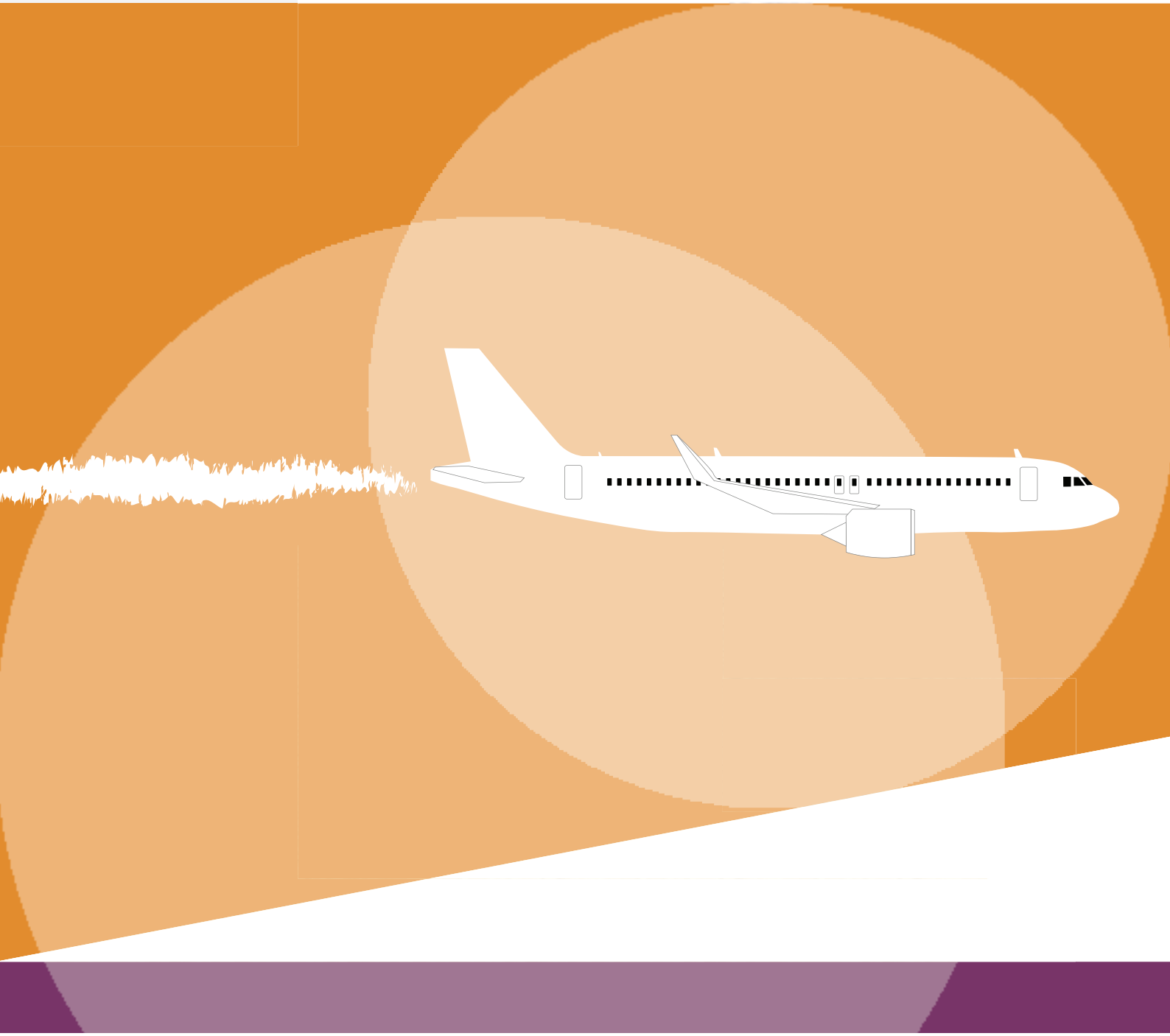
EEA Report | No 03/2022

European Union emission inventory report 1990-2020

Under the UNECE Air Convention



European Environment Agency

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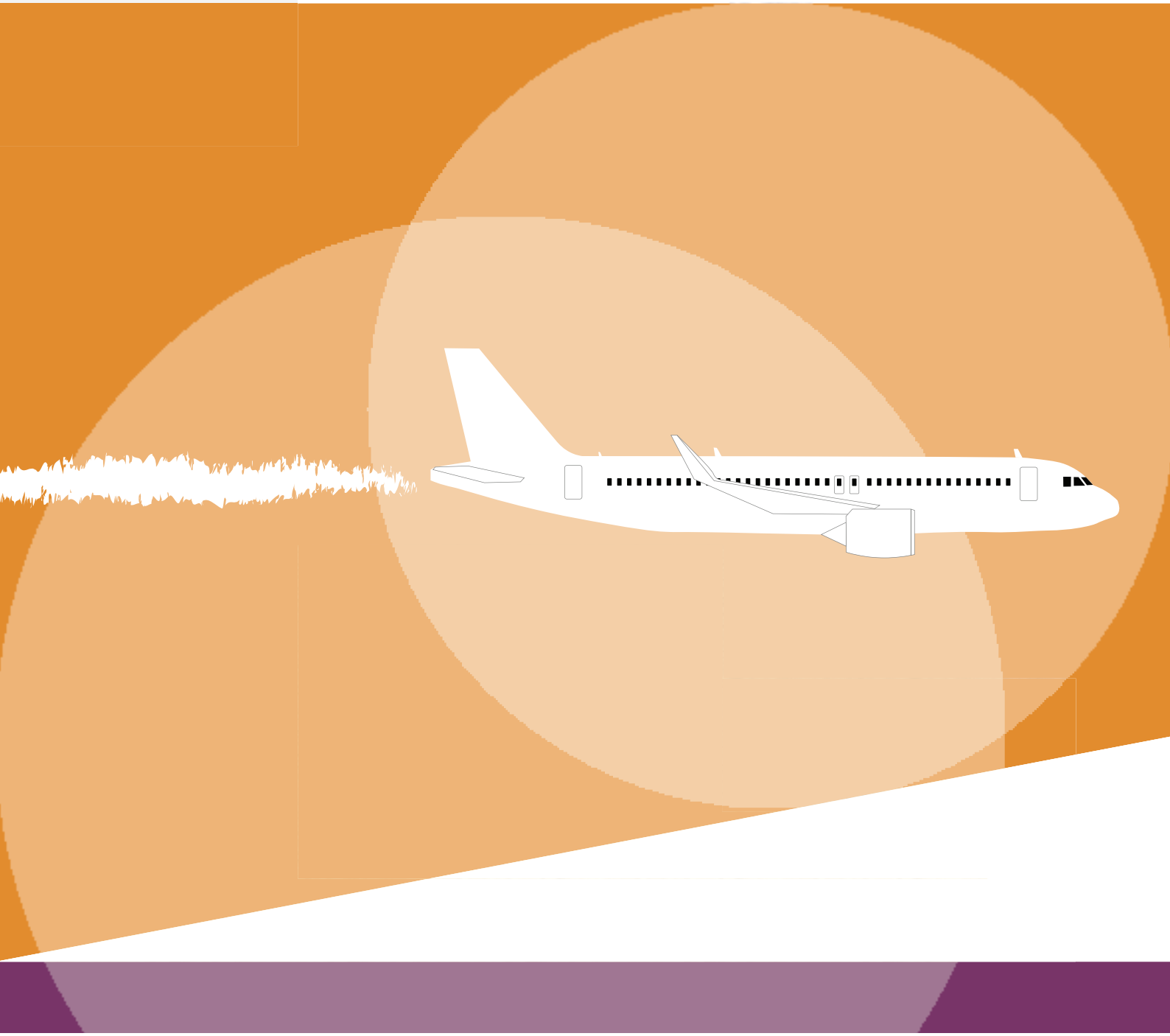

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Executive summary

This document is the annual EU emission inventory report under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (Air Convention) (UNECE, 1979). The report and its accompanying data constitute the official submission to the UNECE secretariat from the European Commission on behalf of the EU as a Party to the UNECE Executive Secretary (Box ES.1). The EEA compiled the report in cooperation with the EU Member States and the European Commission.

Box ES.1 The Gothenburg Protocol

The original Gothenburg Protocol to the Convention on Long-range Transboundary Air Pollution (Air Convention) sets emission ceilings (UNECE, 1999) for 2010 and beyond, for the pollutants nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x) and ammonia (NH_3). In addition to the ceilings for individual countries, the protocol specifies ceilings for the EU, which is a Party to the protocol in its own right (UNECE, 1999). The protocol was amended in 2012, establishing new emission reduction commitments as from 2020 and beyond in terms of percentage reductions relative, to the base year 2005, for the same pollutants and $PM_{2.5}$.

The EU ratified the amended protocol in 2017. Though the emission reduction commitments for 2020 and beyond apply to those Parties that have ratified the amended protocol, the ceilings set for 2010 and the years thereafter are still in place, as there are still Parties to the original protocol that are not yet Parties to the amended version. The emission inventory data and the informative inventory report submitted in 2022 therefore address both the obligations under the emission reduction commitments and those under the emission ceilings.

The Air Convention obliges or invites Parties to report emission data for numerous air pollutants:

- main pollutants: nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x), ammonia (NH_3) and carbon monoxide (CO);
- particulate matter (PM) emitted directly to the air (primary PM):
  - PM with a diameter of 2.5 µm or less ($PM_{2.5}$; also called fine PM);
  - PM with a diameter of 10 µm or less (PM_{10});
  - total suspended particulates (TSPs);
  - black carbon (BC), the most strongly light-absorbing component of PM (additional)
- priority heavy metals (HMs): lead (Pb), cadmium (Cd) and mercury (Hg);
- additional HMs: arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se) and zinc (Zn);
- persistent organic pollutants (POPs): polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs);
- additional reporting of the individual PAHs, benzo(a)pyrene (B(a)P), benzo(b)fluoranthene (B(b)F), benzo(k)fluoranthene (B(k)F) and indeno(1,2,3-cd)pyrene (IP), and the sum of all four.

These pollutants harm human health and the environment. Certain species also contribute to the formation of ground-level ozone (O_3) and secondary PM in the atmosphere. Some pollutants have both an indirect and a direct effect on the sunlight absorbed by the Earth and reflected back to space (radiative forcing) and hence on the climate (EEA, 2014, 2019a).

Box ES.2 EU country groupings in this report

The data reported by the EU to the United Nations Economic Commission for Europe Air Convention in 2022 (Gothenburg Protocol; please see Box ES.1) covers data up to and including 2020.

In the submission year 2022, the EU has 27 Member States (**EU-27**), and reports emission data for these 27 Member States.

The United Kingdom left the EU on 31 January 2020 and is no longer obliged to report air pollutant emission data to the EU.

- In addition to the EU-27 data, this report includes the 2020 sulphur emission (SO_x) data for the EU-11 (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain), in accordance with the EU's reporting obligations under the Air Convention's Protocol on Further Reduction of Sulphur Emissions.

Box ES.3 Status of reporting by EU Member States

In 2022, EU Member States were requested to report emission inventory data and an informative inventory report-(IIR). All 27 EU Member States provided air emission inventories and activity data, but, for those for which emissions data were missing for certain years or pollutants, a gap-filling procedure was applied to obtain a European inventory that was as complete as possible.

The EU should deliver emission inventories and projections by 30 April 2022 and its IIR (i.e. this report) by 30 May. By 15 March 2022, the EU-27 had provided their IIRs. As there is no reporting obligation in 2022 for projections under the Air Convention, their reporting is voluntary; however, three Member States did provide projections. As 2022 is not a reporting year for such data, no Member States have provided gridded data or LPS data. Detailed information on EU Member States' submissions is given in Appendix 3.

In 2012, the Executive Body of the Convention on Long-range Transboundary Air Pollution decided that adjustments to inventories for the purposes of comparing total national emissions with the emission reduction commitments, may be applied in certain circumstances if such a circumstance keeps a Party from being able to meet one of its reduction commitments (UNECE, 2012a). Under the Gothenburg Protocol, the European Monitoring and Evaluation Programme Steering Body accepted inventory adjustment applications for emissions from 10 Parties in 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021.

Circumstances that allow adjustments to emission inventories are defined as follows:

- There are additional categories of emission sources that were not accounted for when the emission reduction commitments were set.
- Emission factors used to determine emission levels for particular source categories for the year in which emission reduction commitments are to be attained are significantly different from the emission factors applied to these categories at the time the emission reduction commitments were set.
- The methodologies for determining emissions from specific source categories have changed significantly between when emission reduction commitments were set and the year they are to be attained.

This report addresses:

- the institutional arrangements and preparation processes behind the EU's emission inventory, methods and data sources, reporting, key category analyses, information on quality assurance and control, general uncertainty evaluation, and information on completeness and underestimations (Chapter 1);
- information on approved adjustments and adjustment applications under the Gothenburg Protocol (Chapter 2);
- emission trends for the EU as a whole and for individual EU Member States, and the contribution of key categories to total emissions (Chapter 3);
- sectoral analyses and emission trends for key pollutants (Secion 3.2);
- information on recalculations and on planned and implemented improvements (Chapter 0);
- brief information on the status of the (not mandatory) reporting of the condensable component of PM_{10} and $PM_{2.5}$ (Section 1.5.5).

Emission data presented in this report are presented in the accompanying annexes and are also available for direct download from the EEA's data service (EEA, 2021a). The following sections summarise the main findings.

EU emission trends

Figures ES.1-ES.3 present the trends in the emission of air pollutants between 1990 and 2020 ([1]). They are aggregated across the EU.

Emission trends for the main air pollutants between 1990 and 2020

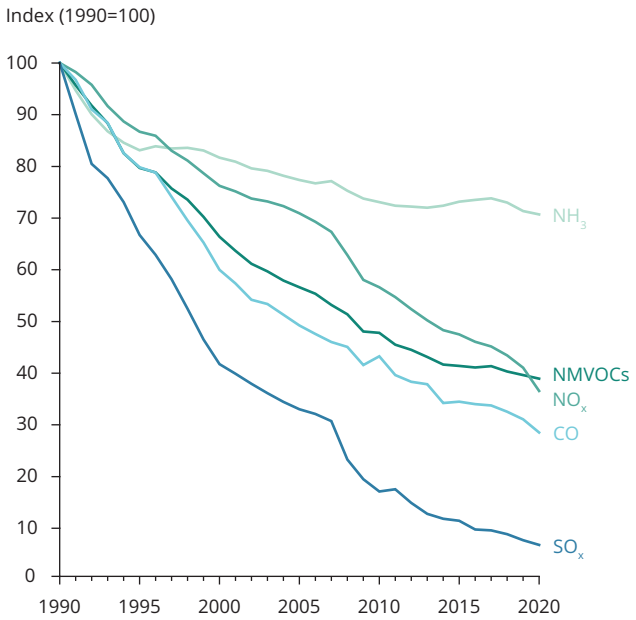
With reference to the main air pollutants, SO_x registered the greatest reduction in emissions across the EU. In 2020, SO_x emissions were 93% lower than in 1990 (Figure ES.1). This reduction is the result of a combination of measures:

- fuel switching in energy-related sectors, moving away from solid and liquid fuels with high sulphur contents to low sulphur fuels such as natural gas;
- applying flue gas desulphurisation (FGD) techniques in industrial facilities;
- implementing EU directives relating to the sulphur content of certain liquid fuels.

Emissions of the other main air pollutants have dropped considerably since 1990, including the three regulated air pollutants primarily responsible for the formation of ground-level ozone: CO (71% reduction), NMVOCs (61% reduction) and NO_x (63% reduction).

For most main air pollutants, emissions decreased more slowly from 2007 to 2020. NH_3 emissions have fallen by less than emissions of the other main pollutants (-29%) since 1990, and since 2013 a positive NH_3 emission trend had been noted for some years (+2.6% from 2013 to 2017).

Figure ES.1 EU-27 emission trends for the main air pollutants



([1]) Each year, by 15 February, Member States must report emissions data for the years up to and including the last calendar year but one. Thus, by 15 February 2022, Member States were obliged to report data for the years up to 2020. Typically, it takes countries about 12-15 months to compile and report emission inventory data (for both air pollutants and greenhouse gases). This delay is mainly because of the time needed for official national and/or trade statistics to become available (typically up to 12 months after the end of the calendar year), together with the time needed for subsequent data processing, calculations, and quality assurance and quality control (QA/QC) checks.

Box ES.4 Changes in the emissions of main air pollutants in the EU Member States between 2019 and 2020

Between 2019 and 2020, emissions of nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_X), carbon monoxide (CO) and ammonia (NH_3) dropped by 11%, 1.8%, 12%, 8.2% and 0.9%, respectively.

NMVOC emissions decreased in 20 EU Member States between 2019 and 2020. Germany, France and Czechia (in order of the largest absolute emission reduction) were responsible for the highest decreases. The main emitter of NMVOCs in the EU is the 'industrial processes and product use' sector.

From 2019 to 2020, the largest reductions in SO_X emissions in absolute terms were reported by Spain, Germany, Italy and Romania (in order of the largest absolute emission reduction). The 'energy production and distribution' sector was the main contributor to the reduction in SO_X emissions.

CO emissions decreased, mainly due to decreased emissions reported by Germany, France, Italy and Spain (in order of the largest absolute emission reduction). The road transport sector contributed most to the decrease in CO emissions.

NH_3 emissions decreased in 12 EU Member States. Germany, France and Czechia reported the highest decreases (in order of the largest absolute emission reduction). The rise in NH_3 emissions in Spain in recent years has been driven by increased consumption of synthetic nitrogen fertilisers and an increase in the numbers of cattle and swine.

The road transport sector has been reducing CO and NMVOCs emissions since 1990, and since 1992 NO_X emissions have also continued to decrease. The sector has achieved this primarily through legislative measures requiring the abatement of vehicle exhaust emissions.

European legislation sets progressively stricter emission limits for air pollutants from cars and vans, trucks and buses and coaches, known as the 'Euro standards'. The standards apply to exhaust emissions of NO_X, determined by laboratory-based tests. These official tests fail to measure the actual level of emissions that vehicles are producing under real driving conditions, i.e. NO_X emissions are higher than EU limits permit. This has contributed significantly to exceedances of the nitrogen dioxide (NO_2) air quality daily limit value at urban traffic stations ([2]) (EEA, 2019b). New tests under real driving conditions now complement laboratory-based testing. Such tests became mandatory for all new cars and vans in September 2019 (EU, 2016a).

NO_X emissions declined considerably in the electricity/energy generation sectors as a result of certain technical measures, mainly:

1. the introduction of combustion modification technologies (e.g. use of low-NO_X burners);
2. the implementation of flue gas abatement techniques (e.g. NO_X scrubbers and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques);
3. fuel switching from coal to gas.

([2]) Stations in urban areas (mainly cities) close to main roads.

Emission trends for particulate matter between 2000 and 2020

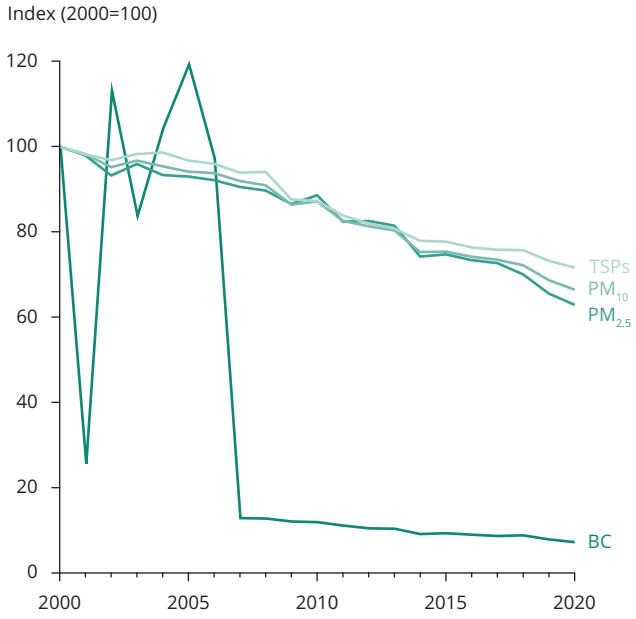
The Air Convention formally requests Parties to report emissions of PM from the year 2000 onwards; hence, emission trends are shown for 2000 and the subsequent years only. Aggregated emissions of TSPs fell by 28% across the EU between 2000 and 2020 (Figure ES.2). Emissions of primary PM_{10}, $PM_{2.5}$ and BC fell by 34%, 37% and 93%, respectively.

The reporting of condensable components is not mandatory, and in recent years there has been no clear definition of whether PM emission reporting includes or excludes the condensable component. However, the reporting table on condensable components within Annex II was provided by 19 EU Member States in 2022. The level of information is rather heterogeneous and for many categories no information is available at all.

Total PM emissions dropped, mainly thanks to the introduction or improvement of abatement measures across the energy, road transport and industry sectors. This has been coupled with other developments in industrial sectors, such as switching from fuels containing high levels of sulphur to those with low levels. SO_x, NO_x and NH_3 play an important role in the formation of secondary PM. Thus, if emissions of these pollutants decrease, this also influences PM formation (EEA, 2022).

NH_3 emissions from agriculture contribute to episodes of high secondary inorganic PM concentrations being experienced across certain regions of Europe each spring. Such episodes contribute to exceedances of the PM_{10} daily limit values set in the EU's Air Quality Directive (e.g. CAMS, 2021).

Figure ES.2 EU-27 emission trends for PM



Note: Strong fluctuations in BC emissions between the years 2000 and 2007 are mainly influenced by BC emissions reported by Bulgaria.

Emission trends for heavy metals and persistent organic pollutants between 1990 and 2020

Since 1990, emissions of the main HMs (Pb, Cd, Hg), dioxins and furans, total PAHs, HCB and PCBs have also dropped substantially (Figure ES.3).

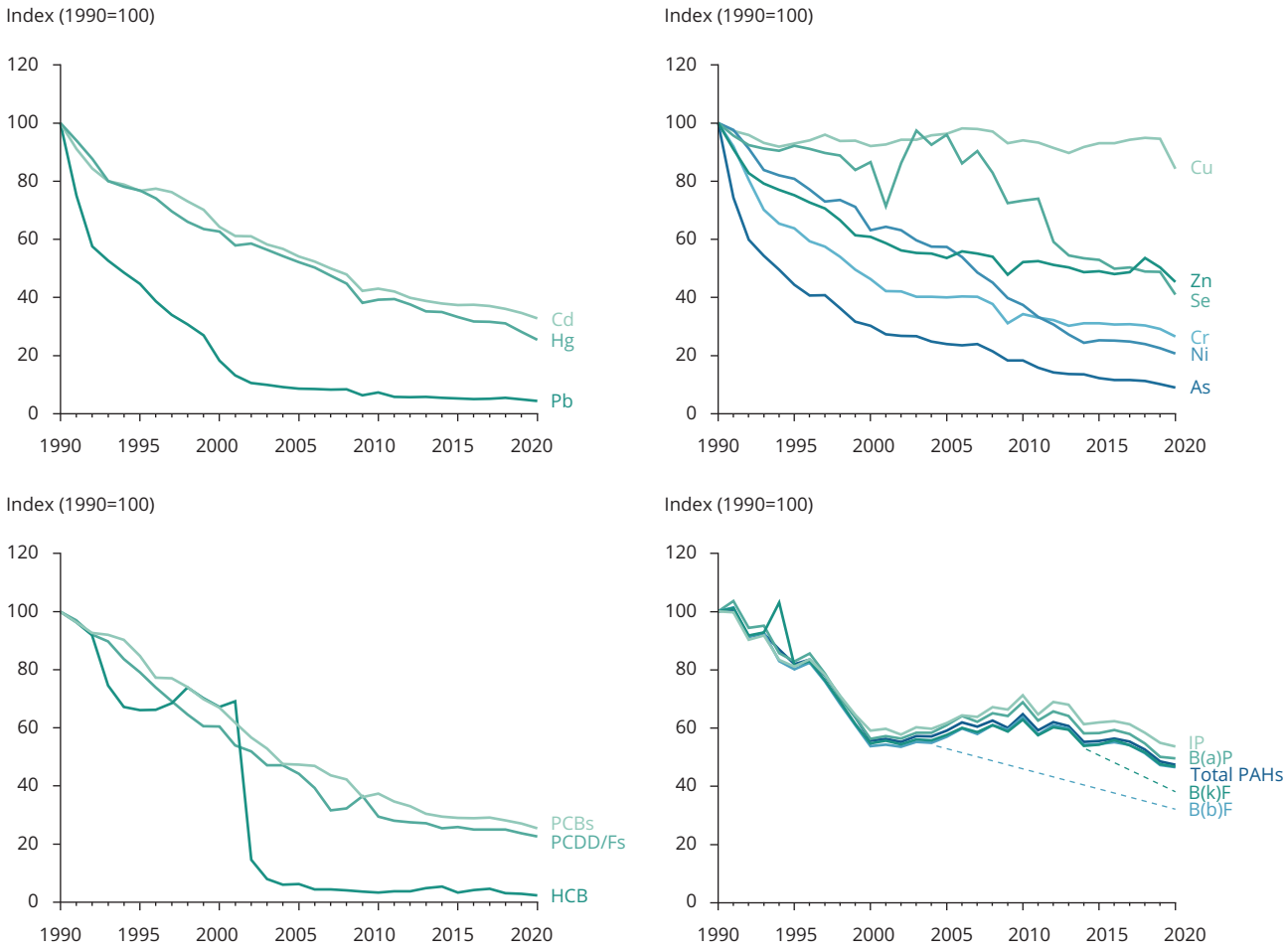
Much progress has been made since the early 1990s in reducing point source emissions of these substances, particularly from industrial facilities. This has been achieved partly through improved abatement techniques for wastewater treatment and incinerators in the metal-refining and smelting industries. In some countries, the reduction in emissions follows the closure of older industrial facilities as a result of economic restructuring. Total emissions fell faster between 1990 and 2000 than in the following years.

Emissions of HMs fell between 1990 and 2020: Pb by 96%, Cd by 67%, Hg by 75%, As by 91%, Cr by 73%, Cu by 16%, Ni by 79%, Se by 59% and Zn by 55%.

Total PAHs decreased by 53% from 1990 to 2020 ([3]). For individual PAHs, the reductions from 1990 to 2020 were 50% for B(a)P, 53% for B(b)F, 53% for B(k)F and 46% for IP. Dioxins and furans decreased by 77% between 1990 and 2020. The reductions in HCB and PCB emissions were 98% and 75%, respectively. Although there have been clear decreases over the last 25 years, emissions of POPs have remained broadly stable since 2003 (Figure ES.3).

([3]) It is difficult to compare reductions in total PAHs with reductions in the other PAHs. The reporting completeness for the EU (the sum of reporting/gap filling of the Member States) differs strongly between total PAHs and the other PAHs.

Figure ES.3 EU-27emission trends for HMs and POPs



Note: The decrease in HCB emissions between 2003 and 2004 is caused by reductions reported by Spain. Fluctuations in Se emissions between 2001 and 2003 are mainly caused by reported data in Belgium and Bulgaria
The peak in B(k)F emissions in 1994 is caused by an large increase reported by Bulgaria.
For certain pollutants, not all Member States reported data.

Box ES.5 Effects of recalculating data for previously reported emissions in the EU Member States

In 2022, all EU Member States that provided submissions reported recalculations for one or more years; changes in gap filling also resulted in recalculations. This caused changes in emission inventories for all pollutants up to 2019 (see Section 5.1).

In their informative inventory reports (see Appendix 5), EU Member States gave an account of their reasons for recalculating parts of time series or whole time series. Explanations included methodological improvements, revision of emission factors or newly implemented emission factors, reallocations, availability of new data, and revision of activity data and correction of errors. They did not always provide information on the rationale behind the recalculations.

EU key categories and main emission sources

EU key categories refer to the individual sources that contributed the most, overall, to emissions of pollutants in 2020. They were determined by a level assessment ([4]) for NO_X, NMVOCs, SO_X, NH_3, CO, $PM_{2.5}$, PM_{10}, BC, Cd, Pb, Hg, PCDD/Fs, total PAHs, B(a)P, HCB and PCBs.

A total of 58 different emission inventory source categories were identified as being key for at least one pollutant. A number of emission categories were identified as being key for more than 1 of the 16 pollutants assessed. Table ES.1 lists the most relevant key categories.

Figure ES.4 shows the share of EU emissions in 2020 by sector group. As observed in previous years, each main air pollutant has one major source category:

1. For NO_X, the major source category is 'road transport'.
2. For SO_X, the major source category is 'energy production and distribution'.
3. For NH_3, the major source category is 'agriculture'.
4. For NMVOCs, the major source category is 'industrial processes and product use'.
5. For CO and PM, the major source category is 'commercial, institutional and households'.

Emissions of NO_X from the road transport sector fell by 68% between 1990 and 2020. Nevertheless, in the EU, this sector is a major source of the ground-level O_3 precursors NO_X, CO and NMVOCs. In 2020, this sector contributed 37% (NO_X), 17% (CO) and 7% (NMVOCs) to the total emissions of these pollutants in the EU. Passenger cars, heavy duty vehicles and buses are the principal contributors to CO emissions from this sector; in 2020, passenger cars alone contributed around 71% of CO emissions from the road transport sector.

The commercial, institutional and households sector is the most important source of primary $PM_{2.5}$, PCDD/Fs, PAHs, CO, PM_{10} and BC. Energy- and process-related emissions from industry contribute considerably to the overall emissions of a number of NMVOCs, HMs and POPs.

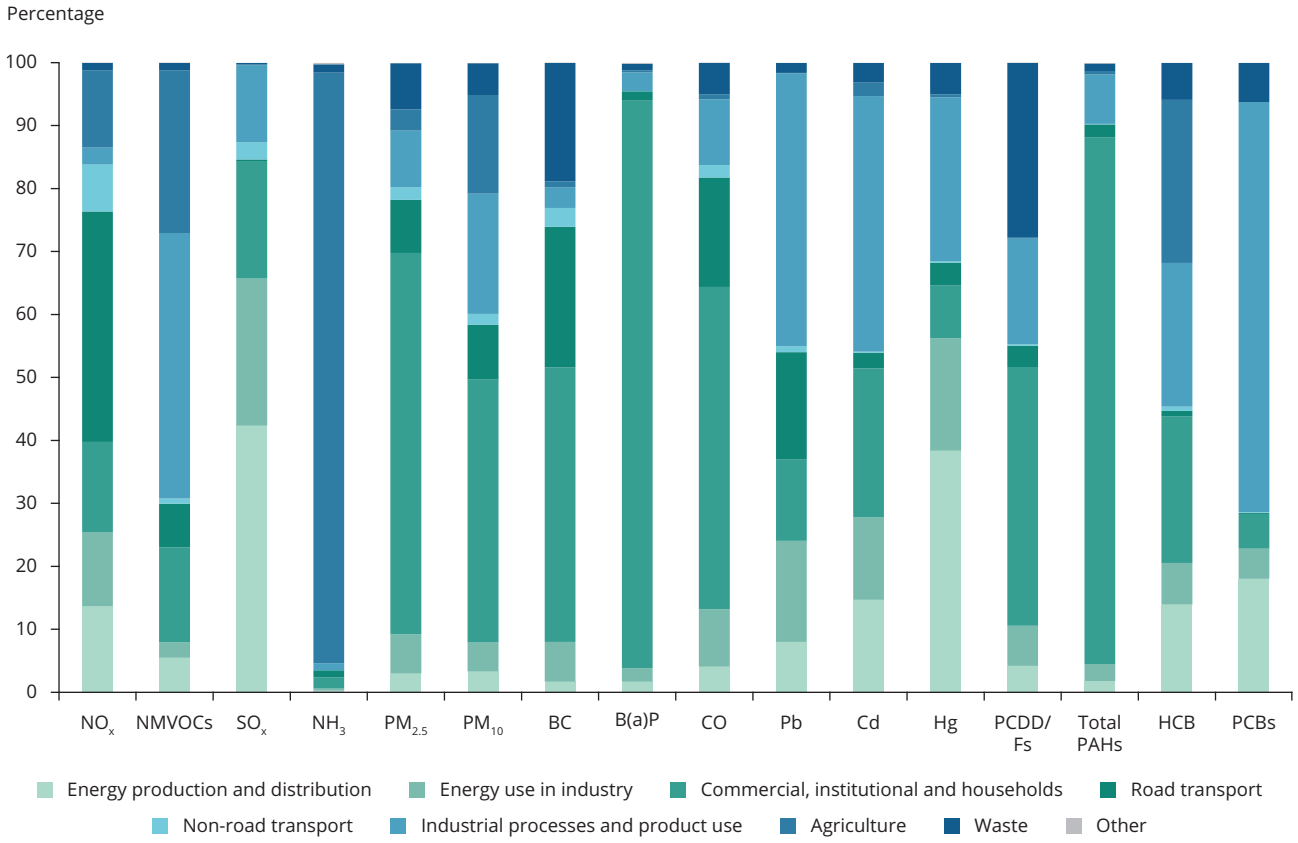
Table ES.1 Most relevant key categories for air pollutant emissions

Name of key category	Number of occurrences as a key category
Residential: stationary (combustion) (NFR 1A4bi)	14 (NO_X, NMVOCs, SO_X, CO, $PM_{2.5}$, PM_{10}, BC, Pb, Cd, Hg, PCDD/Fs, total PAHs, B(a)P, HCB)
Iron and steel production (NFR 2C1)	11 (SO_X, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, total PAHs, HCB, PCBs)
Public electricity and heat production (NFR 1A1a)	11 (NO_X, SO_X, $PM_{2.5}$, PM_{10}, CO, Pb, Cd, Hg, PCDD/Fs, HCB, PCBs)
Stationary combustion in manufacturing industries and construction: non-metallic minerals (NFR 1A2f)	8 (NO_X, SO_X, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg)
Road transport: passenger cars (NFR 1A3bi)	8 (NO_X, NMVOCs, CO, $PM_{2.5}$, PM_{10}, BC, Hg, PCDD/Fs)
Agriculture: Animal manure applied to soils (NFR 3Da2a)	3 (NH_3, NO_X, NMVOCs)

Note: NFR, nomenclature for reporting.

([4]) A key category-level assessment identifies those source categories that have a significant influence on a country's total inventory in terms of its absolute level of emissions. In this report, key categories refer to those that are collectively responsible for 80% of the total emissions of a given pollutant (EMEP/EEA, 2019).

Figure ES.4 Share of EU emissions of the main air pollutants, by sector group in 2020



Adjustments to emission inventories under the Gothenburg Protocol

Parties to the Air Convention were able to 'adjust' their emission inventories downwards if non-compliance with the ceilings set in the Gothenburg Protocol was caused by countries applying improved emission inventory methods in accordance with scientific knowledge updated since the 2010 ceilings were originally set. This was to avoid countries being disadvantaged by applying improved emission inventory methodologies. Emission reduction commitments are in place from 2020 onwards — see below.

Table ES.2 lists inventory adjustment applications that the European Monitoring and Evaluation Programme (EMEP) Steering Body accepted in 2014, 2015, 2016, 2017, 2018, 2019,2020 and 2021.

Table ES.2 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016, 2017, 2018, 2019, 2020, 2021)

Country	Pollutant	NFR
Belgium	NO_X	Road transport (1A3bi-iv), agriculture (3B, 3Da1, 3Da2a)
	NMVOCs	Agriculture (3B, 3De)
Czechia	NMVOC	Agriculture (3B)
Denmark	NMVOCs	Agriculture (3B)
	NH_3	Agriculture (3Da1, 3De)
Finland	NH_3	Energy use in industry (1A2gviii), commercial, institutional and households (1A4ai, 1A4bi, 1A4ci), road transport (1A3bi-iv)
France	NO_X	Road transport (1A3bi-iv), agriculture (3B, 3D)
	NMVOC	Agriculture (3B, 3D)
Germany	NMVOCs	Agriculture (3B, 3De)
	NH_3	Agriculture (3Da2c, 3I)
Hungary	NMVOCs	Agriculture (3B, 3De)
Luxembourg	NO_X	Road transport (1A3bi-iv), agriculture (3B, 3De)
	NMVOCs	Agriculture (3B, 3De)
Netherlands	NMVOCs	Agriculture (3B1a, 3B4h, 3B4d, 3B4e, 3B4giii, 3B4giv, 3B2, 3B4h, 3B4f, 3B1b, 3Da2a, 3Dc, 3B3, 3B4gii, 3B4gi, 3De, 3Da3)
	NH_3	Agriculture (3Da4, 3De, 3B3)
Spain	NO_X	Road transport (1A3bi, 1A3biii), agriculture (3B)
United Kingdom	NO_X	Road transport (1A3bi-iv)

Note: For NFR (nomenclature for reporting) codes, see Appendix 4.

Progress towards meeting the EU's current emission ceilings under the Gothenburg Protocol

The Gothenburg Protocol (1999) set commitments for the European Community, at the time comprising 15 EU Member States (EU-15). Table ES.3 shows their aggregated emissions for 2020 compared with the emission ceilings the protocol specified for the EU in 2010 and for the years thereafter. In 2020, the EU-15 emissions of NO_X, NMVOCs, SO_X and NH_3 were below the ceilings set out (see Appendix 2, Table A2.2, for country groupings). The Gothenburg Protocol was amended in 2012 to set emission reduction commitments for 2020.

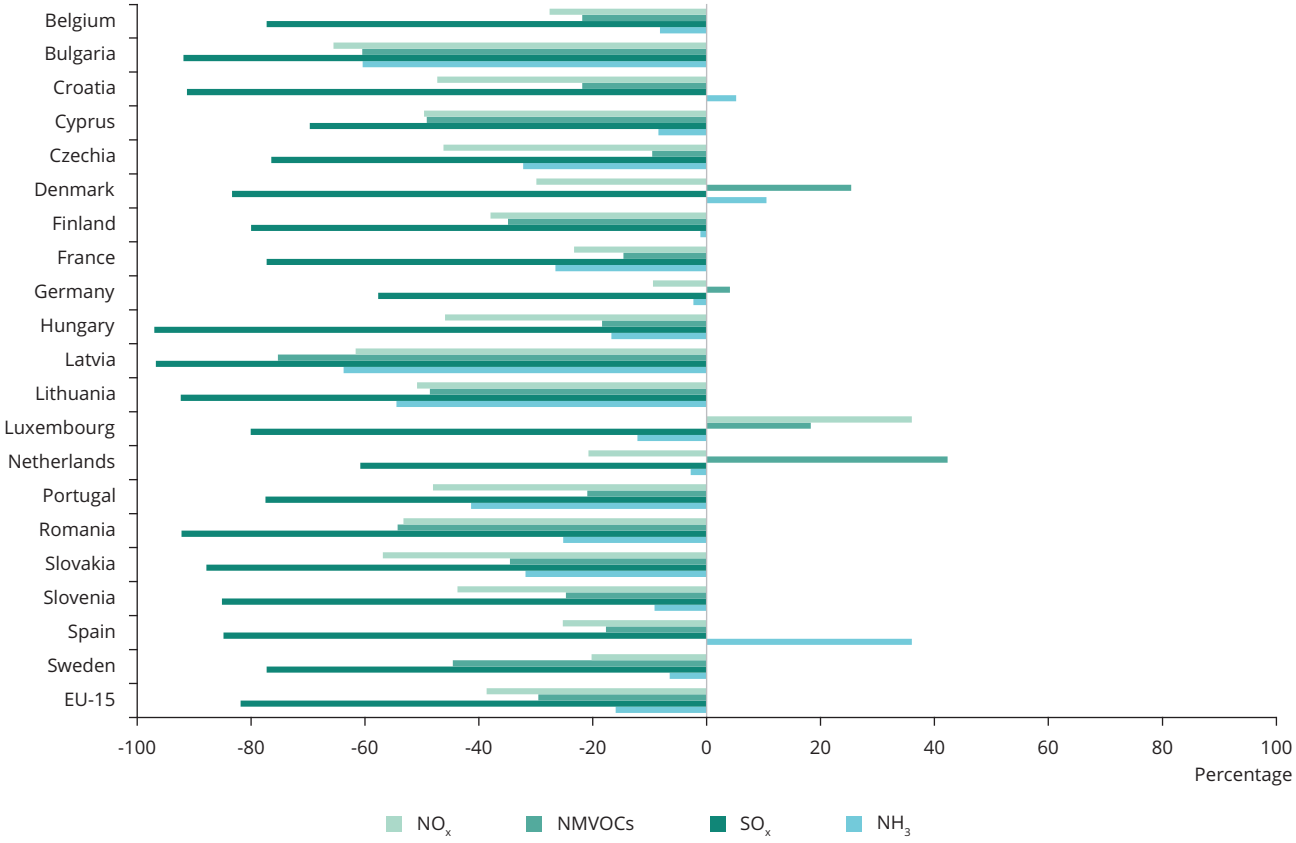
Table ES.3 Emissions reported for 2020 by EU-15 Member States (without the UK) compared with the Gothenburg Protocol EU emission ceilings for 2010 and the years thereafter

Pollutant	EU-15 emissions 2020 (Gg)	EU-15 Gothenburg Protocol 2010 ceillings (Gg)	Difference (%)	Sum of individual EU-15 ceillings (Gg)
NO_X	4,093	6,671	-39%	6,519
NMVOCs	4,647	6,600	-30%	6,510
SO_x	736	4,059	-81%	3,850
NH_3	2,628	3,129	-16.0%	3,110

Notes: The comparison with emission ceilings is based on reporting based on fuel sold for all EU Member States.
For Portugal's 2010 ceilings, emissions from the Azores and Madeira are excluded.
Under the Gothenburg Protocol, the EMEP Steering Body accepted applications from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands and Spain for emission inventory adjustments in 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021. However, as the EU-15 itself has not applied for adjustments, this table does not take these adjusted data into account. The protocol also specifies emission ceilings for individual EU-15 Member States. In some cases, the sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

Figure 3.5 shows whether EU Member States met the Gothenburg Protocol ceilings in 2020. Estonia and Malta do not have Gothenburg ceilings and Austria, Greece, Ireland, Italy and Poland have not yet ratified the Gothenburg Protocol and are therefore excluded from Figure 3.5. Four countries exceeded their NMVOC ceilings (Denmark, Germany, Luxembourg and the Netherlands), while one country didn't meet its NO_X ceiling (Luxembourg). Three countries exceeded their NH_3 ceilings (Croatia, Denmark and Spain). All EU Member States complied with their SO_X ceilings.

Figure ES.5 Distance to Gothenburg Protocol ceilings for EU Member States in 2020



Notes: Estonia and Malta have not signed the Gothenburg Protocol and therefore do not have ceilings. Austria, Greece, Ireland, Italy and Poland have ceilings but have not yet ratified the protocol.

For the EU-15, the comparison is based on fuel sold.

Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands, Spain and the United Kingdom in 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021. This figure takes these adjusted data into account if the country reported it. The EU-15 did not apply for adjustments and thus data for the EU-15 are unadjusted.

Progress towards meeting the EU's emission reduction commitments for 2020 under the Gothenburg Protocol

The original Gothenburg Protocol (1999) set emission ceilings for the European Community, at the time comprising 15 EU Member States (EU-15). The Gothenburg Protocol was amended in 2012 to set emission reduction commitments for 2020 and beyond. A well as the aggregated EU-27 emissions for 2020 and 2005 Table ES.3 shows the actual reduction compared with the emission reduction commitment the protocol specified for the EU-27 in 2020 and beyond. In 2020, the EU-27 emissions of NO_X, NMVOCs, SO_X, NH_3 and $PM_{2.5}$ were below the reduction commitments set out.

Figure ES.5 shows whether or not EU Member States met the Gothenburg reduction commitments in 2020. The reduction commitment for SOx was not met by one Member State (Cyprus). Several Member States did not meet their reduction commitment for NOx- (Denmark, Ireland, Latvia, Lithuania, Romania), NH3- (Austria, Bulgaria, Denmark, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Portugal, Spain, Sweden), NMVOC- (Denmark, France, Ireland, Italy, Lithuania, the Netherlands, Poland) and PM2.5- (Hungary, Romania) emissions.

Actions and recommendations for improving the EU emission inventory

Although reporting has become more complete in recent years, several data gaps remain in the official data sets received from EU Member States. Thus, the completeness of submissions can be further improved, particularly for historical data for the period 1990-2000 and for certain pollutants such as HMs and POPs. To compile as complete an EU inventory as possible, missing emission data are gap filled as far as feasible (for details see Section 1.4.5).

This report also includes several recommendations that may further improve the quality of the EU inventory in the future. EU Member States should submit complete inventories and use proper notation keys, for instance when no values are available. They should recalculate emission data for past years when new methods or new scientific knowledge become available. In this context, it is recommended that EU Member States review and apply the information included in the updated *EMEP/EEA air pollutant emission inventory guidebook — 2019* (inventory guidebook for short; EMEP/EEA, 2019a) when compiling their emission inventory data sets.

EU Member States are encouraged to consider the findings of the annual quality checks performed by the EEA and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM). From 2019 onwards the ETC on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI) and from 2022 onwards the ETC on Human Health and the Environment (ETC/HE) have been performing those checks during the compilation of the EU inventory. Where necessary, EU Member States can either resubmit inventory data (in the nomenclature for reporting 19 (NFR19) format for reporting of air pollutants) or update the following year's inventory to reflect new insights gained or errors identified. In 2022, several EU Member States were contacted by the EEA regarding potential errors identified by the quality assurance and quality control (QA/QC) procedure.

Table ES.4 Emissions reported for 2020 by EU-27 Member States compared with the Gothenburg Protocol EU reduction commitment for 2020 and beyond

Pollutant	EU-27 emissions 2020 (Gg)	EU-27 Emission levels (Gg)	Actual reduction (%)	Reduction commitment from 2005 level (%)
NO_X	5,497	10,060	-48%	-40%
NMVOCs	6,247	9,080	-31%	-28%
SO_x	1,452	7,084	-79%	-59%
NH_3	3,441	3,765	-9%	-6%
$PM_{2.5}$	1,185	1,751	-32%	-22%

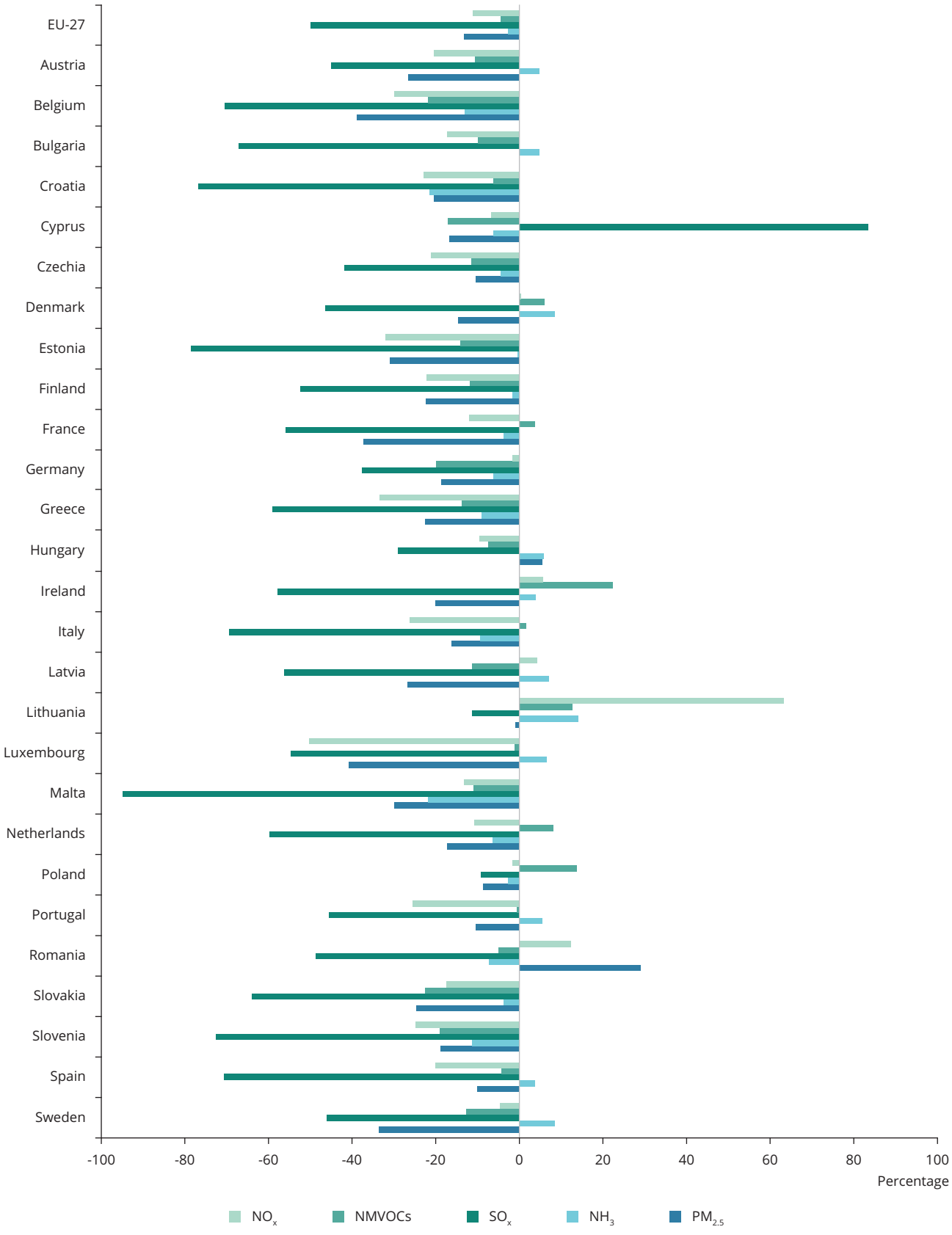
Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands, i.e. data comprise the EMEP domain only.

For Portugal's reduction commitments, emissions from the Azores and Madeira are excluded.

Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands, Spain and the United Kingdom in 2014, 2015, 2016, 2017, 2018, 2019 and 2020. However, as the EU-27 as a whole has not applied for adjustments, this table does not take these adjusted data into account.

Emission reduction commitments are also specified for individual EU-27 EU Member States. The EU-27 emission reduction commitment is the sum of the EU MS reduction commitments. The % specified in annex II for the EU as a whole was corrected in 2022 following changes in the EU membership, in line with EB Decision 2021/3.

Figure ES.6 Distance to Gothenburg reduction commitment for the EU-27 and each EU Member States in 2020



Note: Emission reductions are calculated with the National Total of each Member State as well as for the EU-27.

1. Introduction

The European Commission provides this report and its accompanying data (on behalf of the EU ([5])) as an official submission to the United Nations Economic Commission for Europe (UNECE) Secretariat for the Executive Body of the Convention on Long-range Transboundary Air Pollution (Air Convention).

The report covers the following subjects: the formal institutional arrangements that underpin the EU's emission inventory, the inventory preparation process, methods and data sources, key category analyses, information on quality assurance and quality control (QA/QC), general uncertainty evaluation, general assessment of completeness and information on underestimations (see this chapter); adjustments under the Gothenburg Protocol (Chapter 2); emission trends and the contribution of key categories to total emissions (Chapter 3); sectoral analysis and emission trends for key pollutants (Chapter 4); and information on recalculations and planned improvements (Chapter 5).

EU emission totals are estimated for the pollutants for which data should be reported under the Air Convention (see Appendix 2), i.e. emissions of:

- **main pollutants:**
  - nitrogen oxides (NO_X)
  - non-methane volatile organic compounds (NMVOCs)
  - sulphur oxides (SO_X)
  - ammonia (NH_3)
  - carbon monoxide (CO);

- **particulate matter (PM):**
  - PM with a diameter of 10 µm or less (PM_{10})
  - fine PM with a diameter of 2.5 µm or less ($PM_{2.5}$)
  - total suspended particulates (TSPs)
  - black carbon (BC);

- **priority heavy metals (HMs):**
  - lead (Pb)
  - cadmium (Cd)
  - mercury (Hg);

- **additional HMs:**
  - arsenic (As)
  - chromium (Cr)
  - copper (Cu)
  - nickel (Ni)
  - selenium (Se)
  - zinc (Zn);

- **persistent organic pollutants (POPs):**
  - polychlorinated dibenzodioxins/polychlorinated dibenzofurans (PCDD/Fs)
  - polycyclic aromatic hydrocarbons (PAHs)
  - hexachlorobenzene (HCB)
  - polychlorinated biphenyls (PCBs);

([5]) The United Kingdom left the EU on 31 January 2020 and applied EU law until the end of the transition period, 31 December 2020. This report refers to the air pollutant emission totals of the EU-27.

- **additional reporting of PAHs:**
  - benzo(a)pyrene (B(a)P)
  - benzo(b)fluoranthene (B(b)F)
  - benzo(k)fluoranthene (B(k)F)
  - indeno(1,2,3-cd)pyrene (IP).

Emission estimates are not always available for all pollutants every year, because there are gaps in the data reported in 2022 by the EU Member States. A gap-filling process was developed in 2010 for compiling the EU inventory and was refined in 2011 and 2017 (see Section 1.4.5). Nevertheless, for certain pollutants (additional HMs, BC, individual PAHs), some EU Member States did not report data for any year, which made it impossible to apply such gap-filling techniques. Thus, for these pollutants, the EU total remains incomplete.

Several annexes accompany this inventory report:

- Annex A provides a copy of the EU's formal Air Convention data submission for the period 1990-2020 in the required UNECE format for the reporting of air pollutants (nomenclature for reporting 19 (NFR19)).

- Annex B provides the updated EU NO_X emission data for the period 1987-1989, as required by the 1988 NO_X protocol of the Air Convention. (see Sofia Protocol in Table 1.1)

- Annex C provides results of the key category analyses (KCAs) for the EU, showing the main emitting sectors for each pollutant.

- Annex D presents the EU's gap-filled inventory, colour-coded for the different data sources used and the various additional gap filling methods applied.

- Annex E provides EU Member States' projections for NO_X, NMVOCs, SO_X, NH_3, $PM_{2.5}$ and BC emissions for 2020, 2025, 2030, 2040 and 2050.

- Annexes F presents the EU's Air Convention data submission for the period 1990-2020 for the EU-11. Box ES.2 and Table A2.2 (in Appendix 2) provide information on the country groupings.

- Annex G gives an overview of the sources of data on emissions of the individual pollutants used when compiling the 2022 EU inventory.

- Annex H provides an overview of the completeness of the gap-filled inventory concerning the notation key 'NE' (not estimated).

1.1 Background

The EU ratified the UNECE's Air Convention (UNECE, 1979) in 1982. Since 1984, eight protocols have come into force. Table 1.1 presents the ratification status of each protocol across the EU as a whole. The status differs across EU Member States.

Table 1.1 EU ratification status of the Air Convention and related protocols

Year	Air Convention and its protocols	Ratification status
1979	'Geneva Convention': Convention on Long-range Transboundary Air Pollution (UNECE, 1979)	Signed and ratified (approval)
1984	'Geneva Protocol': Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE, 1984)	Signed and ratified (approval)
1985	'Helsinki Protocol': Protocol on the Reduction of Sulphur Emissions or Their Transboundary Fluxes by at Least 30 Per Cent (UNECE, 1985)	Not signed
1988	'Sofia Protocol': Protocol Concerning the Control of Emissions of Nitrogen Oxides or Their Transboundary Fluxes (UNECE, 1988)	Ratified (accession)
1991	'Geneva Protocol': Protocol Concerning the Control of Emissions of Volatile Organic Compounds or Their Transboundary Fluxes (UNECE, 1991)	Signed
1994	'Oslo Protocol': Protocol on Further Reduction of Sulphur Emissions (UNECE, 1994)	Signed and ratified (approval)
1998	'Aarhus Protocol': Protocol on Persistent Organic Pollutants (UNECE, 1998a)	Signed and ratified (approval)
1998	'Aarhus Protocol': Protocol on Heavy Metals (UNECE, 1998b)	Signed and ratified (approval)
1999	'Gothenburg Protocol': Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (UNECE, 1999)	Ratified (accession)
2012	Amendments to the Gothenburg Protocol (UNECE, 2012b)	Ratified (acceptance)

On 4 May 2012, the Executive Body for the UNECE Air Convention adopted amendments to the Gothenburg Protocol. The amended protocol includes national emission reduction commitments for the major air pollutants NO_X, NMVOCs, SO_X and NH_3, and for $PM_{2.5}$ (and BC as a component of PM). Parties are to meet the reductions commitments in 2020 and beyond. For the EU, the emission reduction commitments relative to 2005 levels for 2020 and beyond are (UNECE, 2012b):

- -59% for sulphur dioxide (SO_2)
- -40% for NO_X (following a technical correction in 2022 to reflect changes in the EU membership since the time of the adoption of the Gothenburg Protocol amendment, in line with EB Decision 2021/3)
- -6% for NH_3
- -28% for NMVOCs
- -22% for $PM_{2.5}$.

The EU ratified the amended Gothenburg Protocol on 30 August 2017.

Although the emission reduction commitments for 2020 and beyond apply to those Parties that have ratified the amended protocol, the ceilings set for 2010 and the years thereafter are still in place as there are still Parties to the original protocol that are not yet Parties to the amended version. The emission inventory data and this informative inventory report submitted in 2022 therefore address both, the obligations under the emission reduction commitments and those under the emission ceilings.

The Executive Body of the Air Convention adopted the revised *Guidelines for reporting emissions and projections data under the Convention on Long-range Transboundary Air Pollution* (reporting guidelines) at its 32nd session, in March 2014 (UNECE, 2014a). Parties were to apply the revised guidelines in 2015 and subsequent years. A summary of the reporting requirements is presented in Appendix 2.

The deadline for individual Parties to submit data to the Air Convention is 15 February each year. There is a separate deadline of 15 March for submitting the accompanying inventory reports. The reporting guidelines specify separate reporting dates for the EU. They allow time to compile an aggregated inventory based on the individual submissions from EU Member States. The EU should submit EU inventory data to the Executive Secretary of UNECE by 30 April each year and the accompanying inventory report by 30 May. The reporting guidelines also request that Parties report emission inventory data using the new European Monitoring and Evaluation Programme (EMEP) NFR19 format.

In 2012, the Executive Body of the Air Convention decided that adjustments to inventories for the purpose of comparing total national emissions with emission reduction commitments, may be applied in certain circumstances if such a circumstance keeps a Party from meeting one of its reduction commitments (UNECE, 2012a; see also Chapter 2).

The EMEP Steering Body reviews any supporting documentation and assesses whether or not the adjustment is consistent with the circumstances and guidance for adjustments (UNECE, 2012c). It makes the review available to the Parties, which have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

In 2014, the EMEP Steering Body accepted inventory adjustment applications for emissions from Denmark and Germany; in 2015, from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain; in 2016, from Germany and Luxembourg; in 2017, from Spain; in 2018, from Hungary and the United Kingdom; in 2019, from the Netherlands; in 2020, from Czechia, and in 2021 from France (UNECE, 2014b, 2015, 2016, 2017, 2018, 2019, 2020). More information and the adjusted emission data can be found in Chapter 2.

1.2 Institutional arrangements

1.2.1 EU Member States

EU Member States are responsible for selecting the activity data, emission factors and other parameters used for their national inventories. EU Member States should also follow the reporting guidelines (UNECE, 2014a) and apply the methodologies in the latest version of the EMEP/EEA inventory guidebook (EMEP/EEA, 2019a).

EU Member States are also responsible for establishing QA/QC programmes for their inventories. Each inventory report should include a description of the QA/QC activities and recalculations.

EU Member States submit their national inventories and inventory reports by participating in Eionet (European Environment Information and Observation Network) (see Section 1.2.2). In addition, they take part in the annual review and commenting phase of the draft EU inventory report. EU Member States check their national data and information used in the inventory report and, if necessary, send updates. They also provide general comments on the inventory report.

1.2.2 The EEA, European Commission, Eionet and ETC/HE

European Environment Agency
The EEA helps the European Commission's Directorate-General (DG) for Environment to compile the annual EU Air Convention inventory.

EEA activities include:

- overall coordination and management of the inventory compilation process;
- coordinating the activities of the EEA's European Topic Centre on Human health and the environment (ETC/HE) ([6]), which checks the data, compiles the inventory and writes the draft report;
- communication with the European Commission;
- communication with EU Member States;
- circulation of the draft EU emission inventory report;
- hosting the official inventory database and disseminating the data and inventory report online.

Since 2004, the EEA and EMEP have supported a separate annual quality review of emission data submitted by the countries. It provides findings for the countries each year to improve the quality of the emission data reported. Each year, EMEP publishes a joint report summarising the review's findings. Section 1.7 provides further details of the annual data review process.

European Commission
The European Commission formally submits the EU emission inventory data and this informative inventory report (IIR) to EMEP via the Executive Secretary of UNECE.

European Topic Centre on Human health and the environment
The main activities of the ETC/HE ([7]) regarding the EU's Air Convention emission inventory include:

- initial checks, tests and a centralised review of Member State submissions in cooperation with the EMEP Centre on Emission Inventories and Projections (CEIP) and compiling results from those checks (status reports, country synthesis and assessment reports, country review reports);
- consulting with EU Member States (via the EEA) to clarify issues with the data and other information provided;
- preparing the gap-filled EU emission inventory by 30 April, based on Member State submissions (which the European Commission subsequently submits to UNECE);
- preparing the updated EU emission inventory and inventory report by 30 May.

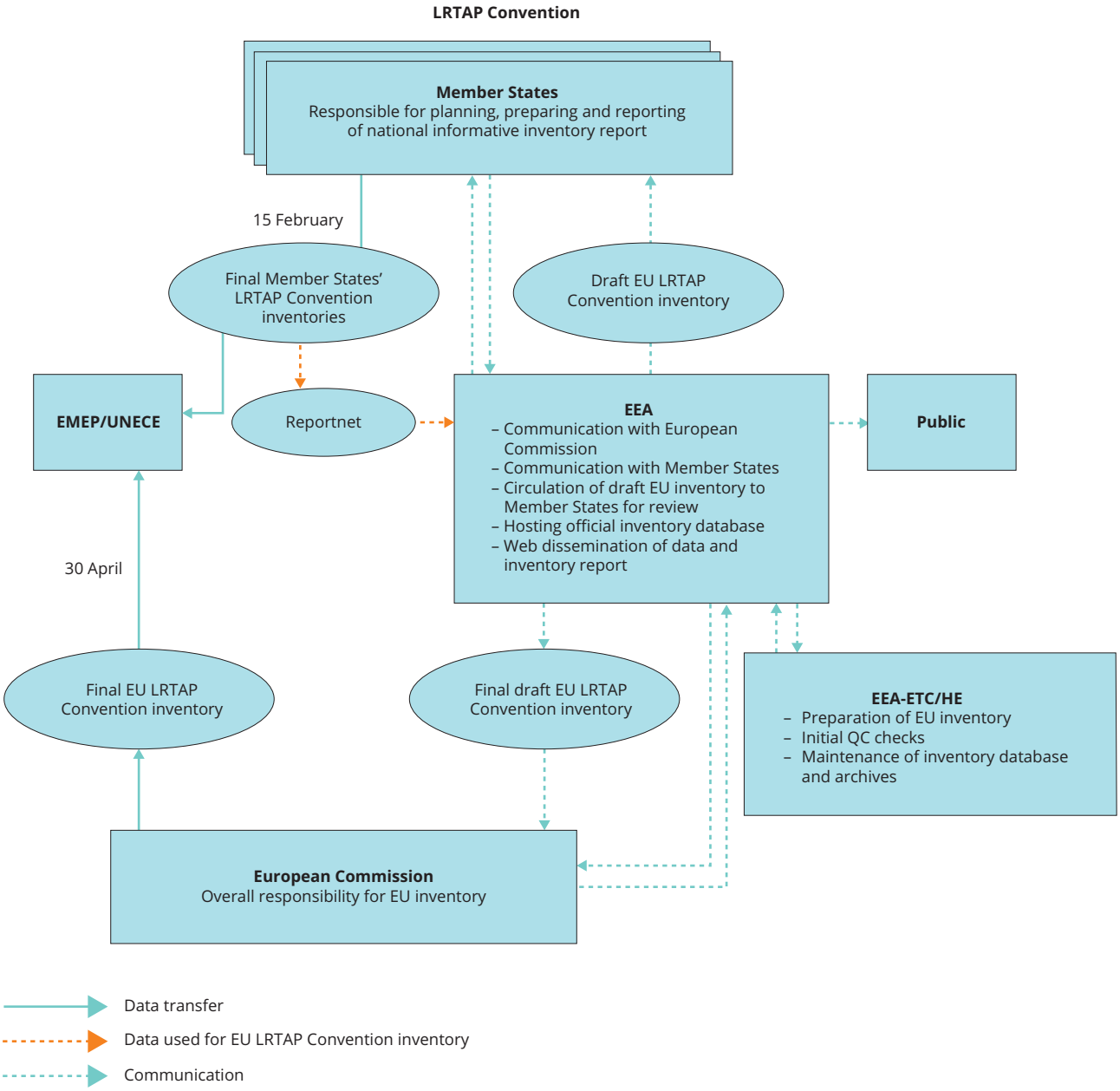
European Environment Information and Observation Network
Eionet facilitates the work of the EEA and the respective European topic centres (EU, 1999) ([8]). It comprises the EEA (supported by its European topic centres) and a supporting network of experts from national environment agencies and other bodies that deal with environmental information (Eionet, 2022a). EU Member States are requested to use the tools of the Central Data Repository (CDR) (Eionet, 2022b) of the Eionet's Reportnet to make their Air Convention submissions available to the EEA.

([6]) The current ETC/HE started its operations on 1 January 2022. Until the end of 2021, the EEA cooperated with the ETC on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI).
([7]) The current ETC/HE was established in 2021 via a contract between the EEA and the lead organisation, the Stiftelsen Norsk Institutt for Luftforskning (Norwegian Institute for Air Research, NILU), and started its operations on 1 January 2022. It works with ten organisations and institutions across nine European countries.
([8]) A brochure describing the structure, working methods, outputs and activities of Eionet is available (EEA, 2012).

1.3 Inventory preparation process

The basis for reporting by individual EU Member States and the EU is the Air Convention (UNECE, 1979), its protocols (Table 1.1) and subsequent decisions taken by the Executive Body. The reporting guidelines describe the data that Parties should report under the Air Convention and its protocols. Under the agreement between Eionet countries and the EEA concerning priority data flows, EU Member States are requested to post a copy of their official submission to the Air Convention in the CDR by 15 February each year. The ETC/HE subsequently collects the data from the CDR, performs a QA/QC procedure, compiles the gap-filled EU Air Convention emission inventory database and produces an EU Air Convention emission inventory and inventory report. The European Commission formally submits the EU's emission inventory data and IIR to EMEP through the Executive Secretary of UNECE. The inventory and accompanying documentation are then made publicly available through the EEA's website (see summary in Figure 1.1).

Figure 1.1 Data flow for compiling the EU Air Convention emission inventory



1.4 Methods and data sources

1.4.1 Reporting obligations under the National Emission reduction Commitments Directive and the EU Greenhouse Gas Monitoring Mechanism Regulation

EU Member States report their emissions of NO_X, NMVOCs, SO_2, NH_3, CO, PM, BC, HMs and POPs under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (EU, 2016b). The 2016 National Emission reduction Commitments (NEC) Directive, which entered into force on 31 December 2016, sets emission reduction commitments for five main air pollutants for the period 2020-2029 and from 2030 onwards. The reduction commitments agreed for 2030 onwards are more ambitious and are designed to reduce the health impacts of air pollution by half compared with 2005.

EU Member States also report emissions of NO_X, SO_2, NMVOCs and CO under EU Regulation No 525/2013, known as the EU Greenhouse Gas Monitoring Mechanism Regulation (MMR) (EU, 2013). EU Member States should also copy this information to the CDR (Eionet, 2021b). Table 1.2 provides an overview of the various reporting obligations for EU Member States.

Table 1.2 Overview of air emission-reporting obligations in the EU, 2022

Legal obligation	Emissions to report	Annual reporting deadline for EU Member States	Annual reporting deadline for the EU [a]
Air Convention [b]	NO_X (as nitrogen dioxide — NO_2), NMVOCs, SO_X (as SO_2), NH_3, CO, HMs, POPs and PM	15 February 2022	30 April 2022
NEC Directive	NO_X (as NO_2), NMVOCs, SO_X (as SO_2), NH_3, CO, HMs, POPs and PM	15 February 2022	Not applicable
EU MMR/United Nations Framework Convention on Climate Change (UNFCCC)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride, NO_X, CO, NMVOCs and SO_2	15 January 2022 to the European Commission and 15 April 2022 to the UNFCCC	15 April 2022

Notes: [a] Over the years, the European Community and the EU have signed a number of protocols. The commitments include varying numbers of EU Member States. Besides the EU-27 data, this report includes the 2020 sulphur emission (Sox) data for the EU-11, in accordance with the EU's reporting obligations under the Air Convention's Protocol on Further Reduction of Sulphur Emissions. (see Box ES.2 and Table A2.2 (in Appendix 2) for more information on EU country groupings).
[b] Parties are formally required to report only on the substances and for the years set forth in protocols that they have ratified and that have entered into force.

Reporting obligations under the Air Convention and NEC Directive have been harmonised since the adoption of the updated reporting guidelines (UNECE, 2014a) and the revision of the NEC Directive (EU, 2016b). Minor differences still occur between reporting under the Air Convention and the NEC Directive:

- Reporting of emission data for B(a)P, B(b)F, B(k)F and IP is voluntary under the Air Convention but is obligatory under the NEC Directive.
- Under the Air Convention, Parties are invited to report their emissions for the EMEP domain. For Portugal, this means that emissions from the Azores and Madeira are included. This differs from reporting under the NEC Directive, for which the Azores and Madeira are excluded.
- Under the NEC Directive, some emissions are not counted for the purpose of compliance (see Directive 2016/2284/EU, Article 4(3)) but they do need to be reported.

- While reporting of projections is required biennially under the NEC Directive, it is only obligatory every 4 years under the Air Convention.

The NEC Directive and Air Convention reporting obligations differ from the United Nations Framework Convention on Climate Change (UNFCCC) obligations by including domestic and international aviation and navigation in the reported national totals. Table 1.3 summarises the main differences between the reporting instruments, the overall impact of which is small for most EU Member States.

Table 1.3 Comparison of air pollutant reporting obligations: the Air Convention, NEC Directive and UNFCCC/MMR

Reporting item	NEC	Air Convention	UNFCCC/MMR
Domestic aviation (LTO)	Incl.	Incl.	Incl.
Domestic aviation (cruise)	Not incl.	Not incl.	Incl.
International aviation (LTO)	Incl.	Incl.	Not incl.
International aviation (cruise)	Not incl.	Not incl.	Not incl.
National navigation (domestic shipping)	Incl.	Incl.	Incl.
International inland shipping	Incl.	Incl.	Not incl.
International maritime navigation	Not incl.	Not incl.	Not incl.
Road transport (fuel sold) [a]	Incl.	Incl.	Incl.

Notes: International inland shipping refers to shipping activity in continental waters and international maritime navigation to shipping activity in marine waters. Air emissions resulting from inland shipping are included, as they are more relevant to air quality for the surrounding environment.
[a] In addition, Parties to the Air Convention may also report emission estimates based on fuel used as an additional 'memo item'. Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, may choose to use the national emission total calculated on the basis of fuel used in the relevant geographical area as a basis for compliance (UNECE, 2014a).
Incl., included in national totals; LTO, landing and take-off; not incl., not included in national totals: memo item.

Under the Air Convention, the EU may deliver its emission and projections report by 30 April, its IIR by 30 May.

1.4.2 General methods

The EU Air Convention emission inventory is based on an aggregation of data reported by EU Member States. The methods that they use should follow those described in the inventory guidebook (EMEP/EEA, 2019). Overall, EU Member States do follow this recommendation, which ensures that they use the best methods available to estimate national emissions and that inventories are improved continuously. Moreover, the technical review procedures set up by the EMEP CEIP check and assess Parties' data submissions, as per the review guidelines. The aim is to improve the quality of emission data and associated information reported to the Air Convention.

The recommended structure for an IIR involves a general description of the methodologies and data sources used. This includes an overview of the emission factors used in the national inventory — country specific or default — given in the inventory guidebook (EMEP/EEA, 2019) and the specification of the sources of default emission factors and methods. It also provides a detailed description of activity data sources where data differ from national statistics. The following two subsections summarise the information that EU Member States provide in their IIRs. This should help readers to understand the basis of the EU inventory. For detailed descriptions of methodologies and data sources, see EU Member States' IIRs (see Appendix 5 for IIR references).

1.4.3 Data sources

The data source for the EU inventory is EU Member States' emission inventories. The IIRs should document detailed information on the data sources used by EU Member States. The level of detail varies widely across EU Member States, although the main data sources are official national statistics. Table 1.4 summarises data sources commonly used for the various sectors.

Table 1.4 Data sources commonly used for inventory sectors

Sector	Sources
Energy	Energy balances, EU Emissions Trading System (ETS) data, large combustion plant data and LPS surveys
Transport	Energy balances, vehicle fleet statistics
Industrial processes and product use	National production statistics, trade statistics, data from plant operators (facility reports), reporting under the European Pollutant Release and Transfer Register (E-PRTR) and its predecessor, the European Pollutant Emission Register (EPER)
Agriculture	National agricultural statistics, specific studies
Waste	Landfill databases, national studies, national statistics, information from municipalities

Sources for emission factors vary according to the tier method used. One main source is the inventory guidebook (EMEP/EEA, 2019), but emission factors can also be country or even plant specific. It is impossible to survey the emission factors used by the EU Member States for all emission sources, as this information is not uniformly available: some countries report details of their methodologies, while others do not. Detailed information is available in EU Member States' IIRs; see Appendix 5.

1.4.4 Comparison of EU Member States' emissions calculated on the basis of fuel sold versus fuel consumed in road transport

In Article V/A, paragraph 22, the reporting guidelines (UNECE, 2014a) specify how to report emissions from transport:

> For emissions from transport, all Parties should calculate emissions consistent with national energy balances reported to Eurostat or the International Energy Agency. Emissions from road vehicle transport should therefore be calculated on the basis of the fuel sold in the Party concerned. In addition, Parties may voluntarily calculate emissions from road vehicles based on fuel used or kilometres driven in the geographical area of the Party. The method for the estimate(s) should be clearly specified in the IIR.

Paragraph 23 of the guidelines provides detailed information on the basis for compliance checking:

> For Parties for which emission ceilings are derived from national energy projections based on the amount of fuel sold, compliance checking will be based on fuels sold in the geographical area of the Party. Other Parties within the EMEP region (i.e. Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, Switzerland and the United Kingdom of Great Britain and Northern Ireland) may choose to use the national emission total calculated on the basis of fuels used in the geographic area of the Party as a basis for compliance with their respective emission ceilings (UNECE, 2014a).

Parties can estimate transport emissions using the amount of fuel sold within the country or the amount of fuel consumed. When fuel purchased within a country is used outside that country (and vice versa), these estimates can differ significantly. The EU inventory compiled in 2022 estimates emissions from road transport based on the fuel sold for all EU Member States.

