22	|	Lithuania	0.50	0.48
Bulgaria	0.25	0.22	|	Luxembourg	0.32	0.31
Cyprus	0.45	0.46	|	Latvia	0.40	0.34
Germany	0.26	0.31	|	Malta	0.15	0.15
Denmark	0.24	0.18	|	Netherlands	0.57	0.40
Spain	0.44	0.36	|	Poland	0.32	0.31
Estonia	0.26	0.30	|	Portugal	0.28	0.26
Finland	0.22	0.22	|	Romania	0.29	0.28
France	0.17	0.18	|	Slovakia	0.45	0.31
United Kingdom	0.31	0.28	|	Slovenia	0.32	0.31
Croatia	0.32	0.32	|	Sweden	0.29	0.31
Hungary	0.30	0.30	|	**EU-KP**	**0.32**	**0.30**
Ireland	0.36	0.35	|			

5.3.3 Manure Management - N_2O (CRF Source Category 3B2)

N_2O emissions in source category *3.B.2 - Manure Management* are 0.46% of total EU-KP GHG emissions and 8.5% of total EU-KP N_2O emissions. They make 5% of total agricultural emissions and 12% 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 countries, Figure 5.37 shows the distribution of N_2O emissions from manure management by livestock category in all countries and in the EU-KP. 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 countries, Figure 5.38 shows the distribution of total manure nitrogen by manure system in all countries and in the EU-KP. 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 EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2018.3.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.

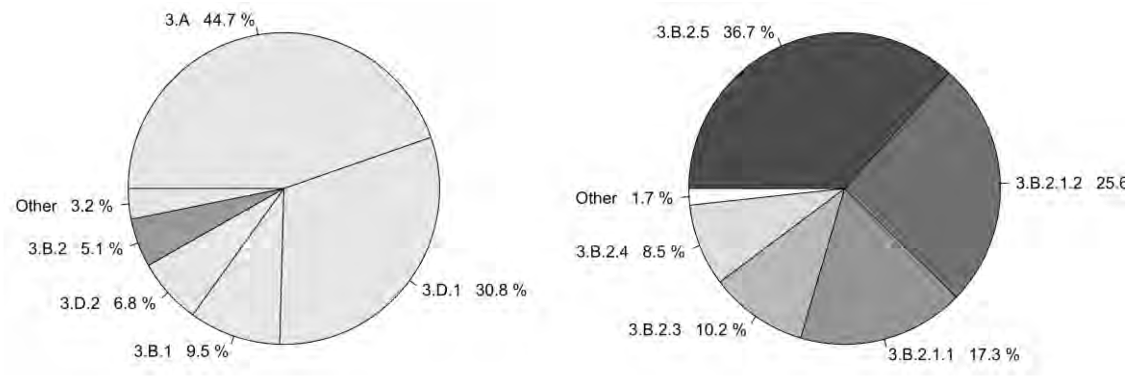


Figure 5.37: Decomposition of emissions in source category 3.B.2 - Manure Management into its sub-categories by country in the year 2018.

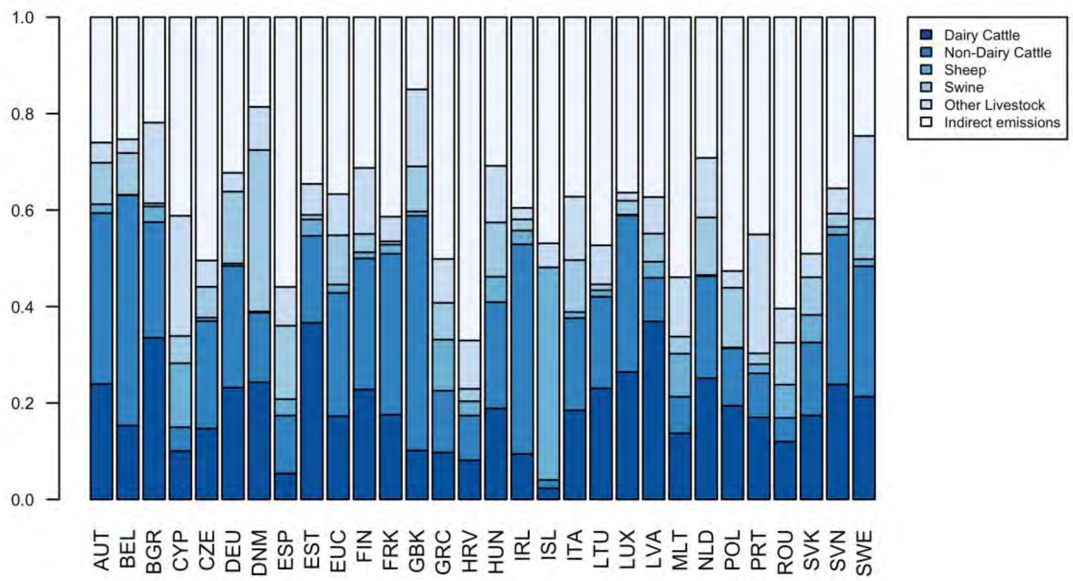
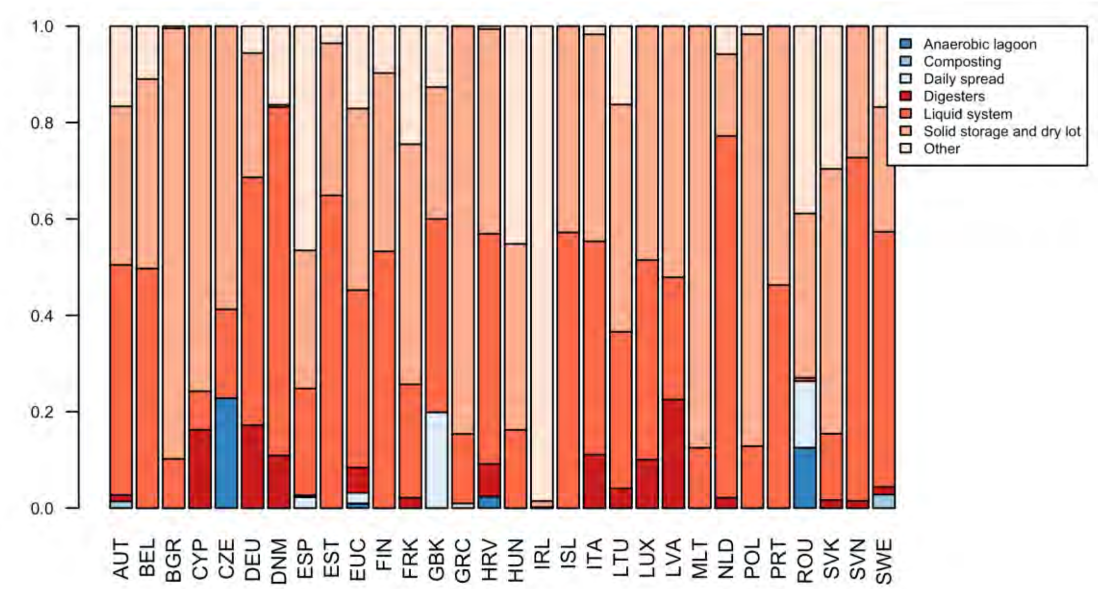


Figure 5.38: Decomposition of manure nitrogen handled in source category 3.B.2 - Manure Management into the different manure management systems by country in the year 2018.



Total GHG and N_2O emissions by country from 3.B.2 *Manure Management* are shown in Table 5.28 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 26% or 7.5 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (73%) and in the Czech Republic in absolute terms (876 kt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 0.3%.

Table 5.28 3.B.2 - Manure Management: Countries' contributions to total EU-GHG and N_2O emissions

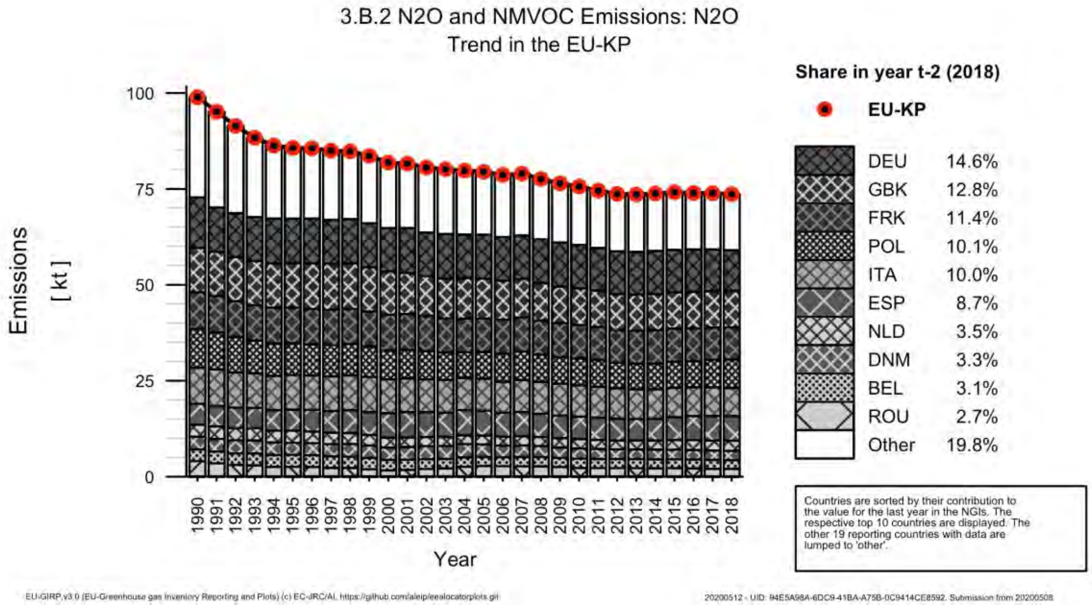
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	436	445	441	2.0%	5	1%	-4	-1%	T2	CS
Belgium	912	681	676	3.1%	-235	-26%	-5	-1%	T2	D
Bulgaria	1 260	476	474	2.2%	-786	-62%	-2	0%	T1,T2	D
Croatia	375	149	136	0.6%	-239	-64%	-13	-9%	T1	CS,D
Cyprus	66	67	68	0.3%	2	3%	1	2%	T1	D
Czechia	1 393	491	518	2.4%	-876	-63%	27	5%	T2	CS,D
Denmark	979	722	733	3.3%	-246	-25%	12	2%	T2	D
Estonia	149	65	64	0.3%	-85	-57%	-1	-1%	T1,T2	CS,D
Finland	284	281	279	1.3%	-5	-2%	-2	-1%	T2	D
France	2 871	2 514	2 501	11.4%	-369	-13%	-13	-1%	T2	CS,D
Germany	3 913	3 261	3 197	14.6%	-716	-18%	-64	-2%	T2	CS,D
Greece	333	289	287	1.3%	-46	-14%	-3	-1%	D	D
Hungary	854	456	456	2.1%	-398	-47%	0	0%	T1,T2	CS,D
Ireland	498	547	543	2.5%	44	9%	-4	-1%	T2	CS,D
Italy	2 817	2 232	2 190	10.0%	-627	-22%	-42	-2%	T2	CS,D
Latvia	295	87	79	0.4%	-216	-73%	-8	-9%	T1,T2	D
Lithuania	581	184	179	0.8%	-403	-69%	-5	-3%	T1,T2	D
Luxembourg	33	28	27	0.1%	-5	-16%	0	-2%	T2	CS
Malta	13	10	10	0.0%	-3	-24%	0	3%	T1,T2	CS,D
Netherlands	940	774	777	3.5%	-163	-17%	3	0%	T1	D
Poland	3 001	2 128	2 210	10.1%	-791	-26%	82	4%	T1,T2	CS,D
Portugal	276	188	189	0.9%	-87	-31%	2	1%	T2	CS,D
Romania	1 204	616	599	2.7%	-605	-50%	-17	-3%	T2	D
Slovakia	467	166	171	0.8%	-295	-63%	5	3%	T1,T2	CS
Slovenia	86	82	81	0.4%	-5	-6%	0	-1%	T1,T2	CS,D
Spain	1 611	1 915	1 906	8.7%	295	18%	-9	0%	T1,T2	D
Sweden	369	334	333	1.5%	-36	-10%	-1	0%	CS,T2	CS,D
United Kingdom	3 443	2 815	2 802	12.8%	-641	-19%	-13	0%	T2	CS,D
EU-27+UK	**29 458**	**22 002**	**21 927**	**100%**	**-7 531**	**-26%**	**-75**	**0%**	**-**	**-**
Iceland	24	21	20	0.1%	-4	-17%	-1	-5%	T1,T2	CS,D
United Kingdom (KP)	3 443	2 815	2 802	12.8%	-641	-19%	-13	0%	T2	CS,D
EU-KP	**29 482**	**22 023**	**21 947**	**100%**	**-7 535**	**-26%**	**-76**	**0%**	**-**	**-**

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 EU-KP by 26% or 7.5 Mt CO_2-eq in the period 1990 to 2018. Figure 5.39 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 80.2% of the total. Emissions decreased in 25 countries and increased in four countries. The largest decreases occurred in the Czech Republic and Poland with a total absolute decrease of 1.7 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 340 kt CO_2-eq.

Figure 5.39: 3.B.2 Manure Management: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.B.2.1 - Cattle - Emissions

N_2O emissions in source category *3.B.2.1 - Cattle* are 0.2% of total EU-KP GHG emissions and 3.7% of total EU-KP N_2O emissions. They make 2.2% of total agricultural emissions and 5.1% 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 EU-KP total. The figures represent the trend in N_2O emissions from manure management for the different countries along the inventory period.

Total GHG and N_2O emissions by country from 3.B.2.1 *Manure Management* are shown in Table 5.29 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 26% or 3.3 Mt CO_2-eq. The decrease was largest in Croatia in relative terms (76%) and in Germany in absolute terms (603 kt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 1%. The ten countries with the highest emissions accounted together for 81.6% of the total. Emissions decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were Germany, the United Kingdom and Italy with a total absolute decrease of 1.4 Mt CO_2-eq. The five countries with the largest increases were Finland, Slovenia, Spain, the Netherlands and Ireland, with a total absolute increase of 80 kt CO_2-eq.

Table 5.29 3.B.2.1 - Cattle: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	258	264	262	2.8%	4	1%	-2	-1%	T2	CS
Belgium	622	432	427	4.5%	-195	-31%	-6	-1%	T2	D
Bulgaria	585	283	272	2.9%	-313	-53%	-10	-4%	T2	D
Croatia	99	27	24	0.3%	-76	-76%	-3	-13%	T1	CS,D
Cyprus	8	10	10	0.1%	2	22%	1	6%	T1	D
Czechia	514	185	192	2.0%	-322	-63%	7	4%	T2	CS
Denmark	326	282	284	3.0%	-42	-13%	2	1%	T2	D
Estonia	71	35	35	0.4%	-36	-51%	0	0%	T2	CS,D
Finland	127	141	139	1.5%	12	9%	-2	-1%	T2	D
France	1 429	1 282	1 274	13.6%	-154	-11%	-8	-1%	T2	CS,D
Germany	2 151	1 573	1 548	16.5%	-603	-28%	-24	-2%	T2	CS,D
Greece	84	66	65	0.7%	-19	-23%	-2	-3%	D	D
Hungary	281	188	187	2.0%	-94	-33%	-1	-1%	T2	CS
Ireland	264	291	287	3.1%	23	9%	-4	-1%	T2	CS,D
Italy	1 201	829	824	8.8%	-377	-31%	-6	-1%	T2	CS,D
Latvia	121	40	36	0.4%	-84	-70%	-4	-9%	T2	D
Lithuania	206	75	75	0.8%	-131	-64%	0	0%	T2	D
Luxembourg	20	16	16	0.2%	-4	-21%	0	-1%	T2	CS
Malta	3	2	2	0.0%	-1	-35%	0	0%	T1,T2	CS,D
Netherlands	342	366	360	3.8%	18	5%	-6	-2%	NA	NA
Poland	885	681	693	7.4%	-193	-22%	12	2%	T2	CS
Portugal	78	49	50	0.5%	-29	-37%	0	1%	T2	CS,D
Romania	214	103	101	1.1%	-113	-53%	-1	-1%	T2	D
Slovakia	160	53	56	0.6%	-104	-65%	2	5%	T2	CS
Slovenia	33	45	45	0.5%	12	37%	0	-1%	T1,T2	CS,D
Spain	317	351	332	3.5%	15	5%	-19	-5%	T2	D
Sweden	176	163	161	1.7%	-15	-8%	-1	-1%	CS,T2	CS,D
United Kingdom	2 088	1 664	1 648	17.5%	-440	-21%	-17	-1%	T2	CS,D
EU-27+UK	**12 662**	**9 495**	**9 404**	**100%**	**-3 259**	**-26%**	**-92**	**-1%**	**-**	**-**
Iceland	1	1	1	0.0%	0	3%	0	-4%	T2	CS,D
United Kingdom (KP)	2 088	1 664	1 648	17.5%	-440	-21%	-17	-1%	T2	CS,D
EU-KP	**12 663**	**9 496**	**9 404**	**100%**	**-3 259**	**-26%**	**-92**	**-1%**	**-**	**-**

Figure 5.40: 3.B.2.1 - Dairy cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

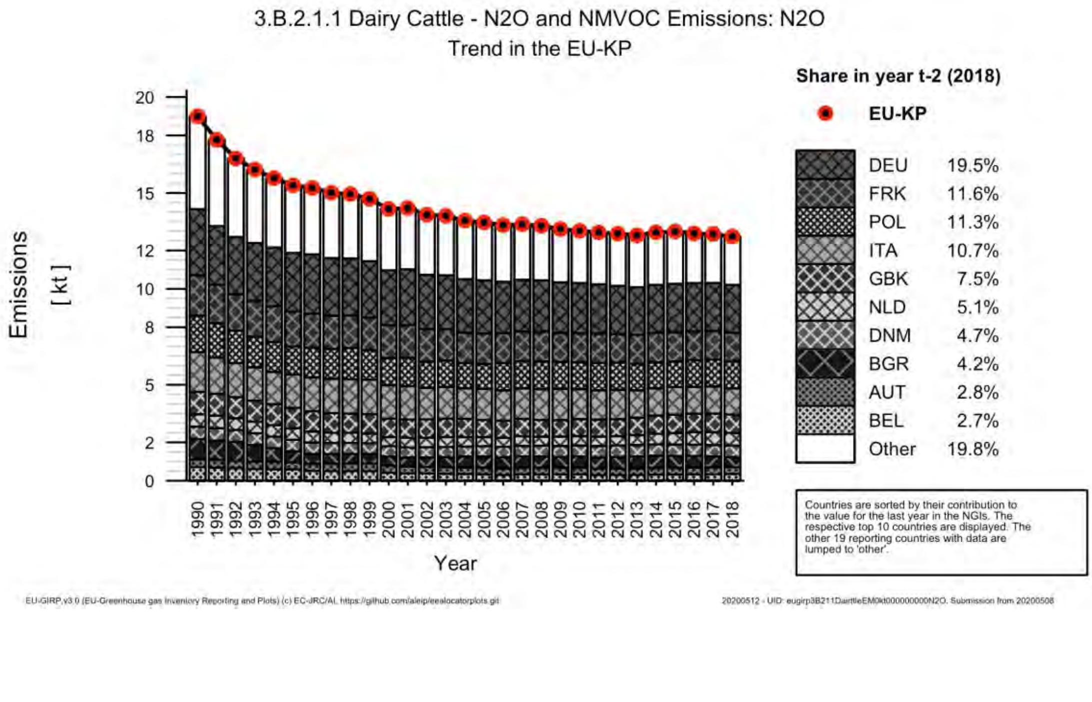
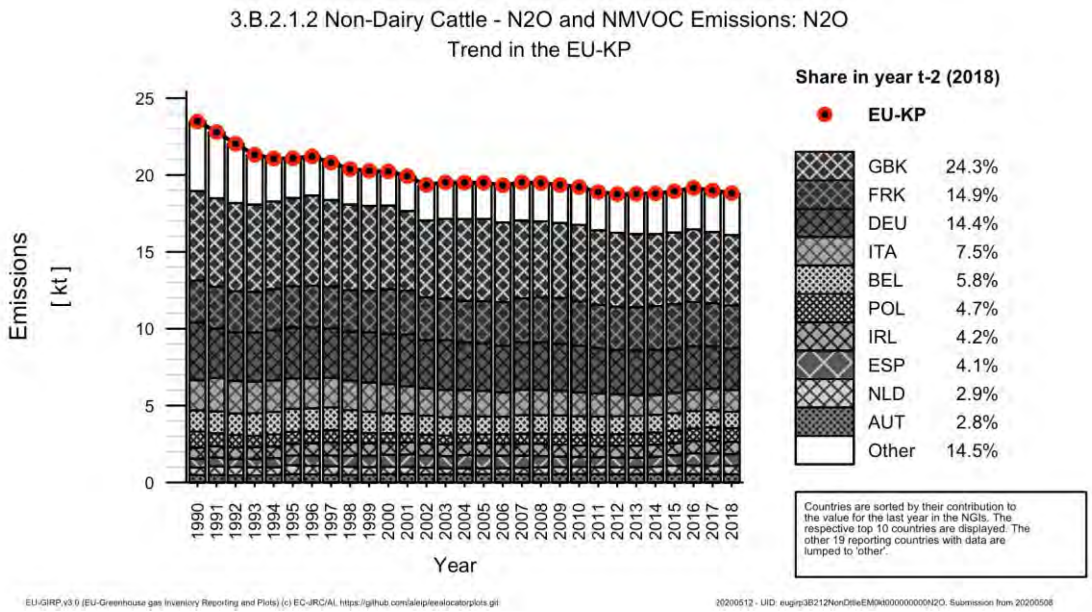


Figure 5.41: 3.B.2.1 - Non-dairy cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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

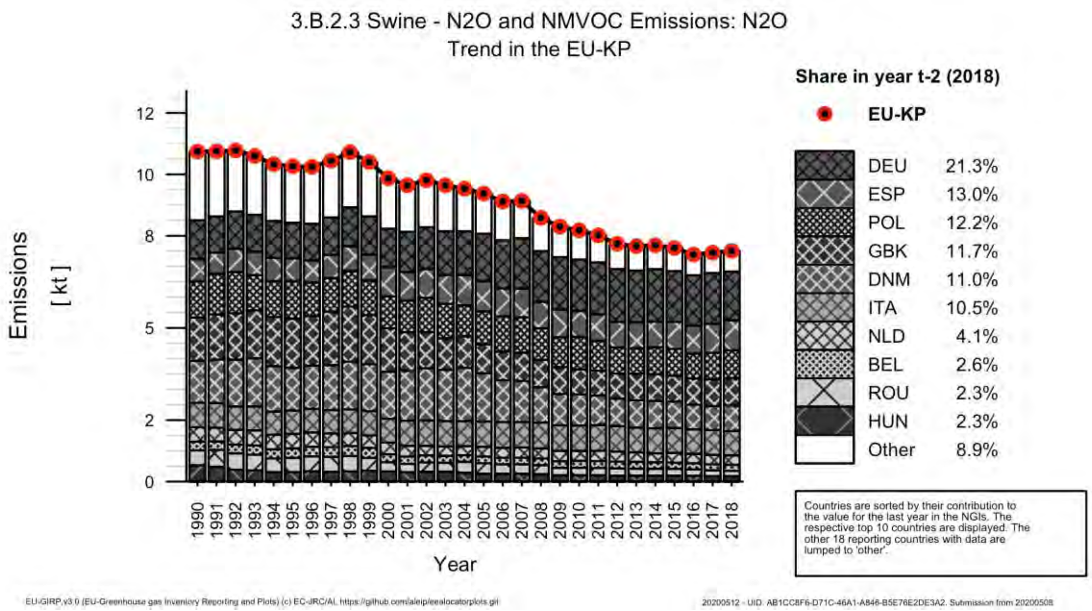
N_2O emissions in source category *3.B.2.3 - Swine* are 0.047% of total EU-KP GHG emissions and 0.87% of total EU-KP N_2O emissions. They make 0.51% of total agricultural emissions and 1.2% of total agricultural N_2O emissions. Figure 5.43 shows the trend of emissions indicating the countries contributing most to the EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period.

Total GHG and N_2O emissions by country from 3.B.2.3 *Manure Management* are shown in Table 5.30 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 30% or 964 kt CO_2-eq. The decrease was largest in Lithuania in relative terms (98%) and in Denmark in absolute terms (162 kt CO_2-eq). From 2017 to 2018 emissions in the current category increased by 0.8%. The ten countries with the highest emissions accounted together for 91.1% of the total. Emissions decreased in 24 countries and increased in four countries. The three countries with the largest decreases were Denmark, the United Kingdom and the Czech Republic with a total absolute decrease of 461 kt CO_2-eq. The largest increases occurred in Spain and Germany, with a total absolute increase of 176 kt CO_2-eq.

Table 5.30 3.B.2.3 - Swine: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Information
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	61	39	38	1.7%	-23	-38%	-1	-2%	T2	CS
Belgium	85	59	58	2.6%	-26	-31%	-1	-1%	T2	D
Bulgaria	10	3	3	0.1%	-7	-70%	0	3%	T2	D
Croatia	24	4	3	0.2%	-20	-85%	0	-9%	T1	CS,D
Cyprus	8	4	4	0.2%	-4	-51%	0	-8%	T1	D
Czechia	174	30	33	1.5%	-141	-81%	3	12%	T2	CS
Denmark	408	233	246	11.0%	-162	-40%	12	5%	T2	D
Estonia	2	1	1	0.0%	-2	-74%	0	6%	T2	CS,D
Finland	26	11	11	0.5%	-15	-59%	0	-1%	T2	D
France	46	17	17	0.8%	-29	-63%	0	-1%	T2	CS,D
Germany	376	494	476	21.3%	100	26%	-18	-4%	T2	CS,D
Greece	31	22	22	1.0%	-10	-30%	0	0%	D	D
Hungary	158	51	51	2.3%	-107	-68%	0	0%	T2	CS
Ireland	10	13	12	0.6%	2	24%	0	0%	T2	CS,D
Italy	236	241	236	10.5%	0	0%	-5	-2%	T2	CS,D
Latvia	40	5	5	0.2%	-36	-89%	-1	-10%	T2	D
Lithuania	110	2	2	0.1%	-108	-98%	0	-10%	T1	D
Luxembourg	1	1	1	0.0%	0	10%	0	-7%	T2	CS
Malta	1	0	0	0.0%	-1	-64%	0	7%	T1	D
Netherlands	140	90	93	4.1%	-47	-34%	3	3%	NA	NA
Poland	353	258	274	12.2%	-79	-22%	16	6%	T2	CS
Portugal	11	4	4	0.2%	-7	-61%	0	-1%	T2	CS,D
Romania	144	58	52	2.3%	-92	-64%	-6	-10%	T2	D
Slovakia	64	13	13	0.6%	-50	-79%	0	1%	T2	CS
Slovenia	7	2	2	0.1%	-5	-67%	0	0%	T1	D
Spain	214	280	290	13.0%	76	35%	11	4%	T2	D
Sweden	42	28	28	1.2%	-14	-34%	0	2%	CS,NA,T2	CS,D,NA
United Kingdom	420	259	262	11.7%	-158	-38%	3	1%	T2	CS,D
EU-27+UK	**3 203**	**2 221**	**2 238**	**100%**	**-964**	**-30%**	**18**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	420	259	262	11.7%	-158	-38%	3	1%	T2	CS,D
EU-KP	**3 203**	**2 221**	**2 238**	**100%**	**-964**	**-30%**	**18**	**1%**	**-**	**-**

Figure 5.42: 3.B.2.3 - Swine: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.B.2.4 - Other Livestock - Emissions

N_2O emissions in source category *3.B.2.4 - Other Livestock* are 0.039% of total EU-KP GHG emissions and 0.73% of total EU-KP N_2O emissions. They make 0.43% of total agricultural emissions and 1% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by country from 3.B.2.4 *Manure Management* are shown in Table 5.31 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 8% or 165 kt CO_2-eq. The decrease was largest in the Czech Republic in relative terms (72%) and in Bulgaria in absolute terms (122 kt CO_2-eq). From 2017 to 2018 emissions in the current category increased by 0.4%. Figure 5.44 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81% of the total. Emissions decreased in sixteen countries and increased in thirteen countries. The four countries with the largest decreases were Bulgaria, Poland, the Czech Republic and Hungary with a total absolute decrease of 330 kt CO_2-eq. The four countries with the largest increases were Germany, the Netherlands, Spain and the United Kingdom, with a total absolute increase of 182 kt CO_2-eq.

Table 5.31 3.B.2.4 - Other Livestock: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	9	18	18	1.0%	9	98%	0	0%	T2	CS
Belgium	10	19	19	1.0%	9	90%	0	2%	T2	D
Bulgaria	201	74	79	4.2%	-122	-61%	6	8%	T1,T2	D
Croatia	24	13	14	0.7%	-10	-43%	1	4%	T1	CS,D
Cyprus	17	17	17	0.9%	0	-1%	0	2%	T1	D
Czechia	100	25	28	1.5%	-72	-72%	3	12%	T2	CS,D
Denmark	46	69	65	3.5%	20	44%	-3	-5%	T2	D
Estonia	13	4	4	0.2%	-9	-68%	0	-8%	T1	D
Finland	29	38	38	2.0%	9	32%	0	1%	T2	D
France	123	128	128	6.8%	5	4%	-1	-1%	T2	CS,D
Germany	99	124	125	6.7%	26	26%	0	0%	T2	CS,D
Greece	30	26	26	1.4%	-4	-12%	0	0%	D	D
Hungary	103	53	54	2.9%	-50	-48%	1	2%	T1,T2	CS,D
Ireland	11	13	13	0.7%	2	15%	0	1%	T2	CS,D
Italy	292	304	288	15.4%	-4	-1%	-16	-5%	T2	CS,D
Latvia	20	8	6	0.3%	-14	-70%	-2	-24%	T1,T2	D
Lithuania	16	17	14	0.8%	-2	-11%	-2	-13%	T1	D
Luxembourg	0	0	0	0.0%	0	166%	0	0%	T2	CS
Malta	1	1	1	0.1%	0	0%	0	6%	T1,T2	CS,D
Netherlands	62	82	96	5.1%	34	56%	14	17%	T1	D
Poland	163	72	77	4.1%	-86	-53%	4	6%	T1,T2	CS,D
Portugal	60	46	47	2.5%	-13	-22%	1	2%	T2	CS,D
Romania	67	42	42	2.3%	-25	-37%	0	0%	T2	D
Slovakia	10	8	8	0.4%	-2	-19%	0	5%	T1	CS
Slovenia	4	4	4	0.2%	0	12%	0	1%	T1	D
Spain	97	155	153	8.2%	57	59%	-2	-2%	T1,T2	D
Sweden	46	57	57	3.1%	12	25%	0	1%	T2	D
United Kingdom	382	445	448	23.9%	65	17%	2	1%	T2	CS,D
EU-27+UK	**2 035**	**1 864**	**1 871**	**100%**	**-164**	**-8%**	**7**	**0%**	**-**	**-**
Iceland	1	1	1	0.1%	0	-15%	0	-6%	T1	D
United Kingdom (KP)	382	445	448	23.9%	65	17%	2	1%	T2	CS,D
EU-KP	**2 037**	**1 865**	**1 872**	**100%**	**-165**	**-8%**	**7**	**0%**	**-**	**-**

3.B.2.4.7 - Poultry - Emissions

Largest contribution to other livestock emissions comes from sub-category poultry with 53% of total N_2O emissions. Other animal types with high emissions are horses with a share of 24% and Goats with a share of 10%. Here only the most important animal type Poultry is discussed.

Emissions in source category *3.B.2.4.7 - Poultry* decreased considerably in EU-KP by 19% or 237 kt CO_2-eq in the period 1990 to 2018. Figure 5.45 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 84.4% of the total. Emissions decreased in seventeen countries and increased in twelve countries. The three countries with the largest decreases were Bulgaria, the Czech Republic and Italy with a total absolute decrease of 220 kt CO_2-eq. The largest increases occurred in Sweden and Germany, with a total absolute increase of 42 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 EU-KP by 4.9% or 79.5 million heads in the period 1990 to 2018. Figure 5.46 shows the trend of poultry population indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 population for the different countries along the inventory period. The ten countries with the highest population accounted together for 84.8% of the total. Population decreased in thirteen countries and increased in sixteen countries. The four countries with the largest decreases were Romania, Hungary, Bulgaria and Poland with a total absolute decrease of 117 million heads. The three countries with the largest increases were France, France and the United Kingdom, with a total absolute increase of 144 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 EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

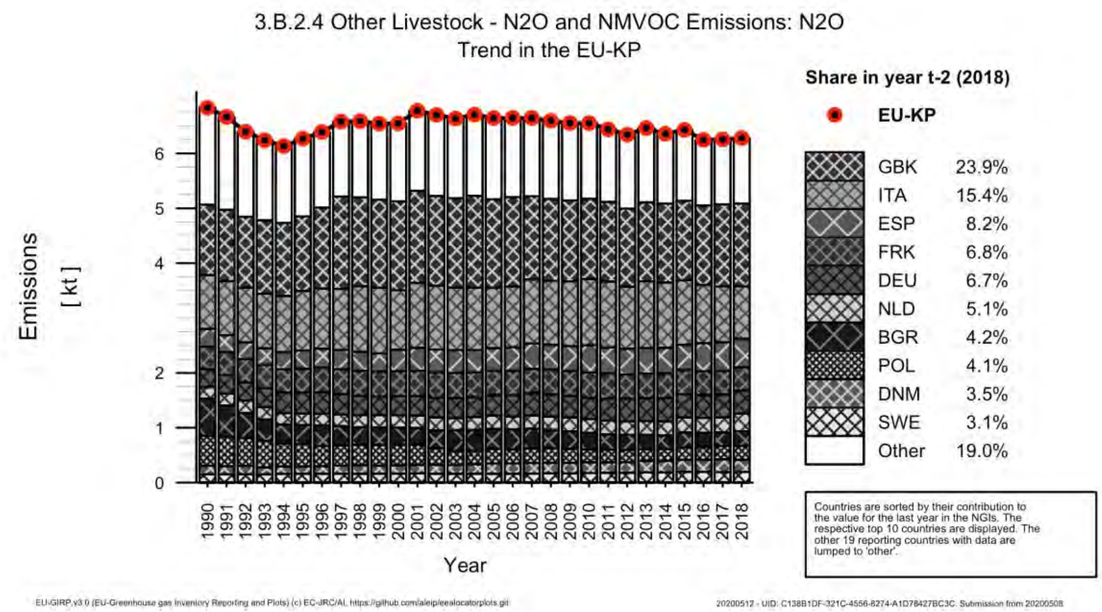


Figure 5.45: 3.B.2.4.7 - Poultry: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

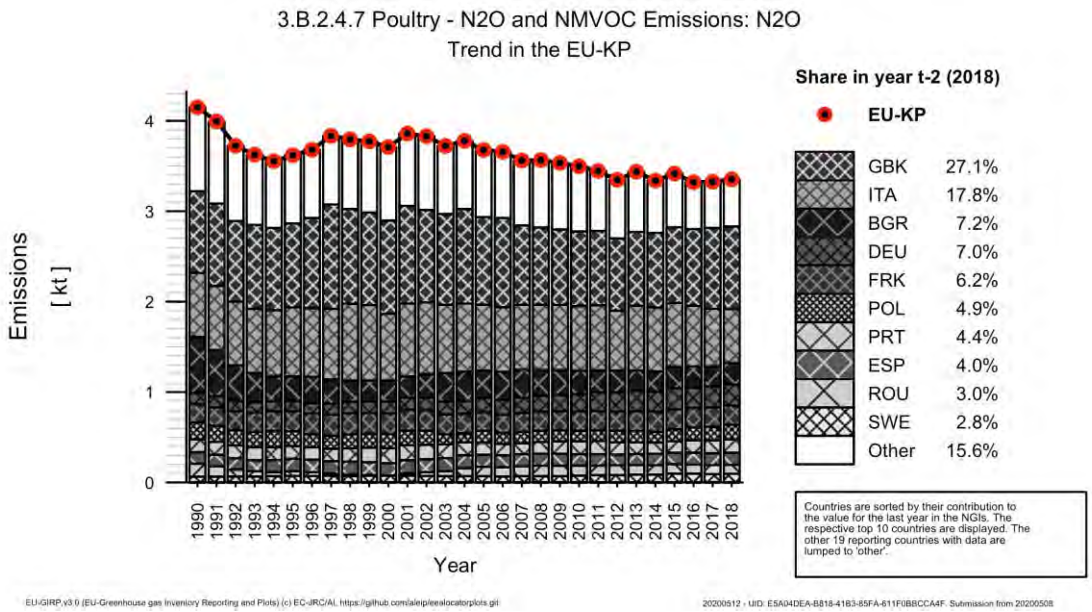
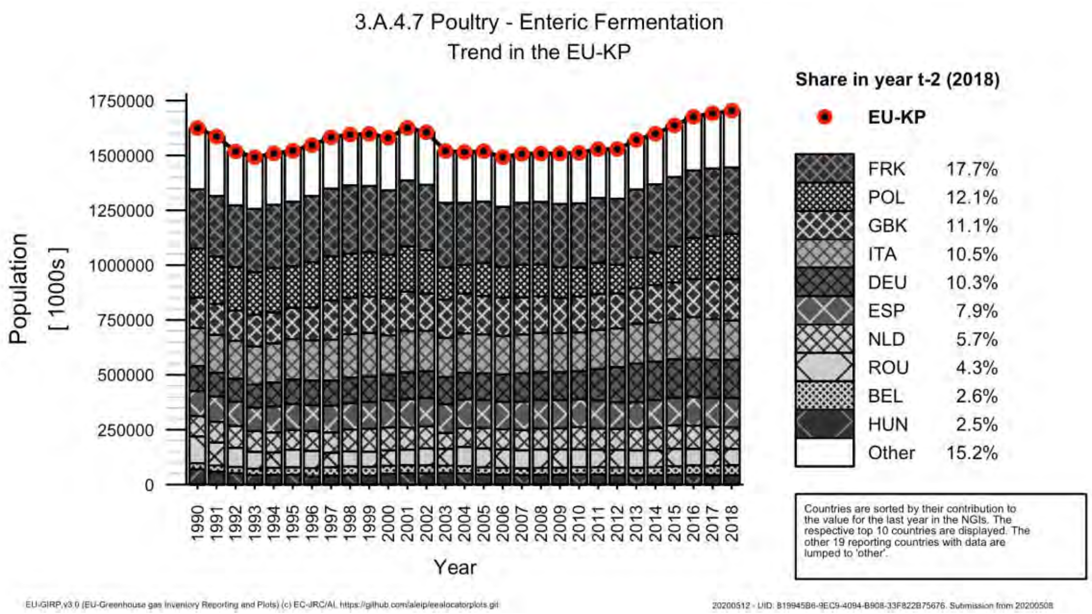


Figure 5.46: 3.A.4.7 - Poultry: Trend in population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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

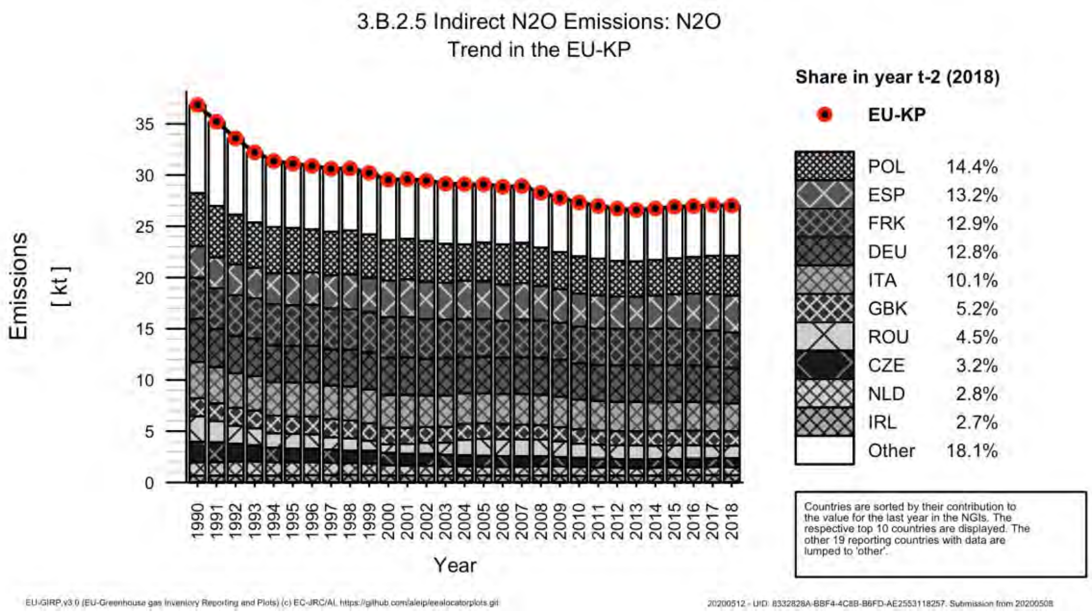
N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect Emissions - Indirect N_2O emissions* are 0.17% of total EU-KP GHG emissions and 3.1% of total EU-KP N_2O emissions. They make 1.8% of total agricultural emissions and 4.3% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by country from 3.B.2.5 *Manure Management - Indirect Emissions* are shown in Table 5.32 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 27% or 2.9 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (73%) and in Romania in absolute terms (383 kt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 0.1%. Figure 5.47 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management - indirect emissions for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81.9% of the total. Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Romania, Poland and the Czech Republic with a total absolute decrease of 1.1 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 179 kt CO_2-eq.

Table 5.32 3.B.2.5 - Manure Management - Indirect Emissions: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	101	116	115	1.4%	13	13%	-1	-1%
Belgium	194	171	171	2.1%	-23	-12%	1	0%
Bulgaria	367	101	104	1.3%	-264	-72%	2	2%
Croatia	224	101	91	1.1%	-133	-59%	-10	-10%
Cyprus	24	27	28	0.3%	4	15%	1	3%
Czechia	602	247	261	3.2%	-340	-57%	14	6%
Denmark	198	136	136	1.7%	-62	-31%	0	0%
Estonia	58	23	22	0.3%	-36	-62%	-1	-2%
Finland	99	88	87	1.1%	-12	-12%	-1	-1%
France	1 199	1 040	1 035	12.9%	-164	-14%	-5	0%
Germany	1 258	1 054	1 032	12.8%	-226	-18%	-22	-2%
Greece	157	145	144	1.8%	-14	-9%	-1	-1%
Hungary	280	140	141	1.7%	-139	-50%	1	0%
Ireland	191	215	215	2.7%	24	13%	0	0%
Italy	1 054	831	815	10.1%	-239	-23%	-16	-2%
Latvia	109	31	29	0.4%	-80	-73%	-2	-6%
Lithuania	248	87	84	1.0%	-163	-66%	-3	-3%
Luxembourg	11	10	10	0.1%	-1	-11%	0	-2%
Malta	7	5	5	0.1%	-1	-19%	0	3%
Netherlands	390	235	227	2.8%	-163	-42%	-8	-3%
Poland	1 545	1 114	1 163	14.4%	-382	-25%	49	4%
Portugal	115	85	85	1.1%	-30	-26%	1	1%
Romania	745	373	362	4.5%	-383	-51%	-11	-3%
Slovakia	216	81	84	1.0%	-132	-61%	3	4%
Slovenia	43	29	29	0.4%	-14	-32%	0	0%
Spain	912	1 064	1 066	13.2%	155	17%	2	0%
Sweden	103	82	82	1.0%	-21	-20%	0	0%
United Kingdom	520	420	419	5.2%	-100	-19%	-1	0%
EU-27+UK	**10 969**	**8 051**	**8 043**	**100%**	**-2 926**	**-27%**	**-8**	**0%**
Iceland	11	10	9	0.1%	-1	-14%	0	-5%
United Kingdom (KP)	520	420	419	5.2%	-100	-19%	-1	0%
EU-KP	**10 980**	**8 061**	**8 052**	**100%**	**-2 927**	**-27%**	**-8**	**0%**

Figure 5.47: 3.B.2.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.B.2.1 - Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* increased in EU-KP slightly between 1990 and 2018 by 1.6% or 0.00577 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 2018 for all countries and EU-KP. The implied emission factor decreased in twelve countries and increased in seventeen countries. No data were available for EU-KP. The largest decreases occurred in Croatia and Portugal with a mean absolute value of 0.2 kg/head/year. The four countries with the largest increases were Bulgaria, Finland, Estonia and Denmark with a mean absolute value of 0.2 kg/head/year.

Table 5.33 3.B.2.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	0.335	0.459	|	Ireland	0.130	0.133
Belgium	0.642	0.591	|	Iceland	0.035	0.033
Bulgaria	1.231	1.715	|	Italy	0.520	0.467
Cyprus	0.511	0.484	|	Lithuania	0.290	0.371
Czech Republic	0.492	0.454	|	Luxembourg	0.316	0.275
Germany	0.370	0.435	|	Latvia	0.281	0.307
Denmark	0.488	0.619	|	Malta	0.532	0.516
Spain	0.207	0.168	|	Netherlands	0.233	0.314
Estonia	0.315	0.466	|	Poland	0.296	0.375
Finland	0.315	0.530	|	Portugal	0.191	0.100
France	0.222	0.230	|	Romania	0.135	0.174
United Kingdom	0.578	0.568	|	Slovakia	0.344	0.426
Greece	0.405	0.403	|	Slovenia	0.206	0.314
Croatia	0.405	0.192	|	Sweden	0.343	0.359
Hungary	0.582	0.713	|	**EU-KP**	**0.351**	**0.357**

3.B.2.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle* increased in EU-KP clearly between 1990 and 2018 by 14.6% or 0.0703 kg/head/year. Figure 5.48 shows the trend of the implied emission factor in EU-KP 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.2.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The implied emission factor decreased in seven countries and increased in 22 countries. No data were available for EU-KP. The largest decrease occurred in Croatia with an absolute value of 0.3 kg/head/year. The four countries with the largest increases were Bulgaria, Estonia, Slovenia and Finland with a mean absolute value of 0.4 kg/head/year.

Figure 5.48: 3.B.2.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

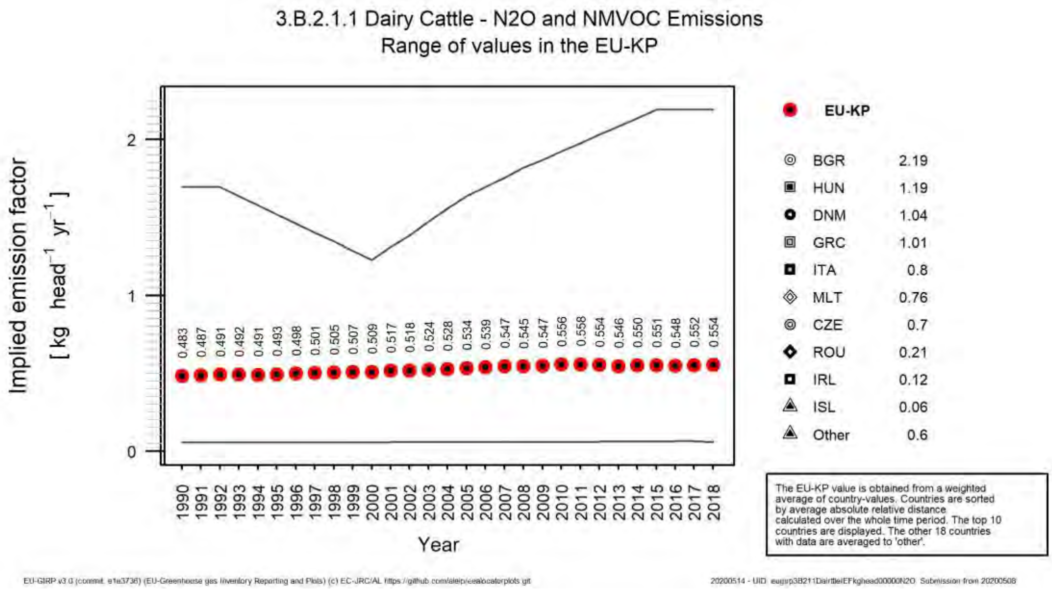


Table 5.34 3.B.2.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018	Country	1990	2018
Austria	0.444	0.664	Ireland	0.128	0.121
Belgium	0.845	0.706	Iceland	0.054	0.058
Bulgaria	1.696	2.192	Italy	0.783	0.801
Cyprus	0.759	0.719	Lithuania	0.375	0.523
Czech Republic	0.718	0.699	Luxembourg	0.563	0.506
Germany	0.543	0.607	Latvia	0.596	0.674
Denmark	0.875	1.038	Malta	0.757	0.757
Spain	0.314	0.421	Netherlands	0.340	0.412
Estonia	0.551	0.923	Poland	0.389	0.593
Finland	0.477	0.785	Portugal	0.472	0.452
France	0.393	0.415	Romania	0.169	0.211
United Kingdom	0.412	0.507	Slovakia	0.520	0.783
Greece	0.784	1.010	Slovenia	0.300	0.634
Croatia	0.538	0.273	Sweden	0.609	0.746
Hungary	0.883	1.190	**EU-KP**	**0.483**	**0.554**

3.B.2.1.1 - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle*, increased in EU-KP strongly between 1990 and 2018 by 25.2% or 23.1 kg/head/year. Figure 5.49 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.35 shows the nitrogen excretion rate in source category *3.B.2.1.1 - Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. Nitrogen excretion rate decreased in one country and increased in 24 countries. It was in 2018 at the level of 1990 in four countries. No data were available for EU-KP. A decrease occurred in the Netherlands with an absolute value of 1 kg/head/year. The four countries with the largest increases were the Czech Republic, Slovakia, Finland and Estonia with a mean absolute value of 42 kg/head/year.

Figure 5.49: 3.B.2.1.1 - Dairy Cattle: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries

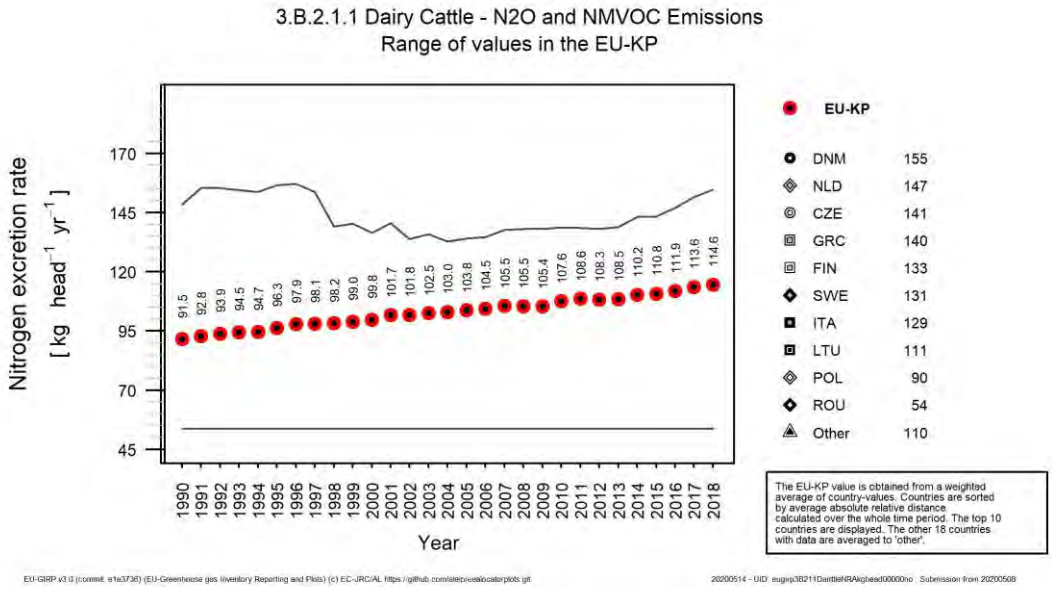


Table 5.35 3.B.2.1.1 - Dairy Cattle: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	77	106	|	Ireland	96	103
Belgium	114	121	|	Iceland	87	98
Bulgaria	98	98	|	Italy	105	129
Cyprus	96	96	|	Lithuania	80	111
Czech Republic	98	141	|	Luxembourg	110	124
Germany	97	124	|	Latvia	86	115
Denmark	129	155	|	Malta	96	96
Spain	85	113	|	Netherlands	148	147
Estonia	85	123	|	Poland	65	90
Finland	91	133	|	Portugal	86	118
France	102	115	|	Romania	54	54
United Kingdom	87	110	|	Slovakia	72	115
Greece	108	140	|	Slovenia	82	117
Croatia	96	99	|	Sweden	102	131
Hungary	83	119	|	**EU-KP**	**92**	**115**

3.B.2.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle* increased in EU-KP barely between 1990 and 2018 by 0.66% or 0.00185 kg/head/year. Figure 5.50 shows the trend of the implied emission factor in EU-KP 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.2.1.2 - Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. The implied emission factor decreased in twelve countries and increased in seventeen countries. No data were available for EU-KP. The largest decreases occurred in Croatia and Portugal with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Bulgaria, Finland, Hungary and Austria with a mean absolute value of 0.2 kg/head/year.

Figure 5.50: 3.B.2.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

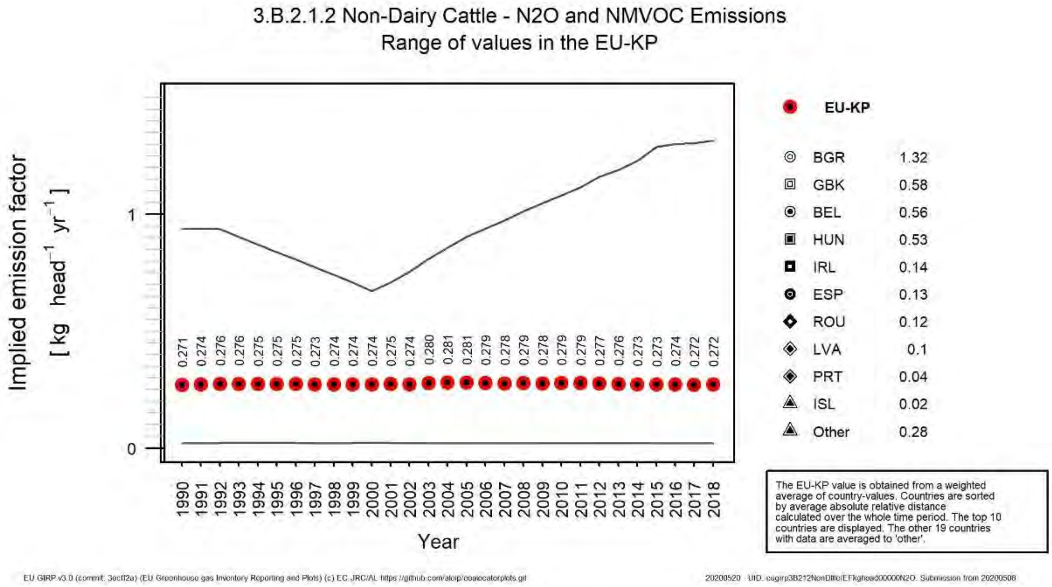


Table 5.36 3.B.2.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2018	Country	1990	2018
Austria	0.276	0.380	Ireland	0.130	0.136
Belgium	0.572	0.562	Iceland	0.021	0.021
Bulgaria	0.936	1.315	Italy	0.384	0.333
Cyprus	0.340	0.290	Lithuania	0.242	0.275
Czech Republic	0.373	0.369	Luxembourg	0.224	0.201
Germany	0.287	0.345	Latvia	0.095	0.096
Denmark	0.292	0.368	Malta	0.354	0.326
Spain	0.160	0.133	Netherlands	0.167	0.245
Estonia	0.175	0.232	Poland	0.206	0.234
Finland	0.223	0.417	Portugal	0.078	0.041
France	0.167	0.186	Romania	0.092	0.122
United Kingdom	0.629	0.583	Slovakia	0.283	0.280
Greece	0.241	0.277	Slovenia	0.137	0.189
Croatia	0.234	0.153	Sweden	0.209	0.255
Hungary	0.422	0.531	**EU-KP**	**0.283**	**0.272**

3.B.2.1.2 - Non-Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle*, increased in EU-KP moderately between 1990 and 2018 by 8% or 3.75 kg/head/year. Figure 5.51 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.37 shows the nitrogen excretion rate in source category *3.B.2.1.2 - Non-Dairy Cattle* for the years 1990 and 2018 for all countries and EU-KP. Nitrogen excretion rate decreased in six countries and increased in 22 countries. It was in 2018 at the level of 1990 in one country. No data were available for EU-KP. The largest decrease occurred in the Netherlands with an absolute value of 15 kg/head/year. The four countries with the largest increases were Finland, the Czech Republic, Portugal and Latvia with a mean absolute value of 14 kg/head/year.

Figure 5.51: 3.B.2.1.2 - Non-Dairy Cattle: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries

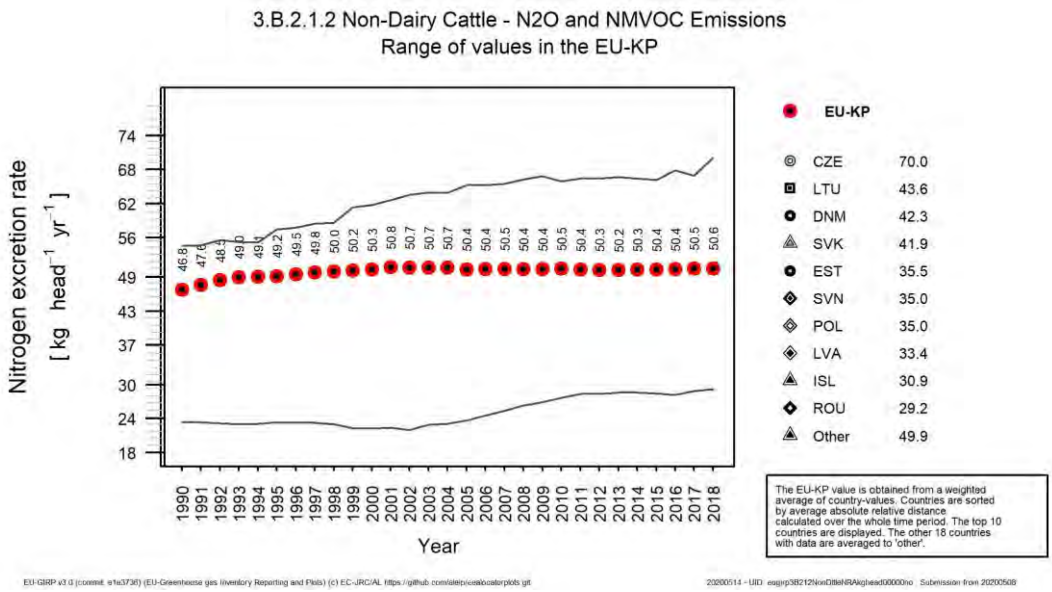


Table 5.37 3.B.2.1.2 - Non-Dairy Cattle: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	40	45	|	Ireland	55	55
Belgium	54	55	|	Iceland	29	31
Bulgaria	54	59	|	Italy	50	52
Cyprus	43	39	|	Lithuania	41	44
Czech Republic	55	70	|	Luxembourg	55	58
Germany	44	50	|	Latvia	23	33
Denmark	36	42	|	Malta	45	42
Spain	57	57	|	Netherlands	57	41
Estonia	32	35	|	Poland	33	35
Finland	34	53	|	Portugal	44	56
France	58	60	|	Romania	29	29
United Kingdom	45	45	|	Slovakia	39	42
Greece	48	55	|	Slovenia	35	35
Croatia	40	39	|	Sweden	39	42

Country	1990	2018		Country	1990	2018
Hungary	44	52	|	**EU-KP**	**47**	**51**

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 EU-KP considerably between 1990 and 2018 by 16.7% or 0.0104 kg/head/year. Figure 5.52 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in 21 countries and increased in seven countries. No data were available for Iceland and EU-KP. The four countries with the largest decreases were Germany, Poland and Bulgaria with a mean absolute value of 0.017 kg/head/year. The three countries with the largest increases were Germany, Poland and Bulgaria with a mean absolute value of 0.017 kg/head/year.

Figure 5.52: **3.B.2.3 - Swine: Trend in implied emission factor in the EU-KP and range of values reported by countries**

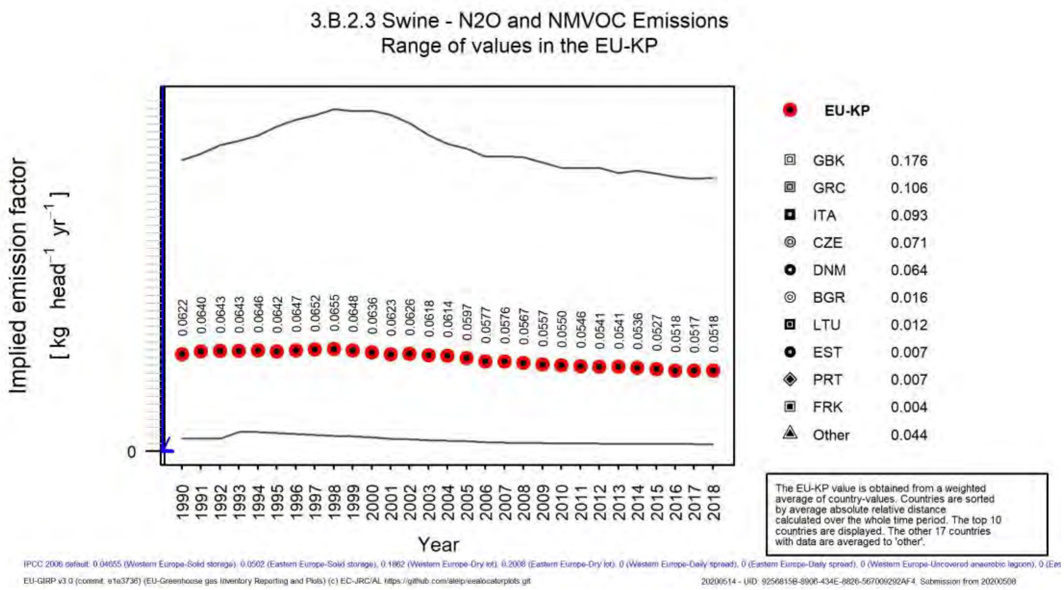


Table 5.38 3.B.2.3 - Swine: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	0.0554	0.0458	|	Ireland	0.0277	0.0263
Belgium	0.0425	0.0309	|	Italy	0.0944	0.0933
Bulgaria	0.0079	0.0161	|	Lithuania	0.1437	0.0122
Cyprus	0.0935	0.0355	|	Luxembourg	0.0393	0.0325
Czech Republic	0.1221	0.0713	|	Latvia	0.0964	0.0505
Germany	0.0477	0.0725	|	Malta	0.0326	0.0332
Denmark	0.1440	0.0645	|	Netherlands	0.0338	0.0251
Spain	0.0437	0.0320	|	Poland	0.0608	0.0778
Estonia	0.0092	0.0070	|	Portugal	0.0145	0.0066
Finland	0.0652	0.0340	|	Romania	0.0402	0.0445
France	0.0124	0.0043	|	Slovakia	0.0847	0.0715

Country	1990	2018		Country	1990	2018
United Kingdom	0.1867	0.1755	|	Slovenia	0.0387	0.0289
Greece	0.1061	0.1061	|	Sweden	0.0626	0.0673
Croatia	0.0503	0.0109	|	**EU-KP**	**0.0622**	**0.0518**
Hungary	0.0609	0.0600	|			

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 EU-KP clearly between 1990 and 2018 by 11.7% or 1.45 kg/head/year. Figure 5.53 shows the trend of the nitrogen excretion rate in EU-KP 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 2018 for all countries and EU-KP. Nitrogen excretion rate decreased in twenty countries and increased in eight countries. It was in 2018 at the level of 1990 in one country. No data were available for EU-KP. The largest decreases occurred in Denmark and Belgium with a mean absolute value of 4 kg/head/year. The three countries with the largest increases were Sweden, Germany and Poland 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 EU-KP and range of values reported by countries

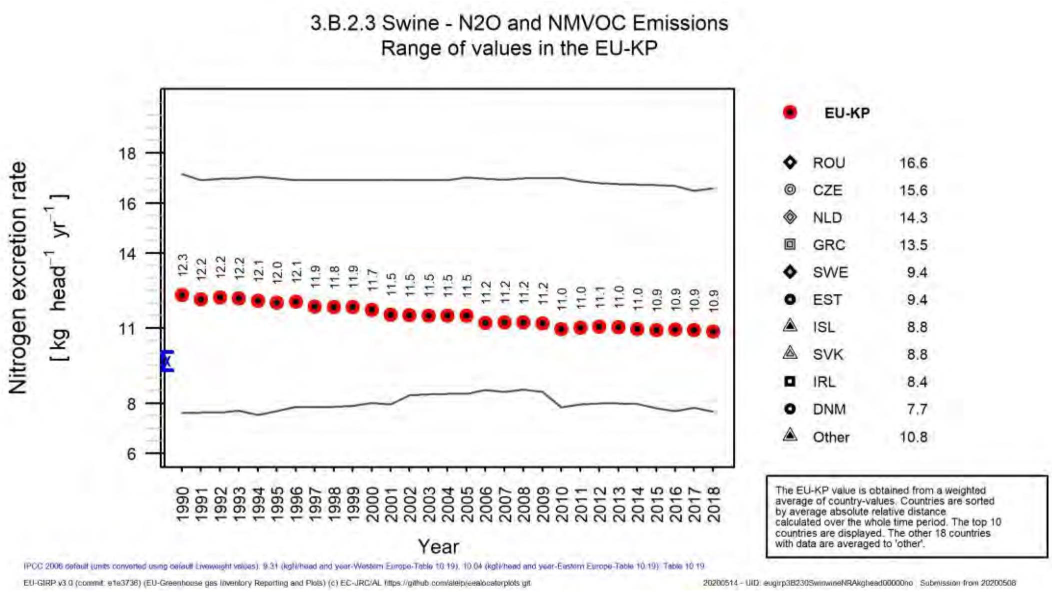


Table 5.39 3.B.2.3 - Swine: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	9.8	9.3	|	Ireland	8.8	8.4
Belgium	12.5	9.2	|	Iceland	9.2	8.8
Bulgaria	12.5	11.7	|	Italy	12.0	12.2
Cyprus	11.9	11.3	|	Lithuania	12.4	11.9
Czech Republic	15.4	15.6	|	Luxembourg	10.6	10.1

Country	1990	2018		Country	1990	2018
Germany	12.1	13.3	|	Latvia	12.3	10.5
Denmark	11.9	7.7	|	Malta	10.4	10.6
Spain	11.9	9.3	|	Netherlands	17.2	14.3
Estonia	8.9	9.4	|	Poland	10.0	10.8
Finland	12.2	12.2	|	Portugal	10.3	9.2
France	10.6	9.4	|	Romania	16.9	16.6
United Kingdom	13.3	10.3	|	Slovakia	10.4	8.8
Greece	13.5	13.5	|	Slovenia	12.7	12.2
Croatia	12.4	12.3	|	Sweden	7.6	9.4
Hungary	9.5	9.4	|	**EU-KP**	**12.3**	**10.9**

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* could not be evaluated at EU-KP level. 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 2018 for all countries and EU-KP. The implied emission factor decreased in 21 countries and increased in seven countries. It was in 2018 at the level of 1990 in one country. No data were available for EU-KP. The four countries with the largest decreases were Lithuania, Germany and Romania with a mean absolute value of 0.00024 kg/head/year. The largest increase occurred in Lithuania with an absolute value of 0.00029 kg/head/year.

Figure 5.54: 3.B.2.4.7 - Poultry: Trend in implied emission factor in the EU-KP and range of values reported by countries

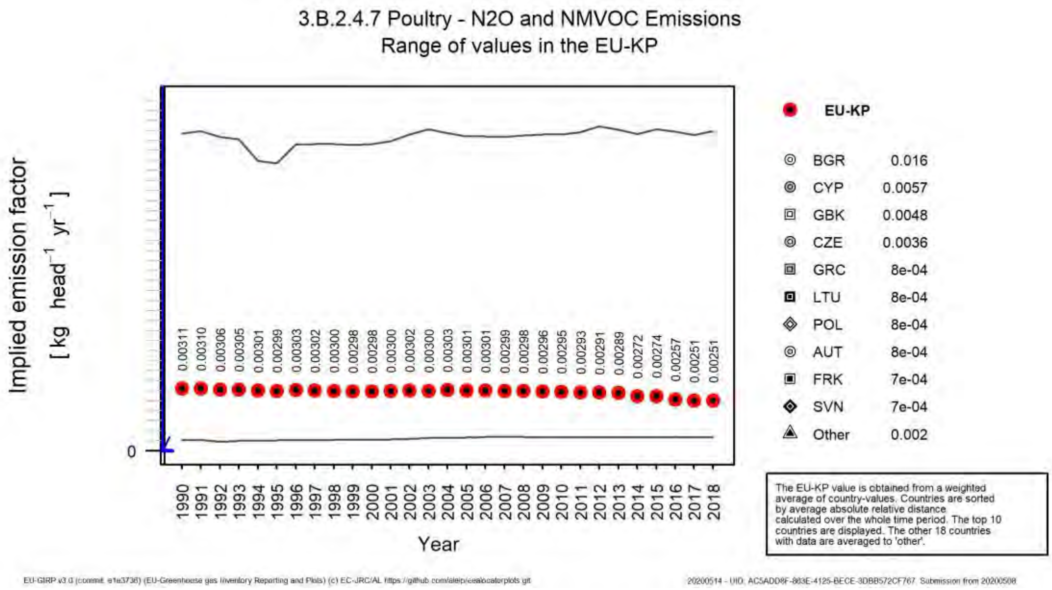


Table 5.40 3.B.2.4.7 - Poultry: countries' implied emission factor (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	0.00090	0.00078	|	Ireland	0.00109	0.00106
Belgium	0.00094	0.00090	|	Iceland	0.00179	0.00089
Bulgaria	0.01585	0.01597	|	Italy	0.00409	0.00333

Country	1990	2018		Country	1990	2018
Cyprus	0.00715	0.00571	|	Lithuania	0.00053	0.00082
Czech Republic	0.01047	0.00360	|	Luxembourg	0.00113	0.00113
Germany	0.00109	0.00133	|	Latvia	0.00342	0.00171
Denmark	0.00112	0.00077	|	Malta	0.00131	0.00132
Spain	0.00112	0.00099	|	Netherlands	0.00110	0.00092
Estonia	0.00383	0.00339	|	Poland	0.00085	0.00080
Finland	0.00288	0.00168	|	Portugal	0.00435	0.00405
France	0.00074	0.00069	|	Romania	0.00119	0.00136
United Kingdom	0.00654	0.00482	|	Slovakia	0.00181	0.00163
Greece	0.00085	0.00085	|	Slovenia	0.00062	0.00068
Croatia	0.00448	0.00380	|	Sweden	0.00473	0.00442
Hungary	0.00232	0.00199	|			

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*, could not be evaluated at EU-KP level. Table 5.41 shows the nitrogen excretion rate in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2018 for all countries and EU-KP. Nitrogen excretion rate decreased in nineteen countries and increased in seven countries. It was in 2018 at the level of 1990 in three countries. No data were available for EU-KP. The three countries with the largest decreases were Iceland, the Czech Republic and the United Kingdom with a mean absolute value of 0.3 kg/head/year. The largest increase occurred in Lithuania 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 EU-KP and range of values reported by countries**

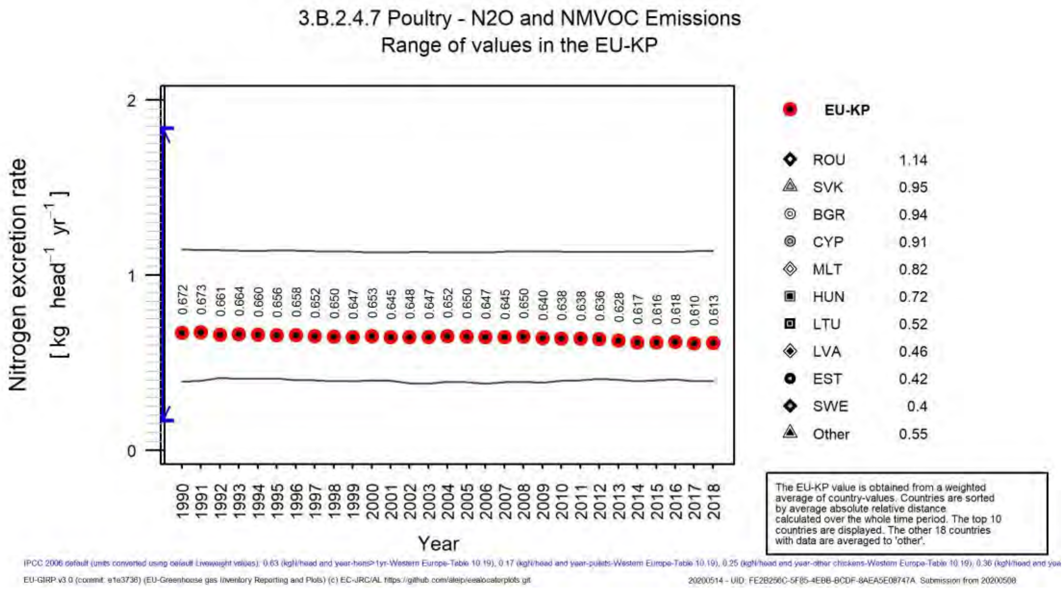


Table 5.41 3.B.2.4.7 - Poultry: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2018		Country	1990	2018
Austria	0.59	0.55	|	Ireland	0.60	0.56
Belgium	0.60	0.57	|	Iceland	1.21	0.63

Country	1990	2018		Country	1990	2018
Bulgaria	0.94	0.94	|	Italy	0.52	0.49
Cyprus	0.91	0.91	|	Lithuania	0.39	0.52
Czech Republic	0.73	0.49	|	Luxembourg	0.72	0.72
Germany	0.69	0.74	|	Latvia	0.45	0.46
Denmark	0.63	0.49	|	Malta	0.82	0.82
Spain	0.71	0.63	|	Netherlands	0.68	0.57
Estonia	0.44	0.42	|	Poland	0.54	0.51
Finland	0.50	0.55	|	Portugal	0.55	0.53
France	0.49	0.48	|	Romania	1.15	1.14
United Kingdom	0.78	0.57	|	Slovakia	0.99	0.95
Greece	0.50	0.50	|	Slovenia	0.47	0.51
Croatia	0.67	0.51	|	Sweden	0.43	0.40
Hungary	0.83	0.72	|			

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 EU-KP barely between 1990 and 2018 by 0.24% or 3.82e-05 kg N_2O/kg N. Figure 5.56 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in four countries and increased in seven countries. It was in 2018 at the level of 1990 in eighteen countries. No data were available for EU-KP. The three countries with the largest decreases were Malta, Latvia and Spain with a mean absolute value of 1.9e-11 kg N_2O/kg N. The three countries with the largest increases were the Netherlands, Croatia and the Czech Republic with a mean absolute value of 0.00026 kg N_2O/kg N.

Table 5.42 3.B.2.5 - Indirect N_2O emissions from manure management: countries' implied emission factor (kg N_2O/kg N)

Country	1990	2018		Country	1990	2018
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	0.016	0.016
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	|	**EU-KP**	**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* decreased in EU-KP barely between 1990 and 2018 by 0.11% or 1.28e-05 kg N_2O/kg N. Figure 5.56 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in four countries. It was in 2018 at the level of 1990 in six countries. No data were available for fourteen countries (Austria, Bulgaria, Germany, Denmark, Croatia, Ireland, Iceland, Luxembourg, Malta, the Netherlands, Slovakia, Slovenia, Sweden and EU-KP). The three countries with the largest decreases were Romania, Poland and the United Kingdom with a mean absolute value of 1e-04 kg N_2O/kg N. The three countries with the largest increases were the Czech Republic, Spain and France with a mean absolute value of 9.1e-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 EU-KP and range of values reported by countries

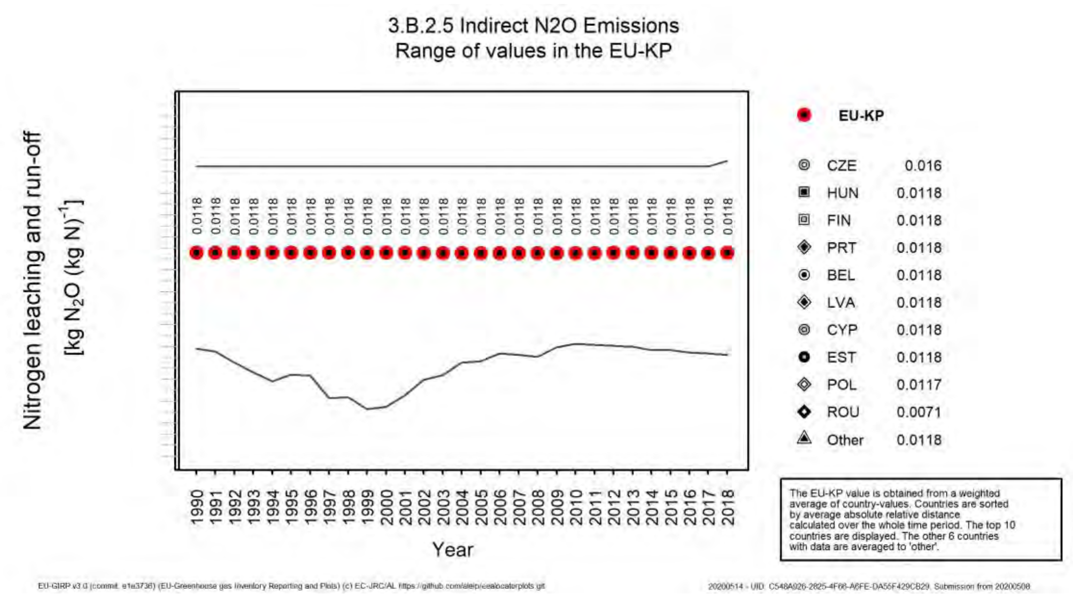


Table 5.43 3.B.2.5 - Indirect N_2O emissions from leaching from manure management: countries' implied emission factor (kg N_2O/kg N)

Country	1990	2018		Country	1990	2018
Belgium	0.0118	0.0118	|	Hungary	0.0118	0.0118
Cyprus	0.0118	0.0118	|	Italy	0.0118	0.0118
Czech Republic	0.0157	0.0160	|	Lithuania	0.0118	0.0118
Spain	0.0118	0.0118	|	Latvia	0.0118	0.0118
Estonia	0.0118	0.0118	|	Poland	0.0117	0.0117
Finland	0.0118	0.0118	|	Portugal	0.0118	0.0118
France	0.0118	0.0118	|	Romania	0.0074	0.0071
United Kingdom	0.0118	0.0118	|	**EU-KP**	**0.0118**	**0.0118**
Greece	0.0118	0.0118	|			

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 2.8% of total EU-KP GHG emissions and 52% of total EU-KP N_2O emissions. They make 30.6% of total agricultural emissions and 72% of total agricultural N_2O emissions. The main sub-categories are 3.D.1.1 (Inorganic N Fertilizers), 3.D.1.2 (Organic N Fertilizers) and 3.D.1.3 (Urine and Dung Deposited by Grazing Animals) as shown in Figure 5.58. Regarding the origin of emissions in the different countries, Figure 5.59 shows the distribution of direct N_2O emissions from managed soils by emission source in all countries and in the EU-KP. 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 EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2018. Categories 3.D.1.1-3.D.1.5: direct N_2O emissions by N source (inorganic fertilizers, organic fertilizers, urine and dung deposited by grazing animals, crop residues and mineralization of soil organic matter); category 3.D.1.6: cultivation of histosols.

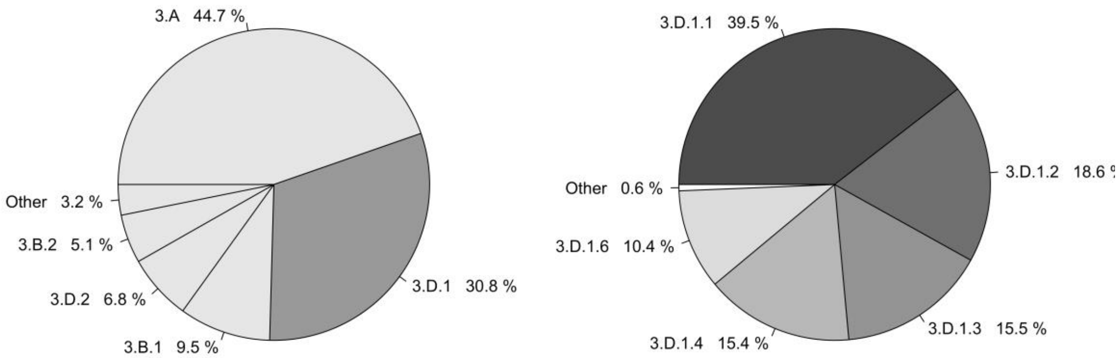
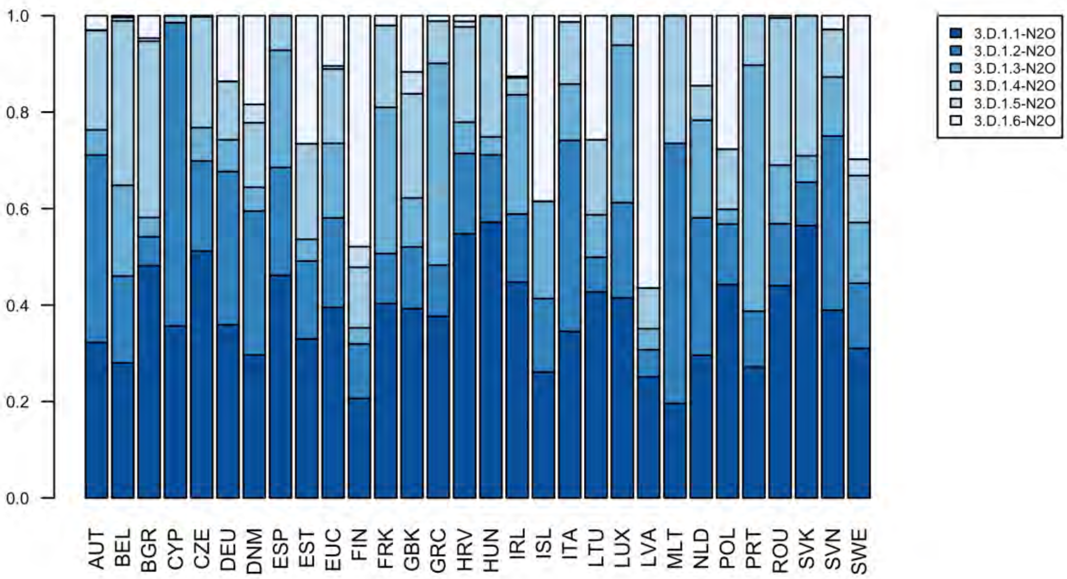


Figure 5.59: Decomposition of emissions in source category 3.D.1 - Direct N_2O Emissions From Managed Soils into its sub-categories by country in the year 2018. 3.D.1.1 inorganic N fertilisers, 3.D.1.2 organic N fertilisers, 3.D.1.3 urine and dung deposited by grazing animals, 3.D.1.4 crop residues incorporated 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 country from 3.D.1 *Direct N_2O Emissions From Managed Soils* are shown in Table 5.44 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 16% or 24.8 Mt CO_2-eq. The decrease was largest in Estonia in relative terms (40%) and in Germany in absolute terms (3.2 Mt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 2.3%.

Table 5.44 3.D.1 - Direct N_2O Emissions From Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions

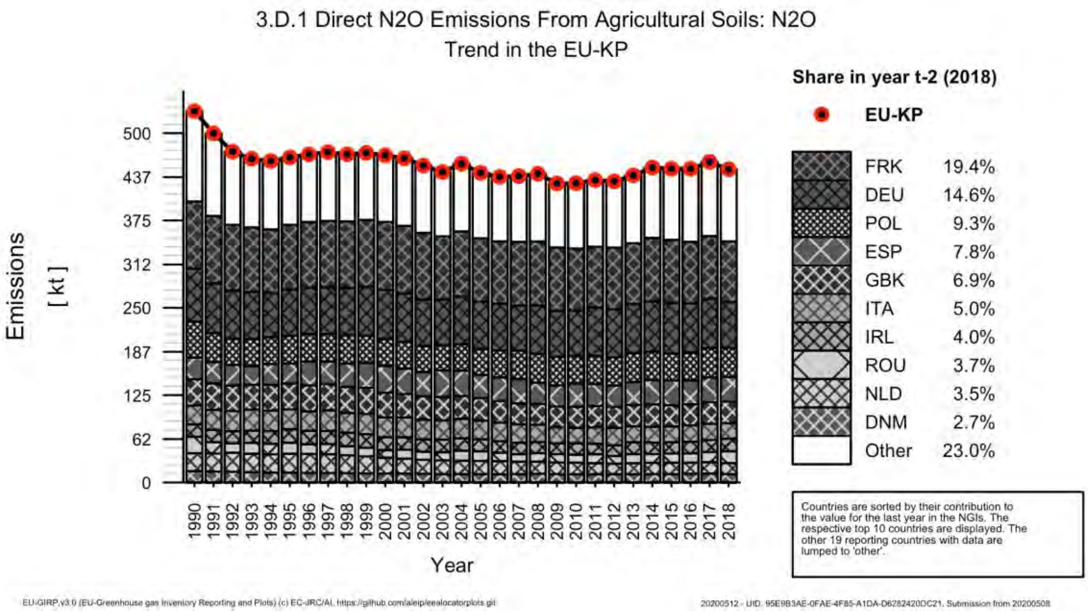
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 884	1 712	1 676	1.3%	-208	-11%	-36	-2%	T1	D
Belgium	3 356	2 718	2 589	1.9%	-767	-23%	-129	-5%	T1	D
Bulgaria	4 252	3 397	3 299	2.5%	-953	-22%	-98	-3%	T1	D
Croatia	1 094	838	850	0.6%	-244	-22%	12	1%	T1	D
Cyprus	118	103	103	0.1%	-15	-13%	-1	-1%	T1	CS,D
Czechia	4 282	3 487	3 219	2.4%	-1 063	-25%	-268	-8%	T1,T2	CS,D
Denmark	4 759	3 737	3 543	2.7%	-1 216	-26%	-194	-5%	CS,D,T1,T2	D
Estonia	923	560	552	0.4%	-371	-40%	-9	-2%	T1	D
Finland	3 299	3 187	3 136	2.3%	-162	-5%	-51	-2%	T1,T2	CS,D
France	28 532	26 755	25 898	19.4%	-2 634	-9%	-857	-3%	T1,T2	D
Germany	22 713	20 944	19 525	14.6%	-3 188	-14%	-1 419	-7%	T1,T2	CS,D
Greece	3 577	2 291	2 230	1.7%	-1 347	-38%	-61	-3%	T1	D
Hungary	3 473	3 471	3 477	2.6%	4	0%	5	0%	T1,T2	D
Ireland	5 313	5 139	5 323	4.0%	10	0%	184	4%	T1	D
Italy	8 083	6 877	6 710	5.0%	-1 374	-17%	-167	-2%	CS,T1	CS,D
Latvia	2 210	1 438	1 390	1.0%	-820	-37%	-48	-3%	T1	D
Lithuania	2 652	1 983	1 931	1.4%	-721	-27%	-52	-3%	T1	D
Luxembourg	177	151	147	0.1%	-30	-17%	-3	-2%	T1	CS,D
Malta	16	14	14	0.0%	-2	-13%	0	1%	T1	D
Netherlands	7 650	4 861	4 718	3.5%	-2 932	-38%	-143	-3%	T1,T1b,T2	CS,D
Poland	15 318	12 544	12 473	9.3%	-2 844	-19%	-71	-1%	T1	CS,D
Portugal	1 807	1 742	1 735	1.3%	-72	-4%	-7	0%	T1	D
Romania	7 003	4 362	4 988	3.7%	-2 015	-29%	626	14%	T1	D
Slovakia	1 711	1 008	1 070	0.8%	-641	-37%	62	6%	T1	CS,D
Slovenia	326	325	328	0.2%	2	1%	3	1%	T1,T2	D
Spain	9 228	10 613	10 481	7.8%	1 254	14%	-132	-1%	CS,T1	D
Sweden	3 203	3 007	2 779	2.1%	-424	-13%	-227	-8%	T1,T2	CS,D
United Kingdom	11 186	9 240	9 176	6.9%	-2 010	-18%	-63	-1%	T1,T1a,T2	CS,D
EU-27+UK	**158 145**	**136 503**	**133 361**	**100%**	**-24 784**	**-16%**	**-3 142**	**-2%**	**-**	**-**
Iceland	224	222	211	0.2%	-14	-6%	-11	-5%	T1,T1b,T2	CS,D
United Kingdom (KP)	11 186	9 240	9 176	6.9%	-2 010	-18%	-63	-1%	T1,T1a,T2	CS,D
EU-KP	**158 370**	**136 725**	**133 572**	**100%**	**-24 798**	**-16%**	**-3 153**	**-2%**	**-**	**-**

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 EU-KP by 16% or 24.8 Mt CO_2-eq in the period 1990 to 2018. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from direct N_2O emissions from managed soils for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 77% of the total. Emissions decreased in 25 countries and increased in four countries. The four countries with the largest decreases were Germany, the Netherlands, Poland and France with a total absolute decrease of 11.6 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 1.3 Mt CO_2-eq.

Figure 5.60: 3.D.1 Direct N_2O Emissions From Managed Soils: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



The main driving force of direct N_2O emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 22% and 12% below 1990 levels in 2018, 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[37]. 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 EU-KP by 23% or 15.6 Mt CO_2-eq in the period 1990 to 2018. Figure 5.61 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from inorganic N fertilisers for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 79.5% of the total. Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Germany, the United Kingdom and France with a total absolute decrease of 7.4 Mt CO_2-eq. The largest increases occurred in Ireland and Hungary, with a total absolute increase of 533 kt CO_2-eq.

[37] http://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Application of inorganic fertilizers

Application of inorganic fertilizers decreased considerably in EU-KP by 22% or 3.3 kt N/year in the period 1990 to 2018. Figure 5.62 shows the trend of application of inorganic fertilizers indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O application of inorganic fertilizers from inorganic N fertilisers for the different countries along the inventory period. The ten countries with the highest application of inorganic fertilizers accounted together for 80.3% of the total. Application of inorganic fertilizers decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Germany, the United Kingdom and France with a total absolute decrease of 1.6 kt N/year. The largest increases occurred in Ireland and Hungary, with a total absolute increase of 95 kt N/year.

