European Environment Agency

30 YEARS

European Union emission inventory report 1990-2022 — Under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention)

EEA Report 08/2024

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel.: +45 33 36 71 00
Web: eea.europa.eu
Contact us: eea.europa.eu/en/about/contact-us

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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 Air Convention from the European Commission on behalf of the EU as a Party to the UNECE Air Convention (Box ES.1). Submission to the Air Convention is done via the UNECE secretariat. 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 (UNECE Air Convention) was adopted in 1999. The protocol was amended in 2012, establishing new emission reduction commitments as of 2020. These are defined as percentage reductions relative to the base year 2005 for nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x), ammonia (NH_3) and fine particulate matter ($PM_{2.5}$). The European Union is a Party to the protocol and has a specified emission reduction commitment, which is the sum of the reduction commitments of the individual EU Member States.

The following additional protocols have been signed and ratified by the EU:

- 'Air Convention': Convention on Long-range Transboundary Air Pollution (UNECE, 1979);
- 'EMEP 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);
- 'Sofia Protocol': Protocol Concerning the Control of Emissions of Nitrogen Oxides or Their Transboundary Fluxes (UNECE, 1988);
- 'Oslo Protocol': Protocol on Further Reduction of Sulphur Emissions (UNECE, 1994);
- 'Aarhus Protocol': Protocol on Persistent Organic Pollutants (UNECE, 1998a);
- 'Aarhus Protocol': Protocol on Heavy Metals (UNECE, 1998b);
- 'Gothenburg Protocol': Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (UNECE, 1999);
- Amendments to the 'Aarhus POPs Protocol' (UNECE, 2009);
- Amendments to the 'Gothenburg Protocol' (UNECE, 2012b);
- Amendments to the 'Arhus Heavy Metals Protocol' (UNECE, 2012).

The Air Convention requires Parties to report emission data for numerous air pollutants, including:

- regulated pollutants with a reduction obligation: nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x), ammonia (NH_3) and PM with a diameter of 2.5µm or less ($PM_{2.5}$, also known as fine PM);
- other: carbon monoxide (CO);
- particulate matter (PM) emitted directly to the air (primary PM);
    - PM with a diameter of 10µm or less (PM_{10});
    - total suspended particulates (TSPs);
    - black carbon (BC), the most strongly light-absorbing component of PM (additional pollutant);
- 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 pollutants also contribute to forming ground-level ozone (O_3) and secondary PM in the atmosphere. Some pollutants have both an indirect and 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

Data reported by the EU to the Air Convention in this report are up to and inclusive of 2022.

The EU has 27 Member States (EU-27) in this submission year and reports emission data for each.

In addition, this report includes the 2022 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 (Oslo Protocol).

Box ES.3

Status of emission reporting by EU Member States

In 2024, EU Member States were requested to report to the EEA emission inventory data and an informative inventory report (IIR) under the Air Convention ([1]). All 27 EU Member States provided air emission inventories and activity data. A gap-filling procedure was applied for those missing emission data for certain years of pollutants to obtain a European inventory as complete as possible.

The EU must deliver its emission inventory annually by 30 April and its IIR (i.e. this report) by 30 May. Every 4 years, the EU is required to report projections by 30 April, and gridded and large point source (LPS) data by 15 June. In the 2024 reporting for projections, gridded and large point source (LPS) data are not required. Detailed information on EU Member States' submissions is given in Appendix 3 ([2]).

In 2012, the Executive Body of the Air 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. This is the case if, for example, such a circumstance keeps a Party from being able to meet one of its reduction commitments (UNECE, 2012a).

The circumstances that allow adjustments to emission inventories are as follows:

- when there are additional categories of emission sources which were not accounted for when the reduction commitments were made;
- when the 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 made;
- when the methods for determining emissions from specific source categories changed significantly between the year emission reduction commitments were made and the year they are to be attained.

Under the provisional application of the amended Gothenburg Protocol, the European Monitoring and Evaluation Programme Steering Body accepted inventory adjustment applications for emissions from 10 countries in 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022.

This report addresses:

- the institutional arrangements and preparation processes behind the EU's emission inventory, methods and data sources, reporting, key category analyses (KCAs), information on quality assurance and quality control (QA/QC), 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-27 and for individual EU Member States and how key categories contribute to total emissions (Chapter 3);
- sectoral analyses and emission trends for key pollutants (Chapter 4);

([1]) Member State national air pollutant emission inventories and Informative Inventory Reports are available on the Central Data Repository.
([2]) For detailed information on LPS and gridded data reporting, please see the Member State submissions on the Central Data Repository.

- information on recalculations and on planned and implemented improvements (Chapter 5);

- 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 used in this report are presented in the accompanying annexes and are also available for direct download from the EEA's datahub. The following sections summarise the main findings.

EU emission trends

Figures ES.1-ES.3 present trends in air pollutant emissions between 1990 and 2022, aggregated across the EU ([3]).

Emission trends for regulated pollutants with a reduction obligation between 1990 and 2022

Among the regulated pollutants with an emission reduction commitment, SO_x emissions were reduced the most across the EU. In 2022, SO_x emissions were 81% lower than in 2005 (Figure ES.1). This reduction is the result of a combination of measures:

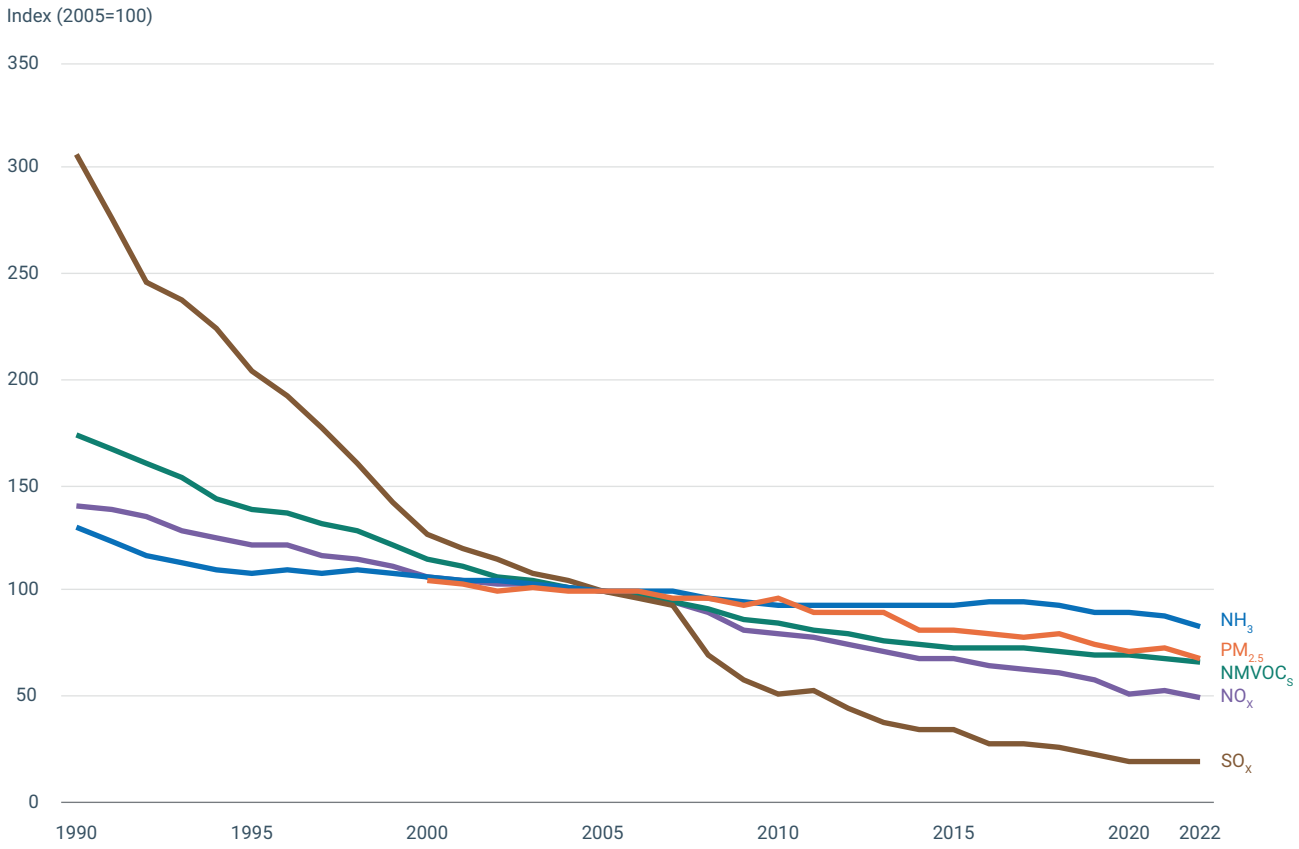
- fuel switching in energy-related sectors, including moving away from solid and liquid fuels with high sulphur contents to low-sulphur fuels such as natural gas;

- applying flue gas desulphurisation (FGD) techniques in industrial facilities;

- implementing EU directives relating to the sulphur content of certain liquid fuels.

([3]) Each year by 15 February, Member States must report emission data for the years up to and including the last calendar year but one. Thus, by 15 February 2024, Member States were obliged to report data for the years up to 2022. 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.

Figure ES.1 Emission trends for regulated pollutants with a reduction obligation in the EU-27



Source(s): The air pollutant emission estimates reported for 2022.

Emissions of other regulated pollutants with a reduction obligation also dropped considerably since 2005: $PM_{2.5}$ (32% reduction), NMVOCs (33% reduction) and NO_x (50% reduction).

For most main air pollutants, emissions decreased more slowly from 2007 to 2022. NH_3 emissions have not fallen to the same extent as those of other pollutants. NH_3 emissions decreased between the years 1990 and 1995, but since 2005 have fallen by only 11%.

Box ES.4

Emission changes of regulated pollutants with a reduction obligation in EU Member States between 2021 and 2022

Between 2021 and 2022 ([4]), EU-27 emissions decreased as follows:

- nitrogen oxides (NO_X): -3.6%;
- non-methane volatile organic compounds (NMVOCs): -2.8%;
- sulphur oxides (SO_X): -4.2%;
- ammonia (NH_3): -4.5%;
- and $PM_{2.5}$: -6.8%.

NO_X emissions decreased on average in the EU, although four Member States reported increased emissions. Poland, France, Spain and Germany reported the highest absolute emission reductions. Road transport is the main emitting source of NO_X.

NMVOC emissions decreased slightly on average in the EU, although four Member States reported increased emissions. The largest absolute emission declines came from Poland, Italy, Czechia and Romania, in order of magnitude. The main source of NMVOCs is the industrial processes and product use sector.

Poland, Romania, France and Spain reported the largest reductions in SO_X emissions in absolute terms between 2021 and 2022, in order of magnitude. These reductions counterbalanced the slight emission increases reported by 12 Member States. The energy production and distribution sector was the main emission source of SO_X.

NH_3 emissions decreased in 25 Member States. Italy, Poland, France and Spain reported the highest decreases (in order of the largest absolute emission changes). Only two Member States reported increases. The agriculture sector is responsible for over 90% of total NH_3 emissions.

$PM_{2.5}$ emissions decreased across the EU, but four Member States reported increases. The greatest decreases were in Poland, France, Romania and Italy (in order of the largest absolute emission changes). Fuel combustion in commercial, institutional and residential buildings is the main source of $PM_{2.5}$ emissions.

Emission reduction measures in the road transport sector have led to a reduction in NMVOC emissions since 1990 and NO_X since 1992. The sector has achieved this primarily through legislative measures requiring the abatement of vehicle exhaust emissions.

EU legislation sets progressively stricter emission limits for air pollutants known as the 'Euro standards' for cars and vans, lorries, and buses and coaches. The standards apply to exhaust emissions of NO_X, as 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. actual NO_X emissions are often higher than EU limits permit. This has significantly contributed to exceedances of the nitrogen dioxide (NO_2) air quality daily limit value at urban traffic stations ([5]) (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, 2017) ([6]).

([4]) The air pollutant emission estimates reported for 2022.
([5]) Stations in urban areas (mainly cities) close to main roads.
([6]) The Commission adopted on 10 November 2022 a proposal for a new Euro 7 emission standard for light and heavy vehicles, proposing further strengthening of testing conditions and monitoring of compliance (COM(2022) 586). For more information, see https://data.consilium.europa.eu/doc/document/ST-14598-2022-INIT/en/pdf.

NO_x emissions declined considerably in the electricity/energy generation sectors, mainly as a result of:

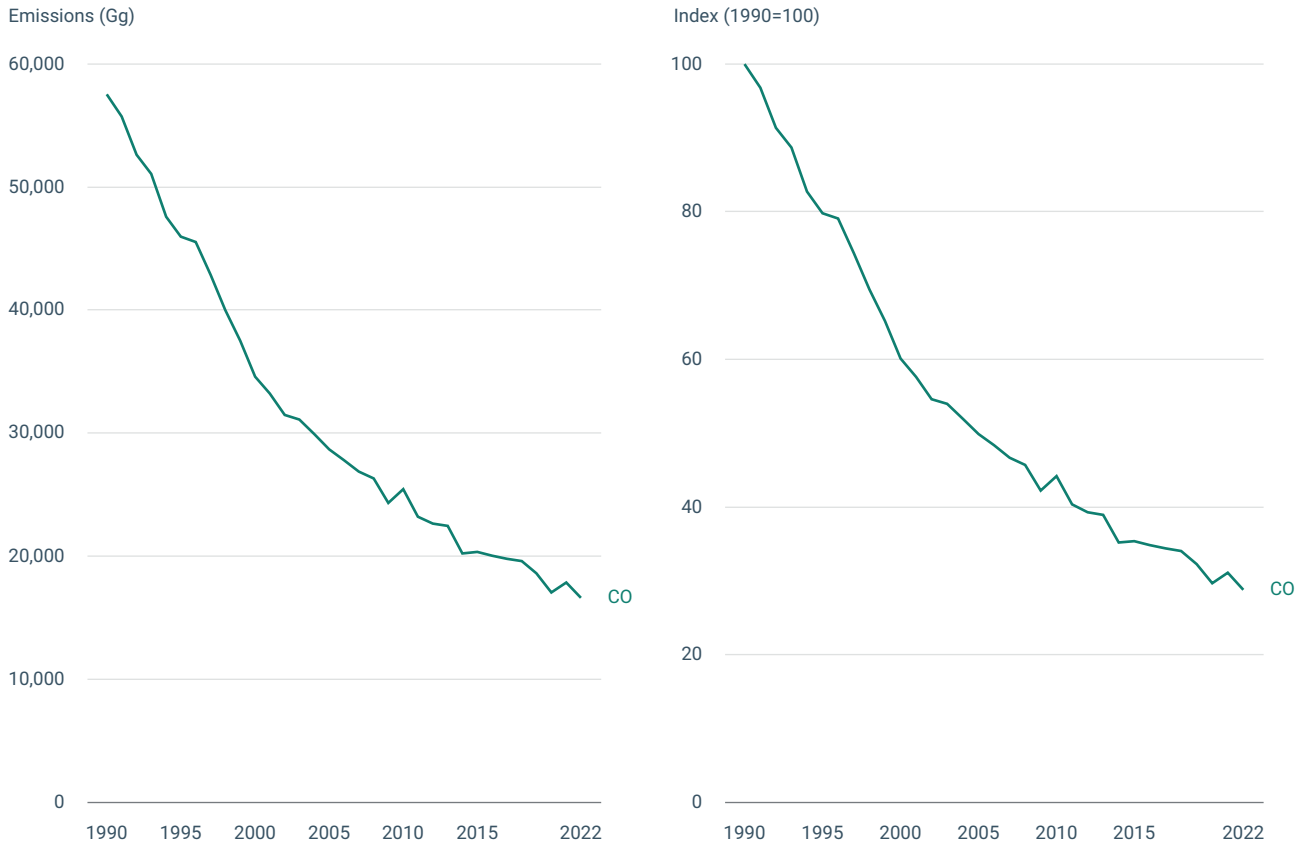
- the introduction of combustion modification technologies (e.g. use of low-NO_x burners);
- the implementation of flue gas abatement techniques (e.g. NO_x scrubbers and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques);
- increases in the energy efficiency of power plants;
- an overall decrease in energy input from NO_x-generating fossil fuels since 2016.

Emission trends for CO

Carbon monoxide (CO) emissions decreased by 71% (Figure ES.2) between 1990 and 2022 and by 35% between 2005 and 2022. The road transport sector contributed the most to the decline.

CO emissions across the EU decreased by 7.2% between 2021 and 2022, mainly due to decreased emissions reported by Poland, France, Italy and Czechia (in order of the largest absolute emission changes).

Figure ES.2 Emission trends for CO in the EU-27



Source(s): The air pollutant emission estimates reported for 2022.

Emission trends for particulate matter (PM) between 2000 and 2022

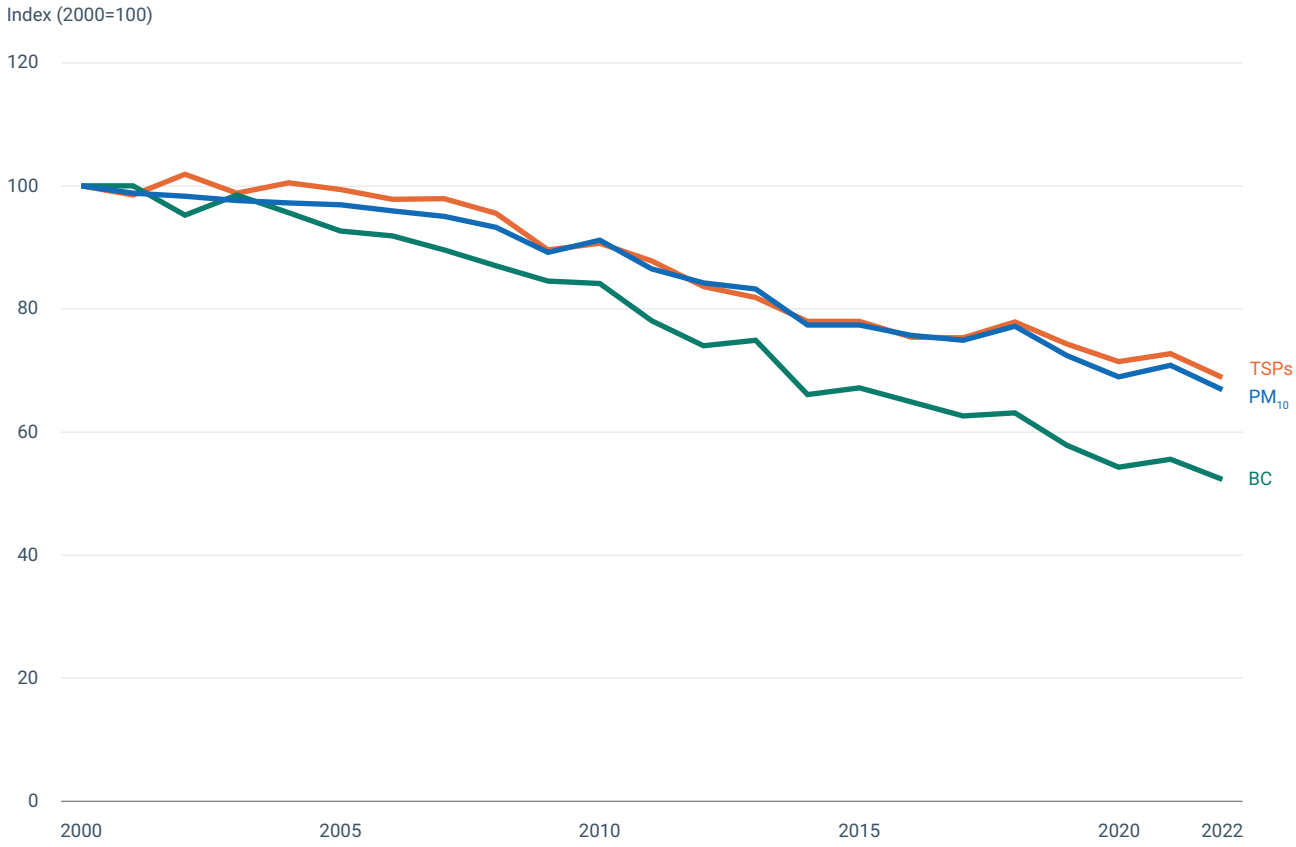
Total Suspended Particulate matter (TSPs) fell by 31% across the EU between 2000 and 2022 (Figure ES.3). Emissions of primary PM_{10} and black carbon (BC) fell by 33% and 48%, respectively.

The reporting of condensable components is not mandatory and in recent years there has been no clear definition as to whether PM emission reporting includes or excludes the condensable component. However, the reporting table on condensable components within Annex II was provided by 18 EU Member States in 2024, which is two more than last year. 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 all contribute significantly to forming secondary PM. Thus, if emissions of these pollutants decrease, this will also influence PM formation (EEA, 2022a).

NH_3 emissions from agriculture contribute to episodes of high secondary inorganic PM concentrations experienced across certain regions of Europe each spring. Such episodes contribute to exceedances of the PM_{10} daily limit values set under the EU's Ambient Air Quality Directive (e.g. CAMS, 2024).

Figure ES.3 Emission trends for PM in the EU-27



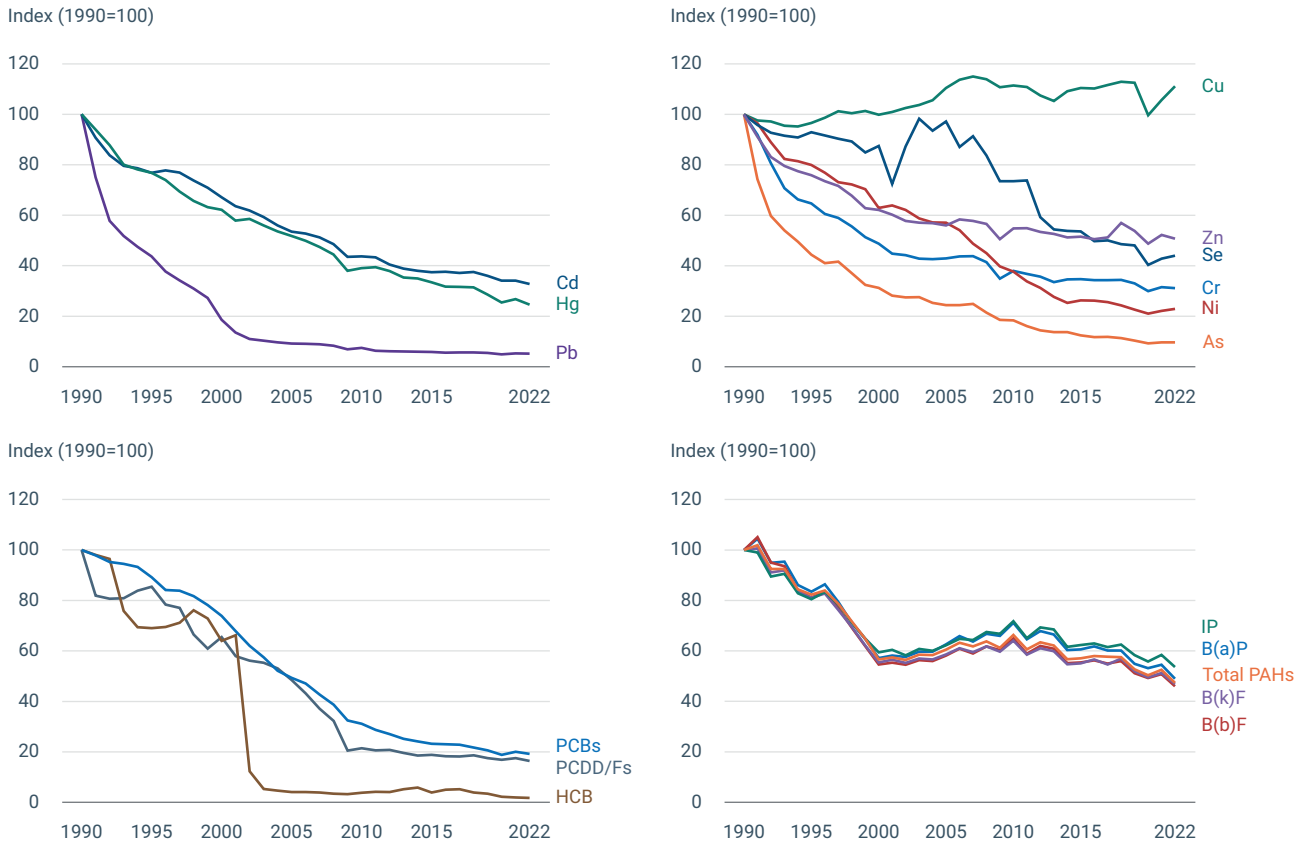
Source(s): The air pollutant emission estimates reported for 2022.

Emission trends for heavy metals (HMs) and persistent organic pollutants (POPs) between 1990 and 2022

Since 1990, emissions of the main HMs (Pb, Cd, Hg), dioxins and furans (PCDD/Fs), total polycyclic aromatic hydrocarbon (PAHs), hexachlorobenzene (HCB) and polycyclic aromatic hydrocarbon (PCBs) have also dropped substantially by at least 50% (Figure ES.4).

Since the early 1990s, much progress has been made in reducing point source emissions of these substances — particularly from industrial facilities. This has been achieved partly through the introduction of incinerators and improved abatement techniques in the metal-refining and smelting industries. In some countries, emission reductions have followed the closure of older industrial facilities due to economic restructuring. Total emissions fell faster between 1990 and 2000 than in the following decade.

Figure ES.4 Emission trends for HMs and POPs in the EU-27



Notes: The decrease in HCB emissions between 2003 and 2004 is caused by reductions reported by Germany. The peak in B(k)F emissions in 1994 is caused by a large increase reported by Bulgaria. Not all Member States reported data for certain pollutants.

Source(s): The air pollutant emission estimates reported for 2022.

Emissions of all heavy metals except copper (Cu) fell between 1990 and 2022: Pb by 95%, Cd by 67%, Hg by 75%, As by 90%, Cr by 69%, Ni by 77%, Se by 56% and Zn by 49%. Cu emissions increased by 11%, mainly due to increased emissions from tyre and brake wear in road transport.

Total polycyclic aromatic hydrocarbons (PAHs) decreased by 53% from 1990 to 2022 ([7]). For individual PAHs, the reductions from 1990 to 2022 were 51% for benzo(a)pyrene (B(a)P), 54% for benzo(b)fluoranthene (B(b)F), 53% for benzo(k)fluoranthene (B(k)F) and 46% for indeno[1,2,3-cd]pyrene (IP). Dioxins and furans decreased by 84% between 1990 and 2022. The reductions in hexachlorobenzene (HCB) and polychlorinated biphenyl (PCB) emissions were 98% and 81%, respectively. Although there have been clear decreases over the last 25 years, emissions of POPs have remained relatively stable since 2003 (Figure ES.4).

Box ES.5

Effects of recalculating data for previously reported emissions in EU Member States

In 2024, all EU Member States reported recalculations for one or more years. This altered emission inventories for all pollutants up to 2021 (see Chapter 5.1), whereby the changes for regulated pollutants with a reduction obligation (NO_x, NMVOCs, SO_x, NH_3 and $PM_{2.5}$) were up to 3.8%.

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

EU key categories and main emission sources

EU key categories refer to the individual sources that contributed the most to total emission levels in 2022. These have been determined by a level assessment ([8]) 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 57 different emission inventory source categories were identified as key for at least one pollutant. Several emission categories were identified as key for more than one of the 16 assessed pollutants. Table ES.1 lists the most relevant key categories.

([7]) 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.

([8]) 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, 2023).

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)
Public electricity and heat production (NFR 1A1a)	9 (NO_x, SO_x, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, HCB, PCBs)
Iron and steel production (NFR 2C1)	8 (SO_x, CO, Pb, Cd, Hg, PCDD/Fs, total PAHs, PCBs)
Road transport: Passenger cars (NFR 1A3bi)	7 (NO_x, NMVOCs, CO, $PM_{2.5}$, PM_{10}, BC, Hg)
Waste: Open burning of waste (NFR 5C2)	6 (CO, PM_{10}, $PM_{2.5}$, BC, Cd, PCDD/Fs)

Note: NFR, nomenclature for reporting.

Source(s): The air pollutant emission estimates reported for 2022.

Table ES.2 and Figure ES.5 show how various sectors contribute to total EU emissions of pollutants in 2022. As observed in previous years, each main air pollutant has one main source category.

Table ES.2 Most relevant key sectors and categories for air pollutant emissions and share in total emissions

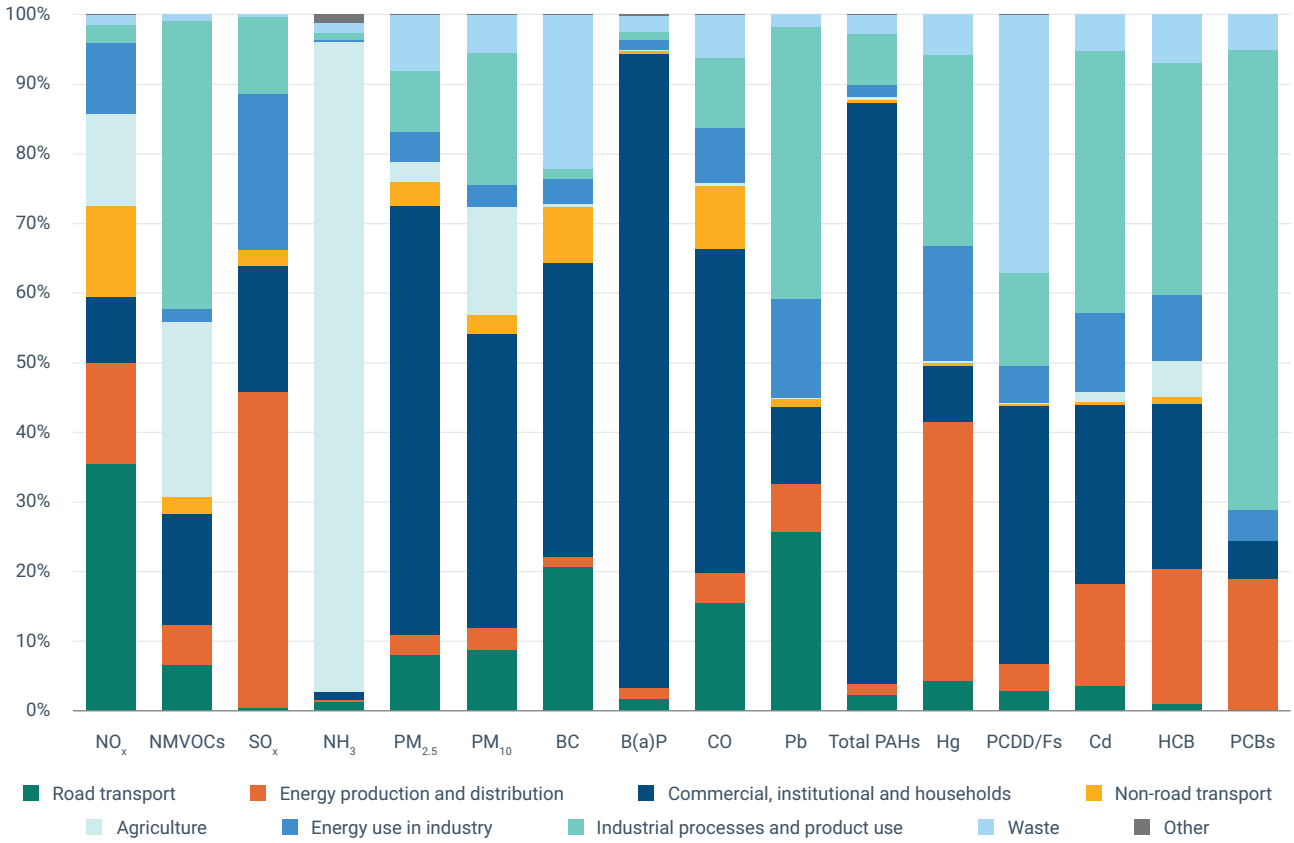
Emission	Main contributing sector	Most relevant subcategory
NO_x	Road transport (35%)	Passenger cars (17%)
SO_x	Energy production and distribution (46%)	Public electricity and heat production (32%)
NH_3	Agriculture (93%)	Animal manure applied to soils (24%)
NMVOC	Industrial Processes and Solvent Use (41%)	Domestic solvent use including fungicides (12%)
CO	Commercial, institutional and households, fuel combustion (47%)	Residential: Stationary fuel combustions (44%)
$PM_{2.5}$	Commercial, institutional and households (62%)	Residential: Stationary fuel combustions (59%)

Source(s): The air pollutant emission estimates reported for 2022.

NO_x emissions from the road transport sector fell by 69% between 1990 and 2022. They declined by a further 57% between 2005 and 2022. Nevertheless, this sector is a major source of the ground-level O_3 precursors NO_x, CO and NMVOCs in the EU. In 2022, road transport contributed 35% (NO_x), 16% (CO) and 7% (NMVOCs) to total emissions. This includes emissions from passenger cars, light duty vehicles, heavy duty vehicles and buses, as well as mopeds and motorcycles. The main emission source for all these pollutants is passenger cars. Gasoline evaporation contributes significantly to NMVOCs, producing 37% of these emissions in the sector.

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

Figure ES.5 Contributory share of sectors to EU emissions of the main air pollutants in 2022



Source(s): The air pollutant emission estimates reported for 2022.

Adjustments to emission inventories under the Gothenburg Protocol

Following the adoption of the amended Gothenburg Protocol and the decision on its provisional application from 2012, parties to the Air Convention were able to adjust their emission inventories downwards. Such adjustments were allowed if non-compliance with the ceilings set in the Gothenburg Protocol was due to the application of improved emission inventory methods in accordance with updated scientific knowledge since the 2010 ceilings were originally set. This was to avoid countries being disadvantaged by applying improved emission inventory methodologies. Emission reduction commitments have been in place since 2020 and the same approach applies, though inventory adjustments now have to be applied to both the year for which the compliance is checked and the base year 2005 — 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, 2021 and 2022. In 2023, no new adjustments have been accepted; previously accepted ones have just been reiterated.

Table ES.3 Accepted inventory adjustment applications

Country	Pollutant	NFR
Belgium	NO_x	Road transport (1A3bi-iv), Agriculture (3B, 3Da1, 3Da2a)
	NMVOCs	Agriculture (3B, 3De)
Czechia	NMVOCs	Agriculture (3B)
Denmark	NMVOCs	Agriculture (3B, 3B1a)
	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)
	NMVOCs	Agriculture (3B, 3D)
Germany	NMVOCs	Agriculture (3B, 3De)
	NH_3	Agriculture (3Da2c, 3l)
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)

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

Sources: UNECE 2014b, 2015, 2016, 2017, 2018, 2019a, 2020, 2021, 2022a.

Progress towards meeting the EU's emission reduction commitments for reported year 2022 under the Gothenburg Protocol

The 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. The EU's reduction commitment is the sum of the reduction commitments of all EU Member States ([9]). Table ES.4 shows the aggregated EU-27 emissions for 2022 and 2005, as well as the actual reduction compared with the emission reduction commitment the protocol specified for the EU in 2020 and beyond. In 2022, the EU-27 emissions of NO_x, NMVOCs, SO_x, NH_3 and $PM_{2.5}$ came below reduction commitments.

([9]) Annex II of the amended Gothenburg Protocol shows the EU reduction commitment as the sum of the 27 countries who were Member States in 2012; the applicable reduction commitment for the EU is updated by technical correction when the membership of the EU changes (see EB Decision 2021/3 on the methodology for such technical corrections).

Table ES.4 Emissions reported for 2022 by EU-27 Member States compared with reduction commitments for 2020 and beyond

Pollutant	EU-27 emissions, 2022 [Gg]	EU-27 emission levels, 2005 [Gg]	Reduction commitment from 2005 level (%)	Current difference (%)
NO_x	5,395	10,710	-40	-50
NMVOCs	5,858	8,960	-28	-35
SO_x	1,303	7,013	-59	-81
HN_3	3,274	3,906	-6	-16
$PM_{2.5}$	1,281	1,884	-22	-32

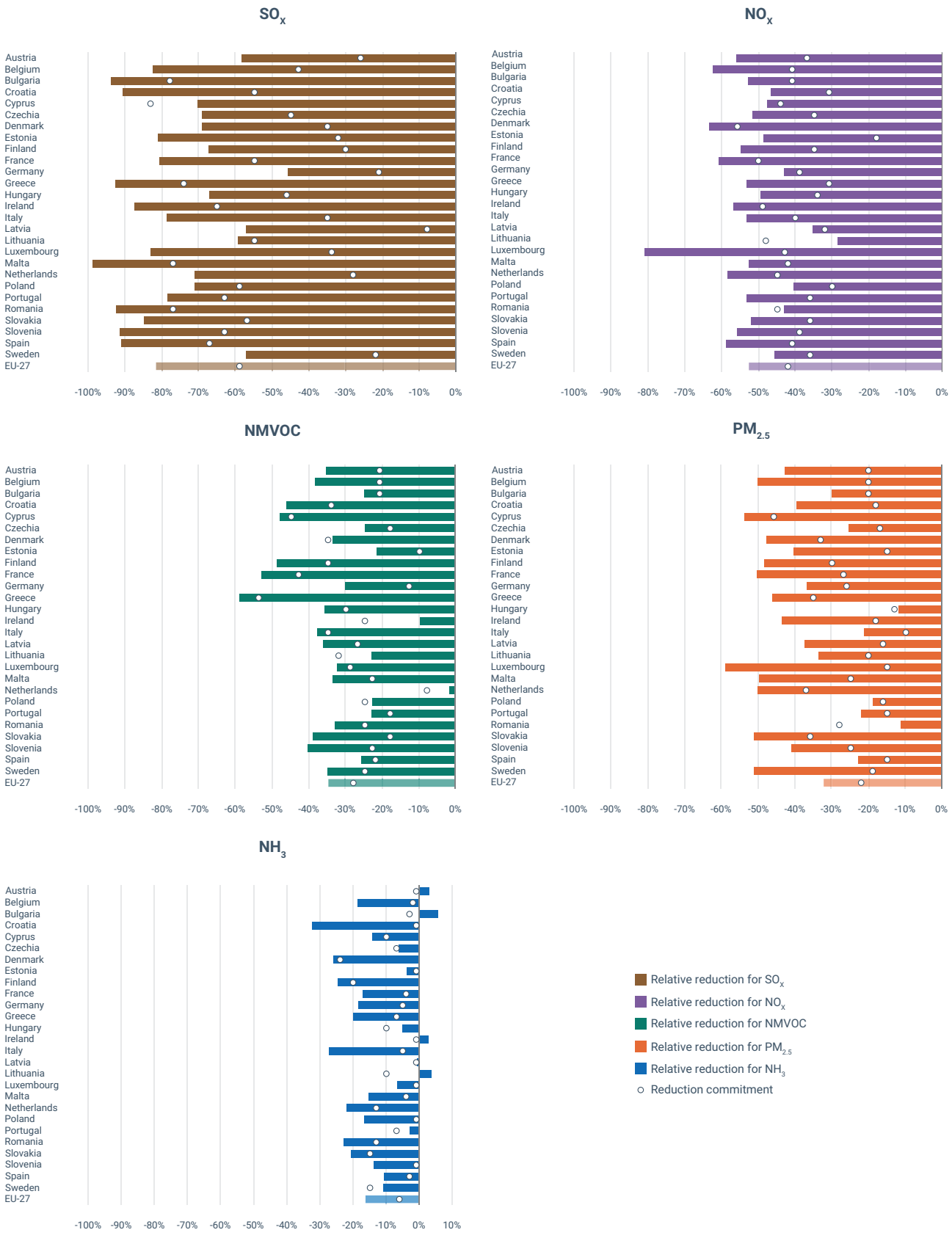
Notes: Emission data for Spain excludes the Canary Islands.
Emission data for Portugal excludes the Azores and Madeira.
Under the Gothenburg Protocol, the EMEP Steering Body accepted applications from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands and Spain for emission inventory adjustments in 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022. This table takes these adjusted data into account.
Emission reduction commitments are also specified for individual EU-27 Member States.

Figure ES.6 shows if EU Member States met their respective Gothenburg Protocol national emission reduction commitments in 2022.

The reduction commitment for SO_x was met by all Member States except Cyprus. Several Member States ([10]) did not meet their reduction commitment for NO_x emissions (Lithuania and Romania), NH_3 emissions (Austria, Bulgaria, Czechia, Hungary, Ireland, Latvia, Lithuania, Portugal and Sweden), NMVOC emissions (Denmark, Ireland, Lithuania, Netherlands and Poland) and $PM_{2.5}$ emissions (Hungary, Romania).

([10]) Austria, Italy and Poland have signed the Gothenburg Protocol but not ratified it. For this reason, the targets are not binding for these countries.

Figure ES.6 **Distance to Gothenburg Protocol reduction commitments for the EU-27 and individual EU Member States in 2022 for all five regulated pollutants**



Source(s): The air pollutant emission estimates reported for 2022.

Actions and recommendations to improve 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. The gap-filling procedure is carried out to compile an EU inventory as complete as far as it is 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. Member States should submit complete inventories and use proper notation keys, for instance when no values are available. They should recalculate emission data for prior years when new methods or scientific knowledge become available. In this context, it is recommended that Member States review and apply the information included in the updated *EMEP/EEA air pollutant emission inventory guidebook — 2023* (EMEP/EEA, 2023) 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 Human Health and the Environment (ETC HE) during the compilation of the EU inventory. Where necessary, EU Member States are invited to either resubmit inventory data — in the correct nomenclature for reporting 19 (NFR19) format for the reporting of air pollutants — or update the following year's inventory to reflect newly-identified insights or errors. In 2024, several Member States were contacted by the EEA regarding potential errors identified during the QA/QC procedures carried out by the EEA.

1 Introduction

The European Commission provides this report and its accompanying data (on behalf of the EU-27) as an official submission to the Convention on Long-range Transboundary Air Pollution (Air Convention) via the Convention secretariat at the United Nations Economic Commission for Europe (UNECE).

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 (KCAs), 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:

- **regulated pollutants with a reduction obligation:**
    - nitrogen oxides (NO_X)
    - non-methane volatile organic compounds (NMVOCs)
    - sulphur oxides (SO_X)
    - ammonia (NH_3)
    - fine PM with a diameter of 2.5µm or less ($PM_{2.5}$)
- **other**
    - carbon monoxide (CO);
- **particulate matter (PM):**
    - PM with a diameter of 10µm or less (PM_{10})
    - 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);
- **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 2024 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 1990-2022 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.
- Annex F presents the EU's Air Convention data submission for the period 1990-2022 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 2024 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 Air Convention (UNECE, 1979) in 1982. Since 1984, eight protocols have come into force. Table 1.1 presents the ratification status of each protocol for the EU as a whole. The status differs across individual 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	'Air Convention': Convention on Long-range Transboundary Air Pollution (UNECE, 1979)	Signed and ratified (approval)
1984	'EMEP 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)
2009	Amendments to the 'Aarhus POPs Protocol'	Ratified (acceptance)
2012	Amendments to the 'Gothenburg Protocol' (UNECE, 2012b)	Ratified (acceptance)
2012	Amendments to the 'Aarhus Heavy Metals Protocol'	Ratified (acceptance)

Note: Ratification is the final step in the process of approving an agreement by which the parties indicate their intention to be bound by that agreement. Once ratification has been completed, an agreement can be concluded and formally enters into force ([11]).

([11]) See: https://eur-lex.europa.eu/EN/legal-content/glossary/ratification-process.html

On 4 May 2012, the Executive Body for the UNECE Air Convention adopted amendments to the Gothenburg Protocol. Now the protocol's text includes national emission reduction commitments for the major air pollutants NO_X, NMVOCs, SO_X, NH_3 and $PM_{2.5}$ (and BC as a component of PM). Countries are to meet the reduction 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 (change from original Gothenburg Protocol annex II table following the change in EU membership after 2012);
- 6% for NH_3;
- 28% for NMVOCs;
- 22% for $PM_{2.5}$;

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

The Executive Body of the Air Convention adopted 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, 2014). Parties were to apply the revised guidelines in 2015 and subsequent years. These guidelines were updated in December 2022 at the 42nd session of the Executive Body (UNECE, 2022b, d). 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 emission reduction commitments, or to inventories for the purpose of comparing them with total national emissions, 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 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, in 2019, from the Netherlands; in 2020, from Czechia; in 2021, from France; and in 2022, from Denmark, France and the Netherlands (UNECE, 2014b, 2015, 2016, 2017, 2018, 2019, 2020, 2021). 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, 2022c,d) and apply the methodologies in the latest version of the EMEP/EEA inventory guidebook (EMEP/EEA, 2023).

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 supports the European Commission's Directorate-General (DG) for Environment to compile the annual EU Air Convention emission 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), 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;
- initial checks;
- preparing the gap-filled EU emission inventory by 30 April, based on Member State submissions (which the European Commission subsequently submits to UNECE).

Since 2004, the EEA and EMEP have supported a separate annual quality review of emission data submitted by the countries. It provides findings each year to help the countries improve the quality of the emission data they report. Each year, EMEP publishes a 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 (ETC HE)
The main activities of the ETC HE([12]) regarding the EU's Air Convention emission inventory include:

- checks on time series consistency, quality tests and supports 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);

- prepares the updated EU Informative Inventory report by 30 May.

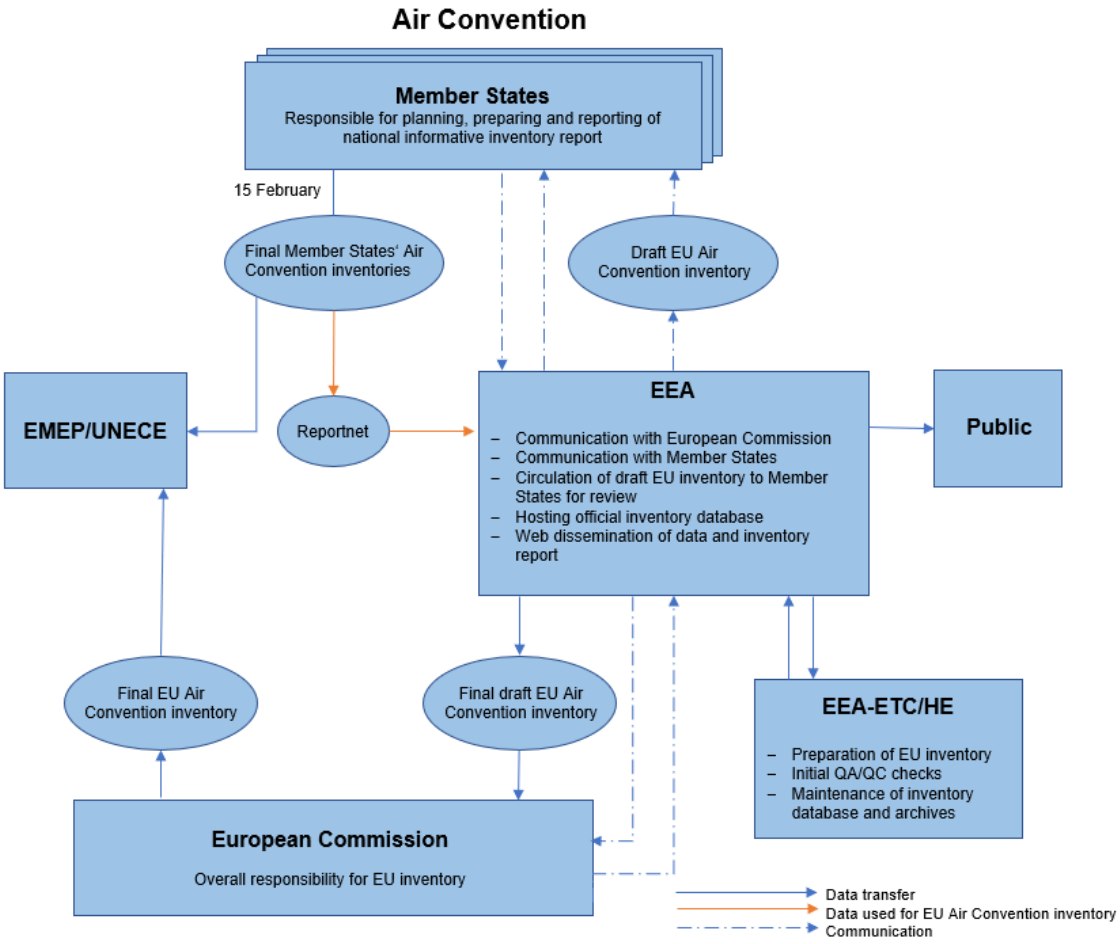
European Environment Information and Observation Network
Eionet facilitates the work of the EEA and the respective European topic centres (ETCs) (EU, 1999b)([13]). It comprises the EEA (supported by its ETCs) and a supporting network of experts from national environment agencies and other bodies that deal with environmental information (Eionet, 2023a). EU Member States are requested to use the tools of the Central Data Repository (Eionet, 2023b) of Eionet's Reportnet to make their Air Convention submissions available to the EEA.

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 EEA, assisted by 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 EU-27 emission inventory. The ETC HE updates an EU Air Convention Informative n Inventory Report. The European Commission formally submits the EU's emission inventory data and Informative Inventory Report 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).

([12]) https://www.eionet.europa.eu/etcs/etc-he.
([13]) https://www.eionet.europa.eu.

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. The EU 2016/2284 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 the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, (EU, 2018) and the Commission Implementing Regulation (EU) 2020/1208 (EU, 2020) EU Member States should also copy this information to the CDR (Eionet, 2023b). 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, 2024

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 2024	30 April 2024
NEC Directive	NO_X (as NO_2), NMVOCs, SO_X (as SO_2), NH_3, CO, HMs, POPs and PM	15 February 2024	Not applicable
EU Governance Regulation/ 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 2024 to the European Commission and 15 April 2024 to the UNFCCC	15 April 2024

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. In addition to the EU-27 data, this report includes the 2022 sulphur emission (SOX) 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 (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, 2022c,d) and the adoption of the NEC Directive (EU) 2016/2284 (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 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]) Parties may also report emission estimates based on fuel used as an additional 'memo item'. Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands and Switzerland 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, 2022c,d).

Incl., included in national totals; LTO, landing/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, and its gridded data and large point source (LPS) data by 15 June.

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, 2023). 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 Centre on Emission Inventories and Projections (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 Informative Inventory Report (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, 2023) 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 sub-sections 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 Scheme (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, 2023), 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 used in road transport

In Article V/A, paragraph 22, the reporting guidelines (UNECE, 2022c,d) 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 of 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, 2022c).*

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 2024 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, 2022c) require that submitted emission inventories are complete. The 2024 gap-filling procedure 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([14]). This procedure is also consistent with the techniques used to fill emission data gaps proposed by the inventory guidebook (EMEP/EEA, 2023). 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 interpolation or extrapolation and manual changes. For further information on the gap-filling procedure, please see 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 2024.
2. Air Convention data submitted to the European Environmental Agency in 2023 are the next source used to fill remaining gaps. All reported data (i.e. values and notation keys) are used.
3. 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.
4. 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.
5. Subsequently, notation keys reported in the current reporting year by EU Member States under the NEC Directive are used to fill any remaining gaps.
6. 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.
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. Next, NECD data submitted to the EEA are the next source of official information used to fill gaps (values and notation keys).
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 ($r2 \geq 0.6$) are available. Extrapolation 'backwards' is never allowed to result in negative values.

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

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. The final step of the gap-filling procedure is the correction of the gap-filled particulate matter data in all cases in which total suspended particulate (TSP) emissions are lower than particulate matter (PM) with a diameter of 10µm or less (PM_{10}) emissions, PM_{10} emissions are lower than PM with a diameter of 2.5µm 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 can only be applied if national total or sectoral data is available. 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 and 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 3.3-Table 3.28) 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 30 April 2024. In the 2024 reporting cycle, all 27 EU Member submitted their inventories and time series on time., using the new NFR19 templates. Appendix 3 presents detailed information on EU Member States' submissions.

1.5.2 Reporting of Activity Data

For the first time, the EU reports aggregated and reported Activity Data following a recommendation from the last LRTAP Stage 3 review in 2020. Activity Data of liquid fuels, solid fuels, gaseous fuels, biomass and other fuels is provided for all categories. For 'Other Activity', categories in sectors 'Energy production and distribution', 'Energy use in industry', 'Non-road transport', 'Road transport', 'Commercial, institutional and households' and 'Industrial processes and product use' were identified, where all Member States report Activity Data in the same unit, which enables an aggregation of the reported activity data.

Activity Data for ‘Other Activity’ is reported in following categories:

1A1a	Public electricity and heat production
1A1b	Petroleum refining
1A1c	Manufacture of solid fuels and other energy industries
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
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals
1A2gvii	Mobile combustion in manufacturing industries and construction (please specify in the IIR)
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)
1A3ai(i)	International aviation LTO (civil)
1A3aii(i)	Domestic aviation LTO (civil)
1A3bi	Road transport: Passenger cars
1A3bii	Road transport: Light duty vehicles
1A3biii	Road transport: Heavy duty vehicles and buses
1A3biv	Road transport: Mopeds & motorcycles
1A3bvi	Road transport: Automobile tyre and brake wear
1A3bvii	Road transport: Automobile road abrasion
1A3c	Railways
1A3di(ii)	International inland waterways
1A3ei	Pipeline transport
1A3eii	Other (please specify in the IIR)
1A4ai	Commercial/Institutional: Stationary

1A4aii	Commercial/Institutional: Mobile
1A4bi	Residential: Stationary
1A4bii	Residential: Household and gardening (mobile)
1A4ci	Agriculture/Forestry/Fishing: Stationary
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
1A4ciii	Agriculture/Forestry/Fishing: National fishing
1A5a	Other stationary (including military)
1A5b	Other, Mobile (including military, land based and recreational boats)
2A2	Lime production
2B1	Ammonia production
2B3	Adipic acid production
2B5	Carbide production
2B6	Titanium dioxide production
2B7	Soda ash production
2C3	Aluminium production
1A3bi(fu)	Road transport: Passenger cars (fuel used)
1A3bii(fu)	Road transport: Light duty vehicles (fuel used)
1A3biii(fu)	Road transport: Heavy duty vehicles and buses (fuel used)
1A3biv(fu)	Road transport: Mopeds & motorcycles (fuel used)
1A3bv(fu)	Road transport: Gasoline evaporation (fuel used)
1A3bvi(fu)	Road transport: Automobile tyre and brake wear (fuel used)
1A3bvii(fu)	Road transport: Automobile road abrasion (fuel used)

1.5.3 Projection data

In 2024, reporting of projection data was voluntary. Thus far, Ireland and Finland have provided projected data on a voluntary basis.

1.5.4 Gridded data

In accordance with 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. Since gridded data for the EU were last submitted in 2021 (EEA, 2022a), there is no obligation to report gridded data this year. In 2024, Finland and Spain have reported gridded data on a voluntary basis.

1.5.5 Large point sources (LPSs)

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, 2022a), and therefore there is no obligation to report LPS data this year. In 2024, Finland and Spain have reported LPS data on a voluntary basis.

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

PM consists of a filterable fraction and a condensable fraction, which reacts on 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, 2023a), Table A6.1, 'Inclusion/exclusion of the condensable component from PM_{10} and $PM_{2.5}$ emission factors', was established. In 2024, 18 EU Member States provided information using this table. The Netherlands, Finland and Italy have not provided information using this table but have reported information on condensable components in their IIRs. 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 analyses

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, 2023).

An analysis of the levels of the 2022 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 2022, 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 57 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. Categories '1A1a — Public electricity and heat production' and '2C1 — Iron and steel production' were identified as being important emission sources for 9 and 8 pollutants, respectively. Categories '1A3bi — Road transport: Passenger cars' and '5C2 — Waste: Open burning of waste' were identified as being key categories for seven and six pollutants, respectively.

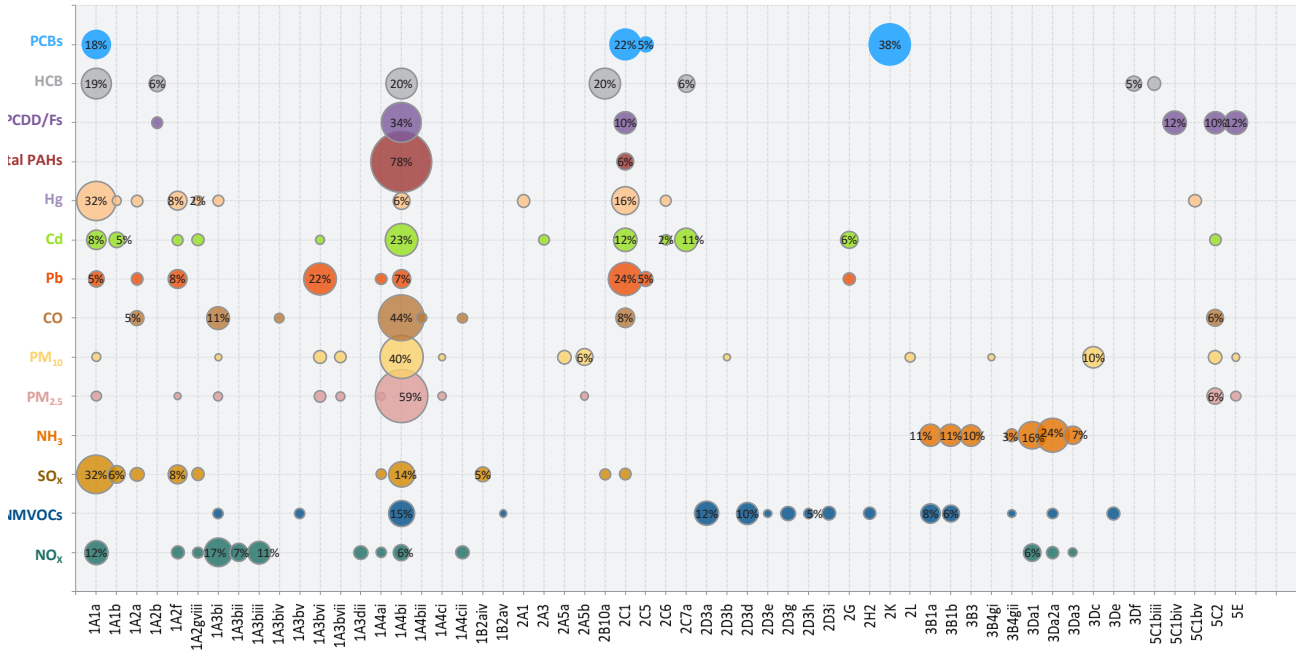
For NO_X and CO, 13 and 8 key categories were identified, respectively; as expected for both pollutants, the key categories with a large share of total emissions reported mainly involve fuel combustion. Ten key categories were identified for SO_X (mainly energy-related sectors) and seven were identified for NH_3 (all from the agriculture sector). PM_{10}, $PM_{2.5}$ and NMVOC emission sources are more diverse and 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 and '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 HMs, 12 key categories were identified for Cd, 9 for Pb and 11 for Hg. 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 from 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 2022



Note: Bubble size indicates the share of the respective category to the national total of the particular air pollutant. All values >5% are indicated. For NFR codes, see the list of source sector abbreviations in 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, 2023).

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 and ETC HE performs on the status of each Member State's submission. Because the emission inventories reported under Air Convention and the NEC Directive are almost the same, checks are compared with those run by the EEA under the NEC Directive.

The EEA IT system harvests data reported by the Member States under Air Convention (emission inventories, adjustments, projections, large point sources and gridded data).

Reported data are harvested into the internal EEA SQL database once technically accepted by EEA in the relevant CDR folder. Automatic SQL procedures and functions populate public QA/QC Tableau data-viewers([15]) to support EEA, DG Environment, and the EU Member States in performing an evaluation of the data reported and request a resubmission when relevant.

In addition, the ETC HE checks Member State data at national total and when it finds outliers, it identifies the categories responsible. When the ETC HE does not find any explanation for a notable trend in a country's IIR, the EEA 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 an overview of the findings is given in Table 1.6.

Table 1.5 Overview of quality checks carried out during the preparation of the EU Air Convention emission inventory and report

	Check											
	Completeness	Consistency	Comparability	Accuracy	Transparency	level	years	First checks	Sub-sequ-ent checks (after gap-filling)	Checks within the draft report	Member States will be informed on the finding	changes/ corrections
Reporting overview	✓		✓		✓	Submissions	1990-2022	×			if submission is missing or in wrong format	gap-filling of missing data as far as possible
Adjustment overview	✓		✓		✓	Submissions	2010-2022	×			if a document is missing or in wrong format	
Completeness	✓				✓	Submissions	1990-2022	×			yes	only in case of resubmissions of the Member State
Time series checks	✓	✓				National Totals, Sectors	1990-2022	×			yes	only in case of resubmissions of the Member State
NFR template line 152 check			✓		✓	National Totals	1990-2022	×			yes	only in case of resubmissions of the Member State
Total PAHs = Sum of PAHs				✓		National Totals	1990-2022	×			yes	only in case of resubmissions of the Member State
TSP-PM10 ratio, PM10-PM2.5 ratio checks				✓		National Totals	1990-2022	×			yes	only in case of resubmissions of the Member State
TSP ≥ PM10, PM10 ≥ PM2.5, PM2.5 ≥ BC checks				✓		National Totals, Categories	1990-2022	×			yes	only in case of resubmissions of the Member State
National Total = Sum of Sectors	✓			✓		National Totals, Sum of Sectors	1990-2022		×		if difference is more than 5%	only in case of resubmissions of the Member State
'NE' analysis	✓					National Totals, Categories	2022		×	×	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	2022		×		yes	only in case of resubmissions of the Member State
Recalculations		✓				National Totals	1990-2021			×	within the review of the draft version of the report	no
Effect of gap-filling	✓				✓	Whole EU inventory	1990, 2022			×	within the review of the draft version of the report	no
Completeness of the EU inventory	✓				✓	Whole EU inventory	1990, 2022			×	within the review of the draft version of the report	no

([15]) https://tableau-public.discomap.eea.europa.eu/views/LRTAP_QAQC_16468126650020/ReportingOverview?%3AshowAppBanner=false&%3Adisplay_count=n&%3AshowVizHome=n&%3Aorigin=viz_share_link&%3AisGuestRedirectFromVizportal=y&%3Aembed=y

Table 1.6 Findings of the quality checks carried out during the preparation of the EU Air Convention emission inventory and report in 2024

Test/check	Findings	Number of EU Member States concerned
Completeness	0	0
Time series checks	13	9
NFR template line 152 check	2	2
Total PAHs=sum of PAHs	12	11
TSP to PM_{10} ratio, PM_{10} to $PM_{2.5}$ ratio checks	23	16
TSP≥PM_{10}, PM_{10}≥$PM_{2.5}$, $PM_{2.5}$≥BC checks	40	11
National total=sum of sectors[a]	8	4
'NE' analysis	647	27
'NA' and 'NO' checks	121	16

Notes: (a) The check was performed on the gap-filled EU inventory.
NA, not applicable; NO, not occurring; NE, not estimated.

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 emission inventories is the annual meeting of the Task Force on Emission Inventories and Projections (TFEIP). This expert meeting discusses quality issues concerning all Air Convention Parties emission reporting (including EU Member states) and was held on 14 and 16 May 2024 (TFEIP, 2024).

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 the 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 system. Revisions of data sets are recorded.

The EMEP CEIP performs more detailed QA activities in an annual review process (EMEP CEIP, 2023b). 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)([16]).

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

([16]) EMEP publishes a summary of the results of the stages 1 and 2 reviews performed in 2024 (EMEP, forthcoming).

Parties follow the same approach each year. The CEIP selects the countries in cooperation with the EEA and EMEP. In 2023, the CEIP reviewed all EU Member States with a focus on the agriculture sector. The results are included in individual country-specific reports (EMEP CEIP, 2023c). In 2024, the CEIP plans to review all EU Member States with a focus on the industrial processes and product use sector.

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. Out of 27 EU Member States, 21 (Austria, Belgium, Cyprus, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden) provided detailed tables quantifying uncertainty in their 2024 emission inventories for at least the main pollutants and PM emissions. The pollutants that they consider and the assumptions behind the uncertainty analysis vary across EU Member States. As not all countries provided an uncertainty estimate, the overall uncertainty of the EU emission 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), 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 EU Member States reported activity data([17]), and all countries reported activity data for the complete time series (1990-2022). The stage 1 review provides detailed results for the completeness of Member State submissions (EMEP CEIP, 2023d).

