EEA Report | No 05/2021

# European Union emission inventory report 1990-2019

## under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention)

European Environment Agency

EEA Report | No 05/2021

# European Union emission inventory report 1990-2019

under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention)

European Environment Agency

Cover design: EEA
Cover photo: © Kamil Szumotalski, Unsplash
Layout: EEA



Luxembourg: Publications Office of the European Union, 2021

ISBN 978-92-9480-375-7
ISSN 1977-8449
doi:10.2800/701303

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel.: +45 33 36 71 00
Internet: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

# Contents

# Acknowledgements

This report was prepared by the EEA and its European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI, partner Umweltbundesamt Austria). The lead authors of the report were Marion Pinterits and Bernhard Ullrich. Other authors (in alphabetical order) were Thomas Bartmann and Michaela Gager. The EEA project manager was Anke Lükewille. The desk officer at the European Commission's Directorate-General for the Environment (DG Environment) was Viviane André. The authors gratefully acknowledge the technical support received from Robert Wankmüller and Erich Koppensteiner (ETC/ATNI).

The EEA acknowledges comments received on the draft report from the Eionet National Reference Centres in EEA member countries and the European Commission (DG Environment).

| | |
|---|---|
| Title of report | European Union emission inventory report 1990-2019 under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention) |
| Contact names | Anke Lükewille (EEA)<br>Marion Pinterits (ETC/ATNI)<br>Viviane André (DG Environment) |
| Organisation | EEA<br>European Commission, DG Environment |
| Address of the EEA | Kongens Nytorv 6<br>1050 Copenhagen K<br>Denmark |
| Email | Anke.Luekewille@eea.europa.eu |
| Address of the European Commission | DG Environment<br>1049 Brussels<br>Belgium |
| Email | Viviane.ANDRE@ec.europa.eu |

# Executive summary

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

**Box ES.1 The Gothenburg Protocol**

The Gothenburg Protocol to the Convention on Long-range Transboundary Air Pollution (Air Convention) sets emission ceilings (UNECE, 1999). Parties to the convention must reduce their emissions to the levels set out in the protocol. These ceilings, for 2010 and beyond, are for the pollutants nitrogen oxides ($NO_x$), non-methane volatile organic compounds (NMVOCs), sulphur oxides ($SO_x$) and ammonia ($NH_3$). In addition to the ceilings for individual countries, the protocol specifies ceilings for the EU, which is a Party to the protocol in its own right (UNECE, 1999). The protocol was amended in 2012. The ceilings set for 2010 and the years thereafter are still in place, but the amended version also specifies new emission reduction commitments in terms of percentage reductions by 2020, relative to the base year 2005 ([2]). Parties are also encouraged to report primary particulate matter and black carbon emissions, in line with the revised emission-reporting guidelines (UNECE, 2014a) ([3]). The EU ratified the amended protocol in 2017.

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

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

([1]) The United Kingdom (UK) left the EU on 31 January 2020 but applied EU law until the end of the transition period, 31 December 2020. In 2021, the UK therefore does not come under the obligation to report 1990-2019 data to the EU. References to 'EU Member States' and the 'EU-28' in this report in relation to information given for the period 1990-2019 therefore refer to the air pollutant emission totals of the EU-27, without UK data (see Box ES.2).

([2]) When the 2020 data are reported in 2022, the ceilings will have been replaced by the emission reduction commitments set in the 2012 amendments to the Gothenburg Protocol.

([3]) In June 2021, the EEA publishes an annual briefing (EEA, forthcoming) that analyses the 2019 emission data for EU Member States reported under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, known as the EU National Emission reduction Commitments (NEC) Directive (EU, 2016b). For the EU Member States, the NEC Directive retains the emission ceilings set for 2010 and the years thereafter until 2019 and establishes new national emission reduction commitments for $NO_x$, NMVOCs, sulphur dioxide ($SO_2$), $NH_3$ and particulate matter with a diameter of 2.5 µm or less ($PM_{2.5}$) for 2020-2029 and for 2030 onwards.


European Union emission inventory report 1990-2019 6

**Box ES.2 Extraordinary situation for the 2019 data reporting**

The United Kingdom left the EU on 31 January 2020; the UK withdrawal transition period ended on 31 December 2020. The data reported by the EU to the United Nations Economic Commission for Europe Air Convention in 2021 (Gothenburg Protocol, please see Box ES.1) covers data up to 2019, when the United Kingdom was still an EU Member State (EU-28). However, in the submission year 2021, the EU has only 27 Member States (EU-27) and the United Kingdom is no longer obliged to report air pollutant emission data to the EU. The EU's official submission in 2021 therefore includes only the data for the current 27 EU Member States. The United Kingdom is expected to report its 1990-2019 data separately under the Air Convention. Therefore, all the data needed to do the compliance review will be available, albeit submitted in two parts. The EU will thereby have fulfilled its reporting requirement.

EU country groupings used in this report are therefore:

- EU-15 refers to the first 15 EU Member States of the EU: note that the United Kingdom is expected to provide its data directly.
- EU-28 refers to the first 28 EU Member States of the EU: note that the United Kingdom is expected to provide its data directly.

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

This report addresses:

- the institutional arrangements and preparation processes behind the EU's emission inventory, methods and data sources, reporting, key category analyses, information on quality assurance and control, general uncertainty evaluation, and information on completeness and underestimations (Chapter 1);
- information on approved adjustments and adjustment applications under the Gothenburg Protocol (Chapter 2);
- emission trends for the EU as a whole and for individual EU Member States, and the contribution of key categories to total emissions (Chapter 3);

**Box ES.3 Status of reporting by EU Member States and the United Kingdom**

In 2021, EU Member States and the United Kingdom were requested to report emission inventory data and an informative inventory report (IIR). All 27 EU Member States provided air emission inventories and activity data but, for those for which emissions data were missing for certain years or pollutants, a gap filling procedure was applied to obtain a European inventory that was as complete as possible.

The EU should deliver emission inventories and projections by 30 April, its IIR (i.e. this report) by 30 May and its gridded and large point source (LPS) data by 15 June. By 20 May 2021, the 27 EU Member States had provided IIRs. As there is no reporting obligation in 2021 for projections under the Air Convention, their reporting is voluntary; however, 17 Member States did provide The EU should deliver emission inventories and projections. Respectively, 21 and 23 Member States have provided gridded data or LPS data in 2021. Detailed information on EU Member States' submissions is given in Appendix 3 ([4]).

In 2012, the Executive Body of the Convention on Long-range Transboundary Air Pollution 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, if such a circumstance keeps a Party from being able to meet one of its reduction commitments (UNECE, 2012a). Under the Gothenburg Protocol, the European Monitoring and Evaluation Programme Steering Body accepted inventory adjustment applications for emissions from 10 countries in 2014, 2015, 2016, 2017, 2018 and 2019.

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

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

([4]) For detailed information on LPS and gridded data reporting, please see the Member State submissions on the Central Data Repository (CDR) (https://cdr.eionet.europa.eu).

- sectoral analyses and emission trends for key pollutants (Chapter 4);
- 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 presented in this report are presented in the accompanying annexes and are also available for direct download from the EEA's data service (EEA, 2020a). The following sections summarise the main findings.

## EU emission trends

Figures ES.1-ES.3 present the trends in the emission of air pollutants between 1990 and 2019 ([5]). They are aggregated across the EU.

### *Emission trends for the main air pollutants between 1990 and 2019*

With reference to the main air pollutants, $SO_X$ registered the greatest reduction in emissions across the EU. In 2019, $SO_X$ emissions were 92 % lower than in 1990 (Figure ES.1). This reduction is the result of a combination of measures:

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

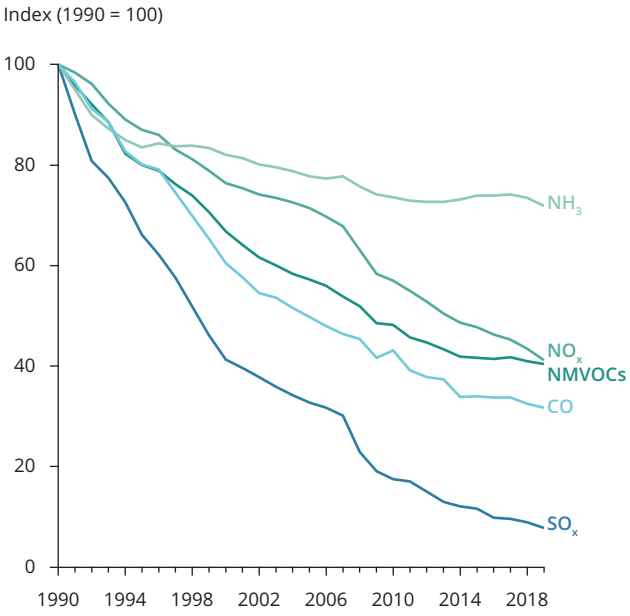
Emissions of the other main air pollutants have dropped considerably since 1990, including the three regulated air pollutants primarily responsible for the formation of ground-level $O_3$: CO (68 % reduction), NMVOCs (60 % reduction) and $NO_X$ (59 % reduction).

For most main air pollutants, emissions decreased more slowly from 2007 to 2019. $NH_3$ emissions have fallen by less than emissions of the other main pollutants (-28 %) since 1990, and since 2013 a positive $NH_3$ emission trend had been noted for some years (plus 2.1 % from 2013 to 2017).

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

European legislation sets progressively stricter emission limits for air pollutants from cars and vans, lorries and buses and coaches, known as the 'Euro standards'. The standards apply to exhaust emissions of $NO_X$, determined by laboratory-based tests. These official tests fail to measure the actual level of emissions that vehicles are producing under real driving conditions, i.e. $NO_X$ emissions are higher than EU limits permit. This has contributed significantly to exceedances of the nitrogen dioxide ($NO_2$) air quality daily limit value at urban traffic stations ([6]) (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).

**Figure ES.1 EU-28 (without the UK) emission trends for the main air pollutants**




([5]) Each year, by 15 February, Member States must report emissions data for the years up to and including the last calendar year but one. Thus, by 15 February 2021, Member States were obliged to report data for the years up to 2019. 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.

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

**Box ES.4 Changes in the emissions of main air pollutants in the EU Member States between 2018 and 2019**

Between 2018 and 2019, emissions of nitrogen oxides ($NO_x$), non-methane volatile organic compounds (NMVOCs), sulphur oxides ($SO_x$), carbon monoxide (CO) and ammonia ($NH_3$) dropped by 5.2 %, 1.4 %, 12.5 %, 2.6 %, and 2.2 %, respectively.

NMVOC emissions decreased in 22 EU Member States between 2018 and 2019. Poland and France (in order of the largest absolute emission reduction) were responsible for the highest decreases. The main emitter of NMVOCs is the 'industrial processes and product use' sector.

From 2018 to 2019, the largest reductions in $SO_x$ emissions in absolute terms were reported by Poland, Spain, Germany and France (in order of the largest absolute emission reduction). The 'energy production and distribution' sector was the main contributor to the reduction in $SO_x$ emissions.

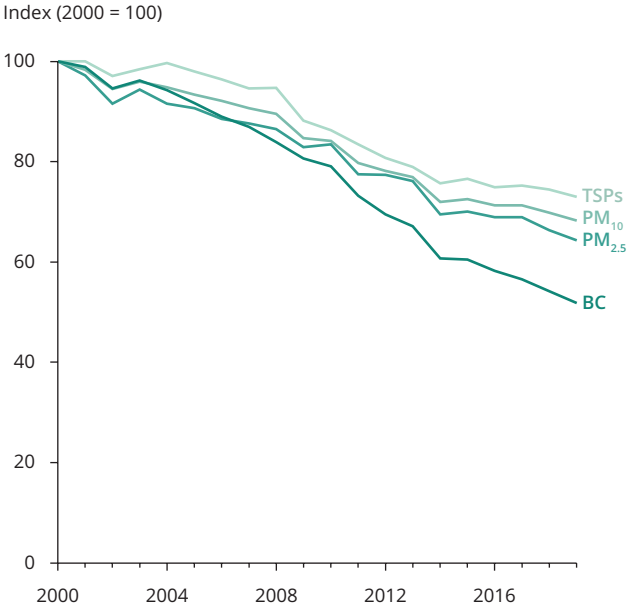
CO emissions decreased, mainly due to decreased emissions reported by Poland, Germany, France and Slovakia (in order of the largest absolute emission reduction). The road transport sector contributed most to the decrease in CO emissions.

$NH_3$ emissions decreased in 23 EU Member States. Germany, France, Poland and Ireland reported the highest decreases (in order of the largest absolute emission reduction). The rise in $NH_3$ emissions in Spain in recent years has been driven by a greater consumption of synthetic nitrogen fertilisers and an increase in the numbers of cattle and swine.

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

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

**Figure ES.2 EU-28 (without the UK) emission trends for PM**




### *Emission trends for particulate matter between 2000 and 2019*

The Air Convention formally requests Parties to report emissions of PM from the year 2000 onwards; hence, emission trends are shown for 2000 and the subsequent years only. Aggregated emissions of TSPs fell by 27 % across the EU between 2000 and 2019 (and by 58 % since 1990) (Figure ES.2). Emissions of primary $PM_{10}$, $PM_{2.5}$ and BC fell by 32 %, 36 % and 48 %, respectively (also between 2000 and 2019).

The reporting of condensable components is not mandatory, and in recent years there has been no clear definition of whether PM emission reporting includes or excludes the condensable component. However, the reporting table on condensable components within Annex II was provided by 19 EU Member States in 2021. The level of information is rather heterogeneous and for many categories no information is available at all.

Total PM emissions dropped, mainly thanks to the introduction or improvement of abatement measures across the energy, road transport and industry sectors. This has been coupled with other developments in industrial sectors, such as switching from fuels containing high levels of sulphur to those with low levels. $SO_x$, $NO_x$ and $NH_3$ play an important role in the formation of secondary PM. Thus, if emissions of these pollutants decrease, this also influences PM formation (EEA, 2020b).

$NH_3$ emissions from agriculture contribute to episodes of high secondary inorganic PM concentrations being observed across certain regions of Europe each spring. Such episodes contribute to exceedances of the $PM_{10}$ daily limit values set in the EU's Air Quality Directive (e.g. CAMS, 2020).

### *Emission trends for heavy metals and persistent organic pollutants between 1990 and 2019*

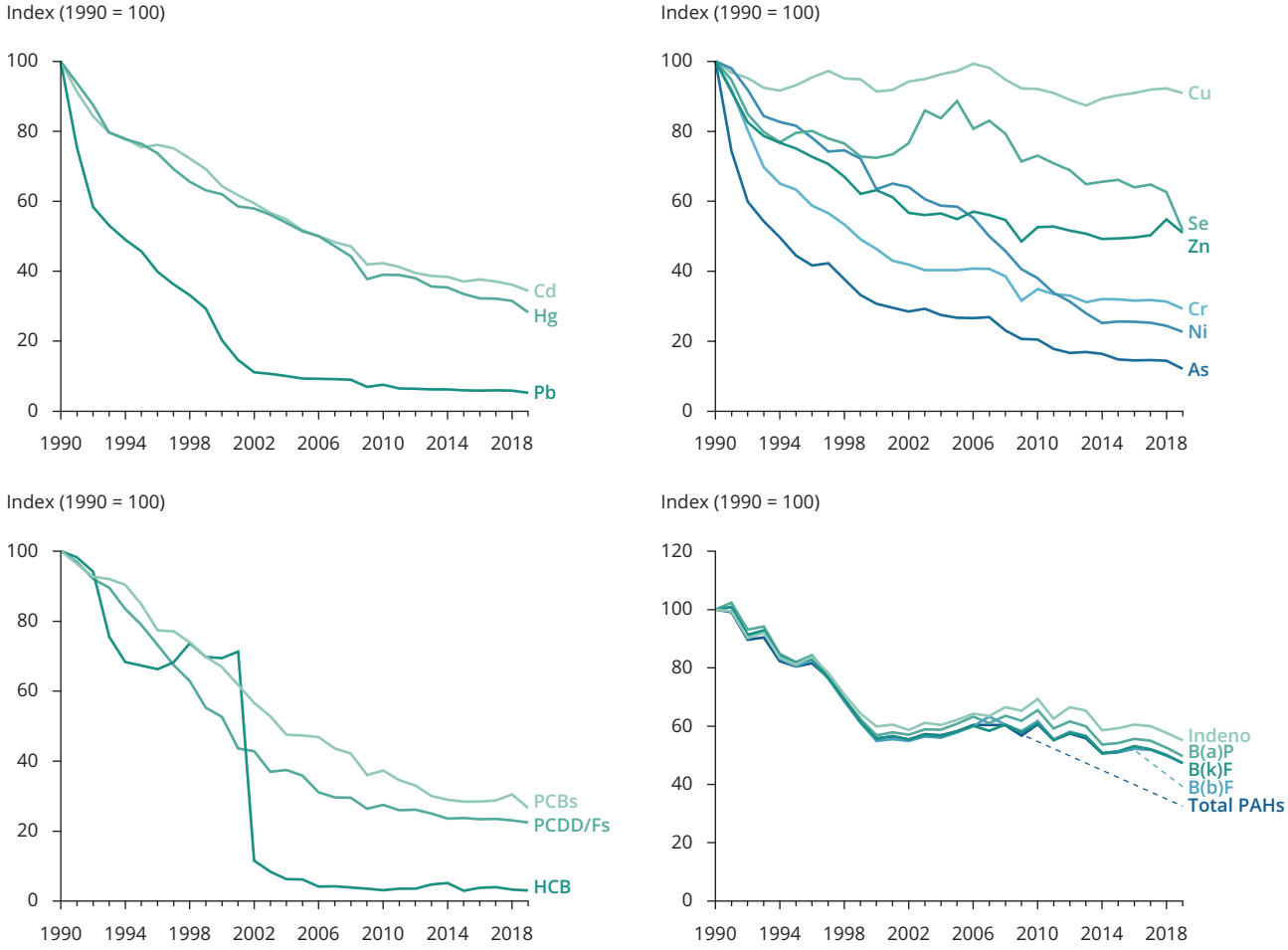
Since 1990, emissions of the main HMs (Pb, Cd, Hg), dioxins and furans, total PAHs, HCB and PCBs have also dropped substantially, by at least 53 % (Figure ES.3).

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

Emissions of HMs fell between 1990 and 2019: Pb by 95 %, Cd by 66 %, Hg by 72 %, As by 88 %, Cr by 71 %, Cu by 9 %, Ni by 77 %, Se by 48 % and Zn by 49 %.

Total PAHs decreased by 53 % from 1990 to 2019 ([7]). For individual PAHs, the reductions from 1990 to 2019 were 50 % for B(a)P, 53 % for B(b)F, 53 % for B(k)F and 45 % for IP. Dioxins and furans decreased by 78 % between 1990 and 2019. The reductions in HCB and PCB emissions were 97 % and 73 %, respectively. Although there have been clear decreases over the last 25 years, emissions of POPs have remained broadly stable since 2003 (Figure ES.3).

**Figure ES.3 EU-28 (without the UK) emission trends for HMs and POPs**




**Note:** The decrease in HCB emissions between 2003 and 2004 was caused by reductions reported by Spain. For certain pollutants, not all Member States reported data.

([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.

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

In 2021, all EU Member States that provided submissions reported recalculations for one or more years; changes in gap filling also resulted in recalculations. This caused changes in emission inventories for all pollutants up to 2019.

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

## EU key categories and main emission sources

EU key categories refer to the individual sources that contributed the most, overall, to emissions of pollutants in 2019. They were 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 56 different emission inventory source categories were identified as being key for at least one pollutant. A number of emission categories were identified as being key for more than 1 of the 16 pollutants assessed. Table ES.1 lists the most relevant key categories.

Figure ES.4 shows the share of EU emissions in 2019 by sector group. As observed in previous years, each main air pollutant has one major source category:

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

Emissions of $NO_X$ from the road transport sector fell by 61 % between 1990 and 2019. Nevertheless, in the EU, this sector is a major source of the ground-level $O_3$ precursors $NO_X$, CO and NMVOCs. In 2019, this sector contributed 39 % ($NO_X$), 20 % (CO) and 8 % (NMVOCs) to the total emissions of these pollutants in the EU. Passenger cars, heavy-duty vehicles and buses are the principal contributors to $NO_X$ emissions from this sector; in 2019, passenger cars alone contributed around 71 % of CO emissions from the road transport sector.

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

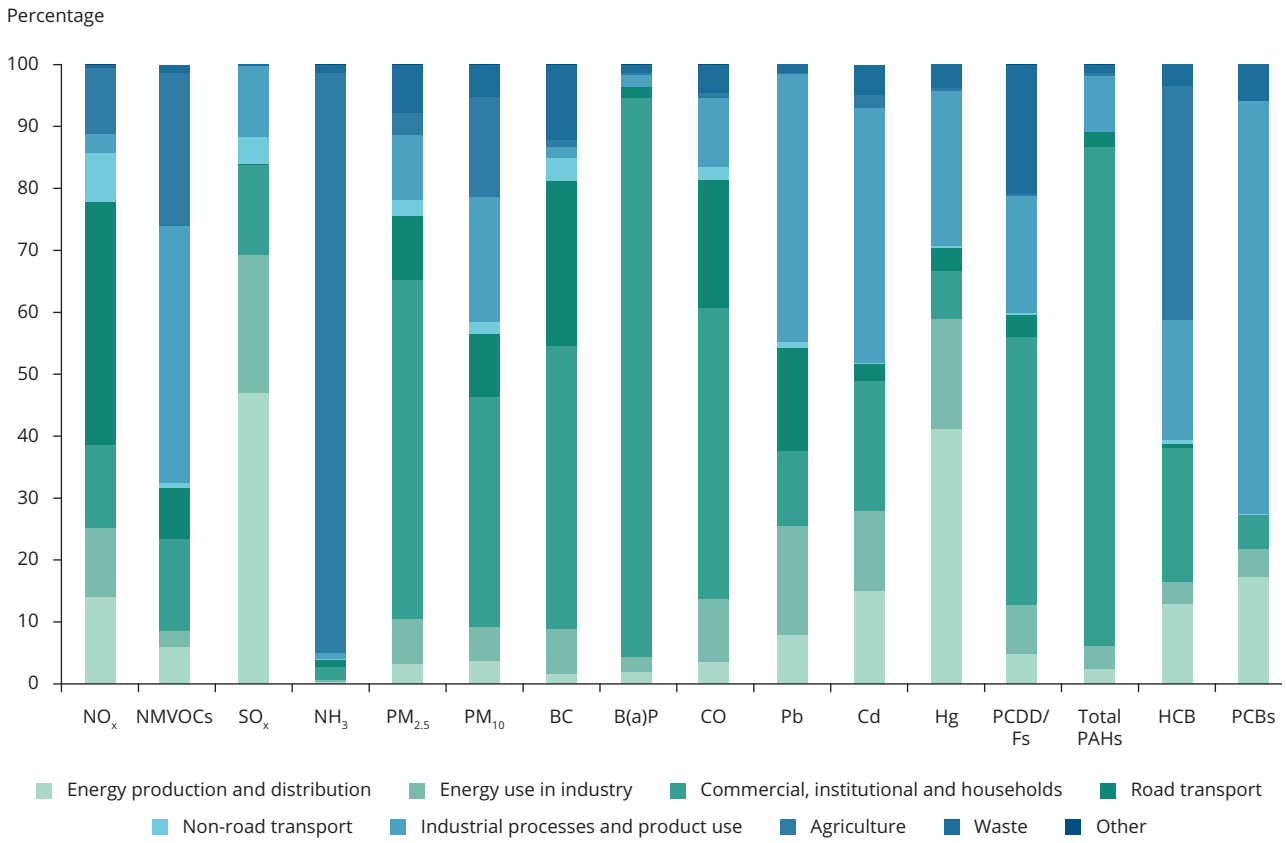
**Table ES.1 Most relevant key categories for air pollutant emissions**

| Name of key category | Number of occurrences as a key category |
|---|---|
| Residential: Stationary (combustion) (NFR 1A4bi) | 14 ($NO_X$, NMVOCs, $SO_X$, CO, $PM_{2.5}$, $PM_{10}$, BC, Pb, Cd, Hg, PCDD/Fs, total PAHs, B(a)P, HCB) |
| Iron and steel production (NFR 2C1) | 11 ($SO_X$, CO, $PM_{2.5}$, $PM_{10}$, Pb, Cd, Hg, PCDD/Fs, total PAHs, HCB, PCBs) |
| Public electricity and heat production (NFR 1A1a) | 10 ($NO_X$, $SO_X$, $PM_{2.5}$, $PM_{10}$, Pb, Cd, Hg, PCDD/Fs, HCB, PCBs) |
| Stationary combustion in manufacturing industries and construction: Non-metallic minerals (NFR 1A2f) | 8 ($NO_X$, $SO_X$, CO, $PM_{2.5}$, $PM_{10}$, Pb, Cd, Hg) |
| Road transport: Passenger cars (NFR 1A3bi) | 8 ($NO_X$, NMVOCs, CO, $PM_{2.5}$, PM10, BC, Hg, PCDD/Fs) |

**Note:** NFR, nomenclature for reporting.

([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, 2019).

**Figure ES.4 Share of EU emissions of the main air pollutants, by sector group in 2019**




## Adjustments to emission inventories under the Gothenburg Protocol

Parties to the Air Convention may 'adjust' their emission inventories downwards if non-compliance with the ceilings set in the Gothenburg Protocol is caused by countries that have applied improved emission inventory methods in accordance with updated scientific knowledge since the 2010 ceilings were originally set. This is to avoid countries being disadvantaged by applying improved emission inventory methodologies.

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 and 2020.

## Progress towards meeting the EU's current emission ceilings and emission reduction commitments for 2021 under the Gothenburg Protocol

The Gothenburg Protocol (1999) set commitments for the European Community, at the time comprising 15 EU Member States (EU-15). Table ES.3 shows their aggregated emissions for 2019 compared with the emission ceilings the protocol specified for the EU in 2010 and for the years thereafter. In 2019, the EU-15 emissions of $NO_x$, NMVOCs, $SO_x$ and $NH_3$ were below the ceilings set out (see Appendix 2, Table A2.2, for country groupings). The Gothenburg Protocol was amended in 2012 to set emission reduction commitments for 2020.

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

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

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

**Table ES.3 Emissions reported for 2019 by EU-15 Member States (without the UK) compared with the Gothenburg Protocol EU emission ceilings for 2010 and the years thereafter**

| Pollutant | EU-15 emissions, 2019 (Gg) | EU-15 Gothenburg Protocol, 2010 ceilings (Gg) | Difference (%) | Sum of individual EU-15 ceilings (Gg) [a] |
|---|---|---|---|---|
| $NO_x$ | 4 589 | 6 671 | -31 | 6 519 |
| NMVOCs | 4 790 | 6 600 | -27 | 6 510 |
| $SO_x$ | 873 | 4 059 | -78 | 3 850 |
| $NH_3$ | 2 673 | 3 129 | -15 | 3 110 |

**Notes:** For Spain, data for emission comparisons exclude emissions from the Canary Islands. The comparison with emission ceilings is based on reporting based on fuel sold for all EU Member States.

For Portugal's 2010 ceilings, emissions from the Azores and Madeira are excluded.

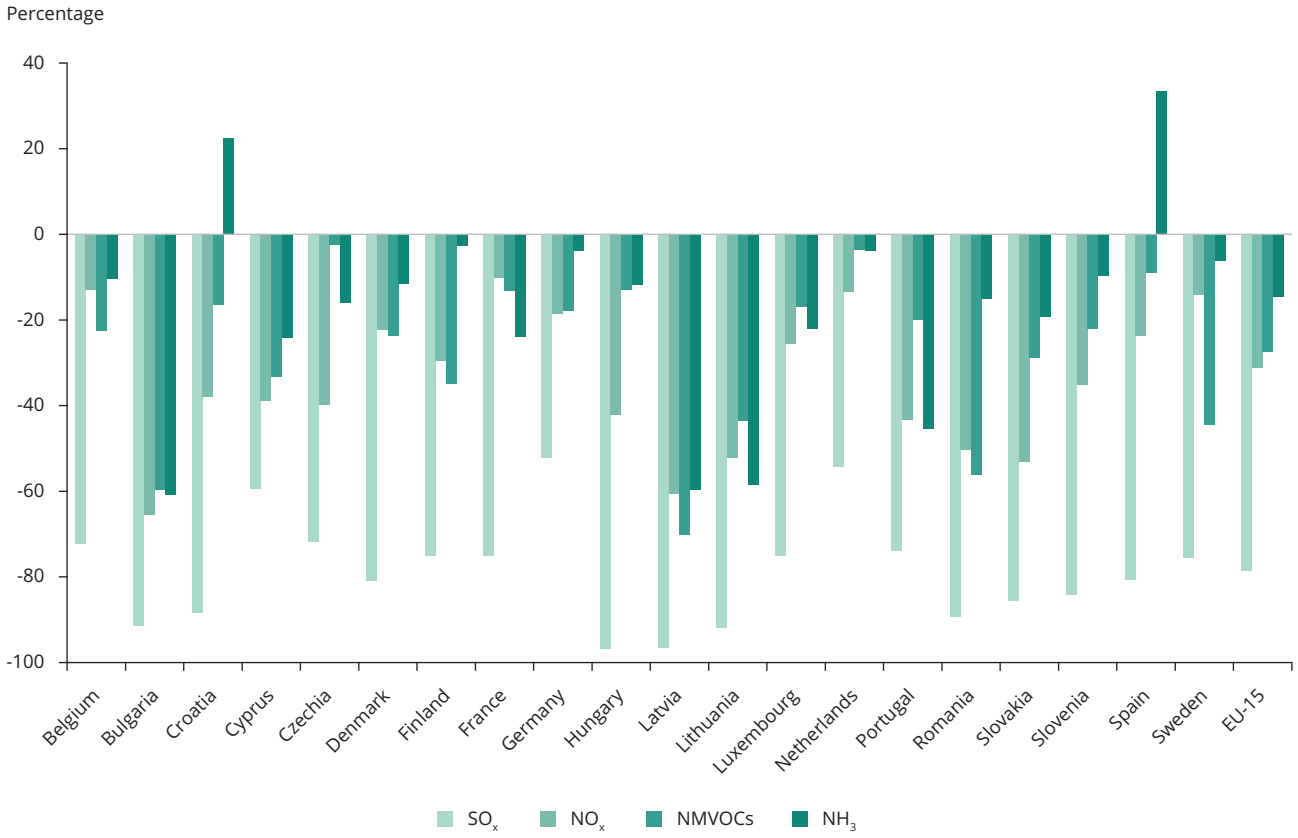
Under the Gothenburg Protocol, the EMEP Steering Body accepted applications from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands, Spain and the United Kingdom for emission inventory adjustments in 2014, 2015, 2016, 2017, 2018, 2019 and 2020. However, as the EU-15 itself has not applied for adjustments, this table does not take these adjusted data into account.

[a] The protocol also specifies emission ceilings for individual EU-15 Member States. In some cases, the sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

Figure ES.5 shows whether or not each EU Member State met the respective national Gothenburg Protocol ceiling in 2019. Two countries exceeded their $NH_3$ ceilings (Croatia and Spain).

All EU Member States complied with their $NO_x$, NMVOC and $SO_x$ ceilings.

**Figure ES.5 Distance to Gothenburg ceilings for EU Member States in 2019**




**Notes:** Estonia and Malta have not signed the Gothenburg Protocol and therefore do not have ceilings. Austria, Greece, Ireland, Italy and Poland have a ceiling but have not yet ratified the protocol. For Spain, data for emission comparisons exclude emissions from the Canary Islands.

The comparison with emission ceilings is based on the reporting of data on fuel sold, except for Belgium, Luxembourg and the Netherlands. These countries may, instead, choose to use the total national emissions calculated based on fuel used in the geographical area of the Party when comparing emissions with the ceilings (UNECE, 2014a). For the EU-15, the comparison is based on fuel sold.

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

## Progress by non-EU EEA member countries in meeting emission ceilings for 2010 and the years thereafter under the Gothenburg Protocol

The Gothenburg Protocol specified emission ceilings for three non-EU EEA member countries (Liechtenstein, Norway and Switzerland) for 2010 and onwards (UNECE, 1979, 1999). Liechtenstein has signed the protocol but has not yet ratified it. EEA members Iceland and Turkey have not yet signed the Gothenburg Protocol. Emission data for Iceland, Norway, Switzerland and Turkey are the latest data reported under the Air Convention (2021 submission round).

Data from the abovementioned countries show that Norway exceeded its $NO_X$ ceilings from 2010 to 2018 and its $NH_3$ ceilings from 2010 to 2019. Switzerland exceeded its ceilings for $NO_X$ from 2010 to 2013 (see Table ES.4).

## Actions and recommendations for improving the EU emission inventory

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

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

EU Member States are encouraged to consider the findings of the annual quality checks performed by the EEA and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) and from 2019 onwards the ETC on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI) during the compilation of the EU inventory. Where necessary, they can either resubmit inventory data (in the nomenclature for reporting 19 (NFR19) format for reporting of air pollutants) or update next year's inventory to reflect new insights gained or errors identified. In 2021, several EU Member States were contacted by the EEA regarding potential errors identified by the quality assurance and quality control (QA/QC) procedure.

**Table ES.4 Progress by non-EU EEA member countries in meeting Gothenburg Protocol emission ceilings for 2010 and the years thereafter**

| Member State | $NO_x$ | | | | | | | | | | NMVOCs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Norway | × | × | × | × | × | × | × | × | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Switzerland | × | × | × | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Member State** | **$SO_2$** | | | | | | | | | | **$NH_3$** | | | | | | | | | |
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Norway | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | × | × | × | × | × | × | × | × | × |
| Switzerland | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Notes:** ✓ indicates that the final (2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018) or provisional (2019) emission data reported by a country either meet or fall below its respective emission ceiling.

× indicates that a ceiling has been exceeded.

# 1. Introduction

The European Commission provides this report and its accompanying data (on behalf of the EU ([9])) as an official submission to the United Nations Economic Commission for Europe (UNECE) secretariat for the Executive Body of the Convention on Long-range Transboundary Air Pollution (Air Convention).

The report covers the following subjects: the formal institutional arrangements that underpin the EU's emission inventory, the inventory preparation process, methods and data sources, key category analyses, information on quality assurance and quality control (QA/QC), general uncertainty evaluation, general assessment of completeness and information on underestimations (see Chapter 1); adjustments under the Gothenburg Protocol (Chapter 2); emission trends and the contribution of key categories to total emissions (Chapter 3); sectoral analysis and emission trends for key pollutants (Chapter 4); and information on recalculations and planned improvements (Chapter 5).

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

- **main pollutants:**
  - nitrogen oxides ($NO_X$)
  - non-methane volatile organic compounds (NMVOCs)
  - sulphur oxides ($SO_X$)
  - ammonia ($NH_3$)
  - carbon monoxide (CO);
- **particulate matter (PM):**
  - PM with a diameter of 10 µm or less ($PM_{10}$)
  - fine PM with a diameter of 2.5 µm or less ($PM_{2.5}$)
  - total suspended particulates (TSPs)
  - black carbon (BC);
- **priority heavy metals (HMs):**
  - lead (Pb)
  - cadmium (Cd)
  - mercury (Hg);
- **additional HMs:**
  - arsenic (As)
  - chromium (Cr)
  - copper (Cu)
  - nickel (Ni)
  - selenium (Se)
  - zinc (Zn);
- **persistent organic pollutants (POPs):**
  - polychlorinated dibenzodioxins/polychlorinated dibenzofurans (PCDD/Fs)
  - polycyclic aromatic hydrocarbons (PAHs)
  - hexachlorobenzene (HCB)
  - polychlorinated biphenyls (PCBs);
- **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).

([9]) The United Kingdom left the EU on 31 January 2020 and applied EU law until the end of the transition period, 31 December 2020. This report refers to the air pollutant emission totals of the EU-27, without the UK (see Box ES.2).

Emission estimates are not always available for all pollutants every year, because there are gaps in the data reported in 2021 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 1990-2019 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.
- Annex C provides results of the key category analyses (KCAs) for the EU, showing the main emitting sectors for each pollutant.
- Annex D presents the EU's gap-filled inventory, colour-coded for the different data sources used and the various additional gap filling methods applied.
- Annex E provides EU Member States' projections for $NO_X$, NMVOCs, $SO_X$, $NH_3$, $PM_{2.5}$ and BC emissions for 2020, 2025, 2030, 2040 and 2050.
- Annexes F presents the EU's Air Convention data submission for the period 1990-2019 for the EU-15. 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 2021 EU inventory.
- Annex H provides an overview of the completeness of the gap-filled inventory concerning the notation key 'NE' (not estimated).
- Annex I provides gridded data for the EU-28.
- Annex J provides data on large point sources (LPSs).

## *1.1 Background*

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

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

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

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

- -59 % for sulphur dioxide ($SO_2$)
- -42 % for $NO_X$
- -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, 2014a). Parties were to apply them in 2015 and subsequent years. A summary of the reporting requirements is presented in Appendix 2.

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

In 2012, the Executive Body of the Air Convention decided that adjustments to 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 or not the adjustment is consistent with the circumstances and guidance for adjustments (UNECE, 2012c). It makes the review available to the Parties, which have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

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

## *1.2 Institutional arrangements*

### 1.2.1 EU Member States

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

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/ATNI

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

EEA activities include:

- overall coordination and management of the inventory compilation process;
- coordinating the activities of the EEA's European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI) ([10]), 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;

([10]) The current ETC/ATNI started its operations on 1 January 2019. Until the end of 2018, the EEA cooperated with the ETC on Air Pollution and Climate Change Mitigation (ETC/ACM).

- hosting the official inventory database and disseminating the data and inventory report on the web.

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

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

***European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution***
The main activities of the ETC/ATNI ([11]) regarding the EU's Air Convention emission inventory include:

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

***European Environment Information and Observation Network***
Eionet facilitates the work of the EEA and the respective ETC (EU, 1999) ([12]). It comprises the EEA (supported by its European topic centres) and a supporting network of experts from national environment agencies and other bodies that deal with environmental information (Eionet, 2021a). EU Member States are requested to use the tools of the Central Data Repository (CDR) (Eionet, 2021b) of the Eionet Reportnet to make their Air Convention submissions available to the EEA.

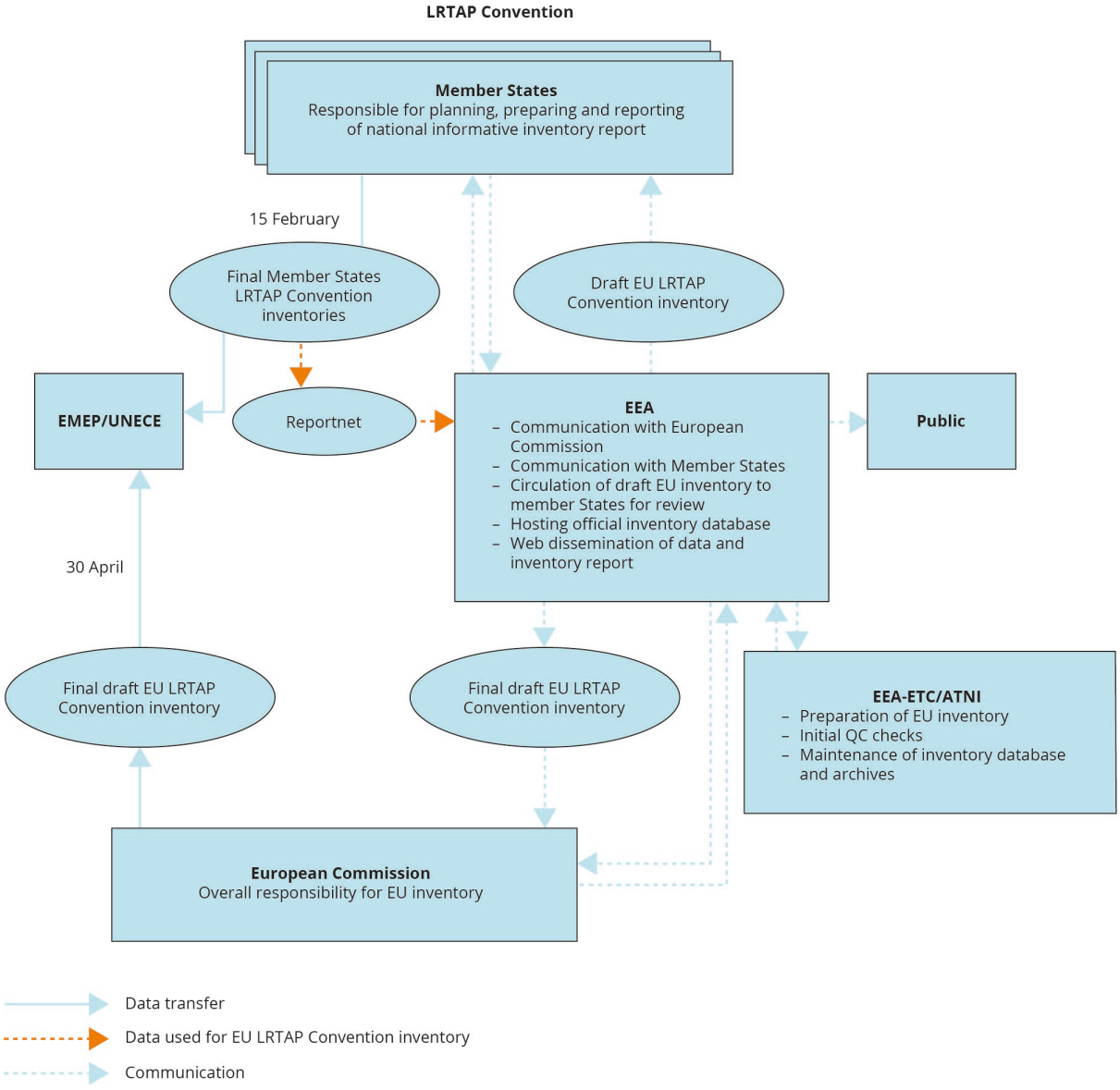
## *1.3 Inventory preparation process*

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 ETC/ATNI subsequently collects the data from the CDR, performs a QA/QC analysis, compiles the gap-filled EU Air Convention emission inventory database and produces an EU Air Convention emission inventory and inventory report. The European Commission formally submits the EU's emission inventory data and IIR to EMEP through the Executive Secretary of UNECE. The inventory and accompanying documentation are then made publicly available through the EEA's website (see summary in Figure 1.1).

([11]) The current ETC/ATNI was established in 2018 via a contract between the EEA and the lead organisation, the Stiftelsen Norsk Institutt for Luftforskning (Norwegian Institute for Air Research, NILU), and started its operations on 1 January 2019. It works with nine organisations and institutions across eight European countries.

([12]) A brochure describing the structure, working methods, outputs and activities of Eionet is available (EEA, 2012).

**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

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

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

### Table 1.2 Overview of air emission-reporting obligations in the EU, 2021

| 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 2021 | 30 April 2021 |
| NEC Directive | $NO_X$ (as $NO_2$), NMVOCs, $SO_X$ (as $SO_2$), $NH_3$, CO, HMs, POPs and PM | 15 February 2021 | Not applicable |
| EU MMR/United Nations Framework Convention on Climate Change (UNFCCC) | Carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride, $NO_X$, CO, NMVOCs and $SO_2$ | 15 January 2021 to the European Commission and 15 April 2021 to the UNFCCC | 15 April 2021 |

**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. For 2019, the EU still needs to report a data subset for the EU-15, because the original Gothenburg Protocol has not yet been closed (there are still Parties to the original protocol that have not yet ratified the amended version of 2012). Therefore, emissions must be reported separately for the EU-15 and EU-28 (see Box ES.2 and Table A2.2 (in Appendix 2) for more information on EU country groupings).

([b]) Parties are formally required to report only on the substances and for the years set forth in protocols that they have ratified and that have entered into force.

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

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

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

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

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

**Notes:** International inland shipping refers to shipping activity in continental waters and international maritime navigation to shipping activity in marine waters. Air emissions resulting from inland shipping are included, as they are more relevant to air quality for the surrounding environment.
(a) In addition, Parties may also report emission estimates based on fuel used as an additional 'memo item'. Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, Switzerland and the United Kingdom may choose to use the national emission total calculated on the basis of fuel used in the relevant geographical area as a basis for compliance (UNECE, 2014a).
Incl., included in national totals; LTO, landing/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, 2019). Overall, EU Member States do follow this recommendation, which ensures that they use the best methods available to estimate national emissions and that inventories are improved continuously. Moreover, the technical review procedures set up by the EMEP CEIP check and assess Parties' data submissions, as per the review guidelines. The aim is to improve the quality of emission data and associated information reported to the Air Convention.

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

### 1.4.3 Data sources

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

**Table 1.4 Data sources commonly used for inventory sectors**

| Sector | Sources |
|---|---|
| **Energy** | Energy balances, EU Emissions Trading 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, 2019), but emission factors can also be country or even plant specific. It is impossible to survey the emission factors used by the EU Member States for all emission sources, as this information is not uniformly available: some countries report details of their methodologies, while others do not. Detailed information is available in EU Member States' IIRs; see Appendix 5.

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

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

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

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

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

Parties can estimate transport emissions using the amount of fuel sold within the country or the amount of fuel consumed. When fuel purchased within a country is used outside that country (and vice versa), these estimates can differ significantly. The EU inventory compiled in 2021 estimates emissions from road transport based on the fuel sold for all EU Member States.

### 1.4.5 Data gaps and gap filling

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

The EMEP reporting guidelines (UNECE, 2014a) require that submitted emission inventories are complete. In 2021, the gap filling procedure is identical to that in 2020 and follows a methodology paper by the EEA and the ETC/ACM (EEA, 2009) and some changes agreed at the meeting of the

Task Force on Emission Inventories and Projections (TFEIP) in 2016 ([13]). This procedure is also consistent with the techniques used to fill emission data gaps proposed by the inventory guidebook (EMEP/EEA, 2019). It applies a stepwise approach using emission data from other reporting obligations to fill gaps in the national data sets, followed by further gap filling procedures such as inter- or extrapolation and manual changes. 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 2019.

2. Air Convention data submitted to the European Monitoring and Evaluation Programme (EMEP) Centre on Emission Inventories and Projections (CEIP) in 2019 are the next source used to fill remaining gaps. All reported data (i.e. values and notation keys) are used. In fact, there should be no difference between the EU Member States' Air Convention emission inventories provided to the EEA and the data submitted to the EMEP CEIP.

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

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

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

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

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

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

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

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

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

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

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

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

Annex G shows how the various officially reported data sets were used to supplement the Air Convention data submissions for those EU Member States for which gap filling was required. Annex D offers a more detailed overview, showing each Member State for which data were gap filled and how this was performed. The trend tables in Chapter 3 (Table 3.6 to Table 3.31) also provide an initial overview, indicating which data have been derived by gap filling.

## *1.5 Reporting*

### 1.5.1 Emission reporting

The deadline for EU Member States to report by was 15 February 2021. In the 2021 reporting cycle, 25 EU Member States submitted their inventories and time series on time. Italy and Luxembourg submitted their data after the formal deadline for submission (see Appendix 3, Figure A3.1). All Member States provided a complete time series in 2021. All 27 EU Member States and the United Kingdom submitted data using the new NFR19 reporting templates. Appendix 3 presents detailed information on EU Member States' submissions.

### 1.5.2 Projection data

In 2021, reporting of projection data was voluntary, and the deadline for EU Member States to report by was 15 March 2021. 21 EU Member States have submitted information on their projections so far, most of them before or one day after the deadline. Submitted data are available in Annex E of this report.

### 1.5.3 Gridded data

According to the revised reporting guidelines, Parties within the geographical scope of EMEP should report gridded data at a resolution of 0.1 ° × 0.1 ° longitude-latitude every 4 years, starting in 2017. Since gridded data for the EU were last submitted in 2017 (EEA, 2017), they are reported this year. In 2021 21 EU Member States provided gridded data (see Appendix 3, Table A3.1).

### 1.5.4 Large point sources

Parties within the geographical scope of EMEP are also required to provide data on LPSs every 4 years, commencing in 2017. LPS data for the EU were last submitted in 2017 (EEA, 2017) and must be reported this year. In 2021, 23 EU Member States have provided LPS data.

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

PM consists of a filterable fraction and a condensable fraction, which reacts upon cooling and dilution, shortly after release, to form solid or liquid PM. The reporting of condensable components is not mandatory, and in recent years there has been no clarity as to 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, 2021a), Table A6.1, 'Inclusion/exclusion of the condensable component from $PM_{10}$ and $PM_{2.5}$ emission factors', was established. In 2021, 20 EU Member States have provided information using this table. Finland and the Netherlands 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 inhomogeneous 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, 2019).

A level analysis of 2019 emissions for 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 2019, 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 or the remaining POPs are not considered here.

A total of 56 different emission inventory source categories were identified as being key categories for at least one pollutant. Several emission categories were identified as being key categories for more than 1 of the 16 pollutants assessed. '1A4bi — Residential: Stationary' and '2C1 — Iron and steel production' were identified as being important emission sources for 12and 11 pollutants, respectively. The category '1A1a – Public electricity and heat production' was identified to be a key category for 10 pollutants. The categories '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' and '1A3bi — Road transport: Passenger cars' were identified as being key categories for eight and seven pollutants, respectively.

For $NO_X$ and CO, 12 and 9 key categories were identified, respectively; as expected for both pollutants, the key categories with a large share of total emissions reported mainly involve fuel combustion. Eleven key categories were identified for $SO_X$ (mainly energy-related sectors) and six for $NH_3$ (all from the agriculture sector). $PM_{10}$, $PM_{2.5}$ and NMVOC emission sources are more diverse, so larger numbers of source categories make up the key category threshold of 80 % of total emissions.

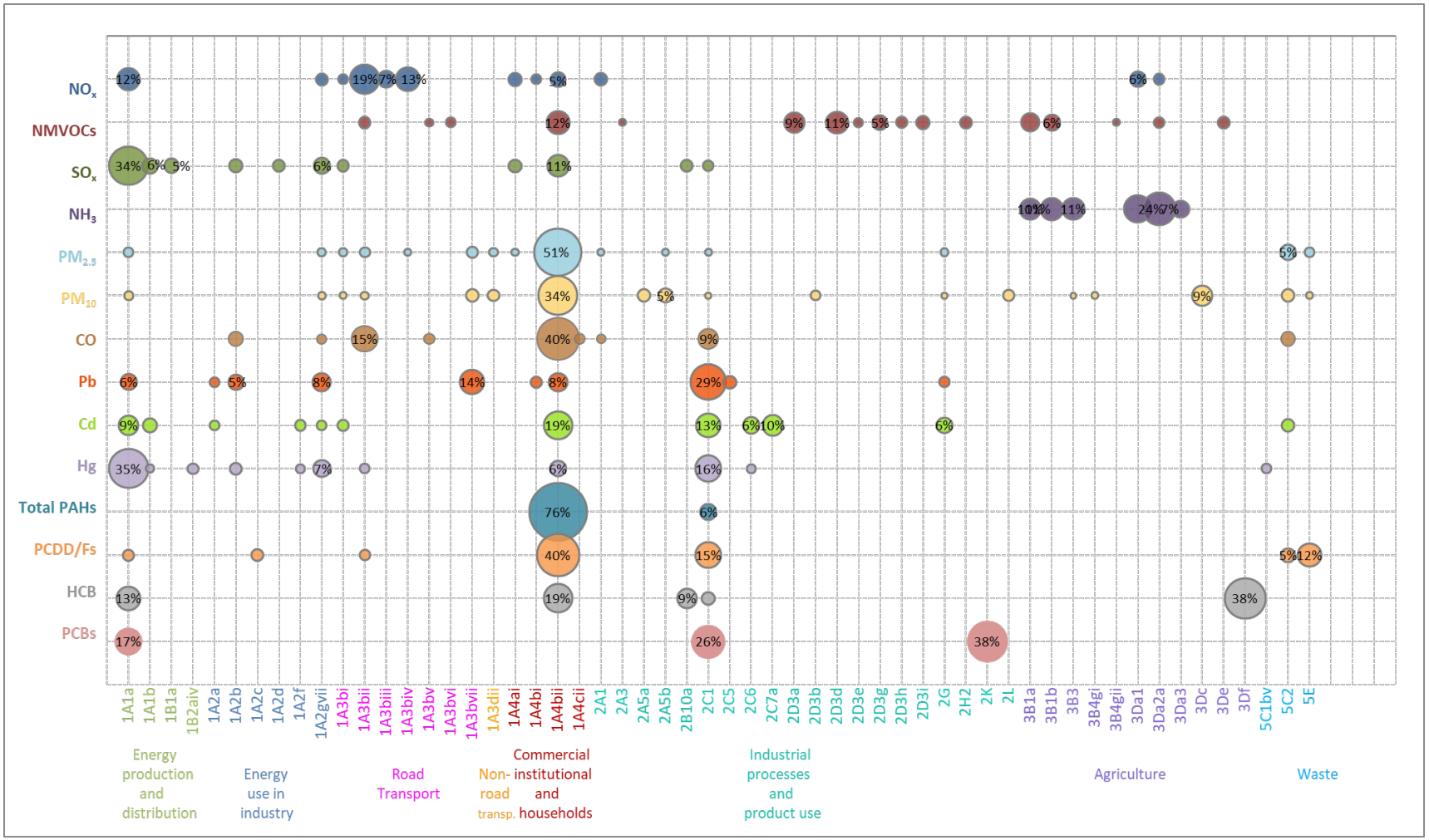
For the PM pollutants, key categories comprise all sectors, while a key aspect for NMVOCs was high activity levels associated with the industrial processes and product use sector.

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

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

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

**Figure 1.2 EU KCA results for 2019**




**Note:** Bubble size indicates the amount of emissions.

All values > 5 % are indicated. For NFR codes, see the list of source sector abbreviations (Appendix 4).

## *1.7 Quality assurance, quality control and verification methods*

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

The main activities improving the quality of the EU inventory, which is based on quality-assured data officially reported by the EU Member States, are the checks that the EEA's ETC/ATNI performs on the status of each Member State's submission. Since 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.

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

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

| | Check | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Completeness | Consistency | Comparability | Accuracy | Transparency | level | years | First checks | Subsequent checks (after gap filling) | Checks within the draft report | Member States will be informed on the finding | changes/ corrections |
| Reporting overview | ✓ | | ✓ | | ✓ | Submissions | 1990-2019 | × | | | if submission is missing or in wrong format | gap-filling of missing data as far as possible |
| Adjustment overview | ✓ | | ✓ | | ✓ | Submissions | 2010-2019 | × | | | if a document is missing or in wrong format | |
| Completeness | ✓ | | | | ✓ | Submissions | 1990-2019 | × | | | yes | only in case of resubmissions of the Member State |
| Time series checks | ✓ | ✓ | | | | National Totals, Sectors | 1990-2019 | × | | | yes | only in case of resubmissions of the Member State |
| NFR template line 144 check | | | ✓ | | ✓ | National Totals | 1990-2019 | × | | | yes | only in case of resubmissions of the Member State |
| Total PAHs = Sum of PAHs | | | | ✓ | | National Totals | 1990-2019 | × | | | yes | only in case of resubmissions of the Member State |
| TSP-$PM_{10}$ ratio, $PM_{10}$-$PM_{2.5}$ ratio checks | | | | ✓ | | National Totals | 1990-2019 | × | | | yes | only in case of resubmissions of the Member State |
| TSP ≥ $PM_{10}$, $PM_{10}$ ≥ $PM_{2.5}$, $PM_{2.5}$ ≥ BC checks | | | | ✓ | | National Totals, Categories | 1990-2019 | × | | | yes | only in case of resubmissions of the Member State |
| National Total = Sum of Sectors | ✓ | | | ✓ | | National Totals, Sum of Sectors | 1990-2019 | | × | | if difference is more than 5% | only in case of resubmissions of the Member State |
| 'NE' analysis | ✓ | | | | | National Totals, Categories | 2019 | | × | × | 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 | 2019 | | × | | yes | only in case of resubmissions of the Member State |
| Recalculations | | ✓ | | | | National Totals | 1990-2018 | | | × | within the review of the draft version of the report | no |
| Effect of gap-filling | ✓ | | | | ✓ | Whole EU inventory | 1990, 2019 | | | × | within the review of the draft version of the report | no |
| Completeness of the EU inventory | ✓ | | | | ✓ | Whole EU inventory | 1990, 2019 | | | × | within the review of the draft version of the report | no |

**Table 1.6 Findings of the quality checks during preparation of the EU Air Convention inventory and report in 2021**

| Test/check | Findings | Number of EU Member States concerned |
|---|---|---|
| Completeness | 0 | 0 |
| Time series checks | 109 | 24 |
| NFR template line 144 check | 1 | 1 |
| Total PAHs = sum of PAHs | 11 | 10 |
| TSP:$PM_{10}$ ratio, $PM_{10}$:$PM_{2.5}$ ratio checks | 3 | 2 |
| TSP ≥ $PM_{10}$, $PM_{10}$ ≥ $PM_{2.5}$, $PM_{2.5}$ ≥ BC checks | 47 | 15 |
| National total = sum of sectors ([a]) | 0 | 0 |
| 'NE' analysis ([a]) | 628 | 26 |
| 'NA' and 'NO' checks ([a]) | 134 | 19 |

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

EU Member States also provide external checks through an Eionet review, before the EU submits the final version of the EU inventory to the Air Convention secretariat. In addition, an important element in improving the quality of national and EU Air Convention inventories is the annual meeting of the TFEIP. This expert meeting discusses quality issues concerning EU Member States' emission reporting. Because of the current COVID-19 situation, the meeting was held in the form of a web conference from 4 to 6 May 2021 (TFEIP, 2020).

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

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

The EMEP CEIP performs more detailed QA activities in an annual review process (EMEP CEIP, 2021b). 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, a joint EMEP/EEA review report publishes summary results of the review (stages 1 and 2) ([14]).

Stage 3 is a technical in-depth review of selected countries. It checks if submitted emission inventories are complete, consistent over time, properly documented and accurate. The annual in-depth review aims to be consistent across the Parties. The process should ensure that the Parties follow the same approach each year. The CEIP selects the countries in cooperation with the EEA and

([14]) EMEP and the EEA will jointly publish a summary of the results of the stages 1 and 2 reviews performed in 2020 (EMEP/EEA, forthcoming).

EMEP. In 2020, it reviewed the EU, Iceland, Kyrgyzstan, North Macedonia and Switzerland. The results are included in individual country-specific reports (EMEP CEIP, 2021c). In 2021, the CEIP plans to review the emission inventories of Bosnia and Herzegovina, Kazakhstan, Liechtenstein, Monaco and Montenegro.

## *1.8 General uncertainty evaluation*

To quantify uncertainty in the EU Air Convention emission inventory, EU Member States first need to provide detailed information on emission uncertainties. Only 16 EU Member States (Austria, Belgium, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Latvia, the Netherlands, Poland, Spain and Sweden) provided detailed tables quantifying uncertainty in their 2019 emission inventories. Czechia and Lithuania mentioned uncertainties for certain categories on a basic level. The pollutants that they consider and the assumptions behind the uncertainty analysis vary across EU Member States. Because so few countries provided an uncertainty estimate, the overall uncertainty of the EU Air Convention inventory cannot be estimated.

## *1.9 Completeness and underestimations*

In this context, completeness means that reports include estimates for all pollutants, all relevant source categories, all years and all territorial areas. For substances for which there are existing reporting obligations under the Convention and the protocols as further specified by Executive Body Decision 2013/4 (please see Appendix 3), all Member States provided a complete time series. For substances and data for which reporting is encouraged, Austria and Luxembourg submitted no data for additional HMs. Finland did not report national totals for the additional HM Se; however, it provided most of the sectoral data. Poland did not provide data for Se. Austria and Luxembourg did not report data for BC. All 27 EU Member States reported activity data ([15]) and all countries reported activity data for the complete time series (1990-2019). The stage 1 review provides detailed results for the completeness of Member State submissions (EMEP CEIP, 2021d).

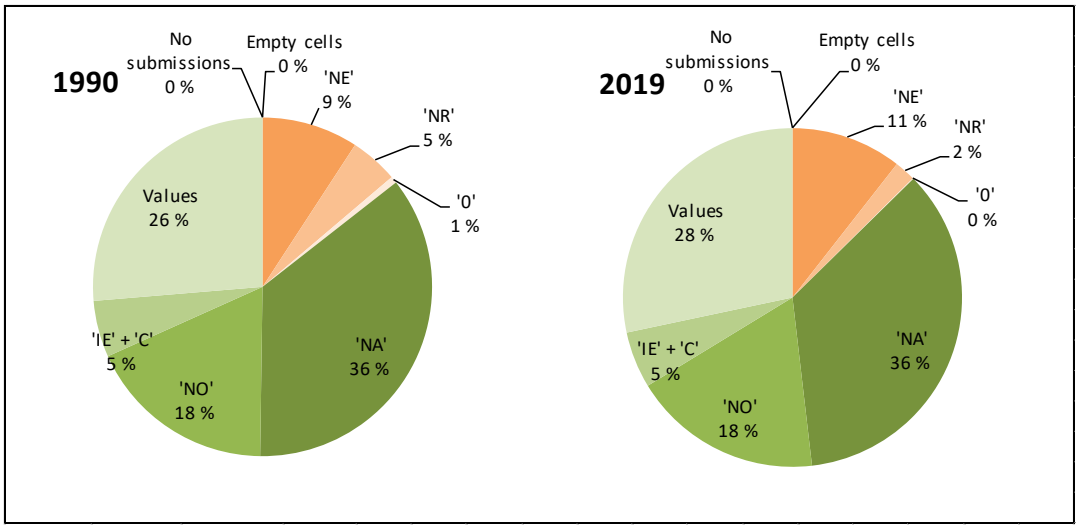
Figure 1.3 shows a simple compilation indicating the completeness of Member State reporting for the inventory years 1990 and 2019. It uses the NFR templates that were submitted originally, i.e. before gap filling. It gives the percentages of each notation key or values that the reports present for source categories. The data are for all EU Member States and all pollutants (excluding national totals). The figures show that more data are available for 2019 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' ([16]), 'No submissions' and 'Empty cells' count as incomplete reporting. EU Member States reported 13 % of the 2019 data entries incompletely, while for 1990 they reported 14 % of the data incompletely.

The EMEP emission-reporting guidelines (UNECE, 2014a) require Parties to report data at least for the base year of the relevant protocol, and from the year it entered into force, and up to the latest year (2 years before the present) (see Appendix 2, Table A2.1). So, ideally, there should be no difference between the availability of data submissions for 1990 and for 2019.

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

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

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



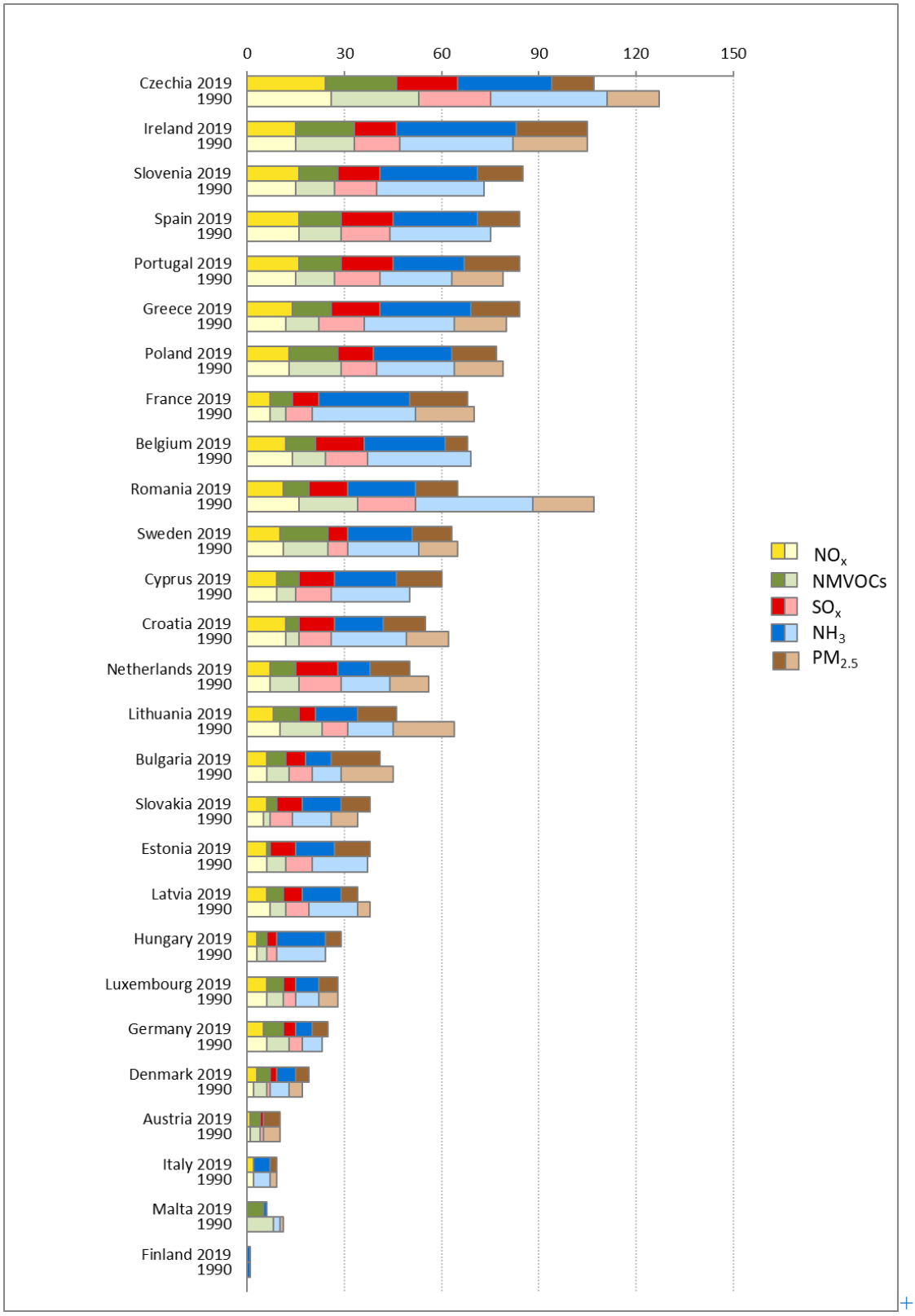

**Notes:** Appendix 1 provides further explanations on notation keys.
C, confidential; NO, not occurring.

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

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

Certain EU Member States use the notation key NE for many source categories (see Figure 1.4). For example, in 1990, Czechia and Romania reported 36 source categories of $NH_3$ as 'NE'. Overall, in most cases, the use of 'NE' in reporting in 2019 is quite similar to its use in 1990. Most uses (across all pollutants and EU Member States) are in the categories '1A3bvii — Road transport: Automobile road abrasion', '5E — Other waste', '2D3g — Chemical products', '1A3ai(i) — International aviation LTO (civil)', '1A3aii(i) — Domestic aviation LTO (civil)' and '2C2 — Ferroalloys production'. Within these categories, more than 25 % of the entries mention 'NE'.