Figure 5.61: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

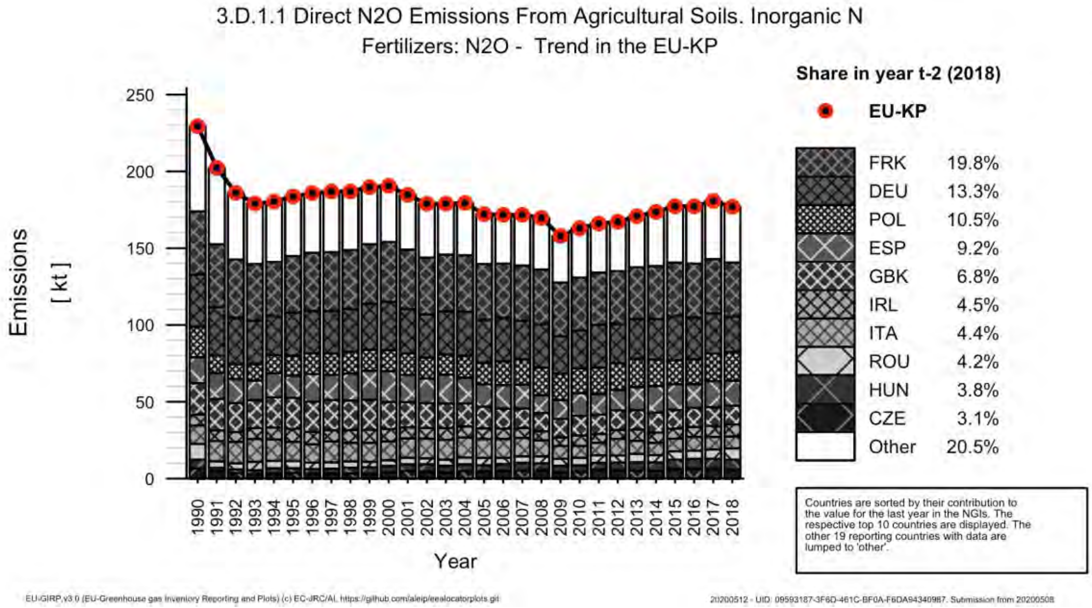
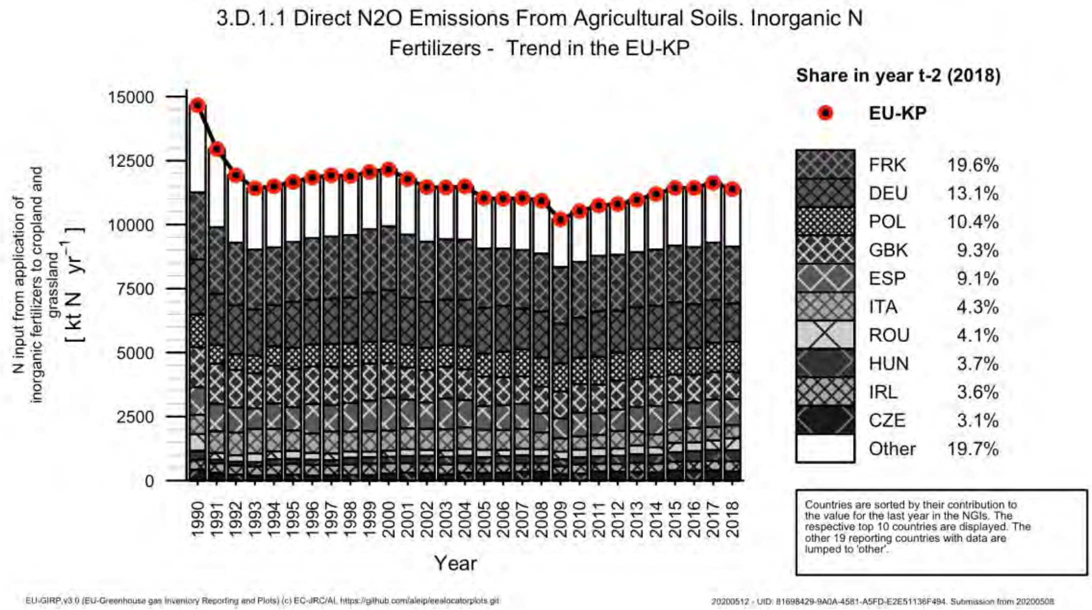


Figure 5.62: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in application of inorganic fertilizers in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 EU-KP by 9.3% or 2.5 Mt CO_2-eq in the period 1990 to 2018. Figure 5.63 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from organic N fertilisers for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.4% of the total. Emissions decreased in nineteen countries and increased in ten countries. The three countries with the largest decreases were Romania, Poland and Bulgaria with a total absolute decrease of 2.1 Mt CO_2-eq. The three countries with the largest increases were Spain, Germany and the Netherlands, with a total absolute increase of 1.5 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 fertilizers decreased clearly in EU-KP by 12% or 775 kt N/year in the period 1990 to 2018. Figure 5.64 shows the trend of N from applied organic N fertilizers indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O N from applied organic N fertilizers from organic N fertilisers for the different countries along the inventory period. The ten countries with the highest N from applied organic N fertilizers accounted together for 83.3% of the total. N from applied organic N fertilizers decreased in 21 countries and increased in eight countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 352 kt N/year. The largest increases occurred in Spain and Germany, with a total absolute increase of 199 kt N/year.

Figure 5.63: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

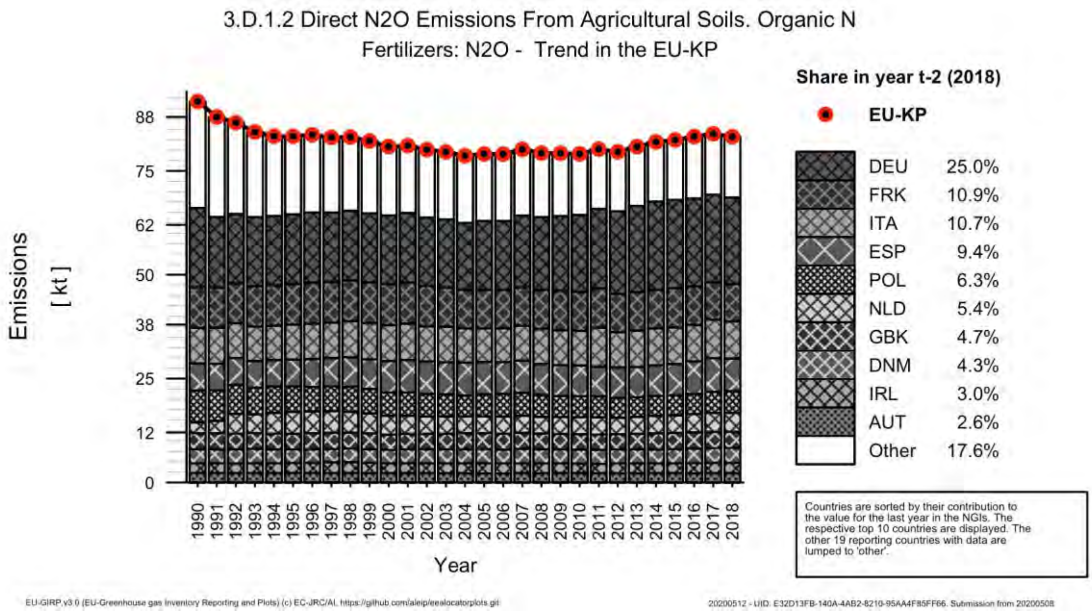
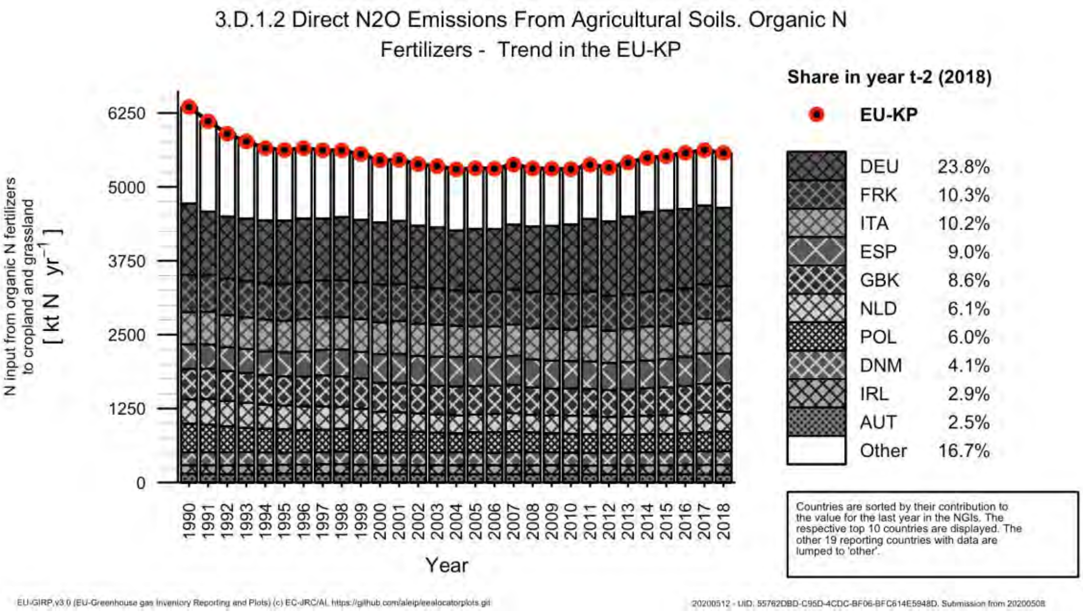


Figure 5.64: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Emissions

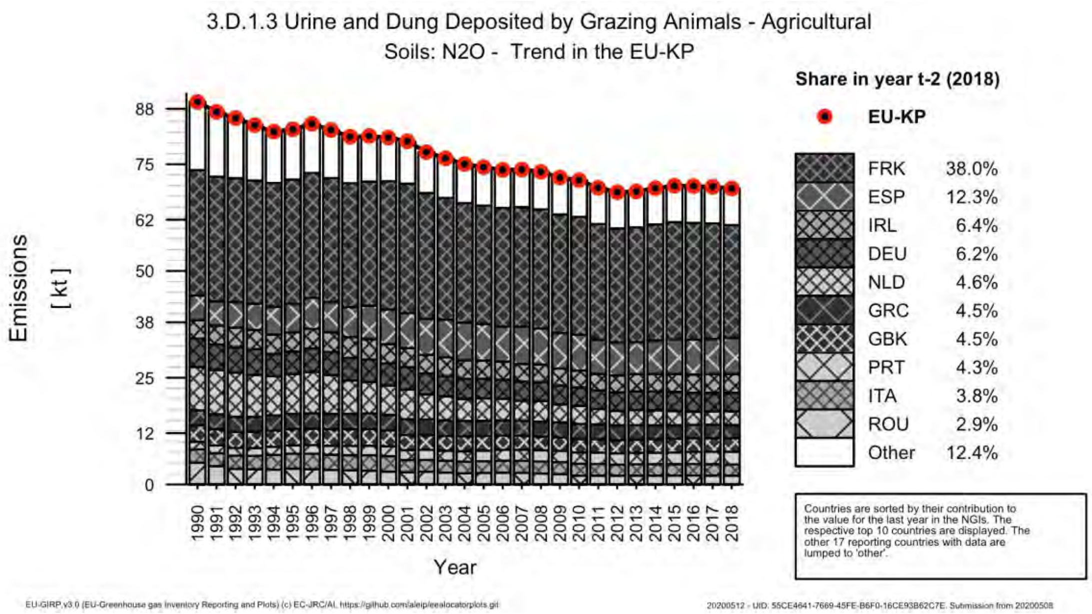
N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* are 0.44% of total EU-KP GHG emissions and 8% of total EU-KP N_2O emissions. They make 4.7% of total agricultural emissions and 11% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by country from 3.D.1.3 *Grazing Animals* are shown in Table 5.45 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 23% or 6 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (79%) and in the Netherlands in absolute terms (2.1 Mt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 0.5%. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from grazing animals for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 87.6% of the total. Emissions decreased in 23 countries and increased in four countries. The three countries with the largest decreases were the Netherlands, Romania and France with a total absolute decrease of 3.9 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 1.2 Mt CO_2-eq.

Table 5.45 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	147	88	87	0.4%	-60	-41%	-1	-1%	T1	D
Belgium	693	486	487	2.4%	-207	-30%	0	0%	T1	D
Bulgaria	616	132	132	0.6%	-484	-79%	0	0%	T1	D
Croatia	137	55	55	0.3%	-82	-60%	-1	-1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	236	211	223	1.1%	-14	-6%	11	5%	T1	D
Denmark	298	176	175	0.8%	-123	-41%	0	0%	T1	D
Estonia	89	25	25	0.1%	-64	-72%	0	0%	T1	D
Finland	150	107	105	0.5%	-45	-30%	-2	-2%	T1	D
France	8 760	8 073	7 851	38.0%	-909	-10%	-222	-3%	T1,T2	D
Germany	1 965	1 304	1 285	6.2%	-680	-35%	-19	-1%	T1	D
Greece	1 059	937	933	4.5%	-126	-12%	-4	0%	T1	D
Hungary	193	130	131	0.6%	-63	-32%	0	0%	T1	D
Ireland	1 310	1 315	1 317	6.4%	7	1%	2	0%	T1	D
Italy	920	790	785	3.8%	-135	-15%	-5	-1%	T1	CS,D
Latvia	150	60	61	0.3%	-89	-60%	1	2%	T1	D
Lithuania	420	173	170	0.8%	-250	-59%	-2	-1%	T1	D
Luxembourg	48	49	48	0.2%	0	-1%	-1	-1%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 028	939	955	4.6%	-2 073	-68%	16	2%	T1	D
Poland	1 048	369	376	1.8%	-672	-64%	6	2%	T1	CS,D
Portugal	538	868	885	4.3%	346	64%	17	2%	T1	D
Romania	1 522	611	606	2.9%	-916	-60%	-5	-1%	T1	D
Slovakia	109	54	59	0.3%	-50	-46%	5	9%	T1	CS
Slovenia	18	40	40	0.2%	22	117%	0	-1%	T1	D
Spain	1 711	2 439	2 547	12.3%	836	49%	109	4%	CS,T1	D
Sweden	356	351	351	1.7%	-5	-1%	0	0%	T1	D
United Kingdom	1 131	948	932	4.5%	-199	-18%	-16	-2%	T2	CS
EU-27+UK	**26 654**	**20 731**	**20 620**	**100%**	**-6 034**	**-23%**	**-111**	**-1%**	**-**	**-**
Iceland	48	46	42	0.2%	-5	-11%	-3	-7%	T1	D
United Kingdom (KP)	1 131	948	932	4.5%	-199	-18%	-16	-2%	T2	CS
EU-KP	**26 702**	**20 777**	**20 663**	**100%**	**-6 039**	**-23%**	**-114**	**-1%**	**-**	**-**

Figure 5.65: 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 EU-KP barely between 1990 and 2018 by 0.67% or 6.68e-05 kg N_2O-N/kg N. Figure 5.66 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in two countries and increased in three countries. It was in 2018 at the level of 1990 in 24 countries. No data were available for EU-KP. Decreases occurred in the United Kingdom and France and France with a mean absolute value of 0.00053 kg N_2O-N/kg N. Increases occurred in Ireland, Iceland and Spain with a mean absolute value of 9.8e-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 EU-KP and range of values reported by countries

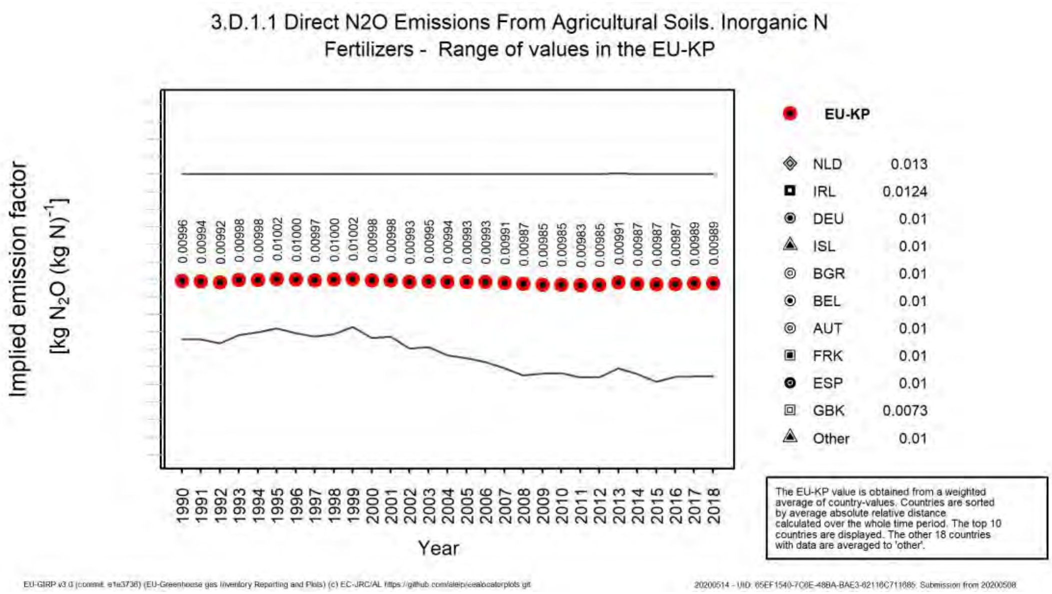


Table 5.46 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2018		Country	1990	2018
Austria	0.0100	0.0100	|	Ireland	0.0122	0.0124
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	0.0073	|	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	|	**EU-KP**	**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 EU-KP slightly between 1990 and 2018 by 3.3% or 0.000308 kg N_2O-N/kg N. Figure 5.67 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The reported implied emission factor in 2018 was at the level of 1990 in 21 countries and increased in all reporting other eight countries. 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 EU-KP and range of values reported by countries

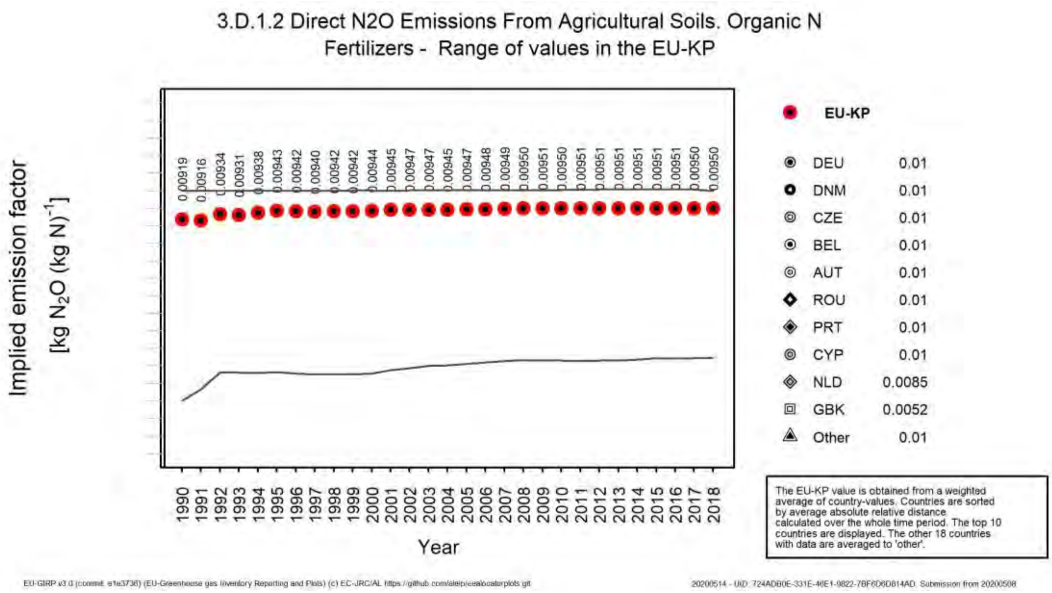


Table 5.47 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2018		Country	1990	2018
Austria	0.0100	0.0100	|	Ireland	0.0100	0.0100
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	0.0040	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	|	**EU-KP**	**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 changed since 1990 from 0.0152 to 0.0153 kg N_2O-N/kg N at EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in thirteen countries and increased in twelve countries. It was in 2018 at the level of 1990 in two countries. No data were available for three countries (Cyprus, Malta and EU-KP). The three countries with the largest decreases were Croatia, Romania and Austria with a mean absolute value of 0.0024 kg N_2O-N/kg N. The three countries with the largest increases were Spain, Portugal and Poland with a mean absolute value of 0.0018 kg N_2O-N/kg N.

Table 5.48 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2018		Country	1990	2018
Austria	0.0186	0.0168	|	Ireland	0.0088	0.0086
Belgium	0.0197	0.0195	|	Iceland	0.0109	0.0113
Bulgaria	0.0120	0.0125	|	Italy	0.0111	0.0112
Czech Republic	0.0174	0.0187	|	Lithuania	0.0190	0.0192
Germany	0.0191	0.0191	|	Luxembourg	0.0198	0.0197
Denmark	0.0187	0.0178	|	Latvia	0.0196	0.0188
Spain	0.0150	0.0172	|	Netherlands	0.0330	0.0330
Estonia	0.0182	0.0166	|	Poland	0.0178	0.0192
Finland	0.0179	0.0169	|	Portugal	0.0163	0.0182
France	0.0189	0.0191	|	Romania	0.0174	0.0149
United Kingdom	0.0045	0.0047	|	Slovakia	0.0158	0.0154
Greece	0.0104	0.0105	|	Slovenia	0.0184	0.0174
Croatia	0.0136	0.0109	|	Sweden	0.0176	0.0172
Hungary	0.0138	0.0149	|	**EU-KP**	**0.0152**	**0.0153**

5.3.5 Indirect Emissions from Managed Soils - N_2O (CRF Source Category 3D2)

N_2O emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* are 0.63% of total EU-KP GHG emissions and 12% of total EU-KP 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 countries, Figure 5.69 shows the distribution of indirect N_2O emissions from managed soils by emission source in all countries and in the EU-KP. 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 EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2018.

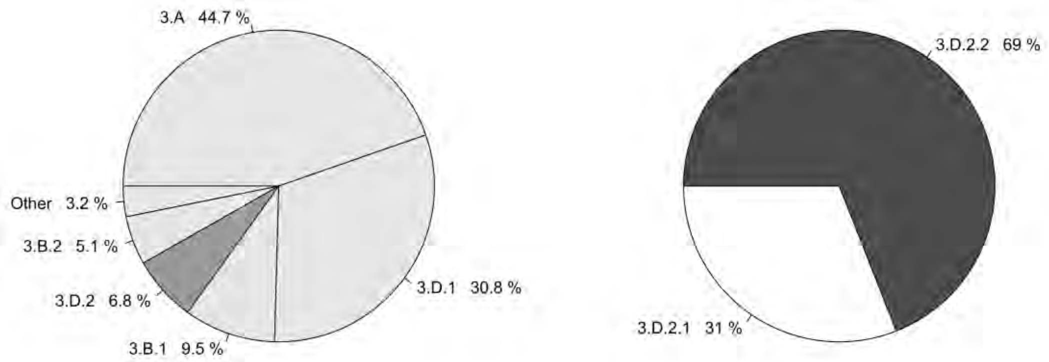
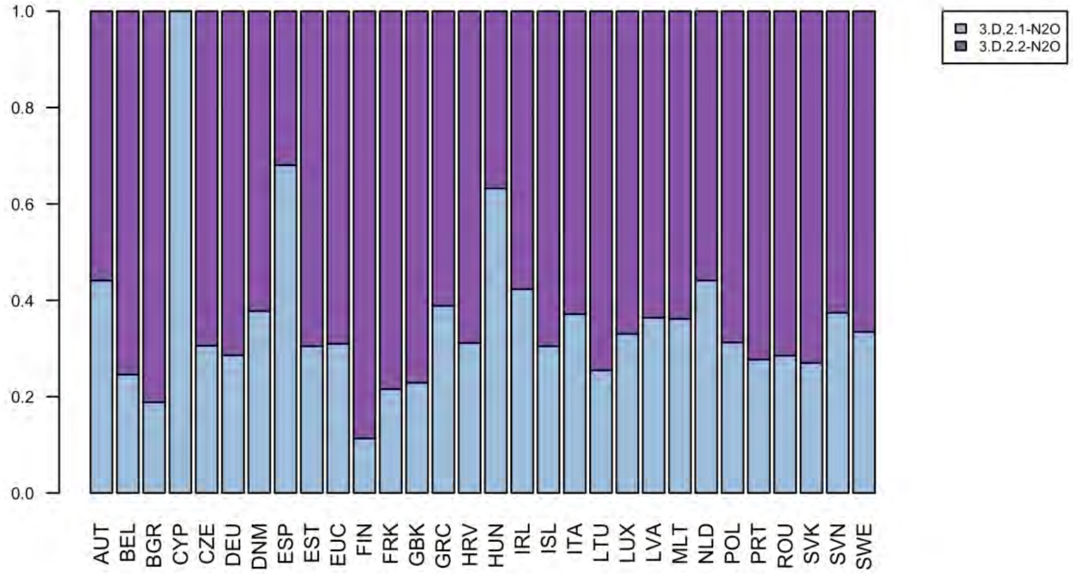


Figure 5.69: Decomposition of emissions in source category 3.D.2 - Indirect Emissions from Managed Soils into its sub-categories by country in the year 2018. 3.D.2.1 Atmospheric Deposition and 3.D.2.2 Nitrogen Leaching and Run-off.



Total GHG and N_2O emissions by country from 3.D.2 *Indirect Emissions from Managed Soils* are shown in Table 5.49 by country plus Iceland, and the total EU-27+UK and EU-KP for the first and the last year of the inventory (1990 and 2018). Values are given in kt CO_2-eq. Between 1990 and 2018, N_2O emission in this source category decreased by 20% or 7.5 Mt CO_2-eq. The decrease was largest in the Netherlands in relative terms (61%) and also in absolute terms (995 kt CO_2-eq). From 2017 to 2018 emissions in the current category decreased by 2.4%.

Table 5.49 3.D.2 - Indirect Emissions from Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions

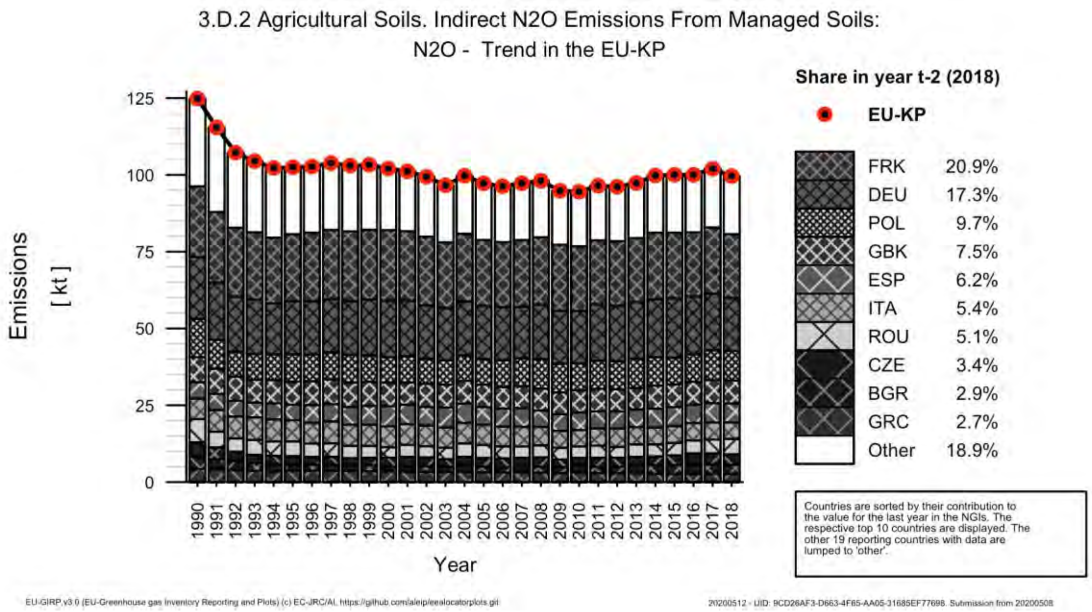
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	353	331	323	1.1%	-29	-8%	-7	-2%	T1	D
Belgium	1 088	721	693	2.3%	-395	-36%	-28	-4%	T1	D
Bulgaria	1 252	890	865	2.9%	-388	-31%	-25	-3%	T1	D
Croatia	358	269	273	0.9%	-84	-24%	4	2%	T1	D
Cyprus	17	17	16	0.1%	0	-3%	0	-1%	T1	D
Czechia	1 345	1 087	1 010	3.4%	-335	-25%	-77	-7%	T1	D
Denmark	909	553	530	1.8%	-379	-42%	-23	-4%	T2	D
Estonia	237	128	128	0.4%	-109	-46%	-1	0%	D,T1	D
Finland	480	415	404	1.4%	-76	-16%	-11	-3%	T1	D
France	6 819	6 388	6 206	20.9%	-613	-9%	-182	-3%	T1,T2	CS,D
Germany	6 042	5 531	5 121	17.3%	-921	-15%	-410	-7%	T1	D
Greece	1 245	816	796	2.7%	-449	-36%	-20	-2%	T1	D
Hungary	356	274	274	0.9%	-82	-23%	-1	0%	T1	D
Ireland	558	556	571	1.9%	13	2%	15	3%	T1	CS,D
Italy	2 002	1 665	1 612	5.4%	-390	-19%	-53	-3%	T1	CS,D
Latvia	312	168	156	0.5%	-155	-50%	-12	-7%	T1	D
Lithuania	607	422	408	1.4%	-199	-33%	-14	-3%	T1	D
Luxembourg	52	43	42	0.1%	-10	-19%	-1	-2%	T1,T2	D
Malta	6	5	5	0.0%	-1	-15%	0	1%	T1	D
Netherlands	1 623	641	628	2.1%	-995	-61%	-13	-2%	T1	D
Poland	3 712	2 885	2 894	9.7%	-818	-22%	9	0%	T1	D
Portugal	495	425	417	1.4%	-79	-16%	-8	-2%	T1,T2	CS,D
Romania	2 251	1 327	1 505	5.1%	-746	-33%	177	13%	T1	D
Slovakia	543	306	323	1.1%	-220	-40%	17	6%	T1	D
Slovenia	113	109	110	0.4%	-3	-3%	1	1%	T1	D
Spain	1 594	1 869	1 835	6.2%	242	15%	-33	-2%	CS,T1,T2	D
Sweden	369	280	279	0.9%	-90	-24%	-1	0%	CS	D
United Kingdom	2 424	2 239	2 218	7.5%	-206	-9%	-21	-1%	T1	D
EU-27+UK	**37 161**	**30 359**	**29 642**	**100%**	**-7 519**	**-20%**	**-717**	**-2%**	**-**	**-**
Iceland	45	44	40	0.1%	-5	-10%	-3	-7%	T1b	D
United Kingdom (KP)	2 424	2 239	2 218	7.5%	-206	-9%	-21	-1%	T1	D
EU-KP	**37 206**	**30 403**	**29 682**	**100%**	**-7 524**	**-20%**	**-720**	**-2%**	**-**	**-**

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 EU-KP by 20% or 7.5 Mt CO_2-eq in the period 1990 to 2018. Figure 5.70 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from indirect emissions from managed soils for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81.1% of the total. Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were the Netherlands, Germany and Poland with a total absolute decrease of 2.7 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 242 kt CO_2-eq.

Figure 5.70: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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 EU-KP by 26% or 3.1 Mt CO_2-eq in the period 1990 to 2018. Figure 5.71 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from atmospheric deposition for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 80.4% of the total. Emissions decreased in 27 countries and increased in two countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 1.1 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 127 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 EU-KP by 26% or 667 kt N/year in the period 1990 to 2018. Figure 5.72 shows the trend of volatilized N from agricultural N inputs indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O volatilized N from agricultural N inputs from atmospheric deposition for the different countries along the inventory period. The ten countries with the highest volatilized N from agricultural N inputs accounted together for 80.6% of the total. Volatilized N from agricultural N inputs decreased in 27 countries and increased in two countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 228 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 27 kt N/year.

Figure 5.71: **3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018**

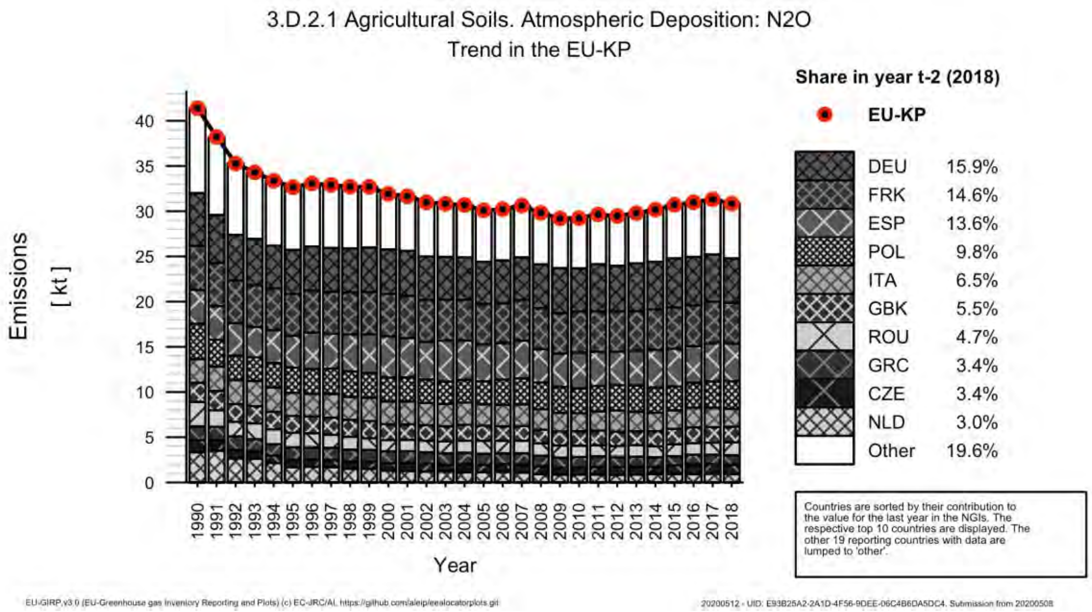
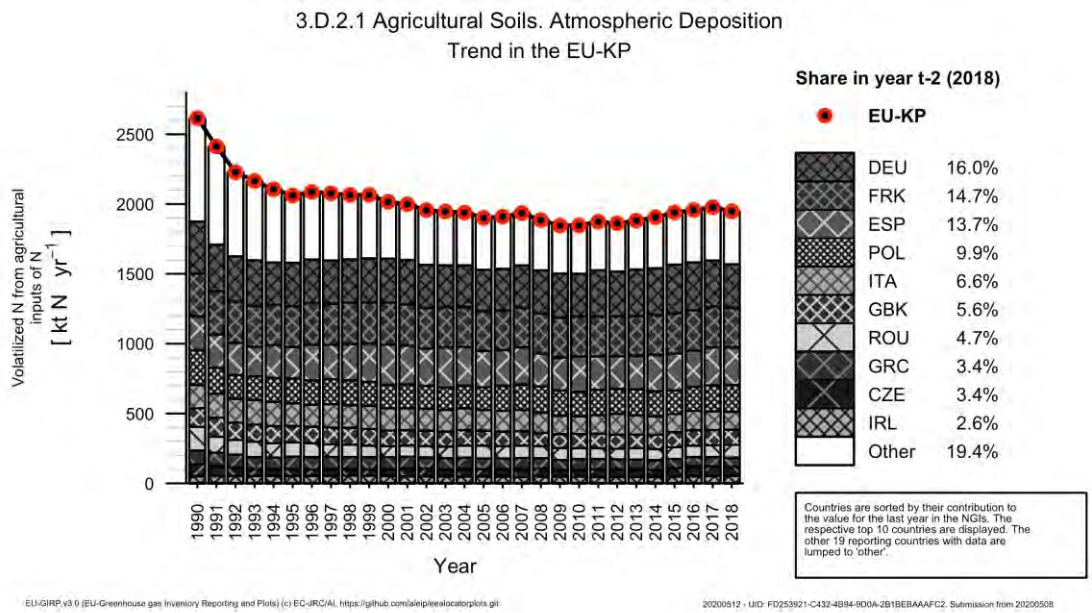


Figure 5.72: **3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018**



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 EU-KP by 18% or 4.4 Mt CO_2-eq in the period 1990 to 2018. Figure 5.73 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.1% of the total. Emissions decreased in 26 countries and increased in two countries. The three countries with the largest decreases were Germany, Poland and France with a total absolute decrease of 1.7 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 115 kt CO_2-eq.

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - N from fertilizers and other agricultural inputs that is lost through leaching and run-off

N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased considerably in EU-KP by 19% or 1.5 kt N/year in the period 1990 to 2018. Figure 5.74 shows the trend of N from fertilizers and other agricultural inputs that is lost through leaching and run-off indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O N from fertilizers and other agricultural inputs that is lost through leaching and run-off for the different countries along the inventory period. The ten countries with the highest N from fertilizers and other agricultural inputs that is lost through leaching and run-off accounted together for 82.7% of the total. N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased in 26 countries and increased in two countries. The three countries with the largest decreases were the Czech Republic, Germany and Poland with a total absolute decrease of 568 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 33 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 EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018

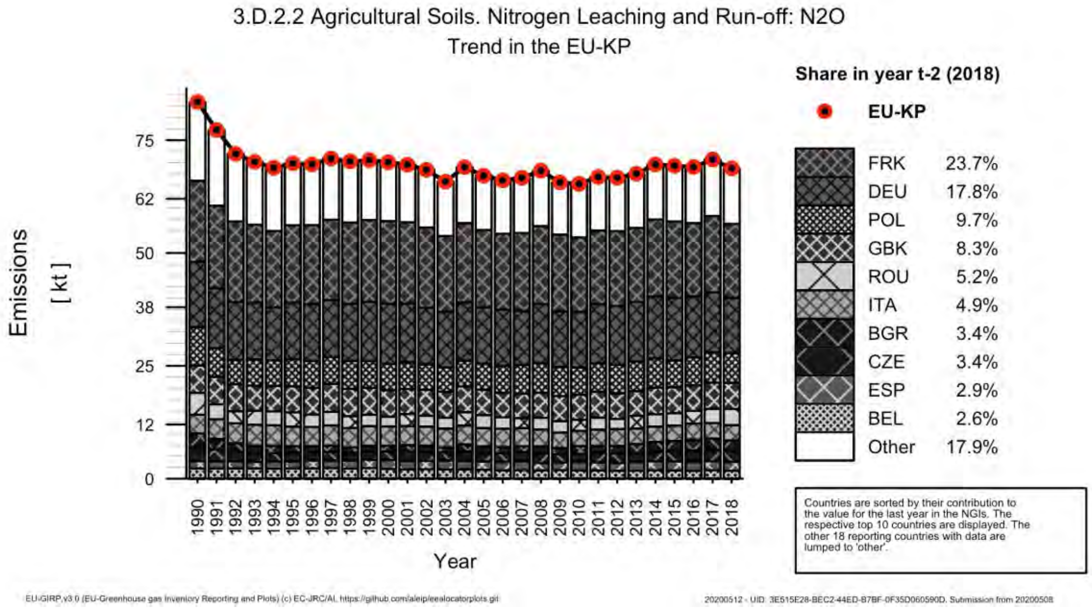
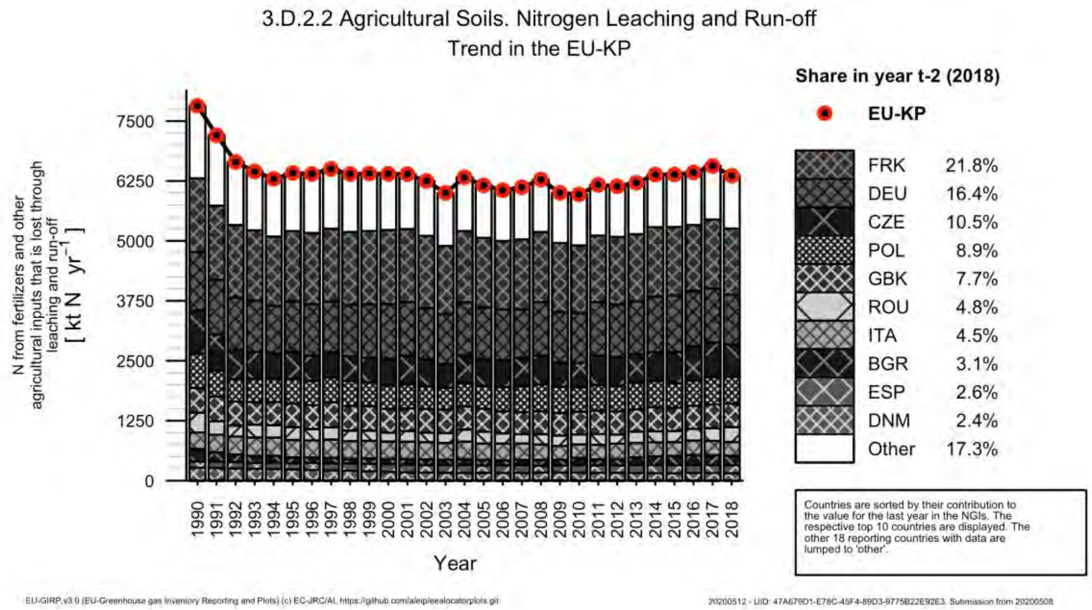


Figure 5.74: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend N leached from fertilisers and other agricultural inputs in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2018



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
- $Frac_{LEACH}$: 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 EU-KP barely between 1990 and 2018 by 0.0022% or 2.21e-07 kg N_2O-N/kg N. Figure 5.75 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in four countries and increased in three countries. It was in 2018 at the level of 1990 in 22 countries. No data were available for EU-KP. The three countries with the largest decreases were Portugal, Iceland and the United Kingdom with a mean absolute value of 2e-05 kg N_2O-N/kg N. Increases occurred in the Netherlands, Finland and France with a mean absolute value of 0.00048 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 EU-KP and range of values reported by countries

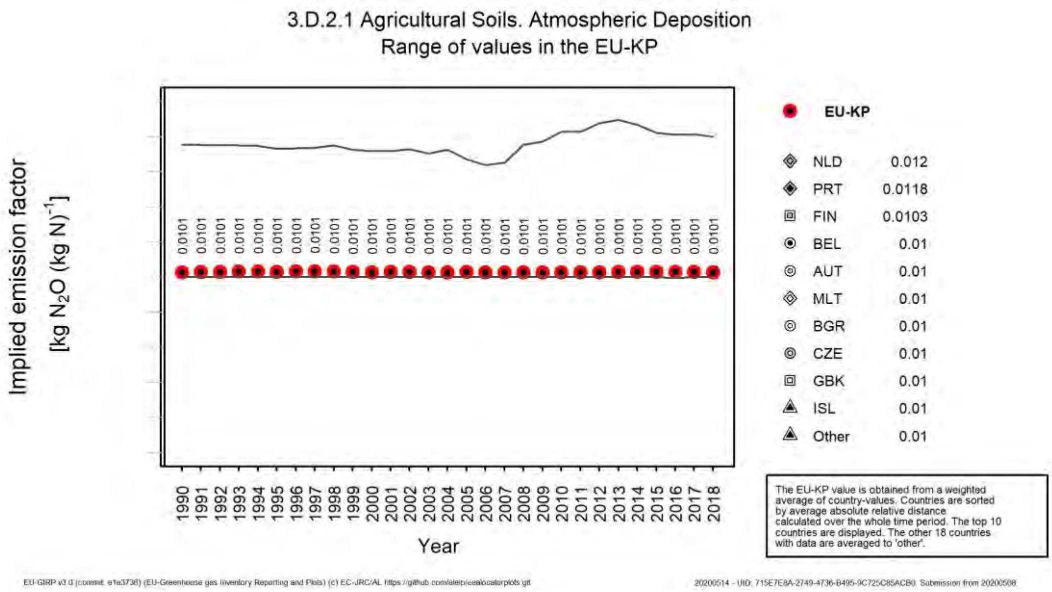


Table 5.50 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2018		Country	1990	2018
Austria	0.010	0.010	|	Ireland	0.010	0.010
Belgium	0.010	0.010	|	Iceland	0.010	0.010
Bulgaria	0.010	0.010	|	Italy	0.010	0.010
Cyprus	0.010	0.010	|	Lithuania	0.010	0.010

Czech Republic	0.010	0.010	|	Luxembourg	0.010	0.010
Germany	0.010	0.010	|	Latvia	0.010	0.010
Denmark	0.010	0.010	|	Malta	0.010	0.010
Spain	0.010	0.010	|	Netherlands	0.011	0.012
Estonia	0.010	0.010	|	Poland	0.010	0.010
Finland	0.010	0.010	|	Portugal	0.012	0.012
France	0.010	0.010	|	Romania	0.010	0.010
United Kingdom	0.010	0.010	|	Slovakia	0.010	0.010
Greece	0.010	0.010	|	Slovenia	0.010	0.010
Croatia	0.010	0.010	|	Sweden	0.010	0.010
Hungary	0.010	0.010	|	**EU-KP**	**0.010**	**0.010**

3.D.2.1 - Indirect emissions from Atmospheric Deposition - $Frac_{GASF}$

The $Frac_{GASF}$, a parameter used for calculating N_2O emissions in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition*, increased in EU-KP slightly between 1990 and 2018 by 1.4% or 0.0269. Table 5.51 shows the $Frac_{GASF}$ in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2018 for all countries and EU-KP. The $Frac_{GASF}$ decreased in six countries and increased in nine countries. It was in 2018 at the level of 1990 in fourteen countries. No data were available for EU-KP. The three countries with the largest decreases were Hungary, Denmark and Ireland with a mean absolute value of 0.009. The largest increase occurred in Germany with an absolute value of 0.011.

Table 5.51 3.D.2.1 - Indirect emissions from Atmospheric Deposition: countries' $Frac_{GASF}$ (-)

Country	1990	2018		Country	1990	2018
Austria	0.048	0.053	|	Ireland	0.030	0.025
Belgium	0.064	0.068	|	Iceland	0.022	0.022
Bulgaria	0.064	0.064	|	Italy	0.089	0.096
Cyprus	0.100	0.100	|	Lithuania	0.063	0.071
Czech Republic	0.100	0.100	|	Luxembourg	0.019	0.019
Germany	0.042	0.052	|	Latvia	0.100	0.100
Denmark	0.059	0.052	|	Malta	0.100	0.100
Spain	0.100	0.100	|	Netherlands	0.041	0.050
Estonia	0.100	0.100	|	Poland	0.100	0.100
Finland	0.016	0.015	|	Portugal	0.052	0.057
France	0.060	0.065	|	Romania	0.100	0.100
United Kingdom	0.032	0.035	|	Slovakia	0.100	0.100
Greece	0.100	0.100	|	Slovenia	0.057	0.054
Croatia	0.100	0.100	|	Sweden	0.022	0.021
Hungary	0.064	0.049	|	**EU-KP**	**1.943**	**1.970**

3.D.2.2 - Indirect emissions from Atmospheric Deposition - $Frac_{GASM}$

The $Frac_{GASM}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition*, decreased in EU-KP slightly between 1990 and 2018 by 3.8% or 0.182. Table 5.52 shows the $Frac_{GASM}$ in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2018 for all countries and EU-KP. The $Frac_{GASM}$

decreased in nine countries and increased in six countries. It was in 2018 at the level of 1990 in thirteen countries. No data were available for the Netherlands and EU-KP. The largest decrease occurred in Denmark with an absolute value of 0.1. The three countries with the largest increases were Belgium, Finland and Iceland with a mean absolute value of 0.012.

Table 5.52 3.D.2.2 - Indirect emissions from Atmospheric Deposition: countries' $Frac_{GASM}$ (-)

Country	1990	2018	Country	1990	2018
Austria	0.159	0.162	Ireland	0.082	0.085
Belgium	0.156	0.174	Iceland	0.216	0.224
Bulgaria	0.200	0.200	Italy	0.238	0.207
Cyprus	0.200	0.200	Lithuania	0.200	0.200
Czech Republic	0.200	0.200	Luxembourg	0.018	0.018
Germany	0.197	0.159	Latvia	0.200	0.200
Denmark	0.146	0.093	Malta	0.200	0.200
Spain	0.200	0.200	Poland	0.200	0.200
Estonia	0.200	0.200	Portugal	0.186	0.142
Finland	0.076	0.086	Romania	0.200	0.200
France	0.095	0.097	Slovakia	0.200	0.200
United Kingdom	0.081	0.080	Slovenia	0.227	0.184
Greece	0.200	0.200	Sweden	0.173	0.159
Croatia	0.200	0.200	**EU-KP**	**4.784**	**4.602**
Hungary	0.135	0.132			

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 EU-KP slightly between 1990 and 2018 by 1.3% or 8.68e-05 kg N_2O-N/kg N. Figure 5.76 shows the trend of the implied emission factor in EU-KP 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 2018 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in three countries. It was in 2018 at the level of 1990 in 22 countries. No data were available for Cyprus and EU-KP. Decreases occurred in Belgium, Iceland and France with a mean absolute value of 3.8e-09 kg N_2O-N/kg N. Increases occurred in Denmark, Spain and the United Kingdom with a mean absolute value of 6.8e-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 EU-KP and range of values reported by countries**

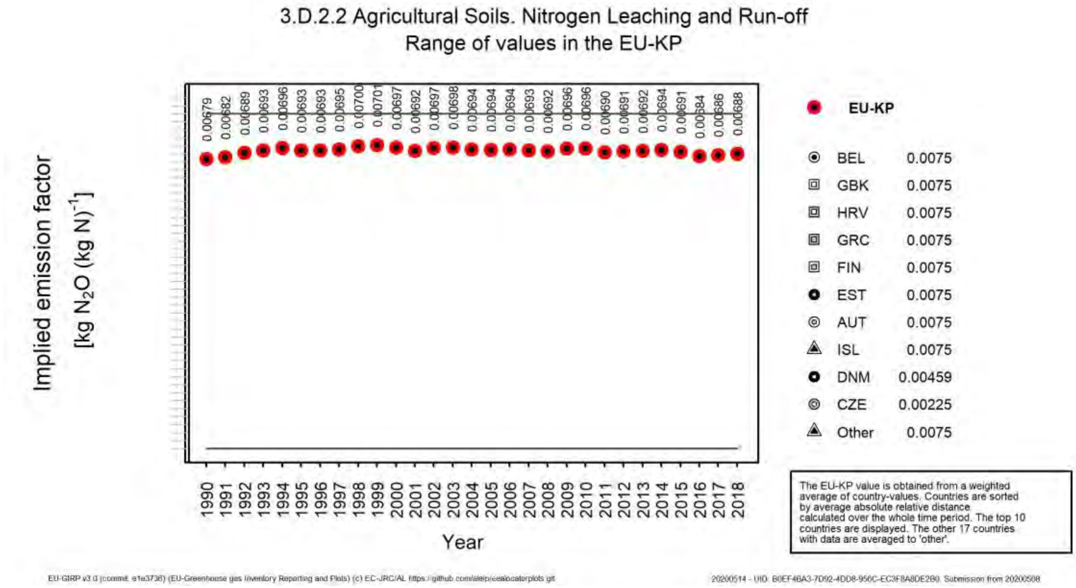


Table 5.53 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2018		Country	1990	2018
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	0.0075	0.0075
Croatia	0.0075	0.0075	|	Sweden	0.0075	0.0075
Hungary	0.0075	0.0075	|	**EU-KP**	**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*, decreased in EU-KP slightly between 1990 and 2018 by 1.3% or 0.0981. 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 2018 for all countries and EU-KP. $Frac_{leach}$ decreased in three countries and increased in two countries. It was in 2018 at the level of 1990 in 23 countries. No data were available for EU-KP and Cyprus. Decreases occurred in Denmark, Sweden and the Netherlands with a mean absolute value of 0.042. Increases occurred in the United Kingdom and Spain with a mean absolute value of 0.014.

Table 5.54 3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off: countries' $Frac_{LEACH}$ (-)

Country	1990	2018	Country	1990	2018
Austria	0.152	0.152	Iceland	0.300	0.300
Belgium	0.300	0.300	Italy	0.207	0.207
Bulgaria	0.300	0.300	Lithuania	0.300	0.300
Czech Republic	0.300	0.300	Luxembourg	0.300	0.300
Germany	0.300	0.300	Latvia	0.230	0.230
Denmark	0.332	0.255	Malta	0.300	0.300
Spain	0.077	0.083	Netherlands	0.150	0.130
Estonia	0.300	0.300	Poland	0.300	0.300
Finland	0.300	0.300	Portugal	0.300	0.300
France	0.300	0.300	Romania	0.300	0.300
United Kingdom	0.173	0.197	Slovakia	0.300	0.300
Greece	0.300	0.300	Slovenia	0.300	0.300
Croatia	0.300	0.300	Sweden	0.167	0.137
Hungary	0.300	0.300	**EU-KP**	**7.288**	**7.190**
Ireland	0.100	0.100			

5.3.6 Agriculture- non-key categories

Table 5.55 Aggregated GHG emissions from nonkey categories in the agriculture sector

Country	2018	CO_2 (kt)	CH_4 (kt) Rice Cultivation	CH_4 (kt) Field burning of agricultural residues	N_2O (kt) Field burning of agricultural residues
Austria		120.39	-	0.02	<0.001
Belgium		190.47	-	-	-
Bulgaria		33.74	3.96	1.11	0.026
Cyprus		0.22	-	0.01	<0.001
Czech Republic		287.29	-	-	-
Germany		2913.82	-	-	-
Denmark		244.18	-	0.14	0.004
Spain		498.61	17.33	0.76	0.020
Estonia		19.41	-	-	-
Finland		211.76	-	0.06	0.002
France		2018.59	2.52	1.83	0.048
United Kingdom		1266.31	-	-	-
Greece		32.91	6.89	1.19	0.029
Croatia		65.05	-	-	-
Hungary		214.25	0.79	0.01	<0.001

Country	2018	CO_2 (kt)	CH_4 (kt) Rice Cultivation	CH_4 (kt) Field burning of agricultural residues	N_2O (kt) Field burning of agricultural residues
Ireland		546.21	-	-	-
Iceland		6.42	-	-	-
Italy		420.71	62.12	0.60	0.013
Lithuania		56.30	-	-	-
Luxembourg		10.98	-	-	-
Latvia		44.49	-	-	-
Malta		-	-	-	-
Netherlands		35.88	-	-	-
Poland		939.83	-	0.98	0.040
Portugal		47.79	5.47	1.31	0.064
Romania		125.42	2.20	10.57	0.323
Slovakia		79.42	-	-	-
Slovenia		22.06	-	-	-
Sweden		128.55	-	-	-
EU-KP		**10581.06**	**101.28**	**18.59**	**0.57**

Table 5.55 shows the aggregated GHG emissions of non-key categories from source categories 3C, 3E, 3F and 3G-I by each country for the year 2018. Total CO_2 emissions is around 10.581 kt, with the highest CO_2 emissions by Germany, France and the United Kingdom. CH_4 emissions from 'Rice Cultivation' is the largest by Italy (62.12 kt), followed by Spain (17.33 kt). Total CH_4 emissions from 'Rice Cultivation' is 101.28 kt. CH_4 emissions from 'Field burning of agricultural residues', is the largest by Romania (10.57 kt), whilst total EU-KP is 18.58 kt. Total CH_4 EU-KP emissions ('Rice Cultivation' and Field burning of agricultural residues') is 119.87 kt, with the highest emissions by Italy, followed by Spain and Romania. Total N_2O emissions for EU-KP is 0.57 kt in 2018, with Romania having the highest emissions (0.323 kt). CH_4 and N_2O emissions from 'Prescribed burning of savannas' are not reported by the countries.

5.4 Uncertainties

Table 5.56 shows the total EU-27+UK 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-27+UK see Chapter 1.6.

Table 5.56 Sector Agriculture: EU-KP uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2017	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	251 983	193 792	-23.1%	10.6%	0.0%
3.A Enteric Fermentation	N2O	0	0		0.0%	
3.B Manure Mangement	CO2	0	0		0.0%	
3.B Manure Mangement	CH4	54 341	42 898	-21.1%	16.6%	0.0%
3.B Manure Mangement	N2O	30 900	23 016	-25.5%	61.3%	0.1%
3.C Rice Cultivation	CO2	0	0		0.0%	
3.C Rice Cultivation	CH4	2 716	2 099	-22.7%	29.9%	0.4%
3.C Rice Cultivation	N2O	0	0		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	198 786	163 135	-17.9%	119.9%	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	1 645	465	-71.7%	52.7%	0.3%
3.F Field Burning of Agricultural Residues	N2O	361	164	-54.6%	54.4%	0.2%
3.G Liming	CO2	10 174	5 985	-41.2%	23.3%	0.1%
3.G Liming	CH4	0	0		0.0%	
3.G Liming	N2O	0	0		0.0%	
3.H Urea application	CO2	3 479	3 783	8.7%	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	590	299	-49.4%	10.2%	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	271	1 542	468.7%	45.0%	2.0%
3.J Other	N2O	178	384	115.8%	89.2%	1.5%
3 (where no subsector data were submitted	all	0	0		0.0%	0.0%
Total - 3	**all**	**555 423**	**437 562**	**-21.2%**	**45.1%**	**2.4%**

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 these countries

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 countries 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 countries 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 countries 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[38]. 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[39], *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
- Addition of further sector-specific checks, in cooperation with the team working on the review of the submissions under the Emissions Sharing Directive. These checks focus on the consistency of reporting within the agricultural sector, the completeness of the background information provided which are important for transparence, in addition to issues related to correct implementation of recommended methodologies.
- The writing of the agriculture chapter of the EU-GHG inventory report has been highly automated[40]. 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.

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38 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.

39 EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

40 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/f1d3elxzd4qn/20131002_icr_agri/

The newly developed system is described in the section QA/QC system in the agriculture sector.

5.5.2.3 Main improvements since 2019

Since the 2019 submission, a new check has been introduced on the correlation between milk yield versus feed digestibility and nitrogen excretion rates. Several parts of the code has been revised to align with current programming libraries the system implemented in 2015 was further developed.

5.5.2.4 Further improvements

The following further improvements are foreseen for the next submission:

- Further addition of sector-specific checks as required
- 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[41] 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, 13 were still unresolved and therefore the corresponding issues were reopened.
- **Check on NEs**[42] and empty cells has been done by extracting all reported 'NE's and the empty cells, respectively, from the data base. From the nine observation on NEs, four are still unresolved. Several are connected also with the recommendations.
- **Notation keys**: we identified emission categories where a country reported a notation key, while 22 or more countries reported emission estimates, in order to assess the potential over/underestimations (these also contained in NE checks and reporting of identical values as in previous submission) 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 EU-KP 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 EU-KP level) is important to

[41] EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

[42] https://github.com/aleip/eealocatorplots/blob/master/eugirp_checknes.r

ensure correct comparison of countries' values and a correct calculation of EU-KP background data. An automated check[43] 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.

- **Within-country outliers**: within-country outliers in IEFs and other parameters are detected on the basis of the distribution of the values provided[44]. 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[45]. All outliers were 'manually' cross-checked and analysed. Countries were notified on the results of the analysis.
- **Time series outliers/inconsistencies**: 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% qualify as 'outliers'. However, this generates 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 out phased*: Relative constant trend with few years above/below the trend that 'looks plausible'.

– *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.

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43 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkunits.r

44 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkoutliers.r

45 See function `ispotentialissue()` in the file https://github.com/aleip/eealocatorplots/blob/master/eugirp_functions.r

– *Jump and shape*: There is a jump at some point in the time trend and, after the jump, the trend changes shape

Time series outliers and inconsistencies can in many cases be explained by socio-economic fluctuations, crises, or other events influencing the time series of populations or emission factors. Explanations received by countries are collected and the issue flagged representing a real trend.

- **Sector-specific checks**: Several checks were performed tailored to the reporting in the sector agriculture[46,47]. 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 FracRPR_CPP and FracRPR_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%.

– 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 (FracLOSSMS) 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**: In the first step of the ESD review, recalculations of more than and also for less than 0.05% of the national total emissions (excluding LULUCF) for years 1990 and 2018, focusing on key categories were asked for justifications of recalculations. Those of them with the impact more than 0.05% were evaluated as potential significant. Three of the potential significant were not resolved in the first step of the review and were hand over to second step.

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46 https://github.com/aleip/eealocatorplots/blob/master/agrichecks1ADs.r

47 https://github.com/aleip/eealocatorplots/blob/master/agrichecks2Nex.r

A slightly higher number of issues were identified (189 for 2018) compared to last year (162 issues were identified in 2017):

- 19 completeness issues (related to 'NE'/'empty'/'notation keys')
- 58 country-outlier issues
- 17 recalculation issues
- 13 time trend issues
- 13 recommendations
- 35 agricheck issues
- 34 other issues (e.g. wrong units, same values reported for 2017 and 2018)

The status of responses as of May 20, 2020 is given in Table 5.57:

Table 5.57 Status of issues as of May 20, 2020

Check	Resolved	Partially resolved	Unresolved	Not yet responded
Completeness	84%	0%	16%	0%
Outliers	55%	14%	31%	0%
Recalculations	53%	12%	35%	0%
Time series	62%	23%	15%	0%
Recommendations	0%	0%	100%	0%
Agrichecks	54%	26%	20%	0%
ESD review	0%	0%	100%	0%

All issues had been responded by May 20 2020, being the Completeness the type of issues with the highest percentage of resolution, followed by the Time series. 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 20% share of questions still unresolved, often requiring detailed information which sometimes the countries cannot easily obtain. Similarly happens with the recommendations, 100% of which have not been resolved yet but countries are working on getting the necessary data for the resolution of the issues. Regarding outliers, 45% 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[48].

Care is being taken to not include in the calculation erroneous values:

[48] https://github.com/aleip/eealocatorplots/blob/master/eugirp_euweightedaverages.r

- 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 EU-KP 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 EU-KP weighted averages to avoid biases in the results. Therefore, the EU-KP weighted averages - in some cases - could not represent 100% of EU-KP 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 countries, a workshop on "Inventories and Projections of Greenhouse Gas Emissions from Agriculture" was held at the European Environment Agency in February 2003. The workshop focused on the emissions of methane (CH_4) and nitrous oxide (N_2O) induced by activities in the agricultural sector, not considering changes of carbon stocks in agricultural soils, but including emissions of ammonia (NH_3). The consideration of ammonia emissions allows the validation of the N_2O emission sources and it further strengthens the link between greenhouse gas and air pollutant emission inventories reported under the UNFCCC, the EC Climate Change Committee, the UNECE Long-Range Transboundary Air Pollution Convention, and the EU national emission ceiling directive. Objectives of the workshop were to compare the countries 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 countries 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[49]

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 countries 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, countries were asked to provide estimation (possibly by means of models) of the volume of water used for irrigation on the agricultural holding.

[49] Leip, A., 2005. N_2O 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.

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[50] 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[51].

A list of characteristics of potential relevance for the quantification of GHG emissions is given in Table 5.58.

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

50 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008R1166

51 http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1448050507039&uri=CELEX:32009R1200

Characteristic			Units/categories
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)
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"[52]. The Eurostat/OECD Methodology and Handbook on Nutrient Budgets has been updated and amended in 2013[53]. 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.

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52 http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction

53 http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/documents/Nutrient_Budgets_Handbook_%28CPSA_AE_109%29_corrected3.pdf

The following gives some information on the project that prepared the recommendations, as extracted from the report from Oenema et al. (2014)[54].

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 countries.

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;
- 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 the EU.
  - $N_{excretion} = N_{intake} - N_{retention}$
  - $P_{excretion} = P_{intake} - P_{retention}$
- We recommend that the European Commission encourages countries 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 countries 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 countries 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 countries 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.

[54] 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.

- 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. countries 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 countries 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 countries 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 countries 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 countries 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 countries 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 countries 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 countries.
- 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[55] 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 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[56] 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.

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55 http://www.capri-model.org/

56 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.

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)[57] 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-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[58]). 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[59]. 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

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57 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.

58 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.

59 http://www.ncgg.info/

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 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[60]

60 ftp://mars.jrc.ec.europa.eu/Afoludata/Public/363_eughginventory2014/koeble_leip2014.livestockallocation.pdf

5.6 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 5.59 to Table 5.62 provide information on the contribution of Member States to EU-KP recalculations in sectors 3A (CH_4), 3B (CH_4 and N_2O) and 3D (N_2O) for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table 5.59 3A Enteric fermentation: Contribution of countries to EU-KP recalculations in CH_4 emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	-	-	1	0.02	Update of livestock numbers (poultry and other animals) and new information on input materials for biogas plants
Belgium	-0.07	-0.001	-44	-1.0	Flemish & Wallon regions: Revision of the milk production per cow for 2015 till 2017. Walloon and Brussels regions: Revision of the livestock numbers from 2013 Brussels region: Implementation of a new module for choice of the factor applied to energy for growth of dairy cows and non-dairy adult cattle.
Bulgaria	-	-	-	-	NA
Croatia	-51	-2.4	-64	-5.8	Due to a change of approach from Tier 2 to Tier 1 and completely updated information of cattle due to new AD and subcategorization of cattle, emissions were recalculated for the 1990-2017
Cyprus	-	-	0.2	0.1	CH_4 emissions were recalculated for the years 2011-2017 due to updated number of mules and asses.
Czechia	-	-	-	-	NA
Denmark	-	-	-	-	NA
Estonia	-	-	-0.05	-0.01	Updated activity data of goats in 2016 and 2017 and sheep in 2017.
Finland	-6	-0.2	1	0.04	Digestible energy DE (% of GE) in the cattle to reflect changes in cattle diets along the time series.
France	-	-	27	0.1	Upward adjustment of the cattle herd for 2017 as well as in the "Others" category (horses, mules and donkeys, goats). Upward adjustment of the 2017 milk yield.
Germany	-	-	-10	-	Updating of animal-population data for weaners, fattening pigs and laying hens for 2017. Updating of weight data and milk production for dairy cows, heifers and male beef cattle for 2017.
Greece	-	-	-	-	NA
Hungary	-86	-2.3	-65	-3.1	A minor revision of livestock number of Buffalos and Poultry for the year 2017. Dairy Cattle - enteric methane conversion factor (Ym) changed based on the new scientific literatures (e.g. Niu et al., 2018 and Hellwing et al., 2016) and the country-specific values of neutral detergent fibre (NDF).
Ireland	-	-	-5	-0.04	Revised estimates of replacement heifer populations for 2017.
Italy	-	-	-22	-0.2	Data updating on milk production for 2017.
Latvia	-	-	1	0.2	Recalculations were done after review of dairy cow weight.
Lithuania	-	-	-4	-0.3	Changes of livestock population data for heifers less than one year used for breeding purposes in the cattle sub-category for the 2017.

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Luxembourg	-0.04	-0.01	0.2	0.1	The 2017 provisional livestock activity data were revised and updated. Net energy for maintenance for sheep, the used Cfi for adult sheep and lamb was corrected.
Malta	-	-	0.0004	0.001	The population data, feed proportions, % of protein, for all livestock categories and cattle weights; bulls & growing cattle were reviewed.
Netherlands	-	-	-	-	NA
Poland	-	-	-	-	NA
Portugal	-	-	-231	-6.3	Revision of the non-dairy cattle emission factors from enteric fermentation (3A.1.b) based on the updated information collected from the breeders associations of the cattle breeds mostly used in Portugal for meat production.
Romania	-	-	-1	-0.007	Corrected livestock for mules and asses in the 2017.
Slovakia	214	8.3	33	3.4	Update of parameters: pregnancy and weight of cattle, new breed structure of cattle for 1995 – 2017 new breed structure of cattle for 1995 – 2017, new feeding plans were updated in cattle and sheep category, feed composition and digestibility of feed (cattle and sheep). Changes in GEI of sheep.
Slovenia	-	-	-	-	NA
Spain	646	4.2	525	3.1	Correction of a mistake for years 2016 and 2017 in the number of animals assigned to two categories of non-dairy cattle. Methodological up-grading for the enteric fermentation for Iberian swine by application the new draft zootechnical document. Methodological up-grading for the enteric fermentation for goats by application the new draft zootechnical document
Sweden	-1	-0.03	-3	-0.1	The emission factor for suckler cows has been corrected from 92 to 91.5 kg/head/year. Minor differences in the reindeer population due to an updated time series.
United Kingdom	-	-	-	-	NA
EU27+UK	715	0.3	140	0.1	
Iceland	12	3.9	13	4.3	Populations of other mature dairy cattle were updated adding interpolated values for the years 1990-1991 as well as for turkeys and geese. Update of average live body weight and feeding characteristics leading to an update of the digestible energy (%). Recalculations for the GE for the whole time series for mature dairy cattle and other mature cattle and lambs due to an update of the coefficient (Cfi) for calculating the net energy for maintenance (NEm). The update for the horse population.
United Kingdom (KP)	-	-	-	-	NA
EU-KP	728	0.3	153	0.1	

Table 5.60 3B Manure Management: Contribution of countries to EU-KP recalculations in CH_4 emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	-	-	2	0.3	Update of livestock data and correction of a linkage error resulted in slightly revised CH_4 emissions for cattle and swine from 2006 onwards
Belgium	-	-	-1	-0.1	Connected with the 3.A, mainly due to the choice of the

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
					factor applied to energy for growth of dairy cows and non-dairy adult cattle.
Bulgaria	-	-	-2	-1.5	The recalculation have been made for 2017 due to technical mistake in activity data for cattle and swine.
Croatia	10	2.4	1	0.3	Due to a change of AD and subcategorization of cattle, emissions were recalculated for the 1990-2017
Cyprus	-	-	-	-	NA
Czechia	36	2.1	-232	-31.6	Changes in body weight for dairy and some of non-dairy categories were implemented in full agreement with the Czech legislation. The update of AWMS for 2017. IEF for swine for 1990-2017 was updated.
Denmark	310	20.1	373	20.6	Updated data for biogas and biomass for the years 2015-2017. Changes in MCF for cattle and swine and the allocation of number of animals in housings, were the manure is send to biogas plants. Fur animals is recalculated for 2017, due to rounding of factors.
Estonia	6	4.0	57	74.1	Updated distribution of the share of cattle and swine AWMS throughout the entire time series. Updated activity data of goats in 2016 and 2017, sheep in 2017 and broilers in 2016.
Finland	-2	-0.4	-1	-0.3	The DE change affects the amount of volatile solids excreted, and thus the change impacts also CH_4 emissions from cattle manure.
France	-	-	4	0.1	See.3.A
Germany	-	-	-6	-0.1	Updating of animal-population data for weaners, fattening pigs and laying hens for 2017. Updating of weight data and milk production for dairy cows, heifers and male beef cattle for 2017. Corrections of relative shares of housing and application procedures for cattle and swine
Greece	-	-	-	-	NA
Hungary	-	-	-	-0.1	See 3.A
Ireland	-	-	1	-	See 3.A
Italy	15	0.4	-259	-6.8	Data updating on manure production for cattle and buffalo. Recalculated emissions because of the revised estimate for grazing of cattle and buffalos and inclusion of ostriches.
Latvia	-	-	-	0.2	See 3.A
Lithuania	-	-	-	-0.1	Recalculated livestock population data of heifers less than one year used for breeding purposes for the 2017.
Luxembourg	-	0.6	-1	-1.6	Country-specific frequency of the distribution of slurry storage, region-specific methane conversion factors and maximum methane producing capacity for manure (Bo) produced by cattle and pigs were updated.
Malta	-	4.6	-	0.9	Tier 2 assumptions and parameters were utilised in the estimates of CH_4 emissions from manure management, revision of GE for cattle.
Netherlands	-	-	-	-	NA
Poland	-	-	-185	-11.2	Introduction of emission abatement measures related to cover of tanks with liquid manure for cattle and swine.
Portugal	-	-	-18	-2.4	Revision of the amounts of VS for non-dairy cattle.
Romania	-	-	-	-	NA
Slovakia	50	12.9	-18	-14.9	Revising of the tier 2 approach, improving VS excretion rates for each subcategory of pigs, taking into account the body weight of animals. The approach was updated for the advanced disaggregation of pigs' subcategories (from 6 to 11 subcategories).
Slovenia	-	-	-	-	NA

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Spain	-206	-2.9	-305	-4.3	Correction of a mistake in the activity data loaded in the Inventory database for dairy cattle. Methodological up-grading following coherence with the national statistics (Nitrogen and Phosphorus Balance in the Spanish Agriculture). Methodological up-grading for manure management (CH_4) for Iberian swine by application the new draft zootechnical document. Methodological up-grading for manure management (CH_4) for goats by application the new draft zootechnical document.
Sweden	-	-	-	-	NA
United Kingdom	-	-	-	-	NA
EU27+UK	220	0.4	-590	-1.4	
Iceland	6	11.7	7	12.3	Volatile solid excretion rates (VS) for cattle and sheep were revised.
United Kingdom (KP)	-	-	-	-	NA
EU-KP	226	0.4	-584	-1.4	

Table 5.61 3B Manure Management: Contribution of countries to EU-KP recalculations in N_2O emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	-6	-1.4	-5	-1.1	Implementation of the EMEP/EEA Guidebook 2019 into air emission inventory, provides updated NH3 emission factors for specific livestock and revised calculation method of the fraction of TAN that is immobilised in organic matter (fimm) when the manure is managed as a litter based solid and the litter is straw.
Belgium	2	0.2	10	1.6	Flemish region: Revision of FracGASM. Brussels & Wallon regions: change to Tier 2 approach of the EMEP/EEA Guidebook (version 2019). The IEF higher in the new tool for non-dairy cattle. For 3.B.2.5, the application of the EMEP methodology increases the figure of the volatilisation of N in NH3 and NO. Emissions of N from leaching and run off were included.
Bulgaria	-	-	-5	-1.1	The recalculation have been made for 2017 due to technical mistake in activity data for cattle and swine.
Croatia	14	3.8	-4	-2.8	Change of Nex from national to default values for all animals.
Cyprus	-	0.3	-1	-0.9	N_2O emissions from other cattle and mules & asses were recalculated due to changes in animal mass and animal population
Czechia	-227	-14.0	-338	-40.8	The error concerned inclusion of nitrogen from pastures, range and paddock in the calculation was corrected (double counting). Based on Klír et al (2011), the update of AWMS for cattle, swine, poultry, goats, horses and sheep was implemented in 2017. The country specific Fracleach was implemented.
Denmark	-	-	6	0.8	Changes for biogas treated slurry in 2017.
Estonia	22	17.7	10	18.4	Updated distribution of the share of cattle and swine AWMS throughout the entire time series. Updated activity data of goats in 2016 and 2017, sheep in 2017 and broilers in 2016.
Finland	-2	-0.5	-	-	N excretion of suckler cows was recalculated based on updated diet information and a minor correction was

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
					made in the calculation of N excretion of dairy cows.
France	-	-	2	0.1	See 3.A
Germany	10	0.2	12	0.4	Increase in the N excretions of suckler cows. Correction of a calculation error with respect to the feed intake of pullets, for the period as of 1990. Updating of the data on "total gross meat quantity obtained at slaughter" for broilers in 2017. Correction of the N-flow calculation for pre-storage systems.
Greece	-	-	-	-	NA
Hungary	-54	-5.9	-14	-3.0	New country-specific nitrogen excretion rates for broiler and laying hens. Nitrogen retention rate for Sows and Breeding boars were corrected to new country-specific values.
Ireland	-	-	1	0.1	See 3.B.1
Italy	-79	-2.7	-56	-2.5	Updating of N excretion rate for buffalo, for dairy cattle based on GEI and performance parameters, for other poultry. The reductions of N excreted for buffalo and other poultry affect the reductions in NH3 and NO2 emissions and consequently the indirect emissions of N_2O.
Latvia	-	-	-	0.2	See 3.A
Lithuania	-149	-20.4	-4	-2.3	Recalculations of N excretion rates. Recalculations of indirect N_2O emissions from manure management were made as new values of FracleachMS taken from 2019 Refinement were used.
Luxembourg	-8	-19.5	-7	-21.2	Nex for dairy cows was be updated, Indirect N_2O-emissions from manure management, a Tier 2 approach was taken.
Malta	-	-	-	-	NA
Netherlands	-	-	-	-	NA
Poland	-134	-4.3	-60	-2.7	See 3.B.1
Portugal	-	-	4	2.2	Revision of N-excreted for the non-dairy cattle.
Romania	-1	-0.1	-	-0.1	Change of percent of managed manure nitrogen losses for livestock due to runoff and leaching during solid and liquid storage of manure (FracleachMS) in 0.1 to 0.01 required in the calculation of the N_2O indirect emissions from leaching, for the entire period 1989-2017.
Slovakia	-25	-5.1	1	0.8	Nitrogen excretion rate for cattle was calculated using tier 2 approach with the implementation of average annual requirements for crude protein. In addition, changes made in the category 3.A.1 had a direct influence also in this category. Nitrogen excretion rate for swine was calculated using tier 2 approach with the implementation of the more developed disaggregation of pigs´ category. This revision is connected with the recalculation of VS and GE in the 3.B.1.3 category.
Slovenia	20	29.5	36	77.7	Default EF for liquid cattle manure (0.001 kg N_2O-N per kg of TAN entering the store, EMEP/EEA 2013) was replaced by EMEP/EEA 2016 factors (0.01 for cattle slurry and 0.00 for liquid fraction (urine and liquids from farmyard manure storage)) and corresponding N_2O emissions have been recalculated for the entire period 1986-2017.
Spain	97	6.4	118	6.6	Methodological up-grading following coherence with the national statistics (Nitrogen and Phosphorus Balance in the Spanish Agriculture). Methodological up-grading for manure management (N_2O) for goats by application the new draft zootechnical document.
Sweden	-	-	1	0.2	Updated Nex value for reindeer.
United Kingdom	-	-	-	-	NA

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
EU27+UK	-521	-1.7	-295	-1.3	
Iceland	-	1.9	-	1.6	Change in the estimation of the Nex rate for mature dairy cattle. the indirect emissions from volatilisation of NH3-N and NO-N change also due to the different activity data.
United Kingdom (KP)	-	-	-	-	NA
EU-KP	-520	-1.7	-295	-1.3	

Table 5.62 3D Agricultural Soils: Contribution of countries to EU-KP recalculations in N_2O emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	2	0.1	7	0.4	Improved methodologies in accordance with the EMEP/EEA Guidebook 2019 resulted in lower NH3-N losses from manure management and minor revisions of the harvested amounts of sugar beet and slight revisions due to updated activity data perennial cropland to annual cropland).
Belgium	24	0.5	19	0.5	Flemish region: Revision of FracGASM and FracGASF. Revision of FSOM. Revision of the amount of compost used in 2017. Revision of the amount manure exported or processed in 2017. Walloon region: N available for application has changed. New data of analysis on organic fertilisers improved the calculation of the emissions and digestates. Brussels Region: Differences are mainly due to the omission of the conversion of N_2O–N emissions to N_2O emissions in the previous tool.
Bulgaria	-	-	2	0.0	Revised data for sludge applied to soils.
Croatia	51	3.7	27	2.5	Minor changes in activity data on crop production for 2017. Due to a new official data on areas from Corine Land Cover, there were significant changes in land use matrix what affected 3.D.1.5.
Cyprus	-	-	-	-0.1	New data on sewage applied on land was available in 2019 for the year 2017.
Czechia	-	-	926	25.4	New source of nitrogen has been added as "Other organic fertilizers applied to the soil" - digestate. The amount of mineral fertilizers used in managed soils has been updated since year 2000. The changed AD from the LULUCF sector resulted in revised estimates of N_2O in Category 3.D.a.5.
Denmark	183	3.3	130	3.1	New estimates for EF for NH3 emission from storage of slurry from cattle, swine and fur animals have been made, due to new estimates for cover of slurry tanks with solid cover. Calculations of N excretions changed, so it takes into account the difference between EF used for emission of NH3 from storage and the factor used to estimate the N excretions ab storage in the normative figures. A recalculation for 2017 have been made, due to updated statistics. N_2O emissions from mineralization from organic soils are estimated with a dynamic soil model. The area with organic soils has been re-evaluated with an updated map for the organic soils.
Estonia	-23	-1.9	-5	-0.7	Updated activity data of crops since 2014. The data on areas of cropland changed to cropland and areas of organic soils cultivated were updated in the framework of the NFI (see chapter LULUCF).

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Finland	-3	-0.1	134	3.9	Emissions from N input from sewage sludge applied to soils were recalculated using a re-estimated share of sewage sludge used on agricultural lands, and annual nitrogen content. Emissions from other organic fertilisers applied to soils (CRF 3.D.1.2.c) were added. the relative areas of annual and perennial plants on organic soil were updated.
France	-	-	-51	-0.2	Revision of the nitrogen value of sludge spread. Modification of crop residue production in 2017. Update of the inclusion of landfill for mineral fertilizers (upward adjustment of landfill in 2017).
Germany	100	0.3	-173	-0.7	First-time availability of data on air-scrubbing systems for housing of laying hens and broilers. New inclusion ot trailing-shoe systems in connection with application of slurry / digested slurry, for the period as of 1990. Updating of the N quantities applied with sewage sludge. Updating of areas of cultivated organic soils. New inclusion of crop residues.
Greece	-	-	37	1.2	N_2O emissions from agricultural soils have been recalculated for 2017 due to updated activity data.
Hungary	237	6.6	123	3.4	Improvement was made to the N-content of sewage sludge. Value of leaching losses (12% of the TAN content of the stored manure) was removed from the 2019 EMEP/EEA Guidebook; therefore N-losses from the stored manure was also revised in accordance with the 2009 Refinement to the 2006 IPCC Guidelines.
Ireland	-1	-0.0	-5	-0.1	Revised estimates of emissions and removals for 4.B Croplands and 4.C Grasslands which are used as the activity data for Direct N_2O Emissions from managed soils (3.D.1.5). Replacement heifer populations also affected estimates of NH3 which provides activity data for Indirect N_2O Emissions from managed soils.
Italy	33	0.3	181	2.2	N_2O emissions have been recalculated because of the updating of the estimate of N2 on the basis of the country specific percentages of the total ammoniacal nitrogen (TAN) for animal categories. Other activity data have been updated for the last years resulting in minor recalculations.
Latvia	-24	-0.9	-87	-5.1	Updated information about organic soil areas, as well as updated information on N content in under and below ground residues of wheat. Improved activity data on area and distribution of organic soils.
Lithuania	-37	-1.1	-3	-0.1	Inorganic N fertilizer for 2017 was recalculated due to updated data. Data on N concentration in sewage sludge and amount of sewage sludge applied to soils was updated for the 2016 and 2017. Cultivation of organic soils were made due to recalculations made in the LULUCF sector for the whole period.
Luxembourg	-7	-2.8	-7	-3.6	AD for crops were revised and updated, with consequently also a revision of the annual amount of synthetic fertilizer used, and the estimated N associated with crop residuals. The annual amount of animal manure N applied to soils (kg N per year) were revised and updated following an N-flow model. The AD for compost was revised.
Malta	-0	-1.7	-0	-1.9	Revision in Fraction of managed manure N that volatilizes as NH3 and Nox; layers. Revision in annual amount of N mineralization associated with loss of soil.
Netherlands	-6	-0.1	-66	-1.2	Changes are related to: − fertiliser use in greenhouses; − the EF for crop residues; − an increase in N excretion for horses and ponies resulting from new insights into food intake;

Country	1990		2017		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
					– changes in the area of peat and other organic soils.
Poland	1 376	7.8	1 269	9.0	Correction of calculations made for Nitrogen left in crop residues and update of AD related to crop production for series before 2015. Update of histosols area under agricultural cultivation for entire series.
Portugal	-8	-0.3	105	5.1	Correction of the tier 2 NH3 algorithm to calculate ammonia emissions from inorganic N fertilizers.
Romania	-	-	10	0.2	Recalculation for the 2017 year from Crop residues due to of the change amount biomass burned available by FAO.
Slovakia	-132	-5.6	89	7.2	New activity data was implemented into the category. Vitahum and digesters slurry consumption were added into calculations. Correction of calculation formulas according to the recommendation from the UNFCCC review 2019 – based on the "Saturday Paper" (reflected already in the October 16, 2019 re-submission).
Slovenia	-5	-1.1	-2	-0.5	Application of urban compost and biogas digestate were included to inventory for the very first time. N_2O emissions from land management change for Cropland Remaining Cropland have been included in the Table3.D. Indirect N_2O emissions due to atmospheric deposition of N compounds were recalculated for the entire period 1986-2017.
Spain	60	0.6	62	0.5	See 3.A-3.B.1&2
Sweden	-16	-0.5	-155	-4.5	New methodology to estimate emissions from mineralization of soil organic matter. Total area of mineral- and organic soils has been updated for several years.
United Kingdom	-	-	12	0.1	Update to the sewage sludge and mineralisation data for 2017.
EU27+UK	1 806	0.9	2 577	1.6	
Iceland	67	33.0	69	35.2	Fertilizers used in forest were included under the total synthetic fertilizers. Changes in the N-flow calculations lead to recalculations in organic fertilisers and in urine and dung deposited by grazing animals. Reallocation of drained histosols used for grazing from the LULUCF chapter, table 4IIH and slight changes in the area of drained organic soils.
United Kingdom (KP)	-	-	-	-	NA
EU-KP	1 873	1.0	2 646	1.6	

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 on 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 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 the resulting trend on land uses 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 that 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[61]); this LULUCF sector is a compilation of the inventories submitted by individual European Member States (MS), UK and Iceland. Submissions by the countries in 2020 are used as the primary source of data and information, unless otherwise specified and referenced in the text.

This LULUCF chapter provides the general trends of GHG emissions and CO_2 removals from LULUCF at EU MS level, including information from UK and Iceland. It provides general information on the methods used by the countries, and describes the efforts carried out to harmonize and improve the quality of the inventories. More detailed information can be found in national inventory reports (NIRs) and common reporting format (CRF) tables submitted by the EU MS, UK 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 CO_2 emissions or removals, 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 in 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 sink is represented by Forest land. Cropland is the largest source of emissions, followed by the conversion of lands to Settlements, and Grasslands, along with the other land use categories, represent a smaller source of emissions. In addition, Harvested Wood Products also results in a carbon sink.

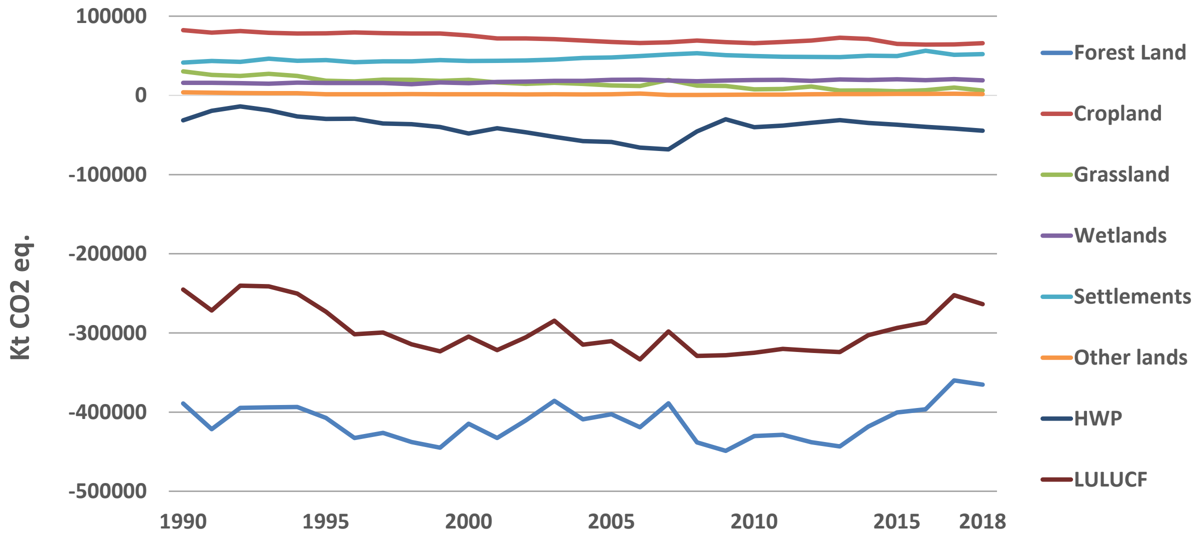
In 2018, the LULUCF sector of the EU MS, UK and ISL results in a total net sink of - 288.470 kt CO_2, which represents an increase of 6% as compared to the net sink reported for the year 1990 (Table 6. 1). Within the sector, the carbon pool Harvested Wood Products is in 2018 reported as a net carbon sink of -44.621 kt CO_2. Emissions of CH_4 and N_2O offset in 2018, 9% of total annual carbon removals, an unusual high value that results from the extraordinary incidence of wildfires in Mediterranean countries. Their impact can be observed in the EU trend.

In terms of CO_2 equivalent this sector results for the year 2018 in -263.656 kt CO_2 equivalent.

Within the EU, few MS have 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. And Germany, N_2O emissions from managed soils in Settlements.

[61] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R0525

Figure 6.1 Sector 4 LULUCF: EU MS, UK and ISL GHG net emissions (+) / removals (-) for 1990–2018, in CO_2 eq. (kt).



Source: EU MS, UK and ISL submissions 2020, CRF Table10s1

The overall trend of the LULUCF sector since 1990 is largely driven 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 result of a general increase in harvest rates. In the late 2000s harvest rate decreased, mainly due to the economic crisis, and the sink increased again. The last years of the time series are affected by the maturity of the forests which leads to lower increment and by higher harvested rates.

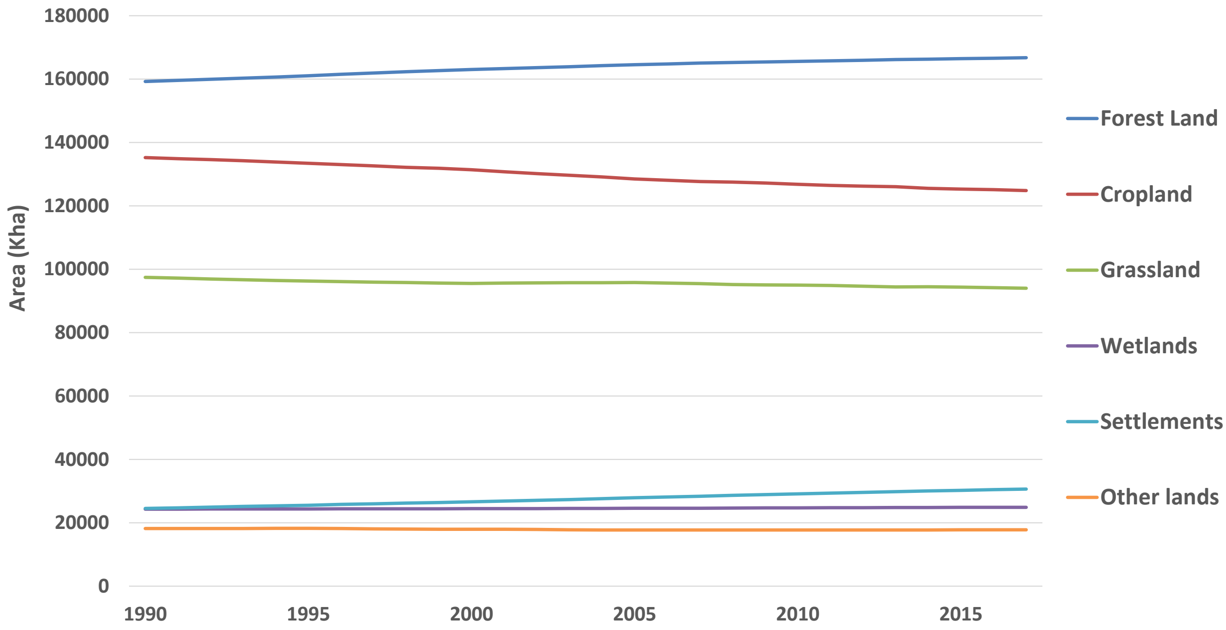
Inter-annual variations are mainly related with natural disturbance events, for instance, major wind storms in central-western Europe (e.g. 2000, 2005, 2007 and 2009) and wildfires (e.g.1990, 2003, 2005, 2007, 2016 and 2017) in Mediterranean countries. However, in some specific years the methods implemented by countries to derive carbon stock changes had also an impact in the 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 4.A1, 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. Additional category-specific information on trends and inter-annual variability is provided in the following sections of this document.