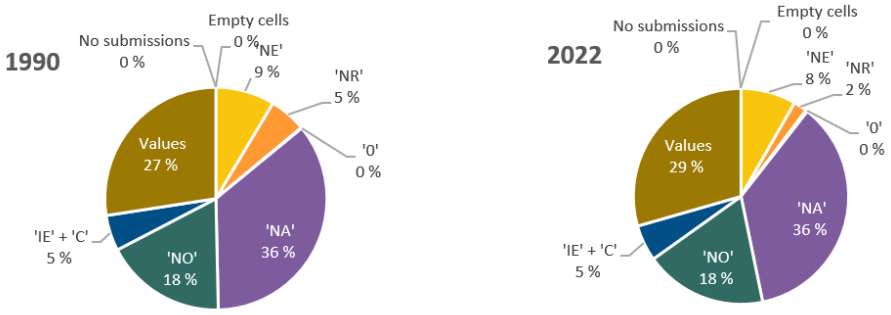
Figure 1.3 shows a simple compilation indicating the completeness of Member State reporting for the inventory years 1990 and 2022. It uses the NFR templates that were submitted originally, i.e. before gap filling. It gives the percentages of each notation key or values that the reports present for source categories. The data are for all EU Member States and all pollutants (excluding national totals). The figures show that more data are available for 2022 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'([18]), 'No submissions' and 'Empty cells' count as incomplete reporting. EU Member States reported 11% of the 2022 data entries incompletely, while for 1990 they reported 14% of the data incompletely.

The EMEP reporting guidelines (UNECE, 2022c) 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). Therefore, ideally, there should be no difference between the availability of data submissions for 1990 and for 2022.

([17]) Activity data should be reported, together with emissions, from 1990 onwards (UNECE, 2014a).

([18]) According to the reporting guidelines (UNECE, 2022c,d), 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)**



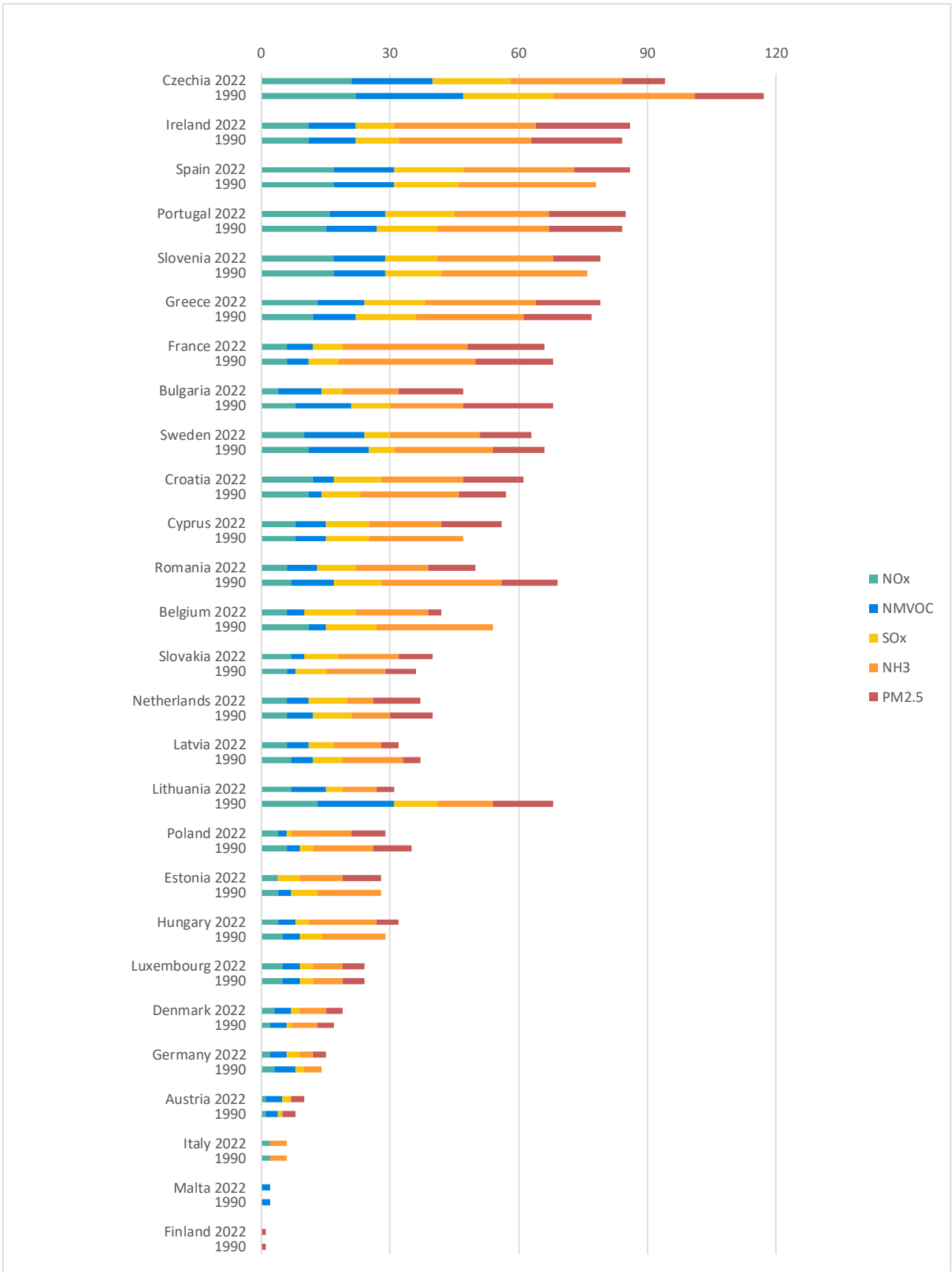
Notes: Appendix 1 provides further explanations of notation keys.
C, confidential; NO, not occurring.

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, 2022c) allow countries to report emissions as 'NE' for some sectors. This is carried out when 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, Slovenia reported 34 source categories of NH_3 as 'NE'. Overall, in most cases, the use of 'NE' in reporting in 2022 is quite similar to its use in 1990. Most uses (across all pollutants and EU Member States) are in the categories '5E — Other waste', '2D3g — Chemical products', '2I — Wood processing', '1A3bvii — Road transport: Automobile road abrasion', '1A3ai(i) — International aviation LTO (civil)', '1A3aii(i) — Domestic aviation LTO (civil)' and '5D1 —Domestic wastewater handling. Within these categories, more than 25% of the entries mention 'NE'.

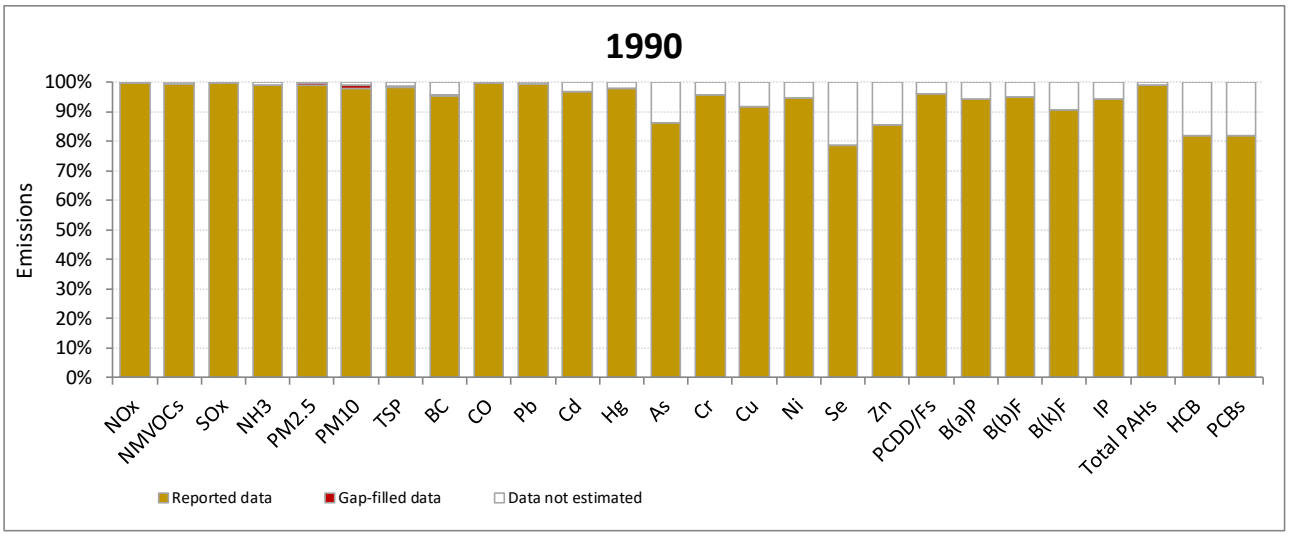
Figure 1.4 **Number of 'NE' source categories for 2022 and 1990**



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.

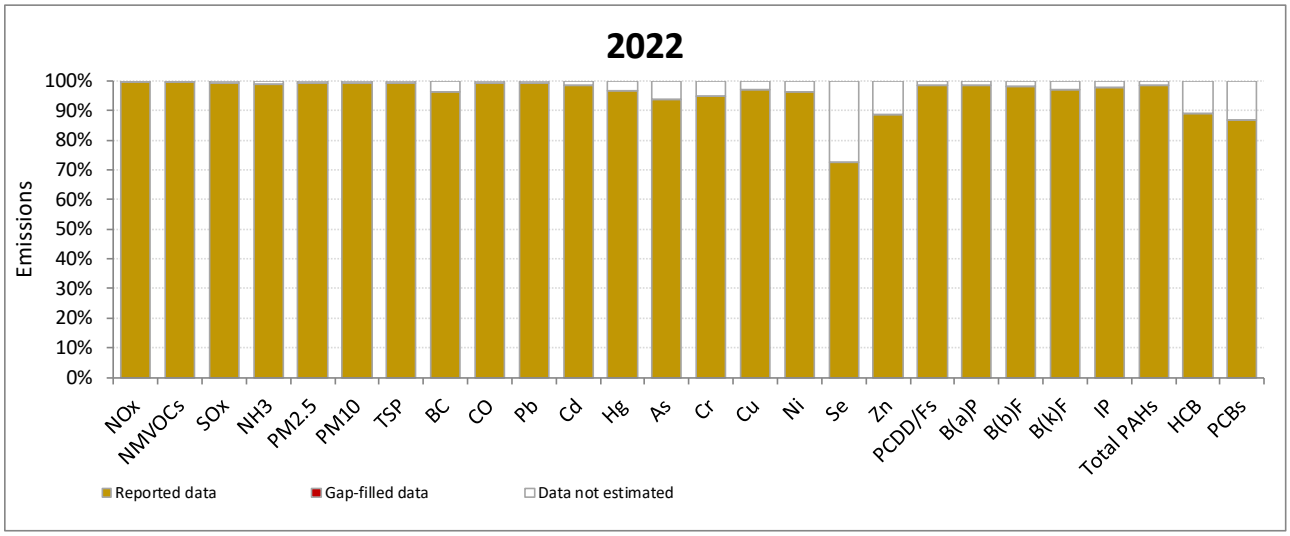
Figure 1.5 and Figure 1.6 show the proportions of gap-filled data and the estimated underestimation of the EU inventory for 1990 (2000 for PMs and BC) and 2022. The calculated underestimation comprises missing data (e.g. if emission data of a pollutant were not estimated by a Member State and no data 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.

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



Note: For $PM_{2.5}$, PM_{10}, TSP and BC, data for the year 2000 are shown.

Figure 1.6 Completeness and effect of gap filling on EU emission data for 2022



2 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 emission reduction commitments or inventories may be made in some 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 or not 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 made.
- Emission factors used to determine emission levels for particular source categories have changed since the emission reduction commitments were made.
- The ways of determining emissions from specific source categories have changed significantly between the time when emission reduction commitments were made and the year that they are to be attained.

Table 2.1 lists inventory adjustment applications accepted by the EMEP Steering Body in the years 2014-2022.

Table 2.1 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	Finland	NH_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, 3I	2010-2014
2016	Germany	NH_3	3Da2c, 3I	2010-2014
2016	Luxembourg	NO_X	3B, 3De	2010-2014

Year of acceptance	Member State	Pollutant	NFR19 code	Years
2016	Luxembourg	NMVOCs	3B, 3De	2010-2014
2017	Spain	NO_X	3B	2010-2015
2018	Hungary	NMVOCs	3B, 3De	2010-2016
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
2022	Denmark	NMVOCs	3B1a	2005, 2020
2022	France	NMVOCs	3B, 3D	2005, 2020
2022	Netherlands	NMVOCs	3B1a	2005, 2020

Note: 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, 2019a, 2020, 2021, 2022a, 2023).

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 Air Convention via 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, 2015b).

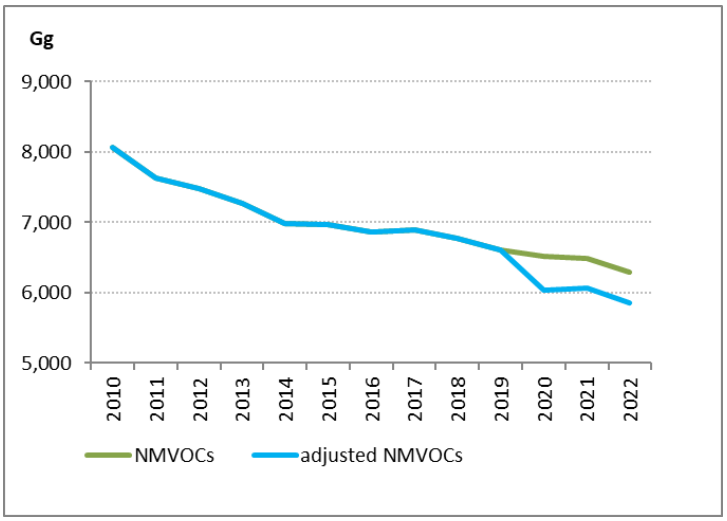
Table 2.2 gives an overview of reported adjustments within the Air Convention submission in 2024. All approved and reported adjustments also appear in the emission trend table in Section 3.3 (non-methane volatile organic compounds, NMVOCs; Table 3.4). Parties must report details of their approved adjusted aggregated emissions using the appropriate row in the main emissions reporting template (Annex I to the reporting guidelines; UNECE, 2015b). They must also provide detailed information by pollutant and sector for each adjustment, using the template provided in Annex IIa 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, Sub-sections A-D, of the guidelines.

Table 2.2 Reporting of approved adjustments within the Air Convention submission 2024 (Annex I and Annex IIa to the reporting guidelines; UNECE, 2022c), as of 11 March 2024

Member State	Pollutant	Years	Annex I ('adjustment row')	Annex IIa	Declaration on consistent reporting of approved adjustments
Denmark	NMVOCs	2005, 2020-2022	Yes	Yes	No
France	NMVOCs	2005, 2020-2022	Yes	Yes	Yes
Netherlands	NMVOCs	2005, 2020	Yes	Yes	Yes

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

Figure 2.1 Adjusted and unadjusted emissions of NMVOCs for the EU, 2010-2022



3 Trends and key categories of EU pollutant emissions

The present EU inventory lists emissions for all the regulated pollutants with a reduction obligation, particulate matter (PM), heavy metals (HMs) and persistent organic pollutants (POPs). It also reports the individual polycyclic aromatic hydrocarbons (PAHs) for which the 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 2.5µm or less ($PM_{2.5}$), PM with a diameter of 10µm 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, , additional HMs,data for several countries (at least for some years) were missing and could not be gap filled. Therefore, the EU total is not complete for these pollutants (see also Section 1.9). For the regulated pollutants with an emission reduction commitment, PM, HMs and POPs, as well as B(a)P and BC, the EU trends in emissions from the five most important key categories are presented.

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

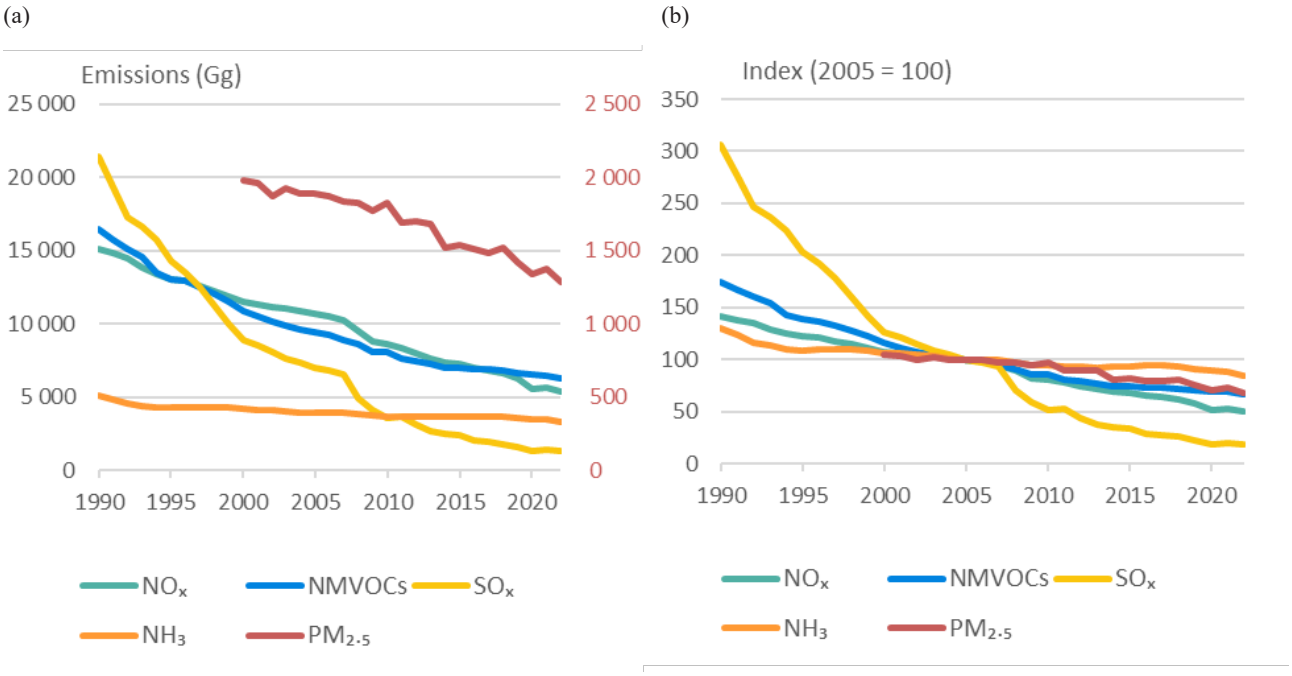
Table 3.3-Table 3.28 include two EU totals. The first is the sum of national totals that EU Member States officially reported. The second is the sum of the sectors of all EU Member States. A difference between these two EU totals occurs when only national totals but no sectoral data are available. There is a third EU total for NMVOCs (Table 3.4). This total refers to approved adjustments (see also Chapter 2).

3.1 Total EU emission trends, projection reporting and progress towards Gothenburg Protocol reduction commitments

3.1.1 Total trends in EU emissions

In 2022, emissions of all pollutants were lower than in 2005 (or in 2000 for PM) (Table 3.1). Among regulated pollutants with a reduction obligation, the largest reductions across the EU (in percentage terms) were for SO_X emissions (-94% since 1990 and -81% since 2005), followed by NO_X (-64% since 1990 and -50% since 2005), NMVOCs (-62% since 1990 and -33% since 2005), NH_3 (-35% since 1990 and -16% since 2005) and $PM_{2.5}$ (-32% since 2005)) (Figure 3.1).

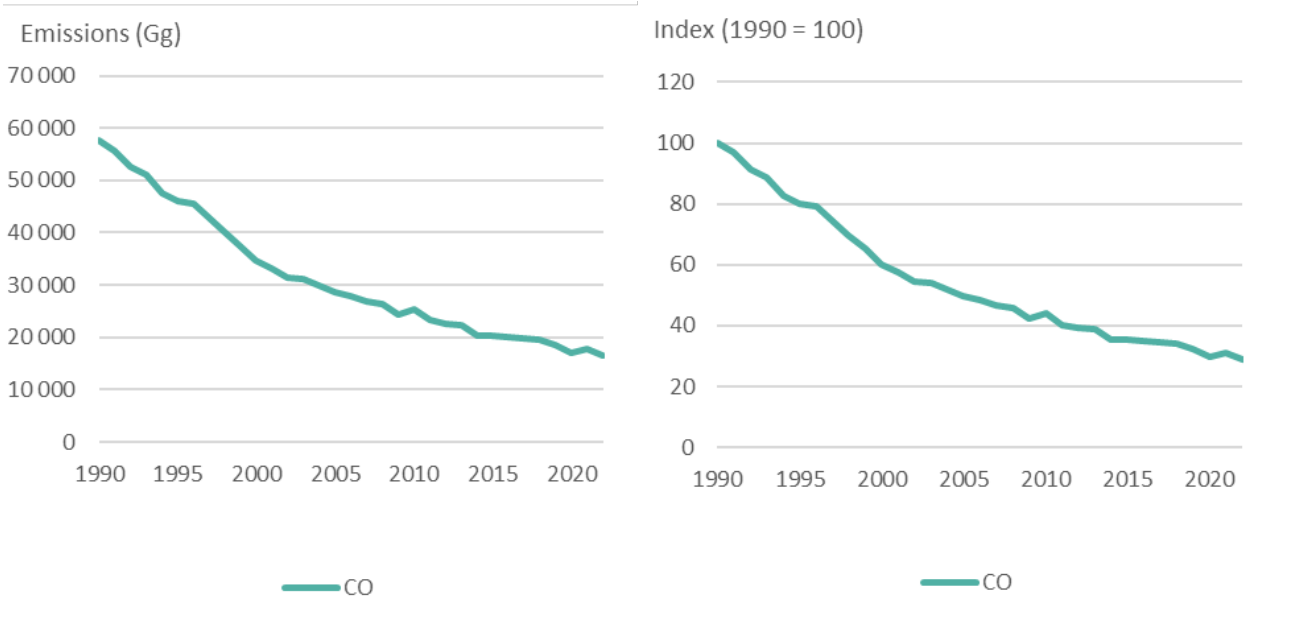
Figure 3.1 **(a) EU-27 emission trends and (b) indexed emissions for regulated pollutants with a reduction obligation**



Note: The right-hand axis gives values for PM2.5 emissions.
The indexed emissions are based on emissions in 2005 (=100%).

CO emissions decreased by 71% (-40956kt CO) between 1990 and 2022, and by 42% between 2005 and 2022. (Figure 3.2).

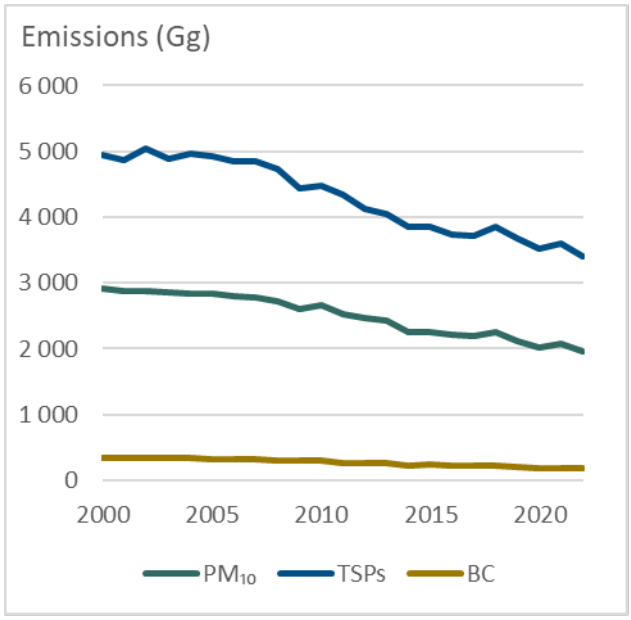
Figure 3.2 **(a) EU-27 emission trends and (b) indexed emissions for CO emissions**



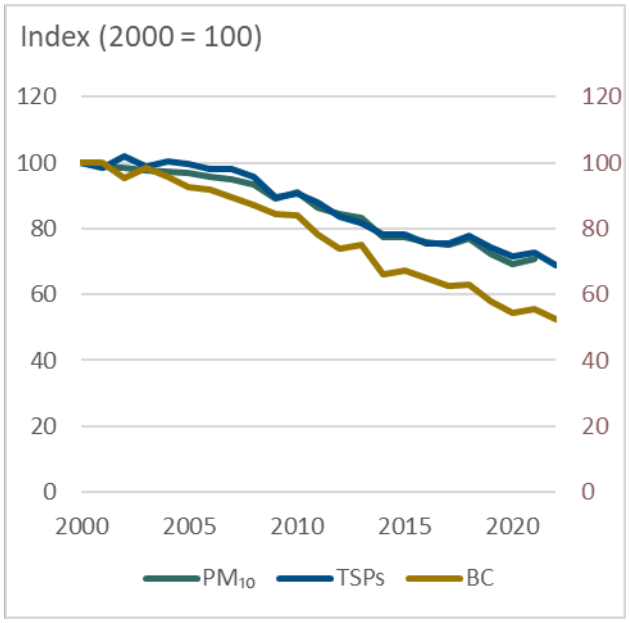
Emissions of TSPs, PM_{10} and BC have also dropped by more than 30% since 2000. Emission data for the period 2005-2022 indicate that TSP and PM_{10} emissions fell by 31% and 32%, respectively. BC emissions dropped by 48% during the same period (Figure 3.3).

Figure 3.3 (a) EU-27 emission trends and (b) indexed emissions for TSP, PM_{10} and BC

(a)



(b)



Notes: Not all countries reported data for BC. Values for indexed BC emissions are given in the secondary y-axis.

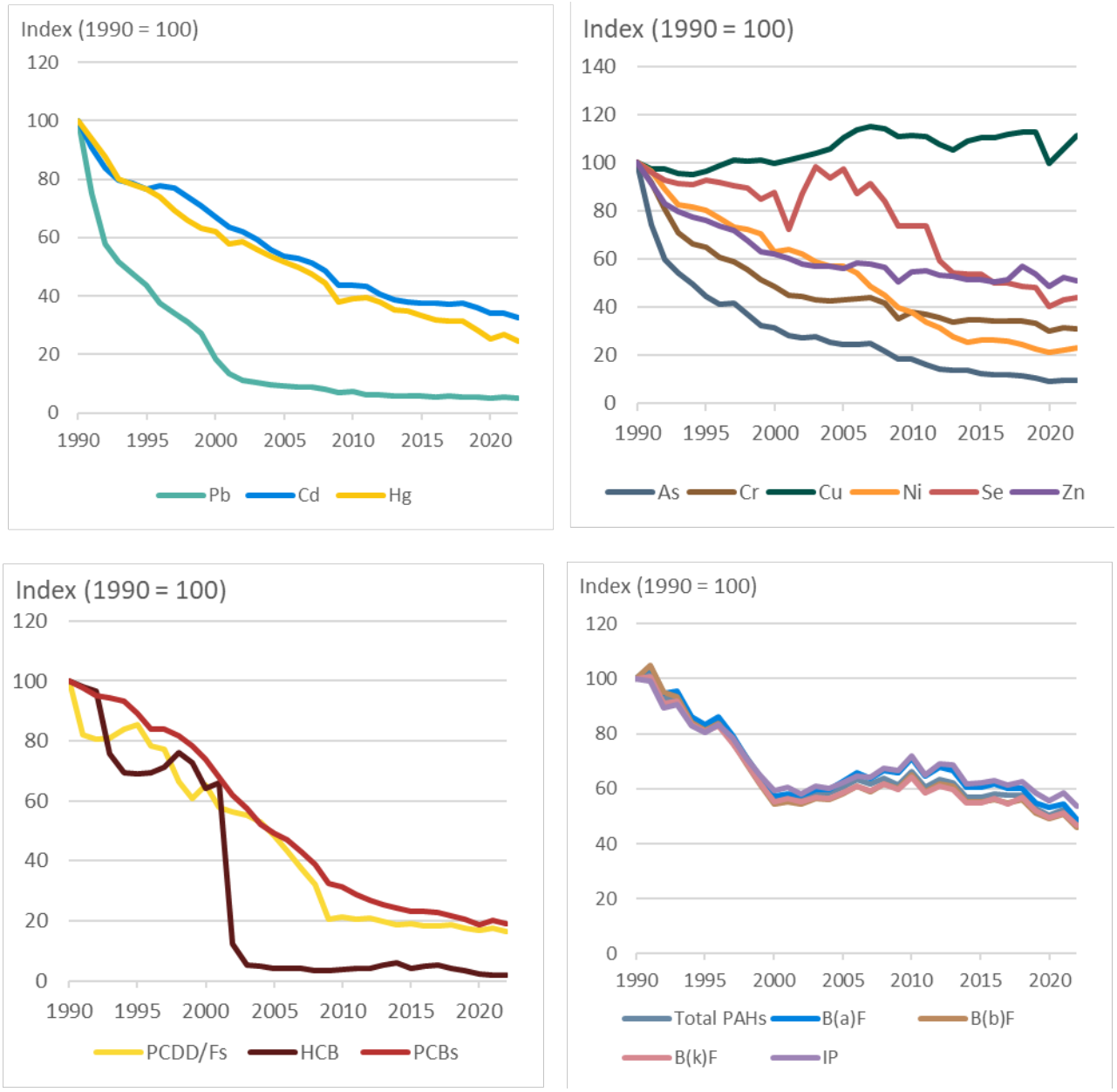
The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Thus, emission trends can be shown for these years only.

The indexed emissions are based on emissions in 2000 (=100%).

In addition, for HMs and POPs, emissions have reduced significantly since 1990 (Figure 3.4), with the only exception of Nickel, which increased by 11%. Reductions are especially high for Pb (-95%) 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 and so they were not included in the EU total. See also Section 1.9 for details on completeness and underestimations.

Figure 3.4 **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.

Table 3.3-Table 3.28 show each Member State's reported emissions. They indicate instances where emissions of a certain pollutant are unrecorded for 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 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	2021	2022	Change 1990—2022	Change 2005—2022	Change 2021—2022
NO_x	Gg	15 102	13 059	11 507	10 710	8 607	8 320	7 980	7 647	7 356	7 229	6 989	6 826	6 607	6 220	5 554	5 596	5 395	-64 %	-50 %	-3.6 %
NMVOCs	Gg	16 414	13 059	10 895	9 417	8 067	7 634	7 474	7 264	6 988	6 964	6 867	6 894	6 770	6 610	6 516	6 483	6 300	-62 %	-33 %	-2.8 %
*NMVOCs **	*Gg*				*8 960*											*6 033*	*6 064*	*5 858*			
SO_x	Gg	21 448	14 305	8 874	7 013	3 591	3 672	3 114	2 655	2 450	2 384	1 991	1 938	1 801	1 561	1 338	1 360	1 303	-94 %	-81 %	-4.2 %
NH_3	Gg	5 065	4 247	4 163	3 906	3 674	3 649	3 640	3 619	3 639	3 667	3 690	3 686	3 641	3 543	3 502	3 429	3 274	-35 %	-16 %	-4.5 %
CO	Gg	57 555	45 957	34 609	28 706	25 446	23 229	22 650	22 444	20 254	20 356	20 053	19 799	19 584	18 593	17 068	17 889	16 599	-71 %	-42 %	-7.2 %
Pb	Mg	20 482	8 949	3 806	1 866	1 522	1 295	1 259	1 228	1 222	1 185	1 138	1 158	1 146	1 115	999	1 085	1 054	-95 %	-43 %	-2.8 %
Cd	Mg	163	125	109	87	71	71	66	63	62	61	61	60	61	59	56	55	53	-67 %	-39 %	-3.9 %
Hg	Mg	146	112	91	76	57	58	55	52	51	49	46	46	46	42	37	39	36	-75 %	-52 %	-7.9 %
As	Mg	575	255	180	140	106	92	83	79	79	71	68	68	65	60	53	56	55	-90 %	-61 %	-0.6 %
Cr	Mg	1 018	658	496	436	386	375	363	341	352	353	349	349	350	336	305	320	316	-69 %	-27 %	-1.2 %
Cu	Mg	2 356	2 276	2 352	2 602	2 625	2 612	2 533	2 481	2 571	2 602	2 598	2 630	2 660	2 652	2 347	2 492	2 618	11 %	1 %	5.1 %
Ni	Mg	1 881	1 505	1 185	1 075	709	635	587	521	475	495	492	482	457	425	397	417	431	-77 %	-60 %	3.4 %
Se	Mg	186	172	162	180	137	137	110	101	100	99	92	93	90	89	75	80	82	-56 %	-55 %	2.6 %
Zn	Mg	6 875	5 216	4 273	3 850	3 770	3 775	3 673	3 616	3 520	3 545	3 477	3 520	3 921	3 699	3 355	3 589	3 487	-49 %	-9 %	-2.8 %
PCDD/Fs	g I-Teq	11 707	10 005	7 662	5 677	2 507	2 414	2 437	2 296	2 169	2 207	2 137	2 133	2 187	2 051	1 971	2 049	1 916	-84 %	-66 %	-6.5 %
B(a)P	Mg	440	367	251	275	313	284	299	293	266	267	272	265	265	241	234	240	215	-51 %	-22 %	-10.2 %
B(b)f	Mg	490	398	268	285	318	288	304	299	270	272	276	269	274	251	242	249	226	-54 %	-21 %	-9.4 %
B(k)f	Mg	235	190	130	138	151	138	144	141	129	129	133	128	134	122	116	121	110	-53 %	-20 %	-8.5 %
IP	Mg	219	177	130	137	157	143	152	150	135	137	138	135	137	128	123	128	118	-46 %	-14 %	-8.3 %
Total PAHs	Mg	1 509	1 242	855	913	1 000	915	956	938	856	861	875	871	868	796	759	792	714	-53 %	-22 %	-9.9 %
HCB	kg	6 044	4 174	3 869	245	228	253	245	315	356	239	302	318	238	208	137	118	108	-98 %	-56 %	-8.5 %
PCBs	kg	6 405	5 713	4 733	3 159	1 996	1 838	1 732	1 615	1 549	1 490	1 476	1 463	1 394	1 317	1 205	1 282	1 230	-81 %	-61 %	-4.0 %
																			Change 2000—2022	Change 2005—2022	Change 2021—2022
TSPs	Gg			4 943	4 918	4 485	4 341	4 134	4 048	3 856	3 856	3 726	3 721	3 850	3 675	3 530	3 596	3 402	-31 %	-31 %	-5.4 %
$PM_{2.5}$	Gg			1 981	1 884	1 828	1 689	1 697	1 681	1 522	1 534	1 506	1 484	1 518	1 416	1 336	1 375	1 281	-35 %	-32 %	-6.8 %
PM_{10}	Gg			2 919	2 830	2 662	2 527	2 461	2 430	2 260	2 259	2 210	2 186	2 253	2 116	2 015	2 068	1 954	-33 %	-31 %	-5.5 %
BC	Gg			347	322	292	271	257	260	229	233	225	217	219	201	188	193	181	-48 %	-44 %	-5.8 %

Notes: * These NMVOC emission data represent the adjusted EU totals.
Negative percentage values indicate that emissions have decreased.
Table 3.1 and Table 3.3-Table 3.28 express changes in emissions between 1990 and 2022 as $100\times(E_{2021}-E_{1990})/E_{1990}$ (%), where E_{2022} and E_{1990} are 2022 and 1990 total emissions, respectively. They express changes in emissions from 2021 to 2022 as $100\times(E_{2022}-E_{2021})/E_{2021}$ (%), where E_{2021} and E_{2022} are the 2021 and 2022 total emissions, respectively.
The bases for the EU inventory shown in Table 3.1 and Table 3.3-Table 3.28 provide 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([19]) 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 reduction commitments

The Gothenburg Protocol to the UNECE Air Convention (UNECE, 1999) and its amendment (UNECE, 2012a) specifies emission reduction commitments for the pollutants NO_X, NMVOCs, SO_X, NH_3 and $PM_{2.5}$. Parties to the protocol must meet them by 2020 and every year thereafter.

The emission reduction commitment for the EU as a whole is the sum of the reduction commitments for the EU Member States ([20]). Table 3.2 sets out the emissions reported for 2022 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 2022 were below the emission reduction commitments.

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

([20]) The reduction commitment levels specified in the amended Gothenburg Protocol annex II for the EU as a whole were based on the EU membership in 2012 (before Croatia's accession and the UK departure); the EU reduction commitment is therefore subject to technical correction when the EU membership changes, cf EB decision 2021/3.

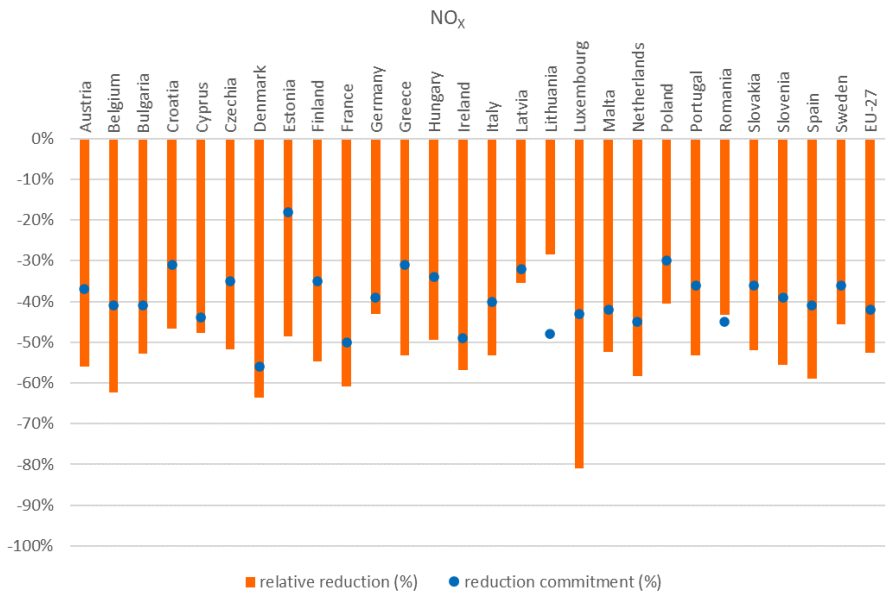
Table 3.2 **Emissions reported for 2022 by the EU-27 compared with the Gothenburg Protocol EU reduction commitments for 2020 and beyond**

Pollutant	EU-27 emissions, 2022 [Gg]	EU-27 emission levels, 2005 [Gg]	Reduction commitment from 2005 level (%)	Current difference (%)
NOx	5,395	10,710	-40	-50
NMVOCs	5,858	8,960	-28	-35
SOx	1,303	7,013	-59	-81
HN_3	3,274	3,906	-6	-16
$PM_{2.5}$	1,281	1,884	-22	-32

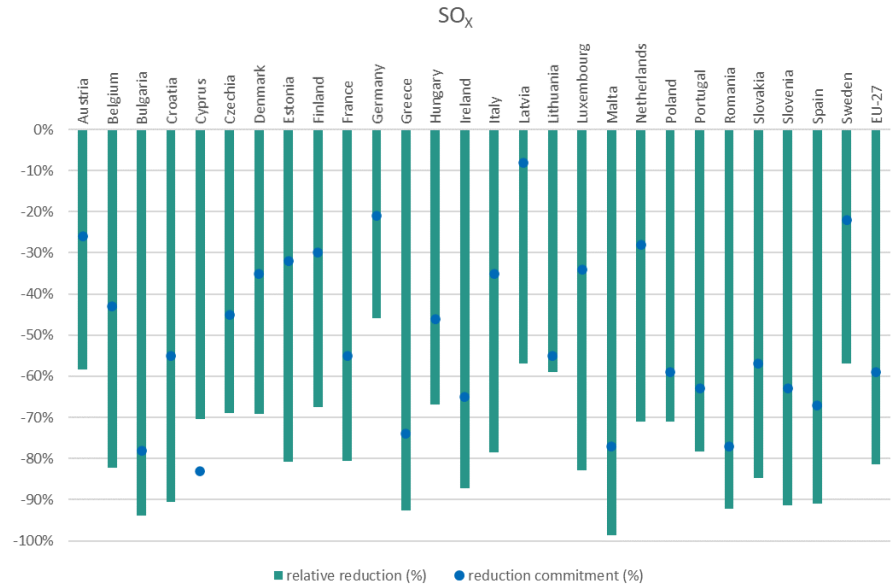
Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands, i.e. data comprise the EMEP domain only.
For Portugal's reduction commitments, emissions from the Azores and Madeira are excluded.
Under the Gothenburg Protocol, the EMEP Steering Body accepted applications from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands and Spain for emission inventory adjustments in 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022. This table takes these adjusted data into account.
Emission reduction commitments are also specified for individual EU Member States.

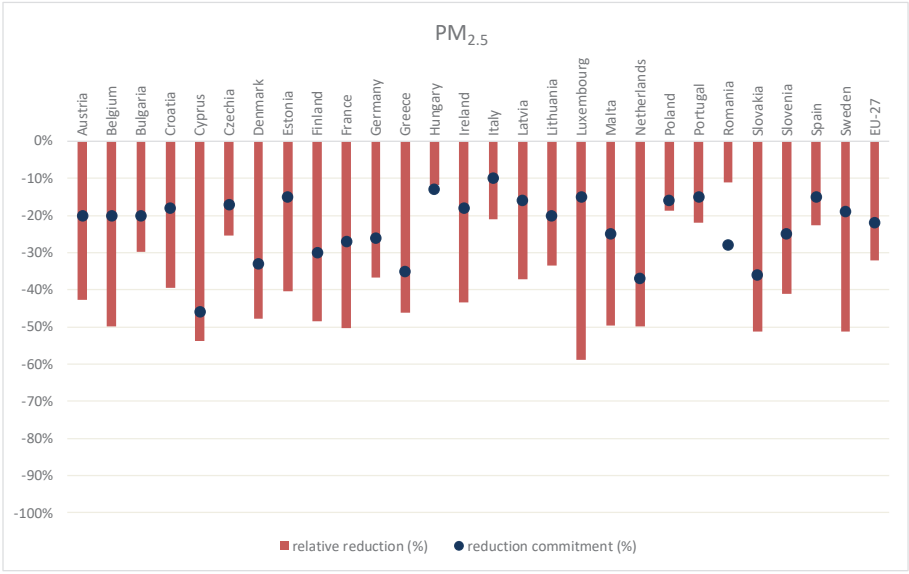
Figure 3.5 shows whether or not EU Member States met the Gothenburg Protocol EU reduction commitments in 2022. Cyprus did not meet the reduction commitment for SO_X emissions. Several Member States ([21]) did not meet their reduction commitment for NO_X emissions (Lithuania and Romania), NH_3 emissions (Austria, Bulgaria, Czechia, Hungary, Ireland, Latvia, Lithuania, Portugal, Sweden), NMVOC emissions (Denmark, Ireland, Lithuania and Portugal) and $PM_{2.5}$ emissions (Hungary, Romania).

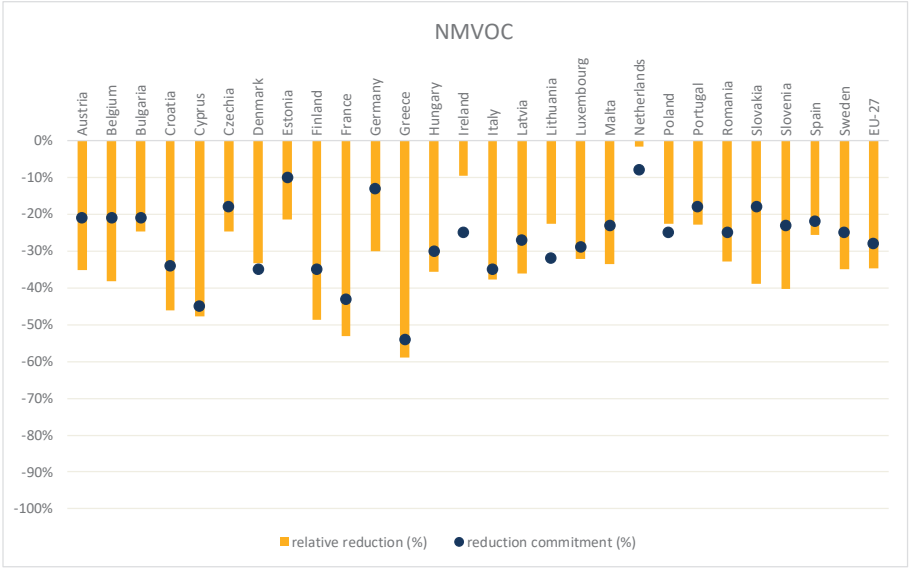
Figure 3.5 **Distance to Gothenburg Protocol reduction commitments for EU Member States in 2022 for all five regulated pollutants**

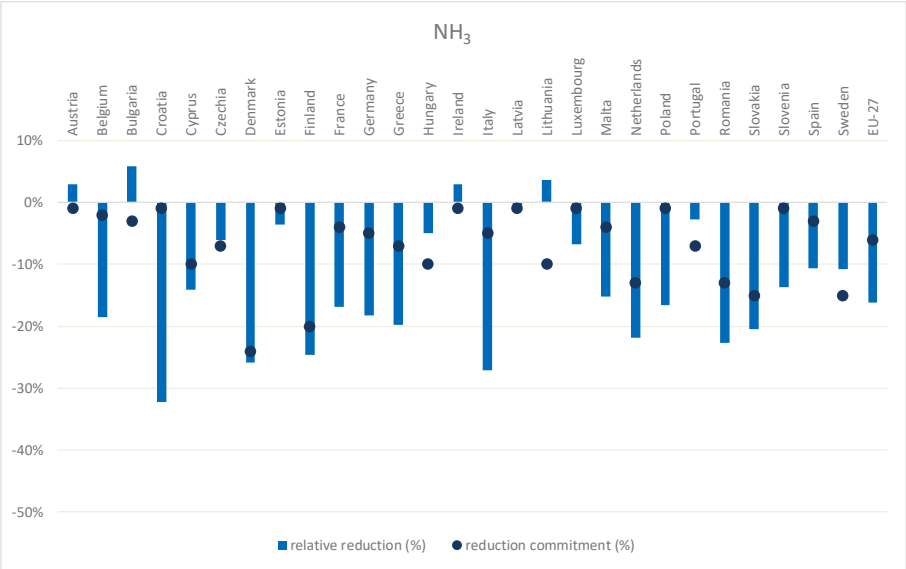


([21]) Austria, Italy and Poland have signed the Gothenburg Protocol but have not ratified it. For this reason, the targets are not binding for these countries.


SOX
Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
EU-27
0%
-10%
-20%
-30%
-40%
-50%
-60%
-70%
-80%
-90%
-100%
relative reduction (%)
reduction commitment (%)


PM2.5
Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
EU-27
0%
-10%
-20%
-30%
-40%
-50%
-60%
-70%
-80%
-90%
-100%
relative reduction (%)
reduction commitment (%)


NMVOC
Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
EU-27
0%
-10%
-20%
-30%
-40%
-50%
-60%
-70%
-80%
-90%
-100%
relative reduction (%)
reduction commitment (%)



Note: Adjustments of NMVOC emissions from Denmark, France and the Netherlands are considered. NOX emissions from soils are not included in the estimates from the member states.

The EEA plans to publish its annual analysis of data reported under the National Emission reduction Commitments Directive (EAA NECD briefing) in June 2024. This report analyses the emission data reported under the EU NEC Directive for EU Member States (EEA, 2023c). The NEC Directive (EU, 2016b) contains national emission reduction commitments for EU Member States for NO_X, NMVOCs, sulphur dioxide (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 2005 and 2022, NO_X emissions dropped by 50% in the EU, and between 2021 and 2022 they decreased by 4%. This recent decrease was mainly caused by Poland, France, Spain and Germany (countries ranked according to the size of their contributions to the absolute change) (Table 3.3).

Table 3.3 Member State contributions to EU emissions of NO_X

Member State	NO_x (Gg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	216	199	213	248	206	184	176	167	155	146	124	123	114	-47 %	-54 %	-7.1 %	1.4 %	2.1 %
Belgium	427	415	362	332	253	204	192	181	173	161	142	144	132	-69 %	-60 %	-8.0 %	2.8 %	2.5 %
Bulgaria	295	193	161	179	131	111	106	94	91	89	83	89	96	-67 %	-46 %	8.3 %	2.0 %	1.8 %
Croatia	103	78	86	84	68	55	54	54	50	49	45	46	46	-56 %	-45 %	-0.5 %	0.7 %	0.8 %
Cyprus	18	21	22	22	19	14	13	13	13	14	12	12	12	-33 %	-45 %	-2.8 %	0.1 %	0.2 %
Czechia	756	387	311	305	258	209	199	195	187	174	159	163	156	-79 %	-49 %	-4.2 %	5.0 %	2.9 %
Denmark	296	285	222	206	152	113	113	111	105	100	92	92	87	-71 %	-58 %	-5.8 %	2.0 %	1.6 %
Estonia	75	48	44	42	42	31	31	32	31	26	23	23	23	-69 %	-45 %	2.9 %	0.5 %	0.4 %
Finland	307	273	241	208	187	139	135	131	127	120	105	104	99	-68 %	-52 %	-4.6 %	2.0 %	1.8 %
France	2,177	1,976	1,816	1,611	1,233	1,022	971	937	885	832	720	744	698	-68 %	-57 %	-6.3 %	14.4 %	12.9 %
Germany	2,842	2,167	1,866	1,599	1,456	1,375	1,335	1,278	1,207	1,117	983	965	942	-67 %	-41 %	-2.4 %	18.8 %	17.5 %
Greece	410	403	431	484	366	262	264	269	261	253	225	223	233	-43 %	-52 %	4.6 %	2.7 %	4.3 %
Hungary	244	191	189	180	148	128	121	122	121	115	108	110	101	-59 %	-44 %	-7.9 %	1.6 %	1.9 %
Ireland	167	169	180	174	120	112	112	110	112	103	95	99	94	-44 %	-46 %	-4.2 %	1.1 %	1.8 %
Italy	2,125	1,988	1,516	1,291	952	745	730	681	683	667	596	608	620	-71 %	-52 %	2.0 %	14.1 %	11.5 %
Latvia	99	53	44	47	42	38	36	37	38	36	33	34	33	-67 %	-30 %	-3.0 %	0.7 %	0.6 %
Lithuania	153	74	62	64	57	58	57	56	57	56	54	53	49	-68 %	-22 %	-6.0 %	1.0 %	0.9 %
Luxembourg	41	35	42	57	39	29	26	23	21	19	15	14	11	-72 %	-80 %	-17.7 %	0.3 %	0.2 %
Malta	7	8	8	10	9	6	5	5	5	5	4	4	5	-35 %	-51 %	7.2 %	0.0 %	0.1 %
Netherlands	681	581	494	431	343	273	262	254	252	240	212	206	195	-71 %	-55 %	-5.7 %	4.5 %	3.6 %
Poland	1,117	1,078	855	846	832	667	670	700	678	631	592	577	529	-53 %	-37 %	-8.4 %	7.4 %	9.8 %
Portugal	260	298	300	284	205	170	162	165	160	155	135	136	136	-48 %	-52 %	-0.1 %	1.7 %	2.5 %
Romania	471	374	315	333	248	222	212	221	223	219	206	214	203	-57 %	-39 %	-5.3 %	3.1 %	3.8 %
Slovakia	137	113	111	107	88	68	64	64	63	59	56	59	55	-60 %	-49 %	-7.3 %	0.9 %	1.0 %
Slovenia	75	75	59	55	48	35	35	34	33	29	25	26	26	-66 %	-54 %	-0.8 %	0.5 %	0.5 %
Spain	1,312	1,321	1,335	1,321	936	812	761	754	743	679	593	612	588	-55 %	-55 %	-3.9 %	8.7 %	10.9 %
Sweden	289	258	222	193	170	147	144	139	134	125	117	115	111	-62 %	-42 %	-3.3 %	1.9 %	2.1 %
EU27 (a)	**15,102**	**13,059**	**11,507**	**10,710**	**8,607**	**7,229**	**6,989**	**6,825**	**6,607**	**6,220**	**5,554**	**5,596**	**5,395**	**-64%**	**-50%**	**-3.6%**	**100%**	**100%**
EU27 (b)	15,102	13,059	11,507	10,710	8,607	7,229	6,826	6,826	6,607	6,220	5,554	5,596	5,395					

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 NO_X emission trends (2005-2022) of the EU were largely determined by emissions from Germany, France, Spain, Italy and Poland (see Figure 3.6). NO_X 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 harmonised application of Euro emission standards in the road transport sector which led to the introduction of improved exhaust emission controls and abatement technologies and fuel/technology 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 (77% and 54%, respectively) between 1990 and 2022. Between 2005 and 2002, NO_x emissions from road transport decreased by 60% and from public electricity and heat production by 14%.This is due to constantly improving fuels mainly due to the harmonised application of Euro emission standards in the road transport sector which led to the introduction of improved exhaust emission controls (see Germany's IIR, listed in Appendix 5).

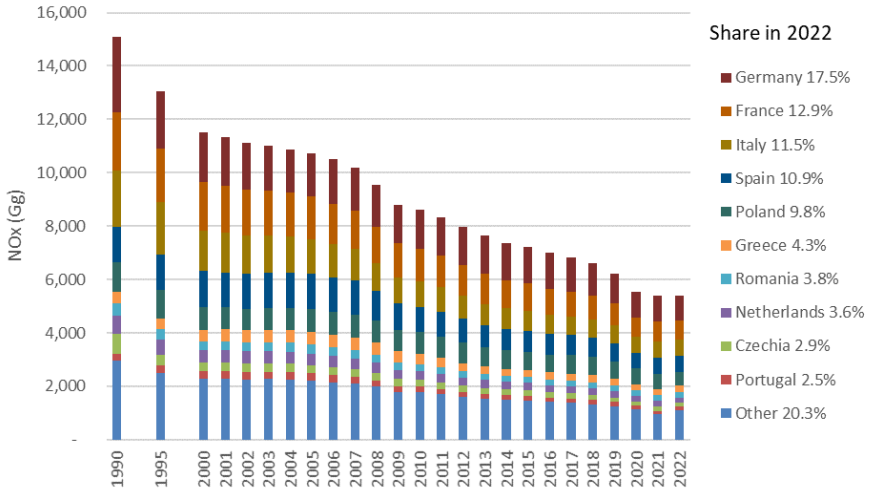
In **France**, road transport is the highest contributor to total NO_X emissions having a share of 44% in 2022. Between 2005 and 2022, these emissions decreased by 61%. Considerable NO_X emissions also arise in agriculture from biological processes of nitrification and denitrification in the soil following the addition of inorganic nitrogen fertilisers (including urea application) with a share of 10% in 2022, and from urine and dung deposited by grazing animals (share of 5% in 2022). The decrease in NO_X emissions between 1990 and 2022 of 68% is caused by (1) the implementation of primary and secondary treatment systems to eliminate NO_X in industry and in combustion facilities, (2) due to the harmonised application of Euro emission standards in the road transport sector which led to the introduction of improved exhaust emission controls, (3) structural changes in the energy mix (nuclear power programme and development of renewable energies) and (4) better energy performance of industrial facilities (see France's IIR, listed in Appendix 5).

In **Italy**, in 2022, 41% of NO_X emission are caused by road transport. Between 1990 and 2022, a decrease of 75% was reported, mainly due to the harmonised application of Euro emission standards in the road transport sector which led to the introduction of improved exhaust emission controls. NOx emissions from national navigation have a share of 16% in 2022, and have been increasing since 2005 by 5%. In recent years, decreasing NO_x emissions trends from energy and industry sectors are due to the conversion to the use of natural gas to replace fuel oil has intensified, thanks to incentives granted for the improvement of energy efficiency. Furthermore, a significant reduction in the use of coal fuels for energy production has been recorded in the last years. These measures, together with those of promoting renewable energy and energy saving, have led to a further reduction of emissions in the sector. In addition, in the last years, more stringent emission limits to the new plants have been established during the authorization process with the aim to prevent air quality issues at local level.

In **Spain**, NO_X emissions are mostly attributed to fuel combustion in road transport (share of 36% in 2022). Open burning of waste is also an important emission source, contributing with 10% to NOx total in 2022, these emissions saw an increase of 7% since 2005. Stationary combustion from non-metallic mineral manufacturing (1A2f)contributes with 8% and public electricity and heat production (1A1a) with 6%. Both emissions sources decreased substantially during 2005-2022, 55% and 89% respectively. Emissions from inorganic fertiliser application have a share of 7% and increasedsince 2005 by 11%. The reduction in the energy sector 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 in NO_X emissions for road transport (54% since 2005) due to the harmonised application of Euro emission standards in the road transport sector which led to the introduction of improved exhaust emission controls. The reduction in NO_X emissions in the industry sector (1A2) is mainly the result of the 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 (share of 31% in 2022) and electricity and heat production (share of 20% in 2022), and also from stationary combustion in buildings (share of 14% in 2022). These main contributing emission sources decreased since 1990 and also since 2005., Since the late 1990s, the largest source of NO_x emissions has been the combustion of fuels in road transport, from which emissions have been steadily increasing until 2017. This is mainly due to increase in the number of vehicles by 219% since 1990. The decrease in NO_x emissions from 2017 is caused by the increasing share of vehicles with the latest Euro quality standards. Decrease in NO_x emissions from public electricity and heat production is a result of the improvement of plants technical parameters to meet more stringent standards resulting from Poland's accession to the EU. (see Poland's IIR, listed in Appendix 5).

Figure 3.6 NO_X emission trends in the EU and shares of Member States



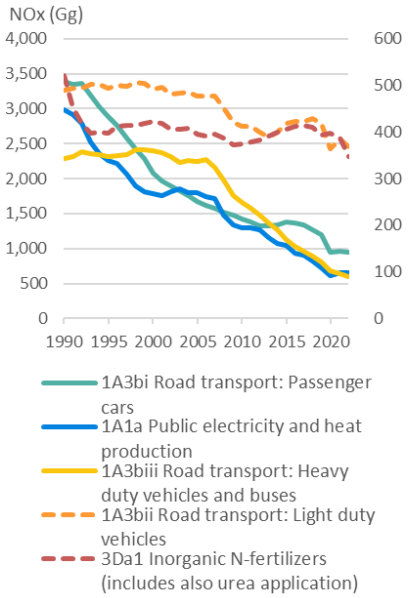
Notes: Countries are sorted by their contribution to the EU total for the last year. The top 10 countries are displayed. Data for the other 17 reporting countries are summed under 'Other'.

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 40% of total emissions (see Figure 3.7). The highest relative reduction in NO_X emissions between 1990 and 2022 occurred in 'Public electricity and heat production' (77.9%) (see Figure 3.7(a)). Significant reductions were also reported for NO_X emissions from heavy duty vehicles and buses (74.2%) and from passenger cars (72.2%). Emissions from light duty vehicles decreased by only 24.9% between 1990 and 2022.

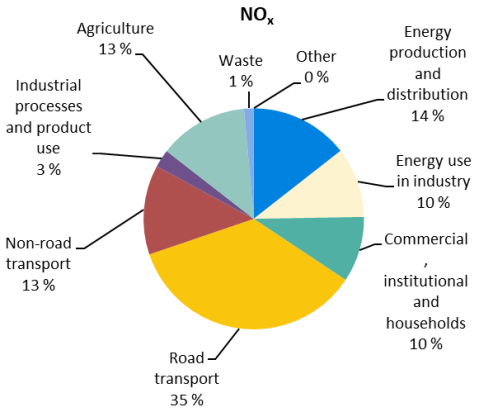
Figure 3.7(b) shows the contribution made by each aggregated sector group to total EU emissions. For NO_X, common key emission sources are the energy and transport sectors. Emission reductions from the road transport sector are primarily due to the harmonised application of Euro emission standards in the road transport sector which led to the introduction of improved exhaust emission controls (EEA, 2023a). Nevertheless, the road transport sector represents the largest source of NO_X emissions, accounting for 35% of total EU emissions in 2022. 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 and selective non-catalytic reduction techniques) and switching from coal to gas.

Figure 3.7 **NO_X emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

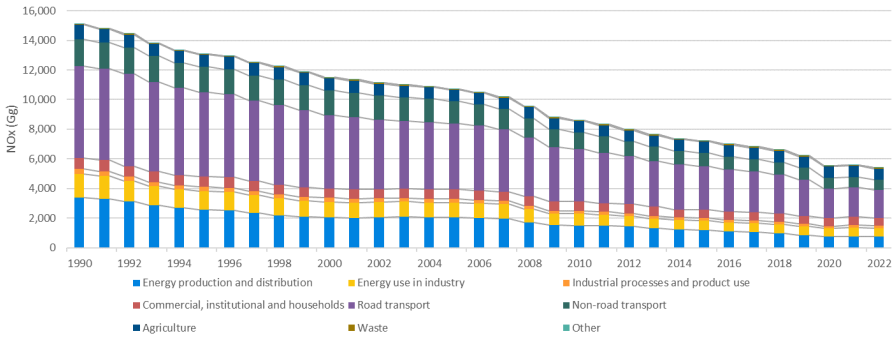
(a)



(b)



(c)



Note: In (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 2005 and 2022, NMVOC emissions dropped by 33% in the EU, and between 2021 and 2022 they dropped by 2.8% (Table 3.4). This recent decrease was due to lower emissions in Poland, Italy and Czechia (countries ranked according to the size of their contributions to the absolute change).

Table 3.4 Member State contributions to EU emissions of NMVOCs

	NMVOCs (Gg)													Change			Share in EU-27	
Member State	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	329	244	177	154	135	112	110	111	107	107	108	108	100	-70 %	-35 %	-7.4 %	2.0 %	1.6 %
Belgium	385	344	264	211	173	146	142	139	137	136	140	139	131	-66 %	-38 %	-6.2 %	2.3 %	2.1 %
Bulgaria	450	144	104	101	82	83	81	81	75	74	73	74	76	-83 %	-25 %	3.1 %	2.7 %	1.2 %
Croatia	174	112	104	113	91	71	72	69	69	74	69	68	61	-65 %	-46 %	-9.5 %	1.1 %	1.0 %
Cyprus	14	14	13	14	12	8	9	9	8	8	9	8	7	-49 %	-48 %	-10.9 %	0.1 %	0.1 %
Czechia	835	601	445	379	375	356	348	344	335	316	304	303	286	-66 %	-25 %	-5.5 %	5.1 %	4.5 %
Denmark	219	220	191	161	137	119	115	113	112	106	109	109	118	-46 %	-26 %	8.7 %	1.3 %	1.9 %
*Adjusted data**				*141*							*85*	*85*	*94*					
Estonia	64	41	36	34	25	24	24	25	25	25	25	27	26	-59 %	-21 %	-2.5 %	0.4 %	0.4 %
Finland	234	204	178	147	113	91	91	89	87	85	85	83	75	-68 %	-49 %	-9.0 %	1.4 %	1.2 %
France	2,920	2,511	2,149	1,794	1,457	1,204	1,196	1,193	*1,153*	*1,121*	1,080	1,077	1,065	-64 %	-41 %	-1.0 %	17.8 %	16.9 %
*Adjusted data**				*1,381*							*664*	*683*	*648*					
Germany	3,929	2,346	1,798	1,477	1,360	1,134	1,126	1,128	1,082	1,054	1,022	1,043	1,035	-74 %	-30 %	-0.8 %	23.9 %	16.4 %
Greece	319	306	312	337	218	167	158	154	149	148	141	140	138	-57 %	-59 %	-1.1 %	1.9 %	2.2 %
Hungary	314	227	202	183	142	135	134	131	125	123	122	121	118	-62 %	-36 %	-2.3 %	1.9 %	1.9 %
Ireland	157	145	127	123	114	111	112	115	115	114	111	112	111	-29 %	-10 %	-1.0 %	1.0 %	1.8 %
Italy	1,970	2,040	1,616	1,322	1,100	891	868	907	879	871	815	847	823	-58 %	-38 %	-2.8 %	12.0 %	13.1 %
Latvia	85	62	53	50	39	35	33	34	38	35	34	36	32	-63 %	-36 %	-11.1 %	0.5 %	0.5 %
Lithuania	117	75	49	61	53	51	50	50	50	50	47	49	47	-60 %	-23 %	-4.1 %	0.7 %	0.7 %
Luxembourg	31	21	16	15	12	9	10	10	*10*	*10*	9	10	10	-68 %	-32 %	-1.7 %	0.2 %	0.2 %
Malta	5	6	5	4	3	3	3	3	3	2	2	3	3	-45 %	-33 %	2.2 %	0.0 %	0.0 %
Netherlands	606	436	337	270	274	258	257	258	252	247	250	244	242	-60 %	-10 %	-1.0 %	3.7 %	3.8 %
*Adjusted data**				*246*							*206*							
Poland	841	944	828	787	759	691	689	686	719	685	713	675	610	-28 %	-23 %	-9.6 %	5.1 %	9.7 %
Portugal	269	256	260	209	171	164	156	157	161	163	162	159	161	-40 %	-23 %	1.1 %	1.6 %	2.6 %
Romania	433	332	323	350	287	257	245	247	241	245	254	251	235	-46 %	-33 %	-6.3 %	2.6 %	3.7 %
Slovakia	246	161	136	135	111	99	98	96	88	85	83	83	82	-67 %	-39 %	-0.1 %	1.5 %	1.3 %
Slovenia	65	63	55	48	39	32	33	32	31	31	32	31	29	-56 %	-40 %	-6.9 %	0.4 %	0.5 %
Spain	1,034	926	893	734	607	556	555	571	*580*	*555*	579	551	545	-47 %	-26 %	-1.1 %	6.3 %	8.6 %
Sweden	367	277	222	204	177	157	150	143	*139*	*139*	138	134	132	-64 %	-35 %	-1.1 %	2.2 %	2.1 %
EU27 (a)	**16,414**	**13,059**	**10,895**	**9,417**	**8,067**	**6,964**	**6,867**	**6,894**	**6,770**	**6,610**	**6,516**	**6,483**	**6,300**	**-62%**	**-33%**	**-2.8%**	**100%**	**100%**
EU27 (b)	16,414	13,059	10,895	9,417	8,067	6,964	6,867	6,894	6,770	6,610	6,516	6,483	6,300					
EU27 (c)	16,414	13,059	10,895	8,960	8,067	6,964	6,867	6,894	6,770	6,610	6,033	6,064	5,858					

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 Denmark, France and the Netherlands.