1.4.5 Data gaps and gap filling

Ideally, there should be no need to fill gaps in the inventory data reported, as it is the responsibility of EU Member States to submit full and accurate inventory data sets. However, EU Member States' submissions include a few data gaps for particular pollutants or years in the time series. Frequently, whole national inventories, emissions of some pollutants or sectoral emission data are missing.

The EMEP reporting guidelines (UNECE, 2014a) require that submitted emission inventories are complete. The 2021 gap-filling procedure was identical to that in 2020 and follows a methodology paper by the EEA and the European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) (EEA, 2009) and some changes agreed at the meeting of the Task Force on Emission Inventories and Projections (TFEIP) in 2016 ([9]). This procedure is also consistent with the techniques used to fill emission data gaps proposed by the inventory guidebook (EMEP/EEA, 2019). It applies a stepwise approach using emission data from other reporting obligations to fill gaps in the national data sets, followed by further gap-filling procedures such as inter- or extrapolation and manual changes Box 1.1.

Box 1.1 Unified Air Convention gap filling for EU and EMEP inventories (ETC/ACM,2015)

A stepwise approach was used to fill gaps in the national data sets:

1. Emission trends for all pollutants have been compiled from 1990 onwards, using the Convention on Long-range Transboundary Air Pollution (Air Convention) emission inventories provided by the EU Member States to the EEA in 2022.

2. Air Convention data submitted to the European Monitoring and Evaluation Programme (EMEP) Centre on Emission Inventories and Projections (CEIP) in 2022 are the next source used to fill remaining gaps. All reported data (i.e. values and notation keys) are used. In fact, there should be no difference between the EU Member States' Air Convention emission inventories provided to the EEA and the data submitted to the EMEP CEIP.

3. For those EU Member States not reporting complete data, emission data officially reported in the current reporting year by EU Member States under the EU Greenhouse Gas Monitoring Mechanism Regulation (MMR) are used to fill gaps. In this step, notation keys are not used.

4. Next, emission data reported officially by EU Member States under the 2016 National Emission reduction Commitments (NEC) Directive in the current reporting year are used to fill gaps. Notation keys are not used in this step.

5. In a further step, notation keys reported in the current reporting year by EU Member States under the MMR are used to fill any remaining gaps.

6. Subsequently, notation keys reported in the current reporting year by EU Member States under the NEC Directive are used to fill any remaining gaps.

7. Next, Member State Air Convention emission inventories provided to the EEA in previous years are used to fill any gaps still remaining (values and notation keys).

8. Older Air Convention data submitted to the EMEP CEIP are the next source of official information used to fill gaps (values and notation keys).

([9]) TFEIP/Eionet meeting and workshop, 16-18 May 2016, in Zagreb.

9. The gap filling continues with emission data reported in previous years under the MMR (values and notation keys).

10. For all remaining cases of missing data, further gap filling procedures are applied:

    a. Linear interpolation is performed if one or several years are missing in the middle of a time series.

    b. Linear extrapolation is performed if one or several years are missing, either at the beginning or at the end of a time series, and if at least 5 consecutive years showing a clear trend ($r^2 \geq 0.6$) are available. Extrapolation 'backwards' is never allowed to result in negative values.

    c. If fewer than 5 consecutive years are available as a basis for extrapolation, or if years do not show a clear trend (as is the case when $r^2 < 0.6$), the value of the previous or next year is used to fill the gaps.

    d. If the notation key 'NA' (not applicable) or 'NO' (not occurring) is used as a basis for gap filling, it is treated as '0' and is not gap filled.

    e. When both national total and sectoral data are unavailable, sectors are first gap filled and then summed to determine the total.

    f. When the national total is available but there are no sectoral data, the sectoral split of the previous or following year is used to fill the gaps.

11. After this automated gap filling procedure, some manual corrections are made to the gap-filled data in all cases in which total suspended particulate (TSP) emissions are lower than particulate matter (PM) with a diameter of 10 µm or less (PM_{10}) emissions, PM_{10} emissions are lower than PM with a diameter of 2.5 µm or less ($PM_{2.5}$) emissions, or $PM_{2.5}$ emissions are lower than black carbon (BC) emissions. In these cases, PM_{10} data are equated with TSP data, $PM_{2.5}$ data with PM_{10} data, and BC data with $PM_{2.5}$ data.

However, gap filling is applied only where national total and sectoral data are unavailable or where a national total was available but there were no sectoral data. In the former instance, sectors were first gap filled and then summed to determine the total. In the latter instance, the sectoral split of the previous or following year was used to fill the gaps. If a national total was available, but the sectoral data were incomplete, no gap filling was carried out. For BC and additional HMs, some EU Member States lacked data for all years, making gap filling impossible. In such instances, the EU emission totals for these pollutants are considered incomplete (i.e. they are underestimated). Furthermore, inventories cannot be considered complete if the notation keys 'NE' and in some cases 'NR' (not relevant), or the value 0, are reported or are used for gap filling. For further information on the effect of gap filling on the EU inventory, see Section 1.9, Figure 1.5 and Figure 1.6.

Annex G shows how the various officially reported data sets were used to supplement the Air Convention data submissions for those EU Member States for which gap filling was required. Annex D offers a more detailed overview, showing each Member State for which data were gap filled and how this was performed. The trend tables in Chapter 3 (Table 3.4 to Table 3.29) also provide an initial overview, indicating which data have been derived by gap filling.

1.5 Reporting

1.5.1 Emission reporting

The deadline for EU Member States to report by was 15 February 2022. In the 2022 reporting cycle, 26 EU Member States submitted their inventories and time series on time. Greece submitted its data after the formal deadline for submission (see Appendix 3, Figure A3.1). All Member States provided a complete time series in 2022. All 27 EU Member States submitted data using the new NFR19 reporting templates. Appendix 3 presents detailed information on EU Member States' submissions.

1.5.2 Projection data

In 2022, reporting of projection data was voluntary, and the deadline for EU Member States to report by was 15 March 2022. Three EU Member States have submitted information on their projections so far, both of them before the deadline. Submitted data are available in Annex E of this report.

1.5.3 Gridded data

According to the revised reporting guidelines, Parties within the geographical scope of EMEP should report gridded data at a resolution of 0.1 ° × 0.1 ° longitude-latitude every 4 years, starting in 2017. As gridded data for the EU were last submitted in 2021 (EEA, 2021a), there is no obligation to report gridded data this year. Thus far no EU Member State has provided gridded data on a voluntary basis.

1.5.4 Large point sources

Parties within the geographical scope of EMEP are also required to provide data on LPSs every 4 years, commencing in 2017. LPS data for the EU were last submitted in 2021 (EEA, 2021) and therefor there is no obligation to report LPS data this year. No EU Member State has provided LPS data in 2022.

1.5.5 Reporting on condensable components from $PM_{2.5}$ and PM_{10}

PM consists of a filterable fraction and a condensable fraction, which reacts upon cooling and dilution, shortly after release, to form solid or liquid PM. The reporting of condensable components is not mandatory, and in recent years there has been no clarity about whether PM emission reporting includes or excludes the condensable component. However, in 2019, a new reporting table within Annex II to the reporting guidelines (EMEP CEIP, 2022a), Table A6.1, 'Inclusion/exclusion of the condensable component from PM_{10} and $PM_{2.5}$ emission factors', was established. In 2022, 18 EU Member States have provided information using this table. One Member State has not provided information using this table but have reported information on condensable components in its IIR. The level of information provided by the Member States is rather heterogeneous and for many categories no information is available at all.

1.6 Key category analysis

A key category is an emission source category that has a significant influence on an inventory. It may affect the absolute level of emissions, the trend in emissions or both. This report classifies categories jointly responsible for 80% of the national total emissions of a given pollutant as key categories (see EMEP/EEA, 2019).

An analysis of the levels of the 2020 emissions of each pollutant (following any necessary gap filling) determined EU key categories. When a Member State used the notation 'IE' (included elsewhere) for a particular source/pollutant combination, the KCA is likely to have underestimated the category concerned and overestimated the one in which emissions were reported instead.

Chapter 3 provides a summary of the top five EU key categories in 2020, for NO_X, NMVOCs, SO_X, NH_3, $PM_{2.5}$, PM_{10}, CO, HMs (Pb, Cd and Hg) and POPs (PCDD/Fs, total PAHs, HCB and PCBs). A complete list of all EU key categories for the emissions of these pollutants is also given in Figure 1.2. Additional HMs, TSPs, BC and the remaining POPs are not considered here.

A total of 59 different emission inventory source categories were identified as being key categories for at least one pollutant. '1A4bi — Residential: Stationary' was identified as being a key category for 14 pollutants assessed. '1A1a – Public electricity and heat production' was identified as key category for 11 pollutants and '2C1 — Iron and steel production' was identified as being important emission sources for seven pollutants. The categories '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' and '1A3bi — Road transport: Passenger cars' were identified as being key categories for nine pollutants each.

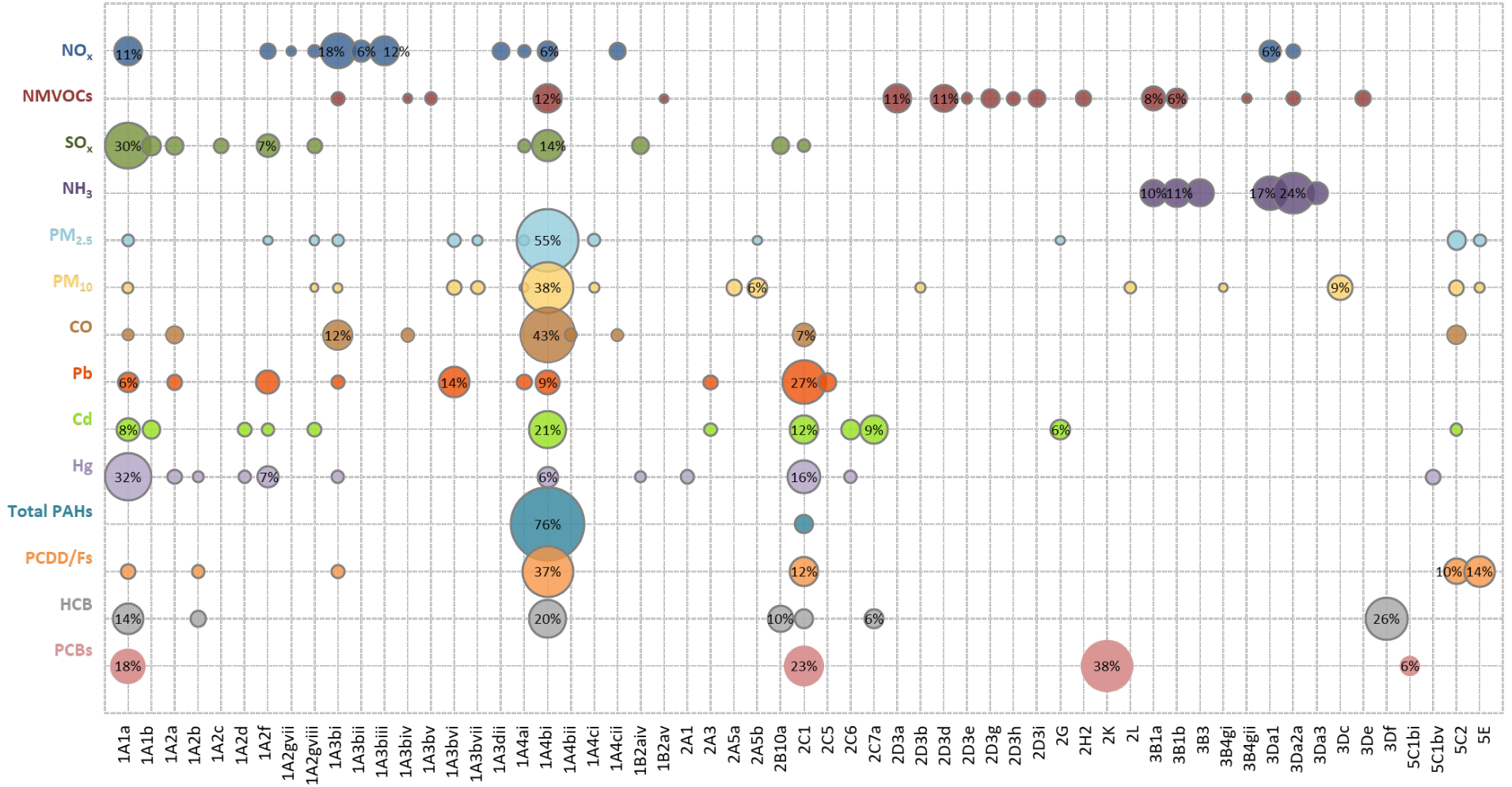
For NO_X and CO, 13 and 9 key categories were identified, respectively; as expected for both pollutants, the key categories with a large share of total emissions reported mainly involve fuel combustion. 11 key categories were identified for SO_X (mainly energy-related sectors) and six for NH_3 (all from the agriculture sector). PM_{10}, $PM_{2.5}$ and NMVOC emission sources are more diverse, so larger numbers of source categories make up the key category threshold of 80% of total emissions. For the PM pollutants, key categories comprise all sectors, '1A4bi Residential: Stationary' is an important key source for all of them. A key aspect for NMVOCs was high activity levels associated with the industrial processes and product use sector.

For the HM Cd, 12 key categories were identified, while for Hg, 10 key categories were identified, as were 10 for Pb. Emissions from these key categories were mostly related to the energy sectors and industrial processes and product use, resulting particularly from processes associated with metal production.

For the POPs, source categories from all sectors except 'Non-road transport' were identified as key categories. Overall, metal production and 'Residential: Stationary' were quite important key sources of POP emissions.

Several factors may influence the determination of key categories at the EU level. The notation key 'IE' (see Appendix 1) means that a Member State can include emission estimates for one NFR sector in those of a different sector. In addition, EU Member States have different ways of allocating emissions to the (sub)sector 'other', which might lead to inconsistencies. Given such issues, the EU KCA may not always accurately reflect the share of all main emission sources. It is also crucial to note that the results of a similar analysis of individual EU Member States will differ from the key sources determined for the EU.

Figure 1.2 EU KCA results for 2020



Note: Bubble size indicates the percentage of total emissions.
All values > 5% are indicated. For NFR codes, see the list of source sector abbreviations (Appendix 4).

1.7 Quality assurance, quality control and verification methods

EU Member States are encouraged to use appropriate QA/QC procedures to ensure data quality and to verify and validate their emission data. These procedures should be consistent with those described in the inventory guidebook (EMEP/EEA, 2019).

The main activities improving the quality of the EU inventory, which is based on quality-assured data officially reported by the EU Member States, are the checks that the EEA's ETC/HE performs on the status of each Member State's submission. As the emission inventories reported under the Air Convention and the NEC Directive are almost the same, checks are compared with those run by the EEA under the NEC Directive.

In addition, the ETC/HE checks the internal consistency of EU Member States' data tables before compiling the EU tables. The ETC checks Member State data at national total and sectoral levels: when it finds outliers, it identifies the categories responsible. When the ETC does not find any explanation for a notable trend in a country's IIR, it contacts the relevant Member State. The checks focus on data that significantly affect EU trends. An overview of the checks performed is given in Table 1.5 and of the findings in Table 1.6.

Table 1.5 Overview of quality checks done during the preparation of the EU Air Convention inventory and report

	Check							First checks	Sub-sequent checks (after gap-filling)	Checks within the draft report	Member States will be informed on the finding	Changes/ Corrections
	Completeness	Consistency	Comparability	Accuracy	Transparency	Level	Years					
Reporting overview	✓		✓		✓	Submissions	1990-2020	×			if submission is missing or in wrong format	gap-filling of missing data as far as possible
Adjustment overview	✓		✓		✓	Submissions	2010-2020	×			if a document is missing or in wrong format	
Completeness	✓				✓	Submissions	1990-2020	×			yes	only in case of resubmissions of the Member State
Time series checks	✓	✓				National Totals, Sectors	1990-2020	×			yes	only in case of resubmissions of the Member State
NFR template line 144 check			✓		✓	National Totals	1990-2020	×			yes	only in case of resubmissions of the Member State
Total PAHs = Sum of PAHs				✓		National Totals	1990-2020	×			yes	only in case of resubmissions of the Member State
TSP-PM_{10} ratio, PM_{10}-$PM_{2.5}$ ratio checks				✓		National Totals	1990-2020	×			yes	only in case of resubmissions of the Member State
TSP ≥ PM_{10}, PM_{10} ≥ $PM_{2.5}$, $PM_{2.5}$ ≥ BC checks				✓		National Totals, Categories	1990-2020	×			yes	only in case of resubmissions of the Member State
National Total = Sum of Sectors	✓			✓		National Totals, Sum of Sectors	1990-2020		×		if difference is more than 5%	only in case of resubmissions of the Member State
'NE' analysis	✓					National Totals, Categories	2020		×	×	within the review of the draft version of the report	only in case of resubmissions of the Member State
'NA' and 'NO' checks				✓	✓	National Totals, Categories	2020		×		yes	only in case of resubmissions of the Member State
Recalculations		✓				National Totals	1990-2019			×	within the review of the draft version of the report	no
Effect of gap-filling	✓				✓	Whole EU inventory	1990, 2020			×	within the review of the draft version of the report	no
Completeness of the EU inventory	✓				✓	Whole EU inventory	1990, 2020			×	within the review of the draft version of the report	no

Table 1.6 Findings of the quality checks done during preparation of the EU Air Convention inventory and report in 2022

Test/check	Findings	Number of EU Member States concerned
Completeness	0	0
Time series checks	25	14
NFR template line 152 check	2	2
Total PAHs =Sum of PAHs	16	16
TSP-PM10 ratio, PM10-PM2.5 ratio checks	2	1
TSP ≥ PM10, PM10 ≥ PM2.5, PM2.5 ≥ BC checks	46	15
National Total = Sum of Sectors	1	1
'NE' analysis	657	27
'NA' and 'NO' checks	161	17

Notes: [a] The check was performed on the gap-filled EU inventory.
NA, not applicable; NO, not occurring.

EU Member States also provide external checks through an Eionet review, before the EU submits the final version of the EU inventory to the Air Convention Secretariat. In addition, an important element in improving the quality of national and EU Air Convention inventories is the annual meeting of the TFEIP. This expert meeting discusses quality issues concerning EU Member States' emission reporting. Because of the current COVID-19 situation, the meeting was held in the form of a web conference from 9 to 12 May 2022 (TFEIP, 2022).

The agreed gap filling procedure is one of the instruments used to ensure and improve the quality of the EU inventory. It analyses and, where possible, fills gaps in reporting of sectoral emissions and total emissions for any year. This improves the key features of completeness, comparability and consistency over the years and motivates EU Member States to report their data in the following reporting cycle (further details on gap filling are available in Section 1.4.5).

All inventory documents (submissions, inventory master files, inventory reports, status reports and related correspondence) are archived electronically on the EEA ETC/HE forum data portal. Revisions of data sets are recorded.

The EMEP CEIP performs more detailed QA activities in an annual review process (EMEP CEIP, 2022b). It reviews Member State Air Convention emission inventories at the same time as the European Commission, assisted by the EEA, reviews those reported under the NEC Directive (EU, 2016b). The EMEP CEIP technical review of inventories is carried out in three stages. Stages 1 and 2 include checks on timeliness, formats, consistency, accuracy, completeness and comparability of existing Member State inventory submissions. Test results, provided to EU Member States or to the EU as a whole, are used to improve the quality of the national emission inventories. Each year, the EMEP review report publishes summary results of the review (stages 1 and 2) ([10]).

Stage 3 is a technical in-depth review of selected countries. It checks if submitted emission inventories are complete, consistent over time, properly documented and accurate. The annual in-depth review aims to be consistent across the Parties. The process should ensure that the Parties follow the same approach each year. The CEIP selects the countries in cooperation with the EEA and EMEP. In 2021, it reviewed Bosnia and Herzegovina, Kazakhstan, Liechtenstein, Monaco and Montenegro. The results are included in individual country-specific reports (EMEP CEIP, 2022c). In 2022 the CEIP reviews all EU Member States with a focus on the condensable component of PM emissions.

([10]) EMEP publishes a summary of the results of the stages 1 and 2 reviews performed in 2022 (EMEP, forthcoming).

1.8 General uncertainty evaluation

To quantify uncertainty in the EU Air Convention emission inventory, EU Member States first need to provide detailed information on emission uncertainties. Only 19 EU Member States (Austria, Belgium, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Latvia, Malta, the Netherlands, Poland, Romania, Slovakia, Spain and Sweden) provided detailed tables quantifying uncertainty in their 2020 emission inventories. Czechia and Lithuania mentioned uncertainties for certain categories at a basic level. The pollutants that they consider and the assumptions behind the uncertainty analysis vary across EU Member States. Because too few countries provided an uncertainty estimate, the overall uncertainty of the EU Air Convention inventory cannot be estimated.

1.9 Completeness and underestimations

In this context, completeness means that reports include estimates for all pollutants, all relevant source categories, all years and all territorial areas. For substances for which there are existing reporting obligations under the Convention and the protocols as further specified by Executive Body Decision 2013/4 (please see Appendix 3), all Member States provided a complete time series. For substances and data for which reporting is encouraged, Austria and Luxembourg submitted no data for additional HMs. Finland did not report national totals for the additional HM Se; however, it provided most of the sectoral data. Poland did not provide data for Se. Austria and Luxembourg did not report data for BC. All 27 EU Member States reported activity data ([11]) and all countries reported activity data for the complete time series (1990-2020). The stage 1 review provides detailed results for the completeness of Member State submissions (EMEP CEIP, 2022d).

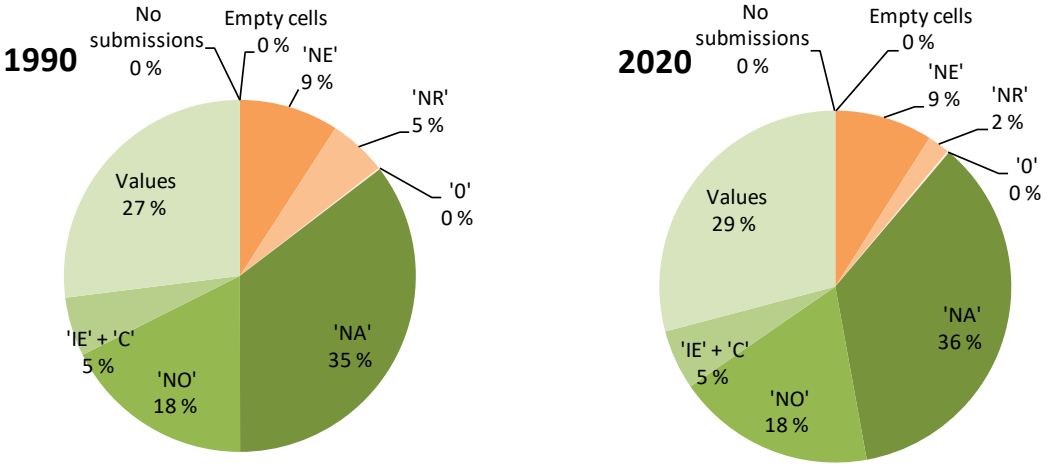
Figure 1.3 shows a simple compilation indicating the completeness of Member State reporting for the inventory years 1990 and 2020. It uses the NFR templates that were submitted originally, i.e. before gap filling. It gives the percentages of each notation key or values that the reports present for source categories. The data are for all EU Member States and all pollutants (excluding national totals). The figures show that more data are available for 2020 than for 1990. The notation key 'NA' (not applicable) appears often because an air pollutant is relevant only to specific emission sources (e.g. NH_3 for agriculture). This makes it necessary to use 'NA' for other sources. The use of the notation key 'NE', the reporting of empty cells, '0', in some circumstances the reporting of the notation key 'NR' ([12]), 'No submissions' and 'Empty cells' count as incomplete reporting. EU Member States reported 11% of the 2020 data entries incompletely, while for 1990 they reported 15% of the data incompletely.

The EMEP emission-reporting guidelines (UNECE, 2014a) require Parties to report data at least for the base year of the relevant protocol, and from the year it entered into force, and up to the latest year (2 years before the present) (see Appendix 2, Table A2.1). So, ideally, there should be no difference between the availability of data submissions for 1990 and for 2020.

([11]) Activity data should be reported, together with emissions, from 2009 onwards (UNECE, 2009).

([12]) According to the emission-reporting guidelines (UNECE, 2014a), emission inventory reporting should cover all years from 1990 onwards if data are available. However, 'NR' has been added to ease reporting where the different protocols do not strictly require details of emissions. Only in these circumstances is 'NR' correct and appropriate.

Figure 1.3 **Completeness of reporting of NFR templates submitted by EU Member States (all data entries for all pollutants, excluding national totals)**



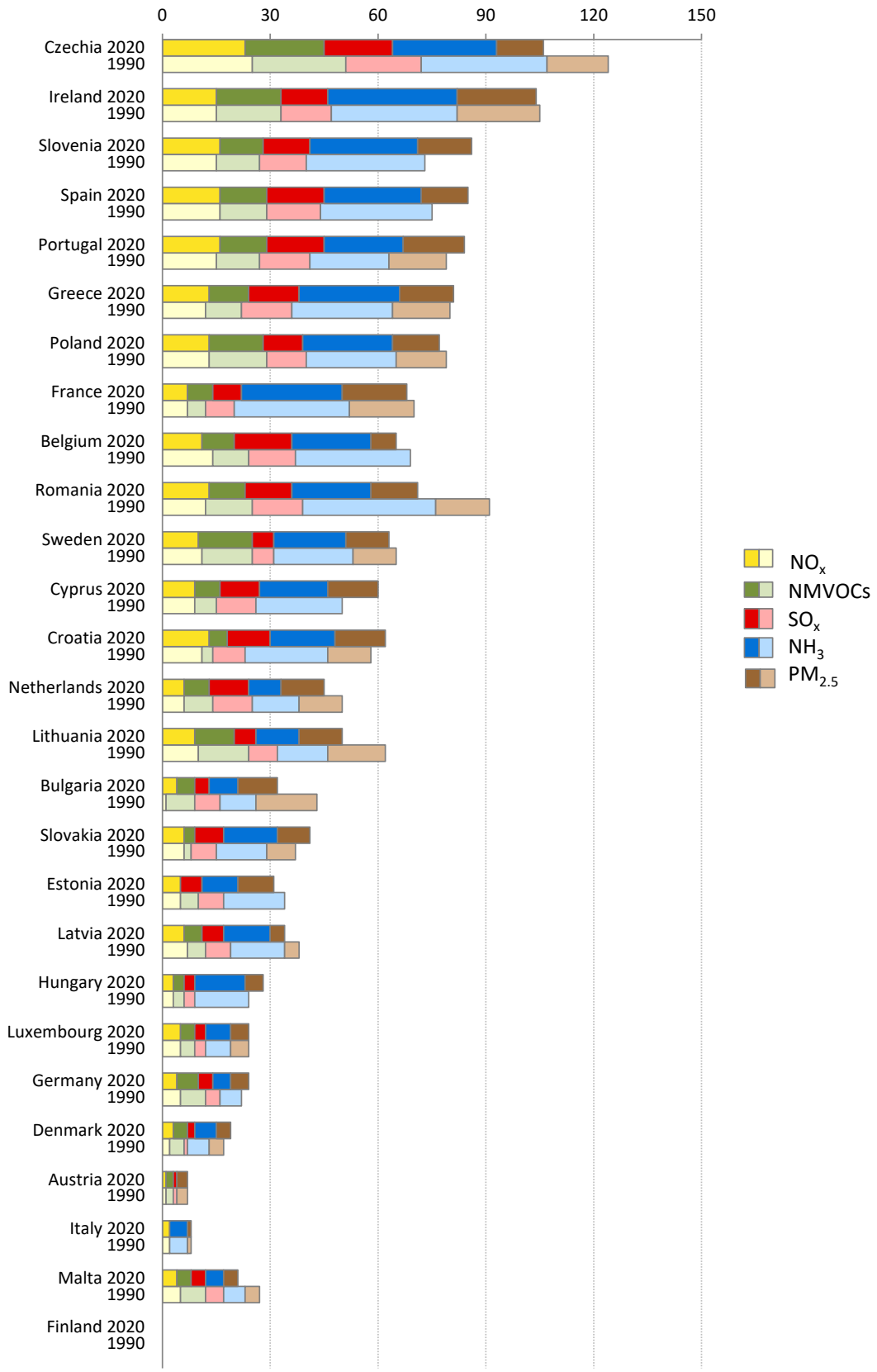
Notes: Appendix 1 provides further explanations on notation keys.
C, confidential; NO, not occurring.

There are many instances in which some countries report emissions for a particular NFR category and pollutant while others use the notation keys 'NA' or 'NO'. Annex H shows, for each Member State for all categories, where data were reported, although 80% or more of the other countries reported 'NA' or 'NO' (not occurring) for these categories.

The official reporting guidelines of the Air Convention (UNECE, 2014a) allow countries to report emissions as 'NE' for some sectors. This is done where they know that emissions occur but have not estimated or reported them. Countries should report in their IIR why they have not estimated emissions.

Certain EU Member States use the notation key NE for many source categories (see Figure 1.4). For example, in 1990, Czechia and Ireland reported 36 and 35 source categories of NH3 as 'NE', respectively, Romania reported 37 source categories of NH3 as not estimated. Overall, in most cases, the use of 'NE' in reporting in 2020 is quite similar to its use in 1990. Most uses (across all pollutants and EU Member States) are in the categories '1A3bvii — Road transport: Automobile road abrasion', '5E — Other waste', '2D3g — Chemical products', '1A3ai(i) — International aviation LTO (civil)', '1A3aii(i) — Domestic aviation LTO (civil)' and '5B2 — Biological treatment of waste'. Within these categories, more than 29% of the entries mention 'NE'.

Figure 1.4 **Number of 'NE' source categories for 2020 and 1990**

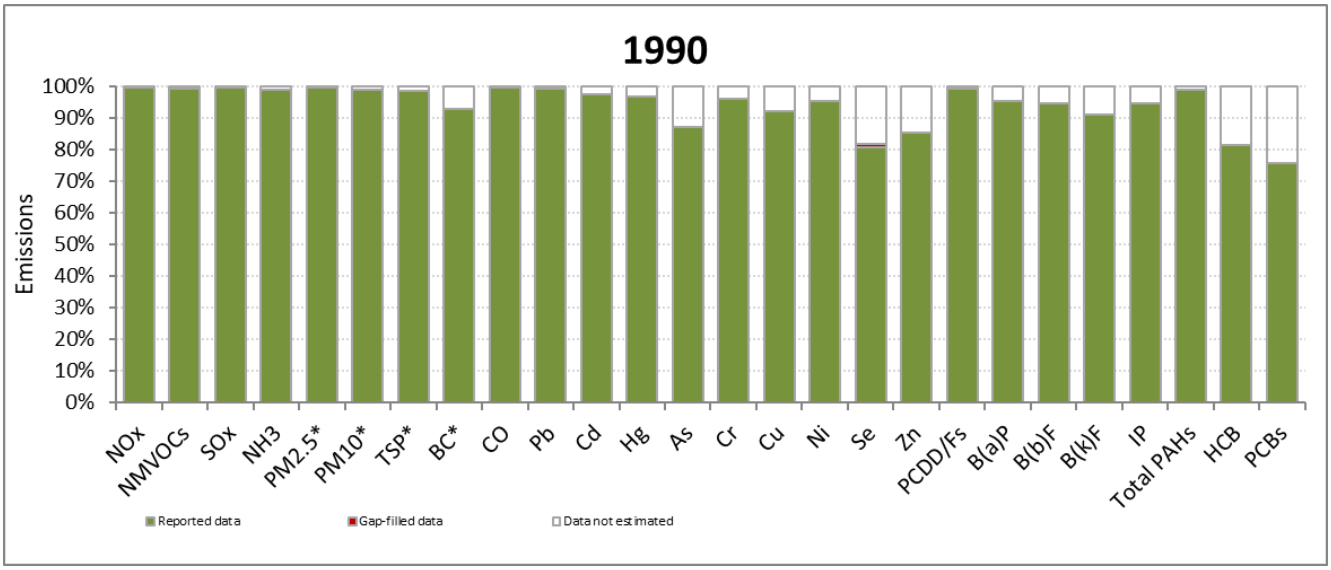


Notes: The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Therefore, 'NE' reporting for PM2.5 in 1990 might be high for several countries.

Figure 1.5 and Figure 1.6 show the proportions of gap-filled data and the estimated underestimation of the EU inventory for 1990 (2000 for PMs and BC) and 2020. The calculated underestimation comprises missing data (e.g. if emission data of a pollutant were not estimated by a Member State and no data were available for gap filling) and the use of the notation keys 'NE' and 'NO' and zero values. To calculate the underestimation, the specific share of total emissions for each Member State was first assessed. The share was calculated as the mean value of the respective EU Member State's share of those pollutants where a national total (gap filled or reported) from all EU Member States was available. In the gap-filled inventory, whenever the notation key 'NE' or 'NR' was used, or zero data were reported within a sector, this EU Member State's share was used to calculate the missing emissions within the respective sector. The sum of the missing emissions from all sectors and EU Member States was then calculated as the percentage value of the total emissions of a pollutant.

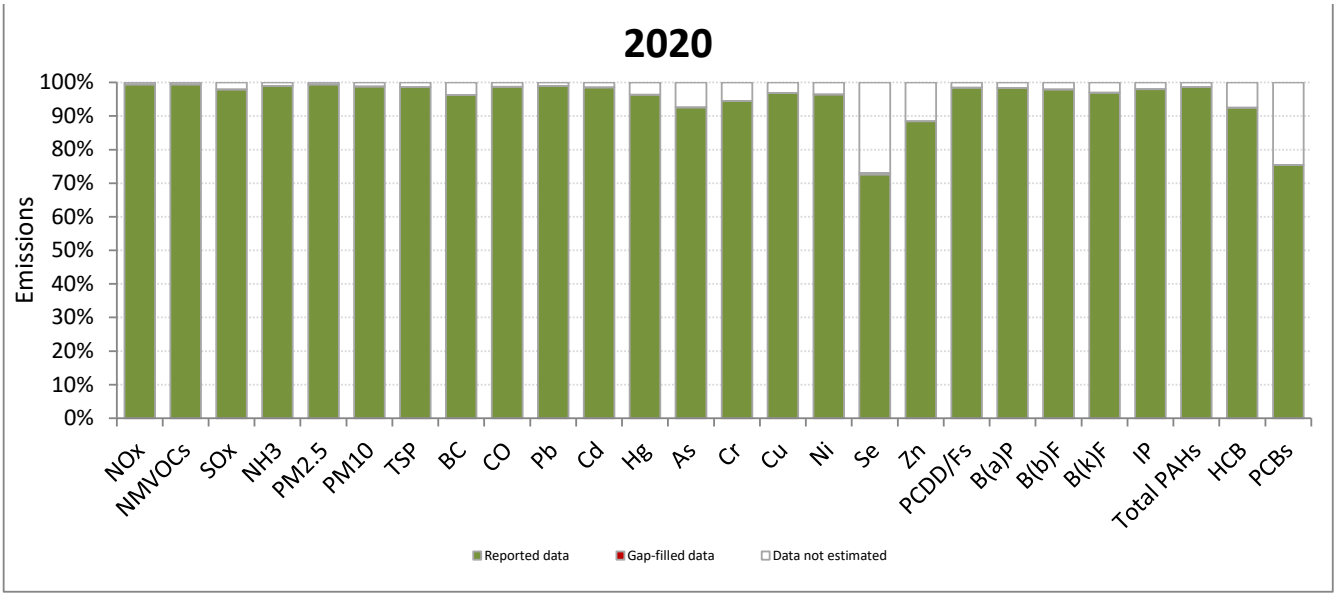
This year gap-filled data had only a minor impact on the EU totals. For Se 1.8 %, of the EU's national total for 1990 represent gap-filled data. For all other pollutants no data were gap filled.

Figure 1.5 Completeness and effect of gap filling on EU emissions data for 1990



Note: * For PM, TSP and BC, data for the year 2000 are shown.

Figure 1.6 Completeness and effect of gap filling on EU emissions data for 2020



2. Inventory adjustments made under the Gothenburg Protocol

In 2012, the Executive Body of the Convention on Long-range Transboundary Air Pollution (Air Convention) decided that adjustments to inventories may be applied in certain circumstances (UNECE, 2012a). The European Monitoring and Evaluation Programme (EMEP) Centre on Emission Inventories and Projections (CEIP) leads the adjustment procedure, coordinates the review of any supporting documentation and assesses whether the adjustment is consistent with the particular circumstances and the guidance for adjustments (UNECE, 2012c). It makes the review available to the Parties, which then have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

These circumstances are as follows:

- Emission source categories are identified that were not accounted for at the time the emission reduction commitments were set.
- Emission factors used to determine emission levels for particular source categories have changed since the emission reduction commitments were set.
- The wa of determining emissions from specific source categories have changed significantly between the time when emission reduction commitments were set and the year that they are to be attained.

Table 2.1 lists inventory adjustment applications accepted by the EMEP Steering Body in 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021.

Table 2.1 Previously accepted inventory adjustment applications

Year of acceptance	Member State	Pollutant	NFR19 code	Years
2014	Denmark	NH_3	3Da1, 3De	2010-2012
2014	Germany	NO_X	1A3b	2010-2012
2014	Germany	NO_X	3B, 3D	2005-2012
2015	Belgium°NO_X	1A3bi-iv, 3B, 3Da1, 3Da2a	2010-2013	
2015	Belgium	NMVOCs	3B, 3De	2010-2013
2015	Denmark	NMVOCs	3B	2010-2013
2015	FinlandNH_3	1A2gviii, 1A4ai, 1A4bi, 1A4ci, 1A3bi-iv	2010-2013	
2015	France	NO_X	1A3bi-iv	2010-2013
2015	Germany	NMVOCs	3B, 3De	2010-2013
2015	Luxembourg	NO_X	1A3bi-iv	2010-2013
2015	Spain	NO_X	1A3bi, 1A3biii	2010-2012
2016	Germany	NO_X	3Da2c, 3l	2010-2014
2016	Germany	NH_3	3Da2c, 3l	2010-2014
2016	Luxembourg	NO_X	3B, 3De	2010-2014
2016	Luxembourg	NMVOCs	3B, 3De	2010-2014
2017	Spain	NO_X	3B	2010-2015
2018	Hungary	NMVOCs	3B, 3De	2010-2016
2018	United Kingdom	NO_X	1A3bi-iv	2010
2019	Netherlands	NMVOCs	3B1a, 3B4h, 3B4d, 3B4e, 3B4giii, 3B4giv, 3B2, 3B4h, 3B4f, 3B1b, 3Da2a, 3Dc, 3B3, 3B4gii, 3B4gi, 3De, 3Da3	2010-2017
2019	Netherlands	NH_3	3Da4, 3De, 3B3	2014-2017
2020	Czechia	NMVOCs	3B	2010-2018
2021	France	NO_X	3B, 3D	2010-2018
2021	France	NMVOCs	3B, 3D	2010-2018

Notes: For nomenclature for reporting (NFR) codes, see the list of source sector abbreviations in Appendix 4.
NH3, ammonia; NMVOCs, non-methane volatile organic compounds; NOX, nitrogen oxides.

Sources: UNECE (2014b, 2015, 2016, 2017, 2018, 2019, 2020, 2021)

If a Party is planning to adjust its inventory for the purpose of comparing total national emissions with emission reduction commitments, it indicates in its notification to the United Nations Economic Commission for Europe (UNECE) Secretariat and the CEIP which categories and pollutants are affected. It uses Annex II to the reporting guidelines as a basis (UNECE, 2014a).

Table 2.3 gives an overview of reported adjustments within the Air Convention submission in 2022. All approved adjustments, reported in the current year, also appear in the emission trend tables in Section 3.3 (non-methane volatile organic compounds, NMVOCs; Table 3.5) and Section 3.5 (ammonia, NH3; Table 3.7). Parties must report details of their previously approved adjusted aggregated emissions using the appropriate row in the main emissions reporting template (Annex I to the reporting guidelines; UNECE, 2014a). They must also provide detailed information by pollutant and sector for each adjustment, using the template provided in Annex VII to the reporting

guidelines. Reporting of information on adjusted emissions in no way suspends the mandatory requirement for Parties to report unadjusted emissions, as laid down in section V, subsections A-D, of the guidelines.

Table 2.2 shows the EU Member State that submitted its adjustment applications, together with its Air Convention submissions, via the Central Data Repository (CDR) in 2022. In 2022, Denmark, France and the Netherlands applied for adjustments.

Table 2.3 gives an overview of reported adjustments within the Air Convention submission in 2022. All approved adjustments, reported in the current year, also appear in the emission trend tables in Section 3.3 (non-methane volatile organic compounds, NMVOCs; Table 3.5) and Section 3.5 (ammonia, NH_3; Table 3.7). Parties must report details of their previously approved adjusted aggregated emissions using the appropriate row in the main emissions reporting template (Annex I to the reporting guidelines; UNECE, 2014a). They must also provide detailed information by pollutant and sector for each adjustment, using the template provided in Annex VII to the reporting guidelines. Reporting of information on adjusted emissions in no way suspends the mandatory requirement for Parties to report unadjusted emissions, as laid down in section V, subsections A-D, of the guidelines.

Table 2.2 Adjustment applications within the Air Convention submission 2022 (Annex II to the reporting guidelines; UNECE, 2014a), as of 06 May 2022

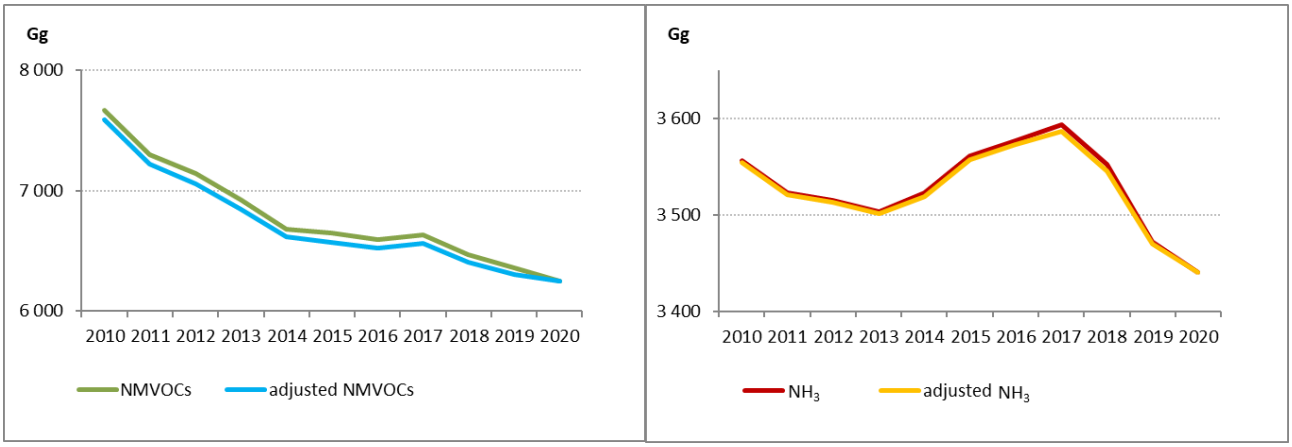
Member State	Pollutant	NFR19 code	Year
Denmark	NMVOC	3B1a	2005, 2020
France	NMVOCs	3B, 3D	2005, 2020
Netherlands	NMVOCs	3B1a	2005, 2020

Table 2.3 Reporting of previously approved adjustments within the Air Convention submission 2022 (Annexes I and VII to the reporting guidelines; UNECE, 2014a), as of 06 May 2022

Member State	Pollutant	Years	Annex I ('adjustment row')	Annex VII	Declaration on consistent reporting of approved adjustments
Finland	NH_3	2010-2019	Yes	No	No
Netherlands	NMVOCs	2010-2019	Yes	No	No
Netherlands	NH_3	2014-2018	Yes	No	No

Figure 2.1 shows the effect in the EU of the previously approved adjustments on the emissions (sum of EU Member States' adjustments).

Figure 2.1 Adjusted and unadjusted emissions of NMVOCs and NH3 for the EU, 2010-2020



Note: Only approved adjustments are considered in the graphs.

3. Trends and key categories of EU pollutant emissions

The present EU inventory lists emissions for all the main air pollutants: particulate matter (PM), heavy metals (HMs) and persistent organic pollutants (POPs). It also reports the individual polycyclic aromatic hydrocarbons (PAHs) for which the Convention on Long-range Transboundary Air Pollution (Air Convention) requires or recommends inventory reporting (UNECE, 1979).

In Chapter 3, the individual sections summarise the contributions each Member State has made to total EU emissions of nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_X), ammonia (NH_3), carbon monoxide (CO), PM with a diameter of 2.5 µm or less ($PM_{2.5}$), PM with a diameter of 10 µm or less (PM_{10}), total suspended particulates (TSPs), black carbon (BC), lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se), zinc (Zn), polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), total PAHs, benzo(a)pyrene (B(a)P), benzo(b)fluoranthene (B(b)F), benzo(k)fluoranthene (B(k)F), indeno(1,2,3-cd)pyrene (IP), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs). For BC, TSPs, additional HMs, B(a)P, B(b)F, B(k)F and IP, data for several countries (at least for some years) were missing and could not be gap filled. Therefore, the EU total is not complete (see also Section 1.9). For the main pollutants, PM, HMs and POPs, as well as B(a)P and BC, the EU's trend in emissions from the five most important key categories, share by sector group and sectoral emission trends are presented.

In the pollutant-specific sections in Chapter 3, Section 3.2 to Section 3.27, the countries listed are always ranked according to certain criteria, e.g. the percentage of their share in the EU total. The criteria for the ranking are specified in brackets.

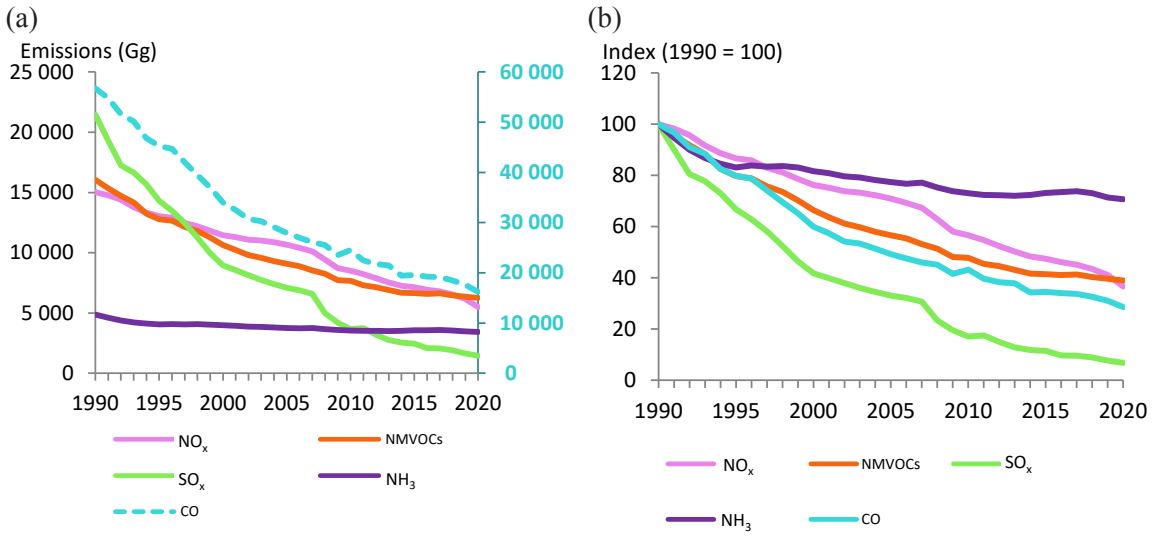
Table 3.4 to Table 3.29include two EU totals. The first is the sum of national totals that EU Member States officially reported. The second is the sum of the sectors of all EU Member States. A difference between these two EU totals occurs when only national totals and no sectoral data are available. There is a third EU total for NO_X (Table 3.4), NMVOCs (Table 3.5) and NH_3 (Table 3.7). This total allows for approved adjustments (see also Chapter 2).

3.1 Total EU emission trends, projection reporting and progress towards the Gothenburg Protocol 2010 emission ceilings and 2020 reduction commitments

3.1.1 Total trends in EU emissions

In 2020, emissions of all pollutants were lower than in 1990 (or in 2000 for PM). Among the main air pollutants, the largest reductions across the EU (in percentage terms) since 1990 were for SO_X emissions (-93%), followed by CO (-71%), NO_X (-63%), NMVOCs (-61%) and NH_3 (-29%) (Figure 3.1) NH_3 emissions decreased around 1990, but since then emissions have remained stable with minor fluctuations. The biggest contributors to the total EU emissions are France, Germany, Italy and Spain with a share of 57% of the EU total. The NH_3 emissions of these countries have not fluctuated much over the years either.

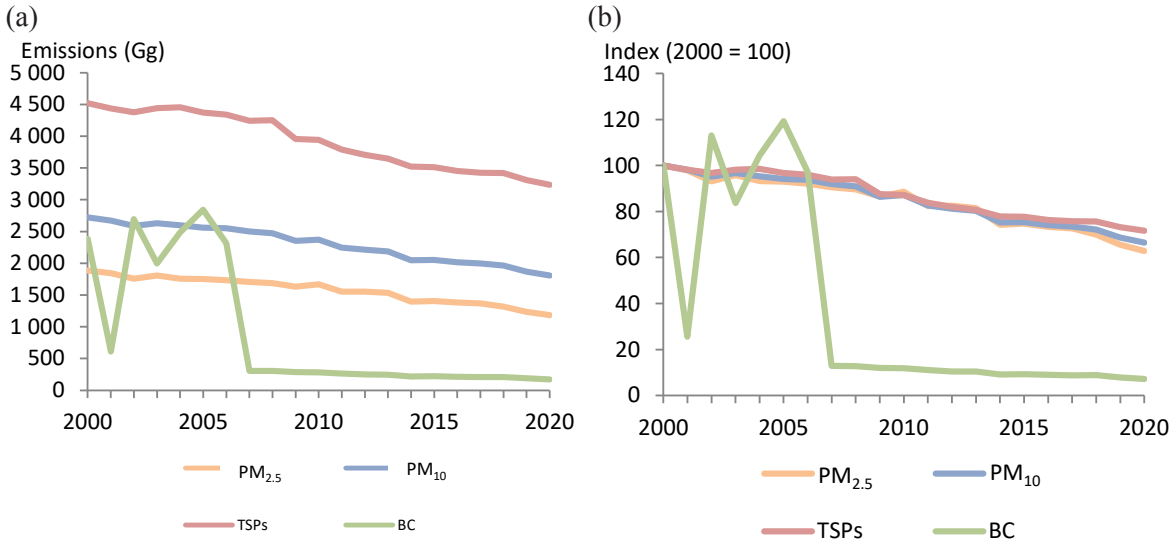
Figure 3.1 **(a) EU-27) emission trends and (b) indexed emissions for the main air pollutants**



Note: The right-hand axis gives values for CO emissions.

Emissions of TSPs, PM and BC have also dropped substantially since 2000. Emission data for the period 2000-2020 indicate that $PM_{2.5}$ and PM_{10} emissions fell by 37% and 34%, respectively. BC emissions also dropped by 93% during the same period (Figure 3.2).

Figure 3.2 **(a) EU-27 emission trends and (b) indexed emissions for PM and BC**

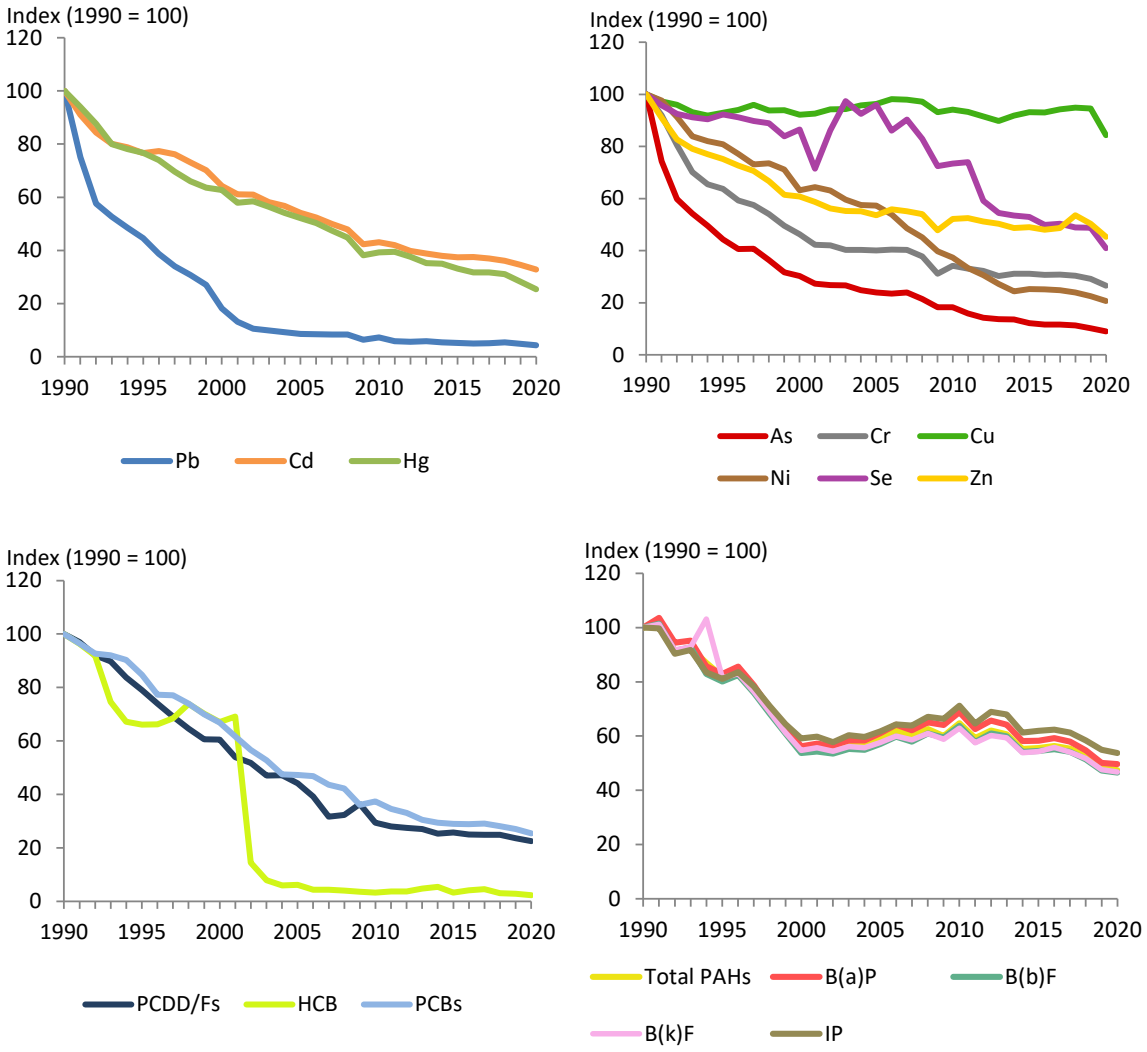


Notes: Not all countries reported data for BC.
The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Thus, emission trends can be shown for these years only.
The indexed emissions are based on emissions in 2000 (= 100%).
Strong fluctuations between the years 2000 and 2006 in BC emissions are caused by data reported by Bulgaria.

In addition, for HMs and POPs, emissions have reduced significantly since 1990 (Figure 3.3). Reductions are especially high for Pb (-96%) and HCB (-98%).

For various pollutants (e.g. BC and HMs), some EU Member States either did not report data or reported the notation key 'NR' (not relevant) for certain years or the whole time series. In some cases, the data could not be gap filled, so they were not included in the EU total. See also Section 1.9 for details on completeness and underestimations.

Figure 3.3 Indexed EU-27 emission trends for HMs and POPs



Notes: The drop in HCB emissions between 2001 and 2002 is caused by reductions reported by Germany.
Fluctuations in Se emissions between 2001 and 2003 are mainly caused by reported data in Belgium and Bulgaria.
The peak in B(k)F emissions in 1994 is caused by an high increase reported by Bulgaria..

Table 3.1 provides information on the total EU emissions of the main air pollutants. Table 3.4 to Table 3.29 show each Member State's reported emissions. They indicate instances where emissions of a certain pollutant are unrecorded in all years. Furthermore, information received from the EU Member States or found in their informative inventory reports (IIRs) is included in the trend sections (see Sections 3.2-3.27). If no information is provided on unusual trends, EU Member States are contacted by the European Topic Centre on Human health and the environment (ETC/HE) and/or the EEA, informed about the findings and requested to send an explanation. As information on unusual trends is often not received, Sections 3.2-3.27 are very inconsistent regarding which variations in trends are explained and which are not.

Table 3.1 Total EU emissions of the main air pollutants: HMs, POPs and PM

Pollutant	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change 1990—2020	Change 2019—2020
NO_x	Gg	15 027	13 031	11 458	10 660	8 510	8 220	7 871	7 544	7 258	7 140	6 923	6 785	6 530	6 173	5 497	-63 %	-10.9 %
NMVOCs	Gg	16 040	12 785	10 650	9 080	7 668	7 298	7 138	6 918	6 682	6 644	6 595	6 633	6 469	6 360	6 247	-61 %	-1.8 %
NMVOCs (adjusted data)*	*Gg*					*7 587*	*7 218*	*7 059*	*6 845*	*6 617*	*6 567*	*6 526*	*6 565*	*6 405*	*6 306*			
SO_x	Gg	21 438	14 311	8 949	7 084	3 671	3 759	3 196	2 746	2 540	2 461	2 093	2 054	1 904	1 655	1 452	-93 %	-12.2 %
NH_3	Gg	4 867	4 045	3 975	3 765	3 557	3 523	3 515	3 503	3 523	3 561	3 577	3 593	3 552	3 472	3 441	-29 %	-0.9 %
NH_3 (adjusted data)*	*Gg*					*3 554*	*3 520*	*3 513*	*3 502*	*3 519*	*3 558*	*3 573*	*3 587*	*3 546*	*3 470*			
CO	Gg	56 691	45 249	34 020	27 913	24 523	22 469	21 730	21 456	19 416	19 562	19 278	19 142	18 462	17 619	16 181	-71 %	-8.2 %
Pb	Mg	20 407	9 113	3 723	1 764	1 486	1 190	1 159	1 188	1 114	1 074	1 027	1 051	1 111	1 003	894	-96 %	-10.9 %
Cd	Mg	160	123	103	87	69	67	64	62	61	60	60	59	58	56	53	-67 %	-5.3 %
Hg	Mg	148	114	93	77	58	58	56	52	52	49	47	47	46	42	38	-75 %	-9.9 %
As	Mg	569	252	172	136	104	90	81	78	77	69	66	66	64	58	51	-91 %	-11.5 %
Cr	Mg	1 001	638	463	401	343	331	323	303	311	312	307	308	304	293	266	-73 %	-9.2 %
Cu	Mg	1 859	1 727	1 713	1 790	1 749	1 734	1 701	1 668	1 707	1 731	1 730	1 752	1 764	1 758	1 567	-16 %	-10.8 %
Ni	Mg	1 899	1 536	1 199	1 089	710	632	582	516	464	480	477	471	455	428	393	-79 %	-8.1 %
Se	Mg	183	169	159	176	135	136	108	100	98	97	92	92	90	90	75	-59 %	-16.1 %
Zn	Mg	6 757	5 078	4 108	3 620	3 527	3 547	3 457	3 404	3 293	3 313	3 247	3 293	3 619	3 403	3 065	-55 %	-9.9 %
PCDD/Fs	g I-Teq	7 832	6 192	4 737	3 458	2 304	2 192	2 152	2 123	1 988	2 021	1 955	1 952	1 951	1 851	1 765	-77 %	-4.6 %
B(a)P	Mg	454	376	255	277	312	284	298	291	264	265	269	263	249	227	225	-50 %	-1.0 %
B(b)f	Mg	494	396	266	282	315	286	301	296	268	269	273	268	254	234	230	-53 %	-1.5 %
B(k)f	Mg	235	192	129	136	148	135	142	140	127	128	131	127	122	112	110	-53 %	-1.8 %
IP	Mg	224	181	132	138	159	145	154	152	137	139	140	137	131	123	120	-46 %	-2.3 %
Total PAHs	Mg	1 532	1 255	853	906	992	908	950	930	847	851	864	848	807	743	726	-53 %	-2.3 %
HCB	kg	5 947	3 932	3 992	368	197	222	217	285	319	194	248	270	181	170	135	-98 %	-20.2 %
PCBs	kg	4 732	4 008	3 166	2 239	1 767	1 639	1 563	1 440	1 391	1 372	1 367	1 374	1 332	1 280	1 204	-75 %	-5.9 %
																	Change 2000—2020	Change 2019—2020
TSPs	Gg			4 522	4 372	3 944	3 790	3 705	3 649	3 521	3 512	3 451	3 427	3 422	3 309	3 238	-28 %	-2.1 %
$PM_{2.5}$	Gg			1 884	1 751	1 669	1 552	1 555	1 534	1 398	1 408	1 382	1 369	1 319	1 234	1 185	-37 %	-4.0 %
PM_{10}	Gg			2 722	2 562	2 372	2 248	2 212	2 187	2 049	2 051	2 018	1 999	1 964	1 869	1 807	-34 %	-3.3 %
BC	Gg			2 383	2 841	284	265	249	247	217	222	213	207	210	188	172	-93 %	-8.4 %

Notes: Negative percentage values indicate that emissions have decreased.
Table 3.1 and Table 3.4 to Table 3.29 express changes in emissions between 1990 and 2020 as 100 × (–2019 - E1990) / E1990 (%), where E_{2020} and E_{1990} are 2020 and 1990 total emissions, respectively. They express changes in emissions from 2019 to 2020 as 100 × (–$_{2020}$ - E_{2019}) / E_{2019} (%), where E_{2019} and E_{2020} are the 2019 and 2020 total emissions, respectively.
The bases for the EU inventory shown in Table 3.1 and Table 3.4 to Table 3.29, are total national data for the entire territory based on fuel sold for all EU Member States. See Section 1.4.4 for further details.
*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications ([13]) for emissions from several EU Member States. This table takes these adjustments into account, whereas emission data are based on fuel sold. See Chapter 2 for further details.

3.1.2 Progress towards the Gothenburg Protocol 2010 emission ceilings

The Gothenburg Protocol to the UNECE Air Convention (UNECE, 1999) specifies emission ceilings for the pollutants NO_X, NMVOCs, sulphur oxides (SO_X) and NH_3. Parties to the protocol must meet them by 2010 and thereafter.

In addition to ceilings for individual countries, the protocol also specifies ceilings for the EU as a whole, which is also a Party to the Air Convention and has ratified the protocol.

([13]) In 2012, the Executive Body for the LRTAP Convention decided that adjustments to emission reduction commitments, or to inventories for the purposes of comparing them with total national emissions, may be applied in some circumstances (UNECE, 2012a).

Table 3.2 sets out the emissions reported for 2020 by the EU-15, compared with the respective emission ceilings specified for the EU (see Table A2.2 in Appendix 2 for an explanation of the country groupings). In this report, the comparison with the EU-15 ceilings in the Gothenburg Protocol is based on fuel sold. For all pollutants, emissions in 2020 were below the ceilings.

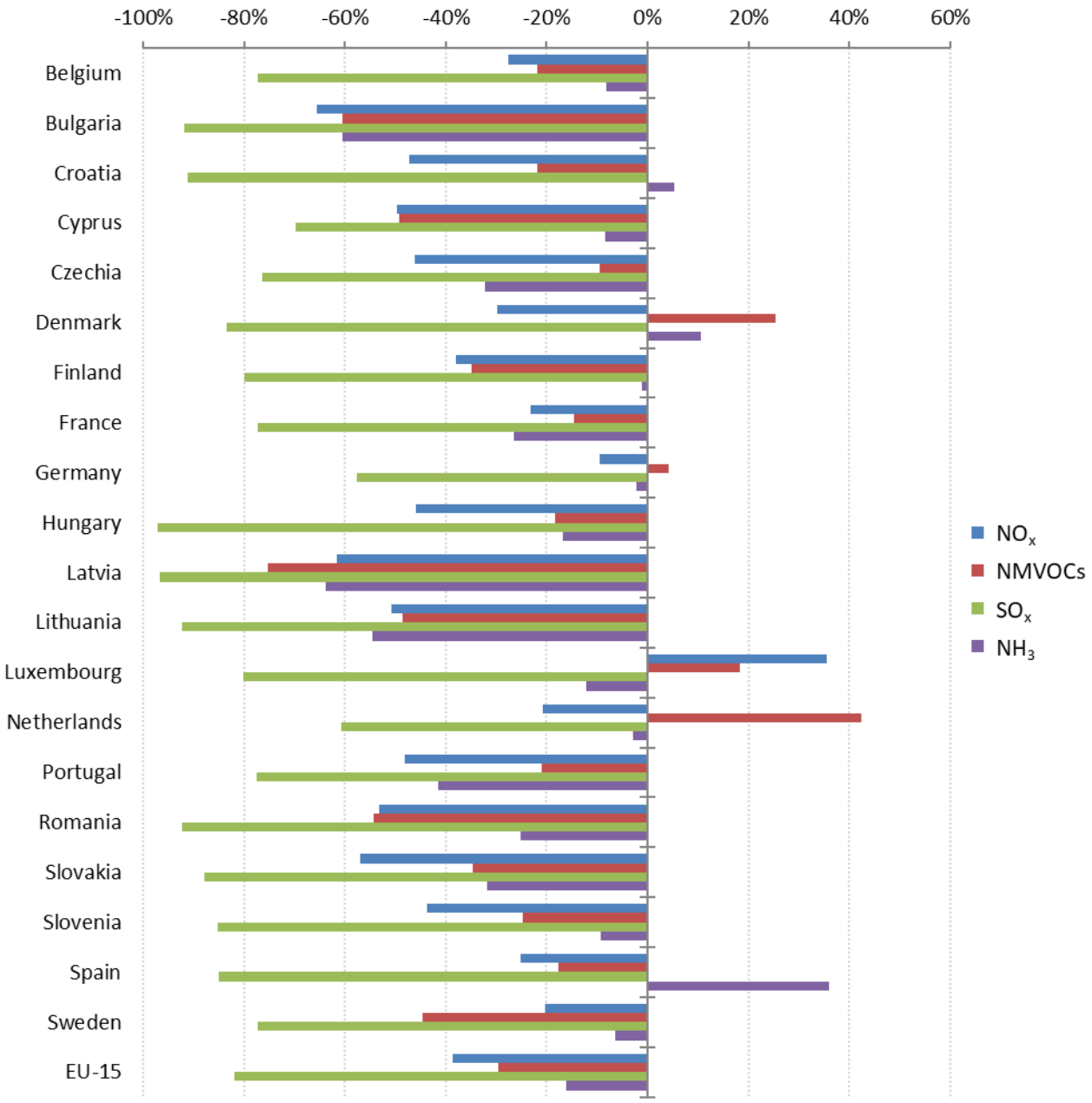
Table 3.2 Emissions reported for 2020 by the EU-15 (without the United Kingdom) compared with the Gothenburg Protocol EU emission ceilings for 2010 and the years thereafter

Pollutant	EU-15 emissions 2020 (Gg)	EU-15 Gothenburg Protocol 2010 ceillings (Gg)	Difference (%)	Sum of individual EU-15 ceillings (Gg)
NO_X	4 093	6 671	-39%	6 519
NMVOCs	4 647	6 600	-30%	6 510
SO_x	736	4 059	-81%	3 850
NH_3	2 628	3 129	-16.0%	3 110

Notes: For Portugal's 2010 emission ceilings, emissions from the Azores and Madeira are excluded.
Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands and Spain in 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021. However, as the EU-15 as a whole has not applied for adjustments, this table does not take these adjusted data into acc.
Emission ceilings are also specified for individual EU-15 EU Member States. The sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

Figure 3.5 shows whether or not EU Member States met the Gothenburg Protocol ceilings in 2020. Estonia and Malta do not have Gothenburg ceilings and Austria, Greece, Ireland, Italy and Poland have not yet ratified the Gothenburg Protocol and are therefore excluded from Figure 3.5. Four countries exceeded their NMVOC ceilings (Denmark, Germany, Luxembourg and the Netherlands), while one country exceeded its NOX ceiling (Luxembourg). Three countries exceeded their NH_3 ceilings (Croatia, Denmark and Spain). All EU Member States complied with their SO_X ceilings.

Figure 3.4 Distance to Gothenburg Protocol ceilings for EU Member States in 2020



Notes: Estonia and Malta do not have Gothenburg ceilings. Austria, Greece, Ireland, Italy and Poland have ceilings but have not yet ratified the protocol. For Spain, data for emission comparisons exclude emissions from the Canary Islands.
For the EU-15, the comparison is based on fuel sold. Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands and Spain in 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021. This figure takes these adjusted data into account. The EU-15 did not apply for adjustments and thus data for the EU-15 are unadjusted.

3.1.3 Progress towards the Gothenburg Protocol reduction commitments

The amended Gothenburg Protocol to the UNECE Air Convention (UNECE, 1999; UNECE 2017b), specifies emission reduction commitment for the pollutants NO_X, NMVOCs, sulphur oxides (SO_X), NH_3 and PM2.5. Parties to the protocol must meet them by 2020 and thereafter.

In addition to emission reduction commitments for individual countries, the protocol also specifies emission reduction commitments for the EU as a whole, which is also a Party to the Air Convention and has ratified the protocol. Table 3.3 sets out the emissions reported for 2020 by the EU-27, compared with the reduction commitments specified for the EU (see Table A2.2 in Appendix 2 for an explanation of the country groupings). In this report, the comparison with the EU-27 reduction commitments in the Gothenburg Protocol is based on fuel sold. For all pollutants, emissions in 2020 were below the ceilings.

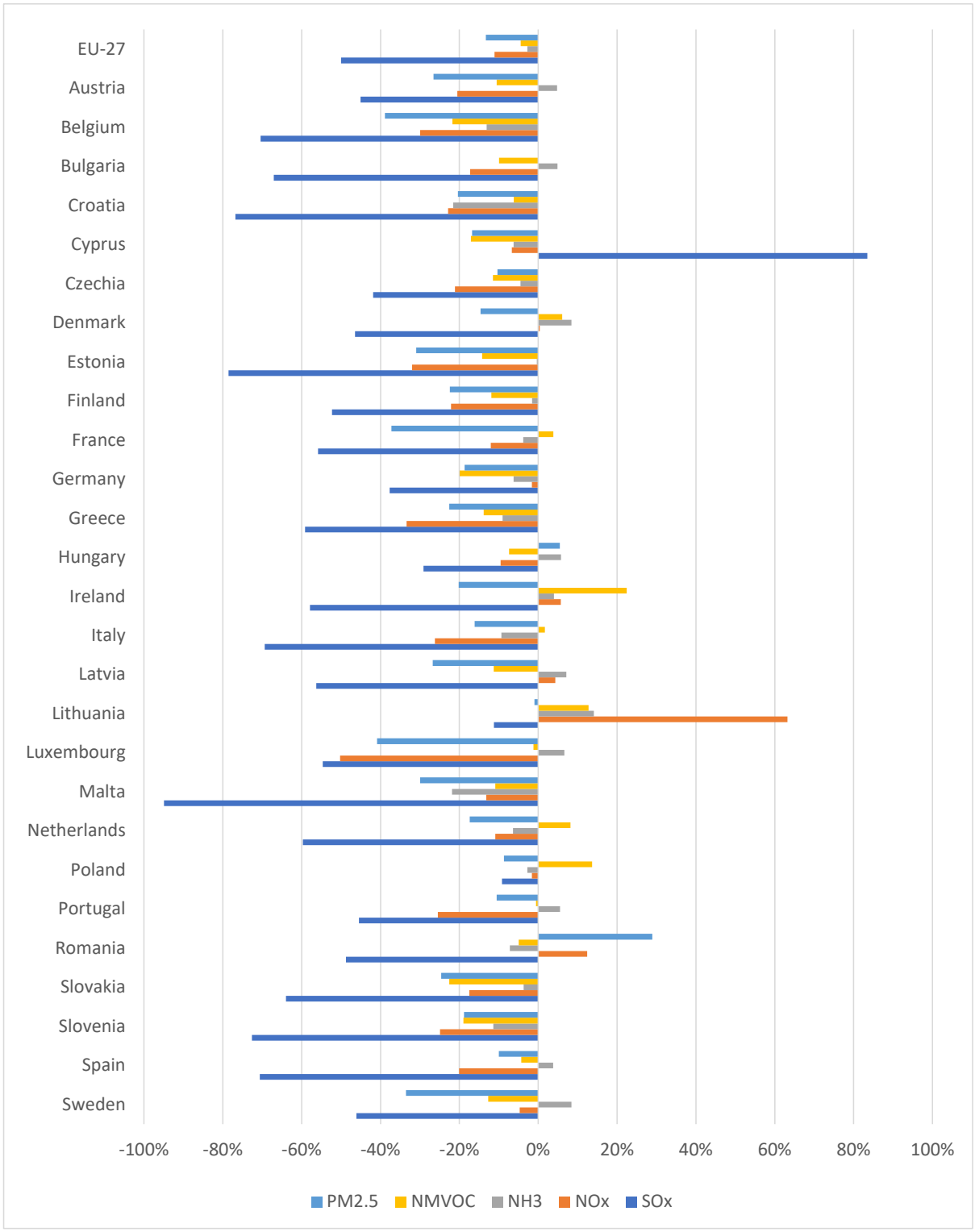
Table 3.3 Emissions reported for 2020 by the EU-27 compared with the Gothenburg Protocol EU reduction commitments for 2020 and beyond

Pollutant	EU-27 emissions 2020 (Gg)	EU-27 Emission levels (Gg)	Actual reduction (%)	Reduction commitment from 2005 level (%)
NO_X	5 497	10 060	-48%	-40%
NMVOCs	6 247	9 080	-31%	-28%
SO_x	1 452	7 084	-79%	-59%
NH_3	3 441	3 765	-9%	-6%
$PM_{2.5}$	1 185	1 751	-32%	-22%

Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands, i.e. data comprise the EMEP domain only.
For Portugal's reduction commitments, emissions from the Azores and Madeira are excluded.
Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands, Spain and the United Kingdom in 2014, 2015, 2016, 2017, 2018, 2019 and 2020. However, as the EU-27 as a whole has not applied for adjustments, this table does not take these adjusted data into account.
([a]) Emission reduction commitments are also specified for individual Member States from the EU-27. The EU-27 emission reduction commitment for a pollutant is the sum of the EU MS reduction commitments. The % specified in annex II to the protocol for the EU as a whole was corrected in 2022 following changes in the EU membership, in line with EB Decision 2021/3.