The total reported area of the different land use categories 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 be different due to different definitions used under each dataset.

As compared with the base year, the changes in total area reported in the current inventory for each land use category are: Settlements (+26%), Croplands (-8%), Forest land (+5%), Grassland (-4%), Wetlands (2%), Other lands (-2%).

Figure 6. 2 Total area for each of the land use categories (kha), as reported in EU MS, UK, and ISL in 2020.



Although, as shown above, the LULUCF sector results in a net carbon sink at the level of EU MS, UK and Iceland, the LULUCF sector reported by individual inventories ranges from a net source (e.g. Denmark, Czechia Netherlands, Ireland) to a small sink (e.g. Estonia, Belgium) or a large sinks (e.g. Italy, Spain, Sweden).

Compared to 1990, individual inventories report this year either a significant increase in the carbon sink or a substantial reduction. Changes are driven by the harvested rates and the impact of natural disturbances.

Table 6. 1 Sector 4 LULUCF: individual contributions to net CO_2 removals in 2018 (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	-12 157	-5 011	-5 311	1.8%	6 845	56%	-300	-6%
Belgium	-3 249	-1 124	-1 116	0.4%	2 133	66%	8	1%
Bulgaria	-19 563	-8 910	-8 961	3.1%	10 602	54%	-51	-1%
Croatia	-6 471	-4 729	-5 218	1.8%	1 253	19%	-489	-10%
Cyprus	-219	-420	-400	0.1%	-181	-83%	20	5%
Czechia	-5 771	-2 343	5 753	-2.0%	11 524	200%	8 097	346%
Denmark	6 173	4 152	6 251	-2.2%	78	1%	2 099	51%
Estonia	-1 945	-2 184	-2 342	0.8%	-397	-20%	-159	-7%
Finland	-18 431	-19 969	-13 057	4.5%	5 373	29%	6 911	35%
France	-26 205	-31 028	-30 044	10.4%	-3 839	-15%	985	3%
Germany	-30 464	-28 869	-29 315	10.2%	1 149	4%	-446	-2%
Greece	-2 177	-3 243	-3 013	1.0%	-836	-38%	230	7%
Hungary	-2 679	-5 243	-4 711	1.6%	-2 032	-76%	532	10%
Ireland	4 327	4 206	3 433	-1.2%	-894	-21%	-773	-18%
Italy	-5 662	-23 229	-36 909	12.8%	-31 247	-552%	-13 680	-59%
Latvia	-11 214	-2 552	97	0.0%	11 311	101%	2 649	104%
Lithuania	-5 710	-3 912	-4 039	1.4%	1 671	29%	-127	-3%
Luxembourg	80	-414	-224	0.1%	-304	-380%	190	46%
Malta	3	4	4	0.0%	1	31%	0	6%
Netherlands	6 485	4 950	4 815	-1.7%	-1 670	-26%	-135	-3%
Poland	-32 992	-37 490	-37 156	12.9%	-4 164	-13%	333	1%
Portugal	272	8 006	-6 714	2.3%	-6 986	-2570%	-14 720	-184%
Romania	-20 250	-23 525	-26 293	9.1%	-6 043	-30%	-2 768	-12%
Slovakia	-9 783	-6 642	-5 728	2.0%	4 054	41%	914	14%
Slovenia	-4 419	-208	213	-0.1%	4 633	105%	421	202%
Spain	-36 633	-39 405	-38 550	13.4%	-1 917	-5%	856	2%
Sweden	-36 236	-44 749	-43 740	15.2%	-7 505	-21%	1 008	2%
United Kingdom	-2 402	-11 535	-11 700	4.1%	-9 298	-387%	-165	-1%
EU-27+UK	**-277 292**	**-285 415**	**-293 975**	**102%**	**-16 683**	**-6%**	**-8 560**	**-3%**
Iceland	5 624	5 410	5 412	-1.9%	-212	-4%	1	0%
United Kingdom (KP)	-2 342	-11 441	-11 607	4.0%	-9 265	-396%	-166	-1%
EU-KP	**-271 609**	**-279 911**	**-288 470**	**100%**	**-16 861**	**-6%**	**-8 559**	**-3%**

At EU level, this year 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 9% of total emissions from other sectors. This year, the category resulted, in terms of CO_2 equivalent, a net sink for all the MS with the exception of Denmark, Slovenia and Czechia (Table 6. 2, column b). The most significant contributors to the total net sink reported for Europe under the category 4A are France, Germany, Spain Italy and Sweden (Table 6. 2, column c).

Table 6. 2 Sector 4 LULUCF: Contribution of Sector 4 (column a) and category 4A -Total Forest land - (column b) to total MS emissions (CO_2 eq. without LULUCF); and MS contribution to total EU category 4A (column c). Information is also presented for UK and ISL.

Country	LULUCF over total inventory excluding LULUCF	Category 4A over total inventory excluding LULUCF	MS contribution to total EU category 4A
	(a)	*(b)*	*(c)*
Austria	-6,5%	-5,4%	1,2%
Belgium	-0,9%	-1,1%	0,4%
Bulgaria	-14,6%	-12,9%	2,2%
Croatia	-21,4%	-22,6%	1,6%
Cyprus	-4,5%	-1,8%	0,0%
Czech Republic	4,5%	5,7%	-2,1%
Denmark	13,8%	0,8%	-0,1%
Estonia	-9,5%	-11,2%	0,7%
Finland	-18,2%	-31,0%	5,0%
France	-5,8%	-11,1%	14,3%
Germany	-3,1%	-7,8%	19,3%
Greece	-3,2%	-2,3%	0,6%
Hungary	-7,4%	-7,1%	1,3%
Ireland	7,1%	-5,8%	1,0%
Italy	-8,5%	-7,8%	9,6%
Latvia	12,1%	-27,4%	0,9%
Lithuania	-19,1%	-23,4%	1,4%
Luxembourg	-2,0%	-2,5%	0,1%
Malta	0,2%	NO,NA	-----
Netherlands	2,6%	-1,0%	0,5%
Poland	-8,8%	-8,9%	10,6%
Portugal	-9,3%	-13,1%	2,6%
Romania	-21,1%	-17,5%	5,9%
Slovakia	-13,1%	-8,7%	1,1%
Slovenia	1,4%	4,1%	-0,2%
Spain	-11,4%	-10,0%	9,6%
Sweden	-81,1%	-83,9%	12,5%
EU 27	-7,0%	-9,2%	100%
United Kingdom	-2,1%	-3,9%	-----
Iceland	185,5%	-7,9%	-----

Source: EU MS, UK and ISL submissions 2020, CRF Table10s1

6.1.2 Contribution of land use changes

The conversion of lands in the territory of the EU MS, UK and ISL results in the net emission of 29.739 kt CO_2 equivalent (Table 6. 3).

Land use changes represent 9% of the total reported land area. The carbon sink resulting from conversions to Forest Land and Grassland is by far balanced by emissions from conversions to Cropland, Wetlands, Settlements and Other land.

Table 6. 3 Contribution of land use changes in 2018 for EU MS, UK and ISL, in terms of area (columns a-b) and net CO_2eq. (Columns c-d) (As aggregation of data from CRF Table 4.)

Land use conversions	(a) land area (Kha)	(b) Area % of the corresponding category[1]	(c) Emissions (+) and removals (-) (Kt CO_2eq.)	(d) Net emissions % of the corresponding category[1,2]
4A2. Land converted to Forest Land	6 898	4%	-41 121	11%
4B2. Land converted to Cropland	10 083	8%	46 021	75%
4C2. Land converted to Grassland	14 364	15%	-26 352	804%
4D2. Land converted to Wetlands	1 314	7%	4 250	31%
4E2. Land converted to Settlements	6 552	21%	46 598	91%
4F2. Land converted to Other Land	625	4%	344	100%
Total land use changes	**39 837**	**9%**	**29 739**	**30%**

[1] The corresponding category is 4A (4.A1 + 4.A2 for Forest land) for 4A2, 4B (4.B1 + 4.B2 for 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 this year, from total area under conversion, 38% is reported as converted to Grassland, 26% as converted to Cropland, 16% as converted to Forest land, 15% as converted to Settlements, 3% as converted to Wetlands, and 1 % to Other lands.

6.1.3 Completeness of the sector

Table 6. 4 shows the current status of reporting in terms of quantitative estimates for each of the land use sub-categories. Information is taken from the individual inventories submitted this year.

This table, along with Table 6. 5 aim to provide an overview of the completeness status. Empty cells should not be directly associated with an incomplete reporting as in many cases the carbon stock changes are assumed in balance, in line with the 2006 IPCC guidelines, or none methods exist for their estimation (in these cases, such pools are marked in grey in table 6.4 and 6.5 to facilitate the assessment of the completeness).

It should also be noted that the tables provide information for the main sub-categories "remaining" and "land converted to". Under the subcategories "land converted to" there are a wide range of methods and status of completeness. For instance, certain carbon pool 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, more information is provided, with a different format in other sections of this chapter. Please refer to table providing information on implied emission factors. Moreover, is pertinent to highlight here that more detailed explanations can be found in individual inventories.

The three main land uses categories, Forest Land, Cropland and Grassland, including their sub-categories, are mostly completed with quantitative estimates. However, under certain subcategories of other land uses categories, 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 (e.g. Dead organic matter in Cropland), 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, often, lack of quantitative estimates also associates with the absence of lands being converted to certain subcategories or the absence of organic soils.

Thus, any judgement on completeness would require a comprehensive case by case assessment, for which it is not possible to include the full set of information in this inventory, and therefore we refer to the country specific information that can be found in individual GHG inventories.

Table 6. 4 Sector 4 LULUCF: Coverage of CO_2 emissions and removals for each of the LULUCF sub-categories for the inventory year, as derived from individual 2020 GHGI submissions

Country	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	R		E		E		E	R
Belgium	R	R	E	E	R	R		R		E			R
Bulgaria	R	R	R	E	E	R		E		E			R
Croatia	R	R	E	E	E	R		E		E			R
Cyprus	R	R	R	R	R	R		R		E		E	E
Czech Republic	E	R	E	E	R	R		E		E			R
Denmark	E	R	E	E	E	E	E			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			R
Germany	R	R	E	E	E	R	E	E	E	E			R
Greece	R	R	E	E	E	R		E		E		E	E
Hungary	R	R	R	E	E	E	E	R		E		E	R
Ireland	R	R	R		E	E	E	R		E		E	R
Italy	R	R	R	E	R	R		E		E			R
Latvia	R	R	E	E	E	E	E	E	E	E			R

Country	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	
Lithuania	R	R	R	E		R	E			E		E	R
Luxembourg	R	R	E	E		R		E		E		E	R
Malta			R	E	R	R				E		E	
Netherlands	R	R	E	E	E	R	R	E	E	E		E	E
Poland	R	R	R	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	E	R	R	E	R	R		E	R	E		E	R
Spain	R	R	R	E		E	E	E		E		E	R
Sweden	R	R	E	E	R	E	E		E	E		E	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. Specifically, looking at their subcategories "land remaining in" whose carbon stock changes are often assumed in equilibrium. On the contrary, carbon stock changes are estimated and reported for land use changes involving such categories.

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.

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 the Tier 1 assumptions, demonstrating the insignificance of the resulting carbon stock changes, because the lack of 2006 IPCC methods, because the absence of organic soils, or because the pool is included elsewhere).

Table 6. 5 **Sector 4 LULUCF: Quantitative estimates of carbon stock changes on carbon pools for the most important land use subcategories for the current inventory year.**

COUNTRY	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	DW	LT	SOC min	SOC org	LB	DW	LT	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org
AUT	R	R		E		R	R	R	R		E		R		E	E	E		R	R		E		R	R	R
BEL	R					R	R	R	R		R		E	E	R		E		R					R	R	R
BGR	R	E				R	E				E		R		R		E		R	E				R	E	
HRV	R					R	R	R	E		E		E	E	R		E		R					R	R	R
CYP	R					R	E	R	R		R				R	E	R		R					R	E	R
CZE	E	E				R	R	R	R		R		E		E	E	E		E	E				R	R	R
DNM	R	E	E		E	R	E	E	R	E	E		E	E	R	E	E		R	E	E		E	R	E	E
EST	R	R		R	E	R	R	R	R	E	E		R	E	E	E	E	E	R	R		R	E	R	R	R
FIN	R			R	E	R			R	E	R		E	E	E	E	E	E	R			R	E	R		
FRA	R	E				R	R	R	R		E		R		E	E	E		R	E				R	R	R
DEU	R	R	E	R	E	R	R	R	R	E	R		E	E	E		E	E	R	R	E	R	E	R	R	R
GRC	R					R					E			E	E		E		R					R		
HUN	R	R			E	R	R	R	R		E		R		E	E	E		R	R			E	R	R	R
IRL	R		R	E	E	R			R	E	R		R						R		R	E	E	R		
ITA	R	R	R			R	R	R	R		E		R	E	E		E		R	R	R			R	R	R
LVA	R	R			E	R	R	R		E	R	E		E	E	E	E	E	R	R			E	R	R	R
LTU	R	R				R		R	R		R		R		E	E	E		R	R				R		R
LUX	R	R				R	R	R	R		E		R		E	E	E		R	R				R	R	R
MLT											R		R		R		E									
NLD	R	R			E	R			R	E				E	E	E	E	E	R	R			E	R		
POL	R			R	E	R			R	E	R		E	E	E		E	R	R			R	E	R		
PRT	R		E	E		R		R	R		R		R		E	E	E		R		E	E		R		R
ROU	R	R			E	R			R		R	E	R	E	R	E	E		R	R			E	R		
SVK	R					R		R	R		R		R				R		R					R		R

COUNTRY	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	DW	LT	SOC min	SOC org	LB	DW	LT	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org									
SLV	E	R				R	R	R	R		R		R	E	R		E	E	E	R				R	R	R									
ESP	R					R	R	R	R		R		R		R	E	E		R					R	R	R									
SWE	R	R	E	R	E	R	R	R	E	E	R	R	E	E	E	E	E	E	R	R	E	R	E	R	R	R									
UK	R	R	R	R	R	R	R	R	E	E	E		E	E	R			E	R	R	R	R	R	R		R									
ISL	R				E	R				E			R	E				E	R				E	R											

Pools: DW-Dead Wood, LT- Litter, 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 could be associated with incompleteness. See more details in following sections.

Source: EU MS, UK and Iceland submissions 2020, CRF table 4A-4C

For the sake of completeness, several improvements have been recently introduced by countries, which have resulted in a more complete reporting of this sector. Specifically, carbon stock changes are now including in:

- GBK: Dead Wood under the category 4.A.1 and 4.A.2.
- IRL: Soil organic carbon in mineral soils under the category 4.A.1 and 4.A.2.
- NLD: Soil organic carbon in organic soils under the category 4.A.1.
- SLV: Living Biomass and soils organic carbon in mineral soils under the category 4.C.1 and dead organic matter under 4.A.2.
- LVA: Dead organic matter under the category 4.B.2.
- POL: Living Biomass under the category 4.B.2.
- HRV: Dead organic matter under 4.A.2.
- LUX: Carbon stock changes under HWP.
- BEL: Carbon stock changes under HWP completed for the whole time series.

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 countries 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 countries 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 guidelines) is likely to result in more accurate 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 in individual GHG inventories.

Usually, for reporting carbon stock changes in "lands remaining in the same category", a single data source is used, which facilitate the categorization of the methodologies under a single Tier. By contrast, multiple data sources are often used to derive emissions from “land converted to” which prevents an easy 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 than for cropland converted to grassland), Table 6. 6 is intended to show only a summary of the main information on methods and carbon stock changes factors used by individual inventories.

Finally, because of different underlying methods applied by each country, 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 EU MS, UK and ISL to calculate CO_2 emissions and removals of different carbon pools in the LULUCF sector, as reported in this year GHGI submissions.

COUNTRY	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	D	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	D	D,D	D	NO	CS	CS	CS	NE	D	NE	NE	NE	CS, D	NE	CS	NE	D	NE	NE	NE	CS	CS	CS	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	D	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
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

COUNTRY	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)
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 2020, 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
1(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	2018		1990	2018
4.A.1 Forest Land remaining Forest Land (CO_2)	-359654	-332111	T	L	L
4.A.2 Land converted to Forest Land (CO_2)	-39301	-41497	T	L	L
4.B.1 Cropland remaining Cropland (CO_2)	26493	15429	T	L	L
4.B.2 Land converted to Cropland (CO_2)	46951	42467	T	L	L
4.C.1 Grassland remaining Grassland (CO_2)	46225	28968	T	L	L
4.C.2 Land converted to Grassland (CO_2)	-20521	-26633	0	L	L
4.D.1 Wetlands: Land Use (CO_2)	7907	9578	T	0	L
4.E.2 Settlements: Land Use (CO_2)	34467	43140	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-31462	-44621	T	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. In terms of area, it represents about 36% of the total. Based on individual submissions reported this year, total forest area reached in 2018, 166.791 Kha, which represents an increase of 5% as compared with 1990.

About 4% 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 less grazing pressure and the abandonment of agricultural activities, which together promote the natural forest expansion. But an important driver behind them has been also the promotion of national afforestation programs, including grant-aid.

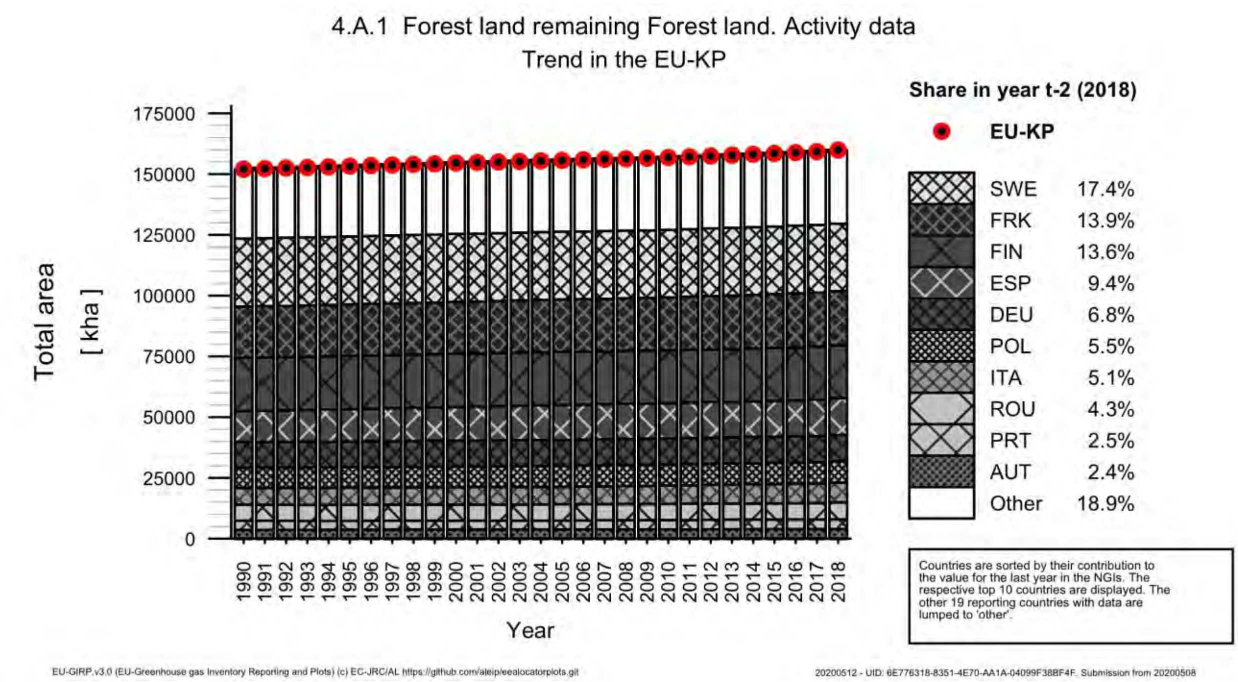
The largest forest area is reported by Sweden, France and Finland, which together report about 45% of the total forest area at EU level. Deforestation does not appear to be a major issue in Europe. Moreover, the absolute area under conversion from forest is by far compensated by new planting areas and natural forest expansion.

6.2.1.2 **Forest Land remaining Forest Land (CRF 4A1)**

Overview of Forest Land remaining Forest Land category

As with the main category, the area of Forest Land remaining Forest Land reported for the inventory year increased by 5% as compared with 1990. However, at the level of individuals submissions there are significant differences. For instance, UK reports an increase of about 39%, 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-KP (kha, 1990-2018)



For this inventory year, the total land area reported under the sub-category 4.A1 reached 159.893 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 -332.111 kt CO_2, decreasing by 8% as compared in 1990. The major contributors are Germany, France, and Sweden (Table 6. 8).

Table 6. 8 4A1 Forest Land remaining Forest Land: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	-7 849	-2 578	-2 577	0.8%	5 272	67%	1	0%
Belgium	-1 724	-1 133	-1 133	0.3%	591	34%	0	0%
Bulgaria	-16 777	-6 234	-6 218	1.9%	10 559	63%	16	0%
Croatia	-6 689	-4 470	-5 125	1.5%	1 565	23%	-655	-15%
Cyprus	-33	-142	-130	0.0%	-97	-295%	12	9%
Czechia	-4 093	-822	7 835	-2.4%	11 929	291%	8 657	1053%
Denmark	-554	117	512	-0.2%	1 066	192%	396	339%
Estonia	-3 607	-2 536	-2 832	0.9%	775	21%	-296	-12%
Finland	-23 983	-26 826	-19 870	6.0%	4 113	17%	6 956	26%
France	-33 458	-42 736	-42 171	12.7%	-8 713	-26%	565	1%
Germany	-69 628	-62 670	-62 514	18.8%	7 114	10%	156	0%
Greece	-1 142	-2 076	-2 079	0.6%	-937	-82%	-4	0%
Hungary	-3 108	-3 803	-3 271	1.0%	-162	-5%	532	14%
Ireland	-3 855	-517	-487	0.1%	3 368	87%	30	6%
Italy	-15 002	-18 276	-27 772	8.4%	-12 770	-85%	-9 496	-52%
Latvia	-17 547	-5 601	-4 013	1.2%	13 534	77%	1 588	28%
Lithuania	-7 480	-3 943	-4 087	1.2%	3 393	45%	-144	-4%
Luxembourg	115	-373	-203	0.1%	-317	-277%	170	46%
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Netherlands	-1 767	-1 348	-1 362	0.4%	405	23%	-14	-1%
Poland	-32 625	-33 602	-33 876	10.2%	-1 251	-4%	-274	-1%
Portugal	-4 151	6 840	-6 580	2.0%	-2 429	-59%	-13 420	-196%
Romania	-19 875	-18 696	-20 284	6.1%	-409	-2%	-1 588	-8%
Slovakia	-6 347	-4 080	-3 432	1.0%	2 915	46%	648	16%
Slovenia	-4 581	586	988	-0.3%	5 569	122%	401	68%
Spain	-21 396	-29 271	-29 502	8.9%	-8 105	-38%	-231	-1%
Sweden	-38 134	-43 811	-43 773	13.2%	-5 639	-15%	37	0%
United Kingdom	-14 334	-18 178	-18 088	5.4%	-3 753	-26%	90	0%
EU-27+UK	**-359 627**	**-326 177**	**-332 044**	**100%**	**27 583**	**8%**	**-5 867**	**-2%**
Iceland	-16	-33	-34	0.0%	-19	-119%	-1	-4%
United Kingdom (KP)	-14 345	-18 211	-18 120	5.5%	-3 775	-26%	91	0%
EU-KP	**-359 654**	**-326 244**	**-332 111**	**100%**	**27 543**	**8%**	**-5 867**	**-2%**

For the year 2018, with the exception of Czech Republic, Denmark and Slovenia, individual submissions report a net carbon sink under Forest Land remaining Forest Land.

Important changes, as compared with 1990, are mainly due to the increase in harvesting rates as reported by Czech Republic, Bulgaria, Latvia and Germany. By contrary, France, Italy and Spain report a significant increase of the carbon sink driven by a steady increase of the forest area that result in a net carbon accumulation.

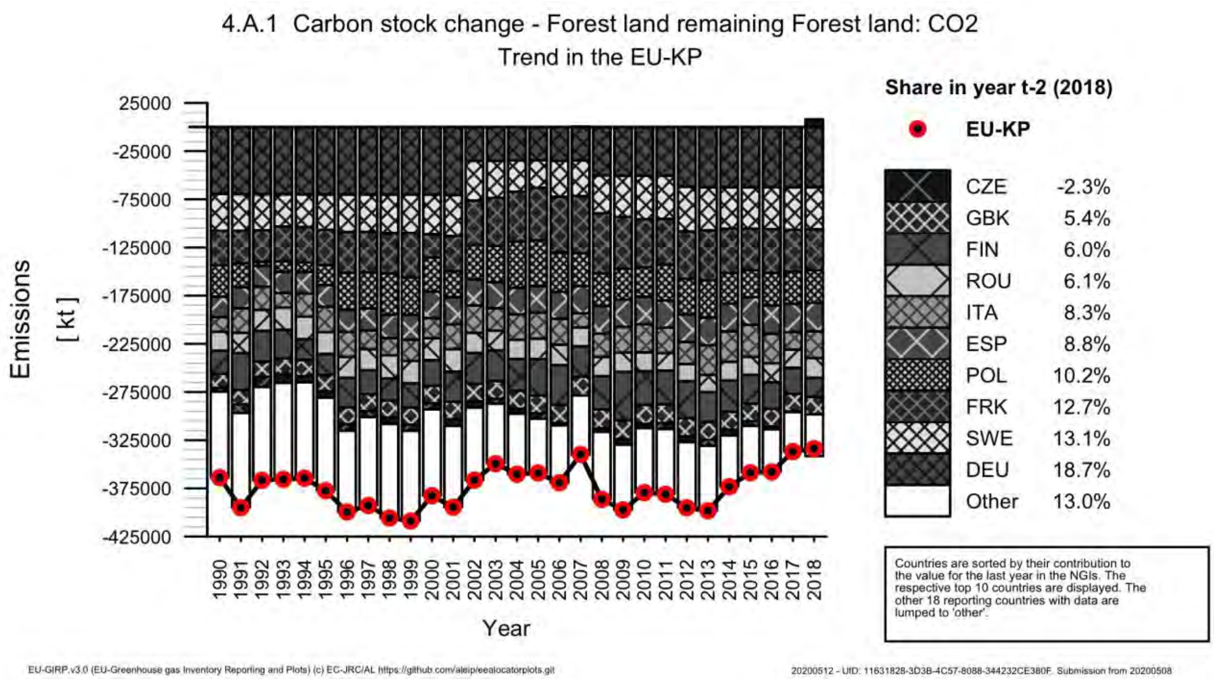
In some cases this category has shifted throughout the years from a net sink to a net source of carbon as occurred, for instance, in Denmark due to the age distribution of the forests.

A particularity is given by Malta that having small areas of forests (0.072 Kha) does not report the carbon stock changes in this land use category following a recommendation of the UN´s expert review team (ERT). Indeed, the ERT noted that the use of IPCC factors, which are not suited for its 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 the meantime, Malta has stated to be working on the acquisition of new data that will allow the reporting of this category in future submissions. Moreover, Malta stated that no wildfires were identified in the mentioned woodlands and that controlled burning cannot occur due to the protection regime that applies to its forest areas.

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 90% of the EU removals (Figure 6. 4).

Figure 6. 4 Trend of emissions (+)/removals (-) in subcategory 4A1 "Forest land remaining Forest Land" in EU-KP (kt CO_2, 1990-2018)



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 central European countries, resulted in a significant source of GHG emissions for specific years that are reflected in the trend at EU level.

Noticeable, is the reporting by Portugal and Italy for the year 2017 of large forest areas affected by wildfires. The impact of these events is a reduction of the forest sink of about 22.550 kt CO_2 due to wildfires which is well reflected in the EU trend of this sector. For the year 2018, the incidence of wildfires seems to be minor than in 2017 but still significant as compared with the average of the time series, a consequence attributable to the new climate conditions.

The CO_2 emissions from biomass burning are, in many cases, implicitly reported 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 carbon budget of the category (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 for single years in the GHG inventories. Other types of disturbances generally have a much localized effects even if, sometimes, they have lower magnitude.

In general, emissions from natural disturbances are not easy 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 the long term estimation through 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, 2017; Italy in 1990, 1993 and 2007, 2017).
- Windstorms (e.g. France in 1999 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 inventory systems in terms of time and space. The forest definitions among countries slightly differ in terms of the 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 reporting 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 countries have changed their forest definition since 1990, but recalculations of the whole time series ensured the consistency on activity data (see dedicated section on this chapter). 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 because it depends on several factors (i.e. land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but is considered small.

Table 6. 9 Quantitative thresholds used to define forests as selected by individual EU MS, UK and Iceland

Country	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)*	20
France	10	5	0.5	20
Germany	10	5	0.1	-
Greece	25	2	0.3	-
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	-
Malta	30	5	1	-
Netherlands	20	5	0.5	30
Poland	10	2	0.1	10
Portugal	10	5	1	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	-
United Kingdom	20	2	0.1	20
Iceland	10	2	0,5	20

**Finland uses 0.25 for southern territories and 0.5 for Northern*

Table 6. 10 Additional qualitative criteria used to define forests complementing quantitative thresholds.

Country	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)
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 does not include municipal parks and gardens.
Czechia	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 available.
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.

Country	Forest land definition
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 available.
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.
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 waiting 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, the estimation of areas, and for the estimation of carbon stock changes in various pools. Nevertheless, this information is, in very few cases, 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, countries 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).

Given that annual data are barely available for this sector, efforts are devoted to adjust the timing of inventory cycles to the timeline of the Kyoto Protocol's accounting frequency. To meet 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, Copernicus products or Corine Land Cover data.

Furthermore, countries usually have disaggregated forest land areas in various subdivisions according to available datasets. The breakdown criteria differ across countries, 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 (e.g. northern, southern territories), 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 methods and transition periods. Usually, carbon stock in understory biomass is only accounted in principle for estimating forest fires emissions.

Table 6. 11 Explicit information on forest carbon pools definitions as reported by EU MS, UK and Iceland.

Country	***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

Country	Description
	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	Modelled 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	Modelled 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.
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.
Czechia, Italy,	Applies a country specific “root- to-shoot” factor.

Country	Description
Poland, Spain	
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 b 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 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.

Country	Description
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 topsoil, also includes the C stock of the litter layer (humus layer).
Croatia	Organic carbon in 0-40 cm topsoil.
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 guidelines 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 for estimating carbon stock changes in forest aboveground biomass.

Country	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 countries, 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 countries 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 this inventory year range from -0.80 to 1.17 to T C ha^{-1} (Table 6. 13). Generally, low values of IEF are shown by countries with high harvesting rates or with less favorable climatic conditions (i.e. lower growth and also more losses by natural disturbances); while higher values are reported by 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 2020.**

Country	Net carbon stock change factor in living biomass t C/ha	
	1990	2018
AUT	0,77	0,31
BEL	0,67	0,45
BGR	1,30	0,46
HRV	0,79	0,61
CYP	0,06	0,23
CZE	0,45	-0,80
DNM	0,37	1,26
EST	0,31	0,23
FIN	0,34	0,19
FRK	0,46	0,54
DEU	1,43	1,16
GRC	0,10	0,17
HUN	0,46	0,45
IRL	2,55	0,52
ITA	0,55	0,91
LVA	1,54	0,24
LTU	0,98	0,50
LUX	-0,49	0,48
MLT	NA	NA
NLD	1,32	1,14
POL	1,04	0,97
PRT	0,40	0,49
ROU	0,83	0,80
SVK	0,96	0,48
SVN	1,18	-0,40
ESP	0,46	0,53
SWE	0,35	0,34
GBK	1,12	0,75
ISL	0,05	0,10

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 4.A (see also Table 6. 5 and Table 6. 6).

When they are estimated, countries 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 assumption 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, an increasing number of countries document on ongoing efforts to estimate emissions and removals from dead organic matter and mineral soils. This has resulted in more countries reporting for first time carbon stock changes in these pools using country-specific data.

When data on soil organic carbon content is available, they are either directly used for estimating carbon stock changes using stock difference approach, or gain-loss methods. In few cases, data is also integrated in models. Moreover, depending on the availability of datasets in individual countries, carbon stock changes in dead organic matter are often disaggregated between dead wood (DW) and litter (LT) or some countries include their estimates within soil organic carbon pool (e.g. Finland).

Finally, a particularity is reported by France that reports carbon stock changes in dead organic matter only for part of the time-series. In line with the 2006 IPCC guidelines, France reports carbon stock changes in the pool stating in 1999 as a result of the significant carbon inputs that entered into the pool after some windstorm that affected dramatically the forest area in that year.

Table 6. 14 Implied carbon stock change factors in DOM carbon pool in 4A1 (t C ha-1 yr-1) reported in individual GHGI 2020.

Country	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2018	1990	2018
AUT	0,02	0,06	NE,IE	NE,IE
BEL	NO	NO	NO	NO
BGR	0,00	0,00	NO,NE	NO,NE
HRV	NO	NO	NO	NO
CYP	NO	NO	NO	NO
CZE	-0,01	-0,01	NO	NO
DNM	0,01	-0,10	-0,01	-1,34
EST	0,02	0,01	NO	NO
FIN	IE	IE	IE	IE
FRK	NE	-0,02	NE	NE
DEU	0,04	0,09	-0,01	-0,01
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	0,03	0,02	NO	NO
IRL	IE	IE	0,11	0,12
ITA	0,02	0,01	0,03	0,01
LVA	0,05	0,21	NA	NA

Country	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2018	1990	2018
LTU	0,07	0,04	NO	NO
LUX	0,09	0,11	NO	NO
MLT	NA	NA	NA	NA
NLD	0,08	0,07	NO	NO
POL	NO	NO	NO	NO
PRT	IE	IE	0,00	0,00
ROU	NO	0,00	NO	NO
SVK	NA	NA	NA	NA
SVN	0,10	0,17	NO	NO
ESP	NA	NA	NA	NA
SWE	0,04	0,06	-0,10	-0,08
GBK	0,27	0,30	0,06	0,03
ISL	NO,IE	NO,IE	NA	NA

Carbon stock changes in mineral soils under forest land remaining forest land in this submission are quantitatively estimated generally as a small net sink of carbon. (Table 6. 15).

Most of the countries report absence or insignificant areas of organic soils under this land use subcategory. However, when organic soils are presented, they are reported, in most of the cases, as resulting in a net source of emissions.

CO_2 emissions from organic soils are associated with managed forests (e.g. drainage of soils to establish plantations), and only UK reports a sink of carbon from organic soils in this sub-category, the reasoning for this can be found in its national inventory report.

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 2020.

Country	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	2018	1990	2018
AUT	-0,19	-0,18	NO	NO
BEL	NO	NO	NO	NO
BGR	NO,NE	NO,NE	NO	NO
HRV	NO	NO	NO	NO
CYP	NO	NO	NO	NO
CZE	NO	NO	NO	NO
DNM	NA	NA	-1,95	-1,30
EST	0,17	0,17	-0,18	-0,18
FIN	0,15	0,15	-0,56	-0,19

FRK	NE	NE	NO	NO
DEU	0,41	0,41	-2,74	-2,57
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NO	NO	-2,60	-2,60
IRL	-0,05	-0,05	-0,55	-0,45
ITA	NO,NA	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	NA	NA	-1,05	-0,93
POL	0,05	0,10	-0,68	-0,68
PRT	0,02	0,00	NO	NO
ROU	NO	NO	-0,68	-0,68
SVK	NA	NA	NO	NO
SVN	NO	NO	NO	NO
ESP	NA	NA	NO	NO
SWE	0,16	0,19	-0,37	-0,35
GBK	0,22	0,41	-0,10	0,65
ISL	NA	NA	-0,37	-0,37

6.2.1.3 Land converted to Forest Land (CRF 4A2)

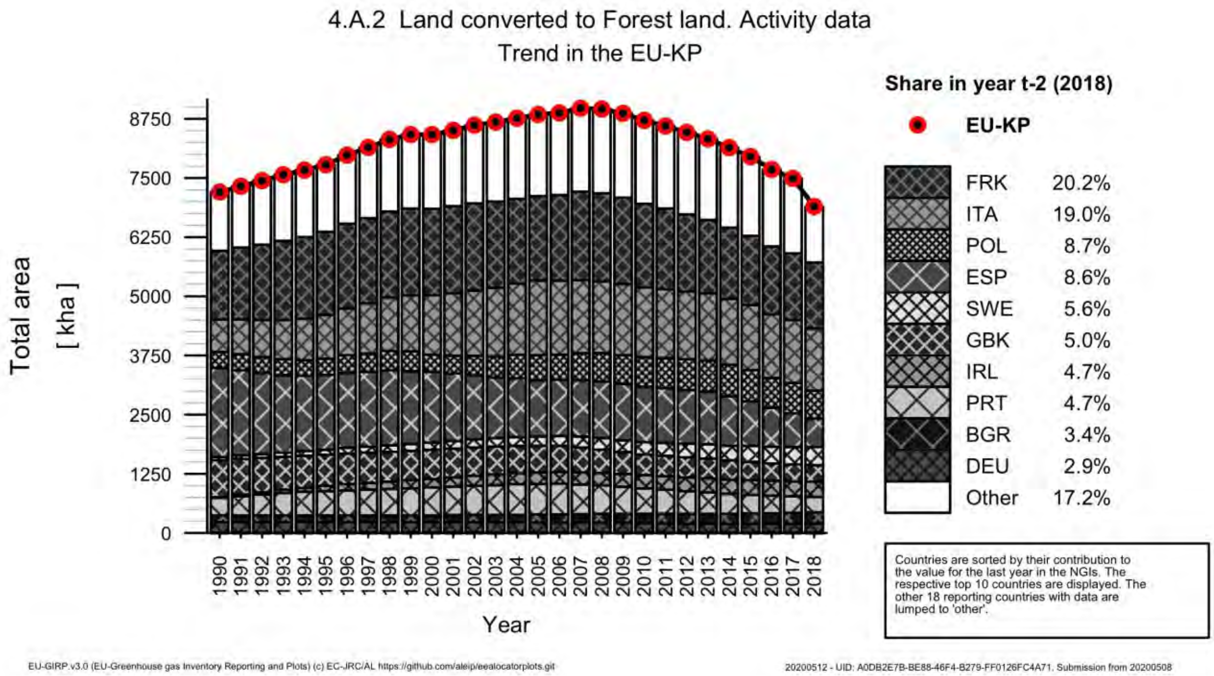
Overview of Land converted to Forest Land category

In this submission, the area reported under this subcategory represents 4% of the total Forest area. This subcategory has decreased by 4% as compared with 1990 (Figure 6. 5), from 7.204 Kha in 1990 to 6.898 Kha in 2018.

Most of the new forest lands take place from former Grasslands and Cropland areas, and although within the overall category they have a low share in terms of areas, they contribute by 11% to the total carbon sink of the European forest.

In term of areas, Italy, France, Poland, and Spain together contribute with about 55% of the total areas being converted to forest land.

Figure 6. 5 Trend of activity data in subcategory 4A2 "Land converted to Forest Land" in EU-KP (kha, 1990-2018)



This subcategory has been always reported as a net carbon sink. In this submission, it reaches 41.497 kt CO_2, which represents an increase of 6% as compared with 1990. This trend in removals is well associated with the trend on areas (Figure 6. 6; Table 6. 16).

Nevertheless, some MS (e.g. Finland, Netherlands, Slovenia and Sweden) 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 that are previous to the afforestation or reforestation activities. The absence of such emissions is often associated with natural expansion of forest areas.

Table 6. 16 4A2 Land converted to Forest Land: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	-3 043	-1 735	-1 729	4.2%	1 314	43%	6	0%
Belgium	-8	-125	-119	0.3%	-111	-1351%	7	5%
Bulgaria	-924	-1 313	-1 355	3.3%	-432	-47%	-42	-3%
Croatia	-29	-176	-260	0.6%	-231	-800%	-84	-48%
Cyprus	-13	-38	-34	0.1%	-21	-167%	5	12%
Czechia	-353	-565	-553	1.3%	-200	-57%	12	2%
Denmark	-20	-252	-163	0.4%	-144	-724%	89	35%
Estonia	-14	-134	-129	0.3%	-115	-825%	5	4%
Finland	116	-211	-197	0.5%	-314	-269%	14	7%
France	-7 256	-8 493	-8 355	20.1%	-1 099	-15%	138	2%
Germany	-1 677	-4 524	-4 762	11.5%	-3 085	-184%	-238	-5%
Greece	NE,NO	-46	-42	0.1%	-42	-∞	4	9%
Hungary	-305	-1 306	-1 250	3.0%	-945	-310%	56	4%
Ireland	-7	-3 492	-3 335	8.0%	-3 329	-49183%	156	4%
Italy	-2 849	-4 224	-5 699	13.7%	-2 850	-100%	-1 475	-35%
Latvia	-14	-220	-209	0.5%	-195	-1392%	12	5%
Lithuania	-799	-1 043	-1 069	2.6%	-270	-34%	-26	-2%
Luxembourg	-303	-72	-57	0.1%	247	81%	15	21%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	32	-496	-494	1.2%	-526	-1624%	2	0%
Poland	-1 387	-2 998	-2 748	6.6%	-1 361	-98%	250	8%
Portugal	-2 156	-1 119	-2 350	5.7%	-194	-9%	-1 231	-110%
Romania	-3 859	-3 858	-84	0.2%	3 775	98%	3 773	98%
Slovakia	-2 210	-369	-362	0.9%	1 848	84%	7	2%
Slovenia	93	-343	-273	0.7%	-366	-393%	70	20%
Spain	-11 369	-5 125	-4 239	10.2%	7 130	63%	886	17%
Sweden	73	-981	-1 032	2.5%	-1 104	-1521%	-50	-5%
United Kingdom	-970	-247	-243	0.6%	727	75%	4	2%
EU-27+UK	**-39 251**	**-43 505**	**-41 142**	**99%**	**-1 891**	**-5%**	**2 363**	**5%**
Iceland	-27	-352	-354	0.9%	-327	-1200%	-1	0%
United Kingdom (KP)	-993	-249	-245	0.6%	748	75%	4	2%
EU-KP	**-39 301**	**-43 859**	**-41 497**	**100%**	**-2 197**	**-6%**	**2 362**	**5%**

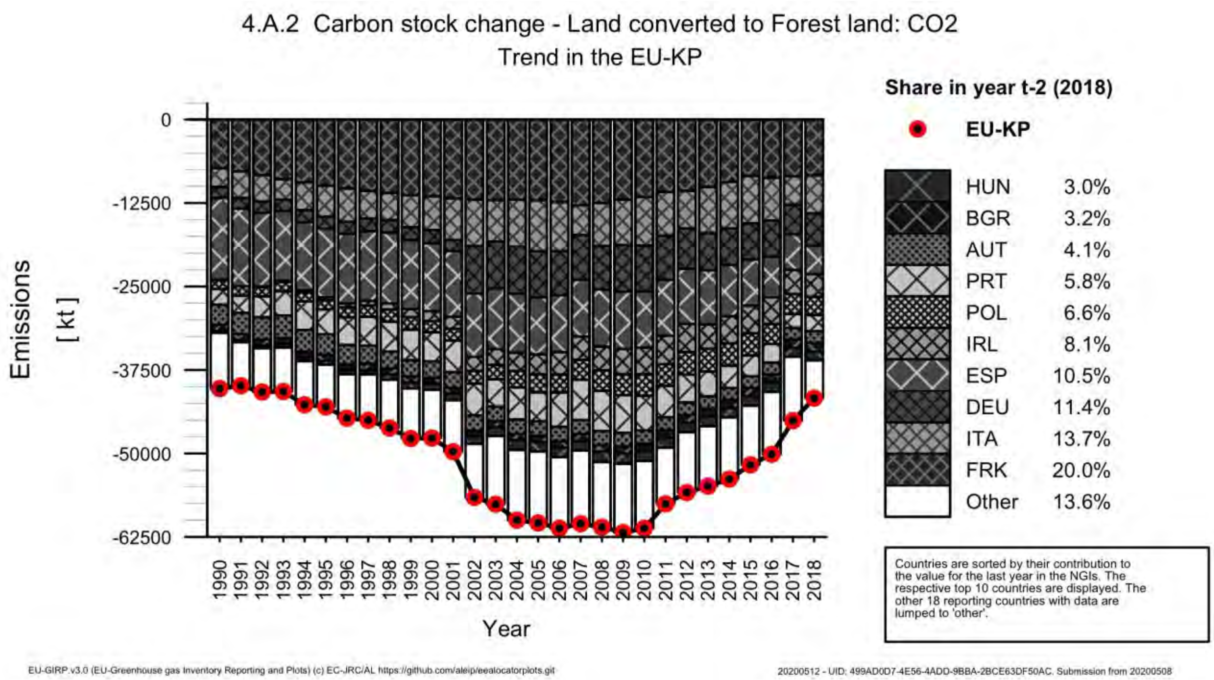
As shown in Table 6. 16, some MS reported significant changes in this subcategory as compared with 1990, for instance, Finland, Sweden, Ireland and Spain.

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 lands converted in forests balanced the removals; much less drainage of organic soils occur in the last years of the time series and therefore larger sink was reported as a result of the carbon accumulation in living biomass..

In the case of Ireland, the increase on removals by the post-1990 forest is due to an increase in forests area, and their 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, the changes in the carbon sink reported by Sweden and Spain are driven by the trend of the area in this category. While Sweden reports a constant increase of land converted to forests, Spain reports a constant decrease that is well reflected in a lower the sink at the end of the time series as compared with the base year.

Figure 6. 6 Trend of emissions (+)/removals (-) in subcategory 4A2 "Land converted to Forest Land" in EU-KP (kt CO_2, 1990-2018)



For this year, about 45% of total carbon sink reported in the subcategory 4A.2 was reported by France, Italy, and Germany while the 10 MS with the larger contribution represent about the 83% 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 the associated 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 the 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 year, Italy was requested to probe that its method does not result in bias estimates. Italy has informed that the For-est model, in its current version does not differentiate between forest land remaining forest land and land converted to forest land since all variables are calculated (current increment, mortality) or collected (harvest, burnt area) at the landscape level.

The apportioning among forest land remaining forest land for the increment is made on the basis of the area proportion of this category over the entire forest area. Regarding losses, the harvest is all assigned to forest land remaining forest land, while the burnt area is divided between subcategories on the basis of the percentage of area of each subcategory in a yearly basis. Moreover, an analysis carried out by Italy across European forest reports showed that its approach does not cause any bias in the GHG estimates, so far as can be judged.

Most of the countries 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 sampling plots, and that, in many cases, is complemented by auxiliary information on the form of satellites images or aerial photography, or 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 countries, 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 the countries 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 quantity of CO_2 emissions estimated from the land that is converted to forests, including lagged emissions.

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 reported this year, Cropland areas covered in 2018 about 125.000 kha, which represent 28% of the lands reported by EU MS, UK and Iceland. However the category shows a steady decreasing trend. For this inventory year the area is about 8% less than in the year 1990.

6.2.2.2 **Cropland remaining Cropland (CRF 4B1)**

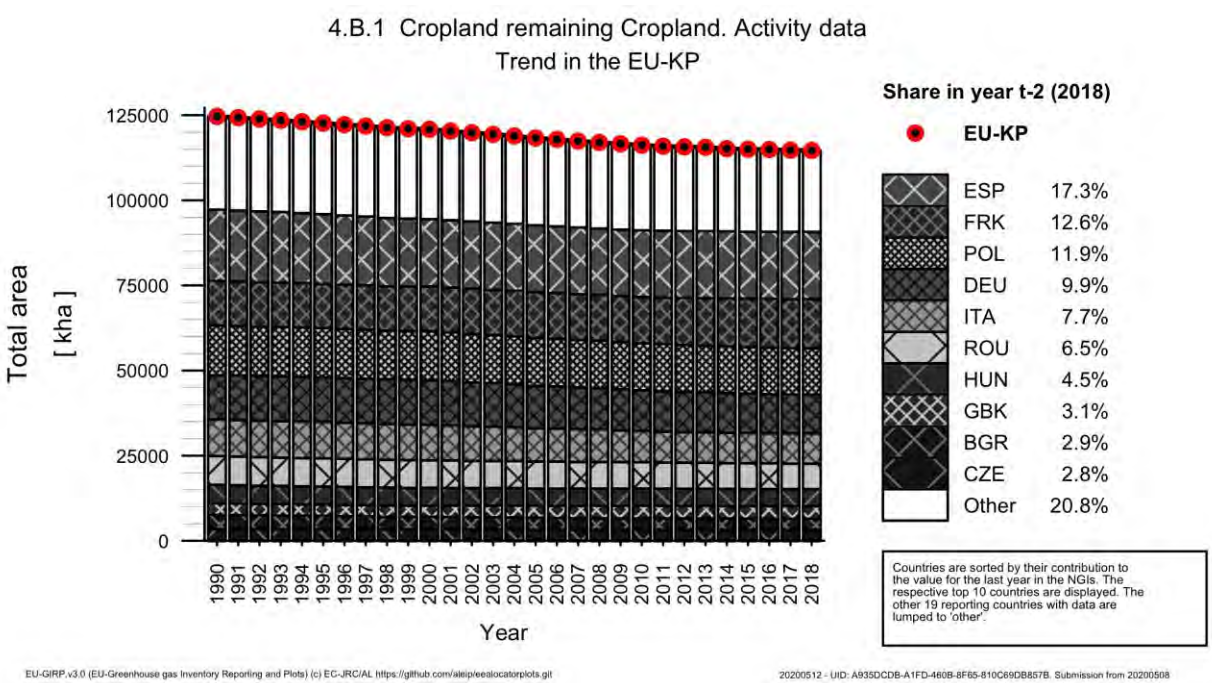
Overview of Cropland remaining Cropland category

In line with the overall category, this subcategory has constantly decreased since 1990 (Figure 6. 7) from 124.634 kha in 1990 to 114.654 kha in 2018. This represents a decrease of 8%.

With the exception of France, UK, Malta, Slovakia and Iceland, other countries report 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 81% of the total area, and more specifically, Spain, France, Poland 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-KP (kha, 1990-2018)



In terms of emissions, at the EU level this subcategory has been always reported as a net source of GHG emissions.

For the year 2018, based on individual submission by EU MS, UK and ISL, GHG emissions from cropland remaining cropland reached 15.429 kt CO_2 which represents a decrease of 42% as compared to 1990 (Table 6. 17).

This trend is mainly driven by Germany, UK and Finland that 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 than those implemented 20 years before. And also, in countries with significant areas of woody crops (i.e. orchards, vineyards, Christmas trees, fruits, bushes, and olive trees) that provide a net sink resulting from carbon accumulation in the living biomass pool.

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.

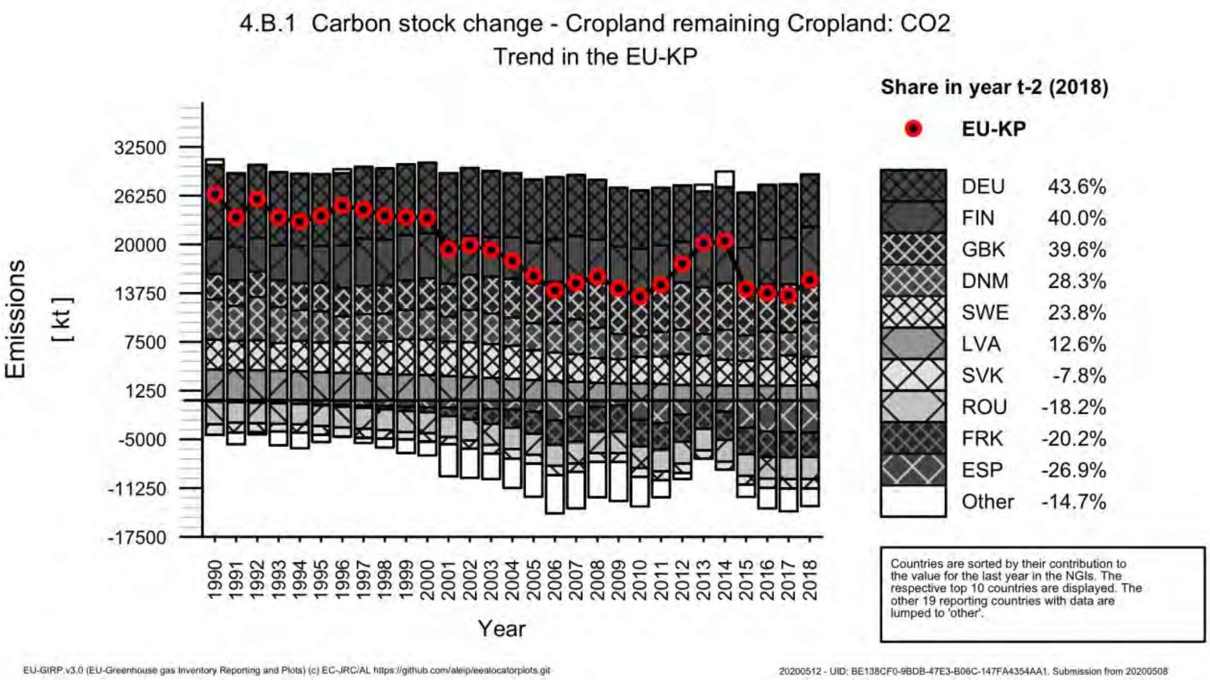
Table 6. 17 4B1 Cropland remaining Cropland: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	-18	-145	-126	-0.8%	-108	-602%	19	13%
Belgium	213	189	189	1.2%	-24	-11%	-1	0%
Bulgaria	-887	-555	-581	-3.8%	306	35%	-26	-5%
Croatia	200	315	379	2.5%	179	90%	64	20%
Cyprus	-135	-132	-132	-0.9%	3	2%	-1	0%
Czechia	90	60	54	0.4%	-36	-40%	-6	-11%
Denmark	5 145	2 979	4 369	28.3%	-777	-15%	1 390	47%
Estonia	678	276	221	1.4%	-457	-67%	-56	-20%
Finland	4 569	5 987	6 170	40.0%	1 601	35%	182	3%
France	77	-3 210	-3 116	-20.2%	-3 194	-4123%	94	3%
Germany	9 414	6 856	6 716	43.5%	-2 698	-29%	-140	-2%
Greece	-808	-140	313	2.0%	1 121	139%	453	324%
Hungary	25	-544	-468	-3.0%	-493	-1956%	76	14%
Ireland	30	-64	-160	-1.0%	-190	-636%	-97	-152%
Italy	775	-1 139	-931	-6.0%	-1 706	-220%	208	18%
Latvia	3 895	1 909	1 938	12.6%	-1 957	-50%	29	2%
Lithuania	77	-1 032	-1 047	-6.8%	-1 125	-1453%	-15	-1%
Luxembourg	-1	1	1	0.0%	2	185%	0	-14%
Malta	-1	-1	-1	0.0%	0	-39%	0	2%
Netherlands	1 636	513	468	3.0%	-1 169	-71%	-46	-9%
Poland	-2 073	-1 122	-1 096	-7.1%	978	47%	27	2%
Portugal	21	-206	-198	-1.3%	-219	-1044%	9	4%
Romania	-2 898	-2 812	-2 808	-18.2%	90	3%	3	0%
Slovakia	-1 391	-1 209	-1 208	-7.8%	183	13%	0	0%
Slovenia	-249	-182	-179	-1.2%	69	28%	2	1%
Spain	-154	-4 088	-4 149	-26.9%	-3 995	-2588%	-61	-1%
Sweden	3 811	3 849	3 675	23.8%	-137	-4%	-175	-5%
United Kingdom	3 251	6 105	6 093	39.5%	2 842	87%	-12	0%
EU-27+UK	**25 294**	**12 462**	**14 383**	**93%**	**-10 911**	**-43%**	**1 921**	**15%**
Iceland	1 189	1 060	1 035	6.7%	-154	-13%	-25	-2%
United Kingdom (KP)	3 262	6 116	6 104	39.6%	2 842	87%	-12	0%
EU-KP	**26 493**	**13 533**	**15 429**	**100%**	**-11 064**	**-42%**	**1 896**	**14%**

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.

Germany reports a significant decrease of emissions from Cropland that is mainly driven by a constant decrease of cropland areas after 2000, and by agricultural practices that result in lower emissions, for instance lower area of cultivation of histosoils.

Figure 6. 8 Trend of emissions (+)/removals (-) in subcategory 4B1 "Cropland remaining Cropland" in EU KP (kt CO_2, 1990-2018)



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 countries.

In some cases, because of the absence of annual information on activity data, coupled 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, countries have implemented a number of years before a land is shifted from/to cropland and grassland.

Table 6. 18 Definitions of lands included under the category 4B: Cropland

Country	***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.

Country	*Definition*
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.).
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

Country	***Definition***
	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, wine yards, 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 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 horticultural 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

Country	*Definition*
	soils".

In overall, following IPCC approach, the living biomass carbon pool is assumed in balance for annual crops, while carbon stock changes are reported for conversions among annual and woody crops (e.g. Austria, Croatia, and Bulgaria). Concerning carbon stock changes in woody crops, countries 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. Sweden) or as a net source (e.g. Latvia and Romania).

A particular case is given by Finland which reports 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 countries, for cultivated 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 approaches, 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).

Applied Tier 2 methods consist on country-specific soil organic carbon reference values 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. An exception is given by Austria, who derived own factors by close comparison with IPCC similar strata.

Parameters to estimate carbon stock change 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 trees 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 GHGI 2020.

Country	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	2018	1990	2018	1990	2018	1990	2018
AUT	0,003	-0,002	NO	NO	0,000	0,028	NO	NO
BEL	NO	0,002	NO	NO	-0,041	-0,040	-10,000	-10,000
BGR	-0,001	-0,005	NO	NO	0,058	0,052	NO	NO
HRV	-0,019	-0,042	NO	NO	0,000	-0,011	-10,000	-10,000
CYP	0,147	0,150	NO	NO	NO	NO	NO	NO
CZE	0,000	0,000	NO	NO	-0,007	-0,005	NO	NO
DNM	0,002	-0,005	NO	NO	-0,044	-0,082	-8,219	-7,595
EST	0,000	0,000	NO	NO	NO	0,107	-6,100	-6,100
FIN	0,000	0,000	IE	IE	0,001	-0,173	-6,479	-6,488
FRK	-0,002	-0,002	NE	NE	0,001	0,061	IE	IE
DEU	-0,001	0,000	NA	NA	-0,002	-0,001	-8,100	-8,100
GRC	0,073	-0,006	NO	NO	NO	NO	-10,000	-10,000
HUN	-0,002	-0,003	NO	NO	0,001	0,028	NO	NO
IRL	0,003	0,019	NO	NO	-0,013	0,037	NO	NO
ITA	-0,030	-0,038	NO	NO	0,031	0,091	-10,000	-10,000
LVA	0,001	0,001	0,000	0,000	NA	NA	-7,900	-7,900
LTU	-0,015	0,006	NA	NA	0,000	0,219	IE	IE
LUX	0,005	-0,006	NO	NO	0,001	0,000	NO	NO
MLT	0,162	0,202	NE	NE	0,048	0,010	NO	NO
NLD	NA	NA	NA	NA	NA	NA	-4,226	-3,594
POL	0,030	0,035	NO	NO	-0,002	-0,001	1,000	-1,000
PRT	-0,002	0,018	NO	NO	NO	0,007	NO	NO
ROU	0,018	0,038	-0,004	-0,004	0,083	0,074	-5,000	-5,000
SVK	0,245	0,204	NA	NA	0,009	0,015	NO	NO
SVN	0,329	0,327	NO,NE	NO,NE	0,000	0,006	-10,000	-10,000
ESP	0,002	0,031	NA	NA	NO	0,026	NO	NO
SWE	0,004	0,024	0,002	0,000	-0,042	-0,092	-6,220	-6,220
GBR	-0,002	0,000	NO	NO	-0,090	0,000	-5,000	-5,001
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, countries 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 some efforts have been implemented during the last years and are still ongoing to harmonize the use of the notation keys among countries; however due to resources constrains the main focus has been given to increase the completeness and accuracy of the estimates.

6.2.2.3 Land converted to Cropland (CRF 4B2)

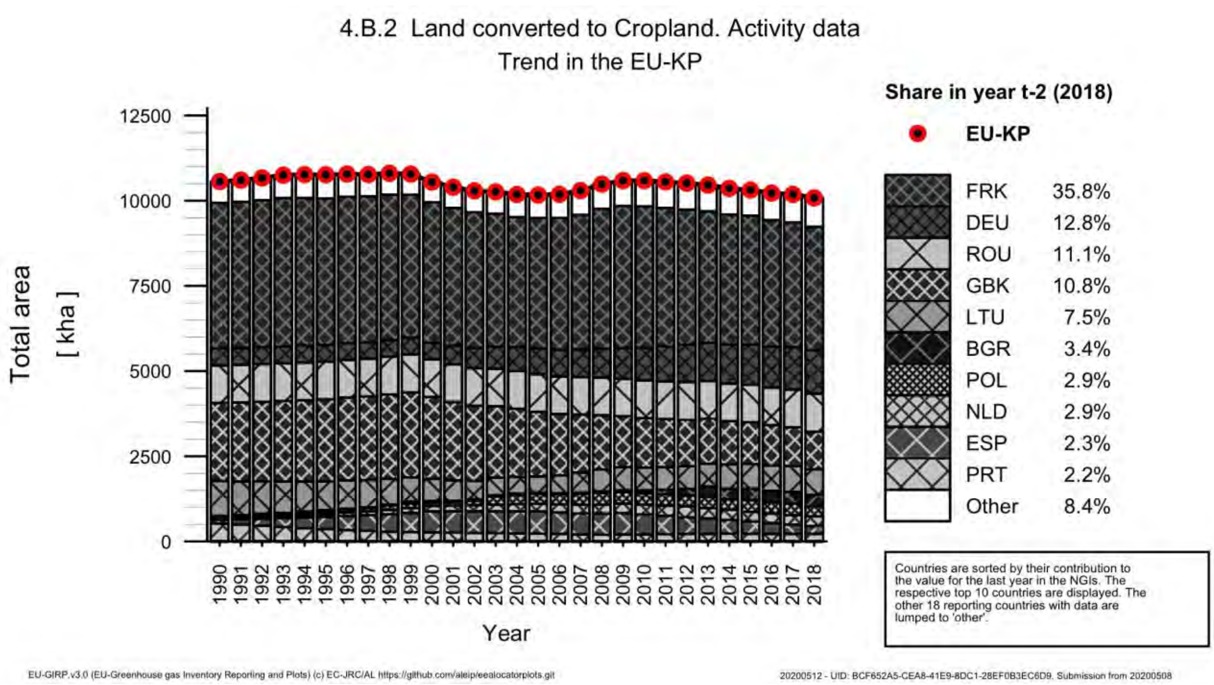
Overview of Land converted to Cropland category

In terms of area, this subcategory represents 8% of the total cropland areas reported at the level of EU MS, UK and Iceland, however it accounts for 75% of the net CO_2 emissions that are reported in Cropland.

In overall, for this inventory year the area decreased by 5% as compared with 1990 from 10.562 kha, reported for the year 1990, to 10.083 Kha (Figure 6. 9). Despite of this, contrary to the trend on areas reported under subcategory 4B.1, the decrease was not constant.

Main conversions of lands to Cropland take place from areas of Grassland and Forest land. The trend in this subcategory is mainly driven by France, Germany and Romania 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 KP (kha, 1990-2018)



In term of emissions, this subcategory is in overall reported as a net source of emissions that for the current inventory year reaches 42.467 Kt CO_2. This represents a decrease of 10% as compared to 1990 (Table 6. 20). The major driver of the trend is France that reports about 43 % of the total emissions in this subcategory; followed by Germany and UK (Figure 6. 10).

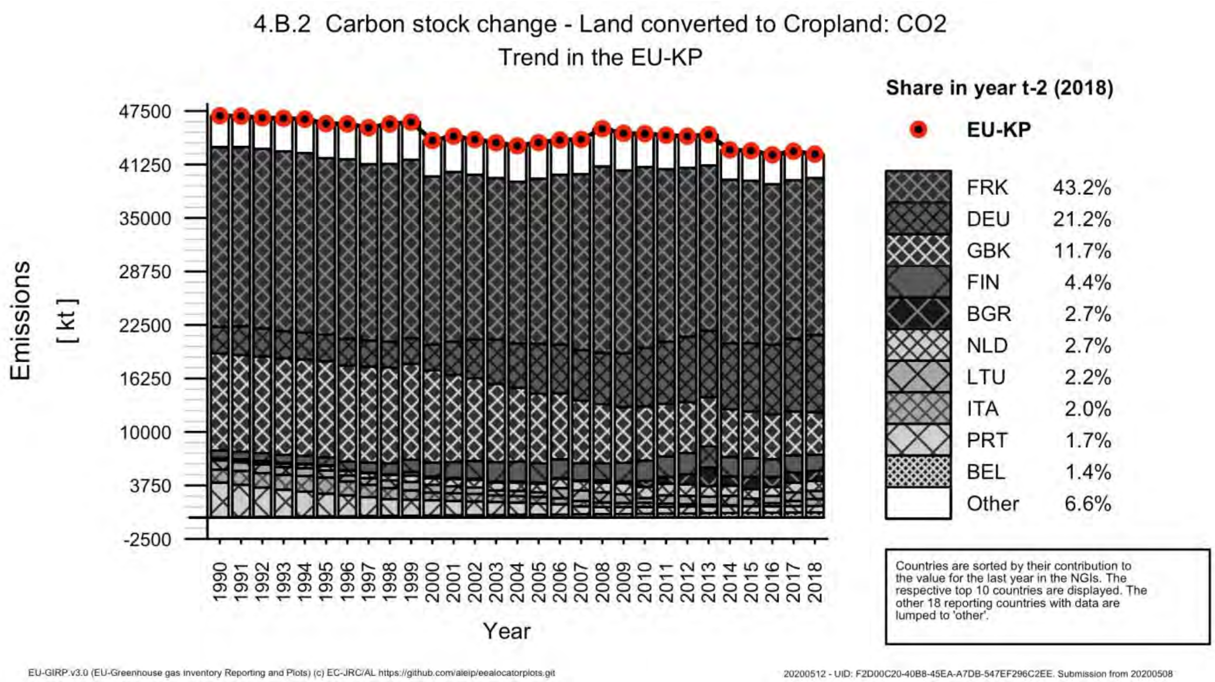
Nevertheless, some individual inventories report this subcategory as a small carbon sink as a result of removals from the living biomass carbon pool when Grassland or Other lands are converted to Croplands with woody vegetation (e.g. Cyprus and Denmark). With some few exceptions, all the other carbon pools have been reported as a net source of emissions.

Table 6. 20 4B2 Land converted to Cropland: EU-KP contributions to net CO_2 emissions (+)/ removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	194	227	231	0.5%	37	19%	4	2%
Belgium	31	569	591	1.4%	560	1792%	21	4%
Bulgaria	127	1 189	1 167	2.7%	1 040	821%	-22	-2%
Croatia	23	72	70	0.2%	47	202%	-2	-3%
Cyprus	-4	-24	-21	-0.1%	-18	-455%	3	12%
Czechia	116	74	43	0.1%	-72	-63%	-31	-42%
Denmark	1	-6	47	0.1%	46	6479%	52	936%
Estonia	NO	95	85	0.2%	85	∞	-10	-11%
Finland	854	1 989	1 886	4.4%	1 032	121%	-103	-5%
France	20 999	18 540	18 348	43.2%	-2 651	-13%	-192	-1%
Germany	3 100	8 507	9 022	21.2%	5 922	191%	515	6%
Greece	52	16	14	0.0%	-38	-72%	-2	-9%
Hungary	120	311	246	0.6%	126	105%	-65	-21%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	1 518	599	835	2.0%	-683	-45%	236	39%
Latvia	11	392	399	0.9%	387	3441%	6	2%
Lithuania	1 063	1 021	954	2.2%	-110	-10%	-68	-7%
Luxembourg	74	31	31	0.1%	-43	-58%	0	-1%
Malta	4	4	4	0.0%	0	4%	0	6%
Netherlands	180	1 136	1 152	2.7%	972	540%	16	1%
Poland	913	553	484	1.1%	-430	-47%	-69	-13%
Portugal	4 048	752	738	1.7%	-3 310	-82%	-14	-2%
Romania	742	742	383	0.9%	-358	-48%	-358	-48%
Slovakia	466	66	60	0.1%	-406	-87%	-6	-9%
Slovenia	156	33	36	0.1%	-120	-77%	4	12%
Spain	171	575	436	1.0%	265	155%	-139	-24%
Sweden	11	130	159	0.4%	148	1313%	29	23%
United Kingdom	11 346	5 092	4 954	11.7%	-6 392	-56%	-138	-3%
EU-27+UK	**46 316**	**42 686**	**42 353**	**100%**	**-3 963**	**-9%**	**-333**	**-1%**
Iceland	635	91	91	0.2%	-544	-86%	0	0%
United Kingdom (KP)	11 346	5 115	4 977	11.7%	-6 370	-56%	-138	-3%
EU-KP	**46 951**	**42 799**	**42 467**	**100%**	**-4 485**	**-10%**	**-333**	**-1%**

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, Bulgaria and Netherlands that report an increase of the area converted to cropland under the subcategory 4B.2, which associate with a constant increase of the emissions in this subcategory. The opposite scenario is given by Portugal, France and UK, which report significant reduction of emissions in this category driven by the same trend in areas.

Figure 6. 10 Trend of emissions (+)/ removals (-) in subcategory 4B2 "Land converted to Cropland" in EU KP (kt CO_2, 1990-2018)



Methodological issues for Land converted to Cropland

For estimating and reporting carbon stocks changes in this subcategory, IPCC default methodology is generally used. However, the implementation of country-specific, or default emissions factors depends on which type of lands is being converted to Cropland and, the carbon pool to be estimated. For instance, concerning the living biomass carbon pool, some countries consider the carbon stocks from one year of growth in Cropland following conversion, while other only take into account the oxidation of 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, countries often apply a 20 years transition period before the carbon stock of the soils converted to cropland reach an equilibrium.

In recent years, improvements have been implemented also in this subcategory, including the use of higher methods (as requested by the ERT), which have resulted in an overall increase of accuracy and completeness of the sector.

For instance, Latvia used also country-specific data and Biosoil Project's to report carbon stock changes from DOM following the conversion from Forest land to Cropland. In addition, also Poland increased the completeness reporting of the category with the inclusion of carbon stock changes in living biomass following the conversion from Grassland to Cropland.

On the contrary, France reports the notation NE for reporting carbon stock changes in a very small area identified as Other Land converted to Cropland, also noting that as defined, Other land category are areas with none or insignificant carbon stock.

6.2.3 Grassland (CRF 4C)

6.2.3.1 Overview of Grassland category (CRF 4C)

Under this category are included lands that covered by natural and artificial meadows, range lands, moors, forage crops. They 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 thresholds used to define forest lands.

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, for the current inventory year total Grassland covers 93.827 Kha. This represents 27% of the total territory of EU MS, UK and ISL. However, as for Cropland, these areas have constantly decreased, and nowadays these ecosystems represent 8% less as compared with the base year.

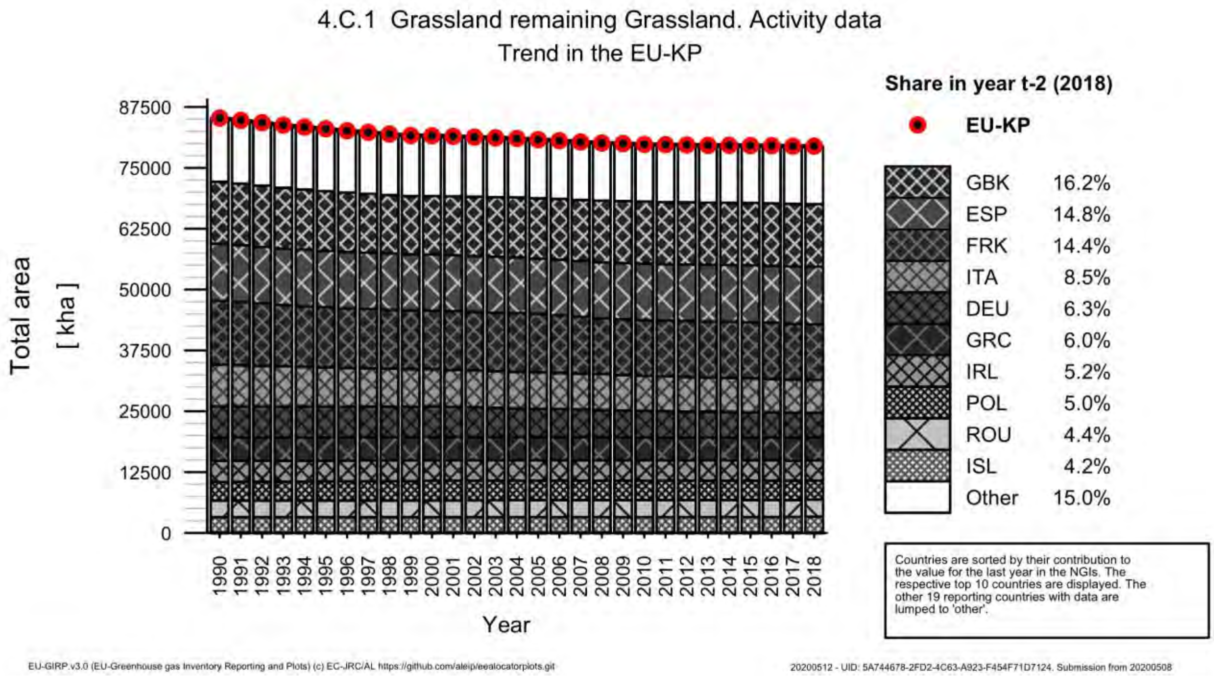
6.2.3.2 Grassland remaining Grassland (CRF 4C1)

Overview of Grassland remaining Grassland category

For the year 2018, total area reported under this subcategory reaches 79.463 Kha. Following the general trend of these lands, this subcategory has also constantly decrease since 1990, and in 2018 it represents 7% less than in 1990 (Figure 6. 11).

UK, Spain and France reported together 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-KP (kha, 1990-2018)



In terms of emissions, this subcategory has always resulted in a net source the level of EU MS, UK and ISL. In the current inventory year, emissions reported reached 28.968 Kt CO_2, which represents a decrease of 37 % as compared with the year 1990 (Table 6. 21).

Nevertheless, individual inventories have reported this subcategory either as a net source or as a net sink of carbon.

As in the case of Cropland areas, the net result of the carbon stock in Grassland depends, on the one hand on whether these areas are subject to agricultural activities, but also, on the presence or absences of significant woody biomass and the intensity and variation of management practices across the years. Moreover, a very significant driver is the present or not of management practices in organic soils.

Table 6. 21 4C1 Grassland remaining Grassland: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

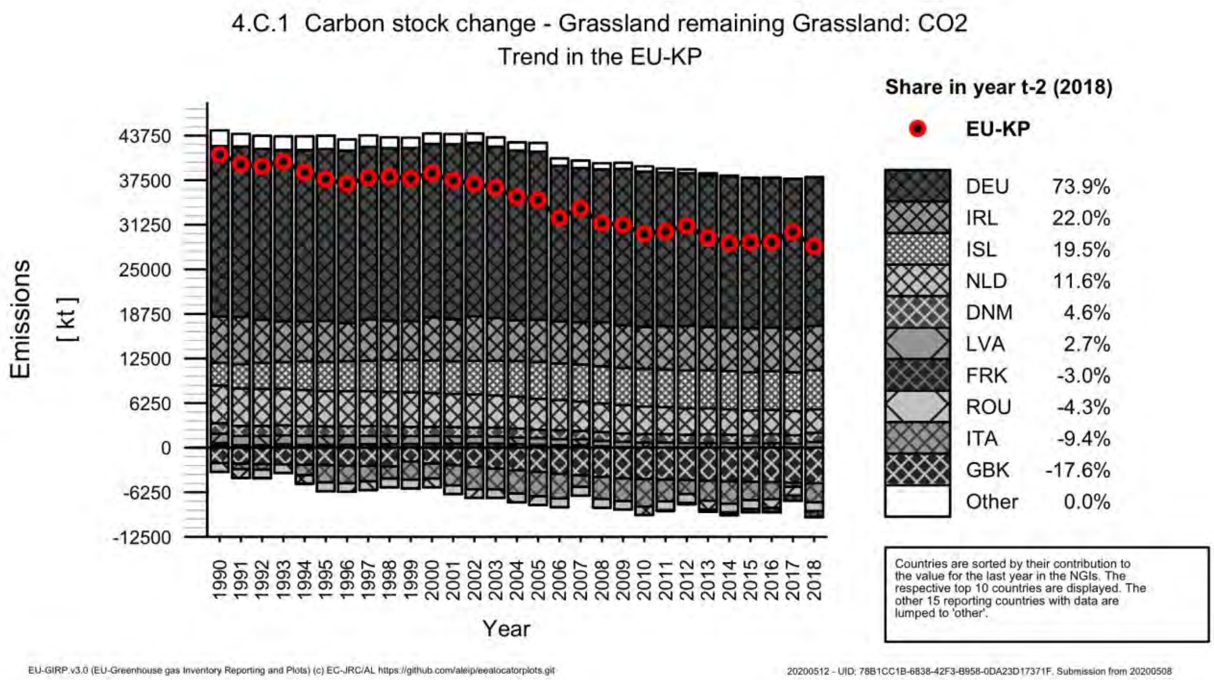
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	294	297	297	1.0%	2	1%	0	0%
Belgium	-427	-371	-368	-1.3%	58	14%	3	1%
Bulgaria	326	113	109	0.4%	-217	-66%	-4	-3%
Croatia	2	2	2	0.0%	0	0%	0	0%
Cyprus	-134	-118	-118	-0.4%	16	12%	0	0%
Czechia	48	-69	-79	-0.3%	-128	-265%	-11	-16%
Denmark	1 435	1 208	1 306	4.5%	-130	-9%	97	8%
Estonia	50	47	49	0.2%	-1	-1%	2	4%
Finland	728	479	484	1.7%	-244	-33%	5	1%
France	301	-743	-849	-2.9%	-1 151	-382%	-106	-14%
Germany	23 906	21 059	20 877	72.1%	-3 029	-13%	-182	-1%
Greece	0	1	1	0.0%	0	174%	0	-41%
Hungary	48	0	1	0.0%	-48	-99%	1	100%
Ireland	6 513	6 088	6 224	21.5%	-288	-4%	136	2%
Italy	5 402	1 418	-2 002	-6.9%	-7 404	-137%	-3 420	-241%
Latvia	1 305	547	772	2.7%	-533	-41%	225	41%
Lithuania	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	-2	0	0	0.0%	2	94%	0	33%
Netherlands	5 317	3 356	3 270	11.3%	-2 047	-38%	-86	-3%
Poland	1 445	770	793	2.7%	-652	-45%	23	3%
Portugal	NO	-437	-375	-1.3%	-375	-∞	62	14%
Romania	-1 222	-1 222	-1 222	-4.2%	0	0%	0	0%
Slovakia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovenia	198	-377	-366	-1.3%	-563	-285%	12	3%
Spain	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Sweden	-271	-354	-354	-1.2%	-83	-31%	0	0%
United Kingdom	-2 168	-4 905	-4 975	-17.2%	-2 808	-130%	-70	-1%
EU-27+UK	**43 095**	**26 788**	**23 475**	**81%**	**-19 620**	**-46%**	**-3 314**	**-12%**
Iceland	3 130	5 448	5 493	19.0%	2 363	75%	45	1%
United Kingdom (KP)	-2 168	-4 905	-4 975	-17.2%	-2 808	-130%	-70	-1%
EU-KP	**46 225**	**32 236**	**28 968**	**100%**	**-17 257**	**-37%**	**-3 268**	**-10%**

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 significant of emissions.

By contrary some others MS have reported this subcategory as a net carbon sink. For instance, Romania that reports significant carbon sink from woody vegetation on grassland areas or UK that reports a significant net sink from mineral soils.

In some Mediterranean countries, as in the case of Italy, inter-annual variability is driven by wildfires affecting woody biomass in grassland area. These episodes although present an erratic behave are expected to increase as a result of the climate change.

Figure 6. 12 Trend of emissions (+)/removals (-) in subcategory 4C1 "Grassland remaining Grassland" in EU-KP (kt CO_2, 1990-2018)



Methodological issues for Grassland remaining Grassland category

Despite of different eco-regions and management approaches existing among the countries, Grassland definitions provided by them show a 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 and the presence or absence of woody vegetation.

In general, there is a wide-spread use of the 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. Lithuania, Hungary). However, some countries have developed country-specific data and (or) methodologies to assess the changes in these pools (e.g. 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 individual submissions have demonstrated that there are no changes over the time in the type of management practices that impact the carbon storage in the soils. In few cases it was also argue the absence of managed soils (e.g. Spain, Lithuania). In these cases, quantitative estimates were not provided, and the notation keys were used instead. However, some others countries report this carbon pool by using IPCC methodology, with country-specific or default data.

For those countries that report presence of organic soils areas under grassland, this carbon pool has been always reported as a net source of emissions that result from the oxidation of the soils organic matter (Table 6. 23).

Table 6. 22 Definitions of lands included under the category 4C: Grasslands

Country	***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.

Country	*Definition*
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 do not 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.
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

Country	Definition
	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 the GHGI 2020

Country	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	2018	1990	2018	1990	2018	1990	2018
AUT	NO	NO	NO	NO	0,002	0,002	-6,402	-6,402
BEL	NO	NO	NO	NO	0,156	0,182	-1,521	-1,891
BGR	0,003	0,000	NE	NE	-0,049	-0,015	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	0,024	NO	NO
DNM	-0,027	-0,277	NO	NO	IE	IE	-6,605	-6,459
EST	0,001	NO	NO	NO	NO	NO	-0,284	-0,292
FIN	0,306	0,303	NE	NE	NA	NA	-3,500	-3,500
FRK	-0,007	0,024	NE	NE	0,001	-0,004	IE	IE
DEU	-0,015	0,005	NO	NO	0,011	0,006	-6,677	-6,749
GRC	0,000	0,000	NO	NO	NO	NO	NO	NO
HUN	NO	NO	NO	NO	-0,011	0,000	NO	NO
IRL	NO	NO	NO	NO	-0,009	0,148	-4,668	-6,803
ITA	-0,011	0,086	0,004	0,004	-0,004	0,019	-2,500	-2,500
LVA	0,010	-0,001	0,002	-0,005	NA	NA	-6,100	-6,100
LTU	NA	NA	NA	NA	NA	NA	IE	IE
LUX	NO	NO	NO	NO	NO	NO	NO	NO
MLT	0,000	0,000	NE	NO,NE	0,032	0,003	NO	NO
NLD	0,006	0,004	NA	NA	0,000	0,003	-4,556	-4,119
POL	NO	NO	NO	NO	-0,056	-0,006	-0,250	-0,250
PRT	NO	NO	NO	NO	NO	0,226	NO	NO
ROU	0,098	0,095	NE	NE	NE	NE	0,250	0,250
SVK	NA	NA	NA	NA	NA	NA	NO	NO
SVN	-0,090	0,235	-0,018	0,065	-0,006	-0,009	NO	NO
ESP	NE	NE	NA	NA	NE	NE	NO	NO

Country	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	2018	1990	2018	1990	2018	1990	2018
SWE	0,163	0,258	0,136	0,174	-0,018	-0,050	-1,310	-1,698
GBR	0,014	-0,001	NO	NO	0,041	0,124	-0,034	-0,034
ISL	0,000	0,000	0,000	0,000	0,000	0,000	-5,691	-5,690

6.2.3.3 Land converted to Grassland (CRF 4C2)

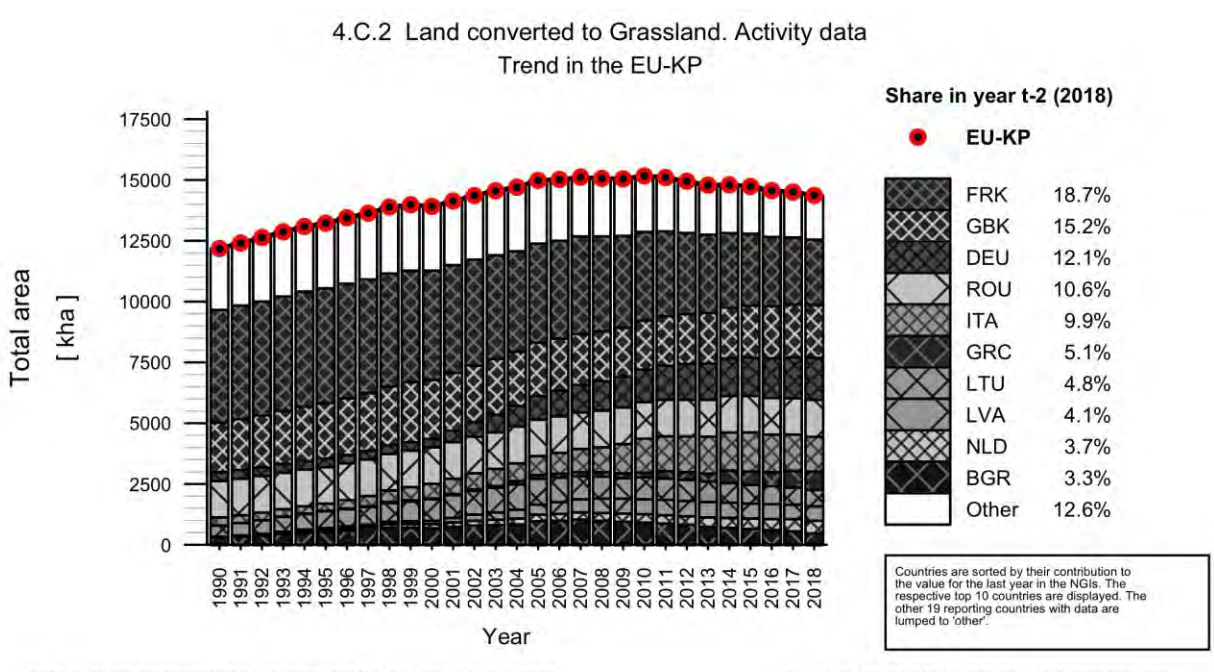
Overview of Land converted to Grassland category

In terms of area, this subcategory represents 15% of the total grassland areas; however the carbon sink reported offsets about 90% of the emissions resulting from grassland remaining grassland.

The area reported under this subcategory for this inventory year reaches 14.364 Kha, which represents an increase of 18% as compared with 1990 (Figure 6. 13). Main conversions to grassland areas have origin in former croplands and, to a lesser extent, on forests land.

The main drivers of the EU trend on new grassland areas are France, UK, Germany, Romania and Italy that together report more that 60% of the total area converted to Grassland.

Figure 6. 13 Trend of activity data in subcategory 4C2 "Land converted to Grassland" in EU-KP (kha, 1990-2018)



In term of emissions, lands in conversion to Grassland represent in the current inventory year a total net sink of 26.633 kt CO_2 that results in an increase of about 30% compared to the year 1990 (Table 6. 24).

The trend in GHG emissions for this subcategory is driven by France, Italy and UK 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 countries (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.