The NMVOC emission trends of the EU were largely determined by emissions from France, Germany, Italy, Poland and Spain (see Figure 3.8). In general, NMVOC emissions in 1990 were caused by emission sources different from those in recent years. In 1990, NMVOC emissions from road transport were most important; however, on account of the introduction of Euro emission standards and renewal of the fleets, these emissions decreased significantly. Nowadays, the emission trend is dominated by NMVOC emissions from solvent use, agriculture and residential heating.

In **France**, the major contributing sectors in 2022 were agriculture from manure management (silage storage) (share of 16%) but also from cultivating crops – specifically the biological functioning of crops (emissions attracting pollinating insects, for example) (share of 16%). Domestic solvent use including fungicides contribute with 17% to total NMVOC emissions and the residential sector with 14%..In 1990, the main emission sources were residential heating (1A4b), road transport (1A3b) and coating applications (2D3d). The decrease in NMVOC emissions of 96% between 1990 and 2022 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 increased share of diesel vehicles, which emit less volatile organic compounds (VOCs). NMVOC emissions from biomass combustion in households (1A4b) decreased by 71% as a result of the renewal of installations with more efficient and less emitting appliances. The general slowdown in the decline in emissions observed from 2010 can be explained in particular by the fact that most regulations have reached a high level of penetration in transport, industry and the residential/tertiary sector in particular. In connection with the Covid-19 pandemic, NMVOC emissions in 2020 and 2021 are higher than in 2019 for the Industrial Processes sector. This is due to increased consumption of hydroalcoholic gel for hand disinfection. (see France's IIR, listed in Appendix 5).

In **Germany**, in 2022, 27% of total NMVOC emissions arise from the agriculture sector from manure management, these emissions experience a decrease of 22% between 2005 and 2022. NMVOC emissions resulting from coating applications includes the use of paints within the industrial and domestic sector have a share of 19%, but decreased by 37% since 1990. Also NMVOC emissions from road transport decreased since 1990 by 60%, and having now a share of 8%. Total NMVOC emissions decreased in Germany by 74% since 1990, mainly due to reduced emissions from the road transport sector (-95%), due to increasingly stricter Euro emission standards, especially incentives for car users to retrofit or buy cars with catalytic converters, and the implementation of the Technical Instructions on Air Quality Control (TA-Luft 2002). Furthermore, decreases of emissions from petrol storage and from fuelling of petrol vehicles (1B2av) by better evaporative controls 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 due to increased share of diesel vehicles has also played a major role with regard to the reduction in NMVOC emissions (see Germany's IIR, listed in Appendix 5).

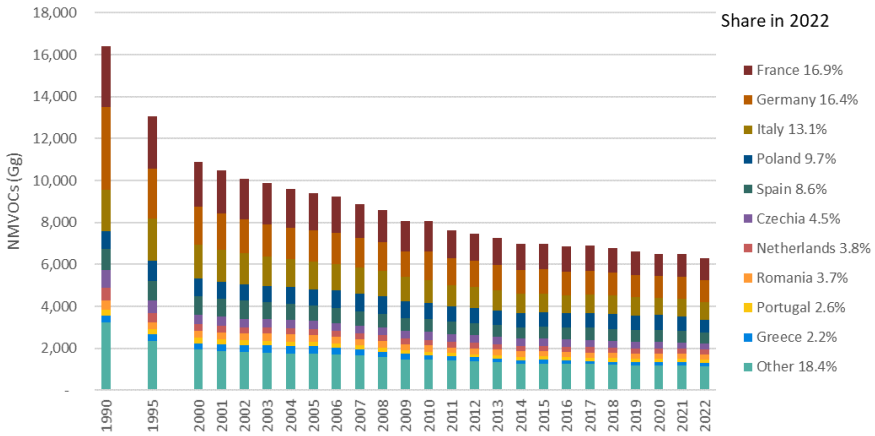
In **Italy**, solvent and other product use cause 45% of NMVOC emissions in 2022, mainly from coating applications and domestic solvent use including fungicides. Between 2005 and 2022, these emissions decreased by 29%. In the residential sector, the solvent use contributes with 17% to total emissions, and emissions related to manure management in the agriculture sector with 12%. Significant reductions of solvent emissions occurred in the 1990s as a result of the introduction of paints with low solvent contents to the market, and the reduction of 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 machines with closed-loop machines, 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. Total NMVOC emissions decreased by 38% between 2005 and 2022 (see Italy's IIR, listed in Appendix 5).

NMVOC emissions from **Poland** decreased by 23% between 2005 and 2022. The largest share (30% in 2022) of total NMOVC emissions is related to industrial processes and solvent use, whereby the domestic use of solvent is most relevant. Fuel combustion in households also contributes with 21% to total emissions, and 18% are caused by manure management in the agriculture sector. The road transport saw significant reductions (64% between 2005 and 2022) and now only has a share of 4%. A relevant emission source are also fugitive emissions from coal mining and handling (1B1a, 9% share). Large increases (+50%) of NMVOC emission have been observed from solvent use (2D) during 1990 and 2022, but since 2005 a decrease of 30% has been noted.The same can be observed for NMVOC emissions from fuel combustion in households. (see Poland's IIR, listed in Appendix 5).

In **Spain**, NMVOC emissions in 2022 declined by 26% compared with 2005, and 47/ compare with 1990. The decrease is mainly related to reductions in Road Transport emissions (-95.5 %), secondarily to the drop of emissions under Solvents use (-35%) and, to a lesser extent, to agriculture activities related to manure management (-50.8 %). The introduction of the EURO standards for road vehicles since 1996, and to the shift towards a diesel predominant car fleet in Spain contributed to decreasing emissions from road transport. Decreasing emissions from solvent use are a result of different regulations on paintings and painting installations (Royal Decree 117/2003 and Royal Decree 227/2006, transposition of Directives 1999/13 and 2004/42, respectively), that lead to a fall of emissions under Coating applications (2D3d). Also the economic downturn had a noticeable effect on the contraction of the activity data (consumption of paintings). The decrease slowed by 2013, and from then a slighter decreasing slope is observed, with minor fluctuations.

Fugitive NMVOC from oil use dropped by -42.4 % between 1990 and 2022. The reduction of 79% of NMVOC emissions from Distribution of oil products (1B2av), is due to the entry into force since 2000 of regulations relating to tanks, distribution of gasoline and gas recovery, together with a drop in gasoline consumption, (see Spain's IIR, listed in Appendix 5).

Figure 3.8 NMVOC emission trends in the EU and shares of Member States



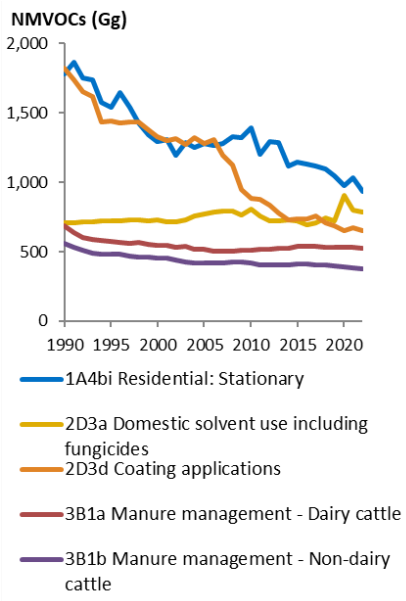
Notes: Countries are sorted by their contribution to the EU total for the last year. The top 10 countries are displayed. Data for the other 17 reporting countries are summed under 'Other'.

The most important key categories for NMVOC emissions were residential heating (1A4bi), domestic solvent use including fungicides (2D3a) and coating applications (2D3d). Together, they made up 38% of total emissions (Figure 3.9 (a)). Among the top five key categories, the highest relative reduction (-64%) in emissions between 1990 and 2022 is reported for coating applications (2D3d) and -49% between 2005 and 2022 (64%).

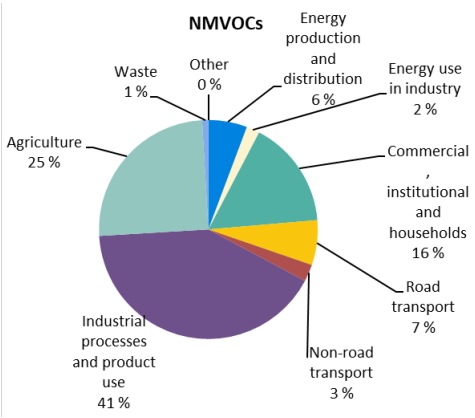
Figure 3.9(b) shows the contribution made by each aggregated sector group to total EU emissions. The main emission source of NMVOCs is industrial processes and product use (41%), followed by agriculture (25%), commercial, institutional and households (16%), road transport (7%) and energy production and distribution (6%).

Figure 3.9 **NMVOC emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

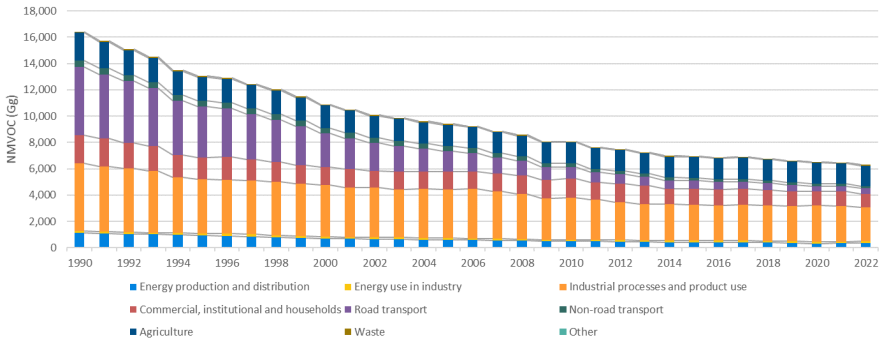
(a)



(b)



(c)



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

3.4 Sulphur oxide emission trends and key categories

Between 2005 and 2022, SO_X emissions dropped by 81% in the EU, and by 4.2% between 2021 and 2022 (see Table 3.5). This recent decrease is due to reduced emissions in Poland, Romania and France (countries ranked according to the size of their contributions to the absolute change).

Table 3.5 Member State contributions to EU emissions of SO_X

Member State	SO_x (Gg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	74	47	32	26	16	14	13	13	12	11	10	11	11	-85 %	-58 %	-0.9 %	0.3 %	0.8 %
Belgium	365	258	171	140	60	41	34	33	32	30	24	24	25	-93 %	-82 %	5.5 %	1.7 %	1.9 %
Bulgaria	1,438	1,693	1,097	940	305	114	74	68	55	50	41	44	58	-96 %	-94 %	32.3 %	6.7 %	4.5 %
Croatia	170	77	60	59	35	16	15	13	10	8	6	6	6	-97 %	-91 %	-2.0 %	0.8 %	0.4 %
Cyprus	32	40	47	38	22	13	16	16	17	16	12	10	11	-65 %	-70 %	12.5 %	0.1 %	0.9 %
Czechia	1,754	1,059	234	208	164	130	116	110	97	79	67	61	65	-96 %	-69 %	5.2 %	8.2 %	5.0 %
Denmark	178	145	32	26	15	9	9	10	10	9	9	8	8	-95 %	-69 %	2.2 %	0.8 %	0.6 %
Estonia	279	117	97	77	83	36	35	39	31	19	11	12	15	-95 %	-81 %	24.9 %	1.3 %	1.1 %
Finland	249	105	82	70	66	41	40	35	33	30	23	23	23	-91 %	-67 %	-1.8 %	1.2 %	1.7 %
France	1,293	937	616	457	271	150	134	129	122	101	91	102	89	-93 %	-81 %	-13.2 %	6.0 %	6.8 %
Germany	5,460	1,743	643	472	396	336	310	300	289	259	242	250	255	-95 %	-46 %	2.0 %	25.5 %	19.6 %
Greece	512	522	558	585	233	102	81	90	86	80	49	47	44	-91 %	-93 %	-6.5 %	2.4 %	3.4 %
Hungary	832	615	427	42	30	24	23	28	23	18	17	14	14	-98 %	-67 %	-0.1 %	3.9 %	1.1 %
Ireland	184	163	145	74	27	17	16	15	14	11	11	13	9	-95 %	-87 %	-26.9 %	0.9 %	0.7 %
Italy	1,784	1,322	756	411	222	127	123	119	113	112	85	79	88	-95 %	-79 %	11.4 %	8.3 %	6.8 %
Latvia	100	49	18	9	4	4	3	4	4	4	4	4	4	-96 %	-57 %	3.4 %	0.5 %	0.3 %
Lithuania	199	76	39	27	18	15	15	13	13	12	11	11	11	-94 %	-59 %	1.8 %	0.9 %	0.9 %
Luxembourg	16	9	4	3	2	1	1	1	1	1	1	1	0	-97 %	-83 %	-40.6 %	0.1 %	0.0 %
Malta	13	11	9	12	8	2	2	1	0	0	0	0	0	-99 %	-99 %	11.1 %	0.1 %	0.0 %
Netherlands	198	136	79	68	36	31	29	27	25	23	20	21	20	-90 %	-71 %	-6.1 %	0.9 %	1.5 %
Poland	2,687	2,079	1,298	1,107	806	616	492	479	455	372	360	366	320	-88 %	-71 %	-12.6 %	12.5 %	24.6 %
Portugal	318	322	294	189	62	45	45	46	45	44	38	39	41	-87 %	-78 %	4.8 %	1.5 %	3.2 %
Romania	819	696	492	604	355	149	98	78	71	86	61	66	47	-94 %	-92 %	-29.8 %	3.8 %	3.6 %
Slovakia	141	122	119	88	69	68	28	29	22	17	15	16	13	-91 %	-85 %	-14.7 %	0.7 %	1.0 %
Slovenia	203	125	93	40	10	6	5	5	5	4	4	4	3	-98 %	-91 %	-16.8 %	0.9 %	0.3 %
Spain	2,049	1,767	1,388	1,207	245	260	217	220	199	151	113	113	109	-95 %	-91 %	-4.3 %	9.6 %	8.3 %
Sweden	102	71	44	34	28	17	17	17	17	16	15	15	15	-86 %	-57 %	-4.5 %	0.5 %	1.1 %
EU27 (a)	**21,448**	**14,305**	**8,874**	**7,013**	**3,591**	**2,384**	**1,991**	**1,938**	**1,801**	**1,561**	**1,338**	**1,360**	**1,303**	**-94%**	**-81%**	**-4.2%**	**100%**	**100%**
EU27 (b)	21,448	14,305	8,874	7,013	3,591	2,384	1,991	1,938	1,801	1,561	1,338	1,360	1,303					

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 SO_X emission trend in the EU was largely determined by emissions from Poland (share of 24.6% in 2022), Germany (19.6% in 2022) and Spain (8.3% in 2022) (see Figure 3.10). SO_X 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 the more stringent standards of the Industrial Emissions Directive. In recent years, the shift from the use of fossil fuels to renewable energy sources has also contributed to lower SO_X emissions.

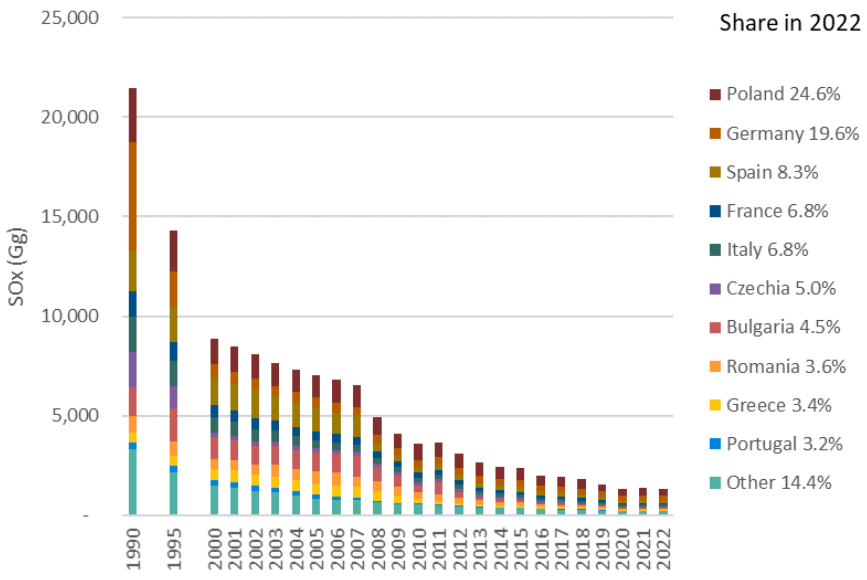
In **Poland**, the main emissions source is public electricity and heat production (1A1a) with a share of 38% in 2022; emissions in this category have decreased by 84% since 2005. The most significant decreases were noted in combustion processes in the 1A1. *Energy industries*. It was the result of the improvement of plants technical parameters to meet more stringent standards resulting from Poland's accession to the EU, for example the 2001/80/EC Directive and the 2010/75/UE Directive (IED). Plant operators also gradually took steps to adjust (until August 16, 2021) large combustion plants to meet the requirements established in the best available techniques (BAT) conclusions. Fuel combustion in the residential sector contributed with 34% to total SO_x emission in 2022, and saw a decrease of 24% between 2005 and 2022, mainly due to reduced fuel use. (see Poland's IIR, listed in Appendix 5).

In **Germany**, SO_X emissions have decreased by 46% since 2005. The main emission sources are stationary combustion for public electricity and heat production (1A1a) with a share of 40% in 2022, petroleum refining (1A1b) with a share of 13%, manufacturing industries and construction (1A2) with a share of 12% and commercial and residential heating (1A4a and 1A4b) with a share of 4%. All of these sub-categories show a reduction >95 per cent between 1990 and 2022, due to stricter regulations of West Germany that applied to the New German Länder after the German Reunification and changed the fuel mix from sulphur-rich solid fuels to liquid and gaseous fuels. (see Germany's IIR, listed in Appendix 5).

Spain reported a SO_X emissions reduction of 91% between 2005 and 2022, which can be mainly attributed to the reductions achieved in public electricity and heat production (1A1a). 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. In 2022, the main emission sources are from stationary combustion in the manufacturing industries and construction of non-metallic minerals (share of 19%) and fugitive emissions from oil refining and storage (18% share). 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**, SO_X emissions saw a decrease of 81% between 2005 and 2022. The largest reductions occurred in public electricity and heat production (1A1a) with a share of 10% in 2022 and petroleum refining with a share o 3%, reflecting the reduction in sulphur content of fossil fuels and abatement technologies. In recent years, the increased importance of renewable energy has also become visible. The highest Sox emissions are a result of stationary combustion in manufacturing industries (1A2), having a share of 50% in 2022. But also these emissions decreased since 2005 by 63% mainly due to the continued implementation of regulations aimed at tightening the emission limit values for industrial installations within the framework of the industrial emissions directive. (directive 2010/75/EU relating to industrial emissions, known as IED) as well as the emission limit values of other combustion installations, in particular between 1MW and 50 MW within the framework of the French decrees on combustion. Fuel combustion in the residential sector contributes with 10% to total Sox emissions and has also decreased by 76% since 2005. Fluctuations in SO_X emissions are also a result of climatic conditions (e.g. warm winters) and changes in energy transformations (nuclear power, fossil fuels, renewables) (see France's IIR, listed in Appendix 5).

Figure 3.10 **SO_X emission trends in the EU and shares of Member States**



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

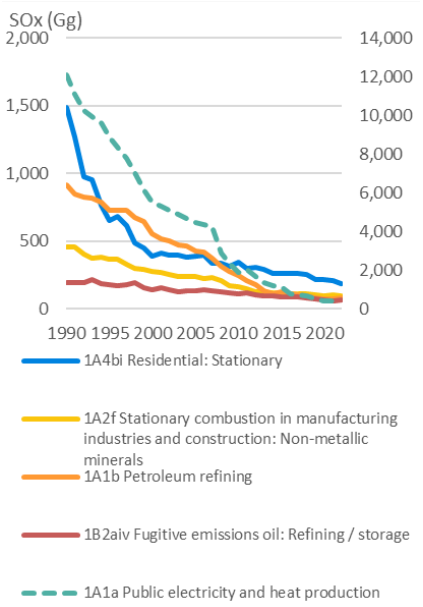
Category '1A1a — Public electricity and heat production' is the most significant key category for SO_X emissions, making up 32% of total SO_X emissions (Figure 3.11(a)). Among the top five key categories, the highest relative reductions in emissions between 2005 and 2022 were achieved in '1A1a — Public electricity and heat production' (91%) and '1A1b — Petroleum refining' (81%). The other three categories of the top five key categories also saw decreases higher than 50%.

Since 1990, several measures have been combined to reduce emissions from these main emitting sources, including 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 (EU, 1999a).

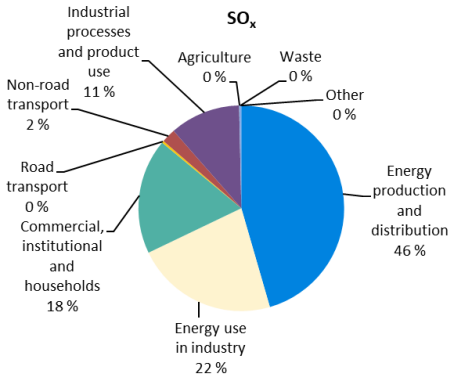
Figure 3.11(b) shows the contribution made by each aggregated sector group to total EU emissions. For SO_X, the common main emission sources are the energy sectors.

Figure 3.11 **SO_X emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

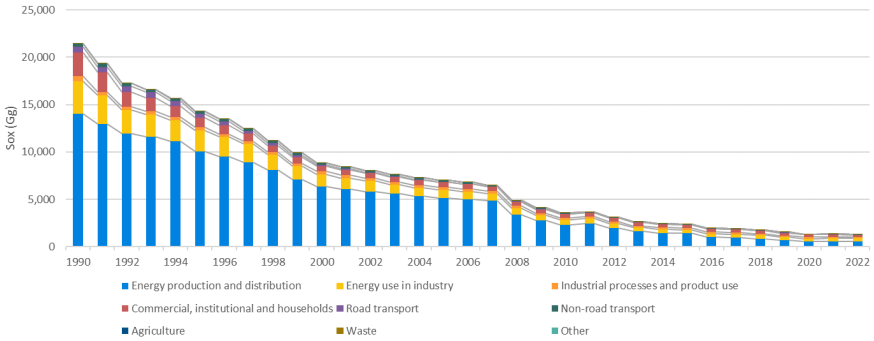
(a)



(b)



(c)



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 2005 and 2022, NH_3 emissions dropped by 11% in the EU and, between 2021 and 2022, emissions decreased by 4.5% (see Table 3.6). The highest emission decreases occurred during 1990 and 1995, which are mainly caused by reduction in Germany, Poland and Romania due to a reduced livestock population and changing agricultural practises during transformation of economies in these countries in the early 1990ies. In the years after, the decreases flattened.

This recent decrease (2021-2022) is mainly due to decreases in Italy, France, Poland, and Spain (countries ranked according to the size of their contributions to the absolute change). Between 1990 and 2022, NH_3 emissions decreased in all countries (mainly between 1990 and 1995, in the following years the decrease was less extensive), except in Ireland (11%) and Cyprus (2%). Ireland reported higher emissions in 2022 than in 1990 , mostly '3B1b — Manure management — Non-dairy cattle' (+39% between 1990 and 2022), whereby the increase in this category between 2005 and 2022 was only 3%.

Table 3.6 Member State contributions to EU emissions of NH_3

Member State	NH_3 (Gg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	74	72	68	66	68	70	71	72	70	69	69	69	68	-8 %	3 %	-1.7 %	1.5 %	2.1 %
Belgium	125	129	95	79	74	71	71	69	69	68	68	67	64	-49 %	-19 %	-3.9 %	2.5 %	2.0 %
Bulgaria	148	72	57	58	56	62	64	63	62	64	60	61	61	-59 %	6 %	0.7 %	2.9 %	1.9 %
Croatia	50	38	39	40	35	30	29	32	32	30	31	30	27	-47 %	-32 %	-9.6 %	1.0 %	0.8 %
Cyprus	8	9	9	9	9	7	7	7	7	8	8	8	8	2 %	-14 %	-2.7 %	0.1 %	0.2 %
Czechia	153	97	89	83	73	90	93	90	85	82	80	80	78	-49 %	-6 %	-2.1 %	3.0 %	2.4 %
Denmark	158	130	114	99	90	85	85	88	86	81	83	76	73	-54 %	-26 %	-3.2 %	3.1 %	2.2 %
Estonia	22	10	9	11	11	12	11	11	11	11	10	11	10	-55 %	-4 %	-3.7 %	0.4 %	0.3 %
Finland	41	39	39	42	40	38	36	36	36	35	34	33	32	-24 %	-25 %	-5.4 %	0.8 %	1.0 %
France	672	654	665	624	599	595	595	593	591	571	550	540	518	-23 %	-17 %	-3.9 %	13.3 %	15.8 %
Germany	734	634	647	627	640	655	649	631	603	582	542	525	512	-30 %	-18 %	-2.5 %	14.5 %	15.6 %
Greece	96	85	82	80	76	68	68	67	66	66	69	68	64	-33 %	-20 %	-5.7 %	1.9 %	2.0 %
Hungary	151	87	93	87	77	86	88	90	90	89	91	91	83	-45 %	-5 %	-9.1 %	3.0 %	2.5 %
Ireland	116	122	126	125	121	125	130	135	142	131	129	130	129	11 %	3 %	-1.1 %	2.3 %	3.9 %
Italy	529	515	517	481	425	403	423	405	392	387	405	393	351	-34 %	-27 %	-10.7 %	10.5 %	10.7 %
Latvia	33	16	13	15	15	16	16	16	16	16	16	16	15	-55 %	-1 %	-4.2 %	0.7 %	0.5 %
Lithuania	82	37	35	36	38	40	39	39	39	39	39	40	38	-54 %	4 %	-5.7 %	1.6 %	1.2 %
Luxembourg	6	7	7	6	6	6	6	7	7	6	6	6	6	-7 %	-7 %	-5.7 %	0.1 %	0.2 %
Malta	2	2	2	2	2	2	2	2	2	2	2	2	2	-31 %	-15 %	-6.2 %	0.0 %	0.0 %
Netherlands	347	220	175	155	135	130	132	133	133	126	125	123	121	-65 %	-22 %	-1.9 %	6.8 %	3.7 %
Poland	503	384	358	332	307	295	296	310	321	307	316	298	277	-45 %	-17 %	-7.0 %	9.9 %	8.5 %
Portugal	68	65	69	57	53	54	54	55	56	57	58	58	56	-18 %	-3 %	-3.7 %	1.3 %	1.7 %
Romania	320	216	176	194	173	169	166	164	162	159	156	157	150	-53 %	-23 %	-4.4 %	6.3 %	4.6 %
Slovakia	59	39	34	35	30	33	34	35	36	35	31	29	28	-53 %	-20 %	-5.1 %	1.2 %	0.8 %
Slovenia	22	20	20	19	18	17	17	17	17	17	17	17	16	-27 %	-14 %	-3.5 %	0.4 %	0.5 %
Spain	484	486	565	488	447	455	454	467	460	451	458	451	436	-10 %	-11 %	-3.3 %	9.6 %	13.3 %
Sweden	60	61	60	57	54	54	52	53	53	52	52	51	51	-15 %	-11 %	0.1 %	1.2 %	1.6 %
EU27 (a)	**5,065**	**4,247**	**4,163**	**3,906**	**3,674**	**3,667**	**3,690**	**3,686**	**3,641**	**3,543**	**3,502**	**3,429**	**3,274**	**-35%**	**-11%**	**-4.5%**	**100%**	**100%**
EU27 (b)	5,065	4,247	4,163	3,906	3,674	3,667	3,690	3,686	3,641	3,543	3,502	3,429	3,274					

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 2022, 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). NH_3 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 2022. Factors driving the emission trend are mainly the number of livestock and changes in manure management practices, feeding practices and abatement technologies in fertiliser application.

The decrease in NH_3 emissions in **France** (17% between 1990 and 2022) is mainly driven by changes in agricultural activities, primarily to the use of mineral fertilisers and a drop in the total amount of mineral nitrogen applied. Emissions from fertiliser use (3D) decreased by 24%

between 1990 and 2022 (-16% between 2005 and 2022). The drop in this item is primarily attributable to mineral fertilization, linked to a drop in total mineral nitrogen spread. The second item contributing to this decline is grazing, mainly linked to the decline in livestock numbers. Finally, emissions linked to the spreading of manure are also decreasing, combining both a drop in the nitrogen spread linked to the drop in livestock numbers, but also an increase in less emitting spreading practices. Emissions linked to the spreading of droppings produced by animals raised in France are decreasing more quickly than the associated quantity of nitrogen spread. The manure management station in the building and storage (NFR 3B) also saw its emissions drop, by 24% between 1990 and 2022 (-17% between 2005 and 2022). This development is observed mainly among dairy cows, in connection with the drop in livestock numbers. Notable reductions are also found in pigs, in particular due to the progression of two-phase feeding and the treatment of effluents by nitrification-denitrification, and finally in poultry, with the gradual disappearance until 2006 of deep pit systems (high emitting systems), the adjustment of feed to nitrogen requirements leading to a drop in nitrogen excreted for certain categories of poultry and a very sharp drop in the turkey population over the period. Still, it is noted that NH3 emissions from manure management of poultry has increase by 70% between 2005 and 2022. (see France's IIR, listed in Appendix 5).

Germany reported a decrease in NH_3 emissions since 1990 of 30% (19% between 2005 and 2022). The biggest emission sources in 1990 and 2022 were application of fertiliser to soils (3D) contributing with 56% to total NH_3 emissions and manure management (3B) contributing with 38%. NH3 Emissions from animal manure applied to soils (3Da2a) decreased significantly between 2005 and 2022 (-17%), while NH3 emissions from other organic fertilisers applied to soils (3DA2c) increased by 218%. Manure management from cattle and swine are most relevant in category 3B. ,and The decrease of NH3 emission in the year 1991 is due to a reduced livestock population that followed after the German reunification, while no explicit trend is discernible for the years up to 2016. Between 2016 and 2022 the emissions are dropping every year adding. (see Germany's IIR, listed in Appendix 5).

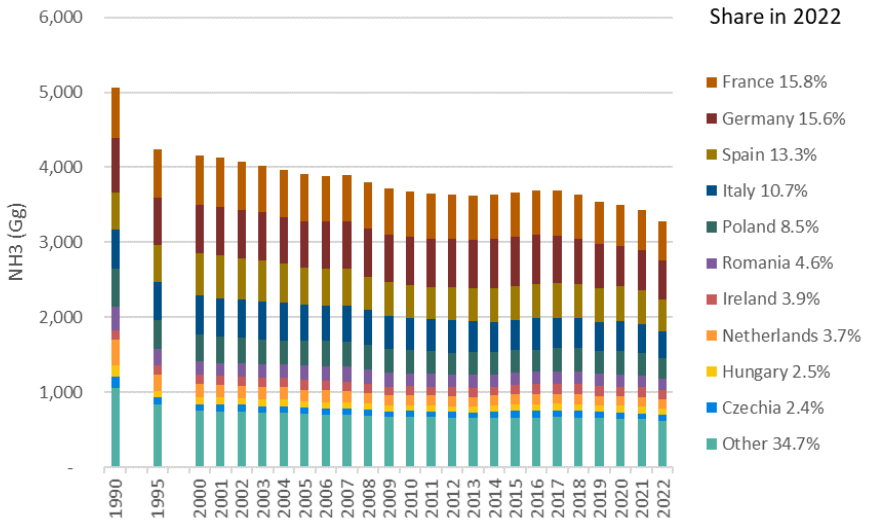
In **Spain**, NH_3 emissions decreased by 10% between 1990 and 2022 and by 3.3% between 2021 and 2022. The most relevant categories are the application of animal manure to soils (3Da2a) contributing with 24% in 2022, the use inorganic nitrogen fertiliser (3Da1) contributing with 24% in 2022 and emission related to the manure management of swine (3B3) contributing with 15%. Emissions related to the inorganic fertiliser used increased by 9% between 2005 and 2022.

Even with no sharp variations in the NH_3 time series, the declines are related to economic recession periods in Spain, weather conditions that affect the use of N-containing fertilizers, and the growing number of some livestock heads, mainly non-dairy cattle, and white swine. Growing trends of the livestock are also reflected in Soil fertilization activities (reported under category 3I Other), via the ammonia emissions derived from Animal manure applied to soils (3Da2a) and Urine and dung deposited by grazing animals (3Da3). In general, drought episodes lead to decreases in emissions from inorganic N-fertilizers use (3Da1) (the fact that fertilization intensifies drought stress results in a decrease in the use of fertilizers during poor rainfall periods). The introduction of fertilization practices with measures for abatement of NH_3 emissions from 2004 onwards and the progressive introduction of abatement techniques in white swine manure management (3B3), improvements in animal feed formulations, as well as the enforcement of animal welfare legislation affecting laying hens since 2010 leads to decreases in the last period of Ammonia emissions. (see Spain's IIR, listed in Appendix 5).

In **Italy**, in 2022, agriculture was the main source of emissions, contributing 90% of the total NH3 emissions. During the period 1990-2022, emissions from this sector show a decrease of 34% (-27% between 2005 and 2022). Manure management from cattle and swine account for 39% of total NH3 emissions in 2022, followed by animal manure applied to soils (share of 19%) and inorganic fertiliser use (share of 13%). All NH3 emissions of these sources have decreased. The waste sector – specifically the waste water treatment and biological treatment of waste accounts for 5% of total emissions. The latter show a strong increase due to increased 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 EU rural development programmes, which provide incentives to introduce good practices and technologies for protecting the environment and mitigating greenhouse gas and NH_3 emissions. The decrease in emissions of 10.7% between 2021 and 2022 is mainly due to lower NH_3 emissions reported for the use of inorganic fertiliser (3Da1) (see Italy's IIR, listed in Appendix 5).

Figure 3.12 NH_3 emission trends in the EU and shares of Member States



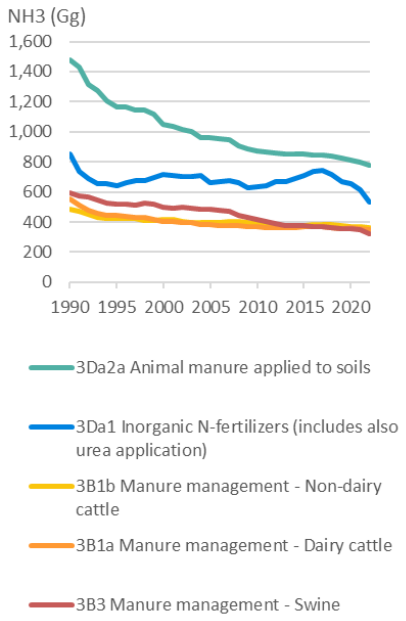
Notes: Countries are sorted by their contribution to the EU total for the last year. The top 10 countries are displayed. Data for the other 17 reporting countries are summed under 'Other'.

The principal key categories for NH_3 emissions are '3Da2a — Animal manure applied to soils', '3Da1 — Inorganic N fertilisers' and '3B1b — Manure management — Non-dairy cattle'. They jointly make up 51% of total NH_3 emissions (see Figure 3.13 (a)). Among the top five key categories, the highest relative and also absolute reduction in emissions between 1990 and 2022 occurred in '3Da2a — Animal manure applied to soils' (47%), the change between 2005 and 2022 was -19%. There were also large reductions in emissions in the fourth most important category '3B3 — Manure management — Swine' (46% between 1990 and 2022, and 33% between 2005 and 2022).

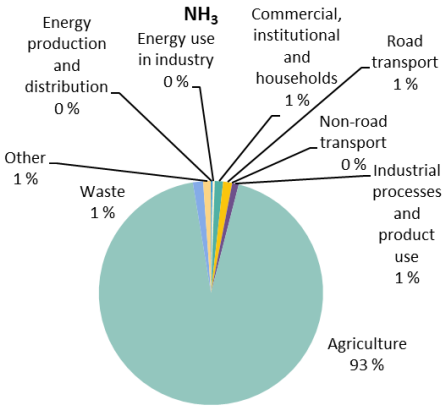
Figure 3.13(b) shows the contribution made by each aggregated sector group to total EU emissions. A single sector group — agriculture — is responsible for most (93%) of the NH_3 emissions in the EU.

Figure 3.13 **NH_3 emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

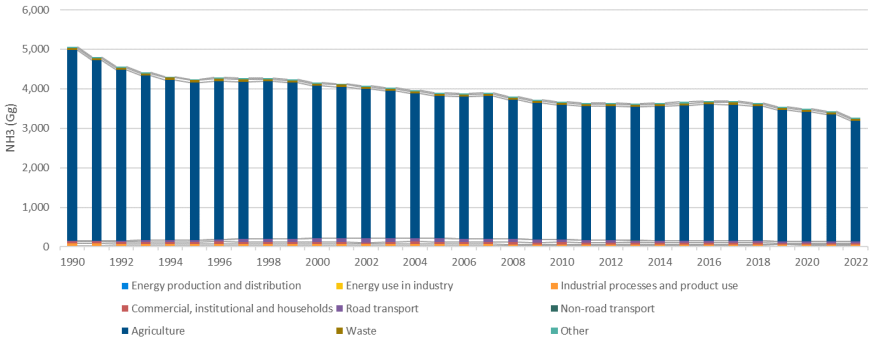
(a)



(b)



(c)



3.6 Fine particulate matter emission trends and key categories

Between 2005 and 2022, $PM_{2.5}$ emissions dropped by 32% in the EU, and between 2021 and 2022, emissions decreased by 6.8% (see Table 3.7), mainly because emissions decreased in Poland, France, Italy and Romania (countries ranked according to the size of their contributions to the absolute change).

In 2022, the EU Member States contributing most (i.e. more than 10%) to $PM_{2.5}$ emissions were Poland, France, Italy and Spain (countries ranked according to their shares of the EU total) (see Figure 3.13). The emission decrease of 32% between 2000 and 2022 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 EU directives introduced for installations as well as the Euro emission standards for 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.

Table 3.7 Member State contributions to EU emissions of $PM_{2.5}$

Member State	$PM_{2.5}$ (Gg)															Change			Share in EU-27	
	2000	2001	2002	2003	2004	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2000—2022	2005—2022	2021—2022	1990	2022
Austria	24	25	24	24	23	23	21	17	16	16	15	15	14	15	13	-44 %	-43 %	-9.6 %	1.2 %	1.0 %
Belgium	40	39	37	37	37	34	31	22	22	20	19	18	17	19	17	-57 %	-50 %	-6.8 %	2.0 %	1.3 %
Bulgaria	36	32	38	41	40	40	36	32	31	30	29	28	30	30	28	-21 %	-30 %	-6.5 %	1.8 %	2.2 %
Croatia	36	38	38	43	42	43	38	32	31	29	28	27	28	29	26	-26 %	-40 %	-10.0 %	1.8 %	2.0 %
Cyprus	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	-61 %	-54 %	-2.9 %	0.1 %	0.1 %
Czechia	85	87	82	83	83	74	82	81	78	76	71	64	60	60	55	-35 %	-25 %	-7.5 %	4.3 %	4.3 %
Denmark	21	21	20	21	21	21	21	17	17	16	15	13	12	12	11	-46 %	-48 %	-7.7 %	1.0 %	0.9 %
Estonia	10	10	11	10	9	8	11	7	6	7	6	5	5	5	5	-52 %	-40 %	4.6 %	0.5 %	0.4 %
Finland	26	27	27	27	27	26	23	17	18	17	17	16	14	14	13	-49 %	-48 %	-5.9 %	1.3 %	1.0 %
France	381	379	358	368	360	342	301	229	235	223	211	206	177	194	170	-55 %	-50 %	-12.2 %	19.3 %	13.3 %
Germany	164	158	152	144	138	133	118	101	95	94	94	89	81	83	84	-49 %	-37 %	1.6 %	8.3 %	6.6 %
Greece	66	70	68	67	68	67	46	42	39	39	37	36	34	35	36	-45 %	-46 %	2.7 %	3.3 %	2.8 %
Hungary	49	52	38	47	43	41	51	51	50	48	41	38	37	38	36	-26 %	-12 %	-4.4 %	2.5 %	2.8 %
Ireland	19	19	18	18	18	19	16	14	14	13	13	12	12	12	11	-44 %	-43 %	-12.0 %	1.0 %	0.8 %
Italy	202	195	171	183	161	183	206	165	159	166	150	147	139	151	144	-29 %	-21 %	-4.7 %	10.2 %	11.3 %
Latvia	27	28	28	29	30	27	21	17	17	18	19	18	17	18	17	-37 %	-37 %	-3.1 %	1.4 %	1.3 %
Lithuania	7	7	8	8	8	9	8	8	8	8	8	7	6	6	6	-14 %	-33 %	-2.9 %	0.4 %	0.5 %
Luxembourg	2	3	2	3	3	3	2	1	1	1	1	1	1	1	1	-57 %	-59 %	-1.5 %	0.1 %	0.1 %
Malta	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	-48 %	-50 %	12.0 %	0.0 %	0.0 %
Netherlands	35	34	32	31	31	29	22	18	17	17	17	16	14	15	14	-59 %	-50 %	-1.6 %	1.8 %	1.1 %
Poland	295	306	312	305	312	323	361	297	306	298	374	325	307	298	262	-11 %	-19 %	-12.0 %	14.9 %	20.5 %
Portugal	66	63	63	60	60	58	49	47	47	47	47	47	44	46	45	-31 %	-22 %	-0.8 %	3.3 %	3.5 %
Romania	107	87	90	106	119	121	129	109	109	110	108	109	108	114	107	1 %	-11 %	-5.7 %	5.4 %	8.4 %
Slovakia	44	43	33	33	30	37	27	21	21	21	17	18	17	20	18	-59 %	-51 %	-9.2 %	2.2 %	1.4 %
Slovenia	14	17	14	15	14	16	15	13	13	12	11	11	10	11	10	-33 %	-41 %	-14.9 %	0.7 %	0.8 %
Spain	187	180	174	190	175	169	162	153	134	134	149	129	131	131	130	-30 %	-23 %	-0.7 %	9.5 %	10.2 %
Sweden	35	34	33	33	32	34	29	20	20	20	19	18	18	17	17	-52 %	-51 %	-1.9 %	1.7 %	1.3 %
EU27 (a)	**1,981**	**1,957**	**1,875**	**1,927**	**1,887**	**1,884**	**1,828**	**1,534**	**1,506**	**1,484**	**1,518**	**1,416**	**1,336**	**1,375**	**1,281**	**-35 %**	**-32%**	**-6.8 %**	**100 %**	**100 %**
EU27 (b)	1,981	1,957	1,875	1,927	1,887	1,884	1,828	1,534	1,506	1,484	1,518	1,416	1,336	1,375	1,281					

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.

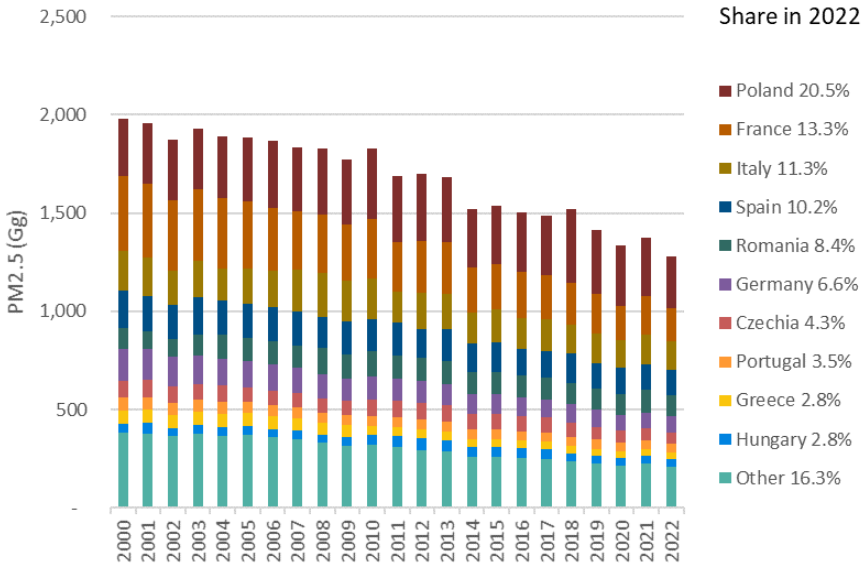
The main source of emissions in **Poland** is the burning of coal and wood by households (1A4bi), representing 76% of total $PM_{2.5}$ emissions in 2022. TSP, PM_{10} and $PM_{2.5}$ emission factors for sector 1A4 include the condensable fraction, which has a large share in PM emission from this sector. Emissions from this source experienced an all time peak in 2018, but decreased significantly since then (-30%). The sudden emission increase for most pollutants in 2018 results from the update of the fuel balance for the years 2018-2020, which was carried out by Statistics Poland at the beginning of 2022. The correction consisted in roughly doubling the amount of solid biomass used in households for 2018-2020 compared to the previous balance. This change had a large impact on the air pollutants emission. (see Poland's IIR, listed in Appendix 5).

France showed the highest $PM_{2.5}$ reductions in absolute terms between 2000 and 2022, namely -211Gg (-50%). $PM_{2.5}$ emissions from the heating of buildings (1A4bi) was the most relevant source category contributing with 57% to total PM2.5 emissions. They decreased by by 52% between 2000 and 2022 (-51% between 2005 and 2022). This decrease is linked to the improved performance of individual wood-burning equipment in the residential sector. Construction and demolition activities contribute with 5.0% in 2022, also showing a decreasing trend. Accidental house and car fires (share of 4.7%), as well as open burning of waste (share of 3.1%) are also relevant emission sources. PM emission from the transport sector (especially passenger cars) showed the highest decreases since 2005 (-75%), linked . (see France's IIR, listed in Appendix 5).

Italy reported $PM_{2.5}$ emission decreases of 29% between 2000 and 2022 (-21% between 2005 and 2022). In 2022, $PM_{2.5}$ emissions were mainly the result of residential heating of buildings (1A4b with a share of 62%), which show an increase 35% between 2005 and 2022. Relevant are also emissions from the transport sector: national shipping (1A3dii) with a share of 5%, and road transport with a share of 8%. $PM_{2.5}$ emissions resulting from road transport (1A3), stationary combustion (1A1a and 1A2) and agriculture activities (1A4c) have been substantially reduced since 2000. This is due to the introduction of Euro emission standards, which led to introduction of particle filters for a large part of new vehicles and the introduction of two regulatory instruments (introduction of plant emission limits). An emission source showing an increasing trend are the accidental house and car fires (category 5E, share of 3% and increase of 38% between 2005 and 2022). (see Italy's IIR, listed in Appendix 5).

Spain reported a decrease of 30% in $PM_{2.5}$ emissions since 2000 (-23% between 2005 and 2022). In 2022, the highest $PM_{2.5}$ emissions were caused by open burning of waste (share of 41%), since 2002 these emissions increased by 36% (+54% since 2005). While in 2000, commercial and residential heating (1A4a and 1A4b) was the highest contributing sector, this changed over time, and in 2022 the accounted for 27%. This decrease is caused by the abandonment of coal as fuel in the Residential stationary sector, and by the increase of use of pellets and advanced stoves and boilers. The fine particulate emissions from public power and electricity production decreased substantially (-67%) since 2000_ mainly due to the shift from solid and liquid fuels to a more predominant gas consumption, and the installation of abatement techniques. In the agriculture sector the abandonment of the practice of field burning (3F), restricted by forest fire prevention legislation and the conditionality of CAP (Common Agricultural Policy) payments contributed to less PM2.5 emissions.

Figure 3.14 $PM_{2.5}$ emission trends in the EU and shares of Member States



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

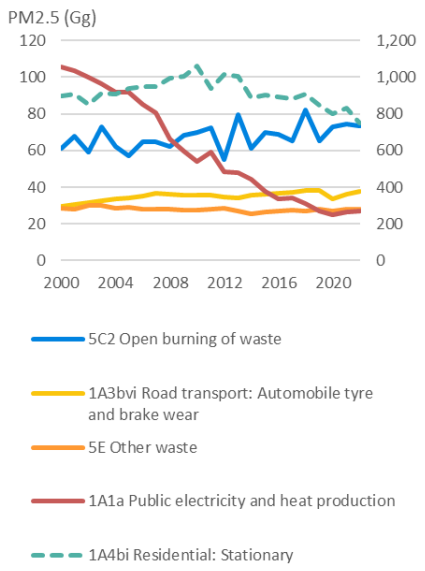
Domestic fuel use in '1A4bi — Residential: Stationary' is the principal key category for $PM_{2.5}$ emissions, making up 59% of the total (Figure 3.15 (a)). Among the top five key categories, the highest relative reduction in emissions between 2000 and 2022 was in '1A1a — Public electricity and heat production' (74.%, -70% between 2005 and 2022), followed by '1A4bi — Residential: Stationary'with a reduction of 16% (-20% between 2005 and 2022) and '5E — Other waste' with a reduction of -3% (between 2000 and 2022, and also 2005 2022).

In contrast, emissions from '1A3bvi — Road transport: Automobile tyre and brake wear' (´share of 2.9%), '1A3bvii — Road transport: Automobile road abrasion' (share of 1.9%) and '5C2 — Open burning of waste' (share of 5.7%19.8%) have increased since 2000 by more than 20%.

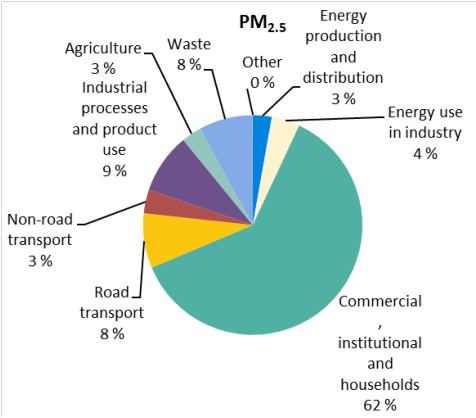
Figure 3.15(b) shows the contribution to total EU emissions made by each aggregated sector group. The commercial, institutional and households sector group is a major source of $PM_{2.5}$, as well as for PM_{10}, CO, PAHs and PCDD/Fs.

Figure 3.15 **$PM_{2.5}$ emissions in the EU: (a) trends in emissions from the five most important key categories, 2000-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

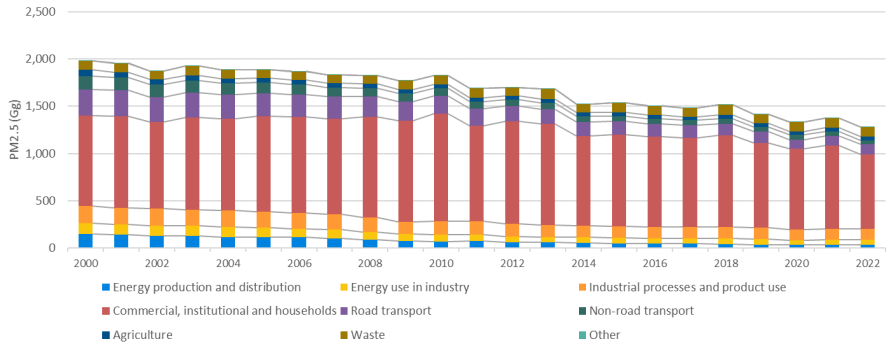
(a)



(b)



(c)



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 2022, PM_{10} emissions decreased by 33% in the EU. Between 2021 and 2022, the decrease was 5.5% (see Table 3.8), mainly because emissions decreased in Poland, France and Romania (countries ranked according to the size of their contributions to the absolute change).

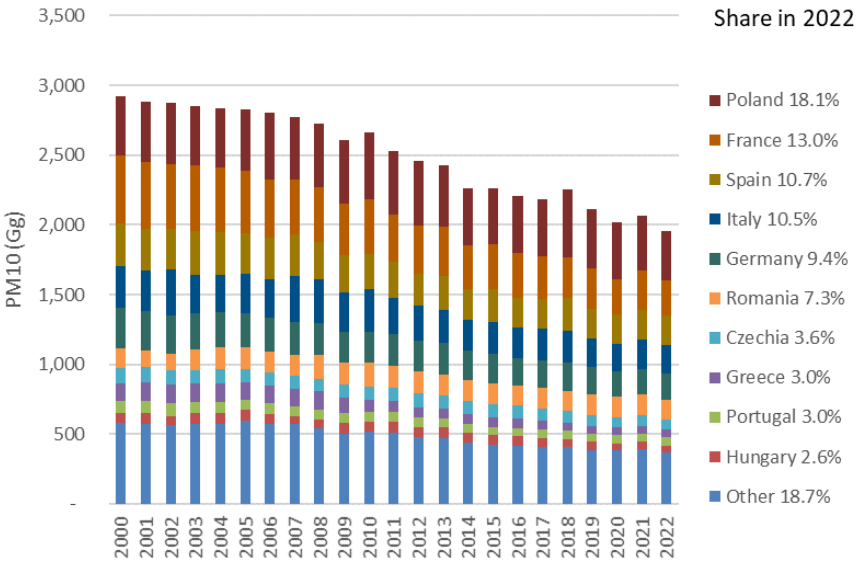
Table 3.8 Member State contributions to EU emissions of PM_{10}

Member State	PM_{10} (Gg)															Change			Share in EU-27	
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2000—2022	2005—2022	2021—2022	2000	2022
Austria	40	39	35	34	33	32	31	31	31	31	30	29	27	29	27	-32 %	-30 %	-6.8 %	1.4 %	1.4 %
Belgium	59	50	48	36	36	37	32	34	34	32	32	29	29	31	29	-50 %	-41 %	-6.0 %	2.0 %	1.5 %
Bulgaria	66	73	54	60	54	50	52	52	46	46	46	46	47	47	42	-36 %	-42 %	-8.8 %	2.3 %	2.2 %
Croatia	47	57	52	51	51	50	42	42	43	38	41	39	44	44	36	-24 %	-37 %	-17.0 %	1.6 %	1.9 %
Cyprus	5	4	3	3	2	2	2	2	2	2	2	2	2	2	2	-60 %	-54 %	-3.1 %	0.2 %	0.1 %
Czechia	106	93	98	97	99	100	94	97	93	91	86	79	74	74	69	-34 %	-26 %	-6.2 %	3.6 %	3.6 %
Denmark	33	33	33	30	29	29	28	27	27	27	26	23	22	22	21	-34 %	-35 %	-4.5 %	1.1 %	1.1 %
Estonia	27	17	21	34	15	20	17	14	12	13	12	10	10	10	9	-66 %	-46 %	-11.4 %	0.9 %	0.5 %
Finland	43	42	38	36	34	34	34	31	32	31	31	30	27	27	27	-37 %	-37 %	-2.1 %	1.5 %	1.4 %
France	489	441	391	339	352	355	311	315	320	311	297	292	256	279	253	-48 %	-43 %	-9.1 %	16.7 %	13.0 %
Germany	295	244	226	225	221	223	214	212	198	200	206	193	180	183	185	-37 %	-24 %	1.1 %	10.1 %	9.4 %
Greece	127	122	88	76	74	70	74	67	67	65	58	58	56	57	59	-53 %	-52 %	4.0 %	4.3 %	3.0 %
Hungary	73	72	72	75	74	77	72	72	70	65	60	58	54	53	51	-29 %	-29 %	-3.7 %	2.5 %	2.6 %
Ireland	32	36	29	22	23	23	23	23	24	23	23	23	22	22	21	-35 %	-41 %	-6.2 %	1.1 %	1.1 %
Italy	297	280	301	262	245	238	215	231	216	226	229	206	200	212	206	-31 %	-27 %	-3.1 %	10.2 %	10.5 %
Latvia	32	34	27	29	29	27	27	26	25	26	27	26	25	28	26	-18 %	-23 %	-5.0 %	1.1 %	1.3 %
Lithuania	9	25	18	20	17	15	18	16	17	15	20	14	14	14	14	60 %	-43 %	1.7 %	0.3 %	0.7 %
Luxembourg	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	-44 %	-47 %	4.2 %	0.1 %	0.1 %
Malta	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	63 %	24 %	34.9 %	0.0 %	0.1 %
Netherlands	51	43	36	34	33	33	32	32	31	31	30	29	27	27	27	-47 %	-37 %	-0.4 %	1.7 %	1.4 %
Poland	420	445	482	455	462	442	410	401	413	408	483	429	404	398	354	-16 %	-21 %	-11.0 %	14.4 %	18.1 %
Portugal	84	76	66	74	69	62	58	58	58	58	58	59	57	59	58	-31 %	-23 %	-1.3 %	2.9 %	3.0 %
Romania	140	159	165	157	161	151	151	145	143	143	141	146	145	152	143	2 %	-10 %	-6.0 %	4.8 %	7.3 %
Slovakia	54	45	33	31	32	30	23	29	27	28	23	24	24	26	23	-57 %	-48 %	-8.9 %	1.8 %	1.2 %
Slovenia	18	21	18	18	17	16	14	15	15	15	13	13	13	15	14	-23 %	-33 %	-10.1 %	0.6 %	0.7 %
Spain	307	297	255	254	229	243	221	238	215	213	229	211	209	211	209	-32 %	-30 %	-0.8 %	10.5 %	10.7 %
Sweden	63	77	69	70	66	68	63	45	46	47	46	45	43	43	43	-32 %	-45 %	-0.5 %	2.2 %	2.2 %
EU27 (a)	**2,919**	**2,830**	**2,662**	**2,527**	**2,461**	**2,430**	**2,260**	**2,259**	**2,210**	**2,186**	**2,253**	**2,116**	**2,015**	**2,068**	**1,954**	**-33 %**	**-31%**	**-5.5 %**	**100 %**	**100 %**
EU27 (b)	2,919	2,830	2,662	2,527	2,461	2,430	2,260	2,259	2,210	2,186	2,253	2,116	2,015	2,068	1,954					

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.

In 2022, the EU Member States contributing most (i.e. more than 10%) to PM_{10} emissions were Poland, France, Spain and Italy (countries ranked according to their shares of the EU total) (see Figure 3.15).

Figure 3.16 PM_{10} emission trends in the EU and shares of Member States

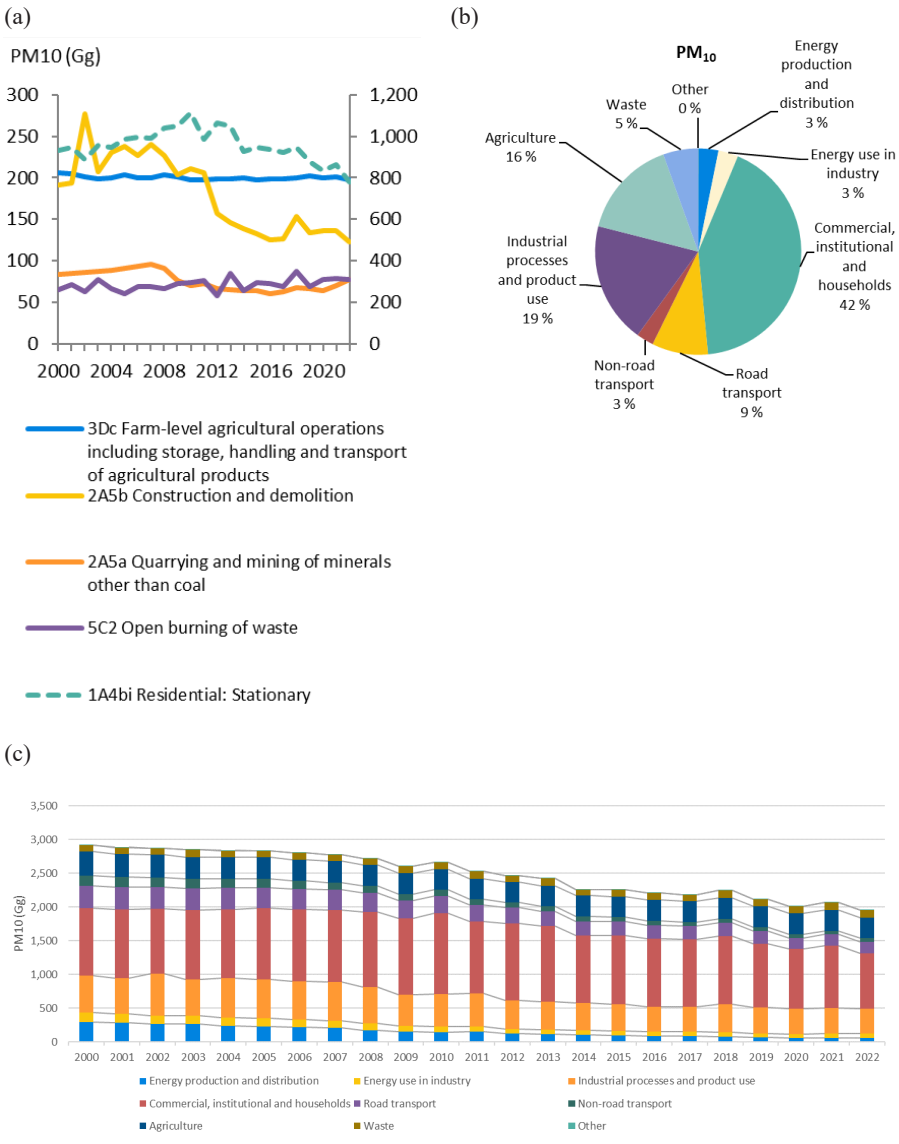


Notes: Countries are sorted by their contribution to the EU total for the last year. The top 10 countries are displayed. Data for the other 17 reporting countries are summed under 'Other'.

As for $PM_{2.5}$, '1A4bi — Residential: Stationary' is the most significant key category for PM_{10} emissions, accounting for 40% of total PM_{10} emissions (see Figure 3.17 (a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2022 was in the third most important '2A5b — Construction and demolition' (35.9%). Reductions in emissions were also observed in the categories '2A5a — Quarrying and mining of minerals other than coal' (7.2%), '3Dc — Farm-level agricultural operations including storage, handling and transport of agricultural products' (4.1%) and '1A4bi — Residential: Stationary' (16.5%). The emissions of the categories '5C2 — Open burning of waste' (19.5%) have increased since 1990, which is dominated by Spain (in 2022, 74% of PM_{10} emissions from this source are reported by Spain).

Figure 3.17(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 3.17 **PM_{10} emissions in the EU: (a) trends in emissions from the five most important key categories, 2000-2022, (b) share by sector group, 2022 and (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 2022, TSP emissions dropped by 31% in the EU. Between 2021 and 2022, emissions decreased by 5.6% (Table 3.9), mainly because of decreases in Poland, France, Romania and Bulgaria (countries ranked according to the size of their contributions to the absolute change).