Figure 3.5 shows whether or not EU Member States met the reduction commitments in 2020. Cyprus did not meet the reduction commitment for SO_x emissions. Several EU Member States did not meet their reduction commitment for emissions of NOx (Denmark, Ireland, Latvia, Lithuania, Romania), NH_3 (Austria, Bulgaria, Denmark, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Portugal, Spain, Sweden), NMVOC (Denmark, France, Ireland, Italy, Lithuania, The Netherlands, Poland) and $PM_{2.5}$(Hungary, Romania).

Figure 3.5 **Distance to Gothenburg Protocol reduction commitments for EU Member States in 2020**



Notes: Emission reductions are calculated with the National Total of each Member State as well as for the EU-27.

The EEA plans to publish its annual National Emission reduction Commitments (NEC) Directive reporting in June 2022. The reporting analyses the emission data reported under the EU NEC Directive for EU Member States (EEA, forthcoming). The NEC Directive (EU, 2016b) contains national emission reduction commitments for EU Member States for NO_X, NMVOCs, SO_2, NH_3 and $PM_{2.5}$ for the period 2020-2029 and for any year from 2030.

3.2 Nitrogen oxide emission trends and key categories

Between 1990 and 2020, NO_X emissions dropped by 63% in the EU, and between 2019 and 2020 they dropped by 11%. This recent decrease was mainly caused by Germany, France, Italy, Poland, Greece and the Netherlands (countries ranked according to the size of their contributions to the absolute change) (Table 3.4).

Table 3.4 Member State contributions to EU emissions of NO_X

	NO_x (Gg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	219	199	213	248	205	196	191	190	182	179	172	163	152	145	124	-43 %	-14.1 %	1.5 %	2.3 %
Belgium	423	412	359	326	244	227	215	206	196	197	185	174	168	156	135	-68 %	-13.4 %	2.8 %	2.5 %
Bulgaria	299	207	164	188	139	158	130	115	120	119	114	104	100	96	92	-69 %	-4.2 %	2.0 %	1.7 %
Croatia	106	79	88	86	69	66	58	57	54	54	54	55	50	49	46	-57 %	-5.6 %	0.7 %	0.8 %
Cyprus	18	21	23	22	19	21	21	15	16	14	14	14	13	14	12	-37 %	-18.8 %	0.1 %	0.2 %
Czechia	758	389	310	300	253	239	227	215	209	204	195	191	184	171	154	-80 %	-10.3 %	5.0 %	2.8 %
Denmark	297	286	221	202	148	139	128	123	114	112	112	110	104	97	89	-70 %	-8.0 %	2.0 %	1.6 %
Estonia	73	47	45	43	42	41	38	37	35	31	32	32	31	26	24	-68 %	-8.7 %	0.5 %	0.4 %
Finland	307	273	241	208	187	171	161	159	151	139	135	130	127	120	105	-66 %	-12.1 %	2.0 %	1.9 %
France	2 088	1 899	1 730	1 500	1 150	1 094	1 071	1 050	976	956	906	874	816	779	660	-68 %	-15.3 %	13.9 %	12.0 %
Germany	2 835	2 184	1 891	1 632	1 446	1 420	1 412	1 412	1 367	1 345	1 317	1 267	1 183	1 109	979	-65 %	-11.7 %	18.9 %	17.8 %
Greece	409	402	430	483	364	326	285	274	269	263	262	268	259	250	222	-46 %	-11.1 %	2.7 %	4.0 %
Hungary	246	191	189	179	148	138	132	128	126	128	120	121	120	115	107	-57 %	-6.7 %	1.6 %	1.9 %
Ireland	169	171	182	176	121	108	110	112	111	113	113	111	111	103	95	-44 %	-7.8 %	1.1 %	1.7 %
Italy	2 124	1 989	1 504	1 289	935	896	847	776	753	716	701	658	659	639	571	-73 %	-10.7 %	14.1 %	10.4 %
Latvia	97	51	42	45	41	39	39	38	38	37	35	35	36	35	32	-67 %	-7.4 %	0.6 %	0.6 %
Lithuania	151	73	61	64	57	56	56	53	56	57	57	56	57	56	54	-64 %	-3.6 %	1.0 %	1.0 %
Luxembourg	41	35	41	57	39	40	37	34	32	28	26	23	21	20	16	-61 %	-19.0 %	0.3 %	0.3 %
Malta	8.3	9.9	10.0	10.0	10.0	8.7	9.5	7.7	7.7	6.6	6.0	5.4	5.0	5.3	5.	-39 %	-5.5 %	0.1 %	0.1 %
Netherlands	669	570	484	430	355	341	322	311	286	284	268	257	250	235	211	-69 %	-10.2 %	4.5 %	3.8 %
Poland	1 128	1 087	874	862	838	818	781	741	690	670	675	704	674	628	594	-47 %	-5.4 %	7.5 %	10.8 %
Portugal	260	297	301	283	204	187	174	170	167	170	163	166	161	155	135	-48 %	-12.7 %	1.7 %	2.5 %
Romania	474	375	316	331	241	250	246	227	221	220	211	220	222	217	204	-57 %	-5.9 %	3.2 %	3.7 %
Slovakia	136	112	110	106	88	81	77	69	66	68	64	63	62	59	56	-59 %	-4.7 %	0.9 %	1.0 %
Slovenia	75	76	59	55	48	47	46	43	39	35	35	34	33	29	25	-66 %	-13.8 %	0.5 %	0.5 %
Spain	1 326	1 338	1 349	1 343	951	949	901	830	825	847	807	810	798	741	633	-52 %	-14.6 %	8.8 %	11.5 %
Sweden	289	258	222	194	170	164	157	153	150	146	144	138	134	126	118	-59 %	-6.3 %	1.9 %	2.1 %
EU27 (a)	**15 027**	**13 031**	**11 458**	**10 660**	**8 510**	**8 220**	**7 871**	**7 544**	**7 258**	**7 140**	**6 923**	**6 785**	**6530**	**6173**	**5497**	**-63%**	**-11%**	**100%**	**100%**
EU27 (b)	15 027	13 031	11 458	10 660	8 510	8 220	7 871	7 544	7 258	7 140	6 923	6 785	6530	6173	5497				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

The NOx emission trends of the EU were largely determined by emissions from Germany, France, Spain, Poland and Italy (see Figure 3.6). NOx emissions from road transport and fuel combustion activities in the energy and industry sector are the main emission sources. In general, these are the sources showing the highest emission reductions since 1990, mainly due to the introduction of EURO standards in the road transport sector, as well as abatement technologies and fuel shifts.

The trend in **Germany** is dominated by emissions from road transport and public electricity and heat production. These categories also saw the highest emission decreases (-60% for road transport and -73% for public electricity and heat production)) between 1990 and 2020. Underlying reasons are constantly improving fuels and increasingly stricter regulations resulting in technical improvements in the transport sector (1A3b) (see Germany's IIR, listed in Appendix 5).

In **France**, NO_X emissions arise during the combustion of fossil fuels or biomass in road transport (1A3), combustion plants for electricity generation and district heating (1A1a), industry (1A2) and residential/ tertiary (1A4). The NFR1 energy sector was thus responsible for the majority (88%) of emissions in 2020. NO_X is also emitted in agriculture by biological processes of nitrification and denitrification in the soil following the addition of mineral or organic nitrogen fertilisers; and in livestock areas at the level of building/storage stations from the nitrogen contained in animal waste. The decrease in NO_X emissions between 1990 and 2020 is caused by (1) the implementation of primary and secondary treatment systems to eliminate NO_X in industry and in combustion facilities, (2) the gradual penetration of catalytic purification devices on road vehicles and (3) structural changes in the energy mix (nuclear power programme and development of renewable energies) (see France's IIR, listed in Appendix 5).

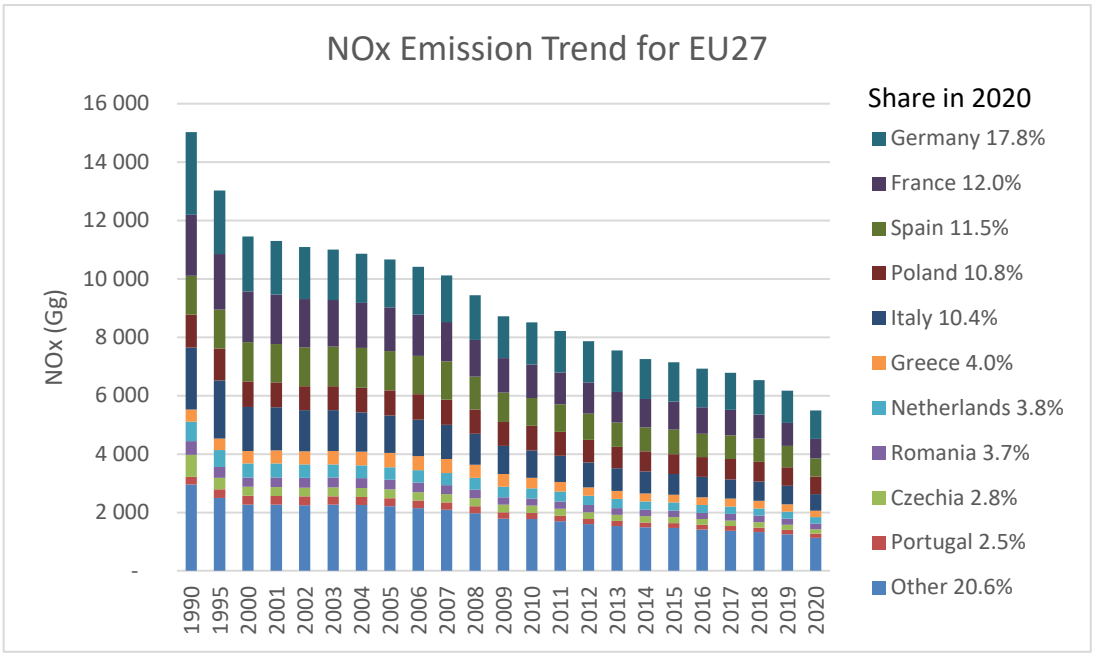
In **Spain**, NO_X emissions are mostly attributed to fuel combustion in road transport (1A3b), in energy industries (1A1a) and in manufacturing industries (1A2). The highest absolute NO_X emission reductions were reported for road transport (-58% since 1990), caused by the introduction of Euro standards in petrol

passenger cars (1A3bi) since 1993 (Euro 1-91/441/EEC) and in heavy duty vehicles and buses (1A3biii) since 2000 (Euro III). The highest relative reductions are those achieved in public power plants, which have decreased by 85% since 1990. The reduction is driven by the progressive introduction of renewable energies, the introduction of abatement techniques in thermal power plants and the shift to combined cycle gas plants. For example, a drastic drop occurred in 2008, due to the closure of the main brown coal mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal plant. The reduction of NO_X emissions in the industry sector (1A2) is mainly the result of progressive introduction of abatement techniques in industrial plants and the shift from liquid fuels to natural gas, especially in the non-metallic minerals industry (1A2f) (see Spain's IIR, listed in Appendix 5).

In **Poland**, NO_X emissions mainly result from road transport (1A3) and energy industries (1A1), and also from stationary combustion in buildings (1A4). The reductions seen since 1990 are caused by the decline in heavy industry and the lower share of coal in combusted fuels in the late 1980s and early 1990s. Since the late 1990s, the largest source of NO_X emissions has been the combustion of fuels in road transport, from which emissions steadily increased until 2017. This was mainly due to the increase in the transport activity and the number of vehicles since 1990. The decrease in NO_X emissions from 2017 is caused by the increasing share of vehicles with the latest Euro quality standards (see Poland's IIR, listed in Appendix 5).

In **Italy**, despite more than 47% of NO_X emissions being caused by road transport in 1990 and 37% in 2020, such emissions saw a decrease of 79% between 1990 and 2020. The decrease is the result of two opposing trends: (1) an increase in emissions in the early years of the historical series, with a peak in 1992, due to the increase in the fleet and in the total mileage travelled by passengers and goods transported by road; and (2) a decrease due to the introduction of technologies to reduce vehicle emissions, as the catalytic converter, required by European directives, in particular Directives 91/441/EC (EU, 1991), 94/12/EC (EU, 1994) and 98/69/EC (EU, 1998) on light vehicles (see Italy's IIR, listed in Appendix 5).

Figure 3.6 **NO_X emission trend in the EU and share of Member States**

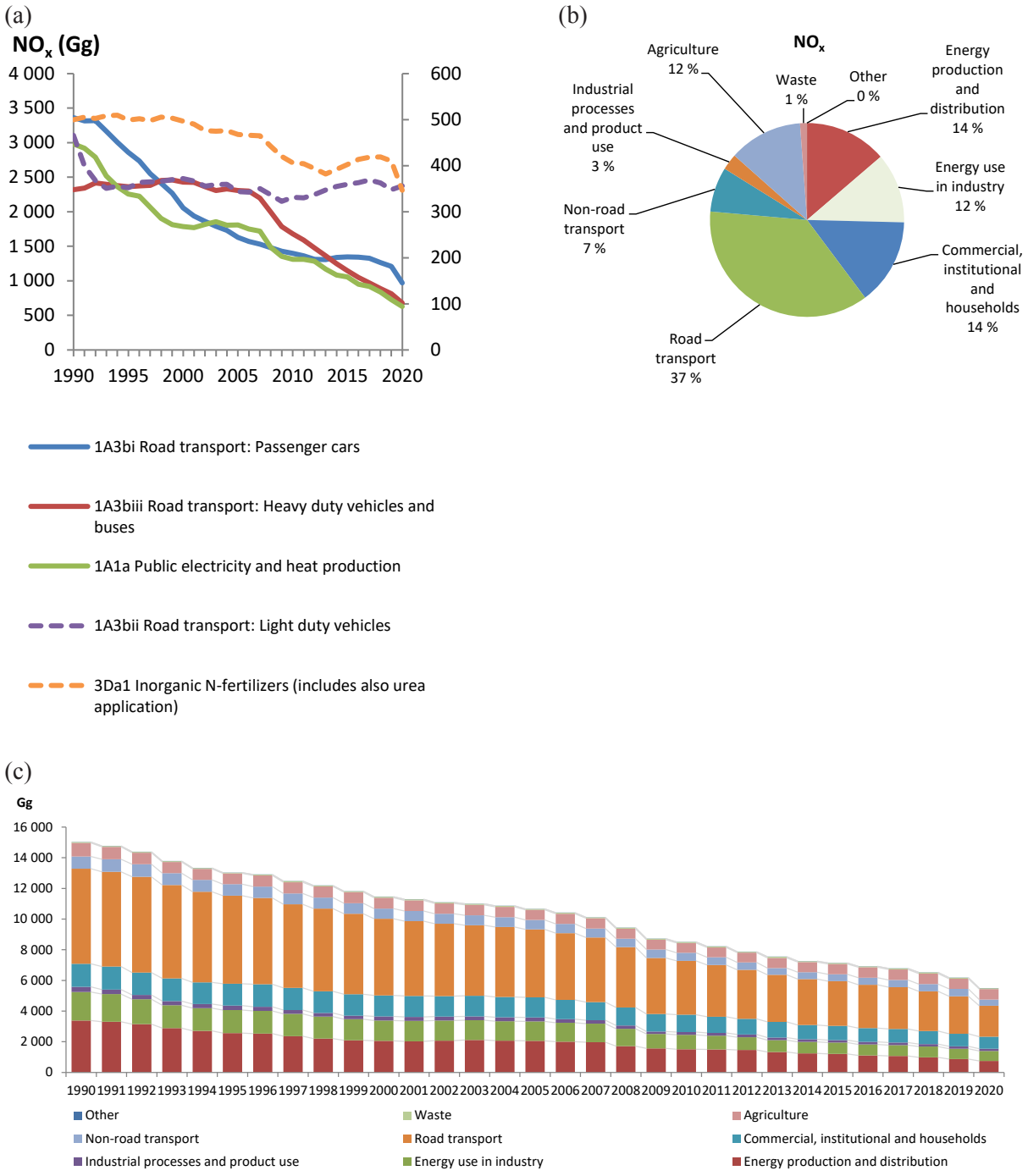


Notes: Countries are sorted by their contribution to the EU total for the last year. The respective top 10 countries are displayed. Data for the other 17 reporting countries with data are summed up under 'other'.

The main key categories for NO_X emissions were Road Transport (1A3bi Passenger cars, 1A3biii Heavy duty vehicles and buses) and 'Public electricity and heat production' (1A1a). Together, they made up 42% of total emissions (see Figure 3.7). The highest relative reduction in NOx emissions between 1990 and 2020 occurred in 'Public electricity and heat production' (-79%) (see Figure 3.7(a)). Significant reductions were also reported for NO_x emissions from passenger cars (-71%) and from heavy duty vehicles and buses (-71%). Emissions from light duty vehicles only decreased by 31% during 1990 and 2020, and the decrease between 2018 and 2020 is mainly caused by France.

Figure 3.7(b) shows the contribution made by each aggregated sector group to total EU emissions. For NO_X, common key emission sources are the energy and transport sectors. Emission reductions from the road transport sector are primarily a result of fitting catalytic converters to vehicles (EEA, 2021c). The legislative standards, known as 'Euro' standards, have driven this move. Nevertheless, the road transport sector represents the largest source of NO_X emissions, accounting for 37% of total EU emissions in 2020. The electricity/energy production sectors have also reduced their emissions, thanks to measures such as introducing combustion modification technologies (e.g. low-NO_X burners), implementing flue gas abatement techniques (e.g. NO_X scrubbers and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques) and switching from coal to gas (EEA, 2021c).

Figure 3.7 **NO_x emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: In Figure 3.7(a), the right-hand axis shows values for '1A3bii — Road transport: Light duty vehicles' and '3Da1 — Inorganic N-fertilisers (also includes urea application)'.

3.3 Non-methane volatile organic compound emission trends and key categories

Between 1990 and 2020, NMVOC emissions dropped by 61% in the EU, and between 2019 and 2020 these dropped by 1.7% (Table 3.5). This recent decrease was due to lower emissions in Germany, France, Czechia and Spain (countries ranked according to the size of their contributions to the absolute change).

Table 3.5 Member State contributions to EU emissions of NMVOCs

	NMVOCs (Gg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	334	248	180	157	137	133	130	124	118	113	111	112	109	109	111	-67 %	2.1 %	2.1 %	1.8 %
Belgium	353	311	234	183	144	132	128	125	118	117	116	114	113	112	113	-68 %	0.8 %	2.2 %	1.8 %
Bulgaria	457	158	127	103	90	93	91	87	83	85	82	82	76	76	73	-84 %	-3.3 %	2.8 %	1.2 %
Croatia	172	120	104	114	91	86	80	75	69	70	72	69	69	74	70	-59 %	-4.8 %	1.1 %	1.1 %
Cyprus	13	14	13	16	13	8.9	8.7	7.5	7.3	7.4	7.4	7.9	7.6	7.6	7.1	-47 %	-6.1 %	0.1 %	0.1 %
Czechia	566	393	320	274	253	242	236	234	230	230	227	228	228	219	199	-65 %	-9.3 %	3.5 %	3.2 %
Denmark	213	211	182	155	132	125	120	121	113	115	111	109	108	103	107	-50 %	3.3 %	1.3 %	1.7 %
Estonia	65	40	35	32	23	23	23	22	22	22	22	23	23	23	24	-62 %	7.0 %	0.4 %	0.4 %
Finland	236	205	179	148	114	105	102	97	95	90	90	88	86	85	85	-64 %	-0.6 %	1.5 %	1.4 %
France	2 893	2 496	2 061	1 587	1 219	1 149	1 100	1 092	1 074	1 047	1 024	1 012	*990*	*973*	939	-68 %	-3.5 %	18.0 %	15.0 %
Germany	3 892	2 342	1 806	1 487	1 361	1 272	1 257	1 212	1 174	1 147	1 141	1 146	1 099	1 072	1 036	-73 %	-3.4 %	24.3 %	16.6 %
Greece	317	303	308	334	215	200	193	176	172	165	157	151	146	146	132	-58 %	-9.1 %	2.0 %	2.1 %
Hungary	307	210	189	173	130	134	135	132	123	126	127	124	118	118	112	-64 %	-5.1 %	1.9 %	1.8 %
Ireland	150	139	124	123	113	110	111	113	110	111	113	117	117	117	113	-25 %	-3.4 %	0.9 %	1.8 %
Italy	1 993	2 058	1 630	1 340	1 116	1 025	1 032	996	924	897	881	921	894	888	885	-56 %	-0.3 %	12.4 %	14.2 %
Latvia	89	65	55	52	41	41	40	39	39	36	35	35	39	36	34	-62 %	-6.1 %	0.6 %	0.5 %
Lithuania	128	86	63	62	57	56	56	55	54	53	52	52	52	52	47	-63 %	-9.5 %	0.8 %	0.8 %
Luxembourg	28	21	16	15	12	12	12	12	11	11	11	11	*11*	*11*	11	-62 %	-6.7 %	0.2 %	0.2 %
Malta	4.4	5.0	3.9	3.8	3.5	3.3	3.2	3.6	3.5	3.0	3.4	2.9	2.7	2.8	2.6	-41 %	-7.2 %	0.0 %	0.0 %
Netherlands	607	437	339	273	278	274	267	262	249	257	253	253	247	243	272	-55 %	11.7 %	3.8 %	4.4 %
*Adjusted data**					*197*	*195*	*187*	*189*	*183*	*180*	*184*	*185*	*182*	*189*				0.0 %	0.0 %
Poland	829	938	812	787	769	765	746	698	690	710	736	737	700	668	671	-19 %	0.4 %	5.2 %	10.7 %
Portugal	249	239	238	196	158	148	141	139	145	146	144	146	146	148	160	-36 %	7.6 %	1.6 %	2.6 %
Romania	404	308	321	335	276	267	268	260	255	250	247	251	245	245	239	-41 %	-2.2 %	2.5 %	3.8 %
Slovakia	258	174	148	144	121	118	116	111	94	109	108	106	98	95	92	-64 %	-3.3 %	1.6 %	1.5 %
Slovenia	65	63	55	48	40	37	36	35	32	32	33	32	32	31	30	-54 %	-2.3 %	0.4 %	0.5 %
Spain	1 050	923	882	738	585	566	543	531	526	540	545	565	*579*	*571*	551	-48 %	-3.5 %	6.5 %	8.8 %
Sweden	368	279	223	204	176	173	165	157	153	154	147	140	*135*	*136*	133	-64 %	-1.7 %	2.3 %	2.1 %
EU27 (a)	**16 040**	**12 785**	**10 650**	**9 080**	**7 668**	**7 298**	**7 138**	**6 918**	**6 682**	**6 644**	**6 595**	**6 633**	**6469**	**6360**	**6247**	**-61%**	**-1.8%**	**100%**	**100%**
EU27 (b)	16 040	12 785	10 650	9 080	7 668	7 298	7 138	6 918	6 682	6 644	6 595	6 633	6 469	6 360	6 247				
EU27 (c)	16 040	12 785	10 650	9 080	7 587	7 218	7 059	6 845	6 617	6 567	6 526	6 565	6 405	6 306	6 247				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.
(c) Sum of national totals, as reported by EU Member States, allowing for approved adjustments.
*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Germany, Hungary, Luxembourg and the Netherlands.

The NMVOC emission trends of the EU was largely determined by emissions from Germany, France, Italy, Poland and Spain (see Figure 3.6). In general, NMVOC emissions in 1990 were caused by different emission sources than in recent years. In 1990, NMVOC emission from road transport caused by emission sources different from those in recent years. In 1990, NMVOC emissions from road transport were most important but on account of the introduction of catalytic converters and renewal of the fleets, these emissions decreased significantly. Nowadays, the emission trend is dominated by NMVOC emissions from residential heating, solvent use and manure management.

In **Germany**, in 1990, NMVOCs were mainly caused by passenger cars (1A3bi) and coating application (2D3d), the latter of which includes the use of paints within the industrial and domestic sector. Until 2020, NMVOC emissions in Germany decreased significantly (by 73%), with coating applications and still the coating application and manure management being the most important emission sources in 2020. The strong decline in emissions from passenger cars (1A3bi) is due to increasingly stricter regulations, especially incentives for car users to retrofit or buy cars with catalytic converters, and the implementation of the Technical Instruction on Air Quality Control (TA-Luft 2002). Furthermore, decreases in the subcategory '1B2av — Emissions from petrol storage and from fuelling of motor vehicles' can be explained by the implementation of the 20th and 21st Ordinances on the Execution of the Federal Immission Control Act (BImSchV). A decline in petrol consumption has played a major role with regard to the reduction in NMVOC emissions (see Germany's IIR, listed in Appendix 5).

In **France**, the major contributing sectors in 2020 were domestic solvent use (2D3a) and the biological functioning of crops (emissions attracting pollinating insects, for example) (3De). In 1990, the main emission sources were road transport (1A3b), residential heating (1A4b) and coating applications (2D3d). The decrease in NMVOC emissions of 96% between 1990 and 2020 in road transport can be explained by the fitting of petrol vehicles with catalytic converters since 1993, in addition to the management of evaporation from these vehicles equipped with activated carbon filters in the tanks, as well as the dieselisation of the vehicle fleet, with diesel vehicles emitting less VOCs. NMVOC emissions from biomass combustion in households (1A4b) decreased by 81% as a result of the renewal of the installations with more efficient and

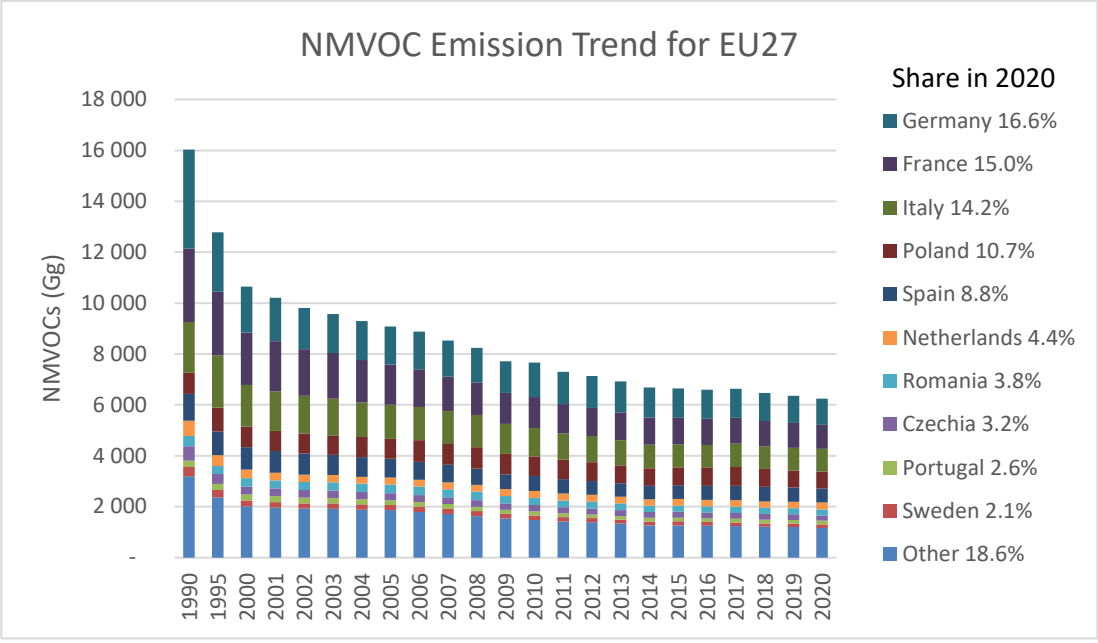
less emitting appliances. The substitution of products containing solvents with products with a lower content or without solvent (2D) led to a reduction of 56% in the respective category (see France's IIR, listed in Appendix 5).

In **Italy**, solvent and other product use is the main source of emissions, contributing to the total with 42% and showing a decrease of about 39%. Significant reductions occurred in the 1990s as a result of the introduction to the market of products using paints with low solvent contents, and the reduction in the total amount of organic solvent used for metal degreasing and in glues and adhesives; furthermore, in many cases, local authorities imposed abatement equipment in the industrial painting sector and forced the replacement of open-loop washing machines with closed-loop ones, even before EU Directive 99/13/EC (EU, 1999) came into force. In 2020, due to the pandemic the use of household products containing solvents increased considerably. The main reductions relate to the road transport sector (-88%), mainly attributed to renewal of the fleet and the use of catalytic devices to reduce exhaust and evaporative emissions from cars. NMVOC emissions gradually reduced.

NMVOC emissions from **Poland** decreased by 19% between 1990 and 2020. The largest reduction occurred in road transport (1A3b) and NMVOC emissions resulting from coal mining and handling (1B1a). The largest increase (145 %) occurred in sector 2D — Other solvent and product use. This is mainly the result of a significant increase in the consumption of solvent-based paints. NMVOC emissions from residential heating were reduced by only 23% between 1990 and 2020.

In **Spain**, NMVOC emissions in 2020 declined by 47.5% from 1990. These reductions were achieved mainly in road transport (-94%) because of the introduction of the Euro standards for road vehicles since 1996 and because of the shift towards a diesel-dominated car fleet. The drop in NMVOC emissions from solvent use is a result of the entry into force of different legislation on paint and painting manufacturing. This led to a fall in emissions attributed to coating applications (2D3d) of 66.9% between 2003 and 2020. Furthermore, the economic downturn also caused a noticeable contraction in activity and therefore on consumption of paints. The decreasing trend had stopped by 2012, and from then a steady increasing trend in emissions has been observed, with minor fluctuations (see Spain's IIR, listed in Appendix 5).

Figure 3.8 **NMVOC emission trend in the EU and share of Member States**

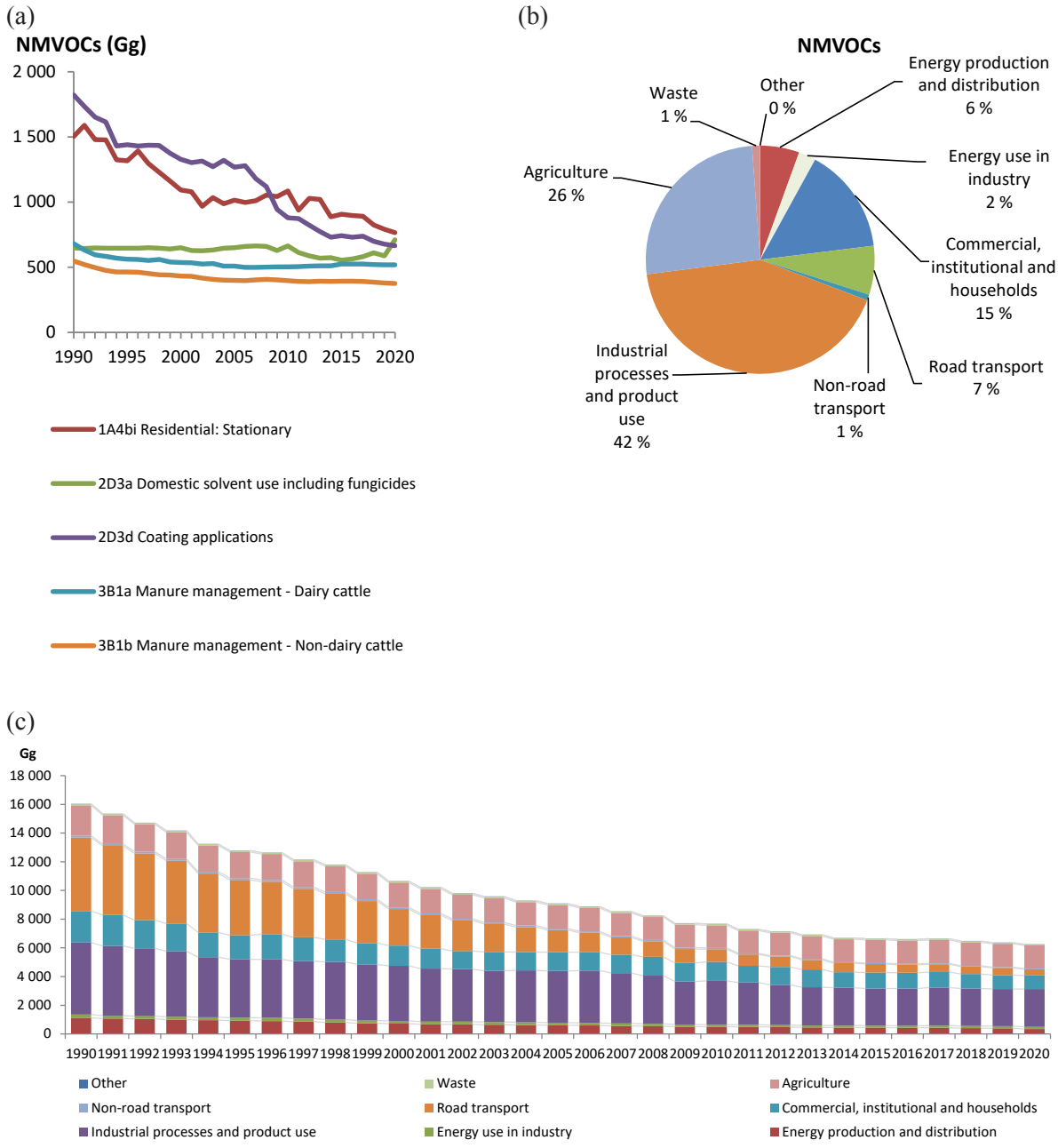


Notes: Countries are sorted by their contribution to the EU total for the last year. The respective top 10 countries are displayed. Data for the other 17 reporting countries with data are summed up under 'other'.

The most important key categories for NMVOC emissions were residential heating (1A4bi), Coating applications (2D3d) and the Domestic solvent use including fungicides (2D3a). Together, they made up 34% of total emissions (Figure 3.9 (a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2020 is reported for coating applications (2D3d) (-63%).

Figure 3.9(b) shows the contribution made by each aggregated sector group to total EU emissions. The main emission source of NMVOCs is industrial processes and product use (42%), followed by agriculture (26%), commercial, institutional and households (15%), road transport (7%) and energy production and distribution (6%).

Figure 3.9 NMVOC emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions



3.4 Sulphur oxide emission trends and key categories

Between 1990 and 2020, SO_X emissions dropped by 93% in the EU, and by 12%between 2019 and 2020 (see Table 3.6). This recent decrease is due to reduced emissions in Spain, Germany, Italy and Romania (countries ranked according to the size of their contributions to the absolute change).

Table 3.6 Member State contributions to EU emissions of SO_x

	SO_x (Gg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	74	47	32	26	16	15	15	14	15	14	13	13	12	11	11	-86 %	-5 %	0 %	1 %
Belgium	365	258	171	143	61	53	47	43	41	41	34	32	32	30	24	-93 %	-19 %	2 %	2 %
Bulgaria	1 448	1 688	1 114	961	329	656	329	169	160	137	101	101	85	73	70	-95 %	-5 %	7 %	5 %
Croatia	171	77	60	59	35	29	24	17	14	16	15	12	10	7.6	6.1	-96 %	-19 %	1 %	0 %
Cyprus	32	40	48	38	22	21	16	14	17	13	16	16	17	16	12	-63 %	-26 %	0 %	1 %
Czechia	1 755	1 059	234	208	164	168	160	145	134	129	115	110	97	80	67	-96 %	-17 %	8 %	5 %
Denmark	178	145	33	26	15	14	13	13	11	9.7	10	10	11	9.3	9.1	-95 %	-2 %	1 %	1 %
Estonia	277	116	98	77	83	73	43	42	44	36	35	39	31	19	11	-96 %	-41 %	1 %	1 %
Finland	249	105	82	70	66	60	50	48	44	41	40	35	33	30	23	-91 %	-22 %	1 %	2 %
France	1 287	938	616	458	269	222	219	202	159	152	136	131	123	100	91	-93 %	-9 %	6 %	6 %
Germany	5 460	1 742	643	473	403	387	368	357	335	334	309	301	290	260	233	-96 %	-10 %	25 %	16 %
Greece	507	517	553	579	230	160	143	122	105	102	81	90	86	80	62	-88 %	-24 %	2 %	4 %
Hungary	829	613	427	43	30	34	30	29	26	24	23	28	23	17	16	-98 %	-6 %	4 %	1 %
Ireland	183	163	144	73	27	25	23	23	17	16	15	15	14	11	11	-94 %	-1 %	1 %	1 %
Italy	1 784	1 322	756	411	222	199	179	148	132	126	120	117	109	105	82	-95 %	-22 %	8 %	6 %
Latvia	100	49	18	8.8	4.3	4.3	4.4	3.9	3.9	3.6	3.4	3.6	3.9	3.7	3.5	-96 %	-5 %	0 %	0 %
Lithuania	202	77	39	28	18	19	17	14	13	15	15	13	13	12	11	-94 %	-6 %	1 %	1 %
Luxembourg	16	9.2	3.7	2.7	1.7	1.3	1.5	1.6	1.5	1.4	.9	1.0	1.0	1.0	.8	-95 %	-18 %	0 %	0 %
Malta	13	10	9.2	12	8.0	7.9	7.7	5.0	4.7	2.1	1.8	.7	.1	.2	.1	-99 %	-12 %	0 %	0 %
Netherlands	197	136	78	67	36	35	35	30	30	31	28	27	25	23	20	-90 %	-14 %	1 %	1 %
Poland	2 679	2 097	1 360	1 160	860	808	779	740	692	672	567	559	527	445	432	-84 %	-3 %	12 %	30 %
Portugal	318	322	295	190	63	57	52	48	44	46	46	47	45	44	38	-88 %	-13 %	1 %	3 %
Romania	819	696	492	603	356	326	261	210	183	151	101	81	76	91	71	-91 %	-22 %	4 %	5 %
Slovakia	140	120	117	86	68	67	57	52	45	67	26	28	20	16	13	-90 %	-15 %	1 %	1 %
Slovenia	203	125	93	40	10	11	11	9.7	7.8	5.6	4.8	5.1	5.0	4.5	4.0	-98 %	-10 %	1 %	0 %
Spain	2 051	1 768	1 388	1 207	245	281	284	221	242	260	216	220	199	151	117	-94 %	-22 %	10 %	8 %
Sweden	103	71	45	36	29	26	26	23	21	18	18	18	17	16	15	-85 %	-7.1 %	0.5 %	1.0 %
EU27 (a)	**21 438**	**14 311**	**8 949**	**7 084**	**3 671**	**3 759**	**3 196**	**2 746**	**2 540**	**2 461**	**2 093**	**2 054**	**1904**	**1655**	**1452**	**-93 %**	**-12 %**	**100 %**	**100 %**
EU27 (b)	21 438	14 311	8 949	7 084	3 671	3 759	3 196	2 746	2 540	2 461	2 093	2 054	1 904	1 655	1 452				

Notes: (a) Sum of national totals, as reported by EU Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

The SOx emission trend of the EU was largely determined by emissions from Poland (30% in 2020), Germany (16% in 2020), Spain (8% in 2020) and France (6% in 2020) (see Figure 3.10). SOx emissions are largely determined by fuel combustion in thermal power plants and industrial installations. The main reductions are due to a shift to fuels with lower sulphur content and retrofitting with desulphurisation installations. After 2010, reductions are also a result of technical improvements to meet more stringent standards of Industrial Emissions Directive. In recent years, also the shift from the use of fossil fuels to renewable energy sources has also contributed to lower SOx emissions.

In **Poland**, the main emissions source is public electricity and heat production (1A1a); emissions in this category have decreased by 92% since 1990. Most of the reductions were caused by the decline in heavy industry in the late 1980s and early 1990s. In the late 1990s the emissions decreased as a result of the diminished share of coal (both hard and brown) among fuels used for power and heat generation. Furthermore, the number of power plants equipped with desulphurisation installations contributed to further SO_X emission decreases. In 2020, SO_X emissions from the residential sector (1A4b) were the second most important emission source (see Poland's IIR, listed in Appendix 5).

In **Germany**, SO_X emissions have decreased by 96% since 1990. The main emission sources are stationary combustion for public electricity and heat production (1A1a), manufacturing industries and construction (1A2) and commercial and residential heating (1A4a and 1A4b). All these sectors saw substantial reductions. In 2020, SO_X emissions from petroleum refining (1A1b) was one of the major emissions sources, as well as production-related SO_X emissions from iron and steel production (2C1).

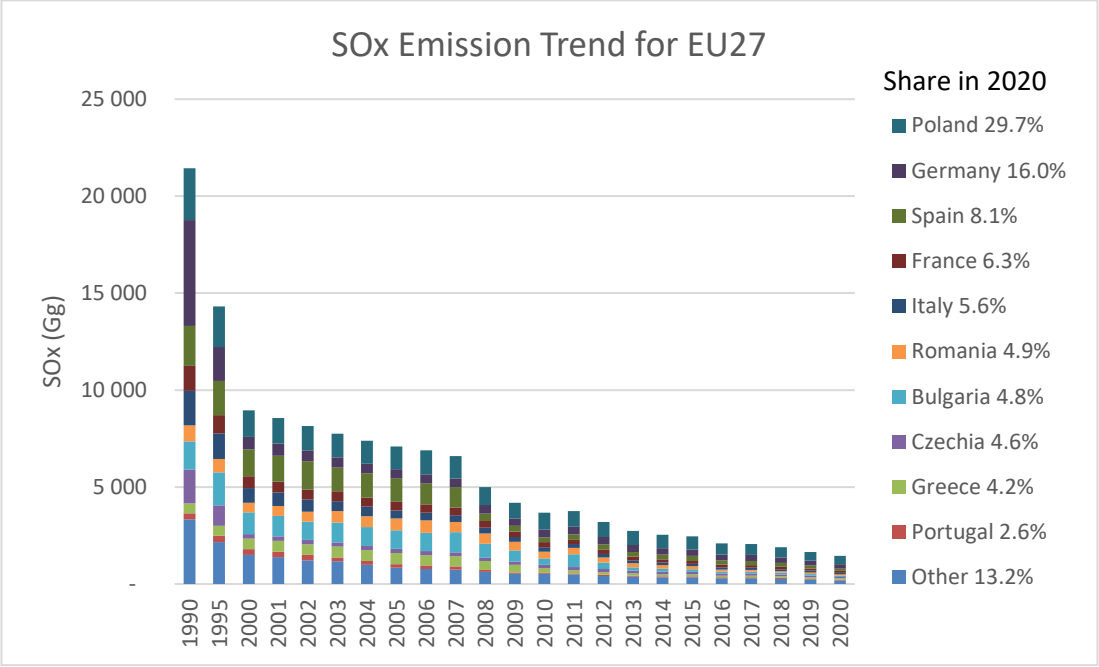
(see Germany's IIR, listed in Appendix 5)

Spain reported a SO_X emissions reduction of 94% between 1990 and 2020, which can be mainly attributed to the reductions achieved in public electricity and heat production (1A1a). The highest absolute reduction was also achieved in this category (1A1a) between 2019 and 2020, due to reduced use of coal. The reduction is a result of the progressive introduction of desulphurisation abatement techniques in thermal power plants and the shift from coal power plants to combined cycle gas plants. The sharp drop observed in 2008 was due to the closure of the main brown coal mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal plant. Desulphurisation abatement technologies have also been applied to industrial installations with fuel combustion (e.g. chemical industry, non-metallic industry), leading to substantially lower SO_X emissions. The decrease in fugitive SO_X emissions from oil refining and storage (1B2aiv) is linked to the reduction observed in the petroleum refining sector (1A1b) (see Spain's IIR, listed in Appendix 5).

In **France**, SOx emissions saw a decrease of 93% between 1990 and 2020, and a 9% decrease during the last year.

The largest reductions occurred in public electricity and heat production (1A1a) and fuel combustion for industrial activities, reflecting the reduction in the sulphur content of fossil fuels and abatement technologies. In recent years, the increased importance of renewable energy has also become visible. Fluctuations in SO_X emissions are also a result of climatic conditions (e.g. warm winters) and changes in the energy mix (nuclear power, fossil fuels, renewables) (see France's IIR, listed in Appendix 5).

Figure 3.10 SOx emission trend in the EU and share of Member States



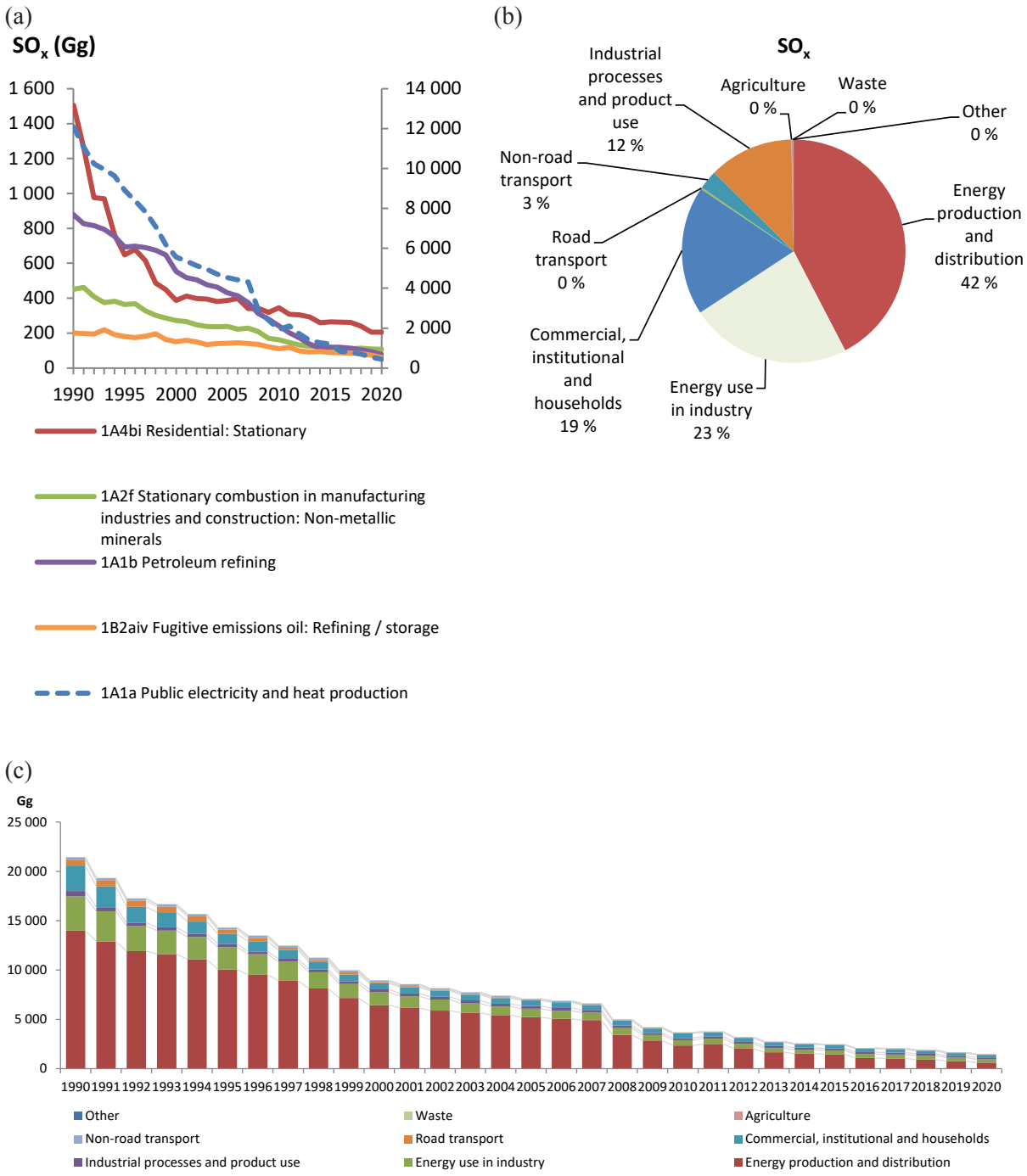
Notes: Countries are sorted by their contribution to the EU total for the last year. The respective top 10 countries are displayed. Data for the other 17 reporting countries with data are summed up under 'other'.

Category 'Public electricity and heat production (1A1a)' is the most significant key category for SO_X emissions, making up 30% of total SO_X emissions (Figure 3.11(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2020 were achieved in 'Public electricity and heat production (1A1a)' (-96.4%) and 'Petroleum refining (1A1b)' (-91.2%). The other three top five key categories also saw significant reductions.

Since 1990, several measures have been combined to reduce emissions from these main emitting sources, namely switching fuel in energy-related sectors away from high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas; fitting flue gas desulphurisation (FGD) abatement technology in industrial facilities; and the impact of implementing EU directives relating to the sulphur content of certain liquid fuels (EEA, 2021a).

Figure 3.11(b) shows the contribution made by each aggregated sector group to total EU emissions. For SO_X, the common main emission sources are the energy sectors.

Figure 3.11 **SO_x emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: In (a), the right-hand axis shows values for '1A1a — Public electricity and heat production'.

3.5 Ammonia emission trends and key categories

Between 1990 and 2020, NH_3 emissions dropped by 29 % in the EU, and between 2019 and 2020, emissions decreased by 0.9% (see Table 3.7).

This recent decrease (2019-2020) is mainly due to decreases in Germany and France (countries ranked according to the size of their contributions to the absolute change), but it should be noted that 15 countries reported emission increases, with the highest noted for Italy and Spain. Between 1990 and 2020 the NH_3 emissions decreased in all countries, except Ireland (12%), Spain (+5%) and Cyprus (+4%). Ireland reported higher emissions in 2020 than in 1990, mostly in the categories '3Da2a — Animal manure applied to soils' and '3B1b — Manure management — Non-dairy cattle'.

Table 3.7 Member State contributions to EU emissions of NH_3

	NH_3 (Gg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	69	68	64	63	66	65	65	65	66	67	68	68	67	66	65	-6 %	-0.8 %	1.4 %	1.9 %
Belgium	132	136	95	80	75	74	74	73	71	72	72	70	70	68	68	-48 %	-0.5 %	2.7 %	2.0 %
Bulgaria	106	51	44	42	39	39	40	41	42	42	44	43	*43*	*42*	43	-60 %	1.5 %	2.2 %	1.2 %
Croatia	50	38	39	41	36	37	36	29	28	31	29	32	33	31	32	-37 %	3.2 %	1.0 %	0.9 %
Cyprus	7.9	9.1	9.9	9.8	9.5	9.4	8.9	8.3	8.4	7.3	7.6	7.7	7.8	7.9	8.2	4 %	3.7 %	0.2 %	0.2 %
Czechia	150	93	82	77	68	68	68	71	72	79	80	79	74	72	68	-54 %	-5.0 %	3.1 %	2.0 %
Denmark	141	117	104	93	84	81	79	77	77	78	79	81	80	75	76	-46 %	1.5 %	2.9 %	2.2 %
Estonia	20	9.2	7.9	9.5	10	10	10	11	11	11	10	10	9.9	9.8	9.4	-53 %	-4.2 %	0.4 %	0.3 %
Finland	36	34	36	39	38	36	36	36	36	34	34	33	33	32	31	-14 %	-4.7 %	0.7 %	0.9 %
*Adjusted data**					*35*	*34*	*34*	*34*	*34*	*33*	*32*	*32*	*31*	*31*				0.0 %	
France	664	647	661	620	618	608	609	607	611	618	618	614	*609*	*596*	573	-14 %	-3.8 %	13.6 %	16.7 %
Germany	718	613	624	603	614	618	625	632	640	639	635	620	594	575	537	-25 %	-6.6 %	14.8 %	15.6 %
Greece	91	80	76	75	71	70	68	68	65	64	64	64	63	63	64	-30 %	0.9 %	1.9 %	1.8 %
Hungary	136	80	85	79	69	69	68	70	70	74	75	75	74	74	75	-45 %	0.7 %	2.8 %	2.2 %
Ireland	110	116	120	120	115	111	117	118	114	120	125	129	135	125	123	12 %	-1.6 %	2.3 %	3.6 %
Italy	469	454	457	421	379	379	387	370	357	357	370	364	351	349	363	-23 %	3.8 %	9.6 %	10.5 %
Latvia	33	16	14	15	15	15	16	16	16	16	16	16	16	16	16	-52 %	-1.6 %	0.7 %	0.5 %
Lithuania	80	36	31	37	36	35	35	35	37	38	37	37	36	35	38	-52 %	7.9 %	1.6 %	1.1 %
Luxembourg	5.5	6.0	6.3	5.8	5.9	5.9	5.7	5.7	5.8	5.9	5.9	6.1	6.2	6.1	6.1	12 %	0.3 %	0.1 %	0.2 %
Malta	2.2	2.3	2.2	1.9	1.8	1.5	1.5	1.6	1.5	1.5	1.4	1.4	*1.4*	*1.4*	1.4	-36 %	1.0 %	0.0 %	0.0 %
Netherlands	345	218	173	153	133	132	125	123	126	129	129	132	130	124	124	-64 %	0.3 %	7.1 %	3.6 %
*Adjusted data**									*124*	*127*	*127*	*127*	*125*					0.0 %	
Poland	500	381	355	333	310	308	299	303	299	298	299	313	324	311	321	-36 %	3.0 %	10.3 %	9.3 %
Portugal	77	72	77	64	59	59	57	56	58	59	60	60	61	62	63	-18 %	2.2 %	1.6 %	1.8 %
Romania	325	220	180	195	169	168	163	165	166	170	165	163	161	160	157	-52 %	-1.6 %	6.7 %	4.6 %
Slovakia	57	38	33	32	28	28	28	29	29	28	29	30	30	30	27	-54 %	-11.5 %	1.2 %	0.8 %
Slovenia	24	22	22	21	20	19	19	19	19	19	19	19	19	18	18	-24 %	-0.9 %	0.5 %	0.5 %
Spain	459	426	517	477	431	421	418	422	442	450	453	472	471	467	480	5 %	2.8 %	9.4 %	14.0 %
Sweden	60	61	60	58	55	55	54	55	55	55	53	54	54	53	53	-12 %	0.5 %	1.2 %	1.5 %
EU27 (a)	**4 867**	**4 045**	**3 975**	**3 765**	**3 557**	**3 523**	**3 515**	**3 503**	**3 523**	**3 561**	**3 577**	**3 593**	**3 552**	**3 472**	**3 441**	**-29%**	**-0.9%**	**100%**	**100%**
EU27 (b)	4 867	4 045	3 975	3 765	3 557	3 523	3 515	3 503	3 523	3 561	3 577	3 593	3 552	3 472	3 441				
EU27 (c)	4 867	4 045	3 975	3 765	3 554	3 520	3 513	3 502	3 519	3 558	3 573	3 587	3 546	3 470	3 441				

Notes: ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
([c]) Sum of national totals, as reported by EU Member States, under consideration of approved adjustments.
*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Denmark, Finland, Germany and the Netherlands.

In 2020, the EU Member States contributing most (i.e. more than 10%) to NH_3 emissions were France, Germany, Spain and Italy (countries ranked according to their shares of the EU total) (see Figure 3.12). NH3 emissions are mainly the result of agricultural activities resulting from manure management (3B) and application of fertiliser to soils (3D). For the EU-27 both categories show a decrease between 1990 and 2020. Factors driving the emission trend are mainly the number of livestock and changes in manure management practises, feeding practises and abatement technologies in fertiliser application.

The decrease in NH_3 emissions in **France** (-14% between 1990 and 2020) is mainly driven by changes in agricultural activities, primarily the use of mineral fertilisers and a drop in the total amount of mineral nitrogen applied. The second item contributing to this drop is a reduction in the area of pasture, mainly in connection with the decline in livestock. Finally, emissions related to the spreading of manure are also low, combining both a drop in the nitrogen spread because of the drop in livestock numbers and improved spreading practices. Emissions related to the spreading of manure produced by animals reared in France are decreasing more rapidly than the associated quantity of nitrogen spread. The manure management station in the building and storage (NFR3B) has also seen its emissions drop, by approximately 16% between 1990 and 2020. This change is observed mainly in dairy cows, in connection with the decline in numbers.

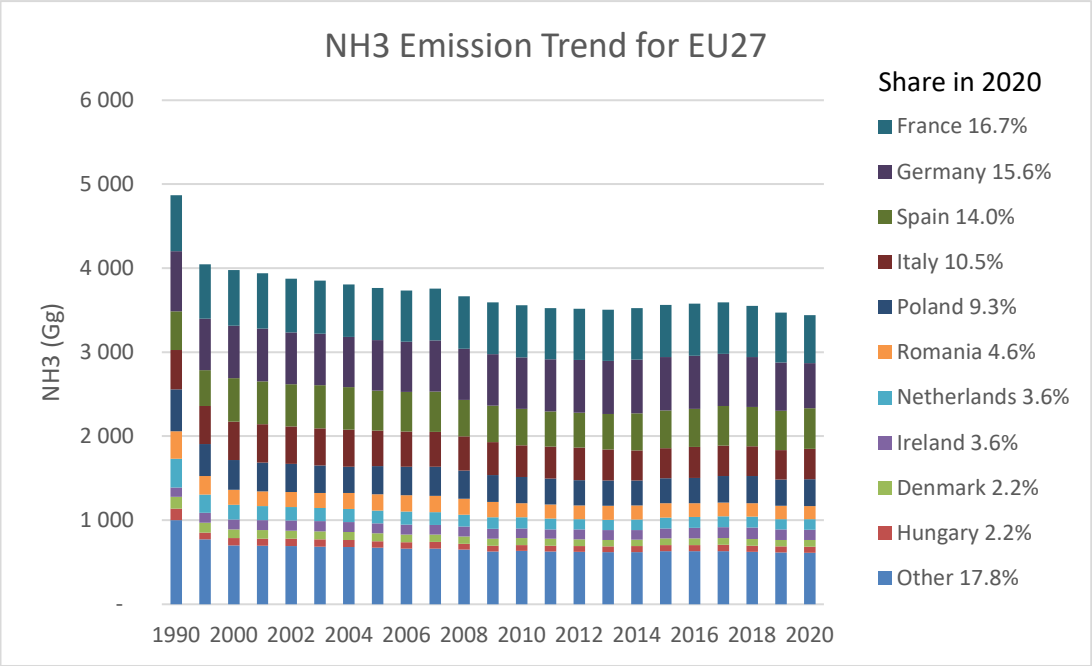
Notable reductions are also found in pigs, in particular because of the increase in biphasic feeding and the nitrification/denitrification of effluent, and finally in poultry, with the gradual disappearance until 2006 of deep pit systems for laying hens (which have very high emissions), the change in feed composition resulting in a drop in the nitrogen excreted by certain categories of poultry, and a very sharp drop in the size of the turkey herd over the period (see France's IIR, listed in Appendix 5).

Germany has reported a decrease in NH_3 emissions of 25% since 1990. The biggest emission sources in 1990, and in 2020, is manure management (3B) and application of fertiliser to soils, which includes animal manure (3Da2a) and inorganic nitrogen fertiliser (3Da1). (see Germany's IIR, listed in Appendix 5).

In **Spain**, NH_3 emissions increased by 4.7% between 1990 and 2020, and by 2.8% between 2019 and 2020. During the period 1990-1996 a decline was observed, which was related to a significant economic recession in Spain together with a period of drought (the fact that fertilisation intensifies drought stress implies a contraction in the fertiliser market during low rainfall periods). From 1996 onwards, emissions increased steadily until reaching maximum levels in the period 2000-2004. During these years, the number of non-dairy cattle had increased significantly relative to 1990, as had the swine population. This led to higher NH_3 emissions not only from livestock but also from application of animal manure to soils. Decreases in the following years are a combination of factors: a second period of drought (2005-2008), an economic downturn (as of 2007), a change in fertiliser application, practices, a reduction in non-dairy cattle numbers (3B1b), the progressive introduction of abatement techniques in pig manure management (3B3), improvements in animal feed formulations and the enforcement of animal welfare legislation affecting laying hens since 2010. The recent upwards trend in NH_3 emissions is driven by increases in fertiliser application and changes in livestock practices (see Spain's IIR, listed in Appendix 5).

In **Italy**, in 2020 agriculture was the main source of emissions, contributing 95% of the total NH_3 emissions; during the period 1990 to 2020, emissions from this sector showed a decrease of about 23%. Emissions from road transport show a strong increase, but the share of the total is only 1.2%. Emissions from waste treatment and disposal, accounting also for only 2.5% of the total, show an increase of about 71% because of the increase of NH_3 emissions from anaerobic digestion at biogas facilities. Specifically, emissions from agriculture have decreased because of the reduction in the number of animals and the trend in agricultural production, and the introduction of abatement technologies due to the implementation of the EU Integrated Pollution Prevention and Control Directive (EU, 1996). In recent years a further reduction in emissions has been the result of the implementation of the EU rural development programmes, which provide incentives to introduce good practices and technologies for protecting environment and mitigating greenhouse gas and NH_3 emissions. The increase in emissions of 3.8% between 2019 and 2020 is mainly due to higher NH_3 emissions reported for the use of inorganic fertiliser (3Da1) (see Germany's IIR, listed in Appendix 5).

Figure 3.12 NH_3 emission trend in the EU and share of Member States



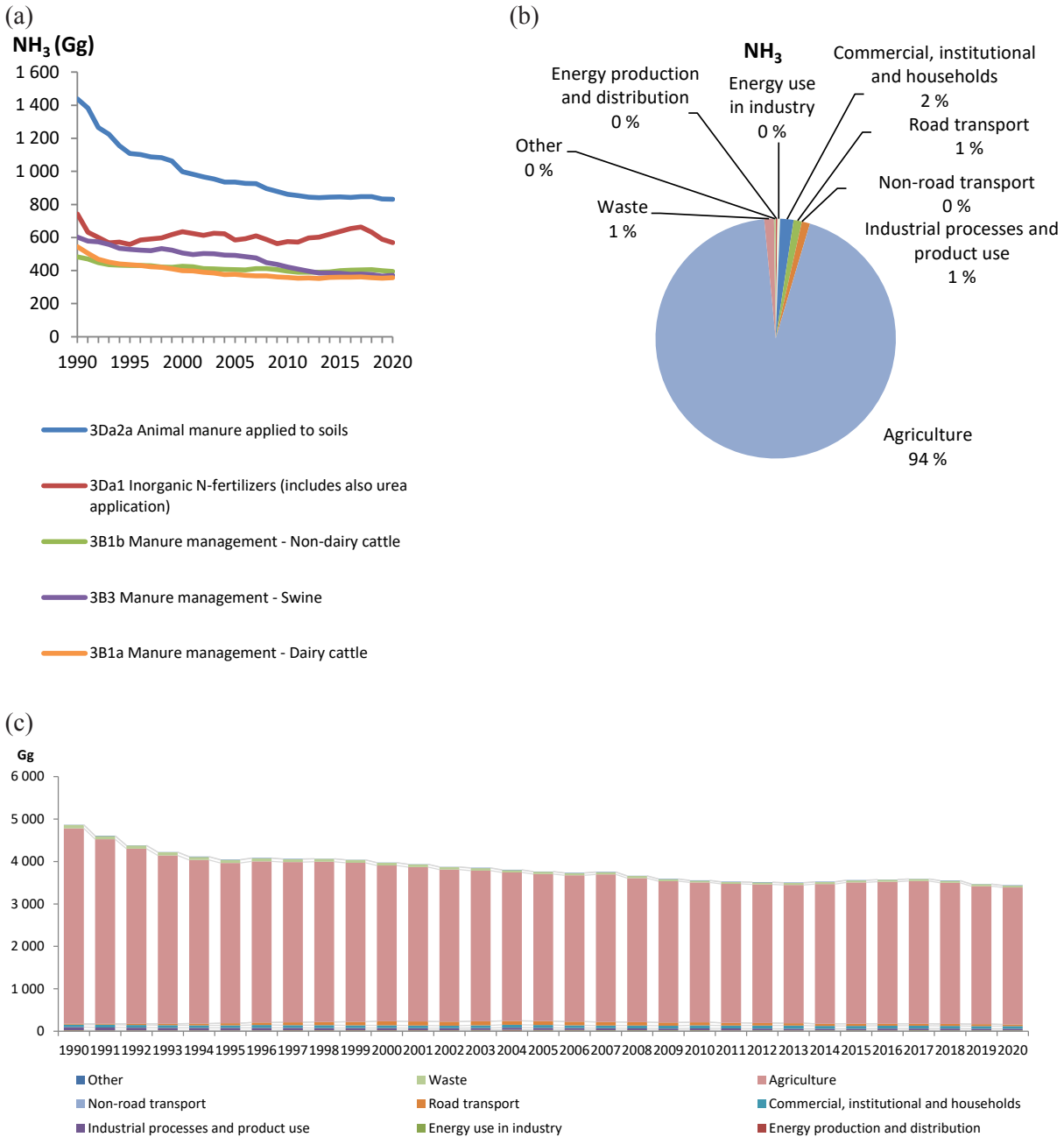
Notes: Countries are sorted by their contribution to the EU total for the last year. The respective top 10 countries are displayed. Data for the other 17 reporting countries with data are summed up under 'other'.

The principal key categories for NH_3 emissions are 'Animal manure applied to soils (3Da2a)', 'Inorganic N-fertilisers (3Da1)' and 'Manure management — Non-dairy cattle (3B1b)'. They jointly make up 52% of total NH_3 emissions (see

Figure 3.13(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2020 occurred in 'Animal manure applied to soils (3Da2a)' (-42.2%). There were also large reductions in emissions in the fourth most important category, Manure management – Swine (3B3)' (-38.5%).

Figure 3.13(b) shows the contribution made by each aggregated sector group to total EU emissions. A single sector group - agriculture - is responsible for most (94%) of the NH_3 emissions in the EU.

Figure 3.13 **NH_3 emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



3.6 Fine particulate matter emission trends and key categories

Between 2000 and 2019, $PM_{2.5}$ emissions dropped by 37% in the EU, and between 2019 and 2020, emissions decreased by 4% (see Table 3.8) mainly because emissions decreased in France, Germany, Spain and Italy (countries ranked according to the size of their contributions to the absolute change). Small increases were reported by Bulgaria, Croatia, Estonia and Ireland in the 2020.

Table 3.8 Member State contributions to EU emissions of $PM_{2.5}$

	$PM_{2.5}$ (Gg)																	Change		Share in EU-27	
Member State	2000	2001	2002	2003	2004	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2000—2020	2019—2020	2000	2020
Austria	24	24	23	23	23	23	20	19	18	18	16	16	15	15	14	14	13	-45 %	-5.4 %	1.3 %	1.1 %
Belgium	40	39	37	37	37	34	30	25	25	25	21	22	22	20	19	18	17	-58 %	-7.7 %	2.1 %	1.4 %
Bulgaria	36	32	37	40	40	40	36	39	38	35	35	35	32	32	31	30	32	-11 %	4.3 %	1.9 %	2.7 %
Croatia	36	39	38	44	42	44	38	36	35	34	30	32	31	29	29	27	28	-21 %	5.5 %	1.9 %	2.4 %
Cyprus	2.5	2.2	2.2	2.2	2.2	2.1	1.6	1.4	1.1	1.0	0.9	0.9	1.0	1.0	1.0	1.1	0.9	-62 %	-10.3 %	0.1 %	0.1 %
Czechia	50	51	47	47	47	43	45	43	43	44	41	41	40	41	39	35	32	-35 %	-8.3 %	2.7 %	2.7 %
Denmark	21	21	20	21	21	22	21	19	18	18	17	17	17	16	15	13	12	-41 %	-6.0 %	1.1 %	1.0 %
Estonia	12	12	13	11	11	10	12	17	7.9	10	8.9	7.4	6.9	7.1	7.0	5.9	5.9	-51 %	0.8 %	0.6 %	0.5 %
Finland	26	27	27	27	27	26	23	20	20	20	19	17	18	17	17	16	14	-46 %	-13.2 %	1.4 %	1.2 %
France	317	305	284	283	269	247	188	160	165	165	142	144	144	137	129	126	113	-64 %	-10.4 %	16.8 %	9.5 %
Germany	165	159	153	146	141	135	119	114	113	111	103	102	97	95	94	90	81	-51 %	-9.7 %	8.8 %	6.9 %
Greece	67	71	69	68	69	69	48	47	49	44	45	43	40	40	37	37	35	-48 %	-5.7 %	3.5 %	2.9 %
Hungary	48	52	38	46	43	40	50	56	58	58	49	51	49	47	41	38	37	-23 %	-3.3 %	2.6 %	3.1 %
Ireland	19	19	18	18	18	19	16	14	14	14	13	14	14	13	13	12	12	-36 %	0.8 %	1.0 %	1.0 %
Italy	197	189	159	178	155	176	199	152	179	172	155	160	155	162	144	138	133	-33 %	-3.4 %	10.5 %	11.2 %
Latvia	27	28	28	29	30	27	21	21	21	20	19	16	16	18	19	18	17	-38 %	-8.9 %	1.4 %	1.4 %
Lithuania	6.8	7.1	7.3	7.2	7.2	8.2	8.0	7.9	8.0	7.9	7.6	7.5	7.4	7.4	7.5	7.0	6.5	-5 %	-7.6 %	0.4 %	0.5 %
Luxembourg	2.4	2.6	2.4	2.6	2.6	2.5	1.9	1.7	1.6	1.6	1.6	1.4	1.5	1.3	1.4	1.3	1.3	-48 %	-1.0 %	0.1 %	0.1 %
Malta	0.9	0.9	0.9	0.9	1.0	0.8	0.6	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.4	-49 %	-11.4 %	0.0 %	0.0 %
Netherlands	34	32	31	30	29	28	21	20	19	19	18	17	17	17	16	16	14	-57 %	-7.4 %	1.8 %	1.2 %
Poland	307	317	322	317	322	332	368	345	347	336	309	306	318	310	293	256	255	-17 %	-0.4 %	16.3 %	21.5 %
Portugal	71	67	67	64	65	62	53	54	52	50	50	50	49	49	49	49	47	-33 %	-3.2 %	3.8 %	4.0 %
Romania	106	87	90	106	119	120	129	119	122	115	115	110	110	111	111	112	112	5 %	-0.4 %	5.6 %	9.4 %
Slovakia	44	43	32	32	30	36	26	24	26	24	16	21	21	21	17	18	17	-60 %	-1.3 %	2.3 %	1.5 %
Slovenia	14	16	14	15	14	16	15	14	14	14	12	13	13	12	11	11	10	-30 %	-5.1 %	0.8 %	0.8 %
Spain	176	169	163	179	163	157	152	155	134	154	133	144	129	128	145	127	120	-32 %	-5.3 %	9.4 %	10.2 %
Sweden	34	33	32	32	31	31	26	26	24	23	20	19	19	19	18	17	17	-50 %	-3.1 %	1.8 %	1.4 %
EU27 (a)	**1 884**	**1 845**	**1 756**	**1 806**	**1 758**	**1 751**	**1 669**	**1 552**	**1 555**	**1 534**	**1 398**	**1 408**	**1 382**	**1 369**	**1319**	**1234**	**1185**	**-37 %**	**-4.0 %**	**100 %**	**100 %**
EU27 (b)	1 884	1 845	1 756	1 806	1 758	1 751	1 669	1 552	1 555	1 534	1 398	1 408	1 382	1 369	1319	1234	1185				

Notes: The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.

In 2020, the EU Member States contributing most (i.e. more than 10%) to $PM_{2.5}$ emissions were Poland, Italy, Spain and France (countries ranked according to their shares of the EU total). The emission decrease of 37% between 2000 and 2020 can be attributed to reductions achieved in stationary fuel combustion in public electricity and heat production (1A1a) and road transport (1A3) as a result of the introduction of EU directives applicable to installations and the transport sector. The reduction in emissions from the heating of buildings (1A4a and 1A4b) is mainly caused by a shift in fuel type and improved heating facilities.

In **Poland**, $PM_{2.5}$ emissions decreased by 17% between 2000 and 2020. The main source of emissions is the burning of coal and wood by households (1A4), representing 78% of total $PM_{2.5}$ emissions in 2020. In case of TSP, PM_{10} and $PM_{2.5}$ emission factors for sector 1A4, the condensable fraction is included.

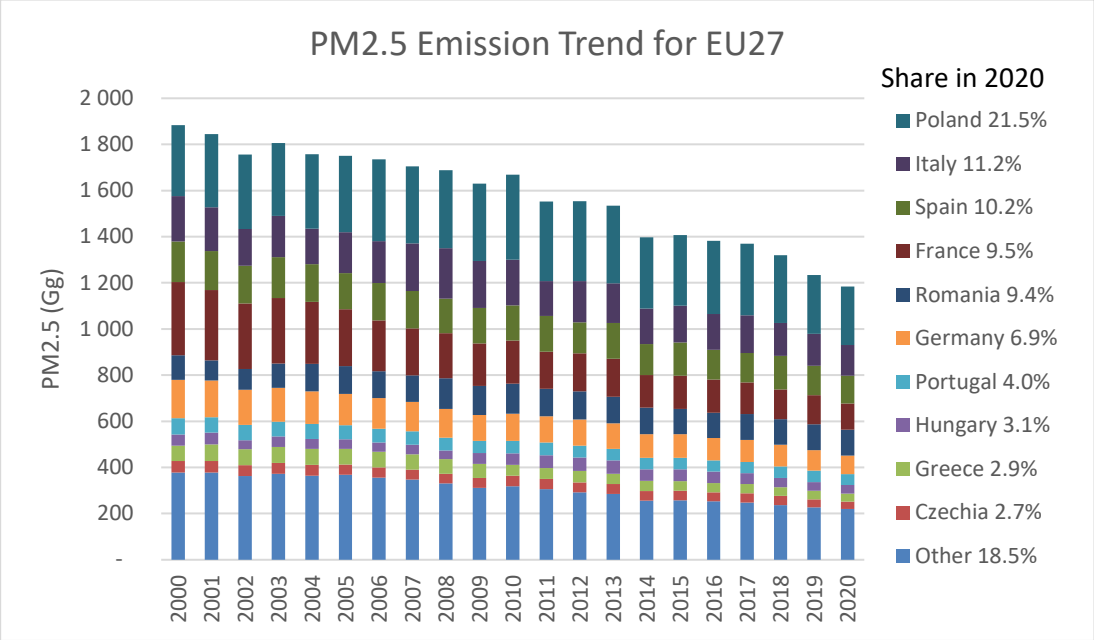
Italy reported $PM_{2.5}$ emission decreases of 33% between 2000 and 2020, and a further reduction of 3% during the last year. In 2000, $PM_{2.5}$ emissions were mainly the result of commercial and residential heating of buildings (1A4a and 1A4b). $PM_{2.5}$ emissions resulting from road transport (1A3) and stationary combustion (1A1a and 1A2) and agricultural activities (1A4c) have fallen substantially since 2000. This is due to the introduction of EU directives controlling and limiting PM emissions from car exhaust pipes and the introduction of two regulatory instruments (introduction of plant emission limits) (see Italy's IIR, listed in Appendix 5).

Spain reported a decrease of 32% in $PM_{2.5}$ emissions since 2000. While in 2000 commercial and residential heating (1A4a and 1A4b) were the highest contributing sectors, this changed in 2020, when $PM_{2.5}$ emissions from burning waste (5C) were the most relevant. The most relevant reduction in emissions affected passenger cars and heavy duty vehicles as a result of the introduction of the Euro standards. $PM_{2.5}$ emissions related to industrial activities are linked to the economic downturn (from 2008), the shift from liquid fossil fuels to more predominant gas consumption, and the installation of abatement techniques. Furthermore, the restriction of field burning (3F) due to the introduction of legislation to prevent forest fires had an effect.