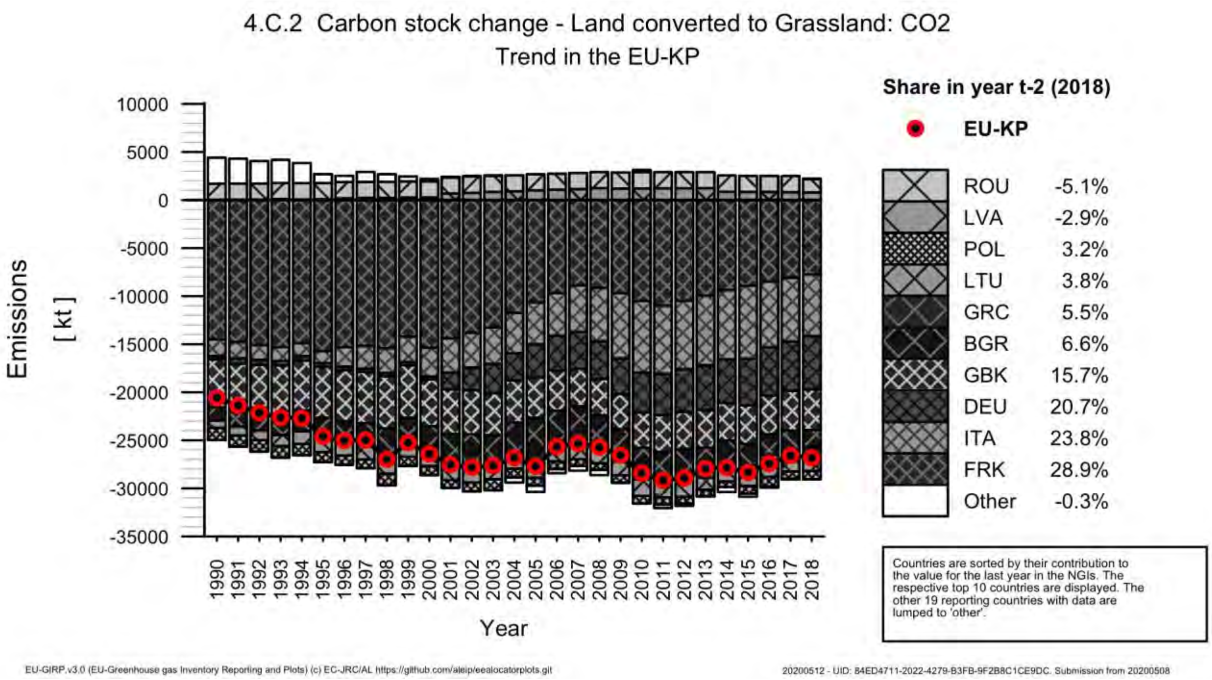
Table 6. 24 4C2 Land converted to Grassland: EU-KP contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	332	26	-6	0.0%	-338	-102%	-32	-124%
Belgium	43	-423	-449	1.7%	-492	-1143%	-26	-6%
Bulgaria	-1 389	-1 924	-1 776	6.7%	-387	-28%	148	8%
Croatia	-10	-148	-225	0.8%	-215	-2121%	-77	-52%
Cyprus	NO,NE	-6	-7	0.0%	-7	-∞	0	-3%
Czechia	-158	-199	-203	0.8%	-44	-28%	-3	-2%
Denmark	2	50	71	-0.3%	69	3013%	22	43%
Estonia	2	-9	-11	0.0%	-12	-752%	-1	-14%
Finland	169	220	244	-0.9%	75	45%	24	11%
France	-14 484	-8 069	-7 751	29.1%	6 733	46%	318	4%
Germany	-359	-5 144	-5 542	20.8%	-5 183	-1443%	-398	-8%
Greece	0	-1 277	-1 489	5.6%	-1 489	-5308019%	-212	-17%
Hungary	-33	-76	23	-0.1%	56	171%	99	131%
Ireland	3	5	16	-0.1%	14	472%	11	214%
Italy	-1 756	-6 636	-6 393	24.0%	-4 637	-264%	243	4%
Latvia	11	812	790	-3.0%	779	6837%	-21	-3%
Lithuania	-766	-1 065	-1 028	3.9%	-263	-34%	36	3%
Luxembourg	32	-43	-42	0.2%	-73	-232%	1	3%
Malta	-3	0	0	0.0%	3	94%	0	33%
Netherlands	220	-27	-75	0.3%	-296	-134%	-49	-183%
Poland	-1 269	-733	-864	3.2%	405	32%	-131	-18%
Portugal	3 228	450	439	-1.6%	-2 789	-86%	-11	-2%
Romania	1 676	1 676	1 368	-5.1%	-308	-18%	-308	-18%
Slovakia	-206	-165	-115	0.4%	91	44%	50	30%
Slovenia	-391	-27	-33	0.1%	358	92%	-6	-22%
Spain	-2 696	-85	42	-0.2%	2 738	102%	127	149%
Sweden	447	174	228	-0.9%	-218	-49%	55	32%
United Kingdom	-4 928	-3 925	-4 001	15.0%	927	19%	-77	-2%
EU-27+UK	**-22 285**	**-26 570**	**-26 788**	**101%**	**-4 503**	**-20%**	**-218**	**-1%**
Iceland	1 773	204	183	-0.7%	-1 590	-90%	-21	-10%
United Kingdom (KP)	-4 936	-3 952	-4 029	15.1%	906	18%	-77	-2%
EU-KP	**-20 521**	**-26 394**	**-26 633**	**100%**	**-6 113**	**-30%**	**-239**	**-1%**

Major changes in the time series of emissions from Land converted to Grassland have been reported by Germany, France, Portugal and Spain, mainly driven by the activity data.

New grassland areas are associated with the abandonment of cropland areas that result in a larger carbon sink reported in mineral soils at the end of the time series as compared with the base year. This is for instance reported by Germany. By contrary, some countries report a significant decrease of the carbon sink in these lands driven by the decrease of these areas after but also for the incidence of fires in specific years. .

Figure 6. 14 Trend of emissions (+)/removals (-) in subcategory 4C2 "Land converted to Grassland" in EU-KP (kt CO_2, 1990-2018)



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 countries 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, by considering also one year of growth after the establishment of the grass.

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, countries often apply a 20 years transition period before the carbon stock of the soils converted to Grassland reach 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, total Wetlands represents 24.904 Kha, which is 5% of the total area reported by EU MS, UK and Iceland together. As compared with the base year, the category has shown a constant trend that slightly increases by 2%.

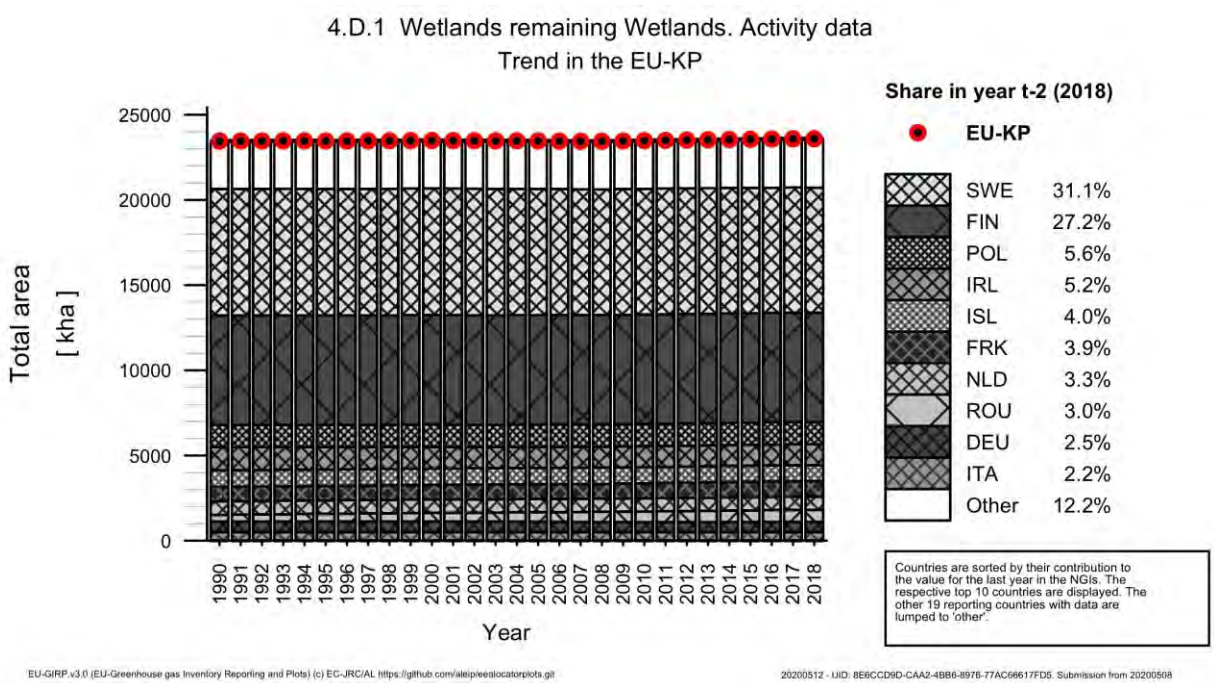
The trend in areas is strongly dominated by Sweden and Finland which, as the other individuals inventories, have reported rather constant values across the time series, mainly, for the dominant subcategory of Wetlands remaining Wetlands (Figure 6. 15).

In terms of emissions, Wetlands remaining Wetlands reaches for this inventory year about 9.578 ktCO_2. Subcategories, 4D1 and 4D2, have been in overall reported as a net source of emissions resulting mostly from countries reporting the management of peatland areas. Nevertheless, in few cases, these subcategories have been also reported as a net carbon sink

Indeed, the main driver of emissions is represented by peat extraction which, even if affecting small areas, has a big impact on final emissions. Within the EU, Poland, Germany, Estonia, Ireland and Finland are the main drivers of the trend in emissions

By contrary, an exception is given by Iceland that under 4D1 reports a significant amount of removals from intact mires.

Figure 6. 15 Trend of activity data and emissions (+)/removals (-) in subcategory 4D1 "Wetlands remaining Wetlands" in EU-KP (kha, Kt CO_2, 1990-2018)



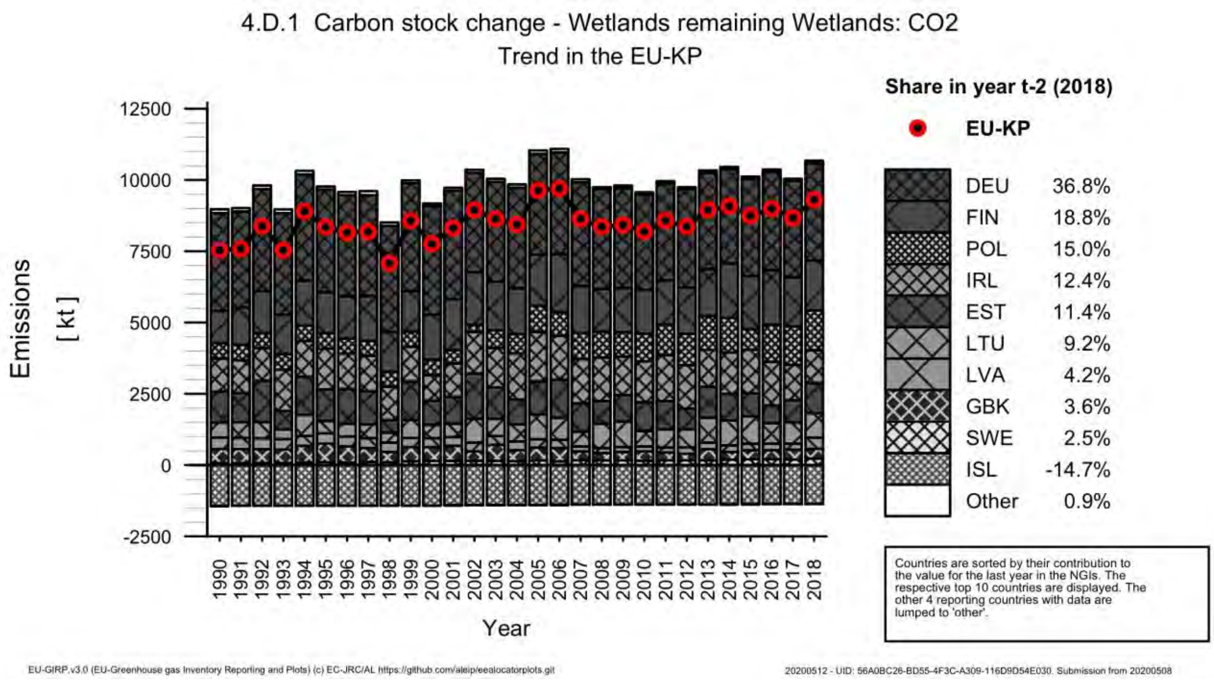

4.D.1 Carbon stock change - Wetlands remaining Wetlands: CO2
Trend in the EU-KP
Share in year t-2 (2018)
EU-KP
DEU 36.8%
FIN 18.8%
POL 15.0%
IRL 12.4%
EST 11.4%
LTU 9.2%
LVA 4.2%
GBK 3.6%
SWE 2.5%
ISL -14.7%
Other 0.9%
Emissions [kt]
12500
10000
7500
5000
2500
0
-2500
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year
Countries are sorted by their contribution to the value for the last year in the NGIs. The respective top 10 countries are displayed. The other 4 reporting countries with data are lumped to 'other'.
EU-GIRP.v3.0 (EU-Greenhouse gas Inventory Reporting and Plots) (c) EC-JRC/AL https://github.com/aleip/eealocatorplots.git
20200512 - UID: 56A0BC26-BD55-4F3C-A309-116D9D54E030. Submission from 20200508

Table 6. 25 CO_2 Emissions and removals from 4.D.1 wetlands remaining wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

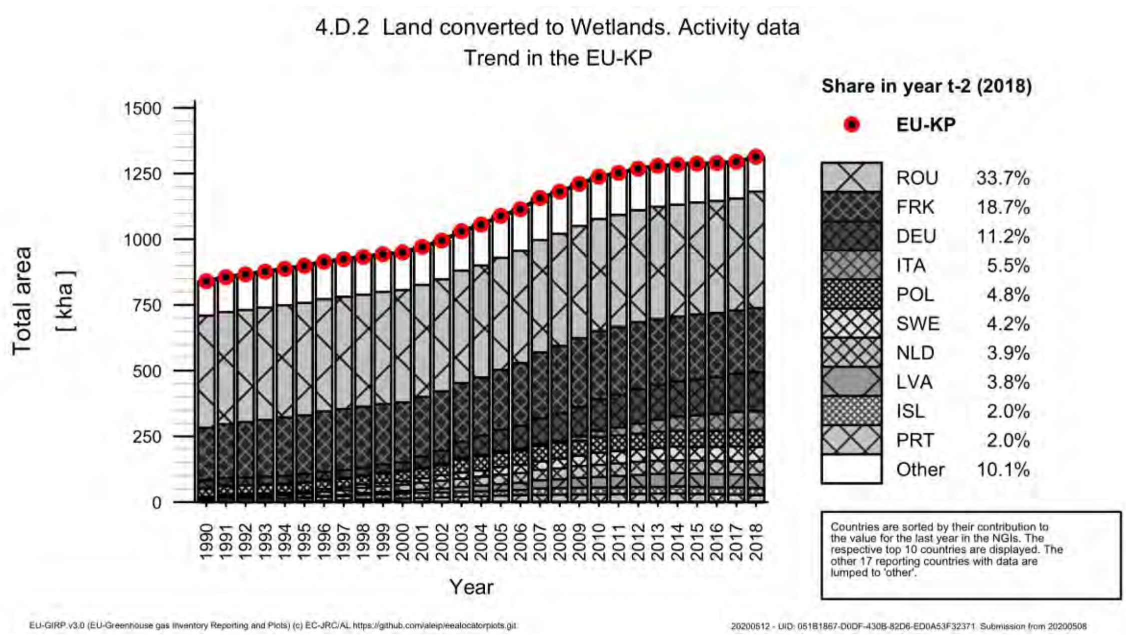
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NA	NA	NA	-	-	-	-	-
Denmark	100	31	53	0.5%	-47	-47%	22	72%
Estonia	1 095	780	1 060	11.1%	-35	-3%	280	36%
Finland	1 138	1 730	1 747	18.2%	609	54%	17	1%
France	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Germany	3 424	3 390	3 421	35.7%	-3	0%	31	1%
Greece	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Hungary	10	0	0	0.0%	-10	-99%	0	100%
Ireland	1 522	2 458	1 422	14.8%	-100	-7%	-1 036	-42%
Italy	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Latvia	408	213	395	4.1%	-13	-3%	182	85%
Lithuania	517	747	855	8.9%	337	65%	107	14%
Luxembourg	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	NO,IE,NA	-2	-2	0.0%	-2	-∞	0	-1%
Poland	536	1 342	1 392	14.5%	856	160%	50	4%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Spain	31	37	37	0.4%	7	22%	0	0%
Sweden	73	195	230	2.4%	157	214%	35	18%
United Kingdom	487	337	335	3.5%	-152	-31%	-2	-1%
EU-27+UK	**9 340**	**11 258**	**10 945**	**114%**	**1 604**	**17%**	**-314**	**-3%**
Iceland	-1 433	-1 372	-1 367	-14.3%	66	5%	5	0%
United Kingdom (KP)	487	337	335	3.5%	-152	-31%	-2	-1%
EU-KP	**7 907**	**9 886**	**9 578**	**100%**	**1 671**	**21%**	**-309**	**-3%**

The other subcategory, land converted to wetlands, represents only 7% of the wetlands area but results in about 31% of the final net emissions reported within the category. For the current inventory year, this subcategory category has reached respectively 1.314 Kha, and 4.145 kt CO_2.

Areas of land converted to wetlands, that are dominated, in overall, by Romania and France, have increased by 51%, as compared with 1990, mainly driven by new areas reported by Sweden, Poland, Germany and Italy in the second half of the time series (Figure 6.17).

Nevertheless, these new areas are not always linked to carbon stock changes, as in some cases 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).

Figure 6. 16 Trend of activity data and emissions (+) / removals (-) in subcategory 4D2 "Lands converted to Wetlands" in EU-KP (kha, Kt CO_2, 1990-2018)



Emissions in this subcategory are mainly reported by Romania and France as a result of the loss of carbon from the living biomass existing in the lands that area converted to wetlands.

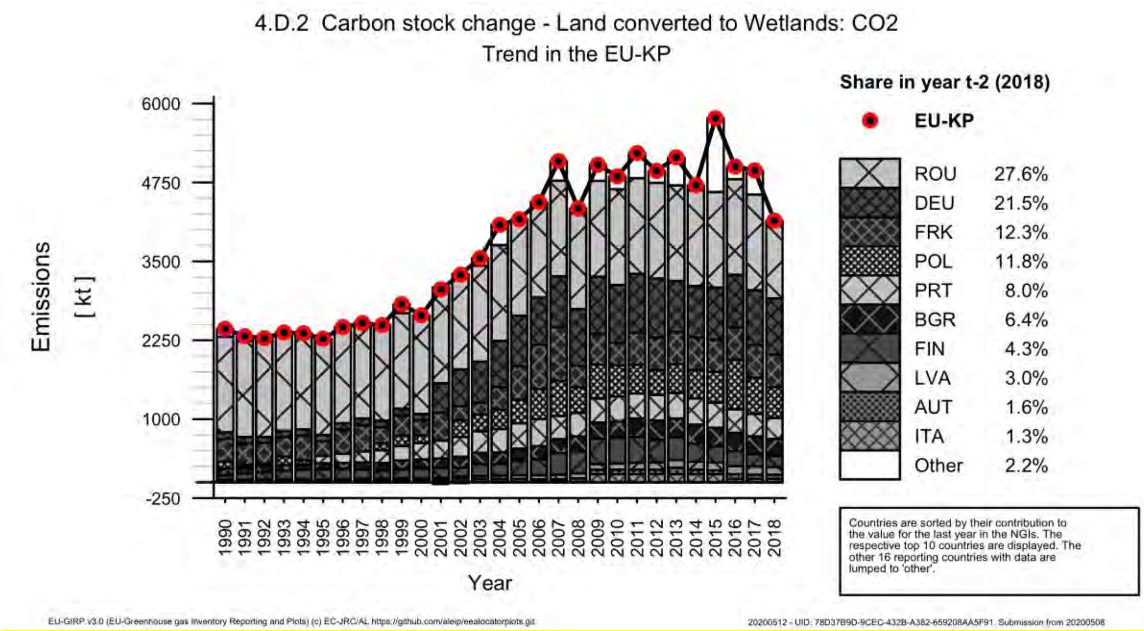

4.D.2 Carbon stock change - Land converted to Wetlands: CO2
Trend in the EU-KP
Share in year t-2 (2018)
EU-KP
ROU 27.6%
DEU 21.5%
FRK 12.3%
POL 11.8%
PRT 8.0%
BGR 6.4%
FIN 4.3%
LVA 3.0%
AUT 1.6%
ITA 1.3%
Other 2.2%
Emissions
[kt]
6000
4750
3500
2250
1000
-250
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Countries are sorted by their contribution to the value for the last year in the NGIs. The respective top 10 countries are displayed. The other 16 reporting countries with data are lumped to 'other'.
EU-GIRP v3.0 (EU-Greenhouse gas Inventory Reporting and Plots) (c) EC-JRC/AL https://github.com/aleip/eealocatorplots.git
20200512 - UID: 78D37B9D-9CEC-432B-A382-659208AA5F91. Submission from 20200508

Table 6. 26 CO_2 Emissions and removals from 4.D.2 land converted to wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	42	67	66	1.6%	24	57%	-1	-1%
Belgium	10	-6	-7	-0.2%	-17	-165%	0	-3%
Bulgaria	109	279	266	6.4%	157	143%	-13	-5%
Croatia	83	12	12	0.3%	-71	-85%	0	2%
Cyprus	-1	-10	-9	-0.2%	-8	-779%	1	9%
Czechia	22	21	20	0.5%	-1	-6%	-1	-3%
Denmark	-1	-1	NO,IE	-	1	100%	1	100%
Estonia	9	14	6	0.2%	-2	-28%	-7	-53%
Finland	65	205	177	4.3%	111	170%	-28	-14%
France	358	511	511	12.3%	153	43%	0	0%
Germany	102	873	893	21.5%	791	777%	20	2%
Greece	NO	0	0	0.0%	0	∞	0	-52%
Hungary	3	-3	-4	-0.1%	-7	-222%	0	-10%
Ireland	NO,IE	11	-1	0.0%	-1	-∞	-12	-111%
Italy	NO	53	53	1.3%	53	∞	0	0%
Latvia	1	125	124	3.0%	123	9073%	-1	-1%
Lithuania	63	285	NO,NE,NA	-	-63	-100%	-285	-100%
Luxembourg	15	4	4	0.1%	-11	-75%	-1	-12%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	87	45	43	1.0%	-44	-51%	-2	-4%
Poland	111	575	490	11.8%	378	340%	-85	-15%
Portugal	NO,IE	353	332	8.0%	332	∞	-21	-6%
Romania	1 516	1 516	1 143	27.6%	-372	-25%	-372	-25%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	3	2	2	0.1%	-1	-19%	0	-4%
Spain	-167	5	16	0.4%	184	110%	12	236%
Sweden	NO,NA	NO,NA	NO,NA	-	-	-	-	-
United Kingdom	0	0	0	0.0%	0	186%	0	28%
EU-27+UK	**2 432**	**4 936**	**4 139**	**100%**	**1 708**	**70%**	**-796**	**-16%**
Iceland	0	6	6	0.1%	5	1083%	0	-1%
United Kingdom (KP)	0	0	0	0.0%	0	186%	0	28%
EU-KP	**2 432**	**4 941**	**4 145**	**100%**	**1 713**	**70%**	**-796**	**-16%**

Under this category, countries 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. In all these areas the carbon fluxes are not reported mainly based on the lack of IPCC methods.

Table 6. 27 Definitions of lands included under the category 4D: Wetlands

Country	***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 Republic	Category Wetlands includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and 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 fulfil 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, and 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.

Country	*Definition*
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 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.), harbours, 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 30.832 kha, which is 7% of the total reported areas. For the inventory year, Settlements areas have resulted in a steady increase of 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 mainly driven by the abandonment of agricultural lands.

In terms of emissions this land use category is reported as a net source that reaches, in this reporting year, 48.339 Kt CO_2. Out of this, 91% are due to emissions resulting from Land converted to Settlement, which although in term of areas it represents only 21% of the total category, it results in significant emissions when forest, other woody lands, or high-carbon content soils are impacted and converted to urban areas.

Definitions of lands included under this category vary across individual inventories (Table 6. 28).

Table 6. 28 Definitions of lands included under the category 4E: Settlements

Country	*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, 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 build-up 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.

Country	***Definition***
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 rifle ranges, 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 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.

Country	*Definition*
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”.

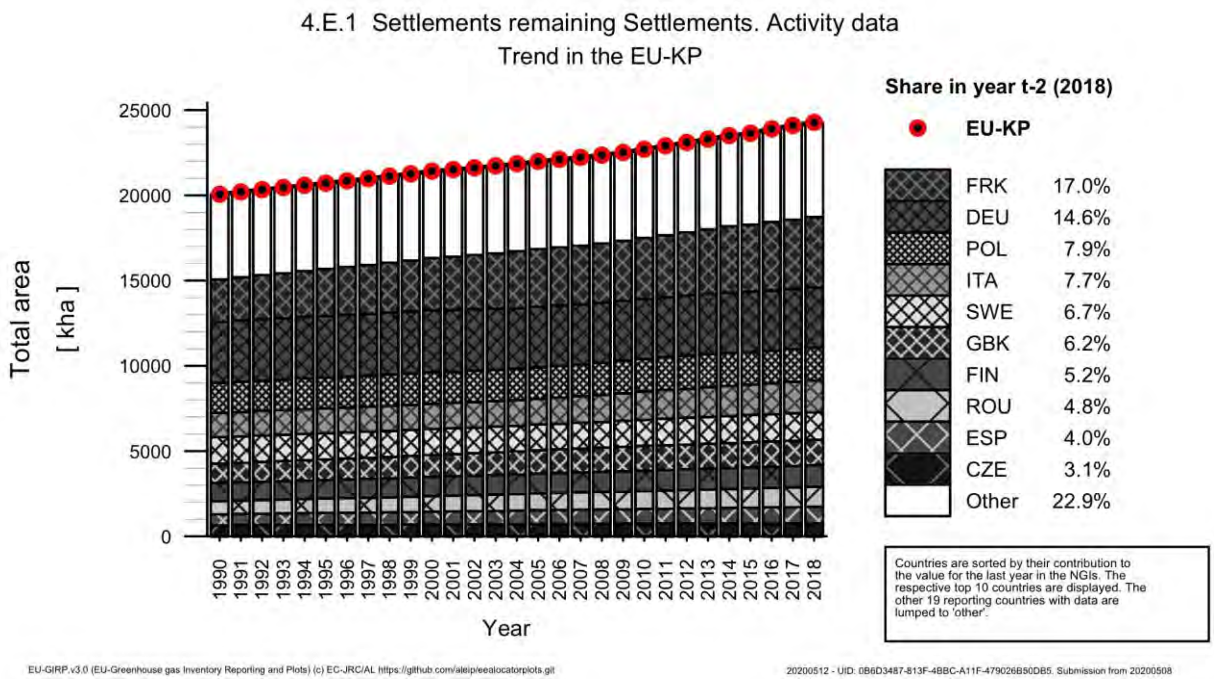
As regards with the methods used for reporting carbon stock changes in these areas, often countries used the Tier 1 assumption of equilibrium under the subcategory 4E1, therefore no carbon stock changes are reported, and notation keys are accordingly included in the CRF tables.

Nevertheless, few countries have reported this subcategory as a net source of GHG 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, Latvia, Poland and Slovenia have reported the subcategory 4E1 as a net sink of carbon due to carbon accumulation 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 biomass and dead organic matter for different land use categories are calculated using the most recent available national forest inventory data “floating NFI cycle” and then with average 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. Reduction of increment in 2017 is result of changes in age structure of woody vegetation, respectively, due to more intensive extraction of trees in settlements like roadsides, buffer zones of drainage ditches and other settlements. The losses due to extraction of wood in settlements are accounted using instant oxidation method due to lack of knowledge about further use of biomass.

Figure 6. 17 Trend of activity data and emissions (+)/removals (-) in subcategory 4E1 “Settlements remaining Settlements” in EU-KP (kha, kt CO_2 1990-2018)


4.E.1 Settlements remaining Settlements. Activity data
Trend in the EU-KP
Total area
[kha]
25000
20000
15000
10000
5000
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 2017 2018
Year
Share in year t-2 (2018)
EU-KP
FRK 17.0%
DEU 14.6%
POL 7.9%
ITA 7.7%
SWE 6.7%
GBK 6.2%
FIN 5.2%
ROU 4.8%
ESP 4.0%
CZE 3.1%
Other 22.9%
Countries are sorted by their contribution to the value for the last year in the NGIs. The respective top 10 countries are displayed. The other 19 reporting countries with data are lumped to 'other'.
EU-GIRP.v3.0 (EU-Greenhouse gas Inventory Reporting and Plots) (c) EC-JRC/AL https://github.com/aleip/eealocatorplots.git
20200512 - UID: 0B6D3487-813F-4BBC-A11F-479026B50DB5. Submission from 20200508

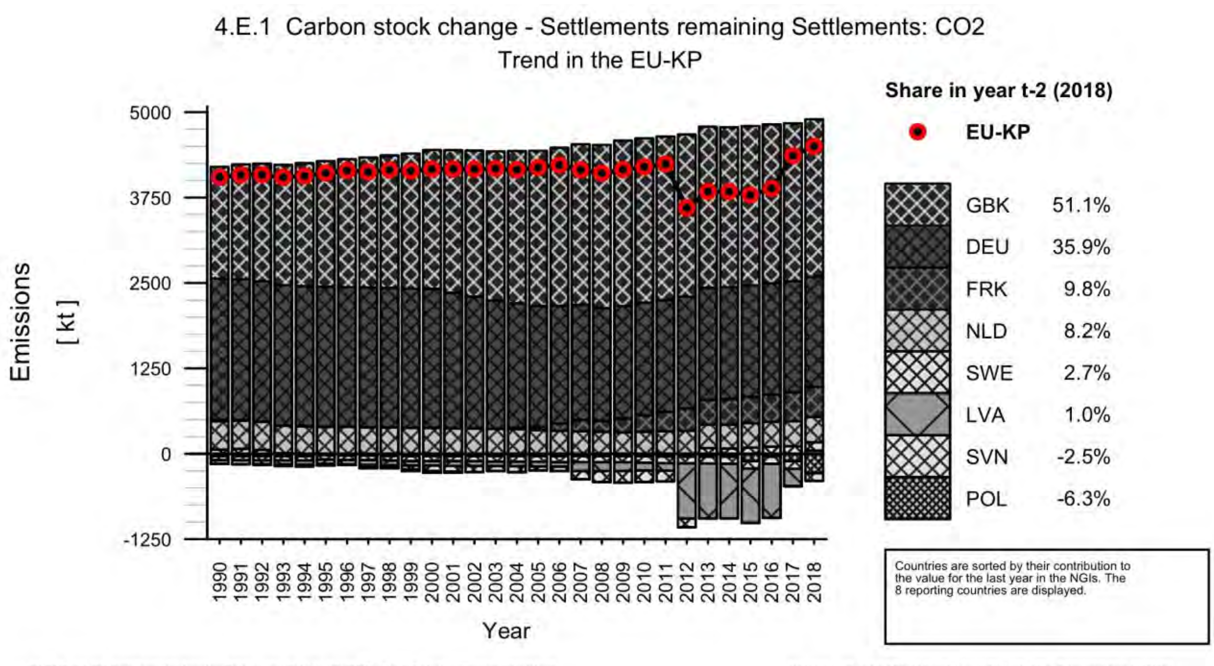
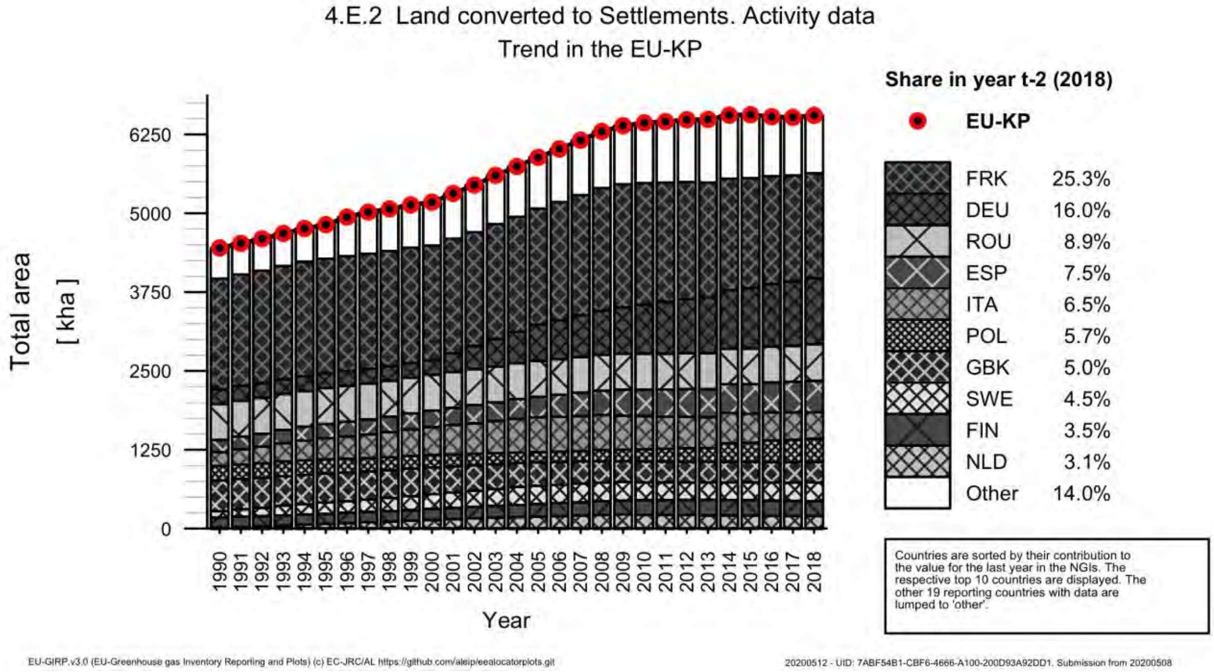
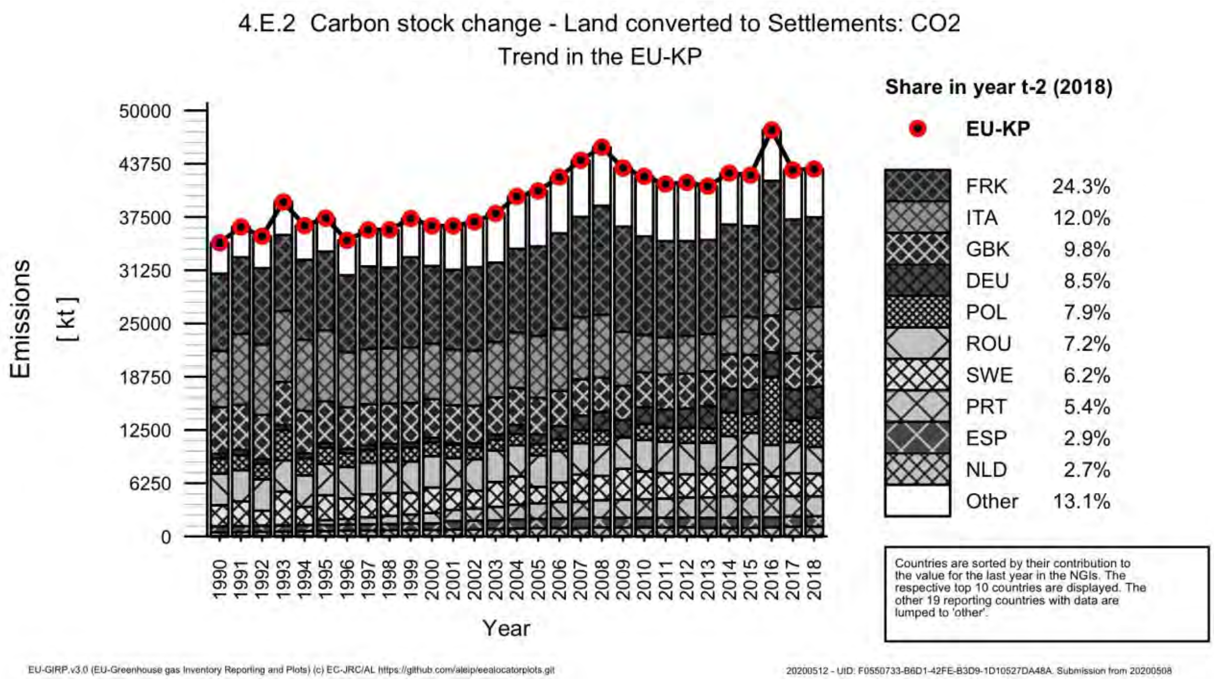

4.E.1 Carbon stock change - Settlements remaining Settlements: CO2
Trend in the EU-KP
Emissions
[kt]
5000
3750
2500
1250
0
-1250
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year
Share in year t-2 (2018)
EU-KP
GBK 51.1%
DEU 35.9%
FRK 9.8%
NLD 8.2%
SWE 2.7%
LVA 1.0%
SVN -2.5%
POL -6.3%
Countries are sorted by their contribution to the value for the last year in the NGIs. The 8 reporting countries are displayed.
EU-GIRP.v3.0 (EU-Greenhouse gas Inventory Reporting and Plots) (c) EC-JRC/AL https://github.com/aleip/eealocatorplots.git
20200512 - UID: 67830CBC-DC69-41B9-A1A9-80089139B314. Submission from 20200508

Figure 6. 18 Trend of activity data and emissions (+)/removals (-) in subcategory 4E2 "Land converted to Settlements" in EU-KP kha, kt CO_2 1990-2018)





As regards, with the subcategory 4E2, annual emissions from Land converted to Settlements have increased by 47% since 1990 (Table 6. 29). For the year 2018 this subcategory was reported as a net source of emissions reaching 43.140 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 (e.g. France, Italy, Romania and UK). In fact, the conversion of forests in Settlements is an important component of the total deforestation. It represents around 30% of total area reported as deforested; and 15% of the Land converted to Settlements. While conversions to Wetland or 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. 29 4E2 Land converted to Settlements: EU-KP contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	570	389	375	0.9%	-195	-34%	-14	-4%
Belgium	134	457	461	1.1%	327	245%	4	1%
Bulgaria	437	710	602	1.4%	165	38%	-108	-15%
Croatia	251	672	675	1.6%	425	169%	3	0%
Cyprus	2	20	20	0.0%	18	1044%	0	0%
Czechia	271	216	124	0.3%	-147	-54%	-92	-43%
Denmark	19	161	180	0.4%	161	868%	19	12%
Estonia	NO	304	274	0.6%	274	∞	-30	-10%
Finland	865	791	719	1.7%	-146	-17%	-71	-9%
France	9 067	10 531	10 495	24.3%	1 428	16%	-35	0%
Germany	522	3 614	3 652	8.5%	3 131	600%	38	1%
Greece	50	131	130	0.3%	81	162%	-1	-1%
Hungary	109	166	164	0.4%	55	51%	-2	-1%
Ireland	80	101	94	0.2%	14	17%	-7	-7%
Italy	6 639	5 178	5 185	12.0%	-1 455	-22%	7	0%
Latvia	81	690	720	1.7%	639	789%	31	4%
Lithuania	16	557	717	1.7%	701	4254%	160	29%
Luxembourg	145	58	55	0.1%	-90	-62%	-3	-6%
Malta	4	1	1	0.0%	-4	-83%	0	-15%
Netherlands	494	1 148	1 161	2.7%	667	135%	13	1%
Poland	1 852	2 577	3 411	7.9%	1 558	84%	834	32%
Portugal	30	2 366	2 320	5.4%	2 290	7510%	-46	-2%
Romania	3 682	3 682	3 116	7.2%	-567	-15%	-567	-15%
Slovakia	96	98	81	0.2%	-15	-16%	-18	-18%
Slovenia	462	290	271	0.6%	-192	-41%	-19	-6%
Spain	657	1 221	1 235	2.9%	578	88%	14	1%
Sweden	2 488	2 664	2 673	6.2%	186	7%	9	0%
United Kingdom	5 335	4 152	4 156	9.6%	-1 179	-22%	4	0%
EU-27+UK	**34 359**	**42 946**	**43 068**	**100%**	**8 710**	**25%**	**123**	**0%**
Iceland	24	6	6	0.0%	-18	-74%	0	0%
United Kingdom (KP)	5 418	4 218	4 221	9.8%	-1 197	-22%	3	0%
EU-KP	**34 467**	**43 018**	**43 140**	**100%**	**8 673**	**25%**	**122**	**0%**

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 large carbon stocks and therefore more carbon is lost from their conversions.

Noteworthy is also Poland that reports for the year 2016 a significant increase of emissions 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 in this reporting year, 17.775 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 variations 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 under conversion. 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, Poland 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, Poland reports a leap on activity data of "Land converted to Other Land" that is reflected in the EU trend.

Definitions of Other land are close among countries and match in overall IPCC general description (Table 6. 30). 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 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, and that are in all the cases considered unmanaged. Following a recommendation from the ERT the definitions of the category have been updated to better reflect lands that are included in the category. But furthermore, following a recommendation of the previous ERT, Finland, UK and Portugal were requested to confirm that all the areas included in this category are unmanaged.

As regards with Finland, which includes 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 are unmanaged. 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.

In the case of UK, this category is defined as areas that do not fall into the other land use categories. And that contain unmanaged lands that include inland rock, standing water and canals and rivers and streams broad habitat types that do not falls in Wetlands.

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, this year 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. Portugal has further informed that once the change is implemented, Grassland will contain 2 sub-categories: pastures and shrubland.

Table 6. 30 Definitions of lands included under the category 4F: Other lands

Country	***Definition***

Country	*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 national system of land use representation and land use change identification.
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 fulfil 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). Other lands (flush rocks, etc.) cover around 0.9 million hectares, and are the lowest source of emissions due to low soil disturbance. This is land with no significant carbon stock, neither in soils nor in biomass.
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 determinate 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

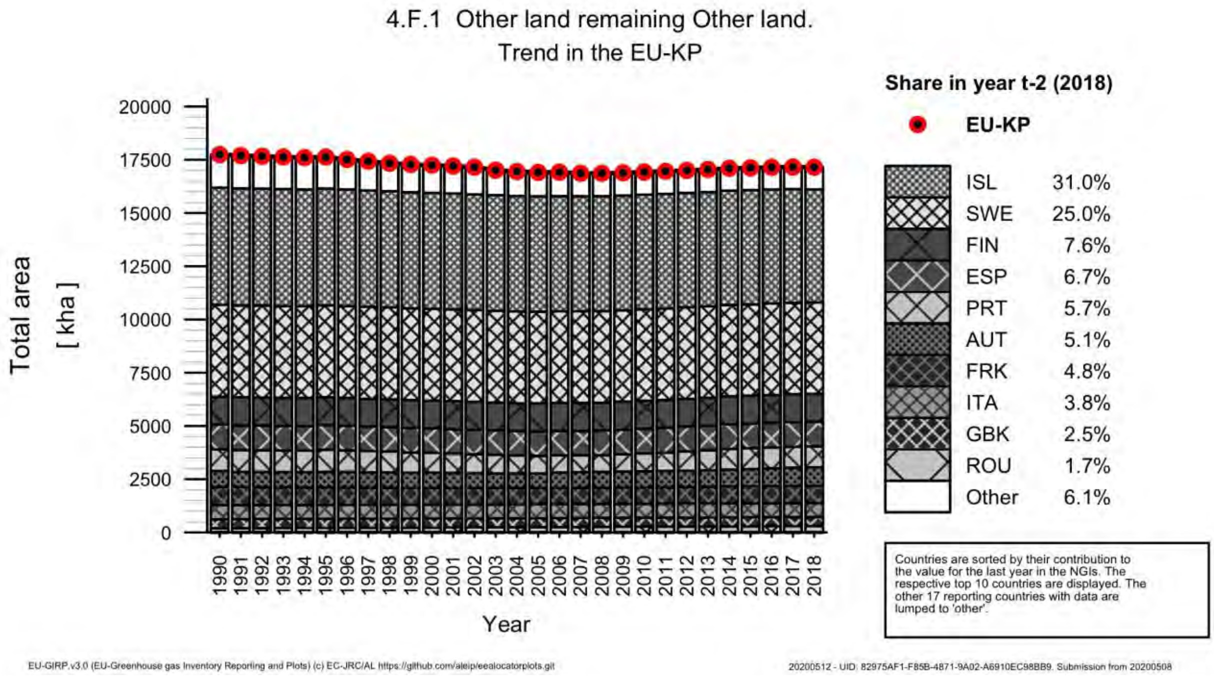
Country	*Definition*
	other categories.
Slovenia	Other land includes non-forest land covered with vegetation lover than 2 m or covered less than 75%, which is not used in agriculture. There are inbuilt areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m2), waste and other 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 resulting from the conversion from other categories to Other land. It reaches for the year 2018, 344 kt CO_2.

Countries report emissions as a result of carbon oxidation from living biomass and soils when lands are converted to Other land as in the case of Romania. However, some have also 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-KP (kha, kt CO_2 1990-2018)



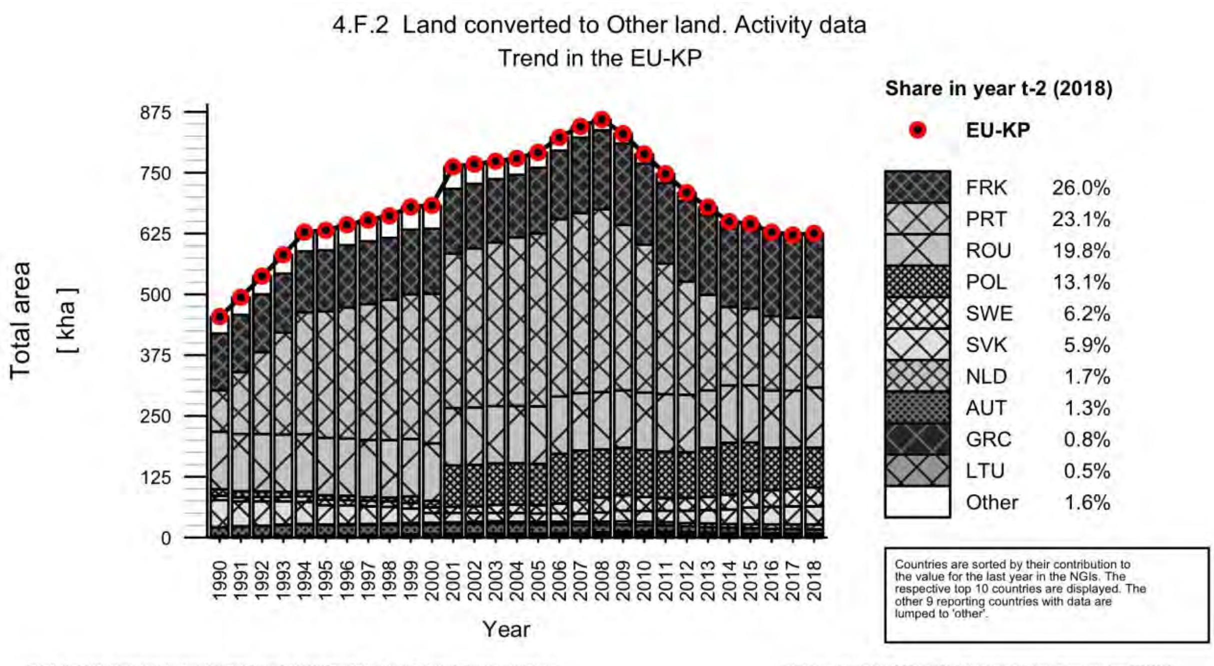
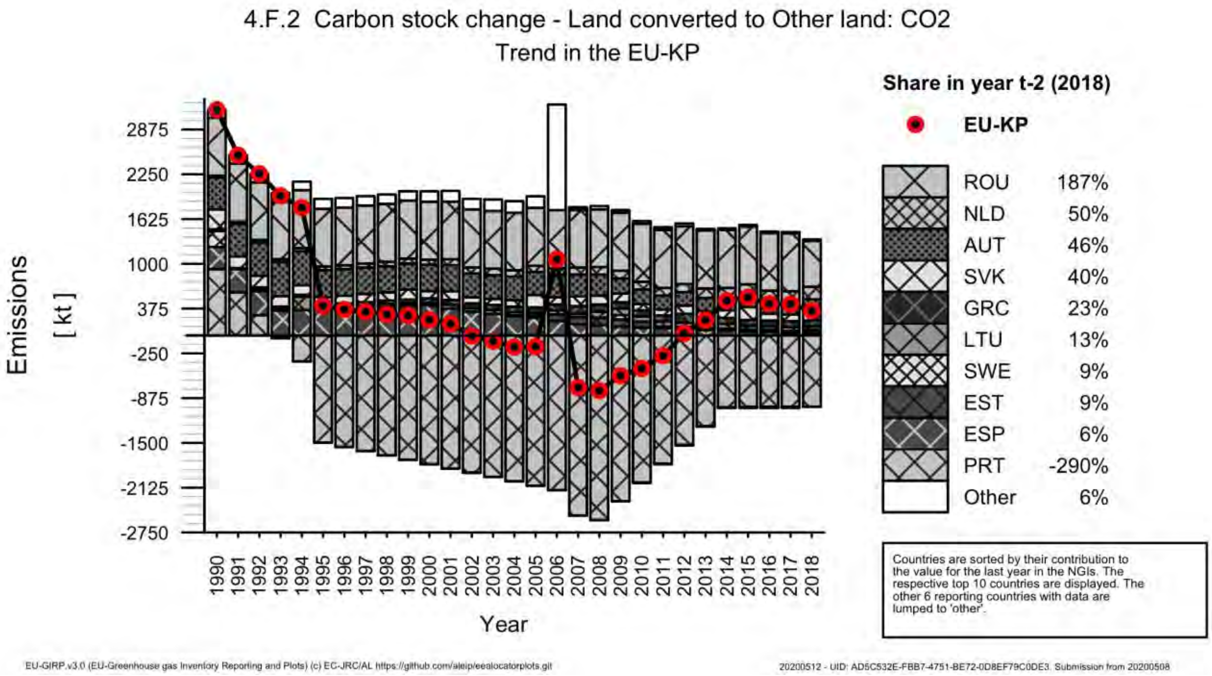


Figure 6. 20 Trend of emissions (+)/removals (-) in subcategory 4F2, "Land converted to Other lands" in EU-KP (kt CO_2, 1990-2018)



6.2.5 Harvest Wood Products (CRF 4G)

6.2.5.1 Overview of the Harvest Wood Products category

This carbon reservoir covers emissions and removals, from carbon stock changes in harvested wood products (HWP), resulting from the annual carbon inflow to the pool (i.e. gains), and carbon outflow from the pool (i.e. losses).

According to the 2006 IPCC guidelines, 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, UK and Iceland a net carbon sink of about -44.621 kt CO_2 in the current inventory year. Most of the countries reported this carbon pool as a net sink; however Cyprus, Greece and Netherlands estimated that HWP resulted in a small net source of emissions for the inventory year.

The main contributors to the carbon sink are Poland, Romania, Sweden, Finland and Germany.

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 countries have recently provided accuracy and complete estimates for this carbon pool in recent submissions. For instance, Cyprus, Iceland and Poland. In the last case, its estimates have significantly contributed to an increase in the sink reported at EU level.

Moreover, Belgium that in previous submissions reported only HWP from 2000 onwards has increased the accuracy and consistency of the reporting of this pool covering the whole time series as requested by the ERT.

The methods and data sources for estimating carbon stock changes in HWP are consistent with methodologies provided by 2006 IPCC GL. 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.

Countries reported carbon stock changes in HWP considering individual estimates for the semi-finished wood products categories of (i) Solid wood, disaggregated in Sawn wood and wood panels, and (ii) Paper and paperboard. To this aim, the IPCC default half-life values have been used by all individual inventories.

A particular case is given by Malta that has stated that carbon stock changes in HWP pool, as considered under the Approach B, does not exist, as commercial logging do not occur in its territory.

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. 31 4G Harvest Wood Products: contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	-3 122	-1 722	-2 001	4.5%	1 122	36%	-279	-16%
Belgium	-1 522	-281	-281	0.6%	1 241	82%	0	0%
Bulgaria	-586	-1 175	-1 175	2.6%	-588	-100%	0	0%
Croatia	-302	-1 008	-746	1.7%	-444	-147%	262	26%
Cyprus	3	24	24	-0.1%	21	637%	0	-1%
Czechia	-1 713	-1 060	-1 488	3.3%	225	13%	-428	-40%
Denmark	-2	-174	-162	0.4%	-160	-6705%	12	7%
Estonia	-157	-1 053	-1 097	2.5%	-940	-598%	-44	-4%
Finland	-2 952	-4 333	-4 417	9.9%	-1 465	-50%	-84	-2%
France	-5 100	-1 108	-914	2.0%	4 186	82%	194	18%
Germany	-1 330	-2 455	-3 239	7.3%	-1 909	-143%	-784	-32%
Greece	-349	63	60	-0.1%	409	117%	-3	-5%
Hungary	-335	-328	-331	0.7%	4	1%	-2	-1%
Ireland	-413	-869	-826	1.9%	-413	-100%	43	5%
Italy	-388	-201	-183	0.4%	204	53%	18	9%
Latvia	-166	-2 251	-2 065	4.6%	-1 898	-1143%	187	8%
Lithuania	-253	-1 045	-935	2.1%	-682	-270%	110	11%
Luxembourg	2	-22	-14	0.0%	-16	-770%	8	35%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	-158	96	113	-0.3%	271	171%	17	18%
Poland	-459	-4 743	-4 859	10.9%	-4 400	-958%	-116	-2%
Portugal	-1 674	4	-44	0.1%	1 629	97%	-49	-1171%
Romania	-817	-5 360	-8 546	19.2%	-7 729	-946%	-3 186	-59%
Slovakia	-470	-1 077	-889	2.0%	-419	-89%	188	17%
Slovenia	-67	-86	-126	0.3%	-59	-88%	-40	-47%
Spain	-2 020	-2 706	-2 448	5.5%	-428	-21%	258	10%
Sweden	-5 016	-6 716	-5 702	12.8%	-686	-14%	1 014	15%
United Kingdom	-2 097	-2 374	-2 330	5.2%	-233	-11%	45	2%
EU-27+UK	**-31 462**	**-41 960**	**-44 621**	**100%**	**-13 158**	**-42%**	**-2 660**	**-6%**
Iceland	NO,NA	0	0	0.0%	0	-∞	0	-59%
United Kingdom (KP)	-2 097	-2 374	-2 330	5.2%	-233	-11%	44	2%
EU-KP	**-31 462**	**-41 960**	**-44 621**	**100%**	**-13 158**	**-42%**	**-2 660**	**-6%**

6.2.6 LULUCF – non-key categories

In this section, general overview of emissions and removals for non-key categories is provided.

Table 6. 32 Aggregated GHG emission from non-key categories in the LULUCF sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		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)	1 959.0	1 427.1	1 465.8	-0.56%	-493	-25%	39	3%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	353.3	464.3	478.8	-0.18%	126	36%	14	3%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	4 388.9	4 216.2	4 196.4	-1.59%	-193	-4%	-20	0%
4.A.1 Forest Land: Land Use (CH_4)	1 681.7	2 641.5	1 104.9	-0.42%	-577	-34%	-1 537	-58%
4.A.1 Forest Land: Land Use (N_2O)	837.4	761.1	609.8	-0.23%	-228	-27%	-151	-20%
4.A.2 Forest Land: Land Use (CH_4)	102.2	253.7	26.7	-0.01%	-76	-74%	-227	-89%
4.A.2 Forest Land: Land Use (N_2O)	475.5	368.0	349.2	-0.13%	-126	-27%	-19	-5%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	890.8	722.2	721.1	-0.27%	-170	-19%	-1	0%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	3 930.8	3 585.1	3 585.9	-1.36%	-345	-9%	1	0%
4.B.1 Cropland: Land Use (CH_4)	89.0	117.3	73.1	-0.03%	-16	-18%	-44	-38%
4.B.1 Cropland: Land Use (N_2O)	56.3	57.8	48.4	-0.02%	-8	-14%	-9	-16%
4.B.2 Cropland: Land Use (CH_4)	57.8	58.2	54.8	-0.02%	-3	-5%	-3.4	-6%
4.B.2 Cropland: Land Use (N_2O)	3 861.7	3 483.6	3 499.5	-1.33%	-362	-9%	16	0%
4.C Grassland: Emissions and removals from drainage and	1 443.2	1 479.8	1 455.3	-0.55%	12	1%	-24	-2%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
rewetting and other management of organic and mineral soils (CH_4)								
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 385.0	1 429.1	1 439.1	-0.55%	54	4%	10	1%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	35.2	17.4	16.7	-0.01%	-18	-53%	-0.7	-4%
4.C.1 Grassland: Land Use (CH_4)	847.3	420.5	216.9	-0.08%	-630	-74%	-204	-48%
4.C.1 Grassland: Land Use (N_2O)	652.2	521.1	444.8	-0.17%	-207	-32%	-76	-15%
4.C.2 Grassland: Land Use (CH_4)	44.4	46.2	44.3	-0.02%	0	0%	-2	-4%
4.C.2 Grassland: Land Use (N_2O)	274.8	231.6	236.7	-0.09%	-38	-14%	5.1	2.2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	3 446.2	3 475.1	3 465.3	-1.31%	19	1%	-10	-0.3%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 938.2	1 639.5	1 567.3	-0.59%	-371	-19%	-72	-4%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	119.4	146.5	146.0	-0.06%	27	22%	-1	0%
4.D.1 Wetlands: Land Use (CH_4)	60.9	202.5	44.8	-0.02%	-16	-27%	-158	-78%
4.D.1 Wetlands: Land Use (N_2O)	18.3	60.8	13.5	-0.01%	-5	-26%	-47	-78%
4.D.2 Wetlands: Land Use (CH_4)	6.9	9.3	9.3	0.00%	2	36%	0.0	0%
4.D.2 Wetlands: Land Use (CO_2)	2 432.1	4 941.5	4 145.2	-1.57%	1 713	70%	-796	-16%
4.D.2 Wetlands: Land Use (N_2O)	59.2	114.0	95.3	-0.04%	36	61%	-19	-16%
4.E Settlements: Biomass Burning (CH_4)	52.6	71.8	164.2	-0.06%	112	212%	92	129%
4.E Settlements: Biomass Burning (CO_2)	46.4	153.0	699.0	-0.26%	653	1406%	546	357%
4.E Settlements: Biomass Burning (N_2O)	5.2	10.8	10.9	0.00%	6	111%	0	1%
4.E.1 Settlements: Land Use (CH_4)	43.7	34.4	34.3	-0.01%	-9	-22%	-0.2	-1%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
4.E.1 Settlements: Land Use (CO_2)	4 049.2	4 363.8	4 500.1	-1.71%	451	11%	136	3%
4.E.1 Settlements: Land Use (N_2O)	140.1	202.9	202.5	-0.08%	62	45%	-0.4	0%
4.E.2 Settlements: Land Use (CH_4)	2.9	15.6	16.3	-0.01%	13	464%	1	4%
4.E.2 Settlements: Land Use (N_2O)	2 624.3	3 349.6	3 442.1	-1.30%	818	31%	93	3%
4.F.2 Other Land: Land Use (CO_2)	3 150.3	437.1	343.6	-0.13%	-2 807	-89%	-93	-21%
4.F.2 Other Land: Land Use (N_2O)	0.1	0.02	0.01	0.00%	-0.1	-88%	-0.004	-29%
4.F.3 Other Land: Direct N_2O Emissions from N Mineralization/Immobilization (N_2O)	614.1	1 172.3	1 171.4	-0.44%	557	91%	-1	0%
4.F.4 Other Land: Biomass Burning (CH_4)	141.4	399.2	31.7	-0.01%	-110	-78%	-368	-92%
4.F.4 Other Land: Biomass Burning (N_2O)	23.2	65.4	5.2	0.00%	-18	-78%	-60	-92%
4.G Atmospheric Deposition: Land Use (N_2O)	17.2	42.7	5.5	0.00%	-12	-68%	-37	-87%
4.G Nitrogen Leaching and Run-off: Land Use (N_2O)	1 130.8	1 060.2	1 061.3	-0.40%	-70	-6%	1	0%
4.H Other LULUCF: Land Use (CH_4)	0.0	219.2	218.7	-0.08%	219	100%	0	-0.2%
4.H Other LULUCF: Land Use (CO_2)	0.0	60.0	52.4	-0.02%	52	100%	-8	-13%
4.H Other LULUCF: Land Use (N_2O)	102.5	110.1	111.2	-0.04%	9	8%	1	1%

6.2.7 Other source of emissions: Tables 4(I)-4(V)

6.2.7.1 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (CRF Table 4(I))

Under CRF table 4(I) countries 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 countries have 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 reported under Agriculture sector when. An accepted approach when it is not possible to separate emissions by land use category. Therefore under the LULUCF almost all the countries have reported these emissions using the notation key NO or IE (Table 6. 33).

Exceptions are given by Finland, Sweden, UK and Iceland, which report N_2O emissions under this source category due to forest fertilization. Sweden reports emissions from nitrogen fertilization as a result of nitrogen inputs occasionally applied to increase the wood production in older forests stands. And, Finland also significant emissions in this category as a result of forest growth fertilizations, and, to a lesser extent vitality fertilizations.

UK and Iceland report low emissions in this source as a result of inorganic nitrogen fertilizers applied to forest when necessary. 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 this inventory year this source of emissions reaches 58 kt CO_2 equivalents, which represent about 20% less than in 1990.

Table 6. 33 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		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	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NA,NO	NO,NA	NO,NA	-	-	-	-	-
Finland	21	29	33	56.7%	13	61%	4	13%
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	5	9.0%	5	∞	0	0%
Italy	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
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	18	18	30.4%	-31	-64%	0	0%
United Kingdom	9	3	2	3.8%	-6	-75%	0	-14%
EU-27+UK	**78**	**55**	**58**	**100%**	**-20**	**-26%**	**4**	**6%**
Iceland	0	0	0	0.2%	0	486%	0	-71%
United Kingdom (KP)	9	3	2	3.8%	-6	-75%	0	-14%
EU-KP	**78**	**55**	**58**	**100%**	**-20**	**-26%**	**3**	**6%**

6.2.7.2 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 this year, total emissions from this source reached 18.648 kt CO_2 equivalent (table 6.34, 6.35 and 6.36) that occurred mostly in organic soils and that are mainly reported by UK, Finland, Sweden and Iceland.

Table 6. 34 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		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	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	49	40	40	0.6%	-9	-19%	0	1%
Estonia	IE,NA,NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Finland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
France	3 266	3 266	3 266	46.2%	0	0%	0	0%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	786	340	177	2.5%	-609	-77%	-163	-48%
Ireland	453	476	479	6.8%	26	6%	2	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	856	1 089	1 199	17.0%	343	40%	110	10%
Lithuania	1 849	1 555	1 558	22.0%	-291	-16%	3	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	),NE,IE,NA	),NE,IE,NA	),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	22%	0	0%
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
United Kingdom	),NE,IE,NA	),NE,IE,NA	),NE,IE,NA	-	-	-	-	-
EU-27+UK	**7 259**	**6 765**	**6 718**	**95%**	**-541**	**-7%**	**-47**	**-1%**
Iceland	348	353	353	5.0%	4	1%	0	0%
United Kingdom (KP)	),NE,IE,NA	),NE,IE,NA	),NE,IE,NA	-	-	-	-	-
EU-KP	**7 607**	**7 118**	**7 071**	**100%**	**-536**	**-7%**	**-47**	**-1%**

Table 6. 35 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		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	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	27	24	24	0.5%	-3	-10%	0	0%
Estonia	256	262	262	5.9%	5	2%	0	0%
Finland	2 081	1 953	1 953	43.7%	-129	-6%	-1	0%
France	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Germany	352	353	355	7.9%	3	1%	2	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0	0	0	0.0%	0	182%	0	-14%
Ireland	103	190	192	4.3%	89	86%	1	1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	538	517	516	11.5%	-22	-4%	-1	0%
Lithuania	35	36	36	0.8%	1	3%	0	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1	1	1	0.0%	0	-5%	0	-1%
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	27	27	1	0.0%	-26	-97%	-26	-97%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	22%	0	0%
Sweden	1 170	1 067	1 071	24.0%	-99	-8%	4	0%
United Kingdom	55	59	59	1.3%	4	6%	0	0%
EU-27+UK	**4 646**	**4 489**	**4 469**	**100%**	**-176**	**-4%**	**-20**	**0%**
Iceland	0	1	1	0.0%	1	635%	0	1%
United Kingdom (KP)	55	59	59	1.3%	4	6%	0	0%
EU-KP	**4 646**	**4 490**	**4 470**	**100%**	**-176**	**-4%**	**-20**	**0%**

Table 6. 36 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	24	24	24	0.3%	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	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	256	296	301	4.2%	46	18%	5	2%
Estonia	62	64	64	0.9%	2	3%	0	0%
Finland	1 531	768	768	10.8%	-763	-50%	0	0%
France	57	57	57	0.8%	0	0%	0	0%
Germany	815	813	812	11.4%	-3	0%	-1	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Ireland	368	393	394	5.5%	27	7%	1	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	437	608	648	9.1%	210	48%	40	7%
Lithuania	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO,NE,NA	NO,NE,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	22%	0	0%
Sweden	470	441	443	6.2%	-27	-6%	2	1%
United Kingdom	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
EU-27+UK	**4 020**	**3 463**	**3 511**	**49%**	**-508**	**-13%**	**48**	**1%**
Iceland	3 720	3 641	3 596	50.6%	-123	-3%	-44	-1%
United Kingdom (KP)	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
EU-KP	**7 739**	**7 104**	**7 107**	**100%**	**-632**	**-8%**	**3**	**0%**

6.2.7.3 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 countries. This evidence significant efforts devoted by countries to increase the completeness for this source of emissions during the last years.

For this year, net emissions from this source category reached 9.114 kt CO_2 equivalent, which represent an increase of 13% as compared to 1990. Significant emissions under this category are reported by France, Romania, UK and Poland (Table 6. 37) and in most of the cases they were estimated using IPCC methodologies and default emissions factors.

Table 6. 37 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-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	129	122	121	1.3%	-8	-6%	-1	-1%
Belgium	6	102	101	1.1%	95	1551%	-1	-1%
Bulgaria	192	404	404	4.4%	212	110%	-1	0%
Croatia	47	121	121	1.3%	74	156%	0	0%
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	9	4	2	0.0%	-7	-73%	-2	-45%
Denmark	0	14	17	0.2%	17	4901%	3	23%
Estonia	0	19	19	0.2%	19	147188%	0	1%
Finland	25	33	32	0.3%	6	25%	-1	-3%
France	2 224	2 239	2 238	24.6%	14	1%	-1	0%
Germany	349	833	861	9.4%	512	147%	28	3%
Greece	1	14	14	0.2%	13	964%	0	-1%
Hungary	22	32	31	0.3%	9	42%	-1	-3%
Ireland	18	195	191	2.1%	173	976%	-4	-2%
Italy	635	404	424	4.7%	-210	-33%	20	5%
Latvia	2	92	102	1.1%	100	4460%	10	11%
Lithuania	74	118	112	1.2%	38	52%	-6	-5%
Luxembourg	17	9	9	0.1%	-9	-49%	-1	-6%
Malta	1	0	0	0.0%	0	-45%	0	0%
Netherlands	6	96	98	1.1%	93	1676%	2	2%
Poland	501	610	678	7.4%	177	35%	67	11%
Portugal	507	315	307	3.4%	-200	-40%	-9	-3%
Romania	1 305	1 816	1 831	20.1%	526	40%	15	1%
Slovakia	75	18	18	0.2%	-57	-76%	0	2%
Slovenia	47	26	25	0.3%	-22	-47%	-1	-6%
Spain	83	142	128	1.4%	45	55%	-14	-10%
Sweden	48	150	156	1.7%	107	222%	6	4%
United Kingdom	1 771	1 081	1 067	11.7%	-705	-40%	-15	-1%
EU-27+UK	**8 094**	**9 012**	**9 107**	**100%**	**1 012**	**13%**	**95**	**1%**
Iceland	0	1	1	0.0%	1	701%	0	0%
United Kingdom (KP)	1 773	1 088	1 073	11.8%	-700	-39%	-15	-1%
EU-KP	**8 096**	**9 019**	**9 114**	**100%**	**1 018**	**13%**	**95**	**1%**

6.2.7.4 **Indirect nitrous oxide (N_2O) emissions from managed soils (CRF Table 4(IV))**

This 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 countries have reported in the CRF table 4(IV) the notation key IE (i.e. included elsewhere).

Nevertheless, the completeness 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 this inventory year, indirect N_2O emissions reported under LULUCF reached 1.067 kt CO_2 equivalents (Table 6. 38). These emissions are mainly reported by Germany, UK and France. Others MS have provided for first time also minor quantities of indirect N_2O emissions.

Table 6. 38 Indirect nitrous oxide (N_2O) emissions from managed soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	15	14	14	1.3%	-1	-6%	0	-1%
Belgium	IE	IE	IE	-	-	-	-	-
Bulgaria	43	91	91	8.5%	48	110%	0	0%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NE	NE	NE	-	-	-	-	-
Czechia	2	1	1	0.1%	-1	-73%	0	-45%
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	0	4	4	0.4%	4	147188%	0	1%
Finland	2	2	2	0.2%	0	11%	0	-5%
France	498	454	449	42.1%	-50	-10%	-5	-1%
Germany	79	187	194	18.2%	115	147%	6	3%
Greece	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Hungary	3	5	5	0.4%	1	42%	0	-3%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	29	9	14	1.3%	-15	-52%	5	48%
Latvia	IE,NA	2	3	0.2%	3	∞	0	10%
Lithuania	17	22	22	2.1%	6	35%	0	0%
Luxembourg	4	2	2	0.2%	-2	-49%	0	-6%
Malta	IE	IE	IE	-	-	-	-	-
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	20	46	10	0.9%	-11	-53%	-37	-79%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	15	5	5	0.5%	-10	-66%	0	4%
Slovenia	9	5	5	0.4%	-5	-49%	0	-6%
Spain	3	5	5	0.5%	2	55%	-1	-10%
Sweden	8	3	3	0.3%	-5	-62%	0	-1%
United Kingdom	401	244	241	22.6%	-161	-40%	-3	-1%
EU-27+UK	**1 148**	**1 103**	**1 067**	**100%**	**-81**	**-7%**	**-36**	**-3%**
Iceland	IE	IE	IE	-	-	-	-	-
United Kingdom (KP)	401	244	241	22.6%	-161	-40%	-3	-1%
EU-KP	**1 148**	**1 103**	**1 067**	**100%**	**-81**	**-7%**	**-36**	**-3%**

6.2.7.5 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 countries 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, countries 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, countries informed that controlled burning on managed lands is not a common practice. With few exceptions for confined areas that are reported by 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 from 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 2018 compared to 1990 in this inventory year emissions reaches 6.443 Kt CO_2 equivalent (Table 6. 39, Table 6. 40 and Table 6. 41) and much more also when the data is compared with the previous year. The reason is the dramatic number of fires that affected Portugal and to a lesser extent Ital in 2017.

Nevertheless, this source of emissions presents a very variable trend and inter-variability that is related with several factors, in many cases driven by climate conditions. It is well known that the countries that often report the larger quantities of emissions as a result of the biomass burning are Italy, France, Spain, and Greece. However, it is remarkable that during the last years northern countries are also reporting significant amount of emissions from this source (e.g. Ireland, Germany) as a result of the incident of wildfires in their territories.

Table 6. 39 CO_2 emissions from Biomass Burning (in kt CO_2)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NE,IE	NO	NO	-	-	-	-	-
Bulgaria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Croatia	15	824	11	0.3%	-4	-24%	-813	-99%
Cyprus	0	4	7	0.2%	6	1315%	3	96%
Czechia	16	20	58	1.6%	42	264%	38	189%
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Finland	3	5	11	0.3%	8	229%	6	132%
France	2 189	804	286	7.7%	-1 903	-87%	-518	-64%
Germany	NO,IE,NA	NO,IE,NA	545	14.7%	545	∞	545	∞
Greece	146	17	12	0.3%	-134	-92%	-5	-27%
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	467	1 638	375	10.1%	-92	-20%	-1 263	-77%
Italy	5 071	2 037	672	18.1%	-4 399	-87%	-1 365	-67%
Latvia	24	37	402	10.8%	378	1551%	365	978%
Lithuania	1	1	1	0.0%	0	-7%	1	138%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	4	5	5	0.1%	1	26%	0	0%
Poland	107	13	70	1.9%	-37	-34%	57	451%
Portugal	1 679	9 409	657	17.7%	-1 022	-61%	-8 752	-93%
Romania	4	18	19	0.5%	15	387%	1	4%
Slovakia	43	80	67	1.8%	25	58%	-13	-16%
Slovenia	21	12	1	0.0%	-20	-95%	-11	-91%
Spain	843	161	133	3.6%	-710	-84%	-28	-17%
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-
United Kingdom	104	374	378	10.2%	274	265%	4	1%
EU-27+UK	**10 739**	**15 458**	**3 711**	**100%**	**-7 028**	**-65%**	**-11 747**	**-76%**
Iceland	NE,IE,NA	),NE,IE,NA	),NE,IE,NA	-	-	-	-	-
United Kingdom (KP)	107	376	380	10.2%	273	255%	4	1%
EU-KP	**10 743**	**15 460**	**3 714**	**100%**	**-7 029**	**-65%**	**-11 747**	**-76%**

Table 6. 40 CH_4 emissions from Biomass Burning (in kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-66%	0	92%
Belgium	1	NO	NO	-	-1	-100%	-	-
Bulgaria	2	11	3	0.2%	1	40%	-7	-68%
Croatia	1	69	1	0.1%	0	6%	-68	-98%
Cyprus	0	0	1	0.0%	1	1315%	0	96%
Czechia	44	14	23	1.3%	-21	-48%	9	67%
Denmark	1	0	0	0.0%	-1	-96%	0	111%
Estonia	0	0	3	0.1%	2	838%	3	2173%
Finland	3	1	1	0.1%	-2	-64%	1	99%
France	966	963	936	52.8%	-30	-3%	-27	-3%
Germany	7	2	104	5.9%	97	1431%	102	5375%
Greece	63	19	19	1.1%	-43	-69%	1	5%
Hungary	23	19	10	0.5%	-13	-58%	-9	-50%
Ireland	83	276	66	3.7%	-17	-21%	-210	-76%
Italy	1 181	1 347	171	9.6%	-1 011	-86%	-1 177	-87%
Latvia	25	11	47	2.7%	22	87%	36	338%
Lithuania	3	0	1	0.0%	-2	-80%	0	100%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	33%	0	0%
Poland	35	5	17	0.9%	-18	-52%	11	206%
Portugal	300	1 259	95	5.3%	-205	-68%	-1 164	-92%
Romania	0	2	2	0.1%	2	402%	0	7%
Slovakia	10	21	21	1.2%	11	108%	0	-1%
Slovenia	2	1	0	0.0%	-1	-95%	-1	-91%
Spain	314	165	165	9.3%	-149	-47%	0	0%
Sweden	2	2	52	2.9%	50	2419%	49	2236%
United Kingdom	17	33	34	1.9%	17	102%	2	6%
EU-27+UK	**3 083**	**4 219**	**1 770**	**100%**	**-1 313**	**-43%**	**-2 450**	**-58%**
Iceland	NE,IE,NA	0	),NE,IE,NA	-	-	-	0	-100%
United Kingdom (KP)	18	33	35	2.0%	17	96%	2	6%
EU-KP	**3 084**	**4 220**	**1 771**	**100%**	**-1 314**	**-43%**	**-2 450**	**-58%**

Table 6. 41 **N_2O emissions from Biomass Burning (in kt CO_2 eq.)**

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-66%	0	92%
Belgium	5	NO	NO	-	-5	-100%	-	-
Bulgaria	2	7	2	0.2%	1	40%	-5	-68%
Croatia	1	49	1	0.1%	0	23%	-48	-98%
Cyprus	0	0	0	0.0%	0	1315%	0	96%
Czechia	29	9	15	1.6%	-14	-48%	6	67%
Denmark	0	0	0	0.0%	0	-94%	0	111%
Estonia	0	0	0	0.0%	0	858%	0	1925%
Finland	2	0	1	0.1%	-1	-64%	0	95%
France	537	459	440	46.0%	-97	-18%	-18	-4%
Germany	4	1	7	0.8%	3	68%	6	501%
Greece	5	2	2	0.2%	-4	-69%	0	5%
Hungary	15	13	6	0.7%	-8	-57%	-7	-53%
Ireland	22	72	17	1.8%	-5	-24%	-55	-76%
Italy	261	108	35	3.6%	-226	-87%	-73	-68%
Latvia	3	1	6	0.6%	3	90%	4	316%
Lithuania	3	0	1	0.1%	-2	-81%	0	90%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	29%	0	0%
Poland	23	4	11	1.2%	-12	-52%	7	206%
Portugal	49	206	16	1.6%	-34	-68%	-191	-92%
Romania	0	1	0	0.0%	0	183%	0	-40%
Slovakia	7	14	14	1.4%	7	108%	0	-1%
Slovenia	1	1	0	0.0%	-1	-95%	-1	-91%
Spain	285	156	155	16.2%	-130	-46%	-1	-1%
Sweden	0	0	4	0.4%	4	2419%	4	2236%
United Kingdom	15	23	25	2.6%	10	67%	2	8%
EU-27+UK	**1 270**	**1 127**	**759**	**79%**	**-511**	**-40%**	**-368**	**-33%**
Iceland	NE,IE,NA	0	O,NE,IE,NA	-	-	-	0	-100%
United Kingdom (KP)	212	221	223	23.3%	10	5%	2	1%
EU-KP	**1 468**	**1 325**	**957**	**100%**	**-511**	**-35%**	**-368**	**-28%**

6.2.8 Emissions from organic soils in the EU GHG inventory

Area of organic soils reported by EU MS, UK and ISL under the three main land use categories (i.e. Forest land, Cropland and Grassland) cover about 18.672 kha that are mainly located in northern countries.

Total CO_2 emissions linked to that area in in the inventory year, reached 94.587 kt CO_2 which represents about 35% of total EU net removals from LULUCF (Table 6. 42). 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, countries 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. 42).

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. 42 Area, CO_2 emissions and average implied C stock change factors in the EU MS, UK and Iceland reported for the year 2018 for organic soils.

Land use subcategory	Area (Kha)	ICECF (tC/ha)	Emissions from Org. Soils. (Kt CO_2)
4A1	12 264	[-2.60; 0.65]	13 631
4A2	407		1 494
4B1	1 242	[-10.01; -1.00]	25 813
4B2	273		5 814
4C1	4 132	[-6.80; 0.25]	42 150
4C2	354		5 683

6.3 Uncertainties

For the year 2018, LULUCF uncertainty was estimated in 22.4% for the uncertainty of the level and 15.0 % for the uncertainty of the trend (Table 6. 43).

For more information on the uncertainty analysis please refer to chapter 1.6.

Table 6. 43 Level and trend uncertainty assessment of the annual EU-KP emission/removal on LULUCF land subcategories and GHG sources.

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	CO2	-358 768	-357 193	-0.4%	12.1%	0.1%
4.A Forest Land	CH4	1 808	1 540	-14.8%	112.9%	0.2%
4.A Forest Land	N2O	2 913	2 451	-15.9%	99.8%	0.1%
4.B Cropland	CO2	77 635	60 429	-22.2%	37.8%	0.1%
4.B Cropland	CH4	775	643	-17.0%	112.0%	0.2%
4.B Cropland	N2O	3 782	3 375	-10.8%	115.1%	0.2%
4.C Grasland	CO2	20 803	-1 545	-107.4%	1018.6%	0.8%
4.C Grasland	CH4	1 555	925	-40.5%	140.2%	0.3%
4.C Grasland	N2O	852	564	-33.8%	89.7%	0.2%
4.D Wetlands	CO2	9 997	13 292	33.0%	56.5%	0.1%
4.D Wetlands	CH4	3 399	3 328	-2.1%	53.4%	0.0%
4.D Wetlands	N2O	326	356	9.2%	57.6%	0.0%
4.E Settlements	CO2	37 975	47 410	24.8%	29.4%	0.1%
4.E Settlements	CH4	99	215	116.5%	67.4%	0.7%
4.E Settlements	N2O	2 693	3 384	25.7%	94.0%	0.2%
4.F Other Land	CO2	3 036	329	-89.2%	143.7%	0.1%
4.F Other Land	CH4	141	32	-77.6%	30.8%	0.2%
4.F Other Land	N2O	535	1 110	107.3%	30.5%	0.3%
4.G Harvested wood products	CO2	-32 196	-42 485	32.0%	42.3%	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	52		30.4%	
4.H Other	CH4	0	219		100.0%	
4.H Other	N2O	501	491	-1.9%	93.5%	0.1%
4.I	CO2	0	0		0.0%	0.0%
4.I	CH4	0	0		0.0%	0.0%
4.I	N2O	21	33	60.9%	196.2%	1.2%
4.II	CO2	1 898	1 598	-15.8%	56.6%	0.1%
4.II	CH4	1 794	1 077	-40.0%	107.5%	0.5%
4.II	N2O	2 143	2 013	-6.1%	112.9%	0.1%
4.III	CO2	0	0		0.0%	0.0%
4.III	CH4	0	0		0.0%	0.0%
4.III	N2O	148	190	28.6%	606.2%	4.4%
4.IV	CO2	0	0		0.0%	0.0%
4.IV	CH4	0	0		0.0%	0.0%
4.IV	N2O	460	276	-40.1%	156.3%	0.6%
4.V	CO2	61	90	47.1%	169.7%	0.6%
4.V	CH4	15	26	71.2%	58.3%	0.2%
4.V	N2O	10	16	60.6%	60.4%	0.2%
4 (where no subsector data were submitted	*all*	*279*	*-50*	*-117.8%*	*542.3%*	*30.2%*
Total - 4	**all**	**-215 309**	**-255 810**	**18.8%**	**22.4%**	**15.0%**

6.4 Sector-specific quality assurance and quality control and verification

6.4.1 Time series consistency

The EU greenhouse gas inventory is compiled rigorously by aggregation of national inventories, thus, its consistency strictly depends on the consistency of individual inventories.

The time-series consistency is checked every year for each individual submission as part of the quality control procedures implemented under the EU GHG Monitoring Mechanism Regulation[62]. Consistency is checked, in terms of each land use subcategory category, and

[62] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525

the overall land representation system, across time and space. Ensuring for instance, that the sum of all land use areas is constant over time and match the official country area. Moreover, there is none circumstances that can justify discontinuities on areas across years. Therefore, the area for each land use category, and KP activity, at the end of one year must be the same as the area at the beginning of the next year.

For the sake of consistency all the parameters used to estimate the GHG fluxes are checked. In this sense, activity data, implied carbon stock change factors, and emissions reported for each land use subcategory across the years of the time series are cheeked to spot potential outliers and to ensure the plausibility of their trends.

Countries provide early submissions to the European Commission that is in charge of implementing a set of quality checks aim to ensure the consistency and completeness but also to increase the accuracy, transparency and comparability. For each potential issue identified during this phase, a dialogue is established to discuss the best way to resolve the issue, if any.

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 are not fully adequate to fulfill reporting requirements or they do not provide data on an annual basis.

Land use definitions are not identical among countries. As shown in previous chapters, each country has its own definition according with its land representation and data collection systems. However, they all are in accordance with IPCC definitions. Differences are given by slightly variations in the treatment of particular lands and in many cases related to historical definitions and available databases. Some examples are the different thresholds used to define forest; the categorization of hedges or bush areas under Cropland, Grassland or Forest land; or the inclusion of woody plantations either under Cropland or Forest land.

After all these years of implementing QA/QC procedures and undoubtedly because of the efforts devoted by countries to overcome with the issues, and to improve their inventories, it can be appreciated a substantial improvement on the consistency of the information. Moreover, every year new projects are launched, and new data are involved, to further improve the land representation system and the estimation of carbon stock changes and other GHG emissions that result in recalculations that aim to enhance the reported numbers.

6.4.2 Quality Assurance and Quality control

Information submitted under the LULUCF sector by EU MS, UK and Iceland are under a double QA/QC system. One implemented at country level, and another one, carried out in the context of the EU GHG Monitoring Mechanism Regulation (MMR), which is performed for this sector by the Joint Research Centre (JRC) of the European Commission in collaboration with countries, the EEA, DG CLIMA and European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/CME)

Under the MMR, the checks focus on early versions of national GHG inventories that are submitted in January. The checks aim to assess and improve the completeness and consistency, but also the accuracy, and transparency, and to the extent possible the comparability. A second round of submissions received in March is also checked in terms of the implementation status of previously raised issues and potential recalculations among the January and March submission.

Ultimately, the checks are intended to identify and resolve calculation errors, to provide suggestions to address completeness issues, to identify the need for further descriptions or lack of transparency, and to spot outliers on time-series consistency and discrepancies among data included on the different sections of the submission. In all the cases, QA/QC procedures are implemented by interacting with national experts to get clarifications and to plan possible improvements.

During the analysis of this year submissions, around 160 findings (i.e. potential issues) were communicated to the countries, 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.

The following list aims to provide an overview of the checks that are implemented on the LULUCF and KP-LULUCF data submitted by countries, but it does not intend to represent an exhaustive description:

1. Completeness check: the use of any notation key "NE", but also possible inappropriate use of "NA", "NO", "IE", whenever IPCC methods are available, is monitored and followed up with the relevant countries. Furthermore, the check also aims to identify empty cells that should have been filled in with information.
2. Time-series check of activity data information:
    a. The sum of areas reported for each land use category is constant on time.
    b. The feasibility of the time series of area and land use changes occurring in a single year.
    c. The area at the end of the previous year (t-1) matches the area at the beginning of the current year (t).
    d. Check to ensure that only annual land use changes from one year to another are reported in the CRF table 4.1
3. Time-series check of emissions/removals and implied carbon stock change factors (ICSCF):
    a. Check the feasibility of potential discontinuities in ICSCF and emissions or removals.
    b. Check for outliers in ICSCF and emissions or removals.
    c. Check the coherence of emissions and removals with activity data.
    d. Check the plausibility of constant values of emissions and removals across years.
4. Check the consistency of areas reported across different CRF tables:
    a. The sum of total area reported under the CRF table 4.1 matches the total area reported under the CRF table NIR-2 (using the cell "Other").
    b. The area reported for each land use category in CRF table 4.1 matches the area reported under the sectorial background data tables (i.e. 4.A-4.F). (**To note**: Despite of this check and the recommendation provided by the EU in the context of the QAQC procedures to ensure the consistency among tables, 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 are 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.
    c. The area reported for each KP activity in CRF NIR-2 matches the area reported under the sectorial background data tables (i.e. 4(KP-I) A.1- 4(KP-I) B-5).

5. Check the consistency among LULUCF and Agriculture: Histosols areas reported in Agriculture are equal or less than organic soils areas reported in Cropland plus Grassland (i.e. N.B.: organic soils for unmanaged grassland are reported in LULUCF but not in Agriculture)
6. Additional checks implemented on LULUCF and KP-LULUCF information:
    a. Check that adequate information on recalculations is included in the NIR.
    b. Check that FMRL value matches the value inscribed in the appendix to the annex of decision 2/CMP.7.
    c. Check that information on key category analysis is provided. (**To note:** some MS have stated bugs in the CRF Reporter software that prevent the inclusion of this information on the CRF table NIR-3)
    d. Check that the Cap value is included in the Accounting table.
    e. Check that unresolved and partially resolved issues from previous year are addressed.
    f. Check that ERT team's recommendation that concern to counties 'submissions are addressed.
    g. Check that HWP information on LULUCF is complete and properly allocated under the correct approach.
    h. Check the coherence among units and activity data used for reporting Biomass burning in CRF table 4(V)

In addition to the routine implementation of QA/QC checks, some additional activities have been implemented during the past years that were meant to improve the quality of both national, and EU GHG inventories, as follows:

- In 2012 an exercise was carried out involving LULUCF reviewers that participate in the UNFCCC review process to assess the reporting of dead organic matter and soils, and identify common issues and alternative solutions. Some decision trees were created and shared with inventory compilers. (E.g. is the "not a source" provision properly applied?)
- In 2014 and 2015 two assessments were carried out to verify data on burned areas reported by individual GHG inventories and those reported in EFFIS[63].
- The JRC have collaborated during the past years, and is doing it so, on several capacity building projects launched by DG CLIMA to support the LULUCF reporting on MS.

Furthermore, with the purpose of enhancing the LULUCF reporting, sharing experiences amongst countries, and the harmonization of methods for estimating GHG emissions and CO_2 removals in the sector, a series of technical workshops dedicated to UNFCCC reporting (including Kyoto Protocol), under the auspices of the Joint Research Center have been organized.

- JRC technical workshop on LULUCF reporting under the Kyoto Protocol 28-29 May 2019 Varese, Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 16-17 May 2018 Arona (NO), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 April 2017 Stresa (NO), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 02-03 May 2016 Stresa (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 May 2015 Arona (NO), Italy.

[63] http://forest.jrc.ec.europa.eu/effis/

- 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 Canadian Forest Service and adapted to the EU conditions (Pilli et al. 2014[64], Pilli et al. 2016[65],[66]), 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.

Besides that, a comprehensive analysis of individual submissions has been also carried out in 2015[67]. In this context, some inconsistencies were found that were communicated to concerned country during the 2016 QA/QC process.

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[64] 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 modelling. 266, 144-171.

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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 address the recommendations received from the UNFCCC's expert review team (ERT); to correct issues identified during our internal quality control process and/or the results of our internal peer review:

- More references have been introduced to the work carried out along with countries to address identified issues. For instance, as requested by the ERT, we have provided explicit information from Italy on why its reporting on the subcategory 4.A. does not result in bias estimates. But also on the use of NE by France for the reporting of other land converted to cropland.
- Sections 6.4.1, 6.4.2 and 6.4.3 have been reformulated to allow readers a better understanding of the QA/QC process implemented on LULUCF.
- New and better explanations, when necessary, on the reasons for changes in trends and inter-annual variability of the emissions and removals across the lands use categories have been added in specific sections dedicated to land use subcategories.
- The overall completeness of the sector has been increased (see details in section 6.1.3). For instance, this year Belgium provided information on carbon stock change in HWP for the entire time series.
- Carbon stock changes in dead wood under forest land remaining forest land are now included for the entire time series by Luxembourg, as requested by previous ERTs.
- More detailed explanations have been included across the sections to explain the underlying reasons for the use of the notation key NE. For instance for the reporting of Forest land by Malta.
- Information on carbon stock changes in HWP has been provided by Luxembourg.
- Correction of identified typo errors that were found across the text.
- Correction of some of the inconsistencies identified across the activity data reported in CRF tables 4.1 and 4.A-4.F. More improvements are expected on this regard in next submission.
- The information on Wetlands category has been improved with the addition of more tables in section 6.2.4.
- In section 6.2.2.3, new text has been added to better describe the improvements that have been implemented this year to increase the complements, including the use of higher tiers, and the explanation of why France uses the notation key NE for reporting of the conversion from Other land to Cropland as was requested by ERT.
- A new table on HWP information has been added to harmonize the type of tables used to report GHG across sections.
- The table 6.5 was improved with the addition of one column to report separately information on DW and LT. In addition, in that section, information on improvements done on completeness was added to highlight changes with respect to previous year.
- More transparent explanations of the planned improvements have been added.

Planned improvements

The following improvements are foreseen for next submission:

- Follow up individual submissions to ensure that remaining inconsistencies on areas reported in CRF table 4.1 and 4.A - 4.F that were not resolved this year are addressed.