**Figure 1.4 Number of 'NE' source categories for 2019 and 1990**



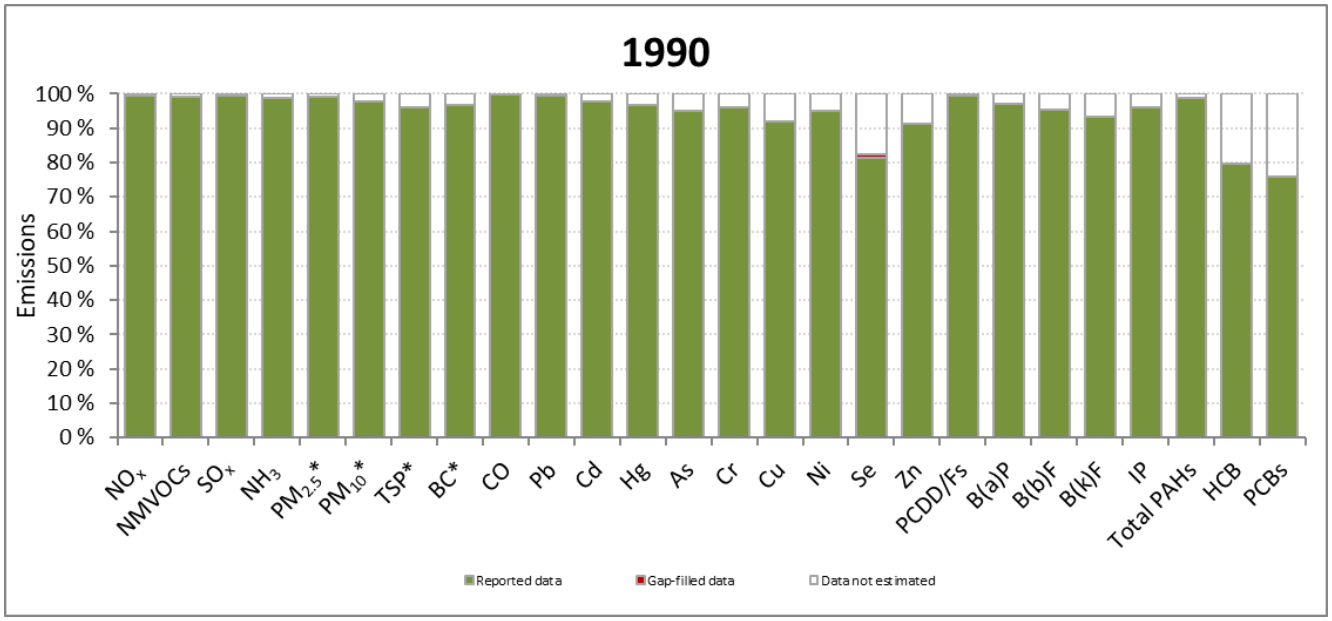

**Notes:** The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Therefore, 'NE' reporting for $PM_{2.5}$ in 1990 might be high for several countries.

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 2019. The calculated underestimation comprises missing data (e.g. if emission data of a pollutant were not estimated by a Member State and

no data were available for gap filling) and the use of the notation keys 'NE' and 'NO' and zero values. To calculate the underestimation, the specific share of total emissions for each Member State was first assessed. The share was calculated as the mean value of the respective EU Member State's share of those pollutants where a national total (gap filled or reported) from all EU Member States was available. In the gap-filled inventory, whenever the notation key 'NE' or 'NR' was used, or zero data were reported within a sector, this EU Member State's share was used to calculate the missing emissions within the respective sector. The sum of the missing emissions from all sectors and EU Member States was then calculated as the percentage value of the total emissions of a pollutant.

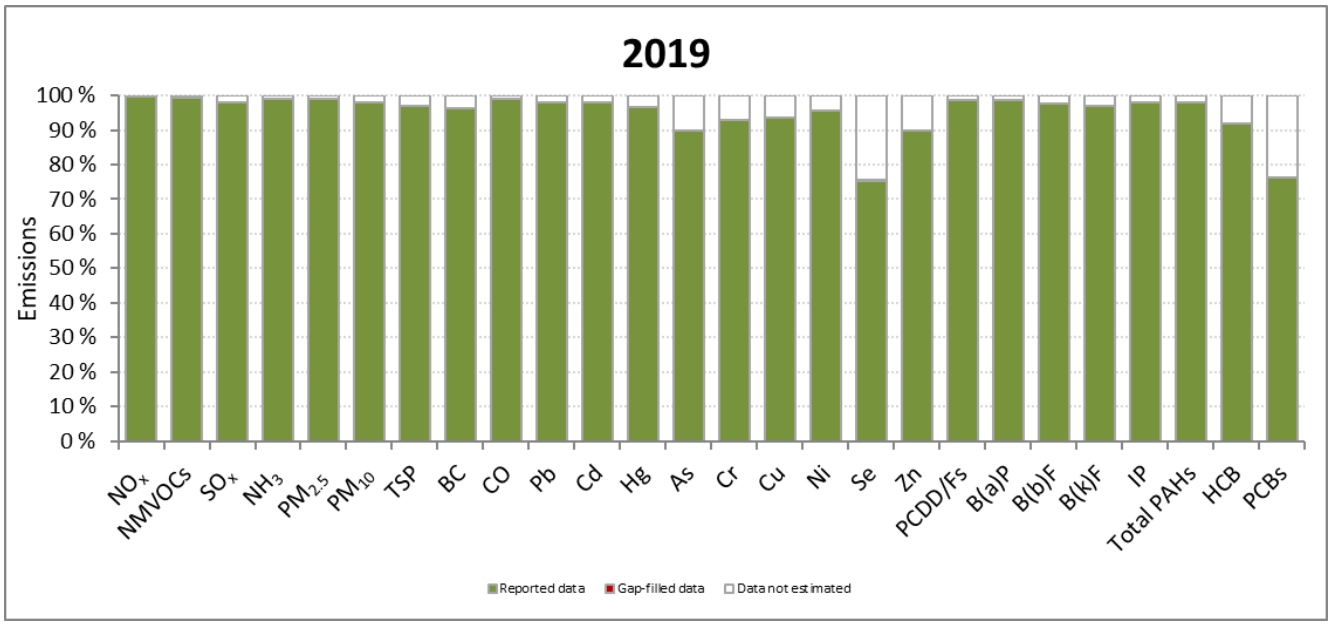
This year gap-filled data only had a minor impact on the EU totals. For Se 1%, of the EU's national total for 1990 represent gap-filled data. For all other pollutants no data were gap filled.

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




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

**Figure 1.6 Completeness and effect of gap filling on EU emissions data for 2019**



# 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 applied 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 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 2014, 2015, 2016, 2017, 2018, 2019 and 2020.

**Table 2.1 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016, 2017, 2018, 2019, 2020)**

| 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, 3l | 2010-2014 |
| **2016** | Germany | $NH_3$ | 3Da2c, 3l | 2010-2014 |
| **2016** | Luxembourg | $NO_X$ | 3B, 3De | 2010-2014 |
| **2016** | Luxembourg | NMVOCs | 3B, 3De | 2010-2014 |
| **2017** | Spain | $NO_X$ | 3B | 2010-2015 |
| **2018** | Hungary | NMVOCs | 3B, 3De | 2010-2016 |
| **2018** | United Kingdom | $NO_X$ | 1A3bi-iv | 2010 |
| **2019** | Netherlands | NMVOCs | 3B1a, 3B4h, 3B4d, 3B4e, 3B4giii, 3B4giv, 3B2, 3B4h, 3B4f, 3B1b, 3Da2a, 3Dc, 3B3, 3B4gii, 3B4gi, 3De, 3Da3 | 2010-2017 |
| **2019** | Netherlands | $NH_3$ | 3Da4, 3De, 3B3 | 2014-2017 |
| **2020** | Czechia | NMVOCs | 3B | 2010-2018 |

**Notes:** For nomenclature for reporting (NFR) codes, see the list of source sector abbreviations in Appendix 4. $NH_3$, ammonia; NMVOCs, non-methane volatile organic compounds; $NO_X$, nitrogen oxides.

If a Party is planning to adjust its inventory for the purpose of comparing total national emissions with emission reduction commitments, it indicates in its notification to the United Nations Economic Commission for Europe (UNECE) secretariat and the CEIP which categories and pollutants are affected. It uses Annex II to the reporting guidelines as a basis (UNECE, 2014a). Table 2.2 shows the EU Member State that submitted its adjustment applications, together with its Air Convention submissions, via the Central Data Repository (CDR) in 2021. In 2021, Czechia and France applied for adjustments.

**Table 2.2 Adjustment application within the Air Convention submission 2021 (Annex II to the reporting guidelines; UNECE, 2014a), as of 20 May 2021**

| Member State | Pollutant | NFR19 code | Year |
|---|---|---|---|
| **Czechia** | $NO_X$ | 3B | 2015 |
| **France** | $NO_X$ | 3B, 3D | 2010-2018 |
| **France** | NMVOCs | 3B, 3D | 2010-2014 |

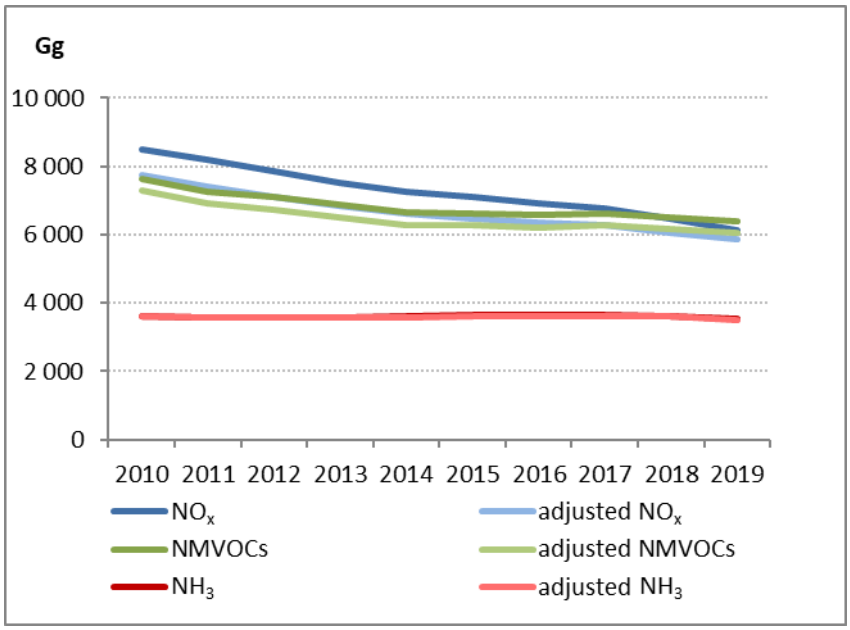
Table 2.3 gives an overview of reported adjustments within the Air Convention submission in 2021. All approved and reported adjustments also appear in the emission trend tables in Section 3.3 (nitrogen oxides, $NO_X$; Table 3.6), Section 3.4 (non-methane volatile organic compounds, NMVOCs; Table 3.7) and Section 3.6 (ammonia, $NH_3$; Table 3.9). 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, 2014a). They must also provide detailed information by pollutant and sector for each adjustment, using the template provided in Annex VII to the reporting guidelines. Reporting of information on adjusted emissions in no way suspends the mandatory requirement for Parties to report unadjusted emissions, as laid down in section V, subsections A-D, of the guidelines.

**Table 2.3 Reporting of approved adjustments within the Air Convention submission 2021 (Annex I and Annex VII to the reporting guidelines; UNECE, 2014a), as of 20 May 2021**

| Member State | Pollutant | Years | Annex I ('adjustment row') | Annex VII | Declaration on consistent reporting of approved adjustments |
|---|---|---|---|---|---|
| Belgium | $NO_X$ | 2010-2015 | Yes | Yes | Yes |
| Czechia | NMVOCs | 2010-2018 | Yes | Yes | Yes |
| Denmark | $NH_3$ | 2010-2019 | Yes | Yes | Yes, in the cover letter |
| Denmark | NMVOCs | 2010-2019 | Yes | Yes | Yes, in the cover letter |
| Finland | $NH_3$ | 2010-2019 | Yes | Yes | Yes |
| France | $NO_X$ | 2010-2018 | Yes | Yes | Yes |
| Germany | $NO_X$ | 2010-2019 | Yes | Yes | Yes |
| Germany | NMVOCs | 2010-2019 | Yes | Yes | Yes |
| Germany | $NH_3$ | 2010-2019 | Yes | Yes | Yes |
| Luxembourg | $NO_X$ | 2010-2019 | Yes | Yes | Yes |
| Luxembourg | NMVOCs | 2010-2019 | Yes | Yes | Yes |
| Netherlands | NMVOCs | 2010-2019 | Yes | Yes | Yes |
| Netherlands | $NH_3$ | 2014-2018 | Yes | Yes | Yes |
| Spain | $NO_X$ | 2010-2012 | Yes (2010-2012) | Yes | Yes |

Figure 2.1 shows the effect in the EU of the adjustments on the emissions (sum of EU Member States' adjustments). For the years 2010-2016, adjusted $NO_X$ emissions had a considerable impact on EU emissions; only slight effects can be seen for NMVOC and $NH_3$ emissions.

**Figure 2.1 Adjusted and unadjusted emissions of $NO_X$, NMVOCs and $NH_3$ for the EU, 2010-2019**



# 3 Trends and key categories of EU pollutant emissions

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

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

In the pollutant-specific sections in Chapter 3, Section 3.3 to Section 3.28, the countries in enumerations are always ranked according to certain criteria, e.g. the percentage of their share in the EU total. The criteria for the ranking are specified in brackets.

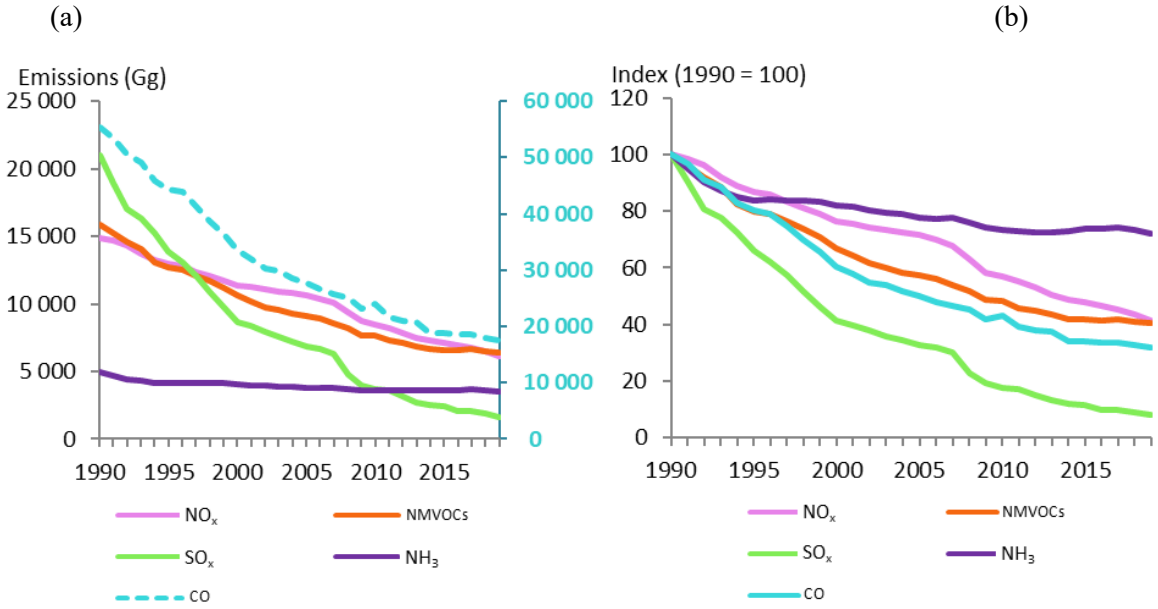
Table 3.8 to Table 3.33 include two EU totals. The first is the sum of national totals that EU Member States officially reported. The second is the sum of the sectors of all EU Member States. A difference between these two EU totals occurs when only national totals and no sectoral data are available. There is a third EU total for $NO_X$ (Table 3.6), NMVOCs (Table 3.7) and $NH_3$ (Table 3.9). This total allows for approved adjustments (see also Chapter 2).

## *3.1 Total EU emission trends, projection reporting and progress towards the Gothenburg Protocol 2010 emission ceilings*

### 3.1.1 Total trends in EU emissions

In 2019, emissions of all pollutants were lower than in 1990 (or in 2000 for PM). Among the main air pollutants, the largest reductions across the EU (in percentage terms) since 1990 were for $SO_X$ emissions (which decreased by 92 %), followed by CO (-68 %), NMVOCs (-60 %), $NO_X$ (-59 %) and $NH_3$ (-28 %) (Figure 3.1) $NH_3$ emissions decreased around 1990, but since then emissions have remained stable with minor fluctuations. The biggest contributors to the total EU emissions are France, Germany and Spain. The $NH_3$ emissions of these countries have not fluctuated much over the years either.

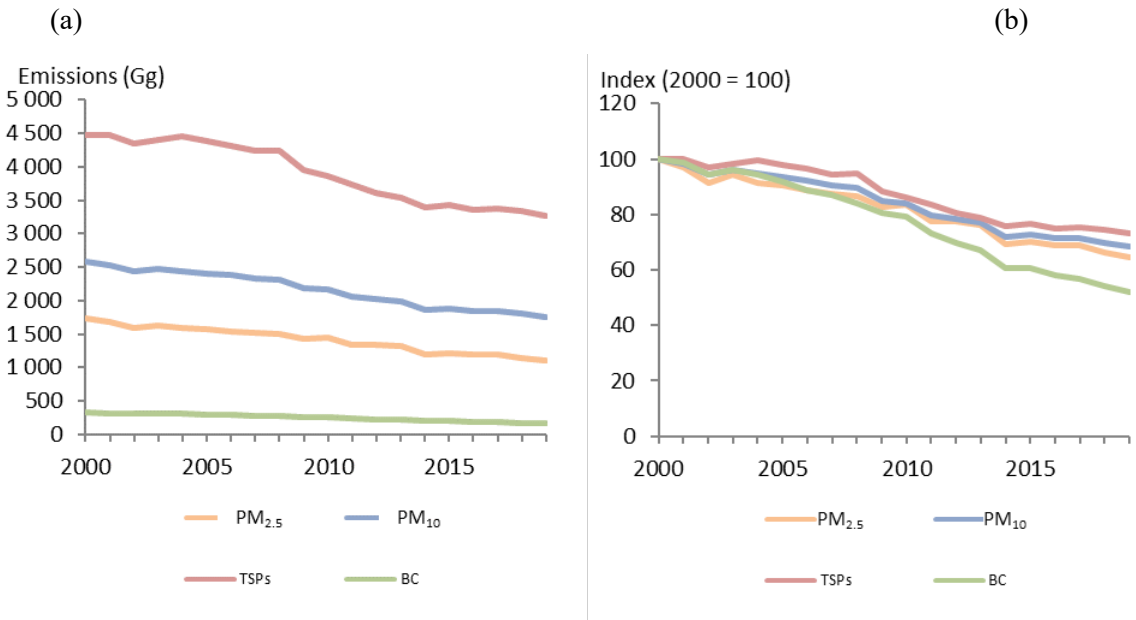
**Figure 3.1 (a) EU-28 (without the UK) emission trends and (b) indexed emissions for the main air pollutants**




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

Emissions of TSPs, PM and BC have also dropped substantially since 2000. Emission data for 2000-2019 indicate that $PM_{2.5}$ and $PM_{10}$ emissions fell by 36 % and 32 %, respectively. BC emissions also dropped by 48 % during the same period (Figure 3.2).

**Figure 3.2 (a) EU-28 (without the UK) emission trends and (b) indexed emissions for PM and BC**

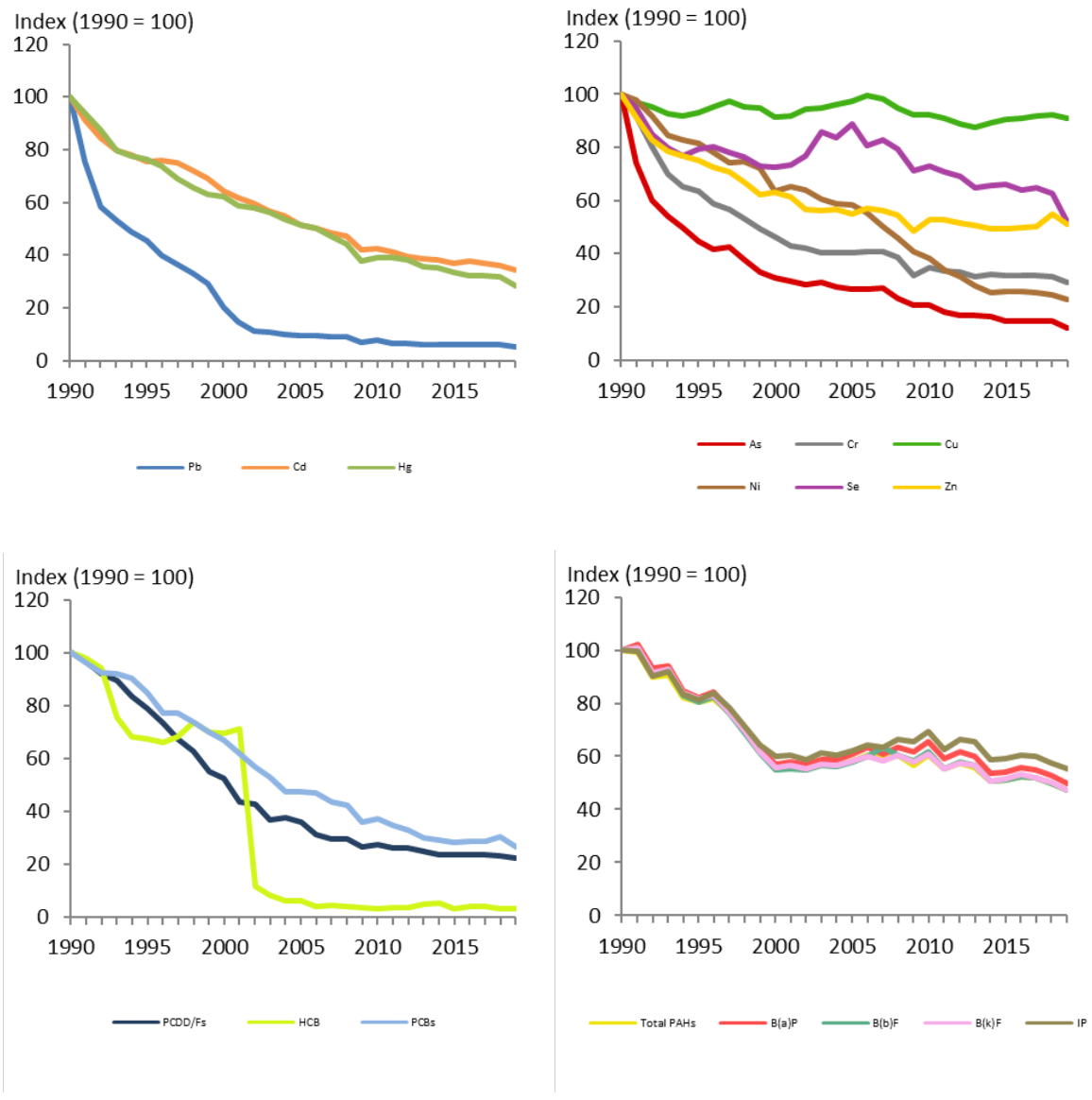



**Notes:** Not all countries reported data for BC.
The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Thus, emission trends can be shown for these years only.
The indexed emissions are based on emissions in 2000 (= 100 %).

In addition, for HMs and POPs, emissions have reduced significantly since 1990 (Figure 3.3). Reductions are especially high for Pb (-95 %) and HCB (-97 %).

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

**Figure 3.3 Indexed EU-28 (without the UK) emission trends for HMs and POPs**




**Notes:** The drop in HCB emissions between 2001 and 2002 was caused by reductions reported by Germany.

Table 3.6 to Table 3.31 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 3.3-3.28). If no information is provided on unusual trends, EU Member States are contacted by the European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI) and/or the EEA, informed about the findings and requested to send an explanation. As information on unusual trends is often not received, Sections 3.3-3.28 are very inconsistent as regards 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 | Change 1990—2019 | Change 2018—2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | Gg | 14 901 | 12 957 | 11 391 | 10 649 | 8 500 | 8 190 | 7 869 | 7 515 | 7 254 | 7 114 | 6 900 | 6 752 | 6 475 | 6 141 | -59 % | -5.2 % |
| *$NO_x$ (adjusted data*)* | *Gg* | | | | | *7 726* | *7 413* | *7 102* | *6 860* | *6 604* | *6 484* | *6 365* | *6 264* | *6 058* | *5 879* | | -3.0 % |
| NMVOCs | Gg | 15 870 | 12 703 | 10 598 | 9 081 | 7 649 | 7 262 | 7 096 | 6 874 | 6 650 | 6 616 | 6 572 | 6 635 | 6 499 | 6 409 | -60 % | -1.4 % |
| *NMVOCs (adjusted data** | *Gg* | | | | | *7 303* | *6 916* | *6 746* | *6 519* | *6 291* | *6 260* | *6 218* | *6 282* | *6 151* | *6 063* | | -1.4 % |
| $SO_x$ | Gg | 21 027 | 13 904 | 8 685 | 6 881 | 3 686 | 3 581 | 3 158 | 2 735 | 2 540 | 2 440 | 2 068 | 2 029 | 1 884 | 1 649 | -92 % | -12.5 % |
| $NH_3$ | Gg | 4 916 | 4 107 | 4 032 | 3 824 | 3 615 | 3 585 | 3 571 | 3 572 | 3 595 | 3 635 | 3 633 | 3 647 | 3 613 | 3 532 | -28 % | -2.2 % |
| *$NH_3$ (adjusted data*)* | *Gg* | | | | | *3 598* | *3 568* | *3 556* | *3 556* | *3 577* | *3 618* | *3 615* | *3 625* | *3 592* | *3 515* | | -2.1 % |
| CO | Gg | 55 425 | 44 420 | 33 512 | 27 595 | 23 902 | 21 693 | 20 965 | 20 699 | 18 765 | 18 840 | 18 698 | 18 698 | 18 033 | 17 568 | -68 % | -2.6 % |
| Pb | Mg | 19 900 | 9 080 | 4 034 | 1 865 | 1 504 | 1 288 | 1 268 | 1 238 | 1 236 | 1 184 | 1 164 | 1 191 | 1 166 | 1 046 | -95 % | -10.3 % |
| Cd | Mg | 161 | 121 | 104 | 83 | 68 | 66 | 64 | 62 | 62 | 60 | 61 | 60 | 58 | 55 | -66 % | -4.8 % |
| Hg | Mg | 147 | 112 | 91 | 76 | 57 | 57 | 56 | 52 | 52 | 49 | 47 | 47 | 46 | 42 | -72 % | -10.5 % |
| As | Mg | 578 | 257 | 177 | 154 | 119 | 103 | 97 | 98 | 95 | 86 | 84 | 84 | 83 | 70 | -88 % | -15.6 % |
| Cr | Mg | 1 010 | 640 | 468 | 407 | 352 | 339 | 334 | 315 | 324 | 323 | 320 | 321 | 316 | 296 | -71 % | -6.5 % |
| Cu | Mg | 1 969 | 1 834 | 1 800 | 1 915 | 1 813 | 1 791 | 1 753 | 1 721 | 1 759 | 1 778 | 1 790 | 1 810 | 1 816 | 1 790 | -9 % | -1.4 % |
| Ni | Mg | 1 887 | 1 540 | 1 198 | 1 104 | 718 | 639 | 592 | 527 | 475 | 484 | 483 | 477 | 460 | 429 | -77 % | -6.9 % |
| Se | Mg | 180 | 143 | 130 | 159 | 131 | 127 | 124 | 117 | 118 | 119 | 115 | 116 | 113 | 93 | -48 % | -17.4 % |
| Zn | Mg | 6 950 | 5 220 | 4 391 | 3 817 | 3 659 | 3 667 | 3 585 | 3 528 | 3 423 | 3 432 | 3 449 | 3 497 | 3 813 | 3 547 | -49 % | -7.0 % |
| PCDD/Fs | g I-Teq | 7 623 | 6 013 | 4 015 | 2 731 | 2 097 | 1 981 | 1 993 | 1 907 | 1 798 | 1 812 | 1 786 | 1 794 | 1 761 | 1 715 | -78 % | -2.6 % |
| B(a)P | Mg | 434 | 356 | 247 | 264 | 284 | 257 | 268 | 260 | 233 | 235 | 241 | 239 | 228 | 216 | -50 % | -5.4 % |
| B(b)f | Mg | 487 | 392 | 268 | 282 | 301 | 270 | 283 | 276 | 247 | 249 | 255 | 254 | 243 | 231 | -53 % | -5.0 % |
| B(k)f | Mg | 230 | 188 | 128 | 134 | 140 | 127 | 133 | 130 | 117 | 118 | 123 | 120 | 115 | 109 | -53 % | -5.8 % |
| IP | Mg | 221 | 180 | 132 | 137 | 154 | 138 | 147 | 145 | 130 | 131 | 134 | 133 | 128 | 122 | -45 % | -4.4 % |
| Total PAHs | Mg | 1 572 | 1 264 | 878 | 916 | 953 | 869 | 903 | 878 | 796 | 803 | 822 | 817 | 785 | 743 | -53 % | -5.4 % |
| HCB | kg | 5 514 | 3 710 | 3 831 | 341 | 175 | 199 | 198 | 263 | 285 | 163 | 210 | 223 | 181 | 170 | -97 % | -6.2 % |
| PCBs | kg | 4 739 | 4 019 | 3 170 | 2 246 | 1 769 | 1 638 | 1 566 | 1 424 | 1 372 | 1 349 | 1 350 | 1 364 | 1 447 | 1 264 | -73 % | -12.6 % |
| | | | | | | | | | | | | | | | | Change 2000—2019 | Change 2018—2019 |
| TSPs | Gg | 7 690 | 4 969 | 4 476 | 4 387 | 3 860 | 3 736 | 3 613 | 3 536 | 3 389 | 3 428 | 3 352 | 3 368 | 3 333 | 3 268 | -58 % | -1.9 % |
| $PM_{2.5}$ | Gg | | | 1 727 | 1 567 | 1 442 | 1 339 | 1 337 | 1 314 | 1 199 | 1 211 | 1 190 | 1 191 | 1 146 | 1 111 | -36 % | -3.0 % |
| $PM_{10}$ | Gg | | | 2 578 | 2 406 | 2 169 | 2 057 | 2 015 | 1 982 | 1 857 | 1 870 | 1 837 | 1 838 | 1 800 | 1 760 | -32 % | -2.2 % |
| BC | Gg | | | 320 | 294 | 253 | 235 | 223 | 215 | 195 | 194 | 186 | 181 | 174 | 166 | -48 % | -4.4 % |

**Notes:** Negative percentage values indicate that emissions have decreased.

Table 3.1 and subsequent tables (Table 3.6 to Table 3.31 express changes in emissions between 1990 and 2019 as 100 × ($E_{2019}$ - $E_{1990}$) / $E_{1990}$ (%), where $E_{2019}$ and $E_{1990}$ are 2019 and 1990 total emissions, respectively. They express changes in emissions from 2018 to 2019 as 100 × ($E_{2019}$ - $E_{2018}$) / $E_{2018}$ (%), where $E_{2019}$ and $E_{2018}$ are the 2019 and 2018 total emissions, respectively.

The bases for the EU inventory shown in Table 3.1 and subsequent tables (Table 3.6 to Table 3.31, inclusive, are total national data for the entire territory based on fuel sold for all EU Member States. See Section 1.4.4 for further details.

*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications ([17]) for emissions from several EU Member States. This table takes these adjustments into account, whereas emission data are based on fuel sold. See Chapter 2 for further details.

### 3.1.2 Progress towards the Gothenburg Protocol 2010 emission ceilings

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

In addition to ceilings for individual countries, the protocol also specifies ceilings for the EU as a whole, which is also a Party to the Air Convention and has ratified the protocol Table 3.2 sets out the emissions reported for 2019 by the EU-15 EU Member States, compared with the respective emission ceilings specified for the EU (see Table A2.2 in Appendix 2 for an explanation of the country groupings). In this report, the comparison with the EU-15 ceilings in the Gothenburg Protocol is based on fuel sold. For all pollutants, emissions in 2019 were below the ceilings.

([17]) 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 applied in some circumstances (UNECE, 2012a).

**Table 3.2 Emissions reported for 2019 by EU-15 Member States (without the UK) compared with the Gothenburg Protocol EU emission ceilings for 2010 and the years thereafter**

| Pollutant | EU-15 emissions, 2019 (Gg) | EU-15 Gothenburg Protocol, 2010 ceilings (Gg) | Difference (%) | Sum of individual EU-15 ceilings (Gg) ([a]) |
|---|---|---|---|---|
| $NO_x$ | 4 589 | 6 671 | -31 | 6 519 |
| NMVOCs | 4 790 | 6 600 | -27 | 6 510 |
| $SO_x$ | 873 | 4 059 | -78 | 3 850 |
| $NH_3$ | 2 673 | 3 129 | -15 | 3 110 |

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

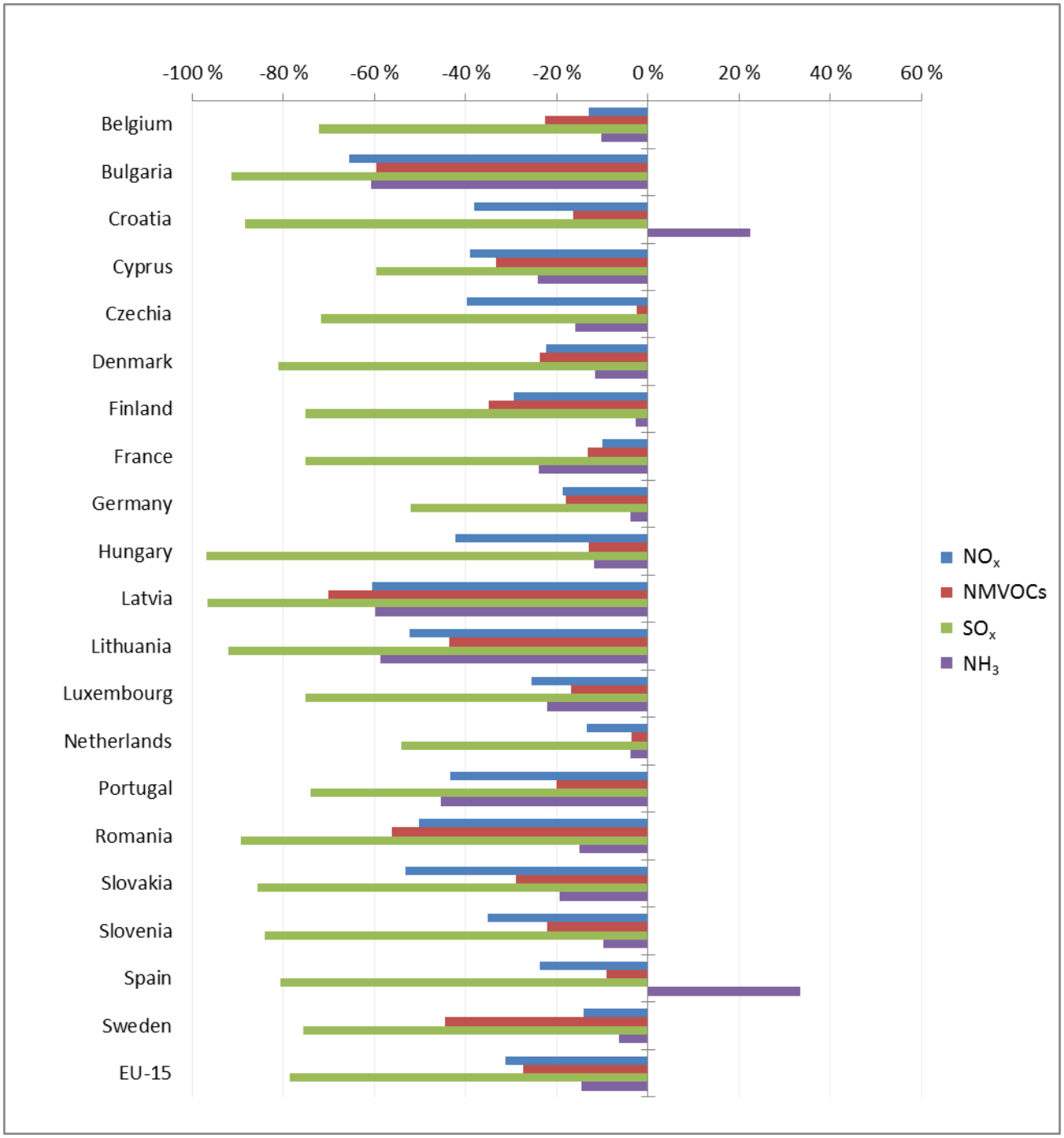
For Portugal's 2010 emission ceilings, emissions from the Azores and Madeira are excluded.

Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands, Spain and the United Kingdom in 2014, 2015, 2016, 2017, 2018, 2019 and 2020. However, as the EU-15 as a whole has not applied for adjustments, this table does not take these adjusted data into account.

([a]) Emission ceilings are also specified for individual EU-15 EU Member States. The sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

Figure 3.4 shows whether EU Member States met the Gothenburg ceilings in 2019. Estonia and Malta do not have Gothenburg ceilings and Austria, Greece, Ireland, Italy and Poland have not yet ratified the Gothenburg Protocol and are therefore excluded from Figure 3.4. Two countries exceeded their $NH_3$ ceilings (Croatia and Spain). All EU Member States complied with their $NO_X$, NMVOC and $SO_X$ ceilings.

**Figure 3.4 Distance to Gothenburg ceilings for EU Member States in 2019**




**Notes:** Estonia and Malta do not have Gothenburg ceilings. Austria, Greece, Ireland, Italy and Poland have ceilings but have not yet ratified the protocol. For Spain, data for emission comparisons exclude emissions from the Canary Islands.

The comparison with emission ceilings is based on data reported on fuel sold, except for Belgium, Luxembourg and the Netherlands. These countries chose instead to calculate their emissions based on fuel used in their territories (UNECE, 2014a). For the EU-15, the comparison is based on fuel sold. Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Luxembourg, the Netherlands and Spain in 2014, 2015, 2016, 2017, 2018, 2019 and 2020. This figure takes these adjusted data into account. The EU-15 did not apply for adjustments and thus data for the EU-15 are unadjusted.

The EEA plans to publish its annual National Emission reduction Commitments (NEC) Directive reporting in June 2021. The reporting analyses the emission data reported under the EU NEC Directive for EU Member States (EEA, forthcoming). For EU Member States, the new NEC Directive (EU,

2016b) contains national emission reduction commitments for $NO_X$, NMVOCs, $SO_2$, $NH_3$ and particulate matter with a diameter of 2.5 µm or less ($PM_{2.5}$) for the period 2020-2029 and for any year from 2030.

## *3.2 Progress of non-EU countries in meeting 2010 emission ceilings under the Gothenburg Protocol to the UNECE Air Convention*

### 3.2.1 Emissions of the non-EU EEA member countries Iceland, Liechtenstein, Norway, Switzerland and Turkey

In 2021, all EEA-5 member countries (non-EU EEA member countries, i.e. Iceland, Liechtenstein, Norway, Switzerland and Turkey) submitted their emission data (see Table 3.3).

**Table 3.3 Emissions reported by the EEA-5 member countries from 2010 to 2019**

| EEA Member Country | Emission data (Gg) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $NO_x$ | | | | | | | | | | NMVOCs | | | | | | | | | |
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Iceland | 26 | 24 | 24 | 23 | 23 | 23 | 21 | 22 | 22 | 21 | 5.7 | 5.6 | 5.4 | 5.3 | 5.4 | 5.5 | 5.7 | 5.5 | 5.5 | 5.2 |
| Liechtenstein | 0.40 | 0.39 | 0.38 | 0.38 | 0.35 | 0.34 | 0.31 | 0.29 | 0.27 | 0.26 | 0.34 | 0.34 | 0.33 | 0.32 | 0.31 | 0.30 | 0.30 | 0.29 | 0.29 | 0.29 |
| Norway | 209 | 210 | 206 | 199 | 191 | 180 | 170 | 162 | 160 | 151 | 169 | 160 | 161 | 160 | 169 | 165 | 163 | 160 | 157 | 153 |
| Switzerland [a] | 83 | 80 | 80 | 80 | 76 | 74 | 73 | 70 | 65 | 62 | 99 | 96 | 94 | 92 | 88 | 85 | 83 | 82 | 82 | 81 |
| Turkey | 959 | 959 | 837 | 816 | 804 | 788 | 796 | 770 | 785 | 779 | 1 103 | 1 077 | 1 130 | 1 072 | 1 065 | 1 108 | 1 085 | 1 110 | 1 089 | 1 121 |
| | $SO_x$ | | | | | | | | | | $NH_3$ | | | | | | | | | |
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Iceland | 76 | 84 | 87 | 72 | 65 | 61 | 52 | 50 | 55 | 58 | 4.6 | 4.7 | 4.5 | 4.4 | 4.7 | 4.8 | 4.8 | 4.8 | 4.6 | 4.5 |
| Liechtenstein | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.21 | 0.21 | 0.21 | 0.21 | 0.22 |
| Norway | 19 | 19 | 17 | 17 | 17 | 17 | 16 | 15 | 16 | 16 | 31 | 30 | 30 | 31 | 30 | 30 | 30 | 30 | 31 | 29 |
| Switzerland [a] | 10 | 8.4 | 8.7 | 8.0 | 7.2 | 5.6 | 5.2 | 5.0 | 4.8 | 4.4 | 59 | 58 | 57 | 56 | 56 | 56 | 55 | 55 | 55 | 54 |
| Turkey | 2 557 | 2 562 | 2 668 | 1 939 | 2 149 | 1 942 | 2 247 | 2 354 | 2 519 | 2 455 | 589 | 616 | 679 | 719 | 717 | 697 | 760 | 796 | 728 | 765 |

**Note:** [a] Data are based on fuel used for road transport.

### 3.2.2 Progress in meeting the ceilings

The Gothenburg Protocol of the Air Convention specifies emission ceilings for 2010 and onwards for three EEA-5 member countries (Liechtenstein, Norway and Switzerland) (UNECE, 1979, 1999); see Table 3.4. Liechtenstein has signed but not yet ratified the protocol. EEA members Iceland and Turkey have not yet signed the Gothenburg Protocol. Emission data for Norway and Switzerland are compared with the countries' emission ceilings under the Gothenburg Protocol.

**Table 3.4 Gothenburg Protocol UNECE Air Convention ceilings**

| Gothenburg Protocol Ceilings | | | | |
|---|---|---|---|---|
| | $NO_x$ | NMVOCs | $SO_x$ | $NH_3$ |
| Liechtenstein | 0.37 | 0.86 | 0.11 | 0.15 |
| Norway | 156 | 195 | 22 | 23 |
| Switzerland | 79 | 144 | 26 | 63 |

Data from the abovementioned countries show that Norway exceeded its $NO_X$ ceiling from 2010 to 2018 and its $NH_3$ ceiling from 2010 to 2019. Switzerland is reporting values above the ceiling for $NO_X$ for the years 2010-2013 (see Table 3.5).

**Table 3.5 Progress in meeting Gothenburg Protocol UNECE Air Convention emission ceilings**

| Member State | $NO_x$ | | | | | | | | | | NMVOCs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Norway | × | × | × | × | × | × | × | × | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Switzerland | × | × | × | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | $SO_2$ | | | | | | | | | | $NH_3$ | | | | | | | | | |
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Norway | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | × | × | × | × | × | × | × | × | × |
| Switzerland | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Note:** Switzerland's assessment is based on data for fuel used.

## *3.3 Nitrogen oxide emission trends and key categories*

Between 1990 and 2019, $NO_X$ emissions dropped by 58.8 % in the EU. Between 2018 and 2019, the decrease was 5.2 %, mainly because Germany, Spain, Poland, France and Italy (countries ranked according to the size of their contributions to the absolute change) reported reductions (Table 3.6). The EU Member States that contributed most (i.e. more than 10 %) to $NO_X$ emissions in 2019 were Germany, France, Poland and Spain (countries ranked according to their shares of the EU total).

Spain stated that the drop in $NO_X$ emissions between 2005 and 2010 (the value for the national total in 2008 was 15.4 % lower than in the previous year) was due to the closure of the main brown coal mine in Spain in 2007. In addition, the necessary retrofitting in 2008 of the adjacent thermal power plant and the introduction of abatement techniques reduced $NO_X$ emissions during this period (see Spain's informative inventory report (IIR), listed in Appendix 5).

Luxembourg explained that an upwards trend in air pollutant emissions recorded from 1999 to 2004 was due to increasing energy consumption and fuel sales in the transport sector. The stabilisation noted in inventory years 2004-2006 was largely the result of relatively steady sales of road fuels that peaked in 2005 (see Luxembourg's IIR, listed in Appendix 5).

## Table 3.6 Member State contributions to EU emissions of $NO_X$

| Member State | $NO_x$ (Gg) | | | | | | | | | | | | | | Change | | Share in EU-28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 217 | 198 | 212 | 247 | 204 | 196 | 191 | 190 | 182 | 179 | 172 | 163 | 151 | 144 | -34 % | -4.8 % | 1.5 % | 2.3 % |
| Belgium | 429 | 416 | 360 | 327 | 245 | 227 | 216 | 207 | 197 | 198 | 187 | 176 | 169 | 160 | -63 % | -5.4 % | 2.9 % | 2.6 % |
| *Adjusted data** | | | | | *181* | *165* | *152* | *144* | *135* | *138* | | | | | | | | |
| Bulgaria | 273 | 182 | 144 | 174 | 125 | 133 | 129 | 112 | 118 | 116 | 110 | 100 | 96 | 91 | -67 % | -5.1 % | 1.8 % | 1.5 % |
| Croatia | 111 | 83 | 91 | 89 | 72 | 69 | 63 | 61 | 58 | 58 | 58 | 58 | 54 | 54 | -52 % | 0.0 % | 0.7 % | 0.9 % |
| Cyprus | 18 | 20 | 22 | 22 | 19 | 22 | 21 | 15 | 16 | 14 | 14 | 13 | 13 | 14 | -21 % | 4.5 % | 0.1 % | 0.2 % |
| Czechia | 749 | 385 | 298 | 290 | 248 | 237 | 224 | 212 | 209 | 204 | 193 | 192 | 184 | 172 | -77 % | -6.3 % | 5.0 % | 2.8 % |
| Denmark | 302 | 290 | 226 | 205 | 150 | 140 | 129 | 125 | 115 | 114 | 114 | 111 | 106 | 99 | -67 % | -6.5 % | 2.0 % | 1.6 % |
| Estonia | 80 | 49 | 46 | 42 | 42 | 41 | 37 | 36 | 35 | 31 | 31 | 31 | 30 | 25 | -69 % | -15.6 % | 0.5 % | 0.4 % |
| Finland | 306 | 273 | 241 | 208 | 187 | 171 | 162 | 158 | 151 | 139 | 135 | 130 | 127 | 120 | -61 % | -5.4 % | 2.1 % | 2.0 % |
| France | 2 042 | 1 869 | 1 709 | 1 497 | 1 144 | 1 086 | 1 060 | 1 040 | 969 | 949 | 902 | 872 | 812 | 774 | -62 % | -4.7 % | 13.7 % | 12.6 % |
| *Adjusted data** | | | | | *998* | *935* | *910* | *882* | *809* | *788* | *751* | *732* | *695* | | | | | |
| Germany | 2 850 | 2 196 | 1 905 | 1 642 | 1 471 | 1 445 | 1 436 | 1 436 | 1 392 | 1 364 | 1 341 | 1 292 | 1 210 | 1 137 | -60 % | -6.1 % | 19.1 % | 18.5 % |
| *Adjusted data** | | | | | *1 059* | *1 025* | *1 014* | *1 009* | *971* | *962* | *964* | *950* | *915* | *880* | | -3.9 % | | 14.3 % |
| Greece | 409 | 402 | 430 | 483 | 364 | 326 | 285 | 274 | 269 | 263 | 262 | 268 | 259 | 250 | -39 % | -3.5 % | 2.7 % | 4.1 % |
| Hungary | 248 | 192 | 189 | 179 | 148 | 138 | 131 | 127 | 126 | 128 | 120 | 121 | 120 | 114 | -54 % | -4.6 % | 1.7 % | 1.9 % |
| Ireland | 171 | 171 | 182 | 177 | 122 | 109 | 111 | 113 | 112 | 115 | 115 | 111 | 110 | 101 | -41 % | -8.3 % | 1.1 % | 1.6 % |
| Italy | 2 125 | 1 989 | 1 504 | 1 289 | 934 | 896 | 848 | 779 | 756 | 719 | 699 | 646 | 639 | 627 | -71 % | -1.9 % | 14.3 % | 10.2 % |
| Latvia | 97 | 51 | 42 | 44 | 40 | 37 | 37 | 36 | 36 | 35 | 34 | 34 | 35 | 33 | -66 % | -4.5 % | 0.7 % | 0.5 % |
| Lithuania | 153 | 74 | 61 | 63 | 56 | 55 | 55 | 52 | 52 | 54 | 54 | 52 | 53 | 52 | -66 % | -1.0 % | 1.0 % | 0.9 % |
| Luxembourg | 41 | 35 | 41 | 57 | 39 | 40 | 37 | 34 | 32 | 28 | 26 | 23 | 21 | 19 | -52 % | -6.6 % | 0.3 % | 0.3 % |
| *Adjusted data** | | | | | *33* | *34* | *31* | *27* | *25* | *22* | *20* | *17* | *16* | *15* | | | | |
| Malta | 6.9 | 9.7 | 9.7 | 9.8 | 10.4 | 8.7 | 9.5 | 7.9 | 7.9 | 6.8 | 6.2 | 5.8 | 5.4 | 5.4 | -21 % | 0.2 % | 0.0 % | 0.1 % |
| Netherlands | 662 | 563 | 472 | 416 | 350 | 333 | 314 | 301 | 281 | 282 | 270 | 259 | 253 | 238 | -64 % | -5.7 % | 4.4 % | 3.9 % |
| Poland | 1 117 | 1 078 | 885 | 886 | 877 | 859 | 820 | 776 | 724 | 706 | 716 | 749 | 725 | 682 | -39 % | -6.0 % | 7.5 % | 11.1 % |
| Portugal | 253 | 290 | 292 | 277 | 198 | 181 | 167 | 163 | 160 | 164 | 157 | 160 | 154 | 148 | -42 % | -4.2 % | 1.7 % | 2.4 % |
| Romania | 429 | 354 | 294 | 331 | 242 | 251 | 246 | 227 | 222 | 220 | 211 | 220 | 222 | 217 | -49 % | -2.1 % | 2.9 % | 3.5 % |
| Slovakia | 128 | 109 | 108 | 104 | 86 | 79 | 76 | 74 | 75 | 73 | 69 | 68 | 67 | 61 | -52 % | -9.6 % | 0.9 % | 1.0 % |
| Slovenia | 73 | 74 | 59 | 54 | 48 | 47 | 46 | 43 | 39 | 35 | 34 | 34 | 32 | 29 | -60 % | -9.2 % | 0.5 % | 0.5 % |
| Spain | 1 334 | 1 355 | 1 351 | 1 346 | 911 | 903 | 861 | 762 | 768 | 772 | 728 | 724 | 690 | 646 | -52 % | -6.4 % | 9.0 % | 10.5 % |
| *Adjusted data** | | | | | *763* | *766* | *737* | | | | | | | | | | | |
| Sweden | 279 | 250 | 215 | 189 | 169 | 162 | 156 | 153 | 151 | 147 | 145 | 140 | 137 | 127 | -54 % | -7.0 % | 1.9 % | 2.1 % |
| **EU28 (a)** | **14 901** | **12 957** | **11 391** | **10 649** | **8 500** | **8 190** | **7 869** | **7 515** | **7 254** | **7 114** | **6 900** | **6 752** | **6475** | **6141** | **-58.8 %** | **-5.2 %** | **100 %** | **100 %** |
| EU28 (b) | 14 901 | 12 957 | 11 391 | 10 649 | 8 500 | 8 190 | 7 869 | 7 515 | 7 254 | 7 114 | 6 900 | 6 752 | 6 475 | 6 475 | | | | |
| EU28 (c) | 14 901 | 12 957 | 11 391 | 10 649 | 7 726 | 7 413 | 7 102 | 6 860 | 6 604 | 6 484 | 6 365 | 6 264 | 6 058 | 5 879 | | | | |

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

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

([c]) Sum of national totals, as reported by EU Member States, allowing for approved adjustments.

*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, France, Germany, Luxembourg and Spain

The adjusted data for Belgium are based on fuel sold emissions and are thus different from national total for compliance, which is based on fuels used.

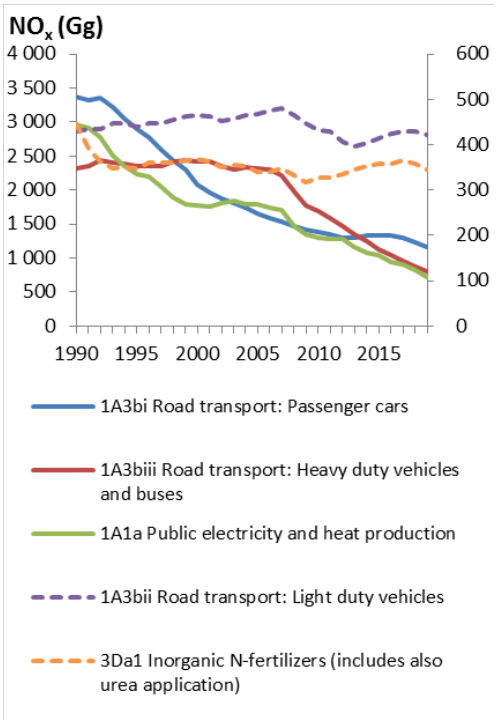
EU-28 does not include data from the United Kingdom (see Box ES.2).

The main key categories for $NO_X$ emissions were '1A3bi— Road transport: Passenger cars', '1A3biii — Road transport: Heavy duty vehicles and buses' and '1A1a — Public electricity and heat production'. Together, they made up 44 % of total emissions (see Figure 3.5). Of the top five key categories, the highest relative reduction in emissions between 1990 and 2019 occurred in the second most important, '1A1a — Public electricity and heat production' (-72 %) (see Figure 3.5(a)). There were also significant reductions in the most important key category, '1A3bi — Road transport: Passenger cars' (-63.6 %), and in the third most important, '1A3biii — Road transport: Heavy duty vehicles and buses' (-61.9 %).

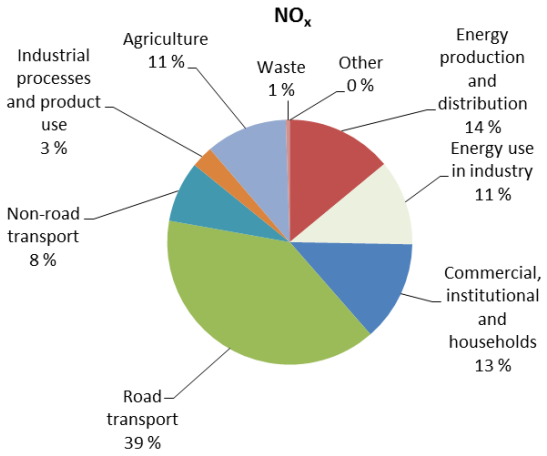
Figure 3.5(b) shows the contribution made by each aggregated sector group to total EU emissions. For $NO_X$, common key emission sources are the energy and transport sectors. Emission reductions from the road transport sector are primarily a result of fitting catalytic converters to vehicles (EEA, 2020c). The legislative standards, known as 'Euro' standards, have driven this move. Nevertheless, the road transport sector represents the largest source of $NO_X$ emissions, accounting for 39 % of total EU emissions in 2019. The electricity/energy production sectors have also reduced their emissions, thanks to measures such as introducing combustion modification technologies (e.g. low-$NO_X$ burners), implementing flue gas abatement techniques (e.g. $NO_X$ scrubbers and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques) and switching from coal to gas (EEA, 2020c).

**Figure 3.5 $NO_X$ emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

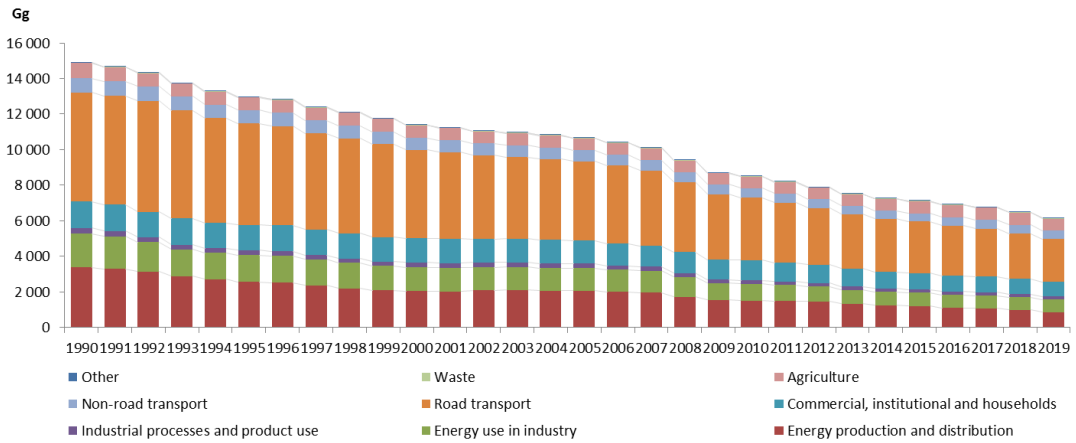
**(a)**




**(b)**




**(c)**




**Note:** In Figure 3.5(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 Non-methane volatile organic compound emission trends and key categories*

Between 1990 and 2019, NMVOC emissions dropped by 59.6 % in the EU. Between 2018 and 2019, EU Member States reported a decrease of 1.4 % (Table 3.7) due to lower emissions in Poland and France (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to NMVOC emissions were Germany, France, Italy and Poland (countries ranked according to their shares of the EU total).

The strong decline in emissions reported by Bulgaria between 1990 and 1995 was due to a drop between 1993 and 1994 (not shown in Table 3.7). This was mainly caused by drastically declining emissions from the industrial processes and product use sector, namely '2D3d — Coating applications' and '2D3e — Degreasing' (see Bulgaria's IIR, listed in Appendix 5).

Emissions in Germany decreased by 40 % between 1990 and 1995 (-1 551 t NMVOC). A decline in emissions in subcategory '1A3bi — Road Transport — passenger cars' was responsible for these reductions because of increasingly stricter regulations, especially incentives for car users to retrofit/buy cars with catalytic converters, and the implementation of the Technical Instruction on Air Quality Control (TA-Luft 2002). Furthermore, decreases in subcategory '1B2av — Emissions from petrol storage and from fuelling of motor vehicles' can be explained by the implementation of the 20th and 21st Ordinances on the Execution of the Federal Immission Control Act (BImSchV). A decline in petrol consumption has played a major role with regard to the reduction in NMVOC emissions (see Germany's IIR, listed in Appendix 5).

### Table 3.7 Member State contributions to EU emissions of NMVOCs

| | NMVOCs (Gg) | | | | | | | | | | | | | | Change | | Share in EU-28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 336 | 248 | 181 | 158 | 138 | 133 | 131 | 125 | 118 | 113 | 112 | 112 | 109 | 109 | -68 % | -0.4 % | 2.1 % | 1.7 % |
| Belgium | 348 | 307 | 232 | 182 | 144 | 132 | 129 | 125 | 118 | 118 | 117 | 115 | 114 | 113 | -68 % | -1.0 % | 2.2 % | 1.8 % |
| Bulgaria | 441 | 140 | 108 | 95 | 85 | 88 | 86 | 83 | 78 | 81 | 78 | 77 | 73 | 75 | -83 % | 3.0 % | 2.8 % | 1.2 % |
| Croatia | 170 | 120 | 103 | 114 | 92 | 87 | 81 | 77 | 70 | 71 | 73 | 70 | 71 | 75 | -56 % | 5.8 % | 1.1 % | 1.2 % |
| Cyprus | 13 | 13 | 13 | 16 | 13 | 11.0 | 10.5 | 8.9 | 8.4 | 8.8 | 8.9 | 11.0 | 9.6 | 9.3 | -28 % | -3.1 % | 0.1 % | 0.1 % |
| Czechia | 566 | 391 | 314 | 270 | 255 | 243 | 237 | 235 | 231 | 230 | 224 | 224 | 223 | 215 | -62 % | -3.5 % | 3.6 % | 3.4 % |
| *Adjusted data** | | | | | *255* | *213* | *207* | *204* | *200* | *198* | *194* | *194* | *192* | *215* | | | | |
| Denmark | 215 | 213 | 185 | 153 | 131 | 125 | 120 | 121 | 112 | 115 | 111 | 109 | 108 | 103 | -52 % | -4.6 % | 1.4 % | 1.6 % |
| *Adjusted data** | | | | | *94* | *88* | *83* | *83* | *75* | *78* | *73* | *70* | *69* | *65* | | | | |
| Estonia | 67 | 41 | 37 | 32 | 23 | 23 | 23 | 23 | 22 | 22 | 22 | 23 | 22 | 23 | -66 % | 3.2 % | 0.4 % | 0.4 % |
| Finland | 233 | 203 | 178 | 146 | 113 | 104 | 102 | 96 | 94 | 89 | 90 | 87 | 85 | 85 | -64 % | -1.1 % | 1.5 % | 1.3 % |
| France | 2 885 | 2 478 | 2 044 | 1 581 | 1 206 | 1 129 | 1 076 | 1 067 | 1 050 | 1 023 | 1 001 | 1 003 | *979* | *956* | -67 % | -2.4 % | 18.2 % | 14.9 % |
| Germany | 3 891 | 2 340 | 1 804 | 1 486 | 1 361 | 1 273 | 1 257 | 1 212 | 1 174 | 1 147 | 1 142 | 1 147 | 1 125 | 1 121 | -71 % | -0.3 % | 24.5 % | 17.5 % |
| *Adjusted data** | | | | | *1055* | *966* | *948* | *898* | *856* | *832* | *829* | *837* | *819* | *817* | | | | |
| Greece | 317 | 303 | 308 | 334 | 215 | 200 | 193 | 176 | 172 | 165 | 157 | 153 | 146 | 144 | -54 % | -1.3 % | 2.0 % | 2.2 % |
| Hungary | 307 | 210 | 190 | 174 | 132 | 135 | 136 | 133 | 124 | 128 | 129 | 126 | 120 | 119 | -61 % | -0.7 % | 1.9 % | 1.9 % |
| Ireland | 144 | 136 | 123 | 121 | 111 | 108 | 109 | 111 | 108 | 109 | 110 | 115 | 115 | 114 | -21 % | -1.1 % | 0.9 % | 1.8 % |
| Italy | 1 994 | 2 059 | 1 630 | 1 340 | 1 117 | 1 026 | 1 030 | 999 | 928 | 901 | 884 | 925 | 897 | 894 | -55 % | -0.3 % | 12.6 % | 14.0 % |
| Latvia | 89 | 64 | 54 | 54 | 45 | 45 | 45 | 44 | 44 | 42 | 40 | 40 | 45 | 41 | -54 % | -9.1 % | 0.6 % | 0.6 % |
| Lithuania | 131 | 83 | 61 | 63 | 58 | 57 | 56 | 55 | 54 | 52 | 52 | 51 | 52 | 52 | -60 % | -0.1 % | 0.8 % | 0.8 % |
| Luxembourg | 28 | 21 | 16 | 15 | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | *11* | *11* | -59 % | 7.2 % | 0.2 % | 0.2 % |
| *Adjusted data** | | | | | *8.5* | *8.5* | *8.9* | *8.4* | *7.6* | *7.3* | *7.3* | *7.2* | *7.1* | *7.9* | | | | |
| Malta | 4.4 | 3.6 | 3.8 | 2.8 | 3.7 | 3.3 | 3.2 | 3.6 | 3.0 | 3.0 | 2.9 | 3.0 | 2.7 | 2.7 | -40 % | -1.8 % | 0.0 % | 0.0 % |
| Netherlands | 606 | 434 | 335 | 267 | 268 | 264 | 258 | 256 | 243 | 251 | 247 | 248 | 240 | 237 | -61 % | -1.5 % | 3.8 % | 3.7 % |
| *Adjusted data** | | | | | *187* | *185* | *179* | *183* | *178* | *174* | *178* | *180* | *176* | *183* | | | | |
| Poland | 792 | 910 | 784 | 766 | 738 | 728 | 704 | 652 | 648 | 668 | 696 | 711 | 680 | 647 | -18 % | -4.8 % | 5.0 % | 10.1 % |
| Portugal | 247 | 239 | 238 | 198 | 162 | 152 | 148 | 146 | 151 | 153 | 150 | 152 | 154 | 161 | -35 % | 4.6 % | 1.6 % | 2.5 % |
| Romania | 326 | 268 | 290 | 325 | 268 | 259 | 259 | 251 | 245 | 239 | 237 | 240 | 236 | 230 | -30 % | -2.7 % | 2.1 % | 3.6 % |
| Slovakia | 263 | 180 | 153 | 150 | 125 | 122 | 118 | 116 | 98 | 112 | 113 | 111 | 103 | 100 | -62 % | -2.9 % | 1.7 % | 1.6 % |
| Slovenia | 65 | 62 | 55 | 48 | 40 | 37 | 36 | 35 | 32 | 33 | 33 | 33 | 32 | 31 | -52 % | -3.5 % | 0.4 % | 0.5 % |
| Spain | 1 026 | 958 | 934 | 787 | 617 | 593 | 568 | 556 | 557 | 577 | 586 | 598 | *610* | *608* | -41 % | -0.3 % | 6.5 % | 9.5 % |
| Sweden | 367 | 279 | 223 | 204 | 177 | 174 | 166 | 158 | 154 | 155 | 148 | 140 | *136* | *134* | -63 % | -1.8 % | 2.3 % | 2.1 % |
| **EU28 (a)** | **15 870** | **12 703** | **10 598** | **9 081** | **7 649** | **7 262** | **7 096** | **6 874** | **6 650** | **6 616** | **6 572** | **6 635** | **6499** | **6409** | **-59.6 %** | **-1.4 %** | **100 %** | **100 %** |
| EU28 (b) | 15 870 | 12 703 | 10 598 | 9 081 | 7 649 | 7 262 | 7 096 | 6 874 | 6 650 | 6 616 | 6 572 | 6 635 | 6 499 | 6 409 | | | | |
| EU28 (c) | 15 870 | 12 703 | 10 598 | 9 081 | 7 303 | 6 916 | 6 746 | 6 519 | 6 291 | 6 260 | 6 218 | 6 282 | 6 151 | 6 063 | | | | |

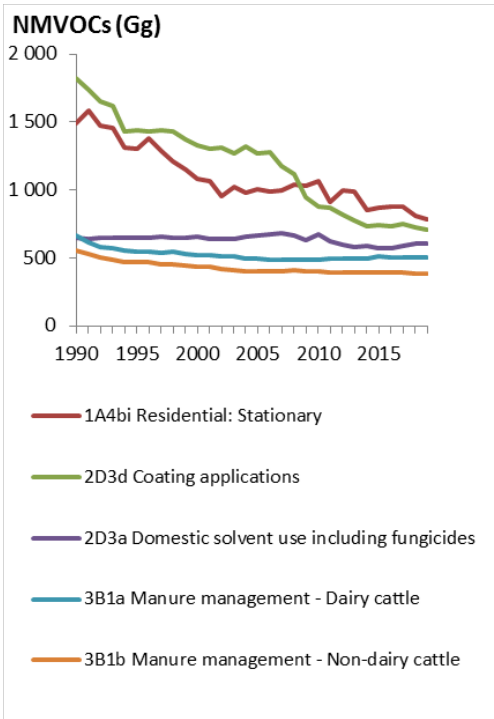
**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.
([c]) Sum of national totals, as reported by EU Member States, allowing for approved adjustments.
*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Czechia, Denmark, Germany, Hungary, Luxembourg and the Netherlands.
EU-28 does not include data from the United Kingdom (see Box ES.2).