Table 3.9 Member State contributions to EU emissions of TSPs

Member State	TSPs (Gg)															Change			Share in EU—27	
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2000—2022	2005—2022	2021—2022	2000	2022
Austria	60	59	53	51	50	49	48	48	48	49	48	48	45	48	45	-24 %	-24 %	-6.6 %	0.7 %	1.3 %
Belgium	95	84	86	59	60	61	56	56	57	56	58	56	55	59	55	-42 %	-34 %	-6.7 %	1.1 %	1.6 %
Bulgaria	127	145	80	93	85	78	96	109	72	74	81	85	78	76	53	-58 %	-63 %	-30.0 %	1.5 %	1.5 %
Croatia	73	87	81	83	85	84	66	61	66	53	65	58	78	72	53	-27 %	-39 %	-26.6 %	0.9 %	1.5 %
Cyprus	10	7	6	5	4	3	2	3	3	3	3	3	3	3	3	-67 %	-54 %	-3.4 %	0.1 %	0.1 %
Czechia	136	116	115	115	118	116	111	114	110	107	101	96	89	90	84	-38 %	-28 %	-6.9 %	1.6 %	2.4 %
Denmark	100	94	96	92	90	89	91	86	86	92	90	87	83	84	82	-18 %	-13 %	-2.2 %	1.2 %	2.3 %
Estonia	63	29	31	46	24	29	24	22	20	20	21	18	20	19	16	-75 %	-45 %	-17.9 %	0.8 %	0.5 %
Finland	57	57	54	51	48	49	48	45	47	45	45	45	40	41	42	-26 %	-26 %	1.6 %	0.7 %	1.2 %
France	1,105	1,036	949	904	916	911	854	870	884	875	854	849	785	828	797	-28 %	-23 %	-3.7 %	13.4 %	22.6 %
Germany	497	411	379	384	378	386	377	372	345	357	371	346	327	327	330	-34 %	-20 %	0.9 %	6.0 %	9.4 %
Greece	245	229	168	124	113	114	127	118	126	120	104	108	108	107	113	-54 %	-51 %	5.9 %	3.0 %	3.2 %
Hungary	105	132	106	102	91	104	107	105	100	90	89	87	77	73	70	-33 %	-47 %	-4.0 %	1.3 %	2.0 %
Ireland	82	99	75	52	54	54	53	56	57	61	59	60	58	59	58	-30 %	-41 %	-1.7 %	1.0 %	1.6 %
Italy	440	440	483	455	343	338	300	344	313	331	378	304	305	312	297	-32 %	-32 %	-5.0 %	5.3 %	8.4 %
Latvia	40	50	40	49	49	43	44	50	45	42	43	42	42	50	46	13 %	-8 %	-9.0 %	0.5 %	1.3 %
Lithuania	13	19	19	18	18	18	18	18	19	19	19	17	16	17	16	29 %	-15 %	-1.8 %	0.2 %	0.5 %
Luxembourg	4	4	3	3	3	3	3	3	3	3	3	2	2	2	3	-33 %	-37 %	15.9 %	0.0 %	0.1 %
Malta	2	4	3	3	3	3	4	4	4	4	5	5	6	5	7	299 %	76 %	37.2 %	0.0 %	0.2 %
Netherlands	57	51	43	42	39	39	38	37	36	35	35	34	31	32	31	-45 %	-39 %	-0.9 %	0.7 %	0.9 %
Poland	591	604	628	608	623	583	545	528	540	545	620	563	525	528	473	-20 %	-22 %	-10.3 %	7.2 %	13.4 %
Portugal	144	133	117	139	128	105	93	92	96	93	94	95	94	96	93	-35 %	-30 %	-3.4 %	1.7 %	2.6 %
Romania	234	299	288	286	284	258	260	237	219	207	214	225	233	223	197	-16 %	-34 %	-11.6 %	2.8 %	5.6 %
Slovakia	73	60	42	40	40	38	30	41	35	36	30	30	31	32	28	-61 %	-53 %	-12.3 %	0.9 %	0.8 %
Slovenia	26	30	26	24	22	21	16	17	20	20	18	19	20	22	23	-8 %	-22 %	7.8 %	0.3 %	0.7 %
Spain	461	481	371	363	324	325	304	337	294	298	319	308	298	306	303	-34 %	-37 %	-1.3 %	5.6 %	8.6 %
Sweden	106	157	145	149	143	146	141	83	85	86	85	84	81	82	82	-23 %	-48 %	-0.2 %	1.3 %	2.3 %
EU27 (a)	**4,943**	**4,918**	**4,485**	**4,341**	**4,134**	**4,048**	**3,856**	**3,856**	**3,726**	**3,721**	**3,850**	**3,675**	**3,530**	**3,596**	**3,402**	**-31 %**	**-31%**	**-5.4 %**	**100 %**	**100 %**
EU27 (b)	4,943	4,918	4,485	4,341	4,134	4,048	3,856	3,856	3,726	3,721	3,850	3,675	3,530	3,596	3,402					

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 2022, the EU Member States contributing most (i.e. more than 10%) to TSP emissions were France and Poland (countries ranked according to their shares of the EU total).

France explained that the reported drop of 28% in TSP emissions between 2000 and 2022 was mainly linked to improvements in wood-burning equipment in the residential sector and reduced emissions from demolition and construction. The category with the highest share in 2022 (84%) are Farm-level agricultural operations including storage, handling and transport of agricultural products (3Dc) showing a relatively stable emission trend over the years.

Poland described that the main source of TSP emissions are stationary combustion processes in households, which account for the majority of national emissions (share of 47% in 2022). These emissions increased between 2000 and 2022, but show a decrease of 11% between 2005 and 2022. Other sectors have the largest share in TSP emissions in the stationary source group – 53%. TSP, PM_{10} and $PM_{2.5}$ emission factors for sector 1A4 include the condensable fraction, which has a large share in PM emission from this sector.

Germany explained that, between 2000 and 2022, TSP emissions dropped by 34% because realized a change-over from solid to gaseous and liquid fuel, as well as advancements in filter technologies of combustion plants and industrial processes.. The highest emissions source with a share of 27% in 2002, is emissions from storage, handling and transport of mineral, chemical and metal products (category 2L). (see Germany's IIR, listed in Appendix 5).

3.9 Black carbon emission trends

Between 2000 and 2022, BC emissions dropped by 48% in the EU (see Table 3.10). Between 2021 and 2022, emissions decreased by 5.8%, mainly because of reduced emissions from France, Poland, Czechia and Italy (countries ranked according to the size of their contributions to the absolute change). Austria and Luxembourg do not report BC emissions.

The main source of BC emission with a share of 40% are fuel combustion in households (1A4bi) followed by open burning of waste (5C2) with 21%.

Table 3.10 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	2021	2022	2000—2022	2005—2022	2021—2022	2000	2022
Austria																				
Belgium	9	8	7	6	5	5	4	4	4	3	3	3	2	3	2	-72 %	-68 %	-6.7 %	2.2 %	1.3 %
Bulgaria	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	8 %	-17 %	-11.5 %	0.8 %	1.7 %
Croatia	5	6	5	5	5	5	4	5	4	4	4	4	4	4	4	-31 %	-42 %	-7.8 %	1.3 %	1.9 %
Cyprus	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-64 %	-61 %	-3.1 %	0.2 %	0.1 %
Czechia	9	9	9	8	8	9	8	8	8	8	7	7	7	7	6	-36 %	-33 %	-11.4 %	2.3 %	3.1 %
Denmark	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	-60 %	-57 %	-8.1 %	1.0 %	0.9 %
Estonia	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-25 %	-19 %	6.2 %	0.4 %	0.6 %
Finland	7	6	5	5	5	5	5	4	4	4	4	4	3	3	3	-52 %	-48 %	-7.4 %	1.6 %	1.7 %
France	78	68	58	51	51	51	44	43	42	39	36	34	29	31	27	-65 %	-60 %	-12.8 %	19.7 %	14.4 %
Germany	39	31	23	21	20	19	17	16	15	14	13	12	10	10	10	-75 %	-68 %	-2.4 %	9.9 %	5.3 %
Greece	11	12	10	9	9	8	8	9	8	8	8	8	8	8	8	-26 %	-31 %	3.5 %	2.7 %	4.2 %
Hungary	8	8	9	9	9	9	8	8	8	8	7	6	6	6	6	-32 %	-26 %	-3.9 %	2.1 %	3.1 %
Ireland	4	4	3	2	2	2	2	2	2	2	2	2	2	2	1	-64 %	-61 %	-7.1 %	1.0 %	0.7 %
Italy	43	40	34	28	29	27	25	24	23	22	20	20	18	19	18	-58 %	-54 %	-3.6 %	10.9 %	9.6 %
Latvia	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	-42 %	-43 %	-3.7 %	0.9 %	1.0 %
Lithuania	2	3	3	2	3	2	2	3	2	2	2	2	2	2	2	-26 %	-32 %	-3.4 %	0.6 %	0.9 %
Luxembourg																				
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-51 %	-40 %	-1.4 %	0.0 %	0.0 %
Netherlands	11	8	5	4	4	4	3	3	3	3	3	3	2	2	2	-80 %	-74 %	-5.5 %	2.7 %	1.1 %
Poland	21	22	24	23	22	21	19	19	20	20	23	21	19	18	16	-21 %	-26 %	-11.6 %	5.2 %	8.6 %
Portugal	10	8	7	7	7	6	6	6	6	6	6	6	5	5	5	-46 %	-38 %	0.7 %	2.4 %	2.8 %
Romania	12	14	15	14	14	13	13	13	13	13	13	13	13	14	13	4 %	-8 %	-4.8 %	3.2 %	6.9 %
Slovakia	4	4	4	4	4	3	2	3	3	3	2	2	2	3	2	-40 %	-45 %	-8.4 %	1.0 %	1.3 %
Slovenia	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	-40 %	-47 %	-13.5 %	0.7 %	0.8 %
Spain	53	50	52	53	42	54	41	47	44	43	52	41	44	44	44	-18 %	-13 %	-1.4 %	13.5 %	23.2 %
Sweden	5	5	4	4	3	3	3	3	3	2	2	2	2	2	2	-67 %	-63 %	-5.2 %	1.4 %	0.9 %
EU27 (a)	**347**	**322**	**292**	**271**	**257**	**260**	**229**	**233**	**225**	**217**	**219**	**201**	**188**	**193**	**181**	**-48 %**	**-44 %**	**-5.8 %**	**88 %**	**96 %**
EU27 (b)	347	322	292	271	257	260	229	233	225	217	219	201	188	193	181					

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.

In 2022, 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.

3.10 Carbon monoxide emission trends and key categories

Between 2005 and 2022, CO emissions fell by 35% in the EU. Between 2021 and 2022, they decreased by 7.2% (Table 3.11), mainly because emissions fell in Poland, France, Italy and Czechia (countries ranked according to the size of their contributions to the absolute change).

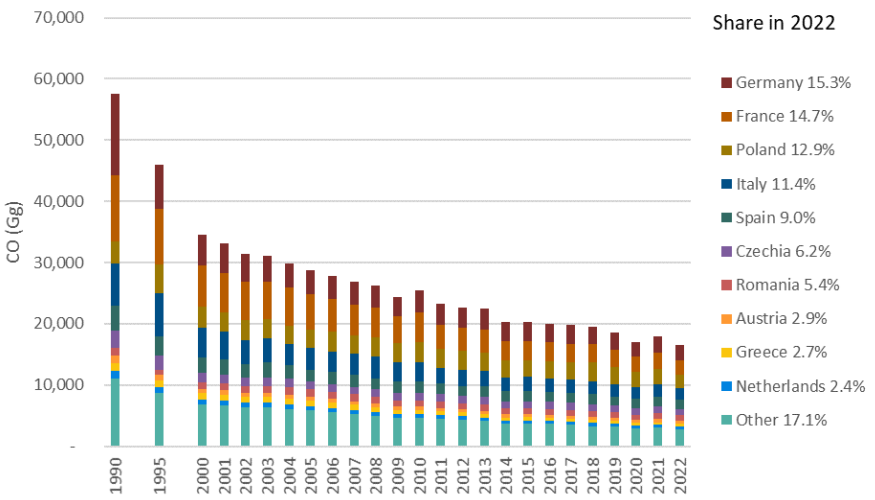
Table 3.11 Member State contributions to EU emissions of CO

Member State	CO (Gg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	1,248	973	728	625	579	541	536	526	484	497	473	537	481	-61 %	-23 %	-10.6 %	2.2 %	2.9 %
Belgium	1,507	1,280	997	801	496	368	350	282	325	355	262	274	264	-82 %	-67 %	-3.9 %	2.6 %	1.6 %
Bulgaria	817	635	410	339	298	255	255	250	234	223	231	238	200	-75 %	-41 %	-15.6 %	1.4 %	1.2 %
Croatia	564	446	466	423	334	271	260	254	233	219	215	228	207	-63 %	-51 %	-9.3 %	1.0 %	1.2 %
Cyprus	45	39	30	24	14	11	11	11	10	10	9	9	9	-80 %	-61 %	-0.1 %	0.1 %	0.1 %
Czechia	2,920	2,292	1,513	1,253	1,264	1,188	1,175	1,163	1,133	1,068	1,078	1,117	1,035	-65 %	-17 %	-7.4 %	5.1 %	6.2 %
Denmark	721	646	473	430	358	268	258	246	228	211	195	194	180	-75 %	-58 %	-7.3 %	1.3 %	1.1 %
Estonia	244	206	178	142	150	114	119	129	125	123	119	109	106	-56 %	-25 %	-2.3 %	0.4 %	0.6 %
Finland	764	662	594	519	446	359	366	357	349	343	317	333	310	-59 %	-40 %	-6.8 %	1.3 %	1.9 %
France	10,711	9,041	6,777	5,804	4,772	3,132	3,187	3,104	2,948	2,883	2,456	2,677	2,437	-77 %	-58 %	-9.0 %	18.6 %	14.7 %
Germany	13,320	7,188	5,097	3,790	3,588	3,171	3,042	3,021	2,917	2,828	2,469	2,596	2,539	-81 %	-33 %	-2.2 %	23.1 %	15.3 %
Greece	1,236	1,059	1,004	862	610	522	471	483	464	460	427	425	441	-64 %	-49 %	3.8 %	2.1 %	2.7 %
Hungary	1,416	981	857	698	546	460	445	434	371	353	334	337	327	-77 %	-53 %	-2.9 %	2.5 %	2.0 %
Ireland	574	432	341	299	226	184	179	152	146	126	120	121	105	-82 %	-65 %	-13.3 %	1.0 %	0.6 %
Italy	6,824	7,118	4,814	3,502	3,076	2,283	2,191	2,249	2,036	2,043	1,861	2,031	1,894	-72 %	-46 %	-6.7 %	11.9 %	11.4 %
Latvia	400	289	241	212	154	107	105	112	116	112	99	101	99	-75 %	-53 %	-2.0 %	0.7 %	0.6 %
Lithuania	386	220	183	175	158	121	121	118	120	112	106	109	102	-74 %	-42 %	-6.5 %	0.7 %	0.6 %
Luxembourg	469	213	47	40	30	22	23	23	21	21	15	18	18	-96 %	-55 %	-2.0 %	0.8 %	0.1 %
Malta	20	27	20	16	10	7	7	7	6	6	4	5	5	-77 %	-70 %	2.4 %	0.0 %	0.0 %
Netherlands	1,172	936	753	708	651	518	511	498	499	482	422	414	398	-66 %	-44 %	-3.8 %	2.0 %	2.4 %
Poland	3,662	4,714	3,345	3,069	3,394	2,676	2,782	2,732	3,079	2,693	2,559	2,479	2,147	-41 %	-30 %	-13.4 %	6.4 %	12.9 %
Portugal	788	811	667	509	375	306	294	294	275	284	253	283	249	-68 %	-51 %	-12.1 %	1.4 %	1.5 %
Romania	1,208	751	1,054	1,224	1,045	907	932	936	936	942	901	953	896	-26 %	-27 %	-6.0 %	2.1 %	5.4 %
Slovakia	1,040	662	552	573	462	373	379	379	320	288	279	352	302	-71 %	-47 %	-14.3 %	1.8 %	1.8 %
Slovenia	291	281	204	182	143	121	120	115	100	96	89	95	79	-73 %	-57 %	-17.3 %	0.5 %	0.5 %
Spain	4,113	3,120	2,624	1,994	1,860	1,735	1,599	1,594	1,799	1,512	1,490	1,573	1,494	-64 %	-25 %	-5.0 %	7.1 %	9.0 %
Sweden	1,094	936	643	493	406	333	337	330	310	303	287	282	277	-75 %	-44 %	-1.8 %	1.9 %	1.7 %
EU27 (a)	**57,555**	**45,957**	**34,608**	**28,705**	**25,446**	**20,356**	**20,053**	**19,799**	**19,584**	**18,593**	**17,068**	**17,889**	**16,599**	**-71%**	**-35%**	**-7.2%**	**100%**	**100%**
EU27 (b)	57,555	45,957	34,609	28,706	25,446	20,356	20,053	19,799	19,584	18,593	17,068	17,889	16,599					

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 2022, the EU Member States contributing most (i.e. more than 10%) to CO emissions were Germany, France, Poland, Italy (countries ranked according to their shares of the EU total) (see Figure 3.17).

Figure 3.18 CO emission trends in the EU and shares of Member States



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

France explained that the decreasing trend in CO emissions between 2005 and 2022 was driven by improvements in the transport sector (installation of catalytic converters to vehicles) and CO reduction in the iron and steel sector explained by the strong variations in production in the steel sector (cast iron, steel, sinter) associated with the dependence of the emission factor relating to the valorization of steel gases. The closure of the Florange steel site at the end of 2011 also had a downward impact on CO emissions. The largest emissions source (share of 42% in 2022) is fuel combustion (mostly biomass) in the residential sector, which saw a decrease of 47% since 2005 in the thanks to the renewal of the real estate stock and tertiary sector to more efficient and less emitting devices.

The decline in CO emissions (-46%) in **Italy** between 2005 and 2022 was mostly caused by reductions in the transport sector (all modes), CO emissions from passenger cars decreased by 85%. (including road, railway, air and maritime transport). Fuel combustion in households is the largest contributor to 2022 total CO emissions (share of 64%), emissions from this source increased since 2005 by 32%.

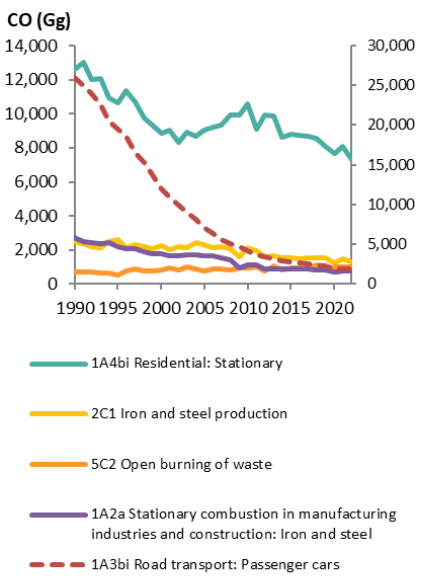
The reductions of 25% in CO emissions between 2005 and 2022 in **Spain** were also driven mainly by reductions in the transport sector (introduction of the Euro standards) Open burning of waste (5C2) contributed most to total CO emissions in 2022, which also increased by 54% since 2005. Fuel combustion in residential heating is responsible for 16% of total emissions. In the 1990ies field burning of agricultural residues was a major source, but because of the abandonement of this practise these emissions have been reduced since 1990 by 98%.

Categories '1A4bi — Residential: Stationary' and '1A3bi — Road transport: Passenger cars' were the most important 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 2022 was in the second most important '1A3bi — Road transport: Passenger cars' (93%) (see Figure 3.19(a)). Reductions in emissions were observed in the categories '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' (72%), '2C1 — Iron and steel production' (46%) and 1A4bi — Residential: Stationary' (42%), CO emissions from the fifth most important key category '5C2 — Open burning of waste' have increased by 37% since 1990. These emissions trends also apply to the time period 2005 to 2022.

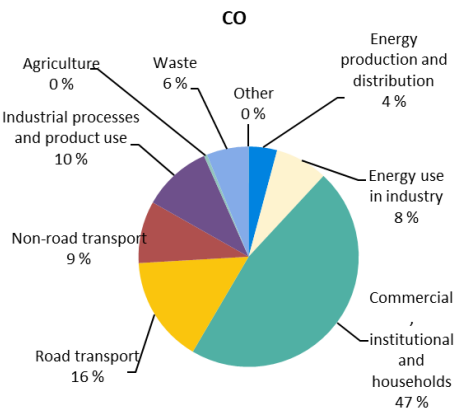
Figure 3.19(b) shows the contribution to total EU emissions made by each aggregated sector group. For CO, the common major emission sources are commercial, institutional and households, and road transport.

Figure 3.19 **CO emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

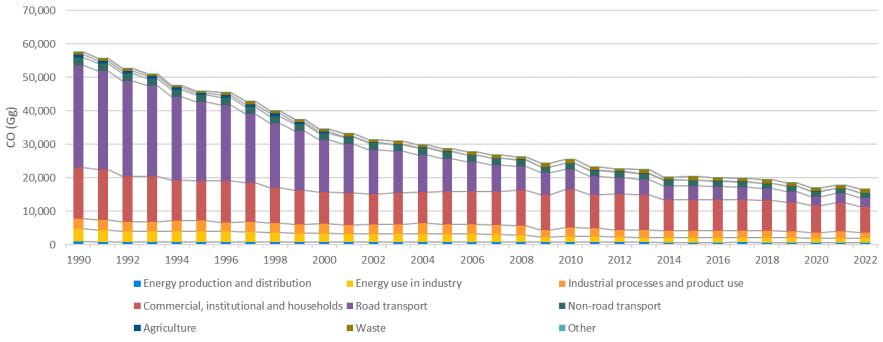
(a)



(b)



(c)



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 2022, Pb emissions dropped by 95% and by 43% between 2005 and 2022 in the EU. Between 2021 and 2022, emissions decreased by 2.8% (see Table 3.12), mainly Poland, Italy and Romania (countries ranked according to the size of their contributions to the absolute change).

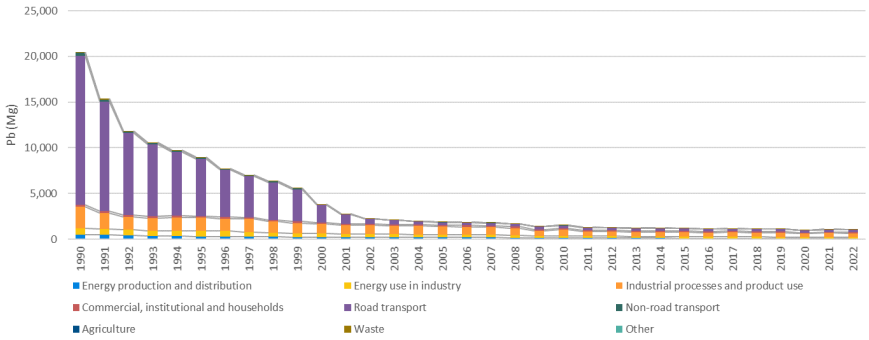
In 2022, the EU Member States contributing most (i.e. more than 10%) to Pb emissions were Poland, Italy and Germany (countries ranked according to their shares of the EU total) (see Figure 3.19).

Table 3.12 Member State contributions to EU emissions of Pb

Member State	Pb (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	233	26	23	27	16	15	16	16	15	15	13	14	14	-94 %	-50 %	-0.7 %	1.1 %	1.3 %
Belgium	257	202	105	81	46	36	33	31	19	20	17	16	17	-93 %	-79 %	8.7 %	1.3 %	1.6 %
Bulgaria	398	273	186	52	25	17	17	15	15	18	16	17	18	-96 %	-66 %	4.3 %	1.9 %	1.7 %
Croatia	529	263	146	15	10	10	10	10	11	7	7	9	8	-98 %	-46 %	-1.9 %	2.6 %	0.8 %
Cyprus	25	27	21	1	1	1	1	1	1	1	1	1	1	-96 %	-23 %	-1.4 %	0.1 %	0.1 %
Czechia	321	259	225	44	30	27	24	24	25	24	21	20	25	-92 %	-43 %	21.2 %	1.6 %	2.4 %
Denmark	132	29	22	20	16	15	15	14	16	15	14	14	13	-90 %	-34 %	-1.1 %	0.6 %	1.3 %
Estonia	202	83	30	9	9	5	5	5	5	5	4	4	4	-98 %	-56 %	7.4 %	1.0 %	0.4 %
Finland	321	73	31	21	20	15	16	16	15	13	12	13	13	-96 %	-42 %	-0.3 %	1.6 %	1.2 %
France	4,294	1,463	273	172	133	103	101	101	100	100	87	92	89	-98 %	-48 %	-3.4 %	21.0 %	8.4 %
Germany	1,899	679	355	228	163	164	161	166	160	158	143	155	152	-92 %	-33 %	-2.3 %	9.3 %	14.4 %
Greece	505	405	340	73	37	15	14	16	15	13	10	11	11	-98 %	-84 %	2.1 %	2.5 %	1.1 %
Hungary	818	145	21	14	12	13	13	13	12	13	13	15	15	-98 %	3 %	-0.2 %	4.0 %	1.4 %
Ireland	158	99	17	11	9	9	9	8	8	8	7	8	7	-95 %	-32 %	-1.7 %	0.8 %	0.7 %
Italy	4,302	2,021	991	328	247	230	203	208	210	204	180	214	205	-95 %	-38 %	-4.4 %	21.0 %	19.4 %
Latvia	233	128	154	170	165	4	4	4	4	4	4	4	5	-98 %	-97 %	19.3 %	1.1 %	0.5 %
Lithuania	9	4	2	3	3	3	3	3	4	4	3	4	5	-42 %	77 %	41.1 %	0.0 %	0.5 %
Luxembourg	19	9	2	2	2	2	2	2	2	2	1	2	2	-92 %	-24 %	-2.2 %	0.1 %	0.1 %
Malta	0	1	1	1	1	1	1	0	1	1	0	0	0	14 %	-16 %	4.5 %	0.0 %	0.0 %
Netherlands	336	155	28	30	38	9	9	9	6	5	6	5	5	-99 %	-85 %	-7.3 %	1.6 %	0.4 %
Poland	545	579	397	280	306	302	295	310	311	289	270	280	263	-52 %	-6 %	-6.1 %	2.7 %	24.9 %
Portugal	568	782	34	31	29	26	25	25	26	25	23	24	25	-96 %	-21 %	4.8 %	2.8 %	2.4 %
Romania	729	356	50	72	48	45	45	45	46	47	41	46	41	-94 %	-44 %	-11.2 %	3.6 %	3.9 %
Slovakia	54	46	46	17	8	8	9	9	8	7	6	8	7	-87 %	-59 %	-13.3 %	0.3 %	0.7 %
Slovenia	43	24	8	7	7	6	6	6	6	6	5	6	5	-87 %	-21 %	-3.7 %	0.2 %	0.5 %
Spain	3,181	790	279	144	132	98	93	90	95	103	86	100	99	-97 %	-31 %	-0.3 %	15.5 %	9.4 %
Sweden	369	30	19	12	10	8	9	9	8	8	8	7	7	-98 %	-42 %	-1.7 %	1.8 %	0.6 %
EU27 (a)	**20,482**	**8,949**	**3,806**	**1,866**	**1,522**	**1,185**	**1,138**	**1,158**	**1,146**	**1,115**	**999**	**1,085**	**1,054**	**-95%**	**-43%**	**-2.8%**	**100%**	**100%**
EU27 (b)	20,482	8,949	3,806	1,866	1,522	1,185	1,138	1,158	1,146	1,115	999	1,085	1,054					

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.

Figure 3.20 Pb emission trends in the EU and shares of Member States



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

EU total emissions of Pb have declined by 95% 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 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. Between 2005 and 2022, lead emissions decreased by 42% mainly driven by reduced lead emissions during iron and steel production.

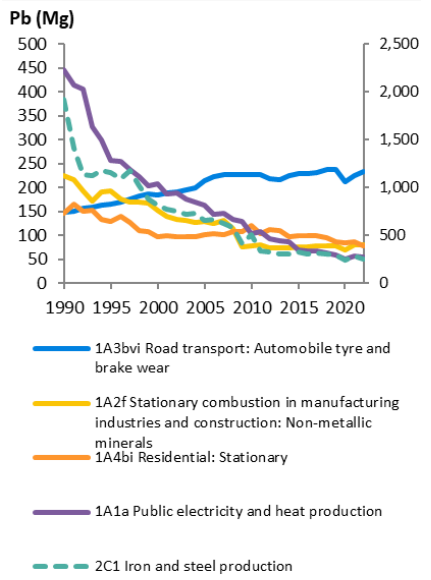
Categories '2C1 — Iron and steel production', '1A3bvi — Road transport: Automobile tyre and brake wear' and '1A4bi — Residential: Stationary' were the leading key categories for Pb emissions in 2022, together making up 54% of total Pb emissions in 2022 (see Figure 3.21 (a)).

The largest relative reductions in emissions between 1990 and 2022 were from the fifth important key category '1A1a — Public electricity and heat production' (87.5%) and the most important category '2C1 — Iron and steel production' (87%). Emissions in the second most important key category '1A3bvi — Road transport: Automobile tyre and brake wear' have increased by 57% since 1990.

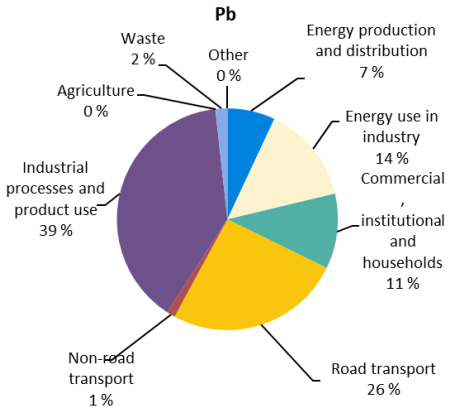
Figure 3.21(b) shows the contribution that each aggregated sector group made to total EU emissions. The sector group industrial processes and product use, road transport, energy use in industry and commercial, institutional and households are significant sources of Pb emissions.

Figure 3.21 **Pb emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

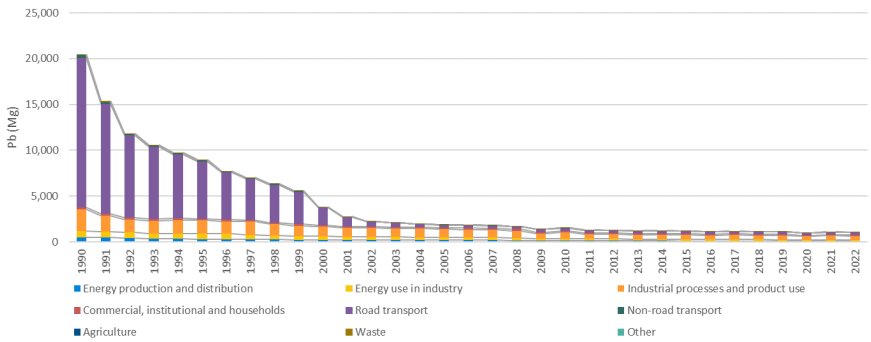
(a)



(b)



(c)



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 2022, Cd emissions fell by 67% in the EU, and between 2005 and 2022 by 39%. Between 2021 and 2022, they decreased by 4.4% (Table 3.13), mainly because decreases in Germany, Poland Italy and Romania (countries ranked according to the size of their contributions to the absolute change).

Table 3.13 Member State contributions to EU emissions of Cd

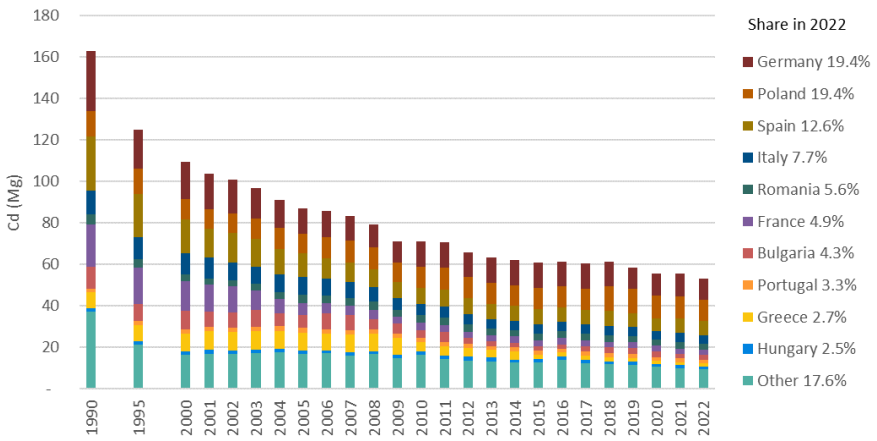
Member	Cd (Mg)													Change			Share in EU-27	
State	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	1.8	1.1	1.0	1.1	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	-49 %	-18 %	-5.3 %	1.1 %	1.7 %
Belgium	6.0	4.9	2.6	2.4	2.0	1.6	2.6	1.4	1.2	1.2	1.1	1.2	1.1	-82 %	-56 %	-10.1 %	3.7 %	2.0 %
Bulgaria	10.5	7.9	8.9	6.1	3.8	1.9	2.0	2.3	2.9	3.0	3.0	2.1	2.3	-78 %	-62 %	8.3 %	6.5 %	4.3 %
Croatia	1.2	0.9	0.9	1.2	1.0	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.8	-34 %	-32 %	-7.0 %	0.7 %	1.5 %
Cyprus	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 %	-62 %	-0.6 %	0.1 %	0.1 %
Czechia	5.2	2.2	1.7	1.7	1.5	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.3	-74 %	-22 %	-4.5 %	3.2 %	2.5 %
Denmark	1.2	0.7	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.6	0.7	0.6	-53 %	-17 %	-13.8 %	0.7 %	1.1 %
Estonia	4.5	2.2	0.8	0.5	0.6	0.5	0.5	0.6	0.6	0.5	0.5	0.4	0.5	-90 %	-11 %	7.2 %	2.7 %	0.9 %
Finland	6.7	2.1	1.4	1.5	1.3	0.9	0.9	1.0	0.9	0.8	0.7	0.8	0.8	-88 %	-46 %	-2.9 %	4.1 %	1.5 %
France	20	18	14	6.1	3.5	3.0	3.4	3.1	2.6	2.8	2.7	2.6	2.6	-87 %	-57 %	0.7 %	12.6 %	4.9 %
Germany	29	19	18	12	12	12	12	12	12	11	11	11	10	-65 %	-16 %	-6.2 %	17.9 %	19.4 %
Greece	7.5	7.8	8.4	8.9	4.6	2.1	2.0	2.1	1.9	1.7	1.5	1.5	1.5	-81 %	-84 %	-4.5 %	4.6 %	2.7 %
Hungary	1.9	1.6	1.8	1.4	1.5	1.7	1.6	1.6	1.5	1.4	1.4	1.4	1.3	-29 %	-1 %	-3.5 %	1.2 %	2.5 %
Ireland	0.6	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	-56 %	-36 %	-3.1 %	0.3 %	0.5 %
Italy	11	11	10	8.6	5.2	4.4	4.3	4.4	4.3	4.2	3.9	4.4	4.1	-63 %	-53 %	-6.6 %	6.8 %	7.7 %
Latvia	0.9	0.8	0.9	1.1	1.0	0.5	0.5	0.6	0.6	0.6	0.5	0.6	0.6	-39 %	-46 %	2.7 %	0.6 %	1.1 %
Lithuania	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	-16 %	38 %	2.5 %	0.2 %	0.5 %
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	-53 %	-52 %	38.1 %	0.1 %	0.1 %
Malta	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	-90 %	-91 %	6.7 %	0.0 %	0.0 %
Netherlands	4.1	3.0	3.0	3.8	4.7	2.9	3.0	2.7	2.6	2.7	2.0	0.9	0.8	-80 %	-79 %	-9.2 %	2.5 %	1.5 %
Poland	12	12	9.9	9.6	10	10	10	10	12	11	10.9	10.7	10.3	-14 %	8 %	-3.6 %	7.3 %	19.4 %
Portugal	1.9	1.9	2.1	2.2	2.0	1.9	1.8	1.9	1.9	1.8	1.8	1.8	1.8	-5 %	-19 %	-1.6 %	1.1 %	3.3 %
Romania	5.0	3.9	3.4	3.7	3.6	3.1	3.2	3.2	3.2	3.2	2.9	3.1	3.0	-41 %	-20 %	-5.4 %	3.1 %	5.6 %
Slovakia	1.5	1.1	1.2	1.0	0.8	0.6	0.6	0.7	0.6	0.6	0.5	0.6	0.6	-62 %	-42 %	-11.7 %	0.9 %	1.0 %
Slovenia	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.5	-20 %	-26 %	-11.3 %	0.4 %	1.0 %
Spain	26	21	16	11	7.8	7.5	6.9	7.0	7.3	6.8	6.3	6.8	6.7	-75 %	-42 %	-1.9 %	16.2 %	12.6 %
Sweden	2.3	0.7	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-78 %	-11 %	3.6 %	1.4 %	0.9 %
EU27 (a)	**163**	**125**	**109**	**87**	**71**	**61**	**61**	**60**	**61**	**59**	**56**	**55**	**53**	**-67%**	**-39%**	**-3.9%**	**100%**	**100%**
EU27 (b)	163	125	109	87	71	61	61	60	61	59	56	55	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.

In 2022, 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) (see Figure 3.21).

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 waste water treatment and incinerators have improved, as have those for metal refining and smelting facilities (EEA, 2023b).

Figure 3.22 Cd emission trends in the EU and share of Member States



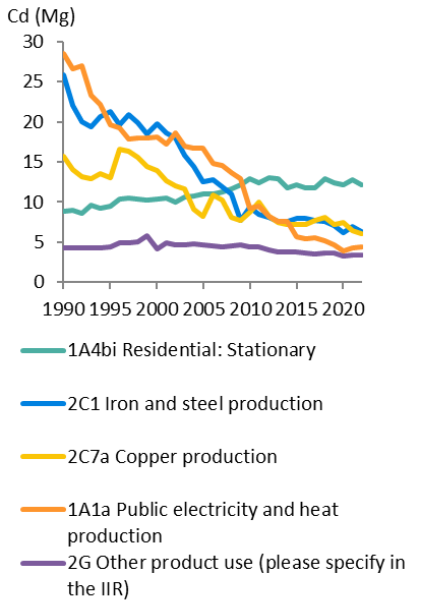
Notes: Countries are sorted by their contribution to the EU total for the last year. The top 10 countries are displayed. Data for the other 17 reporting countries are summed under 'Other'.

Categories '1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '2C7a — Copper production' were the principal key categories for Cd emissions, making up 46% of total Cd emissions (see Figure 3.23(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2022 were in the fourth most important '1A1a — Public electricity and heat production' (85%), the third most important '2C7a — Copper production' (62%) and the second most important '2C1 — Iron and steel production' (76%). In the most important key category '1A4bi — Residential: Stationary', the values of reported emissions have increased since 1990 (37%). Reduction since 2005 are mainly achieved in public electricity and heat production (1A1a) and in iron and steel production (2C1).

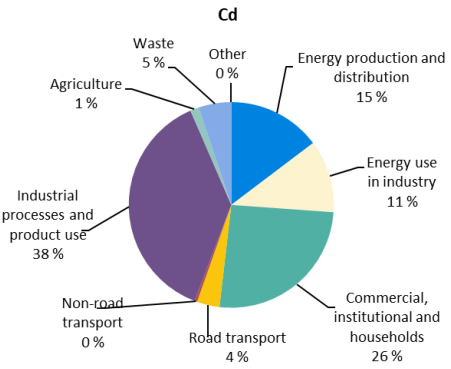
Figure 3.23(b) shows the contribution made by each aggregated sector group to total EU emissions. The common leading sources of Cd emissions are the industrial processes and product use sector and the commercial, institutional and households and energy sector.

Figure 3.23 **Cd emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

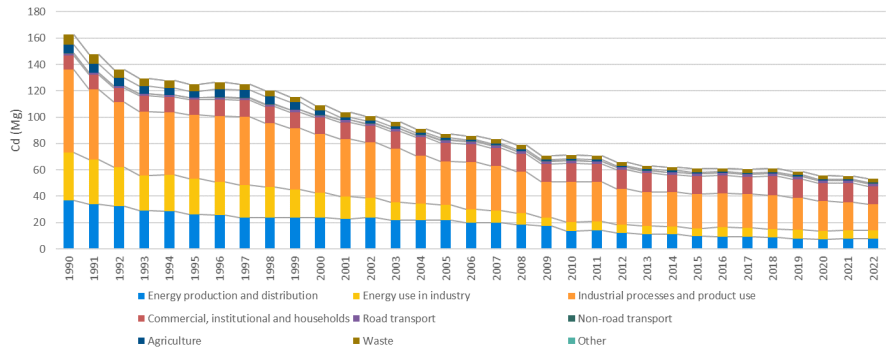
(a)



(b)



(c)



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

3.13 Mercury emission trends and key categories

Between 1990 and 2022, Hg emissions dropped by 75%, and between 2005 and 2022 by 52% in the EU. Between 2020 and 2021, they decreased by 7.9% (see Table 3.14), mainly because of slight decreases in Poland, Italy, France and Spain (countries ranked according to the size of their contributions to the absolute change).

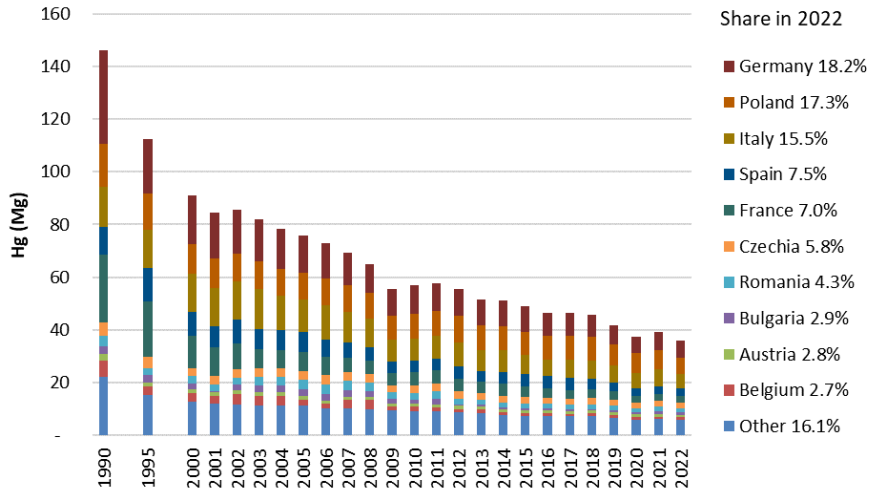
Table 3.14 Member State contributions to EU emissions of Hg

Member	Hg (Mg)													Change			Share in EU-27	
State	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	2.5	1.6	1.4	1.6	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.0	-61 %	-38 %	-5.3 %	1.7 %	2.8 %
Belgium	6.1	3.3	3.2	2.2	1.7	1.1	1.3	0.9	1.2	0.9	0.9	0.9	1.0	-84 %	-56 %	5.8 %	4.1 %	2.7 %
Bulgaria	2.8	2.7	2.4	2.4	1.5	0.5	0.5	0.5	0.5	0.9	0.8	1.0	1.1	-62 %	-56 %	4.2 %	1.9 %	2.9 %
Croatia	1.1	0.2	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	-69 %	-38 %	-2.1 %	0.7 %	0.9 %
Cyprus	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	-70 %	-69 %	-0.7 %	0.1 %	0.1 %
Czechia	5.1	4.3	3.2	3.3	3.1	2.4	2.4	2.3	2.4	2.2	2.0	2.1	2.1	-59 %	-37 %	0.5 %	3.5 %	5.8 %
Denmark	3.2	2.3	1.0	0.7	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	-92 %	-63 %	8.0 %	2.2 %	0.7 %
Estonia	1.2	0.6	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-84 %	7 %	-4.2 %	0.8 %	0.5 %
Finland	1.1	0.8	0.6	0.9	0.9	0.6	0.6	0.6	0.7	0.6	0.5	0.5	0.5	-54 %	-43 %	-2.6 %	0.7 %	1.4 %
France	26	21	12	7.4	4.9	4.1	3.6	3.3	3.2	3.2	2.7	2.8	2.5	-90 %	-66 %	-10.3 %	17.5 %	7.0 %
Germany	36	20	18	14	11	9.5	8.7	8.7	8.4	7.1	6.1	6.7	6.6	-82 %	-53 %	-1.6 %	24.3 %	18.2 %
Greece	2.3	2.3	2.6	2.7	2.5	1.4	1.2	1.3	1.4	1.2	0.8	0.8	0.7	-67 %	-73 %	-12.7 %	1.6 %	2.1 %
Hungary	2.8	2.0	1.7	1.3	0.9	0.9	0.9	1.0	0.8	0.8	0.8	0.8	0.7	-75 %	-48 %	-9.3 %	1.9 %	1.9 %
Ireland	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	-60 %	-40 %	-13.0 %	0.5 %	0.8 %
Italy	15	14	15	13	8.5	7.2	6.4	7.1	6.9	6.4	5.8	6.3	5.6	-64 %	-56 %	-12.2 %	10.5 %	15.5 %
Latvia	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-65 %	16 %	7.1 %	0.2 %	0.3 %
Lithuania	0.4	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	-38 %	56 %	-8.8 %	0.2 %	0.6 %
Luxembourg	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	-51 %	-15 %	-7.5 %	0.3 %	0.5 %
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	-87 %	-81 %	1.2 %	0.0 %	0.0 %
Netherlands	3.7	1.6	1.2	1.0	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	-87 %	-53 %	5.2 %	2.5 %	1.4 %
Poland	16	14	11	10	9.4	9.0	8.8	8.8	9.0	8.3	7.7	7.5	6.2	-62 %	-39 %	-17.2 %	11.3 %	17.3 %
Portugal	1.2	1.4	1.2	0.9	0.8	0.9	0.8	0.9	0.8	0.8	0.7	0.7	0.7	-47 %	-29 %	-9.6 %	0.8 %	1.8 %
Romania	4.2	2.7	2.6	3.5	2.4	1.9	1.8	1.8	1.8	1.8	1.6	1.7	1.6	-63 %	-56 %	-9.2 %	2.9 %	4.3 %
Slovakia	2.0	1.5	1.6	0.9	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-75 %	-48 %	-5.7 %	1.4 %	1.4 %
Slovenia	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-50 %	-20 %	-4.3 %	0.2 %	0.5 %
Spain	10	13	8.9	7.4	4.3	4.5	4.5	4.5	4.3	3.2	2.8	2.9	2.7	-74 %	-64 %	-5.8 %	7.1 %	7.5 %
Sweden	1.6	1.0	0.8	0.7	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	-75 %	-41 %	-3.9 %	1.1 %	1.1 %
EU27 (a)	**146**	**112**	**91**	**76**	**57**	**49**	**46**	**46**	**46**	**42**	**37**	**39**	**36**	**-75%**	**-52%**	**-7.9%**	**100%**	**100%**
EU27 (b)	146	112	91	76	57	49	46	46	46	42	37	39	36					

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 2022, the EU Member States contributing most (i.e. more than 10%) to Hg emissions were Germany, Poland and Italy (countries ranked according to their shares of the EU total) (see Figure 3.23).

Figure 3.24 Hg emission trends in the EU and shares of Member States



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

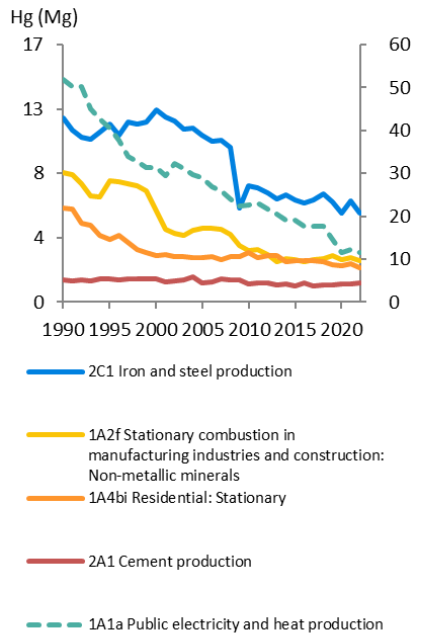
Categories '1A1a — Public electricity and heat production', '2C1 — Iron and steel production' and '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' were the main key categories for Hg emissions, making up 56% of the total (see Figure 3.25(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2022 was in the most important '1A1a — Public electricity and heat production' (78%). The third most important key category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (68%) and the fourth most important category '1A4bi — Residential: Stationary' (64%) also show large reductions.

The reductions achieved since 2005 are mainly occurring in the public electricity and heat production (-17 Mg in 1A1a), the chemical industry (-5 Mg in 2B10a) and the Irons and steel industry (-5 Mg in 2C1). The strong decrease in 2009 in the sector '2C1 — Iron and steel production' mainly reflects lower emissions reported by Belgium (see Figure 3.25). 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 (EEA, 2023b).

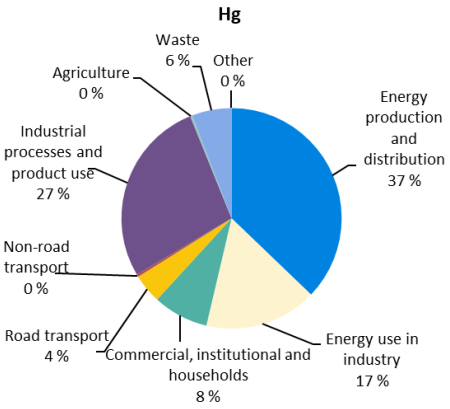
Figure 3.25(b) shows the contribution made by each aggregated sector group to total EU emissions. For Hg, the principal emission sources are the energy sectors and the industrial processes and product use sector.

Figure 3.25 **Hg emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

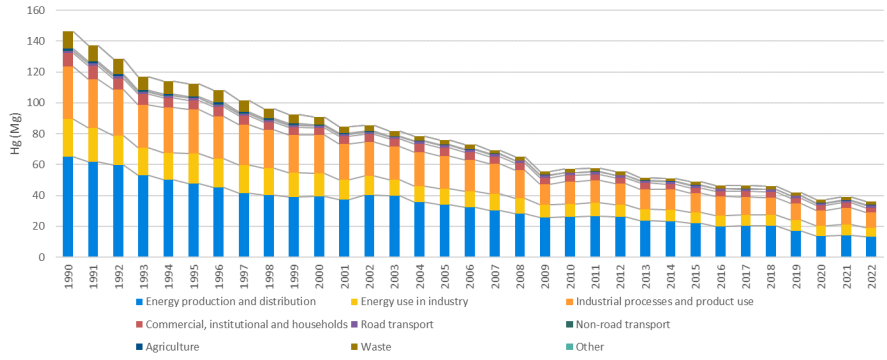
(a)



(b)



(c)



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

3.14 Arsenic emission trends

Between 1990 and 2022, As emissions dropped by 90% in the EU, and by 61% between 2005 and 2022. Between 2021 and 2022, emissions decreased by 0.6% (Table 3.15), mainly because emissions fell in Poland and Romania (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 2022 were Poland, Germany, France (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 3.15 Member State contributions to EU emissions of As

Member State	As (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria																	0.0 %	0.0 %
Belgium	6.7	6.4	3.9	3.1	1.9	1.2	1.0	0.9	0.9	0.9	0.9	0.8	0.8	-88 %	-75 %	-3.4 %	1.2 %	1.4 %
Bulgaria	27	18.0	18.1	14.4	6.1	1.8	2.5	2.5	2.4	3.4	2.9	3.1	3.9	-85 %	-73 %	26.1 %	4.7 %	7.1 %
Croatia	8.7	1.3	1.1	1.2	0.8	0.5	0.4	0.6	0.6	0.6	0.3	0.3	0.4	-96 %	-68 %	8.6 %	1.5 %	0.7 %
Cyprus	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-31 %	-61 %	-1.4 %	0.0 %	0.2 %
Czechia	69	17	3.9	2.2	1.8	1.6	1.5	1.6	1.5	1.4	1.3	1.3	1.4	-98 %	-36 %	5.0 %	12.1 %	2.5 %
Denmark	1.4	0.8	0.9	0.5	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-80 %	-50 %	-6.7 %	0.2 %	0.5 %
Estonia	20	9.7	6.7	1.7	2.0	0.9	1.0	1.1	1.0	0.6	0.5	0.5	0.6	-97 %	-63 %	19.1 %	3.4 %	1.2 %
Finland	35	5.2	4.4	3.0	3.4	2.5	2.6	2.4	2.4	2.1	2.0	2.0	1.9	-94 %	-36 %	-6.2 %	6.1 %	3.5 %
France	17	17	16	13	8.8	6.3	6.4	6.2	6.2	6.0	5.1	5.7	5.5	-68 %	-56 %	-2.9 %	3.0 %	10.0 %
Germany	86	9.1	8.0	7.5	7.1	6.8	6.7	6.5	5.9	5.2	5.0	5.4	5.6	-94 %	-25 %	3.0 %	14.9 %	10.1 %
Greece	2.4	2.6	3.0	3.2	2.4	3.2	2.6	2.8	2.5	1.9	1.2	1.2	1.2	-50 %	-63 %	0.5 %	0.4 %	2.1 %
Hungary	4.0	3.3	3.2	2.6	2.3	2.2	2.0	2.2	2.1	2.0	1.8	1.6	1.4	-65 %	-45 %	-8.3 %	0.7 %	2.6 %
Ireland	1.8	1.9	1.9	1.8	1.4	1.6	1.6	1.5	1.4	1.2	1.1	1.2	1.2	-35 %	-34 %	-4.8 %	0.3 %	2.1 %
Italy	37	28	39	28	17	9.4	7.9	7.5	7.4	6.3	5.3	5.8	6.3	-83 %	-77 %	9.4 %	6.5 %	11.5 %
Latvia	17	8.5	15	17	16	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3	-98 %	-98 %	1.0 %	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	0.3	-63 %	54 %	15.9 %	0.1 %	0.5 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR					
Malta	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	-93 %	-91 %	4.5 %	0.0 %	0.0 %
Netherlands	1.5	1.1	1.1	1.5	0.8	0.8	0.9	0.7	0.5	0.3	0.3	0.3	0.3	-80 %	-79 %	15.0 %	0.3 %	0.6 %
Poland	144	71	30	17	17	17	16	16	16	15	14.5	14.9	14.0	-90 %	-18 %	-6.1 %	25.1 %	25.4 %
Portugal	2.0	2.6	2.9	3.0	1.8	2.2	1.9	2.1	1.9	1.5	1.3	1.2	1.1	-44 %	-62 %	-2.2 %	0.4 %	2.1 %
Romania	73	37	5.8	6.6	5.2	4.7	4.3	4.3	4.3	4.2	3.3	3.6	3.2	-96 %	-52 %	-12.4 %	12.7 %	5.8 %
Slovakia	3.5	2.1	2.1	1.8	1.5	1.2	1.0	1.0	0.9	0.8	0.7	0.9	0.8	-78 %	-56 %	-14.5 %	0.6 %	1.4 %
Slovenia	0.9	0.8	0.8	0.9	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.5	-44 %	-43 %	-16.9 %	0.2 %	0.9 %
Spain	10	9.6	10.1	9.4	5.6	5.6	5.1	5.6	5.4	3.9	3.3	3.4	3.4	-67 %	-63 %	0.6 %	1.8 %	6.2 %
Sweden	5.7	1.6	0.9	1.0	1.0	0.7	0.7	0.8	0.8	0.7	0.7	0.6	0.6	-89 %	-39 %	2.3 %	1.0 %	1.1 %
EU27 (a)	**575**	**255**	**180**	**140**	**106**	**71**	**68**	**68**	**65**	**60**	**53**	**56**	**55**	**-90%**	**-61%**	**-0.6%**	**100%**	**100%**
EU27 (b)	575	255	180	140	106	71	68	68	65	60	53	56	55					

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.

The main source of Arsen emissions are public electricity and heat production (share of 35% in 2022), and domestic aviation cruise (share of 9%). While emissions from the first category decreased by 56% since, emissions from aviation increased by more than 30,000 times.

3.15 Chromium emission trends

Between 1990 and 2022, Cr emissions dropped by 69% in the EU, and by 27% between 2005 and 2022. Between 2021 and 2022, emissions decreased by 1.2% (see Table 3.16), mainly because of decreases in Romania, Poland, Spain and Hungary (countries ranked according to the size of their contributions to the absolute change). In 2022, the EU Member States contributing most (i.e. more than 10%) to Cr emissions were Germany, Poland and Italy (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 3.16 Member State contributions to EU emissions of Cr

Member State	Cr (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria																	0.0 %	0.0 %
Belgium	38	34	23	20	16	8.6	9.0	7.4	7.3	7.2	6.6	6.6	7.2	-81 %	-65 %	8.3 %	3.7 %	2.3 %
Bulgaria	22	17	17.3	13.8	8.8	4.2	4.4	4.9	5.6	7.0	6.7	5.9	6.5	-71 %	-53 %	9.5 %	2.2 %	2.0 %
Croatia	5.7	4.1	3.8	4.4	3.3	2.9	2.8	3.0	2.8	2.8	2.6	2.8	2.9	-50 %	-34 %	0.6 %	0.6 %	0.9 %
Cyprus	0.3	0.4	0.5	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	23 %	-26 %	-1.4 %	0.0 %	0.1 %
Czechia	23	16	12	13	12	12	12	11.6	12	11.3	10.3	11.0	11.1	-52 %	-17 %	1.6 %	2.3 %	3.5 %
Denmark	8.1	5.4	4.1	4.2	4.4	4.4	4.5	4.4	4.3	2.8	2.7	2.7	2.6	-68 %	-38 %	-5.3 %	0.8 %	0.8 %
Estonia	17	9.0	6.9	3.5	4.4	2.8	3.1	3.3	3.0	1.9	1.6	1.8	2.2	-87 %	-39 %	20.6 %	1.7 %	0.7 %
Finland	48	36	29	20	26	17	18	17	15	14	14	14	15	-69 %	-26 %	6.4 %	4.7 %	4.7 %
France	401	199	115	62	47	38	37	36	36	36	33	32	32	-92 %	-49 %	-1.8 %	39.4 %	10.0 %
Germany	166	94	83	76	74	76	77	77	76	71	66	70	70	-58 %	-8 %	0.0 %	16.3 %	22.1 %
Greece	6.0	6.5	6.9	9.8	9.8	17	13	12	13	12	6.	6.	5.9	-1 %	-40 %	-0.8 %	0.6 %	1.9 %
Hungary	18	12	13	13	12	13	10.9	14	14	13	12	10	9	-51 %	-32 %	-10.1 %	1.8 %	2.8 %
Ireland	5.0	5.2	5.9	4.7	3.7	3.8	3.8	3.7	3.7	3.6	3.2	3.4	3.5	-31 %	-25 %	2.3 %	0.5 %	1.1 %
Italy	95	79	55	62	52	47	46	45	45	44	38	44	44	-54 %	-29 %	-0.3 %	9.4 %	13.9 %
Latvia	2.8	2.1	2.4	2.9	2.8	1.5	1.5	1.6	1.7	1.7	1.6	1.7	1.7	-39 %	-41 %	0.5 %	0.3 %	0.5 %
Lithuania	3.0	1.5	1.3	1.5	1.4	1.5	1.6	1.6	1.6	1.6	1.6	1.8	2.3	-24 %	59 %	29.5 %	0.3 %	0.7 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR					
Malta	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	5 %	-9 %	7.1 %	0.0 %	0.1 %
Netherlands	12	8.6	5.1	4.4	3.9	3.5	3.8	3.6	3.5	3.3	3.2	3.5	3.5	-71 %	-20 %	-1.2 %	1.2 %	1.1 %
Poland	56	53	42	42	46	43	44	46	48	47	46	48	46	-17 %	10 %	-2.8 %	5.5 %	14.7 %
Portugal	8	9	10	10	8.4	7.6	7.0	7.2	6.9	6.9	6.6	6.8	6.7	-18 %	-30 %	-1.7 %	0.8 %	2.1 %
Romania	25	19	15	20	14	14	14	14	14	15	13	15	13	-48 %	-36 %	-11.4 %	2.5 %	4.1 %
Slovakia	6.1	3.8	3.0	3.3	3.7	3.5	3.7	3.6	3.4	3.5	3.3	3.8	2.9	-53 %	-12 %	-23.8 %	0.6 %	0.9 %
Slovenia	1.7	1.8	1.8	2.0	2.1	1.9	1.9	1.9	1.8	1.8	1.6	1.8	1.7	-1 %	-17 %	-3.6 %	0.2 %	0.5 %
Spain	27	29	33	32	25	25	24	24	25	23	20	21	20	-26 %	-38 %	-6.2 %	2.6 %	6.3 %
Sweden	23	12	7.0	10	5.1	5.4	5.6	6.7	6.0	6.0	5.2	6.3	6.5	-71 %	-35 %	3.5 %	2.2 %	2.1 %
EU27 (a)	**1,018**	**658**	**496**	**436**	**386**	**353**	**349**	**349**	**350**	**336**	**305**	**320**	**316**	**-69%**	**-27%**	**-1.2%**	**100%**	**100%**
EU27 (b)	1,018	658	496	436	386	353	349	349	350	336	305	320	316					

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.

The main source of chromium emission are arising from automobile tyre and brake wear (1A3bvi) with a share of 27%, these emissions increased by 9% since 2005. Other important contributing categories, such as iron and steel production, residential heating, railways and public electricity and heating saw decreases in Cr emissions during the same time.

3.16 Copper emission trends

Between 1990 and 2022, Cu emissions in the EU increased by 11%, between 2005 and 2022 by only 0.6%. Between 2021 and 2022, they grew by 5.1% (see Table 3.17), mainly because of increases in Germany, France, Italy and Lithuania (countries ranked according to the size of their contributions to the absolute change). In 2022, the EU Member States contributing most (i.e. more than 10%) to Cu emissions were Germany, Italy, Poland and France (together they account for 63% of the 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 3.17 Member State contributions to EU emissions of Cu

Member State	Cu (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria																	0.0 %	0.0 %
Belgium	91	97	100	101	101	97	97	94	93	92	79	81	84	-8 %	-17 %	4.7 %	3.9 %	3.2 %
Bulgaria	73	52	62	54	39	43	44	45	48	48	45	46	46	-36 %	-15 %	1.3 %	3.1 %	1.8 %
Croatia	16.9	14.9	19.7	23.6	23.9	24.9	25.5	27.8	27.3	29.2	26.4	28.2	30.8	82 %	31 %	9.1 %	0.7 %	1.2 %
Cyprus	4.8	6.1	7.4	8.4	9.2	7.3	7.7	7.9	8.0	7.8	7.2	7.7	7.5	58 %	-11 %	-1.6 %	0.2 %	0.3 %
Czechia	53	48	50	66	63	67	69	70	71	72	69	72	74	41 %	12 %	3.6 %	2.2 %	2.8 %
Denmark	49	56	63	68	70	69	69	69	71	66	61	62	63	28 %	-8 %	1.3 %	2.1 %	2.4 %
Estonia	15	8.4	7.7	9.6	10.5	10.7	11.3	11.8	12.1	11.3	10.5	11.2	11.9	-23 %	25 %	6.4 %	0.7 %	0.5 %
Finland	157	116	65	58	42	41	42	41	40	40	38	39	38	-76 %	-34 %	-0.4 %	6.7 %	1.5 %
France	285	291	301	326	339	335	332	330	328	328	279	289	311	9 %	-5 %	7.4 %	12.1 %	11.9 %
Germany	620	522	543	541	547	581	588	591	594	594	524	534	560	-10 %	4 %	5.0 %	26.3 %	21.4 %
Greece	22	26	29	89	87	69	68	70	71	71	59	64	69	207 %	-23 %	6.9 %	1.0 %	2.6 %
Hungary	34	28	34	48	50	51	52	55	58	61	54	60	64	92 %	35 %	8.0 %	1.4 %	2.5 %
Ireland	20	24	41	49	44	47	48	48	48	48	41	44	47	133 %	-5 %	7.2 %	0.9 %	1.8 %
Italy	389	440	466	500	460	457	407	381	386	384	312	376	394	1 %	-21 %	4.6 %	16.5 %	15.0 %
Latvia	10.8	7.5	8.3	11.8	13.2	13.1	13.2	13.9	14.4	14.6	14.1	14.6	14.5	34 %	23 %	-0.7 %	0.5 %	0.6 %
Lithuania	7.7	3.9	3.2	4.3	4.5	5.0	5.2	5.5	5.9	6.1	5.7	5.8	18.2	136 %	327 %	212.8 %	0.3 %	0.7 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR					
Malta	1.3	1.9	2.3	2.6	2.7	3.1	3.2	3.2	3.3	3.1	2.4	2.9	3.0	141 %	17 %	5.8 %	0.1 %	0.1 %
Netherlands	91	100	108	107	115	108	110	111	113	114	102	99	105	15 %	-2 %	6.0 %	3.9 %	4.0 %
Poland	213	227	210	244	315	298	323	363	373	369	358	378	384	80 %	58 %	1.6 %	9.0 %	14.7 %
Portugal	25	31	41	44	36	30	29	30	30	30	26	27	29	15 %	-35 %	6.4 %	1.1 %	1.1 %
Romania	9.8	8.6	6.9	50	57	59	64	68	71	73	72	74	81	725 %	60 %	9.1 %	0.4 %	3.1 %
Slovakia	12	8.6	6.6	8.3	9.3	10	11	11	9.1	9.2	8.0	8.7	9.1	-25 %	10 %	4.5 %	0.5 %	0.3 %
Slovenia	9.1	12.7	12.5	14.7	16.7	16.2	17.1	17.3	17.7	17.2	14.1	16.2	17.9	96 %	22 %	10.7 %	0.4 %	0.7 %
Spain	80	93	119	135	133	122	123	126	127	124	103	114	117	45 %	-14 %	2.0 %	3.4 %	4.5 %
Sweden	66	52	46	38	38	38	39	40	41	40	38	38	39	-41 %	1 %	0.9 %	2.8 %	1.5 %
EU27 (a)	**2,356**	**2,276**	**2,352**	**2,602**	**2,625**	**2,602**	**2,598**	**2,630**	**2,660**	**2,652**	**2,347**	**2,492**	**2,618**	**11%**	**1%**	**5.1%**	**100%**	**100%**
EU27 (b)	2,356	2,276	2,352	2,602	2,625	2,602	2,598	2,630	2,660	2,652	2,347	2,492	2,618					

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.