- Follow up individual submissions to enhance the harmonization of the use of notation keys for the implementation of the IPCC assumption of equilibrium, under Tier 1 methods.
- Follow up the submission of Portugal to track the planned improvement to be implemented in the reporting of Grassland and Other land (see section 6.2.4.6).
- Follow up the submission of Malta to track the planned improvement to be implemented in the reporting of Forest land. (see section 6.2.1.2)

6.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 6. 44 to Table 6. 49 provide information on the contribution of EU MS, UK and ISL to the recalculations in sectors 4A, 4B, 4C, 4D, 4E and 4F (all GHGs) for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table 6. 44 4A Forest Land: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	9	0.5	281	18.3	Recalculation are based on: Flemish region: -Most important recalculations were because of the addition of a matrix reference year 2015. Consequently a less steep trend is observed for the years from 2013 on. - An update of the matrix reference years 1990 – 2009 – 2012 has been made. The most changes occurred in the categories grassland and cropland as well as (but less) LUC in the other categories. Wallonia: - Update of the land-use change matrix. A reassessment of the Land-Use matrix was conducted in 2019, using the new complete coverage of orthophotos 2018. (see Section10.4.2). This has a slight impact on Forest land estimates, as the area is slightly increased (decrease of deforestation). Brussels : - Matrix update: 2018 was added, and 2016 & 2017 were recalculated
Bulgaria	-5 533	-45.5	-279	-3.8	1) In response to the ERT recommendations and implementation of the planned improvements – land representation, change in the way of treating the marginal lands and shrubs; reporting of CSC in soil under CLrCL and GL, reporting of CSC in dead wood in FL. 2) Updating some EF according to 2019 Refinement to the 2006 IPCC Guidelines and new country-specific data – carbon stock in biomass in perennial croplands, in annual crops and grasslands. 3) Recalculation of the average soil organic carbon for all land use categories to the default depth of 0-30 cm. 4) In relation to some uncovered error in the calculations – biomass pool in FL category, HWP
Croatia	-0	-0.0	-47	-1.0	Corrections in the emissions from biomass in subcategory Out of yield forests (Maquies and shrub) were done. For this purpose data on biomass completely burnt in this type of forests were collected. On that basis new calculation was performed.
Cyprus	32	41.4	115	38.9	Change of BCEFI (biomass conversion and expansion factor for increment) from 0.645 tC/m3 to the default value 0.450 tC/m3 (Table 6.4.5, p. 4.51, value for Mediterranean, dry tropical and subtropical coniferous forest). Use of interpolated and extrapolated data provided in Table 6.6 to cover the entire period 1990 to the reported year instead of using an average (0.844 m3/ha/yr) for the entire period (coniferous forest). 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.
Czechia	244	5.2	296	17.6	Following review recommendations the methodology was update. Emission estimates were recalculated for the entire category of 4.A Forest land and reporting period.
Denmark	-	-	1	1.1	Time for all land use transition has been revised to 30 years for all sectors. This affects all sectors but only related to changes in soil carbon stocks.
Estonia	-290	-8.7	-427	-19.0	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

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					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 and Land converted to forest land.
Finland	-14	-0.1	2 804	9.4	New area estimates were calculated due to the updating of NFI data (see Section 6.2). Gains were recalculated due to new NFI data. Emissions from restoration burnings were included in the emissions from biomass burning.
France	-2 192	-5.7	2 922	5.4	The carbon balance of the forest has changed over the past few years due to the integration of the new IGN campaign. This integration has notably led in the past few years to a further drop in gross production and an increase in mortality.
Germany	4 237	5.6	-9 434	-16.3	Introduction of new emission factors for phytomass and dead wood that are based on the new results of the 2017 Carbon Inventory. The EF have also been adjusted, by means of methods changes and data corrections, for previous inventory periods (cf. also Chapter 6.4.2.2 and Chapter 6.4.2.3). The new and old EF are compared in Table 425. Previous uses are not considered in the case of land-use changes leading to Forest Land. • Densification of the sampling network for determination of land use and land-use changes (cf. Chapter 6.3.1ff) • Introduction of the concept of effective transition time (cf. Chapter 6.3.4.2) • Annual calculation and documentation of the current carbon stocks of all pools, as recorded at all points of the sampling grid (e.g. Chapter 6.1.2.1ff)
Greece	-	-	-	-	
Hungary	-132	-4.0	-133	-2.7	This year, recalculations were made (1) to replace previously extrapolated CLC land use change data with those estimated in the 2012-2018 survey; (2) to correct a wrong soil C reference value; and (3) to correct some calculation errors. In addition, we corrected errors in our data upload system.
Ireland	-0	-0.0	5	0.1	Re-estimation of CSC in mineral soils using a refined allocation of mineral soil types based on analysis in the 2017 NFI soil classifications. Recalibration of harvests in the CBM model simulations.
Italy	0	0.0	234	1.0	Slight deviations occur in the 2020 submission, comparing to the 2019 submission, for the forest land remaining forest land (-1.1% for the 2017 reporting year) and land converted to forest land (0.1% for the 2015, 2016 and 2017 reporting years). The recalculation is due to the update of the activity data; in particular, harvest data have been update for the 2015, 2016, 2017 on the basis of the extraordinary data collection, implying also the revision of latest years data, put in place by the regions (Trentino Alto Adige, Veneto, Friuli Venezia Giulia, Lombardy and, only marginally, Piedmont and Valle d'Aosta) affected in late 2018 by the Vaia storm.
Latvia	-156	-0.9	70	1.2	Recalculations are done due to continuous improvement of activity data. New method for calculation of land use changes using the most recent NFI data was implemented in 2019 (Krumsteds et al., 2019).
Lithuania	-173	-2.2	3 293	41.7	Newest growing stock volume data was applied in forest land remaining forest land - extrapolated values in two latest years (for 2016 and 2017) were replaced with actual values. In addition to this, share of organic soils was updated using the most recent NFI (NFI 2014 – 2018) data, which resulted both in change of GHG emissions from drained organic soils and carbon stock changes in mineral soil of land converted to Forest land. Correct value of litter carbon stock in Grassland previous to the conversion to Forest land was applied to estimate carbon stock change in dead organic matter of Land converted to forest land.
Luxembourg	-25	-15.4	-37	-9.0	In order to be in line with the new calculations, under Regulation (EU) 2018/841, of the Forest Reference Level (FRL) the calculation for dead wood was changed.

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					Instead of using a stock change approach a carbon pool variation module that takes account of the dynamic age-related characteristics, is used to estimate the evolution of this carbon pool.
Malta	-	-	-	-	
Netherlands	0	0.0	-17	-0.9	A number of the methodological changes as described in Section 6.1 have resulted in recalculations in the Forest land categories. As a result of the methodological changes in the emission factor for drained organic soils, the reported carbon stock losses in organic soils in this category were recalculated from 2004 onwards. Additionally the methodological change of extrapolating the change in extent of organic soils in the Netherlands resulted in recalculations of emissions from organic soils from 2014 onwards.
Poland	128	0.4	294	0.8	Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968; factors related adjustment of carbon stocks calculation in category 4.A (update of Emission factors for various types of burning); factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).Recalculation of data for years 1988-2017 ensured consistency for whole time-series.
Portugal	-6	-0.1	2 486	76.8	Update/revision of AD:- Burnt areas per land-use type, reflecting the latest information provided by ICNF (Institute for Nature Conservation and Forests)
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	72	1.6	1 400	121.1	Recalculations in the FF subcategory were performed due to inclusion of final forest data from the FECS 2018. As forest was subject to substantial natural disturbances since 2014, the removals in this category were decreased. The stock change method was used to calculate change in carbon stock change of living biomass, whereas trend in the period 2012-2017 was corrected taking into account the SFS harvest data. Recalculations in the LF subcategory were made for the whole reporting period 1986-2017 due to inclusion of new value on dead organic matter, including dead wood and litter.
Spain	-90	-0.3	138	0.4	New estimate of the C content of living biomass in category 4A1 based on new data from national forest inventory. Update of forest fires information for 2016. The carbon content for the subcategory 4A.2 was recalculated based on revision of former data.
Sweden	-397	-1.1	-302	-0.7	Recalculations can be divided into several categories of which the two first ones can be considered “ordinary” recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the MI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calculations and needs to be corrected.

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
United Kingdom	-315	-2.1	-251	-1.4	The changes were mainly seen in the carbon stock changes in all pools under Forest Remaining Forest. The main causes of this change were the correction of the previous double-counting of input to the deadwood and litter pools at harvest in the CARBINE model.
EU27+UK	-4 600	-1.2	3 413	0.9	
Iceland	-0	-0.4	-38	-11.0	Recalculations are based on the area of drained forest land that was re-estimated.
United Kingdom (KP)					NA
EU-KP	-4 596	-1.2	3 378	0.9	

Table 6. 45 4B Cropland: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-0	-0.0	82	82 868.2	The improvements of the assessment of soil C stock changes in cropland remaining cropland which were started two years ago were continued. The methodological regime for separating the cropland into the different tillage and input types was further improved by an adjustment of the areas with cover/catch crops. The area with cover/catch crops (greening measures) was recalculated based on IACS data for 2002 and 2016, the greening areas in the years in between were interpolated. The 2016 and 2017 values of the LUC areas between grassland and cropland were updated, which had an impact on the C stock changes and N_2O emissions due to land-use changes in these years. In this submission the permanent conversions for the years 2016–2018 were recalculated from the average share of permanent conversions in the yearly changes. The perennial cropland areas with soil erosion measures were updated for the years 2015, 2016, 2017 and 2018 which had an impact on the soil C stock changes. An error in the vineyard biomass estimate for the years 2016 and 2017 was corrected. The conversions between annual and perennial cropland in the year 2017 were updated
Belgium	-3	-1.1	-507	-40.1	Flemish region: Most important recalculations were because of the addition of a matrix reference year 2015. Consequently, a less steep trend is observed for the years from 2013 on. - An update of the matrix reference years 1990 – 2009 – 2012 has been made. The most changes occurred in the categories grassland and cropland as well as (but less) LUC in the other categories. Brussels region: - Matrix update: 2018 was added, and 2016 & 2017 were recalculated.
Bulgaria	-95	-14.3	-109	-14.6	Recalculations in CL are related to updating the information on the carbon stock in biomass of perennial croplands based on the 2019 Refinement to the 2006 IPCC Guidelines. The average carbon stock in biomass of annual crops and grasslands were updated. In addition to this a CSC in soils of CLrCL (e.g annual remaining annual and perennial remaining perennial) have been estimated based on the default stock change factor method (eq. 2.25 of the 2006 IPCC Guidelines following the ERT's recommendation. The average SOC content in grassland was estimated for the two subcategories included in the current submission
Croatia	3	1.2	129	49.7	For this reporting Croatia uses revisioned CLC change databases for the first time. Changes in Activity data (areas) results with significant differences in emissions/removals.
Cyprus		-	-	-	

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
	-				
Czechia	29	16.1	103	330.0	Following review recommendations, the methodology was updated. Emission estimates related to soil carbon stock changes were recalculated for both the categories 4.B.1 Cropland remaining Cropland and 4.B.2 Land converted to Cropland, respectively. These changes resulted in altered emissions for the entire category 4.B Cropland.
Denmark	929	21.9	773	34.7	NIR, page 475: A major has been made for area estimate of the organic soils. Due to a misinterpretation of the first developed organic soil map in 2014 the area especially 6-12 % OC organic soils were underestimated. This misinterpretation affects more or less all emissions as it affects the area with mineral soils, N_2O emissions and CH_4 emissions. Furthermore, a consistent 30 yrs default transition time has been implemented for all sectors and for the whole time series.
Estonia	110	19.3	136	57.9	The entire time series of activity data are 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. For instance, the recalculated areas of organic soils and lands under conversion to croplands were somewhat higher compared to the previous submission, which is the main reason for higher emissions from the Cropland category in the 2020 submission. Also, average growing stocks in Forest land and Grassland are updated annually, and the BCEFS values are adjusted according to the changes in the species composition and growing stocks.
Finland	23	0.4	706	9.7	New area estimates were calculated due to the updating of NFI data (see Section 6.2). The proportions of cultivated crop plants grown on mineral and organic soils were updated for the years 2015 to 2017. A minor correction was done on the soil carbon stock change estimation due to error in area classification.
France	1 878	8.7	1 700	10.6	Correction of CO_2 emission factors (and very slightly of CH_4) on organic soils. The emission factors proposed by the Wetland supplement had been used in previous submissions.
Germany	78	0.6	857	5.9	The emissions were recalculated in order to take account of new and improved data sources, changes in methods, and error corrections made as part of ongoing inventory improvements. The following measures affected the results of the emissions calculations for the Cropland land-use category: • Densification of the sampling network for determination of land use and land-use changes • Introduction of the concept of effective transition time • Determination of peat-extraction areas with the help of ATKIS® • Disaggregation of the sub-category "Perennial crops" into the four sub-categories hops, wine, fruit, and other perennial crops (tree nurseries, Christmas tree plantations and short rotation plantations) • Annual calculation and documentation of the current carbon stocks of all pools, as recorded at all points of the sampling grid • Introduction of new mineral-soils EF for Cropland annual, Hops, Vineyards and Orchards, for other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations), Grassland (in the strict sense), Woody Grassland and Terrestrial Wetlands• Introduction of new emission factors for the phytomass of hops, fruit, other perennial crops, and forest land • Introduction of new emission factors for dead wood
Greece	-	-	-	-	

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Hungary	-14	-8.9	-162	-228.4	This year, recalculations were made (1) to replace previously extrapolated CLC land use change data with those estimated in the 2012-2018 survey; (2) to correct a wrong soil C reference value; and (3) to correct some calculation errors. In addition, we corrected errors in our data upload system.
Ireland	39	437.0	20	24.1	Refinement of spatial analysis of the Land Parcel Information System dataset that affect the estimates of the time series.
Italy	121	5.5	-1 769	-144.0	Deviations occur in the 2020 submission, comparing to the 2019 submission, for the whole time series. The recalculation is due to the updated activity data and methodology for the estimation of living biomass carbon pool; the recalculation is also due to the estimates and the inclusion in the reporting of the carbon stock changes from soils pool, for cropland remaining cropland, and to the update of the SOCs used to estimate the soil C stock changed from land converted to cropland, as shown in the table 6.21. A slight deviation is also due to the update of organic soils area
Latvia	440	12.7	-582	-20.2	Recalculations are done due to continuous improvement of activity data. New method for calculation of land use changes using the most recent NFI data was implemented in 2019 (Krumsteds et al., 2019).
Lithuania	-368	-12.5	-1 576	-58.8	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. In addition to this, changes occur due to updated share of organic soils in cropland remaining cropland and land converted to cropland subcategories, which resulted in estimated difference in carbon stock changes both in mineral and organic soils. National carbon stock value in litter was applied to estimate carbon stock changes in dead organic matter (litter) in grassland converted to cropland. Carbon stock changes in mineral soils of cropland remaining cropland were recalculated due to updated certified organic cropland area and stock change factor FI, which was increased to 1.44 after the consultations with specialists from Ministry of Agriculture.
Luxembourg	-0	-0.1	-0	-0.0	In order to be in line with the new calculations, under Regulation (EU) 2018/841, of the Forest Reference Level (FRL) the calculation for dead wood was changed. Instead of using a stock change approach a carbon pool variation module that takes account of the dynamic age-related characteristics, is used to estimate the evolution of this carbon pool.
Malta	-	-	-	-	
Netherlands	-0	-0.0	-103	-5.9	As a result of the methodological changes in the emission factor for drained organic soils as described in Section 6.1, the reported carbon stock losses in organic soils in this category were recalculated from 2004 onwards. Additionally the methodological change of extrapolating the change in extent of organic soils in the Netherlands resulted in recalculations from 2014 onwards. Both changes resulted in reduced emissions from organic soils compared to the NIR 2019.
Poland	-2 084	-225.6	-1 419	-167.1	Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968; factors related adjustment of carbon stocks calculation in category 4.A (update of Emission factors for various types of burning); factors related adjustment of carbon stocks calculation

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					in category 4.C (update of emission factors for various types of burning).Recalculation of data for years 1988-2017 ensured consistency for whole time-series.
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	24	2.6	-	-	The category 4.B Cropland, the subcategory 4.B.1 Cropland remaining Cropland (Perennial Cropland remaining Perennial Cropland) was recalculated for the whole time period since 1990. The main reason for recalculation was correction of biomass loss calculation. The actual biomass losses recalculation includes only the negative sum of biomass loss in all perennial crops subcategories (orchards, vineyards, gardens and hop gardens)
Slovenia	26	22.1	3	1.7	The NIR 2020 changes in soil carbon stock for mineral soil were estimated for the first time in the period 2007-2018. Recalculations were also made due to new data on dead organic matter in grassland, which affected emissions in conversions from grassland to cropland
Spain	-	-	37	1.1	Recalculation based on new infrmation on management practice of woofy crops. And the new estimation of the living biomass in forests, which impact the estimation of forest converted to cropland.
Sweden	515	15.6	506	14.6	Recalculations can be divided into several categories of which the two first ones can be considered “ordinary” recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the MI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calculations and needs to be corrected.
United Kingdom	342	2.4	260	2.4	Changes affect mainly in soil carbon stock change in Cropland remaining Cropland. Change in soil carbon density for cropland management. Correction of cropland areas in England. Revision of deforestation activity data.
EU27+UK	1 991	2.7	-915	-1.5	
Iceland	-28	-1.5	-437	-27.2	The area for this category was revised according to the revised estimate of the total area of the map layer of “Cropland”. The time series for the area of this category was subsequently revised in relation to the new total area for this category. Emissions of all pools depending on that area were recalculated accordingly. Emission/removal factors used for this category are unchanged.
United Kingdom (KP)					NA
EU-KP	1 963	2.6	-1 353	-2.2	

Table 6. 46 4C Grassland: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	7	2.1	The 2017 values of the grassland areas and the LUC areas between grassland and cropland of 2016 and 2017 were updated according to the most recent agricultural statistics which had an impact on the C stock changes in these years.
Belgium	-9	-2.5	-131	-19.7	Flemish region: - Most important recalculations were because of the addition of a matrix reference year 2015. Consequently a less steep trend is observed for the years from 2013 on. - An update of the matrix reference years 1990 – 2009 – 2012 has been made. The most changes occurred in the categories grassland and cropland as well as (but less) LUC in the other categories. Brussels region: - Matrix update: 2018 was added, and 2016 & 2017 were recalculated.
Bulgaria	-1 089	-4 088.3	-124	-7.3	Recalculations in CL are related to updating the information on the carbon stock in biomass of perennial croplands based on the 2019 Refinement to the 2006 IPCC Guidelines. The average carbon stock in biomass of annual crops and grasslands were updated. In addition to this a CSC in soils of CLrCL (e.g annual remaining annual and perennial remaining perennial) have been estimated based on the default stock change factor method (eq. 2.25 of the 2006 IPCC Guidelines following the ERT's recommendation. The average SOC content in grassland was estimated for the two subcategories included in the current submission
Croatia	94	92.1	14	8.9	For this reporting Croatia uses revisioned CLC change databases for the first time. Changes in Activity data (areas) results with significant differences in emissions/removals
Cyprus	-	-	-	-	
Czechia	30	21.4	111	29.2	Following review recommendations the methodology was updated. The emission estimates related to soil carbon stock changes were recalculated for both the categories 4.C.1 Grassland remaining Grassland and 4.B.2 Land converted to Grassland, respectively. These changes resulted in altered emissions for the entire category 4.B Grassland.
Denmark	527	56.9	546	75.4	Time for all land use transition has been revised to 30 years for all sectors. This affects all sectors but only related to changes in soil carbon stocks.
Estonia	-5	-8.0	0	0.6	Activity data as well as growing stock and dead wood stock volumes are being updated and if necessary, corrected every year. As the area of drained organic soils in Grassland remaining grassland was lower compared to the previous submission, also emissions from this category have decreased (Table 6.27). Land converted to grassland areas increased due to the new data from NFI, leading to higher emissions from organic soils, but also increased C sequestration in mineral soils. Biomass and DOM losses increased as a result of higher deforestation area.
Finland	-3	-0.4	69	10.9	All carbon stock changes and non- CO_2 data are areas and are computed from the NFI data were recalculated. Estimates of losses of living biomass were added.

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
France	549	4.0	567	6.6	Correction of CO_2 emission factors (and very slightly of CH_4) on organic soils. The emission factors proposed by the Wetland supplement had been misused in previous submissions. Modification of surfaces, land which was transferred to grassland remaining grassland due to smoothing treatments are now brought back to grassland becoming forests. Updating areas mainly concerns forests that become grassland, which have been reduced by processing Teruti data, allowing IGN and Teruti to be reconciled on forest areas. Hence a reduction in emissions linked to deforestation
Germany	-1 997	-7.8	-6 021	-27.4	The emissions were recalculated in order to take account of new and improved data sources, changes in methods, and error corrections made as part of ongoing inventory improvements. The following measures affected the results of the emissions calculations for the Grassland land-use category: • Densification of the sampling network for determination of land use and land-use changes • Introduction of the concept of effective transition time • Determination of peat-extraction areas with the help of ATKIS® • Disaggregation of the sub-category "Perennial crops" into the four sub-categories Hops, Vineyards, Orchards, and other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations) • Annual calculation and documentation of the current carbon stocks of all pools, as recorded at all points of the sampling grid • Introduction of new mineral-soils EF for Cropland annual, Hops, Vineyards and Orchards, other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations), Grassland (in the strict sense), Woody Grassland and Terrestrial Wetlands • Introduction of new emission factors for the phytomass of hops, fruit, other perennial crops, and forest land • Introduction of new emission factors for dead wood
Greece	-	-	-	-	
Hungary	0	1.7	283	78.8	This year, recalculations were made (1) to replace previously extrapolated CLC land use change data with those estimated in the 2012-2018 survey; (2) to correct a wrong soil C reference value; and (3) to correct some calculation errors. In addition, we corrected errors in our data upload system.
Ireland	3	0.0	-52	-0.8	Revised assessment of the area of grassland on organic soils which has resulted in the recalculation of emissions from this pool.
Italy	-348	-8.7	-1 280	-32.5	Deviations occur in the 2020 submission, comparing to the 2019 submission, for the whole time series. The recalculation is due to the estimates and the inclusion in the reporting of the carbon stock changes from soils pool for grazing land in grassland remaining grassland and to the update of the SOCs used to estimate the soil C stock changed from land converted to grassland, as shown in the table 6.30. A slight deviation is also due to the update of organic soils area. No deviations occur for the other wooded land subcategory and in living biomass pool, both for grassland remaining grassland and land converted to grassland.
Latvia	-647	-33.0	465	52.1	Recalculations are done due to continuous improvement of activity data. New method for calculation of land use changes using the most recent NFI data was implemented in 2019 (Krumsteds et al., 2019).
Lithuania	20	2.7	-161	-19.1	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. In addition to this, changes occur due to updated share of organic soils in grassland remaining grassland and land converted to grassland subcategories, which resulted in estimated difference in carbon stock changes both in

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					mineral and organic soils. National carbon stock value in litter was applied to estimate carbon stock changes in dead organic matter (litter) in other land uses converted to grassland. Carbon stock changes in biomass in cropland converted to grassland were recalculated, including carbon stock losses from perennial cropland converted to grassland (the share of perennial cropland in total cropland area was applied).
Luxembourg	-0	-0.5	-0	-0.0	In order to be in line with the new calculations, under Regulation (EU) 2018/841, of the Forest Reference Level (FRL) the calculation for dead wood was changed. Instead of using a stock change approach a carbon pool variation module, which takes account of the dynamic age-related characteristics, is used to estimate the evolution of this carbon pool.
Malta	-	-	-	-	
Netherlands	0	0.0	-385	-10.4	A number of the methodological changes as described in Section 6.1 have resulted in recalculations in the Grassland categories. As a result of the methodological changes in the emission factor for drained organic soils, the reported carbon stock losses in organic soils in this category were recalculated from 2004 onwards. Additionally the methodological change of extrapolating the change in extent of organic soils in the Netherlands resulted in recalculations of emissions from organic soils from 2014 onwards. Both changes resulted in decreased emissions from drained organic soils.
Poland	-544	-75.6	605	106.7	Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968; factors related adjustment of carbon stocks calculation in category 4.A (update of Emission factors for various types of burning); factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).Recalculation of data for years 1988-2017 ensured consistency for whole time-series.
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-4	-2.0	-59	-17.2	Emissions were recalculated due to inclusion of new data on dead wood and litter of perennial grassland based on data from the study of Mali et al., 2018. Besides, carbon stock changes for mineral soil in subcategory grassland annual remaining grassland annual were calculated for the first time for the period 2007-2018.
Spain	-	-	-0	-0.4	Recalculated information on wildfires in 2016. Recalculation of the carbon content of living biomass in forest that impact the estimation of forest converted to grassland.
Sweden	-129	-42.3	-247	-370.0	Recalculation of biomass and areas depends on small corrections due to new information and new weights of inventory plots. Soil and litter due to updated area. Recalculation due to extrapolation of data for years without a full record of data (2015-2018).
United Kingdom	8	0.1	4	0.0	The changes and their justification are due to the use of CARBINE estimates for biomass lost during deforestation. Revision of deforestation activity data. Adjustment of average biomass densities due to error correction: the IPCC default method for calculating emissions from wildfires had been misapplied as the UK does not use the combustion factors with mass

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					burnt.
EU27+UK	-3 545	-13.8	-5 790	-79.3	
Iceland	16	0.3	268	4.9	The areas of "Cropland abandoned for more than 20 years" and "Cropland converted to Grassland" were revised in relation to the revised estimate of the total area of the map layer of "Cropland" The time series for the areas of these two sub-categories "" were revised according to the revised estimate of the total area of map layer " Cropland". Emissions of all pools depending on those areas were recalculated accordingly. The area for Revegetation since 1990 protected from grazing back to 1990 was revised and emissions accordingly recalculated. Emission/removal factors used for this category are unchanged.
United Kingdom (KP)					NA
EU-KP	-3 530	-11.5	-5 522	-43.2	

Table 6. 47 4D Wetlands: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-3	-23.7	3	33.1	Recalculations due to update of areas in the three regions following last data available. Moreover in the Brussels region Matrix update: 2018 was added, and 2016 & 2017 were recalculated.
Bulgaria	109	100.0	19	7.5	The reasons for the recalculations are: 1) In response to the ERT recommendations and implementation of the planned improvements – land representation, change in the way of treating the marginal lands and shrubs; reporting of CSC in soil under CLrCL and GL, reporting of CSC in dead wood in FL. 2) Updating some EF according to 2019 Refinement to the 2006 IPCC Guidelines and new country-specific data – carbon stock in biomass in perennial croplands, in annual crops and grasslands. 3) Recalculation of the average soil organic carbon for all land use categories to the default depth of 0-30 cm. 4) In relation to some uncovered error in the calculations – biomass pool in FL category, HWP.
Croatia	37	78.4	3	32.5	For this reporting Croatia uses revisioned CLC change databases for the first time. Changes in Activity data (areas) results with significant differences in emissions/removals
Cyprus	-	-	-	-	
Czechia	0	0.0	0	0.3	Following review recommendations the methodology was updated.
Denmark	-2	-2.3	-	-	Time for all land use transition has been revised to 30 years for all sectors. This affects all sectors but only related to changes in soil carbon stocks.
Estonia	33	3.0	45	6.0	Updated activity data, growing stocks and dead wood volumes from the NFI were used for estimating GHG emissions from peatlands and land converted to wetlands. As recalculated peatland areas have increased compared to the previous submission, also GHG emissions from the Wetlands category are higher (Table 6.31).
Finland	-	-	92	5.0	New area estimates were calculated due to the updating of NFI data (see Section 6.2). The existence period of stockpiles on peat extraction sites was recalculated and also subdivision of areas to those where stockpiles exist and to those without stockpiles was recalculated
France	-28	-7.2	-8	-1.5	Recalculation due to changes on the activity data information.

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Germany	-538	-13.2	294	7.4	The emissions were recalculated in order to take account of new and improved data sources, changes in methods, and error corrections made as part of ongoing inventory improvements. The following measures affected the results of the emissions calculations for the Grassland land-use category: • Densification of the sampling network for determination of land use and land-use changes • Introduction of the concept of effective transition time • Determination of peat-extraction areas with the help of ATKIS® • Disaggregation of the sub-category "Perennial crops" into the four sub-categories Hops, Vineyards, Orchards, and other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations) • Annual calculation and documentation of the current carbon stocks of all pools, as recorded at all points of the sampling grid • Introduction of new mineral-soils EF for cropland annual, Hops, Vineyards and Orchards, other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations), Grassland (in the strict sense), Woody Grassland and Terrestrial Wetlands • Introduction of new emission factors for the phytomass of hops, fruit, other perennial crops, and forest land • Introduction of new emission factors for dead wood
Greece	-	-	-	-	
Hungary	-1	-0.1	215	176.4	This year, recalculations were made (1) to replace previously extrapolated CLC land use change data with those estimated in the 2012-2018 survey; (2) to correct a wrong soil C reference value; and (3) to correct some calculation errors. In addition, we corrected errors in our data upload system.
Ireland	123	8.3	-678	-20.9	Revised assessment of the area of wetland harvested for the horticultural peat market.
Italy	-	-	-26	-33.3	Deviations occur in the 2020 submission, comparing to the 2019 submission, for the 2016 and 2017 reporting years. The recalculation is due to update of the activity data and the consequent smoothing process affecting the 2016 and 2017 reporting years. Additional information on the smoothing process is reported in the section 6.1.
Latvia	-3	-0.2	-94	-6.5	Recalculations are done due to continuous improvement of activity data. New method for calculation of land use changes using the most recent NFI data was implemented in 2019 (Krumsteds et al., 2019).
Lithuania	7	1.2	14	1.3	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) 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	-0	-0.0	-0	-0.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. In addition to this, national carbon stock value in litter was applied to estimate carbon stock changes in dead organic matter (litter) in grassland converted to wetlands. Also, carbon stock changes in biomass in cropland converted to wetland were recalculated; including carbon stock losses from perennial cropland converted to wetland (the share of perennial cropland in total cropland area was applied). Recalculations also include distinguishing carbon stock changes in forest land converted to flooded land between mineral and organic soils and application of national carbon stock values as obtained from study "Evaluation of national organic carbon stocks and the determination of stock values in organic and mineral soils in forest

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					and non-forest land", performed by Lithuanian Research Centre for Agriculture and Forestry, Institute of Forestry.
Malta	-	-	-	-	
Netherlands	0	0.0	4	11.0	As a result of the methodological changes in the emission factor for drained organic soils, the reported carbon stock losses in organic soils in this category were recalculated from 2004 onwards. Additionally the methodological change of extrapolating the change in extent of organic soils in the Netherlands resulted in recalculations of emissions from organic soils from 2014 onwards. Both changes resulted in decreased emissions from drained organic soils.
Poland	46	7.6	414	27.6	Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968; factors related adjustment of carbon stocks calculation in category 4.A (update of Emission factors for various types of burning); factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).Recalculation of data for years 1988-2017 ensured consistency for whole time-series.
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	1	41.6	The main recalculations in the Wetlands category, namely Land converted to Wetlands in the NIR 2020 submission were provided due to updated emission factors in forest land (living biomass) and grassland (dead wood and litter), which caused changes in emissions accordingly.
Spain	-	-	-12	-22.8	Recalculations based on the availability of new data for peat production.
Sweden	-	-	-	-	
United Kingdom	-	-	0	0.0	
EU27+UK	-221	-1.6	287	1.7	
Iceland	-	-	-	-	
United Kingdom (KP)					NA
EU-KP	-221	-1.8	287	1.8	

Table 6. 48 4E Settlements: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	0	0.0	

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Belgium	-13	-8.7	-292	-39.0	Recalculation due to soil C in ‘settlements remaining settlements’ was set equal to soil C in ‘cropland remaining cropland’ for the entire time series, in line with the assumption explained in section 6.3.8 above. Formerly, an average value was used in settlements, but this brought minor C stock changes as the soil C in cropland is evolving.- update of areas in the three regions following last data available .Brussels region :- Matrix update : 2018 was added, and 2016 & 2017 were recalculated.
Bulgaria	-31	-6.7	-78	-9.9	The reasons for the recalculations are: 1) In response to the ERT recommendations and implementation of the planned improvements – land representation, change in the way of treating the marginal lands and shrubs; reporting of CSC in soil under CLrCL and GL, reporting of CSC in dead wood in FL. 2) Updating some EF according to 2019 Refinement to the 2006 IPCC Guidelines and new country-specific data – carbon stock in biomass in perennial croplands, in annual crops and grasslands. 3) Recalculation of the average soil organic carbon for all land use categories to the default depth of 0-30 cm. 4) In relation to some uncovered error in the calculations – biomass pool in FL category, HWP. In addition to the changes related to land representation and SOC, described above, as well as all the emissions and removals from LUCs to SM have been updated. The gains in biomass of SM have been estimated for 3% of the area converted to SM as not all new SM area has biomass. The 3% value has been derived based on CLC data for classes 1.4.1. a
Croatia	85	51.3	137	25.7	For this reporting Croatia uses revisioned CLC change databases for the first time. Changes in Activity data (areas) results with significant differences in emissions/removals.
Cyprus	-	-	-	-	
Czechia	-764	-73.8	-368	-63.0	The estimates of soil carbon stock change resulting from land converted to other land use categories that involve Settlements were revised. This is due to an identified error in estimates of reference soil carbon stock applicable to the land-use category Settlements. The revised estimates are, similarly as before, grounded on soil carbon data for land-use categories Forest land, Cropland and Grassland. However, the current revision includes a correction of the technical error when adopting 20 per cent soil carbon loss for paved over areas in line with the 2006 IPCC Guidelines (vol. 4, chap. 8, p.8.24). This revision affects all soil CSC estimates involving land-use conversions from and to Settlements.
Denmark	2	11.3	92	135.0	Time for all land use transition has been revised to 30 years for all sectors. This affects all sectors but only related to changes in soil carbon stocks.
Estonia	-	-	86	39.5	Updated activity data, growing stocks and dead wood volumes from the NFI were used for estimating carbon losses due to land conversion to Settlements. Compared to the previous submission, land areas under Land converted to settlements subcategories are higher and therefore also C losses related to land conversions have increased for all C pools.
Finland	0	0.0	104	15.1	New area estimates were calculated due to the updating of NFI data (see Section 6.2).
France	-43	-0.5	-84	-0.8	Recalculation due to changes on the activity data information.
Germany	774	42.7	1 767	50.9	The emissions were recalculated in order to take account of new and improved data sources, changes in methods, and error corrections made as part of ongoing inventory improvements. The following measures affected the results of the

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					emissions calculations for the Grassland land-use category: • Densification of the sampling network for determination of land use and land-use changes • Introduction of the concept of effective transition time • Determination of peat-extraction areas with the help of ATKIS® • Disaggregation of the sub-category "Perennial crops" into the four sub-categories Hops, Vineyards, Orchards, and other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations) • Annual calculation and documentation of the current carbon stocks of all pools, as recorded at all points of the sampling grid • Introduction of new mineral-soils EF for cropland annual, Hops, Vineyards and Orchards, other perennial crops (tree nurseries, Christmas tree plantations and short-rotation plantations), Grassland (in the strict sense), Woody Grassland and Terrestrial Wetlands • Introduction of new emission factors for the phytomass of hops, fruit, other perennial crops, and forest land • Introduction of new emission factors for dead wood
Greece	-	-	-	-	
Hungary	-1	-1.3	-17	-9.5	This year, recalculations were made (1) to replace previously extrapolated CLC land use change data with those estimated in the 2012-2018 survey; (2) to correct a wrong soil C reference value; and (3) to correct some calculation errors. In addition, we corrected errors in our data upload system.
Ireland	-	-	-	-	
Italy	-0	-0.0	-0	-0.0	No recalculations occur in 2020 submission.
Latvia	58	177.4	462	1 643.3	Recalculations are done due to continuous improvement of activity data. New method for calculation of land use changes using the most recent NFI data was implemented in 2019 (Krumsteds et al., 2019).
Lithuania	1	7.6	9	1.6	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. In addition to this, the share of organic soils in grassland and cropland subcategories, which resulted in estimated difference in carbon stock changes both in mineral and organic soils. National carbon stock value in litter was applied to estimate carbon stock changes in dead organic matter (litter) in grassland converted to settlements. Carbon stock changes in biomass in cropland converted to settlements were recalculated, including carbon stock losses from perennial cropland converted to settlements (the share of perennial cropland in total cropland area was applied). Recalculations also include distinguishing carbon stock changes in forest land converted to settlements between mineral and organic soils and application of national carbon stock values.
Luxembourg	-0	-0.0	-0	-0.0	
Malta	-	-	-	-	
Netherlands	-0	-0.0	-21	-1.4	A number of the methodological changes as described in Section 6.1 have resulted in recalculations in the Settlements categories. As a result of the methodological changes in the emission factor for drained organic soils, the reported carbon stock losses in organic soils in this category were recalculated from 2004 onwards. Additionally the methodological change of extrapolating the change in extent of organic soils in the Netherlands resulted in recalculations of emissions from organic soils from 2014 onwards. As a result of the new mask for the land use maps to be able to include the harbour extension (Maasvlakte 2) into the sea, the area included under

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					Wetland converted to Settlement has increased by 0.11 kha between 2013 and 2017 resulting in small increases in emissions from mineral and organic soils.
Poland	1 314	261.6	76	3.2	Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968; factors related adjustment of carbon stocks calculation in category 4.A (update of Emission factors for various types of burning); factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).Recalculation of data for years 1988-2017 ensured consistency for whole time-series.
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	2	0.4	1	0.4	The main recalculations in the Land converted to Settlements in the NIR 2020 submission were provided due to updated emission factors in forest land (living biomass) and grassland (dead wood and litter), which caused changes in emissions accordingly.
Spain	-	-	-	-	Recalculation of the carbon content of living biomass in forest that impact the estimation of forest converted to settlement.
Sweden	-54	-2.1	682	32.6	Recalculation of biomass and areas depends on small corrections due to new information and new weights of inventory plots. Soil and litter due to updated area. Recalculation due to extrapolation of data for years without a full record of data (2015-2018).
United Kingdom	18	0.3	134	2.1	The changes and their justification are the use of CARBINE estimates for biomass lost during deforestation. Revision of deforestation activity data: The deforestation time series 1990-1999 was revised to use the same precision as reprocessed Countryside Survey data (QA improvement). Areas for England 2017-18 from the latest statistical report.
EU27+UK	1 346	3.6	2 691	6.0	
Iceland	1	3.6	0	7.4	The time series for intact mires is revised according to new estimate of the category in the revised IGLUD land use map. All emissions are recalculated accordingly
United Kingdom (KP)					NA
EU-KP	1 419	3.8	2 789	6.2	

Table 6. 49 4F Other land: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	3	100.0	592	100.0	In response to a recommendation of the ERT to “review the assumptions used to assign land areas to other land and avoid unjustifiable increases in the land area that is assigned to the other land category, ensuring that the IPCC’s definition is

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					consistently applied and avoiding any possible omission or double counting in the reporting of the LULUCF sector" we revised the land use definitions and assumptions. The major change is in the way of how the lands with grassy cover and shrubs are treated. In our previous submissions we included these areas under OL category and LUC to/from OL were reported. We agree with the comment of the ERT that it is more feasible to include these areas under GL category and to revise these assumptions. As a result, we stratify the area of GL into two subcategories to reflect this change and to differentiate between mowed or grazed grasslands and the lands which are not suitable for grazing and mowing or which are not intensively managed for a long time and are now secondary lawns or shrublands. The change affected the LUC matrices thus, required a revision in all categories except for FL.
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	7	27.2	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. Since the Land converted to other land area is higher than in the previous submission, also CO_2 emissions from this category have increased.
Finland	-	-	-	-	
France	-0	-100.0	-0	-100.0	Removal of very low emissions that were mistakenly reported in this category
Germany	-	-	-	-	
Greece	-	-	-	-	
Hungary	-	-	-0	-76.6	This year, recalculations were made (1) to replace previously extrapolated CLC land use change data with those estimated in the 2012-2018 survey; (2) to correct a wrong soil C reference value; and (3) to correct some calculation errors. In addition, we corrected errors in our data upload system.
Ireland	0	1.2	6	203.2	Revised estimate of the land area classified as other land. Revised estimates of emissions associated with the conversion of forestry to other land.
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-3	-6.5	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. In addition to this, national carbon stock value in litter was applied to estimate carbon stock changes in dead organic matter (litter) in grassland converted to Other land. Carbon stock changes in biomass in cropland converted to Other land were recalculated; including carbon stock losses from perennial cropland converted to Other land (the share of perennial cropland in total cropland area was applied). Recalculations also include distinguishing carbon stock changes in Forest land converted to Other land between mineral and organic soils and application of national carbon stock values as obtained from study "Evaluation of national organic carbon stocks and the determination of stock values in organic and mineral soils in forest and non-forest

	1990		2017		Main explanations
	kt CO_2	%	kt CO_2	%	
					land", performed by Lithuanian Research Centre for Agriculture and Forestry, Institute of Forestry.
Luxembourg	-0	-0.1	-0	-0.0	
Malta	-	-	-	-	
Netherlands	0	0.0	6	3.5	As a result of the new mask for the land use maps to be able to include the harbour extension (Maasvlakte 2) into the sea, the area included under Wetland converted to Other land has increased by 0.06 kha between 2013 and 2017 resulting in small increases in emissions from mineral soils.
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden	-8	-3.5	-3	-38.5	Recalculations can be divided into several categories of which the two first ones can be considered "ordinary" recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the MI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calculations and needs to be corrected.
United Kingdom	-	-	-	-	
EU27+UK	-5	-0.2	604	362.2	
Iceland	-	-	-	-	
United Kingdom (KP)					
EU-KP	-5	-0.2	604	362.2	

7 WASTE (CRF SECTOR 5)

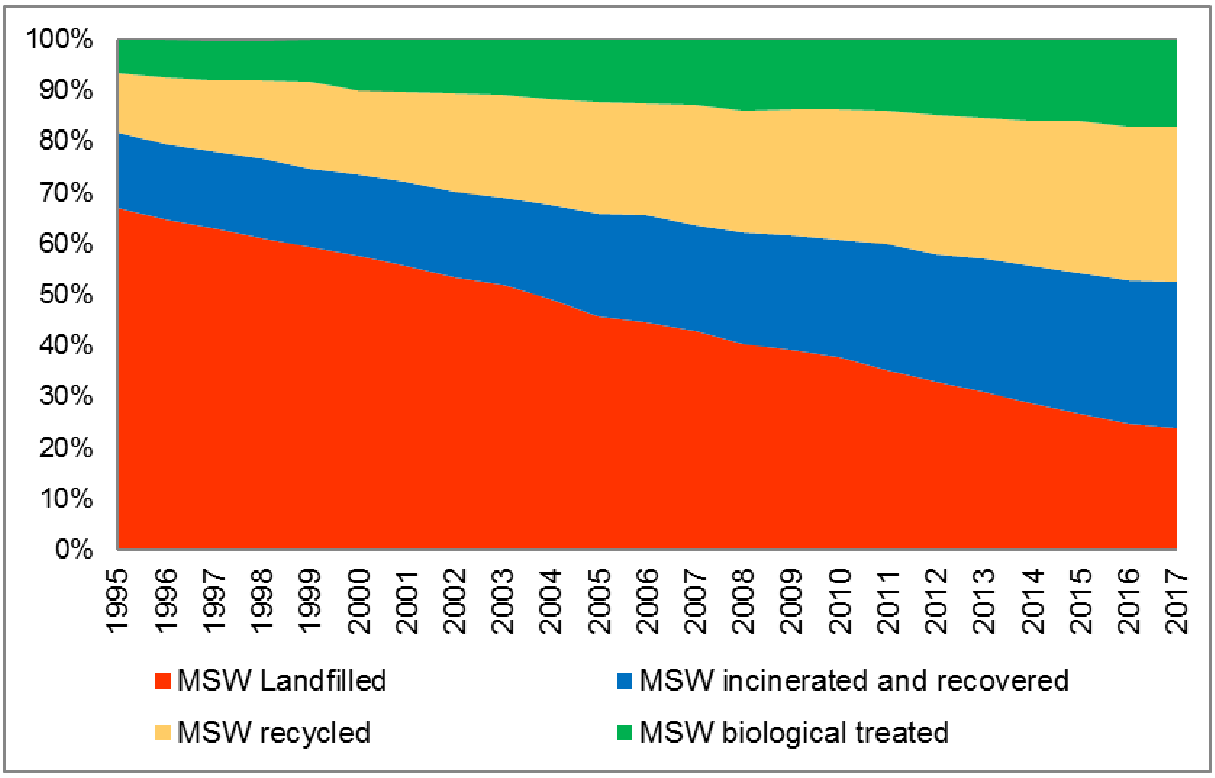
GHG emissions in the waste sector are generated from the treatment and disposal of liquid and solid waste. According to the IPCC 2006 Guidelines emission estimates in the waste sector need to be carried out for four subcategories:

- 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 waste. 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 2017 based on activity data for municipal waste as published in 2019 (updated values will be provided in the May submission if available). 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 countries 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 2017 the amount of municipal waste landfilled is continuously decreasing in the EU countries and Iceland and other waste treatment methods like recycling, biological treatment of waste and waste incineration with energy recovery 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 2017 the share of waste landfilled decreased to 24 % of total waste treated while incineration including energy recovery increased to 29 %, recycling increased to 30 % and biological treatment of waste makes up 17 % of total municipal solid waste (MSW) treated.

Figure 7.1 Sector 5 Waste: Development of municipal waste treatment in the EU-KP

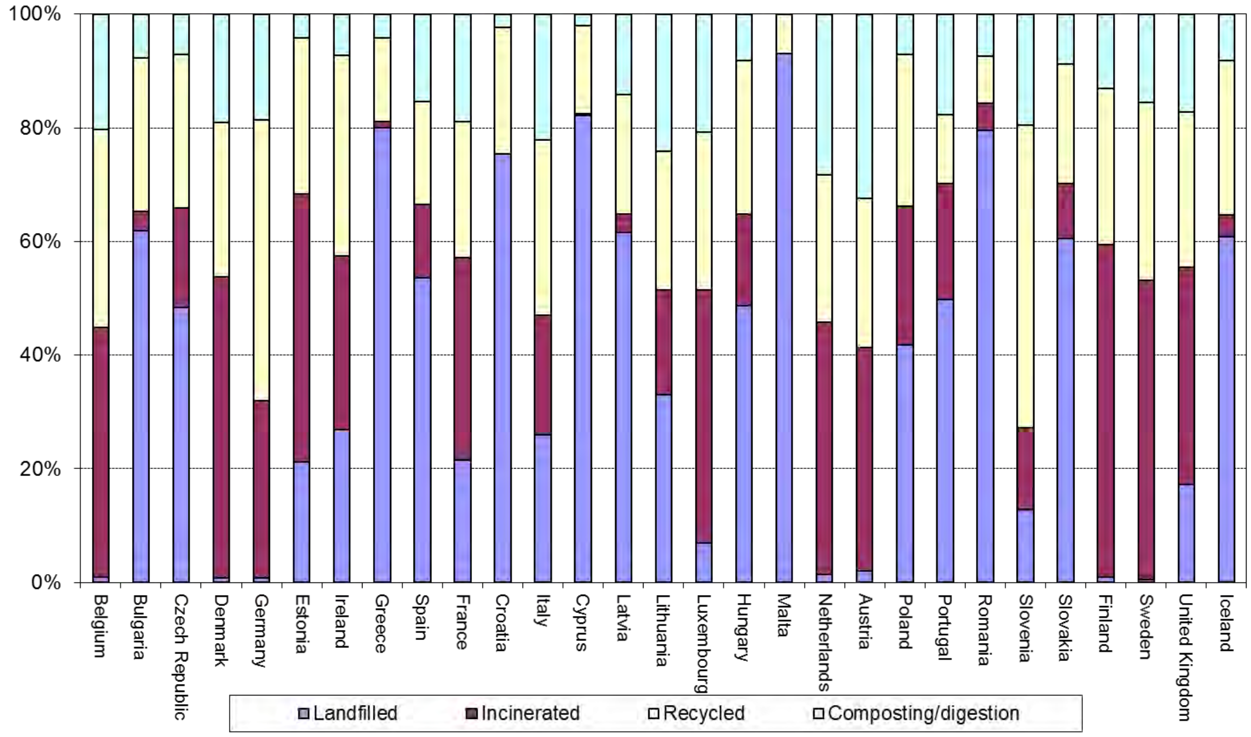


Note: Missing 2013, 2015 and 2017 data for Ireland, 2010 data for Denmark and 2017 data for Iceland have been gap filled by using previous year value,
Source: EUROSTAT 2019, own calculation

Many countries experienced a reduction of waste landfilled and an increase of recycling, composting, landfill gas recovery and waste incineration with energy 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 countries in 2017 (comparison in Figure 7.2). Indeed, 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 countries. For example, disposing municipal waste on SWDS is the predominant (>60%) municipal waste disposal route in Bulgaria, Greece, Croatia, Cyprus, Latvia, Malta and Romania with correspondingly fewer quantities of waste incinerated, recycled or biological treated. In Belgium, Denmark, Germany, Luxembourg, the Netherlands, Austria, Slovenia, Finland, Sweden and the United Kingdom, it is the opposite (<20%). 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-KP(shares) in 2017



Note: In comparison to Inventory data Eurostat data only contains municipal solid waste and does not contain industrial waste and sludge; Data concerning Ireland, Iceland and Latvia relate to 2016
Source: EUROSTAT 2019, own calculations

7.1 Overview of sector

CRF Sector 5 Waste is the fourth largest sector in the EU-KP, after energy, agriculture and industrial processes, contributing 3.3% to total GHG emissions without LULUCF in 2018. Total emissions from waste decreased by 42.6 % from 241 Mt in 1990 to 138 Mt in 2018 (Figure 7.3). In 2018, emissions decreased by 1.3 % compared to 2017.

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 2018). Emissions from the waste sector show a continuously decreasing trend during the last years, but as many countries 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 countries, the declining emission trend is slowing down.

Figure 7.3 Sector 5 Waste: EU-KP GHG emissions, 1990-2018

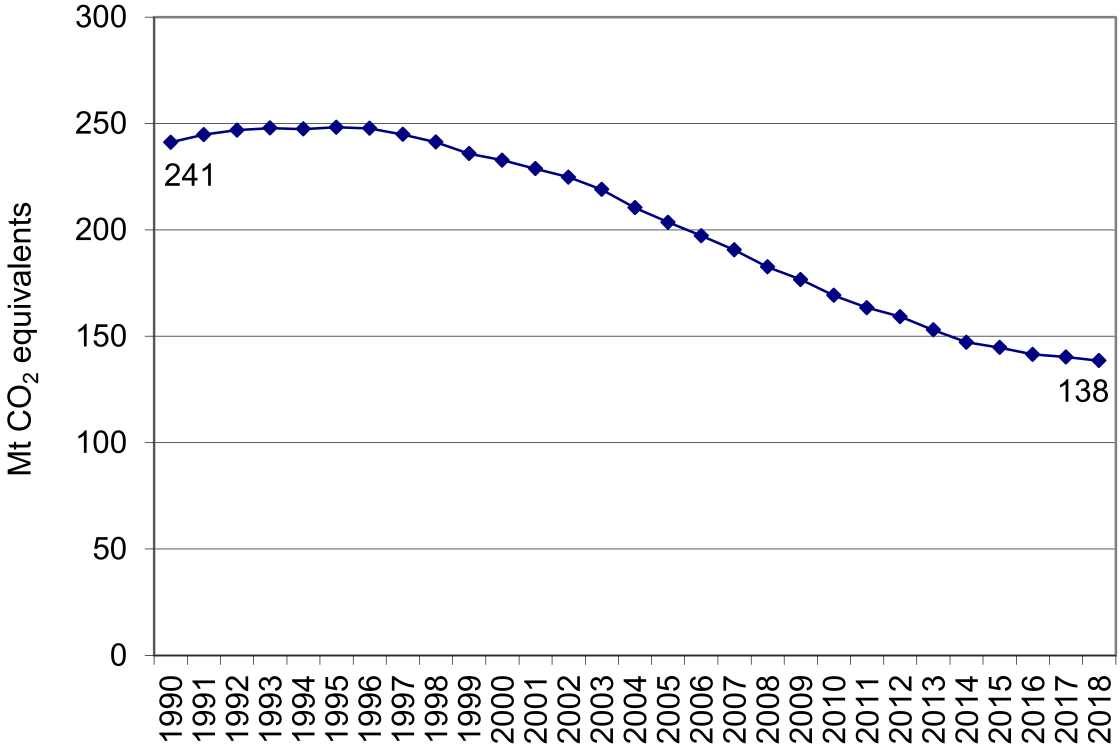
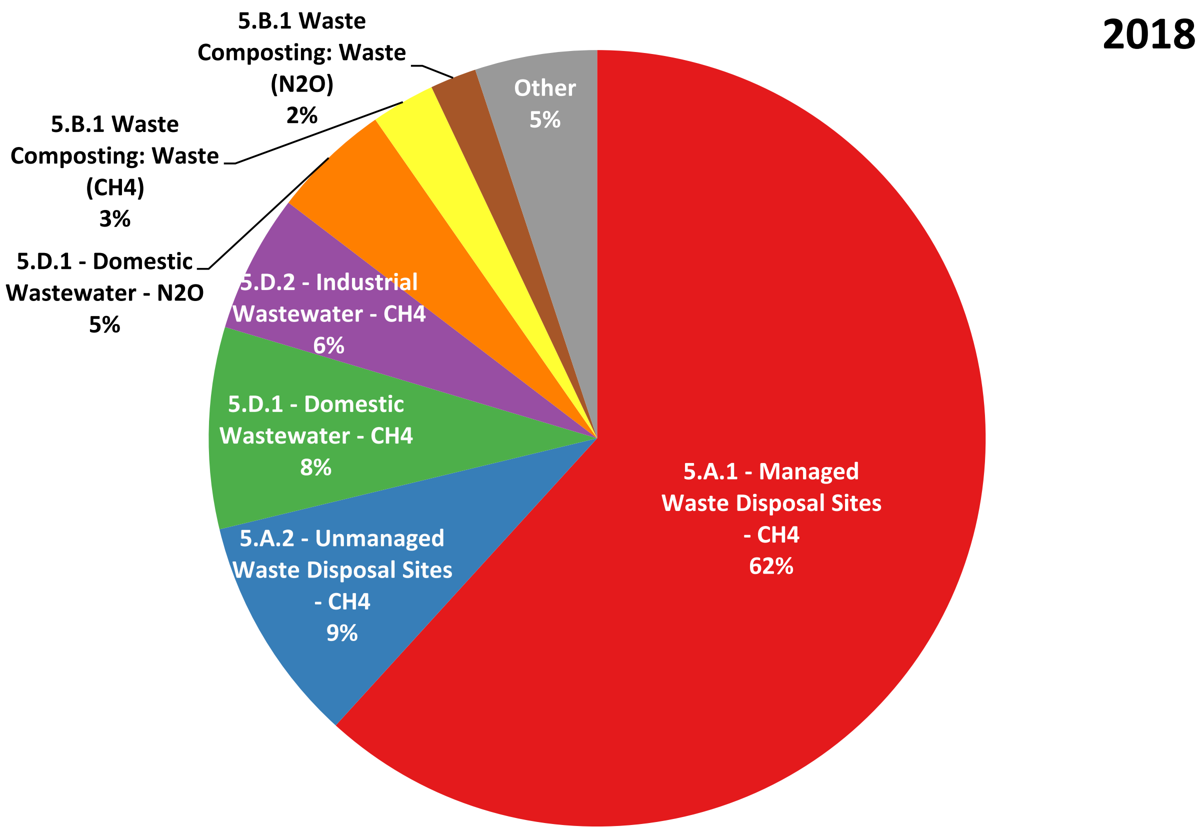


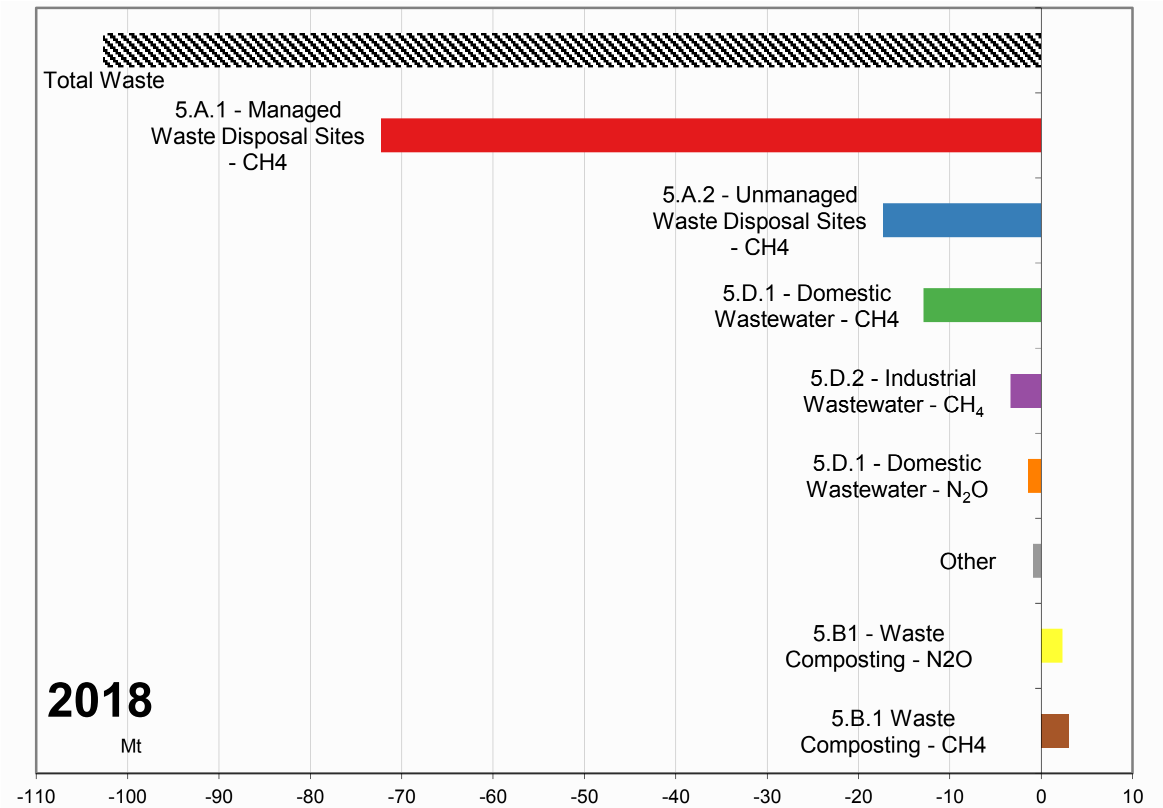
Figure 7.5 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 62 % of waste-related GHG emissions in the EU-KP in 2018 as shown in Figure 7.4.

Figure 7.4 Sector 5 Waste: Share of key source categories and all remaining categories in 2018 for EU-KP



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

Figure 7.5 Sector 5 Waste: Absolute change between 1990 and 2018 of GHG emissions (in CO_2 equivalents) by large key source categories for EU-KP



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

7.2 Source categories and methodological issues

This chapter includes information on emission levels and emission trends for all 28 countries (EU27 + UK) 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 countries' national inventory reports, are provided in the Annex III.

In this section we present information relevant for the EU-KP key source categories in the sector 5 Waste. Source categories considered in detail are:

Table 7.1 Key source categories for level and/or trend analyses and share of MS emissions using higher tier methods

Source category gas	kt CO_2 eq.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	157 755	85 508	T	L	L	96%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	30 443	13 129	T	L	L	100%
5.B.1 Waste Composting: Waste (CH_4)	628	3 688	T	0	0	56
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	24 503	11 624	T	L	L	57
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8 265	6 846	0	0	L	25%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	11 319	7 969	0	L	L	45

The share of higher Tier corresponds to the share of EU emissions documented by countries reporting the method as an IPCC Tier 2 method (T2) or a country-specific method (CS), or countries reporting EF as country-specific (CS). Almost all countries 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 countries using a higher Tier method is much lower.

For CH_4 emissions from composting (5.B.1) France and Germany mainly influence the share of higher Tiers because they have one of the highest shares for this gas, respectively 25% and 9% in this category and are using a higher Tier. However, UK which has the highest share of CH_4 from from composting (27%) is applying a Tier 1.

For CH_4 emissions from domestic wastewater treatment (5.D.1) Poland, which represents 19% of the EU emissions from this category, mainly influences the share of higher Tiers.

For CH_4 emissions from industrial wastewater Greece contributes 11% to the 18 % 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 1.1.1). 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)

Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. This source category includes two key categories: CH_4 from 5A1 Managed waste disposal on land and CH_4 from 5A2 Unmanaged waste disposal on land. In addition, source category 5A includes the category 5A3 CH_4 emissions from uncategorized landfills, but only Estonia (1990-1993) and Poland (1990-2017) report emissions from this category. As this is no EU key category no further information on 5A3 is included in the following chapters.

The source category 5A contributes 2.3 % to total GHG emissions without LULUCF in 2018.

The methane recovery that takes place in the 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 (2002-2017) 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 48 % between 1990 and 2018 in the EU-KP. Sixteen EU-KP countries 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 countries waste disposal changed from unmanaged to managed landfills during the time period 1990 and 2018 which leads to increasing CH_4 emissions from managed landfills. In 2018, CH_4 emissions from landfills decreased by 1.3% compared to 2017.

Table 7.2 5A Solid Waste Disposal on Land: Countries contributions to total GHG emissions and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	3 644	1 045	3 644	1 045
Belgium	3 053	772	3 053	772
Bulgaria	4 945	2 741	4 945	2 741
Croatia	539	1 771	539	1 771
Cyprus	258	503	258	503
Czechia	1 979	3 743	1 979	3 743
Denmark	1 536	560	1 536	560
Estonia	214	199	214	199
Finland	4 328	1 468	4 328	1 468
France	12 594	12 003	12 594	12 003
Germany	34 200	7 578	34 200	7 578
Greece	2 243	3 328	2 243	3 328
Hungary	2 523	2 923	2 523	2 923
Ireland	1 318	693	1 318	693
Italy	12 206	13 704	12 206	13 704
Latvia	283	382	283	382
Lithuania	1 029	662	1 029	662
Luxembourg	92	48	92	48
Malta	41	154	41	154
Netherlands	13 679	2 480	13 679	2 480
Poland	14 166	8 577	14 166	8 577
Portugal	2 821	3 562	2 821	3 562
Romania	1 372	3 639	1 372	3 639
Slovakia	646	1 140	646	1 140
Slovenia	373	234	373	234
Spain	5 474	9 931	5 474	9 931
Sweden	3 422	782	3 422	782
United Kingdom	60 203	14 421	60 203	14 421
EU-27+UK	**189 182**	**99 042**	**189 182**	**99 042**
Iceland	158	214	158	214
United Kingdom (KP)	60 368	14 589	60 368	14 589
EU-KP	**189 505**	**99 424**	**189 505**	**99 424**

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 2.0 % of total EU-KP

GHG emissions. Between 1990 and 2018, CH_4 emissions from managed landfills declined by 46 % in the EU-KP.

Thirteen countries reduced their emissions from this source during that period while Croatia, the Czech Republic, Greece, Hungary, Italy, 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 2018, CH_4 emissions from managed landfills decreased by 0.6% compared to 2017.

Table 7.3 5A1 Managed Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	3 644	1 114	1 045	1.2%	-2 599	-71%	-69	-6%	T2	CS,D
Belgium	3 053	855	772	0.9%	-2 281	-75%	-83	-10%	T2	D
Bulgaria	NO	1 070	1 120	1.3%	1 120	∞	50	5%	T2	CS,D
Croatia	27	1 616	1 639	1.9%	1 612	6041%	22	1%	T2	CS
Cyprus	NO	80	88	0.1%	88	∞	7	9%	T2	D
Czechia	1 979	3 706	3 743	4.4%	1 763	89%	37	1%	T1	CS,D
Denmark	1 536	588	560	0.7%	-976	-64%	-28	-5%	CS,T2	CS,D
Estonia	NO	211	199	0.2%	199	∞	-12	-5%	T2	D
Finland	4 328	1 510	1 468	1.7%	-2 860	-66%	-42	-3%	T2	CS,D
France	12 594	12 333	12 003	14.0%	-591	-5%	-330	-3%	T2	CS,D
Germany	34 200	8 063	7 578	8.9%	-26 622	-78%	-485	-6%	T2	CS
Greece	80	1 741	1 874	2.2%	1 794	2242%	134	8%	T2	CS,D
Hungary	393	1 657	1 703	2.0%	1 310	334%	46	3%	T2	D
Ireland	NO	718	693	0.8%	693	∞	-25	-4%	T2	CS,D
Italy	6 386	11 456	11 612	13.6%	5 225	82%	155	1%	T2	CS
Latvia	NO	236	254	0.3%	254	∞	18	8%	T2	D
Lithuania	684	642	516	0.6%	-168	-25%	-126	-20%	T2	D
Luxembourg	92	51	48	0.1%	-44	-48%	-3	-6%	T1	D
Malta	NO	137	146	0.2%	146	∞	8	6%	T2	M
Netherlands	13 679	2 569	2 480	2.9%	-11 199	-82%	-89	-3%	T2	CS
Poland	5 829	5 118	5 153	6.0%	-676	-12%	35	1%	T2	CS,D
Portugal	744	2 814	2 842	3.3%	2 097	282%	28	1%	T2	CS,D
Romania	NO	1 639	1 760	2.1%	1 760	∞	120	7%	T2	CS,D
Slovakia	NO	1 141	1 140	1.3%	1 140	∞	-1	0%	T2	CS,D
Slovenia	373	261	234	0.3%	-139	-37%	-27	-10%	T2	CS,D
Spain	4 324	9 351	9 278	10.9%	4 955	115%	-73	-1%	T2	CS,D,OTH
Sweden	3 422	841	782	0.9%	-2 640	-77%	-60	-7%	T2	CS,D
United Kingdom	60 203	14 126	14 421	16.9%	-45 782	-76%	295	2%	T2	CS
EU-27+UK	**157 571**	**85 646**	**85 151**	**100%**	**-72 420**	**-46%**	**-495**	**-1%**	**-**	**-**
Iceland	19	179	190	0.2%	171	904%	11	6%	T2	CS,D
United Kingdom (KP)	60 368	14 293	14 589	17.1%	-45 779	-76%	296	2%	T2	CS
EU-KP	**157 755**	**85 992**	**85 508**	**100%**	**-72 246**	**-46%**	**-484**	**-1%**	**-**	**-**

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

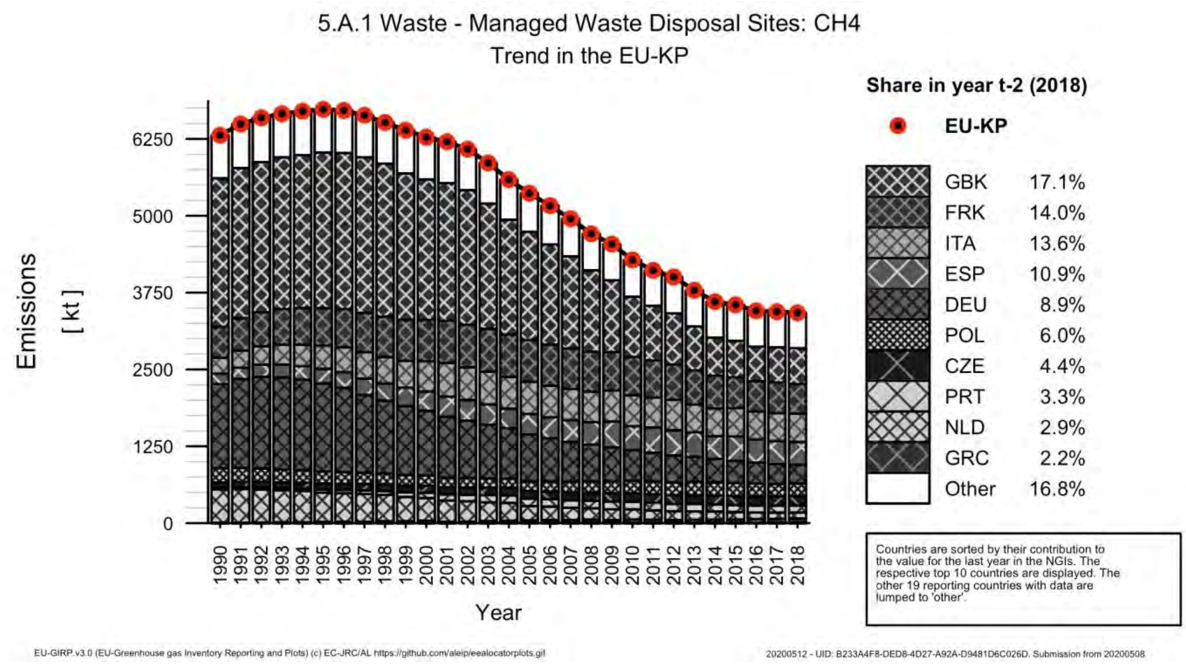
Trends in Emissions and Activity Data

CH_4 emissions from solid waste disposal on managed land decreased considerably between 1990 and 2018 by 46 %. *Figure 7.6* shows the trend of emissions indicating the countries contributing most to EU-KP total.

The countries with highest emissions from this source in 2018 were the United Kingdom, France, Italy, Spain and Germany. These MS account for 64.4 % of EU-KP CH_4 emissions from 5A1 in 2018. The largest reductions in absolute terms between 1990 and 2018 were reported by the United

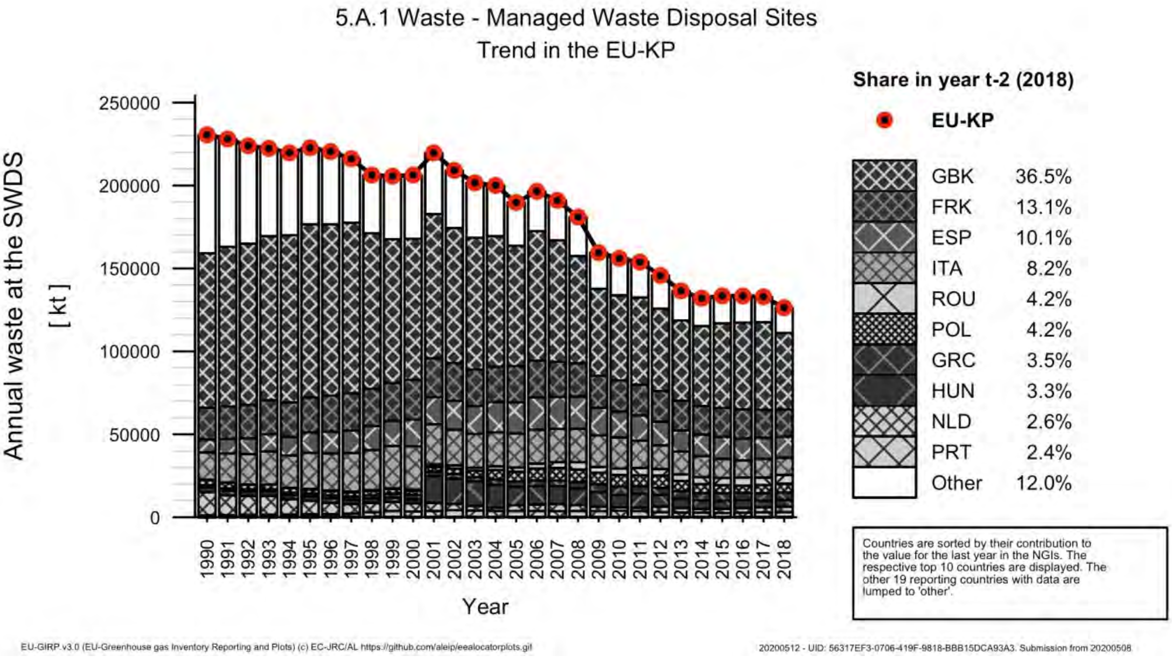
Kingdom (–46 Mt CO_2 equiv.) and Germany (–27 Mt CO_2 equiv.). The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation in these countries. The landfill waste directive was adopted in 1999 and requires the Member States to reduce the 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 countries)



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 2020 the yearly total amount of waste disposal on managed landfills declined by 40 % between 1990 and 2018 (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-KP since 1990 (see Figure 7.8).

Figure 7.7 5A1 Managed waste disposal on land: Waste disposal (Trend in relevant countries)



In the following description more information is provided for the countries that are contributing most to the trend of this key category on the level of the EU-KP.

The **United Kingdom (KP)** has a high share of CH_4 emissions from managed landfills among countries contributing 17,1 % to EU-KP emissions in 2018. 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 2.1 % between 2017 and 2018.

France, contributing with 14.0 % to EU-KP emissions in 2018, 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 steady amount of CH_4 recovery can be found since 2015, which leads to a decrease in CH_4 emissions by 2.7 % between 2017 and 2018.

Italy, contributing with 13.6 % to EU-KP emissions in 2018, 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 up to 2013 and decrease onward. 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 2018, CH_4 emissions from managed solid waste disposal increased by 1.4 % compared to 2017 because of the recovery reduction.

CH_4 emissions in **Spain**, contributing with 10.9 % to EU-KP emissions in 2018, 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 to 2018 recovery rates declined again. In 2018, CH_4 emissions from solid waste disposal decreased slightly by -0.8 % compared to 2017.

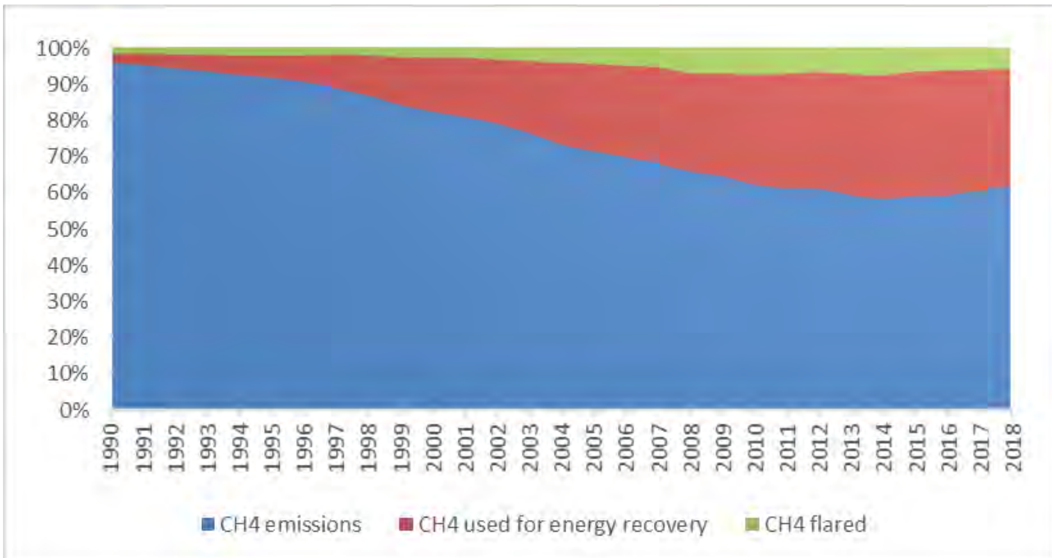
Germany, contributing with 8.9 % to EU-KP emissions in 2018, managed to reduce CH_4 emissions steadily until now from 1993 onwards. The amount of waste disposed on landfills shows a strong decrease from 1990 onwards, while in parallel CH_4 recovery increased. The highest share of CH_4 recovery could be found in 2002 and declined thereafter due to a strong 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-KP increased from 4.4 % of the total amount of CH_4 generated ("emitted" = excluding CH_4 flared and recovered; "generated" = including CH_4 flared and recovered) in managed landfills (only 5A1) in 1990 to 38 % in 2018 (Figure 7.8, Figure 1.9). 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 2017, CH_4 recovery and CH_4 flaring decreased respectively by 5,4% and by 6,2 % in 2018 in managed landfills. This is caused by reduced amounts of waste landfilled and the ban of organic material in the landfilled waste.

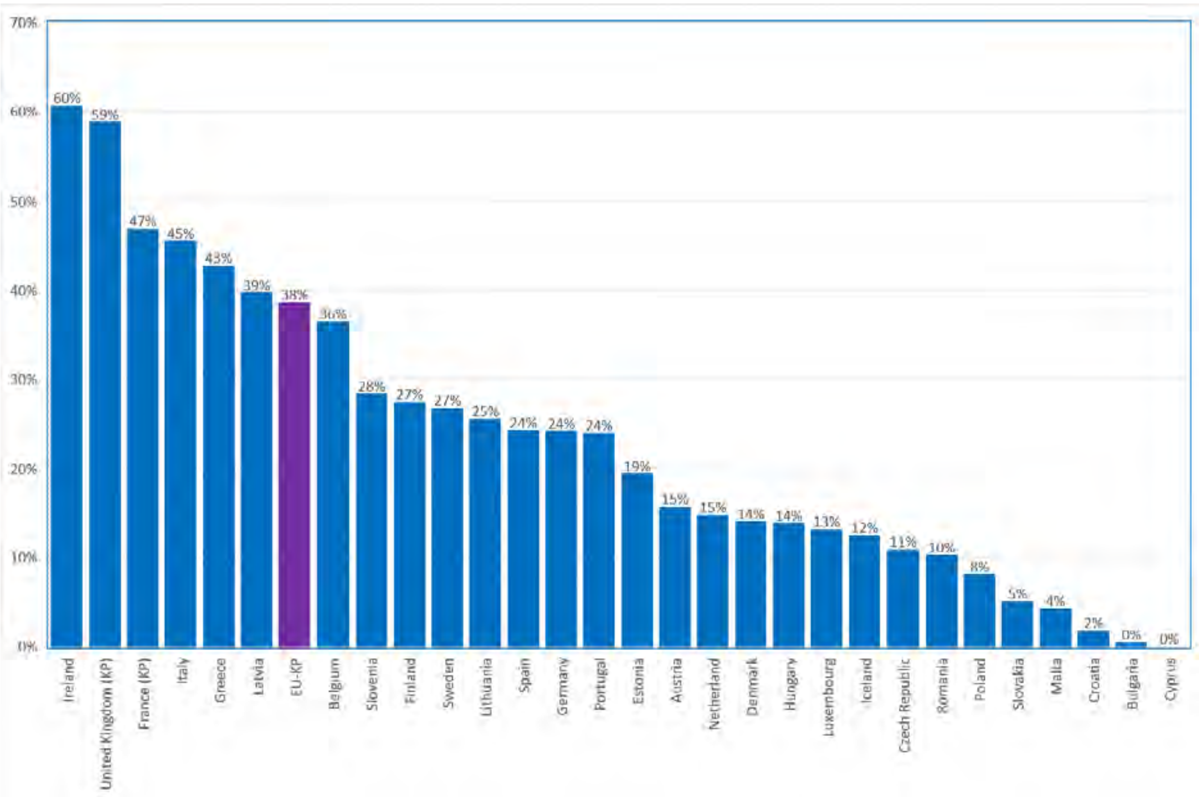
Figure 7.8 5A1 Managed Solid Waste Disposal: Evolution of the share of methane used for energy recovery, methane flared and CH_4 emissions in managed landfills in the EU-KP



Source: CRF 2020, 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 countries between 0 % in Cyprus and 62 % in the United Kingdom and depends - amongst other - on the share of solid waste disposal sites where recovery installations exist. Cyprus does not report any data under 5.A CH_4 recovery and flaring in 2018. For 2011 - 2014 and 2017 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 fraction (energy recovery and flaring)for 2018



CH_4 recovery and flaring in % = (CH_4 recovery in Gg + CH_4 flared in Gg)/ (CH_4 recovery in Gg + CH_4 flared in Gg + CH_4 emissions 5A1 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2020 Table 5A

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 on land and the concentration of biodegradable carbon in that waste. Further methodological information for all EU countries 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.

countries 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 countries 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 countries 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 countries do not provide any information on industrial waste landfilled, while other countries report that industrial waste is not reported separately and included under municipal solid waste. Further information on the reporting of industrial waste by the countries 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, 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-KP. Country specific information on waste composition is provided in the Annex III.

Landfill gas recovery

Countries use different methods to determine CH_4 recovery. Several countries combine different methods and sources to estimate the amounts of CH_4 recovered for flaring or for energy purposes, while other countries are using only one method. Data on landfill gas recovery can be based on measured plant specific data, questionnaires and surveys or can be taken from the energy statistics. Further information on CH_4 recovery in the country is provided in the Annex III of this submission.

Emission factors and parameters

Besides information on the amount of waste landfilled, the waste composition and the amounts of CH_4 recovered, other 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, which reflects the years necessary for the degradable organic carbon 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 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 to determine 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. Countries 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 decomposable 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. Within this submission a table in Annex III is provided containing 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 individual NIRs from the countries.

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-KP GHG emissions in 2018. Between 1990 and 2018, CH_4 emissions from this source decreased by 57 % (Table 7.4). In 2018, CH_4 emissions from unmanaged landfills decreased by 5.6 % compared to 2017. Almost all countries with unmanaged waste disposal feature a decreasing emission trend, due to a decreasing amount of municipal waste going to unmanaged waste disposal sites. Only Romania showed an increase of CH_4 emissions from unmanaged landfills between 1990 and 2018 (+37 %). In Romania CH_4 emissions from unmanaged waste disposal sites increased until 2010, but showed a decreasing trend from 2010 onwards. Between 2010 and 2018 the CH_4 emissions decreased by 25.5 % in Romania.

Table 7.4 5A2 Unmanaged Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	-	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	4 945	1 759	1 621	12.3%	-3 324	-67%	-138	-8%	T2	CS,D
Croatia	512	159	133	1.0%	-379	-74%	-26	-16%	T2	CS
Cyprus	258	414	415	3.2%	156	61%	1	0%	T2	D
Czechia	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	1 509	1 453	11.1%	-710	-33%	-56	-4%	T2	CS,D
Hungary	2 130	1 276	1 220	9.3%	-910	-43%	-56	-4%	T2	D
Ireland	1 318	IE	IE	-	-1 318	-100%	-	-	NA	NA
Italy	5 820	2 189	2 093	15.9%	-3 727	-64%	-96	-4%	T2	CS
Latvia	283	140	128	1.0%	-155	-55%	-12	-9%	T2	CS,D
Lithuania	345	158	145	1.1%	-199	-58%	-13	-8%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	41	8	8	0.1%	-34	-81%	0	0%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	7 244	2 833	2 637	20.1%	-4 607	-64%	-196	-7%	T2	CS,D
Portugal	2 076	773	720	5.5%	-1 356	-65%	-52	-7%	-	-
Romania	1 372	1 974	1 879	14.3%	508	37%	-94	-5%	T2	CS,D
Slovakia	646	NO	NO	-	-646	-100%	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 150	687	653	5.0%	-498	-43%	-34	-5%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**30 304**	**13 878**	**13 104**	**100%**	**-17 200**	**-57%**	**-774**	**-6%**	**-**	**-**
Iceland	139	26	25	0.2%	-114	-82%	-2	-6%	T2	CS,D
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**30 443**	**13 905**	**13 129**	**100%**	**-17 314**	**-57%**	**-776**	**-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 2018 by 57 %. *Figure 7.10* shows the trend of emissions indicating the countries contributing most to EU-KP 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 countries 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). Poland, Italy, Romania, Bulgaria and Greece, are responsible for about 74 % of the total EU-KP emissions from unmanaged waste disposal sites in 2018. Poland, Italy and Bulgaria show large absolute reductions between 1990 and 2018.

Figure 7.10 5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant countries)

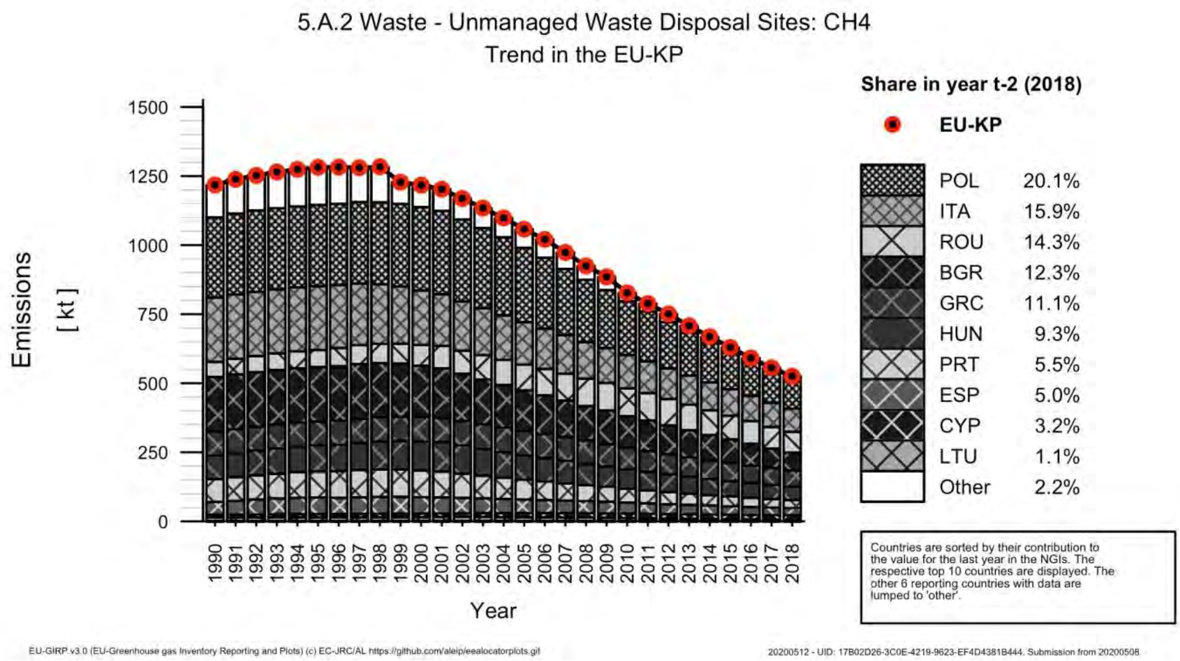
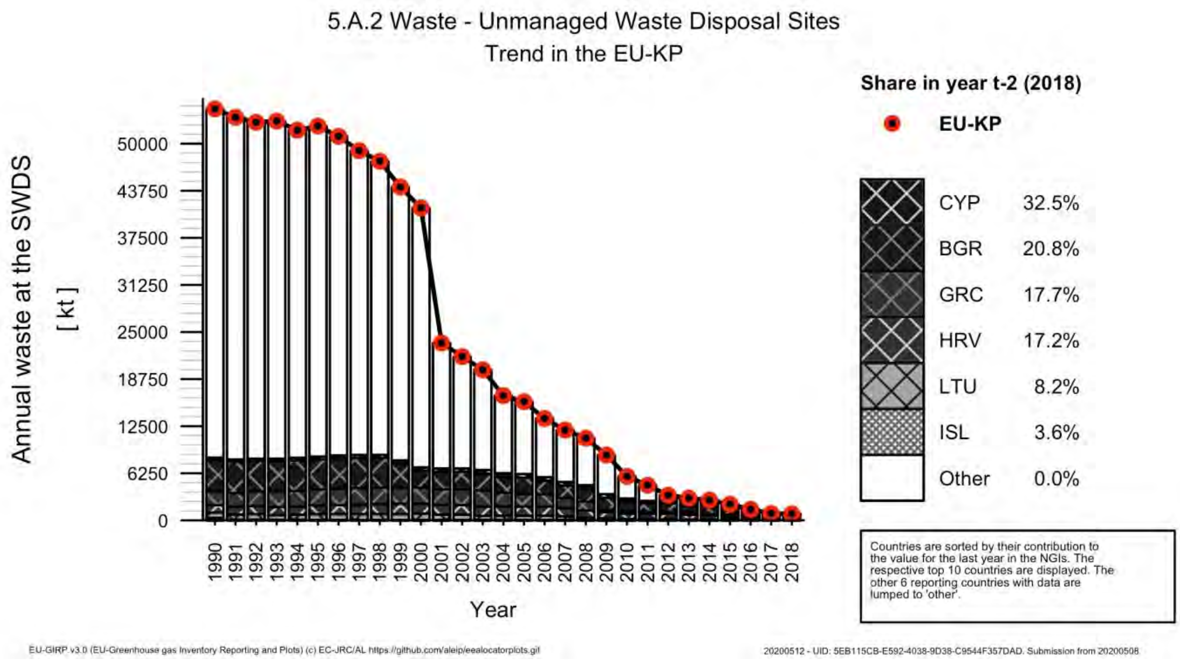


Figure 7.11 shows the relevant trends for the amount of waste disposed on unmanaged landfills. In the description below Figure 1.11 we focus on the countries with the highest CH_4 emissions on unmanaged SWDS in 2018. Note that, in some countries, waste disposal in unmanaged landfills was practiced but does not occur anymore. However, emissions are still produced from the waste disposed in the past. For the following countries, there are still emissions, but no more waste is disposed on the unmanaged landfills as from the year mentioned : Ireland since 1999, Italy since 2000, Hungary since 2001, Finland since 2002, Portugal and Malta since 2005, Slovakia since 2010, Poland since 2012, Latvia and Spain since 2013 and Romania in 2018.

For countries still using unmanaged landfills (Bulgaria, Croatia, Cyprus, Greece, Iceland, Lithuania), solid waste disposal on unmanaged landfillsites is still practiced, but the amount of waste disposed is considerably decreasing since 1992. The highest reductions in the amount of waste disposed between 1990 and 2018 are found for Bulgaria and Greece. In countries which still dispose waste in unmanaged landfills in 2018, the relative decrease of waste disposed is higher than 89% in comparison with1990, except for in Iceland and Cyprus.

Figure 7.11 5A2 Waste disposal on unmanaged landfills: Total waste disposed on unmanaged landfills (Trend in relevant countries)



Poland's CH_4 emissions from the disposal of solid waste on unmanaged landfills contribute 20.1 % to EU-KP emissions from this source category in 2018. 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 (zero disposal on unmanaged SWDS in Poland since 2012).

Italy, contributing with 15,9 % to EU-KP emissions in 2018, managed to reduce CH_4 emissions from solid waste disposal on unmanaged landfills already from 1991 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.

Romania is contributing with 14.3 % to EU-KP CH_4 emissions from unmanaged landfills in 2018. From 2010 CH_4 emissions are declining. The amount of waste disposed on unmanaged landfills is zero since 2018.

Bulgaria is contributing with 12,3 % to EU-KP CH_4 emissions from unmanaged landfills. CH_4 emissions are declining over the time series, due to a reduction of waste disposed on unmanaged landfills. In 2018, waste is still disposed on uncontrolled landfills in Bulgaria.

Methodological issues

CH_4 emissions from unmanaged solid waste disposal sites were reported in 13 EU countries (Bulgaria, Croatia, Cyprus, Greece, Italy, France, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, Czechia and Spain) and Iceland. Only six of these EU countries (Bulgaria, Croatia, Cyprus, Greece, Lithuania, and Slovakia) and Iceland still dispose MSW to unmanaged SWDS, although in small quantities, while in all other countries waste disposal from the past still cause emissions in 2018 (see Table 7.4). 100% of all EU-KP 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 a SWDS 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 2018. All countries 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 2018

Member State	MCF
Bulgaria	0.8
Croatia	0.79
Cyprus	0.4
Czech republic	0,6
France	0.4
Greece	0.8
Iceland	0.2
Italy	0.6
Latvia	0.7
Lithuania	0.56
Malta	0.6
Poland	0.8
Portugal	0.6
Romania	0.74
Slovakia	0.4
Spain	0.6

Source: CRF Table 5.A 2018, NIR 2020

7.2.1.3 Recalculations (CRF Source Category 5A)

Table 7.6 provides information on the contribution of Countries to EU recalculations in CH_4 emissions from 5A Solid Waste Disposal on Land for 1990 and 2017 and main explanations (as available in the national inventory reports) for the largest recalculations in absolute terms. Countries contributing most to the recalculations in the year 2017 for the sector 5.A in absolute terms are Spain and Hungary.