The most important key categories for NMVOC emissions were '1A4bi — Residential: Stationary', '2D3d — Coating applications' and '2D3a — Domestic solvent use including fungicides'. Together, they made up 33 % of total emissions (Figure 3.6 (a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2019 was in the second most important, '2D3d — Coating applications' (-61.4 %).

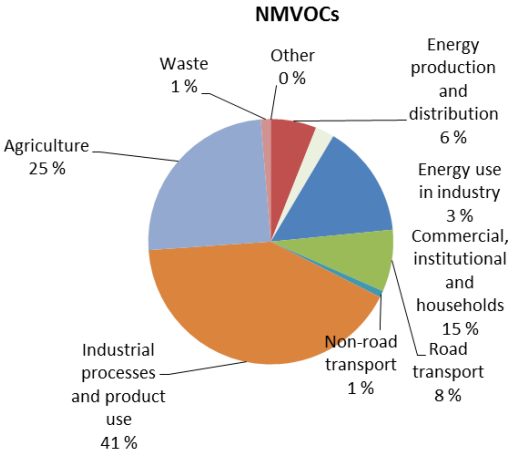
Figure 3.6(b) shows the contribution made by each aggregated sector group to total EU emissions. The main emission source of NMVOCs is industrial processes and product use (41 %), followed by agriculture (25 %), commercial, institutional and households (15 %), road transport (8 %) and energy production and distribution (6 %).

**Figure 3.6 NMVOC emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

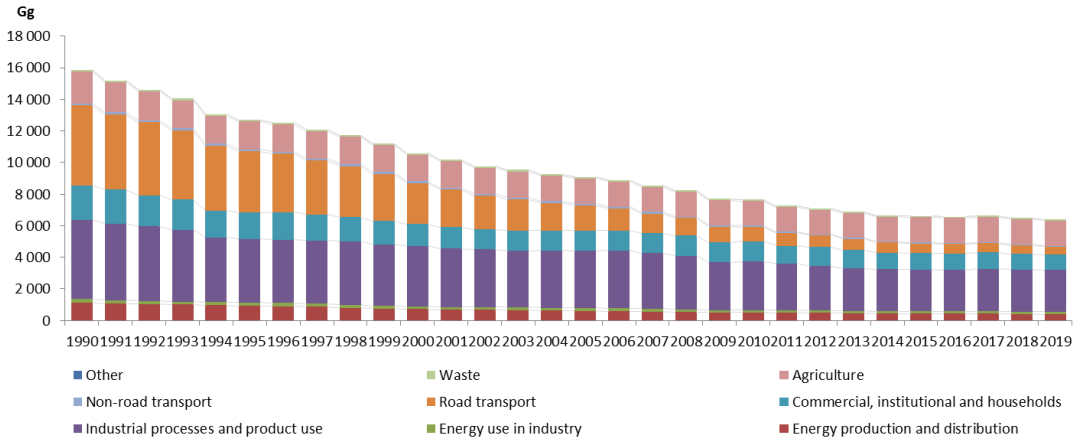
**(a)**




**(b)**




**(c)**



## *3.5 Sulphur oxide emission trends and key categories*

Between 1990 and 2019, $SO_X$ emissions dropped by 92.2 % in the EU. Between 2018 and 2019, emissions decreased by 12.5 % (see Table 3.8), mainly because of reduced emissions in Poland, Spain, Germany and France (countries ranked according to the size of their contributions to the absolute change). The EU Member States contributing most (i.e. more than 10 %) to $SO_X$ emissions in 2018 were Poland (25.7 % of EU-28) and Germany (15.8 % of EU-28).

Spain stated that the dramatic drop in $SO_X$ emissions in 2008 was due to the closure of the main brown coal mine in Spain in 2007. In addition, the necessary retrofitting in 2008 of the adjacent thermal power plant and the implementation of desulphurisation abatement techniques reduced $SO_X$ emissions during this period (see Spain's IIR, listed in Appendix 5).

In Slovakia, data reported for 2015 were significantly higher than for the year 2014. Slovakia explained that all $SO_X$ emissions were emitted from Slovenské elektrárne (an electricity company), which apparently had no emission limitations or abatement technologies in place in 2015. From 2016 onwards, it has been possible to operate such facilities only when they comply with the strict limits set in the legislation. The considerable drop in $SO_X$ emissions is due to the strict regulations in place (see Slovakia's IIR, listed in Appendix 5).

The strong decrease in $SO_X$ emissions in Romania between 2008 and 2018 has been, according to Romania's IIR, due to the use of low-sulphur fuels and also the regulatory binding on maximal fuel content in transport diesel/gas oil, installations of large combustion plant desulphurisation equipment and national legislation. In 2019 the $SO_X$ emissions started to increase again. (see Romania's IIR, listed in Appendix 5).

Between 1999 and 2005 Hungary reduced its $SO_X$ emissions by 95 %. This reduction is mainly represented by decreasing emissions in the sector '1A1a — Public electricity and heat production'.

### Table 3.8 Member State contributions to EU emissions of $SO_X$

| Member State | $SO_x$ (Gg) | | | | | | | | | | | | | | Change | | Share in EU-28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 74 | 47 | 32 | 26 | 16 | 15 | 15 | 14 | 15 | 14 | 13 | 13 | 12 | 11 | -85 % | -5.9 % | 0.4 % | 0.7 % |
| Belgium | 365 | 258 | 171 | 143 | 61 | 53 | 47 | 43 | 41 | 41 | 34 | 32 | 32 | 30 | -92 % | -7.4 % | 1.7 % | 1.8 % |
| Bulgaria | 1 106 | 1 302 | 863 | 779 | 387 | 514 | 328 | 194 | 187 | 142 | 105 | 103 | 89 | 74 | -93 % | -16.4 % | 5.3 % | 4.5 % |
| Croatia | 168 | 77 | 60 | 58 | 35 | 29 | 25 | 17 | 14 | 16 | 15 | 13 | 10 | 8.2 | -95 % | -19.7 % | 0.8 % | 0.5 % |
| Cyprus | 32 | 40 | 48 | 38 | 22 | 21 | 16 | 14 | 17 | 13 | 16 | 16 | 17 | 16 | -51 % | -6.8 % | 0.2 % | 1.0 % |
| Czechia | 1 755 | 1 059 | 233 | 208 | 164 | 167 | 160 | 145 | 134 | 129 | 115 | 110 | 97 | 80 | -95 % | -17.3 % | 8.3 % | 4.8 % |
| Denmark | 178 | 146 | 33 | 26 | 15 | 14 | 13 | 13 | 11 | 10.0 | 10 | 11 | 11 | 10 | -94 % | -8.6 % | 0.8 % | 0.6 % |
| Estonia | 275 | 117 | 97 | 76 | 83 | 73 | 43 | 42 | 47 | 36 | 35 | 39 | 31 | 19 | -93 % | -38.8 % | 1.3 % | 1.1 % |
| Finland | 249 | 105 | 82 | 70 | 66 | 60 | 50 | 48 | 44 | 41 | 40 | 35 | 33 | 29 | -88 % | -12.6 % | 1.2 % | 1.8 % |
| France | 1 287 | 937 | 616 | 462 | 269 | 222 | 220 | 201 | 158 | 151 | 136 | 130 | 122 | 100 | -92 % | -18.3 % | 6.1 % | 6.0 % |
| Germany | 5 474 | 1 751 | 651 | 477 | 405 | 389 | 372 | 361 | 339 | 336 | 312 | 303 | 292 | 264 | -95 % | -9.7 % | 26.0 % | 16.0 % |
| Greece | 507 | 517 | 553 | 579 | 230 | 160 | 143 | 122 | 104 | 102 | 81 | 90 | 86 | 80 | -84 % | -6.7 % | 2.4 % | 4.9 % |
| Hungary | 830 | 614 | 427 | 43 | 30 | 34 | 30 | 29 | 26 | 24 | 23 | 28 | 23 | 17 | -98 % | -24.6 % | 3.9 % | 1.0 % |
| Ireland | 183 | 163 | 144 | 73 | 27 | 25 | 24 | 24 | 18 | 16 | 14 | 15 | 15 | 11 | -94 % | -25.6 % | 0.9 % | 0.7 % |
| Italy | 1 784 | 1 322 | 756 | 411 | 222 | 199 | 180 | 149 | 133 | 127 | 119 | 117 | 109 | 105 | -94 % | -3.6 % | 8.5 % | 6.4 % |
| Latvia | 100 | 49 | 18 | 8.8 | 4.3 | 4.3 | 4.4 | 3.9 | 3.9 | 3.6 | 3.5 | 3.6 | 3.9 | 3.7 | -96 % | -4.1 % | 0.5 % | 0.2 % |
| Lithuania | 202 | 77 | 39 | 28 | 18 | 19 | 17 | 14 | 13 | 15 | 15 | 13 | 13 | 12 | -94 % | -10.1 % | 1.0 % | 0.7 % |
| Luxembourg | 16 | 9.2 | 3.7 | 2.7 | 1.8 | 1.3 | 1.5 | 1.6 | 1.6 | 1.4 | 1.1 | 1.1 | 1.0 | 1.0 | -94 % | -0.2 % | 0.1 % | 0.1 % |
| Malta | 13 | 10 | 9.1 | 12 | 8.0 | 7.9 | 7.7 | 5.0 | 4.7 | 2.2 | 1.8 | .7 | 0.2 | 0.2 | -99 % | -2.6 % | 0.1 % | 0.0 % |
| Netherlands | 197 | 136 | 78 | 67 | 36 | 35 | 35 | 30 | 30 | 31 | 28 | 27 | 25 | 23 | -88 % | -8.2 % | 0.9 % | 1.4 % |
| Poland | 2 613 | 2 071 | 1 341 | 1 132 | 817 | 771 | 739 | 702 | 660 | 639 | 533 | 526 | 495 | 427 | -84 % | -13.8 % | 12.4 % | 25.9 % |
| Portugal | 318 | 322 | 295 | 190 | 63 | 57 | 52 | 48 | 44 | 46 | 46 | 47 | 45 | 44 | -86 % | -2.1 % | 1.5 % | 2.7 % |
| Romania | 819 | 696 | 492 | 603 | 356 | 326 | 261 | 210 | 183 | 158 | 109 | 89 | 84 | 99 | -88 % | 17.5 % | 3.9 % | 6.0 % |
| Slovakia | 140 | 120 | 117 | 86 | 68 | 67 | 57 | 52 | 44 | 67 | 26 | 28 | 20 | 16 | -89 % | -23.0 % | 0.7 % | 1.0 % |
| Slovenia | 203 | 125 | 93 | 40 | 10 | 11 | 11 | 9.6 | 7.7 | 5.5 | 4.7 | 4.9 | 4.8 | 4.3 | -98 % | -10.7 % | 1.0 % | 0.3 % |
| Spain | 2 039 | 1 763 | 1 389 | 1 205 | 243 | 279 | 283 | 219 | 241 | 258 | 215 | 218 | 196 | 149 | -93 % | -23.8 % | 9.7 % | 9.1 % |
| Sweden | 103 | 71 | 45 | 36 | 29 | 26 | 26 | 23 | 21 | 18 | 18 | 18 | 17 | 16 | -84 % | -5.7 % | 0.5 % | 1.0 % |
| **EU28 (a)** | **21 027** | **13 904** | **8 685** | **6 881** | **3 686** | **3 581** | **3 158** | **2 735** | **2 540** | **2 440** | **2 068** | **2 029** | **1884** | **1649** | **-92.2 %** | **-12.5 %** | **100 %** | **100 %** |
| EU28 (b) | 21 027 | 13 904 | 8 685 | 6 881 | 3 686 | 3 581 | 3 158 | 2 735 | 2 540 | 2 440 | 2 068 | 2 029 | 1884 | 1649 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

Category '1A1a — Public electricity and heat production' is the most significant key category for $SO_X$ emissions, making up 34 % of total $SO_X$ emissions (Figure 3.7(a)). Among the top five key

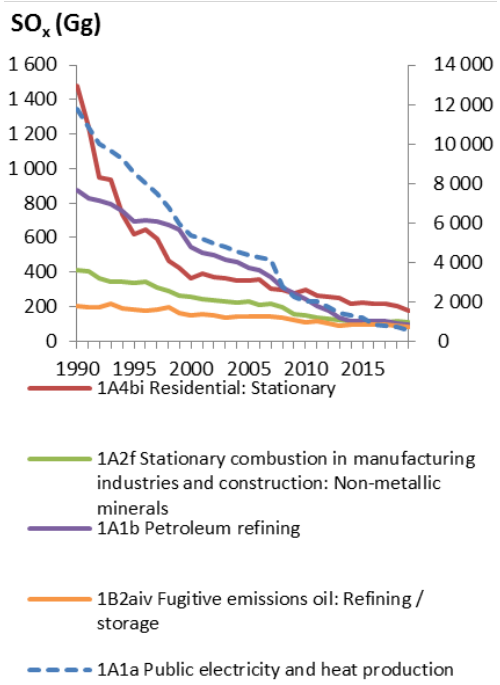
categories, the highest relative reductions in emissions between 1990 and 2019 were achieved in the most important, '1A1a — Public electricity and heat production' (-95.3 %), and the third most important, '1A1b — Petroleum refining' (-89.3 %). The other three top five key categories also saw significant reductions.

Since 1990, several measures have been combined to reduce emissions from these main emitting sources: switching fuel in energy-related sectors away from high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas; fitting flue gas desulphurisation (FGD) abatement technology in industrial facilities; and the impact of implementing EU directives relating to the sulphur content of certain liquid fuels (EEA, 2020a).

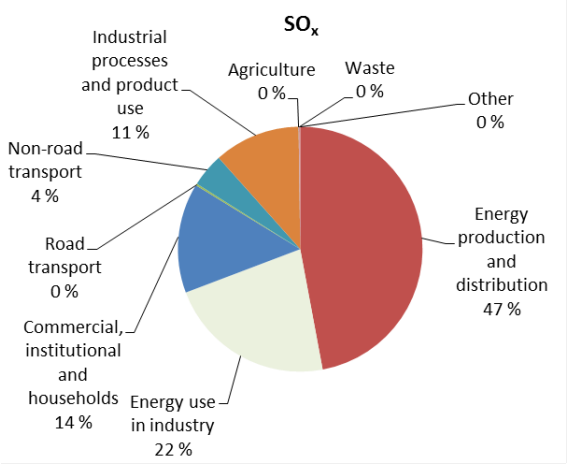
Figure 3.7(b) shows the contribution made by each aggregated sector group to total EU emissions. For $SO_X$, the common main emission sources are the energy sectors.

**Figure 3.7 $SO_X$ emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

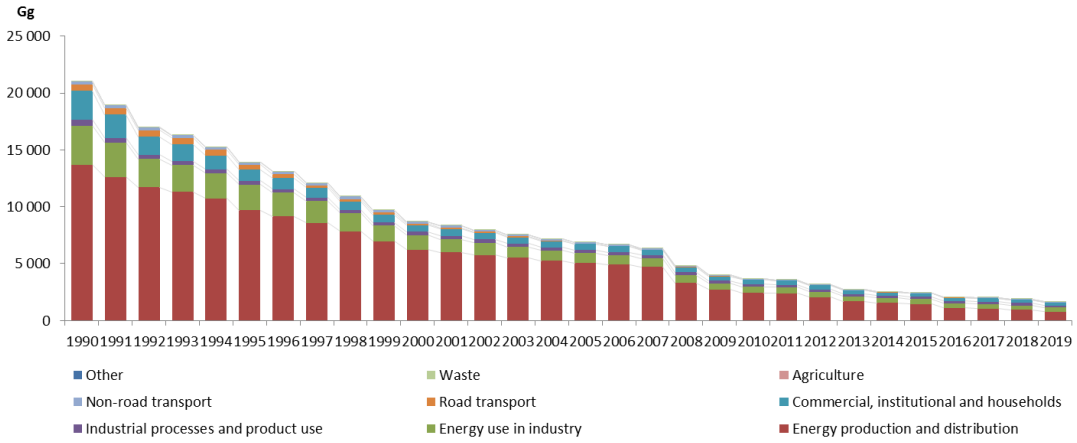
**(a)**




**(b)**




**(c)**




**Note:** In Figure 3.7(a), the right-hand axis shows values for '1A1a — Public electricity and heat production'.

## *3.6 Ammonia emission trends and key categories*

Between 1990 and 2019, $NH_3$ emissions dropped by 28.1 % in the EU. Between 2018 and 2019, emissions decreased by 2.2 % (see Table 3.9) because of decreases in Germany, France, Poland and Ireland (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to $NH_3$ emissions were France, Germany and Spain (countries ranked according to their shares of the EU total).

The $NH_3$ emissions decreased in all countries, except Ireland (14 %), Luxembourg (6 %), Austria (3 %) and Spain (1 %) between 1990 and 2019. Ireland reported higher emissions in 2019 than in

1990, mostly in the categories '3Da2a — Animal manure applied to soils' and '3B1b — Manure management — Non-dairy cattle'.

In Belgium, the significant decrease in $NH_3$ emissions between 1999 and 2000 (not shown inTable 3.9) was mainly because of the implementation of successive manure action plans in Flanders (see Belgium's IIR, listed in Appendix 5).

The increasing $NH_3$ emissions trend reported by Germany, over the period 2009-2015, reflects data mainly reported for the categories '3Da1 — Inorganic N-fertilisers (also includes urea application)' and '3Da2c — Other organic fertilisers applied to soils (including compost)'.

Spain offered the following explanation for the national $NH_3$ emissions trend observed during the period 1990-2015. Between 1990 and 1993, the decline in $NH_3$ emissions is related to the significant economic recession and the drought in Spain. From 1994 onwards, agricultural emissions increased considerably, reaching a maximum in 2003. This rise was mainly caused by significant growth in both the national cattle herd and the swine population. The use of synthetic nitrogen fertilisers also increased during that period. Until 2012, a gradual decline in $NH_3$ emissions was registered at the national level. This reduction was probably due to a combination of factors, including the use of inorganic fertilisers linked to another drought period (2005-2008), a reduction in the number of cattle and the gradual introduction of abatement techniques in manure management and improvements in animal feed formulations. Total $NH_3$ emissions increased between 2012 and 2019, driven by an increase in the consumption of synthetic nitrogen fertilisers and a greater number of cattle and swine (see Spain's IIR, listed in Appendix 5).

## Table 3.9 Member State contributions to EU emissions of $NH_3$

| Member State | $NH_3$ (Gg) | | | | | | | | | | | | | | Change | | Share in EU-28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 62 | 63 | 61 | 60 | 63 | 62 | 63 | 63 | 63 | 64 | 65 | 66 | 65 | 64 | 3 % | -1.6 % | 1.3 % | 1.8 % |
| Belgium | 130 | 135 | 93 | 78 | 73 | 72 | 72 | 71 | 69 | 70 | 70 | 69 | 68 | 66 | -49 % | -2.4 % | 2.6 % | 1.9 % |
| Bulgaria | 102 | 61 | 51 | 48 | 43 | 43 | 43 | 44 | 45 | 45 | 46 | 45 | *44* | *42* | -59 % | -4.9 % | 2.1 % | 1.2 % |
| Croatia | 56 | 43 | 44 | 46 | 42 | 44 | 42 | 35 | 34 | 38 | 36 | 39 | 39 | 37 | -35 % | -5.3 % | 1.1 % | 1.0 % |
| Cyprus | 8. | 9.1 | 9.9 | 9.8 | 9.6 | 9.4 | 8.9 | 8.2 | 8.3 | 8.1 | 8.4 | 8.5 | 8.6 | 6.8 | -14 % | -20.7 % | 0.2 % | 0.2 % |
| Czechia | 170 | 115 | 106 | 99 | 91 | 92 | 86 | 95 | 98 | 107 | 90 | 86 | 86 | 85 | -50 % | -1.7 % | 3.5 % | 2.4 % |
| Denmark | 131 | 109 | 97 | 89 | 81 | 78 | 76 | 74 | 73 | 75 | 75 | 78 | 77 | 75 | -42 % | -2.0 % | 2.7 % | 2.1 % |
| *Adjusted data** | | | | | *69* | *66* | *65* | *62* | *61* | *63* | *62* | *64* | *64* | *61* | | | | |
| Estonia | 22 | 11 | 8.6 | 10 | 10 | 10 | 10 | 11 | 11 | 10 | 10 | 11 | 10 | 11 | -51 % | 1.6 % | 0.4 % | 0.3 % |
| Finland | 35 | 33 | 35 | 38 | 37 | 35 | 35 | 35 | 35 | 34 | 33 | 32 | 32 | 32 | -9 % | -1.6 % | 0.7 % | 0.9 % |
| *Adjusted data** | | | | | *34* | *33* | *33* | *33* | *33* | *32* | *32* | *31* | *31* | *30* | | | | |
| France | 663 | 647 | 662 | 621 | 618 | 607 | 608 | 605 | 609 | 616 | 616 | 612 | *606* | *593* | -11 % | -2.3 % | 13.5 % | 16.8 % |
| Germany | 715 | 613 | 627 | 607 | 619 | 625 | 631 | 637 | 645 | 641 | 638 | 624 | 601 | 587 | -18 % | -2.4 % | 14.5 % | 16.6 % |
| *Adjusted data** | | | | | *617* | *623* | *629* | *635* | *643* | *639* | *637* | *622* | *600* | *585* | | | | |
| Greece | 89 | 78 | 75 | 75 | 71 | 70 | 68 | 68 | 65 | 64 | 64 | 64 | 63 | 64 | -28 % | 0.8 % | 1.8 % | 1.8 % |
| Hungary | 135 | 80 | 85 | 80 | 71 | 72 | 72 | 73 | 74 | 78 | 79 | 80 | 79 | 79 | -41 % | 1.0 % | 2.8 % | 2.2 % |
| Ireland | 110 | 116 | 120 | 120 | 115 | 110 | 117 | 118 | 114 | 120 | 125 | 129 | 135 | 125 | 14 % | -7.2 % | 2.2 % | 3.6 % |
| Italy | 467 | 452 | 454 | 419 | 377 | 379 | 389 | 376 | 364 | 364 | 377 | 371 | 358 | 355 | -24 % | -1.0 % | 9.5 % | 10.0 % |
| Latvia | 33 | 16 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 17 | 17 | 18 | 17 | 18 | -47 % | 1.3 % | 0.7 % | 0.5 % |
| Lithuania | 82 | 38 | 34 | 37 | 37 | 36 | 36 | 34 | 37 | 37 | 36 | 37 | 36 | 35 | -57 % | -3.2 % | 1.7 % | 1.0 % |
| Luxembourg | 5.3 | 5.8 | 6.1 | 5.6 | 5.6 | 5.4 | 5.3 | 5.3 | 5.4 | 5.5 | 5.5 | 5.6 | 5.6 | 5.6 | 6 % | -0.9 % | 0.1 % | 0.2 % |
| Malta | 1.9 | 2.1 | 2.1 | 1.9 | 1.7 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.3 | *1.4* | *1.3* | -30 % | -2.4 % | 0.0 % | 0.0 % |
| Netherlands | 346 | 219 | 173 | 153 | 134 | 132 | 126 | 125 | 129 | 131 | 130 | 132 | 129 | 123 | -64 % | -4.9 % | 7.0 % | 3.5 % |
| *Adjusted data** | | | | | | | | | *126* | *129* | *128* | *127* | *124* | | | | | |
| Poland | 503 | 390 | 362 | 338 | 316 | 315 | 305 | 310 | 304 | 304 | 305 | 319 | 330 | 317 | -37 % | -3.9 % | 10.2 % | 9.0 % |
| Portugal | 77 | 73 | 77 | 65 | 59 | 59 | 57 | 56 | 58 | 59 | 60 | 60 | 59 | 59 | -23 % | -0.2 % | 1.6 % | 1.7 % |
| Romania | 366 | 248 | 197 | 215 | 187 | 187 | 183 | 185 | 186 | 190 | 185 | 182 | 182 | 178 | -51 % | -1.8 % | 7.5 % | 5.0 % |
| Slovakia | 58 | 39 | 33 | 33 | 29 | 28 | 30 | 30 | 30 | 30 | 31 | 32 | 32 | 31 | -45 % | -1.9 % | 1.2 % | 0.9 % |
| Slovenia | 23 | 21 | 22 | 20 | 20 | 19 | 19 | 18 | 18 | 19 | 19 | 19 | 18 | 18 | -22 % | -2.1 % | 0.5 % | 0.5 % |
| Spain | 466 | 431 | 524 | 483 | 435 | 423 | 418 | 422 | 444 | 453 | 457 | 476 | 475 | 471 | 1 % | -0.7 % | 9.5 % | 13.3 % |
| Sweden | 60 | 61 | 60 | 58 | 55 | 54 | 53 | 55 | 55 | 55 | 53 | 54 | 54 | 53 | -11 % | -0.4 % | 1.2 % | 1.5 % |
| **EU28 (a)** | **4 916** | **4 107** | **4 032** | **3 824** | **3 615** | **3 585** | **3 571** | **3 572** | **3 595** | **3 635** | **3 633** | **3 647** | **3 613** | **3 532** | **-28.1 %** | **-2.2 %** | **100 %** | **100 %** |
| EU28 (b) | 4 916 | 4 107 | 4 032 | 3 824 | 3 615 | 3 585 | 3 571 | 3 572 | 3 595 | 3 635 | 3 633 | 3 647 | 3 613 | 3 532 | | | | |
| EU28 (c) | 4 916 | 4 107 | 4 032 | 3 824 | 3 598 | 3 568 | 3 556 | 3 556 | 3 577 | 3 618 | 3 615 | 3 625 | 3 592 | 3 515 | | | | |

**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
([c]) Sum of national totals, as reported by EU Member States, under consideration of approved adjustments.
*Adjusted data: under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Denmark, Finland, Germany and the Netherlands.
EU-28 does not include data from the United Kingdom (see Box ES.2).

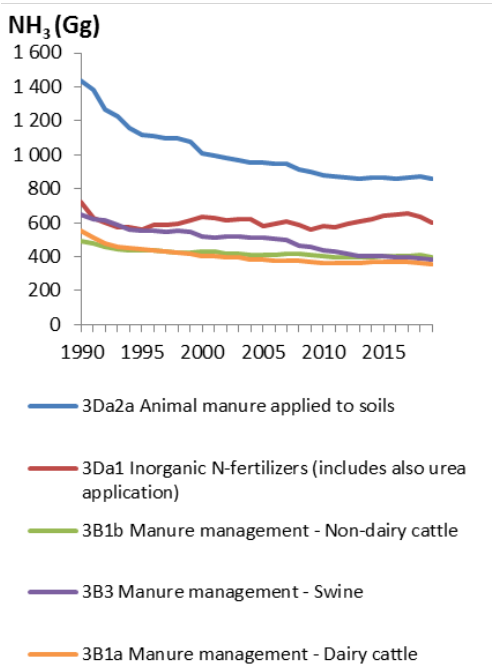
The principal key categories for $NH_3$ emissions are '3Da2a — Animal manure applied to soils', '3Da1 — Inorganic N-fertilisers' and '3B1b — Manure management — Non-dairy cattle'. They jointly make up 52 % of total $NH_3$ emissions (see Figure 3.8(a)). Among the top five key categories,

the highest relative reduction in emissions between 1990 and 2019 was in the fourth most important, '3B3 — Manure management — Swine' (-40.3 %). There were also large reductions in emissions in the most important category, '3Da2a — Animal manure applied to soils' (-40.3 %).

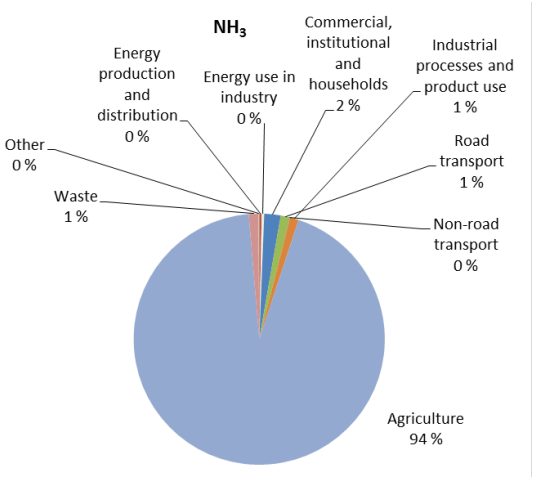
Figure 3.8(b) shows the contribution made by each aggregated sector group to total EU emissions. A single sector group, agriculture, is responsible for most (94 %) of the $NH_3$ emissions in the EU.

**Figure 3.8 $NH_3$ emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

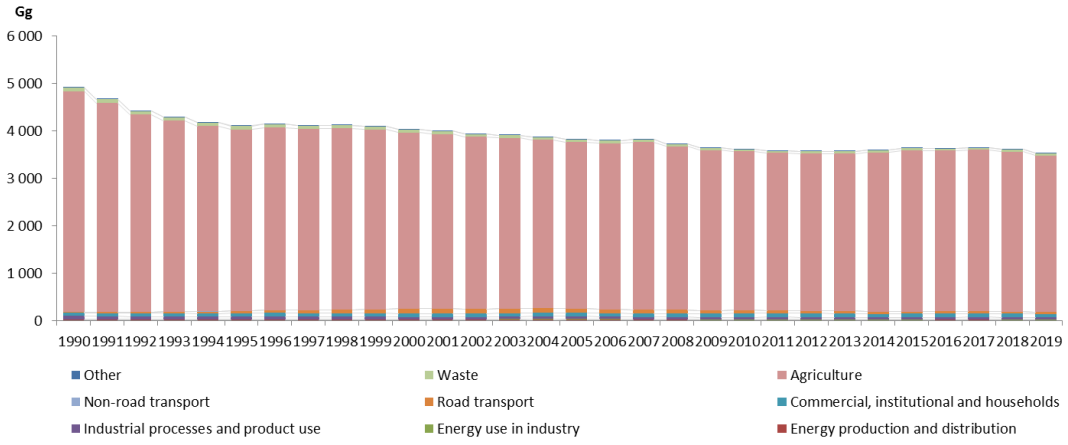
**(a)**




**(b)**




**(c)**



## *3.7 Fine particulate matter emission trends and key categories*

Between 2000 and 2019, $PM_{2.5}$ emissions dropped by 35.6 % in the EU. Between 2018 and 2019, there was a decrease of 3 % (see Table 3.10mainly because emissions decreased in Poland, France, Czechia and Germany (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to $PM_{2.5}$ emissions were Italy, Spain, Poland, France and Romania (countries ranked according to their shares of the EU total).

Estonia reported that the growth in $PM_{2.5}$ emissions from 2010 to 2011 resulted from greater electricity production during that period. In 2011, the significant growth in primary PM emissions in general was due to an increase in electricity production at Estonia's Balti power station (Enefit Power AS) and the incorrect operation of electric precipitators in two of its power units. In 2019, particulate emissions decreased by 12 % in comparison with 2018, mainly because of a decrease in the use of wood and wood waste in the industrial combustion sector and a decrease in electricity production at oil shale power plants (see Estonia's IIR, listed in Appendix 5).

### Table 3.10 Member State contributions to EU emissions of $PM_{2.5}$

| | $PM_{2.5}$ (Gg) | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2000—2019 | 2018—2019 | 2000 | 2019 |
| Austria | 24 | 23 | 20 | 19 | 18 | 18 | 16 | 16 | 15 | 15 | 14 | 14 | -41 % | -1.2 % | 1.4 % | 1.3 % |
| Belgium | 40 | 34 | 31 | 25 | 25 | 26 | 21 | 22 | 22 | 20 | 19 | 18 | -54 % | -4.1 % | 2.3 % | 1.7 % |
| Bulgaria | 25 | 30 | 31 | 33 | 33 | 32 | 31 | 32 | 32 | 31 | 30 | 30 | 19 % | -0.5 % | 1.5 % | 2.7 % |
| Croatia | 35 | 44 | 38 | 37 | 35 | 35 | 30 | 33 | 32 | 30 | 29 | 29 | -19 % | -2.3 % | 2.0 % | 2.6 % |
| Cyprus | 2.5 | 2.2 | 1.6 | 1.4 | 1.1 | 1.0 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 | -58 % | 4.1 % | 0.1 % | 0.1 % |
| Czechia | 49 | 43 | 45 | 43 | 44 | 44 | 42 | 41 | 40 | 41 | 40 | 36 | -28 % | -10.2 % | 2.9 % | 3.2 % |
| Denmark | 21 | 22 | 21 | 19 | 18 | 18 | 17 | 17 | 17 | 16 | 15 | 13 | -38 % | -10.3 % | 1.2 % | 1.2 % |
| Estonia | 15 | 13 | 14 | 18 | 8.6 | 12 | 8.7 | 9.6 | 7.8 | 9.2 | 6.6 | 5.9 | -62 % | -11.5 % | 0.9 % | 0.5 % |
| Finland | 26 | 26 | 24 | 21 | 21 | 20 | 19 | 18 | 19 | 18 | 18 | 17 | -37 % | -6.7 % | 1.5 % | 1.5 % |
| France | 317 | 247 | 189 | 161 | 164 | 164 | 140 | 141 | 140 | 134 | 126 | 121 | -62 % | -3.6 % | 18.3 % | 10.9 % |
| Germany | 169 | 138 | 120 | 115 | 114 | 112 | 104 | 103 | 97 | 96 | 95 | 92 | -46 % | -2.9 % | 9.8 % | 8.3 % |
| Greece | 67 | 69 | 48 | 47 | 49 | 44 | 45 | 43 | 40 | 40 | 38 | 37 | -45 % | -1.7 % | 3.9 % | 3.3 % |
| Hungary | 50 | 42 | 51 | 57 | 60 | 60 | 50 | 53 | 51 | 49 | 42 | 40 | -21 % | -5.7 % | 2.9 % | 3.6 % |
| Ireland | 20 | 19 | 16 | 15 | 14 | 15 | 14 | 14 | 13 | 13 | 14 | 12 | -41 % | -12.8 % | 1.2 % | 1.1 % |
| Italy | 195 | 173 | 196 | 149 | 176 | 170 | 152 | 158 | 153 | 160 | 142 | 139 | -28 % | -1.5 % | 11.3 % | 12.5 % |
| Latvia | 27 | 28 | 22 | 22 | 23 | 21 | 21 | 18 | 18 | 20 | 20 | 20 | -26 % | -2.3 % | 1.6 % | 1.8 % |
| Lithuania | 7.3 | 8.5 | 8.0 | 9.1 | 8.1 | 6.6 | 6.2 | 5.7 | 5.6 | 5.6 | 5.6 | 5.3 | -27 % | -5.6 % | 0.4 % | 0.5 % |
| Luxembourg | 2.4 | 2.5 | 1.9 | 1.7 | 1.6 | 1.6 | 1.6 | 1.3 | 1.5 | 1.3 | 1.4 | 1.2 | -51 % | -15.3 % | 0.1 % | 0.1 % |
| Malta | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | -48 % | 0.6 % | 0.0 % | 0.0 % |
| Netherlands | 35 | 29 | 23 | 21 | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 15 | -56 % | -4.4 % | 2.0 % | 1.4 % |
| Poland | 164 | 155 | 152 | 145 | 140 | 134 | 126 | 126 | 130 | 133 | 130 | 122 | -26 % | -6.5 % | 9.5 % | 11.0 % |
| Portugal | 74 | 67 | 56 | 57 | 54 | 52 | 51 | 51 | 51 | 51 | 50 | 50 | -32 % | 0.0 % | 4.3 % | 4.5 % |
| Romania | 106 | 121 | 130 | 120 | 123 | 115 | 115 | 110 | 110 | 111 | 111 | 112 | 6 % | 1.2 % | 6.1 % | 10.1 % |
| Slovakia | 43 | 36 | 26 | 24 | 26 | 24 | 16 | 21 | 21 | 21 | 17 | 18 | -59 % | 2.5 % | 2.5 % | 1.6 % |
| Slovenia | 14 | 16 | 15 | 14 | 14 | 14 | 12 | 13 | 13 | 12 | 11 | 11 | -25 % | -6.8 % | 0.8 % | 1.0 % |
| Spain | 164 | 147 | 137 | 139 | 122 | 135 | 120 | 128 | 125 | 124 | 136 | 135 | -18 % | -0.9 % | 9.5 % | 12.1 % |
| Sweden | 33 | 31 | 26 | 26 | 24 | 23 | 20 | 19 | 19 | 20 | 19 | 18 | -47 % | -5.2 % | 1.9 % | 1.6 % |
| **EU28 (a)** | **1 727** | **1 567** | **1 442** | **1 339** | **1 337** | **1 314** | **1 199** | **1 211** | **1 190** | **1 191** | **1146** | **1111** | **-35.6 %** | **-3.0 %** | **100 %** | **100 %** |
| EU28 (b) | 1 727 | 1 567 | 1 442 | 1 339 | 1 337 | 1 314 | 1 199 | 1 211 | 1 190 | 1 191 | 1146 | 1111 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

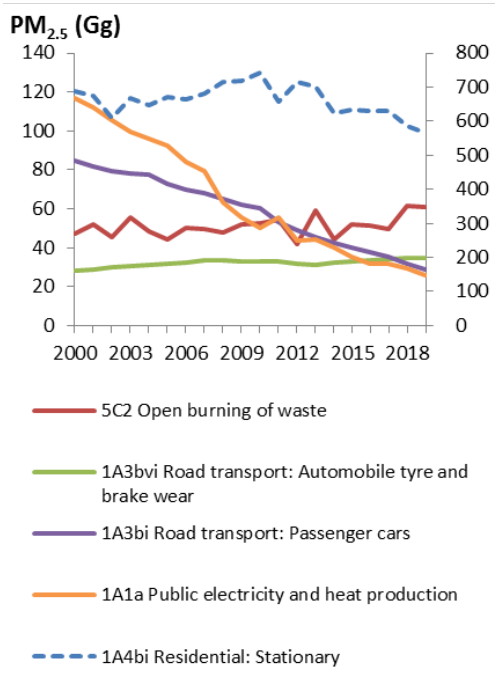
Domestic fuel use in '1A4bi — Residential: Stationary' is the principal key category for $PM_{2.5}$ emissions, making up 51 % of the total (Figure 3.9 (a)). Among the top five key categories, the highest relative reduction in emissions between 2000 and 2019 was in the fifth most important, '1A1a — Public electricity and heat production' (-78.9 %). There were also large reductions in emissions in the fifth most important category, '1A3bi — Road transport: Passenger cars' (-65.8 %).

In contrast, emissions from the third most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear' (+24.8 %), have increased significantly since 1990.

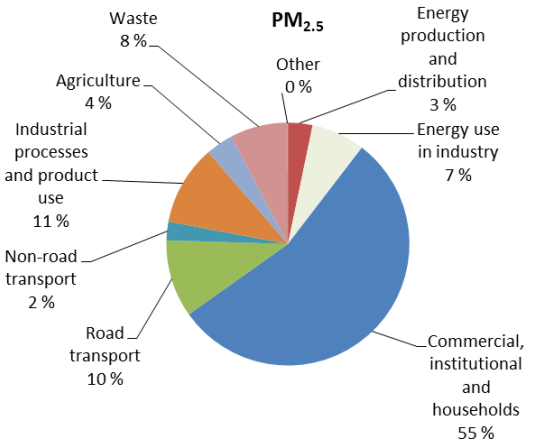
Figure 3.9(b) shows the contribution to total EU emissions made by each aggregated sector group. The commercial, institutional and households sector group is a major source of $PM_{2.5}$, as well as PM with a diameter of 10 µm or less ($PM_{10}$), CO and PCDD/Fs.

**Figure 3.9 $PM_{2.5}$ emissions in the EU: (a) trend in emissions from the five most important key categories, 2000-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

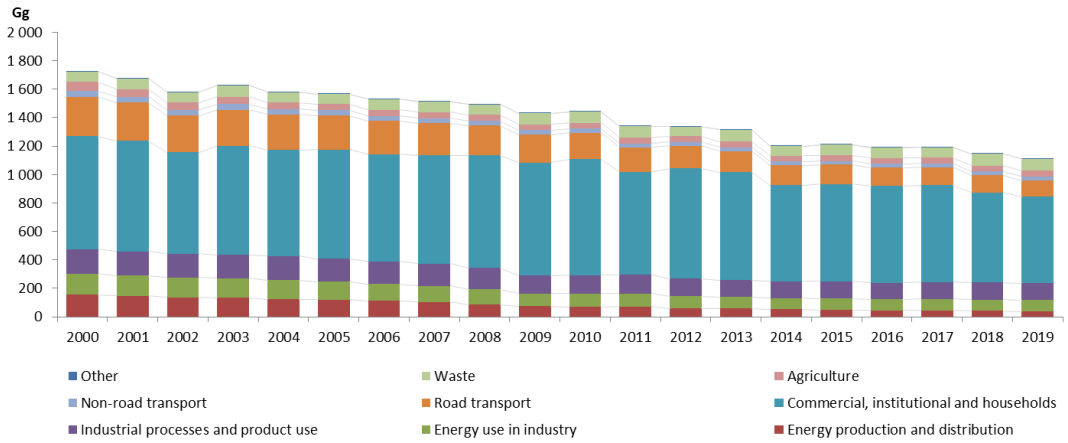
**(a)**




**(b)**




**(c)**




**Notes:** In Figure 3.9(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.

## *3.8 Particulate matter emission trends and key categories*

Between 2000 and 2019, $PM_{10}$ emissions decreased by 32 % in the EU. Between 2018 and 2019, the decrease was 2.2 % (see Table 3.11 ) mainly because emissions dropped in Poland, France, Czechia and Germany (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to $PM_{10}$ emissions were Poland, Germany, France and Spain (countries ranked according to their shares of the EU total).

### Table 3.11 Member State contributions to EU emissions of $PM_{10}$

| Member State | $PM_{10}$ (Gg) | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2000—2019 | 2018—2019 | 2000 | 2019 |
| Austria | 38 | 36 | 32 | 31 | 30 | 30 | 28 | 28 | 28 | 28 | 26 | 26 | -30 % | -0.1 % | 1.5 % | 1.5 % |
| Belgium | 55 | 46 | 40 | 33 | 34 | 35 | 29 | 31 | 31 | 30 | 28 | 27 | -50 % | -3.8 % | 2.1 % | 1.6 % |
| Bulgaria | 46 | 56 | 53 | 57 | 55 | 52 | 52 | 55 | 48 | 47 | 47 | 44 | -5 % | -6.3 % | 1.8 % | 2.5 % |
| Croatia | 45 | 59 | 50 | 48 | 47 | 47 | 41 | 44 | 43 | 41 | 41 | 41 | -8 % | -0.8 % | 1.7 % | 2.3 % |
| Cyprus | 4.8 | 4.1 | 3.1 | 2.8 | 2.2 | 1.8 | 1.7 | 1.7 | 1.9 | 1.9 | 2.0 | 2.1 | -56 % | 6.2 % | 0.2 % | 0.1 % |
| Czechia | 66 | 58 | 58 | 55 | 56 | 56 | 53 | 52 | 51 | 52 | 51 | 47 | -30 % | -8.6 % | 2.6 % | 2.6 % |
| Denmark | 33 | 33 | 33 | 30 | 29 | 29 | 28 | 27 | 27 | 26 | 25 | 23 | -30 % | -9.0 % | 1.3 % | 1.3 % |
| Estonia | 32 | 21 | 23 | 34 | 14 | 20 | 15 | 14 | 12 | 14 | 11 | 9.2 | -71 % | -16.8 % | 1.2 % | 0.5 % |
| Finland | 43 | 42 | 39 | 36 | 35 | 34 | 34 | 31 | 33 | 31 | 31 | 30 | -30 % | -3.4 % | 1.7 % | 1.7 % |
| France | 420 | 341 | 273 | 244 | 247 | 246 | 219 | 222 | 221 | 217 | 207 | 202 | -52 % | -2.3 % | 16.3 % | 11.5 % |
| Germany | 303 | 248 | 228 | 227 | 224 | 226 | 218 | 214 | 200 | 202 | 207 | 204 | -33 % | -1.6 % | 11.7 % | 11.6 % |
| Greece | 128 | 126 | 91 | 78 | 76 | 72 | 76 | 70 | 69 | 68 | 61 | 61 | -53 % | -0.4 % | 5.0 % | 3.5 % |
| Hungary | 74 | 74 | 74 | 77 | 75 | 79 | 74 | 75 | 72 | 67 | 63 | 62 | -17 % | -1.8 % | 2.9 % | 3.5 % |
| Ireland | 39 | 41 | 35 | 29 | 29 | 29 | 28 | 29 | 28 | 29 | 29 | 28 | -28 % | -4.4 % | 1.5 % | 1.6 % |
| Italy | 248 | 223 | 234 | 186 | 211 | 204 | 186 | 191 | 186 | 193 | 174 | 172 | -31 % | -1.3 % | 9.6 % | 9.8 % |
| Latvia | 32 | 37 | 30 | 32 | 33 | 30 | 30 | 29 | 27 | 28 | 29 | 29 | -7 % | 1.0 % | 1.2 % | 1.7 % |
| Lithuania | 9.1 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 26 % | -2.7 % | 0.4 % | 0.6 % |
| Luxembourg | 3.0 | 3.2 | 2.5 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.8 | -39 % | -10.6 % | 0.1 % | 0.1 % |
| Malta | 1.0 | 1.4 | 1.2 | 1.2 | 1.2 | 1.0 | 1.2 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | -1 % | 9.8 % | 0.0 % | 0.1 % |
| Netherlands | 49 | 42 | 36 | 35 | 33 | 32 | 32 | 31 | 30 | 30 | 29 | 28 | -44 % | -4.4 % | 1.9 % | 1.6 % |
| Poland | 288 | 279 | 271 | 258 | 250 | 237 | 225 | 226 | 232 | 237 | 233 | 218 | -24 % | -6.1 % | 11.2 % | 12.4 % |
| Portugal | 110 | 109 | 89 | 95 | 86 | 75 | 69 | 70 | 72 | 73 | 70 | 71 | -36 % | 0.8 % | 4.3 % | 4.0 % |
| Romania | 139 | 159 | 167 | 158 | 163 | 153 | 153 | 148 | 145 | 144 | 147 | 153 | 10 % | 4.0 % | 5.4 % | 8.7 % |
| Slovakia | 53 | 44 | 32 | 30 | 31 | 30 | 22 | 28 | 26 | 27 | 23 | 23 | -56 % | 2.8 % | 2.0 % | 1.3 % |
| Slovenia | 17 | 20 | 17 | 16 | 16 | 16 | 14 | 15 | 15 | 15 | 14 | 13 | -25 % | -5.3 % | 0.7 % | 0.7 % |
| Spain | 249 | 238 | 202 | 201 | 179 | 191 | 175 | 186 | 187 | 184 | 198 | 195 | -22 % | -1.4 % | 9.7 % | 11.1 % |
| Sweden | 52 | 50 | 44 | 45 | 42 | 43 | 39 | 38 | 38 | 39 | 38 | 37 | -30 % | -3.3 % | 2.0 % | 2.1 % |
| **EU28 (a)** | **2 578** | **2 406** | **2 169** | **2 057** | **2 015** | **1 982** | **1 857** | **1 870** | **1 837** | **1 838** | **1 800** | **1 760** | **-32 %** | **-2.2 %** | **100.0 %** | **100.0 %** |
| EU28 (b) | 2 578 | 2 406 | 2 169 | 2 057 | 2 015 | 1 982 | 1 857 | 1 870 | 1 837 | 1 838 | 1 800 | 1 760 | | | | |

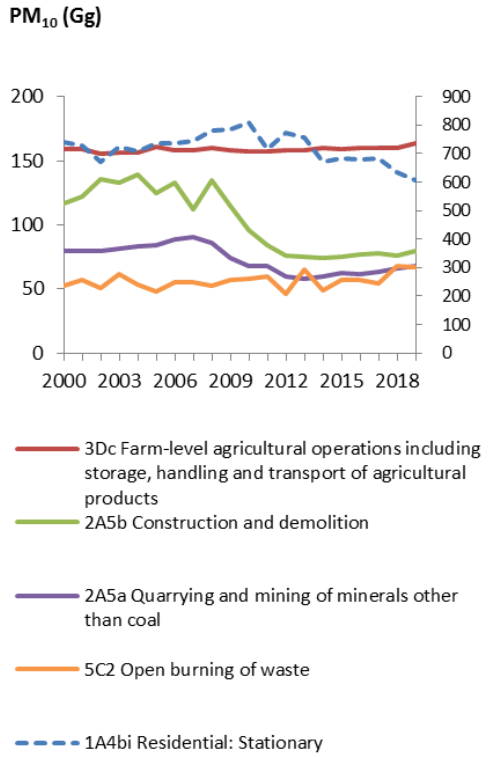
**Notes:** The Air Convention formally requests Parties to report emissions of PM for 2000 and thereafter.
([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.
EU-28 does not include data from the United Kingdom (see Box ES.2).

As for $PM_{2.5}$, '1A4bi — Residential: Stationary' is the most significant key category for $PM_{10}$ emissions, accounting for 34 % of total $PM_{10}$ emissions (see Figure 3.10(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2019 was in the third most important, '2A5b — Construction and demolition' (-31.9 %). Reductions in emissions were also observed in the fourth most important category, '2A5a — Quarrying and mining of minerals other than coal' (-14.7 %). Emissions of the fourth most important key category, '5C2 — Open burning of waste' (+28.5 %), have increased since 1990. Emissions from the other two top five key categories, namely '1A4bi — Residential: Stationary' and '3Dc — Farm-level agricultural operations including storage, handling and transport of agricultural products', have remained quite constant (-18.0 % and +2.8 %, respectively).

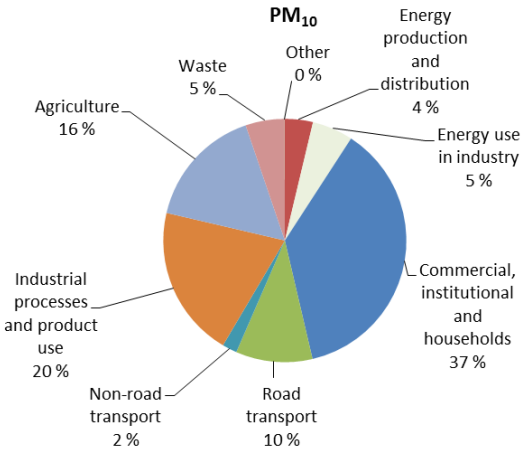
Figure 3.10 (b) shows the contribution of each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is a major source of $PM_{2.5}$ and of $PM_{10}$, CO, PAHs and PCDD/Fs.

**Figure 3.10 $PM_{10}$ emissions in the EU: (a) trend in emissions from the five most important key categories, 2000-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

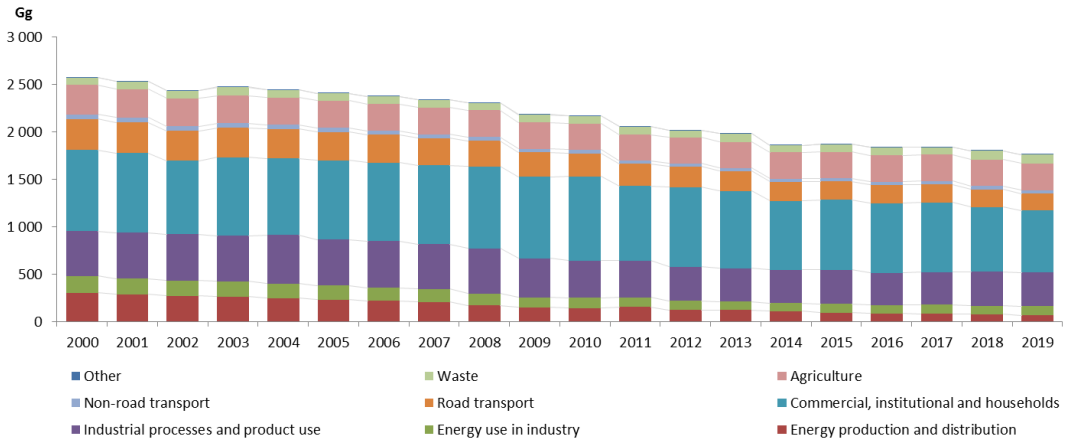
**(a)**




**(b)**




**(c)**




**Notes:** In Figure 3.10 (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.

## *3.9 Total suspended particulate emission trends*

Between 1990 and 2019, total suspended particulate (TSP) emissions dropped by 27 % in the EU. Between 2018 and 2019, emissions decreased by 1.9 % (Table 3.12), mainly because of decreases in Bulgaria, Poland, France and Czechia (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to TSP emissions were France, Germany and Poland (countries ranked according to their shares of the EU total).

Germany explained that, between 2000 and 2019, total TSP emissions dropped by 29 % because of the application of the former West Germany's stricter regulations in the new German *Länder*, following Germany's reunification, the transition from solid to gaseous and liquid fuels, and improved filter technologies for combustion plants and industrial processes (see Germany's IIR, listed in Appendix 5).

Latvia stated that the high TSP emissions in 2004 (not shown in Table 3.12) can be explained by increased road-paving activities. The new 'Via Baltica' motorway was built, connecting the capitals of all Baltic States. The largest part of TSP emissions in 2019 were produced in the industrial processes and product use sector (49.1 %). Compared with 2018, emissions have increased by 3.6 % (see Latvia's IIR, listed in Appendix 5).

### Table 3.12 Member State contributions to EU emissions of TSPs

| | TSPs (Gg) | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2000—2019 | 2018—2019 | 2000 | 2019 |
| Austria | 51 | 48 | 44 | 43 | 42 | 42 | 40 | 40 | 39 | 40 | 38 | 38 | -24 % | 0.4 % | 1.1 % | 1.2% |
| Belgium | 83 | 71 | 58 | 51 | 51 | 52 | 46 | 48 | 49 | 47 | 47 | 46 | -45 % | -2.4 % | 1.9 % | 1.4% |
| Bulgaria | 97 | 143 | 114 | 127 | 113 | 108 | 111 | 139 | 100 | 97 | 105 | 76 | -22 % | -28.1 % | 2.2 % | 2.3% |
| Croatia | 65 | 103 | 78 | 80 | 78 | 80 | 70 | 71 | 70 | 69 | 72 | 72 | 11 % | 0.8 % | 1.5 % | 2.2% |
| Cyprus | 9.5 | 6.6 | 5.4 | 4.8 | 3.7 | 2.8 | 2.5 | 2.6 | 2.8 | 3.1 | 3.2 | 3.5 | -63 % | 9.7 % | 0.2 % | 0.1% |
| Czechia | 90 | 73 | 70 | 67 | 67 | 67 | 64 | 63 | 62 | 63 | 62 | 57 | -36 % | -7.9 % | 2.0 % | 1.7% |
| Denmark | 102 | 96 | 97 | 94 | 91 | 91 | 92 | 86 | 85 | 91 | 90 | 87 | -15 % | -3.3 % | 2.3 % | 2.7% |
| Estonia | 70 | 34 | 30 | 43 | 21 | 27 | 22 | 20 | 17 | 20 | 17 | 14 | -80 % | -16.9 % | 1.6 % | 0.4% |
| Finland | 57 | 57 | 54 | 51 | 49 | 49 | 48 | 45 | 47 | 45 | 45 | 45 | -21 % | -0.2 % | 1.3 % | 1.4% |
| France | 1 040 | 937 | 835 | 813 | 816 | 807 | 769 | 782 | 791 | 791 | 774 | 765 | -26 % | -1.1 % | 23.2 % | 23.4% |
| Germany | 531 | 431 | 396 | 400 | 396 | 406 | 396 | 388 | 361 | 373 | 384 | 380 | -29 % | -1.0 % | 11.9 % | 11.6% |
| Greece | 245 | 230 | 169 | 124 | 114 | 114 | 127 | 119 | 127 | 120 | 103 | 107 | -56 % | 4.3 % | 5.5 % | 3.3% |
| Hungary | 107 | 135 | 109 | 104 | 93 | 106 | 111 | 109 | 103 | 94 | 93 | 95 | -12 % | 1.7 % | 2.4 % | 2.9% |
| Ireland | 87 | 101 | 81 | 59 | 61 | 61 | 59 | 62 | 61 | 67 | 64 | 64 | -26 % | -0.9 % | 1.9 % | 1.9% |
| Italy | 303 | 275 | 287 | 231 | 260 | 251 | 230 | 237 | 231 | 239 | 218 | 215 | -29 % | -1.3 % | 6.8 % | 6.6% |
| Latvia | 40 | 57 | 47 | 57 | 57 | 51 | 50 | 54 | 49 | 46 | 47 | 49 | 21 % | 3.6 % | 0.9 % | 1.5% |
| Lithuania | 12 | 19 | 18 | 17 | 18 | 16 | 16 | 15 | 15 | 16 | 17 | 16 | 35 % | -6.6 % | 0.3 % | 0.5% |
| Luxembourg | 3.7 | 3.9 | 3.2 | 3.0 | 3.0 | 2.9 | 2.9 | 3.1 | 2.7 | 2.8 | 2.7 | 2.5 | -34 % | -8.4 % | 0.1 % | 0.1% |
| Malta | 1.5 | 3.3 | 2.6 | 2.6 | 2.6 | 2.5 | 2.7 | 2.4 | 2.3 | 2.3 | 2.7 | 3.2 | 117 % | 15.9 % | 0.0 % | 0.1% |
| Netherlands | 56 | 48 | 41 | 40 | 39 | 39 | 38 | 37 | 35 | 34 | 33 | 32 | -42 % | -3.5 % | 1.3 % | 1.0% |
| Poland | 428 | 426 | 421 | 408 | 390 | 368 | 350 | 354 | 361 | 368 | 364 | 343 | -20 % | -5.7 % | 9.6 % | 10.5% |
| Portugal | 266 | 301 | 223 | 243 | 212 | 172 | 148 | 154 | 164 | 171 | 156 | 158 | -41 % | 1.1 % | 5.9 % | 4.8% |
| Romania | 233 | 298 | 287 | 284 | 283 | 256 | 258 | 235 | 217 | 207 | 224 | 233 | 0 % | 4.2 % | 5.2 % | 7.1% |
| Slovakia | 73 | 60 | 42 | 39 | 40 | 39 | 30 | 40 | 35 | 37 | 30 | 31 | -58 % | 2.0 % | 1.6 % | 0.9% |
| Slovenia | 24 | 28 | 21 | 19 | 18 | 18 | 16 | 18 | 18 | 19 | 18 | 18 | -26 % | -3.3 % | 0.5 % | 0.5% |
| Spain | 332 | 331 | 268 | 264 | 236 | 246 | 231 | 248 | 248 | 247 | 264 | 261 | -21 % | -1.0 % | 7.4 % | 8.0% |
| Sweden | 70 | 69 | 62 | 65 | 59 | 63 | 57 | 57 | 58 | 60 | 59 | 57 | -19 % | -2.7 % | 1.6 % | 1.7% |
| **EU28 (a)** | **4 476** | **4 387** | **3 860** | **3 736** | **3 613** | **3 536** | **3 389** | **3 428** | **3 352** | **3 368** | **3333** | **3268** | **-27%** | **-1.9 %** | **100 %** | **100 %** |
| EU28 (b) | 4 476 | 4 387 | 3 860 | 3 736 | 3 613 | 3 536 | 3 389 | 3 428 | 3 352 | 3 368 | 3333 | 3268 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.10 Black carbon emission trends*

Between 2000 and 2019, black carbon (BC) emissions dropped by 48 % in the EU (see Table 3.13). Between 2018 and 2019, emissions fell by 4.4 %, mainly because of slightly lower emissions from France, Germany, Italy and Poland (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to BC emissions were Spain, France and Italy (countries ranked according to their shares of the EU total).

Austria and Luxembourg did not provide data for BC, and some of these gaps could not be filled with data. Thus, the EU total is an underestimate.