France is the country showing the greatest $PM_{2.5}$ reductions between 2000 and 2020, namely 64%. $PM_{2.5}$ emissions from the heating of buildings (1A4a and 1A4b) are the most relevant source category, but show a reduction of 67% between 2000 and 2020. This decrease is linked to the improved performance of individual wood-burning equipment in the residential sector. The transport sector also contributes to

the decline observed, which is due to the decrease in the number of vehicles, the growing share of diesel vehicles equipped with particulate filters in recent years, the implementation of the Euro standards and the strengthening of these standards in recent years. In the industrial sector, the reductions are mainly found in the mineral production sector and are explained by the installation of dust collectors on several sites.

Figure 3.14 $PM_{2.5}$ emission trend in the EU and share of Member States



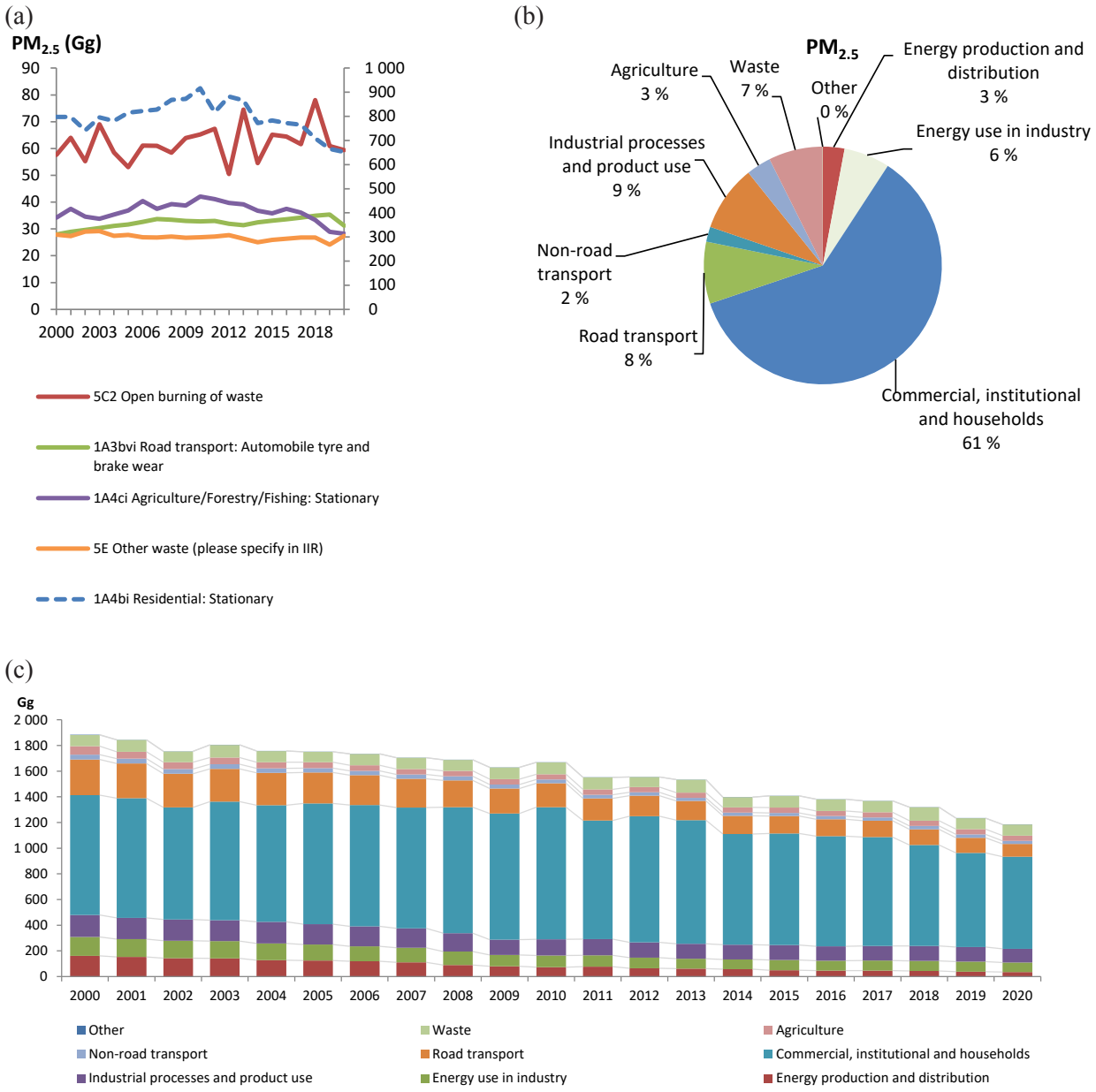
Notes: Countries are sorted by their contribution to the EU total for the last year. The respective top 10 countries are displayed. The other 17 reporting countries with data are summed up under 'other'.

Domestic fuel use in 'Residential: Stationary (1A4bi)' is the principal key category for $PM_{2.5}$ emissions, making up 55% of the total and have decreased by -18% since the year 2000. Figure 3.15(a)). Among the top five key categories, the highest relative reduction in emissions between 2000 and 2020 was in 'Residential: Stationary (1A4bi)' (-18%), but also in 'Agriculture/Forestry/Fishing: Stationary (1A4ci)' reductions occurred (-17.4%).

In contrast, emissions from 'Road transport: Automobile tyre and brake wear (1A3bvi)' (+12%) and 'Open burning of waste (5C2) (+3.1%) have increased significantly since 1990.

Figure 3.15(b) shows the contribution to total EU emissions made by each aggregated sector group. The commercial, institutional and households sector group is a major source of $PM_{2.5}$, as well as PM_{10}, CO and PCDD/Fs.

Figure 3.15 **$PM_{2.5}$ emissions in the EU: (a) trend in emissions from the five most important key categories, 2000-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Notes: In (a), the right-hand axis shows values for '1A4bi — Residential: Stationary'.
The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter.

3.7 Particulate matter emission trends and key categories

Between 2000 and 2020, PM_{10} emissions decreased by 34% in the EU. Between 2019 and 2020, the decrease was 3.3% (see Table 3.9) mainly because emissions dropped in France, Germany, Italy and Spain (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to PM_{10} emissions were Poland, France and Germany (countries ranked according to their shares of the EU total).

Table 3.9 Member State contributions to EU emissions of PM_{10}

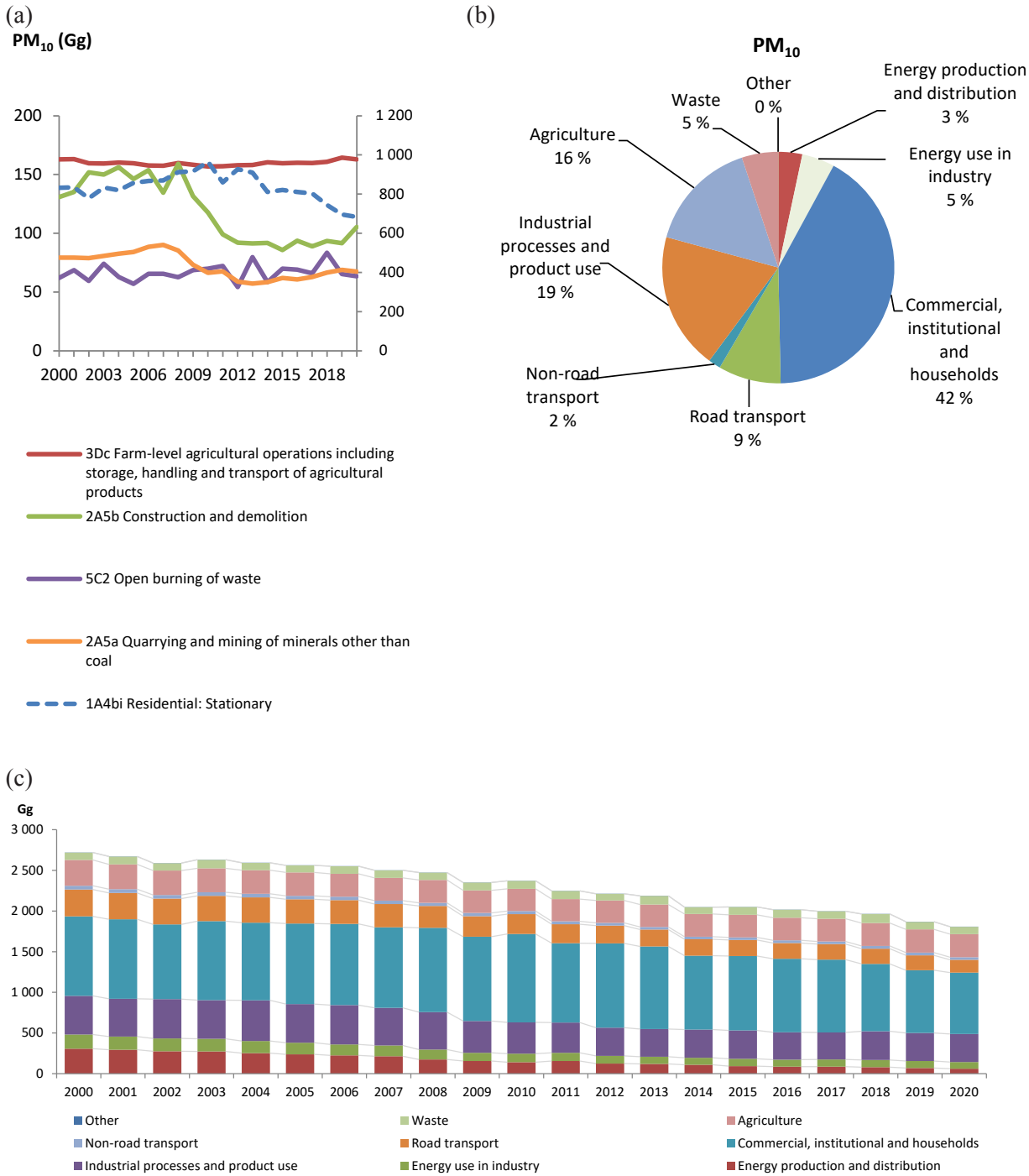
	PM_{10} (Gg)													Change		Share in EU-27	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2000—2020**	**2019—2020**	**2000**	**2020**
Austria	38	36	32	31	31	30	29	28	28	28	27	27	25	-33 %	-4.8 %	1.4 %	1.4 %
Belgium	55	46	39	33	33	34	29	31	31	29	28	27	26	-54 %	-5.9 %	2.0 %	1.4 %
Bulgaria	63	69	50	57	53	48	51	52	44	44	44	45	45	-29 %	-0.2 %	2.3 %	2.5 %
Croatia	48	57	53	48	48	49	45	40	44	38	42	35	51	8 %	48.1 %	1.8 %	2.8 %
Cyprus	4.7	4.1	3.1	2.8	2.2	1.8	1.7	1.7	1.9	1.9	2.0	2.1	1.9	-59 %	-7.9 %	0.2 %	0.1 %
Czechia	67	58	57	55	55	56	53	52	51	52	51	46	42	-37 %	-8.1 %	2.5 %	2.3 %
Denmark	33	33	33	30	29	29	28	27	27	27	26	23	23	-31 %	-3.8 %	1.2 %	1.3 %
Estonia	28	17	21	33	13	18	15	12	11	12	11	9.1	8.9	-68 %	-2.6 %	1.0 %	0.5 %
Finland	43	42	38	36	34	34	34	31	32	31	31	30	27	-38 %	-10.3 %	1.6 %	1.5 %
France	421	341	271	243	248	247	221	223	224	220	210	207	187	-55 %	-9.6 %	15.5 %	10.4 %
Germany	298	245	226	225	222	224	216	214	199	202	207	194	180	-40 %	-7.0 %	11.0 %	10.0 %
Greece	128	126	91	78	76	72	76	70	69	68	61	61	59	-54 %	-3.4 %	4.7 %	3.3 %
Hungary	73	73	72	75	74	77	72	73	70	66	62	60	57	-21 %	-5.3 %	2.7 %	3.2 %
Ireland	37	40	34	27	28	28	27	28	28	28	28	28	28	-24 %	-0.2 %	1.4 %	1.5 %
Italy	257	232	240	192	216	208	190	195	190	196	178	176	166	-36 %	-5.9 %	9.4 %	9.2 %
Latvia	32	36	29	31	31	29	28	27	26	27	28	28	26	-17 %	-6.0 %	1.2 %	1.4 %
Lithuania	11	19	18	19	19	19	19	19	19	18	19	18	18	57 %	-3.1 %	0.4 %	1.0 %
Luxembourg	3.0	3.2	2.5	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.1	1.9	1.8	-39 %	-5.0 %	0.1 %	0.1 %
Malta	1.3	1.9	1.4	1.4	1.4	1.3	1.5	1.3	1.5	1.5	1.7	1.8	1.6	25 %	-10.7 %	0.0 %	0.1 %
Netherlands	49	41	35	34	33	32	32	31	31	30	30	29	27	-44 %	-5.6 %	1.8 %	1.5 %
Poland	417	437	473	447	447	433	402	399	411	405	386	343	340	-18 %	-0.8 %	15.3 %	18.8 %
Portugal	90	80	72	79	73	65	62	61	62	61	61	62	61	-32 %	-0.8 %	3.3 %	3.4 %
Romania	139	159	166	158	163	153	153	148	145	144	148	154	152	9 %	-0.9 %	5.1 %	8.4 %
Slovakia	54	45	33	31	32	30	22	29	27	28	23	24	24	-55 %	0.6 %	2.0 %	1.3 %
Slovenia	20	23	21	16	16	16	14	15	17	15	13	14	14	-28 %	1.8 %	0.7 %	0.8 %
Spain	261	248	216	217	191	210	188	203	191	187	206	186	179	-32 %	-4.2 %	9.6 %	9.9 %
Sweden	53	51	44	45	42	43	39	37	38	39	38	37	35	-33 %	-3.9 %	1.9 %	1.9 %
EU27 (a)	**2 722**	**2 562**	**2 372**	**2 248**	**2 212**	**2 187**	**2 049**	**2 051**	**2 018**	**1 999**	**1 964**	**1 869**	**1 807**	**-34 %**	**-3.3 %**	**100 %**	**100 %**
EU27 (b)	2 722	2 562	2 372	2 248	2 212	2 187	2 049	2 051	2 018	1 999	1 964	1 869	1 807				

Notes: The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter. (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

As for $PM_{2.5}$, '1A4bi — Residential: Stationary' is the most significant key category for PM_{10} emissions, accounting for 38% of total PM_{10} emissions (see Figure 3.16(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2020 was in the third most important category, '2A5b — Construction and demolition' (-19.4%). Reductions in emissions were also observed in the categories, '2A5a — Quarrying and mining of minerals other than coal' (-14.9%), '1A4bi — Residential: Stationary' (-17.9%) . Emissions of the fifth most important key category, '5C2 — Open burning of waste' (+2.4%), have increased since 1990, while emissions from the category '3Dc — Farm-level agricultural operations including storage, handling and transport of agricultural products', have remained quite constant (+0.1%).

Figure 3.16 (b) shows the contribution of each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is a major source of $PM_{2.5}$ and of PM_{10}, CO, PAHs and PCDD/Fs.

Figure 3.16 **PM_{10} emissions in the EU: (a) trend in emissions from the five most important key categories, 2000-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Notes: In (b), the right-hand axis shows values for '1A4bi — Residential: Stationary'.
The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter.

3.8 Total suspended particulate emission trends

Between 2000 and 2020, TSP emissions dropped by 28% in the EU. Between 2019 and 2020, emissions decreased by 2.11% (Table 3.10), mainly because of decreases in France, Germany, Italy and Spain (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to TSP emissions were France, Poland and Germany (countries ranked according to their shares of the EU total).

Germany explained that, between 2000 and 2020, total TSP emissions dropped by 36% because of the application of the former West Germany's stricter regulations in the new German *Länder*, following Germany's reunification, the transition from solid to gaseous and liquid fuels, and improved filter technologies for combustion plants and industrial processes (see Germany's IIR, listed in Appendix 5).

France explained that the reported drop in TSP emissions between 1990 and 2020 was mainly linked to improvements in wood-burning equipment in the residential sector. Improvements in the transport sector (increase in the number of diesel vehicles with particulate filters) in recent years contributed to this decrease in TSP emissions. The decrease of emissions between 2019 and 2020 was caused by the COVID-19 health crisis which affected the transport- and industrial sectors.

Table 3.10 Member State contributions to EU emissions of TSPs

	TSPs (Gg)													Change		Share in EU—27	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2000—2020**	**2019-2020**	**2000**	**2020**
Austria	51	49	44	43	43	42	41	40	40	40	39	39	37	-27 %	-4.7 %	1.1 %	1.1%
Belgium	83	71	58	50	51	52	46	47	48	46	46	46	44	-47 %	-3.2 %	1.8 %	1.4%
Bulgaria	121	137	73	87	78	70	85	95	65	67	71	76	70	-42 %	-8.6 %	2.7 %	2.2%
Croatia	72	84	81	72	75	78	75	54	67	51	69	45	101	40 %	126.4 %	1.6 %	3.1%
Cyprus	9.5	6.5	5.4	4.8	3.7	2.8	2.5	2.5	2.8	3.0	3.2	3.5	3.2	-66 %	-8.1 %	0.2 %	0.1%
Czechia	91	73	70	67	67	67	64	63	61	62	62	57	52	-43 %	-8.6 %	2.0 %	1.6%
Denmark	102	96	97	93	91	90	93	87	86	92	91	88	84	-17 %	-4.1 %	2.3 %	2.6%
Estonia	64	28	27	41	19	24	20	17	15	17	17	14	13	-79 %	-3.4 %	1.4 %	0.4%
Finland	56	57	54	51	48	49	48	45	47	45	45	45	39	-30 %	-11.3 %	1.2 %	1.2%
France	1 040	936	832	812	816	808	770	783	793	792	776	773	722	-31 %	-6.6 %	23.0 %	22.3%
Germany	524	427	390	396	390	400	391	386	359	370	384	359	337	-36 %	-6.0 %	11.6 %	10.4%
Greece	245	231	169	124	114	114	127	119	127	120	104	108	108	-56 %	0.2 %	5.4 %	3.3%
Hungary	105	134	107	103	92	104	109	107	101	92	92	93	88	-17 %	-6.1 %	2.3 %	2.7%
Ireland	85	100	80	58	60	60	59	61	62	66	64	65	64	-25 %	-2.0 %	1.9 %	2.0%
Italy	317	289	295	238	266	256	235	242	236	244	224	221	207	-35 %	-6.4 %	7.0 %	6.4%
Latvia	40	56	45	56	55	49	49	53	47	45	45	47	46	14 %	-2.7 %	0.9 %	1.4%
Lithuania	14	39	37	38	37	37	36	40	37	36	40	37	36	156 %	-1.8 %	0.3 %	1.1%
Luxembourg	3.8	4.0	3.2	3.1	3.0	2.9	2.9	3.1	2.7	2.8	2.7	2.6	2.4	-36 %	-8.5 %	0.1 %	0.1%
Malta	2.2	4.8	3.5	3.5	3.5	3.4	3.7	3.7	4.4	4.7	5.5	5.8	5.6	152 %	-4.4 %	0.0 %	0.2%
Netherlands	56	48	40	40	39	39	38	37	36	35	35	34	32	-43 %	-5.6 %	1.2 %	1.0%
Poland	534	556	596	571	567	546	510	511	523	519	500	454	449	-16 %	-1.0 %	11.8 %	13.9%
Portugal	152	141	128	150	138	113	108	101	105	103	104	105	105	-31 %	-0.2 %	3.4 %	3.2%
Romania	234	297	286	284	283	256	258	236	218	207	225	234	241	3 %	2.9 %	5.2 %	7.4%
Slovakia	74	61	42	40	40	39	31	41	35	37	31	31	32	-57 %	3.1 %	1.6 %	1.0%
Slovenia	31	38	36	19	18	18	17	18	24	18	18	21	23	-26 %	11.6 %	0.7 %	0.7%
Spain	344	341	283	280	248	265	244	264	251	250	272	252	244	-29 %	-3.2 %	7.6 %	7.5%
Sweden	71	69	62	65	59	63	57	56	58	59	58	57	54	-23 %	-4.2 %	1.6 %	1.7%
EU27 (a)	**4 522**	**4 372**	**3 944**	**3 790**	**3 705**	**3 649**	**3 521**	**3 512**	**3 451**	**3 427**	**3422**	**3309**	**3238**	**-28%**	**-2.1%**	**100 %**	**100 %**
EU27 (b)	4 522	4 372	3 944	3 790	3 705	3 649	3 521	3 512	3 451	3 427	3422	3309	3238				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.9 Black carbon emission trends

Between 2000 and 2020, BC emissions dropped by 93% in the EU (see Table 3.11). Between 2019 and 2020, emissions fell by 8.4%, mainly because of slightly lower emissions from France, Spain, Italy and Germany (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to BC emissions were Spain and France (countries ranked according to their shares of the EU total). As Austria and Luxembourg did not provide data for BC, these gaps could not be filled with data. Thus, the EU total is an underestimate.

Table 3.11 Member State contributions to EU emissions of BC

	Black Carbon (Gg)													Change		Share in EU-27	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2000—2020**	**2019—2020**	**2000**	**2020**
Austria																	
Belgium	8.7	7.7	6.6	5.5	5.1	4.8	3.9	3.8	3.6	3.1	2.8	2.6	2.1	-75 %	-16.9 %	2.8 %	1.2 %
Bulgaria	2046	2534	12	12	12	8.2	6.2	7.8	7.6	7.9	12	8.0	6.8	-100 %	-14.4 %	0.7 %	4.0 %
Croatia	5.4	6.4	5.4	5.1	4.8	4.6	4.1	4.4	4.3	4.2	3.9	3.8	3.7	-32 %	-1.7 %	1.4 %	2.2 %
Cyprus	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-68 %	-13.5 %	0.2 %	0.1 %
Czechia	6.5	6.3	5.9	5.5	5.4	5.3	5.0	4.9	4.8	4.8	4.8	4.4	4.1	-37 %	-6.3 %	4.8 %	2.4 %
Denmark	4.2	4.0	3.5	3.3	3.1	2.9	2.7	2.7	2.6	2.4	2.2	2.0	1.9	-56 %	-8.5 %	1.4 %	1.1 %
Estonia	2.6	2.5	2.3	2.2	1.9	2.0	1.8	1.8	1.9	1.9	1.9	1.7	1.8	-30 %	5.6 %	0.8 %	1.1 %
Finland	6.5	6.0	5.5	4.8	5.0	4.6	4.5	4.1	4.3	4.1	3.9	3.8	3.2	-51 %	-16.2 %	2.6 %	1.9 %
France	71	57	44	39	38	36	32	31	29	26	24	22	19	-74 %	-15.8 %	19.4 %	10.9 %
Germany	38	31	23	21	19	19	17	16	15	14	12	12	10	-73 %	-11.7 %	13.9 %	5.9 %
Greece	11	12	10	9.5	9.6	8.6	8.8	10	8.9	9.0	8.7	8.7	8.1	-28 %	-6.4 %	2.8 %	4.7 %
Hungary	8.1	7.4	8.4	8.9	9.1	8.6	7.5	7.9	7.6	7.2	6.4	5.9	5.6	-31 %	-5.5 %	2.1 %	3.2 %
Ireland	3.9	3.6	2.7	2.4	2.3	2.3	2.2	2.2	2.1	1.8	1.8	1.6	1.5	-60 %	-5.7 %	1.1 %	0.9 %
Italy	43	39	32	27	27	26	23	23	21	21	19	18	16	-63 %	-10.2 %	12.1 %	9.2 %
Latvia	3.4	3.4	2.7	2.7	2.7	2.4	2.3	2.0	2.0	2.2	2.2	2.1	1.9	-43 %	-9.7 %	1.0 %	1.1 %
Lithuania	2.2	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.2	2.1	2.0	1.9	-14 %	-6.6 %	0.7 %	1.1 %
Luxembourg																	
Malta	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-59 %	-9.8 %	0.0 %	0.1 %
Netherlands	10	7.9	5.1	4.7	4.2	3.8	3.5	3.2	3.0	2.8	2.6	2.3	2.1	-79 %	-9.9 %	3.3 %	1.2 %
Poland	21	22	24	23	22	21	19	19	20	20	19	17	17	-19 %	-3.8 %	6.7 %	9.7 %
Portugal	11	9.6	8.5	7.9	7.4	7.1	7.0	7.0	6.9	6.9	6.7	6.6	5.6	-51 %	-15.4 %	2.3 %	3.3 %
Romania	12	14	15	14	14	14	13	13	13	13	13	13	13	4 %	-2.0 %	1.5 %	7.5 %
Slovakia	3.9	4.4	3.9	3.4	3.6	3.2	2.3	2.8	2.8	2.8	2.3	2.4	2.3	-42 %	-4.1 %	2.1 %	1.3 %
Slovenia	2.5	3.0	2.8	2.7	2.6	2.5	2.2	2.3	2.3	2.1	1.9	1.8	1.6	-36 %	-8.7 %	0.6 %	0.9 %
Spain	55	51	54	55	43	56	43	48	45	44	53	44	41	-25 %	-6.0 %	13.9 %	23.9 %
Sweden	5.5	4.8	4.0	3.7	3.4	3.2	2.9	2.7	2.6	2.5	2.3	2.1	2.0	-64 %	-7.0 %	1.8 %	1.2 %
EU27 (a)	**2 383**	**2 841**	**284**	**265**	**249**	**247**	**217**	**222**	**213**	**207**	**210**	**188**	**172**	**-93 %**	**-8.4 %**	**100 %**	**100 %**
EU27 (b)	2 383	2 841	284	265	249	247	217	222	213	207	210	188	172				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.

3.10 Carbon monoxide emission trends and key categories

Between 1990 and 2020, CO emissions fell by 71% in the EU. Between 2019 and 2020, the decrease was 8.2% (Table 3.14), mainly because emissions fell in Germany, France, Italy and Spain (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to CO emissions were Germany, Poland, France and Italy (countries ranked according to their shares of the EU total).

France explained that the decreasing trend in CO emissions between 1990 and 2020 was driven by improvements in the transport sector (installation of catalytic converters to vehicles) and sector 'small combustion' (progress in biomass combustion, renewal of residential stock, more efficient and less emitting appliances). The decline of CO emissions between 2019 and 2020 is mainly caused by reductions in the energy sector as a result of the health crisis.

The decline in CO emissions in Italy between 1990 and 2020 was mostly caused by reductions in the transport sector (including road, railways, air and maritime transport).

Reductions in CO emissions between 1990 and 2020 in Spain were also driven by reductions in the transport sector (e.g. the introduction of the Euro standards) and the agricultural sector (e.g. the abandonment of the practice of field burning).

Table 3.12 Member State contributions to EU emissions of CO

	CO (Gg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	1 254	972	725	626	579	563	562	565	529	539	534	525	484	497	475	-62 %	-4.5 %	2.2 %	2.9 %
Belgium	1 508	1 278	995	798	494	396	340	511	317	366	350	282	327	359	266	-82 %	-26.0 %	2.7 %	1.6 %
Bulgaria	840	593	385	348	321	498	455	288	280	280	292	292	273	259	250	-70 %	-3.6 %	1.5 %	1.5 %
Croatia	564	452	474	428	336	311	293	282	249	270	260	254	232	219	217	-61 %	-0.7 %	1.0 %	1.3 %
Cyprus	45	39	30	24	14	13	12	12	12	11	11	11	10	10	8.8	-80 %	-14.3 %	0.1 %	0.1 %
Czechia	2 045	1 547	1 103	942	925	888	877	889	857	852	851	851	859	827	796	-61 %	-3.8 %	3.6 %	4.9 %
Denmark	719	644	474	425	349	307	289	276	252	256	247	237	221	206	192	-73 %	-6.9 %	1.3 %	1.2 %
Estonia	251	221	189	154	157	131	142	136	131	130	144	140	140	139	138	-45 %	-0.6 %	0.4 %	0.9 %
Finland	764	662	594	519	446	407	402	389	383	359	366	357	349	343	317	-59 %	-7.6 %	1.3 %	2.0 %
France	10 950	9 188	6 608	5 246	4 141	3 439	3 149	3 200	2 682	2 644	2 673	2 622	2 501	2 460	2 162	-80 %	-12.1 %	19.3 %	13.4 %
Germany	13 046	7 083	5 068	3 828	3 506	3 421	3 168	3 127	2 958	3 061	2 942	2 957	2 849	2 750	2 452	-81 %	-10.8 %	23.0 %	15.2 %
Greece	1 237	1 065	1 009	869	616	598	641	552	559	538	481	493	469	461	426	-66 %	-7.8 %	2.2 %	2.6 %
Hungary	1 451	982	857	697	552	562	578	559	478	464	450	439	377	358	339	-77 %	-5.1 %	2.6 %	2.1 %
Ireland	563	420	326	285	217	199	193	191	178	179	175	150	146	127	122	-78 %	-3.8 %	1.0 %	0.8 %
Italy	6 797	7 072	4 751	3 467	3 073	2 432	2 696	2 502	2 256	2 267	2 192	2 259	2 050	2 061	1 873	-72 %	-9.1 %	12.0 %	11.6 %
Latvia	469	339	276	235	164	165	163	144	136	112	109	116	119	114	101	-78 %	-11.7 %	0.8 %	0.6 %
Lithuania	373	211	177	173	158	150	147	137	129	122	120	118	119	113	107	-71 %	-5.1 %	0.7 %	0.7 %
Luxembourg	469	213	47	40	29	27	28	28	26	22	23	23	21	22	17	-96 %	-24.3 %	0.8 %	0.1 %
Malta	20	23	15	16.4	14	13	12	11	11	10	9.7	9.4	7.6	7.3	5.6	-72 %	-23.4 %	0.0 %	0.0 %
Netherlands	1 146	924	759	741	706	685	651	617	586	582	565	561	543	525	456	-60 %	-13.0 %	2.0 %	2.8 %
Poland	3621	4 724	3 371	3 065	3 377	3 067	3 089	2 976	2 714	2 659	2 772	2 727	2 563	2 248	2 199	-39 %	-2.2 %	6.4 %	13.6 %
Portugal	797	827	683	523	402	370	355	334	317	324	311	327	285	294	262	-67 %	-10.9 %	1.4 %	1.6 %
Romania	1 208	747	1 048	1 202	1 036	988	973	953	956	912	934	941	943	948	914	-24 %	-3.6 %	2.1 %	5.6 %
Slovakia	1 033	655	542	549	447	414	427	389	317	363	371	373	314	282	279	-73 %	-1.3 %	1.8 %	1.7 %
Slovenia	292	284	206	183	143	140	134	133	114	122	121	116	105	97	87	-70 %	-10.3 %	0.5 %	0.5 %
Spain	4 133	3 144	2 657	2 028	1 906	1 890	1 586	1 897	1 642	1 784	1 637	1 634	1 848	1 590	1 432	-65 %	-9.9 %	7.3 %	8.8 %
Sweden	1 097	942	653	503	413	393	366	359	348	335	336	329	309	301	287	-74 %	-4.5 %	1.9 %	1.8 %
EU27 (a)	**56 691**	**45 249**	**34 020**	**27 913**	**24 523**	**22 469**	**21 730**	**21 456**	**19 416**	**19 562**	**19 278**	**19 142**	**18 462**	**17 619**	**16 181**	**-71 %**	**-8.2 %**	**100 %**	**100 %**
EU27 (b)	56 691	45 249	34 020	27 913	24 523	22 469	21 730	21 456	19 416	19 562	19 278	19 142	18 461	17 619	16 180				

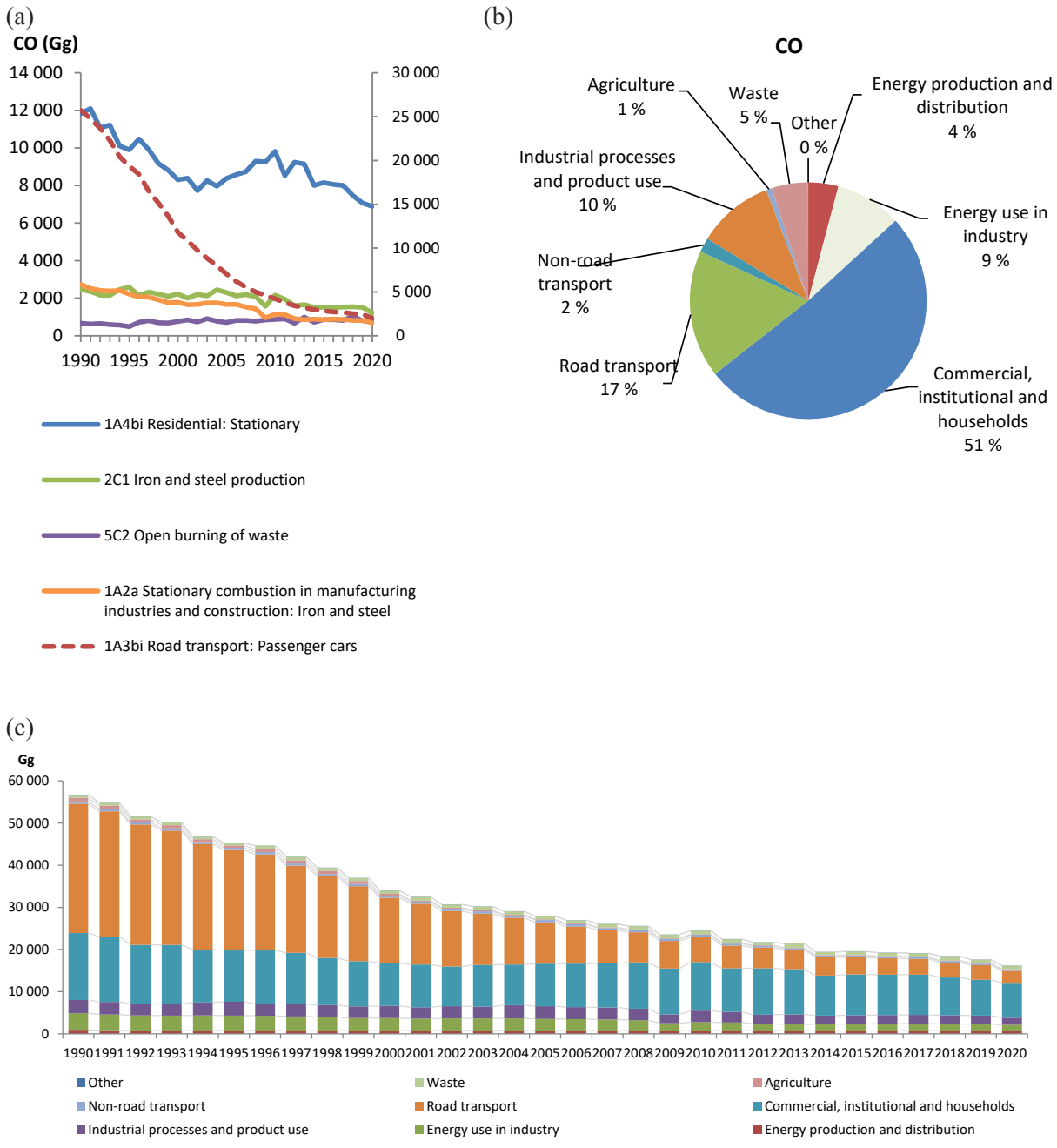
Notes: (a) Sum of national totals, as reported by EU Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Categories '1A4bi — Residential: Stationary' and '1A3bi — Road transport: Passenger cars' were the most important ones for CO emissions, jointly accounting for 55% of the total. Among the top five key categories, the highest relative reduction in emissions between 1990 and 2020 was in the second most important category, '1A3bi — Road transport: Passenger cars' (-92.2%) (see Figure 3.17(a)). Reductions in emissions were observed in the categories '1A4bi — Residential: Stationary' (-41.8%), '2C1 — Iron and steel production' (-50.9%) and '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' (-74.8%). CO emissions from the fifth most important key category, '5C2 — Open burning of waste', have increased by 19.8% since 1990.

Figure 3.17(b) shows the contribution to total EU emissions made by each aggregated sector group. For CO, the common major emission sources are commercial, institutional and households, and road transport.

Figure 3.17 **CO emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: In (a) the right-hand axis gives values for '1A3bi — Road transport: Passenger cars'.

3.11 Lead emission trends and key categories

Between 1990 and 2020, lead (Pb) emissions dropped by 96% in the EU. Between 2019 and 2020, emissions decreased by 11 % (see Table 3.13), mainly in Italy, Spain, Poland and Germany (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to Pb emissions were Poland, Italy and Germany (countries ranked according to their shares of the EU total).

EU total emissions of Pb have declined to less than a 10th of the emissions in 1990, primarily because of reduced emissions from the road transport sector. Thanks to a combination of fiscal and regulatory measures, the promotion of unleaded petrol within the EU has proved a notable success. EU Member States and other EEA member countries have now phased out the use of leaded petrol. In the EU, the Directive on the Quality of Petrol and Diesel Fuels (98/70/EC) regulated that goal (EEA, 2021b).

Table 3.13 Member State contributions to EU emissions of Pb

	Pb (Mg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	233	26	23	26	15	15	15	15	15	14	15	15	14	14	12	-95 %	-11.1 %	1.1 %	1.4 %
Belgium	253	197	99	74	40	29	29	25	23	29	26	25	13	14	12	-95 %	-16.0 %	1.2 %	1.3 %
Bulgaria	383	478	175	41	88	20	11	74	9.8	8.7	9.3	9.8	87	11	11	-97 %	-7.7 %	1.9 %	1.2 %
Croatia	523	264	145	14	8.2	7.9	7.1	8.4	7.8	7.9	8.0	8.1	8.3	5.1	5	-99 %	6.2 %	2.6 %	0.6 %
Cyprus	25	26	20	0.6	0.5	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0	-98 %	-6.5 %	0.1 %	0.0 %
Czechia	324	257	222	39	25	22	24	24	24	21	18	18	19	19	16	-95 %	-14.5 %	1.6 %	1.8 %
Denmark	130	26	20	17	13	13	12	12	12	12	12	12	12	12	11	-91 %	-4.5 %	0.6 %	1.3 %
Estonia	201	83	30	8.9	8.0	11	5.7	6.3	6.1	5.1	5.3	5.5	5.4	4.8	4.2	-98 %	-12.2 %	1.0 %	0.5 %
Finland	321	73	31	21	20	19	16	16	17	15	16	16	15	13	12	-96 %	-11.9 %	1.6 %	1.3 %
France	4 274	1 463	263	155	112	98	100	97	92	86	84	87	85	85	72	-98 %	-15.2 %	20.9 %	8.1 %
Germany	1 899	679	355	230	168	167	158	160	156	162	159	164	159	158	143	-92 %	-9.5 %	9.3 %	16.0 %
Greece	505	405	340	67	31	30	27	25	27	10	9.7	11	10	7.9	6.2	-99 %	-21.3 %	2.5 %	0.7 %
Hungary	816	143	19	11	8.5	9.6	9.4	8.9	8.5	8.9	9.1	8.8	8.3	8.6	7.0	-99 %	-18.0 %	4.0 %	0.8 %
Ireland	157	98	14	7.5	5.7	5.3	5.2	5.4	5.2	5.3	5.4	5.0	4.9	4.6	4.1	-97 %	-9.5 %	0.8 %	0.5 %
Italy	4 278	1 993	961	295	216	226	219	202	205	197	174	181	183	176	156	-96 %	-11.7 %	21.0 %	17.4 %
Latvia	233	127	153	169	164	3.8	5.4	3.6	3.1	3.0	3.0	3.1	3.1	3.0	2.8	-99 %	-7.0 %	1.1 %	0.3 %
Lithuania	10	4.1	3.5	3.6	3.4	3.5	3.6	3.8	3.6	3.6	3.7	3.9	4.1	4.0	3.6	-65 %	-10.7 %	0.0 %	0.4 %
Luxembourg	19	9.1	1.4	1.9	1.4	2.0	2.1	1.5	1.6	1.6	1.5	1.6	1.4	1.5	1.2	-93 %	-14.6 %	0.1 %	0.1 %
Malta	0.3	0.3	0.3	4.0	3.9	2.7	9.9	3.5	4.6	1.5	0.8	0.2	0.2	0.2	0.2	-31 %	-17.2 %	0.0 %	0.0 %
Netherlands	338	155	28	30	38	23	16	14	9.1	8.7	9.0	8.6	6.0	5.2	5.9	-98 %	12.6 %	1.7 %	0.7 %
Poland	540	573	389	270	290	287	300	292	294	287	278	290	287	265	247	-54 %	-6.8 %	2.6 %	27.6 %
Portugal	570	790	35	32	29	28	26	26	26	26	25	26	26	25	23	-96 %	-8.7 %	2.8 %	2.6 %
Romania	729	356	50	68	44	44	41	37	38	41	40	40	41	41	37	-95 %	-11.3 %	3.6 %	4.1 %
Slovakia	57	49	48	21	11	11	11	12	11	11	11	12	11	9.8	8.2	-86 %	-15.9 %	0.3 %	0.9 %
Slovenia	43	23	7.0	5.7	5.4	5.3	5.2	4.9	4.4	4.7	4.7	4.7	4.8	4.3	3.8	-91 %	-12.7 %	0.2 %	0.4 %
Spain	3 179	788	275	142	129	99	91	101	101	95	90	87	93	101	82	-97 %	-18.3 %	15.6 %	9.2 %
Sweden	368	29	18	11	9.6	8.5	8.5	8.2	8.8	8.0	8.9	9.0	7.8	8.1	6.9	-98 %	-15.2 %	1.8 %	0.8 %
EU27 (a)	**20 407**	**9 113**	**3 723**	**1 764**	**1 486**	**1 190**	**1 159**	**1 188**	**1 114**	**1 074**	**1 027**	**1 051**	**1 111**	**1 003**	**894**	**-96 %**	**-11 %**	**100 %**	**100 %**
EU27 (b)	20 407	9 113	3 723	1 764	1 486	1 190	1 159	1 188	1 114	1 074	1 027	1 051	1 111	1 003	894				

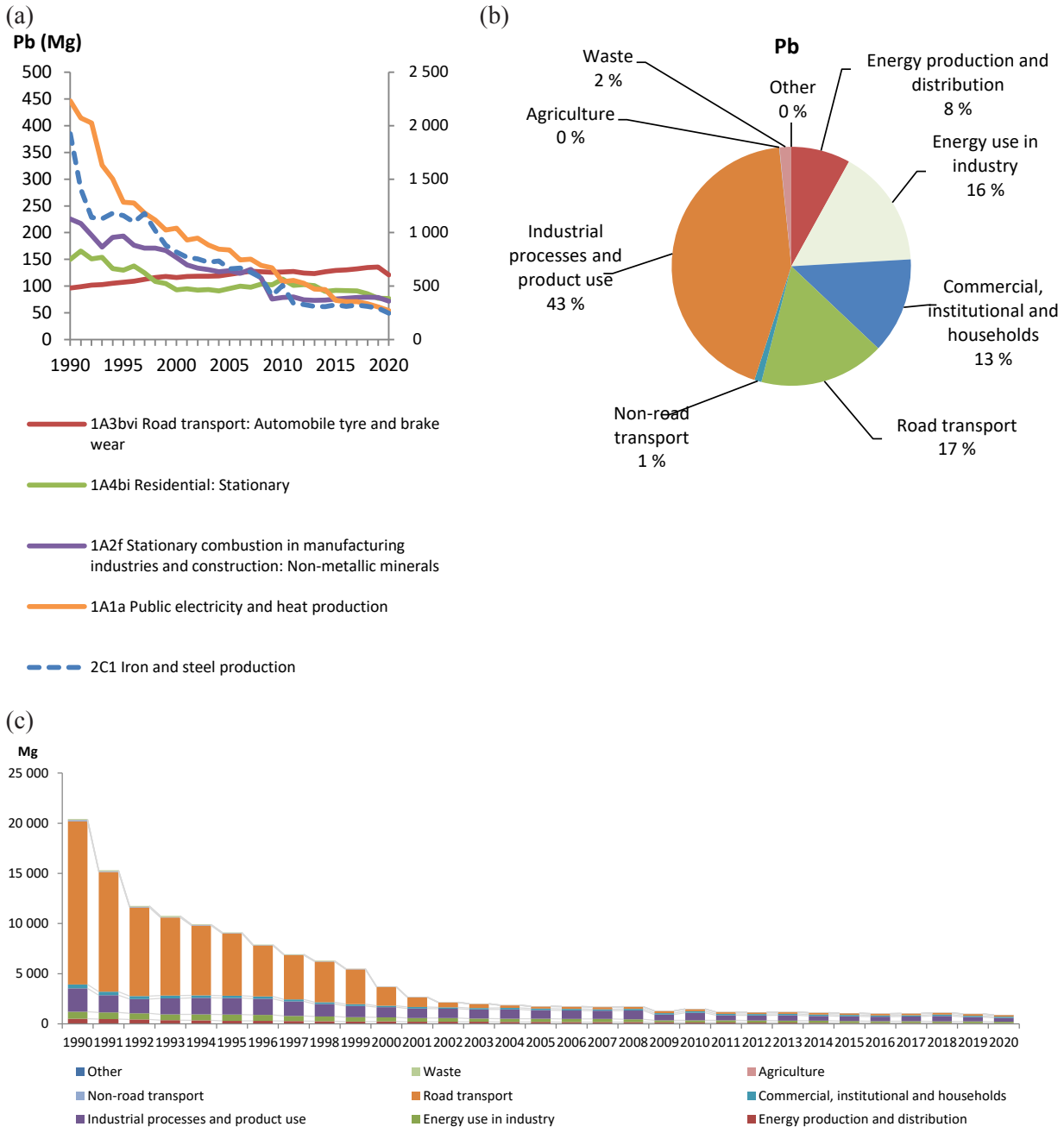
Notes: ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Categories '2C1 — Iron and steel production', '1A3bvi — Road transport: Automobile tyre and brake wear' and '1A4bi—Residential: Stationary' were the leading key ones for Pb emissions in 2020, together making up 41% of total Pb emissions (see Figure 3.18 (a)).

The largest relative reductions in emissions between 1990 and 2020 were from the fifth important key category, '1A1a —Public electricity and heat production' (-87.9%) ', and the most important category, '2C1 — Iron and steel production' (-87.3 %). Emissions in the second most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear', have increased by 25.4% since 1990.

Figure 3.18(b) shows the contribution that each aggregated sector group made to total EU emissions. The sector groups industrial processes and product use, road transport, energy use in industry and commercial, institutional and households are significant sources of Pb.

Figure 3.18 **Pb emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: In (a), the right-hand axis gives values for '2C1 — Iron and steel production'.

3.12 Cadmium emission trends and key categories

Between 1990 and 2020, Cd emissions fell by 67% in the EU. Between 2019 and 2020 they decreased by 5.3% (Table 3.14), mainly because of a slight decrease in the Netherlands, Spain, Poland and Italy (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to Cd emissions were Germany, Poland and Spain (countries ranked according to their shares of the EU total).

Table 3.14 Member State contributions to EU emissions of Cd

	Cd (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	1.8	1.1	1.0	1.1	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.9	-46 %	-2.1 %	1.1 %	1.8 %
Belgium	6.0	4.9	2.6	2.4	1.9	1.6	1.4	1.4	1.2	1.6	2.5	1.3	1.1	1.1	1.0	-83 %	-9.4 %	3.8 %	2.0 %
Bulgaria	7.4	5.6	3.0	5.8	2.0	2.1	1.2	1.3	1.2	1.2	1.2	1.2	1.4	1.4	1.4	-81 %	0.4 %	4.6 %	2.7 %
Croatia	1.2	0.9	0.9	1.2	1.0	0.9	0.9	0.9	0.8	0.9	0.8	0.8	0.8	0.8	0.8	-36 %	-0.6 %	0.7 %	1.5 %
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-61 %	-0.2 %	0.1 %	0.1 %
Czechia	5.3	2.3	1.8	1.8	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	-76 %	-3.7 %	3.3 %	2.4 %
Denmark	1.2	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	-45 %	-4.8 %	0.8 %	1.3 %
Estonia	4.5	2.2	0.8	0.5	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	-89 %	-2.5 %	2.8 %	1.0 %
Finland	6.7	2.1	1.4	1.5	1.3	1.2	1.2	1.1	0.9	0.9	0.9	1.0	0.9	0.8	0.7	-90 %	-11.3 %	4.2 %	1.3 %
France	20	18	14	5.9	3.3	3.1	2.9	3.0	3.1	2.8	3.3	3.0	2.4	2.6	2.6	-88 %	-2.3 %	12.8 %	4.9 %
Germany	29	19	18	12	13	12	12	12	12	12	12	12	12	11	11	-63 %	0.4 %	18.2 %	20.4 %
Greece	7.5	7.8	8.4	8.9	4.7	4.5	4.4	3.8	4.1	2.1	2.0	2.1	1.9	1.7	1.4	-81 %	-14.5 %	4.7 %	2.7 %
Hungary	1.9	1.7	1.8	1.4	1.5	1.7	1.7	1.7	1.5	1.6	1.6	1.6	1.5	1.4	1.4	-27 %	-0.8 %	1.2 %	2.6 %
Ireland	0.6	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	-58 %	-8.0 %	0.4 %	0.4 %
Italy	11	10	10	8.5	5.1	5.1	4.8	4.4	4.3	4.3	4.2	4.3	4.3	4.1	3.8	-65 %	-7.4 %	6.8 %	7.3 %
Latvia	0.9	0.8	0.9	1.1	1.0	0.6	0.8	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.5	-43 %	-8.0 %	0.6 %	1.0 %
Lithuania	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-13 %	-2.2 %	0.2 %	0.6 %
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-40 %	-3.2 %	0.1 %	0.1 %
Malta	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-31 %	-2.6 %	0.0 %	0.1 %
Netherlands	4.1	3.1	2.9	3.8	4.7	3.5	3.1	3.1	3.0	3.0	3.0	2.7	2.6	2.7	2.0	-50 %	-26.1 %	2.5 %	3.8 %
Poland	12	12	9.9	9.7	10	10	11	10	10	11	10	11	10	10	9.8	-19 %	-3.5 %	7.5 %	18.7 %
Portugal	2.4	2.5	2.7	2.4	2.0	2.1	2.0	1.9	1.9	2.0	1.9	1.9	1.9	1.8	1.8	-25 %	-2.2 %	1.5 %	3.4 %
Romania	5.0	3.9	3.4	3.7	3.6	3.5	3.5	3.2	3.2	3.1	3.1	3.2	3.2	3.1	2.8	-43 %	-8.2 %	3.1 %	5.4 %
Slovakia	1.6	1.3	1.4	1.4	1.2	1.2	1.3	1.2	1.1	1.0	1.1	1.1	1.0	1.0	1.0	-39 %	0.0 %	1.0 %	1.9 %
Slovenia	0.6	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	-14 %	-3.9 %	0.4 %	1.0 %
Spain	26	20	15	11	7.0	7.7	6.7	6.8	6.5	6.7	6.2	6.3	6.6	6.2	5.6	-79 %	-9.6 %	16.3 %	10.7 %
Sweden	2.3	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-79 %	-0.8 %	1.4 %	0.9 %
EU27 (a)	**160**	**123**	**103**	**87**	**69**	**67**	**64**	**62**	**61**	**60**	**60**	**59**	**58**	**56**	**53**	**-67 %**	**-5.3 %**	**100 %**	**100 %**
EU27 (b)	160	123	103	87	69	67	64	62	61	60	60	59	58	56	53				

Notes: (a) Sum of national totals, as reported by EU Member States.

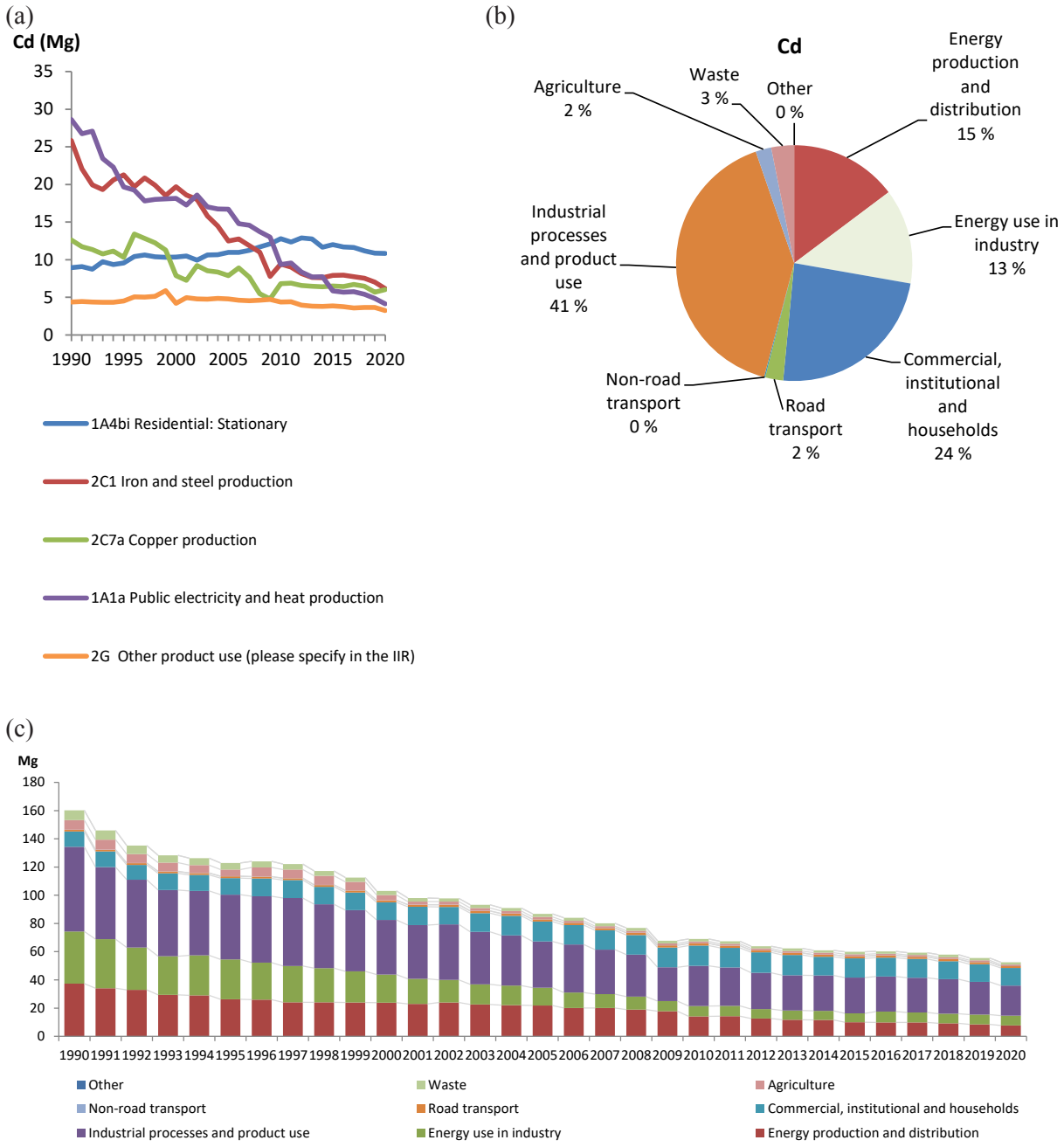
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

As with Pb, industrial sources of Cd emissions have fallen since the early 1990s in all EU Member States. This is largely because the abatement technologies for wastewater treatment and incinerators have improved, as have metal refining and smelting facilities (EEA, 2021b).

Categories '1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '2C7a — Copper production' were the principal key ones for Cd emissions, making up 44% of total Cd emissions (see Figure 3.19(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2020 were in the fourth most important, '1A1a — Public electricity and heat production' (-85.6%), the third most important, '2C7a — Copper Production' (-52.3%) and the second most important, '2C1 — Iron and steel production' (-76.2%). In the most important key category, '1A4bi — Residential: Stationary', the values of reported emissions have increased since 1990 (+21.1%).

Figure 3.19(b) shows the contribution made by each aggregated sector group to total EU emissions. The common leading emission sources of Cd are the industrial processes and product use sector and the commercial, institutional and households energy sector.

Figure 3.19 **Cd emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



3.13 Mercury emission trends and key categories

Between 1990 and 2020, Hg emissions dropped by 75% in the EU. Between 2019 and 2020, the decrease was 9.9 % (see Table 3.15), mainly because of lower emissions in Germany, Italy, France and Spain (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to Hg emissions were Poland, Germany and Italy (countries ranked according to their shares of the EU total).

Table 3.15 Member State contributions to EU emissions of Hg

	Hg (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	2.5	1.6	1.4	1.6	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	-59 %	1.4 %	1.7 %	2.7 %
Belgium	6.1	3.3	3.2	2.2	1.7	1.7	1.3	1.4	1.5	1.1	1.4	1.1	1.4	1.0	1.0	-84 %	-0.5 %	4.1 %	2.6 %
Bulgaria	3.0	2.6	2.5	2.4	1.4	2.1	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.8	0.7	-77 %	-15.5 %	2.0 %	1.8 %
Croatia	1.1	0.3	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	-67 %	2.2 %	0.8 %	1.0 %
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-70 %	5.2 %	0.1 %	0.1 %
Czechia	5.2	4.4	3.3	3.3	3.1	3.1	2.8	2.6	2.5	2.5	2.4	2.3	2.4	2.3	2.0	-62 %	-11.8 %	3.5 %	5.3 %
Denmark	3.2	2.3	1.0	0.7	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	-93 %	1.4 %	2.1 %	0.6 %
Estonia	1.2	0.6	0.5	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-83 %	1.4 %	0.8 %	0.5 %
Finland	1.1	0.8	0.6	0.9	0.9	0.8	0.7	0.8	0.7	0.6	0.6	0.6	0.7	0.6	0.5	-51 %	-8.4 %	0.7 %	1.4 %
France	26	21	12	7.4	4.8	4.8	4.4	4.3	4.6	4.0	3.5	3.3	3.0	3.0	2.4	-91 %	-20.1 %	17.3 %	6.3 %
Germany	36	20	18	14	11	10	10	9.8	9.6	9.4	8.6	8.5	8.3	7.1	6.3	-82 %	-11.1 %	24.0 %	16.7 %
Greece	2.3	2.3	2.6	2.7	2.5	2.4	2.4	2.2	1.6	1.4	1.2	1.3	1.4	1.2	0.8	-64 %	-33.1 %	1.5 %	2.2 %
Hungary	2.8	2.0	1.7	1.4	0.9	0.9	0.9	0.8	0.9	0.9	0.9	1.0	0.9	0.9	0.8	-71 %	-3.2 %	1.9 %	2.2 %
Ireland	0.7	0.6	0.4	0.5	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	-64 %	-22.1 %	0.5 %	0.7 %
Italy	15	14	15	13	8.5	8.6	9.3	7.8	8.5	7.2	6.4	7.1	6.9	6.4	5.8	-62 %	-9.4 %	10.3 %	15.4 %
Latvia	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-72 %	-7.0 %	0.2 %	0.2 %
Lithuania	0.6	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	-58 %	-5.3 %	0.4 %	0.7 %
Luxembourg	0.4	0.2	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-82 %	-23.1 %	0.3 %	0.2 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-48 %	-7.0 %	0.0 %	0.0 %
Netherlands	3.6	1.5	1.2	1.0	0.8	0.9	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.5	-86 %	-16.8 %	2.5 %	1.3 %
Poland	16	14	12	11	9.6	9.5	9.8	9.7	9.2	9.0	8.9	9.0	8.7	7.9	7.6	-53 %	-4.0 %	11.0 %	20.3 %
Portugal	2.2	2.4	2.3	1.8	1.6	1.4	1.4	1.3	1.3	1.4	1.3	1.4	1.3	1.3	1.2	-44 %	-4.4 %	1.5 %	3.2 %
Romania	4.2	2.7	2.6	3.2	2.2	2.6	1.9	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.3	-68 %	-13.6 %	2.8 %	3.5 %
Slovakia	2.3	1.7	1.9	1.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	-64 %	-5.6 %	1.5 %	2.2 %
Slovenia	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-47 %	-2.4 %	0.3 %	0.5 %
Spain	10	13	8.8	7.4	4.3	4.4	4.7	4.1	4.2	4.4	4.4	4.4	4.2	3.1	2.7	-74 %	-13.8 %	7.0 %	7.1 %
Sweden	1.6	1.0	0.7	0.7	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-76 %	-6.1 %	1.1 %	1.0 %
EU27 (a)	**148**	**114**	**93**	**77**	**58**	**58**	**56**	**52**	**52**	**49**	**47**	**47**	**46**	**42**	**38**	**-75 %**	**-9.9 %**	**100 %**	**100 %**
EU27 (b)	148	114	93	77	58	58	56	52	52	49	47	47	46	42	38				

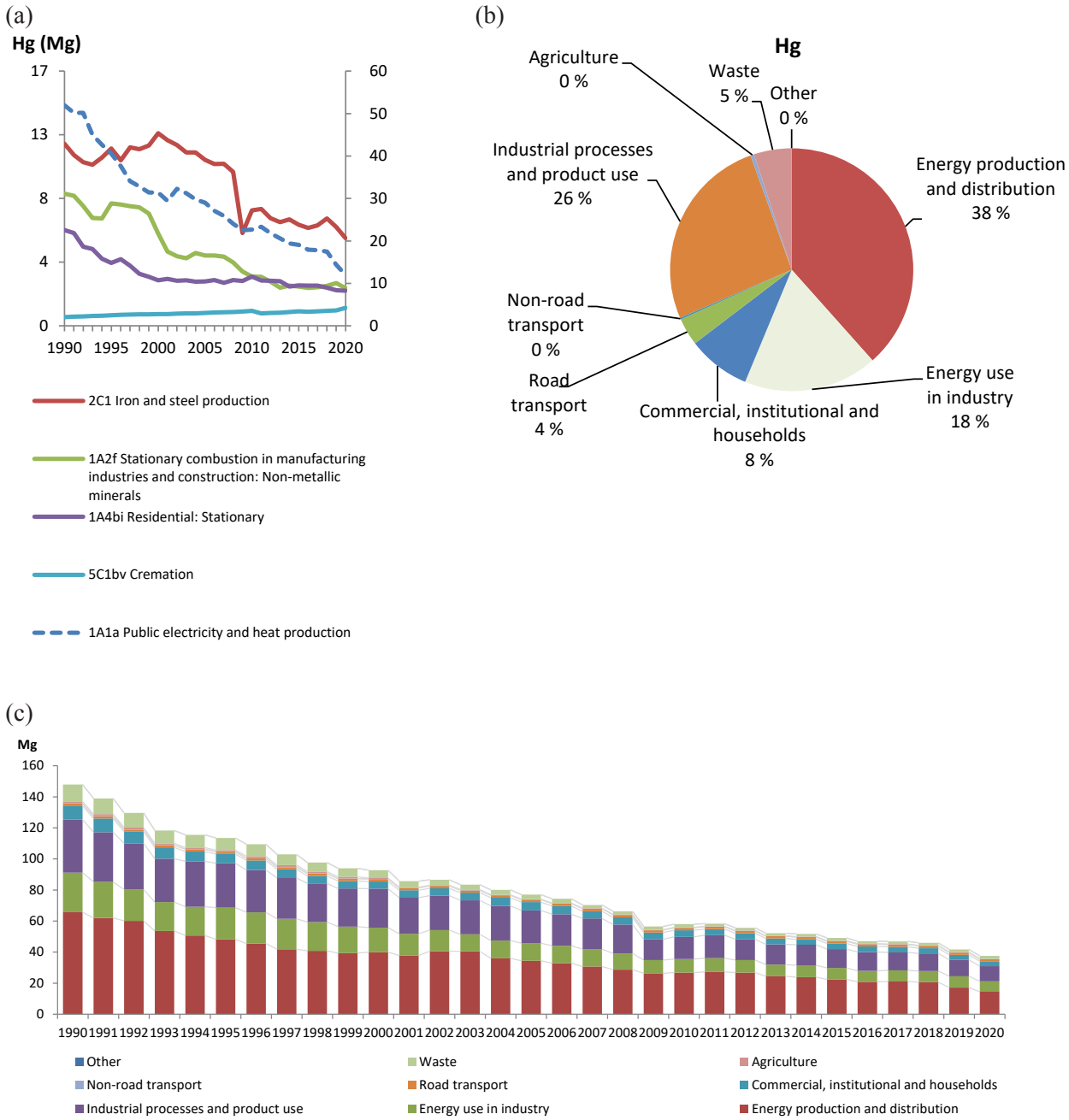
Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Categories '1A1a — Public electricity and heat production', '2C1 — Iron and steel production' and '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' were the main key ones for Hg emissions, making up 54% of the total (see Figure 3.20(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2020 was in the most important category, '1A1a — Public electricity and heat production' (-77%). The third most important key category, '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (-71.4%) and the fourth most important category, '1A4bi — Residential: Stationary' (-63.3%) also show high reductions. In the fifth most important key category, 'Cremation (5C1bv)', the values of reported emissions have increased since 1990 (+104%).

The strong decrease in 2009 in the sector '2C1 — Iron and steel production' mainly reflects lower emissions reported by Belgium (see Figure 3.20). Since 1990, the fall in Hg emissions in the industrial sector is mainly due to better emission controls on Hg cells and replacing them with diaphragm or membrane cells and switching from coal to gas and other energy sources in many countries' power- and heat-generating sectors in many countries (EEA, 2021c).

Figure 3.20(b) shows the contribution made by each aggregated sector group to total EU emissions. For Hg, the principal emission sources are the energy sectors and the industrial processes and product use sector.

Figure 3.20 **Hg emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: In (a), the right-hand axis shows values for '1A1a — Public electricity and heat production'.

3.14 Arsenic emission trends

Between 1990 and 2020, As emissions dropped by 91% in the EU. Between 2019 and 2020, emissions fell by 11.5% (Table 3.16), mainly because emissions decreased in Romania, Italy, Greece and France (countries ranked according to the size of their contributions to the absolute change). The EU Member States that contributed most (i.e. more than 10%) to As emissions in 2019 were Poland and Italy (countries ranked according to their shares of the EU total). As Austria and Luxembourg did not provide emission data for As, the EU total is an underestimate.

Table 3.16 Member State contributions to EU emissions of As

	As (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria																		0.0 %	0.0 %
Belgium	6.7	6.4	3.9	3.1	1.9	1.6	1.5	1.3	1.0	1.1	0.9	0.8	0.9	0.9	0.8	-87 %	-4.6 %	1.2 %	1.6 %
Bulgaria	20	14.5	10.8	11.4	6.4	8.2	1.9	2.2	2.5	1.7	2.4	2.3	2.8	3.1	2.7	-86 %	-14.4 %	3.5 %	5.2 %
Croatia	8.6	1.2	1.1	1.1	0.8	0.6	0.6	0.5	0.4	0.5	0.4	0.5	0.6	0.6	0.3	-97 %	-53.1 %	1.5 %	0.5 %
Cyprus	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-29 %	0.0 %	0.0 %	0.2 %
Czechia	70	17	3.9	2.1	1.7	1.6	1.5	1.7	1.4	1.6	1.5	1.6	1.5	1.4	1.2	-98 %	-9.1 %	12.2 %	2.4 %
Denmark	1.3	0.8	0.8	0.5	0.3	0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.2	-83 %	-2.9 %	0.2 %	0.4 %
Estonia	20	9.7	6.7	1.7	2.0	2.8	1.3	1.4	1.2	0.9	1.0	1.1	1.0	0.6	0.5	-97 %	-16.8 %	3.5 %	1.0 %
Finland	35	5.2	4.4	3.0	3.4	3.0	2.6	2.8	2.7	2.5	2.6	2.4	2.4	2.1	2.0	-94 %	-3.1 %	6.1 %	3.9 %
France	17	17	15	12	7.6	6.4	6.2	6.5	5.5	5.4	5.4	5.2	5.2	5.1	4.4	-75 %	-13.3 %	3.0 %	8.6 %
Germany	86	9.1	8.0	7.5	7.3	6.9	6.8	7.0	6.6	6.7	6.6	6.3	6.0	5.3	5.0	-94 %	-7.1 %	15.1 %	9.6 %
Greece	2.4	2.6	3.0	3.1	2.3	2.1	2.4	2.1	3.5	3.1	2.5	2.7	2.4	1.8	1.1	-54 %	-39.2 %	0.4 %	2.1 %
Hungary	4.1	3.3	3.2	2.6	2.3	2.3	2.2	1.9	2.0	2.2	2.0	2.2	2.1	1.9	1.8	-57 %	-9.6 %	0.7 %	3.4 %
Ireland	1.8	1.9	1.9	1.7	1.4	1.4	1.5	1.4	1.5	1.6	1.6	1.5	1.4	1.3	1.2	-36 %	-8.6 %	0.3 %	2.2 %
Italy	37	27	39	28	17	18	17	17	17	9.1	7.6	7.2	7.1	6.0	5.2	-86 %	-13.0 %	6.5 %	10.1 %
Latvia	17	8.5	15	17	16	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-99 %	-4.4 %	2.9 %	0.5 %
Lithuania	0.8	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-81 %	-9.2 %	0.1 %	0.3 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-94 %	-10.4 %	0.0 %	0.0 %
Netherlands	1.4	1.0	1.0	1.5	0.8	1.2	1.0	0.9	0.8	0.8	0.9	0.7	0.5	0.3	0.3	-80 %	-10.4 %	0.3 %	0.6 %
Poland	144	71	30	17	17	17	17	16	16	16	16	16	15	15	14.3	-90 %	-4.0 %	25.4 %	27.8 %
Portugal	3.3	3.7	3.9	3.9	2.1	2.0	2.2	2.1	2.0	2.2	2.0	2.1	2.0	1.6	1.4	-58 %	-14.3 %	0.6 %	2.7 %
Romania	73	37	5.8	6.4	5.0	5.7	5.2	4.3	4.3	4.5	4.1	4.1	4.1	4.0	3.1	-96 %	-22.2 %	12.8 %	6.0 %
Slovakia	3.6	2.2	2.2	1.8	1.7	1.6	1.7	1.7	1.6	1.7	1.7	1.7	1.6	1.4	1.2	-68 %	-15.7 %	0.6 %	2.3 %
Slovenia	0.9	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.6	0.7	0.7	0.7	0.7	0.7	0.6	-30 %	-3.2 %	0.2 %	1.3 %
Spain	10	9.4	9.8	9.3	5.3	6.0	6.0	5.1	5.1	5.4	4.8	5.3	5.1	3.6	3.0	-71 %	-18.0 %	1.8 %	5.8 %
Sweden	5.6	1.6	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.8	0.7	0.7	0.7	-88 %	-8.8 %	1.0 %	1.3 %
EU27 (a)	**569**	**252**	**172**	**136**	**104**	**90**	**81**	**78**	**77**	**69**	**66**	**66**	**64**	**58**	**51**	**-91 %**	**-11.5 %**	**100 %**	**100 %**
EU27 (b)	569	252	172	136	104	90	81	78	77	69	66	66	64	58	51				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.15 Chromium emission trends

Between 1990 and 2020Cr emissions dropped by 73% in the EU. Between 2019 and 2020, emissions dropped by 9.2% (see Table 3.17), mainly because of decreases in Greece, Germany, Italy and France (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to Cr emissions were Germany, Poland, Italy and France (countries ranked according to their shares of the EU total). As Austria and Luxembourg did not provide emission data for Cr, the EU total is an underestimate.

Table 3.17 Member State contributions to EU emissions of Cr

	Cr (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria																			
Belgium	36	32	21	18	14	12	11	6.4	6.2	6.1	6.5	5.0	4.9	4.9	4.6	-87 %	-6.3 %	3.6 %	1.7 %
Bulgaria	17	13	7.9	13.0	5.4	7.5	2.6	2.4	2.4	2.4	2.4	2.5	2.5	4.0	3.9	-78 %	-3.4 %	1.7 %	1.5 %
Croatia	5.3	3.7	3.2	3.7	2.6	2.5	2.4	2.2	2.0	2.2	2.0	2.1	2.0	1.9	1.9	-64 %	-0.3 %	0.5 %	0.7 %
Cyprus	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-12 %	-5.0 %	0.0 %	0.1 %
Czechia	26	17	13	12	11	11	11	10	10	10	10	9.9	10	9.6	8.7	-67 %	-9.8 %	2.6 %	3.3 %
Denmark	6.0	3.2	1.7	1.7	1.8	1.7	1.6	1.7	1.6	1.8	1.8	1.8	1.7	1.6	1.5	-75 %	-6.3 %	0.6 %	0.6 %
Estonia	17	8.9	6.7	3.3	4.2	4.7	3.4	3.8	3.4	2.5	2.8	3.0	2.7	1.6	1.3	-92 %	-19.4 %	1.7 %	0.5 %
Finland	48	36	29	20	26	17	19	18	23	17	18	17	15	14	14	-71 %	-2.8 %	4.8 %	5.2 %
France	399	197	112	55	38	33	33	33	30	31	30	30	30	30	27	-93 %	-10.5 %	39.8 %	10.2 %
Germany	166	94	83	76	74	74	75	74	75	76	77	76	75	71	66	-60 %	-7.6 %	16.5 %	24.7 %
Greece	6.0	6.5	6.9	7.3	7.4	8.7	9.3	7.7	15	15	11	10	11	10	4.4	-26 %	-56.0 %	0.6 %	1.7 %
Hungary	18	12	12	12	11	12	11	7.8	8.7	11	9.4	12	12	11	10	-43 %	-11.7 %	1.8 %	3.8 %
Ireland	4.5	4.6	4.9	3.4	2.6	2.4	2.4	2.5	2.5	2.6	2.7	2.6	2.6	2.4	2.3	-50 %	-7.4 %	0.5 %	0.9 %
Italy	86	69	44	50	40	41	40	36	35	35	35	35	35	34	30	-66 %	-11.8 %	8.6 %	11.2 %
Latvia	2.5	1.9	2.2	2.5	2.4	1.2	1.4	1.2	1.2	1.1	1.1	1.2	1.3	1.3	1.2	-52 %	-6.0 %	0.3 %	0.5 %
Lithuania	3.2	1.5	1.3	1.4	1.3	1.3	1.4	1.3	1.4	1.5	1.5	1.6	1.6	1.6	1.5	-51 %	-1.8 %	0.3 %	0.6 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-48 %	-15.3 %	0.0 %	0.0 %
Netherlands	12	8.6	5.1	4.4	3.9	3.7	3.8	3.7	3.6	3.5	3.8	3.6	3.5	3.3	3.2	-73 %	-3.4 %	1.2 %	1.2 %
Poland	54	51	39	38	40	39	39	38	37	38	37	38	37	36	36	-33 %	0.1 %	5.4 %	13.7 %
Portugal	12	13	13	12	8.8	8.0	7.8	7.7	7.5	7.7	7.1	7.4	7.0	6.9	6.6	-45 %	-4.6 %	1.2 %	2.5 %
Romania	25	19	15	19	13	12	12	11	11	12	12	12	12	12	11	-55 %	-8.4 %	2.5 %	4.2 %
Slovakia	6.4	4.2	3.5	4.0	4.7	4.7	4.9	4.3	4.1	4.4	4.8	4.8	4.6	4.7	4.4	-31 %	-5.4 %	0.6 %	1.7 %
Slovenia	1.4	1.4	1.4	1.6	1.5	1.5	1.5	1.5	1.3	1.3	1.4	1.4	1.3	1.3	1.2	-17 %	-5.9 %	0.1 %	0.4 %
Spain	27	28	32	32	24	24	25	22	23	24	24	24	24	22	20	-26 %	-10.9 %	2.7 %	7.4 %
Sweden	23	12	6.9	10	5.1	6.4	5.0	4.9	4.5	5.4	5.6	6.7	6.0	6.0	5.2	-78 %	-12.6 %	2.3 %	2.0 %
EU27 (a)	**1 001**	**638**	**463**	**401**	**343**	**331**	**323**	**303**	**311**	**312**	**307**	**308**	**304**	**293**	**266**	**-73 %**	**-9.2 %**	**100 %**	**100 %**
EU27 (b)	1 001	638	463	401	343	331	323	303	311	312	307	308	304	293	266				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.16 Copper emission trends

Between 1990 and 2020, Cu emissions in the EU decreased by 16 %. Between 2019 and 2020, they fell by 11% (see Table 3.18), mainly because of decreases in Germany, France, Italy and Spain (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to Cu emissions were Germany, France and Poland (together they account for 60.6% of EU-27 total) (countries ranked according to their shares of the EU total). As Austria and Luxembourg did not provide emission data for Cu, the EU total is an underestimate.