Table 7.6: 5A Solid Waste Disposal on Land: Contribution of countries to EU recalculations in CH_4 emissions for 1990 and 2017 (difference between latest submission and previous submission)

	1990		2017		Main explanations for Major Changes
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-1.9	-0.2	In Wallonia, updated recovery data have been integrated for the years 2016 and 2017. In the Flemish region no recalculations in this category took place during the 2020 submission.
Bulgaria	-	-	-3.0	-0.1	
Croatia	-	-	-	-	
Cyprus	-0.0	-0.0	18	3.8	Emissions from solid waste management (5A) were recalculated for the time series 1990-2017, in order to include non-municipal solid wastes to the total solid waste.
Czechia	-	-	-14	-0.4	One data change was made in this category because the new activity data on recovered energy from landfill gas for the year 2017 is available.

	1990		2017		Main explanations for Major Changes
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Denmark	-0.0	-0.0	-4.5	-0.8	Implementation of the new Waste Data reporting system (2010-2018)
Estonia	0.0	0.0	0.0	0.0	
Finland	-	-	-23	-1.5	Recalculations have been made to the waste composition of mixed MSW for the years 2010 to 2017. Also, the 2 activity data databasis were aggregated for the years 1997 to 2017. In addition, there is a minor recalculation in the activity data for methane recovery for the years 2009-2017.
France	-	-	-	-	
Germany	-50	-0.1	-12	-0.1	Recalculations have to be carried out annually for the year prior to the previous year, since the waste statistics of the Federal Statistical Öffice appear with a one-year time lag,
Greece	-	-	11	0.3	Updated activity data as far as the amounts MSW for the period 2016 – 2017 have been utilized.
Hungary	-39	-1.5	105	3.7	Following the recommendation of the ESD Review 2019, emissions were calculated separately for managed and unmanaged waste disposal. In addition, smaller changes were made to activity data, e.g. wood waste was re-estimated taking into account also bulky waste, and garden/park waste was included in the IPCC Waste model as a separate waste type.
Ireland	-	-	-24	-3.2	The methane recovered data was revised for the years 2015-2017.
Italy	-	-	0.2	0.0	
Latvia	-	-	-28	-6.9	Recalculations are done according to ESD emissions review team suggestions. Bioreactor's CH_4 emissions are included in managed waste disposal site calculation subsector.
Lithuania	-	-	28	3.7	Methane recovery from SWDS was recalculated using default methane content value (50%) provided in the 2006 IPCC Guidelines. Data on disposal of industrial and commercial waste were corrected adding biodegradable waste from statistical category 10.22. Other mixed and undifferentiated materials, which were omitted in previous submissions.
Luxembourg	-	-	-0.1	-0.3	The emissions for 2017 were updated as the methane recovery was corrected for that year.
Malta	-	-	4.4	3.1	The aeration factor was updated for years 2016 and 2017 since an incorrect calculation was being used, as discussed and clarified during the ESD Review 2019.
Netherlands	-	-	0.1	0.0	
Poland	-	-	-0.0	-0.0	
Portugal	-	-	-6.8	-0.2	Recalculations in this sector relates to the revision of DOC value for sludge from industrial organic waste disposed in SWDL. Previous value of 0.14, has been replaced by 0.13, corresponding to a 25% dm content, and considering an organic content of 50% in dm.
Romania	-	-	-	-	
Slovakia	-	-	-0.0	-0.0	
Slovenia	-60	-13.9	-80	-23.4	IPCC Advanced model (2019 Refinement) has been used for the calculation.
Spain	-	-	-330	-3.2	Update of the activity data for the year 2017 in managed SWDS.
Sweden	-	-	-	-	
United Kingdom	-	-	48	0.3	
EU27+UK	**-149**	**-0.1**	**-313**	**-0.3**	
Iceland	-0.0	-0.0	-0.0	-0.0	
United Kingdom (KP)					NA
EU-KP	**-148**	**-0.1**	**-312**	**-0.3**	

7.2.2 Biological treatment of solid waste (CRF Source Category 5B)

Source category 5B Biological treatment of solid waste includes the key source CH_4 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 0.20 % to EU-KP total GHG emissions without LULUCF in 2018. Decomposition of biomass during biological treatment is much faster than on landfills and the CH_4 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 since 2011.

Table 7.7 5B Biological treatment of solid waste: Countries 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	179	23	97	13	81
Belgium	7	41	4	25	3	16
Bulgaria	NO	16	NO	7	NO	10
Croatia	NE,IE,NO	8	NO,NE,IE	3	NO,NE,IE	5
Cyprus	NO	6	NO	2	NO	3
Czechia	NE,IE	721	NE,IE	66	NE,IE	655
Denmark	52	442	12	83	40	359
Estonia	1	37	0	15	1	22
Finland	44	109	18	41	26	68
France	312	1 212	51	190	261	1 021
Germany	41	1 035	16	316	25	719
Greece	0	72	NO	17	0	55
Hungary	9	151	4	40	5	111
Ireland	NO	26	NO	11	NO	15
Italy	25	634	20	514	5	119
Latvia	29	48	12	20	17	28
Lithuania	0	87	0	26	0	61
Luxembourg	NA,IE,NO	27	NA,NO	6	NO,IE	22
Malta	NO	1	NO	NO,NA	NO	1
Netherlands	20	202	7	90	14	112
Poland	22	204	9	85	13	119
Portugal	9	40	4	15	5	25
Romania	NO	58	NO	24	NO	34
Slovakia	111	199	46	83	65	116
Slovenia	NO	18	NO	8	NO	11
Spain	204	637	85	257	119	380
Sweden	12	105	5	25	7	80
United Kingdom	31	1 924	13	722	18	1 202
EU-27+UK	**966**	**8 240**	**329**	**2 790**	**637**	**5 451**
Iceland	NA,NO	4	NO,NA	2	NO,NA	2
United Kingdom (KP)	31	1 927	13	723	18	1 203
EU-KP	**966**	**8 247**	**329**	**2 792**	**637**	**5 455**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.2.1 Waste Composting (CRF Source Category 5B1)

Emission and Trends

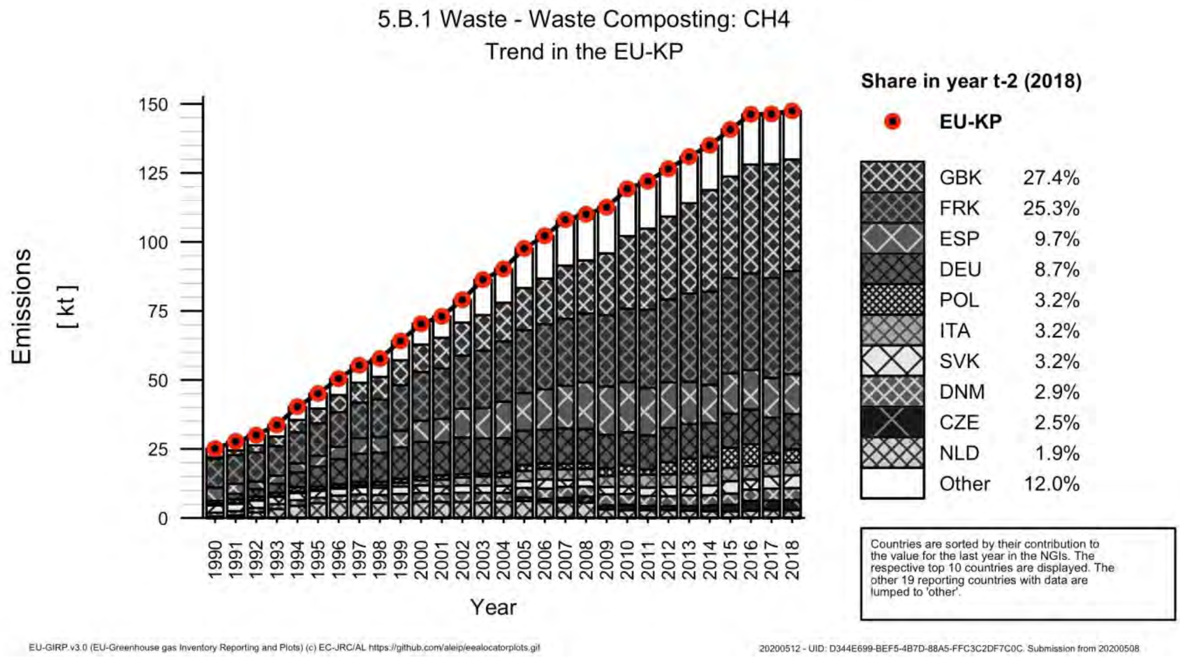
CH_4 emissions from 5B1 Composting account for 0.09 % of total EU-KP GHG emissions in 2018. Between 1990 and 2018, CH_4 emissions from this source increased considerably from 628 kt CO_2 equivalents to 3 672 kt CO_2 equivalents in 2018 (Table 7.8). Malta reports emissions from composting only in the period 1993 - 2006. All countries that practice composting feature an increasing emission trend from 1990 onwards. Nevertheless between 2017 and 2018 seven countries experienced a decrease in CH_4 emissions from composting, among which three experience a decrease higher than 20% (Belgium, Romania, Sweden). Total CH_4 emissions from composting in EU-KP increased slightly by 0,1% between 2017 and 2018 with as most important increase in France and Polland .

Table 7.8: 5B1 Waste Composting: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	13	60	60	1.6%	47	358%	0	0%	T2	CS
Belgium	3	24	16	0.4%	14	528%	-8	-32%	T1	CS
Bulgaria	NO	24	10	0.3%	10	∞	-14	-60%	T1	D
Croatia	IE,NE	4	5	0.1%	5	∞	1	12%	T1	D
Cyprus	NO	3	3	0.1%	3	∞	0	0%	T1	D
Czechia	NE	90	92	2.5%	92	∞	2	2%	T1	D
Denmark	35	108	107	2.9%	72	208%	-2	-1%	CS,T1	CS,OTH
Estonia	1	17	22	0.6%	21	3095%	5	28%	T1	D
Finland	26	55	58	1.6%	32	126%	3	5%	T1	D
France	259	904	933	25.3%	674	260%	29	3%	T2	CS
Germany	25	321	321	8.7%	296	1168%	0	0%	T2	CS
Greece	NO	22	23	0.6%	23	∞	1	3%	D	D
Hungary	5	57	56	1.5%	51	1014%	-1	-2%	T1	D
Ireland	NO	15	15	0.4%	15	∞	0	0%	T1	D
Italy	5	119	117	3.2%	112	2434%	-2	-2%	D	CS
Latvia	17	27	28	0.8%	11	67%	1	5%	D	D
Lithuania	0	31	37	1.0%	37	17917%	6	20%	T1	D
Luxembourg	NO	7	8	0.2%	8	∞	0	5%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	14	69	70	1.9%	56	413%	2	2%	T1	CS
Poland	13	94	119	3.2%	106	836%	25	27%	T1	D
Portugal	5	18	21	0.6%	16	319%	3	15%	T1	D
Romania	NO	35	34	0.9%	34	∞	-1	-4%	T1	D
Slovakia	65	108	116	3.2%	51	79%	8	7%	T1	D
Slovenia	NO	10	11	0.3%	11	∞	1	9%	T1	D
Spain	119	359	359	9.7%	240	201%	0	0%	T1	D
Sweden	7	45	35	1.0%	28	396%	-10	-22%	T1	D
United Kingdom	18	1 029	1 010	27.4%	992	5470%	-19	-2%	T1	D
EU-27+UK	**628**	**3 655**	**3 684**	**100%**	**3 056**	**486%**	**29**	**1%**	**-**	**-**
Iceland	NO,NA	2	2	0.1%	2	∞	0	11%	T2	CS,D
United Kingdom (KP)	18	1 030	1 011	27.4%	993	5477%	-19	-2%	T1	D
EU-KP	**628**	**3 658**	**3 688**	**100%**	**3 059**	**487%**	**29**	**1%**	**-**	**-**

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 countries)



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

Emissions from 5.B.1 relate with composting of municipal (5.B.1.a) and composting of other waste (5.B.1.b). As stated in figure ***Figure 7.14 5B1b Waste Composting of other waste : CH4 emissions (Trend in relevant countries)***, only 10 countries (Denmark, Slovakia, the Netherlands, Czech Republic, Finland, Hungary, Estonia, Lithuania, Poland and Luxembourg) report emissions from other waste composting. Other countries generally report emissions from composting of all types of waste (municipal, industrial, sludge…) in the category 5.B.1.a since statistal data concerning composting generally relate to total waste and do not make a distinction between the various types of waste.

Figure 7.13 5B1a Waste Composting of municipal waste: CH_4 emissions (Trend in relevant countries)

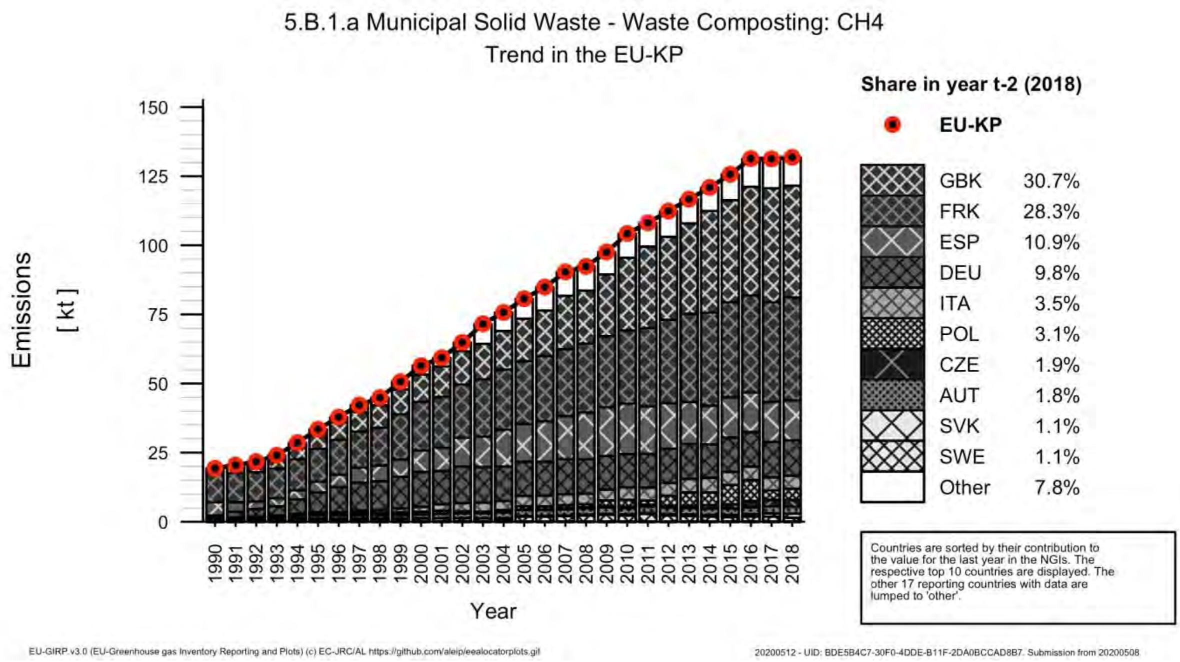
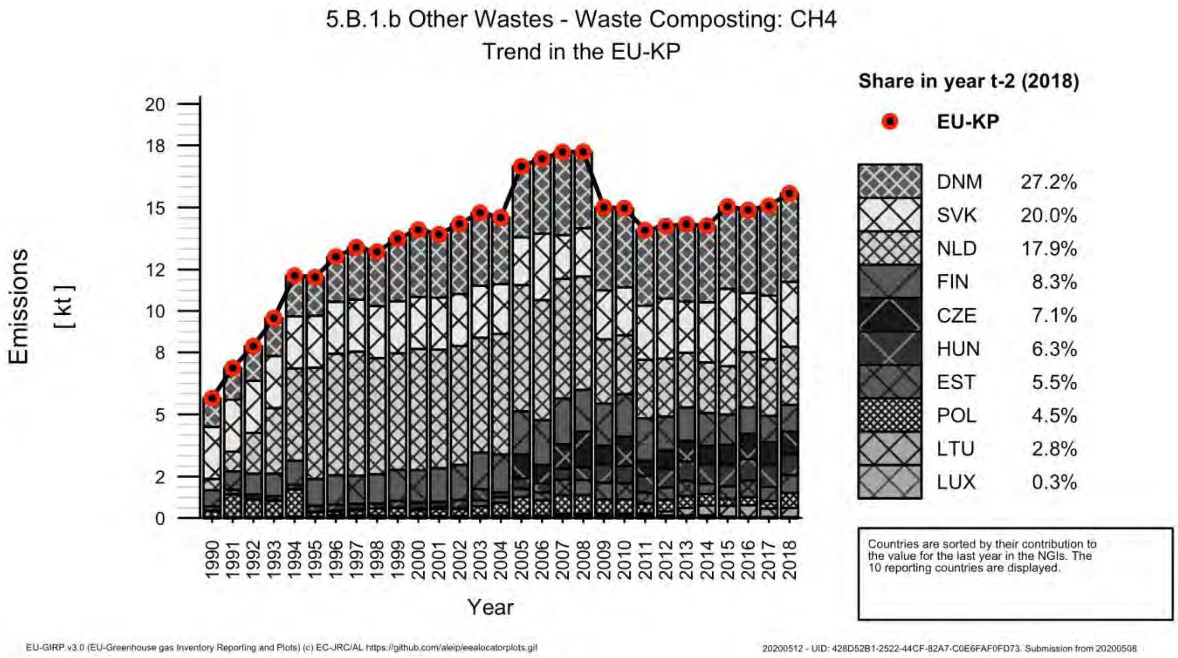


Figure 7.14 5B1b Waste Composting of other waste : CH_4 emissions (Trend in relevant countries)



Methodological information

According to the IPCC 2006 Guidelines CH_4 from composting is 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 countries apply the default EF for CH_4 emissions (see

Table **7.9**). In all cases the EFs (wet vs. dry) applied by the countries are consistent with the unit of AD (wet vs. dry), even if AD is often reported on a wet basis in the CRF tables although dry basis should be reported. Only Austria, Belgium, Finland, France, Germany, Italy, the Netherlands and Sweden present IEFs different from the default one and these EFs are within the interval indicated in the 2006 IPCC guidelines. In most cases country specific EFs are much lower than the IPCC default EF.

Table 7.9 5B1 Composting: EFs applied by countries in 2018 in g CH_4/kg waste treated

Member state	CH4 IEF (g/kg dry matter)	Member state	CH4 IEF (g/kg dry matter)
Austria	1,83	Ireland	4,00
Belgium	0,75	Italy	1,63
Bulgaria	4,00	Latvia	4,00
Croatia	4,00	Lithuania	10,00
Cyprus	4,00	Luxembourg	10,08
Czech Republic	4,00	Malta	NO
Denmark	NO	Netherlands	0,82
Estonia	10,00	Norway	4,00
Finland	5,62	Poland	6,67
France	8,23	Portugal	10,00
Germany	1,40	Romania	10,00
Great Britain	10,00	Slovakia	10,00
Greece	4,00	Slovenia	4,00
Hungary	10,00	Spain	4,00
Iceland	4,00	Sweden	11,43

Further methodological information for all countries is provided in the Annex of this submission

7.2.2.2 Recalculations (CRF Source Category 5B)

Table 7.10 provides information on the contribution of countries to EU recalculations in CH_4 from 5B Biological treatment of solid waste for 1990 and 2018 and main explanations (if available in countries' inventories) for the largest recalculations in absolute terms.

Table 7.10: 5B Biological treatment: Contribution of countries to EU recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission)

	1990		2017		Main explanations for Major Changes
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-0.2	-0.7	In Wallonia, activity data (amount of waste composted) of 2016 and 2017 have been updated. In the Flemish region, the activity data are revised by the waste institute for the years 2016 and 2017.
Bulgaria	-	-	-	-	
Croatia	-	-	0.5	13.2	Updated data on different type of composted waste in 2017 were included in this report.
Cyprus	-	-	-	-	
Czechia	-	-	6.8	1.0	New available activity data on the amount of the composted waste in categories MSW (municipal solid waste) and Other waste.
Denmark	-	-	-1.6	-0.5	Implementation of the new Waste Data reporting system (2010-2018)
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	215	469	744	313	Addition to the inventory of CH_4 and N_2O emissions linked to domestic composting; Modification of CH_4 and N_2O emission factors for composting using the note for WG1 "GHG emissions from biological treatment of waste - overview of existing measurements"
Germany	-	-	11	1.5	Te Federal Statistical Öffice provide waste quantities

	1990		2017		Main explanations for Major Changes
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					with a one-year time lag.
Greece	0	100	23	103	Updated data
Hungary	-	-	7.6	7.0	Produced biogas in 2017 was updated in line with the latest IEA/Eurostat energy statistics.
Ireland	-	-	4.0	36.2	Recalculations to emissions of 36 per cent from composting is a result of an update to activity data in 2017. Improved estimates of household organic waste collected at kerbside and brought to civic amenity/temporary collection sites was included for 2017.
Italy	-	-	-	-	
Latvia	-7.2	-30	-1.9	-6.7	New activity data estimation for households composted amount
Lithuania	-	-	-4.6	-7.8	-No information from MS available.
Luxembourg	-	-	-0.1	-0.4	
Malta	-	-	-	-	
Netherlands	-	-	-0.0	-0.0	
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	42	54.9	2.3	0.6	Update of the 2017 AD following the publication of statistics
Sweden	-	-	-	-	
United Kingdom	0	0.0	27	2.2	The methodology for calculating home composting quantities was revised following a reevaluation of a reference which indicated larger qu antities of materials diversion to home composting per household than had previously been identified. The method for interpolating the quantities of MBT residues composted between historical data points wa s revised.
EU27+UK	**251**	**65**	**818**	**18**	
Iceland	-	-	-	-	
United Kingdom (KP)					NA
EU-KP	**251**	**65**	**818**	**18**	

7.2.3 Incineration and open burning of waste (CRF Source Category 5.C)

This category includes incineration and open burning of waste. Emissions from waste incinerated for energy use are reported under 1A Fuel combustion activities. Emissions from on field burning of agricultural wastes should be reported under 3 Agriculture.

Incineration and open burning of waste is not a key category for the European Union. Some additional information can be found in the chapter 1.1.1 dedicated to waste- non key categories.

7.2.4 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[68]. 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 this chapter. N_2O emissions from industrial wastewater are not a EU key source and are therefore not further analysed in this chapter.

Domestic wastewater includes the handling of liquid wastes and sludges 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 resulting emissions are in that case included under domestic wastewater. On the other hand can industrial wastewater be treated on the industrial site and then the resulting emissions will be accounted under the separate category 5D2 industrial wastewater.

Total emissions from 5D wastewater handling, including N_2O and CH_4 emissions account for 0.6 % of total EU-KP GHG emissions in 2018. Table 7.11 shows total GHG, CH_4 and N_2O emissions by Member State from 5D Wastewater Handling. Between 1990 and 2018, total emissions from wastewater handling decreased by 40.2 % in EU-KP. All countries except for France and Ireland decreased their emissions from wastewater treatment and discharge between 1990 and 2018. Due to the implementation of new wastewater treatment technologies CH_4 emission decreased considerably by 45.4 % between 1990 and 2018, while N_2O emissions decreased moderately by 18.6 %.

[68] In most countries, indirect N_2O 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 7.11 5D Wastewater handling: Countries' contributions to total GHG, CH_4 and N_2O emissions from 5D

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2018 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2018 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2018 (kt CO2 equivalents)
Austria	219	194	96	168	122	26
Belgium	973	282	138	104	835	178
Bulgaria	3 011	912	198	140	2 812	772
Croatia	512	259	67	89	445	170
Cyprus	128	66	12	17	116	49
Czechia	1 124	1 100	234	199	890	901
Denmark	150	116	109	65	41	51
Estonia	151	83	39	32	113	50
Finland	297	243	76	75	221	168
France	2 215	2 656	724	398	1 491	2 258
Germany	4 060	1 043	1 421	496	2 639	547
Greece	2 621	1 342	280	291	2 341	1 051
Hungary	1 050	323	148	75	902	247
Ireland	136	148	75	98	61	50
Italy	4 474	3 787	1 266	1 344	3 209	2 443
Latvia	391	118	53	32	338	87
Lithuania	538	171	67	43	471	129
Luxembourg	13	7	6	4	7	3
Malta	27	9	10	6	17	2
Netherlands	481	296	172	75	309	221
Poland	7 038	3 264	723	760	6 315	2 504
Portugal	1 717	935	200	180	1 517	755
Romania	3 652	2 102	505	532	3 146	1 570
Slovakia	596	342	130	52	466	289
Slovenia	322	169	39	38	282	131
Spain	3 382	2 255	863	802	2 519	1 453
Sweden	263	229	226	200	38	30
United Kingdom	4 962	4 118	765	709	4 197	3 409
EU-27+UK	**44 502**	**26 568**	**8 642**	**7 023**	**35 860**	**19 546**
Iceland	55	51	5	6	50	45
United Kingdom (KP)	4 987	4 154	780	729	4 207	3 425
EU-KP	**44 581**	**26 655**	**8 662**	**7 048**	**35 920**	**19 607**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.4.1 Domestic wastewater (CRF Source Category 5D1)

CH_4 emissions

CH_4 emissions from 5D1 Domestic Wastewater account for 0.3 % of total EU-KP GHG emissions without LULUCF in 2018. Between 1990 and 2018, CH_4 emissions decreased by 53% (Table 7.12). Key drivers for the large emission reduction are the development of centralized wastewater treatment plants (especially implementing aerobic treatments) and an increase of CH_4 recovery and flaring on anaerobic systems (see ***Figure 7.16***). In 2018, CH_4 emissions decreased by 2.2 % in comparison to 2017.

Table 7.12 5D1 Domestic and commercial wastewater: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	121	23	22	0.2%	-99	-82%	0	-1%	T2	CS,D
Belgium	835	182	178	1.5%	-657	-79%	-4	-2%	CR,T1	CR,D
Bulgaria	591	531	562	4.8%	-29	-5%	31	6%	T2	D
Croatia	348	115	61	0.5%	-288	-83%	-55	-47%	T1	D
Cyprus	92	22	18	0.2%	-73	-80%	-4	-16%	T1	D
Czechia	527	439	436	3.7%	-91	-17%	-3	-1%	T1	CS,D
Denmark	41	50	51	0.4%	10	23%	0	1%	CS	CS
Estonia	113	49	47	0.4%	-65	-58%	-1	-3%	T1	D
Finland	194	144	143	1.2%	-52	-27%	-1	-1%	CS,T2	CS,D
France	1 401	2 157	2 158	18.6%	757	54%	2	0%	T1	D
Germany	2 630	517	502	4.3%	-2 128	-81%	-15	-3%	CS,D	CS,D
Greece	1 520	154	153	1.3%	-1 367	-90%	-1	-1%	D	D
Hungary	767	234	222	1.9%	-545	-71%	-12	-5%	T1	D
Ireland	61	51	50	0.4%	-11	-18%	-1	-1%	T1,T2	CS,D
Italy	1 688	1 039	1 029	8.9%	-659	-39%	-10	-1%	T1	D
Latvia	201	79	85	0.7%	-116	-58%	6	7%	T2	CS
Lithuania	471	140	129	1.1%	-342	-73%	-11	-8%	T1	D
Luxembourg	7	3	3	0.0%	-5	-63%	0	-6%	T1	CS
Malta	17	3	2	0.0%	-15	-86%	0	-11%	D	CS
Netherlands	203	199	197	1.7%	-7	-3%	-2	-1%	T2	CS,D
Poland	5 688	2 270	2 229	19.2%	-3 459	-61%	-41	-2%	T1,T2	CS,D
Portugal	1 258	589	525	4.5%	-734	-58%	-64	-11%	T2	CS,D
Romania	2 768	1 443	1 384	11.9%	-1 385	-50%	-59	-4%	D	D
Slovakia	437	289	285	2.5%	-152	-35%	-4	-1%	T2	D
Slovenia	186	127	124	1.1%	-62	-33%	-3	-2%	T1	CS,D
Spain	800	241	242	2.1%	-558	-70%	1	0%	T1,T2	D
Sweden	31	24	24	0.2%	-7	-23%	0	1%	T2	CS
United Kingdom	1 477	729	723	6.2%	-754	-51%	-5	-1%	CS	CS
EU-27+UK	**24 475**	**11 842**	**11 584**	**100%**	**-12 891**	**-53%**	**-258**	**-2%**	**-**	**-**
Iceland	18	23	24	0.2%	6	34%	1	3%	T1	CS,D
United Kingdom (KP)	1 487	744	739	6.4%	-748	-50%	-5	-1%	CS	CS
EU-KP	**24 503**	**11 881**	**11 624**	**100%**	**-12 879**	**-53%**	**-257**	**-2%**	**-**	**-**

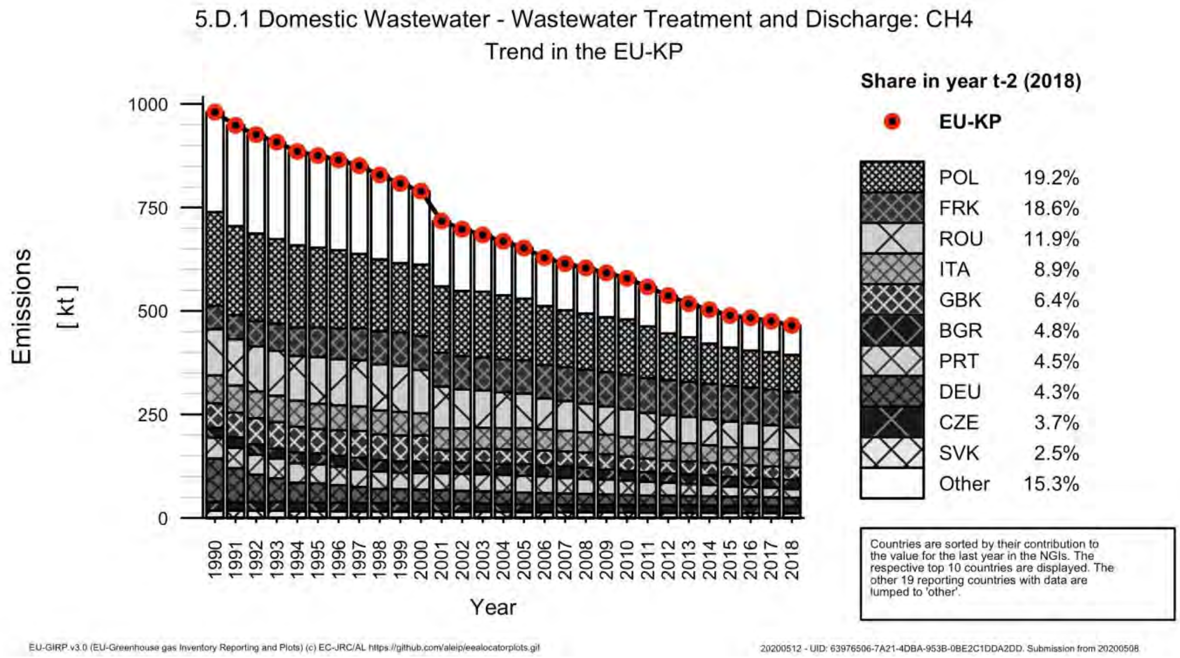
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for CH_4 emissions from domestic wastewater

CH_4 emissions from domestic wastewater treatment and discharge decreased considerably between 1990 and 2018 by 53. Figure 7.15 shows the trend of emissions indicating the countries contributing most to EU-KP total.

Large decreases in absolute terms between 1990 and 2018 are reported by Poland, Germany, Romania and Greece, contributing together to only 37 % of EU-KP emissions from source 5D1 in 2018. Whereas France shows significant emission increases (Table 7.12) between 1990 and 2018. France is responsible for 18.6 %, Poland for 19.2 %, Romania for 11.9 % and Italy for 8.9 % of EU-KP emissions from this source in 2018. Although France increased its emissions between 1990 and 2018 by 54 %, the trend of EU-KP emissions is dominated by the large emission reductions in Poland, Germany, Greece, and Romania. Also the United Kingdom, Portugal, Belgium, Italy, Spain and Hungary achieved significant reductions in emissions compared to 1990.

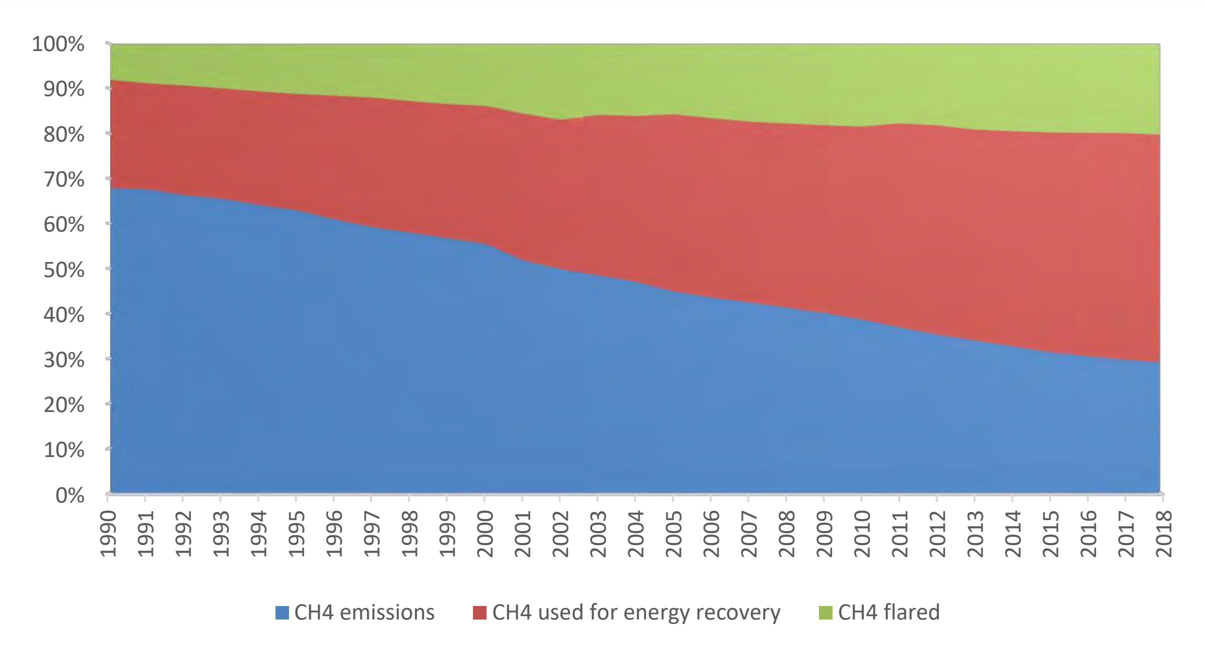
Figure 7.15 5D1 Domestic wastewater: CH_4 emissions (Trend in relevant countries)



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:

- Improvements of wastewater disposal routes with the development of centralized wastewater treatment plants, especially applying aerobic processes
- Amount of sludge removed
- Increased share of CH_4 flared or recovered (see *Figure 7.16*) on anaerobic wastewater and sludge treatment systems

Figure 7.16 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 2020, Table 5D

In 2018, 20 % of the CH_4-emissions generated by Domestic Wastewater Handling were flared and 51 % was recovered for energy purposes.

An important driver for the total CH_4 emissions from 5D Wastewater Handling for the EU-KP are CH_4 emissions from 5D1 Domestic Wastewater in Germany, Greece, Poland and Romania. 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 % average 2001-2018). 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 % since 2005, but the share of anaerobic lagooning is rather high. According to the NIR 2020 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 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 65 % of the total wastewater has been treated appropriate, 9.5 % remained untreated and 25.5 % of total wastewater received only insufficient treatment in 2017. Between 2000 and 2018 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 2018, more than 99 % of population was served by sewer systems and about 85 % 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 autonomous treatments (septic tanks or latrines) for domestic wastewater decreased from 98 % in 1990 to 57% in 2018 and the share of urban populations using autonomous treatments decreased from 55 % to 5.4% in the same period. The treatment pathway using advanced wastewater treatment plants increased from 0 % to 60 % between 1990 and 2018.

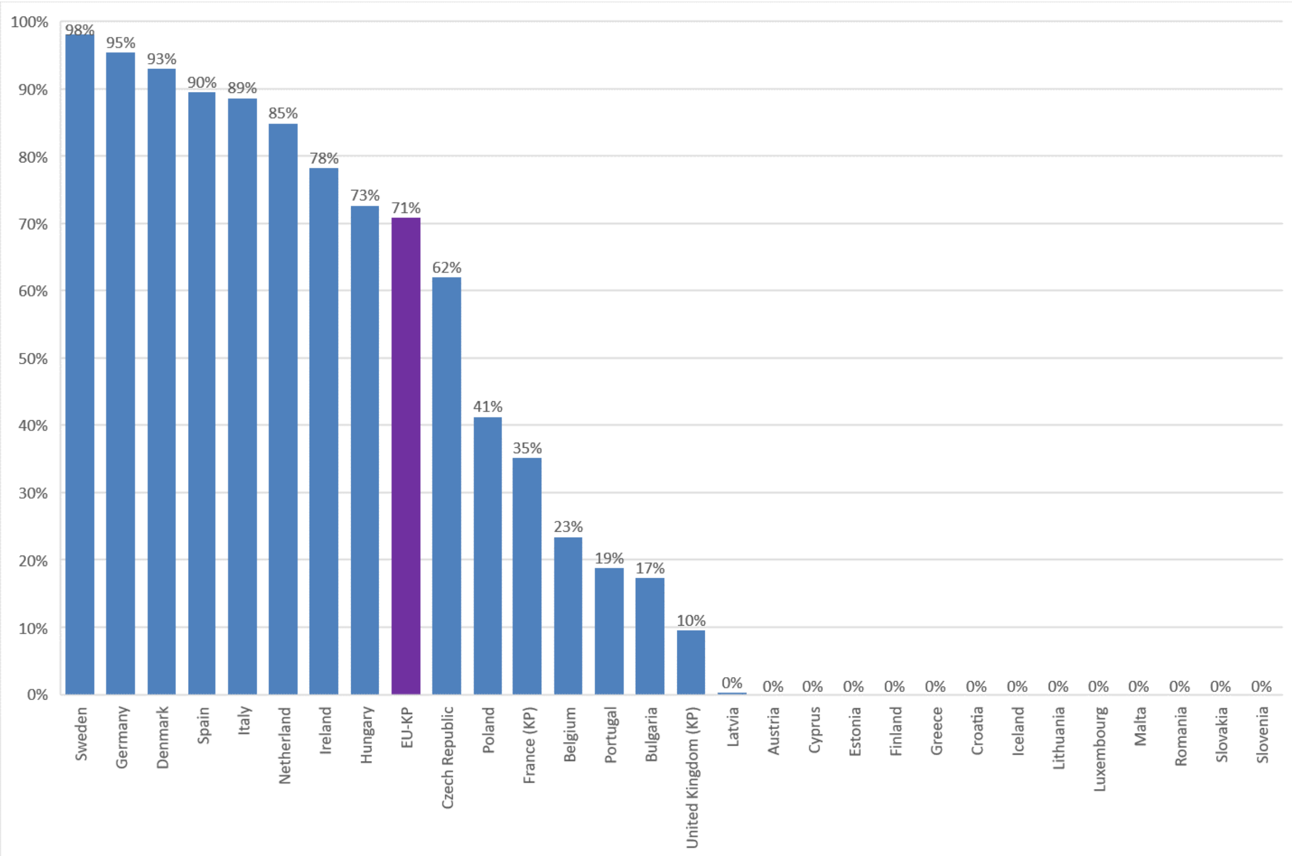
Methodological information for CH_4 emissions from domestic wastewater

All wastewater generated by households as well as any wastewater not disposed on-site in industrial installations is reported as domestic wastewater. CH_4 emissions from wastewater are formed by anaerobic conditions, these 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. Activity 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 countries 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 analyzing wastewater statistics and determining the share of the 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 countries specific methodology is provided.

If methane is recovered and burned (see *Figure 7.16*), 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.

An important remark in the interpretation of data on CH_4-recovery that are reported in the EU's CRF tables (and the countries CRF tables) for wastewater treatment (5D) is that , not all countries are reporting data related to CH_4 recovery, (for energy use of flaring) in CRF table 5D. The reported CH_4 recovery is generally recovered during sludge digestion for biogas production in a follow-up step of aerated wastewater treatment plants. On the opposite, CH_4 emissions relate mainly to anaerobic treatment systems (septic tanks and natural lagoons). Therefore comparing CH_4 emissionsto CH_4 recovery is meaningless. Tree countries are reporting this information as included elsewhere (notation key IE), whereas others countries are reporting not occurring (NO), not applicable (NA) or not estimated (NE). Moreover, information related to the amount of CH_4 recovered on sludge digesters is not necessary to apply the 2006 IPCC Guidelines to estimate CH_4 emissions neither from wastewater treatment nor from sludge digestion. Therefore, not reporting any CH_4 recovered doesn't mean that sludge digestion is not occurring (NO) but that the information is not used for the CH_4 estimate from 5D1.

Figure 7.17 5D1 Managed Solid Waste Disposal: Methane recovery fraction (energy use and flaring) for 2018



Further methodological information for all countries is provided in the Annex III of this submission.

N_2O emissions

Table 7.13 5D1 Domestic and commercial wastewater: Countries' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	96	166	167	2.4%	71	74%	0	0%	CS	CS,D
Belgium	138	104	104	1.5%	-34	-25%	0	0%	D	D
Bulgaria	198	141	140	2.0%	-59	-30%	-1	-1%	T1	D
Croatia	67	89	89	1.3%	22	33%	0	1%	T1	D
Cyprus	12	16	17	0.2%	5	38%	0	1%	T1	D
Czechia	234	198	199	2.9%	-36	-15%	1	0%	T1	CS,D
Denmark	61	61	58	0.9%	-3	-5%	-3	-5%	CS	CS
Estonia	39	32	32	0.5%	-6	-16%	0	0%	T1	D
Finland	56	62	63	0.9%	8	14%	1	2%	CS,T1	D
France	681	362	362	5.3%	-319	-47%	1	0%	T1	D
Germany	1 390	463	469	6.9%	-921	-66%	7	1%	CS,D	CS,D
Greece	274	286	284	4.2%	10	4%	-2	-1%	D	CS
Hungary	148	85	75	1.1%	-72	-49%	-9	-11%	CS	D
Ireland	75	97	98	1.4%	22	30%	0	0%	T1	D
Italy	1 198	1 294	1 291	18.9%	93	8%	-3	0%	T1	D
Latvia	51	32	32	0.5%	-19	-38%	0	-1%	D	D
Lithuania	67	43	43	0.6%	-25	-37%	0	-1%	T1	D
Luxembourg	6	4	4	0.1%	-2	-27%	0	-3%	T1	D
Malta	10	6	6	0.1%	-4	-37%	0	4%	D	D
Netherlands	23	25	25	0.4%	2	11%	0	0%	T1	D
Poland	723	760	760	11.1%	37	5%	0	0%	T1	D
Portugal	200	181	180	2.6%	-20	-10%	0	0%	D	CS,D
Romania	505	535	532	7.8%	26	5%	-3	-1%	D	D
Slovakia	119	52	51	0.7%	-68	-57%	-1	-2%	T2	D
Slovenia	39	37	38	0.5%	-2	-4%	0	1%	T1	D
Spain	863	805	802	11.7%	-61	-7%	-4	0%	D	D
Sweden	208	190	190	2.8%	-17	-8%	0	0%	T1	CS,D
United Kingdom	765	702	709	10.4%	-56	-7%	7	1%	T1	D
EU-27+UK	**8 246**	**6 829**	**6 820**	**100%**	**-1 426**	**-17%**	**-9**	**0%**	**-**	**-**
Iceland	5	6	6	0.1%	1	25%	0	3%	T1	D
United Kingdom (KP)	780	722	729	10.7%	-50	-6%	7	1%	T1	D
EU-KP	**8 265**	**6 854**	**6 846**	**100%**	**-1 419**	**-17%**	**-9**	**0%**	**-**	**-**

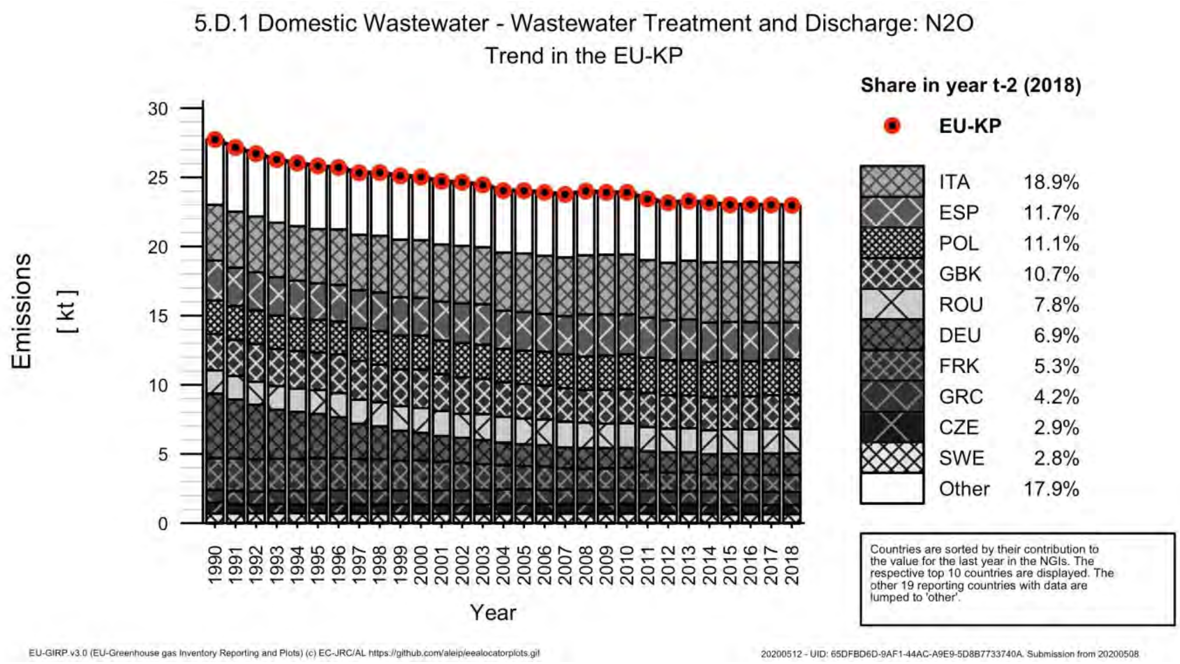
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for N_2O emissions

N_2O emissions from 5D1 Domestic Wastewater account for 0.2 % of total EU-KP GHG emissions in 2018. N_2O emissions from domestic wastewater treatment and discharge decreased moderately between 1990 and 2018 by 17 % (Table 7.13). *Figure 7.18* shows the trend of emissions indicating the countries contributing most to EU-KP total. The countries contributing most to the observed decrease between 1990 and 2018 areGermany and France. Key drivers for the emission reduction are the development of centralized wastewater treatment plants with nitrogen abatement technologies. In 2018, N_2O emissions decreased by 0,1% in comparison to 2017.

Countries with large population have a high share of EU-KP N_2O emissions from this source in general. In 2018, Italy is responsible for 18.9 %, Spain for 11.7 %, Poland for 11.1 % of EU-KP N_2O emissions from wastewater treatment (see Table 7.13). Large decreases in absolute terms are reported by Germany and France between 1990 and 2018, as the amount of wastewater treated in advanced centralized wastewater treatment plants with nitrogen abatement increased over the years.

Figure 7.18 5D1 Domestic wastewater: N_2O emissions (Trend in relevant countries)



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 7.13 only Austria, Denmark, Finland, Germany, Hungary, Portugal and Slovakia apply a country specific methodology or emission factor.

Further methodological information for all countries is provided in the Annex III of this submission.

7.2.4.2 **Industrial wastewater (CRF Source Category 5D2)**

CH_4 emissions from 5D2 Industrial Wastewater account for 0.2 % of total EU-KP GHG emissions in 2018. Between 1990 and 2018, CH_4 emissions decreased by 30 %. 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. CH_4 emissions are almost constant in 2018 in comparison to 2017 (-0.1%) (see Table 7.14).

Table 7.14 5D2 Industrial wastewater: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2018	Change 1990-2018		Change 2017-2018		Method	Emission factor Informa-tion
	1990	2017	2018		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1	3	3	0.0%	3	298%	0	8%	-	-
Belgium	NA	NA	NA	-	-	-	-	-	NA	NA
Bulgaria	2 221	222	210	2.6%	-2 012	-91%	-13	-6%	T2	D
Croatia	97	115	109	1.4%	13	13%	-5	-5%	T1	D
Cyprus	24	31	31	0.4%	7	27%	0	0%	T1	D
Czechia	363	446	465	5.8%	103	28%	19	4%	CS,T1	CS,D
Denmark	IE	IE	IE	-	-	-	-	-	NA	NA
Estonia	NO	6	3	0.0%	3	∞	-3	-52%	T1	D
Finland	27	25	25	0.3%	-2	-7%	0	1%	CS,T2	CS,D
France	90	100	100	1.3%	10	12%	0	0%	T1	D
Germany	9	45	46	0.6%	36	393%	1	2%	CS,T2	CS
Greece	821	883	898	11.3%	77	9%	15	2%	CS,D	CS,D
Hungary	135	24	25	0.3%	-110	-82%	1	2%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 520	1 411	1 414	17.7%	-106	-7%	3	0%	T1	D
Latvia	137	4	2	0.0%	-135	-99%	-2	-58%	T1	PS
Lithuania	IE	IE	IE	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	7	10	10	0.1%	3	45%	1	9%	T2	CS
Poland	627	276	275	3.5%	-351	-56%	-1	0%	T1	CS,D
Portugal	259	234	230	2.9%	-28	-11%	-4	-2%	T2	CS,D
Romania	378	230	187	2.3%	-191	-51%	-43	-19%	D	D
Slovakia	29	5	4	0.1%	-25	-85%	-1	-15%	T1	D
Slovenia	96	7	7	0.1%	-90	-93%	0	-4%	T1	CS,D
Spain	1 719	1 188	1 211	15.2%	-508	-30%	23	2%	T1	CS,D
Sweden	6	5	5	0.1%	-1	-14%	1	14%	T2	CS
United Kingdom	2 720	2 690	2 686	33.7%	-34	-1%	-4	0%	T1	D
EU-27+UK	**11 287**	**7 960**	**7 947**	**100%**	**-3 339**	**-30%**	**-13**	**0%**	**-**	**-**
Iceland	32	20	22	0.3%	-11	-33%	2	8%	NA	NA
United Kingdom (KP)	2 720	2 690	2 686	33.7%	-34	-1%	-4	0%	T1	D
EU-KP	**11 319**	**7 980**	**7 969**	**100%**	**-3 350**	**-30%**	**-11**	**0%**	**-**	**-**

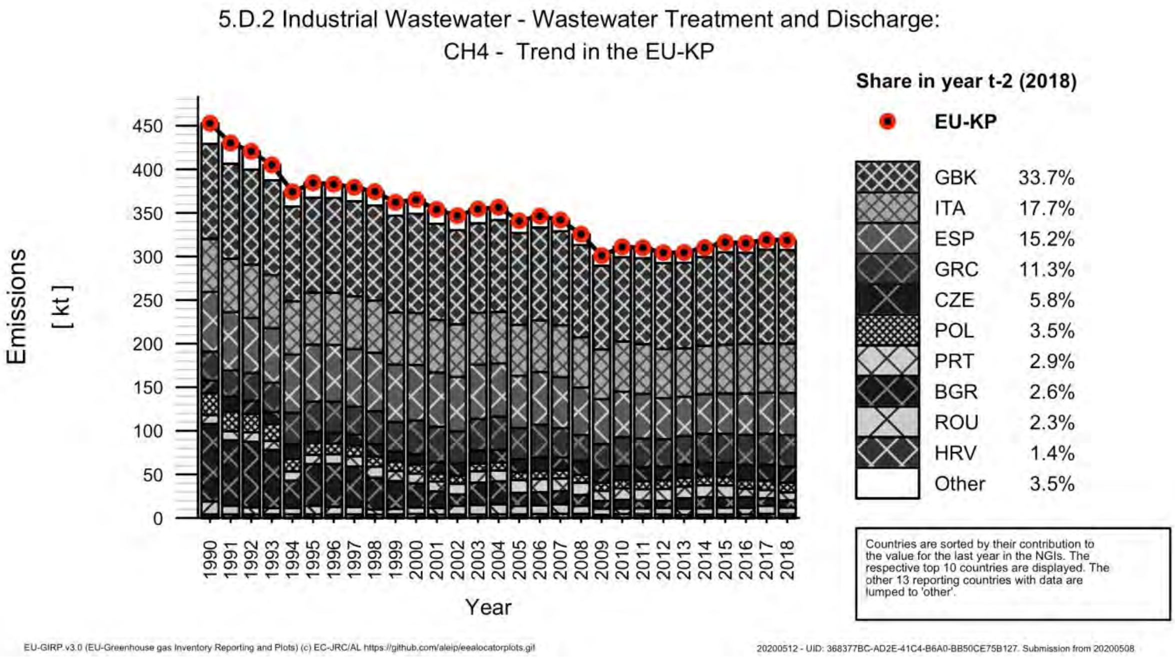
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from industrial wastewater treatment and discharge decreased between 1990 and 2018 by 30 %. *Figure 7.19* shows the trend of emissions indicating the countries contributing most to EU-KP total.

The largest decrease in absolute terms is reported by Bulgaria, followed by Spain and Poland contributing together 21.3 % of EU-KP emissions from source 5D2 in 2018, whereas Czech Republic, Greece and Germany show moderate absolute emission increases between 1990 and 2018 (Table 7.14). The United Kingdom is responsible for 34 %, Italy for 18 %, Spain for 15 % and Greece for 11 % of EU-KP CH_4 emissions from this source in 2018. The emission trends in this sector are mainly influenced by the strong decrease in Bulgaria, Spain and Poland.

Figure 7.19 *5D2 Industrial wastewater: CH_4 emissions (Trend in relevant countries)*



CH_4 emissions from industrial wastewater in the **United Kingdom** are quite constant throughout the time series 1990 and 2018 with lowest emissions during the economic break down in 2009 and 2010. Between 1990 and 2018 CH_4 emissions slightly decreased by 1 %. Given the high share of UKs CH_4 emissions in EU-KP of 33.7 % 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 **Spain**, CH_4 emissions from industrial wastewater decreased by 30 % in 2018 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.

In **Italy,** CH_4 emissions from industrial wastewater decreased only slightly by 7% between 1990 and 2018. 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.

Bulgaria decreased its CH_4 emissions from industrial wastewater until 2005 and remains rather constant in the following years with little annual variations. 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 2005 is caused by decreasing quantities of total industrial wastewater in the country, which decreased from 1,1 billion m³ in 1990 to 0.11 billion m³ in 2018. Between 1990 and 2018 CH_4 emissions decreased by 91 %.

CH_4 emissions from industrial wastewater in **Poland** decreased by 56 % between 1990 and 2018, 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 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 22 countries, while Belgium reports CH_4 emissions as not applicable (NA), Luxembourg reports CH_4 emissions under 5D2 as not occurring (NO) and Denmark, Ireland, Lithuania and Malta report CH_4 emissions from industrial wastewater as included elsewhere (IE).

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 countries. In contrast, the MCF has to be determined country specifically and varies strongly among the countries depending on wastewater treatment systems used.

7.2.4.3 Recalculations CH_4 and N_2O emissions (CRF Source Category 5D)

Table 7.15: 5D Waste water treatment: Contribution of EU-KP countries to recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission)

	1990		2017		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	0.8	0.7	1.9	8.1	More detailed information on flows and treatment practices of industrial wastewater in Austria became available, based on a study conducted 2019, enabling the reporting on emissions (CH_4 and N_2O) under 5.D.2.
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	5.7	2.5	New data on sludge used for composting were excluded from the total organic product for the period 2013 - 2017. Therefore, recalculations of CH_4 emissions were made for the period 2013 - 2017. New data on industrial output (tonne/yr) for 3 industries with the largest potential for wastewater methane emissions (Manufacture of food products and beverages, Manufacture of pulp, paper and paper products and Manufacture of chemicals and chemical products) were included in the emission calculation for 2017.
Cyprus	-	-	-11	-16.7	Updated data of the population served by a sewer and aerobic treatment systems or addressed by IAS (Individual Appropriate Systems). Revision of the 2017 industrial activity data of solid waste production by the Statistical Service.

	1990		2017		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Czechia	-	-	4.0	0.5	New available data about the methan recovery for 2017.
Denmark	-0.0	-0.0	-0.8	-1.5	For 5.D Wastewater treatment and discharge, recalculations occur 2014, 2016 and 2017 resulting in minor changes.
Estonia	0.0	0.0	-	-	
Finland	-	-	-	-	
France	0.2	0.0	4.8	0.2	Update of the fraction of wastewater treated in natural lagooning.
Germany	-	-	1.9	0.3	
Greece	-	-	-	-	
Hungary	-36	-3.8	-24	-8.6	Activity data (people connected to public sewerage system, share of domestic septic systems, protein consumption) have been revised.
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	16	4.9	2.6	3.2	Update of activity data as result of large scale quality check of waste water statistics for the period 2000-2017.
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-0.4	-13.8	The data for total untreated and treated wastewater for years between 2012 and 2017 was revised and updated by the data provider.
Netherlands	-	-	-	-	
Poland	-	-	1.7	0.1	
Portugal	-	-	-7.1	-0.9	Revision of industrial production data.
Romania	-	-	0.5	0.0	
Slovakia	-	-	-	-	
Slovenia	-	-	-0.1	-0.1	
Spain	12	0.5	1.0	0.1	
Sweden	-	-	-0.1	-0.4	Emissions of methane CRF 5.D.2 Industrial wastewater has been recalculated for year 2017 due to a correction of a minor error in the activity data.
United Kingdom	-0.2	-0.0	1.4	0.0	
EU-27+UK	**-7**	**-0.0**	**-18**	**-0.1**	
Iceland	48	2 298.8	37	673.3	Following the 2019 ESD review, Iceland is reporting CH_4 emissions from industrial wastewater separately from domestic wastewater.
United Kingdom (KP)					NA
EU-KP	**41**	**0.1**	**20**	**0.1**	

Table 7.16: 5D Waste water treatment: Contribution of EU-KP countries to recalculations in N_2O for 1990 and 2017 (difference between latest submission and previous submission)

	1990		2017		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	0.4	0.4	1.0	0.6	More detailed information on flows and treatment practices of industrial wastewater in Austria became available, based on a study conducted 2019, enabling the reporting on emissions (CH_4 and N_2O) under 5.D.2
Belgium	-	-	1.8	1.8	In the Flemish region the amounts of N effluent from inhabitants not connected to WWTP are revised for the years 2010,2012 and from 2015 on during this submission in the category 5D. In the Brussels-Capital Region and Wallonia, the consumption of protein per inhabitant was updated from 2014 onwards with the latest information available from the Food and Agriculture Organization of the United Nations (FAO) in the category 5D.
Bulgaria	-	-	-	-	

	1990		2017		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Croatia	-	-	-	-	
Cyprus	-	-	0.0	0.1	
Czechia	-	-	-0.0	-0.0	
Denmark	-0.0	-0.0	0.2	0.3	For 5.D Wastewater treatment and discharge, recalculations occur 2014, 2016 and 2017 resulting in minor changes.
Estonia	-	-	-	-	
Finland	-2.8	-3.5	-8.2	-10.0	Recalculations have been made for the years 2000 to 2017 due to the usage of FAO statistics for the whole time series in protein consumption. Removed municipal sludges and N content of municipal sludges are recalculated for the years 1990 to 2017 for the consistency of time series between acriculture and waste sectors.
France	-	-	-1.3	-0.3	*Not indicated in the NIR.*
Germany	-	-	37	8.1	New data of the Federal Statistical Öffice on the year 2016 are available. It has thus been necessary, on this basis, to reinterpolate the data for the years 2014 and 2015 and to reextrapolate the data for the year 2017
Greece	0.5	0.2	-18	-5.8	Updated activity data, relevant to annual protein consumption, have been utilized for the estimation of N_2O emissions from domestic wastewater handling for the period 1990 - 2016.
Hungary	0.0	0.0	5.0	6.2	Activity data (people connected to public sewerage system, share of domestic septic systems, protein consumption) have been revised.
Ireland	-	-	-	-	
Italy	-	-	5.7	0.4	Recalculations have occurred due to the update of sludge production and sludge used for agricultural purposes .
Latvia	-	-	-0.1	-0.3	Update of activity data as result of large scale quality check of waste water statistics for the period 2000-2017.
Lithuania	-	-	-0.6	-1.4	Preliminary value of protein consumption in 2013 provided by the Health Education and Disease Prevention Centre was used for calculation of N_2O emissions in previous submission. The final corrected value obtained from the scientific publication147 was used in this submission.
Luxembourg	-	-	-	-	
Malta	-	-	-0.1	-1.1	The data for total untreated and treated wastewater for years between 2012 and 2017 was revised and updated by the data provider.
Netherlands	-	-	2.1	2.8	Due to final activity data on total Nitrogen discharges in 2016 and 2017, the emission of N_2O from surface water as a result of discharge of domestic and industrial effluents.
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	3.1	6.1	New data on protein consumption was provided by the Statistical Office of the Slovak Republic for the years 2016 – 2017.
Slovenia	-	-	-	-	
Spain	-	-	-160	-17	Update the activity data from "Base de Datos Española de Composición de Alimentos (BEDCA)" form Ministerio de Ciencia e Innovación and "Food consumption in Spanish homes" from Ministerio de Agricultura Pesca y Alimentación
Sweden	-	-	-	-	
United Kingdom	-	-	0.1	0.0	
EU27+UK	**-1.9**	**-0.0**	**-133**	**-1.9**	
Iceland	-1.3	-23	-1.6	-22	Following the 2019 ESD review, a comment was received on the factor of non-consumed protein added to the wastewater, this factor was changed to 1.1. which is the default for countries where garbage disposal units are not common.
United Kingdom (KP)					NA
EU-KP	**-3.1**	**-0.0**	**-135**	**-1.9**	

7.2.5 Waste – non-key categories

Table 7.17 Aggregated GHG emission from non-key categories in the waste sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2018	Change 1990-2018		Change 2017-2018	
	1990	2017	2018		kt CO_2 equ.	%	kt CO_2 equ.	%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CH4)	1 307	864	787	0.57%	-520	-40%	-77	-9%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (CH4)	9	1 711	1 767	1.28%	1 758	19972%	56	3%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (N2O)	0.0	121	121	0.09%	121	100%	-0.4	0%
5.C.1 Waste Incineration: Waste (CH4)	112	4	3	0.00%	-108	-97%	-0.3	-8%
5.C.1 Waste Incineration: Waste (CO2)	5 021	3 293	3 052	2.20%	-1 968	-39%	-240	-7%
5.C.1 Waste Incineration: Waste (N2O)	193	228	220	0.16%	28	14%	-7	-3%
5.C.2 Open Burning of Waste: Waste (CH4)	357	415	412	0.30%	55	15%	-2	-1%
5.C.2 Open Burning of Waste: Waste (CO2)	105	43	44	0.03%	-61	-58%	1	2%
5.C.2 Open Burning of Waste: Waste (N2O)	244	323	322	0.23%	78	32%	-1	0%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (N2O)	243	151	151	0.11%	-92	-38%	1	0%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (CH4)	98	14	14	0.01%	-84	-86%	0.1	1%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (N2O)	153	53	51	0.04%	-102	-67%	-2	-4%
5.E Other Disposal: Waste (CH4)	46	6	7	0.00%	-40	-85%	0.3	5%
5.E Other Disposal: Waste (CO2)	20	16	18	0.01%	-2	-11%	2	15%
5.E Other Disposal: Waste (N2O)	0.0	67	67	0.05%	67	100%	0.0002	0%

7.3 EU-KP uncertainty estimates

Table 7.18 shows the total EU-27+UK 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 CO_2 and CH_4 from from 5E. Unexpectively CH_4 from 5A has one of the lower uncertainties. Regarding the uncertainty on trend, N_2O from 5D and N_2O from 5B show the highest uncertainty estimates, followed by CH_4 from 5B.. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 7.18 Sector 5 -Waste: EU-KP uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2018	Emission trends Base Year-2018	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	188 684	99 050	-47.5%	27.8%	0.1%
5.A Solid Waste Disposal	N2O	0	0		0.0%	
5.B Biological treatment of solid waste	CO2	0	0		0.0%	
5.B Biological treatment of solid waste	CH4	641	5 452	751.0%	79.3%	3.4%
5.B Biological treatment of solid waste	N2O	247	2 533	926.6%	84.2%	4.0%
5.C Waste Incineration	CO2	5 109	3 096	-39.4%	28.5%	0.6%
5.C Waste Incineration	CH4	215	90	-58.0%	28.5%	0.3%
5.C Waste Incineration	N2O	202	213	5.6%	89.4%	0.5%
5.D Wastewater treatment and discharge	CO2	0	0		0.0%	
5.D Wastewater treatment and discharge	CH4	36 459	19 577	-46.3%	50.2%	0.1%
5.D Wastewater treatment and discharge	N2O	8 732	7 038	-19.4%	450.7%	4.2%
5.E Other	CO2	20	18	-11.2%	300.2%	0.3%
5.E Other	CH4	2	6	147.0%	176.8%	1.2%
5.E Other	N2O	0	67		60.0%	
Total - 5	**all**	**240 311**	**137 140**	**-42.9%**	**31.7%**	**19.1%**

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 of the EU-NIR because uncertainty estimates are not available for all source categories in all countries;*

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 countries data in particular for completeness, time series consistency of emissions and implied emission factors, comparisons of implied emission factors across countries 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 countries 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 countries 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 countries with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU countries 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 countries. 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 countries. 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.

In the autumn of 2018 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2018.

In the autumn of 2019 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2019.

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, 2018, 2019 and 2020, 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.

8 OTHER

Sector Other is not an EU key category (see Annex 1.1) and does not include any emissions in 2020.

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 refuelling 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 countries. 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-KP total of indirect CO_2 emissions are held by Czechia (43 %) and Netherlands (27 %). Nine countries reported indirect N_2O emissions in 2020, with Bulgaria, Romania, Italy and the UK accounting for 85% 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-KP in 2018

Countries	indirect CO_2 [kt CO_2 equ.]	Share in EU-KP [%]	indirect N_2O [kt CO_2 equ.]	Share in EU-KP [%]
Austria	NO,IE,NA	-	14	0.2%
Belgium	NO,NE	-	NO,NE	-
Bulgaria	NO	-	1 081	18%
Croatia	NO,NA	-	NO,NA	-
Cyprus	NE	-	NE	-
Czechia	690	43%	257	4%
Denmark	281	17%	273	4%
Estonia	NO,NE,IE	-	NO,NE	-
Finland	52	3%	168	3%
France	NO,IE,NA	-	NO,NE	-
Germany	NO,NE,IE	-	NO,NE,IE	-
Greece	NO,NE	-	NO,NE	-
Hungary	NO,NE	-	NO,NE	-
Ireland	NO,NE,IE	-	NO,NE	-
Italy	NO	-	972	16%
Latvia	12	1%	NO,IE,NA	-
Lithuania	NO,NE,IE	-	NO,NE	-
Luxembourg	NO,NE	-	NO,NE	-
Malta	NO,NE	-	NO,NE	-
Netherlands	440	27%	NO,NE	-
Poland	NE,IE,NA	-	229	4%
Portugal	137	8%	NO,NE,NA	-
Romania	NO,NE	-	1 867	30%
Slovakia	NO,NE,IE	-	NO,NE	-
Slovenia	NO,NE	-	NO,NE	-
Spain	NE,NA	-	NE,NA	-
Sweden	NO	-	NO	-
United Kingdom	NO,NE	-	1 267	21%
EU-27+UK	**1 612**	**100%**	**6 127**	**100%**
United Kingdom (KP)	NO,NE	-	1 286	21%
Iceland	NE	-	NE	-
EU-KP	**1 612**	**100%**	**6 146**	**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, NOx and NMVOC) used in the above equations are consistent with 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 but Portugal (+55%). The highest percentage decrease has been noted in Denmark (-75%), while in absolute terms Czechia had the biggest share in the EU reduction, decreasing its indirect CO_2 emissions by more than 1.1 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)[69] 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 countries 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.

[69] 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 (>+/- 500 kt CO_2 equiv.) in the year 1990 and 2017 for the EU-27 Member States and the UK. For explanations of the recalculations (including recalculations <+/- 500 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 countries submissions used for the EU submission in May 2019 and MS submissions received until 8 May 2020.

Table 10.1 Main recalculations by source category for 1990 (>+/-500 kt CO_2 eq.)

Category	MS	1990	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	Poland	-773	-0.3
1A2_Manufacturing Industries and Construction CO_2	Italy	-2 016	-2.2
1A2_Manufacturing Industries and Construction CO_2	Portugal	-870	-9.0
1A2_Manufacturing Industries and Construction CO_2	Romania	-755	-1.5
1A3_Transport CO_2	Portugal	596	5.9
1A4_Other sectors CO_2	Portugal	-600	-14.8
1A4_Other sectors CO_2	Romania	879	9.2
3A_Enteric fermentation CH_4	Spain	646	4.2
3D_Agricultural soils N_2O	Poland	1 376	7.8
4A_Forest land CO_2	Bulgaria	-5 533	-45.5
4A_Forest land CO_2	France	-2 192	-5.7
4A_Forest land CO_2	Germany	4 237	5.6
4B_Cropland CO_2	Poland	-2 084	-225.6
4B_Cropland CO_2	Sweden	515	15.6
4B_Cropland CO_2	Denmark	929	21.9
4B_Cropland CO_2	France	1 878	8.7
4C_Grassland CO_2	Germany	-1 997	-7.8
4C_Grassland CO_2	Bulgaria	-1 089	-4 088.3
4C_Grassland CO_2	Latvia	-647	-33.0
4C_Grassland CO_2	Poland	-544	-75.6
4C_Grassland CO_2	Denmark	527	56.9
4C_Grassland CO_2	France	549	4.0
4D_Wetlands CO_2	Germany	-538	-13.2
4E_Settlements CO_2	Czechia	-764	-73.8
4E_Settlements CO_2	Germany	774	42.7
4E_Settlements CO_2	Poland	1 314	261.6

Table 10.2 Main recalculations by source category for 2017

Category	MS	2017	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	Germany	-1 549	-0.5
1A1_Energy Industries CO_2	Poland	535	0.3
1A1_Energy Industries CO_2	Romania	3 031	12.7
1A2_Manufacturing Industries and Construction CO_2	Germany	-3 493	-2.6
1A2_Manufacturing Industries and Construction CO_2	France	-740	-1.5
1A2_Manufacturing Industries and Construction CO_2	United Kingdom	988	1.9
1A2_Manufacturing Industries and Construction CO_2	Spain	1 049	2.5
1A2_Manufacturing Industries and Construction CO_2	Italy	1 298	2.6
1A3_Transport CO_2	Germany	1 062	0.6
1A3_Transport CO_2	Italy	1 374	1.4
1A4_Other sectors CO_2	Germany	-8 681	-6.4
1A4_Other sectors CO_2	Spain	-1 018	-2.6
1A4_Other sectors CO_2	Belgium	1 706	7.6
1B2_Oil and natural gas CH_4	Spain	-558	-78.2
2B_Chemical industries HFCs	Belgium	1 422	>1000
2C_Metal industry CO_2	Germany	2 018	10.5
2F_Product uses as substitute for ODS HFC	France	-940	-5.1
2F_Product uses as substitute for ODS HFC	Poland	-857	-12.4
2F_Product uses as substitute for ODS HFC	Italy	1 114	7.3
3A_Enteric fermentation CH_4	Spain	525	3.1
3D_Agricultural soils N_2O	Czechia	926	25.4
3D_Agricultural soils N_2O	Poland	1 269	9.0
4A_Forest land CO_2	Germany	-9 434	-16.3
4A_Forest land CO_2	Slovenia	1 400	121.1
4A_Forest land CO_2	Portugal	2 486	76.8
4A_Forest land CO_2	Finland	2 804	9.4
4A_Forest land CO_2	France	2 922	5.4
4A_Forest land CO_2	Lithuania	3 293	41.7
4B_Cropland CO_2	Italy	-1 769	-144.0
4B_Cropland CO_2	Lithuania	-1 576	-58.8
4B_Cropland CO_2	Poland	-1 419	-167.1
4B_Cropland CO_2	Latvia	-582	-20.2
4B_Cropland CO_2	Belgium	-507	-40.1
4B_Cropland CO_2	Sweden	506	14.6
4B_Cropland CO_2	Finland	706	9.7
4B_Cropland CO_2	Denmark	773	34.7
4B_Cropland CO_2	Germany	857	5.9
4B_Cropland CO_2	France	1 700	10.6
4C_Grassland CO_2	Germany	-6 021	-27.4
4C_Grassland CO_2	Italy	-1 280	-32.5
4C_Grassland CO_2	Denmark	546	75.4
4C_Grassland CO_2	France	567	6.6
4C_Grassland CO_2	Poland	605	106.7
4D_Wetlands CO_2	Ireland	-678	-20.9

Category	MS	2017	
		kt CO_2 equiv.	%
4E_Settlements CO_2	Sweden	682	32.6
4E_Settlements CO_2	Germany	1 767	50.9
4F_Other land CO_2	Bulgaria	592	100.0
4G_Harvested wood products CO_2	Spain	-777	-40.3
4G_Harvested wood products CO_2	Germany	581	19.1
5B_Biological treatment of solid waste CH_4	France	744	312.8

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-27, United Kingdom and Iceland (EU-KP). 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 1 470 kt (0.03 %). EU-KP GHG emissions for 2017 decreased by 48 kt (-0.001 %) due to recalculations.

Table 10.3 Overview of recalculations of EU-KP total GHG emissions (difference between latest submission and previous submission in kt CO_2 equivalents)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	- 11 188	- 15 401	- 18 186	- 9 265	- 8 826	- 2 659	3 412	- 69	- 13 692	- 5 738
Total CO_2 equivalent emissions including LULUCF (percent)	- 0.21	- 0.30	- 0.37	- 0.19	- 0.18	- 0.05	0.07	- 0.00	- 0.28	- 0.12
Total CO_2 equivalent emissions excluding LULUCF (absolute in kt)	- 1 470	- 3 152	- 1 344	- 6 364	1 066	7 293	10 227	11 667	12 353	15 982
Total CO_2 equivalent emissions excluding LULUCF (percent)	- 0.03	- 0.06	- 0.03	- 0.12	0.02	0.14	0.19	0.22	0.24	0.31

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	- 1 246	- 6 215	- 6 619	- 16 405	- 18 874	- 18 487	- 15 255	4 023	- 5 191	- 3 620
Total CO_2 equivalent emissions including LULUCF (percent)	- 0.03	- 0.14	- 0.15	- 0.38	- 0.44	- 0.44	- 0.38	0.10	- 0.13	- 0.09
Total CO_2 equivalent emissions excluding LULUCF (absolute in kt)	15 493	9 886	13 008	10 211	11 617	8 210	3 150	8 058	5 099	- 48
Total CO_2 equivalent emissions excluding LULUCF (percent)	0.31	0.21	0.27	0.22	0.25	0.18	0.07	0.19	0.12	- 0.00

Table 10.4 provides an overview of recalculations for the key categories for 1990 and 2017 (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 1A2 ‘Manufacturing Industries’ for 1990 and in key category 1A4 ‘Other Sectors’ in 2017.

Table 10.5 and Table 10.6 give an overview of absolute and relative changes of Member States’ emissions due to recalculations for 1990 and 2017. Recalculations of more than 1 million tonnes of CO_2 equivalents were made by Belgium, Germany, Italy, France and Romania. Recalculations in relative terms of more than 2 % were made in Belgium, Italy, Malta, Romania and Iceland.

Table 10.4 Recalculations for EU-KP key source categories 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and in percentage)

Greenhouse Gas Source Categories	Gas	Recalculations 1990		Recalculations 2017	
		(kt CO_2 eqivalents)	(%)	(kt CO_2 eqivalents)	(%)
1.A.1. Energy Industries	CO_2	294	0.0%	- 1 771	0.2%
1.A.2. Manufacturing Industries	CO_2	3 887	-0.5%	1 681	-0.3%
1.A.3. Transport	CO_2	- 260	0.0%	- 3 316	0.4%
1.A.3. Transport	CH_4	- 318	4.8%	- 110	8.8%
1.A.3. Transport	N_2O	- 273	3.4%	- 119	1.2%
1.A.4. Other Sectors	CO_2	- 197	0.0%	8 250	-1.3%
1.A.4. Other Sectors	CH_4	- 274	1.2%	90	-0.5%
1.A.5. Other	CO_2	10	0.0%	- 32	0.5%
1.B.1. Solid Fuels	CH_4	- 37	0.0%	- 193	0.6%
1.B.2. Oil and Natural Gas	CH_4	334	-0.5%	728	-2.6%
1.B.2. Oil and Natural Gas	CO2	64	-0.3%	- 73	0.3%
2.A. Mineral Industry	CO_2	- 38	0.0%	95	-0.1%
2.B. Chemical Industry	CO_2	- 199	0.3%	- 125	0.2%
2.B. Chemical Industry	Unspecified mix of HFCs and PFCs	-	0.0%	-	0.0%
2.B. Chemical Industry	N_2O	- 52	0.0%	- 10	0.1%
2.B. Chemical Industry	HFCs	-	0.0%	- 1 423	329.3%
2.C. Metal Industry	CO_2	35	0.0%	- 1 979	2.7%
2.C. Metal Industry	PFC	- 0	0.0%	- 0	0.0%
2.D. Non-energy products from fuels and solv	CO_2	179	-1.3%	140	-1.4%
2.F. Product uses as substitute for ODS	HFC	- 15	20.4%	616	-0.6%
3.A. Enteric Fermentation	CH_4	- 728	0.3%	- 153	0.1%
3.B. Manure Management	CH_4	- 226	0.4%	584	-1.4%
3.B. Manure Management	N_2O	520	-1.7%	295	-1.3%
3.D. Agricultural Soils	N_2O	- 1 873	1.0%	- 2 646	1.6%
5.A. Solid Waste Disposal	CH_4	148	-0.1%	312	-0.3%
5.B. Biological Treatment of Solid Waste	N2O	12	-3.5%	145	-4.9%
5.B. Biological Treatment of Solid Waste	CH_4	- 251	65.0%	- 818	18.0%
5.D. Waste Water treatment and discharge	CH_4	- 41	0.1%	- 20	0.1%
5.D. Waste Water treatment and discharge	N2O	3	0.0%	135	-1.9%

Note: Many of these source categories are more aggregated than the EU-KP key source categories identified in Section 1.5.

Table 10.5 Contribution of Member States to EU-KP recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2017 (difference between latest submission and previous submission kt of CO_2 equivalents)

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	-178	-201	-153	-139	-94	-135	-68	-165	-140	-173	-283	-381	-334	-387	-129	-238
Belgium	-176	-169	-25	968	731	829	872	789	1 394	1 584	1 550	1 645	1 710	2 296	2 389	3 465
Bulgaria	-55	9	13	211	193	197	189	184	177	144	162	154	152	212	260	316
Croatia	17	-197	-152	-92	-94	-67	-27	-28	-51	-81	-28	-91	-65	-122	-109	12
Cyprus	15	43	67	54	55	60	63	71	56	70	68	70	72	40	50	29
Czechia	-175	-166	138	423	493	591	479	14	176	616	514	303	107	528	387	393
Denmark	488	403	411	461	421	415	463	490	490	487	513	549	499	497	510	461
Estonia	-154	-149	-113	-191	-202	-202	-173	-238	-195	-201	-204	-94	-91	-17	-25	44
Finland	-69	-134	14	23	31	31	52	31	24	97	5	-36	-32	-35	-3	2
France	265	-143	266	-12	211	-59	-1 152	-96	-91	-2 335	-1 760	-789	-1 252	-2 326	-1 958	-1 056
Germany	-1 534	-1 664	-1 761	-145	-118	-103	1 026	1 206	-204	-871	-464	-680	-808	-870	-1 997	-12 315
Greece	208	177	147	165	149	174	130	105	86	139	181	159	164	152	142	165
Hungary	295	33	27	27	-4	73	-57	-104	-92	-112	-77	-33	-25	30	118	-6
Ireland	51	-13	-164	207	43	24	189	189	173	168	141	180	227	204	221	261
Italy	-1 694	-2 984	-1 631	5 930	6 558	9 121	9 255	6 426	7 983	8 813	9 639	4 364	280	5 388	3 969	3 617
Latvia	29	46	23	13	4	1	-4	12	-17	-14	-31	-34	-45	-77	-99	-89
Lithuania	-197	-16	20	-48	-46	-11	54	159	159	168	167	222	203	195	234	200
Luxembourg	-15	-1	-9	-16	-14	-13	-19	-20	-11	-16	-8	-4	-10	-5	-1	0
Malta	467	-15	22	63	69	64	4	22	74	-5	20	34	58	67	48	5
Netherlands	-53	-74	-65	-82	-57	-23	-55	-31	-82	-60	-75	-76	-97	-138	-393	-383
Poland	730	1 759	477	1 035	1 604	864	1 729	642	1 258	973	878	1 173	1 382	1 230	1 146	898
Portugal	-560	-413	-587	-106	-120	-125	-90	-32	-50	-60	-88	-98	-187	-36	-69	-98
Romania	-74	49	28	35	39	1 554	346	-1 591	268	-219	-278	-304	-114	-44	16	3 080
Slovakia	156	90	96	129	138	174	223	225	110	159	129	129	132	186	163	159
Slovenia	-30	-86	-38	-63	-82	-58	-58	-71	-71	-69	-57	-52	-51	-69	-74	-87
Spain	891	287	1 248	2 401	2 390	2 096	1 623	1 318	1 182	887	287	1 252	695	656	507	67
Sweden	-119	-167	-368	37	-289	194	187	156	185	-76	422	241	15	279	343	55
United Kingdom	-114	436	668	347	330	308	294	245	208	172	290	390	549	217	-593	970
EU27+UK	**-1 583**	**-3 260**	**-1 402**	**11 636**	**12 339**	**15 972**	**15 476**	**9 908**	**13 000**	**10 185**	**11 611**	**8 193**	**3 134**	**8 049**	**5 054**	**-73**
Iceland	135	125	133	112	101	94	102	63	84	99	82	90	88	85	115	81

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
United Kingdom (KP)	-136	419	593	266	244	224	209	161	133	99	213	317	479	141	-662	915
EU-KP	**-1 470**	**-3 152**	**-1 344**	**11 667**	**12 353**	**15 982**	**15 493**	**9 886**	**13 008**	**10 211**	**11 617**	**8 210**	**3 150**	**8 058**	**5 099**	**-48**

Table 10.6 Contribution of Member States to EU-KP recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2017 (difference between latest submission and previous submission in percentage)

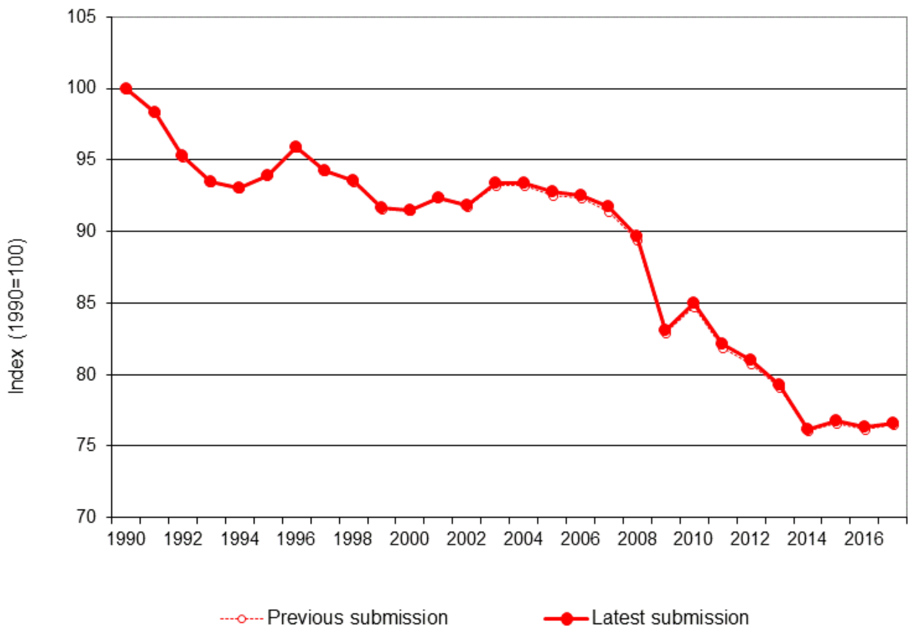
Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	-0.23	-0.25	-0.19	-0.15	-0.10	-0.15	-0.08	-0.21	-0.17	-0.21	-0.35	-0.47	-0.44	-0.49	-0.16	-0.29
Belgium	-0.12	-0.11	-0.02	0.67	0.51	0.60	0.63	0.62	1.05	1.30	1.30	1.38	1.51	1.96	2.06	3.03
Bulgaria	-0.05	0.01	0.02	0.33	0.30	0.29	0.28	0.32	0.29	0.22	0.27	0.28	0.26	0.34	0.44	0.51
Croatia	0.05	-0.86	-0.59	-0.31	-0.31	-0.21	-0.09	-0.10	-0.18	-0.29	-0.11	-0.37	-0.28	-0.50	-0.45	0.05
Cyprus	0.27	0.61	0.80	0.58	0.58	0.60	0.63	0.73	0.60	0.77	0.79	0.90	0.88	0.48	0.58	0.32
Czechia	-0.09	-0.10	0.09	0.28	0.33	0.39	0.33	0.01	0.13	0.44	0.38	0.23	0.08	0.41	0.30	0.30
Denmark	0.69	0.51	0.58	0.70	0.57	0.60	0.70	0.78	0.78	0.84	0.96	1.00	0.98	1.03	1.02	0.96
Estonia	-0.38	-0.74	-0.65	-0.99	-1.09	-0.91	-0.87	-1.42	-0.92	-0.94	-1.01	-0.43	-0.43	-0.09	-0.12	0.21
Finland	-0.10	-0.19	0.02	0.03	0.04	0.04	0.07	0.05	0.03	0.14	0.01	-0.06	-0.05	-0.06	-0.01	0.00
France	0.05	-0.03	0.05	0.00	0.04	-0.01	-0.22	-0.02	-0.02	-0.48	-0.36	-0.16	-0.28	-0.51	-0.43	-0.23
Germany	-0.12	-0.15	-0.17	-0.01	-0.01	-0.01	0.11	0.13	-0.02	-0.09	-0.05	-0.07	-0.09	-0.10	-0.22	-1.36
Greece	0.20	0.16	0.12	0.12	0.11	0.13	0.10	0.08	0.07	0.12	0.16	0.15	0.17	0.16	0.15	0.17
Hungary	0.31	0.04	0.04	0.04	-0.01	0.10	-0.08	-0.16	-0.14	-0.18	-0.13	-0.06	-0.04	0.05	0.19	-0.01
Ireland	0.09	-0.02	-0.24	0.30	0.06	0.03	0.28	0.31	0.28	0.29	0.25	0.31	0.40	0.34	0.36	0.43
Italy	-0.33	-0.56	-0.29	1.02	1.15	1.63	1.69	1.30	1.58	1.79	2.04	0.99	0.07	1.24	0.92	0.85
Latvia	0.11	0.36	0.22	0.12	0.04	0.01	-0.03	0.11	-0.14	-0.12	-0.27	-0.30	-0.40	-0.68	-0.87	-0.79
Lithuania	-0.41	-0.07	0.10	-0.21	-0.20	-0.05	0.22	0.80	0.77	0.79	0.79	1.11	1.02	0.96	1.16	0.98
Luxembourg	-0.12	-0.01	-0.09	-0.12	-0.11	-0.11	-0.15	-0.17	-0.09	-0.13	-0.07	-0.04	-0.09	-0.05	-0.01	0.00
Malta	22.21	-0.57	0.80	2.15	2.34	2.10	0.13	0.75	2.55	-0.17	0.63	1.19	2.03	3.07	2.55	0.21
Netherlands	-0.02	-0.03	-0.03	-0.04	-0.03	-0.01	-0.03	-0.02	-0.04	-0.03	-0.04	-0.04	-0.05	-0.07	-0.20	-0.20
Poland	0.15	0.40	0.12	0.26	0.38	0.21	0.42	0.16	0.31	0.24	0.22	0.29	0.36	0.31	0.29	0.22
Portugal	-0.95	-0.60	-0.71	-0.12	-0.15	-0.16	-0.12	-0.04	-0.07	-0.09	-0.13	-0.15	-0.29	-0.05	-0.10	-0.14
Romania	-0.03	0.03	0.02	0.02	0.03	1.01	0.23	-1.23	0.22	-0.17	-0.22	-0.26	-0.10	-0.04	0.01	2.71
Slovakia	0.21	0.17	0.19	0.25	0.27	0.35	0.45	0.49	0.24	0.35	0.30	0.30	0.32	0.45	0.39	0.37
Slovenia	-0.16	-0.46	-0.20	-0.31	-0.40	-0.28	-0.27	-0.36	-0.36	-0.35	-0.30	-0.28	-0.30	-0.41	-0.42	-0.50

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	0.31	0.09	0.32	0.54	0.55	0.47	0.39	0.35	0.33	0.25	0.08	0.39	0.21	0.19	0.16	0.02
Sweden	-0.17	-0.23	-0.54	0.06	-0.43	0.30	0.30	0.27	0.29	-0.13	0.74	0.44	0.03	0.52	0.65	0.10
United Kingdom	-0.01	0.06	0.09	0.05	0.05	0.05	0.05	0.04	0.03	0.03	0.05	0.07	0.10	0.04	-0.12	0.21
EU-27+UK	**-0.03**	**-0.06**	**-0.03**	**0.22**	**0.24**	**0.31**	**0.31**	**0.21**	**0.27**	**0.22**	**0.25**	**0.18**	**0.07**	**0.19**	**0.12**	**0.00**
Iceland	3.74	3.64	3.30	2.84	2.21	1.93	1.94	1.27	1.74	2.17	1.78	1.95	1.89	1.80	2.47	1.70
United Kingdom (KP)	-0.02	0.06	0.08	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.04	0.06	0.09	0.03	-0.14	0.19
EU-KP	**-0.03**	**-0.06**	**-0.03**	**0.22**	**0.24**	**0.31**	**0.31**	**0.21**	**0.27**	**0.22**	**0.25**	**0.18**	**0.07**	**0.19**	**0.12**	**0.00**

10.3 Implications for emission trends, including time series consistency

Figure 10.1 shows that due to the fact that both 1990 and 2017 emissions have been recalculated in the same order of magnitude the emission trend in the EU-KP did hardly change. In the previous submission the trend of GHG with indirect CO_2 and excluding LULUCF between 1990 and 2017 was - 23.5 %. In the latest submission the trend is - 23.4 %.