### Table 3.13 Member State contributions to EU emissions of BC

| | Black Carbon (Gg) | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2000—2019 | 2018—2019 | 2000 | 2019 |
| Austria | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 8.7 | 7.8 | 6.8 | 5.7 | 5.3 | 5.0 | 4.1 | 4.0 | 3.8 | 3.3 | 3.0 | 2.8 | -68 % | -7.2 % | 2.7 % | 1.7 % |
| Bulgaria | 2.9 | 3.8 | 3.8 | 4.0 | 4.1 | 3.8 | 3.8 | 3.9 | 3.9 | 3.8 | 3.7 | 3.6 | 26 % | -2.1 % | 0.9 % | 2.2 % |
| Croatia | 5.2 | 6.1 | 5.2 | 4.9 | 4.7 | 4.5 | 4.0 | 4.3 | 4.2 | 4.1 | 3.8 | 3.7 | -29 % | -3.4 % | 1.6 % | 2.2 % |
| Cyprus | 0.6 | 0.6 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -63 % | 2.0 % | 0.2 % | 0.1 % |
| Czechia | 6.5 | 6.3 | 6.0 | 5.6 | 5.5 | 5.5 | 5.3 | 5.1 | 5.0 | 5.1 | 5.0 | 4.6 | -29 % | -7.9 % | 2.0 % | 2.8 % |
| Denmark | 4.4 | 4.1 | 3.5 | 3.3 | 3.1 | 2.9 | 2.7 | 2.6 | 2.5 | 2.4 | 2.2 | 2.0 | -54 % | -8.5 % | 1.4 % | 1.2 % |
| Estonia | 3.4 | 3.1 | 3.1 | 3.5 | 2.1 | 2.5 | 2.0 | 2.5 | 2.1 | 2.5 | 1.8 | 1.7 | -49 % | -5.4 % | 1.1 % | 1.1 % |
| Finland | 6.5 | 5.9 | 5.6 | 4.9 | 5.1 | 4.6 | 4.5 | 4.2 | 4.4 | 4.1 | 4.0 | 3.8 | -41 % | -3.3 % | 2.0 % | 2.3 % |
| France | 70 | 57 | 44 | 39 | 38 | 36 | 32 | 30 | 28 | 26 | 23 | 21 | -70 % | -8.6 % | 21.8 % | 12.6 % |
| Germany | 39 | 32 | 23 | 21 | 20 | 19 | 17 | 16 | 15 | 14 | 12 | 12 | -70 % | -6.1 % | 12.2 % | 7.1 % |
| Greece | 11 | 12 | 10 | 9.4 | 9.5 | 8.5 | 8.8 | 10.0 | 8.9 | 8.9 | 8.7 | 8.6 | -22 % | -0.8 % | 3.4 % | 5.2 % |
| Hungary | 8.2 | 7.5 | 8.3 | 8.8 | 9.0 | 8.6 | 7.4 | 7.9 | 7.5 | 7.2 | 6.4 | 5.9 | -28 % | -7.0 % | 2.6 % | 3.6 % |
| Ireland | 3.8 | 3.6 | 2.7 | 2.4 | 2.3 | 2.3 | 2.3 | 2.2 | 2.0 | 1.9 | 1.8 | 1.6 | -57 % | -10.6 % | 1.2 % | 1.0 % |
| Italy | 42 | 38 | 32 | 26 | 27 | 25 | 23 | 22 | 21 | 21 | 19 | 18 | -57 % | -3.4 % | 13.2 % | 10.9 % |
| Latvia | 3.4 | 3.7 | 3.1 | 3.1 | 3.3 | 3.0 | 2.9 | 2.6 | 2.6 | 2.7 | 2.8 | 2.7 | -20 % | -4.1 % | 1.1 % | 1.6 % |
| Lithuania | 2.4 | 2.6 | 2.6 | 2.6 | 2.6 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | -31 % | -3.7 % | 0.8 % | 1.0 % |
| Luxembourg | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Malta | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -48 % | -1.8 % | 0.1 % | 0.1 % |
| Netherlands | 10 | 8.3 | 5.6 | 5.1 | 4.5 | 4.0 | 3.6 | 3.3 | 3.0 | 2.8 | 2.6 | 2.3 | -77 % | -10.1 % | 3.2 % | 1.4 % |
| Poland | 17 | 17 | 18 | 17 | 16 | 15 | 14 | 14 | 14 | 15 | 15 | 14 | -18 % | -5.9 % | 5.3 % | 8.5 % |
| Portugal | 11 | 9.6 | 8.5 | 8.4 | 7.7 | 7.5 | 7.4 | 7.0 | 6.9 | 6.9 | 6.7 | 6.6 | -42 % | -1.8 % | 3.6 % | 4.0 % |
| Romania | 12 | 14 | 15 | 14 | 14 | 14 | 13 | 13 | 13 | 14 | 13 | 13 | 10 % | -0.4 % | 3.8 % | 8.0 % |
| Slovakia | 3.2 | 4.1 | 3.7 | 3.2 | 3.4 | 3.1 | 2.3 | 2.7 | 2.8 | 2.7 | 2.3 | 2.2 | -30 % | -3.9 % | 1.0 % | 1.3 % |
| Slovenia | 2.5 | 3.0 | 2.8 | 2.7 | 2.6 | 2.6 | 2.3 | 2.4 | 2.3 | 2.2 | 2.0 | 1.9 | -27 % | -6.6 % | 0.8 % | 1.1 % |
| Spain | 40 | 38 | 35 | 35 | 29 | 33 | 27 | 29 | 28 | 27 | 30 | 29 | -26 % | -1.7 % | 12.4 % | 17.7 % |
| Sweden | 5.5 | 4.8 | 4.0 | 3.8 | 3.5 | 3.3 | 3.0 | 2.8 | 2.7 | 2.6 | 2.3 | 2.3 | -59 % | -3.1 % | 1.7 % | 1.4 % |
| **EU28 (a)** | **320** | **294** | **253** | **235** | **223** | **215** | **195** | **194** | **186** | **181** | **174** | **166** | **-48 %** | **-4.4 %** | **100 %** | **100 %** |
| EU28 (b) | 320 | 294 | 253 | 235 | 223 | 215 | 195 | 194 | 186 | 181 | 174 | 166 | | | | |

**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.

EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.11 Carbon monoxide emission trends and key categories*

Between 1990 and 2019, carbon monoxide (CO) emissions fell by 68 % in the EU. Between 2018 and 2019, the decrease was 2.6 % (Table 3.14), mainly because emissions fell in Poland, Germany, France and Slovakia (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to CO emissions were Germany, France, Poland and Italy (countries ranked according to their shares of the EU total).

Belgium explained that the peak of CO emissions in 2013 was because one of its plants produced lime without oxygen (see Belgium's IIR, listed in Appendix 5).

Romania reported a significant increase in CO emissions from 2004 to 2005, reflected mainly by data for the category '1A3bi — Road transport: Passenger cars'.

### Table 3.14 Member State contributions to EU emissions of CO

| | CO (Gg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 1 254 | 973 | 726 | 628 | 580 | 562 | 561 | 564 | 528 | 539 | 534 | 525 | 484 | 498 | -60 % | 2.9 % | 2.3 % | 2.8 % |
| Belgium | 1 464 | 1 245 | 981 | 794 | 497 | 399 | 343 | 515 | 320 | 370 | 355 | 288 | 332 | 369 | -75 % | 11.1 % | 2.6 % | 2.1 % |
| Bulgaria | 815 | 573 | 370 | 332 | 312 | 313 | 304 | 281 | 273 | 273 | 285 | 285 | 265 | 262 | -68 % | -1.1 % | 1.5 % | 1.5 % |
| Croatia | 548 | 441 | 463 | 414 | 325 | 302 | 288 | 277 | 244 | 266 | 257 | 251 | 231 | 216 | -60 % | -6.2 % | 1.0 % | 1.2 % |
| Cyprus | 44 | 38 | 30 | 26 | 14 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | -75 % | -2.2 % | 0.1 % | 0.1 % |
| Czechia | 2 060 | 1 561 | 1 070 | 925 | 930 | 899 | 884 | 887 | 858 | 844 | 846 | 844 | 842 | 819 | -60 % | -2.8 % | 3.7 % | 4.7 % |
| Denmark | 728 | 653 | 477 | 428 | 353 | 311 | 293 | 279 | 255 | 260 | 250 | 239 | 223 | 209 | -71 % | -6.6 % | 1.3 % | 1.2 % |
| Estonia | 254 | 221 | 199 | 153 | 157 | 131 | 142 | 134 | 129 | 129 | 140 | 138 | 131 | 131 | -49 % | -0.1 % | 0.5 % | 0.7 % |
| Finland | 770 | 675 | 601 | 524 | 454 | 412 | 409 | 389 | 383 | 360 | 371 | 359 | 350 | 345 | -55 % | -1.5 % | 1.4 % | 2.0 % |
| France | 10 590 | 8 881 | 6 433 | 5 193 | 4 126 | 3 407 | 3 099 | 3 139 | 2 628 | 2 586 | 2 612 | 2 554 | 2 425 | 2 375 | -78 % | -2.1 % | 19.1 % | 13.5 % |
| Germany | 13 171 | 7 169 | 5 135 | 3 916 | 3 617 | 3 550 | 3 291 | 3 252 | 3 089 | 3 190 | 3 060 | 3 082 | 2 958 | 2 883 | -78 % | -2.5 % | 23.8 % | 16.4 % |
| Greece | 1 237 | 1 065 | 1 009 | 869 | 616 | 598 | 641 | 552 | 559 | 538 | 481 | 493 | 469 | 464 | -62 % | -0.9 % | 2.2 % | 2.6 % |
| Hungary | 1 451 | 982 | 857 | 696 | 542 | 551 | 566 | 547 | 468 | 455 | 440 | 431 | 370 | 354 | -76 % | -4.3 % | 2.6 % | 2.0 % |
| Ireland | 348 | 291 | 247 | 217 | 145 | 134 | 127 | 120 | 113 | 111 | 104 | 92 | 82 | 68 | -80 % | -17.1 % | 0.6 % | 0.4 % |
| Italy | 6 797 | 7 072 | 4 751 | 3 467 | 3 073 | 2 432 | 2 680 | 2 503 | 2 260 | 2 271 | 2 195 | 2 261 | 2 052 | 2 062 | -70 % | 0.5 % | 12.3 % | 11.7 % |
| Latvia | 469 | 332 | 263 | 234 | 167 | 169 | 168 | 150 | 142 | 118 | 115 | 121 | 125 | 120 | -74 % | -3.9 % | 0.8 % | 0.7 % |
| Lithuania | 374 | 214 | 182 | 178 | 164 | 157 | 153 | 141 | 131 | 124 | 122 | 120 | 122 | 116 | -69 % | -5.2 % | 0.7 % | 0.7 % |
| Luxembourg | 469 | 213 | 47 | 39 | 29 | 27 | 28 | 27 | 26 | 22 | 23 | 23 | 21 | 21 | -95 % | 3.5 % | 0.8 % | 0.1 % |
| Malta | 25 | 14 | 16 | 9.5 | 15 | 13 | 12 | 11 | 11 | 10 | 9.4 | 9.9 | 7.9 | 7.5 | -70 % | -5.2 % | 0.0 % | 0.0 % |
| Netherlands | 1 148 | 928 | 762 | 730 | 666 | 650 | 619 | 585 | 564 | 562 | 581 | 596 | 628 | 626 | -45 % | -0.3 % | 2.1 % | 3.6 % |
| Poland | 3460 | 4 545 | 3 382 | 2 961 | 2 980 | 2 682 | 2 648 | 2 507 | 2 257 | 2 230 | 2 340 | 2 407 | 2 318 | 2 112 | -39 % | -8.9 % | 6.2 % | 12.0 % |
| Portugal | 798 | 828 | 683 | 523 | 402 | 370 | 355 | 335 | 317 | 325 | 311 | 327 | 285 | 293 | -63 % | 2.7 % | 1.4 % | 1.7 % |
| Romania | 832 | 591 | 888 | 1 203 | 1 037 | 989 | 974 | 953 | 956 | 870 | 885 | 892 | 891 | 894 | 7 % | 0.3 % | 1.5 % | 5.1 % |
| Slovakia | 1 016 | 645 | 547 | 559 | 456 | 423 | 437 | 413 | 321 | 363 | 378 | 373 | 320 | 279 | -72 % | -12.6 % | 1.8 % | 1.6 % |
| Slovenia | 291 | 284 | 205 | 183 | 143 | 140 | 134 | 133 | 113 | 121 | 120 | 115 | 105 | 97 | -67 % | -7.7 % | 0.5 % | 0.5 % |
| Spain | 3 907 | 3 028 | 2 513 | 1 857 | 1 641 | 1 618 | 1 384 | 1 588 | 1 416 | 1 517 | 1 494 | 1 491 | 1 639 | 1 600 | -59 % | -2.4 % | 7.0 % | 9.1 % |
| Sweden | 1 106 | 958 | 676 | 538 | 459 | 440 | 412 | 404 | 390 | 376 | 377 | 368 | 346 | 337 | -70 % | -2.7 % | 2.0 % | 1.9 % |
| **EU28 (a)** | **55 425** | **44 420** | **33 512** | **27 595** | **23 902** | **21 693** | **20 965** | **20 699** | **18 765** | **18 840** | **18 698** | **18 698** | **18 033** | **17 568** | **-68 %** | **-2.6 %** | **100 %** | **100 %** |
| EU28 (b) | 55 425 | 44 420 | 33 512 | 27 595 | 23 902 | 21 693 | 20 965 | 20 699 | 18 765 | 18 840 | 18 698 | 18 698 | 18 033 | 17 568 | | | | |

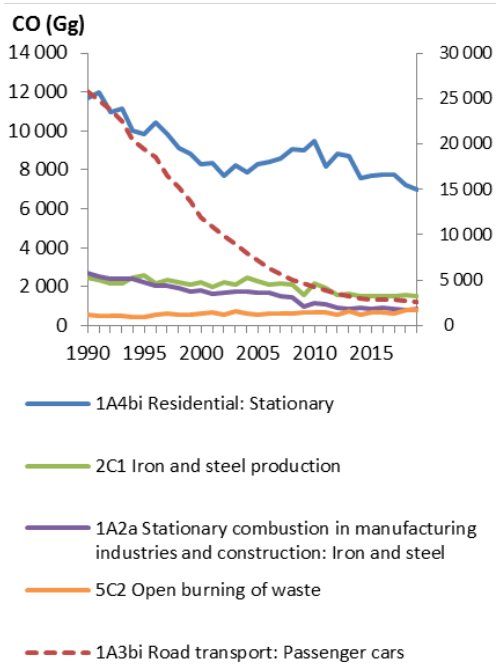
**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.
EU-28 does not include data from the United Kingdom (see Box ES.2).

Categories '1A4bi — Residential: Stationary' and '1A3bi — Road transport: Passenger cars' were the most important ones for CO emissions, jointly accounting for 55.0 % of the total. Among the top five key categories, the highest relative reduction in emissions between 1990 and 2019 was in the second most important, '1A3bi — Road transport: Passenger cars' (-89.9 %) (see Figure 3.11(a)). Reductions in emissions were observed in the categories '1A4bi — Residential: Stationary' (-40.5 %), '2C1 — Iron and steel production' (-38.9 %) and '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' (-69.7 %). The fifth most important key category, '5C2 — Open burning of waste', has increased by 48.1 % since 1990.

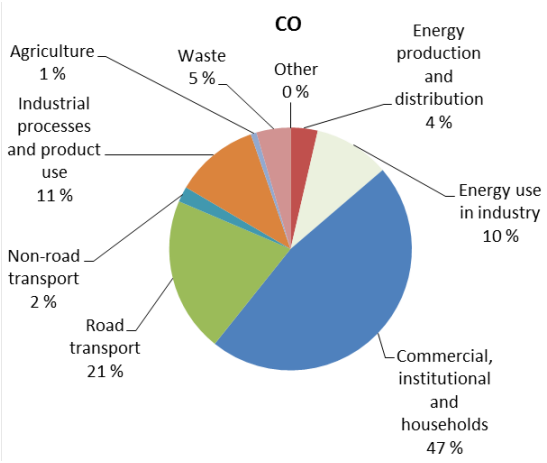
Figure 3.11(b) shows the contribution to total EU emissions made by each aggregated sector group. For CO, the common major emission sources are commercial, institutional and households, and road transport.

**Figure 3.11 CO emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

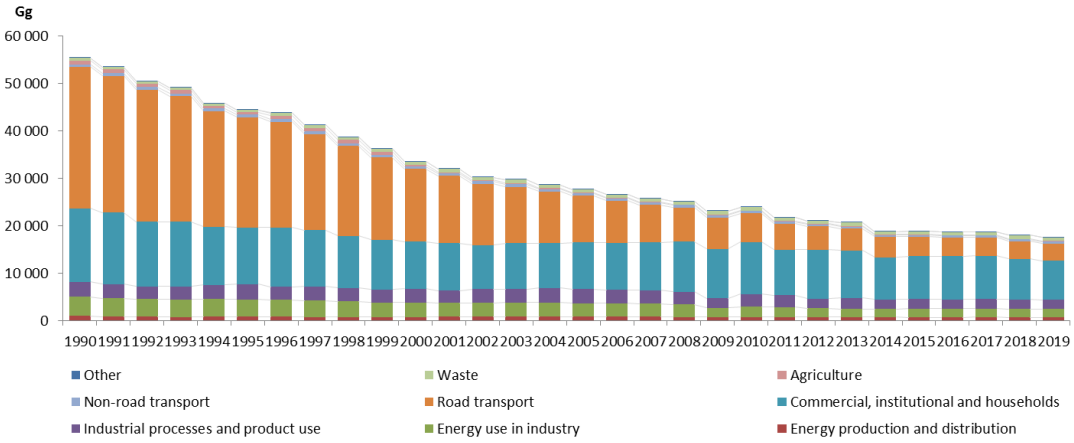
**(a)**




**(b)**




**(c)**




**Note:** In Figure 3.11 (a) the right-hand axis gives values for '1A3bi — Road transport: Passenger cars'.

## *3.12 Lead emission trends and key categories*

Between 1990 and 2019, lead (Pb) emissions dropped by 95 % in the EU. Between 2018 and 2019, emissions decreased by 10.3 % (see Table 3.15), mainly in Bulgaria, Estonia, Poland and, Italy (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Pb emissions were Poland, Italy and Germany (countries ranked according to their shares of the EU total).

EU total emissions of Pb have declined to less than a 10$^{th}$ of the emissions in 1990, primarily because of reduced emissions from the road transport sector. Thanks to a combination of fiscal and regulatory measures, the promotion of unleaded petrol within the EU has proved a notable success. EU Member States and other EEA member countries have now phased out the use of leaded petrol. In the EU, the Directive on the Quality of Petrol and Diesel Fuels (98/70/EC) regulated that goal (EEA, 2020b).

Belgium explained that the decrease in Pb emissions between 1995 and 2000 was mainly due to certain measures taken in two large plants in Flanders. At one plant (2C7c), a number of installations were taken out of service at the end of 1997 (electric kiln, agglomeration and roasting) and the ore park was evacuated. This led to a significant decrease in Pb, cadmium (Cd) and zinc (Zn) emissions. Another factory (2A3) reporting Pb emissions in 1997 did not produce an annual industrial report in 1998 and stopped production in 1999 (personal communication from Belgium in 2018).

In 2012, the Pb emission peak reported by Malta was caused by higher emissions in the category '1A1a — Public electricity and heat production'.

### Table 3.15 Member State contributions to EU emissions of Pb

| | Pb (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 233 | 20 | 17 | 18 | 20 | 20 | 20 | 21 | 20 | 20 | 20 | 21 | 19 | 20 | -91 % | 5.9 % | 1.2 % | 2.0 % |
| Belgium | 253 | 197 | 98 | 74 | 40 | 30 | 29 | 26 | 23 | 29 | 27 | 25 | 13 | 15 | -94 % | 9.2 % | 1.3 % | 1.4 % |
| Bulgaria | 448 | 369 | 275 | 124 | 63 | 67 | 69 | 72 | 81 | 74 | 68 | 75 | 75 | 10 | -98 % | -86.3 % | 2.2 % | 1.0 % |
| Croatia | 516 | 260 | 143 | 14 | 8.0 | 7.8 | 6.8 | 8.4 | 7.8 | 7.9 | 7.9 | 8.0 | 8.1 | 5.2 | -99 % | -36.3 % | 2.6 % | 0.5 % |
| Cyprus | 25 | 26 | 20 | 0.6 | 0.5 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | -98 % | -1.6 % | 0.1 % | 0.0 % |
| Czechia | 318 | 260 | 219 | 36 | 23 | 21 | 22 | 23 | 23 | 20 | 17 | 17 | 18 | 17 | -95 % | -2.1 % | 1.6 % | 1.7 % |
| Denmark | 130 | 26 | 20 | 17 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | -91 % | -3.2 % | 0.7 % | 1.1 % |
| Estonia | 207 | 88 | 40 | 37 | 41 | 40 | 36 | 42 | 39 | 31 | 35 | 36 | 33 | 11 | -95 % | -65.8 % | 1.0 % | 1.1 % |
| Finland | 321 | 73 | 31 | 21 | 20 | 19 | 16 | 16 | 17 | 15 | 16 | 16 | 15 | 13 | -96 % | -14.3 % | 1.6 % | 1.3 % |
| France | 4 286 | 1 458 | 262 | 154 | 112 | 99 | 101 | 98 | 93 | 86 | 85 | 86 | 86 | 85 | -98 % | -1.1 % | 21.5 % | 8.1 % |
| Germany | 1 900 | 682 | 357 | 232 | 171 | 169 | 161 | 163 | 159 | 165 | 161 | 167 | 162 | 161 | -92 % | -0.9 % | 9.5 % | 15.4 % |
| Greece | 505 | 405 | 340 | 66 | 31 | 30 | 27 | 25 | 27 | 10 | 9.5 | 11 | 10 | 7.9 | -98 % | -22.1 % | 2.5 % | 0.8 % |
| Hungary | 816 | 143 | 19 | 11 | 8.5 | 9.6 | 9.4 | 8.9 | 8.5 | 8.9 | 9.1 | 8.8 | 8.3 | 8.6 | -99 % | 2.9 % | 4.1 % | 0.8 % |
| Ireland | 158 | 99 | 15 | 8.0 | 6.2 | 5.7 | 5.6 | 6.0 | 5.6 | 5.7 | 5.5 | 5.4 | 5.4 | 4.8 | -97 % | -11.7 % | 0.8 % | 0.5 % |
| Italy | 4 280 | 1 996 | 964 | 298 | 218 | 229 | 222 | 204 | 207 | 199 | 203 | 206 | 205 | 199 | -95 % | -3.0 % | 21.5 % | 19.0 % |
| Latvia | 233 | 127 | 153 | 169 | 164 | 3.8 | 5.4 | 3.6 | 3.1 | 3.0 | 3.0 | 3.0 | 3.1 | 3.0 | -99 % | -2.5 % | 1.2 % | 0.3 % |
| Lithuania | 8 | 4 | 3.2 | 2.6 | 2.5 | 2.6 | 2.7 | 2.7 | 2.6 | 2.5 | 2.4 | 2.5 | 2.6 | 2.6 | -69 % | -0.9 % | 0.0 % | 0.2 % |
| Luxembourg | 19 | 9.1 | 1.4 | 1.9 | 1.4 | 1.9 | 2.1 | 1.5 | 1.5 | 1.6 | 1.5 | 1.5 | 1.4 | 1.5 | -92 % | 2.1 % | 0.1 % | 0.1 % |
| Malta | 0.2 | 0.3 | 0.2 | 3.9 | 3.8 | 2.6 | 10 | 3.5 | 4.5 | 1.4 | 0.8 | 0.2 | 0.2 | 0.2 | -5 % | 10.0 % | 0.0 % | 0.0 % |
| Netherlands | 338 | 155 | 28 | 30 | 38 | 23 | 16 | 14 | 9.1 | 8.7 | 9.0 | 8.6 | 5.9 | 5.2 | -98 % | -13.1 % | 1.7 % | 0.5 % |
| Poland | 546 | 580 | 393 | 277 | 303 | 300 | 313 | 305 | 307 | 298 | 290 | 302 | 298 | 276 | -49 % | -7.3 % | 2.7 % | 26.4 % |
| Portugal | 570 | 790 | 34 | 32 | 29 | 28 | 26 | 26 | 26 | 26 | 25 | 26 | 26 | 25 | -96 % | -3.3 % | 2.9 % | 2.4 % |
| Romania | 728 | 356 | 50 | 68 | 44 | 44 | 41 | 37 | 38 | 40 | 39 | 39 | 41 | 41 | -94 % | 0.2 % | 3.7 % | 3.9 % |
| Slovakia | 57 | 49 | 48 | 21 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 9.3 | -84 % | -12.6 % | 0.3 % | 0.9 % |
| Slovenia | 42 | 23 | 6.9 | 5.8 | 5.4 | 5.3 | 5.2 | 4.8 | 4.4 | 4.7 | 4.7 | 4.7 | 4.8 | 4.3 | -90 % | -10.5 % | 0.2 % | 0.4 % |
| Spain | 2 586 | 858 | 477 | 132 | 119 | 98 | 91 | 96 | 98 | 96 | 92 | 89 | 93 | 98 | -96 % | 5.9 % | 13.0 % | 9.4 % |
| Sweden | 374 | 29 | 18 | 11 | 9.6 | 8.5 | 8.5 | 8.2 | 8.8 | 8. | 8.9 | 9. | 7.8 | 8.1 | -98 % | 4.2 % | 1.9 % | 0.8 % |
| **EU28 (a)** | **19 900** | **9 080** | **4 034** | **1 865** | **1 504** | **1 288** | **1 268** | **1 238** | **1 236** | **1 184** | **1 164** | **1 191** | **1 166** | **1 046** | **-95 %** | **-10.3 %** | **100 %** | **100 %** |
| EU28 (b) | 19 900 | 9 080 | 4 034 | 1 865 | 1 504 | 1 288 | 1 268 | 1 238 | 1 236 | 1 184 | 1 164 | 1 191 | 1 166 | 1 046 | | | | |

**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. EU-28 does not include data from the United Kingdom (see Box ES.2).

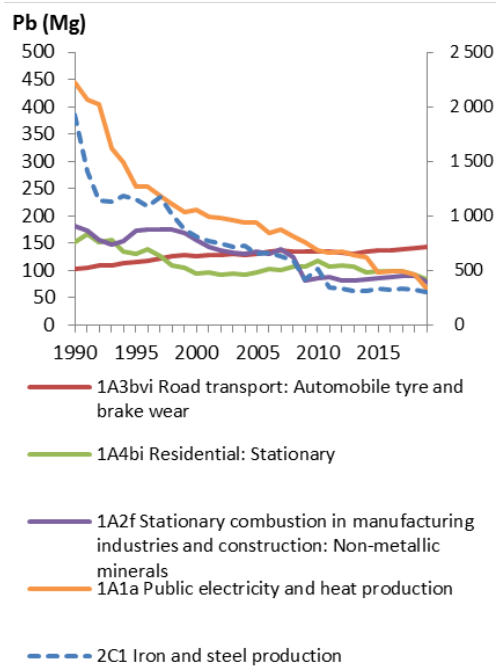
Categories '2C1 — Iron and steel production', '1A3bvi — Road transport: Automobile tyre and brake wear' and '1A4bi—Residential: Stationary' were the leading key ones for Pb emissions in 2019, together making up 51 % of total Pb emissions (see Figure 3.12 (a)).

The largest relative reductions in emissions between 1990 and 2019 were from the fifth important key category, '1a1a — 1A1a Public electricity and heat production' (-85.2 %) ', and the most important category, '2C1 —Iron and steel production' (-84.3 %). Emissions in the second most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear', have increased by 38.8 % since 1990.

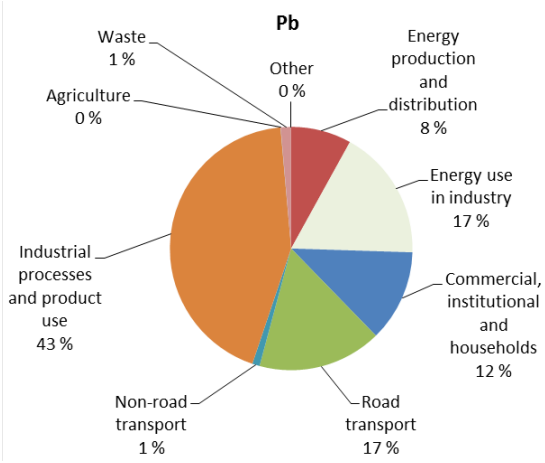
Figure 3.12(b) shows the contribution that each aggregated sector group made to total EU emissions. The sector groups industrial processes and product use, road transport, energy use in industry and commercial, institutional and households are significant sources of Pb.

**Figure 3.12 Pb emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

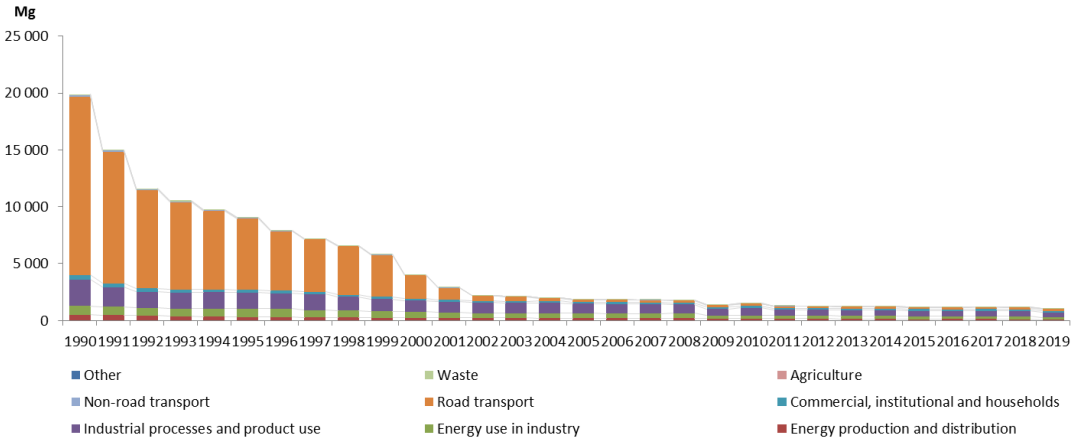
**(a)**




**(b)**




**(c)**




**Note:** In Figure 3.12(a), the right-hand axis gives values for '2C1 — Iron and steel production'.

## *3.13 Cadmium emission trends and key categories*

Between 1990 and 2019, Cd emissions fell by 66 % in the EU. However, between 2018 and 2019 they decreased by 4.8 % (Table 3.16), mainly because of a slight decrease in Germany, Bulgaria, Poland and Estonia (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Cd emissions were Germany, Poland and Spain (countries ranked according to their shares of the EU total).

### Table 3.16 Member State contributions to EU emissions of Cd

| | Cd (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 1.8 | 1.1 | 1.0 | 1.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.2 | 1.1 | 1.2 | -34 % | 2.2 % | 1.1 % | 2.1 % |
| Belgium | 6.0 | 4.9 | 2.6 | 2.2 | 2.0 | 1.7 | 1.5 | 1.5 | 1.3 | 1.6 | 2.6 | 1.4 | 1.2 | 1.2 | -80 % | -0.6 % | 3.7 % | 2.1 % |
| Bulgaria | 5.7 | 3.9 | 3.8 | 3.4 | 1.5 | 1.6 | 1.6 | 1.6 | 2.5 | 1.6 | 1.8 | 1.8 | 1.8 | 1.4 | -75 % | -22.8 % | 3.5 % | 2.5 % |
| Croatia | 1.1 | 0.8 | 0.9 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | -31 % | -5.3 % | 0.7 % | 1.4 % |
| Cyprus | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -61 % | -8.9 % | 0.1 % | 0.1 % |
| Czechia | 5.3 | 2.3 | 1.8 | 1.8 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | -75 % | 0.2 % | 3.3 % | 2.4 % |
| Denmark | 1.2 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | -42 % | -5.0 % | 0.8 % | 1.3 % |
| Estonia | 4.6 | 2.3 | 0.9 | 0.8 | 1.0 | 0.9 | 0.9 | 1.0 | 1.0 | 0.8 | 0.9 | 0.9 | 0.8 | 0.6 | -88 % | -33.2 % | 2.8 % | 1.0 % |
| Finland | 6.7 | 2.1 | 1.4 | 1.5 | 1.3 | 1.2 | 1.2 | 1.1 | 0.9 | 0.9 | 0.9 | 1.0 | 0.9 | 0.8 | -88 % | -9.9 % | 4.1 % | 1.4 % |
| France | 20 | 18 | 14 | 5.9 | 3.3 | 3.1 | 2.9 | 3.0 | 3.1 | 2.8 | 3.3 | 3.0 | 2.5 | 2.6 | -87 % | 4.4 % | 12.7 % | 4.7 % |
| Germany | 29 | 19 | 18 | 12 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | -63 % | -9.2 % | 18.1 % | 19.6 % |
| Greece | 7.5 | 7.8 | 8.4 | 8.9 | 4.7 | 4.5 | 4.4 | 3.8 | 4.1 | 2.1 | 2.0 | 2.1 | 1.9 | 1.7 | -77 % | -9.5 % | 4.7 % | 3.1 % |
| Hungary | 1.9 | 1.7 | 1.8 | 1.4 | 1.5 | 1.7 | 1.7 | 1.7 | 1.5 | 1.6 | 1.6 | 1.6 | 1.5 | 1.4 | -27 % | -4.3 % | 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 | 0.3 | 0.3 | 0.3 | 0.3 | -58 % | -6.2 % | 0.4 % | 0.5 % |
| Italy | 11 | 11 | 10 | 8.7 | 5.3 | 5.3 | 4.9 | 4.6 | 4.4 | 4.5 | 4.5 | 4.6 | 4.5 | 4.4 | -60 % | -2.7 % | 6.9 % | 7.9 % |
| Latvia | 0.9 | 0.8 | 0.9 | 1.1 | 1.0 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | -35 % | -1.3 % | 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 | 0.2 | -42 % | -3.0 % | 0.2 % | 0.3 % |
| Luxembourg | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -32 % | -9.4 % | 0.1 % | 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 | -71 % | 8.3 % | 0.0 % | 0.0 % |
| Netherlands | 3.9 | 2.9 | 2.7 | 3.6 | 4.6 | 3.3 | 3.0 | 3.0 | 2.9 | 2.9 | 2.9 | 2.6 | 2.5 | 2.6 | -32 % | 7.1 % | 2.4 % | 4.8 % |
| Poland | 12 | 11 | 8.4 | 8.3 | 8.8 | 8.9 | 9.0 | 8.6 | 8.8 | 9.0 | 8.8 | 9.0 | 9.0 | 8.6 | -25 % | -4.5 % | 7.2 % | 15.5 % |
| Portugal | 2.4 | 2.5 | 2.7 | 2.4 | 2.0 | 2.1 | 2.0 | 1.9 | 1.9 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | -23 % | -4.5 % | 1.5 % | 3.3 % |
| Romania | 5.0 | 3.9 | 3.4 | 3.7 | 3.6 | 3.5 | 3.5 | 3.2 | 3.2 | 3.0 | 3.0 | 3.1 | 3.1 | 3.0 | -40 % | -2.2 % | 3.1 % | 5.4 % |
| Slovakia | 1.6 | 1.3 | 1.4 | 1.4 | 1.2 | 1.2 | 1.2 | 1.1 | 0.9 | 0.9 | 1.0 | 1.0 | 0.9 | 0.9 | -44 % | -2.7 % | 1.0 % | 1.6 % |
| Slovenia | 0.6 | 0.5 | 0.5 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | -7 % | -3.8 % | 0.4 % | 1.0 % |
| Spain | 29 | 22 | 17 | 11 | 7.6 | 8.2 | 7.1 | 7.5 | 6.9 | 7.2 | 7.0 | 7.1 | 7.5 | 7.4 | -75 % | -2.2 % | 18.2 % | 13.3 % |
| Sweden | 2.3 | 0.7 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | -79 % | 1.7 % | 1.4 % | 0.9 % |
| **EU28 (a)** | **161** | **121** | **104** | **83** | **68** | **66** | **64** | **62** | **62** | **60** | **61** | **60** | **58** | **55** | **-66 %** | **-4.8 %** | **100 %** | **100 %** |
| EU28 (b) | 161 | 121 | 104 | 83 | 68 | 66 | 64 | 62 | 62 | 60 | 61 | 60 | 58 | 55 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

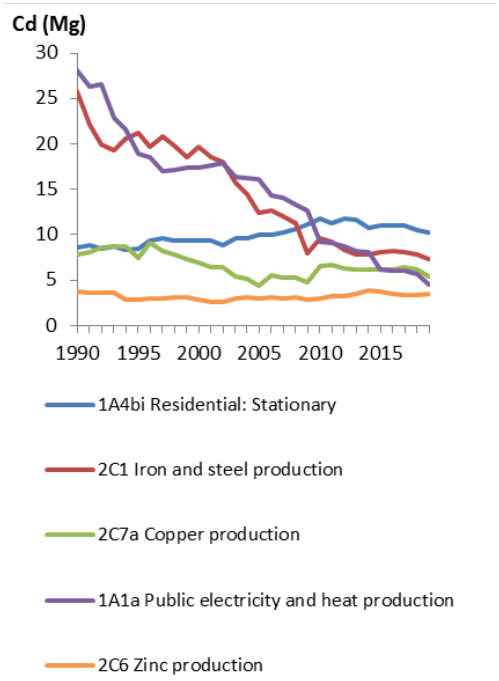
As with Pb, industrial sources of Cd emissions have fallen since the early 1990s in all EU Member States. This is largely because the abatement technologies for waste water treatment and incinerators have improved, as have metal refining and smelting facilities (EEA, 2020b).

Categories '1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '2C7a — Copper production' were the principal key ones for Cd emissions, making up 42 % of total Cd emissions (see Figure 3.13(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2019 were in the fourth most important, '1A1a — Public electricity and heat production' (-82.8 %), the third most important, '2C7a — Copper Production' (-29.6 %) and the second most important, '2C1 — Iron and steel production' (-71.7 %). In the most important key category, '1A4bi — Residential: Stationary', the values of reported emissions have increased since 1990 (+19.7 %).

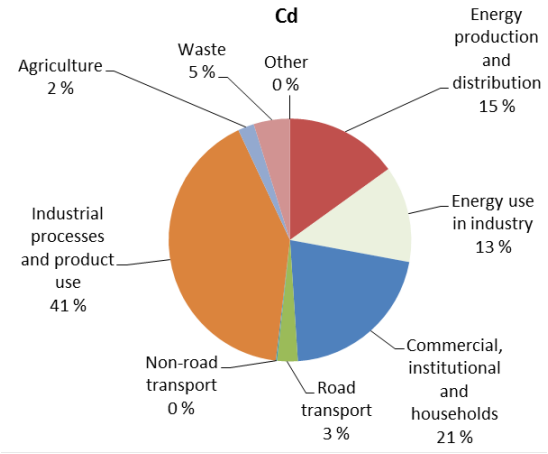
Figure 3.13(b) shows the contribution made by each aggregated sector group to total EU emissions. The common leading emission sources of Cd are the industrial processes and product use sector and the commercial, institutional and households energy sector.

**Figure 3.13 Cd emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

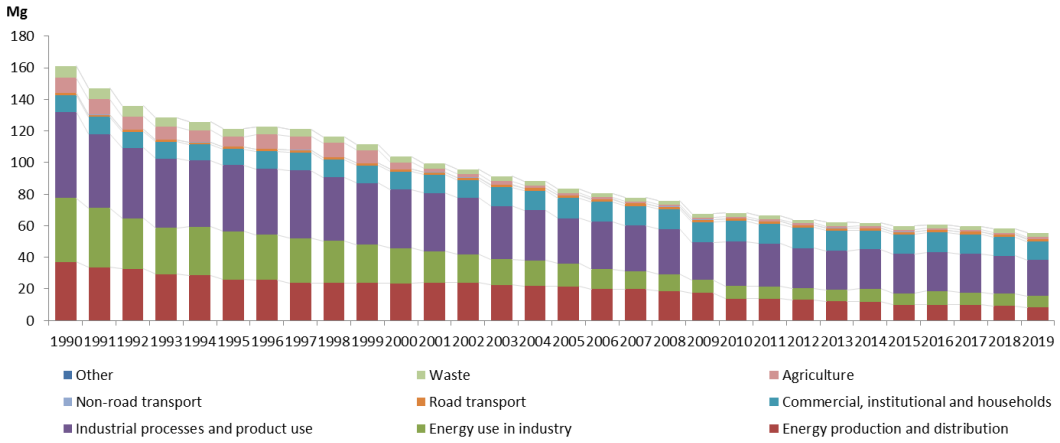
**(a)**




**(b)**




**(c)**



## *3.14 Mercury emission trends and key categories*

Between 1990 and 2019, mercury (Hg) emissions dropped by 72 % in the EU. Between 2018 and 2019, the decrease was 10.5 % (see Table 3.17), mainly because of lower emissions in Spain, Germany, Poland and Italy (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Hg emissions were Poland, Germany and Italy (countries ranked according to their shares of the EU total).

### Table 3.17 Member State contributions to EU emissions of Hg

| | Hg (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 2.2 | 1.2 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | -54 % | 2.7 % | 1.5 % | 2.4 % |
| Belgium | 6.1 | 3.3 | 3.2 | 2.2 | 1.7 | 1.7 | 1.3 | 1.4 | 1.5 | 1.1 | 1.4 | 1.0 | 1.4 | 1.0 | -83 % | -24.8 % | 4.1 % | 2.5 % |
| Bulgaria | 2.6 | 2.0 | 1.5 | 1.6 | 0.9 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 0.8 | 0.8 | -70 % | -5.9 % | 1.7 % | 1.9 % |
| Croatia | 1.1 | 0.3 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | -65 % | -8.5 % | 0.8 % | 0.9 % |
| Cyprus | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -71 % | -5.3 % | 0.1 % | 0.1 % |
| Czechia | 5.2 | 4.4 | 3.3 | 3.3 | 3.1 | 3.1 | 2.8 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.4 | 2.3 | -57 % | -5.8 % | 3.5 % | 5.4 % |
| Denmark | 3.2 | 2.3 | 1.0 | 0.7 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | -93 % | -14.5 % | 2.2 % | 0.6 % |
| Estonia | 1.2 | 0.7 | 0.6 | 0.6 | 0.7 | 0.7 | 0.6 | 0.7 | 0.7 | 0.6 | 0.7 | 0.6 | 0.6 | 0.3 | -73 % | -45.5 % | 0.8 % | 0.8 % |
| Finland | 1.1 | 0.8 | 0.6 | 0.9 | 0.9 | 0.8 | 0.7 | 0.8 | 0.7 | 0.6 | 0.6 | 0.6 | 0.7 | 0.6 | -46 % | -13.6 % | 0.7 % | 1.4 % |
| France | 26 | 21 | 12 | 7.4 | 4.8 | 4.8 | 4.4 | 4.3 | 4.6 | 4.0 | 3.5 | 3.3 | 3.1 | 3.0 | -88 % | -2.8 % | 17.4 % | 7.2 % |
| Germany | 35 | 20 | 18 | 14 | 11 | 10 | 10 | 9.8 | 9.6 | 9.4 | 8.6 | 8.5 | 8.3 | 7.2 | -80 % | -13.1 % | 24.1 % | 17.4 % |
| Greece | 2.3 | 2.3 | 2.6 | 2.7 | 2.4 | 2.4 | 2.4 | 2.2 | 1.5 | 1.4 | 1.2 | 1.3 | 1.3 | 1.2 | -48 % | -12.2 % | 1.5 % | 2.9 % |
| Hungary | 2.8 | 2.0 | 1.7 | 1.4 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 0.9 | 0.8 | 0.9 | 0.8 | 0.8 | -73 % | -3.0 % | 1.9 % | 1.9 % |
| Ireland | 0.8 | 0.7 | 0.5 | 0.5 | 0.4 | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | -60 % | -11.9 % | 0.6 % | 0.8 % |
| Italy | 15 | 14 | 14 | 12 | 8.3 | 8.5 | 9.2 | 7.7 | 8.4 | 7.2 | 6.6 | 7.2 | 7.0 | 6.5 | -57 % | -7.3 % | 10.4 % | 15.6 % |
| Latvia | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -70 % | -3.9 % | 0.2 % | 0.2 % |
| Lithuania | 0.5 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -72 % | 0.4 % | 0.4 % | 0.4 % |
| Luxembourg | 0.4 | 0.2 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -76 % | 74.7 % | 0.3 % | 0.2 % |
| Malta | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -67 % | 1.9 % | 0.0 % | 0.0 % |
| Netherlands | 3.6 | 1.5 | 1.2 | 1.0 | 0.8 | 0.9 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | -84 % | -5.8 % | 2.5 % | 1.4 % |
| Poland | 16 | 14 | 11 | 10 | 9.5 | 9.4 | 9.7 | 9.6 | 9.0 | 8.9 | 8.8 | 8.8 | 8.6 | 7.9 | -51 % | -8.8 % | 10.9 % | 18.9 % |
| Portugal | 2.2 | 2.4 | 2.3 | 1.8 | 1.6 | 1.4 | 1.4 | 1.3 | 1.3 | 1.4 | 1.3 | 1.4 | 1.3 | 1.3 | -41 % | -4.3 % | 1.5 % | 3.1 % |
| Romania | 4.2 | 2.7 | 2.6 | 3.2 | 2.2 | 2.6 | 1.9 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | -65 % | -2.9 % | 2.8 % | 3.5 % |
| Slovakia | 2.3 | 1.7 | 1.9 | 1.2 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | -65 % | -3.9 % | 1.5 % | 1.9 % |
| Slovenia | 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 | 0.2 | -52 % | -3.3 % | 0.2 % | 0.4 % |
| Spain | 11 | 13 | 8.9 | 7.4 | 4.3 | 4.4 | 4.7 | 4.1 | 4.2 | 4.4 | 4.5 | 4.4 | 4.2 | 3.1 | -71 % | -26.6 % | 7.3 % | 7.4 % |
| Sweden | 1.6 | 1.0 | 0.7 | 0.7 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | -74 % | -1.5 % | 1.1 % | 1.0 % |
| **EU28 (a)** | **147** | **112** | **91** | **76** | **57** | **57** | **56** | **52** | **52** | **49** | **47** | **47** | **46** | **42** | **-72 %** | **-10.5 %** | **100 %** | **100 %** |
| EU28 (b) | 147 | 112 | 91 | 76 | 57 | 57 | 56 | 52 | 52 | 49 | 47 | 47 | 46 | 42 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

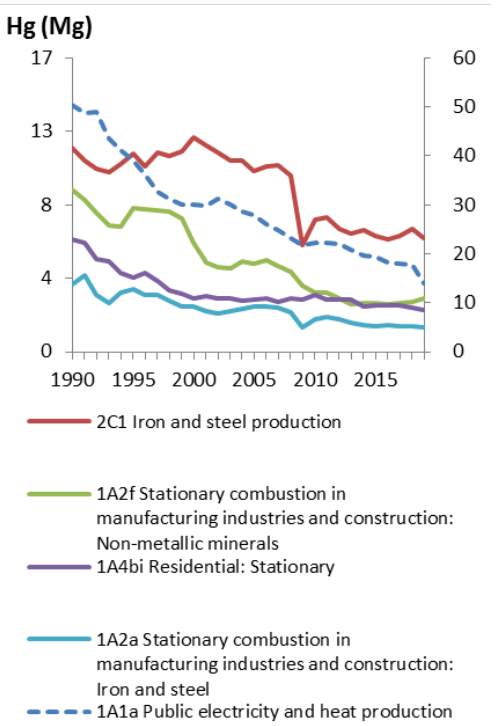
Categories '1A1a — Public electricity and heat production', '2C1 — Iron and steel production' and '1A2f —Stationary combustion in manufacturing industries and construction: Non-metallic minerals' were the main key ones for Hg emissions, making up 58 % of the total (see Figure 3.14(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2019 was in the most important, '1A1a — Public electricity and heat production' (-71.2 %). The third most important key category, '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (-70.0 %) and the fourth most important, '1A4bi — Residential: Stationary' (-63.1 %) also show high reductions. In the fifth most important key category, '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel', the values of reported emissions have decreased since 1990 (-63.4 %).

The strong decrease in 2009 in the sector '2C1 — Iron and steel production' mainly reflects lower emissions reported by Belgium (see Figure 3.14). 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, 2020c).

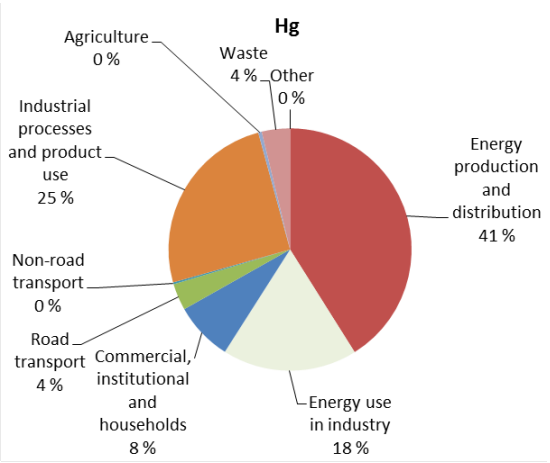
Figure 3.14(b) shows the contribution made by each aggregated sector group to total EU emissions. For Hg, the principal emission sources are the energy sectors and the industrial processes and product use sector.

**Figure 3.14 Hg emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

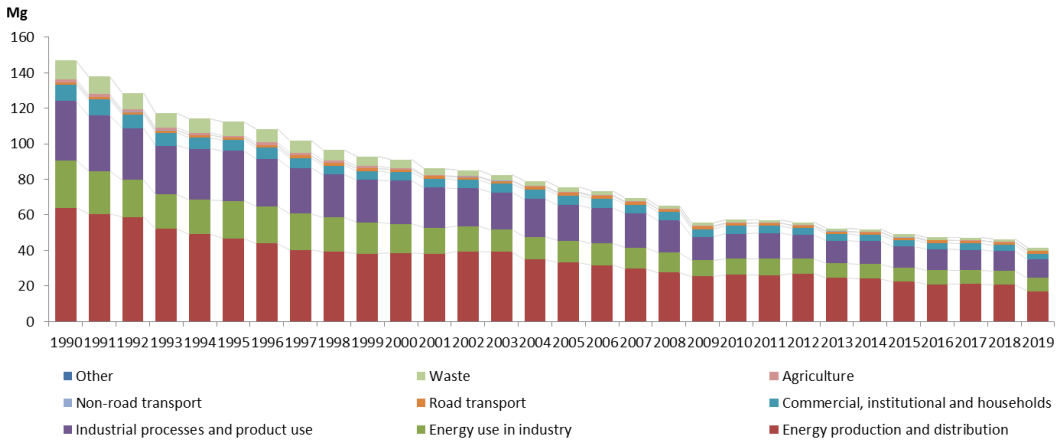
**(a)**




**(b)**




**(c)**




**Note:** In Figure 3.14(a), the right-hand axis shows values for '1A1a — Public electricity and heat production'.

## *3.15 Arsenic emission trends*

Between 1990 and 2019, arsenic (As) emissions dropped by 88 % in the EU. Between 2018 and 2019, emissions fell by 15.6 % (Table 3.18), mainly because emissions decreased in Estonia, Spain, Italy and Poland (countries ranked according to the size of their contributions to the absolute change). The EU Member States that contributed most (i.e. more than 10 %) to As emissions in 2019 were Poland and Spain (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 3.18 Member State contributions to EU emissions of As

| | As (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 6.7 | 6.4 | 3.9 | 3.0 | 1.9 | 1.6 | 1.5 | 1.3 | 1.1 | 1.2 | 0.9 | 0.9 | 0.9 | 0.9 | -86 % | 3.4 % | 1.2 % | 1.3 % |
| Bulgaria | 25 | 15 | 7.5 | 16 | 3.5 | 4.1 | 3.0 | 2.9 | 4.4 | 3.0 | 3.7 | 3.7 | 3.5 | 3.1 | -88 % | -11.8 % | 4.3 % | 4.4 % |
| Croatia | 8.6 | 1.2 | 1.1 | 1.1 | 0.8 | 0.6 | 0.6 | 0.5 | 0.4 | 0.5 | 0.4 | 0.5 | 0.6 | 0.6 | -93 % | 4.7 % | 1.5 % | 0.8 % |
| Cyprus | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -29 % | -9.5 % | 0.0 % | 0.1 % |
| Czechia | 70 | 17 | 3.9 | 2.1 | 1.7 | 1.6 | 1.5 | 1.7 | 1.4 | 1.5 | 1.4 | 1.6 | 1.4 | 1.3 | -98 % | -5.5 % | 12.0 % | 1.9 % |
| Denmark | 1.3 | 0.8 | 0.8 | 0.5 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | -83 % | -5.1 % | 0.2 % | 0.3 % |
| Estonia | 19 | 10 | 8.7 | 9.3 | 11 | 11 | 9.7 | 11 | 10 | 7.8 | 9.0 | 9.5 | 8.7 | 2.0 | -89 % | -76.8 % | 3.3 % | 2.9 % |
| Finland | 35 | 5.2 | 4.4 | 3.0 | 3.4 | 3.0 | 2.6 | 2.8 | 2.7 | 2.5 | 2.6 | 2.4 | 2.4 | 2.1 | -94 % | -14.5 % | 6.0 % | 2.9 % |
| France | 17 | 17 | 15 | 12 | 7.7 | 6.5 | 6.3 | 6.5 | 5.5 | 5.5 | 5.5 | 5.3 | 5.3 | 5.1 | -71 % | -4.0 % | 3.0 % | 7.2 % |
| Germany | 86 | 9.0 | 7.9 | 7.5 | 7.3 | 7.0 | 6.9 | 7.1 | 6.7 | 6.7 | 6.7 | 6.4 | 6.1 | 5.5 | -94 % | -9.9 % | 14.9 % | 7.8 % |
| Greece | 2.4 | 2.6 | 3.0 | 3.1 | 2.3 | 2.1 | 2.4 | 2.1 | 3.5 | 3.1 | 2.5 | 2.7 | 2.4 | 1.8 | -24 % | -26.0 % | 0.4 % | 2.6 % |
| Hungary | 4.1 | 3.3 | 3.2 | 2.6 | 2.3 | 2.3 | 2.2 | 1.9 | 2.0 | 2.2 | 2.0 | 2.2 | 2.1 | 1.9 | -52 % | -9.1 % | 0.7 % | 2.8 % |
| Ireland | 1.7 | 1.7 | 1.7 | 1.6 | 1.3 | 1.3 | 1.4 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.1 | -31 % | -8.8 % | 0.3 % | 1.6 % |
| Italy | 37 | 28 | 39 | 28 | 17 | 18 | 17 | 17 | 17 | 9.2 | 8.6 | 8.1 | 7.9 | 7.0 | -81 % | -11.3 % | 6.4 % | 10.0 % |
| Latvia | 17 | 8.5 | 15 | 17 | 16 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | -99 % | 3.7 % | 2.9 % | 0.3 % |
| Lithuania | 0.9 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -86 % | -4.4 % | 0.2 % | 0.2 % |
| Luxembourg | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | | | | |
| Malta | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -98 % | 1.1 % | 0.0 % | 0.0 % |
| Netherlands | 1.3 | 0.9 | 0.9 | 1.3 | 0.6 | 1.0 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 0.4 | 0.2 | -86 % | -50.2 % | 0.2 % | 0.3 % |
| Poland | 145 | 72 | 31 | 19 | 18 | 18 | 18 | 18 | 18 | 18 | 17 | 18 | 17 | 16 | -89 % | -3.8 % | 25.1 % | 23.2 % |
| Portugal | 3.3 | 3.7 | 3.9 | 3.9 | 2.1 | 2.0 | 2.2 | 2.1 | 2.0 | 2.2 | 2.0 | 2.1 | 2.0 | 1.6 | -51 % | -20.7 % | 0.6 % | 2.3 % |
| Romania | 73 | 37 | 5.8 | 6.4 | 5.0 | 5.7 | 5.2 | 4.3 | 4.3 | 4.5 | 4.1 | 4.1 | 4.1 | 3.9 | -95 % | -4.2 % | 12.6 % | 5.6 % |
| Slovakia | 3.6 | 2.2 | 2.2 | 1.8 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.0 | -71 % | -14.3 % | 0.6 % | 1.5 % |
| Slovenia | 0.9 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.6 | -29 % | -3.2 % | 0.2 % | 0.9 % |
| Spain | 15 | 12 | 16 | 14 | 12 | 13 | 11 | 14 | 11 | 12 | 12 | 12 | 14 | 13 | -14 % | -9.3 % | 2.6 % | 18.1 % |
| Sweden | 5.6 | 1.6 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.7 | 0.7 | 0.8 | 0.7 | 0.7 | -87 % | -1.4 % | 1.0 % | 1.0 % |
| **EU28 (a)** | **578** | **257** | **177** | **154** | **119** | **103** | **97** | **98** | **95** | **86** | **84** | **84** | **83** | **70** | **-88 %** | **-15.6 %** | **100 %** | **100 %** |
| EU28 (b) | 578 | 257 | 177 | 154 | 119 | 103 | 97 | 98 | 95 | 86 | 84 | 84 | 83 | 70 | | | | |

**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.

EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.16 Chromium emission trends*

Between 1990 and 2019, chromium (Cr) emissions dropped by 71 % in the EU. Between 2018 and 2019, emissions dropped by 6.5 % (see Table 3.19), mainly because of decreases in Estonia, Germany, Bulgaria and  (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Cr emissions were Germany, Poland, Italy and France (countries ranked according to their shares of the EU total). As Austria and Luxembourg did not provide emission data for Cr, the EU total is an underestimate.

### Table 3.19 Member State contributions to EU emissions of Cr

| | Cr (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 36 | 32 | 21 | 18 | 14 | 12 | 11 | 6.4 | 6.1 | 6.1 | 6.4 | 4.9 | 4.8 | 4.8 | -87 % | -0.9 % | 3.6 % | 1.6 % |
| Bulgaria | 21 | 10 | 7.5 | 9.9 | 5.4 | 5.8 | 5.5 | 5.3 | 5.7 | 6.4 | 6.8 | 7.1 | 6.7 | 3.5 | -83 % | -47.3 % | 2.1 % | 1.2 % |
| Croatia | 5.3 | 3.7 | 3.2 | 3.7 | 2.5 | 2.5 | 2.4 | 2.2 | 2.0 | 2.2 | 2.0 | 2.1 | 2.0 | 1.9 | -64 % | -2.8 % | 0.5 % | 0.6 % |
| Cyprus | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | .2 | .2 | -3 % | -0.9 % | 0.0 % | 0.1 % |
| Czechia | 26 | 17 | 12 | 12 | 11 | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 10.1 | 9.7 | -63 % | -3.6 % | 2.6 % | 3.3 % |
| Denmark | 6.0 | 3.2 | 1.7 | 1.7 | 1.8 | 1.7 | 1.6 | 1.7 | 1.6 | 1.8 | 1.8 | 1.8 | 1.7 | 1.6 | -73 % | -6.4 % | 0.6 % | 0.5 % |
| Estonia | 18 | 10 | 8.4 | 9.1 | 11 | 10 | 9.2 | 11 | 9.9 | 7.6 | 8.7 | 9.2 | 8.3 | 2.5 | -87 % | -70.2 % | 1.8 % | 0.8 % |
| Finland | 48 | 36 | 29 | 20 | 26 | 17 | 19 | 18 | 23 | 17 | 18 | 17 | 15 | 14 | -70 % | -6.9 % | 4.7 % | 4.8 % |
| France | 399 | 197 | 112 | 55 | 39 | 34 | 34 | 34 | 31 | 31 | 31 | 30 | 30 | 30 | -92 % | 1.3 % | 39.5 % | 10.2 % |
| Germany | 166 | 94 | 83 | 76 | 74 | 75 | 75 | 74 | 75 | 76 | 77 | 77 | 75 | 71 | -57 % | -5.6 % | 16.4 % | 24.0 % |
| Greece | 6.0 | 6.5 | 6.9 | 7.3 | 7.4 | 8.7 | 9.3 | 7.7 | 15 | 15 | 11 | 10 | 11.2 | 10.1 | 68 % | -10.5 % | 0.6 % | 3.4 % |
| Hungary | 18 | 12 | 12 | 12 | 11 | 12 | 11 | 7.8 | 8.7 | 11 | 9.4 | 12 | 12 | 11 | -36 % | -8.7 % | 1.7 % | 3.8 % |
| Ireland | 4.5 | 4.5 | 4.8 | 3.3 | 2.5 | 2.3 | 2.3 | 2.4 | 2.5 | 2.5 | 2.6 | 2.5 | 2.5 | 2.4 | -48 % | -5.3 % | 0.4 % | 0.8 % |
| Italy | 86 | 69 | 44 | 50 | 40 | 41 | 40 | 36 | 35 | 35 | 35 | 35 | 35 | 34 | -61 % | -3.9 % | 8.5 % | 11.4 % |
| Latvia | 2.5 | 1.9 | 2.2 | 2.5 | 2.4 | 1.2 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | -48 % | -1.8 % | 0.2 % | 0.4 % |
| Lithuania | 2.7 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | -61 % | -1.6 % | 0.3 % | 0.4 % |
| Luxembourg | NR | 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 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -33 % | 4.0 % | 0.0 % | 0.0 % |
| Netherlands | 12 | 8.6 | 5.1 | 4.4 | 3.9 | 3.7 | 3.8 | 3.7 | 3.6 | 3.5 | 3.8 | 3.6 | 3.6 | 3.3 | -72 % | -6.3 % | 1.2 % | 1.1 % |
| Poland | 57 | 52 | 39 | 38 | 40 | 39 | 39 | 38 | 37 | 38 | 37 | 38 | 37 | 37 | -35 % | -1.2 % | 5.6 % | 12.4 % |
| Portugal | 12 | 13 | 13 | 12 | 8.8 | 8.0 | 7.8 | 7.7 | 7.5 | 7.7 | 7.1 | 7.4 | 7.0 | 6.9 | -43 % | -1.3 % | 1.2 % | 2.3 % |
| Romania | 25 | 19 | 15 | 19 | 13 | 12 | 12 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | -51 % | 2.0 % | 2.5 % | 4.1 % |
| Slovakia | 6.4 | 4.2 | 3.5 | 4.0 | 4.5 | 4.5 | 4.7 | 4.0 | 3.8 | 4.1 | 4.5 | 4.6 | 4.3 | 4.4 | -31 % | 2.0 % | 0.6 % | 1.5 % |
| Slovenia | 1.4 | 1.3 | 1.3 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.3 | 1.3 | 1.4 | 1.4 | 1.3 | 1.3 | -10 % | -3.5 % | 0.1 % | 0.4 % |
| Spain | 28 | 30 | 35 | 35 | 27 | 27 | 28 | 25 | 26 | 27 | 27 | 27 | 27 | 25 | -10 % | -6.8 % | 2.8 % | 8.6 % |
| Sweden | 23 | 12 | 6.9 | 10 | 5.1 | 6.4 | 5.0 | 4.9 | 4.5 | 5.4 | 5.6 | 6.7 | 6.0 | 6.0 | -74 % | -0.9 % | 2.3 % | 2.0 % |
| **EU28 (a)** | **1 010** | **640** | **468** | **407** | **352** | **339** | **334** | **315** | **324** | **323** | **320** | **321** | **316** | **296** | **-71 %** | **-6.5 %** | **100 %** | **100 %** |
| EU28 (b) | 1 010 | 640 | 468 | 407 | 352 | 339 | 334 | 315 | 324 | 323 | 320 | 321 | 316 | 296 | | | | |

**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.

EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.17 Copper emission trends*

Between 1990 and 2019, copper (Cu) emissions in the EU decreased by 9 %. Between 2018 and 2019, they fell by 1.4 % (see Table 3.20), mainly because of decreases in Bulgaria, Poland, Spain and Italy (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Cu emissions were Germany, France and Poland (together the have 59.3 % of EU-28 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 3.20 Member State contributions to EU emissions of Cu

| | Cu (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 51 | 52 | 49 | 46 | 45 | 44 | 43 | 40 | 40 | 41 | 42 | 40 | 40 | 40 | -22 % | 0.4 % | 2.6 % | 2.2 % |
| Bulgaria | 107 | 77 | 58 | 101 | 23 | 24 | 24 | 23 | 24 | 26 | 26 | 28 | 29 | 9 | -92 % | -69.7 % | 5.5 % | 0.5 % |
| Croatia | 7.3 | 6.1 | 7.4 | 9.3 | 8.1 | 7.9 | 7.4 | 8.4 | 7.9 | 8.3 | 8.5 | 9.3 | 9.2 | 10.1 | 38 % | 9.2 % | 0.4 % | 0.6 % |
| Cyprus | 1.6 | 2.0 | 2.4 | 2.6 | 2.8 | 2.7 | 2.5 | 2.1 | 2.1 | 2.1 | 2.3 | 2.3 | 2.4 | 2.4 | 52 % | 0.5 % | 0.1 % | 0.1 % |
| Czechia | 32 | 26 | 21 | 26 | 24 | 24 | 24 | 24 | 26 | 26 | 26 | 27 | 27 | 27 | -15 % | -0.4 % | 1.6 % | 1.5 % |
| Denmark | 33 | 37 | 40 | 42 | 43 | 43 | 42 | 42 | 41 | 43 | 43 | 43 | 45 | 43 | 33 % | -2.9 % | 1.7 % | 2.4 % |
| Estonia | 11 | 5.6 | 4.3 | 5.4 | 5.8 | 5.9 | 5.7 | 6.0 | 6.0 | 5.5 | 5.8 | 5.9 | 5.9 | 4.9 | -55 % | -16.8 % | 0.6 % | 0.3 % |
| Finland | 157 | 117 | 65 | 58 | 42 | 42 | 41 | 42 | 43 | 41 | 42 | 41 | 40 | 40 | -74 % | 0.0 % | 8.0 % | 2.2 % |
| France | 257 | 260 | 268 | 279 | 274 | 272 | 266 | 266 | 264 | 271 | 268 | 269 | 267 | 270 | 5 % | 1.0 % | 13.1 % | 15.1 % |
| Germany | 620 | 522 | 544 | 540 | 549 | 553 | 555 | 552 | 567 | 579 | 584 | 587 | 585 | 587 | -5 % | 0.3 % | 31.5 % | 32.8 % |
| Greece | 22 | 26 | 29 | 33 | 35 | 32 | 26 | 26 | 30 | 28 | 28 | 29 | 30 | 30 | 33 % | 0.4 % | 1.1 % | 1.7 % |
| Hungary | 16 | 11 | 13 | 16 | 15 | 15 | 14 | 13 | 14 | 16 | 16 | 17 | 18 | 18 | 15 % | -0.6 % | 0.8 % | 1.0 % |
| Ireland | 10 | 11 | 18 | 21 | 18 | 18 | 18 | 18 | 18 | 19 | 20 | 19 | 19 | 19 | 92 % | -0.6 % | 0.5 % | 1.1 % |
| Italy | 193 | 216 | 222 | 230 | 203 | 205 | 194 | 184 | 199 | 189 | 180 | 171 | 173 | 171 | -11 % | -0.9 % | 9.8 % | 9.6 % |
| Latvia | 4.6 | 2.7 | 2.9 | 3.9 | 4.1 | 3.5 | 3.5 | 3.6 | 3.8 | 3.9 | 4.0 | 4.2 | 4.3 | 4.4 | -5 % | 0.6 % | 0.2 % | 0.2 % |
| Lithuania | 7.8 | 3.8 | 3.3 | 4.2 | 4.4 | 4.4 | 4.5 | 4.3 | 4.7 | 4.9 | 5.0 | 5.3 | 5.7 | 5.9 | -23 % | 3.7 % | 0.4 % | 0.3 % |
| Luxembourg | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | | | | |
| Malta | 0.6 | 1.1 | 1.0 | 1.1 | 1.2 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.4 | 131 % | 3.4 % | 0.0 % | 0.1 % |
| Netherlands | 36 | 37 | 38 | 40 | 43 | 42 | 41 | 41 | 41 | 39 | 39 | 41 | 41 | 41 | 14 % | 1.3 % | 1.8 % | 2.3 % |
| Poland | 185 | 196 | 153 | 166 | 199 | 194 | 193 | 184 | 182 | 184 | 193 | 209 | 210 | 204 | 10 % | -2.9 % | 9.4 % | 11.4 % |
| Portugal | 26 | 32 | 42 | 45 | 36 | 32 | 30 | 29 | 30 | 29 | 29 | 30 | 29 | 30 | 12 % | 0.8 % | 1.3 % | 1.7 % |
| Romania | 9.4 | 8.5 | 6.8 | 20 | 20 | 20 | 22 | 21 | 21 | 21 | 22 | 23 | 24 | 26 | 171 % | 4.5 % | 0.5 % | 1.4 % |
| Slovakia | 12 | 8.8 | 6.9 | 8.8 | 9.6 | 9.7 | 10 | 9.0 | 9.4 | 11 | 11 | 11 | 9.4 | 9.7 | -19 % | 3.4 % | 0.6 % | 0.5 % |
| Slovenia | 3.6 | 4.3 | 4.2 | 5.1 | 5.4 | 5.5 | 5.4 | 5.0 | 4.9 | 5.0 | 5.2 | 5.2 | 5.5 | 5.2 | 44 % | -5.5 % | 0.2 % | 0.3 % |
| Spain | 100 | 119 | 156 | 174 | 165 | 153 | 143 | 138 | 142 | 147 | 149 | 152 | 154 | 152 | 52 % | -1.6 % | 5.1 % | 8.5 % |
| Sweden | 65 | 51 | 45 | 37 | 38 | 38 | 38 | 37 | 38 | 38 | 39 | 40 | 41 | 40 | -39 % | -2.1 % | 3.3 % | 2.2 % |
| **EU28 (a)** | **1 969** | **1 834** | **1 800** | **1 915** | **1 813** | **1 791** | **1 753** | **1 721** | **1 759** | **1 778** | **1 790** | **1 810** | **1 816** | **1 790** | **-9 %** | **-1.4 %** | **100 %** | **100 %** |
| EU28 (b) | 1 969 | 1 834 | 1 800 | 1 915 | 1 813 | 1 791 | 1 753 | 1 721 | 1 759 | 1 778 | 1 790 | 1 810 | 1 816 | 1 790 | | | | |

**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.

EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.18 Nickel emission trends*

Between 1990 and 2019, nickel (Ni) emissions dropped by 77 % in the EU. Between 2018 and 2019, they decreased by 6.9 %, mainly because Germany, Spain, Poland and Estonia (countries ranked according to the size of their contributions to the absolute change) (see Table 3.21). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Ni emissions were Germany, Poland and Spain (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.