Table 3.18 Member State contributions to EU emissions of Cu

	Cu (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria																			
Belgium	52	53	50	49	47	45	44	41	41	42	43	41	40	41	36	-31 %	-11.5 %	2.8 %	2.3 %
Bulgaria	35	23	23	29	17	16	17	16	17	18	19	19	20	19	17	-50 %	-6.8 %	1.9 %	1.1 %
Croatia	7.4	6.2	7.5	9.5	8.3	8.1	7.3	8.3	7.8	8.2	8.8	9.6	9.2	9.8	9.7	32 %	-0.7 %	0.4 %	0.6 %
Cyprus	1.7	2.1	2.5	2.8	2.9	2.8	2.6	2.2	2.1	2.2	2.3	2.4	2.4	2.4	2.1	26 %	-10.5 %	0.1 %	0.1 %
Czechia	32	26	22	26	23	23	23	23	25	25	24	25	25	25	23	-27 %	-8.8 %	1.7 %	1.5 %
Denmark	33	37	40	42	43	43	42	42	42	43	43	43	45	43	40	23 %	-7.4 %	1.8 %	2.6 %
Estonia	10	5.3	4.3	5.0	5.7	5.9	5.7	6.0	6.0	5.4	5.8	6.1	6.1	5.2	4.7	-55 %	-10.6 %	0.6 %	0.3 %
Finland	157	116	65	58	42	42	41	42	43	41	42	41	40	40	38	-76 %	-6.3 %	8.4 %	2.4 %
France	254	254	263	275	267	267	261	262	260	270	265	267	266	269	239	-6 %	-11.2 %	13.6 %	15.2 %
Germany	620	522	543	540	548	553	555	552	566	579	584	586	589	591	525	-15 %	-11.3 %	33.3 %	33.5 %
Greece	22	26	29	33	35	31	26	26	30	29	29	29	30	30	24	5 %	-21.0 %	1.2 %	1.5 %
Hungary	16	11	13	16	15	15	14	13	14	16	16	17	18	18	16	3 %	-10.7 %	0.8 %	1.0 %
Ireland	10	11	18	21	19	18	18	18	19	19	20	20	20	20	17	67 %	-14.2 %	0.5 %	1.1 %
Italy	193	216	221	230	203	204	195	184	199	189	170	162	165	164	136	-30 %	-17.2 %	10.4 %	8.7 %
Latvia	4.6	2.7	2.9	3.9	4.0	3.5	3.5	3.6	3.8	3.9	4.0	4.2	4.4	4.4	4.2	-8 %	-3.6 %	0.2 %	0.3 %
Lithuania	7.9	3.8	3.4	4.5	4.8	4.8	4.9	4.7	5.1	5.3	5.5	5.8	6.2	6.4	5.9	-26 %	-8.3 %	0.4 %	0.4 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.5	0.8	0.9	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.9	73 %	-15.5 %	0.0 %	0.1 %
Netherlands	36	37	38	39	41	41	41	41	41	40	41	43	45	45	41	13 %	-8.3 %	2.0 %	2.6 %
Poland	172	177	144	157	185	181	179	170	169	172	180	196	198	192	187	9 %	-2.7 %	9.2 %	11.9 %
Portugal	26	32	42	45	36	32	30	29	30	29	29	30	29	30	25	-3 %	-14.0 %	1.4 %	1.6 %
Romania	9.8	8.6	6.9	20	20	20	22	21	21	21	23	24	25	26	25	158 %	-1.9 %	0.5 %	1.6 %
Slovakia	13	9.1	7.0	8.9	9.7	9.8	10	9.3	9.8	11	12	11	9.9	9.9	8.7	-31 %	-12.2 %	0.7 %	0.6 %
Slovenia	3.7	4.4	4.3	5.2	5.4	5.5	5.5	5.1	5.0	5.0	5.2	5.3	5.6	5.2	4.3	17 %	-17.2 %	0.2 %	0.3 %
Spain	78	90	115	133	130	122	116	111	114	119	120	123	125	122	102	30 %	-16.8 %	4.2 %	6.5 %
Sweden	65	51	45	37	38	38	37	37	38	38	39	40	41	40	37	-43 %	-7.1 %	3.5 %	2.3 %
EU27 (a)	**1 859**	**1 727**	**1 713**	**1 790**	**1 749**	**1 734**	**1 701**	**1 668**	**1 707**	**1 731**	**1 730**	**1 752**	**1 764**	**1 758**	**1 567**	**-16 %**	**-11 %**	**100 %**	**100 %**
EU27 (b)	1 859	1 727	1 713	1 790	1 749	1 734	1 701	1 668	1 707	1 731	1 730	1 752	1 764	1 758	1 567				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.17 Nickel emission trends

Between 1990 and 2020, Ni emissions dropped by 79% in the EU. Between 2019 and 2020, they decreased by 8.1%, mainly because of decreases in Spain, Germany, Greece and France (countries ranked according to the size of their contributions to the absolute change) (see Table 3.19). In 2020, the EU Member States contributing most (i.e. more than 10%) to Ni emissions were Germany and Poland (countries ranked according to share of the EU total). As Austria and Luxembourg did not provide emission data for Ni, the EU total is an underestimate.

Table 3.19 Member State contributions to EU emissions of Ni

	Ni (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria																			
Belgium	77	71	36	29	10	9.3	6.6	5.2	4.9	4.9	4.9	3.9	3.6	3.7	3.3	-96 %	-12.0 %	4.0 %	0.8 %
Bulgaria	59	36	19	21	8.2	9.6	5.7	5.1	4.8	4.9	4.1	4.4	4.3	4.3	3.9	-93 %	-9.8 %	3.1 %	1.0 %
Croatia	17	14	13	14	7.7	6.7	6.0	4.7	3.8	4.5	4.2	4.3	3.5	2.8	2.3	-87 %	-18.1 %	0.9 %	0.6 %
Cyprus	5.9	7.3	10	12	7.2	9.0	9.4	5.2	5.2	5.3	5.7	5.6	5.7	5.1	5.0	-15 %	-1.0 %	0.3 %	1.3 %
Czechia	55	28	14	12	8.0	7.1	6.1	5.5	5.5	5.3	5.0	5.4	5.1	4.8	4.5	-92 %	-6.7 %	2.9 %	1.1 %
Denmark	19	13	7.6	7.2	4.6	4.1	3.8	3.8	3.2	2.9	2.9	3.0	2.7	2.6	2.7	-86 %	3.3 %	1.0 %	0.7 %
Estonia	26	10	6.1	3.3	3.3	3.6	2.8	2.9	2.6	2.5	2.7	2.7	2.4	1.8	1.7	-94 %	-8.0 %	1.4 %	0.4 %
Finland	78	47	35	26	23	20	19	17	17	16	16	15	14	12	9.7	-88 %	-16.1 %	4.1 %	2.5 %
France	286	214	176	145	86	67	59	52	45	42	38	31	24	25	21	-93 %	-14.5 %	15.0 %	5.4 %
Germany	333	204	161	173	151	139	136	132	125	135	145	145	147	138	132	-60 %	-4.2 %	17.5 %	33.5 %
Greece	42	47	50	55	60	56	59	50	34	40	34	32	30	27	22	-47 %	-17.5 %	2.2 %	5.6 %
Hungary	12	20	14	3.7	2.8	2.5	2.5	2.3	2.4	2.5	2.4	2.6	2.5	2.3	2.1	-82 %	-9.0 %	0.6 %	0.5 %
Ireland	21.8	27	32	21	9.9	7.2	6.6	7.1	6.8	6.5	6.5	6.1	6.2	6.5	6.7	-69 %	2.6 %	1.1 %	1.7 %
Italy	114	110	107	112	41	39	36	31	30	30	30	30	29	28	26	-77 %	-7.1 %	6.0 %	6.6 %
Latvia	15	8.5	6.8	6.4	5.8	0.5	1.0	0.5	0.4	0.4	0.4	0.5	0.6	0.5	0.5	-97 %	-8.1 %	0.8 %	0.1 %
Lithuania	31	13	6.3	5.4	4.3	3.4	4.3	3.2	2.6	2.7	2.4	2.3	2.2	2.0	2.1	-93 %	6.1 %	1.6 %	0.5 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	3.4	4.9	4.7	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-97 %	1.0 %	0.2 %	0.0 %
Netherlands	76	87	20	11	2.7	2.8	2.4	2.2	2.2	2.2	2.4	2.2	1.9	1.6	1.8	-98 %	9.1 %	4.0 %	0.5 %
Poland	200	166	120	105	102	95	89	79	77	83	82	81	77	73	72	-64 %	-1.5 %	10.5 %	18.4 %
Portugal	111	116	106	105	46	38	33	27	22	23	22	22	21	21	20	-82 %	-6.0 %	5.9 %	5.0 %
Romania	113	64	35	25	14	16	14	13	11	11	9.2	11	10.7	11	9.9	-91 %	-10.0 %	6.0 %	2.5 %
Slovakia	7.3	3.8	2.5	1.9	2.2	2.1	2.0	2.1	2.0	2.1	2.1	2.0	2.0	1.8	1.6	-78 %	-11.0 %	0.4 %	0.4 %
Slovenia	2.9	2.0	2.4	2.4	2.1	2.0	1.8	1.8	1.4	1.5	1.6	1.5	1.5	1.4	1.4	-52 %	-1.6 %	0.2 %	0.4 %
Spain	165	192	198	177	94	82	67	55	47	44	46	51	50	46	35	-79 %	-23.3 %	8.7 %	9.0 %
Sweden	29	30	18	16	14	11	10	9.2	7.5	6.7	7.3	6.9	7.0	6.2	5.4	-82 %	-12.2 %	1.5 %	1.4 %
EU27 (a)	**1 899**	**1 536**	**1 199**	**1 089**	**710**	**632**	**582**	**516**	**464**	**480**	**477**	**471**	**455**	**428**	**393**	**-79 %**	**-8.1 %**	**100 %**	**100 %**
EU27 (b)	1 899	1 536	1 199	1 089	710	632	582	516	464	480	477	471	455	428	393				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
(a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.18 Selenium emission trends

Between 1990 and 2020, Se emissions dropped by 59% in the EU. Between 2019 and 2020, they decreased by 16% (see Table 3.20), mainly because of decreases in Czechia, Greece, Romania and Bulgaria (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to Se emissions were Czechia, Bulgaria and France (countries ranked according to their shares of the EU total). As Austria, Luxembourg and Poland did not provide emission data for Se, the EU total is an underestimate.

Finland reported emission data at the sectoral level but used the notation key 'NE' (not estimated) for the national total of Se emissions, because the inventory is not yet fully complete (personal communication from Finland in 2021). As envisaged by the gap filling procedure, the national total for Finland was calculated using the sum of sectors.

In 2005, Belgium reported high Se emissions in the category '2A3 — Glass production'. This was caused by one glass plant in Wallonia, which gives annual emissions based on measurements; the concentration of Se was very high in 2005 (personal communication from Belgium in 2014). Likewise, Belgium's high emissions in 2010 were mainly attributable to the operations of a particular company in Wallonia's glass industry (personal communication from Belgium in 2012).

Table 3.20 Member State contributions to EU emissions of Se

	Se (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria																			
Belgium	5.2	6.4	6.5	27	12	4.0	3.6	3.7	4.4	4.2	3.7	3.7	2.8	2.5	2.2	-58 %	-12.7 %	2.8 %	2.9 %
Bulgaria	35.4	33.5	29.9	29.7	17.8	25.4	0.9	1.0	1.0	0.8	0.8	0.9	0.9	9.4	8.2	-77 %	-12.6 %	19.3 %	10.9 %
Croatia	0.5	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.3	-28 %	-9.8 %	0.2 %	0.4 %
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-39 %	-1.4 %	0.0 %	0.1 %
Czechia	33	29	28	30	26	26	24	23	22	22	22	22	22	21	17.2	-47 %	-16.4 %	17.8 %	22.9 %
Denmark	4.2	3.9	2.3	1.4	1.3	1.0	0.8	1.0	0.9	0.7	0.7	0.6	0.5	0.4	0.4	-91 %	-10.4 %	2.3 %	0.5 %
Estonia	9.2	4.9	3.6	1.4	1.8	2.1	1.4	1.5	1.4	1.0	1.2	1.3	1.2	0.7	0.6	-94 %	-24.2 %	5.0 %	0.7 %
Finland	1.8	0.4	0.5	0.5	0.6	0.6	0.7	0.4	0.4	0.5	0.4	0.9	0.5	0.4	0.4	-81 %	-12.2 %	1.0 %	0.5 %
France	13	13	13	12	10	9.7	9.9	9.6	9.5	9.6	9.1	9.3	9.3	9.2	8.0	-38 %	-12.2 %	7.1 %	10.7 %
Germany	5.7	11	8.5	4.9	4.3	4.1	3.8	3.6	3.3	3.2	3.2	3.2	2.9	2.9	2.7	-54 %	-8.0 %	3.1 %	3.5 %
Greece	14	14	16	17	15	15	16	14	13	11	8.9	9.9	9.5	7.1	3.8	-72 %	-46.4 %	7.4 %	5.1 %
Hungary	6.5	5.8	5.8	4.1	3.5	3.7	3.6	3.5	3.4	3.3	3.2	3.0	2.8	2.5	2.3	-64 %	-6.6 %	3.5 %	3.1 %
Ireland	9.3	7.0	5.6	5.2	4.4	4.2	4.6	4.5	4.3	4.6	4.5	3.9	3.7	3.1	2.8	-70 %	-10.0 %	5.1 %	3.7 %
Italy	7.6	7.7	8.3	8.7	7.9	8.0	8.1	7.3	7.2	8.2	7.0	7.0	6.9	6.3	5.8	-24 %	-9.0 %	4.1 %	7.7 %
Latvia	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-77 %	-6.6 %	0.2 %	0.1 %
Lithuania	0.4	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-65 %	-5.5 %	0.2 %	0.2 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-96 %	-10.0 %	0.1 %	0.0 %
Netherlands	0.4	0.4	0.5	2.6	1.6	0.8	0.8	0.5	0.8	1.0	0.7	0.2	0.2	0.2	0.2	-49 %	14.5 %	0.2 %	0.3 %
Poland																			
Portugal	1.9	2.5	2.9	3.2	3.4	3.3	3.4	3.4	3.5	3.4	3.3	3.4	3.7	3.4	3.2	65 %	-6.2 %	1.0 %	4.2 %
Romania	20	16	12	12	12	14	13	10	10	10	9.2	9.3	9.1	8.5	6.0	-70 %	-29.2 %	10.7 %	8.0 %
Slovakia	5.3	2.6	2.7	2.7	3.2	3.1	3.1	3.1	2.9	3.0	3.1	3.2	3.0	2.5	2.2	-59 %	-14.5 %	2.9 %	2.9 %
Slovenia	2.9	2.5	2.4	2.6	2.5	2.6	2.4	2.4	1.8	1.9	2.0	2.0	2.0	1.9	1.8	-38 %	-3.1 %	1.6 %	2.4 %
Spain	6.5	6.8	8.1	8.1	6.0	6.2	6.3	6.1	6.0	6.4	6.3	6.4	6.5	6.3	5.8	-10 %	-6.7 %	3.5 %	7.8 %
Sweden	1.0	1.2	1.0	1.1	1.2	1.2	1.2	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	5 %	-3.5 %	0.6 %	1.4 %
EU27 (a)	**183**	**169**	**159**	**176**	**135**	**136**	**108**	**100**	**98**	**97**	**92**	**92**	**90**	**90**	**75**	**-59 %**	**-16 %**	**100 %**	**100 %**
EU27 (b)	183	169	159	176	135	136	108	100	98	97	92	92	90	90	75				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
(a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.19 Zinc emission trends

Between 1990 and 2020, Zn emissions dropped by 55% in the EU. However, between 2019 and 2020, they decreased by 9.9%, mainly because of decreases in the Netherlands, Italy, France and Germany (countries ranked according to the size of their contributions to the absolute change) (see Table 3.21). In 2020, the EU Member States contributing most (i.e. more than 10%) to Zn emissions were Italy, Poland, France and Spain (countries ranked according to their shares of the EU total). As Austria and Luxembourg did not provide emission data for Zn, the EU total is an underestimate.

Table 3.21 Member State contributions to EU emissions of Zn

	Zn (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria																			
Belgium	230	180	177	126	104	96	82	75	74	76	66	62	63	68	55	-76 %	-19.2 %	3.4 %	1.8 %
Bulgaria	48	36	38	41	35	42	32	30	30	30	32	32	32	33	34	-29 %	2.8 %	0.7 %	1.1 %
Croatia	38	31	29	36	35	33	33	33	30	33	32	32	31	31	31	-20 %	0.3 %	0.6 %	1.0 %
Cyprus	3.3	3.9	5.0	5.8	4.1	4.6	4.4	2.8	2.8	2.9	3.1	3.1	3.1	2.9	2.8	-15 %	-3.9 %	0.0 %	0.1 %
Czechia	105	79	64	60	56	55	52	47	47	45	42	42	42	42	39	-63 %	-6.8 %	1.6 %	1.3 %
Denmark	72	65	54	58	63	60	57	59	57	61	63	63	63	61	57	-20 %	-5.4 %	1.1 %	1.9 %
Estonia	104	60	43	25	31	33	26	28	27	24	27	28	29	24	24	-77 %	-0.7 %	1.5 %	0.8 %
Finland	683	403	128	119	129	124	127	124	132	119	127	120	118	130	117	-83 %	-10.0 %	10.1 %	3.8 %
France	2 086	1 289	891	475	413	398	408	390	372	384	385	380	383	377	340	-84 %	-9.8 %	30.9 %	11.1 %
Germany	474	266	277	259	289	277	291	300	282	292	292	296	295	297	267	-44 %	-10.0 %	7.0 %	8.7 %
Greece	67	71	74	74	72	74	73	67	71	69	63	64	64	61	57	-15 %	-6.9 %	1.0 %	1.9 %
Hungary	77	59	62	56	62	71	75	67	60	63	63	61	55	54	51	-33 %	-3.9 %	1.1 %	1.7 %
Ireland	55	51	58	29	22	21	21	22	23	24	25	23	22	20	19	-65 %	-5.7 %	0.8 %	0.6 %
Italy	913	896	853	920	823	886	853	793	784	765	712	764	784	751	668	-27 %	-11.0 %	13.5 %	21.8 %
Latvia	30	28	26	30	28	25	29	26	25	23	23	25	26	26	24	-18 %	-6.2 %	0.4 %	0.8 %
Lithuania	24	17	18	23	24	24	25	24	25	28	28	29	29	28	28	19 %	-0.4 %	0.4 %	0.9 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	1.6	2.1	2.0	2.4	2.2	2.3	2.5	2.1	2.1	1.4	1.1	0.7	0.6	0.6	0.5	-67 %	-13.1 %	0.0 %	0.0 %
Netherlands	226	148	97	90	105	100	100	91	119	105	103	96	358	283	181	-20 %	-36.1 %	3.3 %	5.9 %
Poland	781	787	555	499	510	505	511	502	490	484	488	503	493	468	455	-42 %	-2.9 %	11.6 %	14.8 %
Portugal	58	59	62	61	55	55	54	53	54	54	54	55	55	54	51	-11 %	-3.9 %	0.9 %	1.7 %
Romania	125	98	103	125	121	111	114	108	108	107	108	109	109	110	106	-15 %	-2.9 %	1.8 %	3.5 %
Slovakia	42	33	35	42	45	45	47	48	45	42	47	48	47	42	40	-3 %	-5.3 %	0.6 %	1.3 %
Slovenia	18	17	16	21	20	20	19	20	18	19	19	19	18	17	16	-14 %	-5.6 %	0.3 %	0.5 %
Spain	313	267	352	347	384	396	330	412	333	379	364	359	422	350	329	5 %	-6.0 %	4.6 %	10.7 %
Sweden	183	132	89	93	97	88	88	80	83	82	79	77	76	74	71	-61 %	-4.8 %	2.7 %	2.3 %
EU27 (a)	**6 757**	**5 078**	**4 108**	**3 620**	**3 527**	**3 547**	**3 457**	**3 404**	**3 293**	**3 313**	**3 247**	**3 293**	**3 619**	**3 403**	**3 065**	**-55 %**	**-9.9 %**	**100 %**	**100 %**
EU27 (b)	6 757	5 078	4 108	3 620	3 527	3 547	3 457	3 404	3 293	3 313	3 247	3 293	3 619	3 403	3 065				

Notes: Dark blue-shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by EU Member States.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.20 Dioxin and furan emission trends and key categories

Between 1990 and 2020, PCDD/F emissions dropped by 77% in the EU. Between 2019 and 2020, the decrease was 5% (see Table 3.22), mainly because Italy, Spain , Slovakia and France (countries ranked according to the size of their contributions to the absolute change) reported lower emissions. In 2020, the Member States contributing most (i.e. more than 10%) to PCDD/F emissions were Poland, Italy, Spain and Romania, with a joint contribution of 56% of EU-27 emissions.

In France, the decrease in dioxin emissions between 1990 and 2002 resulted from regulations limiting emissions, especially in the fields of waste incineration, industrial energy processes (steel and metallurgy) and combustion in manufacturing (see France's IIR, listed in Appendix 5). The drop in dioxin emissions between 1995 and 2000 was due to improvements in sinter plants (personal communication from France in 2013).

Slovakia reported in its IIR that the emissions of PCDD/F dropped in 1999 because of the technological improvement in facilities that combust industrial waste as a fuel to produce energy. The moderate increase in 2005 was because many facilities did not comply with the stricter emission limits that came into force in 2006 and therefore used the last year of their operation to burn more waste. This was followed by a decrease in 2006. Since then, emissions have shown a slightly increasing trend as a result of waste management politics in Slovakia, which prefers the combustion of waste to its disposal to landfill. The main contributing sectors are energy production (includes incineration of municipal waste with energy recovery) and waste incineration without energy recovery, which includes incineration of industrial and clinical waste (see Slovakia's IIR, listed in Appendix 5).

In Spain, the fall in PCDD/F emissions after 1995 was linked to the adaptation of municipal solid waste (MSW) incineration facilities with energy recovery (included in the category '1A1a — Public electricity and heat production') to comply with the maximum levels imposed in legislation; it was also related to the implementation of particle and acid gas abatement techniques as of 1996 (personal communication from Spain in 2017).

The '5C1biii — Clinical waste incineration' category contributed most to the trend in PCDD/F emissions reported by Portugal. The dramatic drop in emissions between 2000 and 2005 was caused by the closing of 25 incinerators on its mainland; since 2004, just one clinical waste incinerator has remained in operation. Other clinical waste receives alternative treatment or is sent abroad (see Portugal's IIR, listed in Appendix 5).

Table 3.22 Member State contributions to EU emissions of PCDD/Fs

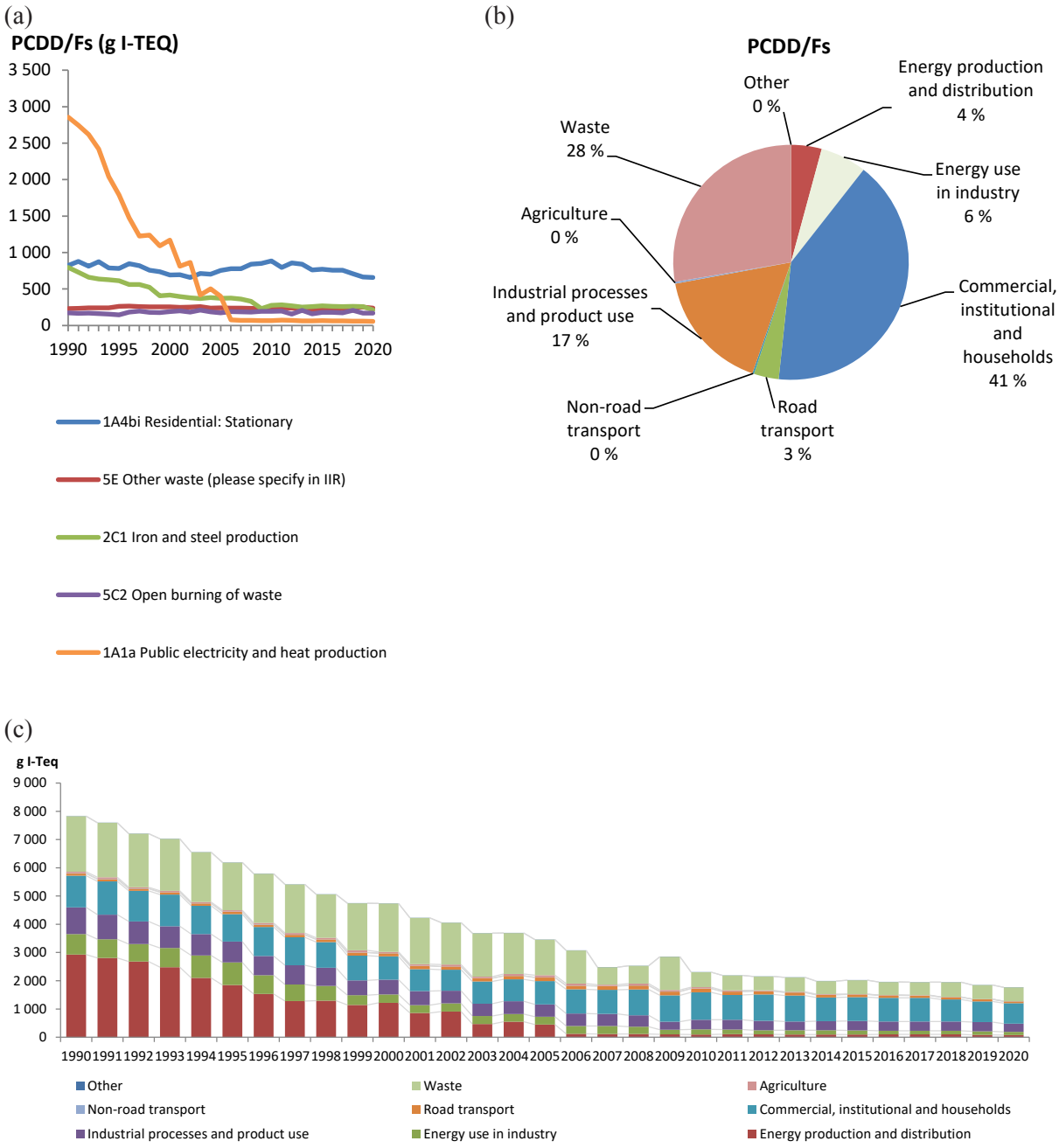
	PCDD/Fs (g I-TEQ)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	125	58	51	36	41	38	39	39	36	37	36	37	33	34	33	-73 %	-1.0 %	1.6 %	1.9 %
Belgium	546	366	92	126	51	44	47	38	30	31	30	32	27	29	28	-95 %	-1.9 %	7.0 %	1.6 %
Bulgaria	115	122	168	144	68	81	58	57	49	48	60	62	57	48	49	-57 %	3.4 %	1.5 %	2.8 %
Croatia	89	79	78	117	82	68	56	55	45	40	33	29	27	26	26	-71 %	-2.0 %	1.1 %	1.4 %
Cyprus	17	20	21	0.7	0.6	0.6	0.6	0.7	0.5	0.5	0.6	0.6	0.6	0.5	0.5	-97 %	-7.6 %	0.2 %	0.0 %
Czechia	106	76	63	64	49	41	42	42	44	39	30	29	29	27	26	-76 %	-5.1 %	1.4 %	1.5 %
Denmark	70	53	35	33	38	35	34	34	33	36	39	37	35	32	30	-57 %	-4.2 %	0.9 %	1.7 %
Estonia	10.5	7.0	7.3	6.6	6.0	6.9	5.3	4.3	4.4	4.1	4.2	4.3	4.4	4.2	4.2	-60 %	-0.3 %	0.1 %	0.2 %
Finland	18	18	18	13	16	14	14	15	16	14	15	12	13	9.5	9.3	-47 %	-2.1 %	0.2 %	0.5 %
France	1 802	1 743	580	265	175	164	154	159	151	151	140	137	134	131	122	-93 %	-6.3 %	23.0 %	6.9 %
Germany	814	341	265	155	141	136	135	135	126	129	126	125	121	120	112	-86 %	-6.8 %	10.4 %	6.3 %
Greece	42	42	42	43	28	32	32	27	27	27	25	26	26	24	23	-45 %	-5.3 %	0.5 %	1.3 %
Hungary	113	79	82	64	78	85	87	79	70	78	77	66	59	65	61	-47 %	-6.5 %	1.4 %	3.4 %
Ireland	44	34	27	25	25	22	22	21	20	22	20	19	21	18	18	-59 %	-1.1 %	0.6 %	1.0 %
Italy	529	511	434	361	342	305	322	317	304	310	312	330	311	307	280	-47 %	-8.7 %	6.8 %	15.9 %
Latvia	30	34	31	35	23	24	27	22	21	18	17	20	19	19	17	-44 %	-10.4 %	0.4 %	1.0 %
Lithuania	23	16	17	20	20	19	19	19	18	17	18	18	19	18	17	-28 %	-5.1 %	0.3 %	0.9 %
Luxembourg	44	35	6.9	3.0	3.1	3.1	2.4	2.2	2.3	2.0	3.4	2.8	2.3	1.8	1.9	-96 %	8.3 %	0.6 %	0.1 %
Malta	0.2	0.2	0.2	0.3	8.0	1.1	3	3	3	3	2	2	2	2	0.2	-6 %	-91 %	0.0 %	0.0 %
Netherlands	745	70	37	35	39	40	33	33	31	31	31	31	31	30	30	-96 %	-1.6 %	9.5 %	1.7 %
Poland	371	456	312	380	429	391	407	377	338	335	341	335	334	292	284	-24 %	-2.7 %	4.7 %	16.1 %
Portugal	551	548	352	66	49	51	53	48	48	48	49	51	55	57	71	-87 %	23.4 %	7.0 %	4.0 %
Romania	266	230	762	756	188	180	184	167	171	168	171	179	182	188	188	-29 %	0.0 %	3.4 %	10.6 %
Slovakia	772	688	908	375	58	64	73	80	98	102	69	69	77	78	69	-91 %	-12.3 %	9.9 %	3.9 %
Slovenia	20	18	18	20	19	19	18	18	16	17	17	16	15	14	13	-35 %	-5.8 %	0.3 %	0.7 %
Spain	499	502	288	271	292	296	256	302	262	290	265	256	291	253	230	-54 %	-9.1 %	6.4 %	13.0 %
Sweden	70	49	41	43	37	31	28	26	24	24	25	25	25	24	23	-67 %	-4.3 %	0.9 %	1.3 %
EU27 (a)	**7 832**	**6 192**	**4 737**	**3 458**	**2 304**	**2 192**	**2 152**	**2 123**	**1 988**	**2 021**	**1 955**	**1 952**	**1 951**	**1 851**	**1 765**	**-77 %**	**-5 %**	**100 %**	**100 %**
EU27 (b)	7 832	6 192	4 737	3 458	2 304	2 192	2 152	2 123	1 988	2 021	1 955	1 952	1 951	1 851	1 765				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.
I-Teq, international toxic equivalent.

Categories '1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '5E — Other waste' were the primary key ones for PCDD/F emissions, together making up 63% of total PCDD/F emissions (see Figure 3.21(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2020 were in the fifth most important 'Public electricity and heat production (-98.1%), the third most important, '2C1 — Iron and steel production' (-72.9%), and the most important, '1A4bi — Residential: Stationary' (-20.4%). Emissions from category '5E – Other waste' increased (+3%).

Figure 3.21(b) shows the contribution made by each aggregated sector group to total EU emissions. The sector groups waste, commercial, institutional and households and Industrial processes and product use are significant sources of PCDD/Fs.

Figure 3.21 **PCDD/F emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: I-Teq, international toxic equivalent.

3.21 Total polycyclic aromatic hydrocarbon emission trends and key categories

Between 1990 and 2020, PAH emissions dropped by 53% in the EU. However, between 2019 and 2020, they dropped by 2.3% (see Table 3.23), mainly because Italy, Finland, Germany and Spain (countries ranked according to their shares of the EU total) reported lower emissions. In 2020, the EU Member State contributing most (i.e. more than 10%) to the EU-27 total PAH emissions was Poland with a share of 32 %.

Spain reported that estimated total PAH emissions are mainly driven by the category '3F — Field burning of agricultural residues'. This activity and the related emissions have notably decreased because of this practice being gradually abandoned, driven by legislation to prevent forest fires and the entry into force of the EU common agricultural policy's conditionality rules and mitigation programmes to reduce the field burning of agricultural waste, particularly between 1999 and 2003 (personal communication from Spain in 2017).

Poland explained the decrease in total PAH emissions between 1990 to 2020 by the reductions in the consumption of hard coal and wood in the household sector. Between 2019 and 2020 this consumption was again increasing.

Reductions of total PAH emissions in Italy between 1990 and 2020 are explained by the adaptation of best abatement technologies for coke production.

Finland explained that verified technology development and a milder winter in 2019/2020 were the main drivers of the reduction of total PAH emissions.

Czechia reported that total PAH emissions were reduced between 1990 and 2020, mainly because of the implementation of technical measurements in coke facilities and the shutting down of old installations.

Table 3.23 Member State contributions to EU emissions of total PAHs

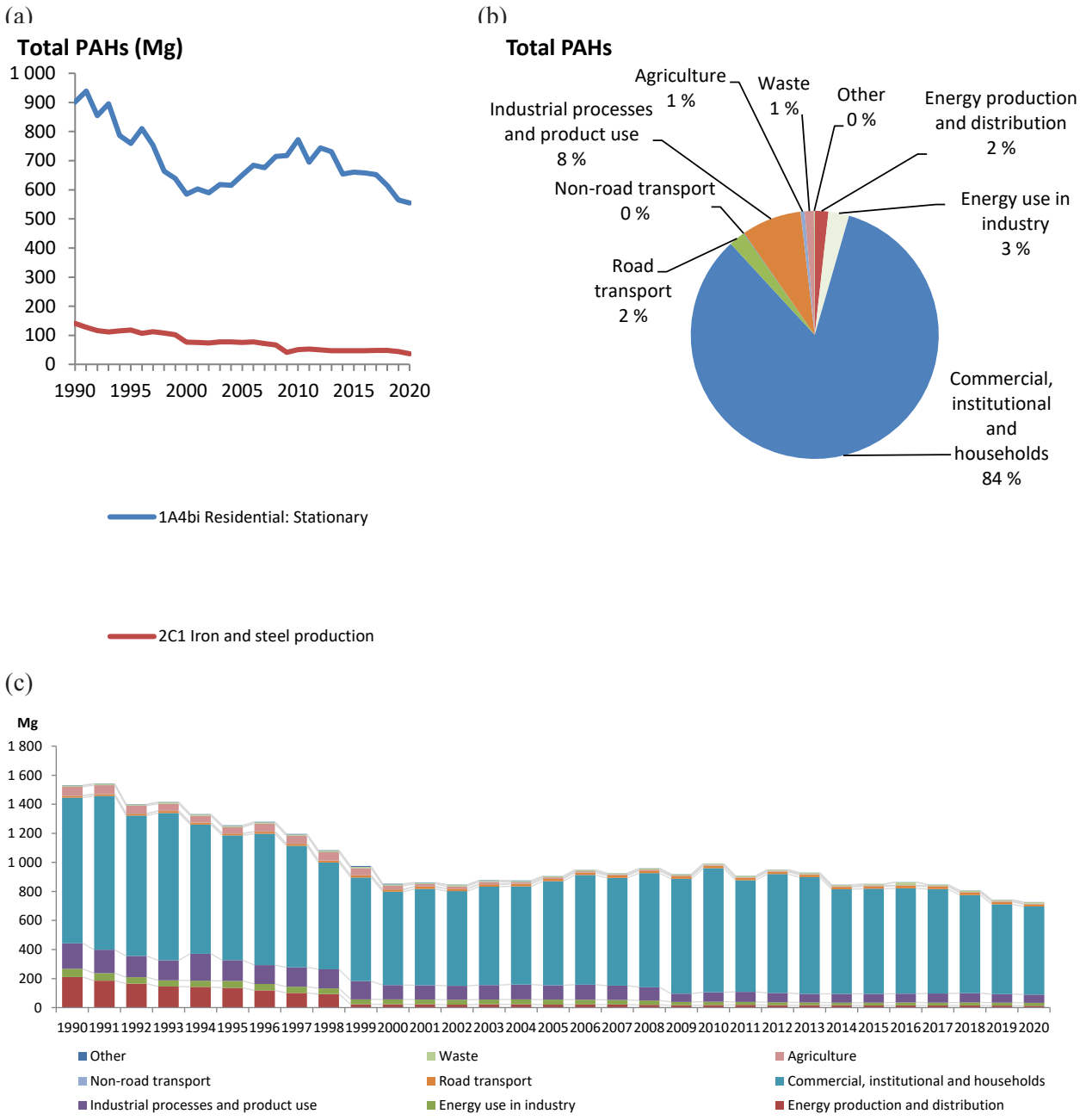
	Total PAHs (Mg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	19	11	8.5	7.2	7.9	7.2	7.4	7.5	6.7	6.9	6.9	7.0	6.5	6.6	6.6	-65 %	0.4 %	1.2 %	0.9 %
Belgium	51	40	32	25	15	13	12	12	8.7	8.5	8.4	7.6	7.2	6.6	5.9	-88 %	-10.6 %	3.3 %	0.8 %
Bulgaria	31	29	20	21	17	21	20	18	16	16	17	17	15	14	15	-51 %	6.9 %	2.0 %	2.1 %
Croatia	22	17	15	19	18	17	17	16	14	16	15	15	14	13	13	-40 %	-0.3 %	1.4 %	1.8 %
Cyprus	14	11	6.2	3.8	0.9	0.9	1.0	0.8	0.7	0.9	0.7	0.6	0.7	0.6	0.9	-94 %	31.8 %	0.9 %	0.1 %
Czechia	280	179	45	40	47	46	48	49	47	47	46	46	45	42	39	-86 %	-7.1 %	18.3 %	5.3 %
Denmark	13	13	10	11	7.7	7.0	6.7	6.8	6.1	6.7	6.9	6.3	5.6	5.0	4.6	-63 %	-7.6 %	0.8 %	0.6 %
Estonia	8.7	9.7	7.2	5.3	5.3	4.3	4.4	4.1	3.9	3.6	3.7	3.6	3.5	3.3	3.3	-62 %	1.9 %	0.6 %	0.5 %
Finland	18	18	18	22	26	22	24	23	23	22	24	23	23	23	18	-1 %	-19.8 %	1.2 %	2.5 %
France	46	44	38	34	36	31	35	38	33	35	37	37	36	36	33	-27 %	-8.7 %	3.0 %	4.6 %
Germany	119	55	57	52	79	71	80	83	67	70	67	69	69	70	67	-44 %	-5.4 %	7.7 %	9.2 %
Greece	24	24	24	22	16	18	20	18	18	19	17	18	18	17	17	-32 %	-2.7 %	1.6 %	2.3 %
Hungary	78	30	25	23	29	33	35	35	29	30	30	30	24	22	21	-73 %	-3.5 %	5.1 %	2.9 %
Ireland	30	21	16	15	15	14	14	15	14	14	15	13	14	12	13	-56 %	4.1 %	1.9 %	1.8 %
Italy	90	92	60	64	87	64	81	78	69	70	70	74	67	65	60	-33 %	-7.8 %	5.9 %	8.3 %
Latvia	18	17	16	13	10	10	11	9.0	8.7	7.2	7.0	7.7	8.0	7.6	6.9	-62 %	-10.2 %	1.2 %	0.9 %
Lithuania	18	8.1	8.4	9.4	10	10	10	10	9.4	8.9	9.0	9.2	9.2	8.6	8.1	-54 %	-5.9 %	1.2 %	1.1 %
Luxembourg	4.6	2.4	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.6	0.5	-88 %	-8.4 %	0.3 %	0.1 %
Malta	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-15 %	5.3 %	0.0 %	0.0 %
Netherlands	21	11	6.0	5.8	5.8	5.9	5.4	5.4	5.3	5.3	5.2	5.1	5.0	4.7	4.4	-79 %	-7.4 %	1.3 %	0.6 %
Poland	341	409	242	310	369	331	340	325	298	291	305	295	275	228	233	-32 %	2.1 %	22.3 %	32.1 %
Portugal	25	24	23	19	15	15	14	14	14	14	14	15	16	17	23	-9 %	32.5 %	1.6 %	3.2 %
Romania	77	46	56	66	64	58	60	57	58	58	58	57	58	58	58	-24 %	-0.2 %	5.0 %	8.0 %
Slovakia	55	34	29	33	30	29	31	30	25	28	29	30	27	25	23	-58 %	-6.1 %	3.6 %	3.2 %
Slovenia	8.7	6.8	6.3	7.0	6.5	6.5	6.3	6.4	5.5	6.0	6.0	5.7	5.1	4.8	4.5	-48 %	-6.8 %	0.6 %	0.6 %
Spain	103	86	68	60	62	60	58	57	57	58	57	48	47	43	39	-62 %	-8.3 %	6.7 %	5.4 %
Sweden	20	20	15	17	11	11	9.8	9.5	8.8	8.6	8.6	8.5	7.5	7.4	7.1	-64 %	-3.0 %	1.3 %	1.0 %
EU27 (a)	**1 532**	**1 255**	**853**	**906**	**992**	**908**	**950**	**930**	**847**	**851**	**864**	**848**	**807**	**743**	**726**	**-53 %**	**-2.3 %**	**100 %**	**100 %**
EU27 (b)	1 532	1 255	853	906	992	908	950	930	847	851	864	848	807	743	726				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

In 2020, '1A4bi — Residential: Stationary' and '2C1 — Iron and steel production' were the principal key categories for these emissions, making up 81% of total PAH emissions (see Figure 3.16 (a)). Among the key categories, the largest change could be observed for in the category '2C1 — Iron and steel production' (--73.7%).

Figure 3.22 (b) shows the contribution made by each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is a very significant source of total PAH emissions.

Figure 3.22 Total PAH emissions in the EU: (a) trend in emissions from the two most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions



3.22 Benzo(a)pyrene emission trends and key categories

Between 1990 and 2020, B(a)P emissions fell by 50% in the EU. Between 2019 and 2020, they decreased by 1% (see Table 3.24), mainly because emissions fell in Finland, Italy and Czechia (countries ranked according to the size of their contributions to the absolute change). In 2020, the Member State contributing most (i.e. more than 10%) to B(a)P emissions was Poland, with a share of 35.9%.

Table 3.24 Member State contributions to EU emissions of B(a)P

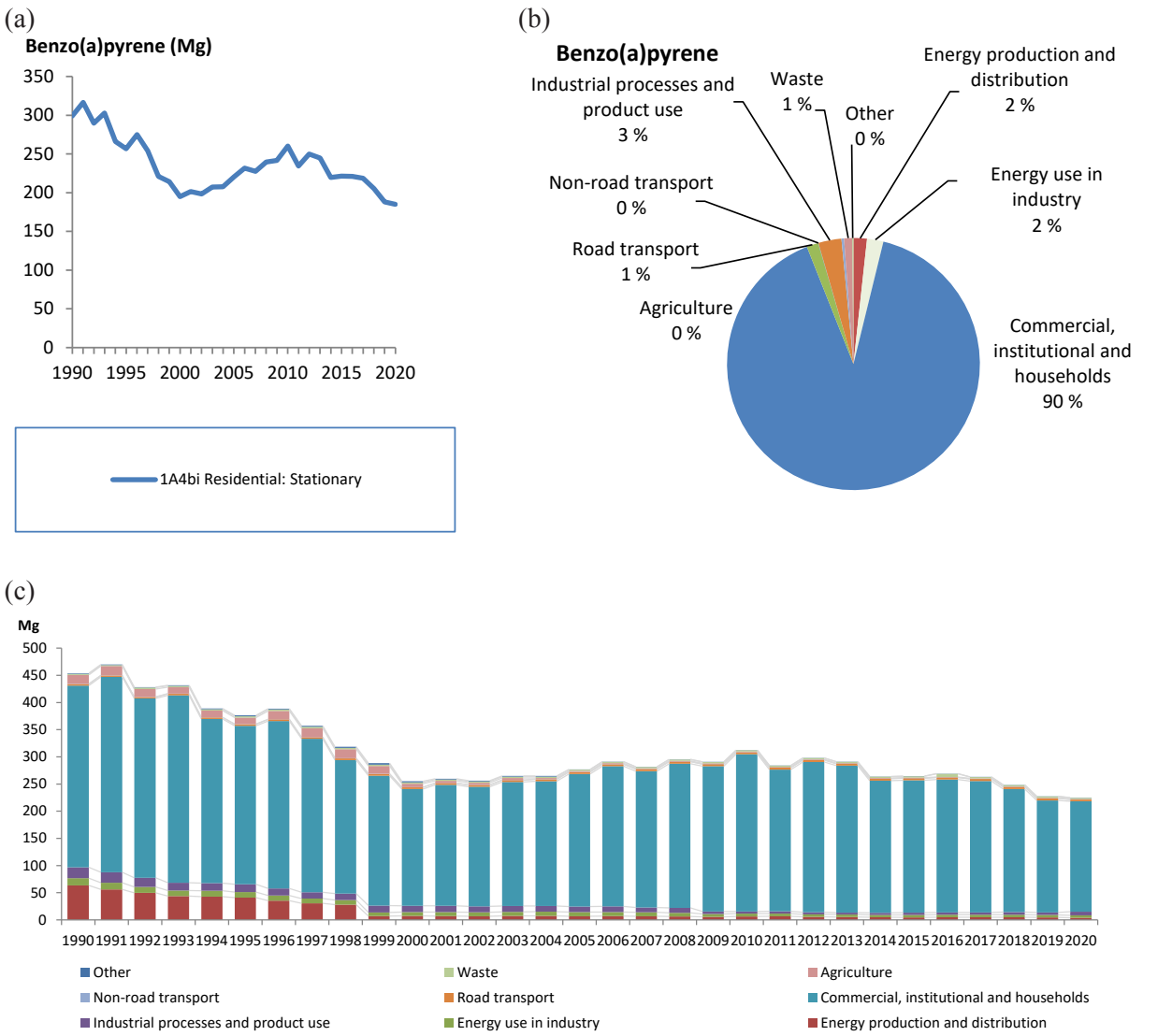
	Benzo(a)pyrene (Mg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	6.3	3.6	2.7	2.3	2.5	2.3	2.4	2.4	2.1	2.2	2.2	2.2	2.0	2.1	2.1	-67 %	0.7 %	1.4 %	0.9 %
Belgium	15	12	9.7	7.8	5.4	4.9	4.2	4.0	2.8	2.7	2.7	2.4	2.3	2.1	1.9	-88 %	-10.5 %	3.4 %	0.8 %
Bulgaria	8	7	5	6	6	7	7	6	5	5	6	6	5.0	4.8	5.2	-39 %	8.7 %	1.9 %	2.3 %
Croatia	7.2	5.8	5.2	6.5	6.1	5.8	5.7	5.7	4.9	5.5	5.3	5.1	4.8	4.7	4.7	-35 %	-0.1 %	1.6 %	2.1 %
Cyprus	2.4	1.9	1.1	0.6	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	-94 %	32.0 %	0.5 %	0.1 %
Czechia	91	60	17	15	17	17	17	18	17	17	16	16	16	15	14	-85 %	-6.9 %	20.2 %	6.1 %
Denmark	3.5	3.5	2.9	3.0	2.4	2.1	2.0	2.0	1.8	2.1	2.1	1.9	1.7	1.5	1.3	-61 %	-8.0 %	0.8 %	0.6 %
Estonia	2.4	2.7	2.0	1.5	1.5	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	-62 %	2.2 %	0.5 %	0.4 %
Finland	5.8	5.6	5.7	7.1	8.2	7.1	7.7	7.4	7.5	7.1	7.7	7.6	7.5	7.4	6.0	3 %	-18.9 %	1.3 %	2.7 %
France	13	13	11	9.7	10	8.8	9.9	11	9.3	9.9	10.6	10.5	10.3	10.4	9.5	-27 %	-8.6 %	2.9 %	4.2 %
Germany	27	11	12	12	18	16	18	19	15	16	15	16	16	16	15	-44 %	-5.4 %	5.9 %	6.8 %
Greece	7.3	7.2	7.2	6.3	4.5	5.4	6.0	5.6	5.6	5.9	5.3	5.4	5.4	5.3	5.1	-30 %	-2.4 %	1.6 %	2.3 %
Hungary	26	9.9	8.5	7.8	9.9	11	12	12	9.8	10	10	10	8.3	7.5	7.3	-72 %	-3.3 %	5.7 %	3.2 %
Ireland	6.8	4.7	3.7	3.7	3.7	3.4	3.4	3.7	3.4	3.5	3.7	3.2	3.5	3.1	3.3	-52 %	4.6 %	1.5 %	1.4 %
Italy	10	11	11	12	21	14	19	19	17	18	17	19	17	17	16	56 %	-7.3 %	2.2 %	6.9 %
Latvia	6.3	6.0	6.1	4.7	3.6	3.6	3.6	3.2	3.1	2.5	2.5	2.7	2.8	2.7	2.4	-62 %	-10.1 %	1.4 %	1.1 %
Lithuania	5.9	2.8	3.0	3.3	3.6	3.6	3.6	3.5	3.3	3.1	3.1	3.1	3.2	2.9	2.8	-53 %	-5.6 %	1.3 %	1.2 %
Luxembourg	1.2	0.6	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	-90 %	-8.3 %	0.3 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29 %	-7.1 %	0.0 %	0.0 %
Netherlands	5.5	3.3	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.6	1.5	-72 %	-5.9 %	1.2 %	0.7 %
Poland	119	143	82	109	131	116	120	115	104	102	107	103	96	79	81	-32 %	2.8 %	26.3 %	35.9 %
Portugal	7.6	6.9	6.4	5.4	4.2	4.2	4.1	4.1	4.0	4.0	4.0	4.2	4.6	5.2	7.5	-1 %	44.3 %	1.7 %	3.4 %
Romania	18	11	16	18	20	18	19	18	18	18	18	18	18	18	18	2 %	1.4 %	3.9 %	8.0 %
Slovakia	16	8.3	6.7	7.6	7.1	6.7	7.2	6.8	4.5	5.8	6.0	6.0	5.0	5.1	5.1	-68 %	-0.1 %	3.5 %	2.3 %
Slovenia	3.1	2.7	2.6	3.0	2.8	2.8	2.7	2.7	2.3	2.5	2.5	2.4	2.1	1.9	1.8	-41 %	-7.3 %	0.7 %	0.8 %
Spain	32	27	20	17	18	18	17	17	17	17	16	13	13	12	11	-66 %	-6.7 %	7.0 %	4.9 %
Sweden	6.4	6.4	4.9	5.4	3.4	3.3	3.1	3.0	2.7	2.7	2.6	2.6	2.3	2.2	2.1	-66 %	-2.6 %	1.4 %	1.0 %
EU27 (a)	**454**	**376**	**255**	**277**	**312**	**284**	**298**	**291**	**264**	**265**	**269**	**263**	**249**	**227**	**225**	**-50 %**	**-1.0 %**	**100 %**	**100 %**
EU27 (b)	454	376	255	277	312	284	298	291	264	265	269	263	249	227	225				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors.

Category '1A4bi — Residential: Stationary' was the principal key one for B(a)P emissions, accounting for 82% of the total. Among the key categories, the largest change could be observed for the most important, '1A4bi — Residential: Stationary' (-38.2%) (see Figure 3.23(a)).

Figure 3.23(b) shows the contribution made by each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is the chief source of B(a)P emissions.

Figure 3.23 **B(a)P emissions in the EU: (a) trend in emissions from the most important key category, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



3.23 Benzo(b)fluoranthene emission trends

Between 1990 and 2020, B(b)F emissions fell by 53% in the EU. Between 2019 and 2020, they dropped by 1.5% (see Table 3.25), mainly because of a slight decrease in Italy, Germany, France and Finland (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member State contributing most (i.e. more than 10%) to B(b)F emissions was Poland with a share of 34.7 %.

Sweden explained that the marked decline in its B(b)F emissions between 2005 and 2010 was because of changes in aluminium production ('2C3 — Aluminium production'). Until 2008, aluminium production at the country's only operating plant (Kubikenborg Aluminium AB) was a key source of B(b)F emissions. In 2008, all the potlines in the plant that used the Soderberg technology were shut down, which caused an abrupt decline in B(b)F emissions between 2008 and 2009 (personal communication from Sweden in 2017).

Table 3.25 Member State contributions to EU emissions of B(b)F

	Benzo(b)fluoranthene (Mg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	6.4	3.8	3.0	2.5	2.8	2.5	2.6	2.7	2.4	2.4	2.5	2.5	2.3	2.4	2.4	-63 %	0.6 %	1.3 %	1.0 %
Belgium	18	14	11	8.7	4.8	3.9	4.0	4.1	3.0	3.0	2.9	2.6	2.5	2.3	2.1	-88 %	-10.3 %	3.6 %	0.9 %
Bulgaria	10	8.3	5.9	6.4	6.0	7.2	6.9	6.2	5.4	5.3	5.7	5.8	5.1	4.8	5.2	-50 %	7.6 %	2.1 %	2.2 %
Croatia	7.6	5.6	5.0	6.2	5.8	5.5	5.4	5.3	4.6	5.1	4.9	4.8	4.5	4.3	4.3	-43 %	-0.5 %	1.5 %	1.9 %
Cyprus	6.6	5.2	3.0	1.8	0.4	0.5	0.5	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.4	-94 %	31.5 %	1.3 %	0.2 %
Czechia	91	57	11	10	12	12	12	13	12	12	12	12	12	11	10	-89 %	-6.5 %	18.4 %	4.4 %
Denmark	3.1	3.2	2.6	2.7	2.1	2.0	1.9	2.0	1.8	2.0	2.1	1.9	1.8	1.6	1.5	-53 %	-6.7 %	0.6 %	0.6 %
Estonia	3.0	2.7	1.9	1.5	1.4	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	-69 %	3.5 %	0.6 %	0.4 %
Finland	4.9	4.7	4.7	5.8	6.6	5.7	6.2	5.9	5.9	5.6	6.1	6.0	5.9	5.8	4.7	-2 %	-18.1 %	1.0 %	2.1 %
France	15	15	12	11	12	10	11	12	11	11	12	12	12	12	11	-28 %	-8.9 %	3.1 %	4.7 %
Germany	36	15	17	17	26	23	27	28	22	23	22	23	23	23	22	-38 %	-5.1 %	7.2 %	9.6 %
Greece	9.1	9.0	8.8	7.8	5.6	6.2	6.7	6.2	6.3	6.5	6.0	6.1	6.0	5.8	5.6	-38 %	-3.1 %	1.8 %	2.4 %
Hungary	30	11	8.5	8.0	9.7	11	12	12	9.5	9.9	10	10	8.2	7.4	7.1	-76 %	-3.7 %	6.0 %	3.1 %
Ireland	12	8	6.7	6.5	6.3	5.8	5.8	6.3	5.8	6.0	6.1	5.4	5.8	5.3	5.5	-53 %	4.3 %	2.4 %	2.4 %
Italy	13	14	14	15	25	16	23	23	20	21	21	22	20	20	18	43 %	-7.1 %	2.6 %	7.9 %
Latvia	6.2	5.4	5.0	4.3	3.3	3.4	3.3	2.9	2.9	2.4	2.3	2.5	2.7	2.5	2.3	-64 %	-10.1 %	1.3 %	1.0 %
Lithuania	7.0	3.0	3.0	3.4	3.9	3.8	3.9	3.8	3.6	3.4	3.4	3.5	3.5	3.3	3.1	-55 %	-5.6 %	1.4 %	1.4 %
Luxembourg	1.5	0.8	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.2	0.2	-85 %	-6.8 %	0.3 %	0.1 %
Malta	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21 %	11.0 %	0.0 %	0.0 %
Netherlands	8.1	3.6	2.0	1.9	1.9	2.0	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.5	1.4	-83 %	-8.7 %	1.6 %	0.6 %
Poland	122	147	85	108	128	114	117	113	103	101	105	102	95	78	80	-35 %	2.3 %	24.7 %	34.7 %
Portugal	7.0	6.3	5.8	4.9	3.8	3.9	3.8	3.8	3.8	3.7	3.7	3.8	4.0	4.3	5.5	-21 %	27.1 %	1.4 %	2.4 %
Romania	22	12	16	18	19	17	18	17	18	17	17	17	17	17	18	-21 %	1.4 %	4.5 %	7.6 %
Slovakia	13	7.1	5.9	6.5	6.0	5.7	6.2	5.9	4.2	5.1	5.3	5.4	4.6	4.7	4.6	-63 %	-0.8 %	2.5 %	2.0 %
Slovenia	2.7	1.9	1.5	1.7	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.1	1.1	-61 %	-6.2 %	0.6 %	0.5 %
Spain	33	27	20	16	17	17	16	16	16	16	15	13	13	12	11	-67 %	-4.8 %	6.8 %	4.8 %
Sweden	6.2	6.1	4.8	5.3	3.4	3.4	3.2	3.1	2.8	2.7	2.7	2.7	2.4	2.3	2.3	-63 %	-2.1 %	1.3 %	1.0 %
EU27 (a)	**494**	**396**	**266**	**282**	**315**	**286**	**301**	**296**	**268**	**269**	**273**	**268**	**254**	**234**	**230**	**-53 %**	**-1.5 %**	**100 %**	**100 %**
EU27 (b)	494	396	266	282	315	286	301	296	268	269	273	268	254	234	230				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.24 Benzo(k)fluoranthene emission trends

Between 1990 and 2020, B(k)F emissions in the EU decreased by 53%. Between 2019 and 2020, they fell by 1.8% (see Table 3.26), mainly in Finland, Italy, France and Germany (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member State contributing most (i.e. more than 10%) to the EU-27 B(k)F emissions was Poland with a share of 33.4%.

Table 3.26 Member State contributions to EU emissions of B(k)F

	Benzo(k)fluoranthene (Mg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	3.7	1.5	1.2	1.0	1.1	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.9	1.0	1.0	-74 %	-0.3 %	1.6 %	0.9 %
Belgium	10	7.8	6.0	4.7	2.4	2.0	2.0	2.0	1.4	1.3	1.3	1.2	1.1	1.0	0.9	-91 %	-11.2 %	4.2 %	0.8 %
Bulgaria	4.0	3.7	2.3	2.5	2.3	2.8	2.7	2.4	2.1	2.0	2.2	2.2	2.0	1.9	2.0	-50 %	7.2 %	1.7 %	1.8 %
Croatia	2.8	2.1	1.9	2.4	2.2	2.1	2.1	2.0	1.8	2.0	1.9	1.8	1.7	1.7	1.7	-41 %	-0.4 %	1.2 %	1.5 %
Cyprus	2.8	2.2	1.3	0.8	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.2	-94 %	31.9 %	1.2 %	0.2 %
Czechia	51	33	8.4	7.4	8.4	8.4	8.6	8.8	8.3	8.3	8.1	8.2	8.0	7.5	7.1	-86 %	-5.6 %	21.5 %	6.4 %
Denmark	2.4	2.5	2.1	2.2	1.7	1.5	1.4	1.4	1.3	1.4	1.4	1.3	1.1	1.0	0.9	-63 %	-8.0 %	1.0 %	0.8 %
Estonia	1.6	1.8	1.3	1.0	1.0	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6	-62 %	1.4 %	0.7 %	0.5 %
Finland	3.6	3.5	3.6	4.4	5.1	4.4	4.7	4.5	4.5	4.3	4.7	4.6	4.5	4.5	3.5	-5 %	-22.9 %	1.5 %	3.1 %
France	9.3	9.1	7.8	7.1	7.4	6.4	7.2	7.7	6.7	7.1	7.6	7.5	7.3	7.4	6.8	-28 %	-8.6 %	4.0 %	6.1 %
Germany	16	7.1	7.9	7.8	12	11	12	13	10	11	10	10	11	11	10	-37 %	-4.7 %	6.9 %	9.3 %
Greece	4.2	4.0	4.1	3.7	2.8	3.2	3.4	3.2	3.3	3.4	3.2	3.2	3.2	3.2	3.1	-24 %	-0.6 %	1.8 %	2.9 %
Hungary	12	4.2	3.3	3.1	3.7	4.3	4.5	4.5	3.7	3.8	3.9	3.9	3.2	2.9	2.7	-76 %	-4.1 %	4.9 %	2.5 %
Ireland	6.2	4.1	3.0	2.9	2.8	2.5	2.6	2.7	2.5	2.6	2.6	2.3	2.5	2.2	2.3	-63 %	3.5 %	2.6 %	2.1 %
Italy	6.0	6.6	6.7	7.5	11	7.6	10	10	9.1	9.6	9.4	10	9.0	9.0	8.3	40 %	-7.6 %	2.5 %	7.6 %
Latvia	2.4	2.1	2.0	1.7	1.3	1.3	1.3	1.1	1.1	0.9	0.9	1.0	1.0	1.0	0.9	-64 %	-10.1 %	1.0 %	0.8 %
Lithuania	3.0	1.4	1.3	1.5	1.7	1.7	1.7	1.7	1.6	1.5	1.5	1.6	1.6	1.5	1.4	-53 %	-5.5 %	1.3 %	1.3 %
Luxembourg	1.0	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-88 %	-10.3 %	0.4 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-31 %	14.8 %	0.0 %	0.0 %
Netherlands	4.2	2.5	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.7	-83 %	-12.4 %	1.8 %	0.6 %
Poland	52	64	39	48	57	51	52	51	46	45	48	46	43	36	37	-29 %	2.4 %	22.0 %	33.4 %
Portugal	3.0	2.7	2.6	2.3	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.8	2.0	2.3	3.5	17 %	50.3 %	1.3 %	3.1 %
Romania	8.7	4.5	6.0	7.0	7.4	6.7	6.9	6.6	6.8	6.7	6.7	6.6	6.6	6.7	6.8	-22 %	1.4 %	3.7 %	6.2 %
Slovakia	7.2	3.9	3.0	3.3	3.0	2.9	3.1	2.9	2.0	2.5	2.6	2.6	2.2	2.3	2.2	-69 %	-0.9 %	3.1 %	2.0 %
Slovenia	1.7	1.5	1.5	1.6	1.5	1.5	1.5	1.5	1.3	1.4	1.4	1.3	1.2	1.1	1.0	-42 %	-7.9 %	0.7 %	0.9 %
Spain	14	12	9.1	7.7	7.8	7.9	7.4	7.2	7.2	7.3	8.9	6.1	6.2	5.0	4.7	-68 %	-6.8 %	6.1 %	4.3 %
Sweden	3.0	2.9	2.3	2.9	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	0.8	0.8	0.8	-74 %	-2.4 %	1.3 %	0.7 %
EU27 (a)	**235**	**192**	**129**	**136**	**148**	**135**	**142**	**140**	**127**	**128**	**131**	**127**	**122**	**112**	**110**	**-53 %**	**-1.8 %**	**100 %**	**100 %**
EU27 (b)	235	192	129	136	148	135	142	140	127	128	131	127	122	112	110				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors.

3.25 Indeno(1,2,3-cd)pyrene emission trends

Between 1990 and 2020IP emissions fell by 46% in the EU. Between 2019 and 2020, they decreased by 2.3%, mainly because Finland, Italy, Czechia and Germany (countries ranked according to the size of their contributions to the absolute change) reported lower emissions (see Table 3.27). In 2020, the EU Member States contributing most (i.e. more than 10%) to IP emissions were Poland and Germany (countries ranked according to their shares of the EU total).

Table 3.27 Member State contributions to EU emissions of IP

	Indeno(123-cd)pyrene (Mg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	2.7	2.0	1.6	1.3	1.5	1.3	1.4	1.4	1.2	1.3	1.3	1.3	1.2	1.2	1.2	-55 %	-0.1 %	1.2 %	1.0 %
Belgium	7.4	5.9	4.7	3.9	2.5	2.0	2.1	2.1	1.5	1.5	1.5	1.3	1.3	1.2	1.0	-86 %	-11.1 %	3.3 %	0.9 %
Bulgaria	3.7	4.2	2.7	3.0	3.0	3.5	3.4	3.1	2.8	2.8	2.9	3.0	2.7	2.6	2.8	-22 %	9.8 %	1.6 %	2.4 %
Croatia	3.9	3.3	3.0	3.8	3.5	3.4	3.3	3.2	2.8	3.2	3.0	2.9	2.7	2.6	2.6	-32 %	0.2 %	1.7 %	2.2 %
Cyprus	2.0	1.6	0.9	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-94 %	32.3 %	0.9 %	0.1 %
Czechia	49	31	10	9.4	11	11	12	12	12	12	11	12	11	10	9.5	-81 %	-8.1 %	22.0 %	7.9 %
Denmark	3.5	3.5	2.6	2.5	1.5	1.4	1.3	1.3	1.2	1.3	1.3	1.2	1.1	1.	0.9	-75 %	-7.9 %	1.6 %	0.7 %
Estonia	1.7	2.6	2.0	1.4	1.5	1.2	1.2	1.1	1.0	1.0	1.0	1.0	.9	.9	0.9	-48 %	0.3 %	0.7 %	0.7 %
Finland	4.1	4.0	4.0	5.0	5.8	4.9	5.4	5.1	5.2	4.9	5.3	5.2	5.1	5.1	4.0	-2 %	-20.4 %	1.9 %	3.4 %
France	8.0	7.8	6.7	6.2	6.6	5.7	6.3	6.8	5.9	6.3	6.7	6.7	6.5	6.6	6.0	-25 %	-8.7 %	3.6 %	5.0 %
Germany	23	9.9	11	11	17	16	18	18	15	15	15	15	15	15	15	-36 %	-4.1 %	10.3 %	12.3 %
Greece	3.4	3.4	3.3	2.9	2.1	2.5	2.8	2.6	2.6	2.7	2.4	2.4	2.4	2.3	2.2	-36 %	-5.1 %	1.5 %	1.8 %
Hungary	11	4.4	4.4	4.0	5.5	6.3	6.7	6.8	5.5	5.8	5.8	5.6	4.6	4.2	4.1	-61 %	-2.6 %	4.7 %	3.4 %
Ireland	5.0	3.3	2.5	2.3	2.3	2.1	2.1	2.2	2.0	2.1	2.2	1.9	2.	1.8	1.9	-62 %	3.6 %	2.2 %	1.6 %
Italy	7.1	7.8	7.8	8.5	14	9.3	13	13	11	12	12	13	11	11	10	44 %	-7.7 %	3.2 %	8.5 %
Latvia	2.9	3.1	3.1	2.6	1.9	2.0	2.0	1.7	1.7	1.3	1.3	1.5	1.5	1.5	1.3	-55 %	-10.4 %	1.3 %	1.1 %
Lithuania	2.5	1.5	1.6	1.8	1.9	1.9	1.9	1.8	1.7	1.6	1.6	1.6	1.6	1.5	1.5	-43 %	-4.9 %	1.1 %	1.2 %
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-91 %	-10.0 %	0.4 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21 %	-7.8 %	0.0 %	0.0 %
Netherlands	2.9	1.6	0.9	0.9	0.9	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	-74 %	-2.8 %	1.3 %	0.6 %
Poland	41	52	31	39	47	42	43	42	38	37	39	38	35	29	30	-28 %	1.7 %	18.3 %	24.7 %
Portugal	4.4	4.	3.6	3.1	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.4	2.6	2.9	4.1	-7 %	39.7 %	2.0 %	3.4 %
Romania	8.0	5.1	8.6	9.7	11	10	11	10	10	9.9	9.9	9.9	9.9	10.	10	27 %	1.1 %	3.6 %	8.4 %
Slovakia	7.9	4.1	3.4	3.9	3.6	3.4	3.7	3.5	2.3	3.0	3.2	3.2	2.7	2.7	2.8	-65 %	0.5 %	3.5 %	2.3 %
Slovenia	0.8	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-57 %	-3.9 %	0.4 %	0.3 %
Spain	14	12	9.3	8.1	9.1	8.9	8.9	8.6	8.7	8.7	8	6.5	6.5	6.3	6.1	-57 %	-3.6 %	6.3 %	5.1 %
Sweden	3.1	3.3	2.5	2.4	1.9	1.9	1.7	1.7	1.5	1.5	1.5	1.4	1.2	1.2	1.2	-63 %	-3.1 %	1.4 %	1.0 %
EU27 (a)	**224**	**181**	**132**	**138**	**159**	**145**	**154**	**152**	**137**	**139**	**140**	**137**	**131**	**123**	**120**	**-46 %**	**-2.3 %**	**100 %**	**100 %**
EU27 (b)	224	181	132	138	159	145	154	152	137	139	140	137	131	123	120				

Notes: ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.

3.26 Hexachlorobenzene emission trends and key categories

Between 1990 and 2020, HCB emissions fell by 98% in the EU. However, between 2019 and 2020, they decreased by 20% (see Table 3.28), mainly because of Poland, Germany, Czechia and Austria (countries ranked according to the size of their contributions to the absolute change). In 2020, the EU Member States contributing most (i.e. more than 10%) to HCB emissions were France, Finland, Czechia and Austria (countries ranked according to their shares of the EU total).

Austria explained that the increase in HCB emissions from 2012 to 2013 reflects the data reported in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. As a result of unintentional releases in 2012, 2013 and 2014, emissions rose to a very high level: HCB-contaminated material (lime) was co-incinerated in a cement plant at temperatures that were too low to destroy the HCB. Thus, the sharp 74.2% decrease in emissions between 2014 and 2015 marked a return to usual levels (see Austria's IIR, listed in Appendix 5).

The peak in HCB emissions (the increase between 1990 and 1995 and the decrease between 1995 and 1999) reported by Belgium was mainly due to higher amounts of burned sludge (personal communication from Belgium in 2017). The strong decline in HCB emissions from 1999 to 2000 was because the sewage sludge incineration sector used a lower emission factor from 2000 onwards (personal communication from Belgium in 2016).

Czechia explained its decrease in emissions as being due to the prohibition of precursors of HCB in aluminium production.

The data reported by Finland show a 266% increase from 2015 to 2016 followed by a fall in HCB emissions. This was mainly caused by emissions from the category '2B10a — Chemical industry: Other'. The emission trend reported by Finland is dominated by fluctuations in the industrial processes and product use sector and may be overestimated for the other sources because of the highly uncertain methods (see Finland's IIR's, listed in Appendix 5).

France reported a pronounced drop in HCB emissions between 1990 and 1995. The decrease in the category '1Ab2 — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' was mainly due to the aluminium industry, which used chlorine to refine aluminium by eliminating magnesium traces. Until the early 1990s, it used hexachloroethane (HCE) as a core source, which resulted in HCB emissions, the main HCB source in the national inventory. In 1993, France banned HCE in secondary aluminium refining, as a result of which this industry no longer emits HCB (personal communication from France in 2015).

Ireland reported a marked decrease in HCB emissions between 1995 and 2000. HCB emissions from the category '2C2 — Ferroalloys production' dominated the inventory for the period up to and including 1996, contributing 40 kg per year. However, this is no longer a source of HCB emissions in Ireland because of the banning the use of HCE-based cover gas use (HCB was present as a contaminant in such cover gases) (see Ireland's IIR, listed in Appendix 5).

In Germany, the drop in HCB emissions from 2001 to 2002 was mainly attributed to data reported in the category '2C3 — Aluminium production'. Data were reported up to 2001, after which the notation key 'NA' (not applicable) was used.

Slovakia explained that HCB emissions are connected to using energy from industrial waste. The general declining trend until 2013, with several jumps in 2003, 2005 and 2008, was the result of tightening legislation on waste incineration plants. Since 2014, emissions have decreased because of a greater use of biomass waste as a fuel than other fuels in industry (see Slovakia's IIR, listed in Appendix 5).

Spain stated in its IIR that the sudden reduction in HCB emissions between 2005 and 2006 and the further drop from 2008 to 2010 were due to a new regulation in line with the framework of the Stockholm Convention on Persistent Organic Pollutants. Previous fluctuations reflect variations in the production of POPs in Spain (see Spain's IIR, listed in Appendix 5).