The main source of copper emissions with a share of 69% in 2022 in the EU are from category automobile tyre and brake ware (1A3bvi). Since 2005, these emissions increased by 9.1%

3.17 Nickel emission trends

Between 1990 and 2022, Ni emissions dropped by 77% in the EU, and by 60% between 2005 and 2022. Between 2021 and 2022, they increased by 3.4%, mainly because of increasing emissions in Germany, Spain, Italy and Lithuania (countries ranked according to the size of their contributions to the absolute change) (see Table 3.18). In 2022, the EU Member States contributing most (i.e. more than 10%) to Ni emissions were France, 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 3.18 Member State contributions to EU emissions of Ni

Member State	Ni (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria																		
Belgium	77	72	36	29	10	5.4	5.3	4.4	4.1	4.2	3.7	3.9	4.3	-94 %	-85 %	10.8 %	4.1 %	1.0 %
Bulgaria	86	47	34	25	10.6	5.4	5.4	5.9	6.0	6.0	5.4	9.7	8.0	-91 %	-68 %	-17.4 %	4.6 %	1.9 %
Croatia	17	14	13	14	7.8	4.6	4.3	4.4	3.6	2.9	2.4	2.6	2.9	-83 %	-79 %	11.3 %	0.9 %	0.7 %
Cyprus	6.0	7.4	10	12	7.3	5.3	5.7	5.7	5.7	5.1	5.1	4.7	4.7	-22 %	-62 %	-1.6 %	0.3 %	1.1 %
Czechia	55	28	14	12	8.2	5.6	5.3	5.6	5.4	5.1	4.8	4.7	5.4	-90 %	-57 %	13.5 %	2.9 %	1.2 %
Denmark	23	18	12.4	12.1	9.9	8.1	8.4	8.3	7.8	4.9	5.0	5.2	5.1	-77 %	-58 %	-1.6 %	1.2 %	1.2 %
Estonia	26	10	6.1	3.4	3.3	2.6	2.8	2.7	2.4	1.8	1.7	1.6	1.7	-93 %	-48 %	12.1 %	1.4 %	0.4 %
Finland	78	47	35	26	23	16	16	15	14	12	9.6	9.9	9.9	-87 %	-62 %	0.1 %	4.2 %	2.3 %
France	290	214	177	147	90	42	38	30	24	25	20	20	22	-93 %	-85 %	7.1 %	15.4 %	5.0 %
Germany	333	204	161	174	143	143	153	151	142	131	133	137	143	-57 %	-18 %	4.8 %	17.7 %	33.3 %
Greece	42	47	50	56	61	40	35	32	30	27	22	23	23	-45 %	-59 %	1.8 %	2.2 %	5.3 %
Hungary	12	20	15	3.8	3.2	2.9	2.9	3.1	3.0	2.9	2.6	2.5	2.4	-81 %	-38 %	-5.8 %	0.7 %	0.6 %
Ireland	22.2	27	32	22	9.6	6.0	5.7	5.3	5.4	5.5	5.5	8.0	6.9	-69 %	-68 %	-13.9 %	1.2 %	1.6 %
Italy	116	112	109	114	43	33	32	32	32	30	28	31	34	-71 %	-70 %	10.6 %	6.1 %	7.8 %
Latvia	15	8.5	6.8	6.5	5.9	0.5	0.5	0.6	0.7	0.6	0.6	0.6	0.7	-95 %	-90 %	4.5 %	0.8 %	0.2 %
Lithuania	32	16	11.8	10.6	6.7	3.7	3.1	2.5	2.3	1.7	2.5	2.0	3.6	-89 %	-66 %	79.9 %	1.7 %	0.8 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR					
Malta	3.9	5.6	5.4	5.2	4.9	1.8	1.1	0.4	0.3	0.3	0.4	0.4	0.5	-88 %	-91 %	10.3 %	0.2 %	0.1 %
Netherlands	76	86	20	11	2.5	2.1	2.4	2.1	1.9	1.6	1.8	1.7	1.7	-98 %	-84 %	-3.0 %	4.0 %	0.4 %
Poland	200	166	120	106	103	84	84	82	79	75	74	78	78	-61 %	-27 %	0.0 %	10.6 %	18.0 %
Portugal	57	64	63	67	33	18	16	16	16	16	15	14	15	-73 %	-77 %	6.9 %	3.0 %	3.5 %
Romania	113	64	35	25	15	11	9.8	12	11.2	12	10.5	11.8	11.5	-90 %	-55 %	-2.9 %	6.0 %	2.7 %
Slovakia	7.4	3.8	2.4	1.6	1.8	1.4	1.3	1.2	1.1	1.1	1.0	1.2	1.1	-85 %	-29 %	-6.5 %	0.4 %	0.3 %
Slovenia	2.9	2.1	2.5	2.4	2.2	1.5	1.6	1.6	1.6	1.5	1.5	1.4	1.3	-57 %	-48 %	-11.1 %	0.2 %	0.3 %
Spain	164	191	197	174	91	45	47	52	51	46	35	37	39	-76 %	-78 %	6.3 %	8.7 %	9.1 %
Sweden	28	30	17	15	14	6.7	7.1	6.6	6.9	6.2	5.4	6.0	5.6	-80 %	-64 %	-6.6 %	1.5 %	1.3 %
EU27 (a)	**1,881**	**1,505**	**1,185**	**1,075**	**709**	**495**	**492**	**482**	**457**	**425**	**397**	**417**	**431**	**-77%**	**-60%**	**3.4%**	**100%**	**100%**
EU27 (b)	1,881	1,505	1,185	1,075	709	495	492	482	457	425	397	417	431					

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.

The main emission source for Ni emission is petroleum refining (1A1b) contributing with a share of 26% to the EU total in 2022. These emissions decreased since 2005 by 62%. Other importat sources are electricity and heat production (share of 15%) and railways (share of 11%).

3.18 Selenium emission trends

Between 1990 and 2022, Se emissions dropped by 56% in the EU. Between 2021 and 2022, they increased by 2.6% (see Table 3.19), mainly because of increases in Bulgaria, Czechia, Italy and Estonia (countries ranked according to the size of their contributions to the absolute change). In 2022, 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 sector totals.

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 3.19 Member State contributions to EU emissions of Se

Member State	Se (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria																	0.0 %	0.0 %
Belgium	5.1	6.4	6.5	27	12	3.7	2.8	2.6	1.9	1.6	1.6	1.9	1.6	-69 %	-94 %	-18.4 %	2.8 %	1.9 %
Bulgaria	35.4	33.5	29.9	29.7	17.8	0.8	0.9	0.9	0.9	9.4	8.2	9.3	11.8	-67 %	-60 %	27.6 %	19.1 %	14.5 %
Croatia	0.5	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.4	-14 %	-1 %	5.0 %	0.2 %	0.5 %
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	-39 %	-62 %	0.1 %	0.0 %	0.1 %
Czechia	32	29	28	30	26	22	22	22	22	21	17.2	18.1	19.6	-40 %	-35 %	8.3 %	17.5 %	24.1 %
Denmark	4.2	3.9	2.3	1.5	1.4	0.7	0.7	0.6	0.5	0.4	0.4	0.5	0.5	-89 %	-68 %	-4.6 %	2.3 %	0.6 %
Estonia	9.2	4.9	3.6	1.4	1.8	1.0	1.2	1.3	1.2	0.7	0.6	0.6	0.7	-92 %	-50 %	21.2 %	5.0 %	0.9 %
Finland	1.8	0.4	0.5	0.5	0.6	0.5	0.4	0.9	0.5	0.4	0.4	0.5	0.4	-77 %	-23 %	-14.9 %	1.0 %	0.5 %
France	13	13	13	12	11	10.2	9.7	9.8	9.8	9.6	8.4	9.4	9.0	-30 %	-28 %	-3.3 %	6.9 %	11.1 %
Germany	5.7	11	8.5	4.8	4.2	3.2	3.3	3.2	2.9	2.8	2.7	2.8	2.9	-50 %	-40 %	4.2 %	3.1 %	3.5 %
Greece	14	14	16	17	15	11	8.9	10.0	9.5	7.1	3.8	3.6	3.6	-74 %	-79 %	-0.4 %	7.4 %	4.4 %
Hungary	6.4	5.8	5.8	4.1	3.5	3.3	3.2	3.0	2.8	2.5	2.3	2.1	2.0	-69 %	-52 %	-5.0 %	3.5 %	2.4 %
Ireland	9.3	7.0	5.6	5.2	4.5	4.6	4.5	3.9	3.6	3.0	2.7	2.9	2.3	-75 %	-56 %	-19.4 %	5.0 %	2.8 %
Italy	7.7	7.8	8.5	8.9	8.1	8.4	7.3	7.3	7.2	6.6	6.0	6.6	6.9	-10 %	-22 %	5.4 %	4.2 %	8.5 %
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	-78 %	3 %	13.0 %	0.2 %	0.1 %
Lithuania	0.3	0.2	0.1	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.4	0.4	29 %	133 %	8.1 %	0.2 %	0.5 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR					
Malta	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-97 %	-89 %	-1.3 %	0.1 %	0.0 %
Netherlands	0.4	0.4	0.5	2.6	1.6	1.0	0.7	0.3	0.2	0.2	0.2	0.2	0.2	-54 %	-93 %	-1.2 %	0.2 %	0.2 %
Poland																	0.0 %	0.0 %
Portugal	3.8	5.2	5.8	6.1	4.7	6.3	5.8	6.2	5.8	4.5	3.6	3.5	3.3	-13 %	-46 %	-3.1 %	2.1 %	4.1 %
Romania	20	16	12	13	12	11	9.4	9.5	9.3	8.7	6.2	6.8	6.4	-68 %	-49 %	-6.2 %	10.6 %	7.8 %
Slovakia	5.5	3.0	3.0	3.2	2.6	1.6	1.1	1.0	1.0	0.9	0.9	0.9	0.9	-84 %	-72 %	-2.3 %	3.0 %	1.1 %
Slovenia	2.9	2.5	2.4	2.6	2.5	1.9	2.0	2.0	2.0	1.9	1.8	1.7	1.4	-53 %	-46 %	-19.4 %	1.6 %	1.7 %
Spain	6.7	6.9	8.1	8.1	6.0	6.5	6.4	6.5	6.6	6.4	6.0	6.4	6.1	-9 %	-25 %	-4.4 %	3.6 %	7.5 %
Sweden	1.0	1.2	1.0	1.1	1.2	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	7 %	2 %	-1.7 %	0.5 %	1.3 %
EU27 (a)	**186**	**172**	**162**	**180**	**137**	**99**	**92**	**93**	**90**	**89**	**75**	**80**	**82**	**-56%**	**-55%**	**2.6%**	**100%**	**100%**
EU27 (b)	186	172	162	180	137	99	92	93	90	89	75	80	82					

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.
Light blue-shaded cells denote gap-filled data. For more detailed information, see Annex D.
(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 main emission source for selenium emissions in the EU are: Public electricity and heat production (1A1a) with a share of 53%, glass production (2A3) with a share of 16% and stationary combustion in manufacturing industries and construction: Non-metallic minerals (1A2f) with a share of 11%.

3.19 Zinc emission trends

Between 1990 and 2022, Zn emissions dropped by 49% in the EU, and by 9.4% between 2005 and 2022. Between 2021 and 2022, they decreased by 2.8%, mainly because of decreases reported by Italy, Poland, France and Romania (countries ranked according to the size of their contributions to the absolute change) (see Table 3.20). In 2022, the EU Member States contributing most (i.e. more than 10%) to Zn emissions were Italy, Poland, Spain and France (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 3.20 Member State contributions to EU emissions of Zn

Member State	Zn (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria																		
Belgium	242	193	192	142	121	93	84	78	79	85	70	76	77	-68 %	-46 %	1.4 %	3.5 %	2.2 %
Bulgaria	47	40	39	46	41	37	39	40	41	43	44	46	42	-10 %	-8 %	-8.5 %	0.7 %	1.2 %
Croatia	41	34	33	39	39	37	36	37	36	36	35	39	38	-8 %	-5 %	-2.7 %	0.6 %	1.1 %
Cyprus	4.1	5.0	6.3	7.3	5.8	4.3	4.5	4.6	4.6	4.4	4.1	4.2	4.1	1 %	-44 %	-1.1 %	0.1 %	0.1 %
Czechia	110	84	71	70	66	55	52	53	53	52	50	52	53	-52 %	-24 %	1.6 %	1.6 %	1.5 %
Denmark	75	70	59	63	66	66	67	65	70	64	60	61	60	-20 %	-5 %	-2.1 %	1.1 %	1.7 %
Estonia	106	61	44	27	32	26	28	30	31	26	26	25	27	-74 %	2 %	8.4 %	1.5 %	0.8 %
Finland	683	403	128	119	129	119	127	120	118	130	116	134	132	-81 %	10 %	-1.6 %	9.9 %	3.8 %
France	2,094	1,299	910	512	460	421	423	414	416	408	364	388	378	-82 %	-26 %	-2.7 %	30.5 %	10.8 %
Germany	474	266	277	259	289	293	295	300	298	298	267	283	292	-38 %	13 %	3.3 %	6.9 %	8.4 %
Greece	67	71	74	90	86	80	74	75	75	73	67	70	72	7 %	-20 %	3.2 %	1.0 %	2.1 %
Hungary	83	65	69	66	73	75	75	74	69	68	65	68	69	-17 %	4 %	0.7 %	1.2 %	2.0 %
Ireland	55	51	60	33	27	28	29	28	28	27	25	27	27	-50 %	-18 %	0.8 %	0.8 %	0.8 %
Italy	971	962	925	999	899	843	783	830	851	818	722	864	795	-18 %	-20 %	-8.0 %	14.1 %	22.8 %
Latvia	31	30	27	33	31	26	26	28	29	29	27	28	29	-8 %	-12 %	1.7 %	0.5 %	0.8 %
Lithuania	23	17	19	23	24	28	29	30	30	29	30	32	34	50 %	48 %	5.7 %	0.3 %	1.0 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR					
Malta	1.7	2.3	2.3	2.9	2.7	1.9	1.6	1.2	1.0	1.0	0.8	0.9	1.0	-43 %	-67 %	5.7 %	0.0 %	0.0 %
Netherlands	226	147	96	89	103	103	101	94	355	280	178	150	156	-31 %	75 %	3.9 %	3.3 %	4.5 %
Poland	790	802	573	522	544	516	524	545	604	573	549	557	528	-33 %	1 %	-5.3 %	11.5 %	15.1 %
Portugal	66	67	70	68	60	53	53	54	54	53	51	52	54	-18 %	-21 %	4.5 %	1.0 %	1.6 %
Romania	125	98	103	135	132	119	120	122	122	124	119	128	121	-3 %	-10 %	-5.2 %	1.8 %	3.5 %
Slovakia	35	26	26	30	32	35	35	36	34	31	28	33	30	-15 %	-1 %	-8.5 %	0.5 %	0.9 %
Slovenia	21	20	19	24	23	22	23	22	21	21	19	21	20	-4 %	-16 %	-6.2 %	0.3 %	0.6 %
Spain	315	270	357	350	387	382	368	362	424	352	370	380	379	20 %	8 %	-0.4 %	4.6 %	10.9 %
Sweden	190	135	93	99	99	82	79	77	76	74	68	68	68	-64 %	-31 %	0.5 %	2.8 %	2.0 %
EU27 (a)	**6,875**	**5,216**	**4,273**	**3,850**	**3,770**	**3,545**	**3,477**	**3,520**	**3,921**	**3,699**	**3,355**	**3,589**	**3,487**	**-49%**	**-9.4%**	**-2.8%**	**100%**	**100%**
EU27 (b)	6,875	5,216	4,273	3,850	3,770	3,545	3,477	3,520	3,921	3,699	3,355	3,589	3,487					

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.

The categories contributing most to total Zn emissions in 2022 are: 'Road transport: Automobile tyre and brake wear (1A3bvi)' with a share of 20%, 'Iron and steel production (2C1) with a share of 20%, residential heating (1A4bi) with a share of 17% and open burning of waste (5C2) with a share of 7%.

3.20 Dioxin and furan emission trends and key categories

Between 1990 and 2022, PCDD/F emissions dropped by 84% in the EU, and by 66% between 2005 and 2022. Between 2021 and 2022, the decrease was 6.5%% (see Table 3.21), mainly because of decreases in Poland, Romania and Italy (countries ranked according to the size of their contributions to the absolute change).

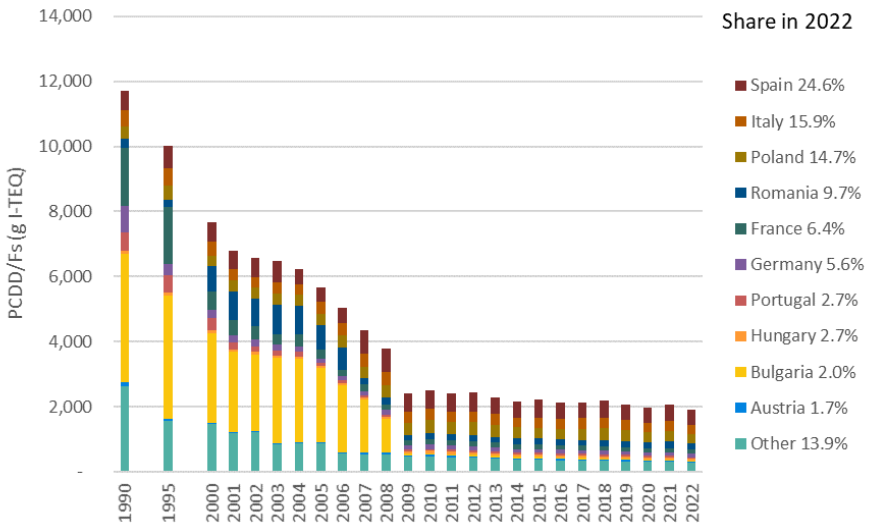
Table 3.21 Member State contributions to EU emissions of PCDD/Fs

Member State	PCDD/Fs (g I-TEQ)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	122	58	51	35	40	37	36	37	33	34	33	37	32	-74 %	-10 %	-15.0 %	1.0 %	1.7 %
Belgium	519	339	91	66	51	31	30	32	26	29	28	28	26	-95 %	-61 %	-6.0 %	4.4 %	1.4 %
Bulgaria	3,931	3,788	2,764	2,301	45	40	39	40	38	38	41	42	38	-99 %	-98 %	-8.4 %	33.6 %	2.0 %
Croatia	84	74	71	110	80	38	30	29	27	26	25	27	25	-70 %	-77 %	-8.6 %	0.7 %	1.3 %
Cyprus	17	19	21	1	1	1	1	1	1	1	1	1	1	-97 %	-27 %	-0.8 %	0.1 %	0.0 %
Czechia	100	69	59	61	43	31	22	20	21	19	19	14	14	-86 %	-78 %	-3.0 %	0.9 %	0.7 %
Denmark	67	49	32	30	34	33	34	32	30	28	27	27	24	-64 %	-19 %	-11.2 %	0.6 %	1.3 %
Estonia	11	6	6	6	5	5	5	5	5	4	4	4	4	-63 %	-30 %	-0.2 %	0.1 %	0.2 %
Finland	18	19	18	14	16	14	15	13	14	10	10	11	9	-47 %	-32 %	-12.4 %	0.2 %	0.5 %
France	1,802	1,743	581	265	175	150	140	137	134	130	120	124	123	-93 %	-54 %	-1.0 %	15.4 %	6.4 %
Germany	805	334	257	145	130	118	116	115	111	110	102	108	108	-87 %	-26 %	0.1 %	6.9 %	5.6 %
Greece	42	42	42	43	28	27	25	26	26	24	23	26	25	-39 %	-41 %	-1.0 %	0.4 %	1.3 %
Hungary	113	79	82	63	77	78	77	66	59	64	60	57	52	-54 %	-18 %	-9.4 %	1.0 %	2.7 %
Ireland	44	34	27	25	25	22	20	19	21	18	18	17	14	-68 %	-43 %	-16.2 %	0.4 %	0.7 %
Italy	529	511	434	361	342	310	312	330	311	307	280	325	304	-43 %	-16 %	-6.6 %	4.5 %	15.9 %
Latvia	32	36	33	37	25	19	19	21	20	20	18	18	18	-45 %	-52 %	-2.8 %	0.3 %	0.9 %
Lithuania	26	18	19	24	22	21	18	19	19	18	16	18	16	-37 %	-31 %	-7.7 %	0.2 %	0.9 %
Luxembourg	39	19	4	3	3	2	2	2	2	1	1	1	1	-97 %	-61 %	0.0 %	0.3 %	0.1 %
Malta	0	0	0	0	8	2	1	1	1	0	0	0	0	-30 %	-25 %	3.1 %	0.0 %	0.0 %
Netherlands	745	70	38	35	40	32	32	32	31	31	30	30	30	-96 %	-14 %	0.0 %	6.4 %	1.6 %
Poland	372	456	314	354	399	340	342	335	402	351	332	316	282	-24 %	-20 %	-10.5 %	3.2 %	14.7 %
Portugal	556	554	358	74	53	51	52	55	59	57	57	55	53	-91 %	-29 %	-5.2 %	4.7 %	2.7 %
Romania	266	231	762	757	188	167	170	178	180	185	184	210	186	-30 %	-75 %	-11.2 %	2.3 %	9.7 %
Slovakia	806	722	945	369	59	64	65	65	66	63	53	40	29	-96 %	-92 %	-26.4 %	6.9 %	1.5 %
Slovenia	21	19	19	21	20	18	18	17	15	15	14	16	13	-38 %	-36 %	-15.6 %	0.2 %	0.7 %
Spain	580	684	604	453	578	541	500	489	519	452	459	480	472	-19 %	4 %	-1.8 %	5.0 %	24.6 %
Sweden	60	34	27	26	21	17	18	17	17	17	17	17	16	-73 %	-38 %	-6.4 %	0.5 %	0.8 %
EU27 (a)	**11,707**	**10,005**	**7,662**	**5,677**	**2,507**	**2,207**	**2,137**	**2,133**	**2,187**	**2,051**	**1,971**	**2,049**	**1,916**	**-84%**	**-66%**	**-6.5%**	**100%**	**100%**
EU27 (b)	11,707	10,005	7,662	5,677	2,507	2,207	2,137	2,133	2,187	2,051	1,971	2,049	1,916					

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.

In 2022, the Member States contributing most (i.e. more than 10%) to PCDD/F emissions were Spain, Italy and Poland, with a joint contribution of 55% of EU-27 emissions (see Figure 3.25).

Figure 3.26 Dioxin emission trends in the EU and shares of Member States



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

The drop in emissions between 2008 and 2009 can be attributed to data reported by Bulgaria in the category '1B1b — Fugitive emission from solid fuels: Solid fuel transformation'. The country reported values until 2008 followed by the notation key for not occurring (NO) from 2009 onwards.

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/Fs dropped in 1999 because of the technological improvement in facilities that burn 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 because of waste management policies in Slovakia, which favour the combustion of waste over 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).

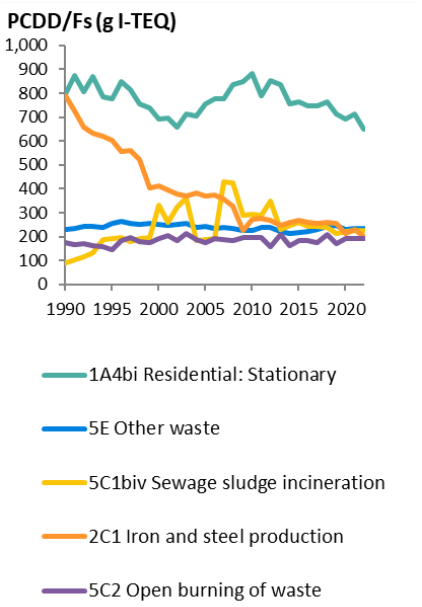
The '5C1biii — Clinical waste incineration' category contributed most to the trend in PCDD/F emissions reported by Portugal. The substantial drop in emissions between 2000 and 2005 was caused by the closing of 25 incinerators on its mainland; since 2004, just one clinical waste incinerator has remained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

Categories '1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '5E — Other waste' were the primary key categories for PCDD/F emissions, together making up 46% of total PCDD/F emissions (see Figure 3.27(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2022 were in the fourth most important '2C1 — Iron and steel production' (75%) and the most important '1A4bi — Residential: Stationary' (19%). Emissions from categories '5C1biv — Sewage sludge incineration' and'5C2 — Open burning of waste' increased (158% and 12%, respectively). PCDD/F emissions from '5E — Other waste' stayed more or less stable (1%).

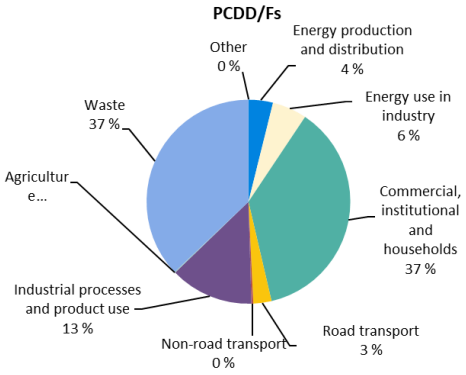
Figure 3.27(b) shows the contribution made by each aggregated sector group to total EU emissions. The sector groups waste, commercial, institutional and households and industrial processes and product use are significant sources of PCDD/F emissions.

Figure 3.27 **PCDD/F emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

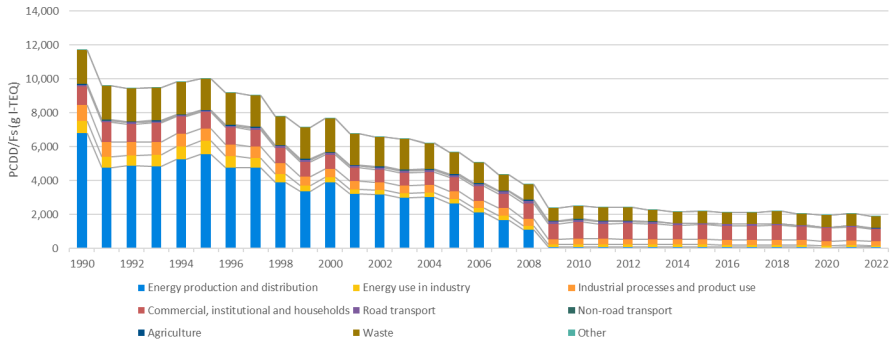
(a)



(b)



(c)



Note: I-TEQ, international toxic equivalent.

3.21 Total polycyclic aromatic hydrocarbon emission trends and key categories

Between 1990 and 2022, PAH emissions dropped by 53% in the EU, and by 22% between 2005 and 2022. Between 2021 and 2022, they fell by 9.9% (see Table 3.22), mainly because of decreases in Poland (40%).

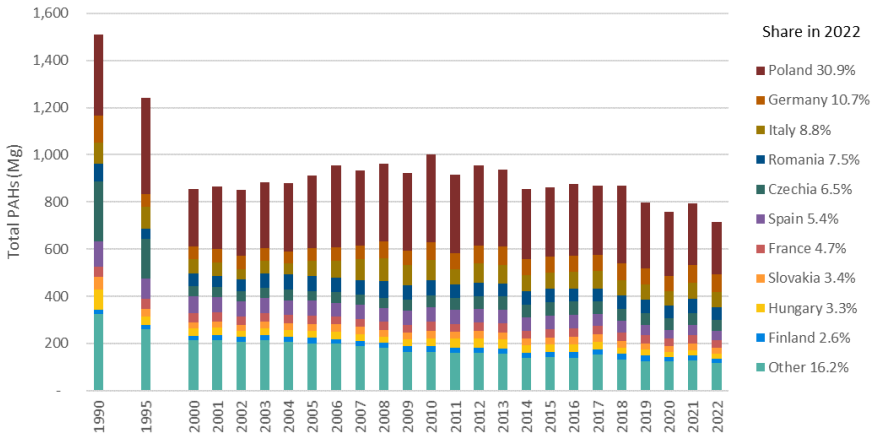
Table 3.22 Member State contributions to EU emissions of total PAHs

Member State	Total PAHs (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	18	11	8.8	7.1	7.9	7.1	7.2	7.2	6.7	6.9	6.5	7.2	5.7	-69 %	-20 %	-21.1 %	1.2 %	0.8 %
Belgium	51	40	31	25	15	8.4	8.3	7.5	7.1	6.6	5.8	6.6	5.9	-88 %	-76 %	-10.4 %	3.4 %	0.8 %
Bulgaria	27	28	23	23	19	15	16	31	15	14	15	16	12	-57 %	-50 %	-26.2 %	1.8 %	1.6 %
Croatia	23	18	16	19	18	16	16	15	14	14	14	15	13	-43 %	-31 %	-9.2 %	1.5 %	1.9 %
Cyprus	14	11	6.2	3.8	0.9	0.9	0.7	0.6	0.7	0.6	0.7	0.7	0.7	-95 %	-82 %	-4.6 %	0.9 %	0.1 %
Czechia	253	166	43	42	51	56	55	54	52	50	48	50	46	-82 %	12 %	-7.9 %	16.8 %	6.5 %
Denmark	13	13	10	11	7.6	6.8	6.9	6.3	5.8	4.9	4.6	4.5	4.2	-66 %	-60 %	-5.0 %	0.8 %	0.6 %
Estonia	9.9	10.4	7.7	5.8	6.0	4.3	4.3	4.3	4.2	3.9	4.0	3.6	3.7	-62 %	-35 %	2.9 %	0.7 %	0.5 %
Finland	18	17	18	22	25	22	23	23	23	22	18	20	19	2 %	-15 %	-7.6 %	1.2 %	2.6 %
France	46	42	38	35	38	36	37	37	36	37	32	37	34	-27 %	-5 %	-8.1 %	3.0 %	4.7 %
Germany	116	53	55	51	77	68	66	68	69	70	66	76	77	-34 %	50 %	1.4 %	7.7 %	10.7 %
Greece	23	23	23	21	15	18	17	17	17	16	16	17	17	-27 %	-18 %	-0.2 %	1.6 %	2.4 %
Hungary	84	35	31	29	34	33	34	33	27	25	24	24	23	-72 %	-19 %	-3.5 %	5.5 %	3.3 %
Ireland	30	20	16	15	15	14	14	12	13	12	12	12	9	-69 %	-39 %	-20.2 %	2.0 %	1.3 %
Italy	90	92	59	64	86	71	70	74	67	65	60	68	63	-30 %	-2 %	-8.1 %	5.9 %	8.8 %
Latvia	18	17	16	13	10	7.2	7.0	7.7	8.0	7.7	6.9	7.0	6.9	-62 %	-48 %	-1.9 %	1.2 %	1.0 %
Lithuania	23	9.7	8.7	9.9	11	9.3	9.5	9.8	9.8	8.8	8.3	8.8	8.5	-62 %	-14 %	-4.0 %	1.5 %	1.2 %
Luxembourg	3.5	2.0	0.7	0.7	0.7	0.6	0.7	0.7	0.8	0.7	0.7	0.7	0.7	-80 %	8 %	0.0 %	0.2 %	0.1 %
Malta	0.8	0.5	0.4	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-82 %	269 %	107.4 %	0.1 %	0.0 %
Netherlands	21	11	6.0	6.0	6.7	5.5	5.4	5.2	5.0	4.7	4.3	4.7	4.8	-77 %	-20 %	1.0 %	1.4 %	0.7 %
Poland	341	409	242	310	369	291	305	295	330	276	271	260	221	-35 %	-29 %	-15.3 %	22.6 %	30.9 %
Portugal	22	20	18	15	12	12	12	11	12	11	11	11	11	-48 %	-25 %	0.2 %	1.5 %	1.6 %
Romania	77	45	56	65	63	56	56	55	55	56	55	59	54	-30 %	-17 %	-9.0 %	5.1 %	7.5 %
Slovakia	53	32	28	32	31	29	30	30	27	25	23	29	24	-54 %	-23 %	-14.9 %	3.5 %	3.4 %
Slovenia	9.9	8.3	7.9	8.9	8.3	7.6	7.6	7.2	6.1	6.0	5.7	6.3	5.1	-49 %	-42 %	-19.3 %	0.7 %	0.7 %
Spain	106	87	71	62	61	59	59	50	49	44	38	41	38	-64 %	-38 %	-7.2 %	7.0 %	5.4 %
Sweden	20	20	15	17	11	8.5	8.5	8.5	7.4	7.4	7.0	7.2	6.8	-66 %	-60 %	-4.6 %	1.3 %	1.0 %
EU27 (a)	**1,509**	**1,242**	**855**	**913**	**1,000**	**861**	**875**	**871**	**868**	**796**	**759**	**792**	**714**	**-53%**	**-22%**	**-9.9%**	**100%**	**100%**
EU27 (b)	1,509	1,242	855	913	1,000	861	875	871	868	796	759	792	714					

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 2022, the EU Member States contributing most (i.e. more than 10%) to the EU-27 total PAH emissions were Poland, with a share of 31%, and Germany (see Figure 3.27).

Figure 3.28 Total PAH emission trends in the EU and shares of Member States



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

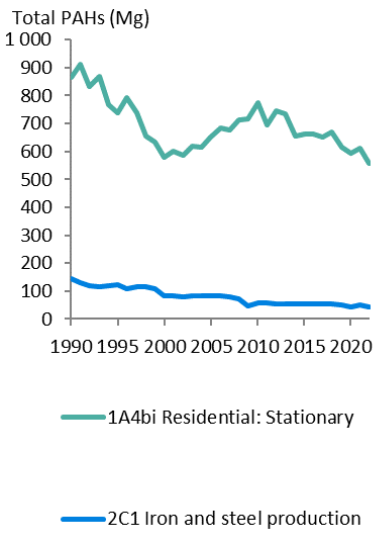
Poland explained the decrease in total PAH emissions between 1990 and 2022 by the reductions in the consumption of hard coal and wood in the household sector. This category (1A4bi) saw also a substantial decrease of 15% (26 Mg) between 2021 and 2022.

In 2022, categories '1A4bi — Residential: Stationary' and '2C1 — Iron and steel production' were the principal key categories for these emissions, making up 84% of total PAH emissions (see Figure 3.29(a)). Both categories show decreases in total PAH emissions (36% and 70% between 1990 and 2022, respectively).

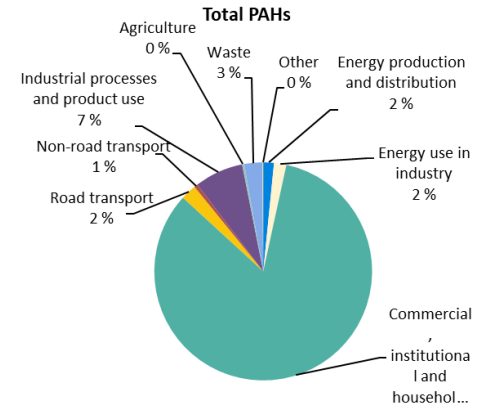
Figure 3.29(b) shows the contribution made by each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is the most significant source of total PAH emissions.

Figure 3.29 **Total PAH emissions in the EU: (a) trends in emissions from the two most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

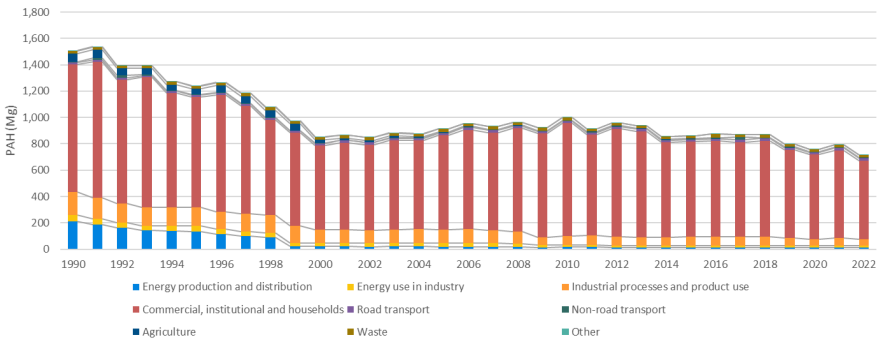
(a)



(b)



(c)



3.22 Benzo(a)pyrene emission trends and key categories

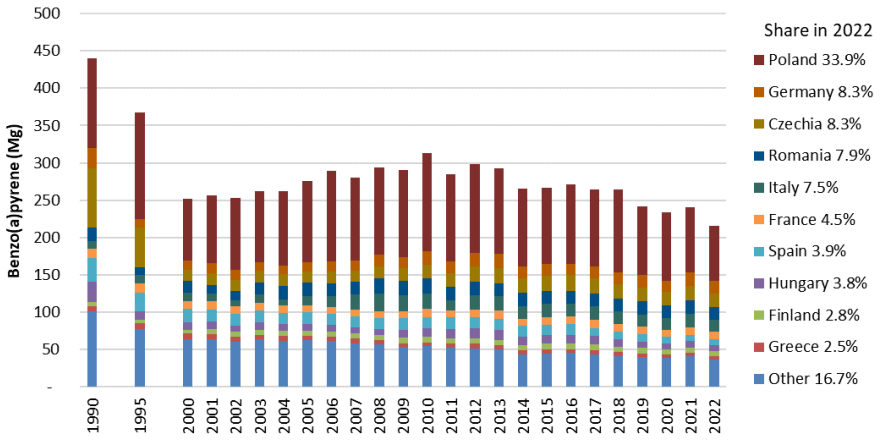
Between 1990 and 2022, B(a)P emissions fell by 51% in the EU, and between 2005 and 2022 by 22%. Between 2021 and 2022, they decreased by 10% (see Table 3.23), mainly because of emission reduction in Poland. In 2022, the Member State contributing most (i.e. more than 10%) to B(a)P emissions was Poland, with a share of 34% (Figure 3.30).

Table 3.23 Member State contributions to EU emissions of B(a)P

Member State	Benzo(a)pyrene (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	6.1	3.6	2.9	2.3	2.5	2.3	2.3	2.3	2.1	2.2	2.1	2.3	1.8	-70 %	-21 %	-21.9 %	1.4 %	0.8 %
Belgium	15	12	9.7	7.8	5.4	2.7	2.7	2.4	2.3	2.1	1.9	2.1	1.9	-88 %	-76 %	-10.7 %	3.5 %	0.9 %
Bulgaria	6	7	6	6	6	5	5	5	5.0	4.7	5.1	5.2	3.8	-34 %	-41 %	-26.7 %	1.3 %	1.8 %
Croatia	7.4	5.9	5.3	6.6	6.2	5.6	5.4	5.2	4.9	4.8	4.7	5.1	4.6	-38 %	-30 %	-9.2 %	1.7 %	2.1 %
Cyprus	2.4	1.9	1.1	0.6	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-95 %	-82 %	-4.0 %	0.5 %	0.1 %
Czechia	80	53	15	15	19	21	21	20	20	19	19	19	18	-78 %	20 %	-8.1 %	18.1 %	8.3 %
Denmark	3.5	3.6	2.9	3.1	2.4	2.1	2.1	1.9	1.7	1.5	1.3	1.3	1.2	-65 %	-59 %	-5.4 %	0.8 %	0.6 %
Estonia	2.8	2.9	2.1	1.6	1.7	1.2	1.2	1.2	1.2	1.1	1.2	1.0	1.1	-62 %	-34 %	3.0 %	0.6 %	0.5 %
Finland	5.7	5.5	5.6	7.0	8.1	7.0	7.6	7.5	7.4	7.3	5.9	6.6	6.1	6 %	-13 %	-8.0 %	1.3 %	2.8 %
France	13	12	11	10.1	11	10.2	10.8	10.6	10.4	10.6	9.3	10.5	9.6	-26 %	-5 %	-8.6 %	3.0 %	4.5 %
Germany	27	11	12	12	18	16	15	16	16	16	15	18	18	-34 %	54 %	2.3 %	6.1 %	8.3 %
Greece	7.4	7.1	7.2	6.3	4.5	5.8	5.3	5.4	5.4	5.2	5.1	5.4	5.4	-26 %	-13 %	-0.5 %	1.7 %	2.5 %
Hungary	27	10.9	9.6	9.0	11.1	11	12	11	9.4	8.7	8.4	8.5	8.1	-70 %	-10 %	-4.3 %	6.2 %	3.8 %
Ireland	6.8	4.7	3.6	3.6	3.6	3.5	3.6	3.1	3.4	3.1	3.2	2.9	2.3	-65 %	-35 %	-20.3 %	1.5 %	1.1 %
Italy	10	11	11	12	21	18	17	19	17	16	15	18	16	62 %	30 %	-7.8 %	2.3 %	7.5 %
Latvia	6.3	6.0	6.1	4.7	3.6	2.5	2.5	2.7	2.9	2.7	2.4	2.5	2.4	-62 %	-48 %	-1.7 %	1.4 %	1.1 %
Lithuania	6.7	3.1	3.1	3.4	3.7	3.2	3.2	3.3	3.3	3.0	2.8	3.0	2.9	-57 %	-16 %	-4.2 %	1.5 %	1.3 %
Luxembourg	1.0	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-84 %	1 %	0.0 %	0.2 %	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	27 %	205 %	83.2 %	0.0 %	0.0 %
Netherlands	5.5	3.4	2.0	2.1	2.2	1.8	1.8	1.7	1.7	1.6	1.5	1.6	1.6	-71 %	-22 %	0.0 %	1.2 %	0.7 %
Poland	120	143	82	109	131	102	107	103	111	92	92	87	73	-39 %	-33 %	-16.4 %	27.3 %	33.9 %
Portugal	6.8	6.0	5.4	4.4	3.4	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.3	-51 %	-24 %	-0.7 %	1.5 %	1.5 %
Romania	18	11	16	18	20	17	17	17	17	17	17	18	17	-4 %	-5 %	-6.5 %	4.0 %	7.9 %
Slovakia	15	7.7	6.1	7.1	7.0	5.8	6.0	5.8	4.8	4.9	4.7	5.6	5.0	-67 %	-30 %	-10.5 %	3.4 %	2.3 %
Slovenia	3.1	2.6	2.6	2.9	2.7	2.5	2.5	2.4	2.0	1.9	1.9	2.1	1.6	-47 %	-44 %	-20.5 %	0.7 %	0.8 %
Spain	31	25	18	15	15	14	14	11	11	9	9	9	8	-73 %	-44 %	-2.4 %	7.1 %	3.9 %
Sweden	6.4	6.4	4.9	5.4	3.4	2.6	2.6	2.6	2.2	2.2	2.1	2.1	2.0	-68 %	-62 %	-4.9 %	1.5 %	0.9 %
EU27 (a)	**440**	**367**	**251**	**275**	**313**	**267**	**272**	**265**	**265**	**241**	**234**	**240**	**215**	**-51%**	**-22%**	**-10.2%**	**100%**	**100%**
EU27 (b)	440	367	251	275	313	267	272	265	265	241	234	240	215					

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.

Figure 3.30 Benzo(a)pyrene emission trends in the EU and shares of Member States



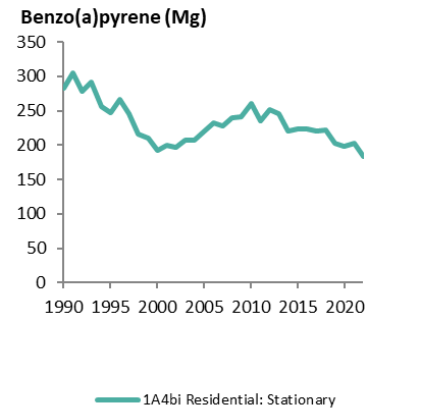
Notes: Countries are sorted by their contribution to the EU total for the last year. The top 10 countries are displayed. Data for the other 17 reporting countries are summed under 'Other'.

Category '1A4bi — Residential: Stationary' was the principal key category for B(a)P emissions, accounting for 85% of the total. Among the key categories, the largest change could be observed for the most important '1A4bi — Residential: Stationary' (35.4%) (see Figure 3.31(a)).

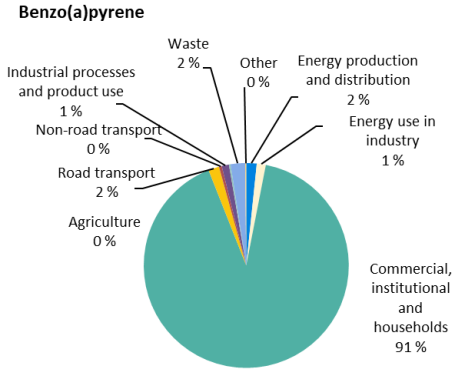
Figure 3.31(b) shows the contribution made by each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is the main source of B(a)P emissions.

Figure 3.31 **B(a)P emissions in the EU: (a) trends in emissions from the most important key category, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

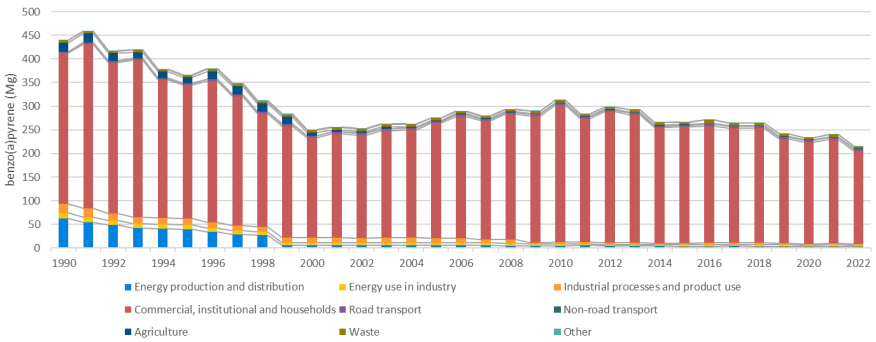
(a)



(b)



(c)



3.23 Benzo(b)fluoranthene emission trends

Between 1990 and 2022, (B(b)F emissions fell by 54% in the EU, and by 21% between 2005 and 2022. Between 2021 and 2022, they decreased by 9.4% (see Table 3.24), mainly because of decreases in Poland.

Table 3.24 Member State contributions to EU emissions of B(b)F

Member State	Benzo(b)fluoranthene (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	6.3	3.8	3.1	2.5	2.8	2.5	2.6	2.6	2.4	2.5	2.3	2.6	2.0	-68 %	-20 %	-21.4 %	1.3 %	0.9 %
Belgium	18	14	11	8.6	4.7	2.9	2.9	2.6	2.5	2.3	2.1	2.3	2.1	-88 %	-76 %	-9.9 %	3.6 %	0.9 %
Bulgaria	5	8.6	6.4	6.9	6.3	5.0	5.1	5.2	4.9	4.6	5.0	5.2	3.7	-30 %	-47 %	-28.8 %	1.1 %	1.6 %
Croatia	8.0	5.9	5.2	6.3	6.0	5.3	5.1	4.9	4.6	4.4	4.4	4.7	4.3	-47 %	-32 %	-9.2 %	1.6 %	1.9 %
Cyprus	6.6	5.2	3.0	1.8	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-95 %	-82 %	-4.8 %	1.3 %	0.1 %
Czechia	89	57	13	12	14	15	15	15	14	13	13	13	12	-86 %	1 %	-8.6 %	18.1 %	5.3 %
Denmark	3.2	3.2	2.6	2.7	2.1	2.0	2.1	1.9	1.8	1.6	1.5	1.4	1.4	-56 %	-49 %	-4.5 %	0.6 %	0.6 %
Estonia	3.6	2.9	2.1	1.6	1.6	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	-72 %	-37 %	3.1 %	0.7 %	0.4 %
Finland	4.8	4.5	4.6	5.6	6.4	5.4	5.9	5.8	5.7	5.6	4.6	5.2	4.8	1 %	-14 %	-6.9 %	1.0 %	2.1 %
France	15	14	12	12	13	12	12	12	12	12	11	12	11	-28 %	-5 %	-8.1 %	3.1 %	4.9 %
Germany	36	15	17	17	26	23	22	23	23	23	22	26	26	-27 %	56 %	1.9 %	7.3 %	11.5 %
Greece	9.1	8.9	8.7	7.7	5.6	6.4	5.9	6.0	6.0	5.8	5.6	5.9	5.9	-35 %	-23 %	0.3 %	1.9 %	2.6 %
Hungary	31	13	10.2	9.7	11.2	10.8	11	11	9.0	8.2	7.8	7.9	7.6	-76 %	-22 %	-3.1 %	6.4 %	3.4 %
Ireland	12	8	6.6	6.3	6.2	5.7	5.9	5.1	5.6	5.0	5.2	4.8	3.9	-67 %	-39 %	-20.0 %	2.4 %	1.7 %
Italy	13	14	14	15	25	21	20	22	20	19	18	20	19	48 %	26 %	-7.6 %	2.6 %	8.4 %
Latvia	6.2	5.4	5.0	4.3	3.3	2.4	2.3	2.5	2.7	2.5	2.3	2.3	2.3	-64 %	-47 %	-1.7 %	1.3 %	1.0 %
Lithuania	8.1	3.5	3.1	3.6	4.0	3.5	3.6	3.7	3.7	3.4	3.1	3.4	3.2	-60 %	-11 %	-4.6 %	1.7 %	1.4 %
Luxembourg	1.2	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-74 %	24 %	0.0 %	0.2 %	0.1 %
Malta	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-86 %	297 %	111.4 %	0.1 %	0.0 %
Netherlands	8.1	3.7	2.0	1.9	2.2	1.8	1.7	1.7	1.6	1.5	1.3	1.5	1.5	-81 %	-19 %	2.5 %	1.7 %	0.7 %
Poland	122	147	85	108	128	101	105	102	114	95	94	90	76	-38 %	-30 %	-15.0 %	24.9 %	33.8 %
Portugal	6.6	5.8	5.3	4.4	3.4	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	-49 %	-23 %	-0.3 %	1.3 %	1.5 %
Romania	22	12	16	18	19	17	17	16	16	16	16	17	16	-28 %	-9 %	-7.1 %	4.5 %	7.1 %
Slovakia	12	6.2	5.1	6.0	6.0	5.3	5.5	5.5	4.7	4.8	4.5	5.1	4.7	-60 %	-23 %	-9.2 %	2.4 %	2.1 %
Slovenia	3.6	2.9	2.6	2.9	2.6	2.4	2.4	2.3	1.9	1.9	1.8	2.0	1.6	-55 %	-44 %	-19.0 %	0.7 %	0.7 %
Spain	34	26	19	15	15	14	14	11	11	10	9	9	9	-73 %	-41 %	-1.7 %	6.9 %	4.0 %
Sweden	6.2	6.1	4.7	5.3	3.4	2.7	2.7	2.7	2.3	2.3	2.2	2.2	2.2	-65 %	-59 %	-3.9 %	1.3 %	1.0 %
EU27 (a)	**490**	**398**	**268**	**285**	**318**	**272**	**276**	**269**	**274**	**251**	**242**	**249**	**226**	**-54%**	**-21%**	**-9.4%**	**100%**	**100%**
EU27 (b)	490	398	268	285	318	272	276	269	274	251	242	249	226					

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 2022, B(k)F emissions in the EU decreased by 53%, and by 20% between 2005 and 2022. Between 2021 and 2022, they fell by 8.5% (see Table 3.25), mainly in Poland. In 2022, the EU Member States contributing most (i.e. more than 10%) to the EU-27 B(k)F emissions were Poland, with a share of 34%, and Germany.

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

Member State	Benzo(k)fluoranthene (Mg)													Change			Share in EU-27	
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	3.6	1.5	1.2	1.0	1.1	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.8	-77 %	-19 %	-19.1 %	1.5 %	0.8 %
Belgium	10	7.8	6.0	4.7	2.4	1.3	1.3	1.2	1.1	1.0	0.9	1.0	0.9	-91 %	-81 %	-9.8 %	4.2 %	0.8 %
Bulgaria	5.5	3.7	2.9	2.8	2.6	2.0	2.1	2.1	2.0	1.9	2.0	2.1	1.5	-72 %	-45 %	-26.8 %	2.4 %	1.4 %
Croatia	3.4	2.5	2.2	2.6	2.5	2.2	2.1	2.0	2.0	1.9	1.9	2.0	1.8	-48 %	-31 %	-8.4 %	1.5 %	1.6 %
Cyprus	2.8	2.2	1.3	0.8	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-95 %	-82 %	-5.0 %	1.2 %	0.1 %
Czechia	45	30	7.0	6.9	8.3	9.0	8.8	8.7	8.4	8.2	7.9	8.3	7.7	-83 %	11 %	-6.8 %	19.1 %	7.0 %
Denmark	2.4	2.5	2.1	2.2	1.7	1.4	1.4	1.3	1.1	1.0	0.9	0.9	0.8	-67 %	-63 %	-6.4 %	1.0 %	0.7 %
Estonia	1.7	1.9	1.4	1.0	1.1	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.7	-61 %	-36 %	2.8 %	0.7 %	0.6 %
Finland	3.6	3.4	3.5	4.3	5.0	4.3	4.6	4.5	4.5	4.4	3.4	3.8	3.5	-2 %	-18 %	-7.6 %	1.5 %	3.2 %
France	9.4	8.6	7.7	7.3	7.7	7.2	7.6	7.4	7.3	7.4	6.6	7.4	6.8	-27 %	-7 %	-7.7 %	4.0 %	6.2 %
Germany	16	7.0	7.9	7.7	12	10	10	10	11	11	10	12	12	-27 %	54 %	1.4 %	6.9 %	10.7 %
Greece	4.2	4.0	4.1	3.7	2.8	3.3	3.2	3.2	3.2	3.2	3.1	3.2	3.2	-23 %	-12 %	0.0 %	1.8 %	2.9 %
Hungary	15	7.5	6.4	6.0	6.2	5.1	5.2	5.0	4.4	4.	3.5	3.6	3.6	-76 %	-40 %	-1.7 %	6.3 %	3.2 %
Ireland	6.2	4.0	3.0	2.8	2.7	2.5	2.6	2.2	2.4	2.1	2.2	2.1	1.7	-73 %	-41 %	-20.3 %	2.6 %	1.5 %
Italy	6.0	6.6	6.7	7.4	11	9.6	9.4	10	9.0	8.9	8.3	9.4	8.7	46 %	17 %	-7.6 %	2.5 %	7.9 %
Latvia	2.4	2.1	2.0	1.7	1.3	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.9	-64 %	-48 %	-1.7 %	1.0 %	0.8 %
Lithuania	3.4	1.5	1.4	1.6	1.7	1.6	1.7	1.7	1.7	1.6	1.5	1.6	1.5	-55 %	-1 %	-2.0 %	1.4 %	1.4 %
Luxembourg	0.7	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	-79 %	6 %	0.0 %	0.3 %	0.1 %
Malta	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-89 %	230 %	84.0 %	0.1 %	0.0 %
Netherlands	4.2	2.6	1.1	1.0	1.2	1.0	1.0	0.9	0.9	0.8	0.7	0.8	0.8	-80 %	-21 %	5.4 %	1.8 %	0.7 %
Poland	52	64	39	48	57	45	48	46	54	46	45	43	37	-28 %	-23 %	-13.5 %	22.1 %	33.7 %
Portugal	2.5	2.3	2.1	1.8	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	-47 %	-25 %	-0.3 %	1.1 %	1.2 %
Romania	8.6	4.5	5.9	6.8	7.2	6.4	6.4	6.2	6.2	6.2	6.2	6.6	6.2	-29 %	-9 %	-7.0 %	3.7 %	5.6 %
Slovakia	7.4	4.0	3.3	4.1	4.0	3.7	3.8	3.7	3.3	3.3	3.0	3.4	3.1	-58 %	-23 %	-7.2 %	3.1 %	2.8 %
Slovenia	1.3	1.1	1.0	1.1	1.0	0.9	0.9	0.9	0.7	0.7	0.7	0.8	0.6	-54 %	-43 %	-18.6 %	0.6 %	0.6 %
Spain	15	12	8.9	7.3	7.1	6.7	8.4	5.6	5.6	4.4	4.1	4.0	4.0	-73 %	-46 %	-1.5 %	6.3 %	3.6 %
Sweden	3.0	2.9	2.3	2.9	1.2	1.0	1.0	0.9	0.8	0.8	0.8	0.8	0.7	-75 %	-74 %	-4.0 %	1.3 %	0.7 %
EU27 (a)	**235**	**190**	**130**	**138**	**151**	**129**	**133**	**128**	**134**	**122**	**116**	**121**	**110**	**-53%**	**-20%**	**-8.5%**	**100%**	**100%**
EU27 (b)	235	190	130	138	151	129	133	128	134	122	116	121	110					

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.

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

Between 1990 and 2022, IP emissions fell by 46% in the EU. Between 2021 and 2022, they decreased by 8.3%, mainly because Poland reported lower emissions (see Table 3.26). In 2022, 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 3.26 Member State contributions to EU emissions of IP

Member	Indeno(123-cd)pyrene (Mg)													Change			Share in EU-27	
State	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	2.5	2.0	1.6	1.3	1.4	1.3	1.3	1.3	1.2	1.3	1.2	1.3	1.0	-59 %	-21 %	-20.9 %	1.1 %	0.9 %
Belgium	7.4	5.9	4.7	3.9	2.5	1.5	1.5	1.3	1.2	1.2	1.0	1.2	1.1	-86 %	-73 %	-11.3 %	3.4 %	0.9 %
Bulgaria	6.2	3.4	3.3	3.3	3.3	2.7	2.9	2.9	2.7	2.6	2.9	2.8	2.2	-64 %	-32 %	-20.8 %	2.8 %	1.9 %
Croatia	3.9	3.3	3.0	3.7	3.5	3.1	3.0	2.9	2.7	2.6	2.6	2.8	2.5	-34 %	-32 %	-9.7 %	1.8 %	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	-95 %	-82 %	-4.2 %	0.9 %	0.1 %
Czechia	40	26	8	7.8	10	11	10	10	10	9	9.0	9.5	8.8	-78 %	12 %	-7.4 %	18.2 %	7.5 %
Denmark	3.6	3.5	2.7	2.6	1.4	1.3	1.3	1.2	1.1	1.	0.9	0.9	0.8	-77 %	-68 %	-3.9 %	1.6 %	0.7 %
Estonia	1.8	2.7	2.1	1.5	1.7	1.2	1.2	1.1	1.1	1.	1.1	1.0	1.0	-44 %	-33 %	2.5 %	0.8 %	0.8 %
Finland	4.1	3.9	4.0	4.9	5.7	4.9	5.3	5.2	5.1	5.0	4.0	4.5	4.1	1 %	-16 %	-7.9 %	1.9 %	3.5 %
France	8.1	7.5	6.8	6.5	7.0	6.5	6.8	6.7	6.6	6.7	5.9	6.7	6.1	-25 %	-5 %	-7.9 %	3.7 %	5.2 %
Germany	23	9.9	11	11	17	15	15	15	15	16	15	17	17	-25 %	57 %	1.0 %	10.5 %	14.7 %
Greece	3.4	3.4	3.3	2.9	2.0	2.7	2.4	2.4	2.4	2.3	2.2	2.4	2.4	-30 %	-19 %	-0.1 %	1.6 %	2.0 %
Hungary	10	4.3	4.3	4.0	5.4	5.7	5.8	5.5	4.5	4.2	4.1	4.1	3.9	-63 %	-1 %	-4.1 %	4.8 %	3.3 %
Ireland	5.0	3.3	2.4	2.3	2.2	2.0	2.1	1.8	1.9	1.7	1.8	1.7	1.3	-73 %	-40 %	-20.5 %	2.3 %	1.1 %
Italy	7.1	7.8	7.8	8.4	14	12	12	13	11	11	10	12	11	51 %	26 %	-7.6 %	3.2 %	9.1 %
Latvia	2.9	3.1	3.1	2.6	1.9	1.3	1.3	1.5	1.5	1.5	1.3	1.3	1.3	-55 %	-50 %	-2.6 %	1.3 %	1.1 %
Lithuania	5.1	2.1	1.7	1.9	2.0	1.7	1.7	1.8	1.8	1.6	1.5	1.6	1.6	-69 %	-16 %	-2.8 %	2.3 %	1.3 %
Luxembourg	0.6	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-86 %	-16 %	0.0 %	0.3 %	0.1 %
Malta	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-77 %	395 %	185.6 %	0.1 %	0.0 %
Netherlands	3.0	1.7	1.0	1.0	1.1	0.9	0.9	0.8	0.8	0.8	0.7	0.8	0.8	-73 %	-19 %	-4.2 %	1.3 %	0.7 %
Poland	41	52	31	39	47	37	39	38	44	37	36	35	30	-28 %	-25 %	-14.7 %	18.7 %	25.2 %
Portugal	4.	3.5	3.2	2.5	2.	2.1	2.	2.	2.	2.	2.0	2.0	2.0	-51 %	-22 %	-0.6 %	1.8 %	1.7 %
Romania	7.9	5.1	8.5	9.6	11	9.6	9.6	9.6	9.5	9.6	10	10	10	21 %	0 %	-6.3 %	3.6 %	8.1 %
Slovakia	7.5	3.7	3.0	3.4	3.3	2.7	2.8	2.8	2.2	2.3	2.3	2.7	2.5	-67 %	-28 %	-10.5 %	3.4 %	2.1 %
Slovenia	1.7	1.5	1.5	1.7	1.6	1.4	1.4	1.4	1.1	1.1	1.1	1.2	0.9	-43 %	-44 %	-20.9 %	0.8 %	0.8 %
Spain	14	12	8.8	7.5	7.9	7.5	8	5.7	5.5	5.3	4.9	4.8	4.7	-66 %	-37 %	-1.7 %	6.4 %	4.0 %
Sweden	3.1	3.3	2.5	2.4	1.9	1.5	1.4	1.4	1.2	1.2	1.1	1.2	1.1	-65 %	-54 %	-5.4 %	1.4 %	0.9 %
EU27 (a)	**219**	**177**	**130**	**137**	**157**	**137**	**138**	**135**	**137**	**128**	**122**	**128**	**118**	**-46%**	**-14%**	**-8.3%**	**100%**	**100%**
EU27 (b)	219	177	130	137	157	137	138	135	137	128	123	128	118					

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.

3.26 Hexachlorobenzene emission trends and key categories

Between 1990 and 2022, HCB emissions fell by 98% in the EU, and between 2005 and 2022 by 56%. Between 2021 and 2022, they decreased by 8.5% (see Table 3.27), mainly because of emission reductions in France (countries ranked according to the size of their contributions to the absolute change).