In Bulgaria, Ni emissions in 2000 and 2001 were much lower than in the years before and after, and they declined again in 2008 because Ni emissions from primary Cu production fell (personal communication from Bulgaria in 2012).

### Table 3.21 Member State contributions to EU emissions of Ni

| | Ni (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 77 | 71 | 35 | 29 | 10 | 9.4 | 6.7 | 5.3 | 5.0 | 5.0 | 4.9 | 4.0 | 3.6 | 3.7 | -95 % | 2.6 % | 4.1 % | 0.9 % |
| Bulgaria | 33 | 28 | 8.0 | 24 | 6.9 | 7.2 | 5.6 | 5.8 | 6.0 | 5.8 | 6.0 | 6.5 | 6.2 | 4.2 | -87 % | -32.1 % | 1.7 % | 1.0 % |
| Croatia | 17 | 14 | 13 | 14 | 7.7 | 6.7 | 6.0 | 4.7 | 3.8 | 4.5 | 4.2 | 4.3 | 3.5 | 2.8 | -84 % | -19.7 % | 0.9 % | 0.7 % |
| Cyprus | 5.9 | 7.3 | 10.1 | 12 | 7.2 | 9.0 | 9.4 | 5.2 | 5.2 | 5.3 | 5.7 | 5.6 | 5.7 | 5.1 | -14 % | -9.9 % | 0.3 % | 1.2 % |
| Czechia | 55 | 28 | 14 | 12 | 8.0 | 7.1 | 6.1 | 5.5 | 5.5 | 5.3 | 5.0 | 5.4 | 5.1 | 4.8 | -91 % | -5.5 % | 2.9 % | 1.1 % |
| Denmark | 19 | 13 | 7.6 | 7.2 | 4.6 | 4.0 | 3.8 | 3.8 | 3.2 | 2.9 | 2.9 | 3.0 | 2.7 | 2.6 | -86 % | -3.6 % | 1.0 % | 0.6 % |
| Estonia | 27 | 11 | 6.5 | 6.4 | 6.6 | 6.5 | 5.7 | 6.5 | 6.1 | 4.7 | 5.4 | 5.7 | 5.1 | 1.6 | -94 % | -68.8 % | 1.5 % | 0.4 % |
| Finland | 78 | 47 | 35 | 26 | 23 | 20 | 19 | 17 | 17 | 16 | 16 | 15 | 14 | 12 | -85 % | -18.4 % | 4.2 % | 2.7 % |
| France | 286 | 214 | 177 | 149 | 87 | 67 | 60 | 53 | 47 | 42 | 38 | 31 | 24 | 25 | -91 % | 2.8 % | 15.2 % | 5.9 % |
| Germany | 340 | 208 | 166 | 177 | 154 | 142 | 140 | 135 | 128 | 135 | 145 | 145 | 147 | 139 | -59 % | -5.3 % | 18.0 % | 32.4 % |
| Greece | 42 | 47 | 50 | 55 | 60 | 56 | 59 | 50 | 34 | 40 | 34 | 32 | 30 | 27 | -36 % | -10.5 % | 2.2 % | 6.3 % |
| Hungary | 12 | 20 | 14 | 3.7 | 2.8 | 2.5 | 2.5 | 2.3 | 2.4 | 2.5 | 2.4 | 2.6 | 2.5 | 2.3 | -80 % | -6.8 % | 0.6 % | 0.5 % |
| Ireland | 21.9 | 27 | 32 | 21 | 10 | 7 | 6 | 7.1 | 6.7 | 6.4 | 6.4 | 5.9 | 6.0 | 6.3 | -71 % | 4.2 % | 1.2 % | 1.5 % |
| Italy | 114 | 110 | 107 | 112 | 41 | 39 | 36 | 31 | 30 | 30 | 30 | 30 | 30 | 28 | -75 % | -5.1 % | 6.1 % | 6.5 % |
| Latvia | 15 | 8.5 | 6.8 | 6.4 | 5.8 | 0.5 | 0.9 | 0.5 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | -97 % | -8.6 % | 0.8 % | 0.1 % |
| Lithuania | 31 | 14 | 6.4 | 4.7 | 3.5 | 2.6 | 3.5 | 2.3 | 1.9 | 1.9 | 1.5 | 1.3 | 1.3 | 1.0 | -97 % | -19.2 % | 1.6 % | 0.2 % |
| Luxembourg | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | | | | |
| Malta | 3.4 | 4.9 | 4.7 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -97 % | 6.1 % | 0.2 % | 0.0 % |
| Netherlands | 75 | 86 | 20 | 10 | 2.3 | 2.5 | 2.2 | 2.0 | 1.9 | 2.0 | 2.1 | 2.2 | 1.8 | 1.6 | -98 % | -13.3 % | 4.0 % | 0.4 % |
| Poland | 206 | 174 | 124 | 109 | 107 | 100 | 94 | 84 | 82 | 88 | 87 | 86 | 82 | 78 | -62 % | -5.2 % | 10.9 % | 18.2 % |
| Portugal | 111 | 116 | 106 | 105 | 46 | 38 | 33 | 27 | 22 | 23 | 22 | 22 | 21 | 21 | -81 % | 1.9 % | 5.9 % | 4.9 % |
| Romania | 113 | 64 | 35 | 25 | 14 | 16 | 14 | 13 | 11 | 10 | 8.5 | 10 | 9.9 | 10 | -91 % | 3.2 % | 6.0 % | 2.4 % |
| Slovakia | 7.4 | 3.9 | 2.6 | 1.9 | 1.9 | 1.9 | 1.7 | 1.8 | 1.6 | 1.8 | 1.7 | 1.7 | 1.6 | 1.5 | -80 % | -9.6 % | 0.4 % | 0.3 % |
| Slovenia | 2.9 | 2.0 | 2.4 | 2.3 | 2.1 | 2.0 | 1.8 | 1.7 | 1.4 | 1.4 | 1.5 | 1.4 | 1.4 | 1.4 | -52 % | -4.8 % | 0.2 % | 0.3 % |
| Spain | 165 | 192 | 197 | 175 | 92 | 80 | 65 | 53 | 46 | 43 | 44 | 49 | 49 | 44 | -74 % | -10.6 % | 8.7 % | 10.2 % |
| Sweden | 29 | 30 | 18 | 16 | 14 | 11 | 10 | 9.2 | 7.5 | 6.8 | 7.3 | 6.9 | 7.0 | 6.2 | -79 % | -12.1 % | 1.6 % | 1.4 % |
| **EU28 (a)** | **1 887** | **1 540** | **1 198** | **1 104** | **718** | **639** | **592** | **527** | **475** | **484** | **483** | **477** | **460** | **429** | **-77 %** | **-6.9 %** | **100 %** | **100 %** |
| EU28 (b) | 1 887 | 1 540 | 1 198 | 1 104 | 718 | 639 | 592 | 527 | 475 | 484 | 483 | 477 | 460 | 429 | | | | |

**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.

EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.19 Selenium emission trends*

Between 1990 and 2019, selenium (Se) emissions dropped by 48 % in the EU. Between 2018 and 2019, they decreased by 17.4 % (see Table 3.22), mainly because of decreases in Bulgaria, Greece, Czechia, Ireland and Romania (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Se emissions were Czechia and Bulgaria (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 on sectoral level but used the notation key 'NE' (not estimated) for the national total of Se emissions, because the inventory is not yet fully complete (personal communication from Finland in 2021). As envisaged by the gap filling procedure, the national total for Finland was calculated using the sum of sectors.

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

### Table 3.22 Member State contributions to EU emissions of Se

| | Se (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 5.2 | 6.4 | 6.5 | 27 | 12 | 4.0 | 3.6 | 3.6 | 4.3 | 4.1 | 3.7 | 3.7 | 2.9 | 2.6 | -50 % | -10.4 % | 2.9 % | 2.8 % |
| Bulgaria | 41 | 13 | 5.2 | 14 | 14 | 16 | 15 | 16 | 19 | 20 | 22 | 23 | 21 | 9 | -77 % | -55.9 % | 22.9 % | 10.0 % |
| Croatia | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | -19 % | -0.9 % | 0.2 % | 0.4 % |
| Cyprus | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -38 % | -8.4 % | 0.0 % | 0.1 % |
| Czechia | 33 | 29 | 28 | 30 | 26 | 26 | 24 | 23 | 22 | 22 | 22 | 22 | 22 | 21 | -37 % | -8.3 % | 18.1 % | 22.2 % |
| Denmark | 4.2 | 3.9 | 2.3 | 1.5 | 1.3 | 1.0 | 0.8 | 1.0 | 0.9 | 0.7 | 0.7 | 0.6 | 0.5 | 0.4 | -90 % | -20.3 % | 2.4 % | 0.5 % |
| Estonia | 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 | 51 % | -1.6 % | 0.0 % | 0.0 % |
| Finland | 1.8 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.4 | 0.4 | 0.5 | 0.4 | 0.9 | 0.5 | 0.4 | -77 % | -11.1 % | 1.0 % | 0.5 % |
| France | 13 | 13 | 13 | 12 | 10 | 9.7 | 9.9 | 9.6 | 9.6 | 9.7 | 9.1 | 9.3 | 9.3 | 9.1 | -29 % | -1.7 % | 7.2 % | 9.8 % |
| Germany | 5.7 | 11 | 8.4 | 5.8 | 7.3 | 7.6 | 7.3 | 7.3 | 7.2 | 7.2 | 7.3 | 7.4 | 7.2 | 7.3 | 28 % | 0.8 % | 3.1 % | 7.8 % |
| Greece | 14 | 14 | 16 | 17 | 15 | 15 | 16 | 14 | 13 | 11 | 8.9 | 9.9 | 9.5 | 7.1 | -48 % | -25.4 % | 7.6 % | 7.6 % |
| Hungary | 6.5 | 5.8 | 5.8 | 4.1 | 3.5 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.0 | 2.8 | 2.5 | -61 % | -9.2 % | 3.6 % | 2.7 % |
| Ireland | 8.8 | 6.5 | 5.1 | 4.7 | 4.0 | 3.8 | 4.1 | 4.1 | 3.9 | 4.0 | 3.8 | 3.5 | 3.4 | 2.6 | -70 % | -23.1 % | 4.9 % | 2.8 % |
| Italy | 7.6 | 7.8 | 8.4 | 8.8 | 8.0 | 8.1 | 8.2 | 7.4 | 7.2 | 8.3 | 7.3 | 7.3 | 7.1 | 6.8 | -11 % | -5.0 % | 4.2 % | 7.3 % |
| Latvia | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | -76 % | 45.3 % | 0.2 % | 0.1 % |
| Lithuania | 0.5 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | -75 % | -0.5 % | 0.3 % | 0.1 % |
| Luxembourg | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | | | | |
| Malta | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -97 % | -3.9 % | 0.1 % | 0.0 % |
| Netherlands | 0.4 | 0.3 | 0.5 | 2.6 | 1.5 | 0.8 | 0.8 | 0.5 | 0.8 | 1.0 | 0.7 | 0.2 | 0.2 | 0.2 | -60 % | -24.3 % | 0.2 % | 0.2 % |
| Poland | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Portugal | 1.9 | 2.4 | 2.9 | 3.2 | 3.4 | 3.3 | 3.4 | 3.4 | 3.5 | 3.4 | 3.3 | 3.4 | 3.7 | 3.4 | 78 % | -8.1 % | 1.1 % | 3.6 % |
| Romania | 20 | 16 | 12 | 12 | 12 | 14 | 13 | 10.0 | 10 | 10 | 9.2 | 9.3 | 9.1 | 8.4 | -57 % | -7.3 % | 10.9 % | 9.1 % |
| Slovakia | 5.3 | 2.7 | 2.6 | 2.7 | 2.4 | 2.4 | 2.2 | 2.1 | 2.0 | 2.1 | 2.0 | 2.0 | 1.9 | 1.6 | -70 % | -13.8 % | 3.0 % | 1.7 % |
| Slovenia | 2.9 | 2.5 | 2.4 | 2.5 | 2.5 | 2.5 | 2.4 | 2.3 | 1.8 | 1.9 | 2.0 | 2.0 | 1.9 | 1.9 | -36 % | -3.6 % | 1.6 % | 2.0 % |
| Spain | 6.9 | 7.1 | 8.6 | 8.5 | 6.5 | 6.8 | 6.6 | 6.7 | 6.4 | 6.9 | 6.8 | 6.9 | 7.2 | 7.0 | 2 % | -2.4 % | 3.9 % | 7.6 % |
| Sweden | 1.0 | 1.1 | 1.0 | 1.1 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 | 10 % | 0.2 % | 0.6 % | 1.2 % |
| **EU28 (a)** | **180** | **143** | **130** | **159** | **131** | **127** | **124** | **117** | **118** | **119** | **115** | **116** | **113** | **93** | **-48 %** | **-17.4 %** | **100 %** | **100 %** |
| EU28 (b) | 180 | 143 | 130 | 159 | 131 | 127 | 124 | 117 | 118 | 119 | 115 | 116 | 113 | 93 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.20 Zinc emission trends*

Between 1990 and 2019, Zn emissions dropped by 49 % in the EU. However, between 2018 and 2019, they decreased by 7 %, mainly because of decreases in Bulgaria, the Netherlands, Italy, Estonia and Poland (countries ranked according to the size of their contributions to the absolute change) (see Table 3.23). In 2019, the EU Member States contributing most (i.e. more than 10 %) to Zn emissions were Italy, Spain, Poland 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.

Ireland explained the decline in its emissions after 2000 by the closure of its only steel plant in 2001. From 1990 to 2001, metal production was the main determinant of the trend in Zn emissions. On average, it accounted for 55 % of national total emissions throughout that period (see Ireland's IIR, listed in Appendix 5).

### Table 3.23 Member State contributions to EU emissions of Zn

| | Zn (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | | | | | | | | | | | | | | | | | 0.0 % | 0.0 % |
| Belgium | 230 | 180 | 177 | 126 | 105 | 97 | 83 | 76 | 74 | 77 | 68 | 63 | 64 | 68 | -70 % | 7.1 % | 3.3 % | 1.9 % |
| Bulgaria | 182 | 107 | 258 | 142 | 95 | 104 | 105 | 110 | 117 | 111 | 117 | 122 | 126 | 29 | -84 % | -76.9 % | 2.6 % | 0.8 % |
| Croatia | 37 | 30 | 28 | 35 | 34 | 32 | 32 | 32 | 29 | 32 | 31 | 31 | 31 | 30 | -17 % | -1.5 % | 0.5 % | 0.9 % |
| Cyprus | 3.2 | 3.9 | 4.9 | 5.8 | 4.0 | 4.6 | 4.4 | 2.8 | 2.8 | 2.9 | 3.1 | 3.1 | 3.1 | 2.9 | -10 % | -6.5 % | 0.0 % | 0.1 % |
| Czechia | 105 | 79 | 64 | 60 | 56 | 56 | 52 | 47 | 47 | 46 | 42 | 42 | 43 | 42 | -60 % | -2.3 % | 1.5 % | 1.2 % |
| Denmark | 72 | 65 | 54 | 59 | 63 | 60 | 57 | 58 | 57 | 61 | 63 | 63 | 63 | 61 | -15 % | -4.1 % | 1.0 % | 1.7 % |
| Estonia | 107 | 64 | 49 | 52 | 62 | 60 | 54 | 62 | 57 | 46 | 52 | 55 | 50 | 23 | -78 % | -53.2 % | 1.5 % | 0.7 % |
| Finland | 683 | 405 | 128 | 119 | 130 | 125 | 129 | 124 | 132 | 118 | 128 | 120 | 119 | 130 | -81 % | 9.8 % | 9.8 % | 3.7 % |
| France | 2 096 | 1 299 | 901 | 487 | 427 | 411 | 421 | 400 | 383 | 394 | 395 | 391 | 393 | 384 | -82 % | -2.2 % | 30.2 % | 10.8 % |
| Germany | 475 | 266 | 278 | 259 | 289 | 277 | 291 | 300 | 282 | 292 | 293 | 297 | 293 | 295 | -38 % | 0.7 % | 6.8 % | 8.3 % |
| Greece | 67 | 71 | 74 | 74 | 72 | 74 | 73 | 67 | 71 | 69 | 63 | 64 | 64 | 61 | -9 % | -3.5 % | 1.0 % | 1.7 % |
| Hungary | 77 | 59 | 62 | 56 | 62 | 71 | 75 | 67 | 60 | 63 | 63 | 61 | 55 | 53 | -31 % | -3.5 % | 1.1 % | 1.5 % |
| Ireland | 53 | 48 | 54 | 25 | 20 | 19 | 19 | 20 | 21 | 21 | 21 | 21 | 22 | 20 | -62 % | -6.6 % | 0.8 % | 0.6 % |
| Italy | 948 | 952 | 906 | 981 | 877 | 941 | 903 | 844 | 824 | 815 | 832 | 874 | 887 | 851 | -10 % | -4.0 % | 13.6 % | 24.0 % |
| Latvia | 30 | 28 | 26 | 31 | 28 | 25 | 29 | 26 | 26 | 24 | 24 | 26 | 27 | 27 | -9 % | -1.9 % | 0.4 % | 0.8 % |
| Lithuania | 26 | 18 | 18 | 19 | 20 | 19 | 20 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | -31 % | -2.8 % | 0.4 % | 0.5 % |
| Luxembourg | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | | | | |
| Malta | 1.5 | 2.2 | 2.1 | 2.6 | 2.4 | 2.4 | 2.6 | 2.3 | 2.3 | 1.6 | 1.3 | 0.8 | 0.7 | 0.7 | -55 % | 3.0 % | 0.0 % | 0.0 % |
| Netherlands | 225 | 147 | 97 | 89 | 104 | 95 | 95 | 86 | 114 | 103 | 97 | 89 | 356 | 281 | 25 % | -21.0 % | 3.2 % | 7.9 % |
| Poland | 781 | 757 | 520 | 459 | 462 | 456 | 461 | 451 | 444 | 435 | 437 | 453 | 447 | 425 | -46 % | -4.8 % | 11.2 % | 12.0 % |
| Portugal | 58 | 59 | 62 | 61 | 55 | 55 | 54 | 53 | 54 | 54 | 54 | 55 | 55 | 54 | -8 % | -3.2 % | 0.8 % | 1.5 % |
| Romania | 125 | 98 | 103 | 125 | 121 | 112 | 114 | 108 | 108 | 107 | 108 | 109 | 109 | 110 | -12 % | 0.8 % | 1.8 % | 3.1 % |
| Slovakia | 38 | 31 | 33 | 40 | 38 | 38 | 40 | 40 | 37 | 34 | 39 | 40 | 38 | 37 | -4 % | -3.3 % | 0.6 % | 1.0 % |
| Slovenia | 18 | 16 | 16 | 21 | 20 | 20 | 19 | 20 | 18 | 19 | 19 | 19 | 18 | 17 | -3 % | -3.8 % | 0.3 % | 0.5 % |
| Spain | 333 | 303 | 387 | 393 | 416 | 425 | 364 | 431 | 363 | 406 | 402 | 400 | 455 | 451 | 35 % | -0.9 % | 4.8 % | 12.7 % |
| Sweden | 182 | 131 | 88 | 94 | 97 | 89 | 89 | 80 | 83 | 82 | 79 | 77 | 76 | 75 | -59 % | -2.4 % | 2.6 % | 2.1 % |
| **EU28 (a)** | **6 950** | **5 220** | **4 391** | **3 817** | **3 659** | **3 667** | **3 585** | **3 528** | **3 423** | **3 432** | **3 449** | **3 497** | **3 813** | **3 547** | **-49 %** | **-7.0 %** | **100 %** | **100 %** |
| EU28 (b) | 6 950 | 5 220 | 4 391 | 3 817 | 3 659 | 3 667 | 3 585 | 3 528 | 3 423 | 3 432 | 3 449 | 3 497 | 3 813 | 3 547 | | | | |

**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.

EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.21 Dioxin and furan emission trends and key categories*

Between 1990 and 2019, polychlorinated dibenzodioxin/dibenzofuran (PCDD/F) emissions dropped by 78 % in the EU. Between 2018 and 2019, the decrease was 2.6 % (see Table 3.24), mainly because Poland, Italy, Bulgaria and Ireland (countries ranked according to the size of their contributions to the absolute change) reported lower emissions. In 2019, the Member States contributing most (i.e. more than 10 %) to PCDD/F emissions were Poland, Italy, Romania and Spain, with a joint contribution of 52.7 % of EU-28 emissions.

Cyprus explained that, from 1990 to 2019, its PCDD/F emissions decreased by 97 % because a clinical waste incineration plant was closed down in 2003 and all clinical waste is now sterilised (see Cyprus's IIR, listed in Appendix 5).

Czechia explained that the fall in emissions between 2007 and 2009 was due to the installation of new fabric filters in the Třinecké železárny sinter plant (personal communication from Czechia in 2018).

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

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

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

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

The emissions reported by Greece for PCDD/F in the category '1A1a — Public electricity and heat production' are responsible for the strong decrease observed since 2009.

The emissions reported by Lithuania for PCDD/F in the category '5C1biii — Clinical waste incineration' are responsible for the peak in 2005.

Malta's reported emissions were 2066 % higher in 2019 than in 1990. The reason for this strong increase is that Malta started reporting in the category '5C1bv — Cremation' in 2009.

## Table 3.24 Member State contributions to EU emissions of PCDD/Fs

| | PCDD/Fs (g I-TEQ) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 125 | 58 | 51 | 36 | 41 | 38 | 39 | 39 | 36 | 37 | 37 | 37 | 34 | 34 | -73 % | 0.3 % | 1.6 % | 2.0 % |
| Belgium | 546 | 365 | 92 | 65 | 52 | 44 | 47 | 38 | 30 | 31 | 30 | 32 | 27 | 29 | -95 % | 8.6 % | 7.2 % | 1.7 % |
| Bulgaria | 117 | 139 | 156 | 155 | 64 | 73 | 62 | 65 | 55 | 55 | 53 | 55 | 55 | 49 | -58 % | -10.3 % | 1.5 % | 2.9 % |
| Croatia | 49 | 43 | 42 | 50 | 41 | 39 | 39 | 36 | 32 | 35 | 33 | 29 | 28 | 27 | -45 % | -3.1 % | 0.6 % | 1.6 % |
| Cyprus | 17 | 20 | 21 | 0.7 | 0.7 | 0.6 | 0.6 | 0.8 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | -97 % | -7.3 % | 0.2 % | 0.0 % |
| Czechia | 106 | 76 | 64 | 64 | 49 | 41 | 42 | 43 | 44 | 39 | 30 | 29 | 30 | 28 | -74 % | -6.7 % | 1.4 % | 1.6 % |
| Denmark | 70 | 53 | 35 | 33 | 38 | 35 | 34 | 34 | 33 | 36 | 39 | 37 | 35 | 32 | -55 % | -8.1 % | 0.9 % | 1.9 % |
| Estonia | 9.9 | 6.7 | 6.9 | 6.4 | 6.1 | 7.0 | 5.4 | 4.3 | 4.6 | 4.8 | 4.8 | 5.4 | 4.6 | 4.6 | -54 % | 0.7 % | 0.1 % | 0.3 % |
| Finland | 18 | 19 | 18 | 14 | 16 | 14 | 15 | 15 | 16 | 14 | 15 | 13 | 13 | 12 | -31 % | -9.6 % | 0.2 % | 0.7 % |
| France | 1 797 | 1 738 | 575 | 260 | 170 | 159 | 149 | 155 | 146 | 146 | 135 | 132 | 128 | 124 | -93 % | -3.0 % | 23.6 % | 7.2 % |
| Germany | 815 | 344 | 266 | 155 | 139 | 134 | 133 | 133 | 125 | 127 | 125 | 124 | 120 | 119 | -85 % | -0.9 % | 10.7 % | 6.9 % |
| Greece | 42 | 42 | 42 | 43 | 28 | 32 | 32 | 27 | 27 | 27 | 25 | 26 | 26 | 24 | -42 % | -5.7 % | 0.6 % | 1.4 % |
| Hungary | 114 | 79 | 85 | 66 | 80 | 88 | 90 | 82 | 72 | 81 | 79 | 68 | 61 | 67 | -41 % | 8.9 % | 1.5 % | 3.9 % |
| Ireland | 59 | 42 | 32 | 28 | 27 | 24 | 24 | 24 | 22 | 23 | 20 | 20 | 23 | 19 | -69 % | -19.3 % | 0.8 % | 1.1 % |
| Italy | 503 | 485 | 408 | 334 | 318 | 277 | 294 | 289 | 275 | 281 | 280 | 296 | 277 | 271 | -46 % | -2.4 % | 6.6 % | 15.8 % |
| Latvia | 30 | 34 | 31 | 35 | 23 | 24 | 27 | 22 | 21 | 18 | 17 | 20 | 19 | 19 | -36 % | -0.7 % | 0.4 % | 1.1 % |
| Lithuania | 27 | 19 | 21 | 34 | 23 | 23 | 23 | 22 | 21 | 19 | 20 | 20 | 21 | 19 | -29 % | -7.4 % | 0.4 % | 1.1 % |
| Luxembourg | 44 | 35 | 6.9 | 3.0 | 3.1 | 3.1 | 2.4 | 2.2 | 2.3 | 2.0 | 3.4 | 2.8 | 2.3 | 1.8 | -96 % | -22.1 % | 0.6 % | 0.1 % |
| Malta | 0.2 | 0.2 | 0.2 | 0.2 | 7.9 | 1.0 | 3.8 | 4.2 | 4.0 | 3.7 | 3.4 | 3.4 | 3.2 | 4.3 | 2066 % | 34.6 % | 0.0 % | 0.3 % |
| Netherlands | 756 | 80 | 46 | 44 | 48 | 47 | 40 | 40 | 37 | 37 | 37 | 36 | 36 | 41 | -95 % | 14.3 % | 9.9 % | 2.4 % |
| Poland | 349 | 428 | 297 | 366 | 396 | 354 | 368 | 335 | 298 | 294 | 299 | 298 | 303 | 274 | -21 % | -9.6 % | 4.6 % | 16.0 % |
| Portugal | 551 | 548 | 352 | 66 | 49 | 51 | 53 | 48 | 48 | 48 | 49 | 51 | 55 | 56 | -90 % | 0.9 % | 7.2 % | 3.3 % |
| Romania | 184 | 144 | 203 | 252 | 188 | 179 | 183 | 166 | 171 | 168 | 170 | 179 | 180 | 186 | 1 % | 3.1 % | 2.4 % | 10.9 % |
| Slovakia | 772 | 688 | 908 | 374 | 56 | 62 | 64 | 66 | 65 | 64 | 66 | 67 | 67 | 65 | -92 % | -3.9 % | 10.1 % | 3.8 % |
| Slovenia | 20 | 18 | 18 | 20 | 19 | 19 | 18 | 18 | 16 | 17 | 17 | 17 | 15 | 14 | -31 % | -7.5 % | 0.3 % | 0.8 % |
| Spain | 432 | 461 | 198 | 185 | 180 | 180 | 177 | 172 | 175 | 181 | 174 | 171 | 173 | 172 | -60 % | -0.5 % | 5.7 % | 10.0 % |
| Sweden | 70 | 49 | 41 | 43 | 37 | 31 | 28 | 26 | 24 | 24 | 25 | 25 | 25 | 24 | -65 % | -1.8 % | 0.9 % | 1.4 % |
| **EU28 (a)** | **7 623** | **6 013** | **4 015** | **2 731** | **2 097** | **1 981** | **1 993** | **1 907** | **1 798** | **1 812** | **1 786** | **1 794** | **1 761** | **1 715** | **-78 %** | **-2.6 %** | **100 %** | **100 %** |
| EU28 (b) | 7 623 | 6 013 | 4 015 | 2 731 | 2 097 | 1 981 | 1 993 | 1 907 | 1 798 | 1 812 | 1 786 | 1 794 | 1 761 | 1 715 | | | | |

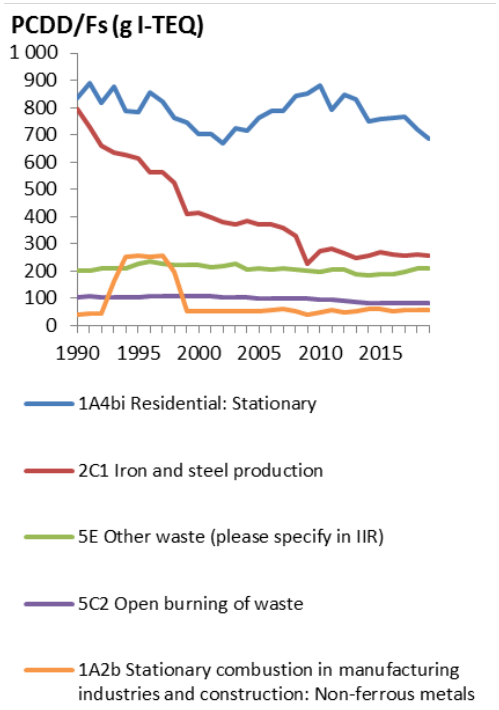
**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.
I-Teq, international toxic equivalent.
EU-28 does not include data from the United Kingdom (see Box ES.2).

Categories '1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '5E — Other waste' were the primary key ones for PCDD/F emissions, together making up 67 % of total PCDD/F emissions (see Figure 3.15(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2019 were in the second most important, '2C1 — Iron and steel production' (-67.8 %), and the fourth most important, '5C2 — Open burning of waste' (-21.8 %).

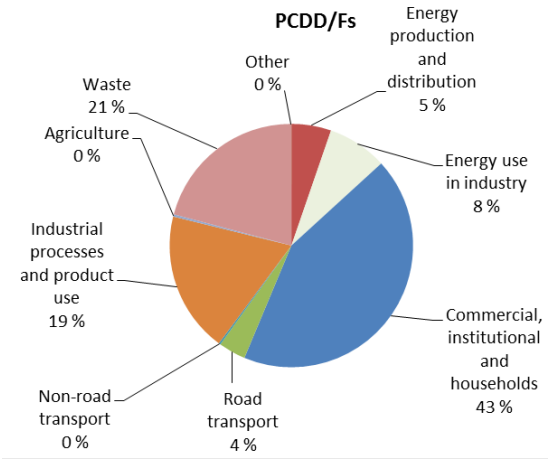
Figure 3.15(b) shows the contribution made by each aggregated sector group to total EU emissions. The sector groups waste, commercial, institutional and households and Industrial processes and product use are significant sources of PCDD/Fs.

**Figure 3.15PCDD/F emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

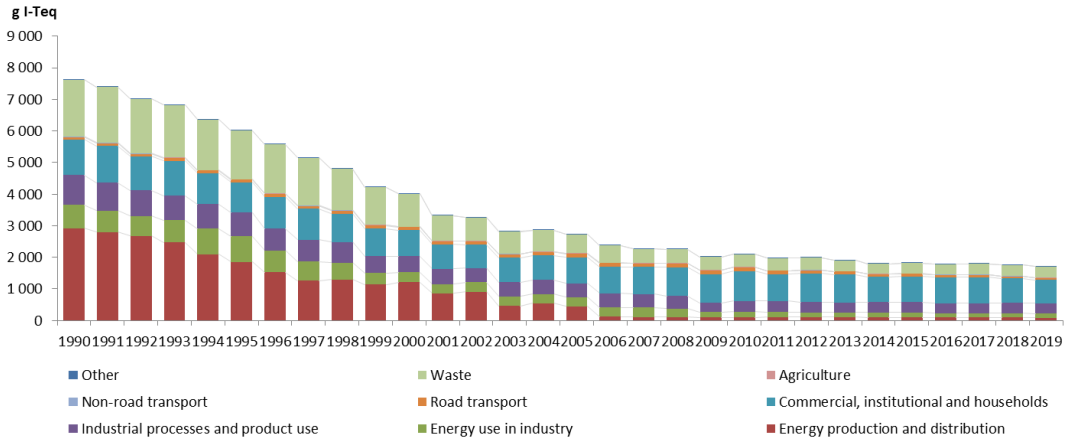
**(a)**




**(b)**




**(c)**




**Note:** I-Teq, international toxic equivalent.

## *3.22 Total polycyclic aromatic hydrocarbon emission trends and key categories*

Between 1990 and 2019, total polycyclic aromatic hydrocarbon (PAH) emissions dropped by 53 % in the EU. However, between 2018 and 2019, they dropped by 5.4 % (see Table 3.25), mainly because Poland, Spain, Czechia and Ireland (countries ranked according to their shares of the EU total) reported lower emissions. In 2019, the EU Member States contributing most (i.e. more than 10 %) to total PAH emissions were Poland and Germany (countries ranked according to the percentage of their share in the EU total).

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

### Table 3.25 Member State contributions to EU emissions of total PAHs

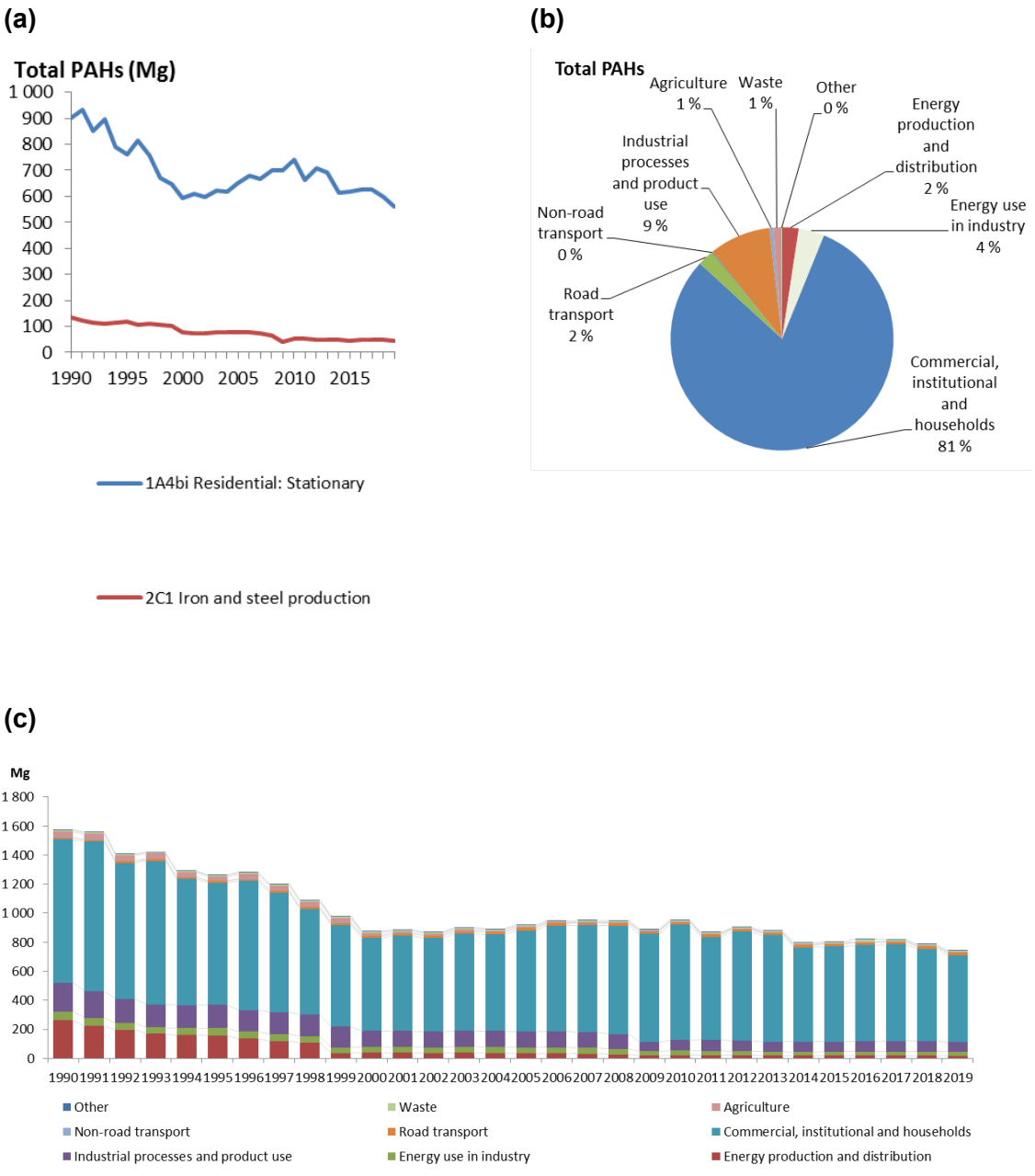
| | Total PAHs (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 19 | 11 | 8.5 | 7.1 | 7.9 | 7.2 | 7.4 | 7.6 | 6.7 | 6.8 | 7.0 | 7.0 | 6.4 | 6.5 | -66 % | 0.8 % | 1.2 % | 0.9 % |
| Belgium | 51 | 40 | 32 | 25 | 15 | 13 | 12 | 12 | 8.7 | 8.6 | 8.6 | 7.8 | 7.3 | 6.7 | -87 % | -8.4 % | 3.2 % | 0.9 % |
| Bulgaria | 37 | 39 | 29 | 28 | 17 | 19 | 19 | 18 | 16 | 15 | 16 | 17 | 15 | 14 | -61 % | -3.3 % | 2.3 % | 1.9 % |
| Croatia | 22 | 17 | 15 | 19 | 18 | 17 | 16 | 16 | 14 | 16 | 15 | 15 | 14 | 13 | -39 % | -3.3 % | 1.4 % | 1.8 % |
| Cyprus | 14 | 11 | 6.2 | 3.8 | 0.9 | 1.0 | 1.0 | 0.8 | 0.7 | 0.9 | 0.7 | 0.6 | 0.7 | 0.7 | -95 % | -3.3 % | 0.9 % | 0.1 % |
| Czechia | 280 | 179 | 45 | 40 | 47 | 46 | 48 | 49 | 47 | 47 | 46 | 46 | 45 | 42 | -85 % | -8.2 % | 17.8 % | 5.6 % |
| Denmark | 13 | 13 | 10 | 11 | 7.8 | 7.0 | 6.7 | 6.8 | 6.1 | 6.8 | 6.9 | 6.3 | 5.6 | 5.0 | -60 % | -11.2 % | 0.8 % | 0.7 % |
| Estonia | 9.1 | 9.9 | 7.2 | 5.2 | 5.2 | 4.3 | 4.3 | 4.0 | 3.8 | 3.6 | 3.5 | 3.6 | 3.4 | 3.2 | -65 % | -5.6 % | 0.6 % | 0.4 % |
| Finland | 19 | 19 | 19 | 22 | 26 | 22 | 25 | 23 | 23 | 21 | 24 | 23 | 23 | 22 | 18 % | -1.4 % | 1.2 % | 3.0 % |
| France | 46 | 44 | 38 | 34 | 36 | 31 | 34 | 37 | 32 | 33 | 35 | 35 | 34 | 34 | -24 % | 1.1 % | 2.9 % | 4.6 % |
| Germany | 177 | 76 | 71 | 59 | 85 | 78 | 86 | 89 | 74 | 77 | 73 | 75 | 76 | 77 | -57 % | 1.4 % | 11.3 % | 10.3 % |
| Greece | 24 | 24 | 24 | 22 | 16 | 18 | 20 | 18 | 18 | 19 | 17 | 18 | 18 | 17 | -29 % | -2.1 % | 1.6 % | 2.3 % |
| Hungary | 78 | 29 | 25 | 23 | 28 | 32 | 34 | 34 | 27 | 29 | 29 | 29 | 23 | 21 | -73 % | -8.7 % | 5.0 % | 2.9 % |
| Ireland | 48 | 31 | 22 | 20 | 19 | 17 | 17 | 19 | 17 | 16 | 15 | 15 | 17 | 14 | -72 % | -17.9 % | 3.1 % | 1.8 % |
| Italy | 90 | 92 | 60 | 64 | 87 | 64 | 82 | 78 | 69 | 71 | 70 | 74 | 67 | 65 | -27 % | -2.0 % | 5.7 % | 8.8 % |
| Latvia | 18 | 17 | 16 | 13 | 10 | 10 | 11 | 9.2 | 8.9 | 7.3 | 7.2 | 7.9 | 8.2 | 7.8 | -56 % | -4.7 % | 1.1 % | 1.0 % |
| Lithuania | 18 | 8.6 | 9.1 | 9.8 | 11 | 11 | 11 | 10 | 9.7 | 8.9 | 9.0 | 9.1 | 9.2 | 8.6 | -53 % | -6.4 % | 1.2 % | 1.2 % |
| Luxembourg | 4.6 | 2.3 | 0.7 | 0.6 | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.6 | 0.7 | 0.6 | -87 % | -12.4 % | 0.3 % | 0.1 % |
| Malta | 0.3 | 0.4 | 0.3 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -74 % | 5.6 % | 0.0 % | 0.0 % |
| Netherlands | 21 | 11 | 6.0 | 5.8 | 5.8 | 5.9 | 5.4 | 5.3 | 5.2 | 5.2 | 5.1 | 5.0 | 4.9 | 4.6 | -78 % | -5.4 % | 1.3 % | 0.6 % |
| Poland | 306 | 379 | 232 | 287 | 307 | 269 | 270 | 252 | 226 | 224 | 235 | 234 | 223 | 197 | -36 % | -11.6 % | 19.5 % | 26.6 % |
| Portugal | 24 | 23 | 22 | 19 | 15 | 15 | 14 | 14 | 14 | 14 | 14 | 15 | 16 | 17 | -32 % | 7.3 % | 1.6 % | 2.2 % |
| Romania | 77 | 46 | 56 | 66 | 64 | 58 | 60 | 57 | 58 | 58 | 58 | 57 | 57 | 58 | -24 % | 1.4 % | 4.9 % | 7.8 % |
| Slovakia | 62 | 39 | 34 | 38 | 35 | 33 | 35 | 34 | 29 | 32 | 33 | 34 | 31 | 31 | -50 % | 1.0 % | 3.9 % | 4.2 % |
| Slovenia | 8.7 | 6.8 | 6.3 | 7.2 | 6.6 | 6.6 | 6.4 | 6.5 | 5.6 | 6.0 | 6.0 | 5.7 | 5.2 | 4.8 | -45 % | -7.7 % | 0.6 % | 0.6 % |
| Spain | 88 | 78 | 72 | 71 | 72 | 72 | 68 | 68 | 68 | 69 | 79 | 69 | 69 | 64 | -28 % | -7.6 % | 5.6 % | 8.6 % |
| Sweden | 18 | 18 | 14 | 16 | 9.8 | 9.7 | 9.0 | 8.7 | 8.1 | 7.9 | 7.9 | 7.9 | 7.0 | 6.8 | -62 % | -2.2 % | 1.1 % | 0.9 % |
| **EU28 (a)** | **1 572** | **1 264** | **878** | **916** | **953** | **869** | **903** | **878** | **796** | **803** | **822** | **817** | **785** | **743** | **-53 %** | **-5.4 %** | **100 %** | **100 %** |
| EU28 (b) | 1 572 | 1 264 | 878 | 916 | 953 | 869 | 903 | 878 | 796 | 803 | 822 | 817 | 785 | 743 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

In 2019, '1A4bi — Residential: Stationary' and '2C1 — Iron and steel production' were the principal key categories for these emissions, making up 81 % of total PAH emissions (see Figure 3.16 (a)). Among the key categories, the largest change could be observed for in the most important, '1A4bi — Residential: Stationary (-37.7 %).

Figure 3.16 (b) shows the contribution made by each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is a very significant source of total PAH emissions.

**Figure 3.16 Total PAH emissions in the EU: (a) trend in emissions from the two most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**



## *3.23 Benzo(a)pyrene emission trends and key categories*

Between 1990 and 2019, benzo(a)pyrene (B(a)P) emissions fell by 50 % in the EU. Between 2018 and 2019, they decreased by 5.4 % (see Table 3.26), mainly because emissions fell in Poland, Czechia, Spain and Ireland (countries ranked according to the size of their contributions to the absolute change). In 2019, the Member State contributing most (i.e. more than 10 %) to B(a)P emissions was Poland, with 29 %.

### Table 3.26 Member State contributions to EU emissions of B(a)P

| | Benzo(a)pyrene (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 6.3 | 3.6 | 2.7 | 2.3 | 2.5 | 2.3 | 2.4 | 2.4 | 2.1 | 2.2 | 2.2 | 2.2 | 2.0 | 2.0 | -68 % | 0.7 % | 1.5 % | 0.9 % |
| Belgium | 15 | 12 | 9.7 | 7.9 | 5.5 | 4.9 | 4.2 | 4.1 | 2.8 | 2.7 | 2.7 | 2.5 | 2.3 | 2.1 | -86 % | -8.5 % | 3.5 % | 1.0 % |
| Bulgaria | 8 | 7 | 5 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 6 | 6 | 4.9 | 4.9 | -41 % | -1.1 % | 1.9 % | 2.3 % |
| Croatia | 7.1 | 5.8 | 5.2 | 6.4 | 6.1 | 5.8 | 5.7 | 5.7 | 4.9 | 5.5 | 5.3 | 5.1 | 4.8 | 4.7 | -34 % | -3.0 % | 1.6 % | 2.2 % |
| Cyprus | 2.4 | 1.9 | 1.1 | 0.7 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | -95 % | -3.8 % | 0.5 % | 0.1 % |
| Czechia | 91 | 60 | 17 | 15 | 17 | 17 | 17 | 18 | 17 | 17 | 16 | 17 | 16 | 15 | -84 % | -7.9 % | 21.1 % | 6.8 % |
| Denmark | 3.5 | 3.5 | 2.9 | 3.0 | 2.4 | 2.1 | 2.0 | 2.0 | 1.8 | 2.1 | 2.1 | 1.9 | 1.7 | 1.5 | -58 % | -12.1 % | 0.8 % | 0.7 % |
| Estonia | 2.6 | 2.7 | 2.0 | 1.5 | 1.4 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | -65 % | -5.3 % | 0.6 % | 0.4 % |
| Finland | 6.0 | 6.2 | 5.9 | 7.1 | 8.4 | 7.2 | 7.9 | 7.3 | 7.4 | 7.0 | 7.8 | 7.6 | 7.4 | 7.3 | 23 % | -1.8 % | 1.4 % | 3.4 % |
| France | 13 | 13 | 11 | 9.7 | 10 | 8.7 | 9.7 | 11 | 9.0 | 9.4 | 10.0 | 9.9 | 9.7 | 9.8 | -24 % | 1.2 % | 3.0 % | 4.5 % |
| Germany | 28 | 12 | 12 | 12 | 18 | 16 | 18 | 19 | 15 | 16 | 15 | 16 | 16 | 16 | -42 % | 1.6 % | 6.4 % | 7.5 % |
| Greece | 7.3 | 7.2 | 7.2 | 6.3 | 4.5 | 5.4 | 6.0 | 5.6 | 5.6 | 5.9 | 5.3 | 5.4 | 5.4 | 5.3 | -28 % | -1.9 % | 1.7 % | 2.4 % |
| Hungary | 26 | 9.9 | 8.5 | 7.8 | 9.6 | 11 | 12 | 12 | 9.4 | 9.9 | 10 | 9.8 | 8.0 | 7.3 | -72 % | -8.7 % | 6.0 % | 3.4 % |
| Ireland | 14 | 8.6 | 6.0 | 5.5 | 5.2 | 4.8 | 4.8 | 5.2 | 4.7 | 4.6 | 4.3 | 4.2 | 4.6 | 3.8 | -72 % | -18.5 % | 3.2 % | 1.7 % |
| Italy | 10 | 11 | 11 | 12 | 21 | 14 | 19 | 19 | 17 | 18 | 17 | 19 | 17 | 17 | 67 % | 0.0 % | 2.3 % | 7.8 % |
| Latvia | 6.3 | 6.0 | 6.1 | 4.8 | 3.6 | 3.7 | 3.6 | 3.2 | 3.1 | 2.6 | 2.5 | 2.8 | 2.9 | 2.8 | -57 % | -4.7 % | 1.5 % | 1.3 % |
| Lithuania | 6.0 | 3.0 | 3.2 | 3.4 | 3.8 | 3.8 | 3.8 | 3.7 | 3.4 | 3.1 | 3.2 | 3.2 | 3.2 | 3.0 | -50 % | -6.1 % | 1.4 % | 1.4 % |
| Luxembourg | 1.2 | 0.6 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | -89 % | -22.4 % | 0.3 % | 0.1 % |
| Malta | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -73 % | 11.9 % | 0.0 % | 0.0 % |
| Netherlands | 5.5 | 3.3 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | -71 % | -4.8 % | 1.3 % | 0.7 % |
| Poland | 101 | 123 | 73 | 93 | 101 | 87 | 87 | 82 | 72 | 72 | 75 | 75 | 71 | 62 | -38 % | -12.6 % | 23.2 % | 28.8 % |
| Portugal | 7.6 | 6.9 | 6.4 | 5.4 | 4.2 | 4.2 | 4.1 | 4.1 | 4.0 | 4.0 | 4.0 | 4.2 | 4.6 | 5.0 | -35 % | 7.3 % | 1.8 % | 2.3 % |
| Romania | 18 | 11 | 16 | 18 | 20 | 18 | 19 | 18 | 18 | 18 | 18 | 18 | 17 | 18 | 0 % | 1.5 % | 4.1 % | 8.2 % |
| Slovakia | 16 | 8.3 | 6.7 | 7.6 | 7.1 | 6.7 | 7.2 | 6.8 | 4.5 | 5.7 | 6.0 | 6.0 | 4.9 | 6.1 | -61 % | 24.0 % | 3.6 % | 2.8 % |
| Slovenia | 3.1 | 2.7 | 2.6 | 3.0 | 2.8 | 2.8 | 2.7 | 2.7 | 2.3 | 2.5 | 2.5 | 2.4 | 2.1 | 1.9 | -38 % | -9.5 % | 0.7 % | 0.9 % |
| Spain | 23 | 21 | 18 | 18 | 19 | 19 | 18 | 18 | 17 | 17 | 21 | 18 | 17 | 16 | -31 % | -7.1 % | 5.3 % | 7.4 % |
| Sweden | 6.2 | 6.3 | 4.9 | 5.3 | 3.4 | 3.3 | 3.1 | 3.0 | 2.7 | 2.6 | 2.6 | 2.6 | 2.2 | 2.2 | -65 % | -2.6 % | 1.4 % | 1.0 % |
| **EU28 (a)** | **434** | **356** | **247** | **264** | **284** | **257** | **268** | **260** | **233** | **235** | **241** | **239** | **228** | **216** | **-50 %** | **-5.4 %** | **100 %** | **100 %** |
| EU28 (b) | 434 | 356 | 247 | 264 | 284 | 257 | 268 | 260 | 233 | 235 | 241 | 239 | 228 | 216 | | | | |

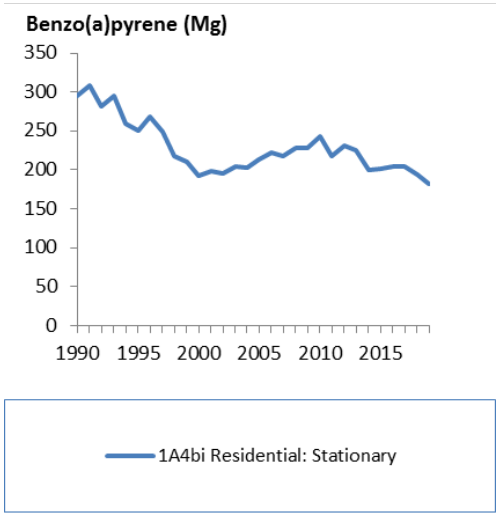
**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
EU-28 does not include data from the United Kingdom (see Box ES.2).

Category '1A4bi — Residential: Stationary' was the principal key one 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' (-38.0 %) (see Figure 3.17(a)).

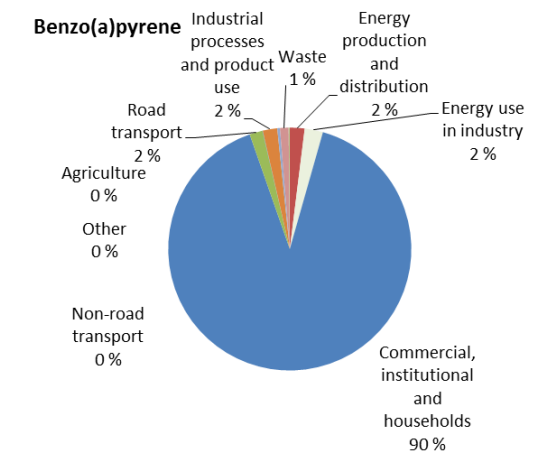
Figure 3.17(b) shows the contribution made by each aggregated sector group to total EU emissions. The commercial, institutional and households sector group is the chief source of B(a)P emissions.

**Figure 3.17 B(a)P emissions in the EU: (a) trend in emissions from the most important key category, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

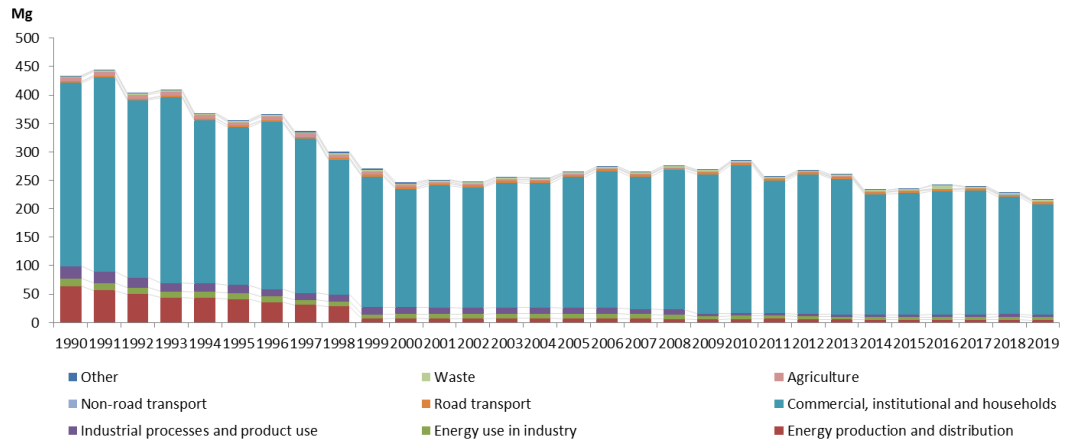
**(a)**




**(b)**




**(c)**



## *3.24 Benzo(b)fluoranthene emission trends*

Between 1990 and 2019, benzo(b)fluoranthene (B(b)F) emissions fell by 53 % in the EU. Between 2018 and 2019, they dropped by 5 % (see Table 3.27), mainly because of a slight decrease in Poland, Ireland, Spain and Czechia (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to B(b)F emissions were Poland and Germany (countries ranked according to their shares of the EU total).

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

### Table 3.27 Member State contributions to EU emissions of B(b)F

| | Benzo(b)fluoranthene (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 6.4 | 3.8 | 3.0 | 2.5 | 2.8 | 2.5 | 2.6 | 2.7 | 2.4 | 2.4 | 2.5 | 2.5 | 2.3 | 2.3 | -64 % | 0.7 % | 1.3 % | 1.0 % |
| Belgium | 18 | 14 | 11 | 8.8 | 4.8 | 3.9 | 4.0 | 4.1 | 3.0 | 3.0 | 3.0 | 2.7 | 2.6 | 2.4 | -87 % | -7.3 % | 3.7 % | 1.0 % |
| Bulgaria | 10 | 7.8 | 5.5 | 6.0 | 5.9 | 6.7 | 6.7 | 6.1 | 5.2 | 5.2 | 5.6 | 5.7 | 5.0 | 4.9 | -51 % | -1.2 % | 2.1 % | 2.1 % |
| Croatia | 7.5 | 5.6 | 4.9 | 6.1 | 5.7 | 5.4 | 5.3 | 5.3 | 4.6 | 5.1 | 4.9 | 4.8 | 4.5 | 4.4 | -42 % | -3.0 % | 1.5 % | 1.9 % |
| Cyprus | 6.6 | 5.2 | 3.0 | 1.8 | 0.4 | 0.5 | 0.5 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | -95 % | -3.0 % | 1.4 % | 0.1 % |
| Czechia | 91 | 57 | 11 | 10.2 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 11 | -88 % | -6.7 % | 18.6 % | 4.7 % |
| Denmark | 3.1 | 3.2 | 2.6 | 2.7 | 2.2 | 2.0 | 1.9 | 2.0 | 1.8 | 2.0 | 2.1 | 1.9 | 1.8 | 1.6 | -49 % | -9.8 % | 0.6 % | 0.7 % |
| Estonia | 3.2 | 2.7 | 1.9 | 1.5 | 1.4 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | -72 % | -4.1 % | 0.7 % | 0.4 % |
| Finland | 4.9 | 5.0 | 4.8 | 5.7 | 6.7 | 5.7 | 6.3 | 5.8 | 5.8 | 5.5 | 6.1 | 5.9 | 5.8 | 5.7 | 16 % | -1.1 % | 1.0 % | 2.5 % |
| France | 15 | 15 | 13 | 11 | 12 | 10 | 11 | 12 | 10 | 11 | 12 | 11 | 11 | 11 | -25 % | 1.1 % | 3.1 % | 4.9 % |
| Germany | 35 | 15 | 17 | 17 | 26 | 23 | 27 | 28 | 22 | 23 | 22 | 23 | 23 | 23 | -34 % | 1.7 % | 7.2 % | 10.1 % |
| Greece | 9.1 | 9.0 | 8.8 | 7.8 | 5.6 | 6.2 | 6.7 | 6.2 | 6.3 | 6.5 | 6.0 | 6.1 | 6.0 | 5.9 | -35 % | -2.2 % | 1.9 % | 2.5 % |
| Hungary | 30 | 11 | 8.5 | 8.0 | 9 | 11 | 11 | 11 | 9.2 | 10 | 10 | 10 | 7.9 | 7.2 | -76 % | -8.9 % | 6.1 % | 3.1 % |
| Ireland | 20 | 13 | 9.4 | 8.4 | 7.9 | 7.2 | 7.1 | 7.8 | 7.0 | 6.9 | 6.4 | 6.3 | 6.9 | 5.7 | -72 % | -17.6 % | 4.1 % | 2.5 % |
| Italy | 13 | 14 | 14 | 15 | 25 | 17 | 23 | 23 | 20 | 21 | 21 | 22 | 20 | 20 | 53 % | 0.0 % | 2.6 % | 8.5 % |
| Latvia | 6.2 | 5.4 | 5.0 | 4.4 | 3.4 | 3.4 | 3.4 | 3.0 | 2.9 | 2.4 | 2.4 | 2.6 | 2.7 | 2.6 | -58 % | -4.8 % | 1.3 % | 1.1 % |
| Lithuania | 7.1 | 3.2 | 3.2 | 3.5 | 3.9 | 3.9 | 3.9 | 3.8 | 3.6 | 3.3 | 3.3 | 3.4 | 3.4 | 3.2 | -56 % | -6.5 % | 1.5 % | 1.4 % |
| Luxembourg | 1.5 | 0.8 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | -84 % | -11.9 % | 0.3 % | 0.1 % |
| Malta | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -35 % | 2.2 % | 0.0 % | 0.0 % |
| Netherlands | 8.1 | 3.6 | 2.0 | 1.9 | 1.9 | 2.0 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | -82 % | -6.1 % | 1.7 % | 0.6 % |
| Poland | 112 | 141 | 85 | 105 | 111 | 97 | 97 | 91 | 81 | 80 | 84 | 83 | 80 | 70 | -38 % | -12.1 % | 23.1 % | 30.3 % |
| Portugal | 7.0 | 6.3 | 5.8 | 4.9 | 3.8 | 3.9 | 3.8 | 3.8 | 3.8 | 3.7 | 3.7 | 3.8 | 4.0 | 4.2 | -40 % | 3.8 % | 1.4 % | 1.8 % |
| Romania | 22 | 12 | 16 | 18 | 19 | 17 | 18 | 17 | 18 | 17 | 17 | 17 | 17 | 17 | -23 % | 1.4 % | 4.6 % | 7.5 % |
| Slovakia | 13 | 7.1 | 5.9 | 6.5 | 6.0 | 5.7 | 6.2 | 5.9 | 4.2 | 5.0 | 5.2 | 5.4 | 4.6 | 6.4 | -49 % | 38.6 % | 2.6 % | 2.8 % |
| Slovenia | 2.7 | 1.9 | 1.6 | 1.7 | 1.5 | 1.5 | 1.4 | 1.5 | 1.3 | 1.4 | 1.4 | 1.3 | 1.2 | 1.2 | -58 % | -5.1 % | 0.6 % | 0.5 % |
| Spain | 28 | 24 | 19 | 18 | 18 | 18 | 17 | 17 | 17 | 17 | 19 | 17 | 17 | 16 | -44 % | -6.2 % | 5.8 % | 6.8 % |
| Sweden | 6.0 | 6.0 | 4.6 | 5.2 | 3.4 | 3.3 | 3.1 | 3.0 | 2.8 | 2.7 | 2.7 | 2.7 | 2.3 | 2.3 | -62 % | -2.4 % | 1.2 % | 1.0 % |
| **EU28 (a)** | **487** | **392** | **268** | **282** | **301** | **270** | **283** | **276** | **247** | **249** | **255** | **254** | **243** | **231** | **-53 %** | **-5.0 %** | **100 %** | **100 %** |
| EU28 (b) | 487 | 392 | 268 | 282 | 301 | 270 | 283 | 276 | 247 | 249 | 255 | 254 | 243 | 231 | | | | |

**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.
EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.25 Benzo(k)fluoranthene emission trends*

Between 1990 and 2019, benzo(k)fluoranthene (B(k)F) emissions in the EU decreased by 53 %. Between 2018 and 2019, they fell by 5.8 % (see Table 3.28), mainly in Poland, Spain, Czechia and Ireland (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member State contributing most (i.e. more than 10 %) to B(k)F emissions was Poland with 29.4 % (according to the shares of the EU total).