Table 3.28 Member State contributions to EU emissions of HCB

	HCB (kg)															Change		Share in EU-27	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**1990—2020**	**2019—2020**	**1990**	**2020**
Austria	83	42	20	17	19	17	41	120	124	16	17	18	16	17	15	-82 %	-14.9 %	1.4 %	10.8 %
Belgium	40	115	21	19	12	27	16	5.1	5	3.6	3.1	33	4.0	3.0	3.3	-92 %	8.0 %	0.7 %	2.4 %
Bulgaria	0.4	0.3	0.5	0.7	0.7	0.9	0.8	0.6	0.6	0.6	0.2	0.3	0.3	0.3	0.3	-29 %	3.9 %	0.0 %	0.2 %
Croatia	7.1	6.4	2.0	0.5	0.9	0.8	0.9	0.8	0.6	0.4	0.5	0.5	0.6	0.6	0.4	-95 %	-40.4 %	0.1 %	0.3 %
Cyprus	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-11 %	2.0 %	0.0 %	0.0 %
Czechia	537	263	175	15	23	20	26	24	23	25	23	23	23	21	15	-97 %	-26.6 %	9.0 %	11.1 %
Denmark	13	11	5.5	3.7	2.8	2.6	2.4	2.6	2.4	2.2	2.3	2.4	2.4	2.1	2.1	-85 %	-4.1 %	0.2 %	1.5 %
Estonia	0.5	0.8	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.5	-13 %	8.7 %	0.0 %	0.4 %
Finland	36	36	39	32	8.7	26	9.5	17	22	16	60	33	32	23	21	-41 %	-6.5 %	0.6 %	15.6 %
France	1197	71	45	12	21	20	20	21	23	25	26	28	23	23	22	-98 %	-4.0 %	20.1 %	16.3 %
Germany	2 898	2 118	2 884	38	29	30	25.2	27	44	40	50	61	13	13	4.8	-100 %	-63.5 %	48.7 %	3.5 %
Greece	21	22	25	27	12	12	11	9.4	10	3.1	2.7	3.3	2.7	1.7	1.3	-94 %	-25.0 %	0.4 %	0.9 %
Hungary	257	630	367	3.3	2.2	2.5	2.6	2.4	3.0	3.2	3.2	3.2	2.9	3.2	2.1	-99 %	-36.2 %	4.3 %	1.5 %
Ireland	48	48	7.9	2.6	2.6	2.6	2.7	2.7	2.6	2.7	2.6	2.6	2.4	2.3	2.4	-95 %	1.5 %	0.8 %	1.8 %
Italy	142	110	33	27	16	16	16	16	17	16	15	16	14.6	14.2	13	-91 %	-8.6 %	2.4 %	9.6 %
Latvia	5.7	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	-91 %	-3.6 %	0.1 %	0.4 %
Lithuania	11	4.7	1.9	2	1	0.9	0.7	0.6	0.3	0.4	0.4	0.4	0.4	0.4	0.5	-96 %	20.1 %	0.2 %	0.3 %
Luxembourg	1.0	1.5	1.0	0.6	0.9	0.9	0.4	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.7	-27 %	-1.5 %	0.0 %	0.5 %
Malta	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	55 %	30.7 %	0.0 %	0.1 %
Netherlands	66	40	17	3.4	3.4	3.6	3.8	3.7	3.7	4.0	4.2	4.0	3.8	3.6	3.7	-94 %	1.6 %	1.1 %	2.7 %
Poland	85	85	14	13	13	13	13	9.7	12	12	13	14	13	15	3.1	-96 %	-78.6 %	1.4 %	2.3 %
Portugal	60	76	101	1.7	1.4	1.4	1.5	1.5	1.6	1.7	1.9	2.0	2.4	2.4	1.3	-98 %	-46.2 %	1.0 %	0.9 %
Romania	2.8	2.9	3.9	4.2	3.2	3.4	3.3	2.9	2.9	3.0	2.9	3.1	3.1	3.1	3.0	4 %	-4.1 %	0.0 %	2.2 %
Slovakia	15.1	5.3	4.9	3.4	3.4	3.5	3.6	3.7	3.3	3.5	3.3	4.2	3.6	3.6	3.3	-78 %	-6.7 %	0.3 %	2.5 %
Slovenia	21	18	20	0.9	1.3	0.8	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.5	-98 %	-11.1 %	0.4 %	0.3 %
Spain	381	207	192	136	12	13	11	7.8	12	10	12	12	13	13	13	-96 %	1.9 %	6.4 %	9.9 %
Sweden	17	17	11	4.5	6.6	4.3	3.8	4.3	3.4	3.8	2.7	3.1	2.8	2.7	2.6	-84 %	-5.3 %	0.3 %	1.9 %
EU27 (a)	**5 947**	**3 932**	**3 992**	**368**	**197**	**222**	**217**	**285**	**319**	**194**	**248**	**270**	**181**	**170**	**135**	**-98 %**	**-20 %**	**100 %**	**100 %**
EU27 (b)	5 947	3 932	3 992	368	197	222	217	285	319	194	248	270	181	170	135				

Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors.

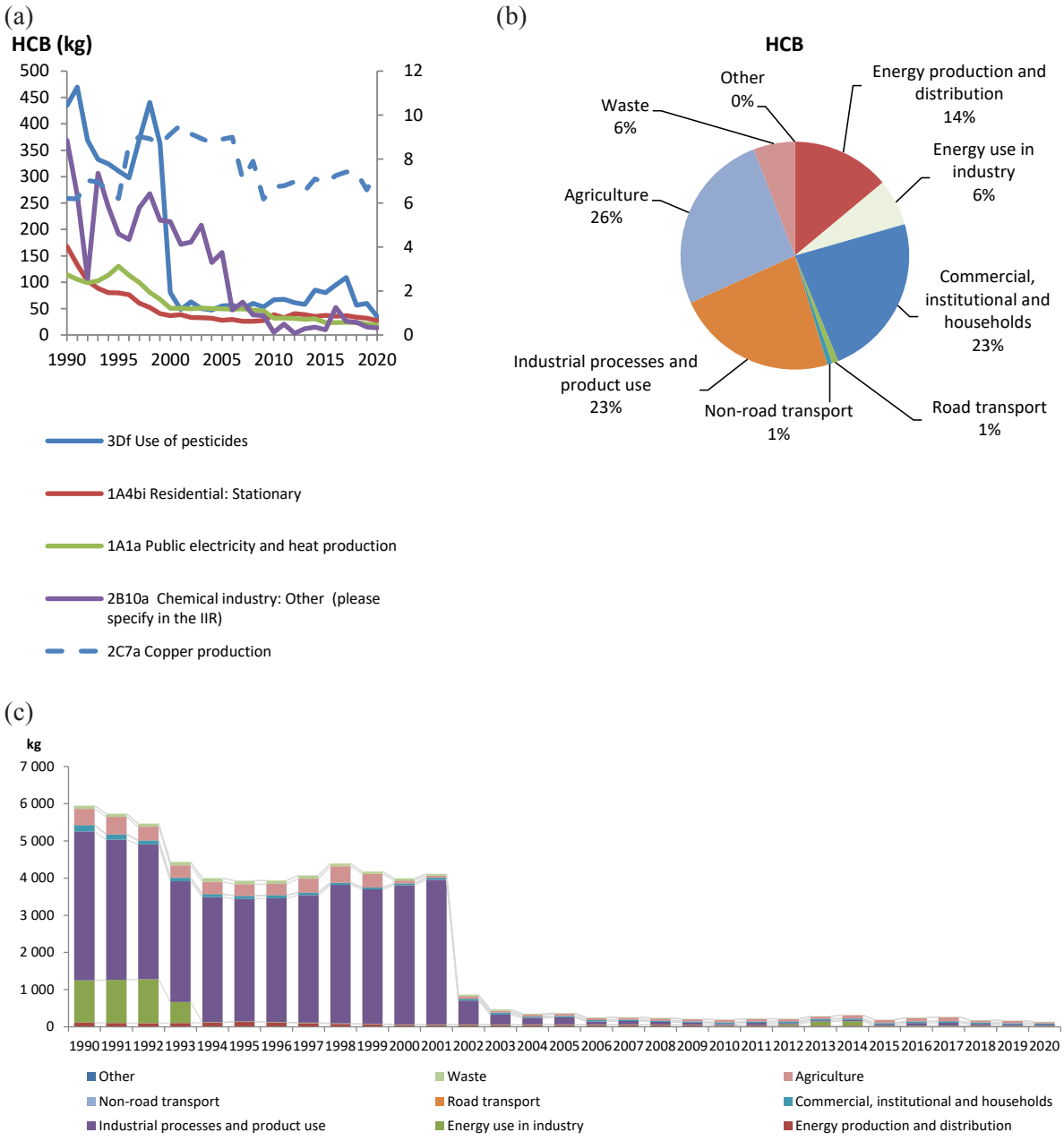
In 2020, '3Df — Use of pesticides', '1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were the main key categories for HCB emissions, together accounting for 60% of the total (see Figure 3.24(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2020 were in the fourth most important, '2B10a — Chemical industry: Other' (-96.4%) and in the most important, '3Df — Use of pesticides' (-92 %).

Figure 3.24 (b) shows the contribution made by each aggregated sector group to total EU emissions. For HCB, the primary emission sources are the commercial, institutional and households, agriculture, and the industrial processes and product use sectors.

The drop between 2001 and 2002, in the category '2C3 — Aluminium production', was caused by reductions reported by Germany.

The major peak in the category '2C1 — Iron and steel production' in 2011 reflects data reported by Belgium.

Figure 3.24 **HCB emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions**



Note: In (a), the right-hand axis shows values for '2C1 — Iron and steel production'.

3.27 Polychlorinated biphenyl emission trends and key categories

Between 1990 and 2020, polychlorinated biphenyl (PCB) emissions dropped by 75% in the EU. Between 2019 and 2020, they fell by 5.9%, mainly because of reductions reported by Greece, Italy, Poland and Germany (countries ranked according to the size of their contributions to the absolute change (see Table 3.29). In 2020, the EU Member States contributing most (i.e. more than 10%) to PCB emissions were Croatia, Germany and Poland (countries ranked according to their shares of the EU total).

Belgium stated that PCB emissions reported in the category '2A1 — Cement production' from one of its plants were very high in 2010 and 2011 because of the use of an alternative raw material containing high concentrations of PCBs. Having removed this raw material at the end of 2011, emissions decreased significantly (see Belgium's IIR, listed in Appendix 5).

The emissions reported by Greece for PCB in the category '2C5 — Lead production' are responsible for the strong increases observed from 2007 to 2008 and from 2017 to 2018. Between 2018 and 2019, PCB emissions fell again by 7%. In 2003, the emission peak in Ireland (not shown in Table 3.29) was caused by an increase in household waste reported in the category '5E — Other waste' (see Ireland's IIR, listed in Appendix 5).

Lithuania explained that the high PCB emissions in 2005 occurred because emissions from electrical transformer oil were estimated (personal communication from Lithuania in 2017).

Table 3.29 Member State contributions to EU emissions of PCBs

	PCB (kg)															Change		Share in EU-27	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	1990—2020	2019—2020	1990	2020
Austria	37	18	17	19	18	18	18	19	19	18	18	20	17	18	16	-57 %	-7.8 %	0.8 %	1.3 %
Belgium	119	103	108	89	116	78	33.3	37.2	35	41	53	49	19	15	8.7	-93 %	-43.1 %	2.5 %	0.7 %
Bulgaria	14	16	11	10	3.6	7.7	4.8	4.1	3.9	2.8	3.2	3.6	3.3	2.7	2.4	-83 %	-11.7 %	0.3 %	0.2 %
Croatia	483	468	441	436	434	433	431	430	429	425	422	415	412	410	407	-16 %	-0.6 %	10.2 %	33.8 %
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11 %	11.4 %	0.0 %	0.0 %
Czechia	3.7	2.8	2.1	2.0	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.6	1.5	-59 %	-7.8 %	0.1 %	0.1 %
Denmark	2.9	2.9	2.3	1.2	0.5	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-87 %	-4.1 %	0.1 %	0.0 %
Estonia	5.0	2.9	2.5	1.7	1.3	1.3	1.2	1.3	1.2	0.8	0.9	1.0	0.9	0.6	0.6	-89 %	-10.1 %	0.1 %	0.0 %
Finland	29	29	30	31	28	27	24	23	24	24	25	23	23	20	20	-29 %	2.1 %	0.6 %	1.7 %
France	178	152	98	68	54	46	50	50	42	41	41	42	38	34	30	-83 %	-11.2 %	3.8 %	2.5 %
Germany	1 736	1 483	948	196	236	235	227	230	230	231	230	228	227	223	214	-88 %	-3.8 %	36.7 %	17.8 %
Greece	9.2	8.9	7.9	19	32	32	30	48	51	55	48	47	53	60	44	377 %	-26.4 %	0.2 %	3.6 %
Hungary	26	12	9.9	11	8.9	9.7	8.8	7.1	7.4	11	9.8	8.5	8.7	6.1	5.0	-81 %	-17.1 %	0.5 %	0.4 %
Ireland	39	33	30	32	12	10	9.4	7.6	7.1	9.2	7.0	7.2	8.4	7.8	7.4	-81 %	-5.3 %	0.8 %	0.6 %
Italy	154	166	157	179	133	139	139	124	121	114	120	122	121	116	103	-33 %	-11.3 %	3.3 %	8.6 %
Latvia	4.3	1.1	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	-97 %	-22.7 %	0.1 %	0.0 %
Lithuania	6.1	1.9	0.8	37	10	1.8	1.5	1.7	1.5	1.4	1.5	1.6	1.6	1.1	0.9	-85 %	-16.8 %	0.1 %	0.1 %
Luxembourg	40	36	12	13	19	27	9.1	4.3	5.1	3.1	3.8	3.7	3.4	3.1	2.6	-93 %	-16.7 %	0.8 %	0.2 %
Malta	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.3	0.0	-98 %	-99.8 %	0.0 %	0.0 %
Netherlands	38	22	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.2	0.2	-100 %	-30.3 %	0.8 %	0.0 %
Poland	206	190	181	173	166	181	183	186	181	182	176	183	179	156	143	-30 %	-8.3 %	4.4 %	11.9 %
Portugal	1059	854	794	670	323	251	262	140	105	86	84	96	92	89	90	-92 %	0.6 %	22.4 %	7.5 %
Romania	62	39	28	39	21	20	19	18	18	20	20	19	20	20	19	-70 %	-7.0 %	1.3 %	1.5 %
Slovakia	28	24	25	27	25	24	25	26	27	26	26	27	27	22	20	-30 %	-12.1 %	0.6 %	1.6 %
Slovenia	415	290	214	135	76	51	44	41	41	39	39	36	36	36	35	-91 %	-0.5 %	8.8 %	2.9 %
Spain	28	42	36	40	38	34	32	30	30	30	27	30	30	28	24	-15 %	-15.8 %	0.6 %	2.0 %
Sweden	9.2	9.6	9.8	9.4	9.2	9.8	8.8	8.5	9.0	9.1	9.2	9.5	9.4	9.2	8.8	-5 %	-4.8 %	0.2 %	0.7 %
EU27 (a)	**4 732**	**4 008**	**3 166**	**2 239**	**1 767**	**1 639**	**1 563**	**1 440**	**1 391**	**1 372**	**1 367**	**1 374**	**1 332**	**1 280**	**1 204**	**-75 %**	**-5.9 %**	**100 %**	**100 %**
EU27 (b)	4 715	4 007	3 165	2 238	1 767	1 638	1 563	1 440	1 391	1 372	1 367	1 374	1 332	1 280	1 204				

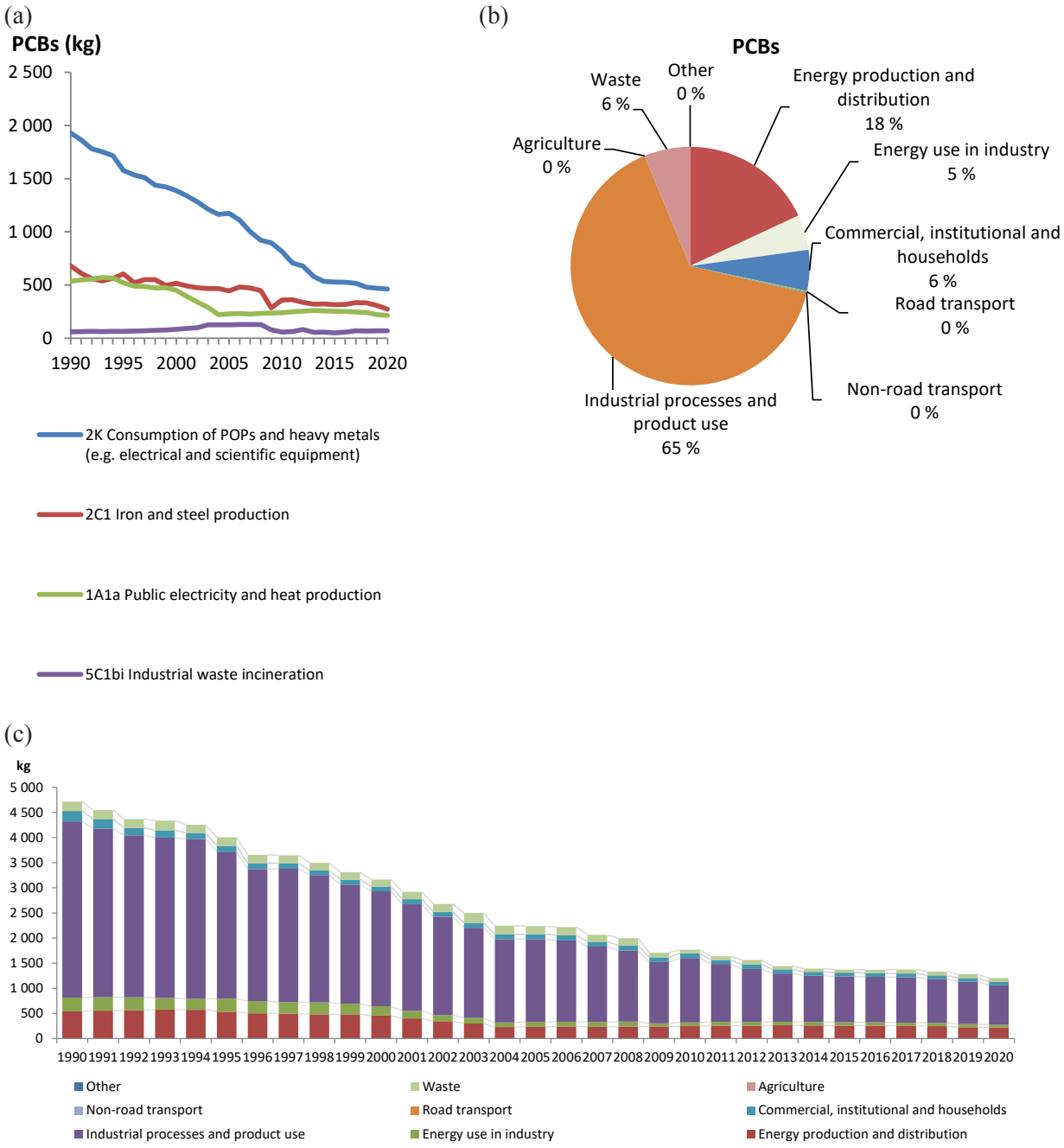
Notes: (a) Sum of national totals, as reported by EU Member States.
(b) Sum of sectors.

The category '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' was the main key category for PCB emissions, making up 38% of the total. Among the top three key categories, the highest relative reductions in emissions between 1990 and 2020 were in the principal most important category, '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' (-76.1%), the second most important category, '2C1 — Iron and steel production' (-59.9%), and in the third most important category, '1A1a — Public electricity and heat production' (--60%) (see Figure 3.25 (a)). The fourth most important key category, 'Industrial waste incineration' (5C1bi) showed an increasing trend (+14.2%) beweet 1990 and 2020.

The strong drop in PCB emissions between 2000 and 2002 in the category '2C1 — Iron and steel production' is mainly caused by data reported from Portugal. This can be explained by significant changes in the only integrated iron and steel plant operating in Portugal, in particular the end of coke and sinter production and the closure and dismantling of the blast furnace (see Portugal's IIR, pp. 3-48 and 56, listed in Appendix 5). The decrease from 2008 to 2009 can be explained by the economic recession, which negatively affected production volumes.

Figure 3.25(b) shows the contribution made by each aggregated sector group to total EU emissions. For PCBs, the most significant emission source is the industrial processes and product use sector group.

Figure 3.25 PCB emissions from key categories in the EU: (a) trend in emissions from the three most important key categories, 1990-2020; (b) share by sector group, 2020; (c) sectoral trends in emissions



4. Sectoral analysis and emission trends for key pollutants

This chapter sets out emission trends in and detailed methodologies for the key pollutants, aggregated into the following main sector groups:

- energy production and distribution;
- energy use in industry;
- industrial processes and product use;
- commercial, institutional and households;
- road transport;
- non-road transport;
- agriculture;
- waste.

Appendix 4 of this report provides a conversion chart showing how the aggregated sector groups include the individual nomenclature for reporting (NFR) source categories (see Table A4.1). Box 4.1 gives some general explanations relevant to the figures in this chapter.

Table 4.2 and the subsequent tables provide information on the relative and absolute difference between emissions reported in 2021 and 2022. Big changes in absolute terms originate from EU Member States having carried out major recalculations (e.g. France, Germany, Poland). Detailed information can be found in Section 5.1.

Box 4.1 Explanations of the figures in this chapter

- The Convention on Long-range Transboundary Air Pollution (Air Convention) formally requests Parties to report emissions of particulate matter (PM) for 2000 and thereafter. The figures in this chapter show only data from 2000 onwards.

  The figures showing indexed values (in percentages) use 1990 as the index year (1990 = 100%), except for total suspended particles (TSPs), black carbon (BC), PM with a diameter of 10 µm or less (PM_{10}) and PM with a diameter of 2.5 µm or less ($PM_{2.5}$), for which the index year is 2000 (2000 = 100%).

4.1 Sectoral analysis and emission trends for energy production and distribution

The energy production and distribution sector grouping comprises emissions from a number of activities that employ fuel combustion to produce energy products and electricity, for instance. It is a primary source of many pollutants, especially sulphur oxides (SO_X) and mercury (Hg). Despite considerable previous reductions, this sector group contributes 43% of the total EU emissions of SO_X and 38% the total EU emissions of Hg.

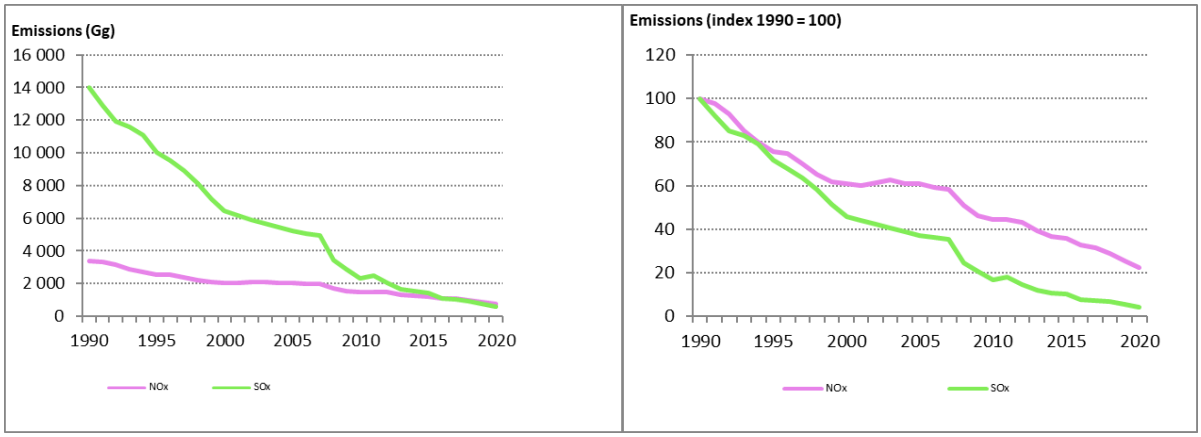
The sector is a significant source of SO_X, Hg, polychlorinated biphenyls (PCBs), cadmium (Cd), hexachlorobenzene (HCB) and nitrogen oxides (NO_X). Countries are ranked according to the size of the absolute values that they reported. In 2020, Poland, Germany and Romania contributed most (in absolute terms) to the emissions of SO_X for this sector. Poland and Germany reported the highest emissions of Hg in the same year. Germany and Poland reported the highest emissions of PCBs, and they also primarily accounted for Cd emissions in this sector in 2020. In addition, in 2020, Germany, Poland and Greece contributed most to NO_X emissions.

For emissions of the main pollutants (see Figure 4.1), between 1990 and 2020, the highest absolute and relative reduction within this aggregated sector was for SO_X (-96%). Between 1990 and 2020, NO_X emissions dropped by 78%.

The significant reduction in NO_X emissions between 2007 and 2008 was mainly because of decreases reported by Spain in the category '1A1a — Public electricity and heat production'. Furthermore, emission reductions reported for the same category in Spain are mainly responsible for the strong decline in SO_X emissions in the same year. Spain explained that the drop in both NO_X and SO_X emissions in 2008 was due to the closure of the country's main brown coal mine in 2007. In addition, the necessary retrofitting in 2008 of the adjacent thermal power plant and the introduction of abatement techniques reduced NO_X and SO_X emissions during this period (see Spain's IIR, listed in Appendix 5).

The declining trend in SO_X emissions between 1990 and 2020 mainly reflects data from Germany, Spain and Poland in the category '1A1a — Public electricity and heat production'. Since 1990, several measures have been combined to reduce emissions from these main emitting sources: switching fuel in energy-related sectors away from high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas fitting flue gas desulphurisation (FGD) abatement technology in industrial facilities; and introducing EU directives relating to the sulphur content of certain liquid fuels (EEA, 2021b).

Figure 4.1 EU emission trends in the energy production and distribution sector for NOX andS OX between 1990 and 2020



High reductions in relative terms were achieved for the heavy metals Cd (-79%) and Hg (-78%), (see Figure 4.2(a)).

HCB showed a relative reduction of -84%, whilst PCB emissions dropped by 60% from 1990 and 2019 (see Figure 4.2(b)). The peak in HCB emissions in 1995 reflects high emission values reported by Belgium in the category '1A1a — Public electricity and heat production'. These high HCB emissions were explained as the result of higher levels of sludge burning in Flanders in 1995 (personal communication from Belgium in 2017).

Figure 4.2 **EU emission trends in the energy production and distribution sector group: (a) heavy metals (Cd and Hg) and (b) persistent organic pollutants (PCBs and HCB) between 1990 and 2020**

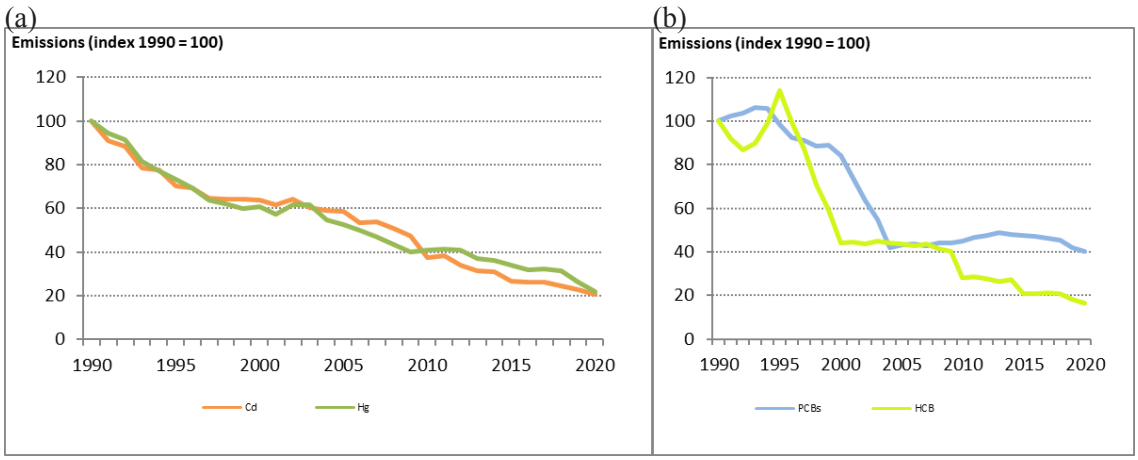


Table 4.1 indicates the number of EU Member States reporting the notation keys 'NA' (not applicable), 'NO' (not occurring), 'NR' (not relevant) and 'NE' (not estimated) within the key categories. Table 4.2 shows the recalculations within the energy production and distribution sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.1 **Number of EU Member States reporting notation keys within the key categories of the energy production and distribution sector group**

Key categories		NA	NO	NR	NE
SO_x	1A1b	0	6	0	0
SO_x	1B2aiv	2	5	0	0
Cd	1A1b	0	6	0	0
Hg	1B2aiv	6	5	0	0
HCB	1A1a	1	0	0	1
PCB	1A1a	0	0	0	1

Note: Only those key categories where notation keys are reported are considered.

Table 4.2 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the energy production and distribution sector group**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	0 %
NMVOCs	0 %	0 %	1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	-1 %	-1 %	0 %	0 %	0 %	0 %	1 %
SOx	2 %	4 %	4 %	3 %	3 %	4 %	4 %	4 %	-3 %	5 %	0 %	-1 %	-2 %	-1 %	-1 %	-1 %	-2 %	-3 %
NH_3	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-3 %	-9 %	-9 %	-9 %	-10 %	-27 %
TSPs	0 %	-2 %	-1 %	0 %	0 %	-1 %	1 %	0 %	-2 %	-1 %	0 %	0 %	0 %	1 %	2 %	3 %	3 %	4 %
CO	1 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	0 %	1 %	0 %	1 %	0 %	7 %	9 %	9 %	10 %	11 %
Pb	0 %	1 %	-1 %	-9 %	-10 %	-12 %	-12 %	-10 %	-17 %	-14 %	-19 %	-22 %	-21 %	-20 %	-22 %	-23 %	-22 %	-2 %
Cd	1 %	1 %	1 %	1 %	1 %	2 %	2 %	2 %	2 %	4 %	-2 %	-3 %	-2 %	-1 %	-1 %	-1 %	0 %	5 %
Hg	3 %	3 %	4 %	4 %	3 %	4 %	4 %	4 %	2 %	5 %	0 %	-1 %	-1 %	0 %	0 %	0 %	0 %	3 %
As	4 %	8 %	6 %	-4 %	-5 %	-7 %	-6 %	-5 %	-12 %	-5 %	-18 %	-22 %	-21 %	-16 %	-19 %	-21 %	-20 %	0 %
Cr	2 %	4 %	4 %	-1 %	-1 %	-1 %	-2 %	-1 %	-4 %	-1 %	-8 %	-9 %	-8 %	-6 %	-7 %	-8 %	-7 %	3 %
Cu	-1 %	-4 %	-3 %	-3 %	-3 %	-4 %	-2 %	-1 %	-2 %	-2 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	-2 %
Ni	1 %	1 %	1 %	1 %	1 %	-1 %	0 %	1 %	0 %	0 %	0 %	-1 %	-1 %	0 %	0 %	-1 %	0 %	1 %
Se	50 %	47 %	41 %	39 %	39 %	42 %	36 %	32 %	29 %	40 %	4 %	5 %	5 %	4 %	5 %	6 %	6 %	24 %
Zn	1 %	0 %	0 %	-4 %	-5 %	-6 %	-6 %	-4 %	-7 %	-5 %	-7 %	-8 %	-7 %	-4 %	-4 %	-4 %	-3 %	5 %
PCDD/Fs	0 %	0 %	0 %	0 %	2 %	2 %	1 %	2 %	1 %	2 %	-8 %	-8 %	-6 %	-7 %	3 %	3 %	4 %	-9 %
B(a)P	0 %	0 %	0 %	0 %	0 %	0 %	1 %	2 %	0 %	1 %	0 %	3 %	3 %	4 %	5 %	6 %	6 %	7 %
B(b)F	0 %	0 %	0 %	1 %	1 %	1 %	2 %	5 %	1 %	3 %	1 %	5 %	6 %	8 %	10 %	10 %	12 %	11 %
B(k)F	0 %	0 %	0 %	0 %	0 %	0 %	0 %	3 %	0 %	2 %	0 %	3 %	4 %	5 %	7 %	8 %	8 %	8 %
IP	0 %	0 %	0 %	-1 %	0 %	0 %	0 %	2 %	-1 %	1 %	0 %	3 %	4 %	5 %	7 %	8 %	9 %	8 %
Total PAHs	-19 %	-13 %	-39 %	-39 %	-36 %	-34 %	-29 %	-21 %	-21 %	-20 %	-22 %	-20 %	-21 %	-22 %	-21 %	-20 %	-19 %	-18 %
HCB	-1 %	-1 %	-3 %	-3 %	-3 %	-4 %	-4 %	-6 %	-9 %	-9 %	-8 %	-8 %	-9 %	-11 %	-10 %	-10 %	-9 %	-11 %
PCBs	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	3 %	3 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			3 %	6 %	7 %	8 %	6 %	6 %	5 %	5 %	8 %	6 %	7 %	4 %	7 %	6 %	7 %	6 %
PM_{10}			1 %	3 %	4 %	4 %	3 %	3 %	0 %	2 %	1 %	1 %	2 %	2 %	4 %	4 %	5 %	5 %
BC			-6 %	-1 %	2 %	-5 %	-3 %	-3 %	-10 %	-21 %	-2 %	-4 %	0 %	4 %	11 %	13 %	17 %	15 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	11	18	13	11	13	13	13	14	12	26	5	4	5	6	8	8	8	3
NMVOCs	-4	-3	8	-7	-4	-4	-4	-4	-7	-3	-2	-3	-3	-2	-1	-1	-2	3
SOx	294	349	220	174	167	202	135	122	-64	121	-6	-24	-32	-13	-14	-12	-14	-23
NH_3	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-3
TSPs	-10	-13	-4	-1	-2	-3	2	0	-5	-2	1	0	1	2	3	3	4	5
CO	10	0	1	1	2	3	4	4	3	7	2	4	2	47	61	62	67	70
Pb	2	2	-2	-20	-20	-26	-23	-18	-27	-21	-29	-33	-31	-23	-27	-28	-25	-2
Cd	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Hg	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1
As	6	5	3	-2	-2	-4	-3	-2	-5	-2	-8	-9	-9	-6	-7	-8	-7	0
Cr	4	4	3	-1	-1	-1	-1	-1	-3	-1	-5	-6	-6	-4	-5	-5	-5	2
Cu	-4	-5	-3	-3	-3	-4	-2	-1	-1	-1	0	0	0	0	1	1	1	-1
Ni	9	5	9	4	3	-4	1	2	-1	1	-1	-2	-2	0	-1	-1	-1	2
Se	41	36	31	30	29	33	27	22	20	28	3	3	3	2	3	3	3	10
Zn	7	2	2	-16	-17	-24	-19	-13	-23	-18	-22	-27	-23	-11	-12	-12	-9	11
PCDD/Fs	2	2	2	2	2	2	2	2	1	2	-9	-9	-6	-7	3	3	4	-8
B(a)P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
B(k)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	-50	-20	-15	-13	-12	-11	-8	-4	-5	-5	-5	-4	-4	-4	-4	-4	-4	-3
HCB	-2	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-3
PCBs	-3	0	1	0	0	0	0	1	0	1	0	1	1	0	0	0	8	7
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			5	7	7	8	5	4	4	4	5	3	4	2	3	3	3	2
PM_{10}			4	7	8	7	5	4	0	3	1	1	2	2	3	3	4	4
BC			-1	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0

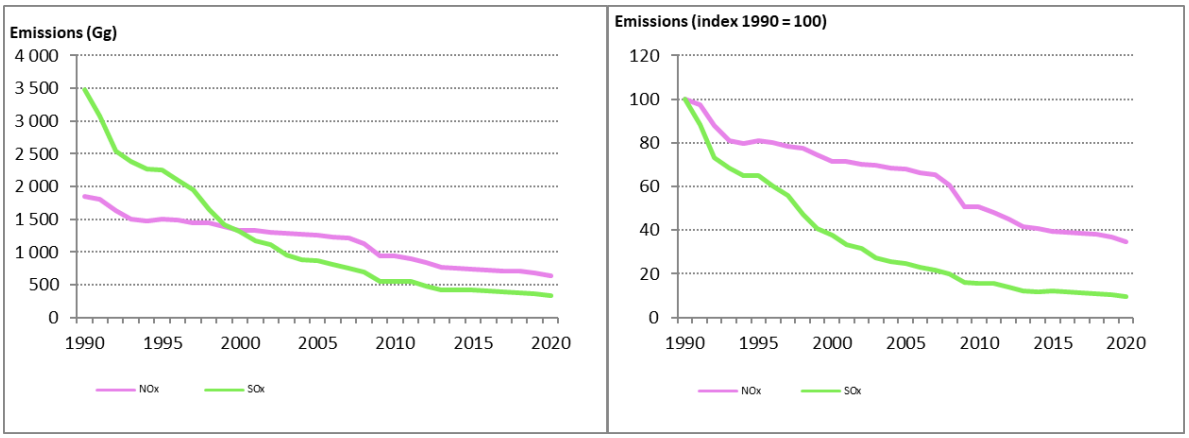
Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; PCBs, polychlorinated biphenyls; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.2 Sectoral analysis and emission trends for energy use in industry sector

Energy use in the industry sector is a significant source of heavy metals (HMs) and SO_X. According to the size of the absolute values reported, Italy, France and Poland contributed most to lead (Pb) emissions in this sector in 2020. For Cd, Poland, Italy and France reported the highest emissions, while Italy and France contributed most to Hg emissions. In addition, in 2020, Poland, France and Spain contributed most to SO_X emissions.

Energy use (fuel combustion) in industry is a significant source of many pollutants. For the main ones, the highest absolute and relative reduction (-90%) between 1990 and 2020 was for SO_X (see Figure 4.3).

Figure 4.3 **EU emission trends in the energy use in industry sector group for NO_x and SO_x between 1990 (2000) and 2020**



Of the three HMs, Cd shows the biggest reduction in relative terms (81% decrease) (see Figure 4.4(a)).

Pb emissions fell between 1996 and 1997 after a minor peak in 1995, decreased considerably between 2008 and 2009, and increased again afterwards. This pattern was mainly the result of data reported by Italy and France in the categories '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel', '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' and '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'.

The increase in Hg emissions between 1994 and 1995 can be linked to higher emissions reported by Spain for the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. Stationary combustion in non-metallic minerals manufacturing industries (1A2f) accounted for 87% of total Hg emissions in this sector in 1990 but its emissions had fallen by 75% by 2020. This reduction resulted from the implementation of abatement techniques in thermal power plants and the shift from coal power plants to combined cycle gas turbine plants (see Spain's IIR, listed in Appendix 5). The strong decline in Hg emissions between 2008 and 2009 was mainly due to reductions reported by Italy in the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' and may have been caused by the economic crisis in 2009.

The high Cd emissions from 1994 to 1997 mainly reflect the high levels reported by Spain in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'.
The drop in Cd emissions between 2008 and 2009 was caused by reductions noted by several countries, in particular in the categories '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (Italy and France) and '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' (France).

HCB registered the largest reduction, compared with 1990 values, of 99% up to 2020. Figure 4.4 presents trends for these pollutants.

Figure 4.4 **EU emission trends in the energy use in industry sector group for HMs (Pb, Cd and Hg)**

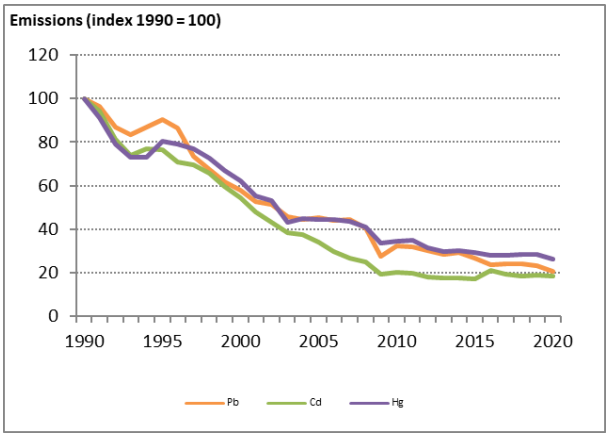


Table 4.3 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.4 shows the recalculations within the energy use in industry sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.3 **Number of EU Member States reporting notation keys within the key categories of the energy use in industry sector group**

Key categories		NA	NO	NR	NE
NO_x	1A2f	0	1	0	0
NO_x	1A2gviii	0	1	0	0
SO_x	1A2a	0	1	0	0
SO_x	1A2c	0	1	0	0
SO_x	1A2f	0	1	0	0
SO_x	1A2gviii	0	1	0	0
$PM_{2.5}$	1A2f	0	1	0	0
$PM_{2.5}$	1A2gviii	0	1	0	0
PM_{10}	1A2gviii	0	1	0	0
CO	1A2a	0	1	0	0
Pb	1A2a	1	1	0	0
Pb	1A2f	0	1	0	0
Cd	1A2d	2	1	0	0
Cd	1A2f	0	1	0	0
Cd	1A2gviii	0	1	0	0
Hg	1A2a	0	1	0	0
Hg	1A2b	0	2	0	1
Hg	1A2d	1	1	0	0
Hg	1A2f	0	1	0	0
PCDD/Fs	1A2b	0	2	0	0
HCB	1A2b	2	3	0	7

Note: Only the key categories where notation keys were reported are considered.

Table 4.4 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the energy use in industry sector group.**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	-1 %	-1 %	0 %	-1 %	-1 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %
NMVOCs	0 %	1 %	1 %	0 %	-1 %	0 %	-1 %	-1 %	-2 %	-2 %	-2 %	-3 %	-3 %	-4 %	-1 %	-1 %	-1 %	-1 %
SOx	2 %	1 %	2 %	-1 %	1 %	1 %	1 %	3 %	1 %	3 %	0 %	-2 %	-1 %	-2 %	-2 %	-2 %	-1 %	-2 %
NH_3	-1 %	0 %	-1 %	-2 %	-2 %	-2 %	-2 %	0 %	-1 %	-3 %	-4 %	-4 %	-3 %	-5 %	0 %	-1 %	1 %	4 %
TSPs	-2 %	-2 %	-5 %	-6 %	-6 %	-6 %	-7 %	-5 %	-5 %	-6 %	-6 %	-7 %	-6 %	-7 %	-6 %	-7 %	-6 %	-5 %
CO	-4 %	-3 %	-3 %	-4 %	-5 %	-5 %	-6 %	-6 %	-7 %	-8 %	-9 %	-9 %	-9 %	-9 %	-8 %	-9 %	-8 %	-8 %
Pb	-11 %	-16 %	-23 %	-24 %	-23 %	-23 %	-37 %	-26 %	-19 %	-20 %	-23 %	-25 %	-27 %	-27 %	-34 %	-34 %	-34 %	-34 %
Cd	-9 %	-7 %	-10 %	-13 %	-14 %	-13 %	-15 %	-12 %	-8 %	-8 %	-10 %	-11 %	-21 %	-11 %	-10 %	-10 %	-11 %	-11 %
Hg	-5 %	-4 %	-4 %	-6 %	-7 %	-6 %	-7 %	-5 %	-4 %	-3 %	-5 %	-6 %	-5 %	-6 %	-9 %	-9 %	-8 %	-8 %
As	-15 %	-15 %	-4 %	-24 %	-24 %	-19 %	-7 %	-17 %	-5 %	-6 %	-7 %	-7 %	-10 %	-12 %	-19 %	-19 %	-18 %	-18 %
Cr	-13 %	-7 %	-7 %	-11 %	-14 %	-10 %	-12 %	-9 %	-7 %	-8 %	-9 %	-9 %	-11 %	-12 %	-12 %	-13 %	-12 %	-11 %
Cu	-38 %	-33 %	-32 %	-52 %	-54 %	-46 %	-11 %	-36 %	-10 %	-11 %	-12 %	-13 %	-13 %	-14 %	-30 %	-30 %	-30 %	-30 %
Ni	1 %	-1 %	0 %	-9 %	-10 %	-9 %	-2 %	-5 %	-1 %	-2 %	-3 %	-3 %	-5 %	-3 %	-4 %	-5 %	-5 %	-5 %
Se	-64 %	-33 %	-11 %	-41 %	-46 %	-45 %	-47 %	-51 %	-49 %	-53 %	-52 %	-55 %	-59 %	-60 %	-64 %	-64 %	-61 %	-61 %
Zn	-12 %	-7 %	-26 %	-16 %	-18 %	-15 %	-13 %	-15 %	-12 %	-13 %	-14 %	-16 %	-18 %	-17 %	-29 %	-28 %	-28 %	-27 %
PCDD/Fs	-1 %	-3 %	-5 %	-6 %	-6 %	-5 %	-4 %	-4 %	-3 %	-2 %	-3 %	-4 %	-4 %	-4 %	1 %	0 %	-4 %	-8 %
B(a)P	-5 %	-3 %	-8 %	-10 %	-8 %	-9 %	-11 %	-9 %	-13 %	-11 %	-10 %	-13 %	-12 %	-13 %	-12 %	-13 %	-11 %	-10 %
B(b)F	-5 %	-3 %	-7 %	-8 %	-7 %	-8 %	-9 %	-8 %	-11 %	-10 %	-9 %	-11 %	-10 %	-10 %	-9 %	-10 %	-9 %	-7 %
B(k)F	-5 %	-3 %	-8 %	-9 %	-8 %	-9 %	-10 %	-8 %	-11 %	-9 %	-9 %	-11 %	-10 %	-11 %	-11 %	-11 %	-10 %	-9 %
IP	-5 %	-4 %	-8 %	-10 %	-9 %	-10 %	-11 %	-9 %	-12 %	-11 %	-11 %	-13 %	-12 %	-12 %	-11 %	-12 %	-10 %	-9 %
Total PAHs	-7 %	-7 %	-15 %	-18 %	-19 %	-21 %	-22 %	-19 %	-24 %	-26 %	-24 %	-27 %	-27 %	-28 %	-28 %	-29 %	-28 %	-27 %
HCB	0 %	28 %	69 %	71 %	71 %	72 %	66 %	64 %	51 %	57 %	11 %	4 %	4 %	67 %	63 %	75 %	71 %	73 %
PCBs	-3 %	1 %	2 %	3 %	4 %	4 %	3 %	4 %	5 %	9 %	6 %	5 %	8 %	8 %	8 %	8 %	8 %	8 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			-1 %	-2 %	-2 %	-1 %	-2 %	-1 %	-2 %	-1 %	-2 %	-3 %	-2 %	-2 %	-2 %	-4 %	-2 %	-1 %
PM_{10}			-1 %	-3 %	-2 %	-2 %	-3 %	-2 %	-3 %	-2 %	-3 %	-4 %	-3 %	-3 %	-4 %	-5 %	-3 %	-2 %
BC			1 %	-1 %	-1 %	0 %	-3 %	-1 %	-3 %	-7 %	-7 %	-9 %	-9 %	-10 %	-5 %	-9 %	-4 %	-4 %

(b)

Absolute difference																	
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NO_x	-28	-9	0	-7	-9	-3	-4	-3	-2	-6	-9	-5	-7	-8	-6	-7	-7
NMVOCs	0	2	2	0	-1	0	-1	-1	-3	-3	-3	-4	-5	-5	-1	-2	-2
SOx	67	28	29	-6	5	9	5	14	3	17	-1	-8	-6	-7	-7	-7	-6
NH_3	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
TSPs	-14	-8	-13	-12	-11	-11	-11	-6	-7	-7	-8	-8	-7	-8	-7	-9	-7
CO	-155	-98	-89	-115	-129	-129	-146	-119	-146	-162	-156	-155	-158	-161	-145	-159	-137
Pb	-84	-119	-120	-97	-94	-90	-165	-67	-55	-58	-61	-65	-74	-69	-85	-88	-86
Cd	-4	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-2	-1	-1	-1	-1
Hg	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	-1	-1	-1
As	-12	-9	-3	-11	-12	-9	-2	-5	-1	-1	-1	-1	-2	-2	-2	-2	-2
Cr	-15	-6	-4	-7	-9	-7	-7	-4	-3	-4	-4	-4	-4	-5	-5	-5	-5
Cu	-88	-61	-44	-83	-86	-64	-9	-32	-7	-8	-8	-9	-8	-9	-18	-18	-18
Ni	6	-3	0	-19	-21	-15	-3	-7	-2	-2	-3	-3	-4	-2	-3	-3	-3
Se	-38	-10	-2	-12	-15	-15	-15	-14	-14	-16	-15	-16	-19	-20	-22	-23	-21
Zn	-144	-74	-227	-106	-115	-91	-78	-73	-63	-69	-74	-81	-87	-82	-137	-134	-134
PCDD/Fs	-10	-21	-16	-18	-18	-15	-10	-6	-6	-4	-4	-6	-6	-6	1	0	-6
B(a)P	-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
B(b)F	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
B(k)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	-5	-4	-6	-7	-8	-8	-8	-5	-7	-7	-7	-7	-7	-8	-8	-8	-8
HCB	3	3	5	5	6	6	5	4	4	4	3	4	5	4	4	5	4
PCBs	-9	2	4	3	4	4	3	2	3	6	4	3	5	5	5	5	5
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
$PM_{2.5}$			-1	-2	-2	-1	-2	-1	-2	-1	-2	-2	-1	-2	-2	-4	-1
PM_{10}			-2	-4	-3	-3	-4	-2	-3	-2	-3	-4	-2	-3	-3	-5	-3
BC			0	0	0	0	-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1

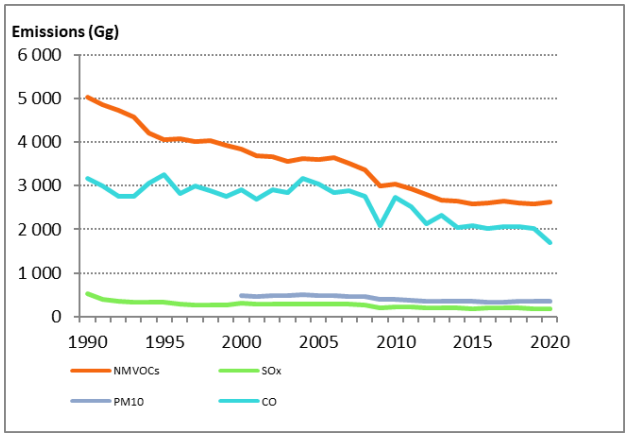
Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; PCBs, polychlorinated biphenyls; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.3 Sectoral analysis and emission trends for the industrial processes and product use sector

The industrial processes and product use sector grouping refers to emissions from industrial sources other than those arising from fuel combustion within the industrial sector. This is the primary sector group for PCB, Pb, non-methane volatile organic compound (NMVOC) and Cd emissions, as well as a significant source of total Hg, HCB, particulate matter with a diameter of 10 µm or less (PM_{10}), polychlorinated dibenzodioxin/dibenzofuran (PCDD/F), SO_X and carbon monoxide (CO) emissions. Countries are ranked according to the size of the absolute values they reported. Italy, Germany and Greece contributed most to PCB emissions in this sector in 2020. Of all the countries that reported data, Germany, Italy and France contributed most to NMVOC emissions. For HCB emissions, the largest contributions were reported by Finland and Austria. For Pb, the greatest contributions came from Poland, Germany and Italy. The EU Cd emission value is mainly driven by data reported by Germany, Poland and Spain. Figure 4.5 shows previous trends in emissions of the relevant main pollutants.

Data from France and Germany for the category '2C1 — Iron and steel production' have a great influence on the trend in CO emissions. In France, CO emissions from the 2C1 category have fluctuated over the years, depending on the amount of blast furnace gas that has been produced, reused or flared. These amounts depend on the operating conditions and how feasible it is for iron and steel or colliery plants to reuse the gas being produced continuously by blast furnaces. This may fluctuate a great deal from one year to another, resulting in peaks (1995, 2004 and 2010) or troughs (1992, 2001 and 2009) (personal communication from France in 2013). The negative peak in 2009 was also influenced by the data reported by several countries, mainly Belgium, France and Germany, in the category '2C1 — Iron and steel production'.

Figure 4.5 **EU emission trends in the industrial processes and product use sector group for NMVOCs, SO_x, PM_{10} and CO between 1990 (2000) and 2020**



Despite considerable reductions since 1990, the industrial processes and product use sector continues to contribute significantly to total EU emissions of HMs. Figure 4.6(a) presents emission trends for these pollutants. Pb shows the highest relative reduction in emissions between 1990 and 2020 (-83%).

The trend in Cd emissions between 1990 and 2007 mainly reflects data reported by Germany in the categories '2C1 — Iron and steel' and '2C7a — Copper production'.

The trend from 1990 to 1997 mainly shows the data reported by Romania in the category '2C1 — Iron and steel production'. The dip in Pb emissions between 2008 and 2009 was mainly caused by reductions in the category '2C1 — Iron and steel production' in several countries, such as Belgium, Latvia, Italy, Poland and Germany, presumably as a result of the economic crisis in 2009. The reduction in Pb emissions between 2010 and 2011 reflected the drastic drop in emissions reported by Latvia in the category '2C1 — Iron and steel production' resulting from a change in the type of furnace used in metal production. Overall, between 2010 and 2011, Latvia's total Pb emissions (national total) fell by 99.7% (see Latvia's IIR, listed in Appendix 5).

Among the persistent organic pollutants (POPs), HCB recorded the highest relative reduction (99%) between 1990 and 2020 (Figure 4.6(b)).

The massive decrease in HCB from 2001 to 2002 (89%) is a result of Germany's reporting the notation key 'NA' in this category. The country's secondary aluminium production has been prohibited by law in Germany since 2002, resulting in the omission of the source of HCB (see Germany's IIR, listed in Appendix 5)

Figure 4.6 **EU emission trends in the industrial processes and product use sector group: (a) HMs (Pb, Cd, Hg) and (b) POPs (PCDD/Fs, HCB, PCBs) between 1990 and 2020**

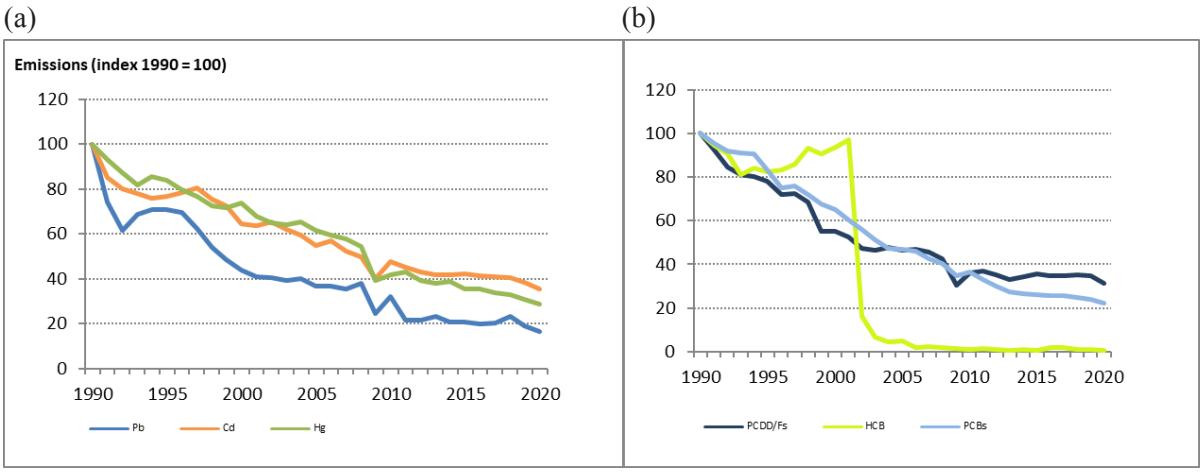


Table 4.5 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.6 shows the recalculations within the industrial processes and product use sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.5 **Number of EU Member States reporting notation keys within the key categories of the industrial processes and product use sector group**

Key categories		NA	NO	NR	NE
NMVOC	2D3e	0	1	0	1
NMVOC	2D3g	0	0	0	1
NMVOC	2D3h	0	0	0	1
NMVOC	2D3i	2	1	0	0
SO_x	2B10a	1	5	0	2
SO_x	2C1	2	4	0	2
$PM_{2.5}$	2A5b	1	0	0	0
PM_{10}	2A5a	1	2	0	1
PM_{10}	2A5b	1	0	0	0
PM_{10}	2D3b	0	0	0	2
PM_{10}	2L	7	13	0	1
CO	2C1	1	4	0	2
Pb	2A3	2	3	0	0
Pb	2C1	0	4	0	0
Pb	2C5	0	9	0	0
Cd	2A3	2	3	0	0
Cd	2C1	1	4	0	0
Cd	2C6	1	12	0	0
Cd	2C7a	0	11	0	1
Hg	2A1	6	1	0	5
Hg	2C1	1	4	0	0
Hg	2C6	2	12	0	0
PCDD/Fs	2C1	0	4	0	1
Total PAHs	2C1	1	4	0	2
HCB	2B10a	13	5	0	7
HCB	2C1	1	3	0	5
HCB	2C7a	4	12	0	5
PCB	2C1	0	4	0	0
PCB	2K	8	7	0	5

Note: Only the key categories where notation keys were reported are considered.

Table 4.6 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the industrial processes and product use sector group.**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	2 %	1 %	-1 %	1 %	1 %	-1 %	-1 %	-8 %	-9 %	-9 %	-10 %	-10 %	-11 %	-11 %	-11 %	-12 %	-11 %	-12 %
NMVOCs	0 %	1 %	0 %	0 %	0 %	-1 %	-1 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-3 %
SOx	-3 %	-4 %	-4 %	-4 %	-4 %	-3 %	-4 %	-5 %	-6 %	-6 %	-4 %	-4 %	-4 %	-4 %	-4 %	-3 %	-4 %	-7 %
NH_3	-2 %	-3 %	-1 %	-6 %	-7 %	-5 %	-5 %	0 %	-2 %	-8 %	-8 %	-10 %	-10 %	-12 %	-10 %	-7 %	-8 %	-9 %
TSPs	4 %	-6 %	-4 %	-9 %	-8 %	-9 %	-9 %	-11 %	-8 %	-10 %	-8 %	-8 %	-4 %	-8 %	-7 %	-9 %	-6 %	-9 %
CO	2 %	1 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %
Pb	1 %	15 %	2 %	1 %	1 %	-1 %	15 %	0 %	10 %	-1 %	-1 %	12 %	-1 %	-1 %	-2 %	-2 %	15 %	-2 %
Cd	12 %	10 %	4 %	14 %	13 %	9 %	5 %	1 %	2 %	1 %	1 %	2 %	1 %	2 %	1 %	2 %	2 %	2 %
Hg	2 %	2 %	3 %	4 %	2 %	1 %	3 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	2 %	1 %	1 %	0 %
As	1 %	3 %	2 %	5 %	5 %	3 %	4 %	0 %	3 %	1 %	1 %	5 %	1 %	1 %	1 %	1 %	5 %	0 %
Cr	1 %	1 %	-1 %	3 %	2 %	1 %	-1 %	-2 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %
Cu	6 %	4 %	5 %	5 %	5 %	4 %	1 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	4 %	4 %
Ni	2 %	2 %	-1 %	4 %	3 %	2 %	-1 %	-2 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %
Se	7 %	3 %	3 %	-1 %	-2 %	-4 %	-6 %	-9 %	-9 %	-14 %	-15 %	-16 %	-16 %	-17 %	-18 %	-17 %	-19 %	-21 %
Zn	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	-1 %	-1 %	0 %	0 %
PCDD/Fs	0 %	-1 %	4 %	0 %	1 %	1 %	1 %	0 %	1 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	3 %
B(a)P	-5 %	-3 %	-2 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	6 %
B(b)F	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	5 %
B(k)F	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	5 %
IP	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	12 %
Total PAHs	-12 %	-12 %	-13 %	-9 %	-8 %	-9 %	-10 %	-11 %	-12 %	-12 %	-12 %	-13 %	-14 %	-13 %	-12 %	-13 %	-12 %	-12 %
HCB	12 %	7 %	4 %	0 %	0 %	0 %	1 %	1 %	3 %	2 %	2 %	1 %	1 %	1 %	0 %	0 %	1 %	1 %
PCBs	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	1 %	1 %	2 %	1 %	0 %	0 %	1 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			0 %	-3 %	-3 %	-3 %	-4 %	-5 %	-3 %	-5 %	-3 %	-3 %	-2 %	-3 %	-4 %	-4 %	-3 %	-5 %
PM_{10}			0 %	-2 %	-2 %	-3 %	-3 %	-5 %	-2 %	-4 %	-3 %	-2 %	0 %	-3 %	-2 %	-4 %	-1 %	-5 %
BC			57 189 %	49 437 %	40 758 %	181 %	322 %	150 %	189 %	199 %	251 %	147 %	84 %	133 %	130 %	161 %	309 %	153 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	8	2	-2	3	3	-3	-3	-14	-18	-18	-18	-19	-21	-20	-20	-22	-21	-21
NMVOCs	16	23	17	0	-16	-28	-19	-5	-16	-16	-17	-17	-25	-30	-26	-36	-56	-68
SOx	-15	-13	-12	-11	-11	-9	-12	-10	-13	-13	-9	-8	-8	-9	-8	-7	-8	-15
NH_3	-2	-2	-1	-3	-4	-3	-3	0	-1	-4	-4	-4	-4	-5	-4	-3	-3	-4
TSPs	60	-68	-58	-140	-118	-123	-132	-146	-92	-117	-91	-79	-39	-88	-69	-95	-61	-95
CO	54	44	49	52	57	56	56	42	48	48	44	45	47	48	48	48	47	45
Pb	14	215	17	13	10	-5	118	-2	67	-6	-5	58	-6	-4	-9	-8	71	-10
Cd	7	4	2	4	4	3	1	0	1	0	0	0	0	0	0	0	1	0
Hg	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
As	3	3	1	2	2	1	1	0	1	0	0	1	0	0	0	0	1	0
Cr	6	3	-1	4	3	2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Cu	21	12	13	14	13	10	2	-1	0	1	1	1	2	4	3	3	11	11
Ni	6	2	-1	3	3	2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Se	1	1	1	0	-1	-1	-1	-2	-2	-3	-3	-3	-3	-3	-3	-3	-4	-4
Zn	4	0	3	-5	6	2	15	3	3	3	4	6	5	7	-14	-9	-5	-4
PCDD/Fs	-3	-7	19	-1	4	2	4	0	4	6	6	6	6	7	5	7	7	8
B(a)P	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(k)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	-24	-20	-15	-9	-9	-10	-10	-7	-9	-9	-9	-9	-9	-9	-9	-9	-9	-8
HCB	-3569	-3073	-3590	-191	-82	-95	-71	-59	-32	-62	-34	-31	-35	-29	-71	-75	-43	-33
PCBs	-10	-11	-13	-16	-9	-11	-12	-8	-11	-12	-11	7	9	14	7	1	4	11
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			0	-5	-5	-5	-7	-7	-4	-7	-4	-4	-3	-3	-4	-5	-4	-6
PM_{10}			1	-12	-10	-13	-15	-21	-9	-15	-11	-8	0	-11	-6	-13	-4	-18
BC			2044	2531	2011	8	16	7	8	8	9	5	3	4	4	4	9	5

Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.4 Sectoral analysis and emission trends for the commercial, institutional and households sector

As indicated in Chapter 2, fuel combustion in commercial and institutional facilities and households makes a significant contribution to the total emissions of many pollutants.

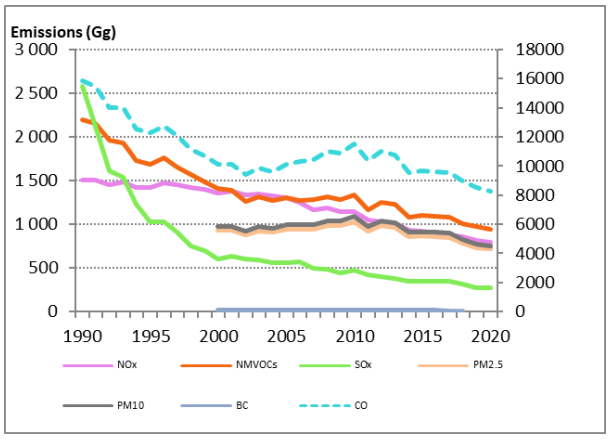
The commercial, institutional and households sector is the primary sector group for B(a)P, PAHs, $PM_{2.5}$, CO, BC, PM_{10} and PCDD/Fs, and is an important sector group for Cd, HCB, SO_X, NO_X and NMVOC emissions. Countries are ranked according to the size of the absolute values that they reported. For B(a)P and PAHs, the greatest contributions were reported by Poland. For primary $PM_{2.5}$ and PM_{10}, Poland, Romania and Italy reported the highest emissions. Poland, Italy and France contributed most to CO emissions. Poland, Romania and Italy emitted the largest proportion of PCDD/F in 2020.

Of the main pollutants, once again the highest relative reduction between 1990 and 2020 for the sector grouping was for SO_X (-90%). In contrast, PM emissions have changed little since 2000 (see Figure 4.7).

The drop in CO emissions between 1990 and 1992 reflects data from Germany in the categories '1A4ai — Commercial/institutional: Stationary' and '1A4bi — Residential: Stationary'. Germany explained that the main driver of the CO emission trends was declining lignite consumption. Since 1990, fuel use has changed from solid fuels, causing high CO emissions, to gaseous fuels, producing much lower emissions (see Germany's IIR, listed in Appendix 5). The increase in CO emissions from 1992 to 1993 reflects data from Poland in the category '1A4bi — Residential: Stationary'. The peak in 1996 reflects data from France and Poland in the same category. Low CO emissions in 2002 and the decreases in 2011 and 2014 reflect data from Italy and France for the category '1A4bi — Residential: Stationary'.

Lower SO_X and NMVOC emissions between 1990 and 1992 were the result of reductions in these air pollutants in Germany. The Member State explained that lower SO_X emissions resulted from the fuel switch from coal (especially lignite with a high emission factor) to natural gas (with a lower emission factor). From 2008 onwards, a further reduction in sulphur dioxide (SO_2) emissions can be explained by the increasing use of fuel oil with low sulphur content. The main reason behind the NMVOC emissions reported by Germany is reduced lignite consumption. In the residential sector, the trend in emissions is also affected by the increasing use of firewood with high emission factors, which counteracts the reduction in SO_2 emissions. Since 1990, fuel use has changed from solid fuels causing high NMVOC emissions to gaseous fuels producing much lower emissions (see Germany's IIR, listed in Appendix 5). The small peak for NMVOC emissions in 1996 is mainly caused by emission data reported by France and Romania in the category '1A4bi — Residential: Stationary'. The data reported by Poland, Germany and France in the category '1A4bi — Residential: Stationary' were the main cause of the dip in NMVOC emissions in 2011.

Figure 4.7 **EU emission trends in the commercial, institutional and households sector group for NO_X, NMVOCs, SO_X, $PM_{2.5}$, PM_{10}, BC and CO between 1990 (2000) and 2020**



Notes: The right-hand axis shows values for CO.

Of the three HMs in the commercial, institutional and households sector, Pb shows the largest reduction, both absolutely and relatively (-71%) (see Figure 4.8(a)).

Since 1990 the trend in Cd emissions has shown an increasing trend in the category '1A4bi — Residential: Stationary' with some fluctuations, mainly related to emissions reported by Poland and Romania.

Poland and Germany contribute most to the trend Pb emission trend. The fall in Pb emissions from 1990 to 1992 is the result of emission reductions reported by several countries, especially Germany and Italy, which reduced their emissions considerably in the categories '1A5b — Other, mobile (including military, land based and recreational boats)' and '1A4cii — Agriculture/forestry/fishing: Off-road vehicles and other machinery'. The small peak in Pb emissions in 2010 relates to Poland's and Germany's emission data in the categories '1A4bi — Residential: Stationary' and '1A4ai — Commercial/institutional: Stationary', respectively.

Among the POPs relevant to the commercial, institutional and households sector, the highest absolute and relative reduction occurred for HCB (-82%) (see Figure 4.8 (b)).

The trend in total emissions of PAHs largely reflects data from Poland, Germany and Italy in the category '1A4bi — Residential: Stationary'. The peaks in 2010 and 2012 reflect data reported by Germany and Poland in the '1A4bi' category. Emissions from Poland reported in the same category caused the peak in total PAHs and B(a)P total emissions in 1993.

Figure 4.8 **EU emission trends in the commercial, institutional and households sector group: (a) HMs (Pb and Cd) and (b) POPs (PCDD/Fs, total PAHs, B(a)P and HCB) between 1990 and 2020**

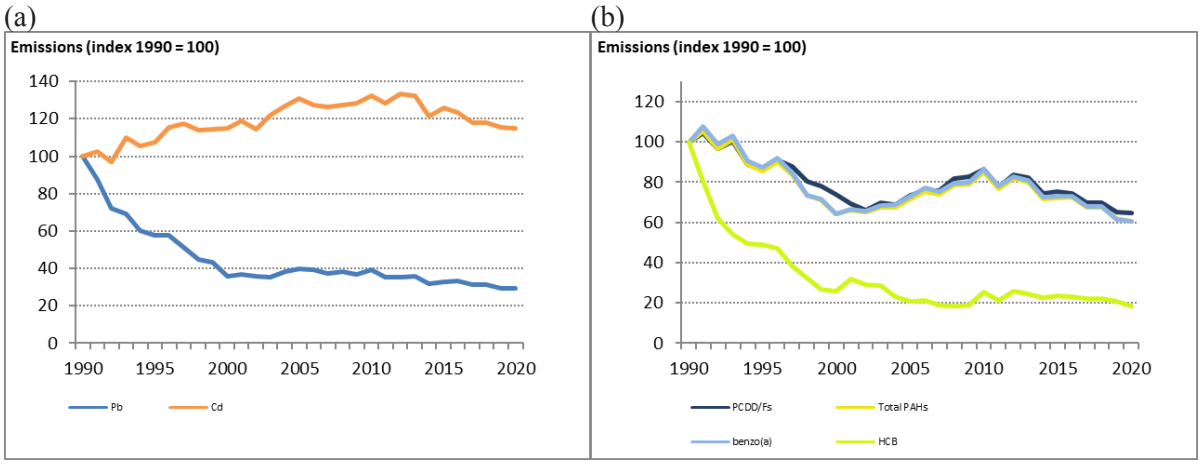


Table 4.7 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.8 shows the recalculations within the commercial, institutional and households sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.7 **Number of EU Member States reporting notation keys within the key categories of the industrial processes and product use sector group**

Key categories		NA	NO	NR	NE
$PM_{2.5}$	1A4ci	0	1	0	0
PM_{10}	1A4ci	0	1	0	0

Note: Only those key categories where notation keys are reported are considered.

Table 4.8 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the commercial, institutional and households sector group**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %
NMVOCs	1 %	2 %	1 %	1 %	2 %	2 %	2 %	2 %	3 %	4 %	4 %	5 %	5 %	5 %	4 %	3 %	3 %	2 %
SOx	3 %	5 %	6 %	10 %	11 %	11 %	13 %	13 %	14 %	15 %	16 %	16 %	16 %	16 %	18 %	17 %	17 %	15 %
NH_3	-5 %	-13 %	-13 %	-12 %	-13 %	-13 %	-12 %	-12 %	-12 %	-13 %	-13 %	-11 %	-12 %	-11 %	-14 %	-15 %	-15 %	-15 %
TSPs	7 %	14 %	11 %	14 %	15 %	15 %	15 %	15 %	18 %	19 %	19 %	20 %	20 %	20 %	19 %	17 %	17 %	14 %
CO	2 %	2 %	1 %	2 %	3 %	3 %	4 %	4 %	5 %	7 %	7 %	6 %	7 %	7 %	6 %	5 %	5 %	3 %
Pb	-2 %	-3 %	-2 %	-3 %	-4 %	-4 %	-5 %	-6 %	-6 %	-7 %	-8 %	-8 %	-8 %	-8 %	-9 %	-9 %	-9 %	-9 %
Cd	2 %	13 %	11 %	10 %	10 %	10 %	10 %	10 %	11 %	12 %	11 %	11 %	10 %	11 %	8 %	7 %	8 %	7 %
Hg	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-2 %	-2 %	-2 %
As	-3 %	-11 %	-13 %	-14 %	-15 %	-16 %	-16 %	-16 %	-16 %	-18 %	-17 %	-17 %	-18 %	-18 %	-18 %	-18 %	-18 %	-18 %
Cr	-1 %	1 %	2 %	2 %	3 %	3 %	3 %	2 %	3 %	4 %	4 %	4 %	4 %	4 %	3 %	2 %	3 %	2 %
Cu	-13 %	-17 %	-12 %	-10 %	-12 %	-12 %	-13 %	-15 %	-16 %	-16 %	-17 %	-17 %	-17 %	-16 %	-17 %	-16 %	-16 %	-16 %
Ni	-2 %	-5 %	-2 %	-1 %	-2 %	-2 %	-2 %	-4 %	-6 %	-5 %	-6 %	-6 %	-6 %	-6 %	-6 %	-6 %	-5 %	-5 %
Se	-1 %	-1 %	0 %	0 %	0 %	0 %	-1 %	0 %	0 %	-1 %	0 %	0 %	0 %	1 %	5 %	-1 %	-2 %	2 %
Zn	1 %	5 %	6 %	7 %	7 %	7 %	6 %	6 %	7 %	8 %	7 %	7 %	7 %	8 %	5 %	5 %	5 %	5 %
PCDD/Fs	0 %	2 %	0 %	1 %	1 %	0 %	1 %	2 %	3 %	3 %	3 %	4 %	4 %	4 %	2 %	1 %	1 %	-1 %
B(a)P	4 %	5 %	3 %	6 %	7 %	8 %	8 %	9 %	11 %	12 %	13 %	13 %	15 %	14 %	13 %	11 %	10 %	6 %
B(b)F	0 %	0 %	-1 %	1 %	2 %	-8 %	3 %	4 %	6 %	7 %	8 %	9 %	10 %	9 %	8 %	6 %	5 %	2 %
B(k)F	2 %	2 %	0 %	2 %	3 %	3 %	4 %	5 %	6 %	8 %	8 %	9 %	10 %	10 %	9 %	7 %	6 %	3 %
IP	0 %	0 %	0 %	1 %	2 %	2 %	3 %	3 %	4 %	5 %	5 %	6 %	7 %	6 %	5 %	4 %	3 %	1 %
Total PAHs	2 %	2 %	1 %	3 %	4 %	1 %	5 %	6 %	8 %	8 %	9 %	10 %	11 %	10 %	9 %	8 %	7 %	3 %
HCB	8 %	5 %	8 %	6 %	8 %	7 %	7 %	7 %	5 %	6 %	6 %	6 %	6 %	6 %	5 %	7 %	4 %	3 %
PCBs	1 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	1 %	0 %	-1 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			18 %	23 %	26 %	23 %	24 %	24 %	26 %	28 %	27 %	27 %	27 %	27 %	26 %	25 %	24 %	21 %
PM_{10}			15 %	19 %	21 %	20 %	20 %	20 %	23 %	24 %	24 %	24 %	25 %	24 %	23 %	22 %	21 %	18 %
BC			2 %	3 %	4 %	4 %	4 %	4 %	5 %	5 %	6 %	6 %	7 %	7 %	4 %	4 %	3 %	2 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	13	8	7	7	8	7	8	8	9	7	8	8	7	8	6	6	6	-1
NMVOCs	12	25	18	18	20	24	27	29	36	43	47	53	50	49	38	31	27	17
SOx	66	47	37	51	56	49	56	53	59	54	55	52	48	49	52	50	46	35
NH_3	-3	-9	-9	-9	-10	-9	-9	-10	-10	-10	-11	-10	-9	-9	-11	-11	-11	-11
TSPs	104	159	102	128	142	136	145	149	175	166	178	181	164	162	153	142	128	101
CO	348	281	126	238	308	301	379	441	565	719	754	654	645	622	527	457	405	249
Pb	-7	-6	-3	-6	-7	-7	-8	-9	-11	-10	-12	-12	-12	-11	-13	-13	-12	-11
Cd	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Cr	0	0	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	1
Cu	-14	-18	-9	-9	-11	-10	-11	-12	-14	-13	-14	-14	-13	-13	-14	-13	-12	-12
Ni	-4	-5	-3	-2	-2	-2	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	3	32	36	41	43	43	43	41	48	51	51	54	49	51	36	34	33	29
PCDD/Fs	4	16	3	4	7	2	12	15	24	28	31	33	33	32	17	9	5	-8
B(a)P	12	15	7	14	17	18	20	23	29	28	31	32	31	30	28	24	20	12
B(b)F	2	1	-3	1	4	-20	8	10	16	17	19	21	21	20	18	15	11	3
B(k)F	3	2	0	2	3	4	5	6	8	8	9	10	10	10	9	7	6	3
IP	0	0	-1	1	2	3	3	4	6	6	7	8	8	8	6	5	3	1
Total PAHs	18	20	5	19	28	5	37	44	60	60	67	71	71	68	62	51	41	19
HCB	13	4	3	2	3	2	2	2	2	2	2	2	2	2	2	3	2	1
PCBs	2	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	-1
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			139	175	192	179	187	189	215	201	207	204	186	183	178	167	153	125
PM_{10}			125	156	172	162	171	174	201	191	198	198	180	177	170	159	145	116
BC			2	3	4	4	4	4	5	5	5	6	6	6	4	3	3	1

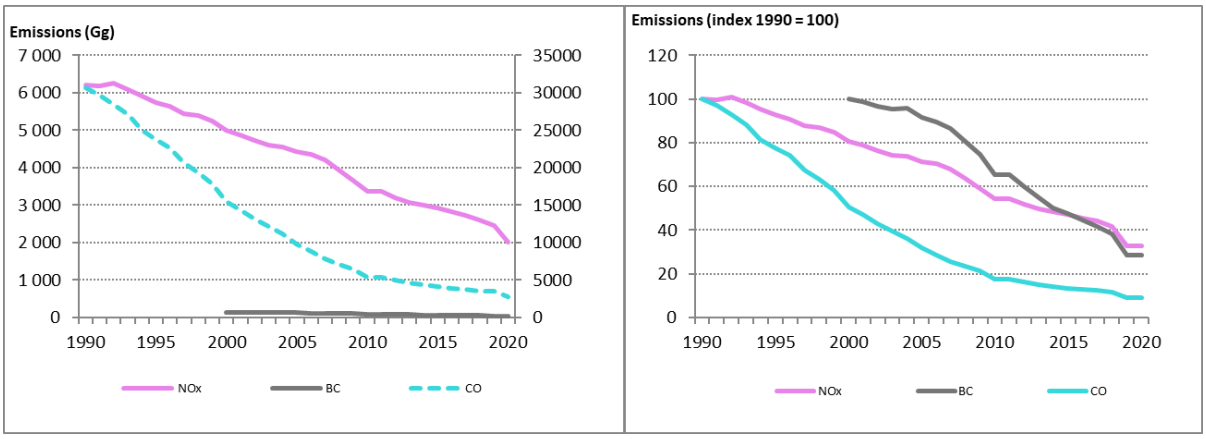
Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.5 Sectoral analysis and emission trends for the road transport sector

The road transport sector group is the primary sector group for NO_X emissions. Together, the individual NFR sources that make up the road transport sector group contribute considerably to the emissions of several pollutants, including BC, CO, Pb. Figure 4.9 and Figure 4.10 show the emission trends for these pollutants in this sector.