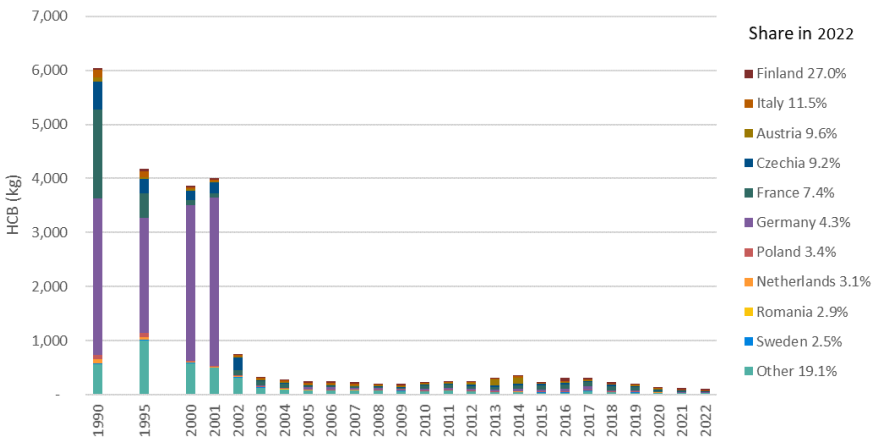
Table 3.27 Member State contributions to EU emissions of HCB

	HCB (kg)													Change			Share in EU-27	
Member State	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	82	43	20	14	15	12	13	14	13	14	11	13	10	-87 %	-24 %	-17.9 %	1.4 %	9.6 %
Belgium	40	115	21	19	11	2.6	2.1	32	3.0	2.0	2.3	2.1	1.9	-95 %	-90 %	-5.6 %	0.7 %	1.8 %
Bulgaria	2.1	2.1	2.1	2.3	2.1	2.4	1.8	2.0	1.8	1.7	1.7	1.8	2.5	19 %	6 %	35.5 %	0.0 %	2.3 %
Croatia	7.1	6.4	2.0	0.5	0.9	0.4	0.5	0.5	0.6	0.6	0.4	0.3	0.3	-95 %	-29 %	-4.0 %	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	-81 %	23 %	-0.5 %	0.0 %	0.0 %
Czechia	516	254	172	14	22	26	25	22	21	15	13	11	10	-98 %	-27 %	-12.4 %	8.5 %	9.2 %
Denmark	13	11	5.5	3.7	2.7	2.2	2.3	2.4	2.4	2.1	2.1	2.4	2.2	-83 %	-39 %	-5.0 %	0.2 %	2.1 %
Estonia	0.5	0.7	0.8	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-9 %	1 %	0.8 %	0.0 %	0.5 %
Finland	36	36	39	32	8.7	16	60	33	32	23	21	23	29	-18 %	-10 %	26.9 %	0.6 %	27.0 %
France	1636	469	100	26	60	72	81	80	85	68	35	18	8	-100 %	-69 %	-56.9 %	27.1 %	7.4 %
Germany	2,901	2,118	2,884	38	29	40	50	61	13	13	5.2	4.6	4.6	-100 %	-88 %	1.5 %	48.0 %	4.3 %
Greece	21	22	25	27	12	3.1	2.7	3.3	2.5	1.6	0.9	0.9	0.9	-96 %	-97 %	-2.7 %	0.4 %	0.8 %
Hungary	257	630	367	3.3	2.2	3.2	3.2	3.2	2.9	3.2	2.1	1.6	1.6	-99 %	-51 %	-2.2 %	4.3 %	1.5 %
Ireland	48	48	7.9	2.6	2.6	2.7	2.6	2.6	2.4	2.3	2.4	2.5	2.6	-95 %	-2 %	3.0 %	0.8 %	2.4 %
Italy	142	110	33	27	16	16	15	16	14.6	14.8	11	13	12	-91 %	-54 %	-5.3 %	2.4 %	11.5 %
Latvia	5.7	0.3	0.2	0.3	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-91 %	87 %	0.8 %	0.1 %	0.5 %
Lithuania	11	4.7	1.9	0	0	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	-97 %	59 %	-6.6 %	0.2 %	0.3 %
Luxembourg	2.4	1.9	1.5	0.8	0.8	0.7	1.2	1.0	0.9	0.9	1.1	1.2	1.2	-47 %	63 %	0.0 %	0.0 %	1.2 %
Malta	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	-20 %	3338 %	-34.0 %	0.0 %	0.0 %
Netherlands	66	40	17	3.4	3.5	4.1	4.3	4.1	4.0	3.8	3.4	3.4	3.3	-95 %	-3 %	-1.2 %	1.1 %	3.1 %
Poland	83	83	13	11	11	11	12	13	13	15	3.3	3.6	3.7	-96 %	-68 %	0.9 %	1.4 %	3.4 %
Portugal	60	76	101	1.7	1.4	1.8	1.9	2.0	2.4	2.4	1.4	1.3	1.2	-98 %	-27 %	-3.9 %	1.0 %	1.1 %
Romania	2.8	2.9	3.9	4.2	3.2	3.0	2.9	3.1	3.1	3.1	3.0	3.6	3.1	10 %	-25 %	-12.8 %	0.0 %	2.9 %
Slovakia	15.7	5.8	5.4	3.6	3.4	3.3	3.0	3.9	3.3	3.3	3.1	3.1	2.4	-85 %	-35 %	-23.3 %	0.3 %	2.2 %
Slovenia	21	18	20	0.9	1.3	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	-98 %	-58 %	-15.9 %	0.4 %	0.4 %
Spain	57	60	16	5	12	10	12	12	13	13	9	2	2	-97 %	-57 %	-4.7 %	1.0 %	1.8 %
Sweden	17	17	11	4.5	6.6	3.8	2.7	3.1	2.8	2.7	2.6	3.1	2.7	-84 %	-40 %	-11.8 %	0.3 %	2.5 %
EU27 (a)	**6,044**	**4,174**	**3,869**	**245**	**228**	**239**	**302**	**318**	**238**	**208**	**137**	**118**	**108**	**-98%**	**-56%**	**-8.5%**	**100%**	**100%**
EU27 (b)	6,044	4,174	3,869	245	228	239	302	318	238	208	137	118	108					

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 2022, the EU Member States contributing most (i.e. more than 10%) to HCB emissions were Finland and Italy (countries ranked according to their shares of the EU total) (see Figure 3.30).

Figure 3.32 HCB emission trends in the EU and shares of Member States



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

In 1990, **Germany** had a share of 48% of the EU-27 HCB emissions, which fell notably to a share of 4.3% in 2022. The drop in HCB emissions was mainly attributed to data reported in the category '2C3 — Aluminium production' (see Figure 3.33). Emission estimates were reported up to 2001, after which the notation key 'NA' (not applicable) was used.

Austria explained that the increase in HCB emissions from 2012 to 2013, from 38kg, which already was an unintentional release, to 116kg, 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 89.6% decrease in emissions between 2014 and 2015, from 120kg to 12kg, marked a return to usual levels (see Austria's IIR, listed in Appendix 5).

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 268% 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 HCB in secondary aluminium refining, as a result of which this industry no longer emits HCB (personal communication from France in 2015).

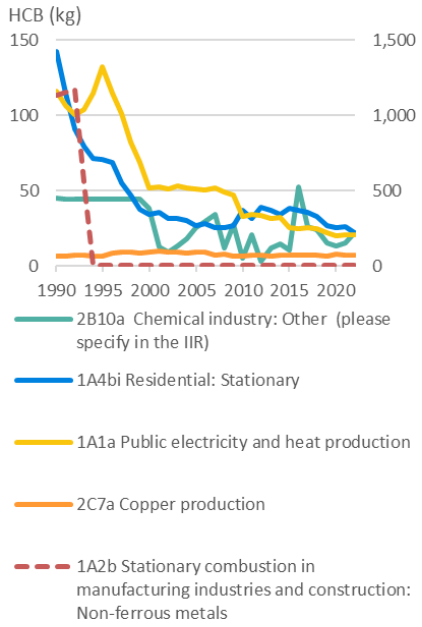
Ireland reported a marked decrease in HCB emissions between 1995 and 2000. HCB emissions from the category '2C2 — Ferroalloys production' dominated the inventory for the period up to and including 1996, contributing 40kg per year. However, this is no longer a source of HCB emissions in Ireland because of the banning 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 2022, '2B10a — Chemical industry: Other', '1A4bi — Residential: Stationary', '1A1a — Public electricity and heat production', were the main key categories for HCB emissions, together accounting for 60% of the total (see Figure 3.33(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2022 were in the fifth most important '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals (99.5%) and in the second most important '1A4bi — Residential: Stationary' (84.6%).

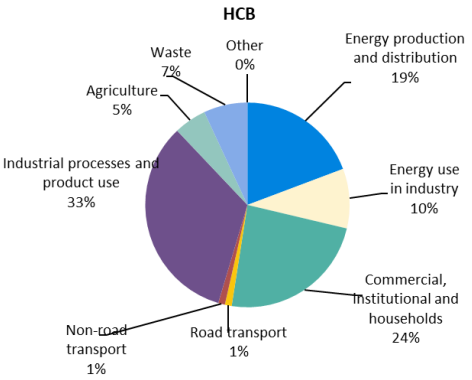
Figure 3.33(b) shows the contribution made by each aggregated sector group to total EU emissions. For HCB, the primary emission sources are the commercial, institutional and households and the industrial processes and product use sectors.

Figure 3.33 **HCB emissions in the EU: (a) trends in emissions from the five most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

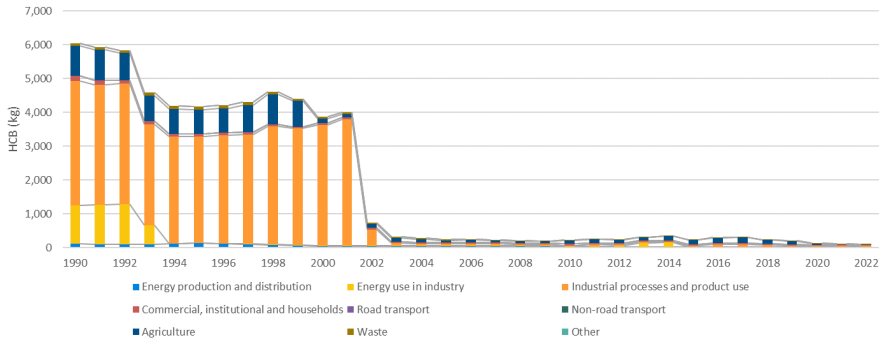
(a)



(b)



(c)



Note: In (a), the right-hand axis shows values for 1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals'.

3.27 Polychlorinated biphenyl emission trends and key categories

Between 1990 and 2022, PCB emissions dropped by 81% in the EU, between 2005 and 2022 by 61%. Between 2021 and 2022, they fell by 4%, mainly because of increases reported by Italy, Poland, Germany and Slovakia (countries ranked according to the size of their contributions to the absolute change) (see Table 3.28).

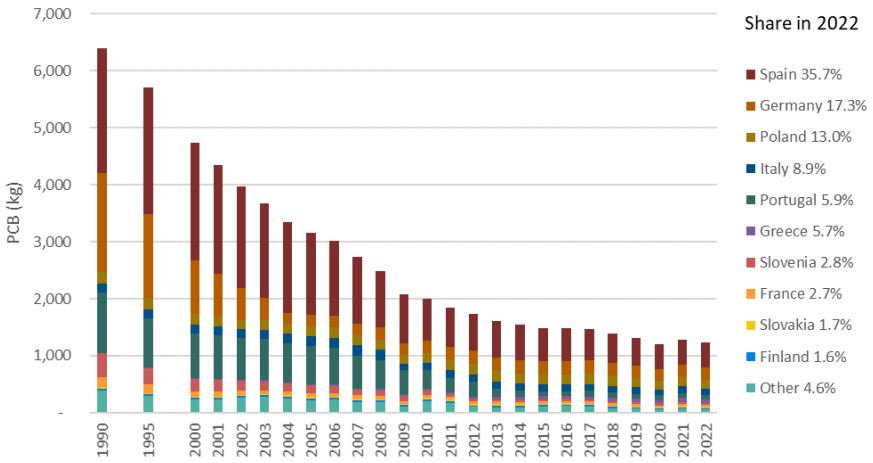
Table 3.28 Member State contributions to EU emissions of PCBs

	PCB (kg)																Change			Share in EU-27	
Member State	1990	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	1990—2022	2005—2022	2021—2022	1990	2022
Austria	36	10	6	4	4	4	4	4	4	4	4	4	4	3	3	3	-92 %	-53 %	-9.8 %	0.6 %	0.2 %
Belgium	119	103	89	116	78	33.3	37.2	35	41	53	49	19	15	8.7	14.0	11.5	-90 %	-87 %	-17.9 %	1.9 %	0.9 %
Bulgaria	11	16	10	3.9	7.7	4.9	4.2	3.8	2.6	2.6	3.0	2.9	2.8	2.4	2.8	2.1	-81 %	-80 %	-27.4 %	0.2 %	0.2 %
Croatia	5	1	4	5	5	4	5	5	5	5	3	3	3	2	3	3	-35 %	-28 %	3.4 %	0.1 %	0.3 %
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	0.0	9 %	13 %	-0.7 %	0.0 %	0.0 %
Czechia	3.6	2.7	2.0	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.6	1.5	1.2	1.2	-68 %	-40 %	-3.6 %	0.1 %	0.1 %
Denmark	2.9	2.9	1.2	0.5	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-86 %	-66 %	-5.3 %	0.0 %	0.0 %
Estonia	4.9	2.8	1.6	1.3	1.3	1.2	1.3	1.2	0.8	0.9	1.0	0.9	0.6	0.6	0.5	0.6	-88 %	-65 %	13.3 %	0.1 %	0.0 %
Finland	29	29	31	28	27	24	23	24	24	25	23	23	20	20	23	20	-30 %	-36 %	-14.4 %	0.4 %	1.6 %
France	178	152	68	54	46	50	50	42	41	41	41	38	34	30	36	34	-81 %	-51 %	-6.4 %	2.8 %	2.7 %
Germany	1,736	1,483	192	232	229	226	229	230	230	229	227	227	223	209	219	213	-88 %	11 %	-2.5 %	27.2 %	17.3 %
Greece	9.2	8.9	19	32	32	30	48	51	55	48	47	53	60	58	72	71	667 %	280 %	-2.0 %	0.1 %	5.7 %
Hungary	26	12	11	8.9	9.7	8.8	7.1	7.4	11	9.8	8.5	8.7	6.1	5.0	4.8	3.3	-87 %	-71 %	-31.0 %	0.4 %	0.3 %
Ireland	39	33	32	12	10	9.4	7.5	6.9	9.0	6.7	7.0	8.1	7.6	7.1	6.5	5.7	-85 %	-82 %	-11.5 %	0.6 %	0.5 %
Italy	154	166	179	133	139	139	124	121	114	120	122	121	117	104	122	109	-29 %	-39 %	-10.7 %	2.4 %	8.9 %
Latvia	4.3	1.1	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	-97 %	-76 %	1.3 %	0.1 %	0.0 %
Lithuania	6.0	1.8	4	2	1.2	1.0	1.2	1.0	0.8	0.9	1.0	1.0	0.8	0.8	0.7	0.7	-88 %	-84 %	-4.5 %	0.1 %	0.1 %
Luxembourg	23	35	11	18	26	8.2	2.3	4.2	2.4	2.3	1.8	1.3	1.8	1.4	1.2	1.2	-95 %	-89 %	0.0 %	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	0.0	-96 %	-47 %	-11.7 %	0.0 %	0.0 %
Netherlands	38	22	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.2	0.2	-100 %	-34 %	-4.5 %	0.6 %	0.0 %
Poland	206	190	172	164	180	183	185	182	182	176	183	179	157	144	160	160	-22 %	-7 %	-0.3 %	3.2 %	13.0 %
Portugal	1,061	858	670	323	251	262	140	105	86	84	96	92	90	87	78	73	-93 %	-89 %	-6.7 %	16.6 %	5.9 %
Romania	62	39	39	21	21	18	17	18	20	20	19	19	19	17	20	15	-76 %	-61 %	-23.9 %	1.0 %	1.2 %
Slovakia	25	21	24	24	22	23	24	25	24	25	26	26	21	18	25	20	-17 %	-13 %	-18.9 %	0.4 %	1.7 %
Slovenia	416	291	136	77	52	45	41	41	39	39	38	37	36	35	35	35	-92 %	-74 %	-0.8 %	6.5 %	2.8 %
Spain	2,185	2,221	1,444	725	684	646	651	630	587	572	550	517	488	440	444	439	-80 %	-70 %	-1.0 %	34.2 %	35.7 %
Sweden	9.2	9.6	9.4	9.2	9.8	8.8	8.5	9.0	9.1	9.2	9.5	9.4	9.2	8.8	9.1	8.7	-6 %	-8 %	-4.5 %	0.1 %	0.7 %
EU27 (a)	**6,389**	**5,713**	**3,159**	**1,996**	**1,837**	**1,732**	**1,615**	**1,548**	**1,490**	**1,476**	**1,463**	**1,394**	**1,317**	**1,205**	**1,282**	**1,230**	**-81%**	**-61%**	**-4.0%**	**100%**	**100%**
EU27 (b)	6,405	5,713	3,159	1,996	1,838	1,732	1,615	1,549	1,490	1,476	1,463	1,394	1,317	1,205	1,282	1,230					

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.

In 2022, the EU Member States contributing most (i.e. more than 10%) to PCB emissions were Spain, Germany and Poland(countries ranked according to their shares of the EU total) (see Figure 3.32).

Figure 3.34 PCB emission trends in the EU and shares of Member States



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

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).

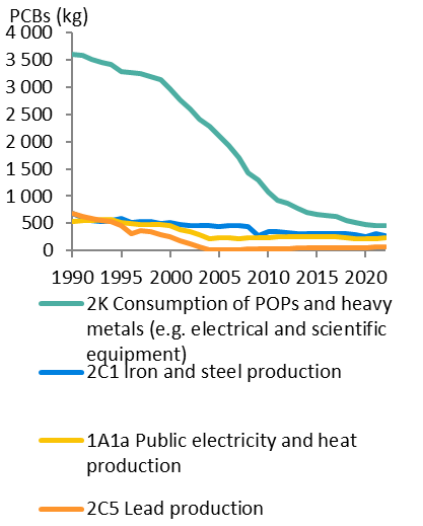
Lithuania explained that the high PCB emissions in 2005 occurred because emissions from electrical transformer oil were estimated (personal communication from Lithuania in 2017).

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 four key categories, the highest relative reductions in emissions between 1990 and 2022 were in the fourth most important '2C5 — Lead production' (90%) and the most important '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' (87%) (see Figure 3.35(a)). But is has also to be noted that PCB emissions from lead production increased almost six-fold between 2005 and 2022, which is mainly due to substantial increases reported by Greece.

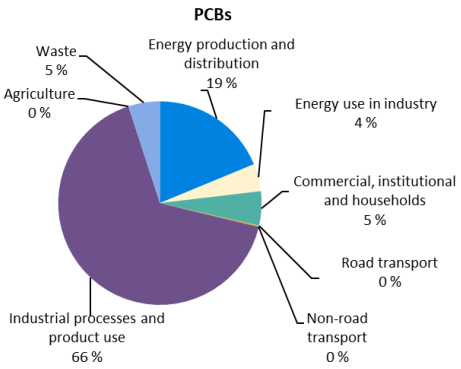
Figure 3.35(b) shows the contribution made by each aggregated sector group to total EU emissions. For PCBs, the most significant emission source is the industrial processes and product use sector group.

Figure 3.35 **PCB emissions from key categories in the EU: (a) trends in emissions from the three most important key categories, 1990-2022, (b) share by sector group, 2022 and (c) sectoral trends in emissions**

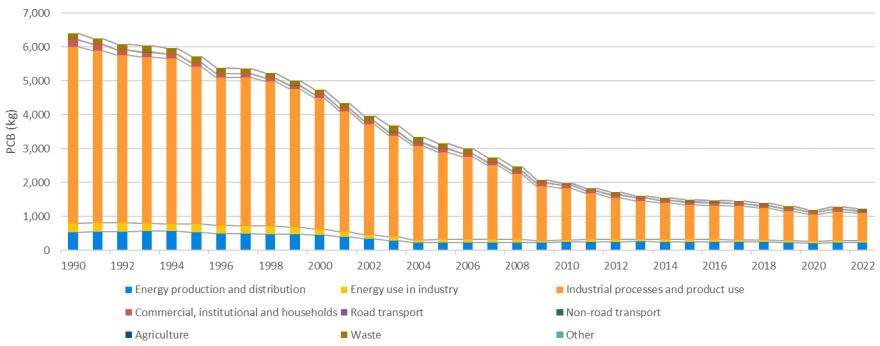
(a)



(b)



(c)



Note: In (a), the right-hand axis shows values for 1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals'.

4 Sectoral analysis and emission trends for air pollutants

This chapter sets out emission trends in and detailed methodologies for the air 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, Table 4.4, Table 4.6, Table 4.8, Table 4.9, Table 4.10, Table 4.12 and Table 4.14 provide information on the relative and absolute differences between emissions reported in 2023 and 2024. Big changes in absolute terms originate from the fact that some EU Member States carried out major recalculations (e.g. France, Bulgaria, Germany, Poland, Spain). 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 data from only 2000 onwards.
- The figures showing indexed values (in percentages) use 1990 as the index year (1990=100%), except for pollutants with emission reduction commitments (NO_X, SO_X, NMVOC, NH_3, $PM_{2.5}$, for which the index year is 2005 (2005=100%) and total suspended particulates (TSPs), black carbon (BC), PM with a diameter of 10µm or less (PM_{10}) and PM with a diameter of 2.5µm 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 46% of the total EU emissions of SO_X and 37% of Hg emissions.

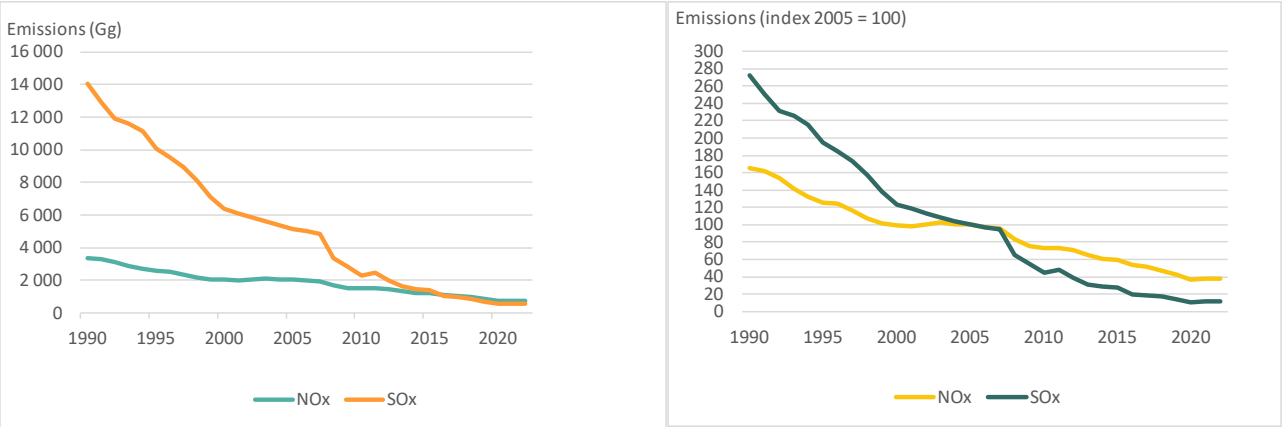
The sector is a significant source of SO_X, Hg, hexachlorobenzene (HCB), cadmium (Cd), nitrogen oxides (NO_X) and polychlorinated biphenyls (PCBs). Countries are ranked according to the size of the absolute values that they reported. In 2022, Poland, Germany, Spain and Romania contributed most (in absolute terms) to the emissions of SO_X for this sector. Poland and Germany reported the highest emissions of Hg in the same year. The Netherlands and France reported the highest emissions of HCB. Germany and Poland primarily accounted for Cd emissions in this sector in 2022. In addition, in 2022, Germany, Poland and Greece contributed most to NO_X emissions.

For emissions of the main pollutants (see Figure 4.1), between 1990 and 2022, the highest absolute and relative reductions within this aggregated sector were for SO_X (96%). Between 1990 and 2022, NO_X emissions dropped by 77%.

Between 2005 and 2022, highest absolute and relative reductions of main pollutants within this sector were reported for SO_X (89%) and PM_{10} (73%).

The declining trend in SO_X emissions between 1990 and 2022 and between 2005 to 2022 mainly reflects data from Germany, Poland and Spain in 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, 2023a).

Figure 4.1 EU emission trends in the energy production and distribution sector for NO_X and SO_X between 1990 and 2022

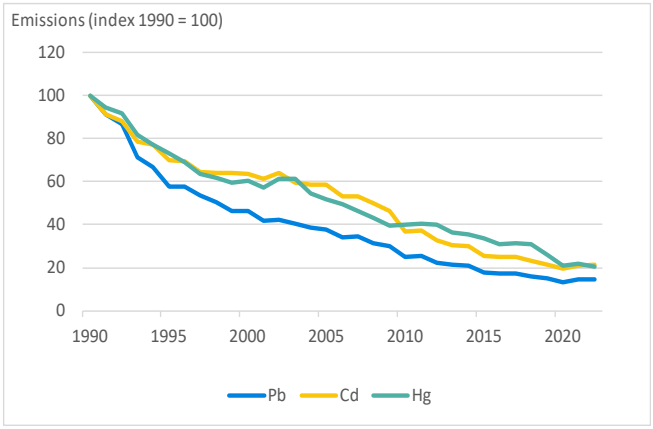


Between 1990 and 2022 as well as between 2005 and 2022, high reductions in relative terms were achieved for the heavy metals (HMs) Cd (1990-2022: 79%, 2005-2022: 64%), Pb (1990-2022: 86%, 2005-2022: 62%) and Hg (1990-2022:80%, 2005-2022: 61%) (see Figure 4.2(a)).

HCB showed a relative reduction of 82%, while PCB emissions dropped by 57% between 1990 and 2022 (see Figure 4.2(b)). Between 2005 and 2022, the reduction of HCB was 60% and for PCB 1%. The peak in HCB emissions in 1995 reflects high emission values reported by Belgium in the category '1A1a — Public electricity and heat production'. The Member State explained that these high HCB emissions were 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) HMs (Cd and Hg) and (b) persistent organic pollutants (POPs) (PCB and HCB) between 1990 and 2022**

(a)



(b)

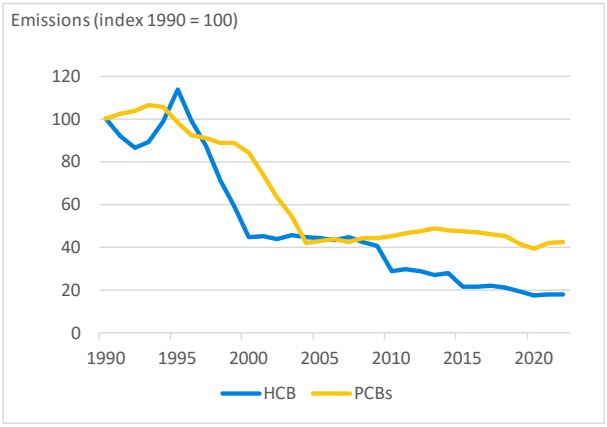


Table 4.1 indicates the number of EU Member States reporting the notation keys 'NA' (not applicable), 'NO' (not occurring), 'NR' (not relevant) and 'NE' (not estimated) within the key categories. Table 4.2 shows the recalculations within the energy production and distribution sector group. For explanations 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
PCB	1A1a	1	0	0	0
HCB	1A1a	1	0	0	0
SO_x	1A1b	0	6	0	0
Cd	1A1b	0	6	0	0

Note: Only the key categories where notation keys were 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 2023 and 2024 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	2020	2021
NO_x	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %
NMVOCs	1 %	1 %	-1 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-4 %
SOx	1 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-1 %	-2 %	-3 %	-3 %	-3 %	-4 %	-5 %
NH_3	-6 %	-2 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-3 %	-3 %	-3 %	-4 %	-4 %	-4 %	-4 %	-6 %	-6 %	-7 %	-12 %
TSPs	0 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-6 %
CO	0 %	0 %	0 %	2 %	3 %	2 %	3 %	3 %	1 %	1 %	0 %	0 %	0 %	0 %	-1 %	1 %	1 %	0 %	0 %	0 %
Pb	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	-1 %	-1 %	-2 %	-3 %	-2 %	-1 %
Cd	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-3 %	-3 %	-2 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-4 %	-5 %	-6 %	-5 %	-3 %
Hg	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	0 %	0 %	-2 %	-8 %
As	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %
Cr	-2 %	-3 %	-3 %	-3 %	-2 %	-2 %	-2 %	-2 %	-2 %	-1 %	-2 %	-2 %	-1 %	-1 %	-2 %	-2 %	-3 %	-3 %	-3 %	-2 %
Cu	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	0 %
Ni	-4 %	-4 %	-3 %	-4 %	-3 %	-4 %	-5 %	-6 %	-4 %	-3 %	-4 %	-3 %	-1 %	2 %	1 %	1 %	-4 %	-6 %	-2 %	0 %
Se	2 %	2 %	3 %	3 %	2 %	2 %	2 %	2 %	1 %	1 %	2 %	2 %	4 %	4 %	3 %	3 %	3 %	0 %	-1 %	0 %
Zn	0 %	-1 %	-2 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %
PCDD/Fs	132 %	201 %	222 %	510 %	1,802 %	1,498 %	950 %	-3 %	-2 %	-4 %	-3 %	-9 %	-3 %	-3 %	-3 %	-3 %	-2 %	-3 %	-2 %	-3 %
B(a)P	-2 %	-2 %	-16 %	-17 %	-17 %	-18 %	-19 %	-14 %	-15 %	-15 %	-16 %	-14 %	-15 %	-16 %	-16 %	-15 %	-14 %	-12 %	-7 %	-12 %
B(b)F	0 %	0 %	2 %	2 %	2 %	2 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %
B(k)F	0 %	0 %	2 %	2 %	2 %	1 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %
IP	0 %	0 %	2 %	2 %	2 %	1 %	1 %	0 %	0 %	1 %	2 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
Total PAHs	0 %	-1 %	-5 %	-5 %	-6 %	-6 %	-7 %	-7 %	-7 %	-7 %	-7 %	-6 %	-6 %	-6 %	-6 %	-6 %	-6 %	-5 %	-3 %	-4 %
HCB	1 %	1 %	3 %	3 %	3 %	4 %	4 %	3 %	4 %	6 %	6 %	5 %	5 %	7 %	6 %	6 %	6 %	6 %	6 %	1 %
PCBs	0 %	0 %	0 %	0 %	0 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-1 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			0 %	1 %	0 %	0 %	0 %	1 %	1 %	1 %	2 %	2 %	2 %	3 %	3 %	2 %	3 %	3 %	1 %	-2 %
PM_{10}			0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	1 %	0 %	-3 %
BC			1 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-8 %	-20 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	-7	-6	-18	-17	-18	-20	-17	-17	-15	-16	-15	-15	-15	-12	-14	-11	-13	-12	-13	-15
NMVOCs	13	6	-7	2	1	-2	-3	-5	-6	-8	-8	-10	-10	-11	-11	-11	-11	-12	-10	-13
SOx	135	35	-25	-26	-24	-25	-25	-26	-30	-30	-29	-29	-29	-21	-25	-27	-26	-24	-23	-29
NH_3	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1
TSPs	-4	-4	-5	-3	-3	-6	-5	-6	-5	-5	-4	-5	-5	-4	-4	-4	-3	-4	-4	-6
CO	-2	-2	-2	16	23	18	21	21	5	4	1	1	0	-2	-4	7	5	2	2	3
Pb	-1	-1	0	0	-1	-1	-2	-2	-1	-1	-1	-1	0	0	0	-1	-2	-2	-1	-1
Cd	0	0	0	0	0	0	-1	-1	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	0	-1
As	-1	-1	-1	-1	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	-4	-3	-2	-3	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Cu	-1	-1	-1	-1	-1	-1	-2	-1	-1	0	-1	0	0	0	0	0	-1	-1	0	0
Ni	-35	-32	-22	-26	-19	-21	-24	-22	-14	-9	-11	-7	-2	4	3	2	-9	-10	-3	0
Se	2	3	3	3	2	2	2	2	1	1	2	1	2	2	2	2	1	0	0	0
Zn	-5	-4	-6	-7	-8	-9	-9	-9	-9	-11	-11	-11	-11	-12	-11	-13	-12	-10	-9	-9
PCDD/Fs	3874	3706	2689	2224	2003	1572	1002	-3	-2	-4	-3	-9	-3	-3	-3	-3	-2	-2	-2	-2
B(a)P	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	-1
B(b)F	0	0	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	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1
HCB	2	1	1	1	2	2	2	2	1	2	2	1	2	2	2	2	1	1	1	0
PCBs	0	0	0	0	0	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	-1
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	-1
PM_{10}			0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	-2
BC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1

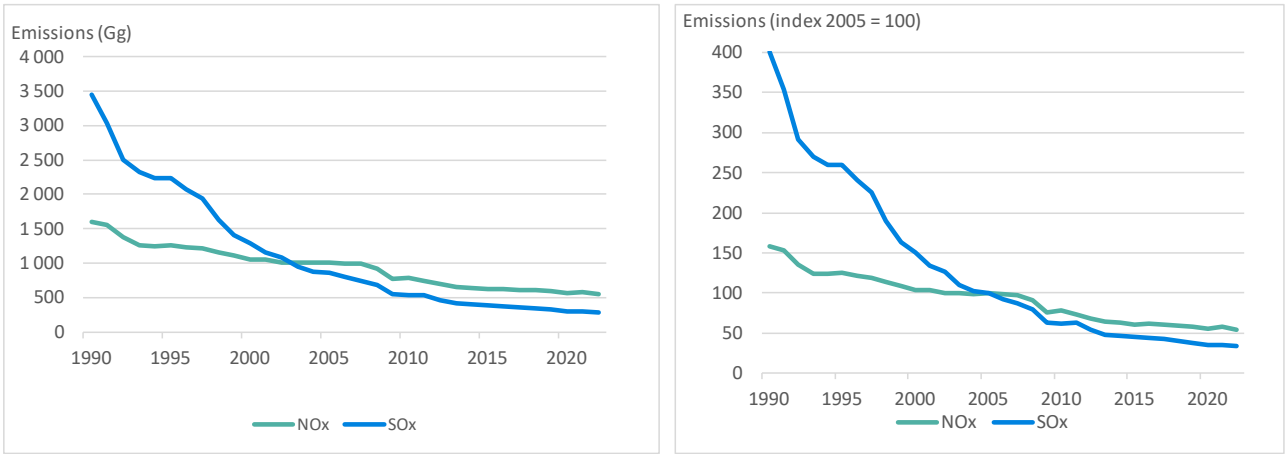
Note: As, arsenic; B(b)F, benzo(b)fluoranthene; BC, black carbon; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd)pyrene; NH_3, ammonia; Ni, nickel; PCBs, polychlorinated biphenyls; Se, selenium; TSP, total suspended particulate; Zn, zinc.

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

Energy use in the industry sector is a significant source of the HMs (Pb, Cd, Hg), SO_X and NO_X. According to the size of the absolute values reported, Italy, France and Poland contributed most to Pb emissions in this sector in 2022. For Cd, Poland, Italy and France reported the highest emissions, while Italy and France contributed most to Hg emissions. In addition, in 2022, France, Poland and Spain contributed most to SO_X emissions. The main emitters of NO_X emissions within the industry sector were Spain, Germany and France.

Energy use (fuel combustion) in industry is a significant source of many pollutants. For the main ones, the highest absolute and relative reduction between 1990 and 2022 (92%) and between 2005 and 2022 (66%) was for SO_X (see Figure 4.3).

Figure 4.3 EU emission trends in the energy use in industry for NO_X and SO_X between 1990 and 2022



Of the three HMs, Cd shows the biggest reduction in relative terms (83% decrease) between 1900 and 2022, while Pb shows the largest reduction between 2005 and 2022 (51% decrease) (see Figure 4.4).

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'.

The development of Cd emissions over the past 30 years mainly reflects data reported by Spain in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals', including the rise in emissions from 1994 to 1995.

Figure 4.4 **EU emission trends in the energy use in industry sector group for HMs (Pb, Cd and Hg) between 1990 and 2022**

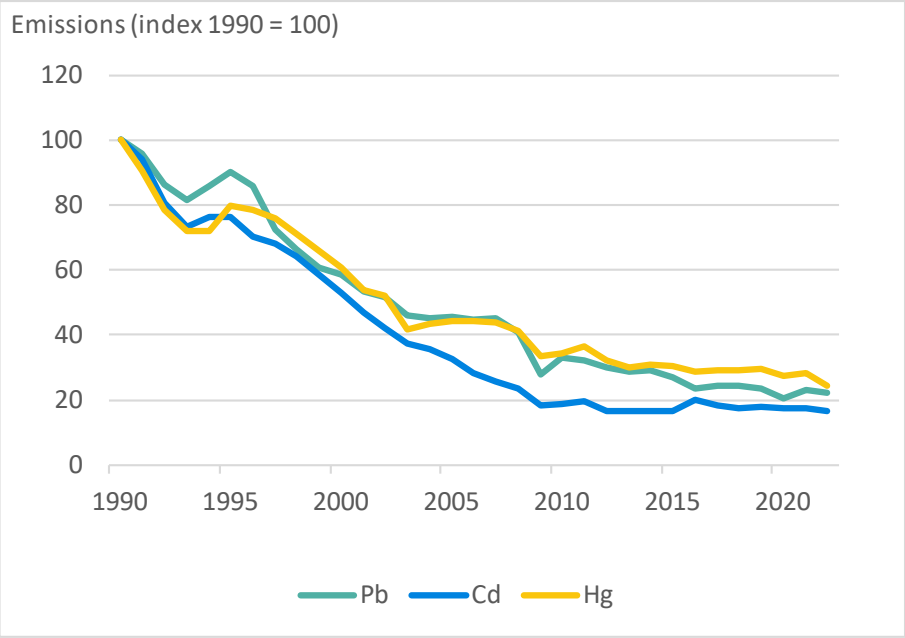


Table 4.3 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.4 shows the recalculations within the energy use in industry sector group. For explanations of EU recalculations, see Section 5.1.

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
SO_x	1A2a	0	1	0	0
CO	1A2a	0	1	0	0
Pb	1A2a	0	1	0	0
Hg	1A2a	0	1	0	0
Cd	1A2a	1	1	0	0
Dioxin	1A2b	1	2	0	0
HCB	1A2b	3	3	0	7
NO_x	1A2f	0	1	0	0
SO_x	1A2f	0	1	0	0
Pb	1A2f	0	1	0	0
Hg	1A2f	0	1	0	0
Cd	1A2f	0	1	0	0
$PM_{2.5}$	1A2f	0	1	0	0

Note: Only the key categories where notation keys were reported are considered. CO, carbon monoxide; NMVOC, non-methane volatile organic compound.

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 2023 and 2024 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	2020	2021
NO_x	-14 %	-16 %	-21 %	-20 %	-20 %	-19 %	-18 %	-19 %	-17 %	-17 %	-17 %	-16 %	-16 %	-16 %	-15 %	-15 %	-15 %	-14 %	-14 %	-13 %
NMVOCs	-26 %	-22 %	-29 %	-27 %	-26 %	-24 %	-22 %	-22 %	-20 %	-18 %	-17 %	-16 %	-16 %	-16 %	-15 %	-14 %	-13 %	-12 %	-12 %	-13 %
SOx	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	1 %	1 %	2 %	1 %	0 %	1 %	1 %	0 %	1 %	-4 %	0 %
NH_3	-23 %	-27 %	-31 %	-19 %	-23 %	-23 %	-21 %	-23 %	-23 %	-19 %	-18 %	-19 %	-20 %	-19 %	-18 %	-19 %	-18 %	-19 %	-18 %	-20 %
TSPs	-5 %	-8 %	-13 %	-13 %	-13 %	-12 %	-11 %	-12 %	-11 %	-10 %	-10 %	-10 %	-10 %	-10 %	-9 %	-9 %	-8 %	-8 %	-10 %	-9 %
CO	-6 %	-9 %	-11 %	-12 %	-12 %	-12 %	-13 %	-14 %	-12 %	-11 %	-9 %	-10 %	-10 %	-15 %	-15 %	-15 %	-14 %	-14 %	-17 %	-16 %
Pb	-2 %	-2 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	-7 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %
Cd	-1 %	-2 %	-3 %	-2 %	-2 %	-2 %	-1 %	-1 %	-1 %	-3 %	-2 %	-1 %	-1 %	-1 %	-1 %	0 %	-1 %	-1 %	-1 %	0 %
Hg	-4 %	-5 %	-6 %	-6 %	-6 %	-6 %	-6 %	-7 %	-7 %	-5 %	-5 %	-4 %	-4 %	-4 %	-5 %	-5 %	-4 %	-4 %	-7 %	-6 %
As	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %
Cr	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %
Cu	-4 %	-4 %	-5 %	-7 %	-8 %	-8 %	-8 %	-9 %	-7 %	-7 %	-7 %	-6 %	-6 %	-7 %	-9 %	-10 %	-10 %	-11 %	-12 %	-12 %
Ni	-4 %	-5 %	-9 %	-6 %	-6 %	-6 %	-6 %	-5 %	-5 %	-4 %	-2 %	0 %	-2 %	-1 %	1 %	0 %	-3 %	-2 %	-2 %	-5 %
Se	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %
Zn	0 %	0 %	1 %	0 %	0 %	0 %	0 %	1 %	1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %
PCDD/Fs	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-3 %	-2 %
B(a)P	-4 %	-4 %	-6 %	-6 %	-6 %	-6 %	-6 %	-7 %	-7 %	-7 %	-8 %	-8 %	-9 %	-8 %	-8 %	-8 %	-8 %	-8 %	-13 %	-11 %
B(b)F	-8 %	-7 %	-9 %	-8 %	-9 %	-9 %	-9 %	-10 %	-10 %	-10 %	-11 %	-12 %	-12 %	-12 %	-11 %	-12 %	-12 %	-11 %	-16 %	-14 %
B(k)F	-6 %	-6 %	-9 %	-9 %	-10 %	-10 %	-11 %	-12 %	-11 %	-12 %	-13 %	-14 %	-15 %	-14 %	-14 %	-14 %	-14 %	-14 %	-20 %	-18 %
IP	-6 %	-5 %	-7 %	-7 %	-8 %	-8 %	-8 %	-9 %	-8 %	-9 %	-10 %	-11 %	-12 %	-11 %	-11 %	-12 %	-12 %	-11 %	-16 %	-14 %
Total PAHs	-7 %	-7 %	-11 %	-10 %	-10 %	-10 %	-10 %	-12 %	-12 %	-13 %	-13 %	-14 %	-14 %	-13 %	-12 %	-13 %	-13 %	-13 %	-17 %	-16 %
HCB	0 %	2 %	2 %	1 %	1 %	0 %	0 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	-1 %
PCBs	0 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	0 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	-5 %	-11 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			-18 %	-18 %	-17 %	-16 %	-15 %	-16 %	-14 %	-14 %	-14 %	-13 %	-13 %	-12 %	-12 %	-11 %	-11 %	-10 %	-11 %	-10 %
PM_{10}			-17 %	-16 %	-16 %	-15 %	-14 %	-14 %	-13 %	-12 %	-12 %	-12 %	-12 %	-11 %	-11 %	-10 %	-10 %	-9 %	-11 %	-10 %
BC			-59 %	-55 %	-54 %	-53 %	-52 %	-50 %	-49 %	-52 %	-51 %	-52 %	-54 %	-49 %	-46 %	-45 %	-43 %	-39 %	-38 %	-37 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	-266	-244	-279	-256	-245	-234	-209	-177	-160	-155	-140	-126	-123	-117	-109	-106	-103	-94	-90	-87
NMVOCs	-57	-47	-53	-50	-45	-41	-37	-31	-28	-26	-23	-21	-20	-21	-20	-20	-19	-18	-18	-19
SOx	-32	-23	-13	-6	-7	-6	0	1	1	5	5	7	4	1	3	4	1	2	-13	-1
NH_3	-2	-2	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
TSPs	-34	-29	-30	-24	-22	-20	-17	-15	-13	-12	-11	-10	-10	-9	-9	-9	-8	-8	-8	-8
CO	-247	-315	-328	-332	-320	-317	-316	-247	-234	-220	-149	-149	-151	-245	-247	-246	-232	-223	-256	-256
Pb	-15	-15	-2	-1	-1	-1	-1	-1	-1	-17	-1	-1	-1	-1	-1	-1	-1	-1	-3	-3
Cd	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0
As	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	-1	-1	-1	-1	-1	-1	-1	0	0	-1	0	0	0	0	0	0	0	-1	-1	-1
Cu	-5	-5	-5	-6	-6	-6	-6	-5	-5	-4	-4	-3	-3	-4	-4	-4	-4	-4	-4	-5
Ni	-16	-20	-20	-11	-11	-9	-8	-6	-6	-4	-2	0	-1	-1	1	0	-2	-1	-1	-3
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	2	3	4	2	1	1	1	2	2	-3	-2	-3	-3	-3	-3	-4	-3	-4	-6	-6
PCDD/Fs	-3	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-3	-3
B(a)P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	-2	-1	-1	-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	0	0	0
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	-4	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3
HCB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PCBs	0	0	0	0	0	0	-1	0	0	0	0	0	-1	0	0	0	0	0	-3	-7
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			-27	-21	-19	-18	-15	-13	-12	-11	-10	-9	-8	-8	-7	-7	-7	-6	-7	-6
PM_{10}			-29	-22	-20	-19	-16	-13	-12	-11	-10	-9	-9	-8	-8	-8	-7	-7	-7	-7
BC			-17	-13	-12	-11	-10	-8	-8	-8	-7	-6	-6	-6	-5	-5	-5	-4	-4	-4

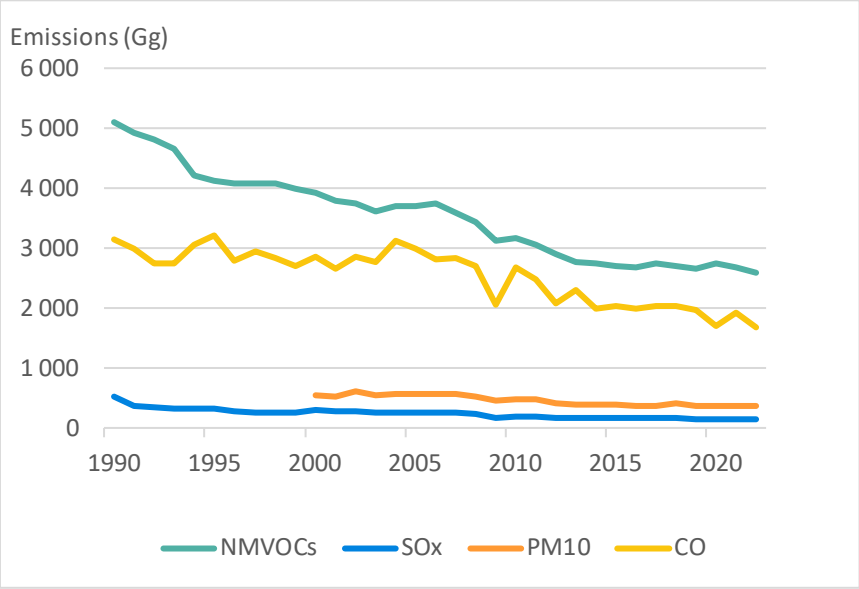
Note: As, arsenic; B(b)F, benzo(b)fluoranthene; BC, black carbon; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd)pyrene; NH_3, ammonia; Ni, nickel; PCBs, polychlorinated biphenyls; Se, selenium; TSP, total suspended particulate; Zn, zinc.

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, non-methane volatile organic compound (NMVOC), Pb and Cd emissions, as well as a significant source of total HCB, Hg, particulate matter with a diameter of 10µm 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. Spain contributed most to PCB emissions in this sector in 2022. Of all the countries, Germany, France and Italy contributed most to NMVOC emissions. 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 Bulgaria. Figure 4.5 shows previous trends in the 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 (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 Germany, Belgium and France, 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 2022**



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 previous emission trends for these pollutants. Pb shows the highest relative reduction in emissions between 1990 and 2022 (82%), while Hg shows highest relative emission reductions between 2005 and 2022 (53%).

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

The dip in Pb emissions between 2008 and 2009 was mainly caused by reductions in the category '2C5 — Lead production' reported by Bulgaria. The reduction in Pb emissions between 2010 and 2011 reflected the drastic drop in emissions reported by Latvia in 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 97% (see Latvia's IIR, listed in Appendix 5).

Among the persistent organic pollutants (POPs), HCB recorded the highest relative reduction (99%) between 1990 and 2022, while PCBs shows highest relative reductions between 2005 and 2022 (68%) (Figure 4.6(b)).

The massive decrease in HCB from 2001 to 2002 (87%) is a result of Germany's reporting the notation key 'NA' in category '2C3 — Aluminium production'. Secondary aluminium production in Germany has been prohibited by law 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 2022**

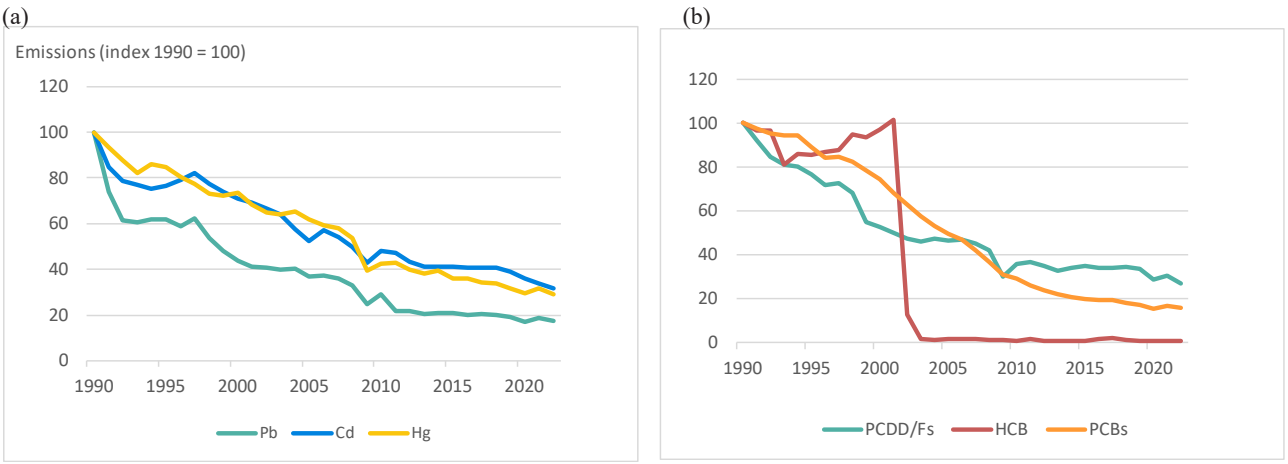


Table 4.5 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.6 shows the recalculations within the industrial processes and product use sector group. For explanations of EU recalculations, see Section 5.1.

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
Hg	2A1	6	1	0	4
Pb	2A3	2	3	0	0
Cd	2A3	2	3	0	0
PM_{10}	2A5a	1	2	0	0
$PM_{2.5}$	2A5b	1	0	0	0
PM_{10}	2A5b	1	0	0	0
SO_x	2B10a	1	5	0	1
HCB	2B10a	13	6	0	5
SO_x	2C1	1	4	0	2
CO	2C1	1	4	0	2
Pb	2C1	0	4	0	0
Hg	2C1	0	4	0	0
Total PAH	2C1	0	4	0	2
Cd	2C1	0	4	0	0
PCB	2C1	0	4	0	0
Dioxin	2C1	0	4	0	1
HCB	2C1	0	5	0	5
Pb	2C5	0	8	0	0
PCB	2C5	1	7	0	1
Hg	2C6	2	12	0	0
Cd	2C6	1	12	0	0
Cd	2C7a	0	11	0	1
HCB	2C7a	3	12	0	5
NMVOC	2D3e	0	1	0	0
NMVOC	2D3g	0	0	0	1
NMVOC	2D3i	0	0	0	1
PCB	2K	7	6	0	5
PM_{10}	2L	5	14	0	0

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 2023 and 2024 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	2020	2021
NO_x	-3 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
NMVOCs	1 %	1 %	1 %	1 %	2 %	1 %	1 %	2 %	1 %	1 %	1 %	1 %	1 %	2 %	1 %	1 %	1 %	1 %	-1 %	-3 %
SOx	-2 %	-1 %	-1 %	-5 %	-5 %	-4 %	-5 %	-7 %	-7 %	-8 %	-8 %	-11 %	-10 %	-10 %	-9 %	-12 %	-11 %	-11 %	-14 %	-3 %
NH_3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-2 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-2 %
TSPs	0 %	34 %	7 %	8 %	12 %	3 %	8 %	6 %	2 %	-3 %	10 %	8 %	9 %	0 %	1 %	1 %	-7 %	1 %	-5 %	4 %
CO	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %
Pb	0 %	-13 %	1 %	1 %	1 %	1 %	-13 %	1 %	-9 %	4 %	1 %	-11 %	1 %	1 %	1 %	0 %	-14 %	0 %	1 %	2 %
Cd	5 %	5 %	16 %	1 %	6 %	8 %	6 %	12 %	6 %	12 %	6 %	3 %	3 %	3 %	3 %	4 %	6 %	7 %	7 %	4 %
Hg	-1 %	0 %	-1 %	-1 %	-1 %	0 %	-2 %	0 %	0 %	1 %	1 %	0 %	1 %	0 %	0 %	0 %	0 %	1 %	2 %	2 %
As	2 %	3 %	15 %	8 %	13 %	12 %	-2 %	2 %	-1 %	3 %	2 %	-3 %	1 %	0 %	1 %	1 %	-3 %	2 %	2 %	1 %
Cr	1 %	1 %	4 %	0 %	1 %	2 %	3 %	5 %	2 %	4 %	2 %	1 %	1 %	1 %	1 %	1 %	2 %	2 %	2 %	1 %
Cu	8 %	7 %	11 %	5 %	8 %	9 %	4 %	5 %	3 %	4 %	3 %	2 %	2 %	3 %	2 %	2 %	2 %	2 %	1 %	4 %
Ni	2 %	2 %	8 %	1 %	3 %	5 %	4 %	6 %	3 %	5 %	3 %	2 %	2 %	2 %	2 %	2 %	3 %	4 %	3 %	3 %
Se	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-2 %	0 %	0 %	0 %
Zn	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %
PCDD/Fs	0 %	-2 %	-5 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-3 %	-4 %	-1 %
B(a)P	-6 %	-7 %	-9 %	-11 %	-8 %	-15 %	-11 %	-23 %	-18 %	-15 %	-16 %	-14 %	-14 %	-12 %	-13 %	-19 %	-26 %	-42 %	-40 %	-45 %
B(b)F	-4 %	-4 %	-5 %	-6 %	-5 %	-8 %	-6 %	-15 %	-12 %	-9 %	-10 %	-8 %	-9 %	-8 %	-8 %	-12 %	-17 %	-32 %	-30 %	-32 %
B(k)F	-5 %	-6 %	-6 %	-7 %	-6 %	-9 %	-7 %	-16 %	-12 %	-9 %	-10 %	-8 %	-8 %	-8 %	-8 %	-12 %	-17 %	-31 %	-30 %	-32 %
IP	-11 %	-13 %	-15 %	-20 %	-17 %	-30 %	-22 %	-46 %	-40 %	-33 %	-36 %	-31 %	-33 %	-29 %	-30 %	-40 %	-49 %	-67 %	-65 %	-66 %
Total PAHs	2 %	4 %	9 %	8 %	7 %	7 %	6 %	4 %	7 %	6 %	6 %	9 %	8 %	10 %	9 %	8 %	7 %	3 %	0 %	3 %
HCB	0 %	0 %	0 %	-5 %	-4 %	-5 %	-7 %	-5 %	-10 %	-6 %	-9 %	-11 %	-9 %	-11 %	-4 %	-5 %	-7 %	-10 %	-9 %	-9 %
PCBs	-8 %	-9 %	-10 %	-15 %	-16 %	-17 %	-19 %	-21 %	-22 %	-24 %	-26 %	-27 %	-28 %	-29 %	-29 %	-29 %	-30 %	-32 %	-34 %	-32 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			4 %	5 %	5 %	3 %	5 %	5 %	5 %	3 %	7 %	6 %	6 %	2 %	5 %	4 %	0 %	2 %	1 %	5 %
PM_{10}			6 %	6 %	8 %	0 %	5 %	3 %	1 %	-4 %	9 %	6 %	6 %	-4 %	0 %	-1 %	-8 %	-3 %	-8 %	1 %
BC			0 %	0 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	-1 %	-1 %	-2 %	-3 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	-9	0	-1	-1	-3	-2	-2	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0
NMVOCs	53	47	39	48	59	50	25	56	44	33	32	41	40	45	29	22	19	21	-23	-83
SOx	-9	-3	-4	-14	-14	-12	-14	-14	-14	-18	-15	-22	-19	-19	-18	-23	-22	-20	-26	-6
NH_3	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	-1
TSPs	4	456	102	132	186	45	127	82	21	-50	113	90	93	0	11	7	-84	15	-54	45
CO	-7	-38	-41	-41	-36	-36	-41	-21	-37	-29	-28	-33	-34	-35	-35	-35	-33	-32	-37	-33
Pb	9	-207	7	8	11	11	-118	4	-67	21	4	-59	5	4	5	1	-77	2	3	8
Cd	3	2	6	0	2	3	2	3	2	3	2	1	1	1	1	1	1	2	1	1
Hg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	7	4	7	3	5	5	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	3	3	9	0	2	3	3	4	2	4	2	1	1	1	1	1	2	2	2	1
Cu	28	23	31	14	22	25	11	12	8	11	7	5	6	7	6	5	5	5	2	10
Ni	4	4	9	1	3	4	3	3	2	3	2	1	1	1	1	1	2	2	2	1
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	0	1	0	3	3	6	-6	5	3	4	4	3	4	5	5	5	4	5	4	6
PCDD/Fs	-4	-15	-26	-1	-2	-3	-5	-2	-4	-5	-4	-5	-5	-5	-6	-6	-6	-10	-10	-4
B(a)P	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2
B(b)F	-1	-1	0	-1	0	-1	-1	-1	0	0	0	0	0	0	0	0	-1	-1	-1	-1
B(k)F	-1	-1	-1	-1	0	-1	-1	-1	0	0	0	0	0	0	0	0	-1	-1	-1	-1
IP	-1	-1	0	-1	0	-1	-1	-1	0	0	0	0	0	0	0	0	-1	-1	-1	-1
Total PAHs	4	6	8	7	7	7	5	2	4	4	4	5	5	6	5	5	4	2	0	2
HCB	3	0	1	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-4	-3	-3	-3	-3
PCBs	-480	-467	-438	-463	-450	-435	-434	-434	-438	-428	-427	-427	-425	-421	-419	-413	-410	-407	-406	-402
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			7	8	9	4	7	7	6	4	8	7	7	3	6	5	0	2	1	5
PM_{10}			32	35	41	1	25	14	7	-18	33	22	23	-15	1	-3	-35	-12	-31	4
BC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: As, arsenic; B(b)F, benzo(b)fluoranthene; BC, black carbon; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd)pyrene; NH3, ammonia; Ni, nickel; Se, selenium; TSP, total suspended particulate; 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 benzo(a) pyrene (B(a)P), polycyclic aromatic hydrocarbons (PAHs), particulate matter with a diameter of 2.5µm or less ($PM_{2.5}$), CO, PM_{10}, black carbon (BC) and PCDD/Fs, and is an important sector group for Cd, HCB, SO_X, NMVOC and NO_X 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, France and Romania reported the highest emissions. Poland, Italy and France contributed most to CO emissions. Poland, Romania and Italy emitted the largest proportion of PCDD/Fs in 2022.

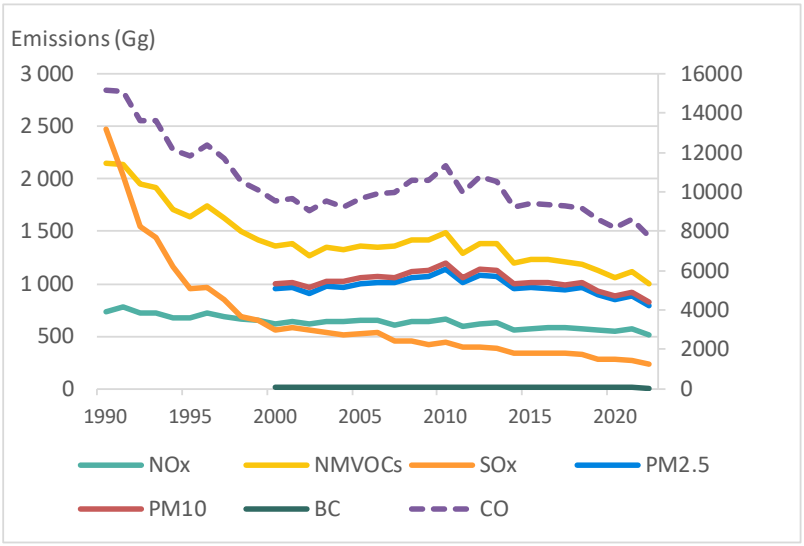
Of the main pollutants, once again the highest relative reduction between 1990 and 2022 and between 2005 and 2022 for the sector grouping was for SO_X (90% and 55%, respectively). In contrast, particulate matter (PM) emissions have changed little since 2000 (PM_{10} and $PM_{2.5}$:18%, BC: 11%) and since 2005 (PM_{10}: 22%, $PM_{2.5}$: 21%, BC: 14%) (see Figure 4.7).

The trend for CO within the commercial, institutional and households sector is mainly influenced by emissions reported by France, Poland and Italy in category '1A4bi — Residential: Stationary'.

Lower SO_X emissions from 1990 onwards were the result of reductions in emissions of this air pollutant 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 a low sulphur content (see Germany's IIR 2022, listed in Appendix 5).

The trend for NMVOC emissions mainly follows the development of data reported by Czechia, France and Italy for category '1A4bi — Residential: Stationary', who are the main contributors.

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 2022



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 in absolute terms, Hg shows largest reduction in relative terms (1990-2022: 67%, 2005-2022: 45%) between 1990 - 2022 and 2005 – 2022. (see Figure 4.8(a)).

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

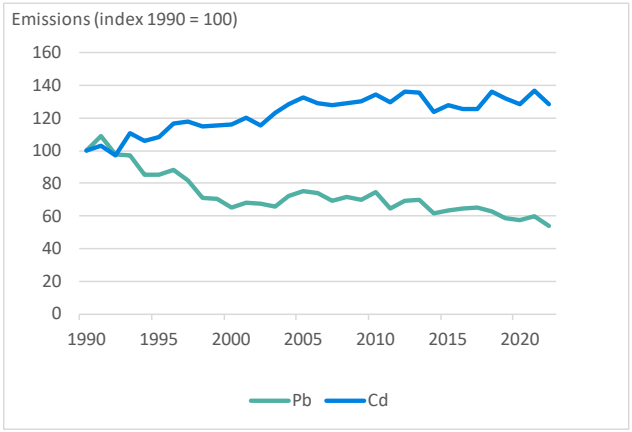
Poland and Germany contribute most to the trend in Pb emissions. The fall in Pb emissions from 1990 to 1992 is the result of emission reductions reported by several countries, especially Germany and Italy, which reduced their emissions considerably in categories '1A5b — Other, mobile (including military,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

Among the POPs relevant to the commercial, institutional and households sector, the highest relative reduction between 1900 and 2022 occurred for HCB (85%) and between 2005 and 2022 for PCBs (28%) (Figure 4.8(b)).

The trend in total emissions of PAHs largely reflects data from Poland, Germany and Italy in category '1A4bi — Residential: Stationary'. The peaks in 2010 and 2012 reflect data reported by Germany and Poland in category '1A4bi — Residential: Stationary'. 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 2022**

(a)



(b)

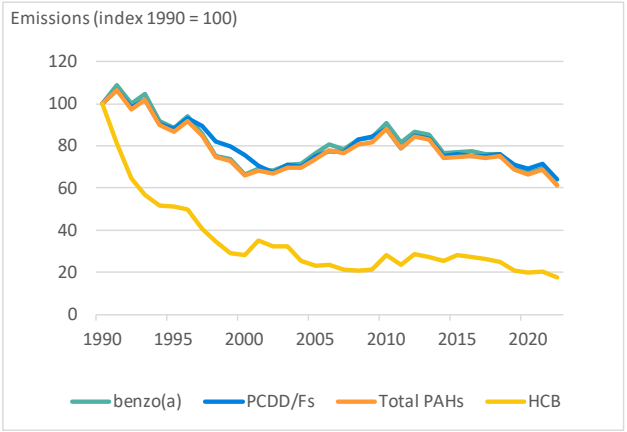


Table 4.7 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.8 shows the recalculations within the commercial, institutional and households sector group. For explanations of EU recalculations, see Section 5.1.