### Table 3.28 Member State contributions to EU emissions of B(k)F

| | Benzo(k)fluoranthene (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 3.7 | 1.5 | 1.2 | 1.0 | 1.1 | 1.0 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 1.0 | -75 % | 1.2 % | 1.6 % | 0.9 % |
| Belgium | 10 | 7.8 | 6.0 | 4.7 | 2.4 | 2.0 | 2.0 | 1.9 | 1.4 | 1.4 | 1.3 | 1.2 | 1.2 | 1.0 | -90 % | -11.8 % | 4.3 % | 0.9 % |
| Bulgaria | 3.9 | 3.5 | 2.1 | 2.3 | 2.3 | 2.6 | 2.6 | 2.3 | 2.0 | 2.0 | 2.2 | 2.2 | 1.9 | 1.9 | -51 % | -1.0 % | 1.7 % | 1.7 % |
| Croatia | 2.8 | 2.1 | 1.9 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.8 | 2.0 | 1.9 | 1.8 | 1.7 | 1.7 | -40 % | -2.7 % | 1.2 % | 1.5 % |
| Cyprus | 2.8 | 2.2 | 1.3 | 0.8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | -95 % | -3.2 % | 1.2 % | 0.1 % |
| Czechia | 51 | 33 | 8.4 | 7.4 | 8.4 | 8.4 | 8.6 | 8.8 | 8.3 | 8.3 | 8.1 | 8.2 | 8.0 | 7.5 | -85 % | -6.6 % | 21.9 % | 6.9 % |
| Denmark | 2.4 | 2.5 | 2.1 | 2.2 | 1.7 | 1.5 | 1.4 | 1.4 | 1.3 | 1.4 | 1.4 | 1.3 | 1.1 | 1.0 | -59 % | -12.2 % | 1.0 % | 0.9 % |
| Estonia | 1.6 | 1.8 | 1.3 | 1.0 | 1.0 | 0.8 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | -65 % | -6.1 % | 0.7 % | 0.5 % |
| Finland | 3.8 | 3.9 | 3.7 | 4.4 | 5.2 | 4.4 | 4.9 | 4.4 | 4.5 | 4.2 | 4.6 | 4.5 | 4.4 | 4.3 | 14 % | -1.2 % | 1.6 % | 4.0 % |
| France | 9.3 | 9.1 | 7.9 | 7.1 | 7.4 | 6.3 | 7.0 | 7.5 | 6.5 | 6.8 | 7.2 | 7.1 | 6.9 | 7.0 | -25 % | 1.1 % | 4.1 % | 6.5 % |
| Germany | 16 | 7.1 | 8.0 | 7.8 | 12 | 11 | 12 | 13 | 10 | 11 | 10 | 10 | 11 | 11 | -33 % | 1.7 % | 6.9 % | 9.8 % |
| Greece | 4.2 | 4.0 | 4.1 | 3.7 | 2.8 | 3.2 | 3.4 | 3.2 | 3.3 | 3.4 | 3.2 | 3.2 | 3.2 | 3.2 | -23 % | -1.6 % | 1.8 % | 2.9 % |
| Hungary | 12 | 4.2 | 3.3 | 3.1 | 3.6 | 4.2 | 4.3 | 4.3 | 3.5 | 3.7 | 3.8 | 3.7 | 3.1 | 2.8 | -76 % | -8.9 % | 5.0 % | 2.6 % |
| Ireland | 7.7 | 4.9 | 3.5 | 3.2 | 3.0 | 2.8 | 2.8 | 3.0 | 2.7 | 2.7 | 2.5 | 2.4 | 2.7 | 2.2 | -71 % | -17.9 % | 3.4 % | 2.0 % |
| Italy | 6.0 | 6.7 | 6.8 | 7.6 | 12 | 7.7 | 11 | 10 | 9.2 | 9.7 | 9.5 | 10 | 9.0 | 9.0 | 50 % | 0.0 % | 2.6 % | 8.3 % |
| Latvia | 2.4 | 2.1 | 2.0 | 1.7 | 1.3 | 1.3 | 1.3 | 1.2 | 1.1 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | -59 % | -4.7 % | 1.0 % | 0.9 % |
| Lithuania | 3.1 | 1.4 | 1.4 | 1.5 | 1.8 | 1.7 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | -53 % | -5.4 % | 1.3 % | 1.3 % |
| Luxembourg | 1.0 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -87 % | 11.9 % | 0.4 % | 0.1 % |
| Malta | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -68 % | 2.7 % | 0.0 % | 0.0 % |
| Netherlands | 4.2 | 2.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | -81 % | -7.5 % | 1.8 % | 0.7 % |
| Poland | 48 | 60 | 38 | 46 | 48 | 43 | 43 | 41 | 37 | 36 | 38 | 38 | 36 | 32 | -33 % | -11.4 % | 20.6 % | 29.4 % |
| Portugal | 3.0 | 2.7 | 2.6 | 2.3 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.8 | 2.0 | 2.2 | -27 % | 9.1 % | 1.3 % | 2.0 % |
| Romania | 8.7 | 4.5 | 6.0 | 7.0 | 7.4 | 6.7 | 6.9 | 6.6 | 6.8 | 6.7 | 6.6 | 6.5 | 6.5 | 6.6 | -24 % | 1.4 % | 3.8 % | 6.1 % |
| Slovakia | 7.2 | 3.9 | 3.0 | 3.3 | 3.0 | 2.9 | 3.1 | 2.9 | 2.0 | 2.5 | 2.6 | 2.6 | 2.2 | 2.3 | -69 % | 2.1 % | 3.1 % | 2.1 % |
| Slovenia | 1.7 | 1.5 | 1.5 | 1.7 | 1.5 | 1.6 | 1.5 | 1.5 | 1.3 | 1.4 | 1.4 | 1.3 | 1.2 | 1.1 | -38 % | -10.2 % | 0.7 % | 1.0 % |
| Spain | 12 | 11 | 8.9 | 8.2 | 8.1 | 8.3 | 7.7 | 7.5 | 7.5 | 7.6 | 10 | 7.6 | 7.6 | 6.5 | -47 % | -13.6 % | 5.4 % | 6.0 % |
| Sweden | 2.9 | 2.9 | 2.3 | 2.9 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | -73 % | -2.7 % | 1.3 % | 0.7 % |
| **EU28 (a)** | **230** | **188** | **128** | **134** | **140** | **127** | **133** | **130** | **117** | **118** | **123** | **120** | **115** | **109** | **-53 %** | **-5.8 %** | **100 %** | **100 %** |
| EU28 (b) | 230 | 188 | 128 | 134 | 140 | 127 | 133 | 130 | 117 | 118 | 123 | 120 | 115 | 109 | | | | |

**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.26 Indeno(1,2,3-cd)pyrene emission trends*

Between 1990 and 2019, indeno(1,2,3-cd)pyrene (IP) emissions fell by 45 % in the EU. Between 2018 and 2019, they decreased by 4.4 %, mainly because Poland, Czechia, Ireland and Hungary (countries ranked according to the size of their contributions to the absolute change) reported lower emissions (see Table 3.29). In 2019, 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 3.29 Member State contributions to EU emissions of IP

| | Indeno(1,2,3-cd)pyrene (Mg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 2.7 | 2.0 | 1.6 | 1.3 | 1.4 | 1.3 | 1.4 | 1.4 | 1.2 | 1.2 | 1.3 | 1.3 | 1.2 | 1.2 | -56 % | 1.0 % | 1.2 % | 1.0 % |
| Belgium | 7.4 | 5.9 | 4.7 | 3.9 | 2.5 | 2.0 | 2.1 | 2.1 | 1.5 | 1.5 | 1.5 | 1.4 | 1.3 | 1.2 | -84 % | -7.3 % | 3.4 % | 1.0 % |
| Bulgaria | 3.5 | 4.0 | 2.5 | 2.8 | 3.0 | 3.3 | 3.3 | 3.1 | 2.8 | 2.7 | 2.9 | 3.0 | 2.7 | 2.7 | -25 % | -1.0 % | 1.6 % | 2.2 % |
| Croatia | 3.8 | 3.3 | 3.0 | 3.7 | 3.5 | 3.3 | 3.3 | 3.2 | 2.8 | 3.2 | 3.0 | 2.9 | 2.7 | 2.6 | -31 % | -3.5 % | 1.7 % | 2.2 % |
| Cyprus | 2.0 | 1.6 | 0.9 | 0.6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -95 % | -3.6 % | 0.9 % | 0.1 % |
| Czechia | 49 | 31 | 10 | 9.4 | 11 | 11 | 12 | 12 | 12 | 12 | 11 | 12 | 11 | 10 | -79 % | -9.8 % | 22.2 % | 8.5 % |
| Denmark | 3.5 | 3.5 | 2.6 | 2.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.3 | 1.3 | 1.2 | 1.1 | 1 | -73 % | -11.0 % | 1.6 % | 0.8 % |
| Estonia | 1.7 | 2.6 | 1.9 | 1.3 | 1.4 | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | .9 | .8 | -50 % | -7.0 % | 0.8 % | 0.7 % |
| Finland | 4.3 | 4.4 | 4.2 | 5.0 | 5.9 | 5.0 | 5.5 | 5.0 | 5.1 | 4.8 | 5.3 | 5.1 | 5.0 | 5.0 | 15 % | -1.2 % | 1.9 % | 4.1 % |
| France | 8.0 | 7.8 | 6.8 | 6.2 | 6.5 | 5.6 | 6.2 | 6.7 | 5.8 | 6.1 | 6.4 | 6.3 | 6.2 | 6.2 | -22 % | 0.8 % | 3.6 % | 5.1 % |
| Germany | 23 | 9.9 | 11 | 11 | 17 | 16 | 18 | 18 | 15 | 15 | 15 | 15 | 15 | 15 | -32 % | 1.9 % | 10.3 % | 12.7 % |
| Greece | 3.4 | 3.4 | 3.3 | 2.9 | 2.1 | 2.5 | 2.8 | 2.6 | 2.6 | 2.7 | 2.4 | 2.4 | 2.4 | 2.3 | -32 % | -1.5 % | 1.5 % | 1.9 % |
| Hungary | 11 | 4.4 | 4.4 | 4.0 | 5.3 | 6.1 | 6.4 | 6.5 | 5.3 | 5.6 | 5.6 | 5.4 | 4.4 | 4.1 | -61 % | -7.9 % | 4.8 % | 3.4 % |
| Ireland | 6.6 | 4.2 | 3.0 | 2.7 | 2.6 | 2.4 | 2.4 | 2.6 | 2.3 | 2.3 | 2.1 | 2.1 | 2.3 | 1.9 | -71 % | -17.6 % | 3.0 % | 1.6 % |
| Italy | 7.1 | 7.8 | 7.8 | 8.5 | 14 | 9.3 | 13 | 13 | 11 | 12 | 12 | 12 | 11 | 11 | 56 % | 0.0 % | 3.2 % | 9.1 % |
| Latvia | 2.9 | 3.1 | 3.1 | 2.6 | 2.0 | 2.0 | 2.0 | 1.7 | 1.7 | 1.4 | 1.3 | 1.5 | 1.5 | 1.5 | -49 % | -4.8 % | 1.3 % | 1.2 % |
| Lithuania | 2.6 | 1.6 | 1.8 | 1.9 | 2.1 | 2.0 | 2.0 | 2.0 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | -39 % | -5.5 % | 1.2 % | 1.3 % |
| Luxembourg | 0.9 | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -90 % | -22.4 % | 0.4 % | 0.1 % |
| Malta | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -90 % | 8.7 % | 0.1 % | 0.0 % |
| Netherlands | 2.9 | 1.6 | 0.9 | 0.9 | 0.9 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | -73 % | -3.2 % | 1.3 % | 0.6 % |
| Poland | 39 | 50 | 31 | 38 | 41 | 36 | 36 | 34 | 30 | 30 | 31 | 31 | 30 | 26 | -32 % | -11.6 % | 17.6 % | 21.6 % |
| Portugal | 4.4 | 4. | 3.6 | 3.1 | 2.4 | 2.4 | 2.4 | 2.4 | 2.3 | 2.3 | 2.3 | 2.4 | 2.6 | 2.8 | -37 % | 6.3 % | 2.0 % | 2.3 % |
| Romania | 7.9 | 5.1 | 8.6 | 9.7 | 11 | 10 | 11 | 10.0 | 10 | 9.9 | 9.8 | 9.9 | 9.8 | 9.9 | 25 % | 1.0 % | 3.6 % | 8.1 % |
| Slovakia | 7.9 | 4.1 | 3.4 | 3.9 | 3.6 | 3.4 | 3.7 | 3.5 | 2.3 | 3.0 | 3.1 | 3.2 | 2.6 | 2.7 | -65 % | 4.0 % | 3.6 % | 2.3 % |
| Slovenia | 0.8 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | -55 % | -1.3 % | 0.4 % | 0.3 % |
| Spain | 12 | 11 | 9.0 | 8.6 | 9.4 | 9.2 | 9.1 | 8.9 | 9.0 | 8.9 | 11 | 8.9 | 8.8 | 8.6 | -27 % | -2.2 % | 5.4 % | 7.1 % |
| Sweden | 3.1 | 3.2 | 2.4 | 2.4 | 1.9 | 1.9 | 1.7 | 1.7 | 1.5 | 1.5 | 1.4 | 1.4 | 1.2 | 1.2 | -61 % | -2.9 % | 1.4 % | 1.0 % |
| **EU28 (a)** | **221** | **180** | **132** | **137** | **154** | **138** | **147** | **145** | **130** | **131** | **134** | **133** | **128** | **122** | **-45 %** | **-4.4 %** | **100 %** | **100 %** |
| EU28 (b) | 221 | 180 | 132 | 137 | 154 | 138 | 147 | 145 | 130 | 131 | 134 | 133 | 128 | 122 | | | | |

**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
EU-28 does not include data from the United Kingdom (see Box ES.2).

## *3.27 Hexachlorobenzene emission trends and key categories*

Between 1990 and 2019, hexachlorobenzene (HCB) emissions fell by 97 % in the EU. However, between 2018 and 2019, they decreased by 6.2 % (see Table 3.30), mainly because of Finland, Czechia, Greece and Bulgaria (countries ranked according to the size of their contributions to the absolute change). In 2019, the EU Member States contributing most (i.e. more than 10 %) to HCB emissions were France, Finland, Czechia and Austria (countries ranked according to their shares of the EU total).

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

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

Czechia explained that the increase from 2009 to 2010 was due to the implementation of new statistical data on hard coal consumption, and the rise between 2011 and 2012 was linked to higher hard coal consumption (personal communication from Czechia in 2018).

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

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

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

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

Portugal's HCB emissions reported in 2021 mainly come from energy industries (1A1), the use of pesticides in agriculture (3Df) and waste incineration sources (5C) (see Portugal's IIR, listed in Appendix 5).

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

Spain stated in its 2021 IIR that the sudden reduction in HCB emissions between 2005 and 2006 and the further drop from 2008 to 2010 were due to a new regulation in line with the framework of the Stockholm Convention on Persistent Organic Pollutants. Previous fluctuations reflect variations in the production of persistent organic pollutant (POPs) in Spain (see Spain's IIR, listed in Appendix 5).

### Table 3.30 Member State contributions to EU emissions of HCB

| | HCB (kg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 83 | 42 | 20 | 17 | 19 | 17 | 41 | 120 | 124 | 16 | 17 | 18 | 16 | 17 | -79 % | 7.6 % | 1.5 % | 10.1 % |
| Belgium | 40 | 115 | 21 | 19 | 12 | 27 | 16 | 5.1 | 5 | 3.6 | 3.1 | 33 | 4.0 | 3.1 | -92 % | -22.9 % | 0.7 % | 1.8 % |
| Bulgaria | 1.8 | 1.8 | 1.8 | 2.0 | 2.4 | 2.4 | 2.1 | 1.8 | 1.9 | 1.9 | 1.7 | 1.8 | 1.6 | 0.3 | -85 % | -82.9 % | 0.0 % | 0.2 % |
| Croatia | 7.1 | 6.4 | 2.0 | 0.5 | 0.9 | 0.8 | 0.9 | 0.8 | 0.6 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | -91 % | 8.7 % | 0.1 % | 0.4 % |
| Cyprus | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -53 % | -1.4 % | 0.0 % | 0.0 % |
| Czechia | 106 | 44 | 19 | 14 | 22 | 19 | 25 | 22 | 22 | 23 | 22 | 22 | 21 | 18 | -82 % | -11.6 % | 1.9 % | 10.9 % |
| Denmark | 13 | 11 | 5.6 | 3.7 | 2.8 | 2.6 | 2.4 | 2.6 | 2.4 | 2.2 | 2.4 | 2.4 | 2.4 | 2.2 | -83 % | -8.9 % | 0.2 % | 1.3 % |
| Estonia | 0.3 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.3 | 37 % | -7.3 % | 0.0 % | 0.2 % |
| Finland | 36 | 36 | 39 | 32 | 8.8 | 26 | 9.5 | 17 | 22 | 16 | 60 | 33 | 32 | 23 | -37 % | -29.0 % | 0.6 % | 13.3 % |
| France | 1197 | 71 | 45 | 12 | 21 | 20 | 20 | 21 | 23 | 25 | 26 | 28 | 29 | 30 | -98 % | 2.9 % | 21.7 % | 17.5 % |
| Germany | 2 898 | 2 118 | 2 884 | 15 | 11 | 11 | 9.9 | 10 | 15 | 13 | 16 | 19 | 13 | 13 | -100 % | -1.3 % | 52.6 % | 7.4 % |
| Greece | 21 | 22 | 25 | 27 | 12 | 12 | 11 | 9.4 | 10 | 3.1 | 2.7 | 3.3 | 2.7 | 1.7 | -92 % | -36.9 % | 0.4 % | 1.0 % |
| Hungary | 257 | 630 | 367 | 3.3 | 2.2 | 2.5 | 2.6 | 2.4 | 3.0 | 3.1 | 3.2 | 3.2 | 2.8 | 3.2 | -99 % | 13.0 % | 4.7 % | 1.9 % |
| Ireland | 48 | 48 | 7.9 | 2.6 | 2.6 | 2.6 | 2.7 | 2.7 | 2.6 | 2.7 | 2.6 | 2.6 | 2.4 | 2.3 | -95 % | -4.1 % | 0.9 % | 1.4 % |
| Italy | 139 | 107 | 28 | 22 | 12 | 11 | 12 | 11 | 12 | 12 | 11 | 11 | 10.3 | 10.4 | -93 % | 1.4 % | 2.5 % | 6.1 % |
| Latvia | 5.7 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | -91 % | -0.1 % | 0.1 % | 0.3 % |
| Lithuania | 11 | 4.7 | 1.9 | 2 | 1 | 0.9 | 0.7 | 0.7 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | -96 % | 4.8 % | 0.2 % | 0.2 % |
| Luxembourg | 0.4 | 1.3 | 0.6 | 0.6 | 0.8 | 0.8 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 22 % | 4.8 % | 0.0 % | 0.3 % |
| Malta | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 17 % | 2.4 % | 0.0 % | 0.0 % |
| Netherlands | 66 | 40 | 17 | 3.4 | 3.4 | 3.6 | 3.8 | 3.7 | 3.7 | 4.0 | 4.2 | 4.0 | 3.8 | 3.8 | -94 % | -0.7 % | 1.2 % | 2.2 % |
| Poland | 85 | 85 | 14 | 13 | 13 | 13 | 13 | 9.8 | 12 | 12 | 13 | 14 | 13 | 15 | -82 % | 12.8 % | 1.5 % | 8.8 % |
| Portugal | 60 | 76 | 101 | 1.7 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 1.7 | 1.9 | 2.0 | 2.4 | 2.4 | -96 % | 0.1 % | 1.1 % | 1.4 % |
| Romania | 2.8 | 2.9 | 3.9 | 4.2 | 3.2 | 3.4 | 3.3 | 2.9 | 2.9 | 3.0 | 2.9 | 3.1 | 3.1 | 3.1 | 9 % | -0.5 % | 0.1 % | 1.8 % |
| Slovakia | 15.1 | 5.3 | 4.9 | 3.4 | 3.2 | 3.3 | 3.4 | 3.5 | 3.1 | 3.3 | 3.1 | 4.0 | 3.4 | 3.4 | -78 % | -1.0 % | 0.3 % | 2.0 % |
| Slovenia | 21 | 18 | 20 | 0.9 | 1.3 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | -97 % | -4.2 % | 0.4 % | 0.3 % |
| Spain | 381 | 207 | 192 | 136 | 12 | 13 | 11 | 7.8 | 12 | 10 | 12 | 12 | 13 | 13 | -97 % | -0.4 % | 6.9 % | 7.6 % |
| Sweden | 16 | 17 | 11 | 4.5 | 6.6 | 4.3 | 3.8 | 4.3 | 3.4 | 3.8 | 2.7 | 3.1 | 2.8 | 2.7 | -83 % | -2.6 % | 0.3 % | 1.6 % |
| **EU28 (a)** | **5 514** | **3 710** | **3 831** | **341** | **175** | **199** | **198** | **263** | **285** | **163** | **210** | **223** | **181** | **170** | **-97 %** | **-6.2 %** | **100 %** | **100 %** |
| EU28 (b) | 5 514 | 3 710 | 3 831 | 341 | 175 | 199 | 198 | 263 | 285 | 163 | 210 | 223 | 181 | 170 | | | | |

**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
EU-28 does not include data from the United Kingdom (see Box ES.2).

In 2019, '3Df — Use of pesticides', '1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were the main key categories for HCB emissions, together accounting for 69 % of the total (see Figure 3.18(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2019 were in the fourth most important, '2B10a — Chemical industry: Other' (-95.8 %) and in the most important, '3Df — Use of pesticides' (-85.3 %).

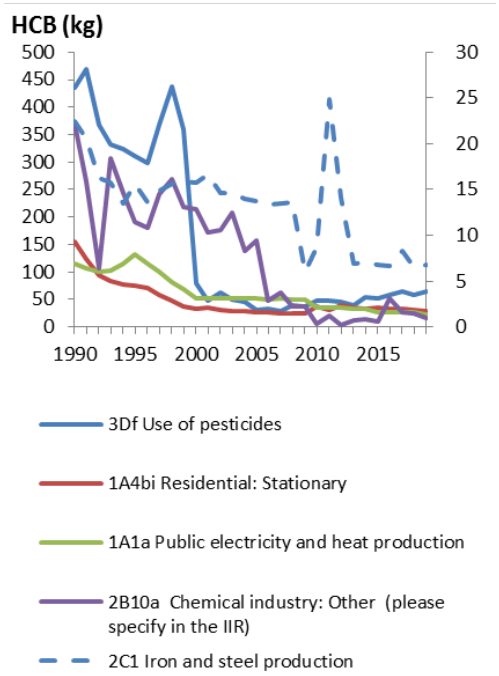
Figure 3.18 (b) shows the contribution made by each aggregated sector group to total EU emissions. For HCB, the primary emission sources are the commercial, institutional and households, agriculture, and the industrial processes and product use sectors.

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

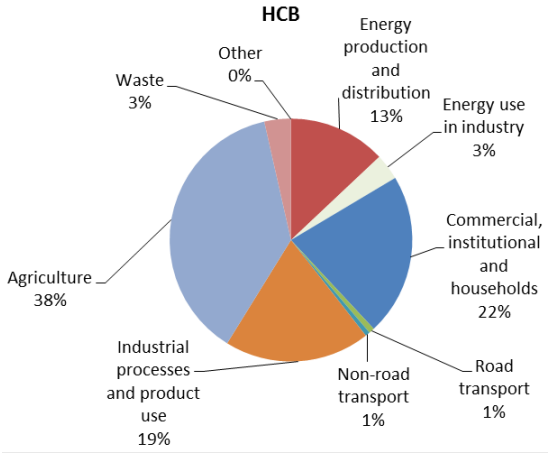
The major peak in the category '2C1 — Iron and steel production' in 2011 reflects data reported by Belgium.

**Figure 3.18 HCB emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

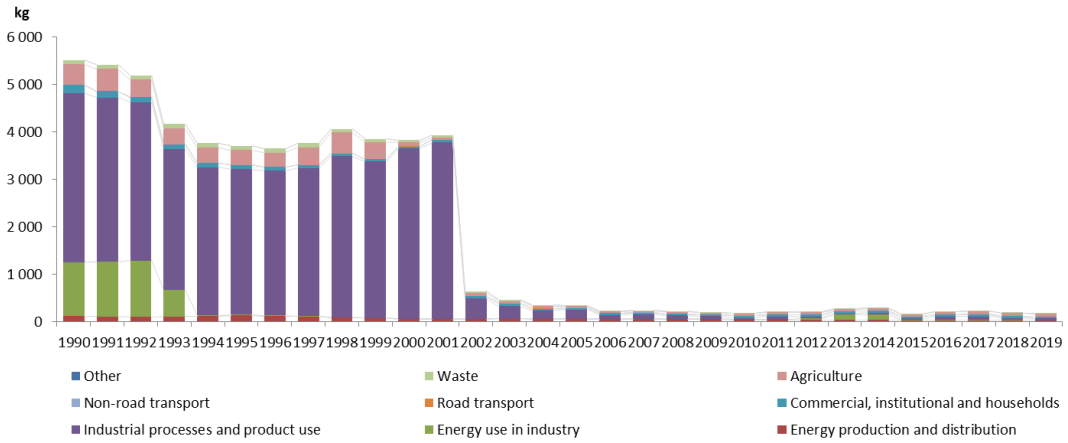
**(a)**




**(b)**




**(c)**




Note: In Figure 3.18(a), the right-hand axis shows values for '2C1 — Iron and steel production'.

## *3.28 Polychlorinated biphenyl emission trends and key categories*

Between 1990 and 2019, polychlorinated biphenyl (PCB) emissions dropped by 73 % in the EU. Between 2018 and 2019, they fell by 12.6 %, mainly because of reductions reported by Luxembourg, Poland, Belgium and France (countries ranked according to the size of their contributions to the absolute change (see Table 3.31). In 2019, the EU Member States contributing most (i.e. more than 10 %) to PCB emissions were Croatia, Germany and Poland (countries ranked according to their shares of the EU total).

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

The emissions reported by Greece for PCB in the category '2C5 — Lead production' are responsible for the strong increases observed from 2007 to 2008 and from 2017 to 2018. Between 2018 and 2019, PCB emissions fell again by 7 %. In 2003, the emission peak in Ireland (not shown in Table 3.31) was caused by an increase in household waste reported in the category '5E — Other waste' (see Ireland's IIR, listed in Appendix 5).

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

### Table 3.31 Member State contributions to EU emissions of PCBs

| | PCB (kg) | | | | | | | | | | | | | | Change | | Share in EU—28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 1990—2019 | 2018—2019 | 1990 | 2019 |
| Austria | 47 | 29 | 30 | 35 | 35 | 35 | 35 | 37 | 37 | 36 | 35 | 38 | 32 | 35 | -26 % | 8.5 % | 1.0 % | 2.8 % |
| Belgium | 119 | 103 | 108 | 89 | 116 | 78 | 33.2 | 37.2 | 35 | 41 | 53 | 49 | 19 | 14 | -88 % | -25.9 % | 2.5 % | 1.1 % |
| Bulgaria | 14 | 16 | 11 | 10 | 4.3 | 5.0 | 4.7 | 4.1 | 3.1 | 3.0 | 3.1 | 3.8 | 3.5 | 2.8 | -80 % | -18.4 % | 0.3 % | 0.2 % |
| Croatia | 483 | 468 | 441 | 436 | 434 | 433 | 431 | 430 | 429 | 425 | 422 | 415 | 412 | 410 | -15 % | -0.5 % | 10.2 % | 32.4 % |
| 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 | 1 % | -4.8 % | 0.0 % | 0.0 % |
| Czechia | 3.7 | 2.8 | 2.1 | 2.0 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | -55 % | -5.3 % | 0.1 % | 0.1 % |
| Denmark | 2.9 | 2.9 | 2.3 | 1.2 | 0.5 | 0.5 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | -86 % | -5.5 % | 0.1 % | 0.0 % |
| Estonia | 3.4 | 1.7 | 1.1 | 1.2 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.6 | 0.7 | 0.8 | 0.7 | 0.4 | -87 % | -36.9 % | 0.1 % | 0.0 % |
| Finland | 29 | 29 | 30 | 31 | 28 | 28 | 25 | 23 | 25 | 24 | 26 | 26 | 26 | 23 | -21 % | -13.3 % | 0.6 % | 1.8 % |
| France | 178 | 152 | 98 | 69 | 54 | 46 | 50 | 50 | 42 | 41 | 41 | 42 | 38 | 33 | -81 % | -11.9 % | 3.7 % | 2.6 % |
| Germany | 1 735 | 1 483 | 948 | 196 | 236 | 235 | 227 | 230 | 230 | 231 | 230 | 228 | 219 | 216 | -88 % | -1.6 % | 36.6 % | 17.1 % |
| Greece | 9.2 | 8.9 | 7.9 | 19 | 32 | 32 | 30 | 29 | 29 | 29 | 30 | 31 | 38 | 35 | 285 % | -7.0 % | 0.2 % | 2.8 % |
| Hungary | 26 | 12 | 9.9 | 11 | 8.9 | 9.7 | 8.8 | 7.1 | 7.4 | 11 | 9.7 | 8.3 | 8.5 | 5.9 | -77 % | -31.0 % | 0.5 % | 0.5 % |
| Ireland | 39 | 33 | 30 | 32 | 12 | 10 | 9.5 | 7.7 | 7.2 | 9.2 | 6.7 | 7.4 | 8.6 | 7.8 | -80 % | -9.3 % | 0.8 % | 0.6 % |
| Italy | 152 | 163 | 152 | 174 | 128 | 133 | 134 | 119 | 116 | 109 | 114 | 117 | 116 | 112 | -26 % | -3.9 % | 3.2 % | 8.8 % |
| Latvia | 4.3 | 1.1 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -96 % | -9.3 % | 0.1 % | 0.0 % |
| Lithuania | 4.6 | 1.7 | 0.7 | 37 | 10 | 1.5 | 1.2 | 1.4 | 1.2 | 1.1 | 1.2 | 1.3 | 1.3 | 0.9 | -81 % | -34.3 % | 0.1 % | 0.1 % |
| Luxembourg | 40 | 36 | 12 | 13 | 19 | 27 | 9.1 | 4.3 | 5.1 | 3.1 | 3.8 | 3.7 | 137.8 | 12.1 | -70 % | -91.2 % | 0.8 % | 1.0 % |
| 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 | 49 % | 2.6 % | 0.0 % | 0.0 % |
| Netherlands | 39 | 22 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | -100 % | -21.5 % | 0.8 % | 0.0 % |
| Poland | 206 | 190 | 181 | 173 | 165 | 180 | 183 | 185 | 181 | 182 | 176 | 182 | 178 | 156 | -24 % | -12.1 % | 4.3 % | 12.4 % |
| Portugal | 1064 | 860 | 794 | 670 | 323 | 251 | 262 | 140 | 105 | 86 | 84 | 96 | 92 | 89 | -92 % | -2.7 % | 22.4 % | 7.1 % |
| Romania | 62 | 39 | 28 | 39 | 21 | 20 | 19 | 18 | 18 | 20 | 20 | 19 | 20 | 20 | -68 % | 0.6 % | 1.3 % | 1.6 % |
| Slovakia | 28 | 24 | 25 | 27 | 20 | 18 | 19 | 20 | 21 | 20 | 20 | 21 | 21 | 18 | -36 % | -17.5 % | 0.6 % | 1.4 % |
| Slovenia | 415 | 290 | 214 | 135 | 76 | 51 | 44 | 41 | 41 | 39 | 39 | 36 | 36 | 35 | -91 % | -0.2 % | 8.8 % | 2.8 % |
| Spain | 26 | 41 | 33 | 36 | 34 | 31 | 29 | 27 | 27 | 27 | 25 | 27 | 27 | 26 | -3 % | -4.6 % | 0.6 % | 2.0 % |
| Sweden | 9.2 | 9.6 | 9.8 | 9.4 | 9.2 | 9.8 | 8.8 | 8.5 | 9.0 | 9.1 | 9.2 | 9.5 | 9.4 | 9.2 | 0 % | -2.2 % | 0.2 % | 0.7 % |
| **EU28 (a)** | **4 739** | **4 019** | **3 170** | **2 246** | **1 769** | **1 638** | **1 566** | **1 424** | **1 372** | **1 349** | **1 350** | **1 364** | **1 447** | **1 264** | **-73 %** | **-12.6 %** | **100 %** | **100 %** |
| EU28 (b) | 4 739 | 4 019 | 3 170 | 2 246 | 1 769 | 1 638 | 1 566 | 1 424 | 1 372 | 1 349 | 1 350 | 1 364 | 1 447 | 1 264 | | | | |

**Notes:** ([a]) Sum of national totals, as reported by EU Member States.
([b]) Sum of sectors.
EU-28 does not include data from the United Kingdom (see Box ES.2).

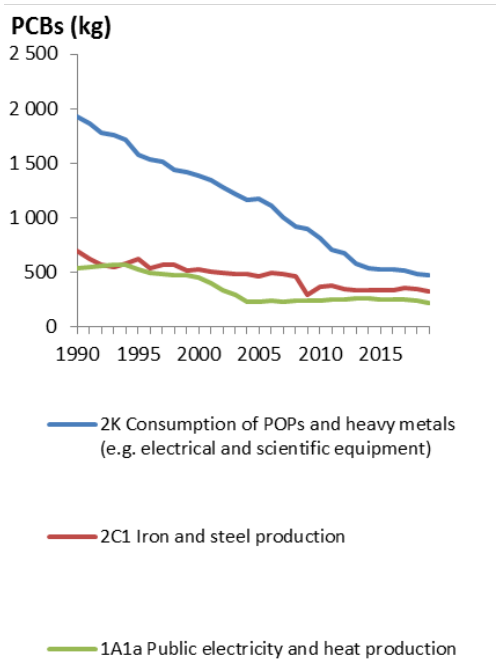
The category '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' was the main key category for PCB emissions, making up 38 % of the total. Among the top three key categories, the highest relative reductions in emissions between 1990 and 2019 were in the principal most important, '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' (-75.8 %), the second most important, '2C1 — Iron and steel production' (-53.3 %), and in the third most important, '1A1a — Public electricity and heat production' (-59.7 %) (see Figure 3.19(a)).

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

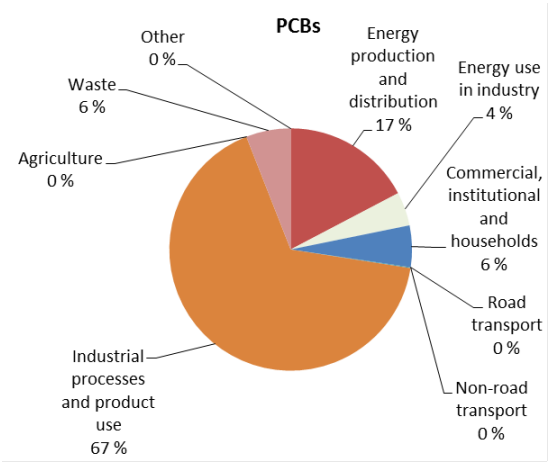
Figure 3.19(b) shows the contribution made by each aggregated sector group to total EU emissions. For PCBs, the most significant emission source is the industrial processes and product use sector group.

**Figure 3.19 PCB emissions from key categories in the EU: (a) trend in emissions from the three most important key categories, 1990-2019; (b) share by sector group, 2019; (c) sectoral trends in emissions**

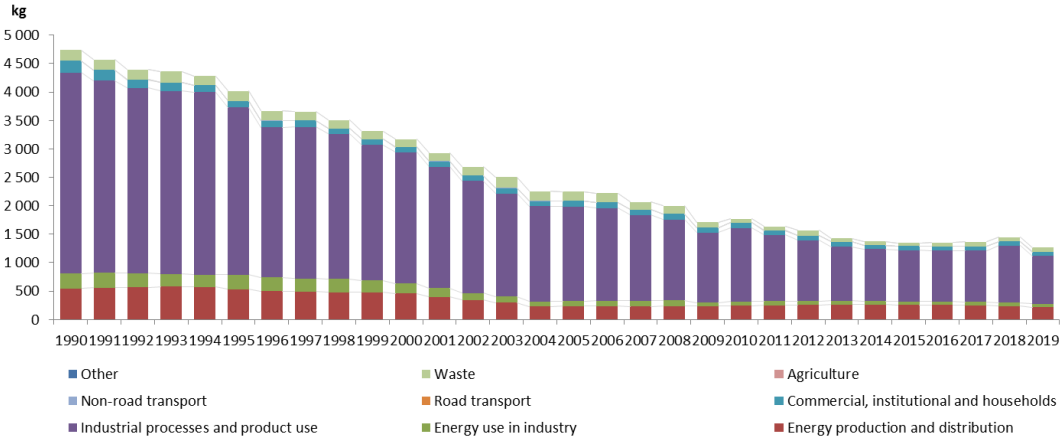
**(a)**




**(b)**




**(c)**



# 4 Sectoral analysis and emission trends for key pollutants

Chapter 4 sets out emission trends in and detailed methodologies for the key pollutants, aggregated into the following main sector groups:

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

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

Table 4.2 and the subsequent tables provide information on the relative and absolute difference between emissions reported in 2020 and 2021. Major recalculations for all pollutants in the submissions made in 2020 and 2021 are required because the UK emission inventory is not included in the EU-28 inventory in 2021 (see Box ES.2). Big changes in absolute terms originate from the fact that EU Member States provided certain data for the first time (e.g. Malta) and carried out major recalculations (e.g. France, Germany, Poland). Detailed information can be found in Section 5.1.

**Box 4.1 Explanations of the figures in this chapter**

- The Convention on Long-range Transboundary Air Pollution (Air Convention) formally requests Parties to report emissions of particulate matter (PM) for 2000 and thereafter. The figures in this chapter show only data from 2000 onwards.
- The figures showing indexed values (in percentages) use 1990 as the index year (1990 = 100 %), except for PM with a diameter of 10 µm or less ($PM_{10}$) and PM with a diameter of 2.5 µm or less ($PM_{2.5}$), for which the index year is 2000 (2000 = 100 %).

## *4.1 Sectoral analysis and emission trends for energy production and distribution*

The energy production and distribution sector grouping comprises emissions from a number of activities that employ fuel combustion to produce energy products and electricity, for instance. It is a primary source of many pollutants, especially sulphur oxides ($SO_X$) and mercury (Hg). Despite considerable previous reductions, this sector group contributes 47 % of the total EU emissions of $SO_X$ as well as 40 % of Hg emissions.

The sector is a significant source of $SO_X$, Hg, polychlorinated biphenyls (PCBs), cadmium (Cd), nitrogen oxides ($NO_X$) and hexachlorobenzene (HCB). Countries are ranked according to the size of the absolute values that they reported. In 2019, Poland, Germany and Romania contributed most (in absolute terms) to the emissions of $SO_X$ for this sector. Poland, Germany and Czechia reported the highest emissions of Hg in the same year. Poland and Germany reported the highest emissions of PCBs, and they also primarily accounted for Cd emissions in this sector in 2019. In addition, in 2019, Germany, Poland and Greece contributed most to $NO_X$ emissions.

For emissions of the main pollutants (see Figure 4.1), between 1990 and 2019, the highest absolute and relative reduction within this aggregated sector was for $SO_X$ (-94 %). Between 1990 and 2019, $NO_X$ and non-methane volatile organic compound (NMVOC) emissions dropped by 75 % and 66 %, respectively. Emissions of particulate matter (PM) with a diameter of 2.5 μm or less ($PM_{2.5}$) and PM with a diameter of 10 μm or less ($PM_{10}$) have decreased notably since 2000: $PM_{2.5}$ by 77 % and $PM_{10}$ by 78 %. In addition, benzo(a)pyrene (B(a)P) emissions fell significantly by 93 % from 1990 to 2019.

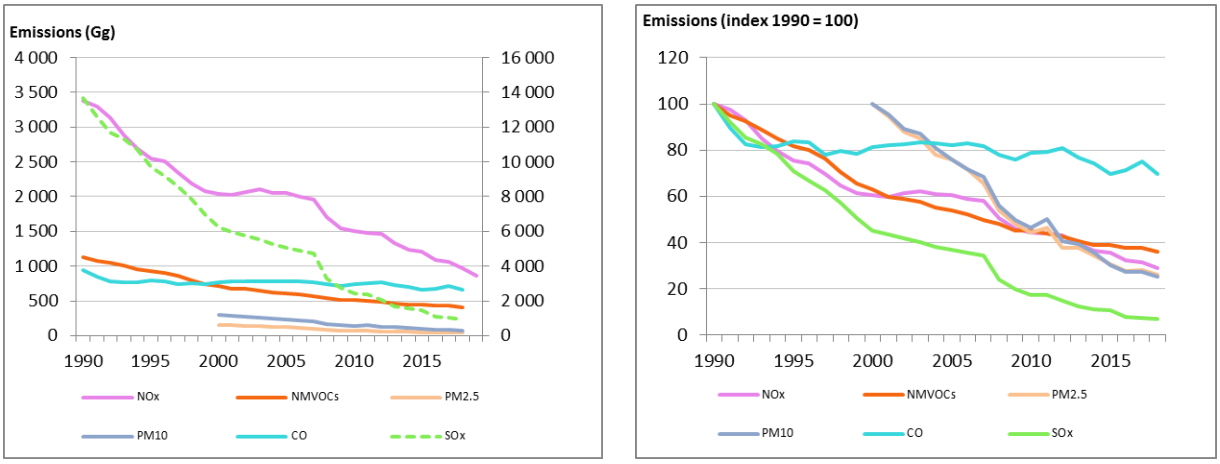
The significant reduction in $NO_X$ emissions between 2007 and 2008 was mainly because of decreases reported by Spain in the category '1A1a — Public electricity and heat production'. Furthermore, emission reductions reported for the same category in Spain are mainly responsible for the strong decline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

The declining trend in $SO_X$ emissions between 1990 and 2019 mainly reflects data from Germany, Spain and Poland in the category '1A1a — Public electricity and heat production'. Since 1990, several measures have been combined to reduce emissions from these main emitting sources: switching fuel in energy-related sectors away from high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas; fitting flue gas desulphurisation (FGD) abatement technology in industrial facilities; and introducing EU directives relating to the sulphur content of certain liquid fuels (EEA, 2020b).

In 2012, the peak in carbon monoxide (CO) emissions was due to reported increases between 2011 and 2012 from Italy and Estonia in the category '1A1c — Manufacture of solid fuels and other energy industries'. Germany reported a steep increase in the category '1A1a — Public electricity and heat production' in 2012. Furthermore, between 2012 and 2013, Croatia, Portugal and especially France reported reductions in the category '1B2aiv — Fugitive emissions oil: Refining/storage', and Italy reported decreases in the categories '1A1a — Public electricity and heat production' and '1A1c — Manufacture of solid fuels and other energy industries'. France explained that CO emissions were mainly caused by the regeneration of catalytic crackers. In 2013, a plant was equipped with a CO boiler and, since then, emissions have fallen (see France's IIR, listed in Appendix 5).

In 2011, peaks in $PM_{2.5}$ and $PM_{10}$ emissions arose from high emission values reported by Estonia in the category '1A1a — Public electricity and heat production'. The Member State explained that the significant growth of $PM_{2.5}$ emissions in 2011 was due to a 34 % increase in electricity production at the Balti Power Plant (Enefit Power AS) which resulted from the incorrect operation of electric precipitators in two of the plant's power units (see Estonia's IIR, listed in Appendix 5).

**Figure 4.1 EU emission trends in the energy production and distribution sector for $NO_X$, NMVOCs, $PM_{2.5}$, $PM_{10}$, CO and $SO_X$ between 1990 (2000) and 2019**




**Note:** In the left-hand panel, the right-hand axis shows values for $SO_X$.

Of the three main heavy metals (HMs), lead (Pb) shows the highest reduction in relative terms (-84 %) (see Figure 4.2(a)).

For emissions of persistent organic pollutants (POPs), the highest relative reduction was in polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs) (97 %) (see Figure 4.2(b)). The peak in HCB emissions in 1995 reflects high emission values reported by Belgium in the category '1A1a — Public electricity and heat production'. 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 (Pb, Cd and Hg) and (b) POPs (PCDD/Fs, PCBs and HCB) between 1990 and 2019**

**(a)** **(b)**

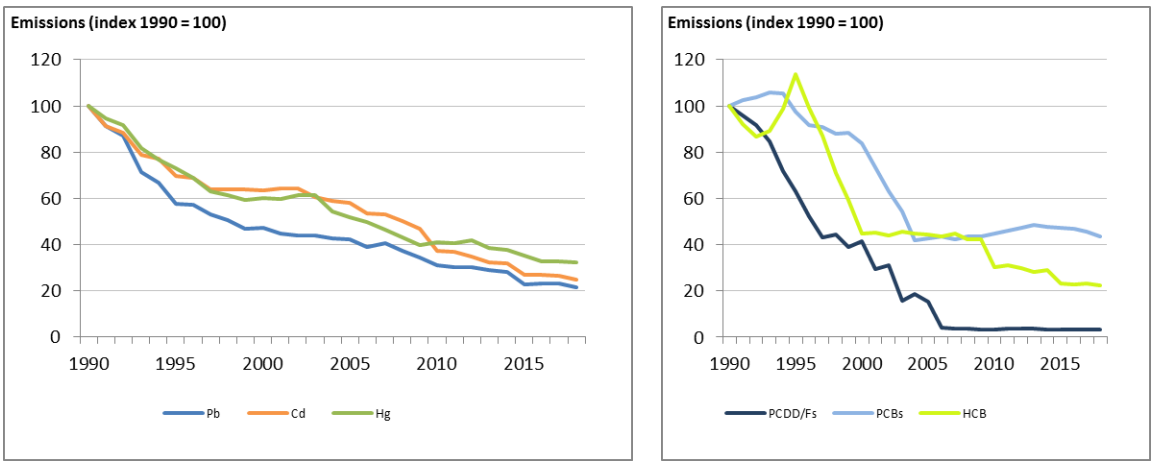


Table 4.1 indicates the number of EU Member States reporting the notation keys 'NA' (not applicable), 'NO' (not occurring), 'NR' (not relevant) and 'NE' (not estimated) within the key categories. Table 4.2 shows the recalculations within the energy production and distribution sector group. For explanations 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 |
|---|---|---|---|---|---|
| $SO_x$ | 1A1b | 0 | 6 | 0 | 0 |
| | 1B2aiv | 1 | 5 | 0 | 0 |
| Cd | 1A1b | 0 | 6 | 0 | 0 |
| Hg | 1A1b | 0 | 6 | 0 | 0 |
| PCDD/Fs | 1A1a | 0 | 0 | 0 | 1 |
| HCB | 1A1a | 1 | 0 | 0 | 1 |
| PCB | 1A1a | 0 | 0 | 0 | 1 |

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

**Table 4.2 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2020 and 2021 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 |
| $NO_x$ | -20 % | -19 % | -18 % | -19 % | -20 % | -19 % | -19 % | -18 % | -18 % | -18 % | -20 % | -21 % | -20 % | -19 % | -16 % | -15 % | -14 % |
| NMVOCs | -40 % | -38 % | -36 % | -30 % | -30 % | -30 % | -28 % | -28 % | -26 % | -26 % | -26 % | -25 % | -25 % | -25 % | -23 % | -24 % | -26 % |
| SOx | -18 % | -15 % | -13 % | -9 % | -8 % | -8 % | -8 % | -8 % | -9 % | -9 % | -13 % | -12 % | -10 % | -8 % | -6 % | -5 % | -5 % |
| $NH_3$ | 3 % | 2 % | 2 % | 1 % | 1 % | 2 % | 2 % | 5 % | 6 % | 4 % | 4 % | 2 % | 3 % | 1 % | 1 % | 1 % | 2 % |
| TSPs | 5 % | -7 % | -2 % | -4 % | -5 % | -4 % | -5 % | -4 % | -4 % | -4 % | -7 % | -7 % | -6 % | -7 % | -5 % | -5 % | -6 % |
| CO | -5 % | -10 % | -1 % | 1 % | 2 % | 1 % | 1 % | 2 % | 3 % | 5 % | 1 % | 4 % | 7 % | -3 % | 0 % | 1 % | 1 % |
| Pb | -25 % | -33 % | -8 % | -6 % | -6 % | -2 % | -2 % | -2 % | -3 % | -3 % | -4 % | -3 % | -3 % | -4 % | -2 % | -3 % | -3 % |
| Cd | -13 % | -7 % | -3 % | -4 % | -4 % | -1 % | 0 % | 1 % | 1 % | 2 % | 1 % | 2 % | 1 % | 1 % | 1 % | 1 % | 0 % |
| Hg | -13 % | -9 % | -5 % | -6 % | -6 % | -6 % | -5 % | -4 % | -5 % | -4 % | -5 % | -5 % | -4 % | -4 % | -3 % | -2 % | -1 % |
| As | -11 % | -14 % | -8 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -3 % | -3 % | -2 % | -2 % | -2 % | -2 % | -2 % |
| Cr | -22 % | -23 % | -17 % | -7 % | -7 % | -5 % | -5 % | -4 % | -4 % | -4 % | -5 % | -5 % | -5 % | -4 % | -3 % | -4 % | -2 % |
| Cu | -13 % | -17 % | -13 % | -4 % | -4 % | -3 % | -3 % | -3 % | -2 % | -2 % | -4 % | -3 % | -2 % | -3 % | -2 % | -3 % | -1 % |
| Ni | -12 % | -11 % | -6 % | -4 % | -4 % | -4 % | -5 % | -4 % | -3 % | -4 % | -4 % | -4 % | -4 % | -4 % | -3 % | -10 % | -6 % |
| Se | -39 % | -27 % | -16 % | -17 % | -15 % | -11 % | -12 % | -10 % | -9 % | -10 % | -15 % | -15 % | -15 % | -12 % | -6 % | -6 % | -5 % |
| Zn | -3 % | -5 % | -3 % | -2 % | -2 % | -3 % | -2 % | -1 % | -1 % | 0 % | -1 % | -2 % | -1 % | -1 % | -1 % | -1 % | -1 % |
| PCDD/Fs | -5 % | -9 % | -4 % | -9 % | -21 % | -24 % | -25 % | -25 % | -15 % | -18 % | -17 % | -15 % | -13 % | -2 % | -3 % | -3 % | -3 % |
| B(a)P | -1 % | -1 % | -3 % | -6 % | -4 % | -4 % | -3 % | -6 % | -7 % | -6 % | -7 % | -8 % | -9 % | -10 % | -8 % | -10 % | -11 % |
| B(b)F | -1 % | -1 % | -6 % | -9 % | -8 % | -7 % | -6 % | -13 % | -15 % | -13 % | -14 % | -15 % | -17 % | -17 % | -17 % | -19 % | -21 % |
| B(k)F | 0 % | -1 % | -3 % | -8 % | -6 % | -6 % | -4 % | -7 % | -9 % | -8 % | -9 % | -12 % | -12 % | -13 % | -12 % | -15 % | -16 % |
| IP | 0 % | -1 % | -4 % | -11 % | -3 % | -8 % | -6 % | -10 % | -12 % | -10 % | -12 % | -14 % | -15 % | -15 % | -16 % | -18 % | -20 % |
| Total PAHs | 2 % | 3 % | 12 % | 12 % | 13 % | 14 % | 17 % | 17 % | 11 % | 13 % | 12 % | 12 % | 11 % | 12 % | 13 % | 9 % | 9 % |
| HCB | 0 % | -2 % | -8 % | -10 % | -10 % | -11 % | -14 % | -17 % | -22 % | -22 % | -24 % | -24 % | -29 % | -39 % | -44 % | -46 % | -50 % |
| PCBs | -16 % | -11 % | -10 % | -19 % | -20 % | -18 % | -17 % | -15 % | -15 % | -15 % | -17 % | -16 % | -14 % | -11 % | -6 % | -6 % | -3 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -1 % | -6 % | -7 % | -7 % | -8 % | -7 % | -7 % | -7 % | -12 % | -12 % | -11 % | -12 % | -12 % | -13 % | -15 % |
| $PM_{10}$ | | | -2 % | -5 % | -6 % | -5 % | -6 % | -5 % | -6 % | -5 % | -9 % | -9 % | -8 % | -9 % | -8 % | -9 % | -11 % |
| BC | | | -9 % | -18 % | -20 % | -21 % | -22 % | -24 % | -20 % | -20 % | -25 % | -26 % | -26 % | -22 % | -23 % | -23 % | -25 % |

**(b)**

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -853 | -589 | -448 | -497 | -502 | -471 | -389 | -347 | -337 | -321 | -369 | -350 | -301 | -275 | -207 | -192 | -164 |
| NMVOCs | -767 | -562 | -403 | -263 | -251 | -244 | -214 | -196 | -177 | -176 | -174 | -153 | -150 | -145 | -131 | -132 | -144 |
| SOx | -2913 | -1752 | -916 | -479 | -455 | -383 | -305 | -235 | -245 | -239 | -294 | -231 | -164 | -131 | -67 | -60 | -45 |
| $NH_3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TSPs | 119 | -59 | -9 | -15 | -17 | -13 | -14 | -10 | -10 | -10 | -15 | -15 | -12 | -11 | -7 | -7 | -8 |
| CO | -50 | -87 | -8 | 5 | 13 | 5 | 9 | 13 | 18 | 38 | 9 | 31 | 44 | -23 | 1 | 9 | 5 |
| Pb | -169 | -142 | -22 | -13 | -13 | -5 | -5 | -4 | -5 | -4 | -6 | -5 | -4 | -4 | -3 | -4 | -4 |
| Cd | -6 | -2 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hg | -10 | -5 | -2 | -2 | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | 0 |
| As | -17 | -10 | -4 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Cr | -57 | -32 | -17 | -6 | -7 | -5 | -4 | -3 | -3 | -3 | -4 | -3 | -3 | -3 | -2 | -2 | -1 |
| Cu | -42 | -23 | -14 | -4 | -4 | -3 | -3 | -2 | -2 | -2 | -3 | -2 | -2 | -2 | -1 | -2 | 0 |
| Ni | -125 | -93 | -42 | -22 | -22 | -21 | -22 | -16 | -13 | -15 | -13 | -11 | -8 | -9 | -7 | -22 | -14 |
| Se | -53 | -29 | -15 | -16 | -13 | -10 | -10 | -8 | -7 | -8 | -12 | -11 | -10 | -8 | -4 | -3 | -3 |
| Zn | -31 | -29 | -14 | -7 | -7 | -10 | -8 | -3 | -3 | -2 | -4 | -9 | -4 | -3 | -3 | -3 | -2 |
| PCDD/Fs | -168 | -189 | -48 | -41 | -32 | -35 | -36 | -33 | -17 | -23 | -23 | -19 | -15 | -3 | -3 | -3 | -3 |
| B(a)P | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 |
| B(b)F | 0 | -1 | 0 | -1 | -1 | 0 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| B(k)F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total PAHs | 6 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| HCB | 0 | -3 | -5 | -6 | -6 | -6 | -8 | -10 | -10 | -10 | -11 | -10 | -14 | -17 | -21 | -23 | -26 |
| PCBs | -107 | -68 | -53 | -54 | -58 | -52 | -49 | -41 | -43 | -43 | -54 | -51 | -41 | -33 | -17 | -15 | -8 |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -2 | -7 | -8 | -7 | -7 | -6 | -6 | -6 | -8 | -8 | -7 | -6 | -6 | -6 | -7 |
| $PM_{10}$ | | | -5 | -12 | -13 | -12 | -11 | -9 | -8 | -9 | -12 | -11 | -9 | -9 | -8 | -8 | -10 |
| BC | | | -1 | -1 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |

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

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

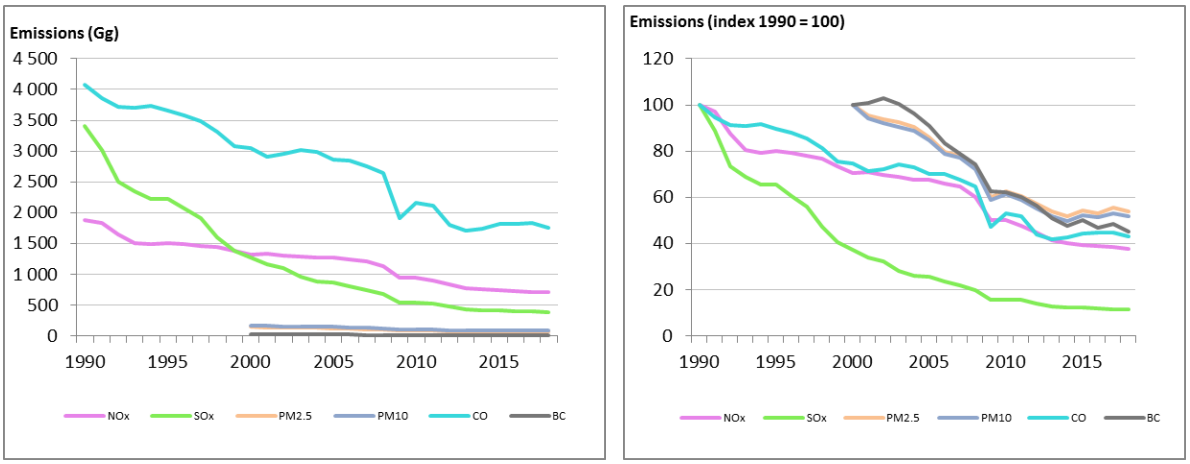
The energy use in industry sector is a significant source of HMs and $SO_X$. According to the size of the absolute values reported, Italy, Bulgaria and France contributed most to Pb emissions in this sector in 2019. For Cd, Italy, Poland and Bulgaria reported the highest emissions, while Italy and France contributed most to Hg emissions. In addition, in 2019, Poland, Spain and France contributed most to $SO_X$ emissions.

Energy use (fuel combustion) in industry is a significant source of many pollutants. For the main ones, the highest absolute and relative reduction (-89 %) between 1990 and 2019 was for $SO_X$ (see Figure 4.3).

The strong decrease in CO emissions between 2008 and 2009 resulted from emission reductions reported by several countries, especially France, Italy and Belgium, in the main category, '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' and may have been caused by the economic crisis.

The negative peak in $PM_{2.5}$ and $PM_{10}$ emissions in 2009 was due to data reported by several countries and might also have been caused by the economic crisis. In 2015, data reported by Estonia and Spain in the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other' was the main reason for the increase in $PM_{2.5}$ and $PM_{10}$ emissions. The increase from 2016 to 2017 was mainly caused by higher emissions reported by Estonia and Poland. Estonia reported higher emissions for the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other', while Poland's reported value for the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' was higher in 2017 than in 2019 and previous years.

**Figure 4.3 EU emission trends in the energy use in industry sector group for $NO_X$, $SO_X$, $PM_{2.5}$, $PM_{10}$, CO and BC between 1990 (2000) and 2019**




**Note:** BC, black carbon.

Of the three HMs, Cd shows the biggest reduction in relative terms (82 % decrease) (see Figure 4.4(a)).

Pb emissions fell between 1996 and 1997, peaked in 2008, decreased considerably between 2008 and 2009, and increased between 2013 and 2014. This pattern was mainly the result of Bulgaria's data for the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals', accentuated by drops in Pb emissions in the categories '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' and '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' reported by Italy from 1996 to 1997 and between 2008 and 2009.

The increase in Hg emissions between 1994 and 1995 can be linked to higher emissions reported by Spain for the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. Stationary combustion in non-metallic minerals manufacturing industries (1A2f) accounted for 15 % of total Hg emissions in 1990 but reduced its emissions by 71 % in 2019. This reduction resulted from the implementation of abatement techniques in thermal power plants and the shift from coal power plants to combined cycle gas turbine plants (see Spain's IIR, listed in Appendix 5). The strong decline in Hg emissions between 2008 and 2009 was due to reductions reported by several countries, especially Italy and Romania in the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel', and may have been caused by the economic crisis in 2009.

The high Cd emissions from 1994 to 1997 mainly reflect the high levels reported by Bulgaria and Italy in the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals'. The drop in Cd emissions between 2008 and 2009 was caused by reductions noted by several countries, in particular Italy, Bulgaria and France in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' and Italy in the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel'.

Among the POPs, PCDD/Fs are key pollutants in the energy use in industry sector group. HCB registered the largest reduction, compared with 1990 values, of 99 % up to 2019. Figure 4.4(b) presents trends for these pollutants.

The peak in PCDD/F between 1992 and 1995 was mainly the result of the reported emissions of France in the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals'. The trend in PCDD/F emissions from1990 to 2000 was mainly attributable to the data reported by France, with peaks from 1995 to 1998 in the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel'. The sudden drop in

PCDD/F emissions from 2008 to 2009 was due to data reported by several countries, especially Italy, Czechia, Belgium and Bulgaria, mainly in the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel', and may have been caused by the economic crisis.

**Figure 4.4 EU emission trends in the energy use in industry sector group: (a) HMs (Pb, Cd and Hg) and (b) POPs (PCDD/Fs) between 1990 and 2019**

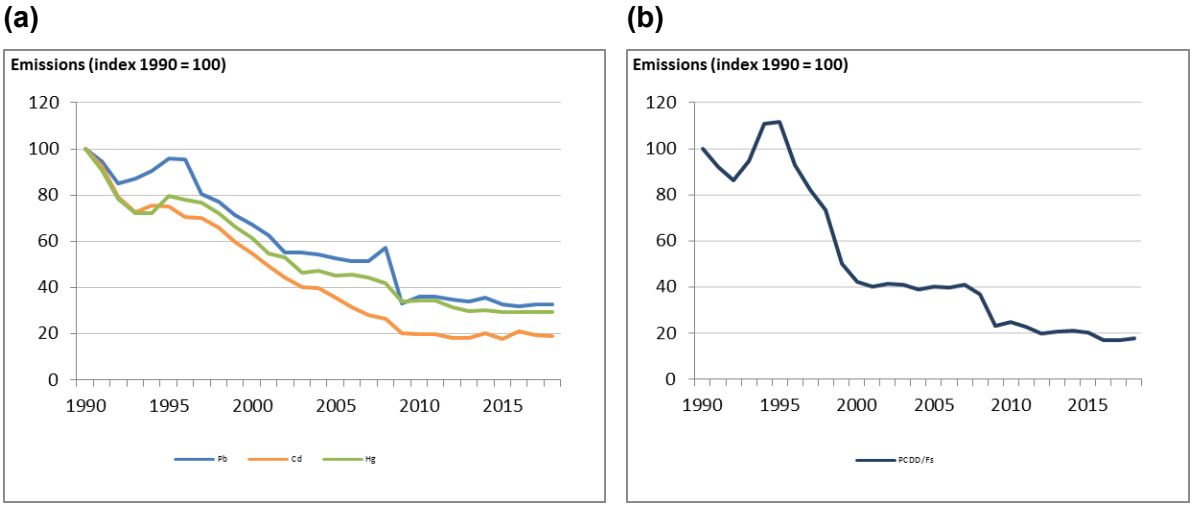



Table 4.3 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.4 shows the recalculations within the energy use in industry sector group. For explanations of EU recalculations, see Section 5.1.