Countries are ranked according to the size of the absolute values that they reported. For primary NO_X, Germany, France and Spain reported the highest emissions. For CO, Germany, Italy and Poland reported the highest emissions. Germany, Spain and France contributed most to Pb emissions.

Figure 4.9 **EU emission trends in the road transport sector group for NO_x, BC and CO between 1990 (2000) and 2020**



Note: In the left-hand panel the right-hand axis shows values for CO.

The main HM for the road transport sector is Pb, which shows a high relative reduction in emissions (-99%) between 1990 and 2020 (see Figure 4.10). However, in recent years, little progress has been made in further reducing emissions from road transport, and over the last few years total Pb emissions have fluctuated between slight reductions and increases. The promotion of unleaded petrol in the EU and other EEA member countries, by means of a combination of fiscal and regulatory measures, has been a success story. For example, EU Member States have completely phased out the use of leaded petrol. Directive 98/70/EC on the quality of petrol and diesel fuels (EU, 1998) achieved that objective. Nevertheless, the road transport sector remains a key source of Pb, contributing around 17% of total Pb emissions in the EU.

Figure 4.10 **EU emission trends in the road transport sector group for the priority HM Pb**

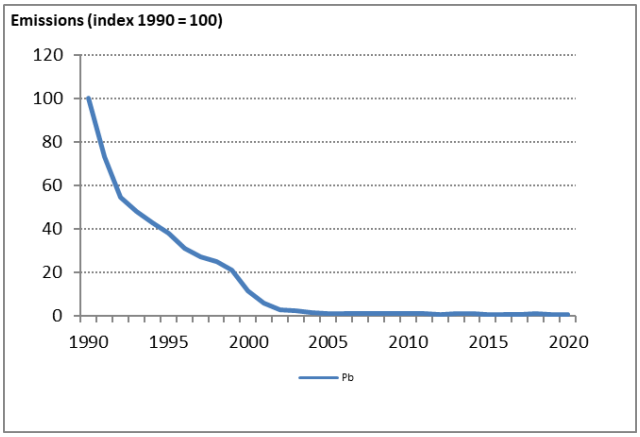


Table 4.9 shows the recalculations within the road transport sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.9 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the road transport sector group**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	1 %	1 %	0 %	-1 %	-1 %	-1 %	0 %	0 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	2 %
NMVOCs	1 %	-1 %	-1 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-5 %	-6 %	-7 %	-5 %
SOx	2 %	2 %	2 %	3 %	4 %	4 %	5 %	4 %	4 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	4 %	4 %
NH_3	3 %	2 %	-2 %	3 %	4 %	5 %	5 %	6 %	5 %	6 %	7 %	7 %	6 %	7 %	7 %	8 %	7 %	7 %
TSPs	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	0 %	1 %	1 %	1 %	1 %	2 %
CO	3 %	2 %	2 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	0 %	-1 %	-1 %	-1 %	-3 %	-4 %	-5 %	-5 %
Pb	4 %	-1 %	-10 %	4 %	4 %	4 %	3 %	4 %	3 %	-2 %	-2 %	0 %	0 %	-3 %	-3 %	-3 %	-2 %	1 %
Cd	-4 %	-5 %	-4 %	-4 %	-3 %	-3 %	-3 %	-2 %	-2 %	-2 %	-1 %	-2 %	-2 %	-1 %	-2 %	-2 %	-2 %	-1 %
Hg	0 %	0 %	-1 %	2 %	3 %	3 %	4 %	5 %	5 %	5 %	4 %	4 %	4 %	4 %	4 %	4 %	5 %	5 %
As	-2 %	-3 %	-4 %	-4 %	-3 %	-3 %	-3 %	-2 %	-4 %	-3 %	-3 %	-2 %	-3 %	-2 %	-3 %	-2 %	-2 %	-2 %
Cr	-5 %	-6 %	-6 %	-6 %	-6 %	-6 %	-6 %	-6 %	-6 %	-5 %	-5 %	-5 %	-5 %	-5 %	-5 %	-5 %	-5 %	-4 %
Cu	-3 %	-4 %	-4 %	-4 %	-4 %	-4 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-2 %	-2 %	-2 %	-2 %	-2 %
Ni	5 %	7 %	10 %	12 %	13 %	13 %	13 %	13 %	13 %	13 %	13 %	12 %	12 %	13 %	13 %	13 %	13 %	14 %
Se	7 %	7 %	8 %	9 %	10 %	11 %	11 %	11 %	10 %	10 %	11 %	10 %	10 %	10 %	10 %	11 %	11 %	12 %
Zn	-8 %	-9 %	-9 %	-10 %	-10 %	-10 %	-9 %	-9 %	-9 %	-9 %	-8 %	-8 %	-8 %	-8 %	-8 %	-8 %	-8 %	-8 %
PCDD/Fs	1 %	0 %	9 %	14 %	15 %	17 %	16 %	16 %	16 %	17 %	16 %	17 %	16 %	16 %	16 %	17 %	18 %	19 %
B(a)P	0 %	-1 %	0 %	1 %	2 %	2 %	2 %	2 %	1 %	2 %	2 %	2 %	2 %	3 %	3 %	5 %	5 %	5 %
B(b)F	1 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	2 %	2 %	2 %	3 %	3 %	4 %	4 %	4 %
B(k)F	1 %	0 %	1 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	3 %	3 %	3 %	4 %	5 %	5 %
IP	1 %	0 %	1 %	1 %	2 %	2 %	2 %	1 %	1 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	3 %	3 %
Total PAHs	1 %	0 %	1 %	1 %	2 %	2 %	2 %	2 %	1 %	2 %	2 %	2 %	2 %	3 %	3 %	4 %	4 %	4 %
HCB	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
PCBs	6 099 %	8 160 %	13 770 %	16 687 %	17 254 %	17 710 %	16 942 %	16 991 %	17 052 %	16 837 %	16 835 %	17 606 %	16 775 %	17 092 %	17 430 %	18 375 %	19 947 %	21 420 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	0 %	1 %	1 %	2 %	2 %	3 %
PM_{10}			0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	2 %
BC			2 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	3 %	2 %	4 %	4 %	5 %	6 %	9 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	67	35	18	-25	-26	-27	-4	-16	-20	-10	2	5	1	14	8	28	36	39
NMVOCs	52	-24	-30	-39	-39	-37	-32	-34	-30	-25	-22	-22	-24	-22	-29	-34	-36	-28
SOx	13	9	3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
NH_3	1	1	-2	2	3	4	4	4	4	4	4	3	3	3	3	3	3	3
TSPs	0	1	2	0	0	0	1	0	0	1	2	2	1	2	2	3	3	4
CO	809	503	244	7	-24	-29	-41	-73	-53	-45	-20	-31	-42	-32	-106	-149	-203	-175
Pb	578	-63	-203	7	8	8	6	7	6	-3	-3	0	0	-5	-5	-5	-4	1
Cd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	-2	-3	-3	-3	-4	-4	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2
Cu	-24	-34	-41	-42	-42	-43	-38	-37	-39	-33	-28	-30	-31	-27	-29	-28	-29	-20
Ni	1	1	1	1	2	2	2	2	2	2	1	1	1	2	2	2	2	2
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	-37	-47	-57	-65	-67	-67	-62	-60	-61	-57	-53	-52	-53	-53	-56	-57	-58	-55
PCDD/Fs	1	0	8	16	17	19	19	18	18	17	16	15	13	13	12	12	12	12
B(a)P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(k)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
HCB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PCBs	1	2	3	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			2	0	0	0	0	-1	-1	0	1	1	0	2	2	2	2	4
PM_{10}			1	-1	-1	-1	0	-1	-1	0	1	1	0	1	1	2	2	4
BC			2	1	1	1	1	1	1	1	2	2	1	2	2	3	3	4

Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.6 Sectoral analysis and emission trends for the non-road transport sector

In this report, emissions from international/domestic aviation and shipping are reported as a simple sum of the emissions from each of the EU Member States. Accordingly, emissions from international/domestic aviation and shipping are not divided into those occurring within the EU and those that cross its geographical boundaries. However, as the guidelines (UNECE, 2014a) define international emissions as those that start in one country and finish in another, the reporting matches the guidelines.

NO_X, BC and SO_X emissions are mainly caused by the non-road transport sector. All pollutants show a downward trend between 2019 and 2020, mainly influenced by reductions in international and domestic aviation as a result of the health crisis.

Within the non-road transport sector group, NO_X is a major pollutant. The countries are ranked according to the size of the absolute values that they reported. Italy, Spain and Germany contributed most (in absolute terms) to emissions of NO_X. Greece, Italy and Spain accounted for most of the SO_X emissions.

BC emissions reported by Italy, Portugal and Greece have shown an upwards trend over the last few years. Italy's emissions reported in the category '1A3dii — National navigation (shipping)', Greece's emissions in category '1A3dii — National navigation (shipping)' and Portugal's emissions in category '1A3ai(i) — International aviation LTO (civil)' were most responsible for this trend.

As the non-road transport sector group does not contribute very much to HM and POP emissions, trends in pollutants from these two groups of substances are not shown (see Figure 4.11).

Figure 4.11 EU emission trends in the non-road transport sector group for SO_x, NO_x and BC between 1990 (2000) and 2020

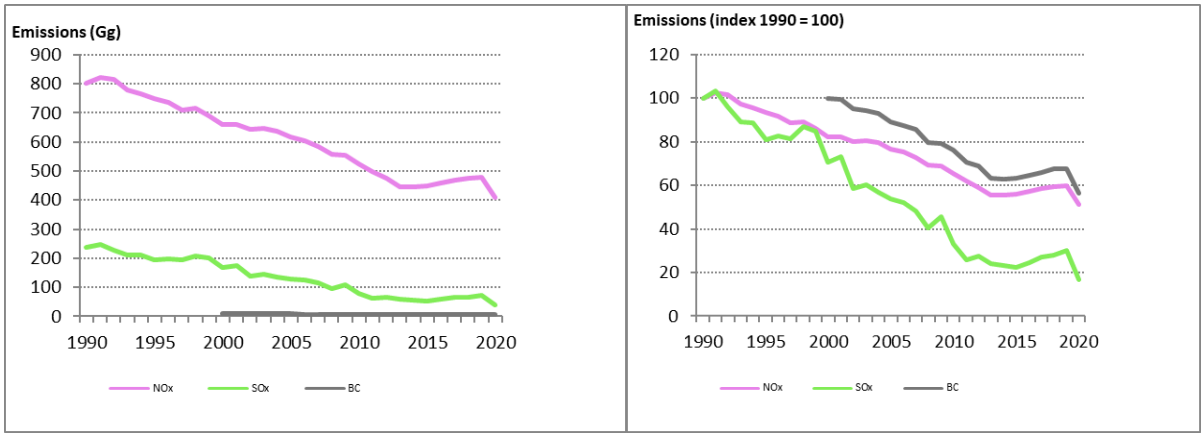


Table 4.10 shows the recalculations within the non-road transport sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.10 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the non-road transport sector group**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-3 %
NMVOCs	0 %	0 %	0 %	0 %	2 %	4 %	8 %	11 %	15 %	16 %	19 %	20 %	19 %	20 %	17 %	13 %	10 %	7 %
SOx	-5 %	-4 %	-5 %	-5 %	-3 %	-4 %	-4 %	-3 %	-3 %	-4 %	-5 %	-5 %	-6 %	-2 %	0 %	-1 %	-1 %	-2 %
NH_3	-77 %	-71 %	-48 %	-25 %	-30 %	-26 %	-24 %	-22 %	-26 %	-26 %	-20 %	-20 %	-21 %	-22 %	-20 %	-22 %	-20 %	-25 %
TSPs	-7 %	-5 %	-6 %	-5 %	-3 %	-4 %	-4 %	-3 %	-2 %	-2 %	-3 %	-3 %	-3 %	-2 %	-2 %	-2 %	1 %	-2 %
CO	3 %	1 %	0 %	0 %	0 %	1 %	1 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %
Pb	6 %	1 %	9 %	15 %	14 %	12 %	10 %	12 %	11 %	0 %	9 %	7 %	7 %	4 %	5 %	6 %	5 %	7 %
Cd	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-4 %	-2 %	-2 %	-3 %	-3 %	-2 %
Hg	4 %	4 %	2 %	1 %	1 %	1 %	0 %	0 %	1 %	-1 %	-2 %	-1 %	-2 %	0 %	-2 %	-2 %	-3 %	0 %
As	8 %	-4 %	-7 %	-9 %	-10 %	-11 %	-12 %	-8 %	-9 %	-10 %	-11 %	-12 %	-11 %	-2 %	-1 %	-2 %	-3 %	-3 %
Cr	-4 %	-3 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %
Cu	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %
Ni	-6 %	-4 %	-5 %	-5 %	-4 %	-5 %	-5 %	-4 %	-4 %	-4 %	-5 %	-5 %	-4 %	0 %	0 %	0 %	0 %	0 %
Se	-15 %	-18 %	-15 %	-17 %	-17 %	-16 %	-14 %	-12 %	-14 %	-10 %	-12 %	-10 %	-14 %	-10 %	-11 %	-10 %	-13 %	-13 %
Zn	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-3 %	-3 %	-3 %	-2 %	-3 %	-3 %	-3 %	-2 %
PCDD/Fs	3 %	11 %	10 %	17 %	15 %	13 %	11 %	13 %	12 %	13 %	9 %	7 %	7 %	15 %	8 %	7 %	4 %	14 %
B(a)P	27 %	24 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-1 %	-1 %	-2 %	-2 %	-2 %	0 %	-3 %	-3 %	-4 %	1 %
B(b)F	-4 %	-2 %	-3 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	0 %	-3 %	-3 %	-3 %	0 %
B(k)F	-6 %	-3 %	-4 %	-3 %	-3 %	-3 %	-4 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-2 %	-4 %	-5 %	-5 %	-1 %
IP	-4 %	-2 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-1 %	-2 %	-2 %	-3 %	-1 %
Total PAHs	12 %	10 %	-2 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-1 %	-2 %	-2 %	-2 %	-36 %
HCB	130 %	147 %	175 %	206 %	198 %	198 %	206 %	188 %	179 %	201 %	182 %	177 %	178 %	176 %	183 %	165 %	172 %	168 %
PCBs	-99 %	7 %	-1 %	-3 %	-3 %	-3 %	-4 %	-2 %	-2 %	-1 %	-2 %	-2 %	-2 %	2 %	0 %	0 %	0 %	0 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			-7 %	-6 %	-4 %	-4 %	-4 %	-3 %	-2 %	-2 %	-4 %	-4 %	-4 %	-3 %	-2 %	-3 %	-3 %	-2 %
PM_{10}			-7 %	-6 %	-3 %	-4 %	-4 %	-3 %	-2 %	-2 %	-3 %	-3 %	-3 %	-2 %	-2 %	-3 %	-2 %	-1 %
BC			-3 %	-3 %	-2 %	-3 %	-3 %	-1 %	-1 %	-1 %	-2 %	-3 %	-4 %	-3 %	-3 %	-4 %	-4 %	-4 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	-1	1	-4	-6	-7	-8	-9	-8	-9	-9	-14	-15	-16	-12	-13	-18	-19	-14
NMVOCs	0	0	0	0	2	4	7	10	12	12	12	12	11	11	10	7	6	4
SOx	-13	-9	-9	-7	-4	-5	-4	-3	-2	-2	-3	-3	-3	-1	0	-1	-1	-1
NH_3	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSPs	-5	-3	-3	-3	-1	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1
CO	15	4	-1	0	2	4	6	9	11	9	9	7	6	7	7	6	7	8
Pb	8	1	2	2	2	2	2	2	2	0	1	1	1	1	1	1	1	1
Cd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2
Ni	-6	-4	-5	-4	-4	-4	-4	-3	-3	-3	-4	-3	-3	0	0	0	0	0
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PCDD/Fs	0	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1
B(a)P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(k)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PCBs	-359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			-3	-2	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
PM_{10}			-3	-3	-1	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0
BC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.7 Sectoral analysis and emission trends for the agriculture sector

This sector group is responsible for the vast majority of ammonia (NH_3) emissions in the EU — namely 94%. With regard to the size of the absolute values that the countries reported, France, Germany and Spain contributed most to NH_3 emissions in 2020.

Agricultural emissions of NH_3 have fallen by 30% since 1990 (see Figure 4.12). These reductions are

mainly influenced by the decrease in the use of inorganic nitrogen fertilisers and changes in livestock farming practices (see Member State IIRs, listed in Appendix 5).

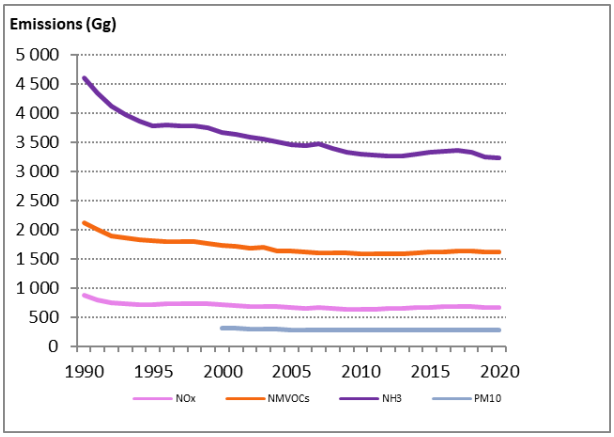
In addition, the agriculture sector produces considerable emissions of NMVOCs, PM_{10} and NO_X.

Manure management (categories 3B1a and 3B1b) is the main source of NMVOC emissions in the agricultural sector.

The trend in NO_X emissions is influenced by the use of fertilisers (categories 3Da1 and 3Da2), but also the ban on field burning of agricultural residues (category 3F) had an effect on the downwards trend (see Member State IIRs, listed in Appendix 5).

During the period 2000-2020, PM_{10} emissions fell by just 11%. This trend was influenced by the abandonment of field burning of agricultural residues (sector 3F) (see Member State IIRs, listed in Appendix 5).

Figure 4.12 **EU emission trends in the agriculture sector group for NH_3, PM_{10}, NMVOCs and NO_X between 1990 (2000) and 2020**



As regards POPs, the agriculture sector contributes considerably to emissions of HCB. Figure 4.13 shows emission trends for this pollutant.

The trend in emissions for HCB largely reflects data reported by several countries, namely Germany, Italy, Poland, Spain and the Netherlands, for the category '3Df — Use of pesticides'. The sharp decrease between 1999 and 2000 (-78%) is due to a a reduction in the amount of HCB in chlorothalonil and the prohibition of the use of lindane (see Member State IIRs, listed in Appendix 5).

Figure 4.13 **EU emission trends in the agriculture sector group for HCB between 1990 and 2020**

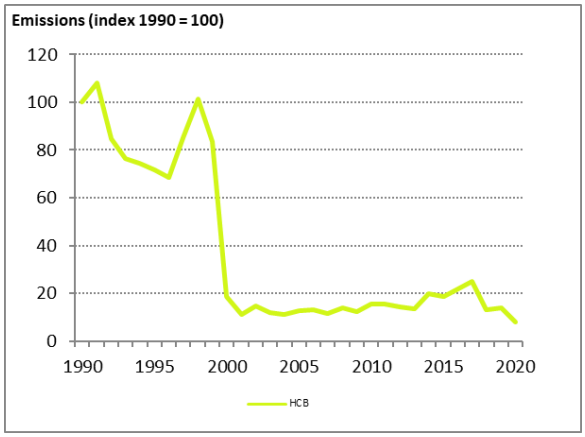


Table 4.11 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.12 shows the recalculations within the agriculture sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.11 Number of EU Member States reporting notation keys within the key categories of the agriculture sector group

Key categories		NA	NO	NR	NE
NMVOC	3Da2a	10	0	0	1
NH_3	3Da3	0	1	0	0
HCB	3Df	2	1	0	4

Note: Only the key categories where notation keys were reported are considered.

Table 4.12 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions (relative data, percentage of EU national totals) for the agriculture sector group.

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	4 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	1 %	1 %	1 %	1 %
NMVOCs	5 %	3 %	3 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %
SOx	-26 %	-21 %	-14 %	7 %	6 %	5 %	7 %	5 %	5 %	3 %	2 %	2 %	2 %	1 %	0 %	0 %	0 %	-5 %
NH_3	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-1 %	-1 %	-2 %	-2 %
TSPs	1 %	1 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
CO	7 %	4 %	5 %	5 %	5 %	3 %	5 %	4 %	4 %	3 %	2 %	2 %	1 %	0 %	0 %	0 %	0 %	-4 %
Pb	-25 %	-19 %	-11 %	3 %	3 %	2 %	3 %	3 %	3 %	2 %	2 %	2 %	2 %	2 %	1 %	1 %	1 %	-1 %
Cd	-29 %	-25 %	-16 %	10 %	10 %	8 %	11 %	9 %	9 %	7 %	5 %	6 %	5 %	4 %	3 %	3 %	3 %	-3 %
Hg	-17 %	-15 %	-9 %	10 %	10 %	8 %	10 %	9 %	9 %	6 %	5 %	6 %	5 %	4 %	3 %	3 %	3 %	-2 %
As	14 %	11 %	7 %	2 %	2 %	2 %	2 %	2 %	2 %	1 %	1 %	2 %	1 %	1 %	1 %	1 %	1 %	0 %
Cr	22 %	17 %	14 %	8 %	8 %	6 %	8 %	6 %	7 %	5 %	4 %	4 %	4 %	3 %	2 %	2 %	3 %	-2 %
Cu	-16 %	-9 %	-7 %	6 %	5 %	4 %	6 %	5 %	5 %	4 %	3 %	3 %	3 %	2 %	2 %	2 %	2 %	-2 %
Ni	-22 %	-16 %	-12 %	9 %	10 %	8 %	10 %	8 %	8 %	6 %	5 %	5 %	4 %	4 %	3 %	3 %	3 %	-2 %
Se	26 %	21 %	16 %	7 %	6 %	5 %	7 %	5 %	6 %	5 %	4 %	5 %	4 %	4 %	3 %	3 %	3 %	0 %
Zn	2 %	2 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	55 %	53 %	57 %	60 %	0 %	70 %	71 %	0 %	-2 %
PCDD/Fs	303 %	330 %	389 %	872 %	763 %	549 %	860 %	678 %	695 %	510 %	317 %	357 %	257 %	103 %	-6 %	-6 %	-7 %	-11 %
B(a)P	137 %	129 %	73 %	3 %	3 %	2 %	4 %	3 %	3 %	2 %	1 %	2 %	1 %	0 %	0 %	0 %	0 %	-3 %
B(b)F	35 %	29 %	21 %	4 %	4 %	3 %	6 %	5 %	5 %	3 %	2 %	2 %	1 %	1 %	0 %	0 %	0 %	-4 %
B(k)F	31 %	30 %	19 %	4 %	4 %	3 %	6 %	4 %	4 %	3 %	2 %	2 %	1 %	1 %	0 %	0 %	0 %	-4 %
IP	44 %	45 %	26 %	4 %	4 %	3 %	5 %	4 %	4 %	3 %	2 %	2 %	1 %	1 %	0 %	0 %	0 %	-4 %
Total PAHs	54 %	50 %	32 %	4 %	3 %	3 %	5 %	4 %	4 %	3 %	2 %	2 %	1 %	1 %	0 %	0 %	0 %	-4 %
HCB	0 %	0 %	0 %	72 %	75 %	67 %	48 %	43 %	41 %	43 %	36 %	45 %	58 %	53 %	60 %	67 %	-4 %	-6 %
PCBs	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	11 %	8 %	10 %	9 %	-2 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			4 %	2 %	2 %	1 %	2 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %
PM_{10}			2 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %
BC			15 %	3 %	2 %	2 %	3 %	2 %	2 %	2 %	1 %	1 %	1 %	0 %	0 %	0 %	0 %	-2 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	31	10	8	6	5	6	7	7	5	4	5	4	4	3	6	5	5	5
NMVOCs	96	57	43	35	36	33	35	34	30	32	32	32	29	30	32	32	34	33
SOx	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	-48	-55	-47	-52	-57	-61	-54	-53	-53	-54	-51	-64	-65	-66	-48	-48	-56	-57
TSPs	12	9	7	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3
CO	54	20	19	9	8	5	8	6	6	4	2	2	2	1	0	0	0	-5
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cd	-3	-2	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	0	0	0	0	0	0	0	0	0	5	4	4	4	0	5	5	0	0
PCDD/Fs	39	35	36	67	59	38	59	44	42	29	17	19	13	5	0	0	0	-1
B(a)P	10	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	7	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(k)F	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	21	14	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCB	0	0	0	23	24	20	20	16	20	20	16	18	31	28	36	44	-3	-4
PCBs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			2	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0
PM_{10}			6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
BC			1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

4.8 Sectoral analysis and emission trends for the waste sector

This sector group is a primary source of PCDD/Fs and a significant source of BC.

Figure 4.14 shows the previous emission trends for these pollutants.

With regard to the size of the absolute values that the countries reported, Spain, France and Poland contributed most to PCDD/F emissions in 2020. For BC emissions, Spain France and Greece are the main contributors within this sector.

The decrease in PCDD/F emissions in the waste sector in the EU (-75% between 1990 and 2020) is led by a decreasing trend in the category 'Clinical waste incineration' (-99% between 1990 and 2020) in Portugal. Other influencing factors were the introduction of municipal waste incineration plants with energy recovery (1A1a) and a progressive reduction in the amount of clinical waste incinerated (5C1biii) in Spain, a decrease in the number of fires, in particular in landfill sites (5E) in Poland and the implementation of treatment of atmospheric effluents at incineration facilities with and without energy recovery (France) (see Member State IIRs, listed in Appendix 5).

The peak in dioxin emissions in 2009 is caused by data reported by Malta in the category '5C1bv — Cremation'.

Open burning of waste (category 5C2) is the most important subcategory with regards to BC emissions. Spain contributes 77% of total BC emissions reported by the EU-27 in this category.

Figure 4.14 **EU emission trends in the waste sector group for the PCDD/Fs and BC between 1990 (2000) and 2020**

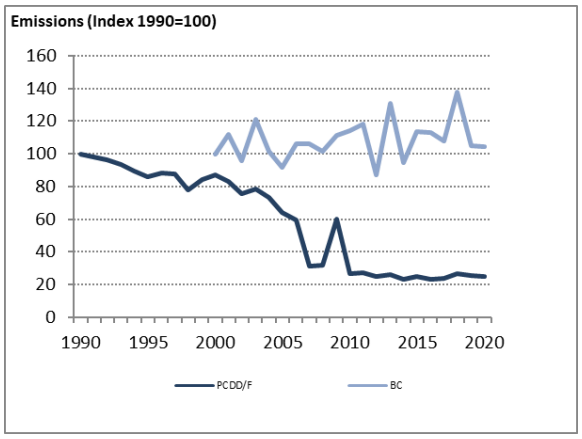


Table 4.13 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.14 shows the recalculations within the waste sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.13 **Number of EU Member States reporting notation keys within the key categories of the waste sector group**

Key categories		NA	NO	NR	NE
$PM_{2.5}$	5C2	0	8	0	3
PM_{10}	5C2	0	8	0	3
CO	5C2	0	8	0	2
Cd	5C2	0	9	0	3
Hg	5C1bv	0	0	0	1
PCDD/Fs	5C2	0	8	0	2
PCB	5C1bi	6	8	0	2

Note: Only the key categories where notation keys were reported are considered.

Table 4.14 **(a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2021 and 2022 submissions for the waste sector group**

(a)

Relative difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	82 %	56 %	106 %	101 %	119 %	121 %	117 %	128 %	130 %	134 %	103 %	148 %	118 %	136 %	135 %	130 %	152 %	97 %
NMVOCs	1 %	2 %	1 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	-1 %	1 %	0 %	0 %	0 %	0 %	-4 %
SOx	12 %	10 %	31 %	31 %	40 %	39 %	35 %	43 %	63 %	67 %	45 %	79 %	59 %	70 %	56 %	60 %	75 %	48 %
NH_3	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	6 %	6 %	2 %	2 %	2 %	2 %	2 %	3 %
TSPs	14 %	14 %	14 %	14 %	14 %	15 %	14 %	15 %	16 %	16 %	14 %	18 %	16 %	17 %	17 %	17 %	19 %	1 %
CO	24 %	18 %	26 %	25 %	27 %	27 %	26 %	28 %	28 %	29 %	25 %	30 %	27 %	29 %	29 %	28 %	31 %	2 %
Pb	0 %	-4 %	-1 %	1 %	6 %	7 %	8 %	11 %	7 %	9 %	0 %	16 %	10 %	12 %	11 %	8 %	6 %	-1 %
Cd	-6 %	-9 %	-17 %	-16 %	-19 %	-20 %	-15 %	-19 %	-28 %	-29 %	-25 %	-29 %	-21 %	-24 %	-28 %	-28 %	-32 %	-39 %
Hg	1 %	1 %	3 %	7 %	8 %	12 %	18 %	17 %	16 %	8 %	9 %	9 %	14 %	12 %	11 %	10 %	4 %	9 %
As	-69 %	-60 %	-75 %	-74 %	-77 %	-77 %	-76 %	-77 %	-79 %	-80 %	-74 %	-82 %	-76 %	-80 %	-80 %	-79 %	-83 %	-84 %
Cr	0 %	-2 %	-1 %	7 %	6 %	5 %	9 %	9 %	-2 %	-3 %	-1 %	-1 %	3 %	4 %	-3 %	-2 %	1 %	-3 %
Cu	-7 %	-7 %	-13 %	-12 %	-16 %	-16 %	-11 %	-16 %	-26 %	-27 %	-24 %	-27 %	-19 %	-22 %	-27 %	-28 %	-27 %	-37 %
Ni	0 %	0 %	1 %	9 %	13 %	11 %	19 %	16 %	7 %	9 %	11 %	17 %	31 %	27 %	8 %	-2 %	3 %	-13 %
Se	-53 %	-53 %	-60 %	-60 %	-61 %	-61 %	-61 %	-61 %	-61 %	-62 %	-59 %	-62 %	-59 %	-61 %	-61 %	-61 %	-62 %	-70 %
Zn	-8 %	-21 %	-13 %	-17 %	-14 %	-13 %	-14 %	-12 %	-11 %	-11 %	-15 %	-8 %	-10 %	-10 %	-8 %	-10 %	-5 %	-25 %
PCDD/Fs	10 %	10 %	65 %	110 %	119 %	38 %	44 %	186 %	31 %	34 %	27 %	46 %	43 %	51 %	41 %	38 %	49 %	39 %
B(a)P	-2 %	-1 %	-2 %	-3 %	-3 %	-3 %	-3 %	-2 %	-2 %	-2 %	-1 %	-1 %	0 %	-1 %	0 %	0 %	0 %	0 %
B(b)F	-3 %	-3 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-3 %	-3 %	-2 %	-3 %	-2 %	-3 %	-3 %	-3 %
B(k)F	-1 %	-2 %	-1 %	-2 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	1 %	-1 %
IP	-2 %	-1 %	-1 %	-3 %	-3 %	-3 %	-3 %	-2 %	-2 %	-1 %	0 %	2 %	2 %	3 %	1 %	3 %	5 %	7 %
Total PAHs	-2 %	-3 %	-3 %	-4 %	-4 %	-4 %	-3 %	-3 %	-3 %	-3 %	-2 %	-2 %	-1 %	-2 %	-1 %	-1 %	-1 %	-2 %
HCB	0 %	0 %	1 %	1 %	1 %	1 %	2 %	15 %	16 %	20 %	20 %	25 %	24 %	26 %	28 %	27 %	12 %	24 %
PCBs	-2 %	-2 %	1 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	0 %	1 %	0 %	0 %	1 %	1 %	1 %	1 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			18 %	17 %	18 %	18 %	18 %	19 %	19 %	20 %	18 %	22 %	20 %	21 %	21 %	21 %	24 %	0 %
PM_{10}			16 %	15 %	16 %	16 %	16 %	17 %	17 %	18 %	16 %	20 %	18 %	19 %	18 %	19 %	21 %	2 %
BC			87 %	81 %	90 %	90 %	87 %	93 %	95 %	97 %	81 %	106 %	89 %	99 %	99 %	97 %	109 %	60 %

(b)

Absolute difference																		
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	26	16	32	28	35	35	33	38	39	41	27	47	30	39	38	36	49	31
NMVOCs	1	2	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	-4
SOx	1	1	1	1	2	2	1	2	2	2	1	2	1	2	2	2	2	1
NH_3	0	0	0	-1	-1	-1	-1	0	0	0	3	3	1	1	1	1	1	1
TSPs	12	12	12	11	12	12	12	13	14	15	11	17	12	15	15	14	19	1
CO	133	79	161	142	175	175	164	187	194	203	135	234	154	196	193	183	249	19
Pb	0	-2	0	0	1	1	1	2	1	1	0	2	1	2	1	1	1	0
Cd	0	0	-1	0	0	0	0	0	-1	-1	-1	-1	0	-1	-1	-1	-1	-1
Hg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	-5	-3	-6	-5	-6	-6	-6	-7	-7	-7	-5	-8	-5	-7	-7	-7	-9	-9
Cr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cu	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-1	-2	-1	-1	-1	-1	-2	-2
Ni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Se	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Zn	-24	-54	-40	-51	-43	-40	-43	-38	-37	-36	-40	-27	-27	-31	-25	-31	-19	-85
PCDD/Fs	179	157	673	660	638	169	192	768	126	135	105	160	138	166	134	129	172	139
B(a)P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(k)F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCB	0	0	0	0	0	0	0	1	1	1	1	1	1	2	1	2	1	1
PCBs	-4	-4	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$			13	12	14	14	13	15	15	16	12	18	13	16	16	16	20	0
PM_{10}			12	11	13	13	12	14	14	15	11	17	13	15	16	15	19	2
BC			14	13	16	16	15	17	17	18	12	21	14	17	17	16	22	12

Note: As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd) pyrene; NH_3, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

5. Recalculations and implemented or planned improvements

5.1 Recalculations

Recalculations are changes made to previous emission estimates (for one or more years) to eliminate errors, consider additional factors and incorporate new data. The inventory guidebook (EMEP/EEA, 2019) stipulates that it is good practice to change or refine data and/or methods when:

- available data have changed;
- the method previously used is not consistent with good practice for a certain category;
- an emission source category has become a key category;
- the method previously used does not reflect mitigation activities transparently;
- the capacity (resources) for inventory preparation has increased;
- new inventory methods become available;
- the correction of errors is necessary.

It is important to identify inventory recalculations and to understand their origin in order to evaluate officially reported emission data properly. EU Member States often do not document why they report numbers that differ from those of the previous year.

5.1.1 Recalculations of the EU inventory

Table 5.1 compares total emissions from the EU submitted in 2021 with those submitted in 2022.

Table 5.1 Comparison of data submitted in 2021 and 2022 by EU Member States: (a) relative data, percentage of EU national total and (b) absolute data

(a)

Pollutant	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	Gg	126	80	71	17	15	35	6	29	4	30	27	36	57	31
NMVOCs	Gg	173	83	60	9	23	40	49	51	36	33	23	- 1	- 28	- 44
SO_x	Gg	411	411	268	203	- 15	178	37	11	-0.03	21	24	25	19	- 9
NH_3	Gg	- 49	- 62	- 56	- 59	- 58	- 62	- 57	- 68	- 72	- 74	- 56	- 56	- 64	- 66
TSPs	Gg			45	- 14	84	55	92	113	132	84	98	58	88	11
CO	Gg	1 267	833	511	334	627	782	770	761	655	727	585	449	433	64
Pb	Mg	512	27	- 310	- 100	- 18	- 97	- 108	- 49	- 121	- 110	- 136	- 140	- 54	- 106
Cd	Mg	0.3	1	- 1	3	1	1	0.3	0.04	-0.8	0.3	-0.4	-0.2	-0.3	-0.3
Hg	Mg	1	1	2	2	1	1	-0.2	-0.3	-0.2	-0.1	-0.4	-0.4	-0.5	0.1
As	Mg	- 9	- 5	- 5	- 18	- 14	- 13	- 16	- 20	- 17	- 16	- 18	- 18	- 19	- 13
Cr	Mg	- 9	- 2	- 5	- 6	- 10	- 7	- 11	- 12	- 12	- 11	- 12	- 13	- 12	- 6
Cu	Mg	- 110	- 106	- 86	- 124	- 62	- 56	- 50	- 53	- 52	- 46	- 58	- 56	- 50	- 42
Ni	Mg	12	- 5	1	- 16	- 8	- 7	- 10	- 11	- 11	- 4	- 6	- 6	- 5	- 3
Se	Mg	4	26	29	17	3	8	- 15	- 17	- 20	- 22	- 23	- 24	- 23	- 15
Zn	Mg	- 191	- 141	- 283	- 203	- 134	- 121	- 130	- 124	- 131	- 120	- 203	- 204	- 193	- 235
PCDD/Fs	g I-Teq	213	183	725	731	210	214	161	218	192	211	173	161	194	132
B(a)P	Mg	20	20	8	13	28	27	30	31	31	30	28	24	20	12
B(b)F	Mg	7	4	- 2	0.1	15	16	19	20	21	20	18	14	11	3
B(k)F	Mg	5	4	0.5	2	8	8	9	10	10	10	9	7	6	3
IP	Mg	3	2	-0.1	1	6	6	7	8	8	8	6	4	3	1
Total PAHs	Mg	- 40	- 9	- 25	- 10	39	39	47	52	51	48	42	31	21	0.2
HCB	kg	447	226	166	31	25	26	22	24	38	34	41	51	2	1
PCBs	kg	- 366	- 10	- 3	- 7	- 2	1	- 3	16	19	23	17	10	20	25
				2000	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
$PM_{2.5}$	Gg			158	185	227	213	218	220	198	197	192	178	173	123
PM_{10}	Gg			145	156	202	191	197	204	192	181	181	161	163	107
BC	Gg			2 063	2 547	31	30	27	32	22	28	27	25	36	22

(b)

Pollutant	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_x	Gg	1 %	1 %	1 %	0.2 %	0.2 %	0.4 %	0.1 %	0.4 %	0.1 %	0.4 %	0.4 %	1 %	1 %	0.5 %
NMVOCs	Gg	1.1 %	1 %	1 %	0.1 %	0.3 %	1 %	1 %	1 %	1 %	0.5 %	0.4 %	0.0 %	-0.4 %	-0.7 %
SO_x	Gg	2 %	3 %	3 %	3 %	0 %	5 %	1 %	0 %	0 %	1 %	1 %	1 %	1 %	-0.5 %
NH_3	Gg	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-1.9 %
TSPs	Gg			1 %	-0.3 %	2 %	1 %	3 %	3 %	4 %	2 %	3 %	2 %	3 %	0.3 %
CO	Gg	2 %	2 %	2 %	1 %	3 %	4 %	4 %	4 %	3 %	4 %	3 %	2 %	2 %	0.4 %
Pb	Mg	3 %	0.3 %	-8 %	-5 %	-1 %	-8 %	-9 %	-4 %	-10 %	-9 %	-12 %	-12 %	-5 %	-10 %
Cd	Mg	0.2 %	1 %	0 %	4 %	1 %	2 %	0.4 %	0.1 %	-1 %	1 %	-1 %	-0.4 %	-0.5 %	-1 %
Hg	Mg	0.6 %	1 %	2 %	2 %	1 %	2 %	-0.4 %	-1 %	0 %	0 %	-1 %	-1 %	-1 %	0.2 %
As	Mg	-2 %	-2 %	-3 %	-12 %	-12 %	-12 %	-16 %	-21 %	-18 %	-19 %	-22 %	-22 %	-23 %	-18 %
Cr	Mg	-1 %	-0.3 %	-1 %	-1 %	-3 %	-2 %	-3 %	-4 %	-4 %	-3 %	-4 %	-4 %	-4 %	-2 %
Cu	Mg	-6 %	-6 %	-5 %	-6 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-2 %
Ni	Mg	1 %	-0.3 %	0.1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %
Se	Mg	2 %	18 %	22 %	11 %	2 %	7 %	-12 %	-14 %	-17 %	-18 %	-20 %	-21 %	-20 %	-15 %
Zn	Mg	-3 %	-3 %	-6 %	-5 %	-4 %	-3 %	-4 %	-4 %	-4 %	-3 %	-6 %	-6 %	-5 %	-6 %
PCDD/Fs	g I-Teq	3 %	3 %	18 %	27 %	10 %	11 %	8 %	11 %	11 %	12 %	10 %	9 %	11 %	8 %
B(a)P	Mg	5 %	6 %	3 %	5 %	10 %	11 %	11 %	12 %	13 %	13 %	11 %	10 %	9 %	5 %
B(b)F	Mg	1 %	1 %	-1 %	0 %	5 %	6 %	7 %	7 %	8 %	8 %	7 %	6 %	5 %	1 %
B(k)F	Mg	2 %	2 %	0.4 %	1 %	5 %	6 %	7 %	8 %	8 %	8 %	7 %	6 %	5 %	3 %
IP	Mg	1 %	1 %	-0.1 %	1 %	4 %	5 %	5 %	5 %	6 %	6 %	4 %	3 %	3 %	1 %
Total PAHs	Mg	-3 %	-1 %	-3 %	-1 %	4 %	5 %	5 %	6 %	6 %	6 %	5 %	4 %	3 %	0.03 %
HCB	kg	8 %	6 %	4 %	9 %	14 %	14 %	11 %	9 %	13 %	21 %	20 %	23 %	1 %	1 %
PCBs	kg	-7 %	-0.3 %	-0.1 %	-0.3 %	-0.1 %	0.1 %	-0.2 %	1 %	1 %	2 %	1 %	1 %	2 %	2 %
				2000	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
$PM_{2.5}$	Gg			9 %	12 %	16 %	16 %	16 %	17 %	17 %	16 %	16 %	15 %	15 %	11 %
PM_{10}	Gg			6 %	6 %	9 %	9 %	10 %	10 %	10 %	10 %	10 %	9 %	9 %	6 %
BC	Gg			644 %	868 %	12 %	13 %	12 %	15 %	11 %	14 %	14 %	14 %	21 %	13 %

Note: As, arsenic; BC, black carbon; B(a)P, benzo(b)pyrene; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cd, cadmium; CO, carbon monoxides; Cr, chromium; Cu, copper; HCB, hexachlorobenzene; Hg, mercury; IP, indeno(1,2,3-cd)pyrene; NH_3, ammonia; Ni, nickel; NMVOCs, non-methane volatile organic compounds; NO_x, nitrogen oxides; PAH, polycyclic aromatic hydrocarbon; Pb, lead; PCBs, polychlorinated biphenyls; PCDD/F, polychlorinated dibenzodioxins/dibenzofuran; $PM_{2.5}$, particulate matter with a diameter of 2.5 µm or less; PM_{10}, particulate matter with a diameter of 10 µm or less; Se, selenium; SO_x, sulphur oxides; TSP, total suspended particulate; Zn, zinc.

Details of recalculations that influenced the EU recalculations are given below. In some cases, recalculations reflect changes in gap filling (see also Section 1.4.5) rather than 'true' recalculations by the countries themselves. Often, high recalculations for EU Member States are for by low recalculations for other EU Member States, and therefore overall EU recalculations are only moderate.

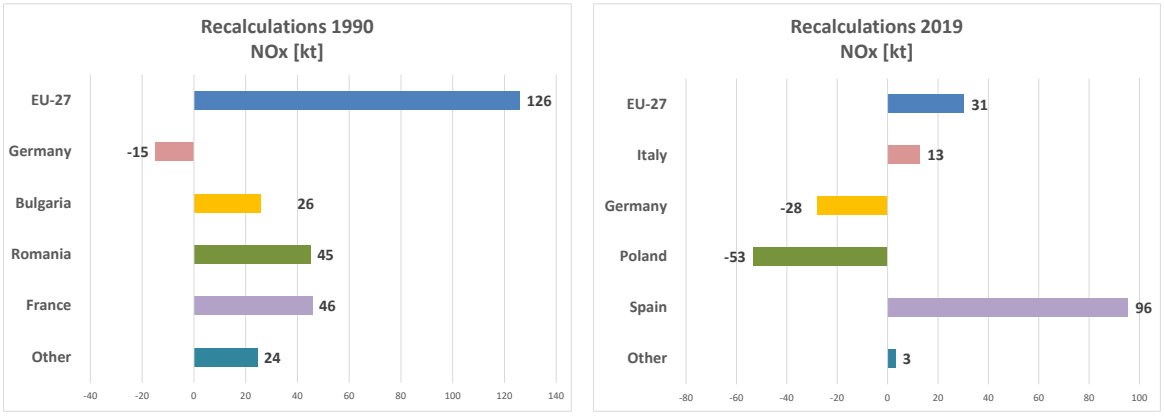
Recalculations of nitrogen oxide emissions

Figure 5.1 shows the recalculations for nitrogen oxide (NO_X) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 2019, recalculations of NOx emissions for the EU-27 add up to an increase of 0.5% (+31kt).

High recalculations occur mainly in the transport sector in Italy (1A3bi, 1A3dii), Poland (1A3bi, 1A3bii and 1A3biii), France (1A3bii and 1A3biii), Romania (1A3bi, 1A3bii and 1A3biii) and Spain (1A3bi, 1A3bii and 1A3biii). Additionally–Spain reports high a recalculation in the sector 5C2 - Open burning of waste. The biggest recalculations for NOx emissions in Germany occur in sector 2B2 - Nitric acid production for both 1990 and 2019. Bulgaria reports major recalculation of NOx emissions in 1990 in sectors 1A1a (Public electricity and heat production), 1A2a (Iron and Steel) 2A1 (Cement production) and 3Da1 (Inorganic N-fertilizers).

Figure 5.1 Recalculations for NO_X emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

Recalculations of non-methane volatile organic compound emissions:

Figure 5.2 shows the recalculations for non-methane volatile organic compound (NMVOC) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

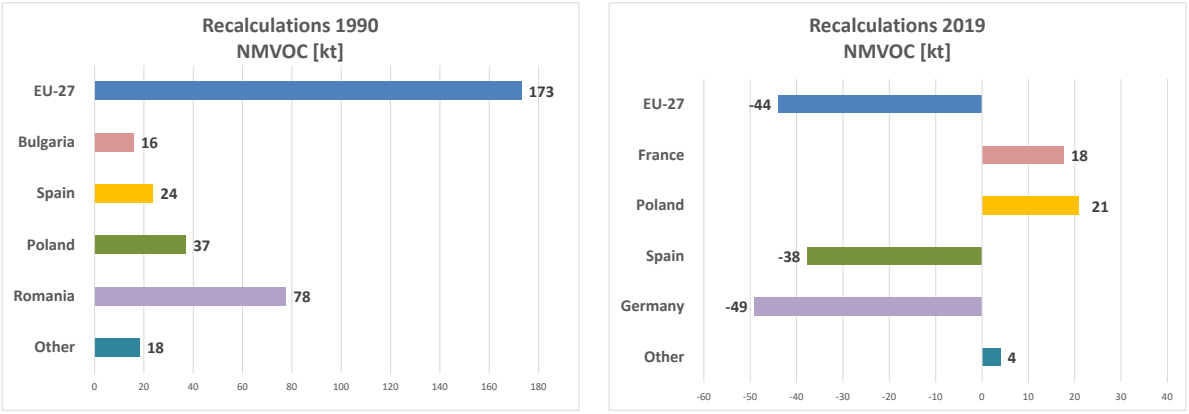
In 2019, recalculations of NMVOC emissions for the EU-27 add up to a decrease of -0.7% (-44kt), while recalculations for the year 1990 result in an increase of 1.1% (+173kt) in total NMVOC emissions.

Spain reported significant recalculations in the sector 1A2e - Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco.

In the Transport sector, high recalculations occur in France (1A3dii), Poland (1A3bi, 1A3bv), Spain (1A3biv) and Romania (1A3bi). Major recalculations in the 'Small combustion' sector were performed by France and Spain (both 1A4bi) and Poland (1A4bi, 1A4vi). France, Spain and Germany also recalculated their emissions in subcategories of 'Other Solvent and Product use'. NMVOC emissions from fugitive emissions were recalculated by Poland (1B1b, 1B2av) and Germany (1B2aiv), in the agricultural sector by Poland (3B1a) and Germany (3B1b) and in the waste sector by Spain (5C2).

Major recalculations in Bulgaria in 1990 occurred mainly in categories 1A1a (Public electricity and heat production), 1A2a (Iron and steel) and 2H2 (Food and beverages industry).

Figure 5.2 Recalculations for NMVOC emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

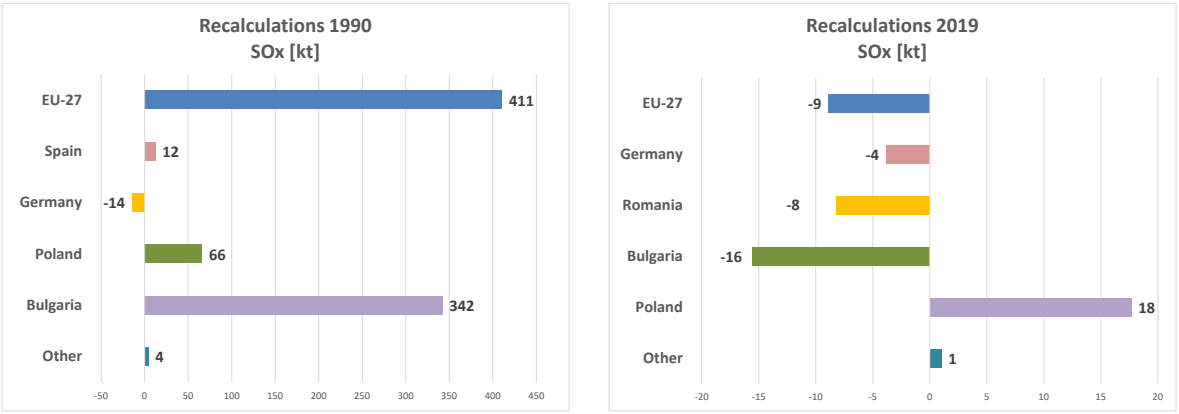
Recalculations of sulphur oxide emissions

Figure 5.3 shows the recalculations for sulphur oxides (SO_X) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990 and 2019, recalculations of SO_x emissions for the EU-27 add up to an decrease of -0.5% (-9kt).

Significant recalculations were performed in sector 'Energy Industries' by Germany (1A1c), Bulgaria and Poland (both in 1A1a), in 'Combustion in manufacturing industry and construction' in Germany (1A2gviii) and Bulgaria (1A2a) and in 'Small Combustion' in Poland (1A4bi) and Bulgaria (1A4ai, 1A4ci). Germany also reported major recalculations in the category 'Mineral Products' (2A3), Romania in category 'fugitive emissions' (1B2aiv), while recalculation of SOx emissions in Spain mainly occur in the sector waste (5C2).

Figure 5.3 Recalculations for SO_x emissions for the years 1990 and 201



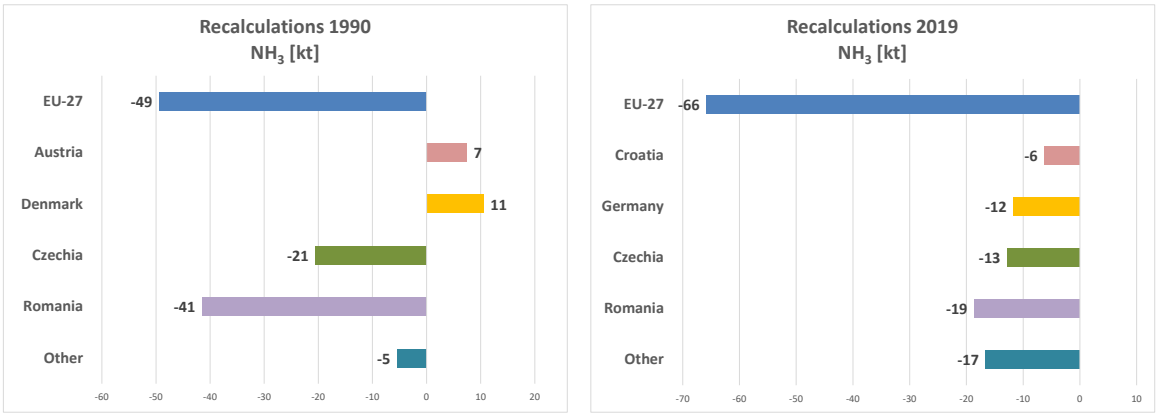
Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

Recalculations of ammonia emissions
Figure 5.4 shows the recalculations for ammonia (NH_3) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990 and 2019, recalculations of NH_3 emissions for the EU-27 add up to a decrease of -1% (-66kt) and -1.9% (-49kt), respectively.

Significant recalculations of NH_3 emissions were made by all Member States, mainly in the sector 'Agriculture'.

Figure 5.4 Recalculations for NH_3 emissions for the years 1990 and 2019



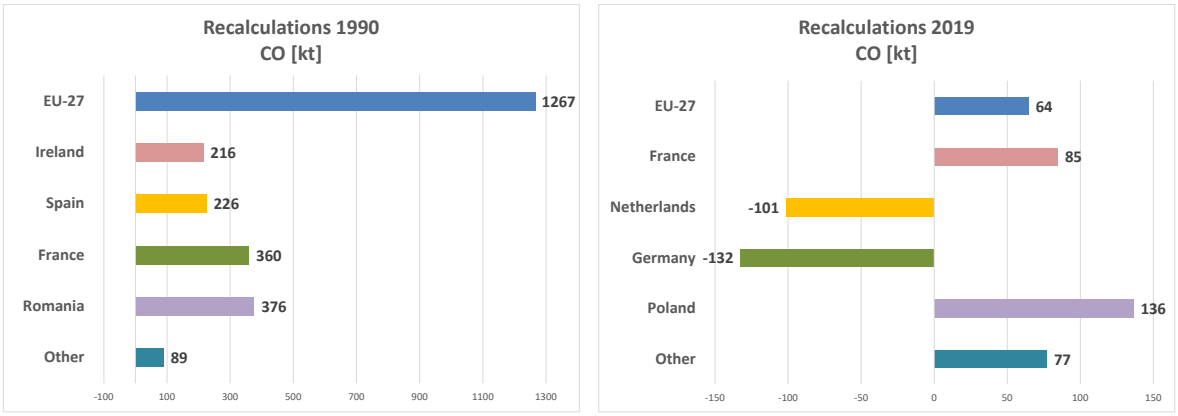
Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

Recalculations of carbon monoxide emissions:
Figure 5.5Figure 5.4 shows the recalculations for carbon monoxide (CO)emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990 and 2019, recalculations of CO emissions for the EU-27 add up to increases of 2% (+1267kt) and 0.4% (+64kt), respectively.

Significant recalculations of CO emissions were reported in the Transport sector by France, the Netherlands, Spain (all in 1A3bi) and by Poland (1A3bi, 1A3bii). In sector 'Small Combustion', France, Ireland and Romania (all in 1A4bi) and Poland (1A4bi, 1A4ci) recalculated CO emissions. Additionally, Germany recalculated CO emissions in 1A2f - Stationary combustion in manufacturing industries and construction: Non-metallic minerals, Romania also reported significant recalculations in sector 1B2aiv (Fugitive emissions from Oil: Refining and storage)

Figure 5.5 Recalculations for CO emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

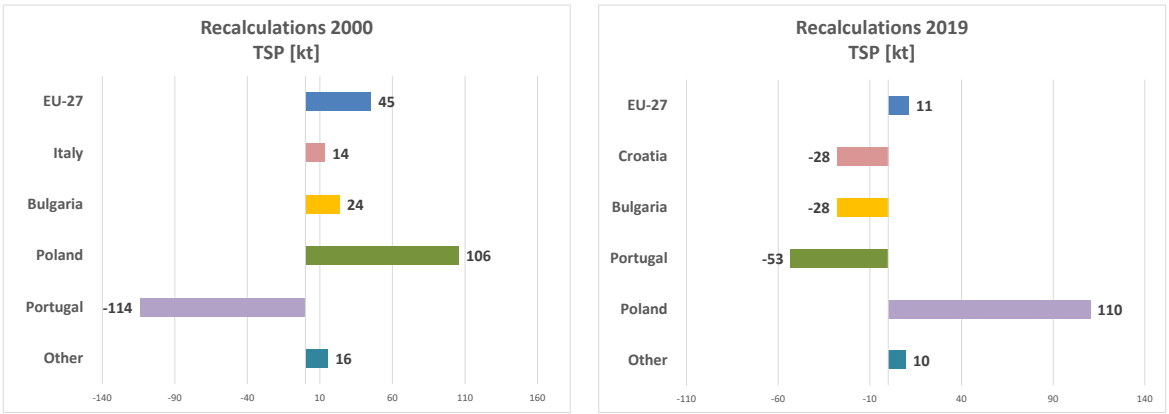
Recalculations of total suspended particle emissions

Figure 5.6 shows the recalculations for TSP emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2000 and 2019.

In 2000 and 2019, recalculations of TSP emissions for the EU-27 add up to increases of 1% (+45kt) and 0.3% (+11kt), respectively.

Significant recalculations of TSP emissions were reported in the sector 'Small Combustion' by Poland (1A4bi, 1A4ci). In the sector 'Other Solvent and Product use', Croatia, Italy, Portugal and Bulgaria recalculated their TSP emissions (all in 2D3b). TSP emissions were also recalculated in sectors 'Mineral Products' by Croatia (2A5b) and Italy (2A1, 2A2) and in the sector 'Chemical Industry' by Bulgaria (2B10a). Additionally, Italy provided revised estimates of TSP emissions sector 'Agriculture' (3B4giv).

Figure 5.6 Recalculations for TSP emissions for the years 2000 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

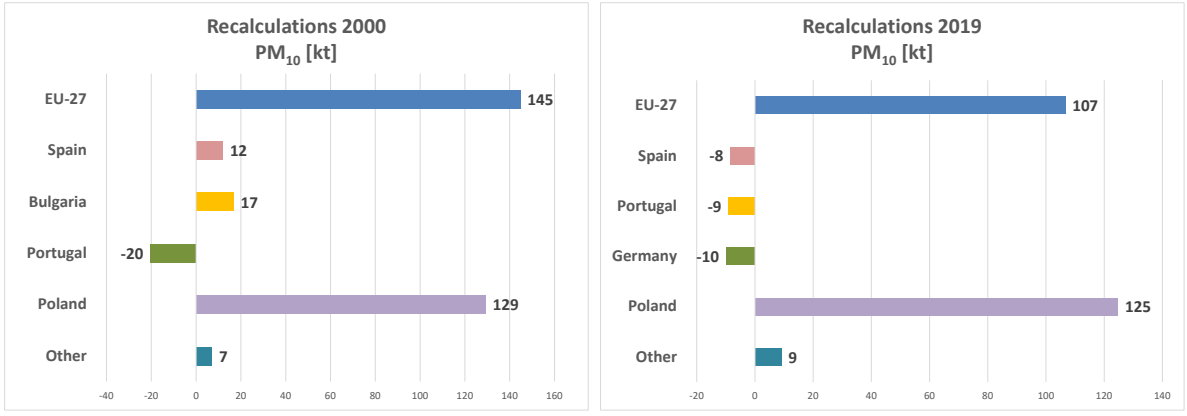
Recalculations for emissions of particulate matter with a diameter of 10 µm or less

Figure 5.7 shows the recalculations for emissions of particulate matter with a diameter of 10 µm or less (PM_{10}) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2000 and 2019.

In 2000 and 2019, recalculations of PM_{10} emissions for the EU-27 add up to an increase of 6% (+145kt +107kt, respectively).

This increase is mainly dominated by recalculations performed in Poland in sector 'Small Combustion' (1A4bi, 1A4ci). Other sectors affected by major recalculations are 'Public electricity and heat production' (Bulgaria – 1A1a), 'Combustion in manufacturing industries and construction' (Bulgaria – 1A2a), 'Other Solvent and Product use' (Bulgaria and Portugal - 2D3b and Germany – 2L), 'Agriculture' and 'Waste' (Spain -3F and 5C).

Figure 5.7 Recalculations of PM_{10} emissions for the years 2000 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

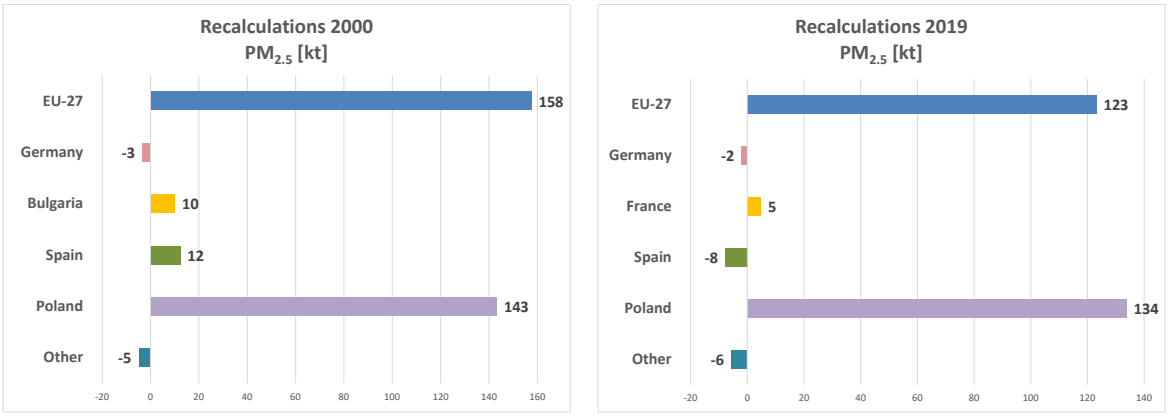
Recalculations of emissions of particulate matter with a diameter of 2.5 µm or less

Figure 5.8 shows the recalculations for emissions of particulate matter with a diameter of 2.5 µm or less ($PM_{2.5}$) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2000 and 2019.

In 2000 and 2019, recalculations of $PM_{2.5}$ emissions for the EU-27 lead to increases of 9% (+158kt) and 11% (+123kt), respectively.

As it is for TSP- and PM_{10}-emissions, the increase in $PM_{2.5}$ emissions is mainly dominated by recalculations performed in Poland in the sector 'Small Combustion' (1A4bi, 1A4ci). Also, Bulgaria, and Germany (both in 1A4bi) and France (1A4bii) also reported recalculations in this subcategory. Other sectors affected by major recalculations were Public electricity and heat pr–duction' (Bulgaria – 1A1a), Transport (Germany - 1A3bvi), 'Other Solvent and Product use' (Germany – 2L) and Waste (Spain – 5C2).

Figure 5.8 Recalculations for $PM_{2.5}$ emissions for the years 2000 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

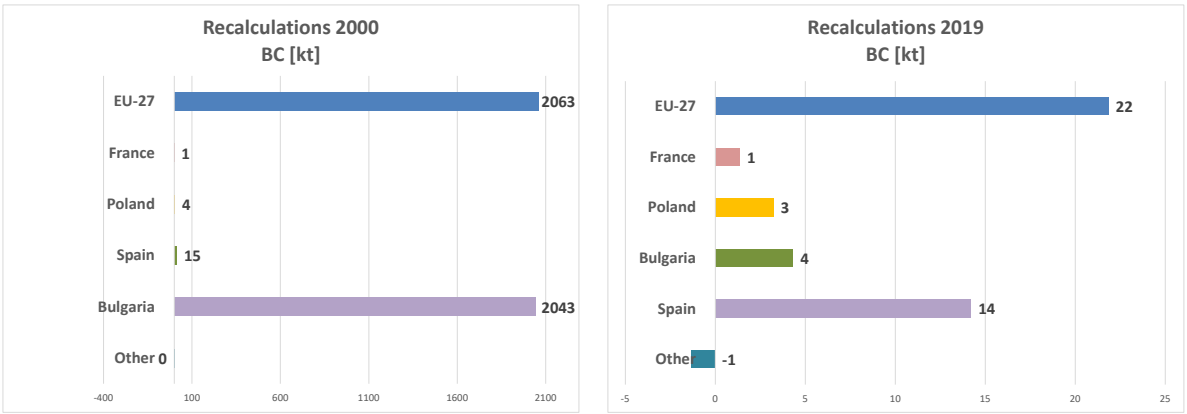
Recalculations of black carbon emissions

Figure 59 shows the recalculations for black carbon (BC) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2000 and 2019.

In 2000 and 2019, recalculations of BC emissions for the EU-27 lead to an increase of 644% (+2043kt) and 13% (+22kt), respectively.

Recalculations of BC emissions in the year 2000 are dominated by recalculations performed in Bulgaria in subcategory 2D3c - Asphalt roofing. Additionally, recalculations were performed in both 2000 and 2019 in sector 'Transport' (France - 1A3bi), 'Small Combustion' (Poland - 1A4bi) and 'Waste (France and Spain in 5C2).

Figure 5.9 Recalculations for BC emissions for the years 2000 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

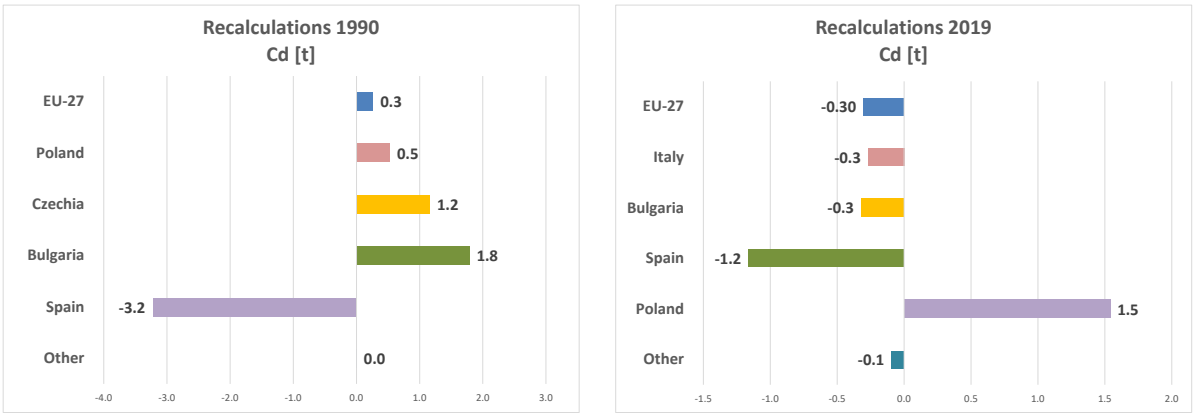
Recalculations of cadmium emissions

Figure 5.12 shows the recalculations for cadmium (Cd) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990, recalculations of Cd emissions for the EU-27 add up to increases of -2% (+0.3t) and in 2019 to a decrease of -1% (-0.3t).

Recalculations of Cd emissions were performed in sectors 'Combustion in manufacturing industry and construction' (Spain - 1A2e, Bulgaria - 1A2a), 'Small combustion' (Spain and Poland - 1A4bi), 'Metal Production' (Italy in 2C1, Czechia in 2C6), 'and 'Waste' (Italy and Spain - 5C2).

Figure 5.10 Recalculations for Cd emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

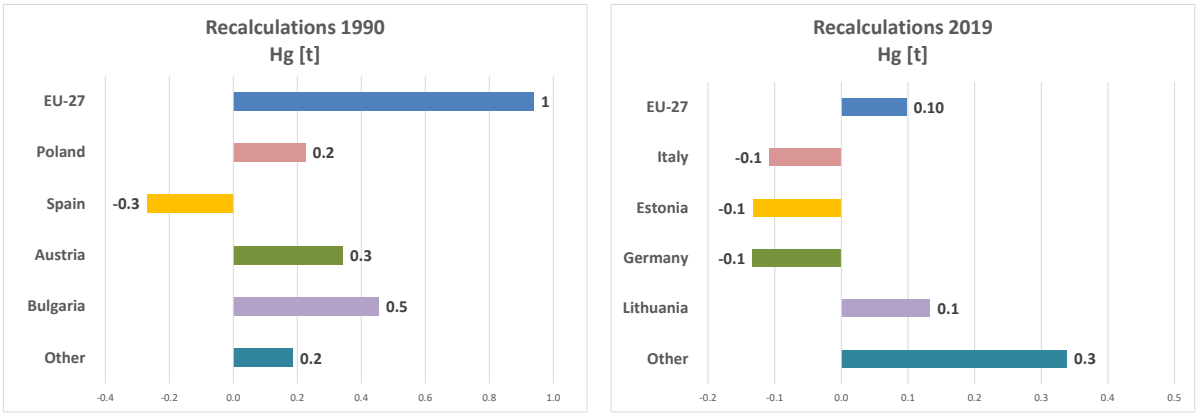
Recalculations of mercury emissions

Figure 5.11 shows the recalculations for mercury (Hg)emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990 and 2019, recalculations of Hg emissions for the EU-27 add up to increases of 0.6% (+1t) and 0.2% (+0.1t), respectively.

Recalculations of Hg emissions were performed in the sectors 'Energy industries' (Bulgaria, Estonia, Germany, Lithuania – all in 1A1a), 'Combustion in manufacturing industry and construction' (Italy - 1A2a– Bulgaria - 1A2f), 'Metal Production' (Austria - 2C1), 'Other Solvent and Product use' (Poland – 2D3a) and 'Agriculture' (Spain - 3F).

Figure 5.11 Recalculations for HG emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

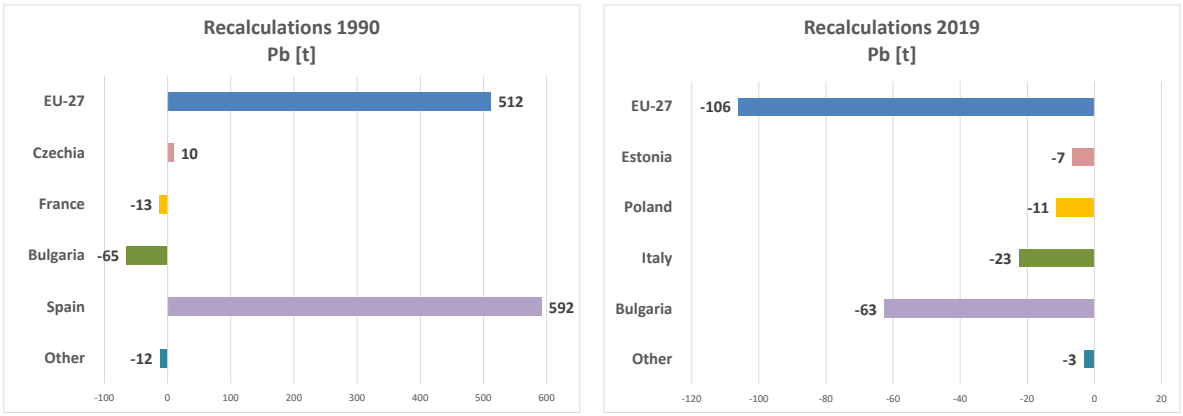
Recalculations of lead emissions

Figure 5.12 shows the recalculations for lead (Pb)emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990, recalculations of Pb emissions for the EU-27 add up to increases of 3% (+512t) and in 2019 to a decrease of -10% (-106t).

Significant recalculations of Pb emissions were reported in 'Public electricity and heat production' (Estonia - 1A1a), 'Stationary combustion in manufacturing industries and construction (Bulgaria - 1A2b, 1A2f;), the Transport sector by Czechia (1A3ai(i)), France (1A3bi, 1A3bii) and Spain (1A3bi, 1A3bii, 1A3biii, 1A3biv). In sector 'Small Combustion', Poland (1A4ci, 1A4bi) recalculated Pb emissions., Italy reported major recalculation in sector 'Combustion in manufacturing industry and construction' (2C1) and in the sector 'Waste' (5C2).