Table 4.7 **Number of EU Member States reporting notation keys within the key categories of the commercial, institutional and households 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 the key categories where notation keys were 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 2023 and 2024 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	2020	2021
NO_x	-51 %	-53 %	-55 %	-50 %	-48 %	-48 %	-45 %	-44 %	-42 %	-43 %	-40 %	-39 %	-40 %	-38 %	-36 %	-35 %	-34 %	-33 %	-33 %	-31 %
NMVOCs	-4 %	-5 %	-10 %	-9 %	-8 %	-7 %	-6 %	-5 %	-3 %	-3 %	-2 %	-1 %	-1 %	1 %	1 %	1 %	1 %	0 %	0 %	2 %
SOx	-4 %	-6 %	-5 %	-5 %	-5 %	-7 %	-5 %	-4 %	-4 %	-6 %	0 %	0 %	-1 %	0 %	-1 %	-1 %	0 %	-1 %	-1 %	-1 %
NH_3	-16 %	-15 %	-18 %	-17 %	-17 %	-18 %	-16 %	-17 %	-18 %	-20 %	-20 %	-20 %	-19 %	-20 %	-20 %	-20 %	-19 %	-18 %	-19 %	-18 %
TSPs	-2 %	-2 %	-4 %	-3 %	-2 %	-2 %	-2 %	-1 %	0 %	0 %	1 %	1 %	1 %	3 %	3 %	3 %	2 %	2 %	1 %	3 %
CO	-6 %	-5 %	-9 %	-10 %	-9 %	-9 %	-9 %	-8 %	-7 %	-8 %	-7 %	-6 %	-7 %	-7 %	-7 %	-7 %	-7 %	-8 %	-9 %	-7 %
Pb	-50 %	-25 %	-4 %	-2 %	-3 %	-4 %	-4 %	-3 %	-3 %	-5 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %
Cd	-2 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %
Hg	-2 %	-1 %	-1 %	-3 %	-3 %	-5 %	-5 %	-4 %	-4 %	-6 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-1 %
As	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	-2 %	-1 %
Cr	-7 %	-5 %	-4 %	-3 %	-3 %	-3 %	-3 %	-3 %	-2 %	-3 %	-2 %	-2 %	-2 %	-1 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %
Cu	-17 %	-16 %	-22 %	-18 %	-17 %	-18 %	-18 %	-17 %	-16 %	-19 %	-17 %	-17 %	-19 %	-20 %	-19 %	-20 %	-21 %	-23 %	-24 %	-25 %
Ni	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-1 %	-2 %	-2 %	-1 %	-1 %	-1 %	-2 %	-3 %	-3 %
Se	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-1 %	-2 %	-2 %	-2 %	-3 %	-2 %
Zn	-2 %	-1 %	-2 %	-1 %	-2 %	-2 %	-2 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %
PCDD/Fs	-3 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	0 %
B(a)P	-4 %	-3 %	-1 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	3 %	3 %	3 %	3 %	3 %	3 %	5 %
B(b)F	-2 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	3 %	2 %	2 %	2 %	2 %	3 %
B(k)F	-4 %	-3 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	-1 %	-1 %	-1 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	3 %
IP	-4 %	-3 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-1 %	0 %	0 %	2 %	3 %	2 %	2 %	2 %	2 %	4 %
Total PAHs	-3 %	-2 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	2 %	3 %	2 %	2 %	2 %	2 %	4 %
HCB	-14 %	-11 %	-6 %	-3 %	-4 %	-3 %	-3 %	-3 %	-5 %	-4 %	-4 %	-4 %	-3 %	5 %	5 %	0 %	0 %	-9 %	-1 %	2 %
PCBs	-2 %	0 %	0 %	-4 %	-5 %	-6 %	-7 %	-5 %	-4 %	-7 %	0 %	0 %	0 %	0 %	-1 %	0 %	0 %	0 %	0 %	1 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			-4 %	-3 %	-2 %	-2 %	-2 %	-1 %	0 %	0 %	1 %	1 %	1 %	3 %	3 %	3 %	3 %	2 %	2 %	3 %
PM_{10}			-4 %	-3 %	-2 %	-2 %	-2 %	-1 %	0 %	0 %	1 %	1 %	1 %	3 %	3 %	3 %	2 %	2 %	2 %	3 %
BC			-30 %	-25 %	-23 %	-21 %	-19 %	-18 %	-15 %	-16 %	-13 %	-12 %	-12 %	-10 %	-9 %	-8 %	-7 %	-7 %	-8 %	-5 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	-767	-749	-744	-659	-603	-565	-537	-505	-477	-456	-407	-393	-372	-349	-325	-307	-294	-273	-265	-249
NMVOCs	-86	-80	-145	-131	-114	-107	-92	-70	-49	-38	-34	-14	-14	10	16	17	13	5	-1	21
SOx	-112	-62	-32	-26	-29	-35	-26	-18	-20	-23	-1	-1	-2	-1	-2	-3	-1	-2	-2	-2
NH_3	-9	-9	-11	-10	-10	-10	-10	-11	-12	-12	-13	-13	-11	-12	-11	-11	-10	-9	-10	-9
TSPs	-28	-27	-43	-30	-23	-21	-19	-12	-2	1	7	11	10	27	29	28	25	20	13	24
CO	-891	-648	-915	-1026	-993	-1028	-998	-895	-838	-868	-806	-722	-728	-665	-655	-656	-693	-745	-774	-604
Pb	-217	-61	-6	-3	-5	-7	-7	-4	-5	-8	0	0	-1	-1	-1	-1	-1	-1	-2	-1
Cd	0	0	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	0	0
As	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	-4	-3	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	0	0	0	0	0	-1	0
Cu	-15	-14	-15	-15	-14	-14	-14	-13	-13	-14	-13	-13	-13	-13	-14	-14	-15	-15	-16	-16
Ni	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	-15	-9	-10	-10	-11	-11	-12	-12	-10	-11	-12	-12	-10	-12	-10	-10	-11	-11	-13	-14
PCDD/Fs	-30	-9	-7	-6	-7	-6	-8	-7	-8	-8	-9	-9	-9	-9	-10	-11	-12	-12	-12	-3
B(a)P	-15	-8	-2	0	0	1	0	1	2	2	2	2	3	7	7	7	7	6	7	10
B(b)F	-7	1	2	3	2	2	1	2	3	3	3	3	3	6	6	5	5	4	4	7
B(k)F	-7	-4	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	1	1	1	1	1	1	3
IP	-6	-4	-1	0	-1	0	-1	0	0	0	-1	-1	-1	3	3	3	3	2	3	4
Total PAHs	-35	-15	-3	2	1	2	0	3	4	3	4	4	5	17	18	17	17	15	15	24
HCB	-24	-10	-3	-1	-1	-1	-1	-1	-2	-1	-2	-1	-1	2	2	0	0	-3	0	1
PCBs	-3	0	0	-4	-5	-6	-7	-5	-3	-6	0	0	0	0	0	0	0	0	0	1
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			-41	-29	-22	-19	-17	-11	-2	1	7	10	10	26	27	26	24	20	14	25
PM_{10}			-43	-30	-23	-20	-18	-12	-3	0	6	9	9	26	27	26	24	20	13	25
BC			-38	-30	-27	-24	-23	-21	-19	-17	-15	-14	-12	-10	-9	-8	-7	-6	-6	-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; NH3, ammonia; Ni, nickel; Se, selenium; TSP, total suspended particulate; 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 Pb, BC and CO. Figure 4.9 and Figure 4.10 show the previous 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 Italy reported the highest emissions. Germany, France and Italy contributed most to Pb emissions. France, Poland and Spain contributed most (in absolute terms) to BC emissions in the road transport sector in 2022. For CO, Germany, Poland and Italy reported the highest emissions.

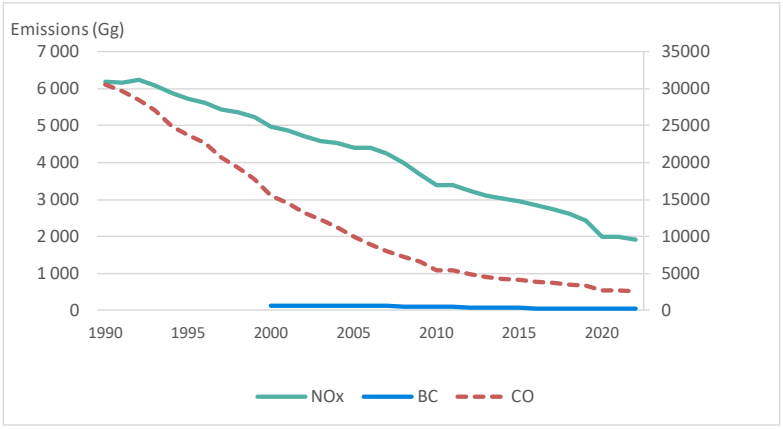
NO_X emissions have decreased between 1990 and 2022 by 69% and by 57% since 2005. The main source of NO_X emissions is category 1A3bi 'Road transport: Passenger cars', which is responsible for 49% of NO_X emissions in the road transport sector in 2022.

CO emissions have decreased by 92% since 1990 and by 74% since 2005 in the road transport sector. Also, for this pollutant, category 1A3bi 'Road transport: Passenger cars' is the main source of CO emissions, responsible for 71% of total CO emissions from this sector in 2022.

Since 1990, BC emissions from this sector have decreased by 72% and by 70% since 2005. Category 1A3bi 'Road transport: Passenger cars' is responsible for 46% of BC emissions in this sector.

The main reasons for the decline of these pollutants are introduction of Euro standards (EU, 2007) as well as the regulation of the catalytic-converter use (EU, 1991).

Figure 4.9 EU emission trends in the road transport sector group for NO_X, BC and CO between 1990 (2000) and 2022



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 (98%) between 1990 and 2022 and between 2005 and 2022 (9%) (see Figure 4.10). 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, 2009a) achieved that objective. Nevertheless, the road transport sector remains a key source of Pb, contributing around 26% of total Pb emissions in the EU.

Figure 4.10 **EU emission trends in the road transport sector group for the priority HM Pb between 1990 and 2022**

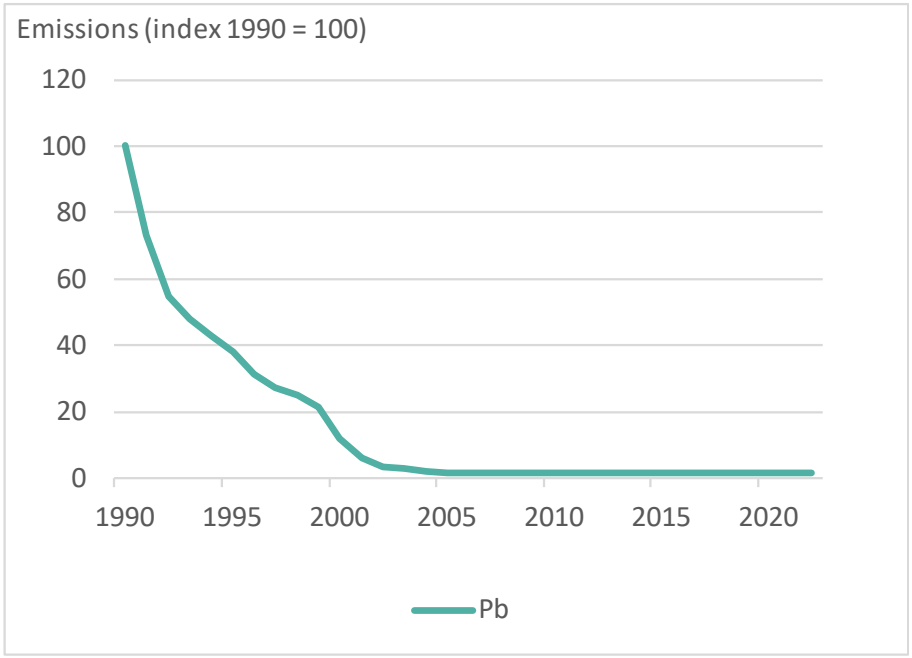


Table 4.9 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.9 shows the recalculations within the road transport sector group. For explanations of EU recalculations, see Section 5.1.

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 2023 and 2024 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	2020	2021
NO_x	0 %	0 %	0 %	0 %	1 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-2 %	-3 %	0 %	0 %	-1 %	-1 %
NMVOCs	0 %	0 %	0 %	0 %	1 %	0 %	0 %	-1 %	-2 %	-2 %	-1 %	-1 %	-4 %	-3 %	-7 %	-9 %	-7 %	-9 %	-11 %	-16 %
SOx	-1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	0 %	0 %	2 %	0 %	2 %	2 %	0 %	0 %	0 %
NH_3	0 %	0 %	0 %	-1 %	0 %	-1 %	0 %	-1 %	-1 %	-1 %	0 %	0 %	0 %	1 %	1 %	0 %	1 %	1 %	0 %	1 %
TSPs	0 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %
CO	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	-1 %	-1 %	-1 %	0 %	-4 %	-3 %	-5 %	-7 %	-3 %	-4 %	-6 %	-10 %
Pb	0 %	0 %	0 %	5 %	5 %	5 %	5 %	6 %	6 %	7 %	7 %	7 %	7 %	7 %	7 %	7 %	7 %	6 %	7 %	6 %
Cd	2 %	2 %	2 %	4 %	3 %	4 %	3 %	4 %	4 %	3 %	4 %	4 %	4 %	6 %	4 %	4 %	4 %	3 %	4 %	3 %
Hg	0 %	0 %	0 %	0 %	1 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	2 %	3 %	3 %	4 %	4 %	4 %	3 %
As	3 %	4 %	4 %	5 %	5 %	5 %	5 %	5 %	6 %	5 %	6 %	6 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %	4 %
Cr	5 %	5 %	5 %	6 %	6 %	6 %	6 %	6 %	7 %	7 %	7 %	7 %	7 %	7 %	7 %	7 %	6 %	6 %	8 %	6 %
Cu	3 %	3 %	3 %	4 %	4 %	4 %	4 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %	4 %	6 %	4 %
Ni	2 %	3 %	3 %	4 %	4 %	4 %	4 %	4 %	5 %	4 %	5 %	5 %	5 %	5 %	5 %	5 %	4 %	4 %	5 %	4 %
Se	2 %	2 %	2 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	4 %	3 %	3 %	3 %	3 %	4 %	3 %
Zn	1 %	1 %	2 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %
PCDD/Fs	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	1 %	1 %	1 %	1 %	0 %	0 %	0 %	-1 %	-2 %	-5 %
B(a)P	3 %	2 %	2 %	1 %	2 %	1 %	1 %	1 %	0 %	1 %	1 %	2 %	1 %	3 %	3 %	2 %	3 %	2 %	2 %	2 %
B(b)F	2 %	1 %	1 %	0 %	1 %	0 %	1 %	0 %	0 %	0 %	0 %	1 %	2 %	3 %	4 %	5 %	7 %	6 %	7 %	5 %
B(k)F	1 %	1 %	1 %	0 %	1 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	2 %	3 %	5 %	7 %	9 %	9 %	10 %	7 %
IP	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	0 %	0 %	1 %	0 %	2 %	2 %	2 %	3 %	3 %	3 %	2 %
Total PAHs	2 %	1 %	1 %	0 %	1 %	1 %	1 %	0 %	0 %	0 %	1 %	1 %	1 %	3 %	4 %	4 %	6 %	5 %	6 %	4 %
HCB	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
PCBs	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	-4 %	-9 %	-14 %	-21 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			0 %	0 %	1 %	1 %	1 %	0 %	0 %	0 %	0 %	1 %	0 %	0 %	0 %	-1 %	1 %	1 %	0 %	-1 %
PM_{10}			0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	2 %	1 %	1 %	0 %
BC			0 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	-1 %	-1 %	0 %	0 %	-2 %	-4 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	-8	-8	12	-6	40	15	30	-8	-13	-15	-8	-11	-36	-43	-53	-72	8	0	-12	-22
NMVOCs	-10	-8	-2	7	7	1	-1	-9	-16	-13	-9	-5	-27	-21	-41	-56	-37	-49	-52	-81
SOx	-5	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	0	0	0	-1	0	-1	0	0	-1	0	0	0	0	1	0	0	0	0	0	0
TSPs	-1	0	-1	3	5	4	4	3	3	3	3	3	3	3	3	2	4	3	2	1
CO	-24	2	92	92	114	78	96	46	-34	-30	-30	-14	-174	-137	-211	-299	-104	-144	-177	-292
Pb	5	7	9	15	15	15	15	16	17	16	16	17	17	17	17	16	16	16	17	14
Cd	0	0	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	0	0
As	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	3	3	3	5	5	5	5	5	6	6	6	6	6	6	6	6	6	5	6	5
Cu	34	34	46	75	79	80	80	82	85	83	84	85	87	89	89	86	85	83	91	75
Ni	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	7	9	12	22	23	24	23	23	24	23	23	24	26	26	25	23	23	22	25	20
PCDD/Fs	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0	0	-1	-1	-3
B(a)P	0	0	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	0	0
B(k)F	0	0	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	0	0
Total PAHs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
HCB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PCBs	0	0	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	2020	2021
$PM_{2.5}$			-1	1	2	1	2	1	0	0	1	1	0	0	0	-1	1	1	0	-1
PM_{10}			0	2	4	3	3	2	2	2	2	3	2	2	1	1	3	2	1	0
BC			0	0	1	0	0	0	0	0	0	0	0	1	-1	-1	0	0	-1	-2

Note: As, arsenic; 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; TSP, total suspended particulate; 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, 2022c) define international emissions as those that start in one country and finish in another, the reporting matches the guidelines.

The non-road transport sector is not a key sector for any pollutant but is a source of NO_X emissions. Emissions of this pollutant show a slight upwards trend between 2021 and 2022, mainly influenced by increases in international and domestic aviation (see Figure 4.11).

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

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.

Figure 4.11 EU emission trends in the non-road transport sector group for NO_X between 1990 and 2022

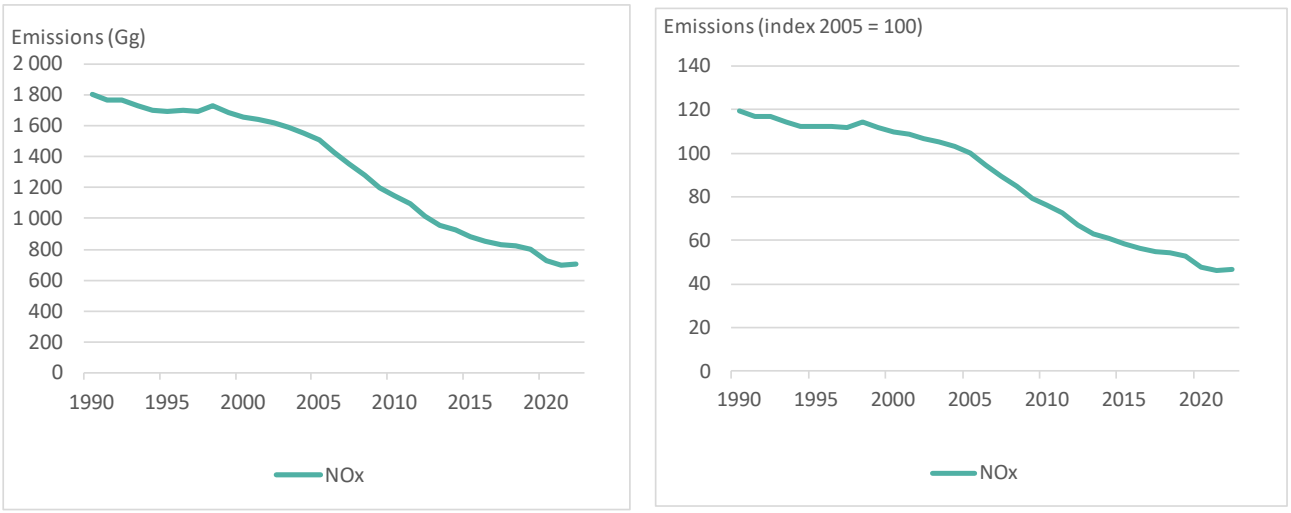


Table 4.10 shows the recalculations within the non-road transport sector group. For explanations of EU recalculations, see Section 5.1.

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 2023 and 2024 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	2020	2021
NO_x	131 %	135 %	159 %	158 %	148 %	144 %	139 %	125 %	127 %	127 %	123 %	122 %	120 %	112 %	104 %	98 %	92 %	85 %	92 %	89 %
NMVOCs	334 %	312 %	328 %	327 %	313 %	303 %	303 %	280 %	296 %	308 %	357 %	338 %	328 %	317 %	300 %	293 %	286 %	280 %	305 %	307 %
SOx	49 %	38 %	25 %	26 %	26 %	27 %	18 %	12 %	17 %	18 %	3 %	2 %	2 %	1 %	0 %	0 %	0 %	0 %	1 %	-1 %
NH_3	240 %	163 %	163 %	128 %	124 %	116 %	113 %	121 %	134 %	132 %	117 %	118 %	123 %	127 %	128 %	133 %	133 %	148 %	276 %	287 %
TSPs	220 %	221 %	221 %	194 %	177 %	166 %	157 %	142 %	135 %	138 %	130 %	127 %	119 %	111 %	100 %	91 %	81 %	74 %	78 %	79 %
CO	451 %	458 %	497 %	491 %	467 %	452 %	459 %	430 %	478 %	510 %	596 %	591 %	580 %	560 %	538 %	524 %	515 %	533 %	657 %	618 %
Pb	249 %	173 %	46 %	18 %	18 %	20 %	20 %	20 %	20 %	30 %	28 %	28 %	25 %	26 %	23 %	30 %	31 %	31 %	31 %	34 %
Cd	108 %	111 %	145 %	162 %	157 %	165 %	169 %	148 %	161 %	176 %	182 %	189 %	189 %	189 %	184 %	186 %	188 %	186 %	208 %	215 %
Hg	28 %	23 %	30 %	28 %	31 %	33 %	35 %	31 %	37 %	44 %	44 %	48 %	48 %	46 %	44 %	43 %	42 %	42 %	51 %	45 %
As	0 %	-8 %	2 %	3 %	3 %	3 %	4 %	-1 %	0 %	1 %	1 %	0 %	1 %	2 %	1 %	1 %	1 %	1 %	2 %	1 %
Cr	9 %	11 %	12 %	13 %	12 %	12 %	12 %	14 %	14 %	14 %	14 %	14 %	13 %	13 %	13 %	13 %	9 %	5 %	1 %	16 %
Cu	47 %	54 %	54 %	56 %	54 %	53 %	53 %	57 %	60 %	59 %	58 %	59 %	56 %	55 %	57 %	58 %	57 %	55 %	56 %	63 %
Ni	3 %	0 %	7 %	8 %	7 %	7 %	8 %	5 %	6 %	7 %	7 %	7 %	7 %	7 %	7 %	7 %	4 %	2 %	0 %	8 %
Se	15 %	11 %	15 %	17 %	17 %	18 %	18 %	14 %	16 %	17 %	18 %	18 %	19 %	19 %	18 %	17 %	17 %	17 %	18 %	19 %
Zn	127 %	128 %	155 %	172 %	176 %	185 %	194 %	178 %	193 %	210 %	217 %	227 %	223 %	221 %	216 %	215 %	217 %	217 %	254 %	254 %
PCDD/Fs	16 %	17 %	24 %	36 %	39 %	36 %	42 %	32 %	44 %	40 %	38 %	43 %	45 %	40 %	41 %	44 %	41 %	39 %	46 %	41 %
B(a)P	303 %	369 %	504 %	648 %	702 %	710 %	712 %	724 %	719 %	725 %	732 %	776 %	812 %	818 %	837 %	837 %	863 %	856 %	990 %	950 %
B(b)F	346 %	425 %	530 %	594 %	620 %	622 %	620 %	639 %	632 %	628 %	636 %	682 %	707 %	708 %	703 %	688 %	699 %	692 %	875 %	865 %
B(k)F	297 %	341 %	422 %	486 %	530 %	553 %	571 %	582 %	578 %	603 %	608 %	654 %	664 %	666 %	658 %	644 %	668 %	664 %	805 %	765 %
IP	381 %	410 %	444 %	491 %	530 %	556 %	544 %	549 %	549 %	574 %	590 %	638 %	677 %	679 %	649 %	608 %	621 %	606 %	773 %	693 %
Total PAHs	242 %	275 %	349 %	410 %	424 %	433 %	428 %	424 %	414 %	432 %	433 %	447 %	453 %	459 %	449 %	2,658 %	453 %	446 %	547 %	543 %
HCB	10 %	9 %	12 %	14 %	15 %	16 %	18 %	15 %	19 %	19 %	20 %	22 %	21 %	21 %	19 %	20 %	19 %	19 %	20 %	21 %
PCBs	0 %	-1 %	6 %	5 %	5 %	11 %	9 %	1 %	2 %	2 %	2 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			283 %	245 %	224 %	211 %	202 %	177 %	168 %	175 %	166 %	163 %	151 %	142 %	125 %	114 %	103 %	90 %	93 %	94 %
PM_{10}			240 %	208 %	189 %	177 %	169 %	150 %	143 %	147 %	138 %	135 %	125 %	117 %	104 %	95 %	86 %	75 %	78 %	80 %
BC			662 %	606 %	559 %	523 %	506 %	452 %	429 %	444 %	410 %	411 %	388 %	352 %	311 %	285 %	256 %	208 %	225 %	204 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	1026	972	1017	925	850	797	746	668	642	614	559	525	503	466	433	411	396	367	348	329
NMVOCs	400	340	325	289	271	254	232	205	208	195	191	172	163	156	145	140	137	132	126	125
SOx	119	75	43	34	34	33	19	15	15	11	2	1	1	0	0	0	0	0	0	0
NH_3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSPs	135	119	112	88	80	73	67	60	55	53	48	45	42	39	36	33	32	29	27	26
CO	1879	1709	1651	1642	1591	1575	1511	1362	1489	1479	1489	1442	1401	1378	1359	1338	1335	1347	1333	1309
Pb	239	69	13	3	3	4	3	3	3	4	4	4	3	3	3	3	3	3	3	3
Cd	0	0	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	0	0
As	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cr	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1	0	3
Cu	77	84	95	95	94	93	94	94	99	98	97	96	93	93	97	98	98	96	84	96
Ni	3	0	6	6	6	6	6	5	5	5	6	5	5	5	6	6	4	1	0	6
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	13	12	13	14	14	15	14	13	14	14	14	13	13	14	14	14	14	15	15	15
PCDD/Fs	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
B(a)P	1	1	1	1	1	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	1	1	1
B(k)F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	18	3	3	3	3
HCB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PCBs	0	0	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	2020	2021
$PM_{2.5}$			104	82	74	67	61	54	50	48	43	40	37	34	31	29	27	25	23	21
PM_{10}			107	84	76	70	63	56	52	50	45	42	39	36	33	31	29	26	24	23
BC			55	44	40	37	34	30	28	27	24	22	21	19	17	16	14	13	12	11

Note: As, arsenic; 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; TSP, total suspended particulate; 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 93%. With regard to the size of the absolute values that the countries reported, France, Germany and Spain contributed most to NH_3 emissions in 2022.

Agricultural emissions of NH_3 have fallen by 37% since 1990 and by 15% since 2005 (see Figure 4.12).

France, which represents 16% of NH_3 emissions from the agriculture sector in 2022 in the EU, reports that the decrease in NH_3 emissions are mainly caused by a reduction of mineral fertilizer spread, the reduction of manure spread and a drop in livestock numbers (see France IIR, listed in Appendix 5).

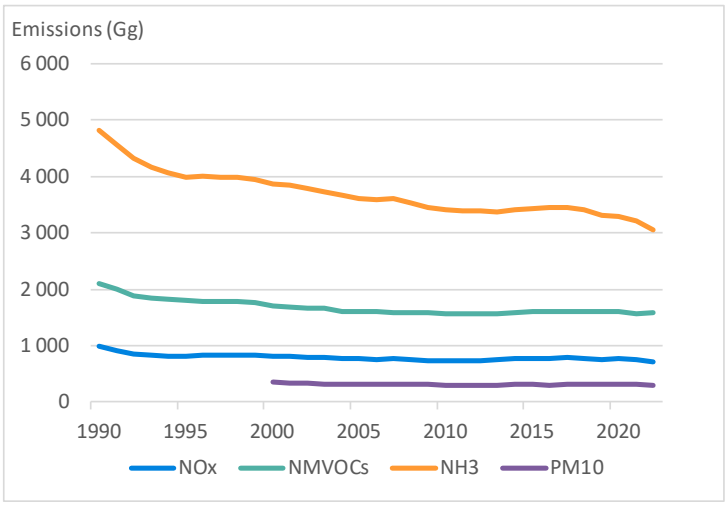
Germany represents 15% of NH3 emissions from the agriculture sector in the EU. The main drivers for the reduction of NH_3 emissions in this category are a reduced livestock population that followed after the German reunification and reported reductions of NH_3 emissions in Manure Management (NFR 3.B) with a 33% reduction between 1990-2022 and Agricultural Soils (NFR 3.D) with a 32% decrease between 1990 and 2022. (see Germany's IIR, listed in Appendix 5).

In 2022, 14% of NH_3 emissions from the agriculture sector are reported by Spain. Reasons for the decline of NH_3 emissions in the Member State are related to economic recession periods, weather conditions that affect the use of N-containing fertilizers, the growing number of livestock (mainly non-dairy cattle) and white swine. The introduction of fertilization practices with measures for abatement of NH_3 emissions from 2004 onwards and the progressive introduction of abatement techniques in white swine manure management (3B3), improvements in animal feed formulations, as well as the enforcement of animal welfare legislation affecting laying hens since 2010 leads to decreases in the last period of Ammonia emissions. (see Spanish IIR, listed in Appendix 5).

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

Manure management (categories 3B1a and 3B1b) is the main source of NMVOC emissions in the agriculture sector. Farm-level agricultural operations including storage, handling and transport of agricultural products (3Dc) is the primary source of PM_{10} emissions in this sector. NO_X emissions arise especially in categories 3Da1 (Inorganic N-fertilizers (includes also urea application)), 3Da2a (Animal manure applied to soils) and 3Da3 (Urine and dung deposited by grazing animals).

Figure 4.12 **EU emission trends in the agriculture sector group for NH_3, PM_{10}, NMVOCs and NO_X between 1990 (2000) and 2022**



With regard to POPs, the agriculture sector contributes considerably to emissions of HCB 8. Figure 4.13 shows the emission trends for this pollutant.

Agriculture is identified as a key category for HCB. The trend in emissions for this pollutant largely reflects data reported by several countries, namely Germany, Poland, Spain, France and the Netherlands, for category '3Df — Use of pesticides'. The sharp decrease between 1999 and 2000 (78%) is due to 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 2022**

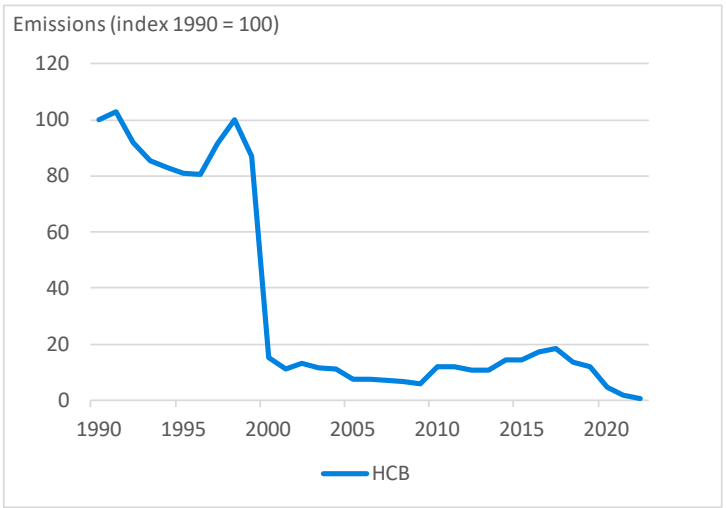


Table 4.11 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.12 shows the recalculations within the agriculture sector group. For explanations of EU recalculations, see Section 5.1.

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	1	0	0	2
NO_x	3Da3	0	1	0	0
NH_3	3Da3	0	1	0	0
HCB	3Df	2	2	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 2023 and 2024 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	2020	2021
NO_x	1 %	1 %	1 %	0 %	0 %	1 %	1 %	1 %	1 %	0 %	0 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %
NMVOCs	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %
SOx	3 %	2 %	0 %	-4 %	-4 %	-5 %	-5 %	-6 %	-7 %	-7 %	-7 %	-8 %	-7 %	-7 %	-9 %	-9 %	-9 %	-9 %	-10 %	-11 %
NH_3	4 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	2 %	2 %	2 %	2 %	2 %
TSPs	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %
CO	3 %	4 %	2 %	0 %	0 %	-1 %	-1 %	-2 %	-3 %	-4 %	-4 %	-4 %	-4 %	-5 %	-6 %	-6 %	-6 %	-7 %	-8 %	-8 %
Pb	0 %	-1 %	-2 %	-4 %	-4 %	-5 %	-5 %	-6 %	-6 %	-7 %	-8 %	-8 %	-9 %	-10 %	-12 %	-13 %	-15 %	-17 %	-18 %	-18 %
Cd	2 %	2 %	0 %	-3 %	-4 %	-4 %	-4 %	-4 %	-5 %	-5 %	-5 %	-6 %	-5 %	-5 %	-6 %	-5 %	-5 %	-6 %	-6 %	-7 %
Hg	2 %	2 %	0 %	-3 %	-4 %	-4 %	-4 %	-4 %	-5 %	-5 %	-5 %	-6 %	-5 %	-5 %	-6 %	-5 %	-6 %	-6 %	-6 %	-7 %
As	2 %	1 %	-1 %	-9 %	-11 %	-13 %	-13 %	-17 %	-19 %	-20 %	-22 %	-23 %	-23 %	-25 %	-28 %	-27 %	-29 %	-30 %	-32 %	-30 %
Cr	4 %	3 %	0 %	-5 %	-6 %	-7 %	-7 %	-9 %	-10 %	-10 %	-11 %	-11 %	-11 %	-11 %	-13 %	-12 %	-12 %	-12 %	-14 %	-13 %
Cu	4 %	2 %	0 %	-5 %	-5 %	-6 %	-7 %	-8 %	-9 %	-9 %	-10 %	-11 %	-11 %	-12 %	-14 %	-14 %	-14 %	-16 %	-17 %	-17 %
Ni	4 %	2 %	0 %	-4 %	-6 %	-6 %	-7 %	-8 %	-9 %	-9 %	-10 %	-10 %	-9 %	-10 %	-12 %	-10 %	-10 %	-11 %	-12 %	-12 %
Se	3 %	3 %	0 %	-6 %	-7 %	-8 %	-8 %	-10 %	-12 %	-12 %	-13 %	-14 %	-14 %	-15 %	-17 %	-16 %	-17 %	-18 %	-19 %	-19 %
Zn	-1 %	-2 %	-3 %	-3 %	-4 %	-5 %	-5 %	-6 %	-4 %	-4 %	-5 %	-5 %	-6 %	-7 %	-8 %	-9 %	-10 %	-12 %	-12 %	-35 %
PCDD/Fs	0 %	0 %	0 %	0 %	0 %	-1 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-4 %	-11 %	-13 %	-15 %	-18 %	-19 %	-19 %
B(a)P	11 %	6 %	3 %	-1 %	-1 %	-1 %	-2 %	-2 %	-3 %	-2 %	-2 %	-3 %	-3 %	-3 %	-4 %	-4 %	-3 %	-4 %	-4 %	-10 %
B(b)F	4 %	3 %	1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-3 %	-4 %	-4 %	-6 %
B(k)F	6 %	3 %	1 %	-1 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-4 %	-4 %	-4 %	-5 %	-4 %	-4 %	-5 %	-5 %	-7 %
IP	8 %	4 %	2 %	-1 %	-1 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-4 %	-3 %	-3 %	-4 %	-4 %	-4 %	-4 %	-4 %	-8 %
Total PAHs	7 %	4 %	2 %	-1 %	-2 %	-3 %	-3 %	-3 %	-4 %	-4 %	-4 %	-4 %	-4 %	-4 %	-5 %	-5 %	-5 %	-5 %	-5 %	-9 %
HCB	101 %	128 %	66 %	24 %	22 %	24 %	0 %	0 %	57 %	53 %	54 %	63 %	49 %	60 %	58 %	50 %	95 %	74 %	79 %	9 %
PCBs	0 %	0 %	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	2020	2021
$PM_{2.5}$			1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %	-2 %
PM_{10}			3 %	2 %	2 %	2 %	3 %	3 %	3 %	2 %	2 %	2 %	2 %	1 %	2 %	2 %	2 %	2 %	2 %	1 %
BC			-1 %	-4 %	-4 %	-5 %	-5 %	-6 %	-7 %	-7 %	-8 %	-8 %	-9 %	-10 %	-12 %	-13 %	-14 %	-16 %	-17 %	-17 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	5	7	6	3	3	4	4	4	4	4	4	3	4	5	7	5	5	7	5	3
NMVOCs	17	21	18	13	13	13	14	14	14	9	7	6	11	10	11	10	10	10	13	12
SOx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	164	129	120	101	114	111	105	94	99	94	98	96	92	89	101	81	76	71	67	77
TSPs	2	8	11	9	9	10	10	11	10	9	8	7	6	5	6	6	7	7	6	9
CO	28	20	6	0	0	-1	-1	-3	-4	-5	-5	-5	-5	-5	-5	-6	-6	-7	-7	-7
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cd	0	0	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	0	0
As	0	0	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	0	0
Cu	0	0	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	0	0
Se	0	0	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	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-3
PCDD/Fs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1
B(a)P	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(b)F	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B(k)F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IP	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCB	440	398	53	13	12	12	0	0	38	36	33	36	41	48	55	54	57	45	18	1
PCBs	0	0	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	2020	2021
$PM_{2.5}$			0	0	0	0	-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
PM_{10}			10	8	7	8	8	8	8	7	6	6	5	4	5	6	6	6	5	4
BC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: As, arsenic; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd)pyrene; Ni, nickel; Se, selenium; TSP, total suspended particulate; 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 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 2022. 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 (65% between 1990 and 2022 and 45% between 2005 and 2022) is led by a decreasing trend in category 'Clinical waste incineration' (99% between 1990 and 2022)in Portugal and Romania (54% between 1990 and 2022, 93% between 2005 and 2022). 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 (see Portugal's and Spain's IIRs, listed in Appendix 5).

Open burning of waste (category 5C2) is the most important subcategory with regard to BC emissions and has increased by 22% since 2000 and by 31% since 2005. Spain contributes 75% of total BC emissions reported by the EU-27 in the waste category for the year 2022 and is also the major contributor in previous years.

Figure 4.14 **EU emission trends in the waste sector group for the PCDD/Fs and BC between 1990 (2000) and 2022**

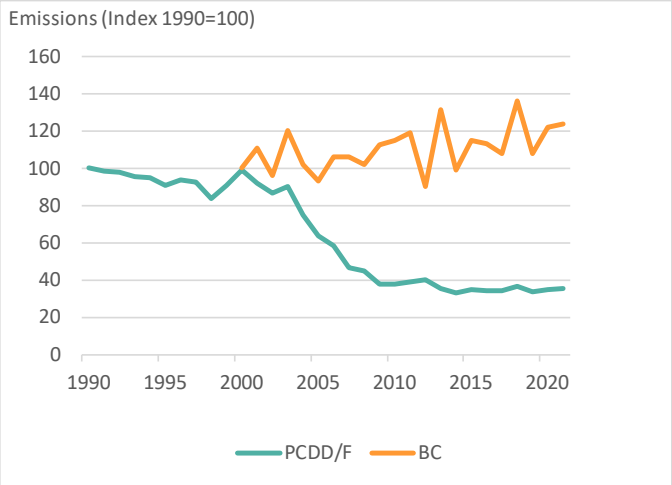


Table 4.13 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.14 shows the recalculations within the waste sector group. For explanations of EU recalculations, see Section 5.1.

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
HCB	5C2	0	8	0	0
Dioxin	5C2	1	14	0	0
Hg	5C2	0	1	0	0
$PM_{2.5}$	5C1biii	0	5	0	2
PM_{10}	5C1biv	0	5	0	2
CO	5C2	0	5	0	2
Cd	5C1biii	0	6	0	3
Dioxin	5C1bv	0	5	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 2023 and 2024 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	2020	2021
NO_x	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	2 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %
NMVOCs	-26 %	-25 %	-25 %	-27 %	-27 %	-27 %	-28 %	-28 %	-29 %	-29 %	-31 %	-29 %	-30 %	-31 %	-31 %	-32 %	-30 %	-30 %	-24 %	-24 %
SOx	-4 %	-6 %	-7 %	-8 %	-8 %	-8 %	-8 %	-10 %	-11 %	-10 %	-13 %	-9 %	-11 %	-14 %	-15 %	-16 %	-13 %	-15 %	-13 %	-12 %
NH_3	-8 %	-5 %	0 %	3 %	4 %	4 %	1 %	5 %	11 %	7 %	6 %	8 %	11 %	12 %	12 %	12 %	13 %	12 %	12 %	11 %
TSPs	2 %	0 %	0 %	-2 %	-2 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-3 %	-2 %	-2 %	-1 %	-1 %
CO	4 %	5 %	4 %	5 %	4 %	4 %	5 %	4 %	4 %	4 %	5 %	3 %	5 %	4 %	5 %	5 %	4 %	5 %	4 %	3 %
Pb	1 %	2 %	2 %	2 %	2 %	-1 %	1 %	1 %	1 %	1 %	3 %	3 %	8 %	5 %	3 %	0 %	6 %	2 %	2 %	-1 %
Cd	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	1 %	1 %	1 %	1 %	2 %	1 %	2 %	1 %	2 %	2 %	2 %
Hg	11 %	13 %	13 %	8 %	7 %	10 %	10 %	9 %	6 %	20 %	21 %	12 %	12 %	12 %	10 %	8 %	8 %	5 %	6 %	7 %
As	4 %	3 %	5 %	8 %	7 %	6 %	7 %	7 %	8 %	8 %	6 %	6 %	12 %	12 %	12 %	12 %	11 %	13 %	12 %	13 %
Cr	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	1 %	2 %	2 %	3 %	3 %	3 %	3 %	3 %	5 %	6 %
Cu	0 %	0 %	0 %	-1 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	1 %	1 %	3 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %
Ni	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	3 %	6 %	7 %	8 %	8 %	9 %	9 %	14 %	19 %	24 %
Se	3 %	3 %	3 %	6 %	4 %	4 %	5 %	5 %	5 %	5 %	11 %	10 %	21 %	20 %	22 %	23 %	18 %	28 %	33 %	40 %
Zn	1 %	2 %	2 %	2 %	2 %	1 %	2 %	1 %	2 %	1 %	2 %	2 %	4 %	3 %	2 %	2 %	3 %	2 %	2 %	-1 %
PCDD/Fs	-2 %	-2 %	-2 %	-10 %	-13 %	-9 %	-12 %	-12 %	-5 %	-4 %	-2 %	-2 %	-1 %	-1 %	-2 %	-2 %	-2 %	-2 %	-5 %	1 %
B(a)P	104 %	57 %	62 %	70 %	66 %	68 %	66 %	63 %	67 %	67 %	58 %	56 %	66 %	70 %	33 %	70 %	69 %	69 %	69 %	64 %
B(b)F	68 %	61 %	65 %	69 %	65 %	66 %	60 %	57 %	63 %	63 %	53 %	40 %	51 %	52 %	32 %	49 %	50 %	47 %	40 %	40 %
B(k)F	120 %	113 %	119 %	122 %	116 %	119 %	104 %	97 %	108 %	108 %	94 %	60 %	76 %	79 %	44 %	73 %	73 %	71 %	55 %	55 %
IP	4 %	5 %	4 %	3 %	4 %	2 %	3 %	3 %	2 %	2 %	4 %	5 %	6 %	6 %	2 %	4 %	8 %	5 %	4 %	-1 %
Total PAHs	83 %	75 %	80 %	85 %	81 %	82 %	75 %	71 %	78 %	78 %	67 %	51 %	63 %	65 %	33 %	62 %	62 %	61 %	52 %	50 %
HCB	-1 %	-1 %	-1 %	-3 %	-4 %	-4 %	-4 %	-17 %	-23 %	-24 %	-20 %	-24 %	-20 %	-22 %	-25 %	-29 %	-27 %	-14 %	-14 %	-15 %
PCBs	-1 %	-1 %	0 %	0 %	0 %	0 %	0 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	0 %	0 %	0 %
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %	-1 %
PM_{10}			-1 %	-1 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-2 %	-1 %	-1 %	-1 %	-1 %	-1 %
BC			2 %	3 %	2 %	2 %	2 %	2 %	2 %	2 %	2 %	1 %	2 %	2 %	2 %	2 %	1 %	2 %	0 %	0 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Absolute difference																				
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
NMVOCs	-29	-27	-27	-27	-27	-26	-27	-27	-27	-28	-28	-28	-27	-27	-28	-27	-27	-25	-18	-19
SOx	0	0	0	0	0	0	0	-1	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1
NH_3	-5	-3	0	1	2	2	0	2	5	3	3	4	5	6	6	6	6	5	5	5
TSPs	2	0	0	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-1	-1
CO	28	30	32	41	38	37	40	38	39	39	34	32	40	41	42	39	40	39	35	32
Pb	1	1	1	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0
Cd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	1	1	1	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	0	0
Cr	0	0	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	0	0
Ni	0	0	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	0	0
Zn	4	5	4	6	5	3	4	4	5	4	4	5	9	7	6	4	9	6	5	-2
PCDD/Fs	-40	-46	-44	-142	-180	-90	-127	-104	-42	-36	-20	-18	-6	-9	-14	-12	-14	-12	-36	5
B(a)P	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
B(b)F	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2	2	2	2	2
B(k)F	5	4	4	5	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2	2
IP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PAHs	10	9	9	10	9	9	9	9	9	9	8	6	8	8	8	7	8	7	6	6
HCB	-1	-1	-1	-1	-1	-1	0	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1
PCBs	-3	-1	0	0	0	0	0	-1	-1	-1	-1	-1	0	-1	-1	-1	-1	0	0	0
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$			-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
PM_{10}			-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-1	-1	-2	-1	-1	-1	-1	-1
BC			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0

Note: As, arsenic; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd)pyrene; Ni, nickel; Se, selenium; TSP, total suspended particulate; 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, 2023) 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 2023 with those submitted in 2024.

Table 5.1 Comparison of data submitted in 2023 and 2024 by EU Member States: (a) relative difference, 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	2020	2021
NO_x	Gg	-0.2 %	-0.2 %	-0.1 %	-0.1 %	-0.2 %	-0.3 %	-0.1 %	-0.2 %	-0.5 %	-0.7 %	-0.9 %	-1.2 %	0.0 %	0.0 %	-0.5 %	-0.7 %
NMVOCs	Gg	1.9 %	2.0 %	1.4 %	1.6 %	1.7 %	1.7 %	1.7 %	2.0 %	1.7 %	2.1 %	1.5 %	1.1 %	1.2 %	1.0 %	0.3 %	-0.9 %
SO_x	Gg	0.4 %	0.4 %	-0.1 %	0.0 %	-1.4 %	-1.5 %	-1.2 %	-1.6 %	-1.8 %	-1.7 %	-2.0 %	-2.5 %	-2.6 %	-2.8 %	-4.6 %	-2.7 %
NH_3	Gg	3.3 %	3.2 %	3.1 %	2.8 %	3.0 %	2.9 %	3.0 %	3.0 %	2.9 %	2.9 %	3.2 %	2.7 %	2.6 %	2.6 %	2.4 %	2.8 %
TSPs	Gg			3.1 %	3.7 %	1.5 %	-0.1 %	4.0 %	3.5 %	3.7 %	1.5 %	1.9 %	1.7 %	-0.8 %	1.7 %	-0.5 %	2.5 %
CO	Gg	1.3 %	1.7 %	1.5 %	1.4 %	1.5 %	1.6 %	2.3 %	2.5 %	1.7 %	1.6 %	1.2 %	0.7 %	1.6 %	1.3 %	0.7 %	0.9 %
Pb	Mg	0.1 %	-2.3 %	0.6 %	1.2 %	-3.4 %	1.3 %	1.9 %	-3.2 %	1.9 %	2.0 %	2.0 %	1.5 %	-5.0 %	1.5 %	1.7 %	1.8 %
Cd	Mg	1.4 %	1.3 %	5.0 %	-0.2 %	2.0 %	3.6 %	1.8 %	0.8 %	0.9 %	0.8 %	0.8 %	1.1 %	1.6 %	1.8 %	2.1 %	1.3 %
Hg	Mg	-0.3 %	-0.2 %	-1.0 %	-1.4 %	-1.5 %	-1.1 %	-0.4 %	-0.9 %	-0.7 %	-0.6 %	-1.3 %	-1.1 %	-0.3 %	-0.2 %	-1.0 %	-3.1 %
As	Mg	1.0 %	0.9 %	3.7 %	1.6 %	-0.6 %	0.5 %	0.3 %	-0.4 %	0.5 %	0.7 %	0.7 %	0.7 %	-0.4 %	0.6 %	0.6 %	0.6 %
Cr	Mg	0.0 %	0.2 %	2.0 %	0.7 %	2.3 %	2.6 %	2.4 %	2.3 %	2.3 %	2.4 %	2.5 %	2.5 %	2.3 %	1.9 %	1.9 %	2.5 %
Cu	Mg	5.2 %	5.6 %	6.8 %	6.7 %	7.1 %	7.1 %	7.2 %	7.3 %	7.1 %	7.1 %	7.2 %	6.9 %	6.7 %	6.6 %	7.2 %	6.9 %
Ni	Mg	-2.3 %	-3.1 %	-2.3 %	-2.7 %	-1.7 %	-0.6 %	-0.9 %	-0.2 %	0.6 %	1.9 %	2.2 %	1.8 %	-1.0 %	-1.7 %	-0.7 %	0.8 %
Se	Mg	0.8 %	1.4 %	1.6 %	1.5 %	0.9 %	0.9 %	1.6 %	1.4 %	2.2 %	2.5 %	1.8 %	1.7 %	1.2 %	0.0 %	-0.4 %	0.1 %
Zn	Mg	0.1 %	0.3 %	0.4 %	0.7 %	0.7 %	0.5 %	0.5 %	0.6 %	0.8 %	0.7 %	0.7 %	0.5 %	0.6 %	0.6 %	0.6 %	0.2 %
PCDD/Fs	g I-Teq	48.0 %	57.1 %	51.7 %	57.6 %	-2.1 %	-2.1 %	-1.4 %	-1.7 %	-1.0 %	-1.1 %	-1.5 %	-1.5 %	-1.5 %	-1.8 %	-3.1 %	-0.4 %
B(a)P	Mg	-2.8 %	-1.8 %	-0.7 %	0.2 %	0.9 %	0.9 %	1.0 %	1.2 %	1.7 %	3.3 %	3.3 %	3.0 %	3.1 %	2.9 %	3.3 %	4.4 %
B(b)F	Mg	-0.7 %	1.0 %	1.9 %	2.1 %	2.0 %	2.1 %	1.9 %	1.8 %	2.2 %	3.2 %	3.3 %	3.1 %	2.9 %	2.5 %	2.4 %	3.4 %
B(k)F	Mg	-0.8 %	0.0 %	1.9 %	2.4 %	2.4 %	2.5 %	2.1 %	1.4 %	2.5 %	3.8 %	3.7 %	3.6 %	3.5 %	3.1 %	2.9 %	3.9 %
IP	Mg	-2.6 %	-2.3 %	-0.7 %	-0.4 %	-0.4 %	-0.4 %	-0.5 %	-0.4 %	-0.4 %	2.3 %	2.5 %	2.2 %	1.9 %	1.3 %	1.5 %	2.9 %
Total PAHs	Mg	-1.2 %	0.0 %	1.6 %	2.0 %	1.7 %	1.8 %	1.6 %	1.7 %	2.2 %	3.8 %	3.8 %	5.4 %	3.5 %	3.2 %	3.0 %	4.2 %
HCB	kg	7.5 %	10.3 %	1.4 %	4.2 %	16.6 %	14.3 %	13.0 %	10.9 %	11.7 %	24.1 %	21.8 %	18.9 %	29.3 %	23.0 %	12.1 %	-2.0 %
PCBs	kg	-7.1 %	-7.6 %	-8.5 %	-12.9 %	-18.1 %	-19.1 %	-19.8 %	-21.0 %	-21.6 %	-22.1 %	-22.2 %	-22.1 %	-22.8 %	-23.6 %	-25.4 %	-24.2 %
				2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$	Gg			2.1 %	2.2 %	2.4 %	2.5 %	2.9 %	3.0 %	3.1 %	3.7 %	3.8 %	3.6 %	3.1 %	2.9 %	2.3 %	3.1 %
PM_{10}	Gg			2.7 %	2.8 %	2.0 %	1.2 %	3.5 %	3.1 %	3.2 %	2.1 %	2.8 %	2.5 %	0.9 %	1.8 %	0.3 %	2.4 %
BC	Gg			0.4 %	0.5 %	0.5 %	0.7 %	0.9 %	1.1 %	1.1 %	1.9 %	1.3 %	1.1 %	1.5 %	1.2 %	0.3 %	0.1 %

Note: Differences of +/- 10% or more are highlighted in red.

(b)

Pollutant	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NO_x	Gg	- 25	- 28	- 6	- 11	- 19	- 26	- 8	- 17	- 38	- 49	- 61	- 81	- 0	- 3	- 27	- 40
NMVOCs	Gg	301	252	148	150	139	124	128	143	115	141	102	76	83	64	17	- 57
SO_x	Gg	94	51	- 5	- 1	- 50	- 56	- 39	- 44	- 45	- 40	- 42	- 50	- 48	- 45	- 64	- 38
NH_3	Gg	163	132	124	108	108	102	106	104	104	102	115	96	93	88	83	92
TSPs	Gg			147	174	66	- 5	160	137	137	58	68	61	- 31	60	- 19	89
CO	Gg	765	758	495	392	387	370	506	552	348	330	243	143	311	237	120	151
Pb	Mg	21	- 207	21	22	- 53	16	23	- 40	23	23	22	17	- 61	17	17	20
Cd	Mg	2	2	5	- 0	1	2	1	1	1	0	0	1	1	1	1	1
Hg	Mg	- 0	- 0	- 1	- 1	- 1	- 1	- 0	- 0	- 0	- 0	- 1	- 1	- 0	- 0	- 0	- 1
As	Mg	6	2	6	2	- 1	0	0	- 0	0	0	0	0	- 0	0	0	0
Cr	Mg	- 0	1	10	3	9	10	8	8	8	8	9	8	8	6	6	8
Cu	Mg	117	121	150	162	174	174	170	170	170	172	174	171	168	163	157	160
Ni	Mg	- 45	- 49	- 28	- 30	- 12	- 4	- 5	- 1	3	9	11	8	- 5	- 8	- 3	3
Se	Mg	1	2	3	3	1	1	2	1	2	2	2	2	1	- 0	- 0	0
Zn	Mg	7	17	18	28	28	19	19	20	28	24	24	19	23	22	19	8
PCDD/Fs	g I-Teq	3,799	3,635	2,612	2,075	- 54	- 52	- 35	- 39	- 22	- 25	- 32	- 32	- 34	- 37	- 63	- 8
B(a)P	Mg	- 13	- 7	- 2	1	3	2	3	3	4	9	9	8	8	7	7	10
B(b)F	Mg	- 3	4	5	6	6	6	6	5	6	9	9	8	8	6	6	8
B(k)F	Mg	- 2	- 0	2	3	4	3	3	2	3	5	5	4	5	4	3	5
IP	Mg	- 6	- 4	- 1	- 1	- 1	- 1	- 1	- 1	- 1	3	3	3	3	2	2	4
Total PAHs	Mg	- 18	0	14	18	17	16	15	16	19	31	32	45	30	25	22	32
HCB	kg	420	390	52	10	32	32	28	31	37	46	54	51	54	39	15	- 2
PCBs	kg	- 486	- 468	- 439	- 468	- 442	- 435	- 428	- 429	- 426	- 423	- 421	- 414	- 411	- 407	- 410	- 410
				2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$	Gg			42	40	42	41	47	48	45	55	55	51	45	41	30	42
PM_{10}	Gg			78	77	53	30	83	73	71	46	60	53	20	37	6	48
BC	Gg			1	2	1	2	2	3	2	4	3	2	3	2	1	0

Note: As, arsenic; B(a)P, benzo(b)pyrene; B(b)F, benzo(b)fluoranthene; BC, black carbon; 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; NMVOC, non-methane volatile organic compound; NO_X, nitrogen oxides; PAH, polycyclic aromatic hydrocarbon; Pb, lead; PCB, polychlorinated biphenyl; PCDD/F, polychlorinated dibenzodioxin/dibenzofuran; $PM_{2.5}$, particulate matter with a diameter of 2.5µm or less; PM_{10}, particulate matter with a diameter of 10µm 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 compensated for by low recalculations for other EU Member States, and therefore overall EU recalculations are only moderate.

Recalculations of nitrogen oxide emissions

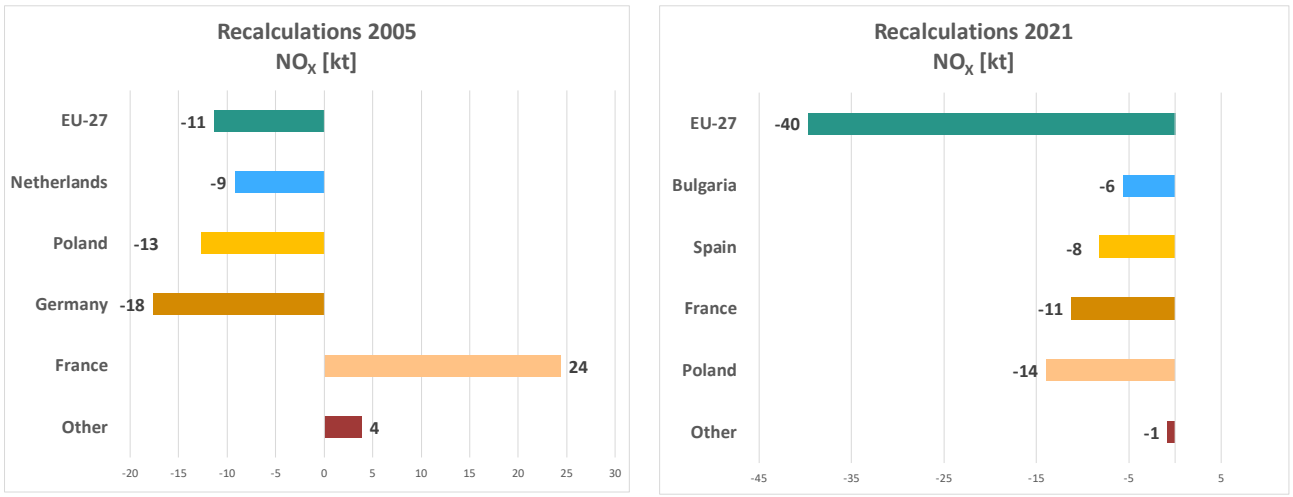
Figure 5.1 shows the recalculations for nitrogen oxide (NO_X) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2021, recalculations of NO_X emissions for the EU-27 add up to a decrease of 0.7% (40kt).

High recalculations occur mainly in the transport sector in France (categories 1A3bi, 1A3bii, 1A3biii), Spain (1A3bi, 1A3bii), Bulgaria (1A3di(ii)), (Germany and the Netherlands (both 1A3biii).

Other sectors influencing the EU recalculations for NO_X are energy production (Poland 1A1a and 1A1c), stationary combustion (1A2gvii in Germany) commercial, institutional and households in Germany (1A4ci) and fugitive emissions in Poland and Bulgaria (both 1B2aiv).

Figure 5.1 Recalculations for NOX emissions for the years 2005 and 2021



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.

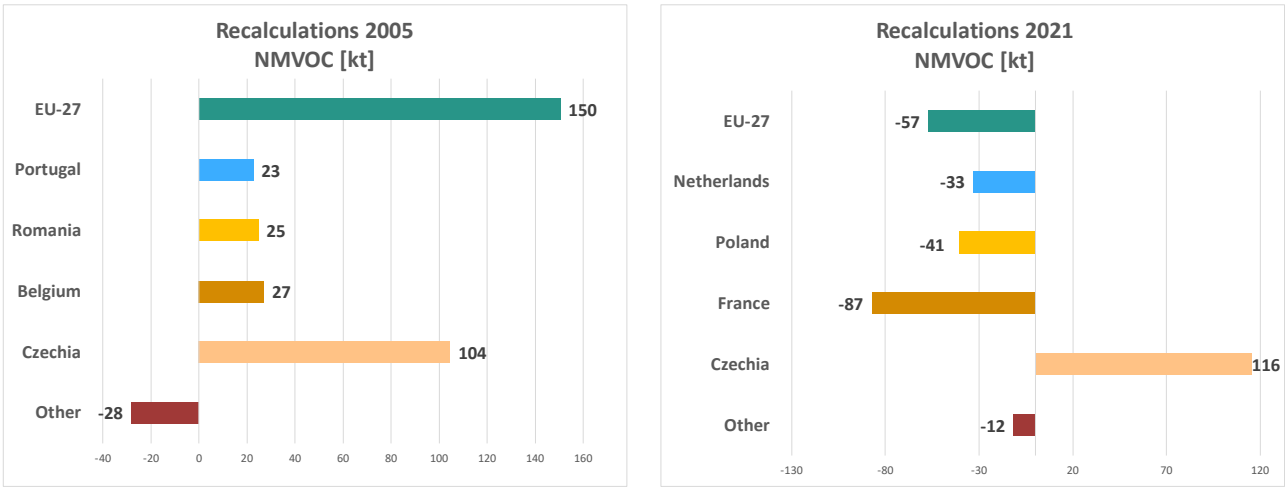
Recalculations of non-methane volatile organic compound emissions

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 2005 and 2021.

In 2021, recalculations of NMVOC emissions for the EU-27 add up to a decrease of 0.9% (57kt), while recalculations for the year 2005 result in an increase of 1.6% (150kt) in total NMVOC emissions.

In the commercial, institutional and households sector, high recalculations occur in Czechia (category 1A4bi). Major recalculations were performed in the industrial processes and product use sector in France (2D3a, 2D3g, 2D3h), Romania (2D3a, 2D3d, 2D3e), Portugal (2D3a, 2D3e, 2H2), Belgium, the Netherlands and Poland (all in 2D3a). In addition, Belgium (3B1a and 3B1b) reported high recalculations in the agriculture sector, France reported recalculation of NMVOC emissions in the transport sector (1A3bi) and Poland recalculated emissions for fugitive emissions (1B2av) and transport (1A3bi).

Figure 5.2 Recalculations for NMVOC emissions for the years 2005 and 2021



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.

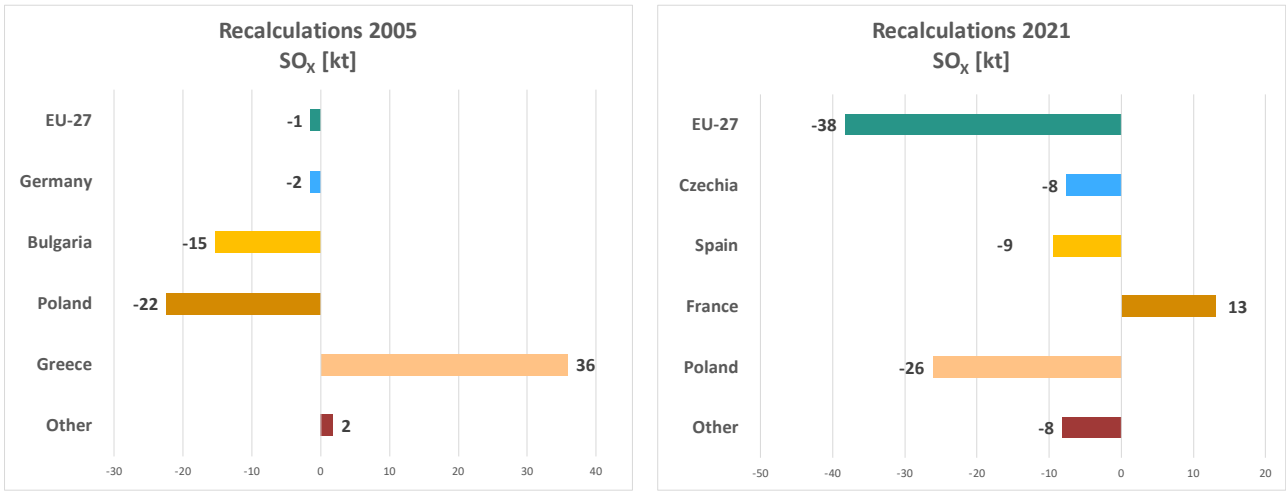
Recalculations of sulphur oxide emissions

Figure 5.3 shows the recalculations for sulphur oxide (SO_X) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of SO_X emissions for the EU-27 add up to a decrease of 0.2% (1kt) and 2.7% (38kt), respectively.

Recalculations of SO_X emissions in the EU are mainly influenced by major recalculations in the energy production and distribution sector in Poland (category 1A1a) and the energy use in industry sector in France (1A2a, 1A2e, 1A2f), Germany (1A2gviii) and Spain (1A2a). In addition, recalculations of SO_X emissions in the industrial processes and product use sector in Czechia and Bulgaria (both in 2B10a) and fugitive emissions in Poland (1B2aiv) contributed to the EU recalculations.

Figure 5.3 Recalculations for SOX emissions for the years 2005 and 2021



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.