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

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

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

**Table 4.4 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2020 and 2021 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 |
| $NO_x$ | -19 % | -21 % | -19 % | -18 % | -17 % | -17 % | -16 % | -16 % | -17 % | -15 % | -16 % | -16 % | -16 % | -17 % | -16 % | -17 % | -17 % |
| NMVOCs | -12 % | -13 % | -15 % | -14 % | -14 % | -17 % | -15 % | -15 % | -14 % | -11 % | -11 % | -10 % | -11 % | -12 % | -11 % | -11 % | -10 % |
| SOx | -11 % | -13 % | -10 % | -11 % | -11 % | -11 % | -11 % | -13 % | -15 % | -13 % | -13 % | -15 % | -15 % | -10 % | -7 % | -9 % | -11 % |
| $NH_3$ | -4 % | -6 % | -2 % | -4 % | -6 % | -5 % | -6 % | -7 % | -8 % | -7 % | -6 % | -8 % | -15 % | -16 % | -16 % | -18 % | -21 % |
| TSPs | -5 % | -9 % | -9 % | -9 % | -10 % | -10 % | -10 % | -12 % | -13 % | -11 % | -12 % | -13 % | -15 % | -14 % | -14 % | -14 % | -15 % |
| CO | -13 % | -14 % | -13 % | -14 % | -14 % | -16 % | -15 % | -18 % | -16 % | -17 % | -19 % | -21 % | -22 % | -21 % | -20 % | -20 % | -19 % |
| Pb | -7 % | -4 % | -3 % | -4 % | -3 % | -4 % | -3 % | -6 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % |
| Cd | -4 % | -5 % | -3 % | -10 % | -12 % | -12 % | -20 % | -18 % | -29 % | -21 % | -23 % | -20 % | -20 % | -20 % | -18 % | -20 % | -20 % |
| Hg | -8 % | -7 % | -5 % | -6 % | -6 % | -6 % | -9 % | -11 % | -10 % | -9 % | -11 % | -13 % | -13 % | -9 % | -7 % | -7 % | -8 % |
| As | -5 % | -6 % | -13 % | -22 % | -23 % | -24 % | -40 % | -45 % | -57 % | -57 % | -58 % | -58 % | -58 % | -74 % | -70 % | -75 % | -76 % |
| Cr | -3 % | -4 % | -3 % | -4 % | -4 % | -4 % | -4 % | -6 % | -6 % | -4 % | -4 % | -5 % | -6 % | -6 % | -5 % | -6 % | -6 % |
| Cu | -3 % | -4 % | -4 % | -3 % | -2 % | -3 % | -9 % | -4 % | -6 % | -4 % | -4 % | -5 % | -5 % | -4 % | -4 % | -4 % | -4 % |
| Ni | -21 % | -22 % | -18 % | -18 % | -13 % | -17 % | -24 % | -18 % | -27 % | -16 % | -27 % | -36 % | -37 % | -18 % | -17 % | -22 % | -23 % |
| Se | -11 % | -20 % | -27 % | -22 % | -20 % | -21 % | -20 % | -20 % | -22 % | -21 % | -21 % | -20 % | -18 % | -17 % | -17 % | -18 % | -19 % |
| Zn | -17 % | -22 % | -22 % | -25 % | -23 % | -24 % | -23 % | -28 % | -28 % | -26 % | -24 % | -26 % | -27 % | -28 % | -27 % | -28 % | -27 % |
| PCDD/Fs | -6 % | -6 % | -8 % | -7 % | -7 % | -6 % | -8 % | -12 % | -13 % | -13 % | -13 % | -13 % | -13 % | -14 % | -15 % | -15 % | -12 % |
| B(a)P | -2 % | -2 % | -2 % | -7 % | -6 % | -6 % | -8 % | -8 % | -7 % | -8 % | -7 % | -6 % | -6 % | -7 % | -6 % | -10 % | -8 % |
| B(b)F | -2 % | -2 % | -1 % | -6 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -6 % | -4 % | -4 % | -6 % | -4 % | -8 % | -6 % |
| B(k)F | -5 % | -4 % | -3 % | -8 % | -7 % | -7 % | -8 % | -8 % | -8 % | -8 % | -8 % | -7 % | -6 % | -8 % | -7 % | -10 % | -8 % |
| IP | -2 % | -1 % | -1 % | -7 % | -6 % | -5 % | -7 % | -6 % | -6 % | -6 % | -6 % | -5 % | -5 % | -7 % | -6 % | -9 % | -7 % |
| Total PAHs | -2 % | -2 % | -2 % | -6 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -6 % | -6 % | -6 % | -7 % | -6 % | -8 % | -7 % |
| HCB | 0 % | -3 % | -5 % | -5 % | -6 % | -5 % | -5 % | -6 % | -5 % | -4 % | -1 % | 0 % | 0 % | -2 % | -3 % | -3 % | -3 % |
| PCBs | -10 % | -4 % | -3 % | -6 % | -7 % | -6 % | -6 % | -9 % | -9 % | -8 % | -7 % | -7 % | -7 % | -7 % | -6 % | -7 % | -7 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -13 % | -13 % | -14 % | -14 % | -14 % | -16 % | -17 % | -16 % | -17 % | -18 % | -20 % | -19 % | -18 % | -19 % | -20 % |
| $PM_{10}$ | | | -12 % | -12 % | -13 % | -12 % | -13 % | -15 % | -16 % | -14 % | -15 % | -16 % | -19 % | -17 % | -17 % | -17 % | -18 % |
| BC | | | -26 % | -25 % | -26 % | -26 % | -26 % | -27 % | -29 % | -26 % | -28 % | -27 % | -31 % | -30 % | -31 % | -32 % | -35 % |

**(b)**

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -434 | -392 | -321 | -270 | -251 | -249 | -223 | -185 | -193 | -164 | -166 | -151 | -149 | -153 | -142 | -146 | -148 |
| NMVOCs | -30 | -31 | -31 | -31 | -29 | -35 | -29 | -25 | -24 | -19 | -19 | -16 | -17 | -19 | -18 | -19 | -17 |
| SOx | -405 | -324 | -135 | -108 | -102 | -96 | -87 | -80 | -94 | -76 | -74 | -78 | -76 | -45 | -32 | -38 | -46 |
| $NH_3$ | 0 | -1 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -2 | -2 | -2 | -2 | -3 |
| TSPs | -38 | -34 | -24 | -20 | -20 | -19 | -19 | -18 | -21 | -18 | -18 | -19 | -21 | -20 | -19 | -20 | -21 |
| CO | -622 | -598 | -447 | -460 | -478 | -515 | -482 | -435 | -420 | -423 | -434 | -458 | -498 | -490 | -447 | -453 | -417 |
| Pb | -56 | -34 | -19 | -19 | -14 | -15 | -15 | -16 | -15 | -14 | -13 | -14 | -14 | -14 | -13 | -14 | -12 |
| Cd | -2 | -2 | -1 | -2 | -2 | -2 | -3 | -2 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 |
| Hg | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| As | -4 | -4 | -8 | -14 | -14 | -14 | -22 | -23 | -29 | -30 | -29 | -29 | -29 | -37 | -31 | -39 | -41 |
| Cr | -4 | -4 | -2 | -3 | -3 | -3 | -2 | -3 | -3 | -2 | -2 | -2 | -3 | -3 | -2 | -3 | -2 |
| Cu | -8 | -8 | -6 | -4 | -4 | -4 | -9 | -4 | -4 | -3 | -3 | -3 | -4 | -3 | -3 | -3 | -3 |
| Ni | -111 | -110 | -53 | -45 | -30 | -36 | -46 | -30 | -46 | -22 | -37 | -48 | -46 | -17 | -14 | -19 | -18 |
| Se | -7 | -8 | -8 | -9 | -8 | -9 | -8 | -7 | -8 | -8 | -8 | -7 | -7 | -7 | -7 | -8 | -8 |
| Zn | -236 | -277 | -243 | -217 | -191 | -195 | -177 | -184 | -208 | -186 | -164 | -170 | -180 | -179 | -181 | -187 | -180 |
| PCDD/Fs | -47 | -51 | -28 | -22 | -21 | -20 | -23 | -23 | -27 | -24 | -22 | -23 | -24 | -24 | -21 | -22 | -18 |
| B(a)P | 0 | 0 | 0 | -1 | -1 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 |
| B(b)F | 0 | 0 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | -1 | 0 | -1 | -1 |
| B(k)F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total PAHs | -1 | -1 | -1 | -3 | -2 | -2 | -3 | -2 | -2 | -2 | -2 | -2 | -1 | -2 | -2 | -2 | -2 |
| HCB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCBs | -30 | -10 | -6 | -6 | -7 | -6 | -6 | -6 | -7 | -6 | -5 | -5 | -5 | -5 | -4 | -5 | -5 |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -22 | -19 | -19 | -18 | -18 | -17 | -19 | -17 | -17 | -17 | -19 | -19 | -18 | -19 | -19 |
| $PM_{10}$ | | | -23 | -20 | -20 | -19 | -18 | -18 | -20 | -17 | -17 | -18 | -20 | -19 | -18 | -20 | -20 |
| BC | | | -10 | -8 | -8 | -8 | -7 | -6 | -7 | -6 | -6 | -5 | -6 | -6 | -6 | -6 | -7 |

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

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

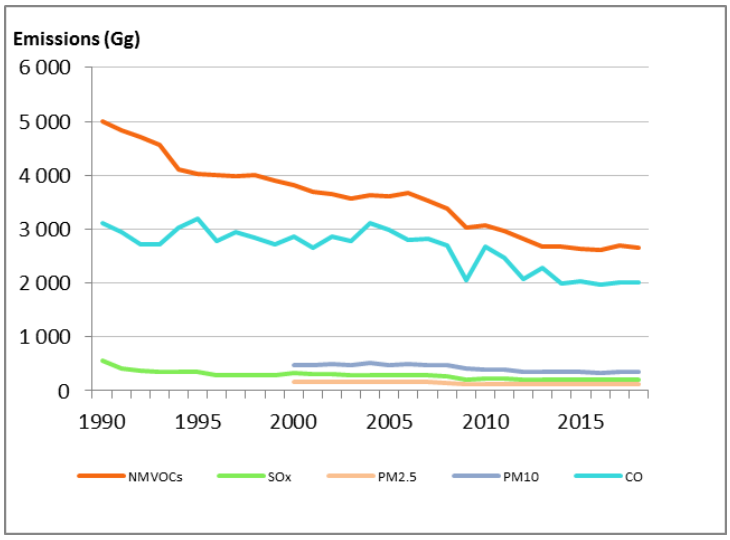
The industrial processes and product use sector grouping refers to emissions from industrial sources other than those arising from fuel combustion within the industrial sector. This is the primary sector group for PCB, NMVOC, Pb and Cd emissions, as well as a significant source of total HCB, Hg, PM, CO and PCDD/F emissions. Countries are ranked according to the size of the absolute values they reported. Greece and Portugal reported the largest contributions to B(a)P emissions. Spain, Germany and Slovakia reported the largest contributions to total polycyclic aromatic hydrocarbon (PAH) emissions. Italy, Germany and Poland contributed most to PCB emissions in this sector in 2019. Of all the countries that reported data, Germany, Italy and France contributed most to NMVOC emissions. For HCB emissions, the largest contributions were reported by Finland, Austria and France. 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 the Netherlands. Figure 4.5 shows previous trends in emissions of the relevant main pollutants.

Data from France and Germany for the category '2C1 — Iron and steel production' have a great influence on the trend in CO emissions. In France, CO emissions from the 2C1 category have fluctuated over the years, depending on the amount of blast furnace gas that has been produced, reused or flared. These amounts depend on the operating conditions and how feasible it is for iron and steel or colliery plants to reuse the gas being produced continuously by blast furnaces. This may fluctuate a great deal from one year to another, resulting in peaks (1995, 2004 and 2010) or troughs (1992, 2001 and 2009) (personal communication from France in 2013). The negative peak in 2009 was also influenced by the data reported by several countries, mainly Belgium, France and Germany, in the category '2C1 — Iron and steel production'. Spain stated that the sharp drop in CO emissions in 2009 in this category was linked to the economic downturn (see Spain's IIR, listed in Appendix 5). The CO emission peak in 2013 followed that reported by Belgium in the '2A2 — Lime production' category. Belgium reported that the sudden increase in 2013 was due to a plant where lime production was taking place without oxygen (reducing atmosphere) (see Belgium's IIR, listed in Appendix 5).

The fall in $SO_X$ emissions from 1990 to 1991, the increase from 1999 to 2000 and the decrease from 2008 to 2009 mainly reflect emission data reported by Germany for several categories. The drop in $SO_X$ emissions from 1990 to 1991 resulted from reductions in the categories '2H1 — Pulp and paper industry', '2B10a — Chemical industry: Other' and '2C1 — Iron and steel production'. The increase in $SO_X$ emissions from 1999 to 2000 and the decrease from 2008 to 2009 mainly reflect data reported in the category '2C1 — Iron and steel production'. Germany explained that all of the categories showed a reduction in $SO_X$ emissions between 1990 and 2019 because of West Germany's stricter regulations, which applied to the new German *Länder* following German reunification; the fuel mix was changed from sulphur-rich solid fuels to liquid and gaseous fuels (see Germany's IIR, listed in Appendix 5). The drop in $SO_X$ emissions from 1995 to 1996 was due to reductions in the category '2B10a — Chemical industry: Other' reported by Italy.

In 2009, many countries reported a fall in $PM_{10}$ emissions, such as Greece, Denmark, France, Belgium and Spain. In 2015, Bulgaria reported a peak in $PM_{10}$ emissions in the category '2D3b — Road paving with asphalt'.

**Figure 4.5 EU emission trends in the industrial processes and product use sector group for NMVOCs, $SO_X$, $PM_{2.5}$, $PM_{10}$ and CO between 1990 (2000) and 2019**




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 2019 (-80 %).

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

The dip in Pb emissions between 2008 and 2009 was mainly caused by reductions in the category '2C1 — Iron and steel production' in several countries, such as Belgium, Latvia, Italy, Poland and Germany, presumably due to the economic crisis in 2009. The reduction in Pb emissions between 2010 and 2011 reflected the significant drop in emissions reported by Latvia in the category '2C1 — Iron and steel production' resulting from a change in the type of furnace used in metal production. Overall, between 2010 and 2011, Latvia's total Pb emissions (national total) fell by 97.4 % (see Latvia's IIR, listed in Appendix 5).

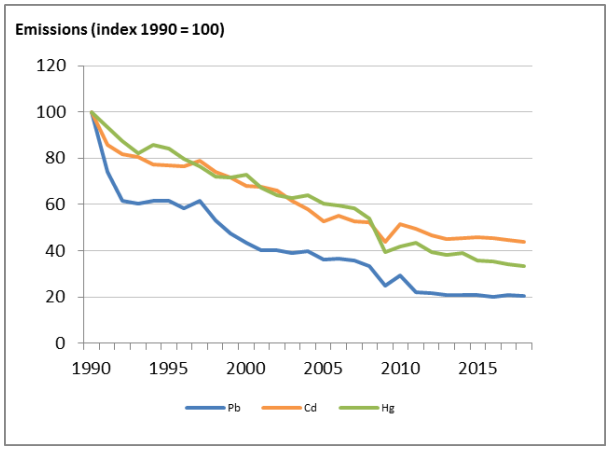
Among the POPs, HCB recorded the highest relative reduction (99 %) between 1990 and 2019 (Figure 4.6(b)).

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

Changes in the total emissions of PAHs follow the data reported by Bulgaria in the category '2D3g — Chemical products' and show a significant drop from 2006 to 2007.

**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, total PAHs, B(a)P, HCB, PCBs) between 1990 and 2019**

**(a)**




**(b)**

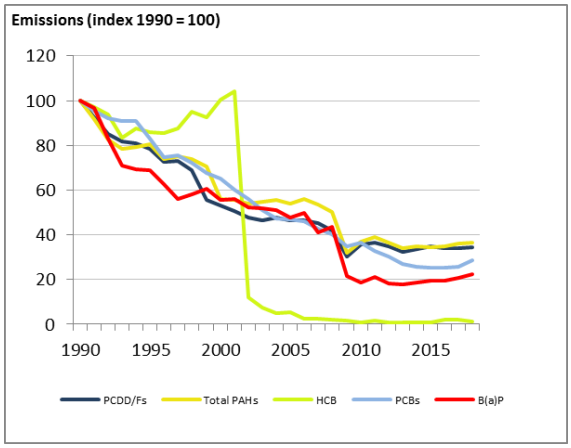



Table 4.5 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.6 shows the recalculations within the industrial processes and product use sector group. For explanations of EU recalculations, see Section 5.1.

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

| Key categories | | NA | NO | NR | NE |
|---|---|---|---|---|---|
| NMVOC | 2D3d | 0 | 0 | 0 | 1 |
| | 2D3e | 0 | 1 | 0 | 1 |
| | 2D3g | 0 | 0 | 0 | 1 |
| | 2D3h | 0 | 0 | 0 | 1 |
| | 2D3i | 3 | 0 | 0 | 0 |
| $SO_x$ | 2B10a | 1 | 5 | 0 | 2 |
| | 2C1 | 1 | 4 | 0 | 2 |
| $PM_{2.5}$ | 2A5b | 0 | 1 | 0 | 2 |
| | 2C1 | 0 | 4 | 0 | 0 |
| $PM_{10}$ | 2A5a | 0 | 2 | 0 | 2 |
| | 2A5b | 0 | 1 | 0 | 3 |
| | 2C1 | 0 | 4 | 0 | 0 |
| | 2D3b | 1 | 0 | 0 | 3 |
| | 2L | 7 | 13 | 0 | 1 |
| CO | 2C1 | 0 | 4 | 0 | 2 |
| Pb | 2A3 | 3 | 3 | 0 | 0 |
| | 2C1 | 0 | 4 | 0 | 0 |
| | 2C5 | 0 | 9 | 0 | 0 |
| Cd | 2A3 | 3 | 3 | 0 | 0 |
| | 2C1 | 0 | 4 | 0 | 0 |
| | 2C6 | 1 | 12 | 0 | 0 |
| | 2C7a | 0 | 11 | 0 | 1 |
| Hg | 2A1 | 5 | 1 | 0 | 5 |
| | 2C1 | 1 | 4 | 0 | 0 |
| | 2C6 | 2 | 12 | 0 | 0 |
| PCDD/Fs | 2C1 | 1 | 4 | 0 | 1 |
| Total PAHs | 2C1 | 3 | 4 | 0 | 1 |
| HCB | 2B10a | 13 | 5 | 0 | 7 |
| | 2C1 | 2 | 3 | 0 | 4 |
| PCB | 2C1 | 1 | 4 | 0 | 0 |
| | 2K | 8 | 7 | 0 | 5 |

**Note:** Only those key categories where notation keys are 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 2020 and 2021 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 |
| $NO_x$ | -4 % | -4 % | -2 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -4 % |
| NMVOCs | -18 % | -17 % | -14 % | -13 % | -13 % | -13 % | -13 % | -14 % | -14 % | -14 % | -15 % | -15 % | -15 % | -15 % | -16 % | -15 % | -15 % |
| SOx | -10 % | -16 % | -11 % | -10 % | -10 % | -9 % | -7 % | -6 % | -5 % | -5 % | -3 % | -4 % | -4 % | -3 % | -4 % | -4 % | -5 % |
| $NH_3$ | -13 % | -17 % | -13 % | -12 % | -13 % | -13 % | -12 % | -13 % | -13 % | -13 % | -13 % | -11 % | -11 % | -9 % | -9 % | -10 % | -10 % |
| TSPs | -17 % | -18 % | -16 % | -15 % | -13 % | -13 % | -10 % | -12 % | -17 % | -15 % | -13 % | -16 % | -15 % | -15 % | -18 % | -20 % | -19 % |
| CO | -12 % | -12 % | -13 % | -9 % | -11 % | -11 % | -11 % | -9 % | -9 % | -10 % | -11 % | -11 % | -13 % | -12 % | -11 % | -12 % | -14 % |
| Pb | -12 % | -17 % | -14 % | -15 % | -15 % | -15 % | -15 % | -17 % | -15 % | -19 % | -20 % | -20 % | -22 % | -22 % | -22 % | -21 % | -22 % |
| Cd | -9 % | -13 % | -7 % | -2 % | -3 % | -4 % | 0 % | 2 % | 3 % | -2 % | -1 % | 0 % | -1 % | -1 % | -1 % | -2 % | -10 % |
| Hg | -34 % | -29 % | -14 % | -12 % | -14 % | -12 % | -12 % | -14 % | -14 % | -15 % | -12 % | -14 % | -13 % | -13 % | -11 % | -13 % | -14 % |
| As | -4 % | -9 % | -17 % | -20 % | -21 % | -21 % | -21 % | -21 % | -20 % | -34 % | -37 % | -41 % | -40 % | -38 % | -36 % | -35 % | -35 % |
| Cr | -16 % | -20 % | -23 % | -24 % | -22 % | -21 % | -21 % | -26 % | -22 % | -22 % | -23 % | -27 % | -25 % | -24 % | -26 % | -26 % | -26 % |
| Cu | -6 % | -5 % | -2 % | 5 % | 3 % | 4 % | 6 % | 8 % | 7 % | 6 % | 8 % | 9 % | 8 % | 9 % | 10 % | 10 % | 9 % |
| Ni | -10 % | -17 % | -16 % | -15 % | -16 % | -19 % | -16 % | -16 % | -14 % | -14 % | -12 % | -12 % | -13 % | -12 % | -13 % | -15 % | -16 % |
| Se | -59 % | -57 % | -62 % | -47 % | -58 % | -57 % | -59 % | -61 % | -57 % | -63 % | -63 % | -63 % | -61 % | -61 % | -62 % | -61 % | -65 % |
| Zn | -17 % | -21 % | -17 % | -16 % | -15 % | -15 % | -15 % | -16 % | -15 % | -15 % | -14 % | -17 % | -17 % | -17 % | -15 % | -15 % | -13 % |
| PCDD/Fs | -12 % | -15 % | -13 % | -6 % | -6 % | -5 % | -6 % | -8 % | -10 % | -7 % | -6 % | -6 % | -6 % | -5 % | -3 % | -3 % | -3 % |
| B(a)P | -82 % | -85 % | -99 % | -100 % | -100 % | -13 % | -62 % | -39 % | -80 % | -85 % | -90 % | -91 % | -96 % | -96 % | -96 % | -94 % | -23 % |
| B(b)F | -70 % | -73 % | -14 % | -14 % | -14 % | -16 % | -15 % | -28 % | -31 % | -27 % | -31 % | -32 % | -33 % | -32 % | -33 % | -32 % | -31 % |
| B(k)F | -61 % | -62 % | -17 % | -16 % | -16 % | -18 % | -18 % | -29 % | -31 % | -28 % | -31 % | -32 % | -32 % | -32 % | -32 % | -31 % | -30 % |
| IP | -66 % | -66 % | -8 % | -9 % | -10 % | -11 % | -10 % | -17 % | -19 % | -18 % | -21 % | -22 % | -23 % | -23 % | -22 % | -20 % | -18 % |
| Total PAHs | -48 % | -46 % | -94 % | -97 % | -97 % | 3 % | -10 % | -4 % | -15 % | -23 % | -30 % | -34 % | -57 % | -59 % | -57 % | -46 % | 3 % |
| HCB | -44 % | -53 % | 10 % | -10 % | -20 % | -16 % | -17 % | 4 % | 9 % | 5 % | 8 % | 7 % | 7 % | 10 % | 4 % | 4 % | 7 % |
| PCBs | -64 % | -61 % | -31 % | -31 % | -31 % | -32 % | -32 % | -32 % | -31 % | -32 % | -32 % | -33 % | -34 % | -32 % | -29 % | -28 % | -19 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -13 % | -11 % | -11 % | -11 % | -10 % | -10 % | -11 % | -10 % | -10 % | -11 % | -12 % | -12 % | -11 % | -12 % | -12 % |
| $PM_{10}$ | | | -14 % | -12 % | -11 % | -11 % | -9 % | -10 % | -13 % | -12 % | -11 % | -12 % | -13 % | -12 % | -14 % | -15 % | -14 % |
| BC | | | -7 % | 0 % | 0 % | 0 % | 1 % | 0 % | 0 % | 0 % | 0 % | 1 % | 0 % | 0 % | 1 % | 1 % | 1 % |

**(b)**

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -15 | -11 | -6 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -7 |
| NMVOCs | -1066 | -812 | -643 | -554 | -549 | -531 | -485 | -493 | -495 | -473 | -489 | -471 | -478 | -480 | -482 | -482 | -480 |
| SOx | -61 | -65 | -42 | -32 | -31 | -29 | -20 | -12 | -11 | -12 | -7 | -8 | -8 | -7 | -8 | -9 | -11 |
| $NH_3$ | -11 | -12 | -7 | -8 | -7 | -7 | -6 | -6 | -6 | -7 | -7 | -5 | -5 | -4 | -4 | -5 | -5 |
| TSPs | -310 | -275 | -251 | -257 | -230 | -216 | -174 | -181 | -248 | -212 | -162 | -192 | -184 | -190 | -225 | -252 | -242 |
| CO | -426 | -442 | -433 | -308 | -342 | -356 | -340 | -194 | -260 | -260 | -249 | -288 | -307 | -280 | -245 | -276 | -316 |
| Pb | -320 | -302 | -164 | -150 | -146 | -142 | -132 | -115 | -121 | -116 | -124 | -119 | -133 | -133 | -130 | -126 | -130 |
| Cd | -5 | -6 | -3 | -1 | -1 | -1 | 0 | 0 | 1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | -3 |
| Hg | -17 | -11 | -4 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -1 | -2 | -2 |
| As | -12 | -12 | -10 | -9 | -10 | -9 | -9 | -7 | -8 | -8 | -8 | -9 | -9 | -9 | -8 | -7 | -7 |
| Cr | -100 | -81 | -60 | -40 | -39 | -37 | -34 | -28 | -28 | -26 | -28 | -30 | -30 | -28 | -30 | -31 | -31 |
| Cu | -21 | -16 | -6 | 12 | 8 | 10 | 16 | 19 | 17 | 14 | 20 | 20 | 19 | 23 | 24 | 25 | 21 |
| Ni | -32 | -31 | -22 | -15 | -18 | -18 | -15 | -11 | -11 | -11 | -9 | -9 | -9 | -10 | -10 | -11 | -12 |
| Se | -25 | -29 | -34 | -37 | -38 | -39 | -38 | -33 | -33 | -32 | -32 | -31 | -32 | -31 | -31 | -31 | -35 |
| Zn | -654 | -590 | -316 | -228 | -230 | -229 | -213 | -171 | -184 | -191 | -178 | -199 | -203 | -210 | -177 | -189 | -192 |
| PCDD/Fs | -128 | -129 | -77 | -26 | -26 | -23 | -23 | -25 | -36 | -24 | -22 | -21 | -21 | -16 | -10 | -9 | -11 |
| B(a)P | -96 | -85 | -1896 | -3425 | -3861 | -1 | -15 | -3 | -16 | -26 | -34 | -38 | -96 | -102 | -97 | -66 | -1 |
| B(b)F | -51 | -35 | -2 | -1 | -2 | -1 | -2 | -1 | -1 | -1 | -1 | -1 | -2 | -2 | -2 | -2 | -2 |
| B(k)F | -24 | -17 | -2 | -1 | -2 | -1 | -2 | -1 | -1 | -1 | -1 | -1 | -2 | -2 | -2 | -2 | -2 |
| IP | -13 | -9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total PAHs | -182 | -140 | -1894 | -3421 | -3857 | 3 | -12 | -3 | -14 | -23 | -31 | -36 | -92 | -99 | -94 | -62 | 2 |
| HCB | -2780 | -3405 | 319 | -21 | -20 | -18 | -14 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| PCBs | -6227 | -4521 | -1026 | -747 | -719 | -701 | -668 | -587 | -570 | -551 | -504 | -474 | -461 | -419 | -365 | -348 | -232 |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -25 | -21 | -20 | -20 | -16 | -15 | -16 | -15 | -14 | -15 | -16 | -16 | -15 | -16 | -16 |
| $PM_{10}$ | | | -79 | -69 | -63 | -61 | -48 | -48 | -57 | -51 | -44 | -49 | -51 | -49 | -54 | -60 | -58 |
| BC | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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

## *4.4 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 $PM_{2.5}$, CO, total PAHs and $PM_{10}$, and is an important sector group for PCDD/F, $NO_X$, B(a)P, HCB, Cd, $SO_X$, and NMVOC emissions. Countries are ranked according to the size of the absolute values that they reported. For primary $PM_{2.5}$, Italy, Romania and Poland reported the highest emissions. Italy, Poland

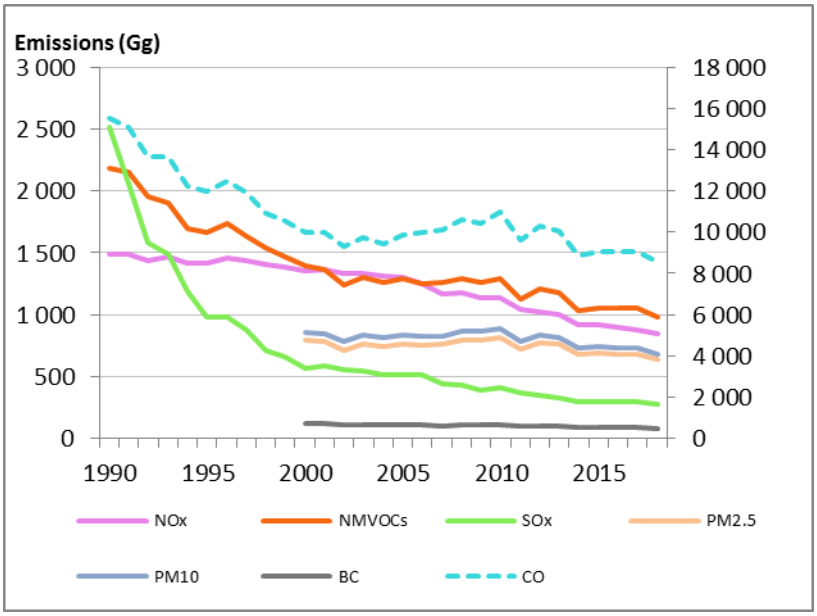
and France contributed most to CO emissions. Italy, Romania and Poland emitted the largest proportion of $PM_{10}$ in 2019.

Of the main pollutants, once again the highest relative reduction between 1990 and 2019 for the sector grouping was for $SO_X$ (-91 %). In contrast, PM emissions have changed little since 2000 (see Figure 4.7).

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

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

**Figure 4.7 EU emission trends in the commercial, institutional and households sector group for $NO_X$, NMVOCs, $SO_X$, $PM_{2.5}$, $PM_{10}$, BC and CO between 1990 (2000) and 2019**




**Notes:** The right-hand axis shows values for CO.
BC, black carbon.

Of the three HMs in the commercial, institutional and households sector, Pb shows the largest reduction, both absolutely and relatively (-68 %) (see Figure 4.8(a)).

The Cd emissions mainly relate to the category '1A4bi — Residential: Stationary' category in Romania. As regards the positive trend in Cd emissions in 2008, Romania also reported an increase in the category '1A4bi — Residential: Stationary'. Since 1990 the trend in Cd emissions increased in this sector.

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

The development of the trend in Hg emissions largely reflects data from Poland, Czechia, Germany and Italy reported for the category '1A4bi — Residential: Stationary'. The Hg peak in 1991 reflects data from France for the category '1A4bi — Residential: Stationary'.

Among the POPs relevant to the commercial, institutional and households sector, the highest absolute and relative reduction occurred for HCB (-79 %) (see Figure 4.8(b)).

The trend in PCB emissions largely reflects data from Germany, Italy and France for the category '1A4bi — Residential: Stationary'. Furthermore, the HCB trend largely reflects data from France and Spain for the category '1A4ai — Commercial/institutional: Stationary'.

The trend in total emissions of PAHs between 1990 and 2000 largely reflects data from Poland, Germany and Italy in the category '1A4bi — Residential: Stationary'. The peaks in 2010 and 2012 reflect data reported by Germany in the '1A4bi' category. Emissions from Poland reported in the same category caused the peak in total PAHs and B(a)P total emissions in 1993.

**Figure 4.8 EU emission trends in the commercial, institutional and households sector group: (a) HMs (Pb, Cd and Hg) and (b) POPs (PCDD/Fs, total PAHs, B(a)P, HCB and PCBs) between 1990 and 2019**

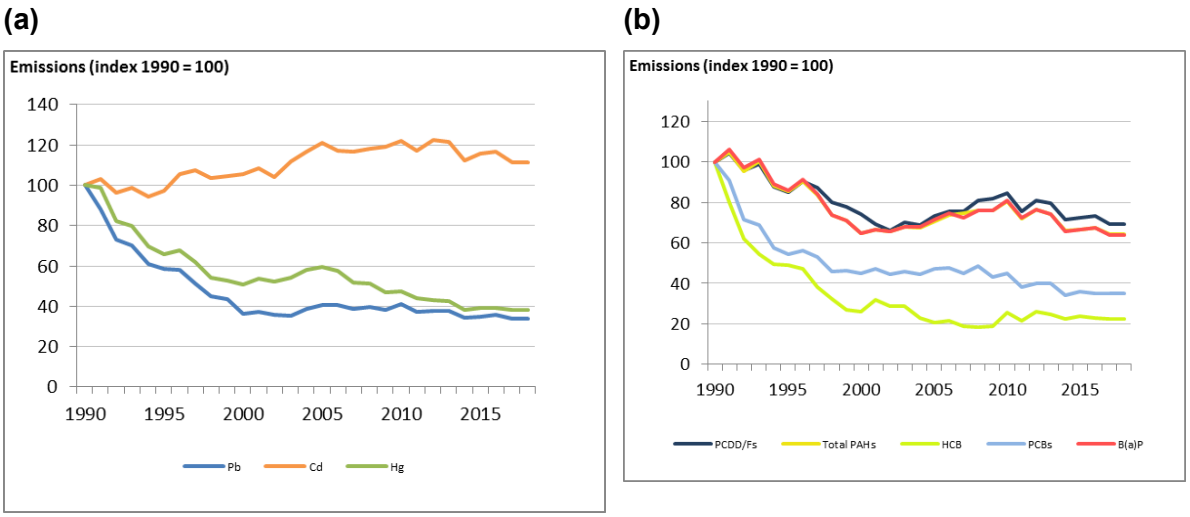



Table 4.7 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.8 shows the recalculations within the commercial, institutional and households sector group. For explanations of EU recalculations, see Section 5.1.

## 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 |
|---|---|---|---|---|---|
| $SO_x$ | 1B1a | 4 | 9 | 0 | 5 |
| CO | 1A4bii | 0 | 1 | 0 | 0 |
| Pb | 1A4ai | 0 | 0 | 0 | 1 |
| HCB | 1A4bi | 1 | 0 | 0 | 0 |

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

## Table 4.8 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2020 and 2021 submissions for the commercial, institutional and households sector group

### (a)

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | -14 % | -13 % | -12 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -12 % | -12 % | -12 % | -12 % | -13 % | -14 % | -15 % |
| NMVOCs | -6 % | -6 % | -6 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -7 % | -7 % | -7 % | -8 % | -8 % | -8 % | -8 % | -10 % |
| SOx | -8 % | -16 % | -16 % | -11 % | -11 % | -12 % | -11 % | -11 % | -13 % | -15 % | -15 % | -15 % | -16 % | -15 % | -17 % | -16 % | -18 % |
| $NH_3$ | 0 % | 0 % | -1 % | -1 % | -1 % | -1 % | -1 % | -2 % | -2 % | -2 % | -2 % | -3 % | -3 % | -3 % | -3 % | -3 % | -5 % |
| TSPs | -3 % | -3 % | -4 % | -3 % | -3 % | -4 % | -4 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -7 % | -7 % | -7 % | -8 % |
| CO | -6 % | -7 % | -6 % | -4 % | -4 % | -4 % | -4 % | -4 % | -5 % | -5 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -7 % |
| Pb | -4 % | -5 % | -4 % | -1 % | -1 % | -1 % | -1 % | 0 % | 0 % | 0 % | 0 % | 0 % | -1 % | -1 % | -1 % | -1 % | -3 % |
| Cd | 5 % | 4 % | 6 % | 6 % | 5 % | 6 % | 5 % | 7 % | 5 % | 6 % | 5 % | 4 % | 4 % | 4 % | 3 % | 3 % | 2 % |
| Hg | -11 % | -14 % | -15 % | -11 % | -11 % | -13 % | -12 % | -13 % | -14 % | -18 % | -17 % | -17 % | -17 % | -17 % | -17 % | -17 % | -16 % |
| As | -21 % | -18 % | -17 % | -8 % | -7 % | -8 % | -8 % | -8 % | -8 % | -9 % | -8 % | -9 % | -10 % | -8 % | -8 % | -9 % | -10 % |
| Cr | -6 % | -4 % | -2 % | 3 % | 3 % | 3 % | 2 % | 3 % | 2 % | 2 % | 2 % | 2 % | 1 % | 0 % | 1 % | 0 % | -1 % |
| Cu | -8 % | -4 % | -3 % | -2 % | -1 % | -1 % | -2 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -1 % | -2 % |
| Ni | -15 % | -44 % | -33 % | -21 % | -23 % | -24 % | -24 % | -26 % | -36 % | -40 % | -44 % | -43 % | -50 % | -54 % | -52 % | -55 % | -57 % |
| Se | -20 % | -26 % | -26 % | -19 % | -19 % | -20 % | -19 % | -18 % | -19 % | -20 % | -18 % | -18 % | -18 % | -17 % | -18 % | -17 % | -12 % |
| Zn | 4 % | 4 % | 5 % | 5 % | 5 % | 5 % | 4 % | 5 % | 4 % | 5 % | 4 % | 3 % | 3 % | 3 % | 3 % | 2 % | 1 % |
| PCDD/Fs | -12 % | -10 % | -9 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -6 % | -8 % |
| B(a)P | -25 % | -10 % | -6 % | -2 % | -2 % | -2 % | -4 % | -3 % | -3 % | -3 % | -4 % | -4 % | -4 % | -3 % | -3 % | -3 % | -4 % |
| B(b)F | 13 % | 7 % | 10 % | 10 % | 11 % | 10 % | 13 % | 12 % | 13 % | 13 % | 14 % | 15 % | 14 % | 14 % | 14 % | 14 % | 13 % |
| B(k)F | 14 % | 9 % | 13 % | 13 % | 13 % | 15 % | 16 % | 15 % | 17 % | 16 % | 18 % | 19 % | 17 % | 18 % | 18 % | 18 % | 18 % |
| IP | 16 % | 10 % | 13 % | 14 % | 15 % | 16 % | 17 % | 16 % | 18 % | 18 % | 19 % | 20 % | 18 % | 18 % | 18 % | 18 % | 18 % |
| Total PAHs | -17 % | -9 % | -11 % | -9 % | -10 % | -10 % | -12 % | -11 % | -12 % | -12 % | -14 % | -15 % | -13 % | -13 % | -12 % | -12 % | -13 % |
| HCB | 0 % | -15 % | -34 % | -37 % | -37 % | -39 % | -40 % | -40 % | -36 % | -38 % | -34 % | -36 % | -35 % | -34 % | -35 % | -34 % | -33 % |
| PCBs | -10 % | -12 % | -10 % | -4 % | -4 % | -5 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -6 % | -5 % | -5 % | -4 % | -2 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -4 % | -3 % | -4 % | -4 % | -5 % | -5 % | -6 % | -6 % | -6 % | -7 % | -7 % | -7 % | -8 % | -7 % | -9 % |
| $PM_{10}$ | | | -4 % | -3 % | -3 % | -4 % | -4 % | -5 % | -6 % | -6 % | -6 % | -7 % | -7 % | -7 % | -7 % | -7 % | -9 % |
| BC | | | -5 % | -4 % | -4 % | -4 % | -4 % | -5 % | -5 % | -6 % | -6 % | -6 % | -6 % | -7 % | -7 % | -8 % | -9 % |

### (b)

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -243 | -219 | -180 | -157 | -149 | -145 | -146 | -143 | -147 | -133 | -138 | -138 | -125 | -127 | -133 | -140 | -144 |
| NMVOCs | -146 | -99 | -90 | -75 | -72 | -82 | -81 | -79 | -87 | -88 | -89 | -94 | -89 | -89 | -94 | -97 | -108 |
| SOx | -206 | -190 | -110 | -66 | -61 | -63 | -55 | -51 | -61 | -65 | -61 | -60 | -55 | -53 | -60 | -57 | -62 |
| $NH_3$ | 0 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -2 | -2 | -2 | -2 | -3 | -2 | -3 | -3 | -4 |
| TSPs | -49 | -39 | -38 | -31 | -33 | -35 | -43 | -47 | -57 | -52 | -58 | -63 | -56 | -58 | -62 | -61 | -71 |
| CO | -1056 | -849 | -651 | -374 | -382 | -399 | -448 | -441 | -520 | -514 | -535 | -584 | -555 | -561 | -574 | -592 | -645 |
| Pb | -15 | -13 | -6 | -1 | -1 | -1 | -2 | 0 | -1 | 0 | 0 | -1 | -1 | -1 | -1 | -2 | -5 |
| Cd | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hg | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| As | -5 | -3 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Cr | -4 | -3 | -1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | -1 |
| Cu | -9 | -5 | -3 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | -1 | -1 | -2 |
| Ni | -26 | -86 | -60 | -36 | -34 | -31 | -30 | -26 | -34 | -36 | -41 | -38 | -45 | -50 | -50 | -56 | -58 |
| Se | -4 | -3 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Zn | 22 | 24 | 27 | 33 | 29 | 31 | 25 | 36 | 27 | 31 | 27 | 21 | 21 | 19 | 18 | 15 | 8 |
| PCDD/Fs | -151 | -110 | -84 | -43 | -43 | -42 | -48 | -46 | -53 | -47 | -50 | -54 | -48 | -49 | -50 | -51 | -64 |
| B(a)P | -107 | -31 | -14 | -4 | -6 | -6 | -9 | -7 | -9 | -8 | -10 | -11 | -8 | -8 | -6 | -6 | -8 |
| B(b)F | 40 | 20 | 21 | 22 | 24 | 25 | 29 | 27 | 32 | 28 | 32 | 33 | 27 | 28 | 27 | 28 | 25 |
| B(k)F | 19 | 10 | 11 | 12 | 13 | 14 | 16 | 15 | 17 | 15 | 17 | 18 | 15 | 15 | 15 | 16 | 15 |
| IP | 24 | 13 | 13 | 15 | 17 | 17 | 19 | 18 | 22 | 19 | 22 | 22 | 18 | 19 | 19 | 19 | 18 |
| Total PAHs | -195 | -81 | -80 | -66 | -80 | -84 | -105 | -91 | -113 | -99 | -117 | -125 | -99 | -99 | -90 | -93 | -96 |
| HCB | 0 | -15 | -23 | -21 | -21 | -21 | -21 | -22 | -24 | -22 | -23 | -24 | -20 | -21 | -22 | -21 | -19 |
| PCBs | -24 | -15 | -11 | -4 | -4 | -4 | -5 | -5 | -5 | -5 | -5 | -5 | -4 | -4 | -3 | -3 | -2 |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -34 | -27 | -29 | -31 | -38 | -42 | -51 | -47 | -52 | -57 | -50 | -52 | -56 | -55 | -62 |
| $PM_{10}$ | | | -34 | -28 | -30 | -32 | -39 | -42 | -52 | -48 | -54 | -58 | -51 | -53 | -57 | -56 | -64 |
| BC | | | -6 | -4 | -4 | -4 | -5 | -5 | -6 | -6 | -6 | -6 | -6 | -6 | -7 | -7 | -8 |

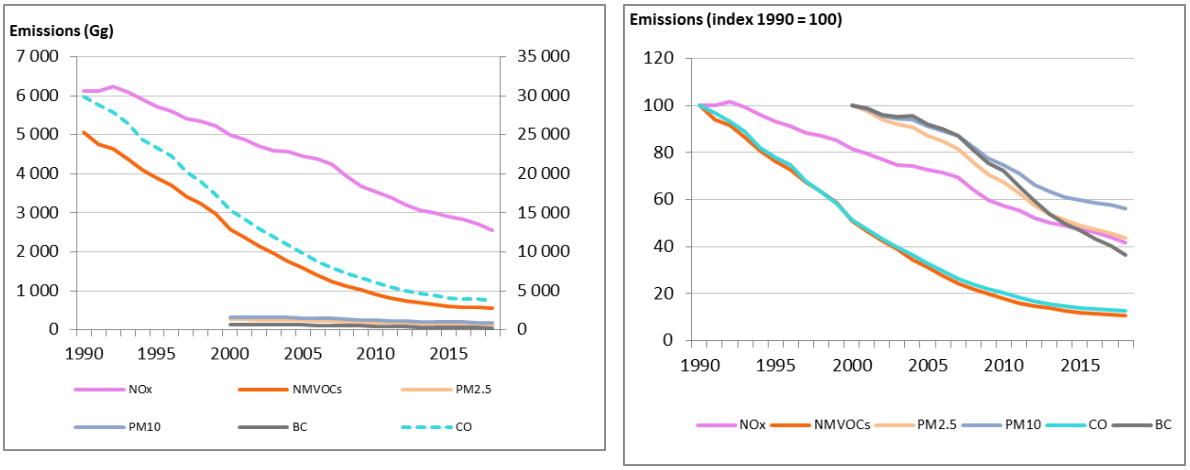
**Note:** As, arsenic; BC, black carbon; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cr, chromium; Cu, copper; IP, indeno(1,2,3-cd)pyrene; $NH_3$, ammonia; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

## *4.5 Sectoral analysis and emission trends for the road transport sector*

Together, the individual NFR sources that make up the road transport sector group contribute considerably to the emissions of several pollutants, including $NO_X$, CO, black carbon (BC), Pb, $PM_{2.5}$, $PM_{10}$ and NMVOCs. 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 Poland reported the highest emissions. Germany, France and Italy contributed most (in absolute terms) to $PM_{2.5}$ and $PM_{10}$ emissions in the road transport sector in 2019. For CO, Germany, Poland and Italy reported the highest emissions. Germany, Spain and France contributed most to Pb emissions, and Italy, Germany and Poland contributed most to NMVOC emissions in this sector in 2019.

**Figure 4.9 EU emission trends in the road transport sector group for $NO_X$, NMVOCs, $PM_{2.5}$, $PM_{10}$, BC and CO between 1990 (2000) and 2019**



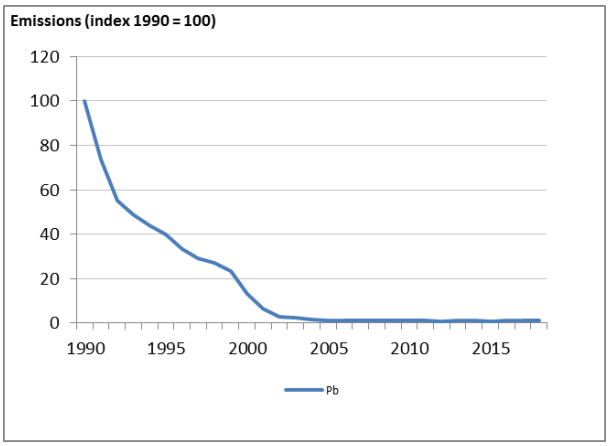

**Note:** In the left-hand panel the right-hand axis shows values for CO.

The main HM for the road transport sector is Pb, which shows a high relative reduction in emissions (-99 %) between 1990 and 2019 (see Figure 4.10(a)). However, in recent years, little progress has been made in further reducing emissions from road transport, and over the last 4 years total Pb emissions have actually increased slightly. The promotion of unleaded petrol in the EU and other EEA member countries, by means of a combination of fiscal and regulatory measures, has been a success story. For example, EU Member States have completely phased out the use of leaded petrol. Directive 98/70/EC on the quality of petrol and diesel fuels (EU, 1998) regulated that objective. Nevertheless, the road transport sector remains a key source of Pb, contributing around 16 % of total Pb emissions in the EU.

PCBs are the most important POPs in the road transport sector group. Figure 4.10(b) shows past emission trends for this group of pollutants, including a 47 % reduction from 1990 to 2019.

**Figure 4.10 EU emission trends in the road transport sector group: (a) the priority HM Pb and (b) PCBs and PCDD/Fs between 1990 and 2019**

**(a)**




**(b)**

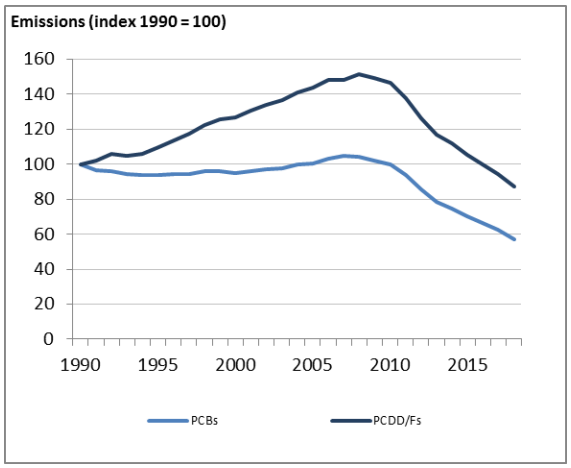



Table 4.9 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.10 shows the recalculations within the road transport sector group. For explanations of EU recalculations, see Section 5.1.

**Table 4.9 Number of EU Member States reporting notation keys within the key categories of the road transport sector group**

| Key categories | | NA | NO | NR | NE |
|---|---|---|---|---|---|
| Pb | 1A3bvi | 0 | 0 | 0 | 2 |
| Hg | 1A3bi | 0 | 0 | 0 | 1 |

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

**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 2020 and 2021 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 |
| $NO_x$ | -19 % | -17 % | -13 % | -11 % | -11 % | -11 % | -11 % | -9 % | -9 % | -9 % | -9 % | -10 % | -9 % | -9 % | -9 % | -10 % | -10 % |
| NMVOCs | -17 % | -16 % | -13 % | -12 % | -12 % | -11 % | -12 % | -9 % | -9 % | -8 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % | -5 % |
| SOx | -10 % | -10 % | -5 % | -10 % | -9 % | -12 % | -10 % | -17 % | -18 % | -27 % | -25 % | -25 % | -25 % | -25 % | -25 % | -25 % | -25 % |
| $NH_3$ | -7 % | -16 % | -22 % | -19 % | -18 % | -19 % | -18 % | -18 % | -17 % | -17 % | -17 % | -17 % | -16 % | -15 % | -15 % | -14 % | -13 % |
| TSPs | -11 % | -11 % | -10 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -10 % | -10 % | -9 % | -9 % | -10 % | -9 % | -9 % |
| CO | -16 % | -17 % | -16 % | -16 % | -16 % | -16 % | -16 % | -13 % | -12 % | -12 % | -11 % | -10 % | -9 % | -9 % | -8 % | -6 % | -4 % |
| Pb | -13 % | -16 % | -4 % | -23 % | -23 % | -24 % | -24 % | -24 % | -24 % | -26 % | -27 % | -26 % | -26 % | -27 % | -27 % | -26 % | -26 % |
| Cd | -23 % | -20 % | -18 % | -18 % | -18 % | -18 % | -18 % | -17 % | -16 % | -16 % | -16 % | -17 % | -17 % | -17 % | -18 % | -18 % | -16 % |
| Hg | -8 % | -6 % | -5 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % | -4 % |
| As | 2 % | 4 % | 5 % | 8 % | 8 % | 8 % | 8 % | 9 % | 10 % | 10 % | 10 % | 8 % | 9 % | 9 % | 8 % | 9 % | 10 % |
| Cr | -3 % | -2 % | -2 % | -1 % | -1 % | -1 % | -1 % | 0 % | 1 % | 1 % | 1 % | 1 % | -8 % | -8 % | -7 % | -6 % | -6 % |
| Cu | -19 % | -17 % | -17 % | -16 % | -16 % | -16 % | -16 % | -16 % | -16 % | -16 % | -16 % | -16 % | -16 % | -16 % | -17 % | -16 % | -16 % |
| Ni | -4 % | -5 % | -5 % | -5 % | -5 % | -5 % | -5 % | -4 % | -4 % | -4 % | -3 % | -4 % | -4 % | -4 % | -5 % | -5 % | -4 % |
| Se | -16 % | -14 % | -13 % | -14 % | -14 % | -14 % | -14 % | -14 % | -14 % | -14 % | -14 % | -15 % | -15 % | -15 % | -16 % | -16 % | -15 % |
| Zn | -25 % | -23 % | -22 % | -21 % | -21 % | -21 % | -21 % | -21 % | -20 % | -21 % | -21 % | -21 % | -21 % | -21 % | -21 % | -21 % | -20 % |
| PCDD/Fs | -72 % | -58 % | -23 % | -18 % | -17 % | -16 % | -16 % | -16 % | -15 % | -14 % | -14 % | -14 % | -13 % | -12 % | -12 % | -11 % | -10 % |
| B(a)P | 10 % | 2 % | 1 % | 3 % | 3 % | 3 % | 3 % | 4 % | 4 % | 4 % | 4 % | 3 % | 3 % | 4 % | 3 % | 3 % | 4 % |
| B(b)F | -7 % | -8 % | -5 % | -2 % | -2 % | -1 % | -1 % | -1 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % |
| B(k)F | -9 % | -9 % | -5 % | -1 % | -1 % | -1 % | -1 % | 0 % | 0 % | 0 % | 0 % | 1 % | 1 % | 1 % | 1 % | 1 % | 1 % |
| IP | -13 % | -13 % | -9 % | -4 % | -4 % | -4 % | -3 % | -3 % | -2 % | -2 % | -2 % | -2 % | -1 % | -1 % | -1 % | -1 % | -1 % |
| Total PAHs | -8 % | -10 % | -7 % | -3 % | -3 % | -3 % | -2 % | -2 % | -1 % | -1 % | -1 % | -2 % | -1 % | -1 % | -1 % | -1 % | -1 % |
| HCB | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % |
| PCBs | -64 % | -51 % | -17 % | -14 % | -13 % | -13 % | -12 % | -11 % | -11 % | -12 % | -14 % | -14 % | -15 % | -18 % | -18 % | -19 % | -22 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -10 % | -10 % | -10 % | -10 % | -10 % | -10 % | -10 % | -9 % | -9 % |
| $PM_{10}$ | | | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -9 % | -8 % | -8 % |
| BC | | | -10 % | -10 % | -10 % | -9 % | -9 % | -9 % | -9 % | -9 % | -8 % | -7 % | -6 % | -5 % | -5 % | -4 % | -4 % |

**(b)**

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -1467 | -1142 | -777 | -568 | -539 | -504 | -465 | -376 | -368 | -337 | -329 | -324 | -313 | -293 | -286 | -288 | -280 |
| NMVOCs | -1019 | -731 | -396 | -220 | -187 | -161 | -146 | -100 | -88 | -73 | -56 | -50 | -49 | -47 | -46 | -42 | -30 |
| SOx | -63 | -47 | -7 | -3 | -2 | -2 | -2 | -2 | -1 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| $NH_3$ | -1 | -9 | -29 | -21 | -19 | -18 | -17 | -15 | -13 | -12 | -11 | -10 | -9 | -8 | -8 | -7 | -7 |
| TSPs | -48 | -52 | -42 | -38 | -38 | -36 | -34 | -33 | -33 | -31 | -30 | -29 | -28 | -28 | -28 | -26 | -26 |
| CO | -5680 | -4779 | -2811 | -1902 | -1694 | -1518 | -1361 | -1000 | -835 | -717 | -619 | -534 | -448 | -403 | -324 | -271 | -162 |
| Pb | -2288 | -1230 | -83 | -59 | -60 | -60 | -61 | -59 | -58 | -59 | -58 | -58 | -58 | -59 | -60 | -59 | -59 |
| Cd | 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 |
| As | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cr | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | -5 | -5 | -5 | -4 | -4 |
| Cu | -195 | -197 | -210 | -220 | -224 | -227 | -225 | -217 | -211 | -217 | -210 | -215 | -220 | -222 | -227 | -224 | -226 |
| Ni | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | -1 | 0 | 0 | -1 | -1 | -1 | -1 | 0 |
| Se | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Zn | -160 | -160 | -167 | -178 | -181 | -183 | -180 | -172 | -169 | -172 | -168 | -172 | -174 | -175 | -180 | -178 | -175 |
| PCDD/Fs | -200 | -117 | -28 | -24 | -23 | -22 | -22 | -21 | -19 | -18 | -16 | -15 | -13 | -11 | -10 | -9 | -8 |
| B(a)P | 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 |
| B(k)F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total PAHs | -1 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HCB | 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 |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -28 | -24 | -24 | -23 | -21 | -20 | -20 | -19 | -18 | -16 | -15 | -14 | -14 | -13 | -12 |
| $PM_{10}$ | | | -33 | -29 | -29 | -27 | -26 | -25 | -25 | -23 | -22 | -21 | -20 | -19 | -19 | -17 | -17 |
| BC | | | -15 | -13 | -13 | -12 | -10 | -10 | -10 | -8 | -7 | -6 | -4 | -4 | -3 | -2 | -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; TSPs, total suspended particulates; Zn, zinc.

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

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

Within the non-road transport sector group, $NO_X$ is a major pollutant. The countries are ranked according to the size of the absolute values that they reported. Italy, Spain and Germany contributed most (in absolute terms) to emissions of $NO_X$. Italy, Greece and Spain accounted for most of the $SO_X$ emissions, and France, Italy and Bulgaria contributed most to CO emissions in 2019.

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

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

**Figure 4.11 EU emission trends in the non-road transport sector group for $SO_X$, CO, $PM_{2.5}$, $NO_X$ and BC between 1990 (2000) and 2019**

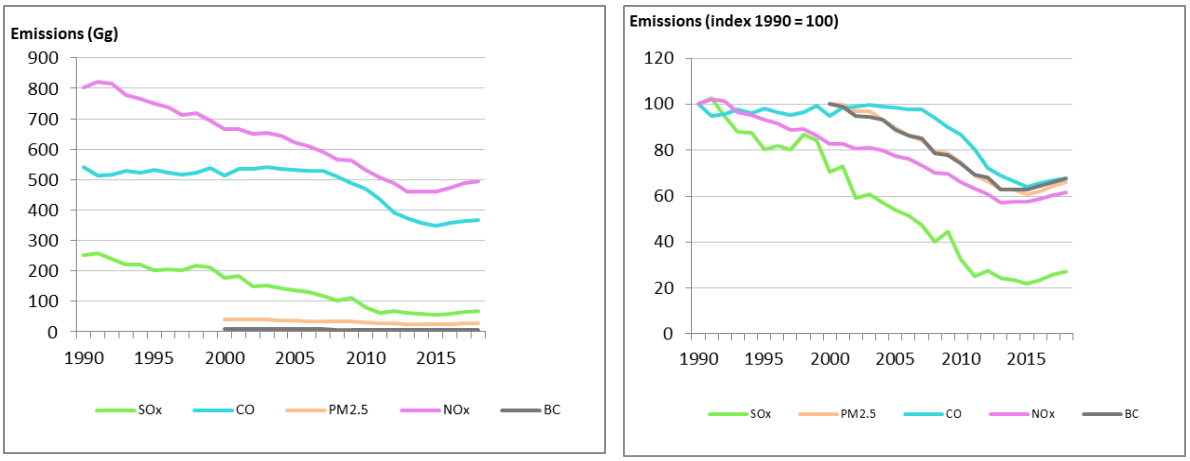



Table 4.11 shows the recalculations within the non-road transport sector group. For explanations of EU recalculations, see Section 5.1.

**Table 4.11 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2020 and 2021 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 |
| $NO_x$ | -21 % | -25 % | -26 % | -25 % | -24 % | -25 % | -24 % | -23 % | -24 % | -24 % | -23 % | -23 % | -24 % | -24 % | -23 % | -22 % | -22 % |
| NMVOCs | -11 % | -11 % | -11 % | -12 % | -12 % | -12 % | -13 % | -13 % | -14 % | -15 % | -16 % | -17 % | -18 % | -18 % | -19 % | -19 % | -19 % |
| SOx | -24 % | -28 % | -27 % | -28 % | -25 % | -21 % | -21 % | -6 % | -12 % | -20 % | -5 % | -9 % | -8 % | 5 % | 9 % | 10 % | 13 % |
| $NH_3$ | 5 % | 0 % | 10 % | -6 % | -3 % | -4 % | -6 % | 0 % | 13 % | 16 % | 9 % | 6 % | 5 % | 10 % | 6 % | 10 % | 5 % |
| TSPs | -22 % | -22 % | -19 % | -20 % | -20 % | -15 % | -14 % | -12 % | -11 % | -11 % | -10 % | -10 % | -10 % | -9 % | -9 % | -9 % | -9 % |
| CO | -15 % | -13 % | -17 % | -17 % | -16 % | -15 % | -15 % | -14 % | -15 % | -16 % | -16 % | -16 % | -18 % | -18 % | -17 % | -18 % | -17 % |
| Pb | -16 % | -17 % | -27 % | -27 % | -25 % | -23 % | -23 % | -28 % | -24 % | -31 % | -33 % | -31 % | -28 % | -31 % | -22 % | -26 % | -26 % |
| Cd | -34 % | -38 % | -45 % | -48 % | -47 % | -49 % | -48 % | -47 % | -48 % | -49 % | -50 % | -51 % | -52 % | -52 % | -53 % | -52 % | -47 % |
| Hg | -31 % | -36 % | -38 % | -35 % | -34 % | -35 % | -35 % | -34 % | -36 % | -36 % | -35 % | -36 % | -36 % | -37 % | -36 % | -34 % | -33 % |
| As | -50 % | -42 % | -46 % | -44 % | -41 % | -42 % | -42 % | -35 % | -36 % | -40 % | -37 % | -38 % | -40 % | -26 % | -26 % | -26 % | -26 % |
| Cr | -2 % | -3 % | -3 % | -3 % | -3 % | -3 % | -2 % | -3 % | -2 % | -2 % | -2 % | -2 % | -2 % | -1 % | -1 % | -1 % | -1 % |
| Cu | -3 % | -3 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | -2 % | 0 % | -1 % |
| Ni | -22 % | -25 % | -26 % | -27 % | -24 % | -25 % | -24 % | -22 % | -21 % | -22 % | -21 % | -21 % | -20 % | -11 % | -10 % | -9 % | -10 % |
| Se | -39 % | -39 % | -41 % | -40 % | -40 % | -42 % | -41 % | -38 % | -38 % | -40 % | -40 % | -41 % | -42 % | -41 % | -41 % | -43 % | -41 % |
| Zn | -21 % | -24 % | -25 % | -24 % | -24 % | -24 % | -24 % | -23 % | -24 % | -23 % | -22 % | -22 % | -22 % | -23 % | -22 % | -22 % | 8 % |
| PCDD/Fs | 1 % | 2 % | 1 % | 3 % | 1 % | -1 % | -1 % | -1 % | -4 % | -3 % | -4 % | -6 % | -6 % | -5 % | -3 % | -3 % | 1 % |
| B(a)P | -3 % | -6 % | -7 % | -8 % | -7 % | -8 % | -8 % | -10 % | -10 % | -10 % | -10 % | -10 % | -10 % | -11 % | -11 % | -10 % | -12 % |
| B(b)F | -19 % | -27 % | -29 % | -32 % | -31 % | -31 % | -30 % | -32 % | -32 % | -31 % | -31 % | -31 % | -32 % | -33 % | -33 % | -32 % | -32 % |
| B(k)F | 5 % | 0 % | -7 % | -11 % | -11 % | -14 % | -16 % | -19 % | -20 % | -22 % | -22 % | -25 % | -25 % | -26 % | -26 % | -24 % | -27 % |
| IP | -26 % | -33 % | -31 % | -32 % | -32 % | -33 % | -29 % | -30 % | -30 % | -28 % | -28 % | -26 % | -29 % | -29 % | -29 % | -28 % | -29 % |
| Total PAHs | -11 % | -17 % | -18 % | -20 % | -19 % | -20 % | -19 % | -20 % | -21 % | -20 % | -20 % | -20 % | -21 % | -21 % | -21 % | -20 % | -21 % |
| HCB | 63 % | 66 % | 76 % | 102 % | 102 % | 99 % | 102 % | 99 % | 90 % | 102 % | 96 % | 92 % | 91 % | 92 % | 102 % | 95 % | 103 % |
| PCBs | -99 % | -22 % | -23 % | -24 % | -23 % | -24 % | -24 % | -21 % | -22 % | -23 % | -22 % | -21 % | -22 % | -13 % | -12 % | -11 % | -10 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -23 % | -24 % | -24 % | -19 % | -18 % | -15 % | -14 % | -14 % | -13 % | -13 % | -13 % | -12 % | -12 % | -12 % | -11 % |
| $PM_{10}$ | | | -21 % | -22 % | -21 % | -17 % | -16 % | -13 % | -12 % | -12 % | -11 % | -11 % | -11 % | -10 % | -10 % | -10 % | -9 % |
| BC | | | -27 % | -27 % | -27 % | -24 % | -24 % | -20 % | -19 % | -19 % | -19 % | -19 % | -19 % | -18 % | -18 % | -17 % | -17 % |

**(b)**

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -211 | -244 | -229 | -203 | -192 | -193 | -179 | -172 | -169 | -158 | -149 | -140 | -150 | -146 | -145 | -141 | -138 |
| NMVOCs | -17 | -16 | -15 | -15 | -14 | -14 | -14 | -13 | -13 | -13 | -12 | -12 | -13 | -13 | -13 | -13 | -13 |
| SOx | -80 | -79 | -65 | -52 | -44 | -33 | -27 | -7 | -11 | -16 | -4 | -6 | -5 | 2 | 5 | 6 | 8 |
| $NH_3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TSPs | -20 | -16 | -13 | -12 | -12 | -9 | -8 | -6 | -5 | -5 | -4 | -4 | -4 | -4 | -4 | -4 | -4 |
| CO | -96 | -79 | -103 | -106 | -103 | -91 | -89 | -81 | -84 | -80 | -75 | -73 | -76 | -74 | -75 | -77 | -77 |
| Pb | -24 | -11 | -10 | -6 | -5 | -5 | -5 | -6 | -5 | -6 | -6 | -6 | -5 | -5 | -3 | -4 | -4 |
| Cd | 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 |
| As | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cr | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cu | -5 | -5 | -4 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -2 | -3 | -3 | -3 | 0 | -1 |
| Ni | -31 | -33 | -30 | -29 | -27 | -28 | -27 | -25 | -23 | -22 | -20 | -19 | -20 | -9 | -9 | -9 | -9 |
| Se | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Zn | -3 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | 1 |
| PCDD/Fs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B(a)P | 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 |
| B(k)F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total PAHs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HCB | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PCBs | -359 | -1 | -1 | -1 | 0 | -1 | 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 |
| $PM_{2.5}$ | | | -13 | -12 | -11 | -8 | -7 | -6 | -5 | -4 | -4 | -4 | -4 | -3 | -3 | -3 | -3 |
| $PM_{10}$ | | | -13 | -12 | -12 | -9 | -7 | -6 | -5 | -5 | -4 | -4 | -4 | -4 | -4 | -4 | -4 |
| BC | | | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |

**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; TSPs, total suspended particulates; Zn, zinc.

## *4.7 Sectoral analysis and emission trends for the agriculture sector*

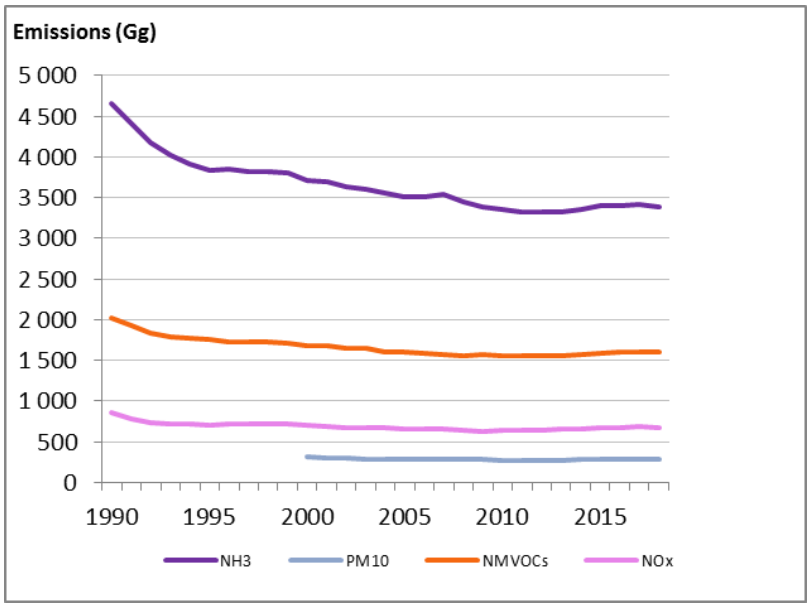
This sector group is responsible for the vast majority of ammonia ($NH_3$) emissions in the EU — namely 94 %. With regard to the size of the absolute values that the countries reported, Germany, France and Spain contributed most to $NH_3$ emissions in 2019.