Figure 10.1: Comparison of EU-KP GHG emission trends 1990–2017 (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 response to UNFCCC review findings as indicated in Tables 3 of the ARR 2018

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
G.2	Transparency	Methods (G.3, 2016) (G.3, 2015) (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 EU has resolved the issue raised in the 2014 ARR regarding inconsistent use of notation keys for deforestation (see ID# KL.8 below). In addition, as part of its routine initial QA/QC checks on member State submissions the EU performs checks on notation keys to ensure their consistent use. Nevertheless, a couple of inconsistencies in the reporting of notation keys among member States remain from the 2014 ARR (see ID#s I.35 and KL.2 below).	The EU carries out QA/QC checks on Member States' use of notation keys as part of the regular initial checks. Due to this process, past and existing inconsistencies have been resolved; however new reporting from Member States may add further cases of inconsistencies in the use of notation keys. Countries, as own Parties to UNFCCC, also have their own reasons for reporting specific notation keys according to their national circumstances. Sometimes it can be about correctness (which we try to adress) but other times is about interpretation of the reporting guidelines. The EU tries to harmonise notation keys to the extent possible. We suggest that open-ending recommendations are avoided and that they are as specific as possible so that the EU can implement and resolve them effectively. We believe that we have implemented the recomendations, as we 'work with Member states to improve the reporting of notation keys'. If the ERT believes that something is not yet resolved we would suggest opening a new finding for the specific issue, while closing the more generic recommendation here as resolved.
E.1	Transparency	1. General (energy sector) (E.2, 2016) (E.2, 2015) (40, 2014) Transparency	Present methodological summaries that are consistent among member States and categories, at least for the key categories.	Addressing. The NIR includes tables with the methodology used and EF applied for subcategories 1.A.1.a (public electricity and heat production) and 1.A.1.c (manufacture of solid fuels and other energy industries), but not for the key categories 1.A.2.g (other (manufacturing industries and construction)), 1.A.3.b (road transportation) and 1.A.5.b (mobile (other)).	Information on methodology used and EFs applied for subcategories 1.A.2g, 1.A.3.b and 1.A.5.b are not provided in the XML of MS and cannot be provided automatically in these tables. The EU focuses on categories, that are KC in both trend and level in the most current reporting year, which includes in 2018 CO_2 emissions from categories 1.A.2.b - gaseous fuels, 1.A.2.g - solid fuels, 1.A.3.b - diesel oil, 1.A.3.b - gasoline, 1A3.b - LPG and N_2O emissions from 1.A.3.b - diesel oil. The EU sets efforts to collect this information and provides it in the corresponding tables of the EU NIR in future submissions.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
E.2	Accuracy	1. General (energy sector) – gaseous, solid and liquid fuels – CO_2, CH_4 and N_2O (E.9, 2016) (E.9, 2015) Accuracy	Work with 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 EU and the relative importance of the	Addressing. During the review, the EU explained that capacity-building activities to help member States improve the methodology used to estimate emissions for key categories have been carried out, and the EU foresees supporting countries in moving to higher-tier methods for key categories in the second half of 2018.	Every year in Autumn capacity-building activities are organized to help member States improve their methodology used to estimate emissions for key categories and support countries in moving to higher-tier methods for key categories. In this context capacity building webinars are organized and guidance documents have been prepared. The share of higher tier methods applied is continuously increasing. This information is available to the ERT upon request
E.3	Transparency	1. General (energy sector) – gaseous fuels – CO_2, CH_4 and N_2O (E.10, 2016) (E.10, 2015) Transparency	Provide information in the NIR on the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included.	Not resolved. Additional information on the reporting of the recovery of emissions from coal mining and oil and gas operations is not included in the NIR. During the review, the EU explained that when a member State reports CH_4 recovery as “IE” in the CRF tables, the NIR provides information regarding the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included.	Recovery of CH_4 emissions does only occur in subcategory 1B1 in 3 countries (UK, Romania, Slovakia). A description of the share and allocation of recovered CH_4 emissions for each reporting country is included in chapter 1B of the EU NIR.
E.12	Comparability	1.A.3.b Road transportation – liquid fuels – CO_2, CH_4 and N_2O (E.15, 2016) (E.15, 2015) Comparability	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.	Not resolved. The required summary information on emissions from lubricant use is not included in the NIR. During the review, the EU explained that for member States that have provided information in their NIR on how they reported emissions from lubricant use, the recommendation is considered to have been implemented. In the case of member States for which no clear conclusion can be drawn from the information reported, additional actions are needed by the EU, which it will carry out for the next submission.	All countries provide relevant information on the NIR concerning lubricant use. In cases where lubricants are not reported separately in Transport category a justification is provided that no over/underestimation of emissions occurs. A summary of information is provided in the EU NIR, chapter 3.2.3.2.
I.2	Transparency	2. General (IPPU) (I.26, 2016) (I.26, 2015) Transparency	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.	Addressing. Information on the methodologies used by member States is still inconsistent within the NIR (chapter 4 versus annex III). Although there were improvements in the consistency of information between the sections on Denmark in the EU NIR, inconsistencies in the sections on Greece, Lithuania and France were identified for cement production.	The information in the NIR (chapter 4.2.1.1) was updated accordingly. For France and Lithuania, consistent tiers are reported. For Greece, it is specified that a country-specific method was used (in line with the national submission). In addition, it is specified that the level of complexity of that method is Tier 3, which is consistent with the information provided in Annex III.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.3	Transparency	2. General (IPPU) (I.27, 2016) (I.27, 2015) Transparency	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.	Addressing. The EU generally provides methodological information for key categories for all member States in annex III to the NIR. However, the previous review report specifically identified the issues listed in ID#s I.6 and I.8 below in this context, and these issues were not resolved in the NIR.	The information on the methodological tier for those countries that report country-specific methods was added in chapters 4.2.1.1 and 4.2.1.2 (cf. IDs 6 and 8, below).
I.6	Transparency	2.A.1 Cement production – CO_2 (I.29, 2016) (I.29, 2015) Transparency	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.	Addressing. Information on the tier used to estimate emissions from cement production has been updated in the NIR only for Hungary (in chapter 4 and annex III) and Sweden (in chapter 4 only). Tiers for Cyprus, Greece and the Netherlands are missing. During the review, the EU indicated that the missing information would be addressed in a future submission.	Information on the methodological tier is provided for all countries in chapter 4.2.1.1 of the NIR. Please note that the information provided in tabular format in this chapter is identical with the information submitted in the various national submissions. As Greece uses a country-specific method and reports "CS" in its national submission, the information on the methodological tier used by Greece (T3) is provided below the table.
I.8	Transparency	2.A.2 Lime production – CO_2 (I.30, 2016) (I.30, 2015) Transparency	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.	Addressing. Information on the tier used to estimate emissions from lime production has been updated in the NIR for France and Hungary in both table 4.5 and annex III, and for Austria and Sweden in table 4.5 only (in annex III, the column for method and EF used is blank). No information is included for Greece, Malta or the Netherlands.	Information on the methodological tier is provided for all countries in chapter 4.2.1.2 of the NIR. Please note that the information provided in tabular format in this chapter is identical with the information submitted in the various national submissions. As Greece and the Netherlands use a country-specific method and report "CS" accordingly, the information on the methodological tier used (T3) is provided below the table.
I.9	Comparability	2.A.2 Lime production – CO_2 (I.30, 2016) (I.30, 2015) Transparency (I.31, 2016) (I.31, 2015) Comparability	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.	Addressing. The Netherlands now reports CO_2 emissions from lime production in the IPPU sector, but under the category food industries (2.D.2) rather than lime production (2.A.2).	CO_2 emissions from lime production are now reported under category 2.A.2, as recommended by the ERT (see chapter 4.2.1.2.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.16	Accuracy	2.B.1 Ammonia production – CO_2 (I.36, 2016) (I.35, 2015) Accuracy	Work with Czechia 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.	Not resolved. During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission.	Investigations which will allow the estimation of CO_2 emissions using plant-specific emission factors are ongoing, but have not been completed yet.
I.20	Accuracy	2.B.4 Caprolactam, glyoxal and glyoxylic acid production – N_2O (I.40, 2016) (I.38, 2015) Accuracy	Work with Czechia to recalculate and report more accurate N_2O emissions from caprolactam production, taking into account the data collected under the EU ETS.	Not resolved. During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission. The ERT notes that Czechia reports annual emissions from caprolactam production of 0.25 kt N_2O (74.5 kt CO_2 eq) and that emissions have been measured since 2012, so any underestimation is below the level of significance given in decision 22/CMP.1 in conjunction with decision 4/CMP.11, annex, paragraph 80(b). In response to a draft version of this report, the EU stated that it continues to work with Czechia to report more accurate emissions from caprolactam production, taking into account the data collected under the EU ETS.	Emissions are estimated using a plant-specific emission factor, which was derived from a mass balance calculation. It is not possible to switch to a method using EU ETS data, because the facility reports several sources of emissions together and data are not available separately for the caprolactam production process.
I.23	Comparability	2.B.8 Petrochemical and carbon black production – CO_2 (I.42, 2016) (I.40, 2015) Comparability	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.	Not resolved. During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission.	All emissions from ethylene production (combustion and process) are now fully reported in category 2B10 and not in the energy sector. More information can be found in section 4.3.2.9 of the French NIR.
I.24	Comparability	2.B.9 Fluorochemical production – HFCs (I.43, 2016) (I.41, 2015) Comparability	Explain in the NIR how tetrafluoromethane emissions from the production of HCFC-22 occur and work with Italy to allocate these 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).	Not resolved. The EU continues to report tetrafluoromethane emissions as by-product emissions from the production of HCFC-22, but an explanation for how these emissions occur is not included in the NIR.	IT-2B9-2020-0002: The origin of the CF4 emissions was not fully clarified but does not relate to the production of HCFC-22 for feedstock use as only HFC-23 is formed as by-product during that process. However, the answer says that CF4 is still measured AFTER treatment of the flue gases from different production lines. CF4 might be formed during the incineration process of hydrocarbons and fluorine. It is certain that it is formed during incineration of PTFE at temperatures of around 800°C. Therefore the emissions

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
					might either result from an incomplete abatement process or are formed in the course of the treatment process or come from other production processes. Due to these uncertainties and ongoing communication on the issue this has not been picked up in the NIR.
I.29	Transparency	2.C.1 Iron and steel production – CO_2 (I.49, 2016) Transparency	Work with Hungary to estimate and report the CO_2 IEF, expressed in t CO_2 per t sinter produced.	Not resolved. The EU continues to report a comparatively high CO_2 IEF for Hungary of 5.28 t CO_2/t sinter for 1990 and 5.08 t CO_2/t sinter for 2016 (NIR, table 4.17). During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission.	Hungary provides in their NIR information as to why they report a relatively high IEF. The EU will undertake efforts to assess, if capacity building is necessary to address this problem, and what can be done by the EU to help Hungary allocate emissions from BOF and limestone and dolomite use to the respective subsectors.
I.31	Transparency	2.C.3 Aluminium production – CO_2 (I.50, 2016) (I.47, 2015) Transparency	Include in the NIR information on the method, assumptions, EFs and AD used to estimate CO_2 emissions from aluminium production.	Addressing. Some additional information on the methods used to estimate CO_2 emissions from aluminium is included in the NIR (p.488); however, EFs and AD were not provided (AD were reported for PFC emissions).	The scope of the EU NIR entails information on key categories only (please refer to the Introduction for additional information), this is why no information is included on CO_2 emissions from 2A3, Aluminium Production. Could the TERT please specify, if additional information on PFC emissions is necessary to increase transparency?
I.33	Transparency	2.D Non-energy products from fuels and solvents use – CO_2 (I.52, 2016) (I.49, 2015) Transparency	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.	Addressing. Information on methodologies and EFs is included only for other non-energy products from fuel and solvent use (2.D.3) (NIR, table 4.40).	The scope of the EU NIR entails information on key categories only (please refer to the Introduction for additional information), this is why no information is included on CO_2 emissions from 2D1 and 2D2. Could the TERT please specify, if additional information should be added on emissions from 2C3 to increase transparency?

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.34	Transparency	2.F Product uses as substitutes for ozone- depleting substances – HFCs (I.20, 2016) (I.20, 2015) (74, 2014) Transparency	Endeavour to provide in the NIR summary overviews of methodologies used to estimate emissions from the consumption of halocarbons and SF6 for key categories based on the relevant methodological descriptions reported in the NIRs of member States.	Addressing. The two key categories are refrigeration and air conditioning, and aerosols. Information on the methodologies used to estimate HFC emissions from refrigeration and air conditioning for all member States is included in the NIR (table 4.45). Regarding aerosols, methodological information is reported for all member States, except Cyprus, in table 4.48.	Methodological information regarding aerosols is reported for Cyprus in the EU NIR, Table 4.50.
I.35	Transparency	2.F Product uses as substitutes for ozone- depleting substances – HFCs, PFCs and SF6 (I.21, 2016) (I.21, 2015) (75, 2014) Transparency	Make the necessary corrections in the use of the notation keys to ensure the transparency of the reporting (specifically: “NE” reported by Denmark for the amount of gas remaining in products at decommissioning; “NO” reported by Finland for SF6 emissions from aluminium and magnesium foundries; “IE” and “NA” reported by Ireland for AD and emission estimates for HFC emissions from refrigeration and air-conditioning equipment (except mobile air conditioning); “NO” reported by Luxembourg for potential emissions of PFCs from refrigeration and air-conditioning equipment; “NA” and “NA and NO” reported by the Netherlands for AD and IEFs of emissions from stocks in industrial refrigeration and mobile equipment, whereas the emissions are actually estimated; and empty cells in the CRF tables for Spain as a replacement of “NA” and “NE” notation keys for reporting emissions from semiconductor manufacturing).	Addressing. The only outstanding issue of the specific issues with notation keys listed in the annual review report of the 2014 submission is that Finland still reports “NO” for SF6 emissions from aluminium and magnesium foundries.	SF6 emissions from 2C4 occurred in Finland only in the years 1994 to 2009 and in 2012, but ceased since then. For these years "IE" is reported and emissions are included in 2H3. For all other years "NO" is reported as Mg die casting did not occur and therefore no emissions occurred.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.37	Transparency	2.F.6 Other applications (product uses as substitutes for ozone-depleting substances) – HFCs, PFCs and SF6 (I.25, 2016) (I.25, 2015) (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 SF6 in the Netherlands, and enhance the QC procedures to ensure that the information in the NIR of the EU accurately reflects the information in the NIRs of member States.	Addressing. The NIR does not include consumption data for aerosols, fire extinguishers, foams or solvents under category 2.F to address the transparency issue of the current reporting for the Netherlands. Table 4- 44 of the NIR reports "IE, NA" for category 2.F.2, blank cells for 2.F.3 and 2.F.5, and "NO" for category 2.F.4. No explanation for the reporting of "IE" and blank cells for the Netherlands has been provided. During the review, the EU confirmed that, as stated in the NIR (table 10.7), a new methodology for estimating emissions for this category is being developed by the Netherlands and will be implemented for the next submission.	Notation keys have not been corrected in the EU NIR, a note has been added that the Netherlands reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.
A.1	Transparency	3. General (agriculture) – CO_2 (A.8, 2016) (A.8, 2015) Transparency	Indicate in the NIR where in the inventory of the Netherlands indirect CO_2 emissions from the agriculture sector are included.	Not resolved. The EU has reported in the NIR (table 10.7) and confirmed during the review that the recommendation will be implemented in a future submission.	NDL NIR (15/04/2020), Chapter 9.1, page 271. The data is provided in the EU NIR, Table 9.1.
A.2	Transparency	3. General (agriculture) – CO_2 (A.8, 2016) (A.8 2015) Transparency	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.	Not resolved. The EU has reported in the NIR (table 10.7) and confirmed during the review that the recommendation will be implemented in a future submission. that the recommendation will be implemented in a future submission.	The Notation Key for indirect emissions in agriculture of Slovakia is reported in the Table 6 and were corrected to "NE".
A.3	Transparency	3. General (agriculture) – CH_4 (A.9, 2016) (A.9, 2015) Transparency	Compile and report information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for all member States and Iceland.	Addressing. The EU has reported information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for all member States but not Iceland (NIR, tables 5.5, 5.6, 5.16 and 5.17). During the review, the EU indicated that Iceland used a tier 2 method to estimate CH_4 emissions from sheep. For Iceland's approach to estimating emissions from cattle, see ID# A.16 in table 5.	Information on Iceland IEFs, methodological tiers and emissions from cattle, sheep and swine were included in appropriate tables of the EU NIR 2020. Please see Chapter 5.3.1.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
A.5	Transparency	3.A.1 Cattle – CH_4 (A.11, 2016) (A.11, 2015) Transparency	Work with the Netherlands to include the Party's milk yield for dairy cattle in the NIR of the EU, as is the case for all other member States.	Addressing. The EU reported that it has included the Netherlands' milk yield for dairy cattle in the EU NIR (table 10.7). The ERT notes, however, that the EU mentioned that, while the Netherlands does not report this milk yield in its CRF tables, the data are available in table 5.4 of the Netherlands' 2018 NIR (EU NIR, p.548). The milk yield for the Netherlands has therefore not actually been provided in the EU NIR, as acknowledged by the Party during the review.	Netherlands CRF Table 3.A2 doesn´t include information on milk yield. Table 5.10 of the EU NIR 2020 therefore does not include data on milk yield for NDL; a comment is provided: Netherlands does not report milk yield in their CRF, but such data are available in their NIR (see also Annex III).
A.6	Comparability	3.B Manure management – N_2O (A.12, 2016) (A.12, 2015) Comparability	Work with the Netherlands to investigate whether N_2O emissions from manure management can be estimated and reported separately for each livestock category.	Not resolved. The EU reported that the Netherlands reports the amount of manure managed in each animal system (EU NIR, table 10.7). Nevertheless, the EU uses the notation key "IE" to report N_2O emissions from manure management for cattle and swine for the Netherlands in tables 5.29 and 5.30 of the NIR. The ERT notes that in CRF table 3.B(b) the EU also uses the notation key "IE" to report N_2O emissions from manure management for sheep and swine for the Netherlands. For 2018 the Netherlands reported manure by MMS and livestock category, but emissions in category 3.B.b were still reported under other livestock. According to the Netherlands' improvement plan, the disaggregation of emissions by livestock category is expected to be completed in time for the next submission.	Tables 5.29 and 5.30 of the EU NIR (15/04/2020) included information on cattle and swine.
A.11	Accuracy	3.B.3 Swine – CH_4 A.16, 2016) (A.16 2015) Accuracy	Work with Cyprus, Czechia, Greece and Slovakia to move to a higher-tier method to estimate CH_4 emissions from manure management for swine.	Addressing. The EU has reported that Cyprus is now using a tier 2 method to estimate CH_4 emissions from manure management for swine, while a tier 1 method is still being used by Czechia, Greece and Slovakia (NIR, table 5.17). During the review, the EU indicated that ongoing efforts are being made together with the member States concerned to move to a higher- tier method and that the issue is included in the member States' respective improvement plans.	Slovakia: SVK NIR 15/04/2020, Chapter 5.8.1, pages 268-273, T2 for swine CH_4 emissions in 3.B.1 and CS EF Cyprus: CY NIR 15/04/2020 Chapter 5.3.2.1 page 156, swine CH_4 emissions estimated by T2 (2006 IPCC Guidelines, vol. 4, Annex 10A.2) and default EF CZ not yet resolved: will be implemented as regards the improvement plan in the future Greece not resolved
A.12	Comparability	3.D.b Indirect N_2O emissions from managed soils – N_2O (A.7 2016) (A.7, 2015) (92, 2014) Comparability	Work with member States to ensure more consistent reporting of the area of organic soils between the agriculture and LULUCF sectors.	Not resolved. The total area of organic cultivated soils reported in CRF table 3.D (86,174.66 kha for 2016) is more than 10 times higher than the sum of the areas reported in CRF tables 4.B and 4.C (6,084.71 kha for 2016). During the review, the EU explained that it checked if the sum of the areas reported in CRF tables 4.B and 4.C is at least as large as the area of cultivated histosols reported in CRF table 3.D. The EU found that the reporting was correct in the	Check done during the initial ESD review 2020.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
				January 2018 submission (for all countries reporting both categories) but that there was an error in the Netherlands' March submission to the EU in CRF table 3.D. The EU noted in its response that differences between the sum of areas reported in CRF tables 4.B and 4.C and the area reported in CRF table 3.D could be explained by non-cultivated or non- managed areas; for example, non-cultivated grassland, which needs to be reported in CRF table 4.C but not in CRF table 3.D, as CRF table 3.D includes emissions from cultivation and management of cropland and grassland (as noted in its footnote 2). The ERT asked the EU to provide the area of non-cultivated grassland that is reported only under category 4.C and to explain whether this non-cultivated component of grassland is managed or not, but the EU did not provide that information. In this regard, keeping in mind the level of aggregation required in the CRF tables, during the initial QA/QC checks of member State submissions, the EU noted that the figures reported by member States are considered inconsistent only when the area under "cultivation of histosols" in CRF table 3.D is greater than the sum of the areas of organic soils reported under cropland (CRF table 4.B) and grassland (CRF table 4.C). The ERT disagrees with the assessment of the EU that the area under "cultivation of histosols" in CRF table 3.D should not be equal to the sum of the areas of cultivated organic soils reported under cropland (CRF table 4.B) and grassland (CRF table 4.C). In response to a draft version of this report, the Party indicated that it will work to better understand the reasons for the differences between category 3.D and the sum of categories 4.B and 4.C for the 2020 annual submission.	
L.1	Completeness	4. General (LULUCF) (L.1, 2016) (L.1, 2015) (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 EU demonstrated that improvements have been made by some member States in providing estimates for mandatory categories in the LULUCF sector (see ID# L.10 below). However, some member States are still using the notation key "NE" for reporting these emissions (see ID# L.16 below). During the review, the EU indicated that further improvements are expected to be implemented in future submissions.	The EU has continued improving the completeness of the LULUCF sector in order to provide emissions from all the mandatory source categories. Specific information on this regard is provided in section 6.1.3 of the EU NIR where we have reflected the improvements implemented on completeness at country level. Among others improvements, Belgium reports now carbon stock changes from HWP for the whole time series (addressing ID# L.10), and the use of NE by France in land converted to Cropland has been now explained in the EU NIR in the relevant

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
					section (addressing ID# L.1)
L.2	Completeness	4. General (LULUCF) (L.2, 2016) (L.2, 2015) (95, 2014) (76, 2013) (86, 2012) Completeness	Work with member States with a view to reporting mandatory pools and categories that are currently not estimated in order to increase the completeness of the inventory.	Addressing. See ID# L.1 above.	See ID# L.1 above.
L.3	Adherence to the UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF) (L.13, 2016) (L.13, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Include in the NIR information on planned inventory improvements for the LULUCF sector and KP-LULUCF activities.	Addressing. In the NIR, the EU reports planned improvements (section 6.4.4) and implemented improvements (section 11.3.6). However, for two of the planned improvements listed in section 6.4.4, the information is not sufficient to allow the ERT to identify what type of improvements are being considered by the EU for future submissions. In particular, the EU indicates that a planned improvement is the implementation of additional sector-specific checks, without describing the planned checks. Similarly, the EU does not provide sufficient information on the required corrections it identified during the QA/QC checks, but which could not be implemented for the 2018 annual submission (p.767). During the review, the EU provided more details on the planned improvements that will be included in the next submission.	For the GHG 2019 the EU reformulated the information included in sections 6.4.4 and 11.3.6 of the EU NIR in order to better describes the planned improvements for the LULUCF and KP-LULUCF sectors. This has resulted in a more transparent and clear description of what is planned to continue improving these sectors of the EU NIR.
L.4	Adherence to the UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF) (L.16, 2016) (L.15, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Correct the inconsistencies in the reported areas in CRF tables 4.1 and 4.A–4.F.	Not resolved. The inconsistencies in the reported areas in CRF tables 4.1 and 4.A–4.F remain.	This issue is subject to a specific QAQC check that is implemented every year. This has resulted in a less inconsistent reporting among the areas reported in CRF tables 4.1 and 4.A–4.F. However, despite of this check and the recommendation that was provided by the EU to its MS whenever this issue was identified in individual inventories, some discrepancies remain in 2020.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
L.5	Comparability	4. General (LULUCF) – CO_2 (L.12, 2016) (L.12, 2015) Comparability	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).	Addressing. The EU is continuing its inventory improvement efforts with regard to using the notation key "NA" where carbon stock changes are considered neutral (e.g. Latvia now reports "NA" for mineral soils for grassland remaining grassland). The ERT commends the EU for the fact that France provided a quantitative assessment of carbon stock changes in mineral soils for grassland remaining grassland instead of using a notation key. However, some member States continue to report "NO" for mandatory pools. For instance, Estonia, Greece, Lithuania, Luxembourg and Slovakia have reported "NO" for carbon stock changes in mineral soils for grassland remaining grassland. During the review, the EU indicated that it is working with member States to ensure use of the notation key "NA" where carbon stock changes are considered neutral. This issue was discussed with member States during the annual LULUCF workshop led by the JRC.	QA/QC checks on member State submissions on the correct use of notation keys to ensure are part of the annual routine initial checks carried out before submission of the EU inventory and NIR. This issue has been also discussed with MS during the annual LULUCF workshops organized by the JRC, as well as communicated to the MS during the meeting that are organized by the EC under the Climate Change Committee. MS has now used more the notation key NA to report carbon stock changes from carbon pools where carbon stock changes are neutral. However, some MS continue using the notation NO or NE because they have focused the efforts on improve the accuracy, consistency and completeness of the sector and to a lesser extend to change the notation key.
L.6	Consistency	4.A.1 Forest land remaining forest land – CO_2 (L.17, 2016) (L.16, 2016) Consistency	Work with Luxembourg to improve the time-series consistency of net carbon stock changes in deadwood in forest land remaining forest land.	Addressing. Luxembourg has reported an inconsistent time series of net carbon stock changes in deadwood for forest land remaining forest land ("NO" is reported for 1990–2000, and net carbon stock changes for thereafter). During the review, the EU noted that it had already held discussions with Luxembourg on this issue specifically and that the issue was included in the planned improvements section of the NIR (p.767). The Party indicated that this issue will be addressed in the 2019 submission	For the GHG 2020, Luxembourg reports a complete time series of carbon stock changes in deadwood in forest land remaining forest land.
L.7	Transparency	4.A.2 Land converted to forest land – CO_2 (L.4, 2016) (L.4, 2015) (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.	Addressing. The original recommendation from the 2013 ARR related to the reporting by Italy. The EU does not provide transparent information in the NIR (section 6.2.1.3) for Italy regarding its methodological approach to improving accuracy for all forest-related subcategories. It is not clear from the description what exactly was improved in Italy's methodology.	In order to address the recommendation of the ERT, the EU has requested Italy to provide specific information on the methodological approach that is using to report carbon stock changes from Land converted to Forest land. In section 6.2.1.3 of the GHG 2020 specific information on this issues is now included.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
L.10	Completeness	4.B.2 Land converted to cropland – CO_2 (L.7, 2016) (L.7, 2015) (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. Quantitative estimates of carbon stock changes in mineral soils for Cyprus were included in CRF table 4.B of the EU submission. However, some member States continue to use the notation key "NE" for reporting net carbon stock changes (e.g. France uses "NE" for carbon stock changes in all pools for other land converted to cropland). In addition, the EU has not reported information on methodological changes by member States or the efforts they have made to move to a higher- tier methodology in the designated section of the NIR (section 6.2.2.3).	The EU has included in section 6.2.2.3 information on the use by France of the notation key "NE" to report carbon stock changes for land converted to Cropland. And on improvements that have been implemented in this subcategory, including the use of higher methods (as requested by the ERT), which have resulted in an overall increase of accuracy and completeness of the sector.
L.11	Transparency	4.F Other land – CO_2 (L.20, 2016) (L.19, 2015) Transparency	Include in the NIR information on whether land areas reported under other land in Finland, Portugal and the United Kingdom of Great Britain and Northern Ireland 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.	Addressing. The EU does not provide transparent information on whether land areas reported under other land for Finland, Portugal and the United Kingdom are unmanaged. The EU has reported, however, that Portugal intends to reallocate its estimate of carbon stock changes for other land remaining other land for shrubland to grassland in the next submission (NIR, p.738).	The EU has included information on this regard in section 6.2.4.3. Moreover, as included in the improvement plan section 6.4.4, the EU is following the reporting of Portugal to track that the planned improvement the reporting of Grassland and Other land is implemented.
L.16	Completeness	4.G HWP – CO_2 (L.22, 2016) (L.21, 2015) Completeness	Work with Belgium and Cyprus to ensure that the information on HWP in CRF table 4.G is complete for the whole time series.	Addressing. The EU has included in CRF table 4.G HWP estimates made by Cyprus in 2018 for the entire time series. Belgium is still working to provide HWP estimates for the entire time series.	Belgium reports in 2020 a complete time series of estimates for carbon stock changes in HWP.
KL.2	Transparency	General (KP-LULUCF) (KL.1, 2016) (KL.1, 2015) (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.	Addressing. The EU has worked with member States to improve consistency in the use of notation keys. Every year a presentation is given on this issue during the annual JRC LULUCF workshop and a Working Group 1 meeting. Although progress has been made (see ID# KL.8 below), some inconsistency and lack of transparency in the use of notation keys by member States persist. The ERT noted that "NE" is mainly used when the "not a net source" provision is applied (decision 2/CMP.8 annex II, paragraph 2(e)), and that "NO" is used by some member States for existing activities.	QA/QC checks on Member State submissions on the correct use of notation keys to ensure are part of the annual routine initial checks carried out before submission of the EU inventory and NIR. This issue has been also discussed with MS during the annual LULUCF workshops organized by the JRC, as well as communicated to the MS during the meeting that are organized by the EC under the Climate Change Committee. MS has now used more the notation key NA to report carbon stock changes from carbon pools where carbon stock changes are neutral. However, some MS continue using the notation NO or NE because they have focused the efforts on improve the accuracy, consistency and completeness of the sector and to a lesser extend to

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
					change the notation key.
KL.4	Adherence to the UNFCCC Annex I inventory reporting guidelines	General (KP-LULUCF) (KL.7, 2016) (KL.7, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Correct the error found in the aggregation process of member States' inventories to ensure the consistency of information of the EU and its member States.	Addressing. The ERT commends the EU for the efforts it has made to ensure the consistency and transparency of its reporting in this area. Some inconsistencies have been resolved and the aggregation process has been improved (e.g. consistent information is provided in NIR tables 11.3 and 11.5 and CRF tables NIR-2 and 4(KP)). However, some inconsistencies remain in the data reported within CRF tables NIR-2 and 4(KP)A.1–4(KP)B.4, and additional transparent information on approaches used to identify HWP from deforestation events is needed.	This issue is subject to a specific QAQC check that is implemented every year. This has resulted in a less inconsistent reporting among the areas reported in CRF tables NIR-2 and 4(KP)A.1–4(KP)B.4. However, despite of this check and the recommendation that was provided by the EU to its MS whenever this issue was identified in individual inventories, some discrepancies remain in 2020.
KL.5	Transparency	General (KP-LULUCF) (KL.7, 2016) (KL.7, 2015) Transparency	Ensure that issues identified during the aggregation process, which affect the accuracy and completeness of the submission, are resolved.	Addressing. See ID# KL.4 above.	See ID# KL.4 above.
KL.10	Completeness	Article 3.4 activities – CO_2 (KL.11, 2016) (KL.11, 2015) Completeness	Work with the United Kingdom to estimate the net carbon stock changes in the litter and deadwood pools under CM and GM and CO_2 emissions/removals from WDR.	Addressing. The United Kingdom has reported "NE" for carbon stock changes in the litter and deadwood pools under CM and GM and for CO_2 emissions/removals from WDR. The EU provides information on the research and methodological development programme of the United Kingdom that aims to provide full estimates for these activities (NIR, p.893).	The EU has requested information to UK in order to know reporting status of WDR by the UK. During the last LULUCF workshops organized by the JRC, UK provided information on its research and methodological development programme that is ongoing to allow the reporting of carbon stock changes for this KP activity. 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 program and efforts on methodological development.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
KL.13	Transparency	FM – CO_2 (KL.14, 2016) (KL.14, 2015) Transparency	Work with Cyprus and Malta to estimate net CO_2 emissions/removals from FM activities.	Addressing. Cyprus has reported estimates for FM in the 2018 submission. Malta has reported "NE" for all pools except organic soils, where "NO" was used. The EU includes in the NIR (p.888) information on the reasoning for the use of "NE" by Malta (e.g. as a result of discussions with a previous ERT during Malta's in-country review, related to ID# KL.6 in document FCCC/ARR/2015/MLT), but does not include the explanation in table 11.17 of the NIR. The EU also has not provided transparent and verifiable information on the use of "NE" for "not a net source" for Malta, in accordance with decision 2/CMP.8, annex II, paragraph 2(e). Such information should demonstrate that the area is not changing, or that no harvesting or fires occur.	Information for Malta has now been included in table 11.17. and more information on the use of NE by Malta to estimate net CO_2 emissions/removals from FM activities is now included in section 11.3.2. Under request by the JRC, Malta has informed that new information to report and update Forest Management activity has been gathered and will be used to report estimates in this category. For the time being, Malta has also stated that no controlled burning is allowed in those reserved forest, and moreover, no wildfires have occurred in those areas, from which emissions could have been omitted.
KL.14	Transparency	FM – CO_2 (KL.15, 2016) (KL.15, 2015) Transparency	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 EU 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 taking into consideration the changes made in the coverage of the FMRL.	Addressing. The EU has not provided in CRF table 4(KP-I)B.1.1, as appropriate, accurate information on the FMRL inscribed in decision 2/CMP.7, as was recommended by the ERT. It provided this value only in the documentation box to CRF table 4(KP-I)B.1.1 and for information purposes in the NIR (pp.905–906). The value reported in CRF table 4(KP-1)B.1.1 is –315,476.50 kt CO_2 eq, whereas the value inscribed in decision 2/CMP.7 is –306,736 kt CO_2 eq for the EU (27), applying the first-order decay function for HWP, and–154 kt CO_2 eq for Iceland, assuming instantaneous oxidation. The difference between the FMRL provided for the EU in decision 2/CMP.7 and the one reported by the EU should be reflected as a technical correction and described in the NIR. The EU also has not provided the value of the technical correction for the EU as a whole, in accordance with the requirements of decision 2/CMP.8, annex II, paragraph 5(f). The EU has reported a technical correction in the CRF accounting table (16,020.40 kt CO_2 eq). However, this value does not include all member States. For instance, the EU reports that some member States (e.g. the Netherlands and Spain) were not able to implement a technical correction owing to constraints in time and/or resources during this inventory year (NIR, p.906). The EU thus provides the technical corrections for some member States (NIR, table 11.22), while notation keys ("NA", "NO" or "NE") are used for others, but the reasoning for their use is not provided in the NIR.	The EU will provide a technical correction for each of the MS at the latest at the end of this commitment period when the real accounting quantities will be derived. Moreover, the EU considers that it is important to bear in mind that the accounting quantities for the KP activity FM as reported in the CRF table Accounting of the EU GHG inventory depends on the FMRL values and their technical corrections (TC) reported by countries in such CRF table. Thus, in order to ensure the consistency among the EU GHG inventory (i.e. as a sum of individual 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 as reported by current EU MS plus, UK plus Iceland. Doing it in this way, the sum of accounting quantities for FM submitted by individual inventories matches the accounting quantity that is reflected in the EU CRF table 'Accounting" Furthermore, if the difference between the FMRL provided for the EU in decision 2/CMP.7 and the one reported by the EU (which consider the current composition of the Union) is reflected as a technical correction, the sum of the TC of its MS would not match the TC of the EU.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
KL.15	Transparency	FM – CO_2 (KL.16, 2016) (KL.16, 2015) Transparency	Provide transparent information on the background level of emissions associated with natural disturbances included in the FMRL of the EU 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 FM in relation to the treatment of natural disturbances, and to calculate a technical correction where required.	Addressing. The EU has reported information on the background level of emissions and the margin associated with natural disturbances for more member States than in the 2016 submission (e.g. for France and Portugal) (NIR, section 11.4.4 and table 11.21). This demonstrates that the EU has made an effort to improve its reporting in this regard. However, the EU has not provided the background level of emissions associated with natural disturbances of its FMRL. During the review, the EU explained that it is of the view that, while the information provided on the background level at the time of FMRL setting (in accordance with decision 2/CMP.7) may appear to be imprecise, the future final background level determined by the Party, as well as methodological consistency of the value with any technically corrected final FMRL, is what will ensure the accuracy of the final accounting.	The EU has included in section 11.5.2.2 information on the background level of emissions associated with natural disturbances included in the FMRL of the EU and has worked bilaterally with some MS to support the calculation of the technical corrections
KL.18	Completeness	HWP – CO_2 (KL.19, 2016) (KL.19, 2015) Completeness	Work with Belgium to estimate net CO_2 emissions/removals from HWP.	Addressing. Belgium has reported "NO" for net CO_2 emissions and removals from HWP. The EU has provided information on its ongoing work with Belgium under the planned improvements in chapter 11.3.6 of the NIR. During the review, the EU informed the ERT that Belgium intends to report net CO_2 emissions and removals from HWP for the entire time series in the next submission.	Belgium reports in 2020 a complete time series of estimates for carbon stock changes in HWP
KL.19	Accuracy	HWP – CO_2 (KL.20, 2016) (KL.20, 2015) Accuracy	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 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (p.2.119).	Not resolved. The EU has reported quantitative carbon stock changes in HWP for land subject to deforestation for Denmark, Hungary, Latvia and Romania. However, information on how these member States distinguish HWP from regrowth on deforested land and from deforestation events is not included in the NIR.	The EU has requested information of these MS to ensure that HWP from deforestation events are accounted for on the basis of instantaneous oxidation. On this regard, information has been included in Section 11.4.5 which explains how and why these countries reported HWP under deforestation.

Table 10.8 Improvements made in response to UNFCCC review findings as indicated in Tables 4 of the ARR 2018

ID#	Previous recommendation for the issue identified	Number of successive reviews issue not addresseda	Status of Implementation
E.1	Present methodological summaries that are consistent among member States and categories, at least for the key categories 3 (2014–2018)	3 (2014–2018)	Annex III of the EU NIR shows updated methodological information on Member States level.
I.34	Endeavour to provide in the NIR summary overviews of methodologies used to estimate emissions from the consumption of halocarbons and SF6 for key categories based on the relevant methodological descriptions reported in the NIRs of member States	3 (2014–2018)	Overview of methodologies used to estimate emissions from the consumption of halocarbons and SF6 for key categories has been added.
I.35	Make the necessary corrections in the use of the notation keys to ensure the transparency of the reporting (specifically: "NE" reported by Denmark for the amount of gas remaining in products at decommissioning; "NO" reported by Finland for SF6 emissions from aluminium and magnesium foundries; "IE" and "NA" reported by Ireland for AD and emission estimates for HFC emissions from refrigeration and air-conditioning equipment (except mobile air conditioning); "NO" reported by Luxembourg for potential emissions of PFCs from refrigeration and air-conditioning equipment; "NA" and "NA and NO" reported by the Netherlands for AD and IEFs of emissions from stocks in industrial refrigeration and mobile equipment, whereas the emissions are actually estimated; and empty cells in the CRF tables for Spain as a replacement of "NA" and "NE" notation keys for reporting emissions from semiconductor manufacturing)	3 (2014–2018)	SF6 emissions from 2C4 occurred in Finland only in the years 1994 to 2009 and in 2012 but ceased since then. For these years "IE" is reported and emissions are included in 2H3. For all other years "NO" is reported as Mg die casting did not occur and therefore no emissions occurred.
A.12	Work with member States to ensure more consistent reporting of the area of organic soils between the agriculture and LULUCF sectors	3 (2014–2018)	Check done during the initial ESD review 2020.
L.1	Continue efforts to improve the completeness of the reporting of emissions from all mandatory source categories in the LULUCF sector	5 (2012–2018)	The EU has continued to improve the completeness of the LULUCF sector in order to provide emissions from all the mandatory source categories. Specific information on this regard is provided in section 6.1.3 of the EU NIR where we have reflected the improvements implemented on completeness at country level. Among others improvements, Belgium reports now carbon stock changes from HWP for the whole time series (addressing ID# L.10), and the use of NE by France in land converted to Cropland has been now explained in the EU NIR in the relevant section (addressing ID# L.1).

ID#	Previous recommendation for the issue identified	Number of successive reviews issue not addresseda	Status of Implementation
L.2	Work with member States with a view to reporting mandatory pools and categories that are currently not estimated in order to increase the completeness of the inventory	5 (2012–2018)	The EU has worked with MS with a view to reporting mandatory pools and categories that were not estimated. This has resulted in a more complete inventory submitted in 2020. A description of the resulting improvements on completeness has been included in section 6.1.3.
L.7	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	4 (2013–2018)	The EU has improved the transparency of the reporting with the inclusion of updated information from MS and on its internal QA/QC checks with the aim of ensuring that the aggregated reporting is complete and consistent. Among others examples, section 6.4.2 has been reformulated in order to better describe the specific QA/QC checks implemented in the LULUCF sector. And section 6.2.4.3 now includes updated information from MS on how the category other lands is defined by MS.
L.10	Work with the member States to improve the completeness of their reporting and use higher-tier methods in order to enhance accuracy	5 (2012–2018)	The EU has worked with MS to improve the completeness of the reporting and towards the use of higher tier methods. Among others an annual LULUCF workshop is held every year in order to support MS on addressing specific issues on the LULUCF reporting and to discuss the use of higher tier methods. This, along with huge efforts implemented at country level, has resulted in a more widespread use of higher tier methods nowadays and the associated improvement on completeness. See section 6.1.3.

Table 10.9 Improvements made in response to UNFCCC review findings as indicated in Table 5 of the ARR 2018

Sector	TACCC	Category	Recommendation	Status of Implementation

Sector	TACCC	Category	Recommendation	Status of Implementation
G.6	Adherence to the UNFCCC Annex I inventory reporting guidelines	Key category analysis	The ERT noted discrepancies in the total figures used for the calculation of the key categories and the totals reported in the CRF tables. In the Excel file of the key category analysis provided by the EU during the review, for instance, the value reported for total emissions for 1990, excluding LULUCF and indirect CO_2 emissions, used in the key category analysis is 5,653,399.40 CO_2 eq, whereas the value reported in the CRF table Summary2 is 5,652,249.73 CO_2 eq. Discrepancies were also observed in the total emissions (excluding indirect CO_2 emissions) reported for 2016, which are 4,295,862.27 CO_2 eq in the key category analysis and 4,298,569.36 CO_2 eq in CRF table Summary2 excluding LULUCF, and 4,003,573.43 CO_2 eq in the key category analysis and 4,007,313.10 CO_2 eq in CRF table Summary 2 including LULUCF. There is no transparent reason given for these differences. A note under the table reporting the key category analysis results (NIR, table 1.12) explains that the totals may not include data for Sweden owing to confidentiality concerns. During the review, the EU explained that data from all member States, including Sweden, are considered in the analysis. Nevertheless, the ERT found that the overall figures used for the key category analysis and those reported in the corresponding CRF tables do not match. The ERT recommends that the EU conduct QA/QC checks on the database used for the calculation of key categories, and ensure that all key category analyses are carried out using the same set of data. The ERT also recommends that the EU include in the NIR transparent information on the use of confidential data, including from which key category analysis such data have been excluded.	We can ensure that all key category analysis are carried out using the same set of data. Information on the reporting of confidential data is given in the EU NIR in section 1.7.2.
G.7	Adherence to the UNFCCC Annex I inventory reporting guidelines	Uncertainty analysis	The tier 1 uncertainty analysis of the EU is performed on the basis of the information on uncertainties and corresponding emissions provided by member States. Because not all member States report their emissions and uncertainties at the category level owing to confidentiality concerns, the emission estimates do not match those reported in the CRF tables, neither by sector nor in total. This situation is clearly explained in the NIR (section 1.6). However, for consistency and to ensure completeness and accuracy, the uncertainty analysis should be carried out on the same data as those reported in the CRF tables. The ERT recommends that the EU attribute the uncertainty values and category groupings derived from its analyses of data reported by member States to the same level of emissions reported at the category level in the CRF tables.	Given the limitations which even the ERT mentions in the finding (i.e. confidential sector estimates) implementing a full solution will likely be impossible. Merging the final reported emissions from the CRF Tables with the uncertainty estimates at different sector resolutions will require substantial programming effort. Nonetheless, we will explore options with which we can best address the issue and update procedures for the next submission.
G.8	Transparency	Methods	The ERT welcomed the annex on methodologies (annex III to the NIR). During the review, the ERT found that the sectoral Excel files in the annex had not been updated with the latest information available at the member State level (e.g. for categories 2.A.2 and 5.A). In response, the EU provided the ERT with an updated version of annex III. The ERT recommends that the EU ensure that annex III to the NIR, which includes summaries of the descriptions of the methodologies used by member States for the estimation of EU key categories, reflects the latest submissions of member States and is coherent with the information in the NIR and CRF tables.	The Annex III is updated by Member States every year according to a schedule. The Annex is sent out in Autumn each year and should be updated if changes occur in the methodolgies used from MS by 15 January the following year and if necessary again during the initail check phase between 15. January and 31 March.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.13	Transparency	1.A.1.a Public electricity and heat production – peat – CO_2	The ERT noted that CO_2 emissions from peat consumption in public electricity and heat production show some relatively large inter-annual fluctuations; for example, a 13.3 per cent decline between 2003 (13,403.65 kt CO_2) and 2004 (11,618.63 kt CO_2), and a 16.1 per cent increase between 2009 (10,865.03 kt CO_2) and 2010 (12,615 kt CO_2). During the review, the EU explained that the trend is dominated by Finland's emissions and that there might be several reasons for the fluctuations, such as price competition with other fuels (some of the peat plants also use wood biomass or natural gas) or environmental issues related to peat collection. The ERT recommends that the EU include in the NIR clear reasons for the inter-annual fluctuation in CO_2 emissions from peat consumption in public electricity and heat production.	The following was added in paragraph 1.A.1.a Electricity and Heat Production - Peat (CO_2) of the NIR: "Several parameters such as weather conditions greatly influence the peat consumption: in Finland, peat represents 5% of electricity production and is the third most important energy source in district heat production. In 2018, the growth in peat use was affected by the exceptional weather conditions during the heating season at the start of the year and the resulting growth in demand."
E.14	Transparency	1.A.1.a Public electricity and heat production – other fossil fuels – CO_2	The ERT noted that other fossil fuels are not included in figure 3.6 of the NIR, which presents the emission trends and AD for public electricity and heat production. During the review, the EU provided the ERT with a revised figure 3.6 that includes the emission trends and AD for other fossil fuels. The ERT recommends that the EU include in the NIR an updated version of figure 3.6 that includes the emission trends and AD for other fossil fuels.	Other fossil fuels has been included in Figure 3.6 of the NIR.
E.15	Transparency	1.A.1.a Public electricity and heat production – liquid, solid and gaseous fuels –CO_2, CH_4 and N_2O	Under NIR tables 3.7, 3.8 and 3.9 for liquid fuels, solid fuels and gaseous fuels, respectively, there is a note stating that the total figures do not include data from Sweden owing to confidentiality concerns. This explains why the data reported in these tables do not match those reported in the CRF tables. The ERT noted that the total figures for 2015, for which emissions from Sweden are reported as "C", are the same values as those in CRF table 1.A(a) (e.g. 803,105.58 kt CO_2 for solid fuels), but the total figures for 2016, for which emissions from Sweden are reported in the tables, are different from those in CRF table 1.A(a) (e.g. for solid fuels, the value reported in NIR table 3.8 is 713,314 kt CO_2, whereas the value reported in CRF table 1.A(a) is 715,805.59 kt CO_2). During the review, the EU explained that the confidential emission data from Sweden for 2015 for liquid, solid and gaseous fuels consumed in public electricity and heat production (1.A.1.a) and all fuels consumed in petroleum refining (1.A.1.b) and manufacture of solid fuels and other energy industries (1.A.1.c) are included under other fossil fuels in subcategory 1.A.1.a. Owing to the inclusion of confidential data from Sweden, the value in CRF table 1.A(a)s1 for other fossil fuels for 2015 (43,485.64 kt CO_2) is higher than the value in NIR table 3.10 (37,621 kt CO_2). The ERT recommends that the EU clarify whether confidential emission data from Sweden have been included in NIR tables 3.7–3.10.	There is no more confidential issues of energy consumption concerning Sweden.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.16	Transparency	1.A.1.a Public electricity and heat production – other fossil fuels – CO_2, CH_4 and N_2O	According to the NIR (p.127), other fossil fuels covers mainly the fossil fuel component of MSW incineration, including plastics, where there is energy recovery. During the review, in response to a question from the ERT about additional types of fuel, the EU clarified that incinerated waste may include hazardous waste, bulky waste and waste sludge. The ERT recommends that the EU include in the NIR all types of fuel consumed in MSW incineration, including hazardous waste, bulky waste and waste sludge.	Explanation was added in paragraph "1.A.1.a Electricity and Heat Production - Other Fuels (CO_2)" of the NIR.
E.17	Transparency	1.A.1.c Manufacture of solid fuels and other energy industries – solid fuels – CO_2	The EU states in the notes under NIR tables 3.16 and 3.17 that the figures in those tables do not include confidential emission data from Sweden. The ERT noted that the total emissions for 2016 reported in NIR table 3.17 (manufacture of solid fuels and other energy industries – solid fuels (1.A.1.c)) (31,227 kt CO_2 eq), in which the emissions from Sweden are reported, are different from the total emissions reported in CRF table 1.A(a) (31,802.82 kt CO_2 eq). However, for 2015, NIR table 3.16 (manufacture of solid fuels and other energy industries – all fuels (1.A.1.c)) has the same value for total emissions as CRF table 1.A(a) (53,610.55 kt CO_2), although the same note appears under both NIR tables 3.16 and 3.17. During the review, the EU explained that Sweden frequently uses the notation key "C" for 2015 in subcategories of energy industries (1.A.1). The EU noted that confidential emission data from Sweden for 2015 for liquid, solid and gaseous fuels consumed in public electricity and heat production (1.A.1.a) and all fuels consumed in petroleum refining (1.A.1.b) and manufacture of solid fuels and other energy industries (1.A.1.c) are included under other fossil fuels in subcategory 1.A.1.a. The ERT recommends that the EU remove from the NIR the note under table 3.16 referring to confidential emission data from Sweden being excluded from the table.	There is no more confidential issues of energy consumption concerning Sweden.
E.18	Transparency	1.A.1.c Manufacture of solid fuels and other energy industries – biomass – CO_2	The ERT noted significant inter-annual fluctuations in the consumption of biomass, in particular between 2012 (20,344.54 TJ) and 2013 (37,625.43 TJ) an increase of 84.9 per cent. During the review, the EU informed the ERT that the main cause for this trend is the data from Germany, which reported emissions from biomass of about 1.1 Mt for 2012 and about 2.7 Mt CO_2 for 2013 and an increase in AD from 8 PJ in 2012 to 25.6 PJ in 2013. The EU also explained that the energy balance of Germany indicates that its biomass mainly consists of biogas that is used in gasification plants. The ERT recommends that the EU include in the NIR information on the types of biomass consumed and any particular impact they have on the overall trend.	This issue is still under investigation.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.19	Transparency	1.A.2.a Iron and steel – liquid fuels – CO_2	The ERT noted that the CO_2 IEFs for liquid fuels reported for 2008–2012, which range from 76.21 to 78.71 t CO_2/TJ, are higher than those reported for 1990–2007, which ranged from 73.46 to 76.50 t CO_2/TJ. The ERT noted increases between 2007 (73.46 t CO_2/TJ) and 2008 (76.58 t CO_2/TJ), and between 2015 (70.51 t CO_2/TJ) and 2016 (124.54 t CO_2/TJ), the latter constituting an increase of 76.6 per cent. During the review, the EU explained that the large increase between 2015 and 2016 is due to the confidential data of Sweden – emissions were reported under this category but AD were aggregated elsewhere, increasing the CO_2 IEF given in the NIR. The EU further explained that the high CO_2 IEF reported for 2008–2012 is mainly due to the contribution of Spain's CO_2 emissions to the EU total (up to 36 per cent, in 2010) and its high CO_2 IEF (ranging from 92.4 to 96.1 t CO_2/TJ) for those years, which is attributable to the consumption of petroleum coke in those years (from a low of 8 PJ to a high of 12 PJ, in 2010). Petroleum coke has a much higher carbon content (97.5 t CO_2/TJ) than the usual liquid fuels reported under this category. In contrast, from 2005 to 2007 and 2013 to 2016, Spain's CO_2 IEF ranged from 74.1 to 75.6 t CO_2/TJ and its contribution of CO_2 emissions to the EU total was only 7–12 per cent. The ERT recommends that the EU include in the NIR the reasons for the high CO_2 IEF for liquid fuels for 2008– 2012 and for the large increase in the IEF observed between 2015 and 2016.	Explanation implemented in the paragraph '1.A.2.a Iron and Steel - Liquid Fuels (CO_2)' in the chapter 3.2.2.1 of the NIR.
E.20	Transparency	1.A.2.a Iron and steel – solid fuels – CO_2	The ERT noted that the CO_2 IEF for solid fuels increased from 120.06 t CO_2/TJ in 2011 to 130.50 t CO_2/TJ in 2016. During the review, the EU explained that the reason for the increasing CO_2 IEF is the high variability in member State IEFs and iron production (and consequent CO_2 emission) trends. The main reason for the increase in the CO_2 IEF from 2012 (121.16 t CO_2/TJ) to 2013 (128.55 t CO_2/TJ) is Italy's decrease in CO_2 emissions. For these years, the share of Germany's CO_2 emissions in the EU total increased from 27 to 29 per cent, and Germany's CO_2 IEF was one of the highest reported, increasing from 155.17 t CO_2/TJ in 2012 to 158.47 t CO_2/TJ in 2013. The ERT recommends that the EU include in the NIR an explanation for the trend in the CO_2 IEF for solid fuels, particularly for 2011 onward.	Explanation implemented in the paragraph '1.A.2.a Iron and Steel - Solid Fuels (CO_2)' in the chapter 3.2.2.1 of the NIR.
E.22	Transparency	1.A.2.f Non- metallic minerals – liquid fuels – CO_2	The footnote below NIR table 3.45 states: "EU trends in this table do not include Sweden for confidentiality reasons and to preserve time-series consistency for the EU. The EU explains the differences between the numbers in this table and the CRF". According to the EU (see ID# E.15 above), confidential data from Sweden have been included in other fossil fuels in the subcategory public electricity and heat production (1.A.1.a). Sweden states in its NIR 2018 (p.70) that "several data sources that are used for producing emissions estimates for the inventory are confidential at a micro level (e.g. company or plant level)". The ERT recommends that the EU include in the NIR the reason for the emissions from liquid fuels in Sweden being reported as confidential and how time-series consistency at the EU level has been preserved.	Explanation of the reason for the emissions from liquid fuels in Sweden being reported as confidential implemented in the paragraph '1.A.2.f Non-metallic Minerals - Liquid Fuels (CO_2)' in the chapter 3.2.2.6 of the NIR.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.23	Transparency	1.A.2.f Non- metallic minerals – other fossil fuels – CO_2	The ERT noted that Poland reported a CO_2 IEF of 126.50 t CO_2/TJ in 2016, which is within the IPCC default values for industrial waste. However, the CO_2 IEFs of the other member States (NIR, figure 3.75) are lower than the IPCC default values (110–183 t t CO_2/TJ). During the review, the EU explained that the member States included CO_2 emissions from cement kilns, whose operators have had to report under the EU ETS since 2005. The lower end of the IPCC default EF range (110 t CO_2/TJ) is much higher than the typical values for the waste fractions of waste oil, waste tyres and plastics incinerated in cement kilns, which are typically around 80 t fossil CO_2/TJ fossil energy (according to EU ETS data from Austria). The ERT recommends that the EU include in the NIR information on the main components incinerated in cement kilns by member States to support the low CO_2 IEFs reported for other fossil fuels.	Information on the main components incinerated in cement kilns included in the paragraph '1.A.2.f Non-metallic Minerals – Other Fossil Fuels (CO_2)' in the chapter 3.2.2.6 of the NIR. 'Sweden reports emissions as ‘C’ (confidential) since 2016 in order to comply with the Public Access to Information and Secrecy Act of the Swedish law. This decision was made based on the results of the internal review.'
E.24	Transparency	1.A.2.g Other (manufacturing industries and construction) – liquid fuels – CO_2, CH_4 and N_2O	Member States have variously reported emissions from liquid fuels for off-road vehicles in the subcategories other (manufacturing industries and construction) (1.A.2.g), other transportation (1.A.3.e) or off-road vehicles and other machinery (1.A.4.c ii). The ERT noted that Greece, Ireland, Portugal and Slovakia have reported these emissions as “IE”, while Cyprus, Czechia, Estonia, France, Italy, Malta, Poland, Romania and Spain have left the relevant table cells blank (NIR, table 3.49). During the review, the EU provided detailed information on off-road machinery for the member States for which the relevant NIR table 3.49 cells are blank. The ERT recommends that the EU include in NIR table 3.49 a note explaining why cells for CO_2, CH_4 and N_2O emissions from liquid fuels for off-road vehicles are left blank (i.e. for Cyprus, Czechia, Estonia, France, Italy, Malta, Poland, Romania and Spain).	In the table 3.49 in the NIR, "IE" is reported only by Greece emissions are included in 1.A.2.f), other mentioned Member States reported emissions in this category. Therefore explanation on blank cells are no longer needed.
E.25	Transparency	1.A.4.b Residential – biomass – CH_4	The ERT noted that the CH_4 IEF for biomass in this subcategory decreased from 335.26 kg CH_4/TJ in 1990 to 232.50 kg CH_4/TJ in 2016, a decrease of 30.7 per cent. The ERT further noted that, according to the NIR, boilers and stoves have been replaced by modern technologies (p.317). During the review, the EU explained that it has not yet gathered information from member States on the biomass combustion technologies considered in their inventories. However, modern boilers are mostly automated, allowing their continuous operation and thus avoiding the high emissions of carbon monoxide, volatile organic compounds and particulate matter generated from incomplete combustion during the ignition and cooling phases of their operation (in contrast, for example, to wood stoves). It is generally assumed that lower carbon monoxide and volatile organic compound emissions correlate with lower CH_4 emissions, which arise mainly due to incomplete combustion in manually operated boilers and stoves and as a result of low fuel quality (e.g. high water content of fuelwood). The ERT recommends that the EU include in the NIR information on the characteristics of modern biomass boilers and stoves, which would explain the decrease in the CH_4 IEF for biomass in this subcategory for the period 1990– 2016.	Explanation of the boilers added in the NIR in 1.A.4.b Residential – Biomass (CH_4). Modern boilers are mostly automated, allowing their continuous operation and thus avoiding the high emissions of carbon monoxide, volatile organic compounds and particulate matter generated from incomplete combustion during the ignition and cooling phases of their operation (in contrast, for example, to wood stoves). It is generally assumed that lower carbon monoxide and volatile organic compound emissions correlate with lower CH_4 emissions, which arise mainly due to incomplete combustion in manually operated boilers and stoves and as a result of low fuel quality (e.g. high water content of fuelwood). The stoves have to fulfil the European standard 303-5:2013, plus eventually are also certified based in the EU Regulation No. 2015/1189.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.26	Accuracy	1.A.5.a Stationary – solid fuels – CO_2, CH_4 and N_2O	In CRF table 1.A(a)s4 and in the NIR (p.333) the EU reports "IE" for Poland's emissions for this subcategory. The ERT noted that there is no explanation, either in the NIR or in CRF table 9, as to where these emissions are reported. During the review, the EU explained that it could not find any explanation in the CRF tables or the NIR of Poland's submission as to where these emissions are included, and indicated that it will include this information in the next NIR. The ERT recommends that the EU ensure that Poland's CO_2, CH_4 and N_2O emissions for this category are included in the EU inventory, and that it include in the NIR a description of where these emissions are included.	Polands' NIR does not contain any information on sector 1.A.5. The Polish CRF tables show the notation keys NO and IE. The latest review report from Poland does not reflect any issues with the reporting of 1.A.5. The EU can follow up on this issue with Poland, with the aim of improving the transparency of reporting, even though it has not been raised by the UNFCCC review of Poland. However, we think that this is a very specific issue and we refer the ERT to the conclusions from the 2019 lead reviewers meeting on the approach to the reviews of the EU.
E.27	Transparency	1.B.1.a Coal mining and handling – solid fuels – CH_4	The ERT noted that CH_4 emissions from underground coal mining decreased between 1990 (3,526.48 kt CH_4) and 1993 (3031.76 kt CH_4) by 14.0 per cent. In the same period, the CH_4 IEF exhibited a steep increase (287.0 per cent): from 2.54 kg/t in 1990 to 9.84 kg/t in 1993. According to the NIR, the increase in the CH_4 IEF was due to a strong decrease in CH_4 emissions in Belgium, which was responsible for 73 per cent of CH_4 emissions in 1990 (p.353). The ERT found that, according to figure 3.158 of the NIR, Belgium was responsible for less than 73 per cent of EU CH_4 emissions in 1990. During the review, the Party clarified that Belgium was responsible for 73 per cent of the AD for the EU in 1990, but only 0.44 per cent of its CH_4 emissions. In response to the question from the ERT, the EU contacted Belgium regarding the low CH_4 IEF. Belgium clarified that the AD in CRF table 1.B.1 of the EU submission were erroneously reported in kt instead of Mt; therefore, the AD need to be corrected by a factor of 1,000 (e.g. for 1990 the correct AD are 1.036 Mt, not 1,036 Mt). The EU indicated that corrected values will be reported in the next submission and that the explanation on page 353 of the NIR will also be corrected. The ERT recommends that the EU work with Belgium to ensure the correct reporting of AD for underground coal mining in CRF table 1.B.1, and that it correct the explanation of the trend for this subcategory in the NIR (i.e. that Belgium was responsible for 73 per cent of AD, not CH_4 emissions, in 1990).	Belgium provided corrected AD for underground mining. The EU trend was corrected and the corresponding text in the NIR was updated.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.28	Transparency	1.C CO_2 transport and storage gaseous fuels – CO_2, CH_4 and N_2O	The EU reports an amount of 133.85 kt CO_2 captured for storage in 2016. The ERT noted, however, that the transport of CO_2 is reported as “NO” and injection and storage of CO_2 are reported as “IE, NO”. During the review, the EU explained that only Finland reported the amount of CO_2 captured and that France reported fugitive emissions from CCS as “IE”. The ERT noted that fugitive emissions from CCS are reported by the EU as “NO”, although Finland reported captured CO_2. The EU explained that Finland reported fugitive emissions from CCS as “NA” in its submission, but, owing to an error in the software used by the EU to aggregate member State data, the correct notation key has not been reported in CRF table 1.C. The EU indicated that “NA” will be used in the next submission, but that the total amount of CO_2 captured (e.g. 133.85 kt in 2016) is less than 0.05 per cent of the EU’s national total, and therefore any fugitive emissions from CCS must be less than the threshold of significance. The ERT recommends that the EU use in CRF table 1.C the notation key for fugitive emissions from CCS reported by Finland (i.e. “NA”) and explain in the NIR why its use is appropriate.	The correct notation key is included in the EU CRF Table 1.C.
I.38	Transparency	2. General (IPPU) – CO_2	The EU described the gap-filling procedure for AD for the categories lime production (2.A.2), glass production (2.A.3) and ammonia production (2.B.1) (NIR, p.521). The procedure includes three steps: (1) aggregation of the emissions of those member States using the same type of AD; (2) calculation by the EU of the IEF for the member States included in step 1; and (3) multiplication of the IEF by the emissions of the 28 member States in order to derive a gap-filled estimate for AD for the EU. The ERT assumes that multiplying the IEF by emissions is an error, and that instead, in step 3 of the procedure, the EU should estimate its AD by dividing the total CO_2 emissions by the IEF estimated in step 2.	The error was corrected in chapter 4.3.1, as recommended by the ERT.

Sector	TACCC	Category	Recommendation	Status of Implementation
I.39	Transparency	2.B.1 Ammonia production – CO_2	The EU has reported the total AD (17,216 kt ammonia) and the estimated CO_2 emissions (23,935 kt CO_2) for ammonia production in NIR table 4.15. The CO_2 IEF (1.39 t CO_2/t ammonia) is calculated as the ratio of CO_2 emissions to AD. The EU describes the AD gap-filling procedure for this category (NIR, p.521). The ERT noted that Germany and France, which contribute significantly (22.4 per cent combined) to the total CO_2 emissions reported by the EU under this category, report CO_2 emissions from ammonia production in both the energy and the IPPU sector (NIR, p.450). In its estimation of the CO_2 IEF, however, the EU includes only CO_2 emissions reported under ammonia production. Not including CO_2 emissions reported in the energy sector by Germany and France results in a lower IEF, affecting comparability with other reporting Parties and also affecting the results of the estimation of AD by the gap-filling procedure. During the review, the EU informed the ERT that it was not possible to obtain detailed data from the published national energy balances of France and Germany to estimate CO_2 emissions from ammonia production reported in the energy sector, and that the EU could not change member States' reported estimates. The EU noted that EU ETS verified CO_2 emissions from ammonia production for 2016 (21,167 kt) are reasonably close to, but less than, the amount in the EU's GHG inventory (23,935 kt). The ERT acknowledged the EU's clarifications. In response to a draft version of the ARR, the EU stated that it will include a table in the NIR that includes the ammonia production combustion-related EU ETS emission values for France and Germany rather than only the process-related emissions reported for ammonia production. The ERT recommends that the EU improve the comparability of its CO_2 IEF estimates with those of other Parties by including in the NIR a table that includes the combustion-related EU ETS emission values for France and Germany rather than only the process-related emissions reported for ammonia production. The ERT notes that a similar table for iron and steel production (table 4.34) is already included in the EU NIR.	In chapter 4.2.2.1 of the NIR, a table, including discussion, was included, as recommended by the ERT.

Sector	TACCC	Category	Recommendation	Status of Implementation
I.40	Transparency	2.F.1 Refrigeration and air conditioning – HFCs and PFCs	In CRF table 2(II)B-Hs2, the EU has reported emissions from an unspecified mix of HFCs and PFCs for the subcategories commercial refrigeration (2.F.1.a) and industrial refrigeration (2.F.1.c). For 2016, the reported product manufacturing factor is 594 per cent and the product life factor is 99,000 per cent. According to information provided in table 7.9 of the 2006 IPCC Guidelines, the potential release of F-gases should not exceed 100 per cent. During the review, the ERT requested clarification from the EU on the reported EFs. The EU informed the ERT that in its technical opinion, for commercial refrigeration, the product life factor of a particular system can exceed 100 per cent if leakage occurs, no repairs are performed and the refrigerant is refilled several times per year. Product life factors of several hundred per cent have been observed for developing countries and ships, where low-quality servicing is available and refilling keeps refrigeration systems running. Furthermore, a system within the EU that is subject to total refrigerant loss (e.g. because of an accident) but which is refilled and begins leaking again would have an operational EF of more than 100 per cent in a given year. The EU acknowledged, however, that it is unlikely that such high operational EFs would relate to the entire stock of a country. Further, the EU explained that “unspecified mix of HFCs and PFCs” and “unspecified mix of HFCs” are reported for refrigeration and air conditioning (2.F.1) by several member States. A high amount of “unspecified mix of HFCs” in operating systems is, for example, reported by Denmark. A possible explanation for the high EFs reported is that some member States report “unspecified mix of HFCs and PFCs” from disposal in manufacturing or operating stocks because the refrigerants are not separated during end-of-life treatment and hence disposal emissions cannot be reported by substance. In some cases, “unspecified mix of HFCs” and “unspecified mix of HFCs and PFCs” are reported in a particular subcategory for confidentiality reasons. The EU indicated that it would need to follow up with member States to obtain more information on these matters and possibly the data on both “unspecified mix of HFCs” and “unspecified mix of HFCs and PFCs” in order to further analyse the F-gases reported. While the ERT recognizes that some types of equipment can be filled more than once a year, it notes that, to reach a 99,000 per cent product life factor the equipment would need to be refilled more than twice a day, which is not a realistic scenario, especially for large commercial and industrial applications. The ERT considers that if equipment is filled more than once a year, it should be reflected in increased AD, such as the amount of HFCs and PFCs used in operating stock, and not in the product life EF. The ERT recommends that the EU further analyse the F-gases reported as “unspecified mix of HFCs and PFCs” for commercial and industrial refrigeration applications, focusing on the practices related to refilling, and reflecting these refilling practices in the AD and not in the EFs (i.e. if equipment is filled more than once a year, it should be reflected in increased AD, such as the amount of HFCs and PFCs used in operating stock, and not in the product life EF).	This issue is followed up in the second step of the ESD review 2020. See more infromation about this process in section 1.2.3.1 of the EU NIR.

Sector	TACCC	Category	Recommendation	Status of Implementation
I.41	Transparency	2.F.1 Refrigeration and air conditioning – HFCs	The EU reported HFC-134a emissions from disposal in the subcategory mobile air conditioning (2.F.1.e) in CRF table 2(II)B-Hs2. The ERT noted that in 1995 the disposal loss factor was 100 per cent. This value is high compared with the values for 1996–2016, which range from 36.3 per cent (1997) to 51.1 per cent (2008). During the review, in response to the request of the ERT for more information on the 1995 disposal loss factor, the EU provided information showing that HFC-134a was introduced in the early 1990s, and 1995 was the first year in which it was used on a large scale for mobile air conditioning in passenger cars. The reported (very small) disposal emissions in 1995 relate to particularities of the inventories of France and Latvia: both of these member States run models of the vehicle stock that assume end of life of a certain share of vehicles each year, in line with a Gaussian normal distribution. Thus, some cars reached their end of life in the first year of widespread use of HFC-134a in mobile air conditioning. Because at that time no measures were in place in these countries to recover the refrigerant during end-of-life treatment, a disposal loss factor of 100 per cent was applied. The ERT considers realistic the assumption that not every car reaches an average lifespan and that some are disposed of earlier (e.g. owing to damage in an accident). The ERT also considers acceptable the assumption that in the first year when disposal emissions occurred there was no recovery of emissions. The ERT recommends that the EU include information in the NIR to explain the rationale for its reporting of a 100 per cent disposal loss factor in 1995 for the subcategory mobile air conditioning (2.F.1.e).	An explanation has been added in the EU NIR in section 4.2.5 under 2F1e.
I.44	Comparability	2.F.4 Aerosols – HFCs	The EU reported that HFC emissions from aerosols (2.F.4) (which mainly concerns the use of metered-dose inhalers) occur in all member States except the Netherlands (i.e. the Netherlands reported the emissions as "NO") (NIR, table 4.44). Taking into account the EU open market, the ERT would expect some emissions to occur in the Netherlands. During the review, the ERT requested clarification as to whether the reporting of "NO" by the Netherlands had been verified by the EU. In response, the EU informed the ERT that emissions from aerosols do occur in all member States and the Dutch NIR states (p.163) that emissions from this category (2.F.4) are included in the category other applications (2.F.6). The EU acknowledged that use of the notation key "NO" for the Netherlands was an error and "IE" should be used. The ERT recommends that the EU use the correct notation key to report HFC emissions from aerosols for the Netherlands in NIR table 4.44 and CRF table2(II)B-Hs2, that is to use "IE" rather than "NO", and include information in the NIR as to where these emissions have been allocated.	Notation key has not been corrected in the EU NIR, a note has been added that the Netherlands report HFC emissions from 2.F.4 in 2.F.6.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.14	Adherence to the UNFCCC Annex I inventory reporting guidelines	3. General (agriculture) – CO_2	The previous ERT (which conducted the review of the 2015 and 2016 submissions) noted that the EU used the notation key "IE" to report indirect CO_2 emissions from the agriculture sector in CRF table 6 for Slovakia. As the previous ERT did not find any indication in the NIR of Slovakia that indirect CO_2 emissions had been estimated, it concluded that the correct notation key for reporting indirect CO_2 emissions from the agriculture sector would be "NE" (see ID# A.2 in table 3). During the current review, the EU indicated that Slovakia had explained that indirect CO_2 emissions are reported in the documentation box of its CRF table 3s2, so the EU could report this as a resolved issue in its next submission. The ERT noted, however, that indirect CO_2 emissions are reported by Slovakia in CRF table 3s2 and CRF table 3.G-I, and that the information in the documentation box of CRF table 3s2 is not linked to the issue. The ERT recommends that the EU work with Slovakia to clarify where indirect CO_2 emissions from the agriculture sector are reported and to ensure those emissions are included in the EU NIR.	Notation key provided for indirect emissions in agriculture of Slovakia, reported in the Table 6, were corrected to "NE".

Sector	TACCC	Category	Recommendation	Status of Implementation
A.15	Transparency	3.A.1 Cattle – CH_4	The CH_4 IEF reported by the EU for dairy cattle in 2015 (128.82 kg CH_4/head/year) and 2016 (129.22 kg CH_4/head/year) is higher than the IPCC default value (99 kg CH_4/head/year for Eastern Europe, 117 kg CH_4/head/year for Western Europe and 128 kg CH_4/head/year for North America). The comparatively high average appears to be driven by several member States. During the review, the EU confirmed that the high average CH_4 IEF for dairy cattle is driven by several member States but mostly by Denmark and Sweden. These countries use a national methodology for estimating the IEF that assumes the cattle are fed sugar beet and employs the gross energy feed per unit estimated by the Danish Centre for Food and Agriculture (the Danish Normative System). Use of this method leads to a very high milk yield (26 l/day in Denmark and similar in Sweden) and accordingly a high CH_4 IEF. The ERT noted that the contributions of Denmark and Sweden to the EU dairy cattle population and CH_4 emissions are too low to drive the average CH_4 IEF for dairy cattle of the EU – the cattle population of Denmark comprises 2.4 per cent of the EU cattle population, and Denmark's CH_4 emissions represent just 2.9 per cent of the EU total for 2016, while Sweden is not among the 10 countries with the highest population of cattle or CH_4 emissions. In response to a question from the ERT on how the EU determines that these two countries drive the high average CH_4 IEF for dairy cattle, the EU explained that all member States report a higher IEF than the default value for Eastern European countries and 15 member States report a higher IEF than the default value for Western European countries. The CH_4 IEF of the EU is influenced most by those countries with a high cattle population, and those with the highest deviation from the average IEF. Germany, Italy and the Netherlands have a great influence as they have high CH_4 IEFs and shares of CH_4 emissions of 18.9, 8.6 and 7.4 per cent, respectively. The highest IEFs are reported by Denmark (156 kg CH_4/head/year) and Finland (151 kg CH_4/head/year) and they contribute shares of 2.9 and 1.4 per cent, respectively, to the total EU CH_4 emissions. As requested, the EU provided the ERT with the member States' contributions to the EU dairy cattle population andCH_4 emissions and their CH_4 IEFs. On the basis of the clarifications and the documentation provided, the ERT acknowledges that the high average CH_4 IEF for dairy cattle is driven by several member States, but disagrees that Denmark and Sweden are the predominant drivers. The ERT recommends that the EU consider the share of each member State's contribution to the EU's total dairy cattle population and the CH_4 IEF of each member State to determine the factors driving the average CH_4 IEF for dairy cattle of the EU, and report on those factors in the NIR.	Explanation on IEFs for dairy cattle among the EU MSs is provided in the EU NIR, Table 5.8, Figure 5.1.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.16	Transparency	3.A.1 Cattle – CH_4	In NIR table 5.5 the EU reports that Iceland used a tier 2 method to estimate CH_4 emissions from cattle but did not provide any information on the EF (see ID# A.3 in table 3). During the review, the EU explained that Iceland used livestock population characterization to calculate GE of cattle (Iceland NIR 2018, pp.102–103). The values for GE were used to calculate the CH_4 EFs for enteric fermentation (using equation 10.21 from the IPCC good practice guidance). The CH_4 conversion rate depends on several interacting feed and animal factors. The ERT concluded that Iceland used a country-specific CH_4 EF for cattle, but this information is missing from Iceland's NIR and CRF tables. See ID# A.3 in table 3 for the outstanding recommendation from the previous review report on this issue.	Information on Iceland IEFs, methodological tiers and emissions from cattle, sheep and swine was included in appropriate tables of the EU NIR 2020. Please see Chapter 5.3.1.
A.17	Transparency	3.A.2 Sheep – CH_4	In NIR table 5.6 the EU reports that Denmark used a tier 2 method to estimate CH_4 emissions from sheep with default EFs. The ERT noted that the use of a tier 2 method suggests the use of a country-specific EF. During the review, in response to a question from the ERT on how Denmark used a tier 2 method with a default EF, the EU explained that Denmark used a tier 2/country-specific method for enteric fermentation, which is different from the IPCC tier 2 method in the calculation of GE (Denmark NIR 2018, pp.367–370). GE is estimated as gross energy per feed unit. The feed unit is based on the composition of feed intake and the energy content in proteins, fats and carbohydrates, and the actual efficacy of feeding controls or actual feeding plans at the farm level, data on which are collected by the Danish Agricultural Advisory Service or the Danish Centre for Food and Agriculture. For horses, heifers, suckling cattle, sheep and goats, an average winter feed plan is provided on the basis of information from the Danish Centre for Food and Agriculture and SEGES, on which the calculation of GE is based. The ERT concluded that Denmark used a country-specific EF to estimate CH_4 emissions from sheep and not a default EF. The ERT recommends that the EU report accurately in the NIR the method and CH_4 EF used by Denmark to estimate CH_4 emissions from sheep.	Please see Table 5.6 of the EU NIR.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.18	Transparency	3.B Manure management – N_2O	The EU used the notation key “IE” to report N_2O emissions from manure management for cattle and swine for the Netherlands in NIR tables 5.29 and 5.30. In CRF table 3.B(b), the EU used the notation key “IE” to report N_2O emissions from manure management for sheep and swine for the Netherlands. The ERT noted that no explanation is provided, either in the documentation box of CRF table 3.B(b) or in the NIR, as to where in the inventory the emissions have been included. During the review, the EU explained that the Netherlands reported manure in CRF table 3.B(b) in the different MMS without distinguishing among livestock categories until the last inventory year, and the EU had no data for individual animal types; it therefore assigned all manure to the category other. The EU has been working with the Netherlands on this issue for a few years, and the Netherlands is now advancing in the recommended calculations. For 2018 the Netherlands reported manure by MMS and livestock category (see ID#s A.6 and A.7 in table 3), but emissions for category 3.B.b were still reported under other livestock. According to the Netherlands’ improvement plan, the disaggregation of emissions by livestock category is expected to be finished in time for the next submission. See ID# A.6 in table 3 for the outstanding recommendation from the previous review report on this issue.	Tables 5.29 and 5.30 of the EU NIR included information on cattle and swine.
A.19	Transparency	3.B Manure management – N_2O	In CRF table 3.B(b), the EU used the notation key “NA” to report direct N_2O emissions from manure management for liquid systems for Bulgaria and for daily spread for Bulgaria, Czechia and Poland. The ERT noted that no explanation is provided in the NIR as to why this notation key is used. During the review, the EU explained that Bulgaria reported manure managed in liquid systems for swine and buffalo, but used an EF of zero for this MMS; Czechia reported manure in the daily spread system for cattle, but used an EF of zero; and Bulgaria and Poland did not report manure managed in the daily spread system. The ERT recommends that the EU work with Bulgaria and Poland to clarify why they use “NA” to report N_2O emissions from MMS when manure is not reported in those MMS in their NIR.	BG reported in the CRF Table 3.B(b) "NA" for "their livestock" only, Poland has not reported "NA" in the CRF Table 3.B(b).
A.20	Transparency	3.B Manure management – N_2O	In CRF table 3.B(b) the EU uses the notation key “NA” to report direct N_2O emissions from manure management for composting systems for Croatia, Poland and Slovenia. The ERT noted that no explanation is provided in the NIR as to why this notation key is used. The ERT also noted that composting is practiced in these countries, as shown in figure 7.2 of the NIR. During the review, the EU explained that Croatia, Poland and Slovenia reported in their NIRs that only urban waste is composted; composting of manure waste is not mentioned. The ERT recommends that the EU work with Croatia, Poland and Slovenia to clarify in their NIRs the use of the notation key “NA” to report direct N_2O emissions from manure management for composting systems.	This issue has been clarified, Poland, Croatia and Slovenia have changed the use of the notation key in their CRF Tables (Table 3.B.(b)) accordingly. PL: no "NA" used in the CRF Table 3.B(b) HR: no "NA" used in the CRF Table 3.B(b) SI: no "NA" used in the CRF Table 3.B(b)

Sector	TACCC	Category	Recommendation	Status of Implementation
A.21	Transparency	3.B Manure management – N_2O	In CRF table 3.B(b), the EU used the notation key “NE” to report direct N_2O emissions from manure management for composting systems for Finland and the United Kingdom. The ERT noted that no explanation is provided in CRF table 9 or in the NIR as to why this notation key is used. During the review, the EU explained that in Finland emissions from manure composting are negligible (Finland 2018 NIR, table 5.3.1). In chapter 7 of its 2018 NIR the United Kingdom reports household and non-household waste as composting sources, but does not mention manure. The ERT considers it incorrect to use the notation key “NE” to report direct N_2O emissions from manure management for composting systems for the United Kingdom. The ERT recommends that the EU work with the United Kingdom to clarify the use of the notation key “NE” to report direct N_2O emissions from manure management for composting systems, or replace “NE” with “NO” if these emissions do not occur, always reporting in the NIR the rationale for using this notation key.	Not yet resolved for UK: used "NE" for composting and digester, explanation in the Table 9 not provided. Explanation in the UK NIR Table page 510: Addressing. Emissions of CH_4 and N_2O emissions from the anaerobic digestion of livestock manures and from the application of digestates (from anaerobic digestion of manures, crop-based AD and food waste-based AD) are currently being incorporated in the UK model and will be fully reported in the 2021submission. Activity data on composting and the application of composts to land are being reviewed.
A.22	Transparency	3.B.3 Swine – CH_4	In NIR table 5.17 the EU reports that Cyprus and the United Kingdom used a tier 2 method to estimate CH_4 emissions from manure management for swine. The EU also reports that these member States used default information for the CH_4 EF. As the use of a tier 2 method for CH_4 emissions from manure management implies the use of a country-specific EF estimated using country-specific data, the ERT asked the EU to explain how Cyprus and the United Kingdom used default information for the CH_4 EF for manure management when applying a tier 2 method. During the review, the EU explained that Cyprus and the United Kingdom estimated the CH_4 EF from manure management for swine on the basis of the IPCC tier 2 method using country-specific values for the manure managed in each MMS and that the EU had incorrectly interpreted these member States’ explanations of how they calculate the EFs. The ERT recommends that the EU report accurately in the NIR the method and CH_4 EF used by Cyprus and the United Kingdom to estimate CH_4 emissions from manure management for swine.	CY (see answer A.11). UK (NIR 2020 page 329): The emission factors for manure management are calculated following IPCC Tier 2 methodology for cattle, sheep, pigs and poultry, according to IPCC (2006) Equation 10.23.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.23	Completeness	3.D.a.2 Organic nitrogen fertilizers – N_2O	In CRF table 3.D the EU uses the notation key "NE" to report direct N_2O emissions from other organic fertilizers applied to soils for Croatia and Finland, and did not report on these emissions for Iceland. The ERT noted that no explanation is provided in CRF table 9 or in the NIR as to why this notation key is used. During the review, the EU explained that, in the case of Croatia, the Party reported "NA" for these emissions in CRF table 3.D, although it also referred to composting activities in the waste sector. The EU raised the issue with the Party and suggested that Croatia make efforts to find data related to other organic fertilizers applied to soils for CRF table 3.D, and in the meantime use the notation key "NE" rather than "NA" to report these emissions. The EU noted that Croatia has included this issue in its improvement plan and might be in a position to report those emissions soon. Regarding Finland, the EU explained that the Party stated in its NIR (p.252) that it did not report N_2O emissions from "other organic fertilizers applied to fields (for example, composted household waste and industrial waste) under the agriculture sector as there is no register from which to obtain the data and the amounts applied to fields are considered insignificant (most is used in landscaping and not in fields) and that the emissions of the composted waste types are reported in the waste sector (5.B.1)". Finally, the ERT noted that the EU did not report direct N_2O emissions from other organic fertilizers applied to soils for Iceland, which used the notation key "NE" in CRF table 3.D. The ERT concluded that Croatia partially estimated N_2O emissions from other organic fertilizers applied to soils (only for composted household waste and industrial waste) and reported them under the waste sector. Therefore, the appropriate notation key to be used for this Party is "IE, NE". The ERT recommends that the EU work with Croatia and Iceland to estimate and report direct N_2O emissions from other organic fertilizers applied to soils under the agriculture sector (organic nitrogen fertilizers (3.(II).D.A.2)). If N_2O emissions are determined to be insignificant, the ERT recommends that the EU work with the countries so that they can explain the use of the notation key "NE" to report these emissions in their NIRs, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	This issue has been considered under the initial checks 2020; but could not be resloved for all MS within this year. FI: explained in the NIR, that emissions are under the threshold (0.05%) IS: not yet resolved HR: explanation provided during ESD 1st step review

Sector	TACCC	Category	Recommendation	Status of Implementation
A.24	Transparency	3.D.a.5 Mineralization/immobilization associated with loss/gain of soil organic matter – N_2O	In CRF table 3.D the EU used the notation key “NA” to report direct N_2O emissions from mineralization/ immobilization associated with loss/gain of soil organic matter for Finland, Germany and Spain, and “NE” for Iceland. The ERT noted that no explanation is provided in the NIR, or in the case of Iceland in CRF table 9, as to why these notation keys are used. During the review, in response to a question raised by the ERT on the reason for not using the notation key “NE” for Finland, Germany and Spain, the EU explained that for Finland numerical values were reported for direct N_2O emissions in this category for some years (those in which loss of organic carbon takes place), and “NA” was used when no loss of organic carbon took place (Finland NIR, table 5.4-2). Regarding Germany, the EU explained that the soils pool was not a source of emissions given that there have been no changes in management practices in the country since 1990, as reported in the documentation box of Germany’s CRF table 3.D. Finally, the EU noted that Spain indicated in CRF table 3.D that the net carbon stock change in mineral soils in cropland remaining cropland was positive (a gain) for the entire time series, and therefore equation 11.8 from the 2006 IPCC Guidelines is not applicable. The ERT concluded that reporting for Finland, Germany and Spain is consistent with the UNFCCC Annex I inventory reporting guidelines, but reporting for Iceland is not because the rationale for the use of “NE” is not transparent. The ERT recommends that the EU, in reporting direct N_2O emissions from mineralization/immobilization associated with loss/gain of soil organic matter in CRF table 3.D, work with Iceland to include in its NIR and CRF table 3.D the justification for the use of “NE” for reporting direct N_2O emissions from mineralization/immobilization associated with loss/gain of soil organic matter.	Iceland used notation key "NO"
A.25	Adherence to the UNFCCC Annex I inventory reporting guidelines	3.D.b Indirect N_2O emissions from managed soils – N_2O	When responding to the ERT regarding a previous recommendation (see ID# A.12 in table 3), the EU indicated that the Netherlands reported a different (higher) value in its March submission to the EU for the area of cultivated histosols in the subcategory indirect N_2O emissions from managed soils (3.D.b) from its January submission, which, according to the EU, was probably due to a reporting error. The EU explained that it would address the issue with the Netherlands in the next reporting period. It also indicated it would continue with consistency checks between the agriculture and LULUCF sectors for organic soils. The ERT recommends that the EU work with the Netherlands to correct the error made in reporting the area of cultivated histosols in CRF table 3.D and report the correct value in the EU CRF table 3.D.	This issue has been considered under the initial checks 2020 and could be resolved.

Sector	TACCC	Category	Recommendation	Status of Implementation
KL.20	Completeness	CM – CO_2	The ERT noted that for Italy the EU has reported net carbon stock changes in mineral soils in CRF table 4(KP-I)B.2 using the notation key "NE", while reporting an area of mineral soils (8,994.9 kha) for 2016. During the review, the EU explained that the notation key "NE" was used for carbon stock changes in mineral soils following a recommendation in the 2016 annual review report of Italy (see ID# KL.2 in document FCCC/ARR/2016/ITA). While the ERT acknowledges the Party's reporting of "NE", it notes that transparent and verifiable information indicating that this pool is not a net source of emissions is not provided in the NIR as required by paragraph 2(e) of annex II to decision 2/CMP.8. The ERT recommends that the EU provide transparent and verifiable information on the use of notation key "NE" to report CM for Italy in order to increase transparency.	Addressing the recommendation of the ERT, in the GHG inventory 2020 Italy has reported carbon stock changes from mineral soils in Cropland Management.
W.3	Comparability	5.B.1 Composting – CH_4 and N_2O	In CRF table 5.B the EU reported two types of waste treated by composting: MSW and other waste. However, the ERT noted that in the NIR (section 7.2.2.1) the EU reported information only on MSW. No information regarding the type of waste contained in other waste is included in the NIR. During the review, the EU explained that in 2016 10 member States reported CH_4 and N_2O emissions for the subcategory other (5.B.1.b). Many member States apply the same EFs for category 5.B.1.b as for MSW (5.B.1.a) (IPCC defaults: 4 g CH_4/kg wet waste and 0.24 g N_2O/kg wet waste). Other member States report emissions from composting only under subcategory 5.B.1.b. Still others use IPCC default EFs but report different waste categories under category 5.B.1.b and differentiate between dry and wet waste. Some member States report industrial solid waste and construction waste as well as municipal sludge and industrial sludge under category 5.B.1.b using IPCC default EFs. The ERT considers that the explanation provided by the EU highlights the potential issue related to the comparability of data among member States; it is clear they are not reporting each type of waste under the correct subcategories (5.B.1.a and 5.B.1.b). According to the specifications provided in CRF table 5.B, subcategory 5.B.1.a should include emissions from MSW and subcategory 5.B.1.b should include emissions from all organic waste sources not covered by MSW. The ERT recommends that the EU report the CH_4 and N_2O emissions of each type of composting waste in the correct subcategory: 5.B.1.a (for MSW) or 5.B.1.b (for other organic waste). The ERT also recommends that the EU improve the transparency of the NIR by including more information on both types of waste composted, including AD, EFs and the type of waste included under other (5.B.1.b).	In 2020, a huge effort has been made among MS to report consistent AD as asked in their CRF tables (dry basis as required in the CRF tables). Anyway, reporting AD in a dry basis unit as required in the CRF tables seems inappropriate because data are usually available in a wet basis.