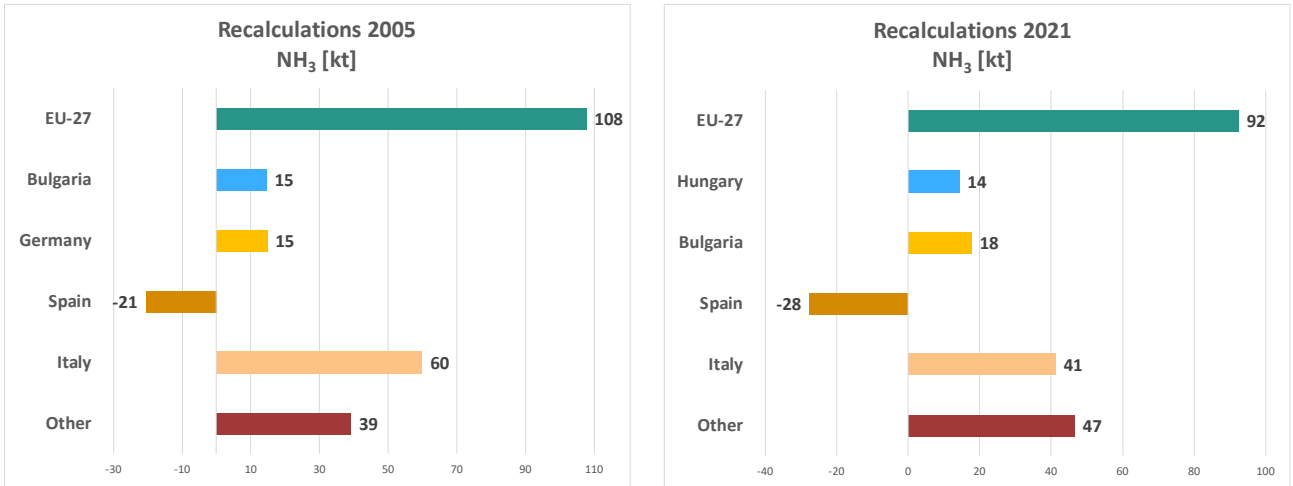
Recalculations of ammonia emissions

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 2005 and 2021.

In 2005 and 2021, recalculations of NH_3 emissions for the EU-27 add up to an increase of 2.8% (108kt and 92kt), 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 2005 and 2021



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.

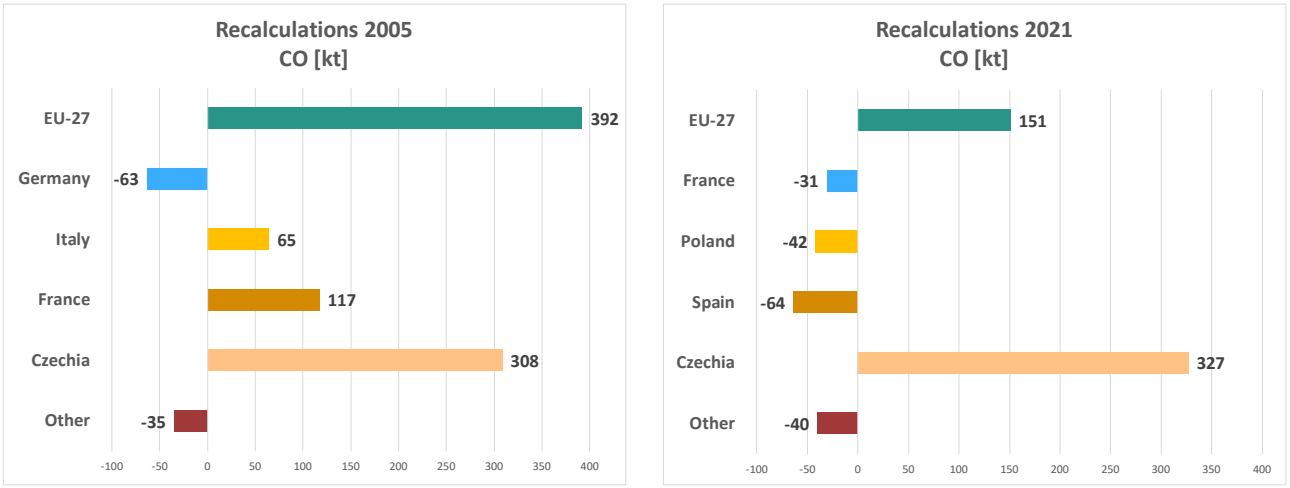
Recalculations of carbon monoxide emissions

Figure 5.5 shows the recalculations for carbon monoxide (CO) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of CO emissions for the EU-27 add up to an increase of 1.5% (392kt) and 0.9% (151kt), respectively.

Major recalculations of CO emissions were reported for the commercial, institutional and households sector by Czechia, Germany (both in 1A4bi) and France (1A4bii) and in the road transport sector by Italy and Poland (both in category 1A3bi), Spain (1A3bi, 1A3biv) and France (1A3bi, 1A3bii, 1A3biv. In sector industrial processes and product use, recalculations of CO were reported by Germany (2C3). Italy substantially recalculated emissions from open burning of waste (5C2).

Figure 5.5 Recalculations for CO emissions for the years 2005 and 2021



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.

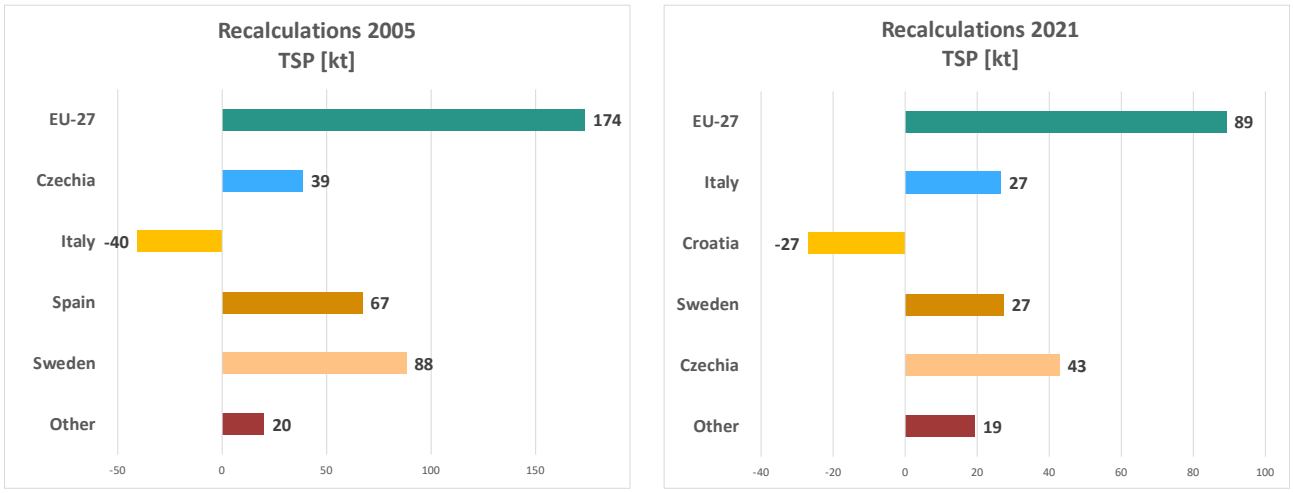
Recalculations of total suspended particle emissions

Figure 5.6 shows the recalculations for total suspended particulate (TSP) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of TSP emissions for the EU-27 add up to increases of 3.7% (174kt) and 2.5% (89kt), respectively.

Recalculations in the commercial, institutional and households sector in Czechia and Italy (both category 1A4bi) had the biggest impact on the EU recalculations of TSP emissions in both 2005 and 2021. In addition, major recalculations were reported in the transport sector (Italy in 1A3ii) and in the industrial processes and product use sector in Sweden, Italy and Croatia (all in 2A5b) and Spain (2A5a and 2A5b).

Figure 5.6 Recalculations for TSP emissions for the years 2005 and 2021



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.

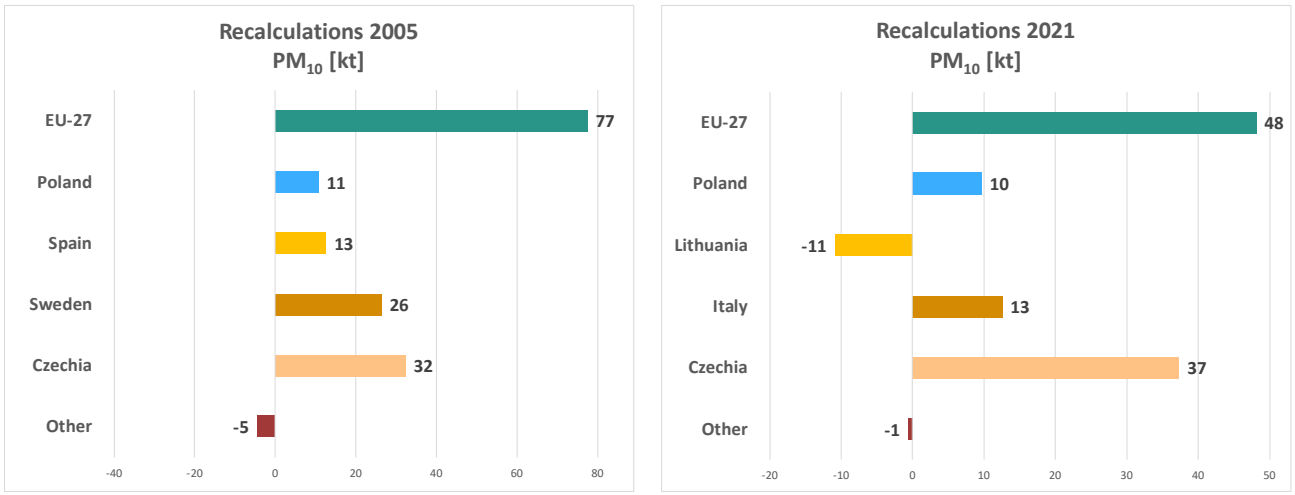
Recalculations for PM_{10} emissions

Figure 5.7 shows the recalculations for emissions of particulate matter with a diameter of 10µm or less (PM_{10}) for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of PM_{10} emissions for the EU-27 add up to increases of 2.8% (77kt) and 2.4% (48kt), respectively.

These increases are mainly dominated by recalculations performed in the commercial, institutional and households sector in Czechia and Italy (both category 1A4bi). Other sectors affected by major recalculations are industrial processes and product use in Sweden, Lithuania (both in 2A5b), Spain (2A5a and 2A5b) and Italy (2A5a), as well as agriculture (Poland: 3Dc).

Figure 5.7 Recalculations of PM_{10} emissions for the years 2005 and 2021



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.

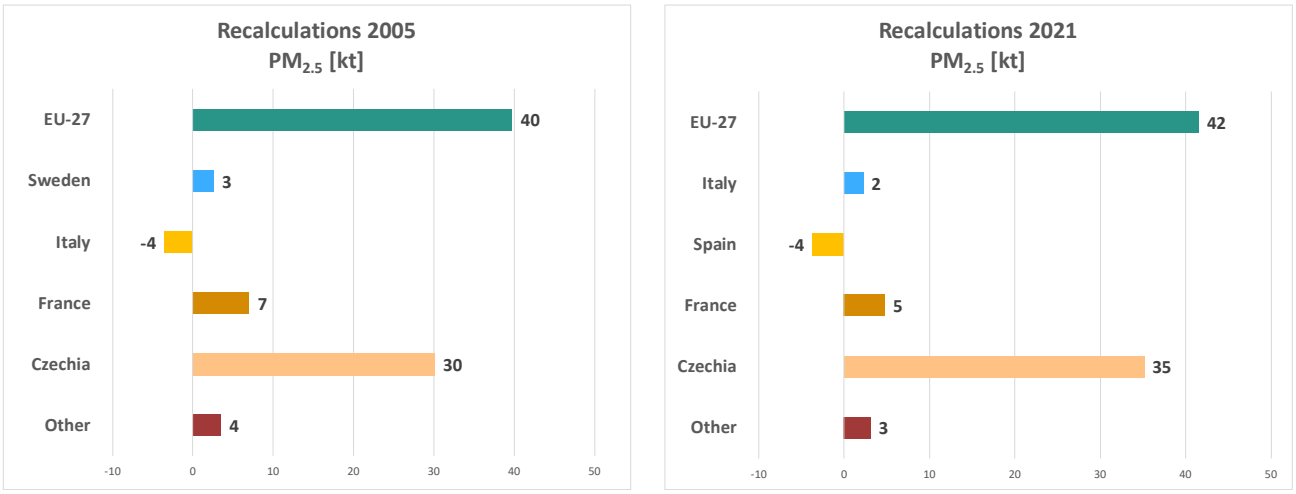
Recalculations of $PM_{2.5}$ emissions

Figure 5.8 shows the recalculations for emissions of particulate matter with a diameter of 2.5µm or less ($PM_{2.5}$) for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of $PM_{2.5}$ emissions for the EU-27 led to increases of 2.2% (40kt) and 3.1% (42kt), respectively.

As for TSP and PM_{10} emissions, the increase in $PM_{2.5}$ emissions is mainly dominated by recalculations performed in the sectors commercial, institutional and households (Czechia and Italy: category 1A4bi), energy production and distribution (Spain: 1A1c), transport (Italy: 1A3bii and Spain: 1A3bi) and industrial processes and product use (Sweden: 2A5b; France: 2B10a).

Figure 5.8 Recalculations for $PM_{2.5}$ emissions for the years 2005 and 2021



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.

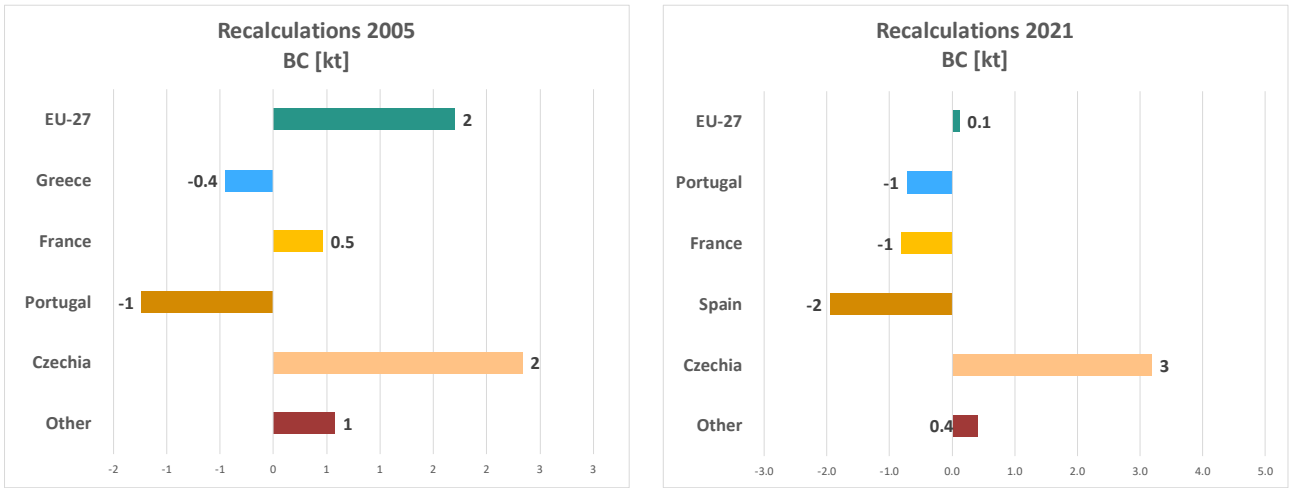
Recalculations of black carbon emissions

Figure 5.9 shows the recalculations for black carbon (BC) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of BC emissions for the EU-27 led to increases of 0.5% (2kt) and 0.1% (0.1kt), respectively.

Major recalculations of BC emissions were performed in sector 'Commercial, institutional and households' in category 1A4bi in Czechia. Additionally, recalculations of BC emissions mainly occurred in the sector 'Industrial processes and product use' in categories 1A2f, 1A2d, 1A2f and 1A2gviii in Portugal, road transport (Greece: 1A3dii, Spain: 1A3bi, France: 1A3bi, 1A3bii) and waste (France: 5C2).

Figure 5.9 Recalculations for BC emissions for the years 2005 and 2021



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

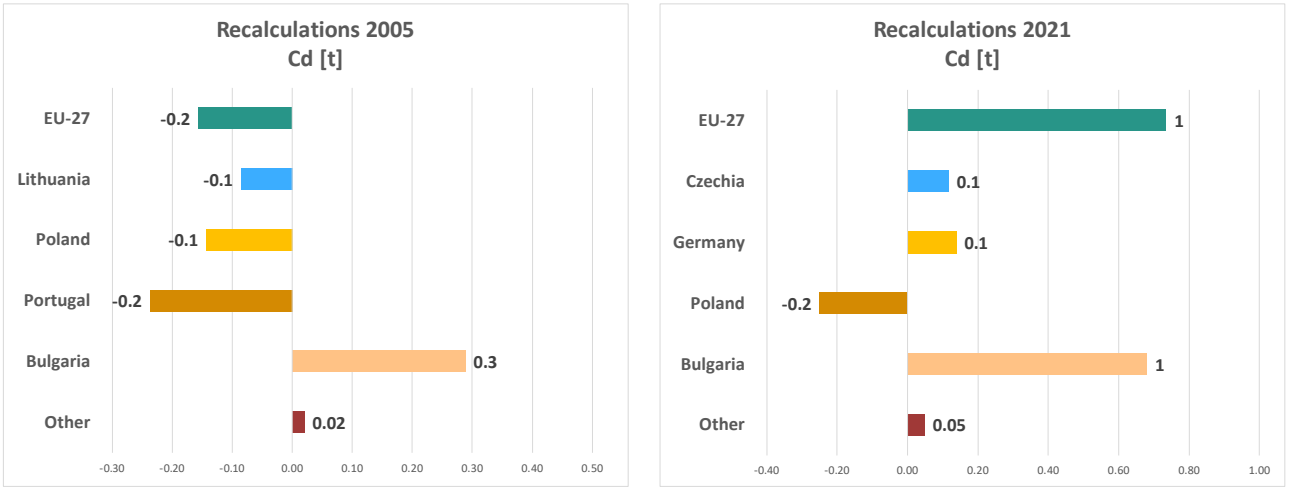
Recalculations of cadmium emissions

Figure 5.10 shows the recalculations for cadmium (Cd) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005, recalculations of Cd emissions for the EU-27 add up to a decrease of 1.4% (0.2t) and in 2021 to an increase of 1.3% (0.7t).

Major recalculations of Cd emissions were performed in sector 'Industrial processes and product use' in Bulgaria (2C7a). Other sectors that also affected the EU total, were 'Energy production and distribution'(Poland: 1A1a, Germany: 1A1b), 'Energy use in industry' (Portugal: 1A2d and 1A2gviii), 'Commercial, institutional and households' (Czechia: 1A4bi) and 'Fugitive Emissions' (Poland and Lithuania: 1B2aiv).

Figure 5.10 Recalculations for Cd emissions for the years 2005 and 2021



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.

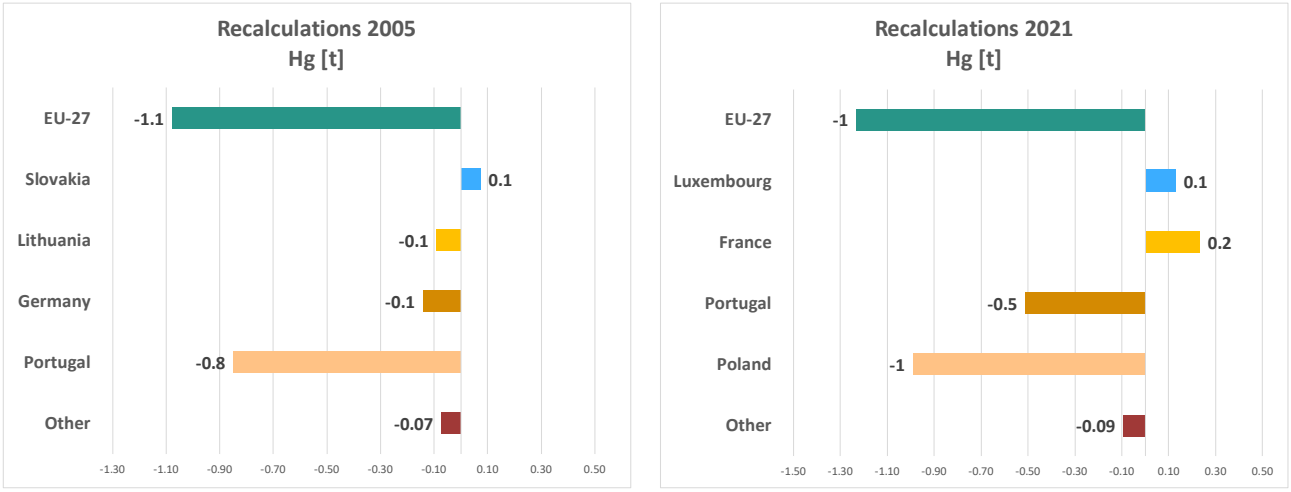
Recalculations of mercury emissions

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 2005 and 2021.

In 2005 and 2021, recalculations of Hg emissions for the EU-27 add up to a decrease of 1.4% (1.1t) and 3.1% (1.2t), respectively.

Major recalculations of Hg emissions were performed in sectors 'Energy production and distribution' (Poland: 1A1a), 'Energy use in industry' (Luxembourg: 1A2a; Portugal: 1A2d, 1A2f and 1A2gviii), 'Commercial, institutional and households' Germany and Slovenia both in 1A4ai), 'Fugitive Emissions' (Lithuania in 1B2aiv) and 'Industrial processes and product use' (France: 2D3a).

Figure 5.11 Recalculations for Hg emissions for the years 2005 and 2021



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.

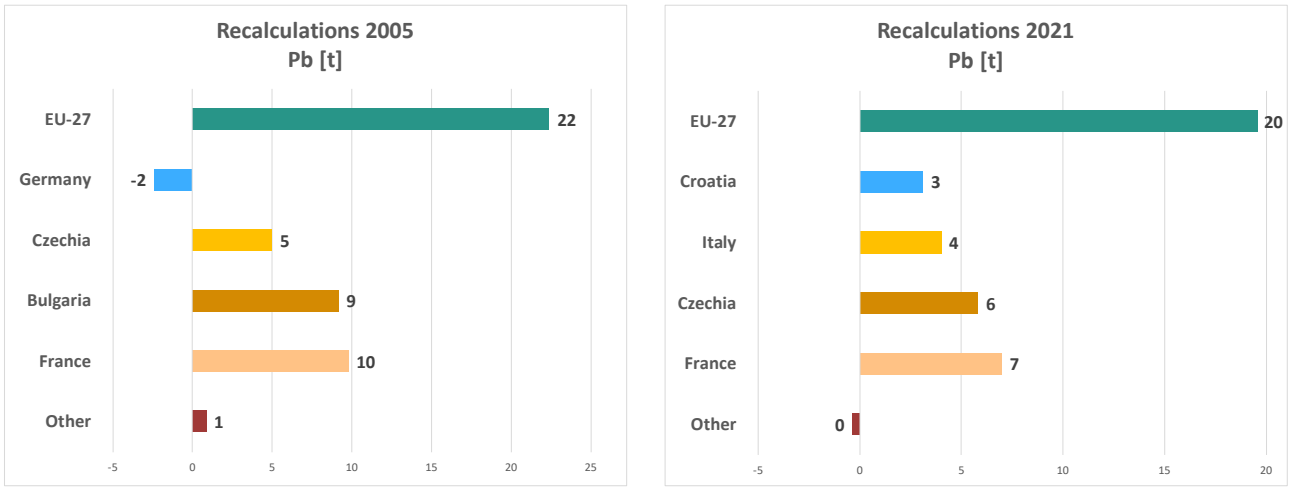
Recalculations of lead emissions

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 2005 and 2021.

In 2005 and 2021, recalculations of Pb emissions for the EU-27 add up to an increase of 1.2% (22t) and 1.8% (20t), respectively.

Recalculations of Pb emissions in the EU were dominated by recalculations in sectors 'Road transport' (France: 1A3bi and 1A3bvi; Czechia: 1A3bvi; Croatia: 1A3bvi), 'Commercial, institutional and households' (Italy: 1A4bi, Germany: 1A4ai, 1A4bi) and 'Industrial processes and product use' (Bulgaria: 2C5, 2C7a).

Figure 5.12 Recalculations for Pb emissions for the years 2005 and 2021



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.

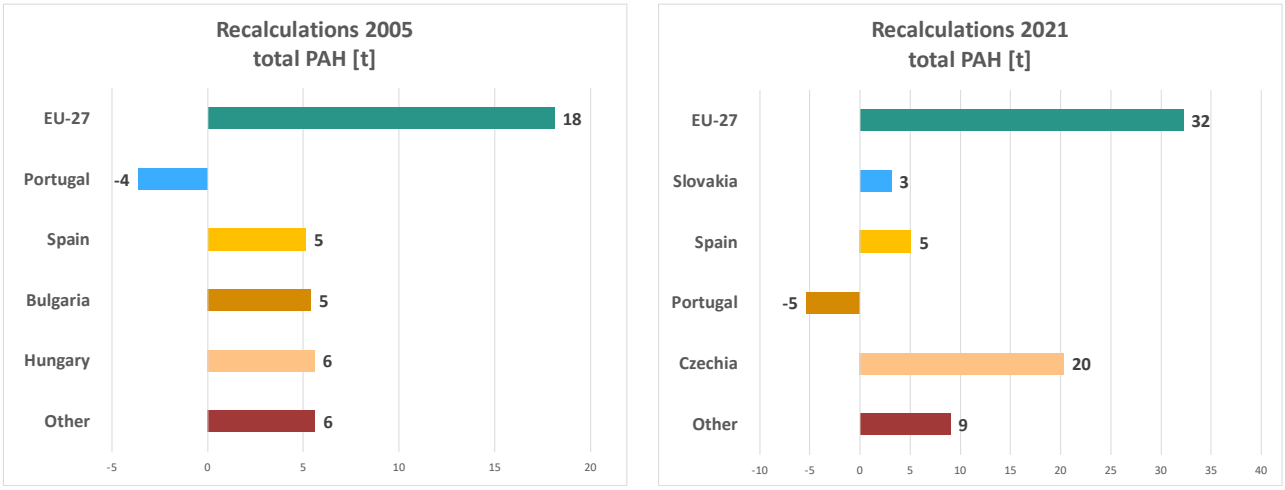
Recalculations of total polycyclic aromatic hydrocarbon emissions

Figure 5.13 shows the recalculations for total polycyclic aromatic hydrocarbons (PAHs) emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005 and 2021, recalculations of total PAH emissions for the EU-27 add up to an increase of 2.0% (18t) and 4.2% (32t), respectively.

Significant recalculations of total PAH emissions were reported in the sectors 'Commercial, institutional and households' (Czechia, Slovakia and Bulgaria: all 1A4bi), 'Industrial processes and product use' (Portugal: 2D3i, Spain: 2C1) and 'Waste' (Hungary: 5C2).

Figure 5.13 Recalculations for PAH emissions for the years 2005 and 2021



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.

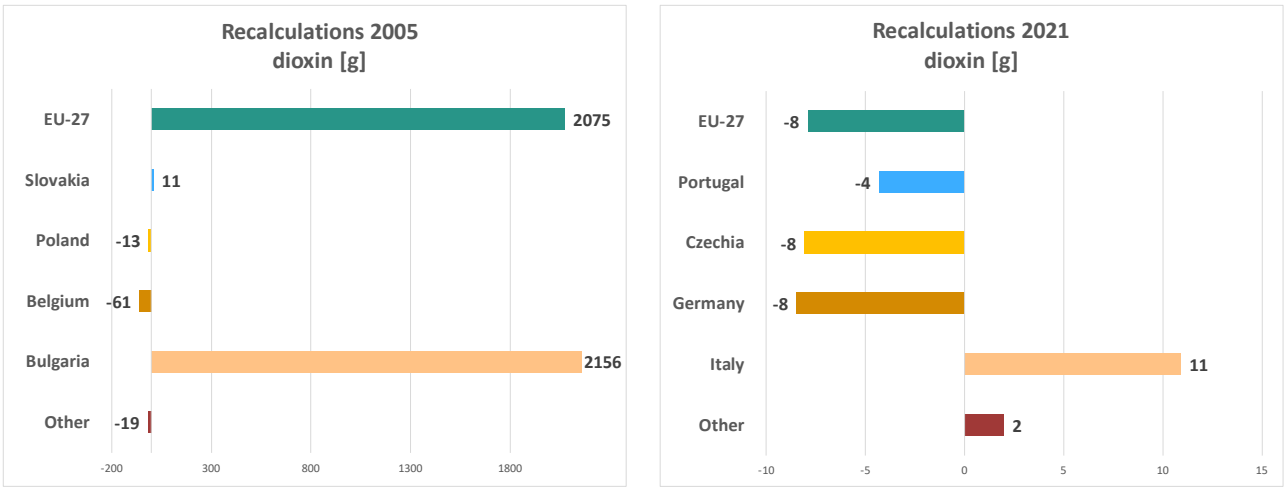
Recalculations of dioxin emissions

Figure 5.14 shows the recalculations for dioxin emissions for the EU-27 and the four biggest contributors to these recalculations for the years 2005 and 2021.

In 2005, recalculations of dioxin emissions for the EU-27 add up to an increase of 58% (2075g) and in 2021 to a decrease of 0.4% (8g).

Recalculations in the sector 'Fugitive Emissions' (Bulgaria: 1B1b) had the biggest impact on EU recalculations of dioxins. In addition, significant recalculations were performed in sectors 'Commercial, institutional and households' (Czechia and Italy all in 1A4bi), 'Industrial processes and product use' (Portugal in 2D3i) and 'Waste' (Germany and Italy: 5E; Belgium: 5C1biv, Poland: 5C1bi and Slovakia: 5C1biii).

Figure 5.14 Recalculations for dioxin emissions for the years 2005 and 2021



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.

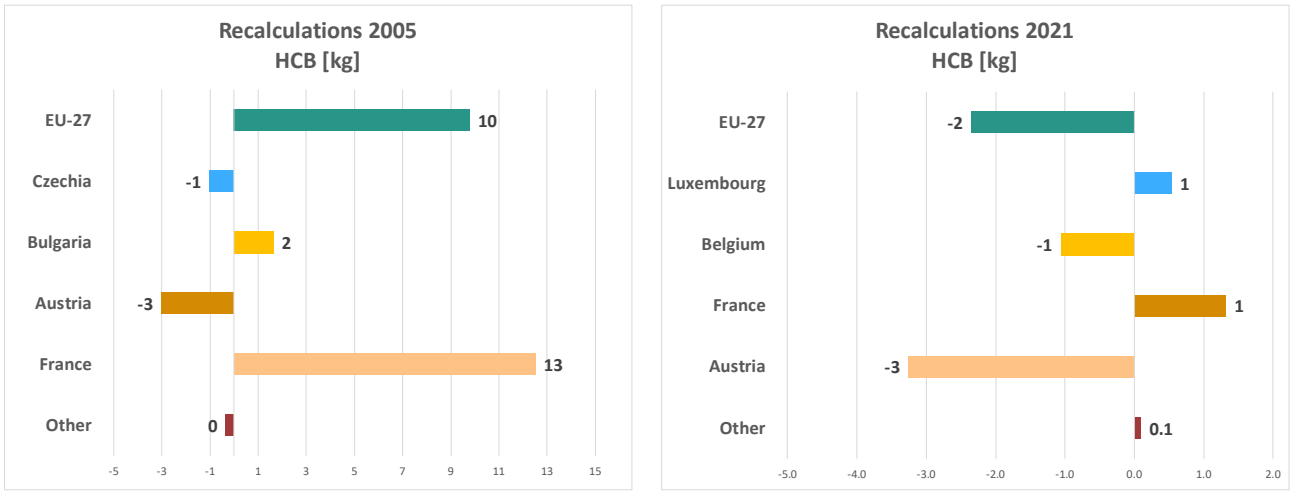
Recalculations of hexachlorobenzene emissions

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 2005 and 2021.

In 2005, recalculations of HCB emissions for the EU-27 add up to an increase of 4.2% (10kg) and in 2021 to a decrease of 2% (2kg).

Significant recalculations of HCB emissions were performed mainly in the sectors 'Agriculture' (France: 3Df), 'Energy use in industry' (Bulgaria:1A2a), 'Commercial, institutional and households' (Czechia 1A4bi) and 'Industrial processes and product use' (Luxembourg and Austria both 2C1)).

Figure 5.15 Recalculations for HCB emissions for the years 2005 and 2021



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.

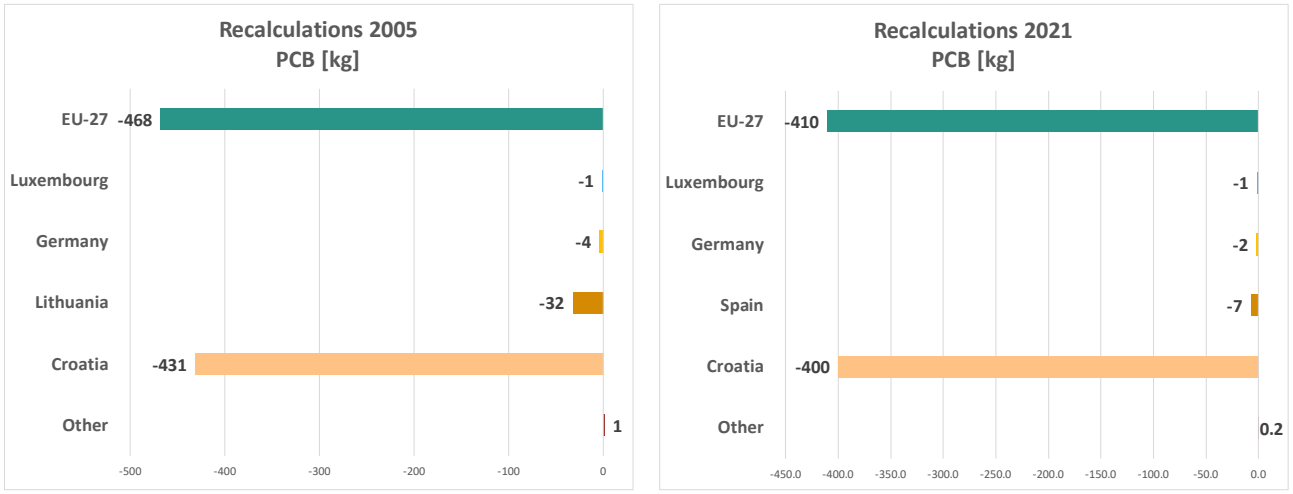
Recalculations of polychlorinated biphenyl emissions

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 2005 and 2021.

In 2005 and 2021, recalculations of PCB emissions for the EU-27 add up to decreases of 13% (468kg) and 24.2% (410kg), respectively.

Recalculations of PCB emissions at the EU level are dominated by recalculations performed in the sector 'Industrial processes and product use' (Croatia and Luxembourg: category 2K). In addition, recalculations in sectors 'Energy production and distribution' (Germany: 1A1a), 'Energy use in industry' (Spain: 1A2f) and 'Commercial, institutional and households' (Germany: 1A4ai, 1A4bi)were significant.

Figure 5.16 Recalculations for PCB emissions for the years 2005 and 2021



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, 2022c), 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). Short summaries of the information provided by the Member States on their recalculations are provided in the following:

Austria provided detailed information concerning its recalculations, which were carried out for several reasons, such as updated data and revised methodologies. Activity data have been updated in the several categories of the Energy, Industry and waste sector. In the agriculture sector a new Tier 2 emission factor has been applied.. Detailed information is provided within Austria's IIR (see Austria's IIR, Chapter 7, p. 437, 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 new inventory guidebook (EMEP/EEA, 2023), update of the energy balance, addition of new emission sources (e.g. PM emissions from road construction) and a switch to an updated agricultural calculation model. (see Belgium's IIR, Chapter 8,p. 1896f., listed in Appendix 5).

Bulgaria provides in each chapter information on the recalculations carried out. Recalculations were mainly caused in the transport sector by the introduction of an updated version of the COPERT model, corrections to be in line with the PRODCOM statistics, application of Tier 2 approaches for solvent use, and some corrections and improvements in the agriculture sector. (see Bulgaria's IIR, p. 126, listed in Appendix 5).

Cyprus stated some methodological improvements were included in the national emission inventory. The changes were done based on TERT previous recommendations or technical corrections aiming at the full implementation of the EMEP/EEA guidebook 2019. Major recalculations were carried out for the industrial and the waste sector. (see Cyprus's IIR, p. 172, listed in Appendix 5).

Czechia stated that recalculations were carried out, among other reasons, because of the use of new emissions factors from the EMEP/EEA Guidebook 2023, correction of activity data and some error correction. Emissions from stationary combustion in the residential sector were completely recalculated, and also the agriculture sector has been updated mainly affecting emissions from fertiliser application. More information about the recalculations is provided in Czechia's IIR (see Czechia's IIR, p. 122., listed in Appendix 5).

Denmark provided detailed information on its recalculations within the sectoral chapters. Very minor recalculations were carried out for stationary combustion and industrial processes. In the agriculture sector, the new NH3 emissions for inorganic fertiliser application from the EMEP/EEA guidebook 2023 had a considerable effect. Considerable improvement have also been carried out in the waste and the transport sector (see Denmark's IIR, Chapter 8, p. 486, listed in Appendix 5).

Estonia provided detailed information on its recalculations for the period 1990-2021. Recalculations have been carried out for all pollutants and in all sectors, which are mainly due to correction of activity data and emission factors. In the agriculture sector updated information about technologies and the corresponding emission reduction measures have been taken into account. (see Estonia's IIR, Chapter 8, p. 287, listed in Appendix 5).

Finland provided detailed information on its recalculations. Most of the recalculations are due to update of statistical data, introduction of the new methodologies or emission factors from the EMEP/EEA Guidebook 2023, and in some cases due to new information from the plants. In the case of ammonia, the most significant recalculations originate from the agriculture sector and were due to update of nitrogen excretion data for all cattle categories and sheep and implementation of new emission factors from the EMEP/EEA Guidebook 2023 in category 3Da1. (see Finland's IIR, 1B_General, p. 4, listed in Appendix 5).

France carried out recalculations in the residential sector associated with the combustion of wood, in the transport sector due to updated activity data and emission factors, in the industry sector including new plant specific data, in the agriculture sector for NH3 and the waste sector mainly related to open fires. (see France's IIR, sectoral chapters and Annex 5, listed in Appendix 5).

Greece reported that all emissions were recalculated on account of changes in or refinements of methods, inclusion of new sources, re-allocation, updated activity data and correction of errors. Recalculations were carried out for mobile combustion (new emissions factors and updated fleet composition) for solvent use due to updated activity data and for the agriculture sector due to methodological improvement following the EMEP/EEA 2019 Guidebook, (see Greece's IIR, Chapter 7 and sectoral chapters, listed in Appendix 5).

Hungary provided information on recalculations in the sector-specific chapters. These were due to the consideration of more point sources, the consideration of the 2023 EMEP/EEA Guidebook for seve5ral sources, updated activity data for fuel combustion, use of COPERT model 5.6.1, improvements in the solvent sector, error correction and revision of N-content inn biogas feedstock in the agriculture sector, and some improvements in the waste sector. (see Hungary's IIR, chapter 8 and sectoral chapters, listed in Appendix 5).

Ireland's recalculations in the energy sector are the result of a review of emission factors and updated all acid gas, heavy metals, and POPs emission factors to the most recent version of Inventory guidebook (EMEP/EEA, 2023). Recalculations in the industry sector affected mainly particulate matter emissions. In the agriculture sector transcription errors were corrected affecting NH_3 and PM emissions. (see Ireland's IIR, sectoral chapters, listed in Appendix 5).

Italy stated in its IIR that recalculations were carried out for all sectors affecting the whole time series. Underlying reasons are improvements in the oil refining and coke production, application of updated COPERT model, use revised/corrected emission factors in the agriculture sector, application of EMEP/EEA 2023 guidebook, and updated activity data mainly for the waste sector. (see Italy's IIR, Chapter 9, p. 203, listed in Appendix 5).

Latvia provided detailed information on recalculations in the sector-specific chapters. Updated activity data for jet fuel consumption, implementation of new EMEP/EEA 2023 guidelines, update of NMVOC EF for distribution of gasoline, application of new COPERT model, methodological improvements in solvent use, transition to Tier 2 in the agriculture sector contributed to recalculations across all sectors.(see Latvia's IIR, Chapter 8 and sectoral chapters, listed in Appendix 5).

Luxembourg provided detailed information on the recalculations in the sector-specific chapters of the IIR. Main reasons for recalculations were the update of activity data (e.g. fuel consumption data), reallocation of emissions, methodological improvements (e.g. for non-energy poducts from fuels and solvent use, manure management, agricultural crops) and the correction of errors, (see Luxembourg's IIR, chapter 8 and sectoral chapters, listed in Appendix 5).

The **Netherlands** provided detailed information on the recalculations carried out affecting all sectors.. The main reasons for these were the inclusion of updated/improved activity data, changes in the energy statistics, improvements/error correction in the emission estimates for individual companies and error corrections, reallocation of emissions, updated emission factors and error corrections. Compared with the IIR 2023, several improvements in source allocation and emission factors used were implemented in the Pollutant Release and Transfer (PRTR) system (see Netherlands' IIR, Chapter 11, listed in Appendix 5).

Poland reported that in 2024 the methodology was updated based on updating the methodology and emission factors of air pollutants in connection with the publication of the updated EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023, recommendations resulting from 2023 NECD Comprehensive Review of Polish Inventory, new emission sources not estimated previously were added to the inventory, the methodology for estimating emissions was verified in several sectors, activity data update according to the latest available data and the update of the international software COPERT 5 used to determine emissions from road transport. (see Poland's IIR, Chapter 8, listed in Appendix 5).

Portugal provided detailed information on its recalculations in the sector-specific chapters. The majority of these recalculations were due to the update of emission factors to the latest version of the 2023 Guidebook. These impacts are significant because in many cases, very outdated emission factors such as AP-42 and CORINAIR 2009 were being used. Methodological improvement occurred in the industry sector, revision of activity data (e.g. livestock numbers) in the agricultural and waste sector, (see Portugal's IIR, sectoral chapters, listed in Appendix 5).

Romania noted that recalculations were carried out in all sectors. Transport emissions follow now the latest COPERT model, and emission factors are in line with the EMEP/EEA 2023 Guidebook for the fuel combustion in the residential sector, updated activity data and emission factors from the solvent sector, and updates of activity data in the agriculture and waste sector. (see Romania's IIR, p. 356, listed in Appendix 5).

Slovakia provided detailed information and figures and tables on its recalculations. The main reasons were the implementation of the IPCC 2019 Refinement and Implementation of EMEP/EEA GB2023 in the agriculture and waste sector, update of activity data in fuel consumption, consideration of additional emissions from charcoal production, (see Slovakia's IIR, chapter 8 and sectoral chapters, listed in Appendix 5).

Slovenia provided detailed information on its recalculations, which are mainly caused by the application of the methodology and emission factors from the new EMEP/EEA Air Pollutant Emission Inventory Guidebook, application of the latest COPERT model, 2023 for most sectors and some methodological improvements were carried out in the agricultural sector. (see Slovenia's IIR, Chapter 7, listed in Appendix 5).

Spain provided very detailed information on its recalculations. Activity data have been updated for the road transport sector and fugitive emissions. Methodological improvements have been carried out for the agricultural and waste sector. Largest recalculations occurred for the emission from quarrying and mining of mineral other than coal, as well as emissions from construction and demolition. (see Spain's IIR, Chapter 8, , listed in Appendix 5).

Sweden provided detailed information on its recalculations in the sector-specific chapters. Reasons for recalculations mentioned by Sweden included the consideration of revised activity data from the energy balance and industry, updates to the road transport emission model, methodological improvements to the agriculture and waste sector. (see Sweden's IIR, Chapter 8 and sectoral chapters, 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) website in July 2024 (EMEP CEIP, 2023c).

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, 2023b; 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 to the 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 particulate matter (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 Figure 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 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 for each MS inventory under the National Emission reduction Commitments (NEC) Directive (EU, 2016b). The results of the review of these processes also improve the quality of the Air Convention submissions.

- **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 yearly inventory review 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 MS 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 or low 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.

5.2 Improvements implemented

The joint EMEP/EEA annual review of inventory data submitted under the Air Convention helps to improve the EU Member States' inventories. The review of data reported under the Air Convention is held in parallel to the review of data reported by the EU Member States under the NEC Directive ; they are nevertheless independent processes. Since 2009, there has been a centralised stage 3 review process under the Air Convention review process (EMEP CEIP, 2023b). 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 (UNECE, 2013, 2019b) was reviewed (UNECE/CEIP, 2021). 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 for 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: summaries of the methodologies used by the MSs for emissions in the EU's key categories	No	Gathering this information would mean considerable effort; such an analysis is not feasible within the limited time-frame
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 MSs. 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	MSs' inventories and IIRs are also part of the EU submission, and provide information on methods applied to sub-sectors. Including this information in the EU IIR is not feasible within the limited time-frame
Sources included	Include in the IIR: sub-sector-level information on sources included in the inventory, especially in the industry sector	No	MSs' inventories and IIRs are also part of the EU submission, and provide information on sources to sub-sectors. Including this information in the EU IIR is not feasible within the limited time-frame

Review findings (2020)			
Topic	**Recommendation**	**Implemented**	**Comment**
Gap-filling procedure	Include in the IIR: information at the 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 on 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: links to 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 MSs is outside the scope of this report
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	This task would mean considerable effort; such an analysis is not feasible within the limited time-frame
Eurostat data for data gaps	Further improve the completeness and comparability of the inventory in consultation with the MSs by exploring the potential 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 time-frame
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 time-frame
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	Yes	Fuel data is provided in the NFR tables (Annex A) for those years and sectors, which is possible
Uncertainty of 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
Uncertainty analysis	The ERT also recommends that the Party develops a parallel uncertainty analysis independent of the MSs' submissions, including an assessment of the impacts of the gap-filling procedure and improvements following the NEC Directive technical review on inventory uncertainty	No	Gathering this information would mean considerable effort; such an analysis is not feasible within the limited time-frame

Review findings (2020)			
Topic	**Recommendation**	**Implemented**	**Comment**
Comparability			
Notation keys	Always use notation keys in line with 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	No	EEA decided to go with the current approach.
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 time-frame
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 time-frame
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	Figures 1.5 and 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 and Air Pollution Interactions and Synergies (model); IE, included elsewhere; IIASA, International Institute for Applied Systems Analysis; LPS, large point source; MS, Member State; NFR, nomenclature for reporting; QA/QC, quality assurance and quality control.

5.2.2 Further improvements undertaken in 2024

- Activity data for those sectors where all Member States are reporting in the same unit, was added.
- Trend tables for the relevant pollutants to the reduction commitment (NO_X, SO_X, NH_3, NMVOC and $PM_{2.5}$) include an additional column for the change between 2005 and the latest year.
- Trend description on pollutant level and sectoral level include now the changes and trends for the time period 2005-2022.

5.2.3 Improvements at the Member State level

Improvements at the 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, 2022c, TFEIP, 2023) request that Parties to the Air Convention provide emission data using the NFR19 format. All the EU Member States that submitted data used the new template.

Units, symbols, abbreviations and acronyms

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
CO	Carbon monoxide
Cr	Chromium
Cu	Copper
DG	Directorate-General
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme
ERT	Expert review team
ETC	European topic centre
ETC HE	European Topic Centre on Human Health and the Environment
EU	European Union
FGD	Flue gas desulphurisation
Gg	1 gigagram=10^9g=1kilotonne (kt)
GNFR	Gridding nomenclature for reporting
HCB	Hexachlorobenzene
HCE	Hexachloroethane
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=10^3g (gram)
LPS	Large point source
LRTAP	Long-range Transboundary Air Pollution; (UNECE) Air Convention
LTO	Landing/take-off
Mg	1 megagram=10^6g=1 tonne (t)
MMR	Monitoring Mechanism Regulation
NA	Not applicable
NE	Not estimated
NEC	National Emission reduction Commitments (Directive)
NFR	Nomenclature for reporting
NFR1	Nomenclature for reporting 1
NFR14	Nomenclature for reporting 14
NFR19	Nomenclature for reporting 19
NH_3	Ammonia
Ni	Nickel
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
PM	Particulate matter
$PM_{2.5}$	Particulate matter with a diameter of 2.5µm or less
PM_{10}	Particulate matter with a diameter of 10µm or less
POP	Persistent organic pollutant
QA	Quality assurance
QC	Quality control
Se	Selenium
SO_2	Sulphur dioxide
SO_X	Sulphur oxides
t	1 tonne (metric)=1 megagram (Mg)=10^6g
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 (also includes 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

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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, 2023) 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([22]).

NO 'Not occurring' means that an emission source or process does not exist in a country.

NE **'**Not estimated' means that 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 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.

([22]) Further explanation and guidance concerning the use of these notation codes are in the European Monitoring and Evaluation Programme (EMEP) reporting guidelines (UNECE, 2022c).

Appendix 2 Air Convention emission-reporting programme for 2024

Emission data should be submitted to the European Monitoring and Evaluation Programme (EMEP) Centre on Emission Inventories and Projections (CEIP) by **15 February 2024**. Informative inventory reports (IIRs) should reach the centre no later than **15 March 2024**. Table A2.1 summarises information in the revised reporting guidelines (UNECE, 2022c,d).

Table A2.1 Summary of the information requested in the EMEP reporting guidelines

Description of contents	Pollutant(s)	Reporting years[a]
Yearly: minimum (and additional)		
A. National total emissions		
1. Main pollutants other than PM	NO_X, NMVOCs, SO_X, NH_3, CO	1990-2022
2. Particulate matter[b]	$PM_{2.5}$, PM_{10} (TSPs, BC)	2000-2022
3. Heavy metals[b]	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2022
4. Persistent organic pollutants[b]	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2022
B. Emissions by NFR source category		
1. Main pollutants other than PM	NO_X, NMVOCs, SO_X, NH_3, CO	1990-2022
2. Particulate matter[b]	$PM_{2.5}$, PM_{10}, (TSPs, BC)	2000-2022
3. Heavy metals[b]	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2022
4. Persistent organic pollutants[b]	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2022
C. Activity data	NO_X, NMVOCs, SO_X, NH_3, CO	1990-2022
4-yearly: minimum reporting (from 2017 to the next reporting year (2025))		
D. Gridded data in the EMEP 0.1°×0.1° longitude/latitude 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 large point sources (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	2025, 2030, where available 2040 and 2050
2. Emission projections by NFR19	NO_X, NMVOCs, SO_X, NH_3, $PM_{2.5}$, BC	2025, 2030, where available 2040 and 2050
3. Projected activity data by NFR19		2025, 2030, where available 2040 and 2050

Description of contents	Pollutant(s)	Reporting years([a])
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 10 March 2023)
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; B(a)P, benzo(a)pyrene; B(b)F, benzo(b)fluoranthene; BC, black carbon; B(k)F, benzo(k) fluoranthene; Cd, cadmium; CO, carbon monoxide; Cr, chromium; Cu, copper; GNFR19, gridding nomenclature for reporting 19; HCB, hexachlorobenzene; Hg, mercury; IP, indeno(1,2,3-cd)pyrene; NFR, nomenclature for reporting; NFR19, nomenclature for reporting 19; NH_3, ammonia; Ni, nickel; NMVOC, non-methane volatile organic compound; NO_X, nitrogen oxides; LPSs, large point sources; PAH, polycyclic aromatic hydrocarbon; Pb, lead; PCB, polychlorinated biphenyl; PCDD/F, polychlorinated dibenzodioxin/dibenzofuran; $PM_{2.5}$, particulate matter with a diameter of 2.5µm or less; PM_{10}, particulate matter with a diameter of 10µm or less; Se, selenium; SO_X, sulphur oxides; TSP, total suspended particulate; VOC, volatile organic compound; Zn, zinc.

Reporting format

Each Party should use the reporting format in Annex IV of the Air Convention reporting guidelines (UNECE, 2022c,d) for its annual submissions. It should submit the information to the CEIP formally, preferably in electronic format, and notify the Air Convention via 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 nomenclature for reporting 19 (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, Netherlands, Greece, Portugal and Spain
EU-27 refers to the 27 Member States of the EU

Appendix 3 Status of reporting and timeliness

Table A3.1 EU Member State inventory submissions 2024: date received by the EEA, years covered and information provided (as of 30 April 2024)

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	15.02.2024	14/03/2024						14.03.2024 15.03.2024	2019-1
Belgium	15.02.2024	17.02.2024 15.03.2024						15.03.2024 19.04.2024	2019-1
Bulgaria	15.02.2024	19.02.2024 15.03.2024						15/03/2024	2019-1
Croatia	30.01.2024							08/03/2024	2019-1
Cyprus	14.02.2024	14/03/2024						14/03/2024	2019-1
Czechia	15.02.2024	14/03/2024	15.02.2024 25.04.2024					15/03/2024	2019-1
Denmark	15.02.2024		15.02.2024 19.02.2024					15/03/2024	2019-1
Estonia	13.02.2024	14/03/2024						14/03/2024	2019-1
Finland	14.02.2024			15/03/2024	30.04.2024	30.04.2024		15/03/2024	2019-1
France	09.02.2024		09.02.2024					04/04/2024	2019-1
Germany	14.02.2024							15/03/2024	2019-1
Greece	13.02.2024							15/03/2024	2019-1
Hungary	16.02.2024	19.04.2024						19/04/2024	2019-1
Ireland	15.02.2024			15/03/2024				15/03/2024	2019-1
Italy	15.02.2024	15.03.2024 30.04.2024						15.03.2024 30.04.2024	2019-1
Latvia	15.02.2024	15/03/2024						15/03/2024	2019-1
Lithuania	15.02.2024	29.02.2024 13.03.2024						15/03/2024	2019-1
Luxembourg	15.02.2024	14/03/2024						14/03/2024	2019-1
Malta	06.02.2024	15/03/2024						15/03/2024	2019-1
Netherlands	13.02.2024		14.02.2024 16.02.2024 21.02.2024					15/03/2024	2019-1
Poland	12.02.2024							13/03/2024	2019-1
Portugal	15.02.2024	15/03/2024						15/03/2024	2019-1
Romania	14.02.2024	13/03/2024						13/03/2024	2019-1
Slovakia	15.02.2024	15/03/2024						15/04/2024	2019-1
Slovenia	06.02.2024							13/03/2024	2019-1
Spain	14.02.2024				26.04.2024	26.04.2024		14/03/2024	2019-1
Sweden	16.01.2024							26/02/2024	2019-1

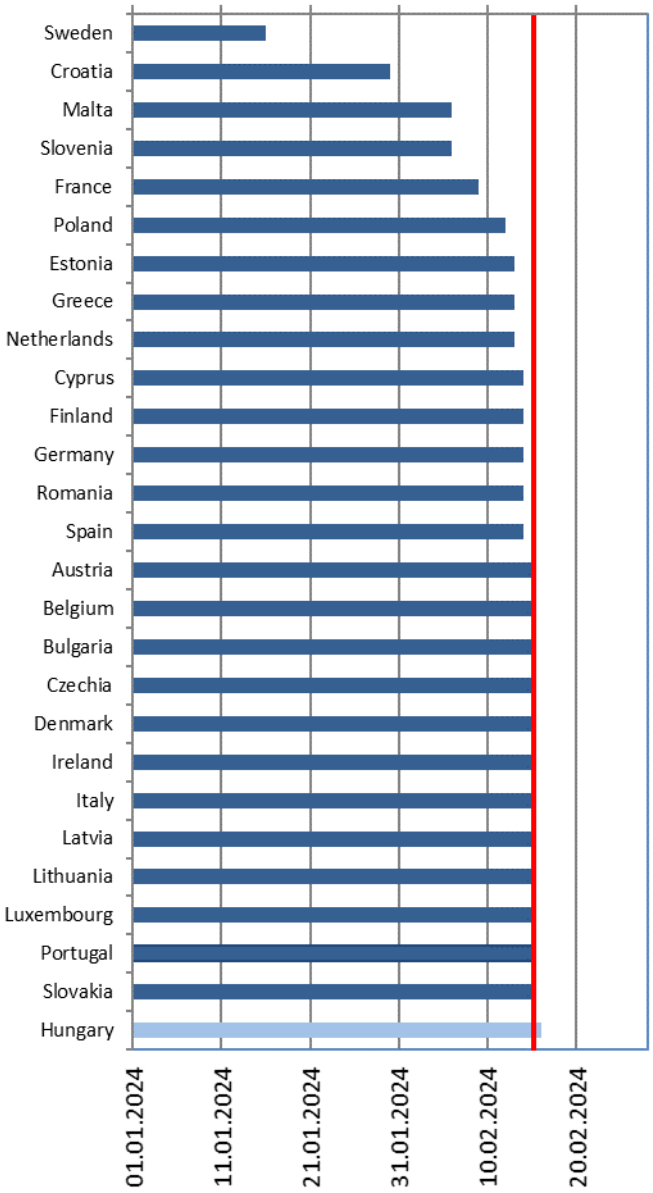
Notes: Dates in red indicate that data were submitted after the formal deadline for submissions (submissions 15 February; resubmissions 15 March; projections 15 March; IIR 15 March).
(a) Refers to the first submission of inventory data to the Central Data Repository (CDR); submission of other data are possible at later dates.
IIR, informative inventory report; LPS, large point source; NFR, nomenclature for reporting.

Table A3.2 EU Member State submissions of 2022 data (as of 30 April 2024)

Years reported									
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	Projections WM
1990-2022	1990-2022		1990, 1995, 2000-2022	1990, 1995, 2000-2022		1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	2000-2022	2000-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	2025, 2030, 2040, 2050
1990-2022	1990-2022	1990-2022	2000-2022	2000-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1985-2022*	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	2000-2022	1990-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1980-2022*	1990-2022	1990-2022**	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1980-2022	
1980-2022*	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1980-2022	
1990-2022	1990-2022	1990-2022	1995-2022	1990-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	2000-2022	2000-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1990-2022*	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022		1990-2022	1990-2022		1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	
1980-2022*	1990-2022	1990-2022	2000-2022	2000-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	2000-2022	2000-2022	2000-2022	1990-2022	1990-2022	1990-2022	
1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	1990-2022	

Notes: Reporting of additional HMs is not mandatory.
EU Member States do not have to report TSPs if they report PM emissions.
B(a)P, benzo(a)pyrene; B(b)F, benzo(b)fluoranthene; BC, black carbon B(k)F, benzo(k)fluoranthene; Cd, cadmium; CO, carbon monoxide; PCDD/F, polychlorinated dibenzodioxin/dibenzofuran; HCB, hexachlorobenzene; Hg, mercury; HM, heavy metal; IP, indeno(1,2,3-cd)pyrene; NE, not estimated; NT, national total; NH_3, ammonia; NMVOC, non-methane volatile organic compound; NO_X, nitrogen oxides; PAH, polycyclic aromatic hydrocarbon; Pb, lead; PCB, polychlorinated biphenyl; particulate matter (PM); $PM_{2.5}$, particulate matter with a diameter of 2.5µm or less; PM_{10}, particulate matter with a diameter of 10µm or less; POP, persistent organic pollutant; Se, selenium; SO_2, sulphur dioxide; TSP, total suspended particulate; NT, National Total.

Figure A3.1 **Dates of first data submissions received from EU Member States (as of 23 February 2024)**



Note: The red line marks the submission deadline of 15 February 2024.

Appendix 4 Conversion chart for aggregated sector groups

To enable the presentation of sectoral emission trends (Chapter), 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

NFR code	Full name	EEA aggregated sector name
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
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

NFR code	Full name	EEA aggregated sector name
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
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

NFR code	Full name	EEA aggregated sector name
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
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; NFR, nomenclature for reporting; POPs, persistent organic pollutant.

Appendix 5 EU Member State informative inventory reports

Table A5.1 List of submitted informative inventory reports (IIRs) including source and date of submission (as of 30 April 2023)

Country code	Title of IIR	Source	Date of submission
AT	Austria's Informative Inventory Report (IIR) 2024 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. Report	https://cdr.eionet.europa.eu/at/un/clrtap/iir/envzhzvmw	15.04.2024
BE	Informative Inventory Report about Belgium's air emissions submitted under the UNECE Convention on Long -Range Transboundary Air Pollution CLRTAP and National Emission Ceiling Directive NECD, March 2024	https://cdr.eionet.europa.eu/be/un/clrtap/iir/envziji1g	19.04.2024
BG	Bulgaria's Informative Inventory Report 2024 (IIR) Submission under the UNECE Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/bg/un/clrtap/iir/envzfsktg	15.03.2024
CY	Cyprus Informative Inventory Report for 2022	https://cdr.eionet.europa.eu/cy/un/clrtap/iir/envzfkzaw	14.03.2024
CZ	Informative Inventory Report Czechia 2024. Submission under the UNECE Convention on Long-range Transboundary Air Pollution. Reported inventories 1990-2022	https://cdr.eionet.europa.eu/cz/un/clrtap/iir/envzfysgg	21.03.2024
DE	German Informative Inventory Report 2024 (IIR 2024)	https://cdr.eionet.europa.eu/de/un/clrtap/iir/envzfscqw https://iir.umweltbundesamt.de/2024/	15.03.2024
DK	Annual Danish Informative Inventory Report. Emission inventories from the base year of the protocols to year 2022. Submitted to the UNECE and the European Commission	https://cdr.eionet.europa.eu/dk/un/clrtap/iir/envzfpzjq	15.03.2024
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/envzfkawg	14.03.2024
EL	Greece's Informative Inventory Report (IIR) 2024. 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/envzfrujq	15.03.2024
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. 2024 edition (1990-2022)	https://cdr.eionet.europa.eu/es/un/clrtap/iir/envzfl2na	114.03.2024
FI	Finland's Informative Inventory Report 2024. Air Pollutant Emissions 1980-2022 under the UNECE CLRTAP and the EU NECD.	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envzfreia	15.03.2024
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 2024	https://cdr.eionet.europa.eu/fr/un/clrtap/iir/envzfhv2q	04.04.2024
HR	Republic of Croatia 2024 informative inventory report (1990 – 2022)	https://cdr.eionet.europa.eu/hr/un/clrtap/iir/envzer7la	08.03.2024

Country code	Title of IIR	Source	Date of submission
HU	Informative Inventory Report. 1990-2022. Hungary	https://cdr.eionet.europa.eu/hu/un/clrtap/iir/envzii9ba	19.04.2024
IE	Ireland Informative Inventory Report 2024. Air Pollutant Emissions in Ireland 1990-2022 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/envzfrwua	15.03.2024
IT	Italian Emission Inventory 1990-2022 Informative Inventory Report 2024	https://cdr.eionet.europa.eu/it/un/clrtap/iir/envzfrnxq	15.03.2024
LT	Lithuania's Informative Inventory Report 2024. Air Pollutant Emissions 1990-2022. Under the UNECE CLRTAP and the EU NECD	https://cdr.eionet.europa.eu/lt/un/clrtap/iir/envzfsstg	15.03.2024
LU	DRAFT-Luxembourg's Informative Inventory Report 1990-2022. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lu/un/clrtap/iir/envzflgtg	14.03.2024
LV	2024. Latvia's Informative Inventory Report. Submitted under the Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envzfrx9q	15.03.2024
MT	2024 submission. Malta's annual informative inventory, 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, Emission inventories from 1990 to 2022	https://cdr.eionet.europa.eu/mt/un/clrtap/iir/envzfqbiw	15.03.2024
NL	Informative Inventory Report 2024 Emissions of transboundary air pollutants in the Netherlands 1990–2022	https://cdr.eionet.europa.eu/nl/un/clrtap/iir/envzh5mog	16.04.2024
PL	Poland's Informative Inventory Report 2024 Submission under the UNECE CLRTAP and NEC Directive. Air pollutant emissions in Poland 1990–2022.	https://cdr.eionet.europa.eu/pl/un/clrtap/iir/envzfgeqq	13.03.2024
PT	National Informative Inventory Report 2024 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/envzfsjeg	15.03.2024
RO	Romania's Informative Inventory Report 2024. Submission under UNECE Convention on Long Range Transboundary Air Pollution Directive (Eu) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the Reduction of National Emissions of Certain Atmospheric Pollutants	https://cdr.eionet.europa.eu/ro/un/clrtap/iir/envzfhaza	13.03.2024
SE	Informative Inventory Report Sweden 2024. Submitted under the Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/se/un/clrtap/iir/envzdxdwq	26.02.2024
SI	Slovenian Informative Inventory Report 2024. 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/envzegwpg	13.03.2024
SK	Informative Inventory Report 2024. Submission under the CLRTAP and NECD	https://cdr.eionet.europa.eu/sk/un/clrtap/iir/envzh0ag	15.04.2024

Note: EMEP, European Monitoring and Evaluation Programme; IPPU, industrial processes and product use; NEC (also NECD), National Emission reduction Commitments (Directive); CLRTAP: Convention on Long-range Transboundary Air Pollution (the Air Convention).

European Environment Agency

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European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K, Denmark
Tel.: +45 33 36 71 00
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

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