Figure 5.11 Impact on recalculations for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

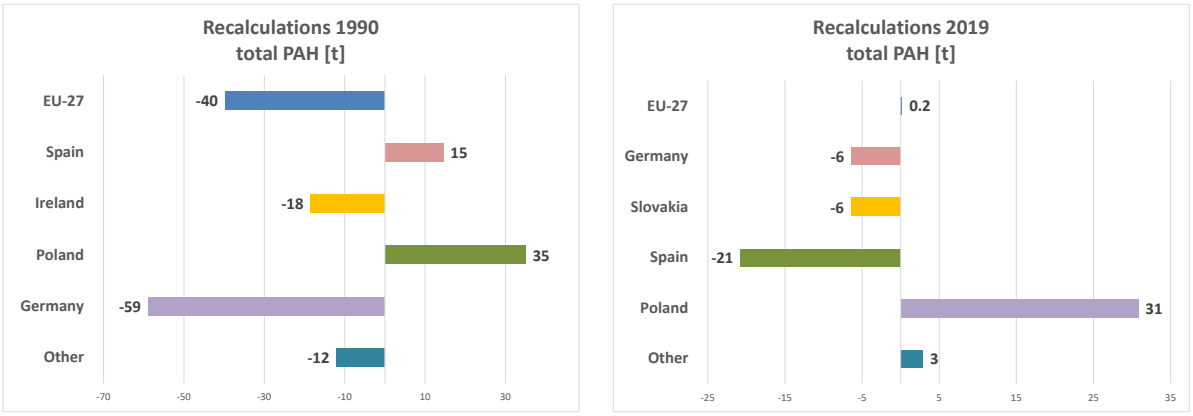
Recalculations of total polycyclic aromatic hydrocarbon emissions

Figure 5.13 shows the recalculations for total polycyclic aromatic hydrocarbon (PAH) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990, recalculations of total PAH emissions for the EU-27 add up to a decrease of -3% (-40t) and in 2019 to an increase of -0.03% (+0.2t).

Significant recalculations of total PAH emissions were reported in the sectors 'Combustion in manufacturing industry and construction' (Spain - 1A2a), 'Small Combustion' (Slovakia - 1A4aii; Spain - 1A4bi; Poland - 1A4bi, 1A4ci; Ireland - 1A4bi) and 'Fugitive Emissions' (Slovakia - 1B1b). Germany performed major recalculations for total PAHs in the subcategory 2A1 - Cement production.

Figure 5.13 Recalculations for PAH emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

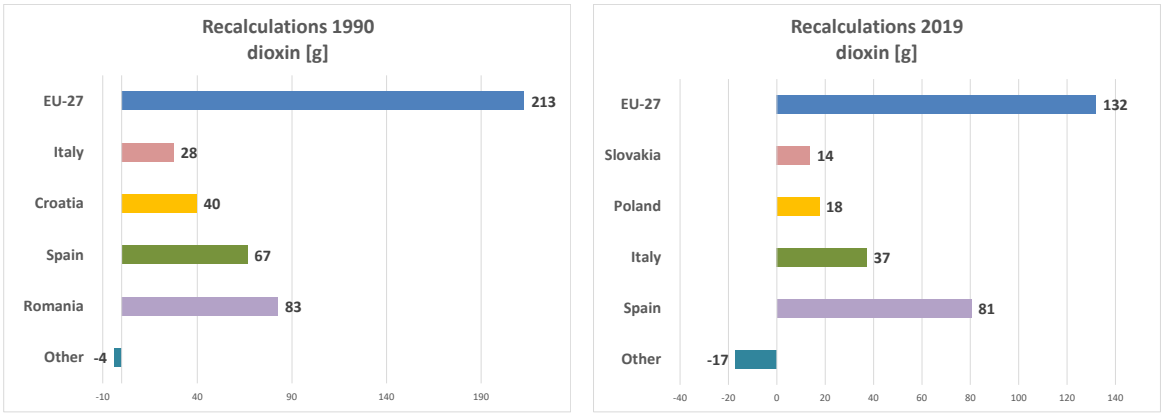
Recalculations of dioxin emissions

Figure 5.13 shows the recalculations for dioxin emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990 and 2019, recalculations of dioxin emissions for the EU-27 add up to a increases of 3% (+213g) and 8% (+132g), respectively.

Significant recalculations of dioxin emissions were performed mainly in sector 'Waste' (Slo–akia - 5C1bv, Italy – 5E, Spain - 5C2, Romania - 5C1biii). Additionally, Poland recalculated dioxin emissions in sector 'Small Combustion' (1A4bi, 1A4ci) and Croatia in the sector 'Agriculture' (3F).

Figure 5.14 Recalculations for dioxin emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

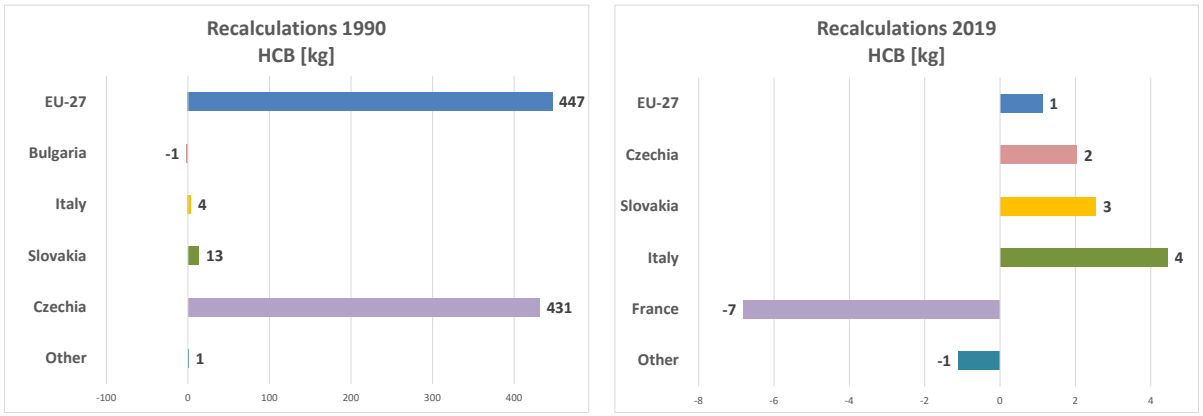
Recalculations of hexachlorobenzene emissions

Figure 5.15 shows the recalculations for hexachlorobenzene (HCB) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990 and 2019, recalculations of HCB emissions for the EU-27 add up to increases of 8% (+447kg) and 1% (+1kg).

Significant recalculations of HCB emissions were performed mainly in the sectors 'Public electricity and heat production (Bulgaria – 1A1a), 'Combustion in manufacturing industry and construction' (Italy - 1A2a) and 'Small combustion' (Italy - 1A4ai, Slovakia – 1A4bii) and 'Agriculture' (Czechia and France - 3Df). In 1990, the increase in recalculations was dominated by reported recalculations in Czechia in the category 2C3 - Aluminium production.

Figure 5.15 Recalculations for HCB emissions for the years 1990 and 2019



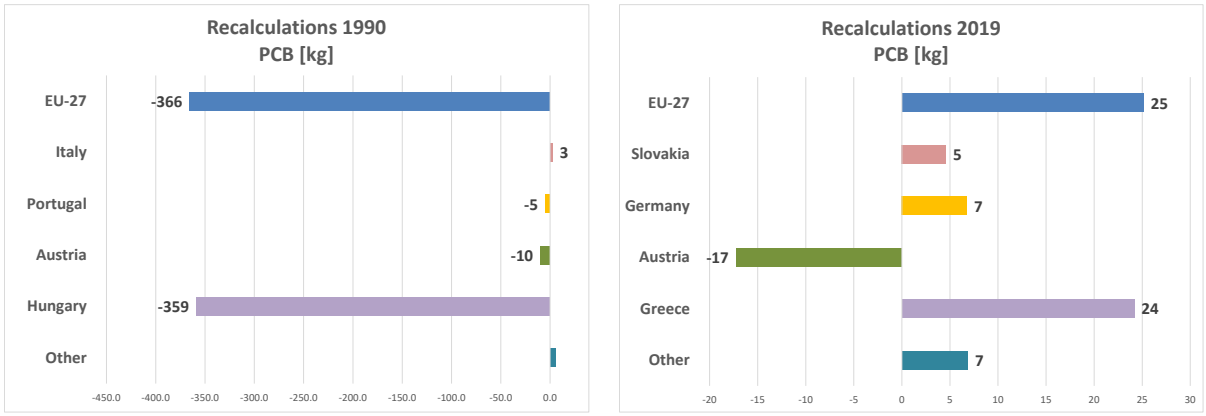
Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

Recalculations of polychlorinated biphenyl emissions
Figure 5.16 shows the recalculations for polychlorinated biphenyl (PCB) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 1990 and 2019.

In 1990, recalculations of PCB emissions for the EU-27 add up decreases of -7% (-366kg) and in 2019 to an increase of -2% (+25kg).

In 1990, recalculations are dominated by recalculations performed in Hungary in the transport sector (1A3dii). Important recalculations of PCB emissions were performed in the sectors 'Energy industries' (Germany - 1A1a), 'Combustion in manufacturing industry and construction' (Italy - 1A2b), 'Metal production' (Austria and Slovakia - 2C1, Greece - 2C5), –and 'Waste (Portugal - 5C1bi).

Figure 5.16 Recalculations for PCB emissions for the years 1990 and 2019



Note: The figure shows recalculations for the EU-27 and the four biggest contributors. 'Other' is the sum of the recalculations from all other Member States.

5.1.2 EU Member States' recalculations

Under the revised reporting guidelines (UNECE, 2014a), all countries should submit explanatory informative inventory reports (IIRs) that include details explaining any recalculations made. Some EU Member States provide very detailed explanations for their recalculations of parts of the time series or the whole time series (e.g. methodological improvements, revisions of emission factors, reallocations, revisions of activity data and corrections of errors).

Austria provided detailed information concerning its recalculations, which were carried out because of

Austria provided detailed information on its recalculations, which were carried out for several reasons, including updated data and revised estimates. Detailed information is provided in Austria's IIR (see Austria's IIR, p. 428ff., listed in Appendix 5).

Belgium provided detailed information on its recalculations for its individual regions (Brussels, Flanders and Wallonia) for the sectors energy, industrial processes and product use, agriculture, and waste. Among the main reasons for recalculations at the sectoral level were the application of emission factors from the inventory guidebook (EMEP/EEA, 2019), terror correction, updated and revised data, and the optimisation of models (see Belgium's IIR, p. 204f., listed in Appendix 5).

Bulgaria stated in its IIR that recalculations had been carried out for several sectors using emission factors from the guidebook and information provided in the stage 3 review (see Bulgaria's IIR, p. 130, listed in Appendix 5).

Croatia provided detailed information on its recalculations for different sectors. The main reasons for the recalculations included the availability of updated activity data and sources, the implementation of higher tier methods, updated methodology, the use of the new Copert 5 model and the correction of errors in the time series. Table ES4-1 in Croatia's IIR provides an overview of the recalculations (see Croatia's IIR, p. 253f., listed in Appendix 5).

Cyprus stated that it had made some methodological improvements to its national emission inventory. The changes were made in response to previous recommendations from the Technical Expert Review Team (TERT) or technical corrections. This led to recalculations of the time series 1990-2019, aiming to improve the accuracy of the emission data. The main reason for the recalculations was the full implementation of the provisions of the new inventory guidebook (EMEP/EEA, 2019) and the implementation of the TERT's suggestions in 2017, 2018, 2019,2020 and 2021 (see Cyprus's IIR, p. 153, listed in Appendix 5).

Czechia stated that recalculations were carried out among other reasons because of updated data (e.g.: Eurocontrol fuel consumption for aviation) and update to Copert 5.5 (version 3.3 was previously used). More information about the recalculations for the transport and agriculture sectors is provided in Czechia's IIR (see Czechia's IIR, p. 117f., listed in Appendix 5).

Denmark provided detailed information on its recalculations within the sectoral chapters. The main reason for recalculation was updates to the inventory guidebook (EMEP/EEA, 2019)(see Denmark's IIR, p. 456, listed in Appendix 5).

Estonia provided detailed information on its recalculations for the period 1990-2019. The reasons for the recalculations were new approaches, updated emission factors and error correction (see Estonia's IIR, p. 286, listed in Appendix 5).

Finland provided detailed information on its recalculations, which were carried out for several reasons. Most of the recalculations are due to the updating of statistical data and in some cases the application of new emission factors and error corrections (see Finland's IIR, 1B_General, p. 5, listed in Appendix 5).

France stated that recalculations were due to the updating of activity data, methodological improvements, correction of errors and the availability of new information and a new methodology (see France's IIR, listed in Appendix 5).

Germany provided detailed information within the respective sector chapters. Recalculations were performed due to update in activity data from actualized Energy Balances, change of methods, emission factors or data sources (see Germany's IIR, listed in Appendix 5)

Greece reported that all emissions were recalculated on account of changes in or refinements of methods, inclusion of new sources, reallocation, updated activity data and correction of errors (see Greece's IIR, p. 146, listed in Appendix 5).

Hungary provided information on recalculations in the sector-specific chapters. These were mainly carried out because of the availability of updated and new activity data and the use of the new Copert 5 model (see Hungary's IIR, listed in Appendix 5).

Ireland provided information on recalculations in the sector-specific chapters. Among other reasons, recalculations were carried out because of the availability of updated and revised activity data and error corrections (see Ireland's IIR, listed in Appendix 5).

Italy stated in its IIR that recalculations were mainly due to changes in methodologies, different allocations of emissions, error correction and new available information (see Italy's IIR, p. 180, listed in Appendix 5).

Latvia provided detailed information on recalculations in the sector-specific chapters. They were carried out because of updated activity data and emission factors, as well as the implementation of sector-specific research results, and following recommendations from the TERT (see Latvia's IIR, p.13 listed in Appendix 5).

Luxembourg presented its main revisions and recalculations in Section 8.1.1 of its IIR (p. 472). Reasons for the recalculations include updated activity data, methodology and emission factors and correcting errors (see Luxembourg's IIR, listed in Appendix 5).

Malta stated in its IIR that recalculations were carried out, among other reasons, because of the use of emission factors from the guidebook, revised estimates and data, error correction and updated methodology (see Malta's IIR, listed in Appendix 5).

The **Netherlands** provided detailed information on the recalculations carried out. The main reason for these was the inclusion of updated/improved activity data. Compared with the IIR 2021, only a few methodological changes were implemented in the pollutant release and transfer register (PRTR) system (see Netherlands' IIR, p. 193, listed in Appendix 5).

Poland reported that recalculations were carried out mainly because of updated emission factors, updated activity data, verified methodologies, new emission sources not estimated previously and an update to the latest version of the Copert 5 software (see Poland's IIR, p. 165f, listed in Appendix 5).

Portugal provided detailed information on its recalculations in accordance with the results of the annual review of the National Emission reduction Commitments (NEC) Directive. Since the last submission, recalculations have been carried out mainly because of revised data, updated activity data, error correction and updated methodology (see Portugal's IIR, pp. 8-16, listed in Appendix 5).

Romania noted that, following the review of the emission inventory, recalculations of emissions were carried out based on updated emission factors, new and revised estimates and activity data, corrections of emission factors, the application of a higher tier method, reallocation of data and error correction (see Romania's IIR, p. 333, listed in Appendix 5).

Slovakia provided detailed information and figures and tables on its recalculations. The main reasons were the implementation of higher tier methods, new information (e.g. new information about the vehicle fleet structure) and improved activity data and methodology (see Slovakia's IIR, p. 342f., listed in Appendix 5).

Slovenia provided detailed information on its recalculations, which were carried out because of error correction, first-time reporting of emissions, new activity data, the application of a higher tier method and an update to the latest version of Copert 5. Some of these recalculations were carried out following recommendations from the TERT (see Slovenia's IIR, p. 283f, listed in Appendix 5).

Spain provided very detailed information on its recalculations, with the main reasons for them being error correction, the use of new emission factors, the availability of new data, updated activity data and methodological improvements (see Spain's IIR, p. 417, listed in Appendix 5).

Sweden provided detailed information within the respective sector chapters. Reasons for recalculations mentioned by Sweden include newly available sources, error correction, inclusion of new and updated activity data and improved methods (see Sweden's IIR, p. 283f, listed in Appendix 5).

The annual European Monitoring and Evaluation Programme (EMEP) inventory review report (EMEP, forthcoming) presents a summary of the individual recalculations reported by EU Member States. This yearly report will be available on the Centre on Emission Inventories and Projections' (CEIP's) website in July 2022 (EMEP CEIP, 2022c).

5.1.3 Changes in EU Member States' emission inventories due to improvements based on the review

In addition, EMEP CEIP has the task of reviewing the emission inventories submitted to help Parties improve their national inventories (EMEP CEIP, 2021b; EMEP, forthcoming). These yearly reviews should help EU Member States compile their individual emission estimates and submit their improved inventories together with their IIRs.

The stage 1 review — an automated test — is held every year to assess timeliness, completeness and format. The stage 2 review assesses recalculations, key category analysis (KCA), inventory comparison, trends and time series. Stage 3 is an in-depth review by experts nominated by the Parties.

5.1.4 Improvements planned at the EU level

The EEA and the European Topic Centre on Human Health and the Environment (ETC/HE) have noted that the main future challenge for EU Member States remains improving the quality of data submissions in order to deliver more complete and more timely emission inventories in accordance with the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (Air Convention). Improvements cannot be implemented at the EU level alone; the EU Member States themselves must also develop and prioritise reliable and timely inventory reporting systems.

The EEA and ETC/HE have identified the following challenges:

- **Further progress on the completeness of reporting.** Although clear progress has been made in recent years on making reporting complete, a full set of emission inventory data for air pollutants is still not available for all EU Member States, as noted earlier in this report. In addition, for certain pollutants (mainly PM and heavy metals, HMs), data could not be fully gap filled, because some EU Member States had not reported emission values in any year; this is especially the case for pollutants for which reporting is not obligatory (see Figure 1.5 and 1.6).

- **Updating of emissions data by EU Member States**, including for previous years. The ETC/HE has also identified a problem with gap filling using data submitted several years ago. In a number of cases, because countries have not since submitted corrected or updated data sets, the EU inventory unavoidably includes inconsistencies. Therefore, the quality of the EU's inventory will be enhanced if the consistency and completeness of EU Member States' submissions improve. Such improvements would help reliable trend analysis to inform policy. Since 2017, emission inventory reviews have been conducted under the NEC Directive (EU, 2016b). The results of the review of these processes should also improve the quality of the Air Convention submissions.

- **Review of the current gap filling procedures to ensure that they use the best approach**, reflecting real emissions. Although the improved inventory gap filling procedure carried out since 2011 has helped to develop a more complete EU emission inventory, there is still room for improvement (e.g. by including manual changes in the procedure).

- **Reducing the need for gap filling**. This is achievable if the EU Member States report complete time series as far as possible, and if they have already provided the data in earlier submissions under the Air Convention. Current gap filling procedures first use submissions received in the current reporting years under various reporting mechanisms and then use older Air Convention submissions. However, because of the review of processes under the NEC Directive, it is expected that the completeness of submissions (under the NEC Directive and Air Convention) will improve.

- **More explanatory information on trends and recalculations**. This would be possible only if the IIRs included such information. Thus, countries are encouraged to provide it.

- **Further research on outliers in EU Member States' emission data to ensure that they reflect real emissions**. A comparison of Member States' contributions to the EU total reveals extraordinarily high proportions in some instances. Future investigation could determine whether these high proportions reflect actual emissions or are attributable to incomplete reporting (or underestimates) by other EU Member States.

- **More attention to data quality**. In several submissions from EU Member States and as a result of the gap filling procedure, values of BC exceed $PM_{2.5}$ values, values of $PM_{2.5}$ exceed PM_{10} values, or values of PM_{10} exceed TSP values — all of which should be impossible. Changes in the gap filling procedure and improved Member State emission data should resolve these problems.

5.2 Improvements implemented

The joint EMEP/EEA annual review of inventory data helps to improve the EU Member States' inventories. The review of data reported under the Air Convention is held jointly, along with the review of data reported by the EU Member States under the NEC Directive. Since 2009, there has been a centralised stage 3 review process under the Air Convention review process (EMEP CEIP, 2021b). Two teams of emission experts perform the reviews. EU Member States are encouraged to nominate reviewers for the EMEP roster of emission review experts; the details of the nomination process are available on the CEIP website. In 2020, the EU emission inventory report (1990-2018) under the UNECE Air Convention (EEA, 2017) was reviewed (UNECE/CEIP, 2020). The findings and their implementation are summarised in Table 5.2.

5.2.1 Improvements in response to the stage 3 review of the EU inventory in 2020

Table 5.2 lists the status of improvements implemented in response to the stage 3 review by an expert review team (ERT) in 2020 (UNECE/CEIP, 2020).

Table 5.2 EU stage 3 review results 2020 and improvements implemented

Review findings (2020)			
Topic	**Recommendation**	**Implemented**	**Comment**
Transparency			
Timeliness	Submit the IIR a few weeks before the deadline of 30 May, or, if that is not possible, provide the ERT with a draft IIR a few weeks earlier in those years when the EU is being reviewed, to facilitate the work of the ERT	Yes	The EU will provide the draft IIR before the reporting deadline in review years
Methodologies	Include in the IIR: summarised information about methodologies used by the MSs for emissions in the EU's key categories	No	Member States' inventories and IIRs are also part of the EU submission and provide information on methods applied to subsectors. Including this information in the EU IIR is not feasible within the limited timeframe
Trends	Include in the IIR: explanations for all emission trends in the EU inventory, in consultation with the MSs	Partly	The EU has made efforts to provide explanations for trends in consultation with the Member States. More information on emission trends will be included in future submissions
Methods	Include in the IIR: sub-sector level information on methods used to calculate emissions	No	Member States' inventories and IIRs are also part of the EU submission and provide information on methods applied to subsectors. Including this information in the EU IIR is not feasible within the limited timeframe
Sources included	Include in the IIR: subsector level information on sources included in the inventory, especially in the industry sector	No	Member States' inventories and IIRs are also part of the EU submission and provide information on sources to subsectors. Including this information in the EU IIR is not feasible within the limited timeframe
Gap filling procedure	Include in the IIR: information on sector level in the main text of the IIR about the gap filling procedure, or at least provide Annex D containing this information as a public part of the IIR	Yes	Annex D will be publicly available in future submissions
EU-level inventory improvement programme	Include in the IIR: information on improvements and progress with improvement work	Ongoing	Table 5.3 (improvements implemented) and Table 5.4 (improvements planned) are provided in the EU IIR
Condensable Component	Include in the IIR: summary information at the sectoral level on whether the condensable component of PM is included or not in MSs' inventories	Yes	Information on condensable components of PM is included in the EU IIR
Include links	Include in the IIR: include links in the IIR for relevant websites where gridded data and LPS data are available	Yes	The links are provided within the relevant sections of this report
Sector-specific QA/QC, trends	Implement sector-specific QA/QC procedures to investigate the data in detail and find explanations for real but unusual sector trends, and work with the individual MSs to provide more details on the drivers behind the trends	Ongoing	Work on outliers and unusual trends has already been established; further cooperation with the MS is outside the scope of this report

Review findings (2020)			
Topic	**Recommendation**	**Implemented**	**Comment**
Accuracy			
KCA to prioritise improvements	Use the results of the EU inventory's KCA to prioritise improvements in the inventory; include this issue in the improvement plan with clear steps and a schedule and report on progress in the next submissions	Ongoing	The EU is taking results from the KCA into account to improve the inventory and will provide information in the improvement plan
Completeness			
Completeness assessment	Include in the IIR: sector-specific assessment of the completeness of the inventory	No	Member States' inventories and IIRs are also part of the EU submission and provide information on methods applied to subsectors. Including this information in the EU IIR is not feasible within the limited timeframe
Eurostat data for data gaps	Further improve the completeness and comparability of the inventory in consultation with the MSs by exploring possibilities to use the Eurostat data or other data sources in cases where an MS does not include an existing source in its inventory although methods are available in the inventory guidebook	No	This task would mean considerable effort; such an analysis is not feasible within the limited timeframe
Activity data	Further improve the completeness and comparability of the inventory in consultation with the MSs by using the results of the NEC Directive technical review to improve the reporting of activity data in the EU submission	No	This task would mean considerable effort; such an analysis is not feasible within the limited timeframe
Fuel data	Further improve the completeness and comparability of the inventory in consultation with the MSs by including fuel data in the NFR tables for the years and the sectors for which this is possible	Ongoing	The EU will work on the provision of activity data in categories, where possible
Uncertainty information from MSs	The ERT recommends that the Party include an uncertainty analysis in line with paragraph 31 of the reporting guidelines and work with the MSs to increase their reporting on uncertainties in their inventories and report on summarised information on uncertainties	No	To develop an uncertainty analysis, possibly on GAINS and IIASA data for the years 2005 and 2010, would exceed the workload of 2021
Uncertainty analysis	The ERT also recommends that the Party develops a parallel uncertainty analysis independent of the Member States' submissions, including an assessment of the impacts of the gap filling procedure and improvements following the NEC Directive technical review on inventory uncertainty	No	Member States' inventories and IIRs are also part of the EU submission and provide information on methods applied to subsectors. Including this information in the EU IIR is not feasible within the limited timeframe

Review findings (2020)			
Topic	**Recommendation**	**Implemented**	**Comment**
Comparability			
Notation keys	Always use notation keys in line with the paragraph 12 of the reporting guidelines, and especially check that the use of the notation key 'NE' is in line with the reporting guidelines. Include information in the IIR to justify the uses of the notation keys; for 'IE' also document where the emissions are included	Ongoing	This needs further discussion within the framework of the Task Force on Emission Inventories and Projections (TFEIP)
Compare MS data	Further improve the completeness and comparability of the inventory in consultation with the MSs by ensuring the comparability of MS data before aggregation at the EU level	No	This task would mean considerable effort; such an analysis is not feasible within the limited timeframe
Consistency			
Sector-specific QA/QC	Include in the IIR: sector-specific information on QA/QC procedures	No	This task would mean considerable effort; such an analysis is not feasible within the limited timeframe
Sector-specific recalculations	Include in the IIR: sector-specific information on recalculations wherever possible	Ongoing	Considerable efforts have already been undertaken to extract this information either from the IIRs or by contacting the MSs
Recalculations	Include in the IIR: information of the impacts of recalculations based on gap filling	Yes	Figure 1.5 and Figure 1.6 of the EU IIR provide this information. Because of increasing completeness of reporting by the MSs the percentage of gap-filled values within the EU inventory is steadily decreasing

Note: GAINS, Greenhouse Gas — Air Pollution Interactions and Synergies (model); IE, included elsewhere; IIASA, International Institute for Applied Systems Analysis; LPS, large point source; MS, Member State; NE, not estimated; NFR, nomenclature for reporting; QA/QC, quality assurance and quality control.

5.2.2 Further improvements undertaken in 2022

- The description of trends for NO_X, SO_X, NMVOC, NH_3 and $PM_{2.5}$ were improved.
- NFR (nomenclature for reporting) tables are submitted in the recommended format NFR2019-1.
- Again, explanations on unusual trends, peaks and troughs were improved.
- Information on recalculations was improved, including new graphs and the description on recalculations in 1990 and 2019.
- Quality control of data for PM_{10}, $PM_{2.5}$ and BC improved the gap-filled inventory.

5.2.3 Improvements at Member State level

Improvements at Member State level also automatically improve the EU inventory. Information on Member State level improvements can be found within the respective IIRs (see Appendix 5).

The updated reporting guidelines (UNECE, 2014a) request that Parties to the Air Convention provide emission data using the NFR19format. All of the EU Member States that submitted data used the new template.

Units, symbols, abbreviations, and acronyms

Air Convention	UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)
As	Arsenic
B(a)P	Benzo(a)pyrene
B(b)F	Benzo(b)fluoranthene
BC	Black carbon
B(k)F	Benzo(k)fluoranthene
Cd	Cadmium
CDR	Central Data Repository
CEIP	Centre on Emission Inventories and Projections
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
COPERT	Computer program to calculate emissions from road transport
Cr	Chromium
Cu	Copper
DG	Directorate-General
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme (cooperative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe)
EPER	European Pollutant Emission Register
E-PRTR	European Pollutant Release and Transfer Register
ERT	Expert review team
ETC	European topic centre (of the EEA)
ETC/CM	European Topic Centre on Climate change mitigation
ETC/HE	European Topic Centre on Human health and the environment
ETC/ATNI	European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollutio
ETS	Emissions Trading System
EU	European Union
FGD	Flue gas desulphurisation
Gg	1 gigagram = 10^9 g = 1 kiloton (kt)
GNFR	Gridding nomenclature for reporting/UNECE nomenclature for reporting of air
HCB	Hexachlorobenzene
HCE	Hexachloroethane
HFC	Hydrofluorocarbon
Hg	Mercury
HM	Heavy metal
IE	Included elsewhere
IIR	Informative inventory report
IP	Indeno(1,2,3-cd)pyrene
I-Teq	International toxic equivalent
KCA	Key category analysis
kg	1 kilogram = 10^3 g (gram)
LPS	Large point source

LRTAP	Long-range Transboundary Air Pollution; (UNECE) Convention on LRTAP or Air Convention
LTO	Landing and take-off
Mg	1 megagram = 10^6 g = 1 tonne (t)
MMR	Monitoring mechanism Regulation
MSW	Municipal solid waste
MWe	Megawatt electric
NA	Not applicable
N_2O	Nitrous oxide
NE	Not estimated
NEC Directive	National Emission reduction Commitments (Directive 2016/2284/EU)
NFR	Nomenclature for reporting/UNECE nomenclature for reporting of air pollutants
NH_3	Ammonia
Ni	Nickel
NILU	Norwegian Institute for Air Research
NMVOC	Non-methane volatile organic compound
NO	Not occurring
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
NR	Not relevant
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
PCB	Polychlorinated biphenyl
PCDD/F	Polychlorinated dibenzodioxin/dibenzofuran
PFC	Perfluorocarbon
PM	Particulate matter
$PM_{2.5}$	Particulate matter with a diameter of 2.5 µm or less
PM_{10}	Particulate matter with a diameter of 10 µm or less
POP	Persistent organic pollutant
QA	Quality assurance
QC	Quality control
SCR	Selective catalytic reduction
Se	Selenium
SNCR	Selective non-catalytic reduction
SO_2	Sulphur dioxide
SO_X	Sulphur oxides
t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
TERT	Technical Expert Review Team
TFEIP	Task Force on Emission Inventories and Projections
TSP	Total suspended particulate
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile organic compound
WM	With measures (projections)
WaM	With additional measures (projections)
Zn	Zinc

Key category source sector abbreviations referred to in the main text

1A1a	Public electricity and heat production
1A1b	Petroleum refining
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals 1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals
1A2gvii	Mobile combustion in manufacturing industries and construction
1A2gviii	Stationary combustion in manufacturing industries and construction: Other
1A3bi	Road transport: Passenger cars
1A3bii	Road transport: Light duty vehicles
1A3biii	Road transport: Heavy duty vehicles and buses
1A3biv	Road transport: Mopeds and motorcycles
1A3bv	Road transport: Gasoline evaporation
1A3bvi	Road transport: Automobile tyre and brake wear
1A3bvii	Road transport: Automobile road abrasion
1A3dii	National navigation (shipping)
1A4ai	Commercial/institutional: Stationary
1A4bi	Residential: Stationary
1A4bii	Residential: Household and gardening (mobile)
1A4ci	Agriculture/forestry/fishing: Stationary
1A4cii	Agriculture/forestry/fishing: Off-road vehicles and other machinery
1B2aiv	Fugitive emissions oil: Refining/storage
1B2av	Distribution of oil products
2A1	Cement production
2A3	Glass production
2A5a	Quarrying and mining of minerals other than coal
2A5b	Construction and demolition
2B10a	Chemical industry: Other
2C1	Iron and steel production
2C3	Aluminium production
2C6	Zinc production
2C7a	Copper production
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3d	Coating applications
2D3e	Degreasing
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use
2G	Other product use
2H2	Food and beverages industry
2K	Consumption of POPs and heavy metals
2L	Other production, consumption, storage, transportation or handling of bulk products
3B1a	Manure management — Dairy cattle

3B1b	Manure management — Non-dairy cattle
3B3	Manure management — Swine
3B4gi	Manure management — Laying hens
3B4gii	Manure management — Broilers
3Da1	Inorganic N-fertilisers (includes also urea application)
3Da2a	Animal manure applied to soils
3Da3	Urine and dung deposited by grazing animals
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
3De	Cultivated crops
3Df	Use of pesticides
3F	Field burning of agricultural residues
5C1bi	Industrial waste incineration
5C1biii	Clinical waste incineration
5C1bv	Cremation
5C2	Open burning of waste
5E	Other waste

Country codes

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

References

CAMS, 2021, *Interim annual assessment report for 2020 — European air quality in 2020*, Copernicus Atmosphere Monitoring Service (https://policy.atmosphere.copernicus.eu/reports/CAMS71_IAR_2020.pdf) accessed 22 March 2022.

EEA, 2009, *Proposed gap filling procedure for the European Community Air Convention emission inventory*, Technical Paper for the meeting of the Air and Fuels Committee under Directive 96/62/EC, concerning 'Information on the EU Member States' reporting under the National Emission Ceilings Directive 2001/81/EC', 28 September 2009, Brussels, European Environment Agency (available upon request).

EEA, 2012, *Eionet connects — Sharing environmental information in Europe*, EEA Brochure No 1/2012, European Environment Agency (https://www.eea.europa.eu/publications/eionet-connects) accessed 06 April 2022.

EEA, 2014, *Effect of air pollution on European ecosystems*, EEA Technical Report No 11/2014, European Environment Agency (http://www.eea.europa.eu/publications/effects-of-air-pollution-on) accessed 06 April 2022.

EEA, 2019a, 'Emissions of primary $PM_{2.5}$ and PM_{10} particulate matter (CSI 003)', European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/emissions-of-primary-particles-and-5) accessed 01 April 2022.

EEA, 2019b, 'Nitrogen oxides (NOx) emissions', European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/eea-32-nitrogen-oxides-nox-emissions-1/assessment.2010-08-19.0140149032-3) accessed 17 March 2019

EEA, 2022, 'Air pollutant emissions data viewer (Gothenburg Protocol, Air Convention) 1990-2020', European Environment Agency (https://www.eea.europa.eu/data-and-maps/dashboards/air-pollutant-emissions-data-viewer-4) accessed 21 March 2022.

EEA, 2021b, 'Emissions of the main air pollutants in Europe', European Environment Agency (https://www.eea.europa.eu/ims/emissions-of-the-main-air) accessed 21 March 2022.

EEA, 2021c, 'Heavy metal emissions', European Environment Agency (https://www.eea.europa.eu/ims/heavy-metal-emissions-in-europe) accessed 21 March 2022.

EEA, 2021d, European Union emission inventory report 1990-2019 under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention), EEA Report No 5/2021, European Environment Agency (https://www.eea.europa.eu//publications/lrtap-1990-2019) accessed 06 April 2022.

EEA, forthcoming, *Reporting by EU Member States under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC*, EEA Briefing, European Environment Agency.

Eionet, 2022a, 'Eionet — European Environment Information and Observation Network', European Environment Information and Observation Network (http://eionet.europa.eu/) accessed 22 March 2022.

Eionet, 2022b, 'Eionet — Central Data Repository', European Environment Information and Observation Network (http://cdr.eionet.europa.eu/) accessed 22 March 2022.

EMEP CEIP, 2022a, 'Annexes to the reporting guidelines', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/reporting-instructions/annexes-to-the-2014-reporting-guidelines/) accessed 22 March 2022.

EMEP CEIP, 2022b, 'Review process', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/review-of-emission-inventories/review-process) accessed 22 March 2022.

EMEP CEIP, 2022c, 'Review reports', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/review-of-emission-inventories/technical-review-reports) accessed 22 March 2022.

EMEP CEIP, 20221d, 'In-depth review or air emission inventories', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/review-of-emission-inventories/in-depth-review-of-ae-inventories) accessed 22 March 2022.

EMEP/EEA, 2019a, *EMEP/EEA air pollutant emission inventory guidebook — 2019*, EEA Technical Report No 13/2019, European Environment Agency (https://www.eea.europa.eu/publications/emep-eea-guidebook-2019) accessed 04 April 2022.

EMEP/EEA, 2019b, *Inventory review 2021: Review of emission data reported under the Air Convention stage 1 and 2 review*, Technical Report CEIP, European Monitoring and Evaluation Programme(https://www.ceip.at/review-of-emission-inventories/technical-review-reports/rr2021-1) accessed 5 April 2022.

ETC/ACM, 2015, *Proposed unification of the gap filling procedures for the EU Air Convention emission inventory and the EMEP Air Convention emission inventory*, Technical Paper, European Topic Centre on Air Pollution and Climate Change Mitigation (available upon request).

EU, 1998, Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC (OJ L 350, 28.12.1998, p. 58) (http://eur-lex.europa.eu/resource.html?uri=cellar:9cdbfc9b-d814-4e9e-b05d-49dbb7c97ba1.0008.02/DOC_1&format=PDF) accessed 6 April 2022.

EU, 1999, Council Regulation (EC) No 933/1999 of 29 April 1999 amending Regulation (EEC) No 1210/90 on the establishment of the European Environment Agency and the European Environment Information and Observation Network (OJ L 117, 5.5.1999, p. 1-4) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999R0933&from=SL) accessed 6 April 2022.

EU, 2013, 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 national and Union level relevant to climate change and repealing Decision No 280/2004/EC (OJ L 165/13, 18.6.2013, p. 13-40) (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&from=EN) accessed 7 April 2022.

EU, 2016a, Directive (EU) 2016/646 of 20 April 2016 amending Regulation (EC) No 692/2008 as regards emissions from light passenger and commercial vehicles (Euro 6) (OJ L 109, 26.4.2016, p. 22) (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0646&from=EN) accessed 7 April 2022.

EU, 2016b, Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (OJ L 344, 17.12.2016, p. 31) (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2016:344:FULL&fr[om]=EN) accessed 19 March 2021.

TFEIP, 2022, '23rd Joint EIONET & UNECE Task Force on Emission Inventories & Projections Meeting', Task Force on Emission Inventories and Projections (https://www.tfeip-secretariat.org/web-conference-2022) accessed 7 April 2022.

UNECE, 1979, The 1979 Geneva Convention on Long-range Transboundary Air Pollution, United Nations Economic Commission for Europe (https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVII-1&chapter=27&clang=_en) accessed 7 April 2022.

UNECE, 1984, EMEP Protocol: the 1984 Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/emep_h1.html) accessed 7 April 2022.

UNECE, 1985, The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent, United Nations Economic Commission for Europe https://unece.org/sites/default/files/2021-10/1985.Sulphur.e.pdf) accessed 7 April 2022.

UNECE, 1988, Protocol concerning the Control of Emissions of Nitrogen Oxides: the 1988 Sofia Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/nitr_h1.html) accessed 7 April 2022.

UNECE, 1991, Protocol concerning the Control of Emissions of Volatile Organic Compounds: the 1991 Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/vola_h1.html) accessed 7 April 2022.

UNECE, 1994, Protocol on Further Reduction of Sulphur Emissions: the 1994 Oslo Protocol on Further Reduction of Sulphur Emissions, United Nations Economic Commission for Europe (https://unece.org/environment-policyair/protocol-further-reduction-sulphur-emissions) accessed 7 April 2022.

UNECE, 1998a, Protocol on Persistent Organic Pollutants (POPs): the 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs*)*, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/pops_h1.html) accessed 7 April 2022.

UNECE, 1998b, Protocol on Heavy Metals: the 1998 Aarhus Protocol on Heavy Metals, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/hm_h1.html) accessed 7 April 2022.

UNECE, 1999, Protocol to Abate Acidification, Eutrophication and Ground-level Ozone: the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone*,* United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/multi_h1.html) accessed 7 April 2022.

UNECE, 2006, Decision 2006/2: Implementation Committee, its structure and functions and procedure for review*,* United Nations Economic Commission for Europe (ECE/EB.AIR/2006/2) (http://www.unece.org/fileadmin/DAM/env/documents/2006/eb/EB/EB Decisions/Decision 2006.2.pdf) accessed 7 April 2022.

UNECE, 2009, Guidelines for reporting emission data under the Convention on Long-range Transboundary Air Pollution, ECE/EB.AIR/97, United Nations Economic Commission for Europe (https://undocs.org/en/ECE/EB.AIR/97) accessed 7 April 2022.

UNECE, 2012a, Decision 2012/3: Adjustments under the Gothenburg Protocol to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them, ECE/EB.AIR/111, United Nations Economic Commission for Europe (http://www.unece.org/fileadmin/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1__ENG_DECISION_3.pdf) accessed 7 April 2022.

UNECE, 2012b, Decision 2012/2: Amendment of the text of and annexes II to IX to the 1999

Protocol to Abate Acidification, Eutrophication and Ground-level Ozone and the addition of new annexes X and XI (https://unece.org/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1__ENG_DECISION_2.pdf) accessed 17 March 2022.

UNECE, 2012c, Decision 2012/12: Guidance for adjustments under the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them, ECE/EB.AIR/113, United Nations Economic Commission for Europe (http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/Decision_2012_12.pdf) accessed 26 March 2022.

UNECE, 2014a, Guidelines for reporting emissions and projections data under the Convention on Long-range Transboundary Air Pollution, ECE/EB.AIR/125, United Nations Economic Commission for Europe () (https://www.ceip.at/fileadmin/inhalte/ceip/1_reporting_guidelines2014/ece.eb.air.125_advance_version_reporting_guidelines_2014.pdf) accessed 15 March 2022.

UNECE, 2014b, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, ECE/EB.AIR/GE.1/2014/10, United Nations Economic Commission for Europe (https://unece.org/fileadmin/DAM/env/documents/2014/AIR/EMEP/ECE_EB.AIR_GE.1_2014_10_ENG.pdf) accessed 7 April 2022.

UNECE, 2015, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, ECE/EB.AIR/WG.1/2015/13, United Nations Economic Commission for Europe (https://unece.org/fileadmin/DAM/env/documents/2015/AIR/EMEP/ECE_EB.AIR_GE.1_2015_10_ECE_EB.AIR_WG.1_2015_13_ENG.pdf) accessed 7 April 2022.

UNECE, 2016, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, /EB.AIR/WG.1/2016/18, United Nations Economic Commission for Europe (https://unece.org/fileadmin/DAM/env/documents/2016/AIR/EMEP/ece.eb.air.ge.1.2016.10_ece.eb.air.wg.1.2016.18.pdf) accessed 7 April 2022.

UNECE, 2017a, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, /EB.AIR/WG.1/2017/20, United Nations Economic Commission for Europe (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2017/advance_ece_eb_air_ge_1_2017_10_ece_eb_air_wg_1_2017.pdf) accessed 7 April 2022.

UNECE, 2017b, Annex II and Annex III; Emission reduction commitments. (https://unece.org/sites/default/files/2021-10/Annex_II_and_III_updated_clean.pdf) accessed 7 April 2022.

UNECE, 2018, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, ECE/EB.AIR/GE.1/2018/21, United Nations Economic Commission for Europe (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2018/adj_ece.eb.air.ge.1.2018.10-ece.eb.air.wg.1.2018.21_advance.pdf) accessed 7 April 2022.

UNECE, 2019, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, ECE/EB.AIR/GE.1/2019/10-ECE/EB.AIR/WG.1/2019/22, United Nations Economic Commission for Europe (https://unece.org/fileadmin/DAM/env/documents/2019/AIR/EMEP_WGE_Joint_Session/Advance_ECE_EB.AIR_GE.1_2019_2-ECE_EB.AIR_WG.1_2019_2_final.pdf) accessed 7 April 2022.

UNECE, 2020, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, ECE/EB.AIR/WG.1/2020/21, United Nations Economic Commission for Europe (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020/adj-status_ece_eb.air_ge.1_2020_10-2008939e.pdf) accessed 7 April 2022.

UNECE/CEIP, 2021, *Report for the stage 3 in-depth review of emission inventories submitted under the UNECE Air Convention and EU National Emissions Ceilings Directive for: European Union*, CEIP/S3.RR/2020/EU 24/11/2020CEIP/S3.RR/2017/EU, United Nations (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020_s3/eu_s3_rr_2020_final.pdf) accessed 7 April 2022.

Appendix 1 Notation keys

Where there are methodological or data gaps in the inventories, information on these gaps should be presented in a transparent manner. Parties should clearly indicate the sources that they have not considered in their inventories — although the inventory guidebook (EMEP/EEA, 2019) includes them — and explain the reason for excluding them. Similarly, each Party should indicate if it has excluded part of its territory and explain why. In addition, each Party should use the notations presented below to fill the blanks in all the tables in the nomenclature for reporting (NFR) inventory. This approach helps in assessing how complete the emission data reports are. The notations are as follows ([14]).

NO 'Not occurring' means an emission source or process does not exist in a country.

NE **'**Not estimated' means emissions occur but have not been estimated or reported. Where an inventory uses 'NE', the Party should indicate why it could not estimate emissions.

NA 'Not applicable' means that a source exists but relevant emissions are considered never to occur.

IE 'Included elsewhere' is for emissions that are estimated and included in the inventory but are not presented separately for the relevant source. Where it uses 'IE', the Party should indicate where the inventory includes the emissions from the displaced source category and should give the reasons for deviating from the expected category.

C 'Confidential' is for aggregated emissions that the inventory includes elsewhere because reporting at a disaggregated level could lead to the disclosure of confidential information. Where an inventory uses 'C', it should make reference to the protocol provision that authorises it.

NR 'Not relevant' eases reporting where different protocols do not strictly require details of the emissions. According to Article III paragraph 9 in the emission-reporting guidelines, emission inventory reporting should cover all years from 1980 onwards if data are available. However, for example, some Parties do not need to report emissions of non-methane volatile organic compounds (NMVOCs) prior to 1988.

If a Party estimates emissions from country-specific sources, it should explicitly describe which source categories these are, as well as which methodologies, emission factors and activity data it has used to estimate them.

([14]) Further explanation and guidance concerning the use of these notation codes are in the European Monitoring and Evaluation Programme (EMEP) emission-reporting guidelines (UNECE, 2014a).

Appendix 2 Air Convention emission-reporting programme for 2022

Emission data should be submitted to the EMEP Centre on Emission Inventories and Projections (CEIP) by **15 February 2022**. Informative inventory reports (IIRs) should reach the centre no later than **15 March 2022**. Table A2.1 summarises information in the revised emission-reporting guidelines (UNECE, 2014a).

Table A2.1 Summary of the information requested in the EMEP emission-reporting guidelines

Description of contents		Pollutant(s)	Reporting years [a]
Yearly: minimum (and additional)			
A.	**National total emissions**		
1.	Main pollutants	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2020
2.	Particulate matter [b]	$PM_{2.5}$, PM_{10} (TSPs, BC)	2000-2020
3.	Heavy metals [b]	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2020
4.	Persistent organic pollutants [b]	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2020
B.	**Emissions by NFR source category**		
1.	Main pollutants	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2020
2.	Particulate matter [b]	$PM_{2.5}$, PM_{10}, (TSPs, BC)	2000-2020
3.	Heavy metals [b]	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2020
4.	Persistent organic pollutants [b]	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2020
C.	Activity data	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2020
4-yearly: minimum reporting (from 2017 to the next reporting year: 2025)			
D.	**Gridded data in the EMEP 0.1 ° × 0.1 ° long/lat grid — sector emissions (GNFR19)** [c] **and national totals (optional)**	NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not previously reported)
E.	Emissions from LPSs	NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not previously reported)
F.	**Projected emissions and projected activity data**		
1.	National total emission projections	NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, BC	2020, 2025, 2030, where available 2040 and 2050
2.	Emission projections by NFR19	NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, BC	2020, 2025, 2030, where available 2040 and 2050
3.	Projected activity data by NFR19		2020, 2025, 2030, where available 2040 and 2050
5-yearly: additional reporting for review and assessment purposes			
VOC speciation/height distribution/temporal distribution			Parties are encouraged to review the information used for modelling at https://www.ceip.at/webdab-emission-database/emissions-as-used-in-emep-models (accessed 15 March 2022)
Land-use data/Hg breakdown			
Percentage of toxic congeners of PCDD/F emissions			
Pre-1990 emissions of PAHs, HCB, PCDD/Fs and PCBs			
Information on natural emissions			

Notes: [a] As a minimum, data for the base year of the relevant protocol and from the year of entry into force of that protocol and up to the latest year (i.e. the second-last before the current year) should be reported.
[b] Parties report the pollutants listed in brackets voluntarily.
[c] Gap-filled NFR19.
As, arsenic; BC, black carbon; B(a)P, benzo(a)pyrene; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cd, cadmium; CO, carbon monoxide; Cr, chromium; Cu, copper; GNFR14, gridding nomenclature for reporting; HCB, hexachlorobenzene; Hg, mercury; IP, indeno(1,2,3-cd)pyrene; NMVOC, non-methane volatile organic compound; NOX, nitrogen oxides; NH_3, ammonia; Ni, nickel; LPSs, large point sources; Pb, lead; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; PCDD/Fs, polychlorinated dibenzodioxins/dibenzofurans; $PM_{2.5}$, particulate matter with a diameter of 2.5 µm or less; PM_{10}, particulate matter with a diameter of 10 µm or less; Se, selenium; SO_x, sulphur oxides; TSPs, total suspended particulates; VOC, volatile organic compound; Zn, zinc.

Reporting format

Each Party should use the reporting format in Annex IV of the reporting guidelines (UNECE, 2014a) for its annual submissions. It should submit the information to the CEIP formally, preferably in electronic format, and notify the United Nations Economic Commission for Europe (UNECE) secretariat. The reporting format, including the nomenclature for reporting (NFR), is standardised for reporting estimates of emissions. It includes activity data, projected activity data, projected emissions and other relevant information. The reporting format aims to facilitate electronic submissions by making it easier to process emission information and prepare useful documentation about technical analysis and synthesis.

The NFR19 format covers:

- national annual emissions and national annual sector emissions (Annex I).
- total and aggregated sector emissions for reporting emissions of nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_X), ammonia (NH_3), particulate matter (PM), black carbon (BC), carbon monoxide (CO), lead (Pb), cadmium (Cd), mercury (Hg), polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs) for the EMEP 0.1 ° × 0.1 ° grid cell and from large point sources (LPSs) (Annexes V and VI);
- for 2020, 2025, 2030, 2040 and 2050, projected activity data and projected national total emissions of NO_X, NMVOCs, sulphur and NH_3, which Parties are to report for the source categories listed in Annex IV (A-with measures — WM; B-WM; A-with additional measures — WaM; B-WaM).

Table A2.2 EU: country groupings

EU-11 refers to the following 11 Member States of the EU: Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, The Netherlands, Greece, Portugal and Spain
EU-15 (without the UK) refers to the 15 Member States from 1 January 1995 to 30 April 2003: the EU-12 plus Austria (AT), Finland (FI) and Sweden (SE)
EU-27 refers to the first 27 Member States of the EU. The United Kingdom left the EU on 31 January 2020 and is no longer obliged to report air pollutant emission data to the EU.

Appendix 3 Status of reporting and timeliness

Table A3.1 EU Member State inventory submissions 2022: date received by the EEA, years covered, and information provided (as of 08 May 2022)

Country	Reporting date and format								
Member State	Submission date*	Resubmission date	Adjustment date (Information or Annex submission)	Projection submission date	Grid submission date	LPS submission date	Date of additional information	Date of IIR	NFR template version
Austria	15.02.2022	15.03.2022						15.03.2022 (draft) 21.04.2022	2019-1
Belgium	15.02.2022	15.03.2022						15.03.2022	2020-1
Bulgaria	15.02.2022	15.03.2022						15.03.2022	2019-1
Croatia	14.02.2022							10.03.2022	2019-1
Cyprus	14.02.2022	15.03.2022		28.01.2022				15.03.2022	2019-1
Czechia	15.02.2022	15.03.2022						15.03.2022	2019-1
Denmark	15.02.2022		11.04.2022					15.03.2022	2014-1
Estonia	11.02.2022	15.03.2022						15.03.2022	2019-1
Finland	14.02.2022	15.03.2022		15.03.2022	01.05.2022	29.04.2022		15.03.2022	2019-1
France	11.02.2022		11.02.2022					15.03.2022	2019-1
Germany	08.02.2022							21.04.2022	2019-1
Greece	18.02.2022							15.03.2022	2019-1
Hungary	15.02.2022	15.03.2022						15.03.2022	2019-1
Ireland	15.02.2022	15.03.2022		13.04.2022				15.03.2022 26.04.2022	2019-1
Italy	15.02.2022	15.03.2022						22.03.2022	2019-1
Latvia	15.02.2022	15.03.2022 13.04.2022						15.03.2022 13.04.2022	2019-1
Lithuania	15.02.2022							16.03.2022	2021-1
Luxembourg	11.02.2022	15.03.2022						15.03.2022 (draft)	2019-1
Malta	14.02.2022	29.03.2022						29.03.2022	2019-1
Netherlands	15.02.2022	15.03.2022						15.03.2022	2019-1
Poland	09.02.2022							14.03.2022	2019-1
Portugal	15.02.2022	15.03.2022						15.03.2022 07.04.2022	2019-1
Romania	15.02.2022	15.03.2022						15.03.2022	2019-1
Slovakia	15.02.2022	15.03.2022						15.03.2022	2019-1
Slovenia	05.02.2022							12.03.2022	2019-1
Spain	15.02.2022	14.03.2022						14.03.2022	2019-1
Sweden	14.02.2022							11.03.2022	2019-1

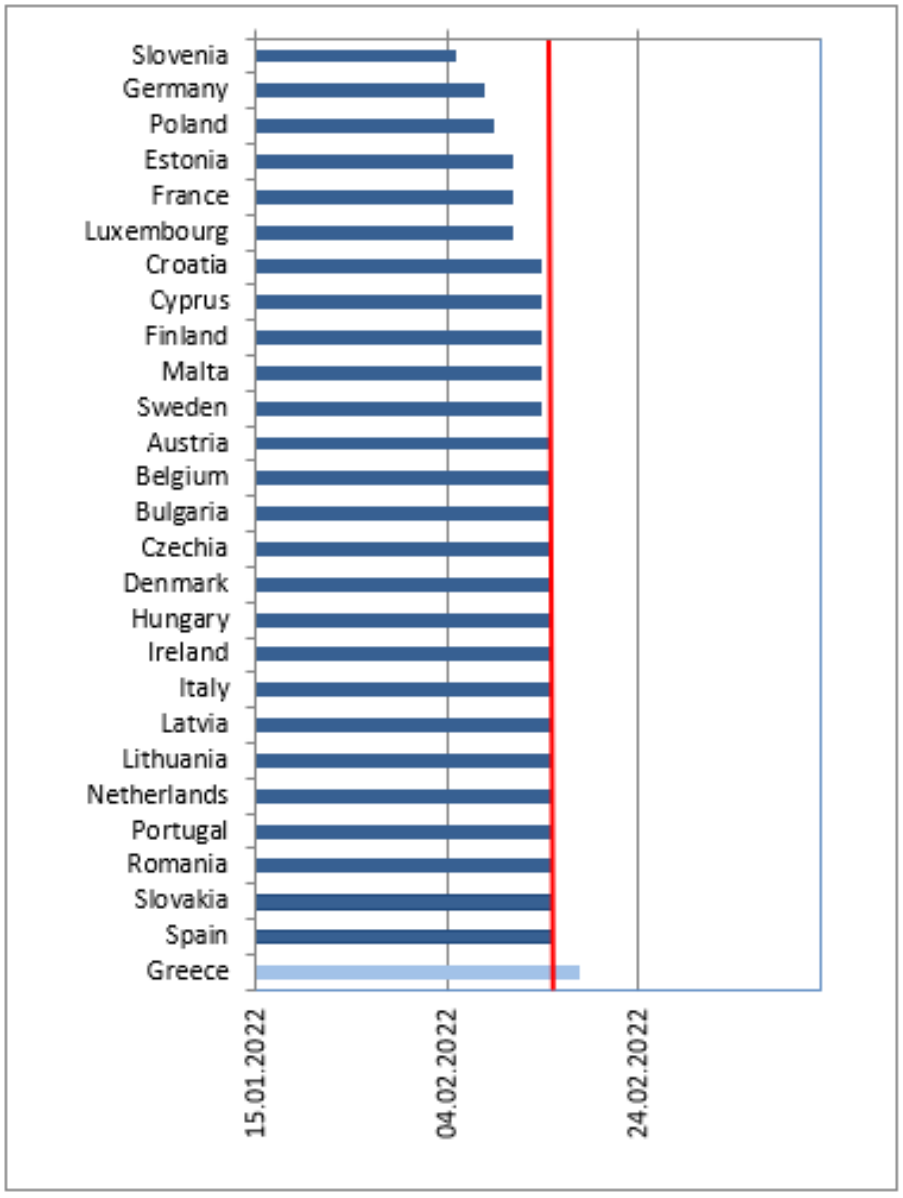
Notes: Dates in red indicate that data were submitted after the formal deadline for submissions (submissions 15 February; resubmissions 15 March; projections 15 March; IIR 15 March).
([a]) Refers to the first submission of inventory data to the Central Data Repository (CDR); submission of other data are possible at later dates.

Table A3.2 EU Member State submissions of 2020 data (as of 06 May 2022)

Country	Years reported									Comments
Member State	SO_2, NO_X, CO, NH_3, NMVOC	Cd,Hg, Pb	additional HM	$PM_{2.5}$, PM_{10}	TSP	BC	POPs: PAH DIOX HCB PCB	Additional PAHs: B(a)P, B(b)F, B(k)F, IP	Activity data	
Austria	1990-2020	1990-2020		1990, 1995, 2000-2020	1990, 1995, 2000-2020		1990-2020	1990-2020	1990-2020	
Belgium	1990-2020	1990-2020	1990-2020	2000-2020	2000-2020	2000-2020	1990-2020	1990-2020	1990-2020	
Bulgaria	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Croatia	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Cyprus	1990-2020	1990-2020	1990-2020	2000-2020	2000-2020	2000-2020	1990-2020	1990-2020	1990-2020	
Czechia	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Denmark	1985-2020*	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1980-2020	*SOx from 1980
Estonia	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Finland	1980-2020*	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1980-2020	*NMVOC from 1987, CO from 1990
France	1980-2020*	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1980-2020	*NMVOC from 1988
Germany	1990-2020	1990-2020	1990-2020	1995-2020	1990-2020	2000-2020	1990-2020	1990-2020	1990-2020	
Greece	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Hungary	1990-2020	1990-2020	1990-2020	2000-2020	2000-2020	2000-2020	1990-2020	1990-2020	1990-2020	
Ireland	1990-2020*	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	*SOx, NOx, NMVOC also 1987
Italy	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Latvia	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Lithuania	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Luxembourg	1990-2020	1990-2020		1990-2020	1990-2020		1990-2020	1990-2020	1990-2020	
Malta	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Netherlands	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Poland	1990-2020	1990-2020	1990-2020*	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	*No Se reported
Portugal	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Romania	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Slovakia	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	
Slovenia	1980-2020*	1990-2020	1990-2020	2000-2020	2000-2020	2000-2020	1990-2020	1990-2020	1990-2020	*NMVOC from 1990, NH3 from 1986
Spain	1990-2020	1990-2020	1990-2020	2000-2020	2000-2020	2000-2020	1990-2020	1990-2020	1990-2020	
Sweden	1990-2020	1990-2020	1990-2020	1990-2020	1990-2020	2000-2020	1990-2020	1990-2020	1990-2020	

Notes: Reporting of additional HMs is not mandatory.
EU Member States do not have to report TSPs if they report PM emissions.
BC, black carbon; B(a)P, benzo(a)pyrene; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cd, cadmium; CO, carbon monoxide; DIOX, Polychlorinated dibenzodioxin/dibenzofuran; HCB, hexachlorobenzene; Hg, mercury; HM, heavy metal; IP, indeno(1,2,3-cd) pyrene; NH3, ammonia; NMVOC, non-methane volatile organic compound; NOX, nitrogen oxides; PAH, polycyclic aromatic hydrocarbon; Pb, lead; PCB, polychlorinated biphenyl; PM2.5, particulate matter with a diameter of 2.5 µm or less; PM10, particulate matter with a diameter of 10 µm or less; POP, persistent organic pollutant; Se, selenium; SO2, sulphur dioxide; TSP, total suspended particulate.

Figure A3.1 Dates of first data submissions received from EU Member States (as of 18 February 2022)



Note: The red line marks the submission deadline of February 15, 2022

Appendix 4 Conversion chart for aggregated sector groups

To enable the presentation of sectoral emission trends (Chapter 3), individual nomenclature for reporting (NFR) source categories for the EU-27 inventory were aggregated into the following main sector groups:

- energy production and distribution;
- energy use in industry;
- industrial processes and product use;
- commercial, institutional and households;
- road transport;
- non-road transport;
- agriculture;
- waste.

Table A4.1 provides a conversion chart showing which of the individual NFR source categories appeared in each of the aggregated sector groups.

Table A4.1 Conversion chart for aggregated sector groups

NFR code	Full name	EEA aggregated sector name
1A1a	Public electricity and heat production	Energy production and distribution
1A1b	Petroleum refining	Energy production and distribution
1A1c	Manufacture of solid fuels and other energy industries	Energy production and distribution
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Energy use in industry
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Energy use in industry
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Energy use in industry
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, paper and print	Energy use in industry
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Energy use in industry
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Energy use in industry
1A2gvii	Mobile combustion in manufacturing industries and construction	Energy use in industry
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Energy use in industry
1A3ai(i)	International aviation LTO (civil)	Non-road transport
1A3aii(i)	Domestic aviation LTO (civil)	Non-road transport
1A3bi	Road transport: Passenger cars	Road transport
1A3bii	Road transport: Light duty vehicles	Road transport
1A3biii	Road transport: Heavy duty vehicles and buses	Road transport
1A3biv	Road transport: Mopeds and motorcycles	Road transport
1A3bv	Road transport: Gasoline evaporation	Road transport
1A3bvi	Road transport: Automobile tyre and brake wear	Road transport
1A3bvii	Road transport: Automobile road abrasion	Road transport
1A3c	Railways	Non-road transport
1A3di(ii)	International inland waterways	Non-road transport
1A3dii	National navigation (shipping)	Non-road transport
1A3ei	Pipeline transport	Non-road transport
1A3eii	Other	Non-road transport
1A4ai	Commercial/institutional: Stationary	Commercial, institutional and households
1A4aii	Commercial/institutional: Mobile	Commercial, institutional and households
1A4bi	Residential: Stationary	Commercial, institutional and households
1A4bii	Residential: Household and gardening (mobile)	Commercial, institutional and households
1A4ci	Agriculture/forestry/fishing: Stationary	Commercial, institutional and households
1A4cii	Agriculture/forestry/fishing: Off-road vehicles and other machinery	Commercial, institutional and households
1A4ciii	Agriculture/forestry/fishing: National fishing	Non-road transport
1A5a	Other stationary (including military)	Commercial, institutional and households
1A5b	Other, mobile (including military, land-based and recreational boats)	Commercial, institutional and households

NFR code	Full name	EEA aggregated sector name
1B1a	Fugitive emission from solid fuels: Coal mining and handling	Energy production and distribution
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	Energy production and distribution
1B1c	Other fugitive emissions from solid fuels	Energy production and distribution
1B2ai	Fugitive emissions oil: Exploration, production, transport	Energy production and distribution
1B2aiv	Fugitive emissions oil: Refining/storage	Energy production and distribution
1B2av	Distribution of oil products	Energy production and distribution
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	Energy production and distribution
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Energy production and distribution
1B2d	Other fugitive emissions from energy production	Energy production and distribution
2A1	Cement production	Industrial processes and product use
2A2	Lime production	Industrial processes and product use
2A3	Glass production	Industrial processes and product use
2A5a	Quarrying and mining of minerals other than coal	Industrial processes and product use
2A5b	Construction and demolition	Industrial processes and product use
2A5c	Storage, handling and transport of mineral products	Industrial processes and product use
2A6	Other mineral products	Industrial processes and product use
2B1	Ammonia production	Industrial processes and product use
2B2	Nitric acid production	Industrial processes and product use
2B3	Adipic acid production	Industrial processes and product use
2B5	Carbide production	Industrial processes and product use
2B6	Titanium dioxide production	Industrial processes and product use
2B7	Soda ash production	Industrial processes and product use
2B10a	Chemical industry: Other	Industrial processes and product use
2B10b	Storage, handling and transport of chemical products	Industrial processes and product use
2C1	Iron and steel production	Industrial processes and product use
2C2	Ferroalloys production	Industrial processes and product use
2C3	Aluminium production	Industrial processes and product use
2C4	Magnesium production	Industrial processes and product use
2C5	Lead production	Industrial processes and product use
2C6	Zinc production	Industrial processes and product use
2C7a	Copper production	Industrial processes and product use
2C7b	Nickel production	Industrial processes and product use
2C7c	Other metal production	Industrial processes and product use
2C7d	Storage, handling and transport of metal products	Industrial processes and product use
2D3a	Domestic solvent use including fungicides	Industrial processes and product use
2D3b	Road paving with asphalt	Industrial processes and product use
2D3c	Asphalt roofing	Industrial processes and product use
2D3d	Coating applications	Industrial processes and product use
2D3e	Degreasing	Industrial processes and product use
2D3f	Dry cleaning	Industrial processes and product use

NFR code	Full name	EEA aggregated sector name
2D3g	Chemical products	Industrial processes and product use
2D3h	Printing	Industrial processes and product use
2D3i	Other solvent use	Industrial processes and product use
2G	Other product use	Industrial processes and product use
2H1	Pulp and paper industry	Industrial processes and product use
2H2	Food and beverages industry	Industrial processes and product use
2H3	Other industrial processes	Industrial processes and product use
2I	Wood processing	Industrial processes and product use
2J	Production of POPs	Industrial processes and product use
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	Industrial processes and product use
2L	Other production, consumption, storage, transportation or handling of bulk products	Industrial processes and product use
3B1a	Manure management — Dairy cattle	Agriculture
3B1b	Manure management — Non-dairy cattle	Agriculture
3B2	Manure management — Sheep	Agriculture
3B3	Manure management — Swine	Agriculture
3B4a	Manure management — Buffalo	Agriculture
3B4d	Manure management — Goats	Agriculture
3B4e	Manure management — Horses	Agriculture
3B4f	Manure management — Mules and asses	Agriculture
3B4gi	Manure management — Laying hens	Agriculture
3B4gii	Manure management — Broilers	Agriculture
3B4giii	Manure management — Turkeys	Agriculture
3B4giv	Manure management — Other poultry	Agriculture
3B4h	Manure management — Other animals	Agriculture
3Da1	Inorganic N-fertilisers (includes also urea application)	Agriculture
3Da2a	Animal manure applied to soils	Agriculture
3Da2b	Sewage sludge applied to soils	Agriculture
3Da2c	Other organic fertilisers applied to soils (including compost)	Agriculture
3Da3	Urine and dung deposited by grazing animals	Agriculture
3Da4	Crop residues applied to soils	Agriculture
3Db	Indirect emissions from managed soils	Agriculture
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Agriculture
3Dd	Off-farm storage, handling and transport of bulk agricultural products	Agriculture
3De	Cultivated crops	Agriculture
3Df	Use of pesticides	Agriculture
3F	Field burning of agricultural residues	Agriculture
3I	Agriculture other	Agriculture
5A	Biological treatment of waste — Solid waste disposal on land	Waste

NFR code	Full name	EEA aggregated sector name
5B1	Biological treatment of waste — Composting	Waste
5B2	Biological treatment of waste — Anaerobic digestion at biogas facilities	Waste
5C1a	Municipal waste incineration	Waste
5C1bi	Industrial waste incineration	Waste
5C1bii	Hazardous waste incineration	Waste
5C1biii	Clinical waste incineration	Waste
5C1biv	Sewage sludge incineration	Waste
5C1bv	Cremation	Waste
5C1bvi	Other waste incineration	Waste
5C2	Open burning of waste	Waste
5D1	Domestic waste water handling	Waste
5D2	Industrial waste water handling	Waste
5D3	Other waste water handling	Waste
5E	Other waste	Waste
6A	Other (included in national total for entire territory)	Other

Note: LTO, landing/take-off; POPs, persistent organic pollutants.

Appendix 5 EU Member State informative inventory reports (IIRs)

Table A5.1 List of latest submitted IIRs including source and date of submission (as of 06 May 2022)

Country code	Title of IIR	Source	Date of submission
AT	Austria's Informative Inventory Report (IIR) 2022 Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants	https://cdr.eionet.europa.eu/at/un/clrtap/iir/envymeocw	21.04.2022
BE	Informative Inventory Report about Belgium's air emissions submitted under the Convention on Long-range Transboundary Air Pollution CLRTAP and the National Emission Ceilings Directive NECD. March 2022	https://cdr.eionet.europa.eu/be/un/clrtap/iir/envyjd0kg	15.03.2022
BG	Bulgaria's Informative Inventory Report 2022 (IIR). Submission under the UNECE Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/bg/un/clrtap/iir/envyjcqug	15.03.2022
CY	Cyprus Informative Inventory Report for 2020	https://cdr.eionet.europa.eu/cy/un/clrtap/iir/envyi9apw	15.03.2022
CZ	Informative Inventory Report Czechia 2022. Submission under the UNECE Convention on Long-range Transboundary Air Pollution. Reported inventories 1990-2020	https://cdr.eionet.europa.eu/cz/un/clrtap/iir/envyhpheq	15.03.2022
DE	German Informative Inventory Report 2022	https://iir.umweltbundesamt.de/	201.04.2022
DK	Annual Danish Informative Inventory Report to UNECE. Emission inventories from the base year of the protocols to year 2020	https://cdr.eionet.europa.eu/dk/un/clrtap/iir/envyi75dq	15.03.2022
EE	Estonian Informative Inventory Report 1990-2022. Submitted under the Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/ee/un/clrtap/iir/envyja7qg	15.03.2022
EL	Greece's Informative Inventory Report (IIR) 2022. Submission under the UNECE Convention on Long-rang Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants	https://cdr.eionet.europa.eu/gr/un/clrtap/iir/envyjanva	15.03.2022
ES	Informative Inventory Report. Submission to the Secretariat of the Geneva Convention and EMEP programme. Reporting to the European Commission under Directive (EU) 2016/2284. Edition 2022 (1990-2020)	https://cdr.eionet.europa.eu/es/un/clrtap/iir/envyi9fig	14.03.2022

Country code	Title of IIR	Source	Date of submission
FI	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2020 under the UNECE CLRTAP and the EU NECD. Part I — General A	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2020 under the UNECE CLRTAP and the EU NECD. Part 1B — General	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2020 under the UNECE CLRTAP and the EU NECD. Part 2 — Energy	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. under the UNECE CLRTAP and the EU NECD. Air Pollutant Emissions 1980-2020. Part 3 — Transport	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2020 under the UNECE CLRTAP and the EU NECD. Part 4 — IPPU	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2022 under the UNECE CLRTAP and the EU NECD. Part 5 — Agriculture	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2020 under the UNECE CLRTAP and the EU NECD. Part 6 — Waste	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
	Finland's Informative Inventory Report 2022. Air Pollutant Emissions 1980-2020 under the UNECE CLRTAP and the EU NECD. Part 7 — Annexes	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyjcadw	15.03.2022
FR	Inventaire des émissions de polluants atmosphériques en France au titre de la convention sur la pollution atmosphérique transfrontalière à longue distance et de la directive européenne concernant la réduction des émissions nationales de certains polluants atmosphériques CEE – NU/NFR & NEC Mars 2022	https://cdr.eionet.europa.eu/fr/un/clrtap/iir/envyjcjga	15.03.2022
HR	Republic of Croatia 2022 Informative Inventory Report (1990-2020). Submission under the Convention on Long-range Transboundary Air Pollution (CLRTAP) and National Emission Ceilings Directive (NECD 2016/2284/EU)	https://cdr.eionet.europa.eu/hr/un/clrtap/iir/envyimf7w	10.03.2022
HU	Informative Inventory Report. 1990-2020. Hungary	https://cdr.eionet.europa.eu/hu/un/clrtap/iir/envyjdna	15.03.2022
IE	Ireland. Informative Inventory Report 2022. Air Pollutant Emissions in Ireland 1990-2020 reported to the Secretariat of the UN/ECE Convention on Long-range Transboundary Air Pollution and to the European Union	https://cdr.eionet.europa.eu/ie/un/clrtap/iir/envymepra	26.04.2022
IT	Italian Emission Inventory 1990-2020 — Informative Inventory Report 2022	https://cdr.eionet.europa.eu/mt/un/clrtap/iir/envykko3w	22.03.2022
LT	National Air Pollutant Inventory. Informative Report Lithuania 1990-2020 (part I)	https://cdr.eionet.europa.eu/lt/un/clrtap/iir/envyjejlg	16. 03.2022
LU	Luxembourg's Informative Inventory Report 1990-2020. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lu/un/clrtap/iir/envyjdeiw	15.03.2022

Country code	Title of IIR	Source	Date of submission
LV	2022. Latvia's Informative Inventory Report. submitted under the Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envylbxcw	13.04.2022
MT	Informative Inventory Report for Malta 2020	https://cdr.eionet.europa.eu/mt/un/clrtap/iir/envykko3w	29.03.2022
NL	Informative Inventory Report 2022. Emissions of transboundary air pollutants in the Netherlands 1990-2020	https://cdr.eionet.europa.eu/nl/un/clrtap/iir/envyjdveq	15.03.2022
PL	Poland's Informative Inventory Report 2022 Submission under the UNECE CLRTAP and NEC Directive. Air pollutant emissions in Poland 1990–2020.	https://cdr.eionet.europa.eu/pl/un/clrtap/iir/envyi8lmq	14.03.2022
PT	National Informative Inventory Report 2022 Portugal. Submission under the NEC Directive (EU) 2016/2284 and the UNECE Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/pt/un/clrtap/iir/envyk8q6w	07.04.2022
RO	Romania's Informative Inventory Report 2022. Submission under the UNECE Convention on Long Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/ro/un/clrtap/iir/envyjcvog	15.03.2022
SE	Informative Inventory Report Sweden 2022. Submitted under the Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/se/un/clrtap/iir/envyiofcw	11.03.2022
SI	Slovenian Informative Inventory Report 2022. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants	https://cdr.eionet.europa.eu/si/un/clrtap/iir/envyioula	12.03.2022
SK	Slovak Republic. Informative Inventory Report 2022. Submission under the Air Convention and under the NEC Directive	https://cdr.eionet.europa.eu/sk/un/clrtap/iir/envyjcgwq	15.03.2022

Note: EMEP, European Monitoring and Evaluation Programme; IPPU, industrial processes and product use; NEC (also NECD), National Emission reduction Commitments (Directive); LRTAP, Long-range Transboundary Air Pollution.

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