Sector	TACCC	Category	Recommendation	Status of Implementation
W.4	Comparability	5.B.2 Anaerobic digestion at biogas facilities – CH_4 and N_2O	In CRF table 5.B the EU has reported the AD for waste treated by anaerobic digestion at biogas facilities (category 5.B.2) as "NE" for the entire time series. However, CH_4 emissions have been estimated and reported for all years. No information regarding category 5.B.2 is included in the NIR. During the review, the EU explained that the reporting of AD and emissions for this category varies among member States. While some report AD as well as CH_4 and N_2O emissions, others report emissions but not AD. This would lead to unreliable CH_4 and N_2O IEFs in CRF table 5.B. The EU noted that in the CRF Reporter software it is not possible to report "NE" for the IEFs; therefore AD have been reported as "NE" in order to avoid the reporting of unreliable IEFs for this category. The Party also noted that because information on AD for each member State is included in the commenting field of the CRF table cell, information is not lost. The ERT considers that the explanation provided by the EU highlights the potential issue related to comparability of data among member States; it is clear they are not reporting all of the information required in the CRF tables. The ERT recommends that the EU improve the comparability of the inventory by working with member States to ensure that AD on the annual amount of waste treated through anaerobic digestion at biogas facilities (category 5.B.2) are reported for all Parties, thereby allowing the correct calculation and reporting of the CH_4 and N_2O IEFs for this category. The ERT also recommends that the EU improve the transparency of the NIR by including information on the AD and EFs used, as well as the calculation methodology followed, for the estimation of CH_4 and N_2O emissions for this category.	In 2020, a huge effort has been made among MS to report consistent AD as asked in their CRF tables (dry basis as required in the CRF tables). Anyway, reporting AD in a dry basis unit as required in the CRF tables seems inappropriate because data are usually available in a wet basis.
W.5	Adherence to the UNFCCC Annex I inventory reporting guidelines	5.C Incineration and open burning of waste – CO_2, CH_4 and N_2O	The ERT noted that a section for the category incineration and open burning of waste (5.C) is not included in the NIR. During the review, the EU explained that the chapter for category 5.C was mistakenly deleted from the May submission of the 2018 NIR, but had been included in the April 2018 submission and was therefore available for the ERT to review. The ERT recommends that the EU ensure that the section for the category incineration and open burning of waste (5.C) is included in the NIR and that the EU conduct a quality check of the NIR before submission.	The paragraph is presented in the 2020 NIR, but 5C is not a key category for the EU in 2020, therefore no detailed information is presented.

Sector	TACCC	Category	Recommendation	Status of Implementation
W.6	Transparency	5.D.1 Domestic wastewater – CH_4	The ERT noted that figure 7.15 in the NIR shows only the total fractions of CH_4 emissions, CH_4 recovered and CH_4 flared from domestic wastewater treatment facilities at the EU level. The ERT also noted that the amounts of CH_4 recovered and CH_4 flared are more than double the CH_4 emissions in recent years. Given this situation, the ERT considers that the technologies and practices related to CH_4 recovery and CH_4 flaring in individual member States need to be more clearly explained in the NIR. The ERT recommends that the EU include in the NIR a table reporting the amount of CH_4 emissions, CH_4 recovered and CH_4 flared by member State, and provide the results of an analysis of major trends related to CH_4 recovery and flaring practices.	As indicated in the NIR, the CH_4 recovery is generally recovered during sludge digestion for biogas production in a follow-up step of aerated wastewater treatment plants. On the opposite, CH_4 emissions relate mainly to anaerobic treatment systems (septic tanks and natural lagoons). Therefore comparing CH_4 emissions to CH_4 recovery is meaningless. Moreover, information related to the split between flaring and energy use of CH_4 recovered on sludge digesters is not necessary to apply the 2006 IPCC Guidelines and to estimate CH_4 emissions from waste water treatment and sludge digestion. Therefore, the text has been completed, but the split is still not presented.

10.4.2 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 sector-specific QA/QC activities within the EU internal review;

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 EU Member States (MS), UK and Iceland. For the voluntary activities under the Article 3(4), information is included only for those countries that elected to account for these activities during the second commitment period (CP2) of the Kyoto Protocol (KP).

It is important to note that each country will account for net emissions and removals for each activity under Article 3(3), and 3(4) if elected, by issuing removals units (RMUs) or cancelling KP units based on their own reported emissions and removals from their 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 relevant supplementary information for KP-LULUCF activities, as reported by EU MS, UK and Iceland.

In the absence of an official annotated outline for the provision of supplementary information under the CP2 of the KP, the JRC[70] provided to the countries a proposal on the outline for reporting KP-LULUCF supplementary information within the national inventory reports (NIRs). Nevertheless, the type and amount of information reported by individual inventories slightly differs among them. Therefore, note that this chapter does not aim to provide an exhaustive compilation of all supplementary information reported by EU MS, UK and Iceland, but an overview of the most important elements on KP-LULUCF as included in the individual inventories. For more detailed information, we encourage readers to refer to information included in the NIR of the countries.

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 EU MS, UK 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 EU MS, UK and Iceland have implemented technical corrections, and information about conversion from natural to planted forests).

The main postulation 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 EU MS, UK and Iceland GHG inventories with the IPCC good practices is checked twice every year before national GHG inventories are officially submitted to the UNFCCC. A first

[70] Joint Research Centre of the European Commission. https://ec.europa.eu/jrc/en

check is carried out at country level as part of the own QA/QC procedures, and a second one in the context of the EU's QA/QC procedures as implemented by the JRC experts pursuant the Regulation 525/2013 (see section 6.4 on QAQC procedures implemented for LULUCF and KP-LULUCF)

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; 6 EU MS and UK have elected to account for Cropland Management, 5 EU MS and UK for Grazing Land Management, 1 EU MS and Iceland for Revegetation, and only UK for Wetland Drainage and Rewetting. Concerning the accounting frequency, with the exception of 2 EU MS, all others 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.

Country	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
Luxembourg	---	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 reporting activity for the KP- 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, UK and Iceland for each mandatory and elected activity.

Carbon stock changes are estimated in all cases for living biomass pool. For dead organic matter and soil organic carbon pools notation keys are also used. “NE”, “NO” “NA” are used mainly 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 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 carbon pools are estimated by using models not capable to apportion net carbon stock changes among those pools.

Despite of the continuous improvements implemented by EU MS, UK 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 other sources of GHG emissions, 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 forests does not occur) 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 between LULUCF and Agriculture the final destination of nitrogen fertilizers.

Table 11.2 Synthesis of carbon pools and other sources of GHG emissions reported for KP-LULUCF activities in EU MS, UK and Iceland, based on table NIR-1 and sectorial tables for the current inventor year.

Country	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	IE	R	R
Croatia	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	R	R	R
Cyprus	R	R	R	NO	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	NO	NO	NO	NO	NO	R	NE	R	R	R

Country	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
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	R	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	R	R	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
Luxembourg	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
Netherlands	R	R	NR	R	R	R	IE	NO	NE	R	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	NR	NR	R	IE	NO	NO	NO	NO	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	R	R	R	R	R	R	R	NE	R	R	NE	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	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Cyprus	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	R	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	NO	IO	NO	NO	NO	R	NE	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
Luxembourg	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	IE	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

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HW P	Fertilizatio n	Drained, rewetted and other soils		Nitrogen mineralizatio n in mineral soils	Indirect N_2O emission s from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	NO	NO	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,R	IO	NO	NO	NO	R	NO	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
Belgium	R	R	NO	NO	NR	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	NO	R	NO	NO	R	NO	NO	NO	NO	NO	IE	R	R
Croatia	R	R	NO	NO	NO	NO	R	NO	NO	NO	NO	NO	R	R	R
Cyprus	R	R	NO	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	R	R	IE	R	NR	R	R	NO	NO	NO	NO	NO	R	R	R
Denmark	R	R	R	R	R	R	R	R	R	R	NO	R	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	R	R	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	NO	R	NO	NO	NO	R	NE	R	R	R
Germany	R	R	R	R	R	R	R	NO	R	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	R	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
Luxembourg	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	NR	R	R	R	R	NO	NE	R	R	NO	R	R	R
Poland	R	R	R	R	R	R	R	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
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
Sweden	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
United Kingdom	R	R	R	R	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		R		NO	NO	NO
Germany	R	R	IE	IE	R	R			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

Country	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
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,NO	R	R
Grassland Management															
Denmark	R	R	NO	NO	R	R			R		R		NO	NO	NO
Germany	R	R	IE	IE	R	R			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
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE,NO	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		NR	NR	NR		NR	NR	NR	NR

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, UK and Iceland is about 252,000 kha, which is approximately 55% of the total area reported under the Convention (Table 11.3).

The activity that covers the largest area is Forest Management (61%), followed by Cropland Management (21%), Grazing land Management (12%), Afforestation/Reforestation (4%) and Deforestation (1%), while Revegetation covers less than 1%. The reporting of Wetland Drainage and Rewetting is not yet provided by UK but as informed by the country, efforts are ongoing to provide the relevant information by the end of this commitment period. See relevant subsection for more information on this category.

With the exception of Belgium, Finland, Netherlands and Romania all individual GHG inventories report larger areas under afforestation/reforestation than under deforestation. Consequently, forest area reported under KP increases over time.

Regardless of specific activities, most of the area under the KP accounting is reported by Spain, Germany, Sweden, Italy, France, UK. The largest area under AR, and D is reported by France, and the largest under FM is reported by Sweden. For CM and GM, respectively Spain and Germany report the largest area.

Table 11.3 Synthesis of total area (kha) reported under KP-LULUCF activities by EU MS, UK and Iceland in the CRF table NIR-2. Grey cells indicate that the activity has not been elected.

Country	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	

Country	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Austria	239,77	78,99	3.807,96					4.126,73
Belgium	24,41	24,96	680,04					729,42
Bulgaria	300,80	5,58	3.621,75					3.928,12
Croatia	63,78	4,72	2.311,01					2.379,51
Cyprus	9,67	1,11	143,37					154,15
Czech Republic	64,63	18,80	2.608,77					2.692,19
Denmark	107,79	13,22	531,32	2.858,49	181,13			3.691,95
Estonia	54,99	26,48	2.391,29					2.472,76
Finland	196,69	437,28	21.637,43					22.271,39
France	2.308,13	1.128,04	20.632,68					24.068,85
Germany	304,74	130,51	10.692,27	13.262,11	6.967,82			31.357,44
Greece	34,25	5,69	1.247,69					1.287,62
Hungary	174,56	18,70	1.764,62					1.957,88
Ireland	327,09	20,53	446,14	781,67	4.161,90			5.737,32
Italy	2.019,97	62,56	7.449,29	8.999,78	3.943,47			22.475,06
Latvia	117,31	94,63	3.127,61					3.339,55
Lithuania	53,83	4,63	2.157,66					2.216,12
Luxembourg	9,00	5,94	87,19					102,13
Malta	NO,NA	NO,NA	0,07					0,07
Netherlands	47,50	78,58	306,45					432,53
Poland	787,96	29,21	8.649,29					9.466,46
Portugal	629,44	379,41	3.738,95	2.342,80	591,09			7.681,69
Romania*	35,24	494,81	6.924,21			106,07		7.560,33
Slovakia	48,93	8,93	1.977,10					2.034,96
Slovenia	NO,NA	26,62	1.132,22					1.158,84
Spain	1.262,80	124,52	14.425,21	20.179,82				35.992,35
Sweden	351,16	340,16	27.877,90					28.569,22
EU	**9.574,43**	**3.564,59**	**150.369,46**	**48.424,68**	**15.845,40**	**106,07**		**227.884,63**
United Kingdom	584,95	73,40	2.976,89	4.816,64	15.317,39	NA	NE,NA	23.769,27
Iceland	47,13	0,06	93,67			310,87		451,73
EU +UK+ Iceland	**10.206,51**	**3.638,06**	**153.440,02**	**53.241,32**	**31.162,79**	**416,94**	NE,NA	**252.105,63**

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 EU MS, UK and Iceland in CRF table NIR-3. However, in some cases the information was taken from the NIR because, as explained by some countries during the implementation of the EU QA/QC procedures, remaining open issues in the CRF Reporter prevented the provision of this information in table NIR-3 in 2020, in the same way as already stated in previous years.

Table 11.4 Synthesis of KP-LULUCF activities being key category as reported by EU MS, UK and Iceland (from table NIR-3). "KC" indicates a key category.

Country	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	KC				
Czech Republic			KC				
Denmark			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		
Latvia	KC	KC	KC				
Lithuania	KC	KC	KC				
Luxembourg	KC	KC	KC				
Malta	----	----	----				
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 EU MS, UK and Iceland for each of the KP activities; and the sum for total EU and total EU plus UK 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: -1,116,013 kt CO_2eq. With the addition of UK and Iceland the total net accounting results in a net sink of -1,131,658 kt CO_2eq. These values should be considered with caution, because a number of technical corrections to FMRLs still need to be implemented. Moreover, the cap value could be implemented in some country.

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 50% of total GHG emissions from this activity in (see table 11.6)

Tables 11.5 Net emissions and removals (kt CO_2eq.) from KP-LULUCF activities for the period 2013-2018, as reported by EU MS, UK and Iceland. Based on MS CRF accounting tables

Country	Net emissions (+) and removals (-), kt CO_2 equivalent											
	Art 3.3 Activities											
	A.1 AR						**A.2 D**					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
AUT	-2017,55	-2031,47	-2065,27	-2098,48	-2142,58	-2182,11	536,48	524,77	518,33	511,89	505,45	499,01
BEL	-140,32	-137,74	-135,18	-139,04	-135,20	-131,35	224,19	223,06	221,93	417,90	420,92	423,96
BGR	-1596,20	-1751,69	-1894,22	-2048,63	-2202,00	-2364,37	144,81	62,83	189,71	157,82	167,91	70,79
HRV	-88,52	-97,35	-136,05	-235,24	-186,69	-276,66	53,90	33,74	68,60	35,98	29,29	30,57
CYP	-37,75	-42,98	-41,64	-36,77	-37,55	-35,32	0,82	0,70	0,58	0,47	0,37	0,26
CZE	-499,36	-533,38	-548,41	-554,34	-565,38	-538,58	254,05	251,20	197,61	238,40	264,66	151,06
DNM	8,56	-341,86	-620,66	27,58	-600,50	-332,29	36,50	122,41	256,38	154,53	26,39	165,55
EST	-259,73	-239,69	-218,32	-238,25	-235,24	-208,61	409,78	382,07	378,20	374,28	345,94	294,74
FIN	-469,62	-475,15	-449,55	-371,74	-434,00	-519,43	4176,98	3912,37	3570,88	3300,06	3139,16	3046,28
FRA	-13882,62	-14000,82	-13393,65	-14797,46	-15157,96	-15758,42	11799,17	11843,41	11804,51	11852,57	11821,43	11872,15
DEU	-6671,93	-6974,63	-7277,73	-7581,69	-7280,83	-7878,75	1130,59	1138,08	1146,78	1158,66	1620,81	1634,24
GRC	-135,85	-146,89	-124,41	-138,41	-80,13	-80,13	47,33	47,28	44,90	56,17	52,39	52,39
HUN	-1248,27	-1087,11	-1241,08	-1189,01	-1281,56	-1209,49	122,45	150,67	218,24	288,24	294,68	420,15
IRL	-3586,89	-4289,90	-4231,51	-4115,94	-3632,76	-3606,02	1065,06	261,00	1346,10	361,97	283,02	275,87
ITA	-7993,33	-8405,07	-8861,33	-8423,30	-5230,21	-8030,90	2011,72	2022,73	2033,48	2043,66	2045,69	2054,38
LVA	-179,78	-194,10	-208,54	-222,73	-240,66	-254,53	1125,92	882,64	915,92	949,14	982,46	1015,45

Country	Net emissions (+) and removals (-), kt CO_2 equivalent											
	Art 3.3 Activities											
	A.1 AR						**A.2 D**					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
LTU	-214,26	-234,97	-269,79	-332,64	-289,50	-418,10	206,58	271,70	27,45	165,87	85,27	1373,70
LUX	-179,71	-176,68	-173,63	-170,55	-167,45	-164,33	46,94	44,74	42,53	40,33	38,13	35,92
MLT	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NLD	-601,50	-602,39	-602,72	-602,56	-605,18	-613,27	1107,63	1147,54	1188,58	1229,41	1275,14	1317,70
POL	-2892,63	-2872,86	-2903,52	-2878,48	-3032,87	-3049,33	284,50	232,66	369,19	6779,71	223,43	269,15
PRT	-3430,08	-3605,08	-3427,94	-2466,94	-313,76	-2836,17	2124,60	2100,52	2075,59	2058,68	2068,01	1985,19
ROU	-511,81	-521,62	-529,65	-535,84	-543,89	-260,92	8076,74	8076,74	8076,74	8076,74	8076,74	8503,73
SVK	-443,28	-462,92	-497,16	-523,25	-543,92	-565,20	42,22	61,37	59,33	27,89	55,67	109,33
SVN	NA	NA	NO,NA	NO,NA	NO,NA	NO,NA	233,45	233,47	233,89	234,84	236,31	236,91
ESP	-8211,82	-7909,25	-7289,35	-6506,20	-6161,17	-5514,26	640,61	637,85	634,55	633,22	632,78	632,28
SWE	-1200,01	-1152,28	-1182,02	-1242,00	-1284,01	-1284,44	2980,80	3217,69	3651,52	2389,32	2497,58	2584,09
EU	**-56484,29**	**-58287,86**	**-58323,32**	**-57421,91**	**-52385,01**	**-58112,96**	**38883,85**	**37883,23**	**39271,53**	**43537,75**	**37189,61**	**39054,84**
UK	-1246,73	-1502,64	-1857,11	-2202,83	-2518,04	-2822,27	1534,79	1552,01	1467,17	1928,75	1635,35	1663,17
ISL	-182,94	-203,30	-223,66	-242,42	-291,59	-291,64	0,16	0,11	0,65	0,27	0,46	0,46
EU+UK+ISL	**-57913,96**	**-59993,81**	**-60404,10**	**-59867,15**	**-55194,64**	**-61226,86**	**40418,79**	**39435,35**	**40739,34**	**45466,77**	**38825,43**	**40718,47**

Country	Net emissions (+) and removals (-), kt CO_2 equivalent					
	Art. 3.3 Activities					
	A2 FM					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
AUT	-3477,70	-3669,55	-3515,33	-3363,45	-3894,80	-4128,54
BEL	-1405,87	-1381,59	-1431,92	-1404,70	-1408,69	-1408,17
BGR	-7535,19	-7586,83	-7740,93	-7410,01	-7333,87	-7318,33
HRV	-7070,99	-6967,67	-6310,85	-6288,76	-5536,30	-5473,97
CYP	-140,71	-141,29	-139,69	96,51	-143,78	-134,94
CZE	-6292,56	-6187,48	-5259,28	-4219,91	-1859,34	6345,74
DNM	-2543,65	-3741,03	677,04	703,31	322,53	554,20
EST	-4940,16	-3329,45	-3959,62	-4028,09	-3469,20	-3800,96
FIN	-48033,17	-46805,19	-41359,82	-37887,16	-36832,18	-28989,70
FRA	-51926,89	-45735,94	-41179,69	-42185,79	-39250,37	-37622,92
DEU	-63454,87	-64268,88	-63906,76	-64004,89	-64507,68	-65239,57
GRC	-1964,66	-1964,66	-1953,56	-1922,38	-1952,18	-1952,18
HUN	-2243,96	-3366,74	-4317,79	-3014,08	-3590,83	-3198,53
IRL	-1452,75	-782,56	-1137,40	-1346,96	-984,07	-815,21
ITA	-30338,91	-31359,54	-32562,01	-29445,73	-14068,22	-25914,06
LVA	-6628,04	-942,54	-2727,10	-1866,59	-3103,11	-2334,01
LTU	-9229,40	-8266,94	-5028,20	-3481,44	-3084,03	-3132,82
LUX	-433,83	-352,82	-296,86	-386,94	-277,37	-94,94
MLT	NO	NO	NO	NO	NO	NO
NLD	-1081,75	-1075,71	-1039,62	-1065,23	-1048,56	-1027,30
POL	-42707,73	-35472,01	-31627,78	-37896,64	-37781,87	-37958,98
PRT	-7430,18	-8981,86	-8048,99	-1452,70	10031,56	-3433,42
ROU	-75536,03	-80922,58	-85072,81	-90772,92	-94051,85	-28955,46
SVK	-7036,28	-5094,95	-5648,42	-5468,23	-5384,61	-4566,14
SVN	-5156,99	918,17	810,43	897,56	506,76	865,92
ESP	-28050,35	-28890,58	-29678,00	-29320,93	-30547,78	-30277,86
SWE	-48890,54	-47420,46	-48789,28	-50386,22	-49501,02	-47956,37
EU	**-465003,15**	**-443790,67**	**-431244,21**	**-426922,36**	**-398750,85**	**-337968,51**
UK	-19899,73	-19202,41	-18847,98	-18496,40	-17991,88	-17553,26
ISL	-80,78	-84,10	-87,84	-90,64	-91,94	-94,85
EU+UK+ISL	**-484983,66**	**-463077,18**	**-450180,04**	**-445509,40**	**-416834,68**	**-355616,62**

Country	Net emissions (+) and removals (-), kt CO_2 equivalent						
	Art. 3.4 Activities						
	B.3 CM						
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
DNM	5448,09	3028,97	4093,35	3588,46	3848,83	5448,09	3028,97
DEU	12966,42	15732,09	15615,27	15852,65	15964,95	12966,42	15732,09
IRL	33,37	-20,47	-72,36	-73,77	-108,85	-59,58	-156,37
ITA	425,92	-2134,68	-2904,79	-4277,15	-5852,50	-5771,42	-5444,95
PRT	3352,41	347,01	358,35	356,34	356,76	400,68	359,74

Country	Net emissions (+) and removals (-), kt CO_2 equivalent						
	Art. 3.4 Activities						
	B.3 CM						
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
ESP	-95,02	1663,53	74,29	-2111,38	-2734,32	-2979,37	-3164,01
EU	**22131,18**	**18616,46**	**17164,11**	**13335,15**	**11474,88**	**11068,98**	**12851,91**
UK	14785,11	13120,61	12934,08	12851,07	12740,96	12678,87	12547,22
EU+UK	**36916,28**	**31737,06**	**30098,19**	**26186,21**	**24215,84**	**23747,86**	**25399,13**

Country	Net emissions (+) and removals (-), kt CO_2 equivalent						
	Art. 3.4 Activities						
	B.3 GM						
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
DNM	1573,90	1315,61	1417,16	1246,10	1390,53	1381,45	1470,80
DEU	23969,85	18486,63	18511,25	18097,99	17844,22	18769,34	18186,93
IRL	6899,36	6442,70	6432,53	6437,75	6416,83	6602,05	6596,52
ITA	122,15	-754,67	-1198,00	-833,92	-885,78	-489,53	-465,97
PRT	1442,74	43,30	22,54	-39,60	-100,14	-146,88	-132,03
EU	**34008,01**	**25533,57**	**25185,50**	**24908,32**	**24665,66**	**26116,43**	**25656,25**
UK	-6558,37	-5458,33	-5511,02	-5590,27	-5645,57	-5717,46	-5779,00
EU+UK	**27449,63**	**20075,24**	**19674,48**	**19318,05**	**19020,09**	**20398,96**	**19877,25**

Country	Net emissions (+) and removals (-), kt CO_2 equivalent						
	Art. 3.4 Activities						
	B.3 RV						
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
ROU	-1698,59	-1211,36	-1222,00	-1254,60	-1297,36	-1330,60	-1330,60
ISL	-347,70	-585,13	-591,67	-599,01	-605,81	-620,70	-637,01
EU+ISL	**-2046,30**	**-1796,49**	**-1813,68**	**-1853,61**	**-1903,17**	**-1951,31**	**-1967,62**

Country	Net emissions (+) and removals (-), kt CO_2 equivalent						
	Art. 3.4 Activities						
	B.3 WDR						
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
United Kingdom	NE	NE	NE	NE	NE	NE	NE

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 2013-2018 of KP-LULUCF activities as reported by EU MS, UK and Iceland (Kt CO_2eq), based on CRF accounting tables*

Country	**Accounting quantity**							
	Article 3.3		**Article 3.4**					**Accounting amount on LULUCF activities (RMUs)**
	AR	**D**	**FM**	**CM**	**GM**	**RV**	**WDR**	
Austria	-12 537	3 096	-17 891					-27 333
Belgium	- 819	1 932	-5 087					-3 974
Bulgaria	-11 857	794	2 775					-8 288

Croatia	-1 021	252	-5 344					-6 112
Cyprus	- 232	3	338					109
Czech Republic	-3 239	1 357	10 643					8 761
Denmark	-1 859	762	-5 986	-10 180	-1 222			-18 485
Estonia	-1 400	2 185	-7 081					-6 296
Finland	-2 719	21 146	-51 483					-33 057
France	-86 991	70 993	15 788					- 209
Germany	-43 666	7 829	-282 483	18 154	-33 923			-334 088
Greece	- 706	300	-1 992					-2 397
Hungary	-7 257	1 494	-13 488					-19 250
Ireland	-23 463	3 593	- 65	- 692	-2 468			-23 095
Italy	-46 944	12 212	-20 612	-28 941	-5 361			-89 646
Latvia	-1 300	5 872	9 990					14 561
Lithuania	-1 759	2 131	621					992
Luxembourg	-1 032	249	- 425					-1 209
Malta	NO	NO	0.00					0.00
Netherlands	-3 628	7 266	2 212					5 850
Poland	-17 630	8 159	-60 647					-70 118
Portugal	-16 080	12 413	2 100	-17 936	-9 009			-28 513
Romania	-2 904	48 887	-360 554			2 545		-312 025
Slovakia	-3 036	356	-11 941					-14 621
Slovenia	NO,NA	1 409	17 868					19 277
Spain	-41 592	3 811	-38 165	-8 681				-84 627
Sweden	-7 345	17 321	-92 197					-82 221
EU	**-341 015**	**235 821**	**-913 105**	**-48 276**	**-51 982**	**2 545**	**NA**	**-1 116 013**
United Kingdom	-12 150	9 781	-4 034	-11 838	5 649		NE	-12 591
Iceland	-1 436	2	- 68			-1 553		-3 054
EU +UK+ Iceland	**-354 601**	**245 604**	**-917 207**	**-60 113**	**-46 334**	**992**	**NE,NA**	**-1 131 658**

**any information on EU KP-LULUCF activities presented here is shown for information purpose only.*
*** The FM accounting quantity of Romania is not correct; therefore, the sum at EU level in this table does not represent the proper sum of the quantities. Romania needs to recalculate the whole time series of estimates according with new data available to ensure the consistency of the time series. This issue has been identified during the QAQC checks implemented at Union level and communicated to Romania who has informed to be working on the solution of this issue. However, it should be noted that because the EU CRF tables must be compiled by direct aggregation of the CRF tables provided by the countries the accounting value provided by the EU in its submission includes for the moment the value provided there by Romania.*

11.1.6 Definition of forest and any other criteria

The threshold values applied to define “forest” under the KP by EU MS, UK and Iceland are summarized in Table 11.7.

With an exception, threshold values and definitions applied for reporting forest areas under the KP are identical to those used to report forest area under the Convention. Finland 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.

Country	Minimum crown cover (%)	Minimum height (m)	Minimum area (ha)	Minimum width (m)

Country	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	10
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	--
Luxembourg	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	10
United Kingdom	20	2	0.1	20
Iceland	10	2	0.5	20

Only few countries provided explicit definitions on what is considered as natural forests. The vast majority of countries 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 national territories.

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 countries considered all national pre-1990 forest area to be subject to management and, therefore, associated to FM activity. Only in few cases, countries 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 countries 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, countries 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, countries 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 being 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 also 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, countries 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 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, countries 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 national submissions, the spatial assessment unit applied for identifying and tracking lands under Afforestation/Reforestation and Deforestation, as well as for Forest management, is in line with the thresholds value of minimum area, and minimum width (if applicable), used to define forest. This ensures that no 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 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 checking the consistency of the reported areas for land categories and KP activities across the time series.

Annual areas for KP activities are estimated by EU MS, UK 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 by the countries, 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, UK and Iceland

Country	Methods	Land identification and tracking features for the

	NFI	Mapping by Earth Observations methods	Land registry systems, including surveys	"lands" or "units of lands"
Austria	X			Statistical methods
Belgium	X	X		Statistical methods
Bulgaria	X			maps and forest management plans
Croatia	X	X		Statistical methods
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 GM)
Italy	X		X	Statistical methods
Latvia	X			Statistical methods
Lithuania	X	X		Wall-to-wall mapping approach (ARD) and statistical methods (FM)
Luxembourg		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 of the countries 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)

Country	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
Luxembourg	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 non-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 country. In addition, more detailed information on such methodologies can be found as an annex to this report (Annex III) and in the 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 the countries. 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 countries using notation keys for these carbon pools in the current inventory.

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 countries 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 countries, however some differences on which notation key have to be used when the "not a source" provision is implemented, still remain across submissions.

Table 11.10 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under AR activity by EU MS, UK and Iceland (for the year 2018), based on KP CRF tables.

AR						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0,97	0,26	0,77	0,02	0,44	NO,NA
Belgium	0,78	0,15	NO,NA	NO,NA	0,54	NO,NA
Bulgaria	2,67	NO,IE	0,40	NO,NE	-0,83	NO
Croatia	0,84	0,36	0,22	0,02	-0,25	NO,NA
Cyprus	0,59	0,16	0,27	NO	0,01	NO
Czech Republic	1,29	0,27	0,44	0,03	0,25	NO
Denmark	1,56	0,36	-1,04	0,02	0,11	-1,30
Estonia	0,46	0,20	0,30	0,01	0,17	-0,34
Finland	0,89	0,31	IE,NA	IE,NA	0,09	-1,13
France	1,16	0,47	0,16	0,03	0,05	NO,IE

AR						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Germany	6,16	0,90	0,47	0,22	-0,53	-2,25
Greece	0,54	0,10	NE,NA	NE,NA	NE,NA	NA
Hungary	1,45	0,37	NE,NA	0,08	NE,NA	NO,NA
Ireland	1,78	0,39	0,49	0,52	0,09	-0,74
Italy	0,79	0,16	0,01	0,01	0,12	NO,NA
Latvia	0,36	0,09	0,08	0,09	NO,NA	-0,52
Lithuania	1,47	0,27	0,09	NO,NA	0,47	-0,74
Luxembourg	3,46	0,70	0,29	0,10	0,43	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	3,12	0,44	NO,NE	0,10	0,01	-1,02
Poland	0,81	0,22	NO	NO	0,08	-0,68
Portugal	1,05	0,09	0,04	NO,IE	0,19	NO
Romania	1,93	NO,IE	0,06	NO,IE	NO	NO,IE
Slovakia	1,25	0,28	0,42	NO,NA	1,21	NO,NA
Slovenia	NA	NA	NA	NA	NA	NA
Spain	0,88	IE,NA	0,06	0,03	0,26	NO,NA
Sweden	0,70	0,23	0,23	0,03	-0,06	-2,09
United Kingdom	1,35	0,45	0,07	0,14	-0,64	-0,95
Iceland	0,96	0,24	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 the activity does not take 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 country 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 countries 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 in the cell, 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". This is also valid for other similar tables.*

Table 11.11 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under D activity in EU MS, UK and Iceland (for the year 2018), based on KP CRF tables.

D						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	-0,63	-0,15	-0,49	0,00	-0,40	NO,NA
Belgium	-2,59	-0,53	-0,20	-0,05	-1,15	NO,NA
Bulgaria	-0,88	NO,IE	-0,25	-0,04	-2,10	NO
Croatia	0,00	-0,02	-0,01	-0,01	-1,57	NO,NA
Cyprus*	0,15	0,04	-0,16	NO	-0,21	NO
Czech Republic	-1,46	-0,32	-0,19	-0,05	-0,17	NO,NA
Denmark	-1,11	-0,12	-1,39	-0,07	-0,29	-5,10
Estonia	-1,09	-0,26	-0,57	-0,06	-0,98	-1,53
Finland	-0,41	-0,12	IE,NA	-0,01	-0,29	-4,82
France	-1,52	-0,42	-0,17	-0,05	-0,66	NO,IE
Germany	-1,82	-0,13	-0,98	-0,12	0,24	-5,86
Greece	-0,32	-0,12	-0,14	-0,01	-1,76	NO,NA
Hungary	-3,34	-0,63	-1,04	-0,31	-0,73	NO
Ireland	-0,31	-0,05	-0,01	-0,01	-0,28	-0,96
Italy	-2,80	-0,59	-0,17	-0,09	-4,89	NO,NA
Latvia	-0,30	-0,16	-0,37	-0,50	-0,25	-5,02
Lithuania	-22,86	-5,73	-3,14	-1,36	-38,23	-87,89
Luxembourg	-0,63	-0,15	-0,13	-0,04	-0,62	NO,NA
Malta	NO	NO	NO	NO	NO	NO
Netherlands	-2,86	-0,38	-1,09	-0,08	0,09	-2,33
Poland	-1,20	-0,24	0,00	-0,02	-0,76	NO
Portugal	-0,28	-0,04	-0,04	IE	-0,98	NO
Romania	-2,22	IE,NA	-0,29	IE,NA	-2,17	NO,NA
Slovakia	-2,41	-0,53	-0,23	-0,14	-0,04	NO,NA
Slovenia	-0,93	-0,11	-0,07	-0,13	-1,09	NA
Spain	-1,02	IE,NA	-0,07	-0,03	-0,24	NO,NA
Sweden	-0,67	-0,23	-0,40	0,00	-0,71	-1,57
United Kingdom	-1,76	IE,NA	-0,55	IE,NA	-2,12	-7,90
Iceland	NO,IE,NA	NO,IE,NA	NO,IE,NA	NO,IE,NA	-0,62	-7,87

* *The values of IEF reported by Cyprus are not correct. Cyprus must report in its CRF table 4(KP-I)A.2 values for "losses" which are currently nor reported. . This issue has been identified during the QAQC checks implemented at Union level and communicated to Cyprus who has informed to be working on the solution of this issue. However, it should be noted that because the EU CRF tables must be compiled by direct aggregation of the CRF tables provided by the countries the accounting value provided by the EU in its submission includes for the moment the value provided there by. Cyprus*

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, removals and emissions from FM were not estimated 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.

However, Malta has informed that new information to report and update Forest Management activity has been gathered and will be used to report estimates in this category. For the time being, Malta has also stated that no controlled burning is allowed in those reserved forest, and moreover, no wildfires have occurred in those areas, from which emissions could have been omitted.

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.

Italy use the not a source provision for reporting DOM under CM and GM explaining that the pools are not estimated on the basis that either DOM stocks are insignificant (annual crops) and consequently any change is insignificant too or that DOM stocks are at equilibrium (perennial crops) and therefore that C stock changes are insignificant. Furthermore, considering that agricultural practices within the European Union policies are increasingly sustainable and climate-friendly and that the area of annual and perennial crops is decreasing across time any comparison among GHG fluxes in the base year and in the CP´s years results in a net sink so that the DOM pools cannot be a net source.

This year Italy reports for first time carbon stock changes from mineral soils under CM, which address the recommendation of the last ERT.

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 $ha^{-1}yr^{-1}$) by pool reported under FM activity in EU MS, UK and Iceland (for the year 2018), based on MS CRF tables.

FM						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0,253	0,030	NO,NE,IE,NA	0,059	-0,185	NO,NA
Belgium	0,387	0,066	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	0,466	NO,IE	NO,NE	-0,003	NO,NE	NO
Croatia	0,506	0,120	NE,NA	NE,NA	NE,NA	NO,NA
Cyprus	0,239	0,067	NO	0,003	NO	NO
Czech Republic	-0,656	-0,142	NO,IE	-0,011	NO,NE	NO
Denmark	0,970	0,073	-1,224	-0,108	NO,NA	-1,300
Estonia	0,226	IE,NA	NE,NA	0,012	0,188	-0,158
Finland	0,166	0,016	IE,NA	IE,NA	0,154	-0,185
France	0,345	0,140	0,001	-0,024	IE,NA	IE,NA
Germany	0,983	0,175	-0,013	0,094	0,410	-2,244
Greece	0,332	0,118	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Hungary	0,365	0,091	NE,NA	NE,NA	NE,NA	-2,600
Ireland	0,468	0,048	0,216	-0,100	-0,046	-0,449

FM						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Italy	0,783	0,158	0,003	0,002	NO,NE,NA	NO,NA
Latvia	0,272	0,068	0,002	0,062	NO,NA	-0,520
Lithuania	0,430	0,100	0,004	-0,018	NO,NE,NA	-1,476
Luxembourg	0,148	0,035	0,000	0,114	0,000	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	0,849	0,153	NO,NE	0,056	NO	-0,928
Poland	0,769	0,205	NO,NA	NO,NA	0,095	-0,680
Portugal	0,321	0,154	-0,002	NO,IE	-0,006	NO
Romania	0,801	NO,IE,NA	0,004	NO,NA	NO,NA	-0,680
Slovakia	0,370	0,142	NE,NA	NE,NA	NE,NA	NO,NA
Slovenia	-0,338	-0,067	NO,NA	0,167	NO,NA	NO,NA
Spain	0,533	NO,IE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Sweden	0,254	0,082	-0,073	0,057	0,186	-0,346
United Kingdom	0,449	0,136	0,028	0,312	0,476	0,780
Iceland	0,204	0,054	0,006	NO,IE,NA	0,014	-0,370

Table 11.13 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under CM activity in EU MS and UK (for the year 2017), based on MS CRF tables.

CM						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Denmark	0,001	-0,006	NO	NO	-0,086	-7,493
Germany	-0,010	-0,013	IE,NA	NO,IE,NA	-0,095	-7,812
Ireland	0,019	IE	NO	NO	0,036	NO
Italy	-0,024	-0,013	NE	NE	0,228	-10,000
Portugal	0,015	-0,003	-0,001	IE	-0,044	NO
Spain	0,027	IE	0,000	NO	0,017	NO
United Kingdom	0,014	NE,IE	NE	NE	-0,600	-5,001

Table 11.14 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under GM activity in EU MS and UK (for the year 2018), based on MS CRF tables.

GM						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Denmark	-0,1151	-0,0748	NO	NO	-0,0237	-6,6528
Germany	-0,0811	0,0058	IE,NA	NO,IE,NA	0,3654	-6,4876
Ireland	-0,0003	NO,IE	NO	NO	0,1442	-6,8030
Italy	NO	NO	NE	NE	0,0322	NO
Portugal	-0,0082	-0,0070	0,0006	IE	0,0960	NO
United Kingdom	-0,0107	NE,IE	NE	NE	0,1389	-0,0371

Table 11.15 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under RV activity in EU MS and Iceland (for the year 2018), based on MS CRF tables.

RV						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Romania	3,16	IE	0,01	NO	0,25	NO
Iceland	0,06	IE	IE	NO	0,51	NA

Table 11.16 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under WDR activity in UK (for the year 2017), based on its CRF tables.

WDR						
Country	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 countries report fertilization of mature forests (e.g. Sweden) or young plantations (e.g. UK). For the majority of them, 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 country 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 countries 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 counties 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 the JRC, and countries 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, countries 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 countries 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 EU MS, UK and Iceland to demonstrate that omitted carbon pools are not a net source of emissions.

Country	Activity	Reasoning
Belgium	AR (LT, DW) FM (LT, DW, SOCmin)	Consistent with tier 1 presented in IPCC 2006 Guidelines, section 2.3.2.2, it is assumed that afforestation results in buildup of litter and dead wood carbon pools, starting from zero carbon in those pools. DOM carbon gains on land converted to forest occur linearly, starting from zero, over a default transition period of 20 years. The litter and deadwood C stock is assumed stable in the case of forest management, with respectively 1,9 t /ha and 7,56 t C/ha. Consequently, no variation of the C stock for the DOM category is calculated for forest management. The UNFCCC review drew the attention to the fact that the carbon stock change applied for SOC appeared to be an outlier compared to other Parties. The SOC stock change reported by Belgium in the former submissions was the highest of all member states: 18 member States report no change in carbon stocks and the other present an extremely limited sink (or source for 2 MS). Only one Member State currently reports an annual change of the same order of magnitude. As a consequence, and considering that no recent information confirms that the drivers of the SOC change between 1960 and 2000 are applicable to the present forest, Belgium is revising its estimates for Soil carbon in this submission. In the absence of complete updated values from the regional forest inventories, it is deemed that the currently available data and studies do not allow the application of the average carbon stock change factor from 1960-2000 to the recent years, as it appears likely to overestimate the actual carbon stock change.
Bulgaria	AR (DW) FM (LT, SOCmin)	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	FM (LT, DW, SOCmin)	Data on wood removal from FRA reports (for 1990 FRA 2005 and for 2000 and 2005 FRA 2010) were compared to NIR data on fellings. The comparison indicated that not all wood was removed from the forest and that certain percentage (about 10-15%) was left in the forest; thus, contributing to a C input in other carbon pools. Reporting on wood removals under the FRA fits adequately to the wood removals practices conducted in Croatia that is performed in a way that harvest residues and wood less than 7 cm in diameter are left in the forest. Within the KP Forest management reporting, total gross fellings (i.e. including branches and bark) are reported. Considering latter, there are no underestimations in regard to dead wood. Furthermore, based on the available data on growing stocks and harvest which prove steadily increase in the standing stocks in Croatia (Table 11.3-5) while the forest management methods remain the same. Under such circumstances and due to the fact that mortality is correlated with stand density, also an increase in dead wood stocks is very likely, as indicated by the FRA results. Within the reporting period, there was no change in the forest management. At this moment in Croatia there is no expert and scientific literature or investigation the hypothesis soil pool under the Forest management is not a source of emissions. However, based on the data and information provided above that prove carbon stock increases in biomass, dead wood and litter pool, an increase in these pools is correlated with an increase of the C input to the mineral soil and consequently with an increase of carbon stock in soil. Consequently, it can be also assumed this pool is not a source of emission.

Country	Activity	Reasoning
Czech Republic	FM (SOCmin)	It is assumed that, under the conditions of current forestry practices in the country and at the country-level scale, forest soils do not represent a net source of CO_2 emissions. Justification for this approach is based on the targeted peer-reviewed modelling analysis performed for the actual circumstances of FM in the country (Cienciala et al., 2008b). It uses the well-established YASSO soil model (Liski et al., 2003, 2005) in combination with the similarly well-known and established EFISCEN forest scenario model (e.g., Karjalainen et al., 2002) and the actual data for forest biomass, growth performance and growing conditions in the country. The analysis shows that, under the adopted sustainable forest management practices implemented in the Czech Republic, the forest soil carbon pool (including litter) does not decrease, i.e., it is not a net source of emissions. The study contains further details on the country-specific model application, definition of scenarios and results related to both biomass and soil carbon pools, including the probable effect of changing climatic conditions. It also contains a discussion that elucidates the aspect of the YASSO model concept of litter input and aggregated output for litter/organic and mineral soil layers and its justification, as well as the reasoning with respect to the Kyoto protocol LULUCF reporting requirements. There is a wealth of literature on YASSO model applications that can be further consulted (www.environment.fi/syke/yasso). To conclude, the forest soil carbon pool and inherently the litter carbon pool under current forest management practices and growth trends can be assumed not to be a source of emissions. The underlying assumptions will be further verified.
Denmark	FM (SOCmin) CM (LT, DW) GM (LT, DW)	Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops, in accordance with IPCC Supplementary GPG 2014. No litter and dead organic matter are reported under CM, as this is seen as not occurring, or as very insignificant because it only related to a small area with fruit plantations and hedges. Therefore, only above- and belowground living biomasses for perennial fruit plantations, edgerows and willow plantations for bioenergy purposes on agricultural land, are reported under CM. CL converted to other land uses, such as WE and SE, is assumed not to store litter and other dead organic matter. Christmas trees are reported under Forest Management
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.
Greece	AR (LT, DW, SOCmin) FM (LT, DW, SOCmin)	Based on several studies SOC and DOM increase in AR. For FM, selvicultural 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 (LT, SOCmin) FM (LT, DW, SOCmin)	For FM and AR, Hungary does not explicitly quantify emissions and removals for three forest carbon pools, i.e. soil, deadwood and litter, but demonstrates that these pools are not a source. 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 LI is based on expert judgment which is a practicable method in our situation. Further demonstration is included separately for FM and R in the NIR

Country	Activity	Reasoning
Ireland	CM (DW, LT) GM /DW, LT)	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. Changes in biomass associated with transitions between grassland and croplands within the CM cohort are estimated. Changes in the biomass of hedgerows, and other non-forest wood features, have not been estimated. Biomass changes due to changes in the area of perennial woody crops are based on the analysis of the dominant crops, apple orchards and Christmas trees. It the case of Christmas trees, there is evidence that the market for trees is stable or increasing over time, and as such the biomass associated with this crop is stable or increasing, See section 6.4.7. The area of apple orchard decreased in the early 1990s but has been in near equilibrium in recent years as shown in Figure 6.21. Hedgerows are an integral part of the CM landscape. However, there is very limited long-term monitoring data as to conditions and extent of these features. The EPA has funded a research project to pilot an analysis of historic and contemporary remote sensing data to establish a robust time series of changes in these landscapes.
Italy	FM (SOCmin) CM (DW, LT) GM (DW, LT)	In relation to CM and GM, Tier1 is applied for litter and deadwood pools: those pools are not estimated on the basis that either DOM stocks are insignificant (annual crops) and consequently any change is insignificant too or that DOM stocks are at equilibrium (perennial crops) and therefore that C stock changes are insignificant. Furthermore, considering that agricultural practices within the European Union policies are increasingly sustainable and climate-friendly (see figure 9.2) and that the area of annual and perennial crops is decreasing across time any comparison among GHG fluxes in the base year and in the CP-year's results in a net sink so that the DOM pools cannot be under any circumstances a net source. Following the main finding of 2011 review process, Italy has decided not to account for the SOC changes in mineral soils from activities under forest management, providing transparent and verifiable information to demonstrate that SOM in mineral soils is not a source, as required by par. 21 of the annex to decision 16/CMP.1.
Latvia	FM (SOCmin)	According to the NFI conversions to forestland that can be classified as afforestation/reforestation take place only on grasslands. 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.
Lithuania	AR (DW) FM (SOCmin)	Based on NFI 1998-2011 data changes of dead wood are not significant in the afforested and reforested lands, as any dead wood in young forest stands usually are fine (trees from natural losses or thinning residues) and decay in one year. For estimation of carbon stock change of dead wood, it was assumed to be zero and reported as 'NO'.
Malta	FM (LB, DW, LT SOCmin)	Considered in equilibrium following a recommendation of ERT during the in-country review.
Netherlands	AR (LT) FM (LT, SOCmin)	The NIF provides an estimate for the average amount of litter (in plots on sandy soils only) and the amount of dead wood (all plots) for plots in permanent forests. The data provide the age of the trees and assume that the plots are no older than the trees. However, it is possible that several cycles of forest have been grown and harvested on the same spot. The age of the plot does not take into account this history or any effect it may have on litter accumulation from previous forests in the same location. Therefore, the age of the trees does not necessarily represent the time since AR. This is reflected in a very weak relation between tree age and carbon in litter and a large variation in dead wood, even for plots with young trees. Apart from Forest land, no land use class has a similar carbon stock in litter (in Dutch Grassland, management prevents the built-up of a significant litter layer). The conversion of non-forest to forest, therefore, always involves a build-up of carbon in litter. But because good data are lacking to quantify this sink, we report the accumulation of carbon in litter for AR conservatively as zero.

Country	Activity	Reasoning
Poland	AR (LT DW) FM (LT, DW)	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. In lack of representative measurements, the rate and timing of accumulation is not known, however, standard forestry experience suggests that they depend on species, site and silvicultural regime, and quickly accumulate over time. Fast growing species are usually planted so that no large amount of deadwood is produced, or thinned so that self-thinning does not ensue, but litter is continuously produced even in these stands. On the other hand, slow-growing species tend to produce dead wood and litter even at an early stage. Overall for all AR land, also considering that AR activity has been continuous since 1990 and stands on AR land are usually younger for deadwood and litter accumulation to saturate, it can safely be concluded that the carbon in the deadwood and litter pools in AR lands was increasing between 2008-2010, i.e. these pools are not a source. The above demonstration is based upon well-established principles of forest science, the every-day experiences of forestry practice, the experience and data of forest surveys, as well as sound reasoning.
Romania	AR (SOCmin) FM (DW, SOCmin) RV (DW)	DW in Afforestation/Reforestation and Revegetation is reported as NR (as not occurring or it is considered as a very small sink since initial mass is null, then it could only increase in time, or in any case it cannot decrease). Litter becomes a measurable pool in AR lands in some 4 years since planting (sampled data is available from Romanian JI and national FORLUC project mentioned under AFOLU sector chapter), thus C stock change is estimated and reported. Instead, DW cannot be defined as a standing alone pool, also recalling that dead wood is considered under same definition and dimensional thresholds as in NFI. Nevertheless, by the age of 20 years old of stands, the dead trees barely occur caused by natural mortality and especially by competition. This should lead to a continually increasing number of dead trees, thus expected that inputs are larger than decomposition. With such argumentation, we can safely and conservatively assume that DW is not a net source of emissions on AR lands. Forest Management – C stock changes in organic matter pool of mineral soils For the year 2018 in order to estimate the C stock change in mineral soils the 3.2.32 equation has been used. The values of C stock were obtained from NFI and the data indicate no changes between the two NFI cycles. For the moment the lack of information at plot level or common region from NFI the tier 1 approach was used to obtain C stock change.
Slovakia	AR (DW) FM (LT, DW, SOCmin)	It can be demonstrating that DW carbon pool is not a source of CO_2 emissions. The evidence is based on increasing growing stock in Slovak forests published in the latest Slovak Green Report 2017 http://www.mpsr.sk/en/index.php?navID=17&id=67. The growing stock in forests is gradually increasing as indicated by trends and actual age structure of forests. On large temporal and spatial scales, the amount of deadwood is roughly proportional to the growing stock. The statistically representative empirical data from the second Slovak NFI, which will confirm this assumption, are under the evaluation. Slovakia has assumed that, under the conditions of current forestry practices at the country level, forest soils and litter do not represent a net source of CO_2 emissions. This assumption was confirmed by soil data analysis (Slovak ICP forests data) in 1993 and 2006 (Table 11.11). The results of statistical analysis have not confirmed the changes of soil C stocks in FM areas. A similar conclusion was obtained from comparison of carbon stocks in litter. The litter C stock in 2006 were even found slightly higher compared the first evaluation (1993).
Slovenia	AR (DW) FM (LT, SOCmin)	For calculations of carbon stock changes in litter and soils “a pool is not a source” approach was used. According to this approach the net emissions/removals from litter and soils is balanced and therefore equal to zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal and Simoncic 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.

Country	Activity	Reasoning
Spain	FM (LT, DW, SOCmin) CM (DW)	Regarding the forest's DW and LT deposits, at least in the inventoried period (1990-2018), the set of both deposits it has not been a source, but rather a sink. However, accurate quantification of the net fixation of C by the set of these two arrangements is not presented in this edition of the National Inventory, since the process of modifications is still in progress development.
United Kingdom	CM (DW,LT) GM (DW, LT)	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 program for these activities to enable full reporting by the end of the commitment period.
Iceland	AR (DW) RV (DW)	Change in the carbon stock of other vegetation than trees are omitted in this year's submission. A research project where carbon stock in other vegetation than trees was measured on afforestation sites of different ages of larch plantations did show very low increase C-stock 50 years after afforestation although the variation inside this period where considerable (Sigurðsson, et al., 2005). Losses in Revegetation are not specifically detected. The losses are assumed to be reflected as changes in the C-pool estimates of NIRA. Potential losses include losses in revegetated area, due to changes in land use. Losses in C-pools through grazing, biomass burning, and erosion are also recognized as potential. These losses are expected to be detected in the current NIRA upgrade and will be reported in future submissions.

For a consistent demonstration of 'not a source', EU MS, UK 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.

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)

Country	Overview of reasons for recalculations
Austria	The HWP production figures for the years 2006 to 2017 were updated in the most recent FAO statistics. Consequently, the HWP removal figures for afforestation and forest management for the years 2013 to 2017 had to be updated accordingly and led to a change in the annual HWP removals of afforestation in the range of -0.01 to 0.15 kt CO_2e and in the annual HWP removals of forest management in the range of -0.73 to 8.40 kt CO_2e for these years.
Belgium	Wallonia: Update Of the land use change matrix. This decreases the areas under afforestation and deforestation for the recent years, with impact on Art 3.3. estimates and a slight impact on Art 3.4 (increase of the area under FM). Further details are presented in section 10.2 Flemish region: Most important recalculations were because of the addition of a matrix reference year 2015. Consequently, a less steep trend is observed for the years from 2013 on. ▯ An update of the matrix reference years 1990 – 2009 – 2012 has been made. The most changes occurred in the categories grassland and cropland as well as (but less) LUC in the other categories. Brussels region: Matrix update : 2018 was added, and
Bulgaria	Recalculations reflect the changes made in estimation of the average biomass growth of stands from first and second age classes as the expansion and conversion factors have been recalculated. The losses of biomass and dead wood due to deforestation have been recalculated as a technical error in its previous estimations have been found. N_2O Emissions from N mineralization associated with a loss of soil organic matter have been estimated and reported.
Croatia	The new value for soil carbon stock in sealed areas is determined. The CS in soil changed from previously reported 18.08 tC/ha to 17.89 tC/ha as a result of new CLC data on sealed and unsealed areas in Settlements that are used for NIR 2020 reporting The performed estimation led to the average difference of 0.23% between emissions/removals for total ARD activities between NIR 2019 and NIR 2020 in period 2008-2017.
Cyprus	This is the first submission hence no recalculations are reported.
Czech Republic	In response to the issues KL.8 and KL.9, data of the available statistical programs, i.e., NFI1 (2001-2004), NFI2 (2011-2014) and the landscape inventory CzechTerra (CZT 1 2008-2009 and CZT 2 2014-2015), were used to construct trend line and estimate carbon stock change also for the previously missing years of the reporting period. This applies both for standing and lying deadwood components. Hence, this revision resulted in a complete data series for this subcategory. The updated estimates marginally changed emissions in this category, extending the estimates prior 2001 and beyond 2015 using the observed trends.
Denmark	Only recalculations due to update with minor adjustments of the land use mapping. Transition time for Land Use Conversion have been changed to 30 years for all land use Conversions.
Estonia	Areas subject to Afforestation/Reforestation, Deforestation and Forest management are updated annually by NFI, new data is integrated into the overall activity data. New method was applied for estimating carbon stock changes in biomass under the AR category; previously it was calculated on the basis of differences in the aggregate average growing stocks for the total AR area, but in the current submission C stock changes in the subcategories (CLtoFL, WLtoF, SLtoFL) are summed to obtain aggregate emissions. Also, miscalculation errors were corrected, resulting in recalculations for dead wood and soil C pools in AR and D categories. In Table 10.3, Table 10.4 and 10.5 an overview of the quantitative impact of ARD and FM recalculations has been provided. 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. 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. For the forest management tree growth, a recalculation was applied due to new NFI data. Due to the recalculation of activity data and biomass stocks to calculate litter input, also time series in carbon stock changes of mineral and organic soils were recalculated. For more information about recalculations related to forest land see Section 6.4.5 and Appendix_6c. Losses in living biomass (due to harvesting) on afforestation were recalculated due to new NFI data and due to new BCEFs calculated specifically for afforestation drain (in the previous submissions the BCEFs for forest management were applied). Biomass burning emissions were recalculated due to inclusion of restoration burnings, which are reported under controlled burning in CRF Table 4(KP-II)4 (see Section 6.10.5). For harvested wood products, small updates in the FAOSTAT production data and application of national data for mechanical and semi-chemical, and chemical wood pulp caused a small recalculation for the year 2017. For the years 2014 to 2016 a minor recalculation was conducted due to updates in the FAOSTAT data
France	The carbon balance of the forest has changed over the past few years due to the integration of the new IGN campaign. This integration has notably led in the past few years to a further drop in gross production and an increase in mortality

Country	Overview of reasons for recalculations
Germany	The recalculations were carried out in connection with the KP categories Afforestation (A), Deforestation (D) and Forest management (FM), which Germany is required to report on, and with Cropland management (CM) and Grazing land management (GM). They were needed due to modification of numerous emission factors (phytomass, mineral soils and dead wood (cf. Chapters 10.1.1.1 and 11.3.1.4) and of the method for surveying land use. For Harvested Wood Products (HWPs), the product categories a) paper and paperboard, b) sawn lumber and c) wood materials were updated, with the help of the FAÖ database (cf. Chapter 6.10.5).
Greece	The KP information submitted in 2020 did not undergo any recalculations.
Hungary	This year, some numbers have changed for the HWP pool Table 11.10. The reasons for this are the same as those for the UNFCCC reporting. For other details, see Chapter 6.1.4. Note that the scale of difference expressed in percent may be misleading due to the reference which in the case of (gross or net) removals can be close to zero and does not necessarily represent a useful reference for the calculation of percentages.
Ireland	Cropland Management: - Refinement of the analysis of the LPIS spatial dataset; Further information on these recalculations is presented in section 6.4.11. Grazing land Management: - Revised assessment of land area statistics and management practices. Revised area of organic soils. Further information on these recalculations is presented in section 6.5.7.
Italy	A comprehensive comparison of 2020 and 2019 submissions has been carried out; in table 9.9 a summary related to the ARD and FM activities is reported. With reference to the ARD activities, the 2020 submission results in a slight deviation for the Afforestation/Reforestation activities (average decrease of 0.91%), due to the update, for 2017, of the harvest volume for some regions, and no deviations for Deforestation activities, respect the previous estimates. An average decrease of 1.56% results by the comparison of the last two submissions for FM activities, due to the update, for 2017, of the harvest data on the basis of the extraordinary data collection, implying also the revision of latest years data, put in place by the regions (Trentino Alto Adige, Veneto, Friuli Venezia Giulia, Lombardy and, only marginally, Piemonte and Valle d'Aosta) affected in late 2018 by the Vaia storm.
Latvia	Implementation of changes due to improvement of activity data by the NFI team, which leads to minor changes in the whole time series. The most significant changes in activity data are associated with transfer of lands converted to forest lands with signs of human induced afforestation (as soon as these signs, like tending, thinning, supplementary planting or legal conversion of land use in forest register, are identified by the NFI teams) from the forest management activity to afforestation activity. Recalculations are done for the whole time series starting from the year of afforestation
Lithuania	Difference in total GHG removals from forest land resulted in adjustment of living biomass carbon stock change in forest land remaining forest land due to the newest growing stock volume data applied – extrapolated values in two latest years (for 2016 and 2017) were replaced with actual values. In addition to this adjustment, share of organic soils was updated using the most recent NFI (NFI 2014-2018) data, which resulted both in change of GHG emissions from drained organic soils and carbon stock changes in mineral soil of land converted to Forest land. In addition to this, correct value of litter carbon stock in Grassland previous to the conversion to Forest land was applied to estimate carbon stock change in dead organic matter of Land converted to forest land.
Luxembourg	No recalculations have occurred in the KP-LULUCF inventory since submission 2019.
Malta	During the UNFCCC in-country review of the GHG emissions and removals Inventory for Malta of October 2016, the Forest Reference Level was reviewed based on changes in the forest land category of the LULUCF. Thus, through the help of the LULUCF Expert Review Team, the FMRL was recalculated and set to zero.
Netherlands	This year, five methodological changes have been implemented resulting in changes in various carbon stock changes and associated emissions and removals along the whole time series (see Chapter 6.1). These also resulted in recalculations for AR, D and FM. Because the separate changes may interact with each other, the effects of the separate changes cannot be quantified.
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 that are reported in the relevant sections. For previous recalculations, see our previous NIRs.
Portugal	No recalculations have occurred in the KP-LULUCF inventory since submission 2019.
Romania	Parameter values used to estimate annual increment of living biomass (country specific); Annual decrease of carbon stock due to biomass loss ; Annual carbon loss due to wood harvesting ; Annual change in Deadwood pool (Changing the method of reporting to Stock Change in the case of deadwood pool in forestland remaining forest land. Changes in the carbon stocks in the harvested wood products (HWP) pool were estimated based on the methodological guidance of the IPCC 2006 GL the IPCC 2013 KP Supplement,

Country	Overview of reasons for recalculations
	and IPCC Refinements 2019
Slovakia	No recalculations have occurred in the KP-LULUCF inventory since submission 2019.
Slovenia	Considering ERT revision report and recommendations data and methodologies were internally revised, and recalculations were made.
Spain	Emissions / removals from the period 1990-2017 of this edition of the National Inventory of LULUCF sector, differ from those collected in the previous edition, due to changes in the underlying information available
Sweden	Recalculations can be divided into several sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the MI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calculations and needs to be corrected.
UK	Reconciliation of harvest volume and forest age data (see section 6.2.7). Improvement to the soil model describing soil acidity. Correct the half-life used for pallet wood to be that for sawn wood (35 years), not 25 years. Updates to deforestation activity data. A change in the soil carbon density used for calculating the effect of cropland management on mineral soils.
Iceland	As explained in Chapter 6.4. and above in Chapter 11 are data on area in CF slightly revised. This led to revision on area dependent stock changes. Emission/removal factors used are unchanged

11.3.6 Improvement status and plan

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 during the UNFCCC expert review:

- The layout of table 11.17 was changed for a better readability of the information.
- More clear description on whether Malta intends to apply the natural disturbances provision has been added.
- An error found in the reporting of HWP from Deforestation in Hungary, Romania and Latvia was discussed and resolved. These countries stated that they do not have HWP from trees growing in deforested lands and that reporting quantities previously submitted were the result of an error while importing the data.
- Italy has increased the completeness of the carbon stock changes in its inventory. Italy reports for first time carbon stock changes from mineral soils under Cropland.
- Inclusion of information on KC for all the countries, despite of remaining bugs in the CRF Reporter Software, which prevent the inclusion of that information in the CRF table NIR-3 for some countries.
- We have added information on the approach used by Iceland for the implementation of the ND provision.
- Belgium estimated carbon stock changes in HWP for the whole time series, which has resulted in the current reporting of this carbon pool in KP.
- More information on HWP originating from Deforestation events is now provided in the CRF table (i.e. information item) of the countries for which this source of HWP is relevant. Information has been also added in the relevel subsection of this NIR to clarify the origin of HWP from deforested lands reported by Denmark.

Furthermore, the EU plans to continue devoting efforts to enhance the overall TACCC of the KP information with some further improvements and the correction of some identified issues for which a correction was not possible in this submission. In particular, the focus will be on:

- To continue tracking the consistency among the data reported within CRF tables NIR-2 and background KP activity tables to resolve some remaining inconsistencies reported by individual inventories that were not corrected on time for the submission of this inventory.
- To continue working with countries to ensure the completeness of the inventory, in particular with Malta for the mandatory KP activities, and with UK in order to provide quantitative estimates for the KP activities including WDR.
- To continue supporting countries 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 countries towards the harmonization on the use of the notation keys.
- To continue working with Romania to ensure that the use of new NFI data used in the estimation of the emissions/removals from forest related activities does not results in an inconsistent reporting of the time series.
- To continue working with Cyprus to ensure that the reporting of carbon stock changes in Living biomass under Deforestation in CRF table (KP-I) A.2 includes "losses"

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. Detailed information on these QAQC procedures can be found in chapter 6

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 ensuring 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, UK and Iceland aimed at demonstrating that Afforestation/Reforestation activities are direct human-induced.

Country	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	
Czechia	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			
Luxembourg			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 countries, so that around 90% of the total area reported under conversion to forest land is assumed as directly human-induced AR. However, some countries 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 countries 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 countries 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 EU MS and Iceland in their GHG inventories.

Country	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 photointerpretation 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 an 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 an 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

Country	Short description
	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 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 monitor 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 for 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.
Luxembourg	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

Country	Short description
	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 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; 13 MS, UK and Iceland originally stated in their “Initial Reports” the intention of excluding emissions resulting from natural disturbances that affect AR lands during the CP2. However, during the review of that submission, Malta indicated that it would not exclude emissions from natural disturbances for any KP-LULUCF activity irrespective of the information in its Initial Report. (Table 11.21).

In general, countries 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 countries 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 countries 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 countries 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, countries 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 countries 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.

Countries 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, countries 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 countries 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 EU MS, UK and Iceland that intend to apply the natural disturbance provision under AR activity during CP2, as reported in individual NIR

Country	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	0.000	0.000	Wildfires

Country	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
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
Portugal	Default method	29.870	9.540	---
Romania	Default method	0.200	0.220	Wildfires
Spain	Default method	[0.287t CO_2eq/ha.]	[0.209t CO_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	---	---	---	Only ND of catastrophic size that heavily will affect the normal emission/removal account

So far, emissions from natural disturbances have not been excluded from the accounting of AR activities. Some countries 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 countries 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 countries 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 GHG inventories.

Some countries 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 countries 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, countries 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, countries 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 countries report, and account, for emissions and removals from HWP originated from trees growing in lands subject to deforestation. While, some countries 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.

Emissions and removals that are reported from HWP originating from Deforestation lands are in overall insignificant. For this year submission, Denmark reports 5.37 kt CO_2. Denmark were requested to provide information on how HWP from Deforestation events (i.e. to be accounted for as instantaneous oxidation) are distinguished from HWP resulting from trees growing in previously deforested lands.

Denmark explained that despite of that small quantity, in general there are no HWP resulting from trees growing in previously deforested lands because Deforestation in the period since 1990 have been reported for land use changes from forestry to other land uses, mainly cropland, grassland and settlement. The very few areas having truly changed from forestry – another land use – forestry within the reporting period, will in no circumstances have reached a size (height/diameter) that can provide HWP products. This deforestation will have been in effect for at least 1-2 years before any reforestation could occur. The land use matrix is based on wall-to-wall mapping in 1990, 2005 and 2011 and subsequently annual updates based on cadastral data and the Land Parcel Information System which is able to track and capture that land.

As with regards to the former reporting of HWP under deforestation by Hungary, Latvia and Romania, it has also been clarified that the former reporting approach was due to an error in the data importing procedure that has now been resolved.

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 enters 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 are management activities, they always qualify as direct human induced. In most of the cases, countries 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 of years ago. Currently, each country 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 countries 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 comparison 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.

Finally, as previously mentioned, Malta does not report removals and emissions from FM 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.

11.5.2.1 Conversion of natural forest to planted forest

The vast majority of countries have 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 2018, only Romania (9.071 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.

11.5.2.2 Forest Management Reference Level (FMRL)

For the construction of the FMRL, EU MS, UK 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, UK, 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; 10 MS, UK 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, UK and Iceland in this inventory year.

Country	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	1940		X	
Bulgaria	-7950	NA		X	
Croatia	-6289	905	X		
Cyprus	-157	NA			X
Czech Republic	-4686	NA		X	
Denmark	409	-83	X		
Estonia	-2741	NE		X	
Finland	-20466	-10938	X		
France	-67410	21795		X	
Germany	-22418	5268	X		
Greece	-1830	210			X
Hungary	-1000	-40		X	
Ireland	-142	-934	X		
Italy	-22166	-1680		X	
Latvia	-16302	11703		X	
Lithuania	-4552	-922		X	
Luxembourg	-418	182		X	
Malta	-49	49			X
Netherlands	-1425	NE		X	
Poland	-27133	NA	X		
Portugal	-6830	3261	X		
Romania	-15793	NE		X	
Slovakia	-1084	-2459		X	
Slovenia	-3171	NE	X		
Spain	-23100	NO		X	
Sweden	-41336	7878	X		
EU*	**-307 055**	**41 959**	----	----	----
UK	-8268	-9725	X		
Iceland	-154	77	X		
EU + UK+ Iceland **	**-315 476,5**	**32 310,7**	----	----	----

**The FMRL value for EU is: The value inscribed in the Appendix to the annex to decision 2/CMP.7 for EU27 (applying FOD function for HWP for those EU MS for which this value is available in the decision or instantaneous oxidation, when FOD function value is not available), plus the value applying instantaneous oxidation inscribed for Croatia, minus the value of UK..*

*** The FMRL value for EU+UK+ISL is: The value inscribed in the Appendix to the annex to decision 2/CMP.7 for EU 27(this includes UK as at that time UK was a EU MS) , plus the values applying instantaneous oxidation inscribed for Croatia, plus the value of Iceland .*

It should be noted that the FMRL value inscribed in the decision 2/CMP.7 for the EU corresponds to the 27 EU MS that were part of the Union at that moment. Such values as inscribed in the appendix of the decision are:

I. -253 336 kt CO_2 eq/yr, applying instantaneous oxidation,
II. -306 736 kt CO_2 eq/yr, applying first-order decay function for HWP.

Nevertheless, although these values are included here for information purposes. It is important to bear in mind that the accounting quantities for the KP activity FM as reported in the CRF table Accounting of the EU GHG inventory depends on the FMRL values and their technical corrections (TC) reported by countries in such CRF table. Thus, in order to ensure the consistency among the EU GHG inventory (i.e. as a sum of individual 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 as reported by current EU MS plus, UK plus Iceland:

I. FMRL: -315 476.5 kt CO_2 eq/yr
II. TC: 32 310.7 kt CO_2 eq/yr

Doing it in this way, 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.

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, countries 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 EU MS, UK 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 countries 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 countries 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 done for some EU 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 countries 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

Country	Information on the need for applying Technical Correction to the FMRL
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:
Belgium	Updated historical data became available since the submission of the FMRL in 2011 and recent improvements were performed in the inventory. The most important recalculation in 2019 is Soil organic carbon, with a difference around 1350 kt CO_2-eq. The second one are the revisions in Wallonia (forest inventory data and BEF), which reduces the sink by 350 kt CO_2 from 2002 to present. Considering the magnitude of the changes, a technical correction of the reference level is proposed, in order to ensure methodological consistency between the FMRL and the current reporting for forest management.
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 report-ed 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.
France	here are no plans to completely recalculate the FMRL based on new modeling. The modification of the calculation parameters is therefore not intended to improve the consistency between the FM activity and the FMRL, in particular with regard to the age class structure and the areas. However, the FMRL modeling is brought back into overall coherence with the inventory using a technical correction.
Germany	With regard to carbon stocks in living biomass, the previous FMRL, which was reported to the UNFCCC Secretariat and the EU in 2011, is based on data of the 2008 Inventory Study and, for the projection, on the forest management scenario of the WEHAM forest development and wood-production model. For the pools dead biomass (litter, dead wood) and soils, and for emissions from fertilization, drainage and combustion of biomass (forest fires), country-specific emission factors either were not available or were not recorded. Carbon in harvested wood products (HWP) was not accounted for in a manner consistent with decision 2/CMP.7 and the KP Supplement adopted following the submission of the FMRL. The reference level used to date does not contain all categories and other emissions that are reported relative to KP 3.4, pursuant to the current rules for GHG reporting, and thus are part of the pertinent accounting (cf. Table 510). Additional recommendations relative to corrections are provided in the "Report of the technical assessment of the FMRL submission of Germany submitted in 2011" (FCCC/TAR/2011/DEU). For this reason, Germany has carried out a technical correction of the FMRL.
Finland	The FMRL was constructed in 2011 and since then, several changes have been done to the applied data and methods. New NFI data are used to estimate FM and D areas for 1990-2009. Recalculated CO_2 emissions from drained organic soils. Emissions from wildfires were estimated according to 2006 IPCC Guidelines. Correction to the emission factor of N_2O emissions from drained organic forest soils. The MELA model was adjusted to more accurately produce the historical results. Fuelwood consumption in small-scale housing (5.5 million m3 per year) was included, it was previously not included in the reference scenario used for the FMRL which was based on the Finland's National Forest Program 2015 (Ministry of Agriculture and Forestry 2008).

Country	Information on the need for applying Technical Correction to the FMRL
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
Italy	The following changes have been done since the submission of the MFRL which trigger the need for TC: The FMRL has been calculated with the EU models G4M (IIASA) and EFISCEN (EFI). Estimates of emissions and removals under FM activities have been carried out with the growth model For-est, used to estimate the net change of carbon in the five reporting pools. Availability of new data resulting from the ongoing NFI and consequent recalculations of the reported data under FM and Forest Land Remaining Forest Land used to establish the reference level. The estimates have been carried out on the basis of the 2013 KP Supplement (IPCC 2014) methodology
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.
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.
Romania	A technical correction is planned in the light of new data available from NFI (for 2008-on).
Slovakia	Technical corrections were (TC) calculated for the first time in submission 2018. The actual value of technical correction is -1 164.0 kt CO_2 eq. the TC values recalculated for 2019 submission. Methodology for reporting of Forest Management evolved significantly during CP2, leading to relatively high value of TC.

Country	Information on the need for applying Technical Correction to the FMRL
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. T - 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;
ISL	Iceland did estimate Forest Management Reverence level (FMRL) for current commitment period in February 2011 (Snorrason, 2011). It was clear in the beginning that the estimates were uncertain. Especially was the estimate for the natural birch forest (NBF) critical as the ERT did point out (see page 19 paragraph h) in Synthesis report of the technical assessments of the forest management reference level submissions. Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol Sixteenth session, part four Durban, 29 November 2011. FCCC/KP/AWG/2011/INF.2) New approach to estimate the change in the carbon stock of natural birch forest was conducted soon after the reference level was accepted.

11.5.2.4 Carbon equivalent Forest Conversion

This provision is not relevant for EU MS, or for UK, or Iceland.

11.5.3 Information related to the natural disturbances provision under article 3(4)

In accordance with decision 2/CMP.7; 18 MS, UK and Iceland originally stated their intention of excluding emissions resulting from natural disturbances that affect areas subject to FM during CP2, (Table 11.24). However, during the review of that submission, Malta indicated that it would not exclude emissions from natural disturbances for any KP-LULUCF activity irrespective of the information in its Initial Report.

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.

As with the KP activity AR, so far, emissions from natural disturbances have not been excluded from the accounting of FM activities.

Table 11.24 **Synthesis of Information from EU MS, UK and Iceland that intends to apply the natural disturbance provision under FM activities during CP2.**

Country	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	14.910	23.030	Wildfires, extreme weather events – windbreaks, snow breaks and ice breaks
Croatia	Default method	59.480	114.070	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	---	---	---	Only ND of catastrophic size that heavily will affect the normal emission/removal account

11.5.4 Information on Harvested Wood Products under Article 3(4)

All counties 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, five countries have reported quantitative information on CRF table 4(KP-I) C. All the other 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 countries 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 program and efforts on methodological development.

Definitions implemented by the countries 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

Countries 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 countries 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 2019 for the EU[71] 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 31.12.2019 as well as information on transfers of the units in 2019 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.[72] 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'[73]. 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[74] and was established upon the completion of the initial review[75]. 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.

[71] The Community registry was replaced by the Union registry in 2012

[72] OJ L 207, 4.8.2015, p. 17

[73] 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.

[74] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016SC0316&from=en

[75] Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of the European Union - FCCC/IRR/2016/EU - GE.18-07661(E)

Table 12.1 Transactions included in Table 2(b) in the EU registry.

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Total transfers and acquisitions												
AT	NO	NO	NO	531	NO	NO	NO	NO	NO	NO	NO	NO
AU	NO	NO	NO	722.419	NO	NO	NO	NO	NO	1.092.080	NO	NO
BE	NO	NO	NO	1.523	NO	NO	NO	NO	NO	NO	NO	NO
CDM	NO	NO	NO	515	NO	NO	NO	NO	NO	NO	NO	NO
CH	NO	NO	NO	3.768.871	NO	NO	NO	NO	NO	3.696.943	NO	NO
DE	NO	NO	NO	4.899.665	NO	NO	NO	NO	NO	386.230	NO	NO
DK	NO	NO	NO	1.199	NO	NO	NO	NO	NO	299	NO	NO
ES	NO	NO	NO	365.442	NO	NO	NO	NO	NO	136.345	NO	NO
FI	NO	NO	NO	334.701	NO	NO	NO	NO	NO	111.721	NO	NO
GB	NO	NO	NO	437.845	NO	NO	NO	NO	NO	700.153	NO	NO
IT	NO	NO	NO	12.401	NO	NO	NO	NO	NO	95.000	NO	NO
NL	NO	NO	NO	12.730.228	NO	NO	NO	NO	NO	296.710	NO	NO
NO	NO	NO	NO	277.593	NO	NO	NO	NO	NO	261.018	NO	NO
SE	NO	NO	NO	1.420.654	NO	NO	NO	NO	NO	101.145	NO	NO
FR	NO	NO	NO	NO	NO	NO	NO	NO	NO	111.895	NO	NO
IE	NO	NO	NO	NO	NO	NO	NO	NO	NO	400.576	NO	NO
LI	NO	NO	NO	NO	NO	NO	NO	NO	NO	53.463	NO	NO
Sub-total	NO	NO	NO	24.973.587	NO	NO	NO	NO	NO	7.443.578	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 lCERs 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
No ERUs have been issued in the EU Registry in 2018
No ERUs have been issued in the EU Registry in 2019

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
No AAUs have been issued in the EU Registry in 2018
No AAUs have been issued in the EU Registry in 2019

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

No ERUs have been issued in the EU Registry in 2018

No ERUs have been issued in the EU Registry in 2019

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
2018	ES	0	0	0	22.316
2018	GB	0	0	0	5.775.293
2018	DE	0	0	0	3.805.830
2018	CH	0	0	0	8.469.849
2018	SE	0	0	0	2.465.927
2018	NL	0	0	0	8.531.061
2018	NO	0	0	0	121.637
2018	FI	0	0	0	58.031
2018	IT	0	0	0	4.789
2018	AU	0	0	0	975.901
2018	DK	0	0	0	2.559
2018	BE	0	0	0	107.616
2019	AT	0	0	0	531
2019	AU	0	0	0	722.419
2019	BE	0	0	0	1.523
2019	CDM	0	0	0	515

2019	CH	0	0	0	3.768.871
2019	DE	0	0	0	4.899.665
2019	DK	0	0	0	1.199
2019	ES	0	0	0	365.442
2019	FI	0	0	0	334.701
2019	GB	0	0	0	437.845
2019	IT	0	0	0	12.401
2019	NL	0	0	0	12.730.228
2019	NO	0	0	0	277.593
2019	SE	0	0	0	1.420.654
TOTAL		**0**	**0**	**0**	**187 017 959**

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

No RMUs have been issued in the Union registry in 2018

No RMUs have been issued in the Union registry in 2019

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
2018	ES	0	0	0	174.349
2018	GB	0	0	0	405.983
2018	DE	0	0	0	283.839
2018	LI	0	0	0	28.938
2018	CH	0	0	0	4.113.163
2018	SE	0	0	0	162.030
2018	NL	0	0	0	256.230
2018	NO	0	0	0	109.909
2018	FI	0	0	0	90.271
2018	IT	0	0	0	105.000
2018	AU	0	0	0	1.458.014
2018	DK	0	0	0	952
2018	FR	0	0	0	336.000
2019	AU	0	0	0	1.092.080
2019	CH	0	0	0	3.696.943
2019	DE	0	0	0	386.230

2019	DK	0	0	0	299
2019	ES	0	0	0	136.345
2019	FI	0	0	0	111.721
2019	GB	0	0	0	700.153
2019	IT	0	0	0	95.000
2019	NL	0	0	0	296.710
2019	NO	0	0	0	261.018
2019	SE	0	0	0	101.145
2019	FR	0	0	0	111.895
2019	IE	0	0	0	400.576
2019	LI	0	0	0	53.463
TOTAL		**0**	**0**	**0**	**57 280 256**

No ERUs, CERS, AAUs or RMUs were transferred to other registries in 2018.

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
2018	0	0	0	0
2019	0	0	0	0
TOTAL	**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
2018	0	0	0	0
2019	0	0	0	0
TOTAL	**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
2018	0	0	0	4.115.756
2019	0	0	0	4.520.677
TOTAL	**0**	**0**	**0**	**13.437.408**

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
2018	0	0	0	0
2019	0	0	0	0
TOTAL	**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[76], 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.

The United Kingdom has left the EU on 1 February 2020, but will continue to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[77].

[76] Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of the European Union - FCCC/IRR/2016/EU - GE.18-07661(E)

[77] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The European Union (EU) 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 2019 inventory submission related to the national system, as the United Kingdom, which left the EU on 1 February 2020, continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[78].

As mentioned in the 2018 inventory submission of the EU under the Kyoto Protocol, the Kyoto greenhouse inventory for the second commitment period follows the terms of the joint fulfilment agreement for the second commitment period. This included, until 31 January 2020, 28 Member States[79] and Iceland, and includes 27 Member States and United Kingdom and Iceland thereafter.

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 in the second commitment period. The Directorate-General (DG) for Climate Action of the European Commission has overall responsibility for the inventory of the EU while each Member State is responsible for the preparation of its own inventory which is the basic input for the inventory of the EU. 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/CME) as well as other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC).

[78] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

[79] 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 occurred in 2019. Note that the 2019 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	There have been no new EUCR releases after version 8.2.2 (the production version at the time of the last Chapter 14 submission). No change was therefore 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	No changes have been introduced since version 8.2.2 of the national registry (Annex B). It is to be noted that 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 are 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.

Reporting Item	Description
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 to the registry internet address 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	No change during the reported period.

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, most of the text from the last year's inventory report was included and additional or 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 emission reduction 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 effects 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 European 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 by the Council and the Parliament. This approach ensures that potential adverse social, environmental and economic impacts are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also for 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. This process is governed by the so-called "Better Regulation Guidelines"[80].

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 countries". 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[81]:

- 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 (especially 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 competitiveness of exporters in developing countries in terms of intended or unintended trade barriers?
- What are the impacts of 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 foreign direct investment) 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)?

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[80] http://ec.europa.eu/smart-regulation/guidelines/toc_guide_en.htm

[81] Better regulation toolbox (page 266), http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf

- 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 ecosystems?
- 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 low carbon technology transfer and its availability in developing countries?
- What is the impact on 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 the Action plan on Forest Law enforcement, Governance and Trade (FLEGT)[82], the Extractive Industries Transparency Initiative (EITI)[83] or the Kimberley agreement[84]?

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 between the policy option and its impacts is carried out. 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 approaches 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 Fourth Biennial Report[85] 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

[82] 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

[83] 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

[84] 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/

[85] https://unfccc.int/documents/204815

Impact Assessment Board are published online[86]. 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 to illustrate how the EU is striving to minimize adverse impacts.

Major EU policies such as the directives on the promotion of the use of energy from renewable sources are presented in more detail as examples in this chapter, because the related impact assessments identified potential impacts on third countries.

Directives on the promotion of the use of renewable energy Promotion of biomass and biofuels

The Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the "Renewable Energy Directive") 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 Renewable Energy Directive creates pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. The sustainability criteria adopted include:

- Establishment of a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclusion of the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclusion of the use of biofuels from land with high carbon 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.

A directive amending the 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;

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[86] http://ec.europa.eu/transparency/regdoc/?language=en

- To provide additional market incentives to the existing 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 EU wants to promote 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[87]. 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.

In December 2018, the revised Renewable Energy Directive (EU) 2018/2001 was adopted, which set a new target, namely to achieve a share of at least 32% of energy from renewable energy sources in the EU's gross final energy consumption by 2030. In addition to biofuels and bioliquids, the directive now also covers solid biomass and biogas for heat and power. More specifically, it includes the following requirements that have to be applied to all biofuels, to biogas used in installations with a total rated thermal input equal to or exceeding 2 MW and to solid biomass with a total rated thermal input equal to or exceeding 20 MW:

- Requirements for minimum greenhouse gas emissions savings have been strengthened.
- Agriculture production within the EU is no longer interlinked with sustainability requirements under the Common Agriculture Policy, but globally applicable criteria to mitigate risks for soil quality and carbon have been added for agricultural biomass.
- A new sustainability criterion on forest biomass has been introduced, focusing on legality of harvest, forest regeneration, maintaining or improving long term productivity, protected areas, minimizing negative impacts on soil quality and biodiversity during harvest as well as LULUCF-requirements

Furthermore, high indirect land use change risks biofuels like biofuels from palm oil shall not exceed the level of consumption in 2019 and shall gradually decrease to 0 % (31 December 2023 until 31 December 2030).

In April 2019, the European Commission published its regular Renewable Energy Progress Report[88] under the framework of the 2009 Renewable Energy Directive. The report includes information on the assessment of sustainability of EU biofuels. In 2016, the net savings in greenhouse gas emissions resulting from the use of renewable energy in transport in the EU amounted to approx. 33 Mt CO_2-equivalent. Taking into account indirect Land Use Change (ILUC) emissions associated to biofuels consumed in the EU, net savings of 12 Mt CO_2 equivalent remain.

The Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme[89] sets up a system for certifying sustainable biofuels,

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[87] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0296&from=EN

[88] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52019DC0225

[89] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52010XC0619%2801%29

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 2020) recognised 14 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, Better Biomass NTA 8080, RSPO RED (Roundtable on Sustainable Palm Oil RED), , KZR INIG System, Trade Assurance Scheme for Combinable Crops **and Universal Feed Assurance Scheme, Universal Feed Assurance Scheme, U.S. Soybean Sustainability Assurance Protocol (SSAP)**[90].

The 2030 climate and energy framework

In 2018, the main legislation was adopted 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 32% share for renewable energy
- At least 32.5% improvement in energy efficiency

The 2030 climate and energy framework constitutes the main instrument for implementing the European Union's Nationally Determined Contribution (NDC) under the Paris Agreement. In its conclusions[91] of 12 December 2019, the European Council invited the European Commission to put forward its proposal for an update of the EU's NDC for 2030, after a thorough impact assessment, in good time before COP26. The legislation under the 2030 climate and energy framework will be revised to reflect this updated NDC.

To achieve the greenhouse gas emissions reduction target under the current framework, the EU emissions trading system (ETS) sectors will have to cut emissions by 43% (compared to 2005) – to this end, the ETS was reformed and strengthened. The non-ETS sectors will need to cut emissions by 30% (compared to 2005) – this was translated into individual binding targets for Member States. While binding at the EU level, there are no binding renewable targets for Member States individually but the objective is to be fulfilled through clear commitments decided by the Member States themselves. These 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 climate and energy framework makes use of a new governance framework based on national plans for competitive, secure and sustainable energy.

As a part of the proposal for the 2030 climate and energy framework, an impact assessment was conducted[92] , 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

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[90] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

[91] https://data.consilium.europa.eu/doc/document/ST-29-2019-INIT/en/pdf

[92] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2014/swd_2014_0015_en.pdf

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 impact assessment 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 sharply 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 – between 4% to 22% below 2010 levels in all scenarios by 2030 and approx. 50% below 2010 levels in most scenarios by 2050.[93]

Regulation for energy efficiency labelling

In 2017, Regulation (EU) 2017/1369 setting a framework for energy efficiency labelling was adopted. It aims at further exploiting the potential of energy efficiency especially with regard to the EU target of substantially improving energy efficiency by 2030 compared to 2005. Its implementation will contribute to a moderation of energy demand and a reduction of the energy dependency of the European Union. Based on 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 previous Energy Labelling Directive and of specific aspects of the Ecodesign Directive. Furthermore, it carried out an impact assessment accompanying the proposal for the Regulation for energy efficiency labelling[94]. 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 use of energy efficiency classes from A to G has been followed as a model in many different countries around the world and some countries have also implemented EU Ecodesign regulations[95]. 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.

[93] 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

[94] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/swd_2015_0139_en.pdf

[95] https://ec.europa.eu/energy/sites/ener/files/documents/201404_ieel_third_jurisdictions.pdf

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 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. As an example, the cooperation activities specified in subparagraph (d) help both developing and developed countries in reducing emissions from fossil fuel technologies, but they do not directly address the minimization of potential adverse impacts in developing country 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) of the Kyoto Protocol, 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 an 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 the 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 EU Emissions Trading System, 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 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 research, development and innovation, 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”[96] 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

[96] Official Journal No C 82, 1.4.2008, p.1

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 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. The ETS Directive (2003/87/EC as amended) required the European Commission to compile a list of sectors and sub-sectors deemed exposed to significant risk of carbon leakage. Sectors on the list 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. According to the ETS Directive, it is 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.

The revised ETS Directive 2003/87/EC (as amended in 2018) 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.
- 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.

Under the revised ETS Directive, several support mechanisms are 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 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 (European Commission 2001)".

Council Decision 2010/787/EU on State aid to facilitate the closure of uncompetitive coal mines adopted a new coal regulation enabling Member States to grant State aid to facilitate the closure of uncompetitive mines until 2018, following the expiry of the current Coal Regulation (Council Regulation (EC) N° 1407/2002). 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"[97] 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;

The EU is cooperating with other developing and developed country Parties (Australia, Brazil, Canada, China, Czech Republic, France, Germany, Greece, India, Italy, Japan, Republic of 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 also aims at promoting awareness and championing legal, regulatory, financial, and institutional environments conducive to such technologies. In 2017 a 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. **At the most recent meeting, the 2019 technical group annual meeting of the CSLF in Chatou, France, the focus was on carbon capture, utilization, and storage (CCUS). Workshops were held on hydrogen production with CCUS and on CCUS with energy intensive industries.**

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[97] http://ec.europa.eu/economy_finance/publications/economic_briefs/2015/pdf/eb40_en.pdf

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)[98], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, the "EUROGULF" project analysed 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 European Commission has started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Technology Network. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy. On the network's website[99] further information on 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 have taken place each year from 2013 onwards. As an essential element of the project, five Working Groups focus on areas of common interest for the stakeholders of the two regions (EU, GCC):

- 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

Energy efficiency activities in the upstream or downstream sector are also candidates for Clean Development Mechanism (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).

[98] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

[99] http://www.eugcc-cleanergy.net

- 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.

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, which contribute to the reduction of dependence on fossil fuels, to meeting rural electricity needs, and to the improvement of air quality. The EU support programmes include:

Africa, Caribbean and the Pacific 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.

- *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).

Since 2010, 43 projects (28 bilateral and 15 multi-country) have been launched, representing a total investment cost of approximately EUR 9 billion with an EU LAIF contribution of over EUR 377 million.

Caribbean 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..

Global Energy Efficiency and Renewable Energy Fund (GEEREF)

The Global Energy Efficiency and Renewable Energy Fund (GEEREF)[100], 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.

Economic Partnership Agreements

The EU through the Directorate General Development and Cooperation – EuropeAid also supports African, Caribbean and Pacific countries in diversifying their economies. These activities are not limited to fossil fuel exporting countries, but are open to ACP countries based on Economic Partnership Agreements (EPAs) [101]. 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. The majority of ACP countries are either implementing an EPA or have concluded EPA negotiations with the EU.

15.3 European 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[102] and the related European Council Conclusions of 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 and the Member States will revitalise the EU's energy and climate diplomacy.
- The Commission 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.

[100] https://geeref.com/

[101] https://ec.europa.eu/trade/policy/countries-and-regions/development/economic-partnerships/

[102] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0080

In July 2015, the Foreign Affairs Council adopted Council Conclusions on EU Energy Diplomacy, which included an EU Energy Diplomacy Action Plan[103]. 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 emphasised strong support to give energy cooperation 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[104].

The International Renewable Energy Agency IRENA) 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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[103] http://data.consilium.europa.eu/doc/document/ST-10995-2015-INIT/en/pdf

[104] https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/neighbourhood/pdf/key-documents/151118_joint-communication_review-of-the-enp_en.pdf

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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/CME	European Topic Centre on Climate Change Mitigation and Energy
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				

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
T1b — IPCC Tier 1b				
T1c — IPCC Tier 1c				
T2 — IPCC Tier 2				
T3 — IPCC Tier 3				