Agricultural emissions of $NH_3$ have fallen by 29 % since 1990 (see Figure 4.12).

In addition, the agriculture sector produces considerable emissions of NMVOCs, $PM_{10}$ and $NO_X$. The drop in emissions of NMVOCs between 1990 and 1992 reflects data reported by Germany, mainly in the categories '3B1b — Manure management — Non-dairy cattle' and '3B1a — Manure management — Dairy cattle'.

During the period 2000-2019, $PM_{10}$ emissions fell slightly by just 8 %.

**Figure 4.12 EU emission trends in the agriculture sector group for $NH_3$, $PM_{10}$, NMVOCs and $NO_X$ between 1990 (2000) and 2019**




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

The trend in emissions of total PAHs largely reflects data that Spain reported for the category '3F — Field burning of agricultural residues'. The Member State explained that high emissions of total PAHs fell significantly, particularly between 1999 and 2003, due to a gradual reduction in the field burning of agricultural residues. This practice has been restricted by a combination of legislation aimed at preventing forest fires, the fact that the EU's common agricultural policy's conditionality rules entered into force and national mitigation programmes aimed at reducing the field burning of agricultural waste (personal communication from Spain in 2017).

**Figure 4.13 EU emission trends in the agriculture sector group for total PAHs between 1990 and 2019**

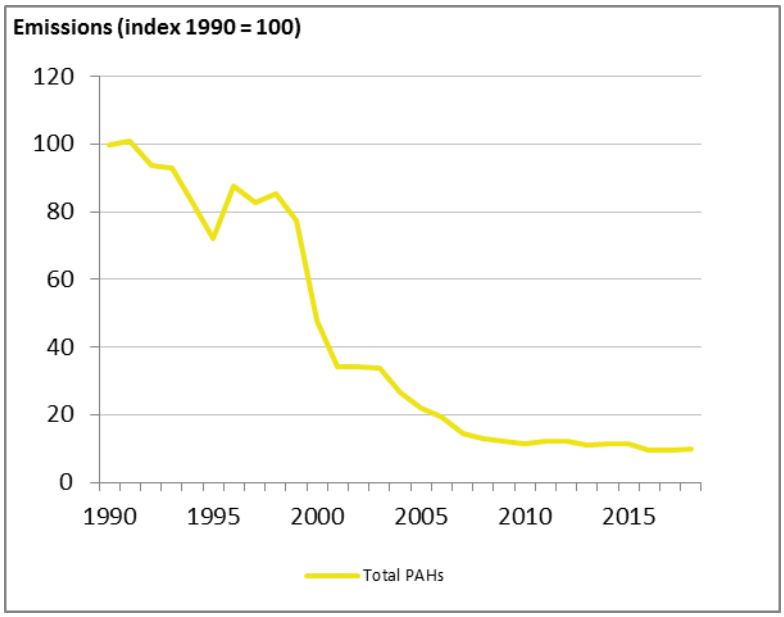


Table 4.12 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.13 shows the recalculations within the agriculture sector group. For explanations of EU recalculations, see Section 5.1.

**Table 4.12 Number of EU Member States reporting notation keys within the key categories of the agriculture sector group**

| Key categories | | NA | NO | NR | NE |
|---|---|---|---|---|---|
| $NO_x$ | 3Da2a | 1 | 0 | 0 | 0 |
| NMVOC | 3Da2a | 10 | 0 | 0 | 1 |
| $NH_3$ | 3Da3 | 0 | 1 | 0 | 0 |
| HCB | 3Df | 2 | 1 | 0 | 5 |

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

**Table 4.13 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2020 and 2021 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 |
| $NO_x$ | 9 % | 13 % | 14 % | 15 % | 14 % | 16 % | 14 % | 16 % | 15 % | 14 % | 15 % | 14 % | 14 % | 14 % | 15 % | 14 % | 14 % |
| NMVOCs | 19 % | 22 % | 22 % | 23 % | 24 % | 22 % | 22 % | 23 % | 22 % | 23 % | 22 % | 22 % | 22 % | 22 % | 21 % | 21 % | 22 % |
| SOx | -19 % | 0 % | 0 % | 0 % | 0 % | -1 % | -2 % | -3 % | -4 % | -6 % | -7 % | -9 % | -9 % | -11 % | -12 % | -13 % | -13 % |
| $NH_3$ | -5 % | -6 % | -5 % | -5 % | -6 % | -5 % | -5 % | -5 % | -5 % | -6 % | -5 % | -6 % | -6 % | -6 % | -6 % | -6 % | -6 % |
| TSPs | -8 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % | -6 % | -7 % | -6 % | -7 % | -7 % | -7 % |
| CO | -19 % | 0 % | 0 % | 0 % | 0 % | -2 % | -3 % | -4 % | -6 % | -7 % | -9 % | -11 % | -12 % | -13 % | -14 % | -14 % | -14 % |
| Pb | -17 % | 0 % | 0 % | 0 % | 0 % | -4 % | -7 % | -10 % | -14 % | -17 % | -20 % | -24 % | -24 % | -24 % | -25 % | -25 % | -25 % |
| Cd | -22 % | 0 % | 0 % | 0 % | 0 % | -1 % | -2 % | -3 % | -3 % | -4 % | -6 % | -7 % | -8 % | -9 % | -10 % | -11 % | -11 % |
| Hg | -27 % | -12 % | -17 % | 0 % | 0 % | -1 % | -1 % | -2 % | -3 % | -4 % | -5 % | -6 % | -7 % | -9 % | -9 % | -11 % | -11 % |
| As | 0 % | 0 % | 0 % | 0 % | 0 % | -2 % | -4 % | -5 % | -7 % | -9 % | -10 % | -13 % | -14 % | -14 % | -14 % | -14 % | -14 % |
| Cr | 0 % | 0 % | 0 % | 0 % | 0 % | -1 % | -1 % | -2 % | -3 % | -4 % | -5 % | -7 % | -8 % | -9 % | -10 % | -11 % | -11 % |
| Cu | 0 % | 0 % | 0 % | 0 % | 0 % | -2 % | -4 % | -6 % | -8 % | -10 % | -13 % | -16 % | -16 % | -16 % | -17 % | -18 % | -18 % |
| Ni | 0 % | 0 % | 0 % | 0 % | 0 % | -1 % | -1 % | -2 % | -2 % | -3 % | -4 % | -6 % | -7 % | -8 % | -9 % | -10 % | -10 % |
| Se | 0 % | 0 % | 0 % | 0 % | 0 % | -2 % | -3 % | -5 % | -6 % | -8 % | -10 % | -12 % | -13 % | -14 % | -14 % | -15 % | -15 % |
| Zn | 0 % | 0 % | 0 % | 0 % | 0 % | -4 % | -8 % | -13 % | -11 % | -21 % | -25 % | -30 % | -30 % | -21 % | -30 % | -51 % | -21 % |
| PCDD/Fs | -77 % | 2 % | 2 % | 5 % | 4 % | -1 % | -2 % | -6 % | -10 % | -14 % | -19 % | -22 % | -22 % | -22 % | -21 % | -23 % | -22 % |
| B(a)P | -81 % | -86 % | -90 % | -95 % | -95 % | -96 % | -97 % | -97 % | -97 % | -97 % | -97 % | -97 % | -97 % | -97 % | -97 % | -97 % | -97 % |
| B(b)F | -82 % | -87 % | -91 % | -96 % | -96 % | -97 % | -98 % | -98 % | -98 % | -98 % | -98 % | -98 % | -97 % | -97 % | -98 % | -98 % | -98 % |
| B(k)F | -82 % | -87 % | -91 % | -96 % | -96 % | -97 % | -98 % | -98 % | -98 % | -98 % | -97 % | -98 % | -97 % | -97 % | -98 % | -98 % | -98 % |
| IP | -82 % | -87 % | -91 % | -96 % | -96 % | -97 % | -98 % | -98 % | -98 % | -97 % | -97 % | -98 % | -97 % | -97 % | -98 % | -98 % | -97 % |
| Total PAHs | -82 % | -87 % | -91 % | -96 % | -96 % | -97 % | -98 % | -98 % | -98 % | -97 % | -97 % | -98 % | -97 % | -97 % | -98 % | -97 % | -97 % |
| HCB | 16 % | 35 % | -8 % | -49 % | -47 % | -39 % | -32 % | -36 % | -33 % | -20 % | -16 % | -3 % | 2 % | 0 % | -4 % | 2 % | 1 % |
| PCBs | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % | -100 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | -6 % | -8 % | -9 % | -9 % | -9 % | -9 % | -10 % | -10 % | -11 % | -11 % | -11 % | -11 % | -12 % | -12 % | -12 % |
| $PM_{10}$ | | | -10 % | -10 % | -11 % | -10 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % |
| BC | | | 0 % | 0 % | 0 % | -3 % | -6 % | -9 % | -12 % | -15 % | -18 % | -22 % | -22 % | -23 % | -24 % | -24 % | -24 % |

**(b)**

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | 71 | 80 | 84 | 87 | 82 | 92 | 79 | 86 | 84 | 76 | 82 | 80 | 82 | 84 | 86 | 83 | 84 |
| NMVOCs | 328 | 317 | 306 | 300 | 309 | 286 | 286 | 294 | 283 | 289 | 283 | 281 | 283 | 289 | 276 | 275 | 284 |
| SOx | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NH_3$ | -233 | -230 | -212 | -203 | -207 | -191 | -184 | -196 | -185 | -215 | -190 | -198 | -202 | -210 | -225 | -230 | -202 |
| TSPs | -83 | -64 | -63 | -62 | -62 | -61 | -61 | -60 | -61 | -61 | -61 | -60 | -61 | -61 | -62 | -63 | -63 |
| CO | -191 | 0 | 0 | 0 | 0 | -3 | -5 | -7 | -9 | -11 | -14 | -17 | -19 | -20 | -20 | -22 | -22 |
| Pb | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cd | -3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hg | -1 | 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 |
| Cr | 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 |
| Ni | 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 |
| Zn | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | -8 | -3 |
| PCDD/Fs | -44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -2 | -1 |
| B(a)P | -30 | -33 | -32 | -33 | -30 | -29 | -35 | -34 | -30 | -31 | -30 | -31 | -27 | -26 | -25 | -25 | -26 |
| B(b)F | -85 | -91 | -88 | -91 | -84 | -82 | -99 | -94 | -85 | -86 | -85 | -86 | -75 | -72 | -70 | -71 | -72 |
| B(k)F | -36 | -39 | -38 | -39 | -36 | -35 | -42 | -40 | -36 | -37 | -36 | -37 | -32 | -31 | -30 | -30 | -31 |
| IP | -26 | -28 | -27 | -28 | -26 | -25 | -30 | -29 | -26 | -26 | -26 | -26 | -23 | -22 | -21 | -22 | -22 |
| Total PAHs | -178 | -191 | -185 | -191 | -176 | -171 | -206 | -197 | -177 | -181 | -177 | -180 | -158 | -150 | -146 | -148 | -150 |
| HCB | 59 | 81 | -7 | -31 | -29 | -19 | -19 | -20 | -24 | -12 | -8 | -1 | 1 | 0 | -3 | 1 | 1 |
| PCBs | -3 | -2 | -1 | -1 | -1 | -1 | 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 |
| $PM_{2.5}$ | | | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 |
| $PM_{10}$ | | | -34 | -33 | -34 | -33 | -34 | -34 | -34 | -35 | -34 | -34 | -34 | -34 | -35 | -35 | -36 |
| BC | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | -1 | -1 | -1 |

**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; TSPs, total suspended particulates; Zn, zinc.

## 4.8 Sectoral analysis and emission trends for the waste sector

This sector group is a primary source of PCDD/Fs and a significant source of certain pollutants, including PCB, Hg and PM. Figure 4.14 shows the previous emission trends for these pollutants.

Between 1990 and 2019, PCB emissions decreased by 60 %. The peak in 1993 is mainly the result of the emission '5C1bii — Hazardous waste incineration' reported by France. From 2000 onwards it mainly reflects the PCB emissions reported by Portugal in the category '5C1bi — Industrial waste incineration'. PCB emissions reported by this Member State correspond closely to the amount of waste burnt in industrial incineration plants. Portugal explained that the fluctuations in the results from industrial waste incineration arose, at least partly, from variations in fluxes in other forms of treatment (landfilling, shipping abroad and recycling) as a consequence of annual demand in the waste market (see Portugal's IIR, listed in Appendix 5). The slight increase in 1993 reflects the data reported by France in the category '5C1bii — Hazardous waste incineration'.

The trend in PCDD/F emissions reported by Portugal from 1990 until 2001 contributed most to the drop observed in the category '5C1biii — Clinical waste incineration'. In its IIR, Portugal stated that 25 incinerators had been closed in recent years on its mainland, with just one clinical waste incinerator remaining in operation since 2004. Other clinical waste receives alternative treatment or is sent abroad (see Portugal's IIR, listed in Appendix 5).

The upwards trend from 2011 to 2019 was caused by data reported by Romania in the category '5C1biii — Clinical waste incineration'.

The decrease in HCB emissions between 1990 and 2005 largely reflected data from France for the category '5C1biv — Sewage sludge incineration'. However, high HCB emissions between 1993 and 1997 were also influenced by data reported by Belgium under the same category. This Member State commented that this category has disappeared as a key source of HCB because nearly all incineration plants now have energy recovery systems and emissions are allocated to the category '1A1a — Public electricity and heat production' (see Belgium's IIR, listed in Appendix 5).

The cause of the peak in $PM_{10}$ emissions in 2003 and 2016 is data reported by Spain in the categories '5C2 — Open burning of waste' and '5E — Other waste'. The slight increase in Spain's $PM_{10}$ emissions resulted from accidental fires (see Spain's IIR, listed in Appendix 5).

**Figure 4.14 EU emission trends in the waste sector group for the HM Hg, POPs (PCDD/Fs, PCBs), $PM_{2.5}$ and $PM_{10}$ between 1990 (2000) and 2019**

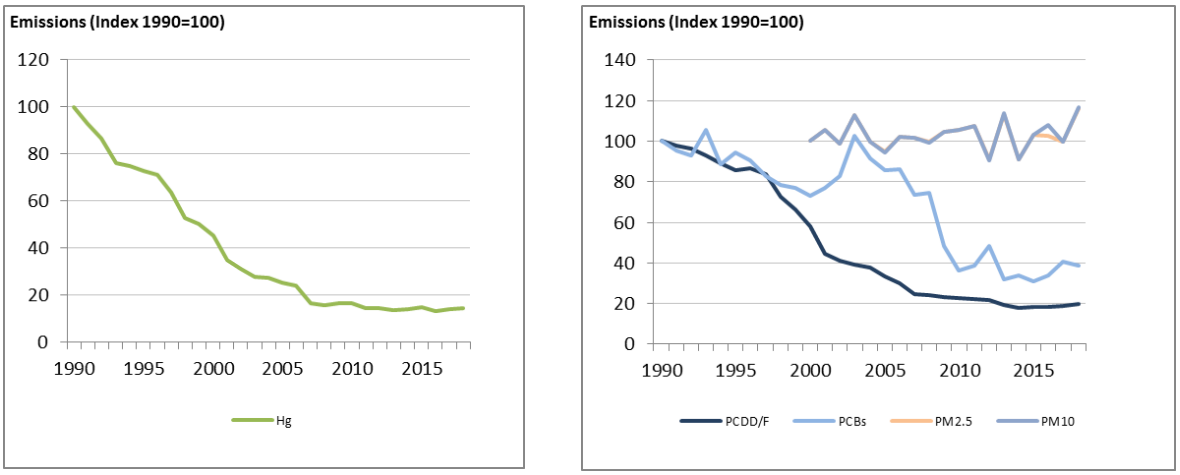



Table 4.14 presents the number of EU Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories. Table 4.15 shows the recalculations within the waste sector group. For explanations of EU recalculations, see Section 5.1.

## Table 4.14 Number of EU Member States reporting notation keys within the key categories of the waste sector group

| Key categories | | NA | NO | NR | NE |
|---|---|---|---|---|---|
| $PM_{2.5}$ | 5C2 | 0 | 9 | 0 | 2 |
| $PM_{10}$ | 5C2 | 0 | 9 | 0 | 2 |
| CO | 5C2 | 0 | 9 | 0 | 2 |
| Cd | 5C2 | 0 | 10 | 0 | 2 |
| Hg | 5C1bv | 0 | 0 | 0 | 2 |
| PCDD/Fs | 5C2 | 0 | 9 | 0 | 2 |

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

## Table 4.15 (a) Relative difference (relative data, percentage of EU national totals) and (b) absolute difference between reported emissions when comparing the EU's 2020 and 2021 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 |
| $NO_x$ | -30 % | -17 % | -30 % | -28 % | -33 % | -34 % | -33 % | -36 % | -36 % | -38 % | -28 % | -42 % | -33 % | -39 % | -39 % | -38 % | -28 % |
| NMVOCs | -21 % | -23 % | -20 % | -17 % | -16 % | -16 % | -16 % | -15 % | -14 % | -13 % | -17 % | -9 % | -12 % | -10 % | -10 % | -11 % | -6 % |
| SOx | -46 % | -40 % | -29 % | -27 % | -29 % | -28 % | -24 % | -26 % | -34 % | -36 % | -29 % | -40 % | -33 % | -33 % | -29 % | -30 % | -27 % |
| $NH_3$ | -5 % | -6 % | -7 % | -9 % | -9 % | -9 % | -8 % | -11 % | -7 % | -11 % | -11 % | -11 % | -10 % | -10 % | -11 % | -11 % | -10 % |
| TSPs | 7 % | 6 % | 7 % | 8 % | 9 % | 9 % | 9 % | 9 % | 9 % | 9 % | 9 % | 9 % | 8 % | 8 % | 7 % | 8 % | 25 % |
| CO | 19 % | 24 % | 17 % | 18 % | 16 % | 16 % | 16 % | 15 % | 15 % | 14 % | 19 % | 11 % | 15 % | 13 % | 13 % | 14 % | 41 % |
| Pb | -74 % | -51 % | -12 % | -10 % | -10 % | -13 % | -13 % | -15 % | -16 % | -19 % | -18 % | -22 % | -23 % | -23 % | -26 % | -25 % | -22 % |
| Cd | -49 % | -8 % | 8 % | 19 % | 29 % | 29 % | 26 % | 30 % | 31 % | 28 % | 16 % | 32 % | 15 % | 20 % | 18 % | 14 % | 31 % |
| Hg | -38 % | -12 % | -10 % | -28 % | -32 % | -40 % | -44 % | -48 % | -44 % | -42 % | -41 % | -42 % | -41 % | -41 % | -43 % | -43 % | -43 % |
| As | -41 % | -58 % | -29 % | -35 % | -23 % | -23 % | -27 % | -19 % | -17 % | -14 % | -38 % | -3 % | -32 % | -17 % | -18 % | -22 % | 2 % |
| Cr | -41 % | -68 % | -79 % | -80 % | -81 % | -82 % | -83 % | -84 % | -84 % | -85 % | -86 % | -86 % | -87 % | -87 % | -86 % | -87 % | -86 % |
| Cu | -43 % | -44 % | -50 % | -54 % | -53 % | -55 % | -56 % | -56 % | -56 % | -58 % | -64 % | -56 % | -65 % | -61 % | -64 % | -65 % | -61 % |
| Ni | -3 % | -8 % | -15 % | -23 % | -28 % | -27 % | -29 % | -32 % | -54 % | -60 % | -58 % | -66 % | -58 % | -54 % | -58 % | -58 % | -51 % |
| Se | 155 % | 105 % | 164 % | 152 % | 173 % | 174 % | 166 % | 178 % | 180 % | 181 % | 150 % | 189 % | 168 % | 179 % | 180 % | 175 % | 259 % |
| Zn | 18 % | 17 % | 21 % | 20 % | 21 % | 21 % | 20 % | 20 % | 21 % | 21 % | 21 % | 21 % | 21 % | 21 % | 21 % | 21 % | 44 % |
| PCDD/Fs | -33 % | -21 % | -10 % | -6 % | -5 % | -10 % | -9 % | -6 % | -3 % | -3 % | 0 % | -5 % | -7 % | -7 % | -7 % | -5 % | -4 % |
| B(a)P | -81 % | -68 % | -80 % | -78 % | -80 % | -80 % | -78 % | -80 % | -81 % | -82 % | -75 % | -84 % | -77 % | -81 % | -65 % | -80 % | -80 % |
| B(b)F | -77 % | -69 % | -81 % | -79 % | -82 % | -82 % | -80 % | -81 % | -83 % | -83 % | -77 % | -85 % | -78 % | -82 % | -74 % | -82 % | -81 % |
| B(k)F | -89 % | -84 % | -92 % | -90 % | -92 % | -92 % | -91 % | -91 % | -92 % | -93 % | -89 % | -93 % | -90 % | -92 % | -87 % | -92 % | -91 % |
| IP | -60 % | -57 % | -56 % | -55 % | -46 % | -41 % | -38 % | -37 % | -37 % | -40 % | -40 % | -40 % | -39 % | -38 % | -12 % | -38 % | -38 % |
| Total PAHs | -86 % | -80 % | -89 % | -88 % | -89 % | -89 % | -88 % | -89 % | -90 % | -90 % | -86 % | -91 % | -87 % | -90 % | -79 % | -89 % | -89 % |
| HCB | -6 % | -3 % | 0 % | -2 % | -4 % | -8 % | -6 % | -8 % | -10 % | -13 % | -19 % | -20 % | -20 % | -20 % | -23 % | -21 % | -25 % |
| PCBs | -65 % | -62 % | -64 % | -56 % | -51 % | -53 % | -52 % | -60 % | -65 % | -63 % | -57 % | -66 % | -64 % | -66 % | -64 % | -59 % | -60 % |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | 7 % | 8 % | 8 % | 8 % | 8 % | 8 % | 9 % | 9 % | 9 % | 8 % | 8 % | 8 % | 7 % | 8 % | 25 % |
| $PM_{10}$ | | | 9 % | 9 % | 10 % | 10 % | 10 % | 10 % | 10 % | 10 % | 10 % | 9 % | 9 % | 9 % | 9 % | 9 % | 28 % |
| BC | | | -22 % | -19 % | -23 % | -23 % | -22 % | -24 % | -24 % | -25 % | -17 % | -29 % | -22 % | -26 % | -26 % | -25 % | -10 % |

### (b)

| Absolute difference | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $NO_x$ | -13 | -6 | -13 | -11 | -15 | -15 | -14 | -17 | -17 | -18 | -10 | -23 | -13 | -18 | -18 | -17 | -12 |
| NMVOCs | -28 | -31 | -27 | -19 | -18 | -18 | -18 | -17 | -15 | -14 | -18 | -9 | -11 | -10 | -9 | -10 | -6 |
| SOx | -8 | -5 | -2 | -1 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -2 | -1 | -1 | -1 | -1 | -1 |
| $NH_3$ | -4 | -4 | -5 | -5 | -5 | -5 | -4 | -6 | -3 | -6 | -5 | -6 | -5 | -5 | -6 | -6 | -5 |
| TSPs | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 6 | 8 | 6 | 7 | 6 | 6 | 20 |
| CO | 87 | 84 | 89 | 87 | 88 | 88 | 86 | 86 | 88 | 88 | 87 | 78 | 76 | 78 | 77 | 77 | 234 |
| Pb | -225 | -59 | -4 | -2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -4 | -3 | -4 | -4 | -5 | -4 |
| Cd | -7 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Hg | -7 | -1 | -1 | -1 | -1 | -1 | -1 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| As | -5 | -7 | -3 | -4 | -2 | -2 | -3 | -2 | -2 | -2 | -4 | 0 | -3 | -2 | -2 | -2 | 0 |
| Cr | -9 | -9 | -11 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 |
| Cu | -10 | -10 | -10 | -8 | -7 | -7 | -7 | -7 | -7 | -8 | -8 | -8 | -9 | -8 | -9 | -9 | -9 |
| Ni | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | -1 | 0 | 0 |
| Se | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Zn | 49 | 37 | 52 | 49 | 54 | 54 | 52 | 55 | 56 | 57 | 46 | 59 | 46 | 53 | 52 | 50 | 106 |
| PCDD/Fs | -882 | -399 | -114 | -37 | -26 | -49 | -41 | -27 | -11 | -10 | -1 | -18 | -24 | -24 | -25 | -19 | -16 |
| B(a)P | -9 | -5 | -10 | -9 | -10 | -10 | -9 | -11 | -11 | -11 | -8 | -13 | -9 | -11 | -11 | -10 | -10 |
| B(b)F | -15 | -10 | -18 | -16 | -19 | -19 | -18 | -20 | -20 | -21 | -14 | -25 | -16 | -21 | -20 | -19 | -19 |
| B(k)F | -31 | -19 | -38 | -34 | -41 | -40 | -38 | -43 | -45 | -47 | -31 | -54 | -35 | -45 | -44 | -42 | -42 |
| IP | -1 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total PAHs | -56 | -37 | -69 | -62 | -72 | -71 | -67 | -76 | -78 | -82 | -54 | -94 | -62 | -79 | -77 | -73 | -73 |
| HCB | -6 | -3 | 0 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -2 | -1 | -1 | -1 | -2 | -2 | -2 |
| PCBs | -349 | -291 | -242 | -199 | -170 | -153 | -148 | -135 | -124 | -122 | -120 | -116 | -112 | -113 | -112 | -112 | -111 |
| | | | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | | | 5 | 5 | 6 | 6 | 5 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 17 |
| $PM_{10}$ | | | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 7 | 8 | 6 | 7 | 7 | 7 | 20 |
| BC | | | -5 | -4 | -5 | -5 | -5 | -6 | -6 | -6 | -3 | -8 | -4 | -6 | -6 | -6 | -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; Ni, nickel; Se, selenium; TSPs, total suspended particulates; Zn, zinc.

# 5 Recalculations and implemented or planned improvements

## *5.1 Recalculations*

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

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

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

### 5.1.1 Recalculations of the EU inventory

Table 5.1 compares total emissions from the EU submitted in 2020 with those submitted in 2021.

## Table 5.1 Comparison of data submitted in 2020 and 2021 by EU Member States: (a) relative data, percentage of EU national total and (b) absolute data

### (a)

| Pollutant | Unit | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | Gg | -18 % | -16 % | -14 % | -13 % | -12 % | -11 % | -12 % | -12 % | -12 % | -12 % | -11 % | -11 % | -11 % |
| NMVOCs | Gg | -15 % | -13 % | -11 % | -9 % | -7 % | -7 % | -8 % | -7 % | -7 % | -7 % | -7 % | -7 % | -7 % |
| $SO_x$ | Gg | -15 % | -15 % | -13 % | -10 % | -10 % | -10 % | -12 % | -12 % | -11 % | -9 % | -7 % | -7 % | -8 % |
| $NH_3$ | Gg | -5 % | -6 % | -6 % | -6 % | -6 % | -7 % | -6 % | -6 % | -6 % | -6 % | -7 % | -7 % | -6 % |
| TSPs | Gg | -5 % | -10 % | -9 % | -9 % | -10 % | -9 % | -9 % | -10 % | -10 % | -10 % | -11 % | -11 % | -11 % |
| CO | Gg | -13 % | -13 % | -12 % | -10 % | -8 % | -8 % | -8 % | -8 % | -9 % | -9 % | -8 % | -8 % | -7 % |
| Pb | Mg | -13 % | -16 % | -7 % | -12 % | -12 % | -14 % | -14 % | -14 % | -15 % | -16 % | -16 % | -15 % | -16 % |
| Cd | Mg | -12 % | -8 % | -3 % | -3 % | -2 % | -3 % | -3 % | -1 % | -3 % | -3 % | -3 % | -4 % | -7 % |
| Hg | Mg | -20 % | -15 % | -8 % | -9 % | -11 % | -10 % | -10 % | -11 % | -10 % | -10 % | -9 % | -9 % | -9 % |
| As | Mg | -7 % | -12 % | -14 % | -15 % | -26 % | -28 % | -31 % | -29 % | -32 % | -37 % | -33 % | -38 % | -37 % |
| Cr | Mg | -15 % | -17 % | -16 % | -12 % | -11 % | -10 % | -11 % | -12 % | -13 % | -13 % | -13 % | -13 % | -13 % |
| Cu | Mg | -13 % | -13 % | -12 % | -11 % | -10 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % | -11 % |
| Ni | Mg | -15 % | -19 % | -15 % | -12 % | -15 % | -14 % | -17 % | -19 % | -21 % | -16 % | -16 % | -20 % | -19 % |
| Se | Mg | -33 % | -33 % | -32 % | -29 % | -27 % | -28 % | -30 % | -30 % | -30 % | -28 % | -27 % | -27 % | -29 % |
| Zn | Mg | -13 % | -16 % | -13 % | -13 % | -12 % | -11 % | -11 % | -12 % | -13 % | -13 % | -12 % | -13 % | -10 % |
| PCDD/Fs | g I-Teq | -18 % | -14 % | -9 % | -7 % | -7 % | -7 % | -6 % | -7 % | -8 % | -7 % | -6 % | -6 % | -6 % |
| B(a)P | Mg | -36 % | -30 % | -89 % | -93 % | -19 % | -23 % | -23 % | -27 % | -38 % | -39 % | -37 % | -31 % | -17 % |
| B(b)F | Mg | -19 % | -23 % | -25 % | -24 % | -20 % | -23 % | -20 % | -23 % | -22 % | -21 % | -21 % | -20 % | -22 % |
| B(k)F | Mg | -24 % | -26 % | -34 % | -32 % | -32 % | -36 % | -28 % | -37 % | -32 % | -35 % | -33 % | -33 % | -34 % |
| IP | Mg | -7 % | -13 % | -10 % | -10 % | -3 % | -6 % | -4 % | -4 % | -5 % | -3 % | -3 % | -3 % | -4 % |
| Total PAHs | Mg | -28 % | -26 % | -72 % | -80 % | -29 % | -31 % | -30 % | -33 % | -34 % | -35 % | -33 % | -32 % | -29 % |
| HCB | kg | -33 % | -47 % | 8 % | -19 % | -24 % | -18 % | -17 % | -12 % | -10 % | -19 % | -17 % | -16 % | -19 % |
| PCBs | kg | -60 % | -55 % | -30 % | -31 % | -30 % | -31 % | -31 % | -31 % | -31 % | -30 % | -27 % | -26 % | -20 % |
| | | | | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | Gg | | | -7 % | -7 % | -7 % | -7 % | -8 % | -8 % | -9 % | -8 % | -9 % | -9 % | -9 % |
| $PM_{10}$ | Gg | | | -8 % | -8 % | -8 % | -8 % | -8 % | -9 % | -9 % | -9 % | -9 % | -10 % | -9 % |
| BC | Gg | | | -11 % | -10 % | -11 % | -11 % | -10 % | -12 % | -11 % | -11 % | -12 % | -12 % | -11 % |

### (b)

| Pollutant | Unit | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | Gg | -3 168 | -2 524 | -1 892 | -1 624 | -1 151 | -1 060 | -1 083 | -1 050 | - 973 | - 934 | - 850 | - 845 | - 811 |
| NMVOCs | Gg | -2 746 | -1 966 | -1 300 | - 879 | - 618 | - 568 | - 576 | - 526 | - 526 | - 515 | - 518 | - 521 | - 516 |
| $SO_x$ | Gg | -3 736 | -2 461 | -1 276 | - 740 | - 426 | - 411 | - 441 | - 386 | - 311 | - 237 | - 166 | - 160 | - 159 |
| $NH_3$ | Gg | - 269 | - 273 | - 269 | - 256 | - 229 | - 261 | - 235 | - 242 | - 245 | - 252 | - 267 | - 273 | - 245 |
| TSPs | Gg | - 423 | - 536 | - 436 | - 429 | - 428 | - 381 | - 342 | - 375 | - 360 | - 364 | - 401 | - 427 | - 414 |
| CO | Gg | -8 034 | -6 750 | -4 363 | -3 058 | -2 021 | -1 879 | -1 831 | -1 845 | -1 783 | -1 774 | -1 607 | -1 606 | -1 400 |
| Pb | Mg | -3 097 | -1 791 | - 307 | - 250 | - 207 | - 204 | - 211 | - 205 | - 219 | - 221 | - 214 | - 214 | - 218 |
| Cd | Mg | - 23 | - 10 | - 4 | - 3 | - 1 | - 2 | - 2 | - 1 | - 2 | - 2 | - 2 | - 2 | - 4 |
| Hg | Mg | - 37 | - 20 | - 8 | - 8 | - 7 | - 7 | - 6 | - 7 | - 6 | - 5 | - 5 | - 5 | - 5 |
| As | Mg | - 44 | - 36 | - 28 | - 28 | - 41 | - 41 | - 43 | - 41 | - 44 | - 49 | - 42 | - 51 | - 49 |
| Cr | Mg | - 176 | - 130 | - 92 | - 58 | - 43 | - 40 | - 41 | - 44 | - 50 | - 48 | - 48 | - 49 | - 49 |
| Cu | Mg | - 290 | - 264 | - 253 | - 230 | - 212 | - 219 | - 207 | - 212 | - 218 | - 215 | - 219 | - 214 | - 220 |
| Ni | Mg | - 327 | - 355 | - 208 | - 149 | - 128 | - 106 | - 121 | - 125 | - 129 | - 95 | - 91 | - 118 | - 111 |
| Se | Mg | - 90 | - 70 | - 60 | - 64 | - 50 | - 50 | - 53 | - 50 | - 50 | - 47 | - 43 | - 43 | - 46 |
| Zn | Mg | -1 015 | - 998 | - 665 | - 552 | - 486 | - 468 | - 445 | - 476 | - 500 | - 501 | - 477 | - 501 | - 437 |
| PCDD/Fs | g I-Teq | -1 620 | - 993 | - 380 | - 193 | - 164 | - 148 | - 135 | - 151 | - 146 | - 129 | - 120 | - 113 | - 120 |
| B(a)P | Mg | - 242 | - 155 | -1 952 | -3 471 | - 67 | - 77 | - 82 | - 94 | - 141 | - 147 | - 140 | - 109 | - 46 |
| B(b)F | Mg | - 112 | - 118 | - 89 | - 89 | - 76 | - 83 | - 70 | - 81 | - 68 | - 68 | - 66 | - 65 | - 69 |
| B(k)F | Mg | - 72 | - 65 | - 67 | - 63 | - 65 | - 70 | - 51 | - 75 | - 54 | - 62 | - 61 | - 58 | - 60 |
| IP | Mg | - 17 | - 26 | - 15 | - 15 | - 5 | - 8 | - 5 | - 5 | - 6 | - 4 | - 4 | - 4 | - 5 |
| Total PAHs | Mg | - 608 | - 447 | -2 226 | -3 739 | - 381 | - 384 | - 380 | - 435 | - 411 | - 428 | - 407 | - 378 | - 318 |
| HCB | kg | -2 727 | -3 346 | 285 | - 79 | - 56 | - 42 | - 41 | - 35 | - 32 | - 37 | - 44 | - 41 | - 43 |
| PCBs | kg | -7 100 | -4 908 | -1 339 | -1 011 | - 749 | - 728 | - 688 | - 650 | - 624 | - 573 | - 502 | - 482 | - 357 |
| | | | | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $PM_{2.5}$ | Gg | | | - 124 | - 110 | - 116 | - 106 | - 113 | - 117 | - 112 | - 111 | - 113 | - 114 | - 108 |
| $PM_{10}$ | Gg | | | - 215 | - 196 | - 195 | - 179 | - 181 | - 188 | - 183 | - 180 | - 188 | - 193 | - 189 |
| BC | Gg | | | - 40 | - 34 | - 32 | - 29 | - 25 | - 28 | - 23 | - 25 | - 24 | - 24 | - 21 |

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

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

**Recalculations for particulate matter (PM), total suspended particulates (TSPs) and black carbon (BC).** The highest recalculations for PM with a diameter of 2.5 µm or less ($PM_{2.5}$), PM with a diameter of 10 µm or less ($PM_{10}$), BC and TSPs, reducing emissions and relevant for the EU recalculations, were carried out by France ($PM_{2.5}$, $PM_{10}$,), Poland (TSP, $PM_{2.5,}$ $PM_{10}$) and Spain ($PM_{10}$, BC). On the other hand, recalculations from Spain ($PM_{2.5}$), Greece (BC, $PM_{2.5}$), the Netherlands (TSP, $PM_{2.5}$), Croatia (TSP) and Italy ($PM_{2.5}$) led to an increase in EU emissions.

**Recalculations for the main pollutants and carbon monoxide (CO).** Recalculations for nitrogen oxides ($NO_X$), non-methane volatile organic compounds (NMVOCs), sulphur oxides ($SO_X$) and CO that are relevant for the EU recalculations were carried out by several countries (see also Table 5.2).

For **lead (Pb)**, Slovenia carried out significant recalculations that increased the impact of Pb emissions (1990-2005) and were relevant for the EU recalculations in the category '2C1 — Iron and steel production', which were counterbalanced by recalculations that decreased the impact of Pb emissions from Germany (1995-2020), the Netherlands (1990-1991, previously reported but now filled with the notation key 'NE' (not estimated) for the period 1990-2019) and Hungary (1992) in the category '1A3bi — Road transport: Passenger cars'. Germany explained in its informative inventory report (IIR) that the reason for the recalculations was a fundamental revision of its TREMOD (Transport Emission Model) (see Germany's IIR, listed in Appendix 5).

The EU recalculation trend for **copper (Cu)** mainly represents recalculated data reported by Germany for the category '1A3bvi — Road transport: Automobile tyre and brake wear' for the years 1990-2018. Germany stated in its IIR that recalculations were carried out because of a shift towards the default emission factor for heavy metal (HM) emissions from tyre and break wear, as provided in the inventory guidebook (EMEP/EEA, 2019), and the revision of the TREMOD (see Germany's IIR, listed in Appendix 5).

For **zinc (Zn)**, significant recalculations influencing the EU results (emissions were reduced) were carried out by Italy (1990-2018) in the category '1A2f — Stationary combustion in manufacturing industries and construction' and by France in the category '1A3bvi — Road transport: Automobile road abrasion'. Italy stated that the revision of emission factors on the basis of European Pollutant Release and Transfer Register (E-PRTR) plant-level data on Zn emissions is the reason for the decreased emissions (see Italy's IIR; listed in Appendix 5).

**Recalculations for persistent organic pollutants (POPs).** For **dioxin** emissions, several countries carried out recalculations that affected the EU results. By far the highest recalculations (resulting in a decreasing impact) were identified in Poland as a result of decreasing emissions in the sectors '5C1bi — Industrial waste incineration' and '1A4bi — Residential: Household and gardening (mobile)'.

The highest recalculations resulting in a negative impact for **total polycyclic aromatic hydrocarbon (PAH)** emissions were carried out by Bulgaria between 2000 and 2006 in the category '2D3g — Chemical products' and Greece from 1990 to 2018 in the category '3F — Field burning of agricultural residues'. In its IIR, Greece mentioned that emissions were recalculated for this category, Appling updating emission factors from the EMEP/EEA air pollutant emission inventory guidebook (see Greece's IIR, listed in Appendix 5).

For **hexachlorobenzene (HCB)** emissions, the biggest recalculations affecting the EU's national total (resulting in decreasing emissions) originate particularly from the sector '3Df — Use of pesticides'. Poland's recalculations in 2018 are largely responsible for the reduction. Poland stated that the reduction is the result of an update to the methodology in 1990-2019 and the review recommendations (see Poland's IIR, listed in Appendix 5).

The EU recalculation trend for **polychlorinated biphenyls (PCBs)** is mainly driven by recalculated data reported by Belgium (which had a decreasing impact in the period 1990-2018). This is mainly the result of reductions in the category '2K — Consumption of POPs and heavy metals'. Belgium stated in its IIR that the lower emissions are the result of the recalculations performed on emissions from metal shredders in Wallonia (see Belgium's IIR, listed in Appendix 5).

**Table 5.2 Recalculations by EU Member States (gap-filled inventory) that have a significant impact on the EU recalculations**

| Pollutant | EU countries making significant recalculations | |
|---|---|---|
| | **Countries for which recalculations had a decreasing effect** | **Countries for which recalculations had an increasing effect** |
| $NO_X$ | FR 1990-2018; PL 1990-2000; CZ 2013-2018 | DE 1990-2000; IT 2016-2018; PL 2016-2018; ES 1990-2018 |
| NMVOCs | FR 1990-2018; IT 1990-2000; LT 1990; RO 1990-2006 | BG 1990-199; DE 1990-2005; PL 1990-2018; SK 1990-2000 |
| $SO_X$ | EL 1990- 2018; LT 1990-1994 | FR 1990-2001; SK 1990-1999; CY 1990-2003 |
| $NH_3$ | CZ 1990-2018; PL 1990-2000; RO 1990-1997 | DE 1990-2019; NL 1990-2003; IT 2005-2018 |
| $PM_{2.5}$ | PL 2000-2003; NL 2000-2018; EL 2000-2018 | FR 1990-2018; DE 1990-2018; PL 2011-2018 |
| $PM_{10}$ | PL 2000-2003; NL 2000-2018; EL 2000-2018 | PL 2014-2018; ES 2000-2017, FR 2010-2018 |
| TSPs | HR 2000-2018, PL 2000-2002; EL 2000-2018 | ES 2000-2017; FR 2010-2017; BG 2005-2006; PL 2018 |
| BC | EL 2000-2018; HU 2000-2012; PL 2000-2004; PT 2000-2010 | ES 2000-2018 |
| CO | BE 1990-2005; FR 1990-1994; EL 1990-2018; RO 1990-2018; SK 2016, 2017 | FR 1994-2018; DE 1990-2005; IT 2004-2018; LT 1990-1999; SK 1990-1998; ES 1990-2017 |
| Pb | NL 1990-1996; SE 1990 | FR 1990-2018; DE 1990-2018; LT 1990-1996; SI 1990-2005 |
| Cd | NL 1990-2018; ES 1990-2018 | DE 1990-2018; IT 2003-2018; PL 1990-2000; MT 1990-2004 |
| Hg | PL 1990-2018; NL 1990-2018 | MT 1990-2004; SK 1990-2018; HU 1990-2018 |
| As | ES 1990-2018 | IT 2000-2018 |
| Cr | FR 1990-2018; BE 1990-2001; NL 1990-2018; ES 1990-2018 | SK 1990-2018; PT 1997-2018 |
| Cu | FR 1990-2018; NL 1990-2018 | DE 1990-2018; PT 1990-2018 |
| Ni | FR 1990-1991, 1999-2010; ES 1990-2018 | HU 1990-1999; MT 1990-2004; FR 1992-1999 |
| Se | ES 1990-2018; SK 1990-1993 | PT 2011-2018 |
| Zn | ES 1990-2018; NL 1990-2018; EL 1990-2018 | FR 1990-2018; IT 1990-2018 |

| Pollutant | EU countries making significant recalculations | |
|---|---|---|
| | **Countries for which recalculations had a decreasing effect** | **Countries for which recalculations had an increasing effect** |
| PCDD/Fs | FR 2010-2018; RO 2000-2005, 2017-2018; SK 2003 | BE 1990-2000; EL 1990-2009; PL 1990-2004; SK 1990-1998 |
| B(a)P | AT 1990-2019; FI 1990-2018 | BG 2000-2006 |
| B(b)F | DE 1990-2018; FI 1990-2018 | EL 1990-2018; ES 1990-2018 |
| B(k)F | DE 1990-2018; FI 1990-2018; AT 1990-1997 | EL 1990-2018; ES 1990-2018 |
| IP | DE 1990-2018; FI, 1990-2018 | EL 1990-2018 |
| Total PAHs | FI 1990-2018; FR 1999-2018; SK 1990-2018 | BG 2000-2006; DE 1990-2018; EL 1990-1999; ES 1990-2018 |
| HCB | HU 1990-2002; IT 1990-1999; PL 1990-1995 | AT 1993-2018; IT 2001-2012 |
| PCBs | BE 2013-2018; SK 1990-2005 | EE 1990-2018; FR 1990-2001 |

**Notes:** EU countries making significant recalculations are listed in descending order, reflecting the impact on recalculated emissions for the EU as a whole. Recalculations concern the gap-filled inventory.
As, arsenic; B(a)P, benzo(b)pyrene; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cd, cadmium; Cr, chromium; Hg, mercury; IP, indeno(1,2,3-cd)pyrene; $NH_3$, ammonia; Ni, nickel; PCDD/F, polychlorinated dibenzodioxins/dibenzofuran; Se, selenium.

### 5.1.2 EU Member States' recalculations

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

**Austria** provided detailed information concerning its recalculations, which were carried out because of revisions, new estimates, updates of activity data, updated models, and improvements in methodologies and emission factors (see Austria's IIR, p. 431, 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. The main reasons for recalculations at the sectoral level were the application of emission factors from the inventory guidebook (EMEP/EEA, 2019), the availability of new data (e.g. mobility data) and the application of new approaches (see Belgium's IIR, p. 199f., listed in Appendix 5).

**Bulgaria** reported that it had made recalculations in several sectors — nomenclature for reporting (NFR) 2D3g, 2H2, 3Dc, 3De and 5A (see Bulgaria's IIR, p. 116, listed in Appendix 5).

**Croatia** provided detailed information on its recalculations for different sectors. The main reasons for the recalculations included the availability of new information, the implementation of higher tier methods, changed methodology and the correction of inconsistencies in the time series. Table ES4-1 in Croatia's IIR provides an overview of the recalculations (see Croatia's IIR, p. 231f., listed in Appendix 5).

**Cyprus** stated that it had made some methodological improvements to its national emission inventory. The changes were made in response to previous recommendations from the Technical Expert Review Team (TERT) or technical corrections. This led to recalculations of the time series

1990-2018, aiming to improve the accuracy of the emission data. The main reason for the recalculations was the full implementation of the provisions of the new inventory guidebook (EMEP/EEA, 2019) and the implementation of the TERT's suggestions in 2017, 2018, 2019 and 2020 (see Cyprus's IIR, p. 149, listed in Appendix 5).

**Czechia** stated that recalculations were carried out because of updated data and the introduction of the computer program to calculate emissions from road transport version 5 (COPERT V) model. Recalculations were realised in several sectors, such as 1A4b, 3B, 3D, 1A4bi, 1A1c, 2A3, 5A and 2C1(see Czechia's IIR, p. 108f., listed in Appendix 5).

**Denmark** provided detailed information on its recalculations within the sectoral chapters, having put considerable work into improving the inventory. The submission includes recalculated inventories for the whole time series. The reasons for recalculation were changes in methodology, the updates to the inventory guidebook (EMEP/EEA, 2019) and activity data, new data, correction of errors and updated emission factors (see Denmark's IIR, p. 449, listed in Appendix 5).

**Estonia** provided detailed information on its recalculations for the period 1990-2018. The reason for the recalculation was the TERT recommendation to use the tier 2 method for calculating the key source of POPs (see Estonia's IIR, p. 265, listed in Appendix 5).

**Finland** provided detailed information on its recalculations, which were carried out for several reasons, such as the addition of new sources and emissions, updates following the information in the inventory guidebook (EMEP/EEA, 2019) and correction of errors (see Finland's IIR, listed in Appendix 5).

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

**Germany** provided detailed information on its recalculations, which were carried out for several reasons, namely the updating and revision of the entire German emission inventory model, newly implemented emission factors, including new (sub-)categories, revision of existing emission factors and reallocation of activity data and emissions (see Germany's IIR, listed in Appendix 5).

**Greece** reported that all emissions were recalculated for the period 2015- 2018 for several categories in the 'Solvents and other product use' sector. Recalculations were carried out because of updated activity data (see Greece's IIR, p. 116, listed in Appendix 5).

**Hungary** provided information on recalculations in the sector-specific chapters. These were mainly carried out because of methodological changes, the use of the new COPERT V model and the revision of activity data, as well as the availability of updated fuel consumption data (see Hungary's IIR, p. 245, listed in Appendix 5).

**Ireland** provided information on recalculations in the sector-specific chapters. These were mainly related to updated activity data, as well as revised emission factors, improvements in the calculation procedures and methodology (see Ireland's IIR, listed in Appendix 5).

**Italy** stated in the IIR that recalculations were mainly due to updated emission factors, the addition of new categories, the upgrade to the new COPERT V model, revised estimates and new estimates (see Italy's IIR, p. 166, listed in Appendix 5).

**Latvia** provided detailed information on recalculations in the sector-specific chapters. They were carried out because of updated activity data and emission factors, as well as the implementation of sector-specific research results, and following recommendations from the TERT (see Latvia's IIR, p.154 listed in Appendix 5).

**Lithuania** stated that it had recalculated emissions based on improved data and enhanced methodology and to correct errors (see Lithuania's IIR, listed in Appendix 5).

**Luxembourg** presented its main revisions and recalculations in Section 8.1.2 of its IIR (p. 466). The reasons for the recalculations were updated activity data, methodology and emission factors and correcting errors (see Luxembourg's IIR, listed in Appendix 5).

The **Netherlands** provided detailed information on the recalculations carried out. The main reasons for these were the inclusion and calculation of new emission sources. Compared with the IIR 2020, only a few methodological changes were implemented in the EPRTR (see Netherlands' IIR, p. 179, listed in Appendix 5).

**Poland** reported that recalculations were carried out mainly because of updated activity data, verified methodologies, new emission sources not estimated previously and an update to the latest version of the COPERT V software. New emission sources not estimated previously were added to the inventory (see Poland's IIR, p. 161, listed in Appendix 5).

**Portugal** provided detailed information on its recalculations. Since the last submission, recalculations have been mainly carried out because of revised data/emission factors/estimates, error correction and the implementation of emission factors from the inventory guidebook (EMEP/EEA, 2019) (see Portugal's IIR, pp. 8-2, listed in Appendix 5).

**Romania** noted that, following the review of the emission inventory, recalculations of emissions were carried out based on improved activity data, updated statistics, new sources, the application of a higher tier method, an update to the latest version of COPERT V and new estimates (see Romania's IIR, p. 289, listed in Appendix 5).

**Slovakia** provided detailed information and tables on its recalculations. The main reasons were new estimates, the implementation of a higher tier method, error correction and new/improved methodology (see Slovakia's IIR, p. 34f., listed in Appendix 5).

**Slovenia** provided detailed information on its recalculations, which were carried out because of error correction, first-time reporting of emissions, new activity data, improved data, the implementation of emission factors from the inventory guidebook (EMEP/EEA, 2019), the application of a higher tier method and an update to the latest version of COPERT V. Many of these recalculations were carried out following recommendations from the TERT (see Slovenia's IIR, p. 278, listed in Appendix 5).

**Spain** provided very detailed information on its recalculations, the main reasons for them being methodological improvements, including updates to emission factors in the inventory guidebook (EMEP/EEA, 2019), the availability of new data, adjustments in the calculations and correction of errors (see Spain's IIR, p. 180, listed in Appendix 5).

**Sweden** provided detailed information on its recalculations. The reasons were the revision and updating of emission factors and activity data, reallocation of emissions, availability of new data, updated emission inventory models and correction of emissions (see Sweden's IIR, p. 279f, listed in Appendix 5).

The annual European Monitoring and Evaluation Programme (EMEP) inventory review report (EMEP, forthcoming) presents a summary of the individual recalculations reported by EU Member States. This yearly report will be available on the Centre on Emission Inventories and Projections' (CEIP's) website in July 2021 (EMEP CEIP, 2021c).

### 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 submitted emissions to help Parties improve their national inventories (EMEP CEIP, 2021b; EMEP, forthcoming). These yearly reviews should help EU Member States compile their individual emission estimates and submit their improved inventories together with their IIRs.

The stage 1 review — an automated test — is held every year to assess timeliness, completeness and format. The stage 2 review assesses recalculations, key category analysis (KCA), inventory comparison, trends and time series. Stage 3 is an in-depth review by experts nominated by the Parties. Each year, the plan is for two teams to review 10 Parties' inventories.

In 2020, EMEP CEIP reviewed the EU, North Macedonia, Iceland, Kyrgyzstan and Switzerland, resulting in individual country-specific reports (EMEP CEIP, 2021c). In 2021, Kazakhstan, Liechtenstein, Monaco and Montenegro will be reviewed as part of the stage 3 review.

### 5.1.4 Improvements planned at EU level

The EEA and the European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI) 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 timelier United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (Air Convention) emission inventories. 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/ATNI have identified the following challenges:

- **Further progress concerning the completeness of reporting**. Although clear progress has been made in recent years on making reporting complete, a full set of emission inventory data for air pollutants is still not available for all EU Member States, as noted earlier in this report. In addition, for certain pollutants (mainly PM and 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/ATNI has also identified a problem with gap filling using data submitted several years ago. In a number of cases, because countries have not since submitted corrected or updated data sets, the EU inventory unavoidably includes inconsistencies. Therefore, the quality of the EU's inventory will be enhanced if the consistency and completeness of EU Member States' submissions improve. Such improvements would help reliable trend analysis to inform policy. Since 2017, emission inventory reviews have been conducted under the National Emission reduction Commitments (NEC) Directive (EU, 2016b). The results of the review of these processes should also improve the quality of the Air Convention submissions.
- **Review of the current gap filling procedures to ensure that they use the best approach**, reflecting real emissions. Although the improved inventory gap filling procedure carried out since 2011 has helped to develop a more complete EU emission inventory, there is still room for improvement (e.g. by including manual changes in the procedure).
- **Reducing the need for gap filling**. This is achievable if the EU Member States report complete time series as far as possible, and if they have already provided the data in earlier submissions under the Air Convention. Current gap filling procedures first use submissions received in the current reporting years under various reporting mechanisms and then use older Air Convention submissions. However, because of the review of processes under the NEC Directive, it is expected that the completeness of submissions (under the NEC Directive and Air Convention) will improve.
- **More explanatory information on trends and recalculations**. This would be possible only if the IIRs included such information. Thus, countries are encouraged to provide it.
- **Further research on outliers in EU Member States' emission data to ensure that they reflect real emissions**. A comparison of Member States' contributions to the EU total reveals extraordinarily high proportions in some instances. Future investigation could determine whether these high proportions reflect actual emissions or are attributable to incomplete reporting (or underestimates) by other EU Member States.

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

## *5.2 Improvements implemented*

The joint EMEP/EEA annual review of inventory data helps to improve the EU Member States' inventories. The review of data reported under the Air Convention is held jointly, along with the review of data reported by the EU Member States under the NEC Directive. Since 2009, there has been a centralised stage 3 review process under the Air Convention review process (EMEP CEIP, 2021b). Two teams of emission experts perform the reviews. EU Member States are encouraged to nominate reviewers for the EMEP roster of emission review experts; the details of the nomination process are available on the CEIP website. In 2020, the EU emission inventory report (1990-2018) under the UNECE Air Convention (EEA, 2017) was reviewed (UNECE/CEIP, 2020). The findings and their implementation are summarised in Table 5.3..

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

Table 5.3 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 5.3 EU stage 3 review results 2020 and improvements implemented**

| Review findings (2020) | | | |
|---|---|---|---|
| **Topic** | **Recommendation** | **Implemented** | **Comment** |
| *Transparency* | | | |
| Timeliness | Submit the IIR a few weeks before the deadline of 30 May, or, if that is not possible, provide the ERT with a draft IIR a few weeks earlier in those years when the EU is being reviewed, to facilitate the work of the ERT | Yes | The EU will provide the draft IIR before the reporting deadline in review years |
| Methodologies | Include in the IIR: summarised information about methodologies used by the MSs for emissions in the EU's key categories | No | 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 Member States. More information on emission trends will be included in future submissions |
| Methods | Include in the IIR: sub-sector level information on methods used to calculate emissions | No | Member States' inventories and IIRs are also part of the EU submission, and provide information on methods applied to subsectors. Including this information in the EU IIR is not feasible within the limited time-frame |
| Sources included | Include in the IIR: subsector level information on sources included in the inventory, especially in the industry sector | No | Member States' inventories and IIRs are also part of the EU submission, and provide information on sources to subsectors. Including this information in the EU IIR is not feasible within the limited time-frame |
| Gap filling procedure | Include in the IIR: information on sector level in the main text of the IIR about the gap filling procedure, or at least provide Annex D containing this information as a public part of the IIR | Yes | Annex D will be publicly available in future submissions |

| Review findings (2020) | | | |
|---|---|---|---|
| **Topic** | **Recommendation** | **Implemented** | **Comment** |
| EU-level inventory improvement programme | Include in the IIR: information on improvements and progress with improvement work | Ongoing | Table 5.3 (improvements implemented) and Table 5.4 (improvements planned) are provided in the EU IIR |
| Condensable Component | Include in the IIR: summary information at the sectoral level on whether the condensable component of PM is included or not in MSs' inventories | Yes | Information on condensable components of PM is included in the EU IIR |
| Include links | Include in the IIR: include links in the IIR for relevant websites where gridded data and LPS data are available | Yes | The links are provided within the relevant sections of this report |
| Sector-specific QA/QC, trends | Implement sector-specific QA/QC procedures to investigate the data in detail and find explanations for real but unusual sector trends, and work with the individual MSs to provide more details on the drivers behind the trends | Ongoing | Work on outliers and unusual trends has already been established; further cooperation with the MS is outside the scope of this report |
| *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 possibilities to use the Eurostat data or other data sources in cases where an MS does not include an existing source in its inventory although methods are available in the inventory guidebook | No | This task would mean considerable effort; such an analysis is not feasible within the limited time-frame |

| Review findings (2020) | | | |
|---|---|---|---|
| **Topic** | **Recommendation** | **Implemented** | **Comment** |
| 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 | Ongoing | The EU will work on the provision of activity data in categories, where possible |
| Uncertainty information from MSs | The ERT recommends that the Party include an uncertainty analysis in line with paragraph 31 of the reporting guidelines and work with the MSs to increase their reporting on uncertainties in their inventories and report on summarised information on uncertainties | No | To develop an uncertainty analysis, possibly on GAINS and IIASA data for the years 2005 and 2010, would exceed the workload of 2021 |
| Uncertainty analysis | The ERT also recommends that the Party develops a parallel uncertainty analysis independent of the 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 |
| *Comparability* | | | |
| Notation keys | Always use notation keys in line with the paragraph 12 of the reporting guidelines, and especially check that the use of the notation key 'NE' is in line with the reporting guidelines. Include information in the IIR to justify the uses of the notation keys; for 'IE' also document where the emissions are included | Ongoing | This needs further discussion within the framework of the Task Force on Emission Inventories and Projections (TFEIP) |
| Compare MS data | Further improve the completeness and comparability of the inventory in consultation with the MSs by ensuring the comparability of MS data before aggregation at the EU level | No | This task would mean considerable effort; such an analysis is not feasible within the limited time-frame |

| Review findings (2020) | | | |
|---|---|---|---|
| **Topic** | **Recommendation** | **Implemented** | **Comment** |
| *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 | Figure 1.5 and Figure 1.6 of the EU IIR provide this information. Because of increasing completeness of reporting by the MSs the percentage of gap-filled values within the EU inventory is steadily decreasing |

**Note:** GAINS, Greenhouse gas — Air pollution Interactions and Synergies (model); IE, included elsewhere; IIASA, International Institute for Applied Systems Analysis; LPS, large point source; MS, Member State; QA/QC, quality assurance and quality control.

### 5.2.2 Further improvements undertaken in 2021

- Section 1.5.5 on the reporting of the condensable components from $PM_{2.5}$ and $PM_{10}$ was further improved.
- Again, explanations on unusual trends, peaks and troughs were improved.
- Information on recalculations was improved.
- Quality control of data for $PM_{10}$, $PM_{2.5}$ and BC improved the gap-filled inventory.
- Further information on gridded data and large point source (LPS) data was provided.

### 5.2.3 Improvements at Member State level

Improvements at Member State level also automatically improve the EU inventory. For this reason, it is of interest to note which countries plan to improve their inventories. Table 5.4 provides an overview of these, but it is not easy to gain a systematic overview of the overall situation, as EU Member States provide varying amounts of information.

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

**Table 5.4 Overview of improvements planned at Member State level**

| Member State | Improvements planned |
|---|---|
| Austria | Required methodological changes and planned improvements are presented in the respective sectoral chapters (Appendix 5, Austria's IIR, p. 442) |
| Belgium | Belgium's IIR lists planned improvements in Sections 8.1-8.4 and in the corresponding sector analysis chapters (Appendix 5, Belgium's IIR, p. 195f.) |
| Bulgaria | Bulgaria's IIR lists the planned improvements on p. 116 (Appendix 5, Bulgaria's IIR).<br>Planned improvements:<br>• application of higher tier method for estimation of emissions<br>• incorporation of the ETS and the E-PRTR databases into the emission inventory in NFR sector 1 energy and NFR sector 2 industrial processes and other solvents and product use<br>• incorporation of data, provided by branch business associations<br>• improvement of transparency, completeness and consistency, including recalculations and time series and comparability of the national emission inventory |
| Croatia | Table ES6-1 in Croatia's IIR details planned improvements, including calculation methodologies, recalculations, updating of emission factors and collection of new data (Appendix 5, Croatia's IIR, p. 19) |
| Cyprus | Cyprus reports improvements in Chapter 16, 'Recalculations and Improvements' (Appendix 5, Cyprus's IIR, p. 149) |
| Czechia | Required methodological changes and planned improvements are presented in the respective sectoral chapters. Chapter 8 is about planned recalculations and improvements. For the next submission Czechia plans to update the 'Chapter of Gridded and LPS emission' (Appendix 5, Czechia's IIR) |

| | |
|---|---|
| Denmark | The relevant sectoral chapters describe planned sector-specific improvements; priority will be given to key categories with a significant impact on the national total emissions (Appendix 5, Denmark's IIR, p. 449) |
| Estonia | Estonia's IIR lists planned source-specific improvements. Checking POP emissions from the energy sector and waste incineration, correcting activity data and emission factors in energy industries and comprehensively checking activity data and emissions in the waste sector are priorities for future inventory improvements (Appendix 5, Estonia's IIR, p. 266) |
| Finland | Table 8 in Finland's IIR 'Part 1 General B' sets out the planned source-specific improvements (Appendix 5, Finland's IIR, p. 10) |
| France | Some planned and ongoing improvements are mentioned in the French IIR:<br>• conducting research to improve accuracy, especially for key categories<br>• establishing measures to determine uncertainties<br>• reducing the number of unconsidered or poorly determined pollutants — there are still plans to improve the estimation of emissions from heating boilers in the residential sector, which could strongly influence $NO_X$ emissions<br>• introducing further splits in energy consumption in the industry sector<br>• updating the methodology for estimating emissions from wood combustion in various sectors (excluding industry sector)<br>• improving existing methods to reduce $NH_3$ emissions<br>• strengthening all activities for improved QA/QC of the system, especially towards the implementation of procedures and tools, cooperation with experts from different fields and maintaining the ISO 9001 certification system (Appendix 5, France's IIR) |
| Germany | Germany is planning to prioritise improvements based on the results of the uncertainty analysis. Planned improvements for the source category stationary fuel combustion category include revision of 2004-2011 biogas and liquid biomass activities to improve the consistency of the time series, new measurements and revision of emission factors for POPs, HMs, $SO_2$, CO and $NH_3$. For the mobile combustion category, planned improvements include the implementation of new emissions, as well as the validation and revision of the approach for abrasive emissions from railways. Germany lists the revision of emission factors within refinery processes as a planned improvement in the fugitives category, collects activity data for titanium dioxide production and calculates these emissions in the category of industrial processes (Appendix 5, Germany's IIR) |
| Greece | Greece plans recalculations of and improvements to the inventory that are associated with key categories (Appendix 5, Greece's IIR, p. 144) |
| Hungary | Hungary plans to further improve the coordination with E-PRTR reporting and the reporting process and to execute a quantitative uncertainty analysis; another planned improvement is better QA/QC (Appendix 5, Hungary's IIR, p. 245) |
| Ireland | In the sectoral chapters of Ireland's IIR, the planned source-specific improvements have been compiled (Appendix 5, Ireland's IIR) |
| Italy | Italy's IIR lists certain areas for improvement. For the energy and industrial processes and product use sectors harmonisation of information, as well as detection of data discrepancies and potential errors, will be carried out. For the agriculture and waste sectors new information, emission factors and activity data |

| | |
|---|---|
| | will be implemented. Furthermore, for $PM_{2.5}$ and BC an update of emission factors is planned in line with the inventory guidebook (EMEP/EEA, 2019) (Appendix 5, Italy's IIR, p. 166) |
| Latvia | For the energy sector, planned improvements include developing tier 2 calculation methodology, and the industrial processes and product use sector plans to review data for the year 2019 to get more precise data; planned improvements in the agriculture sector include the continued quantification and preparation of detailed documentation of abatement strategies for $NH_3$ emissions so that they can be implemented in the inventory (Appendix 5, Latvia's IIR, p. 154) |
| Lithuania | Lithuania's inventory improvements are prioritised based on the following factors:<br>• stages 1, 2 and 3 inventory reviews, which can be accessed on the ceip.at website<br>• KCA categories, which are not estimated using the tier 2 approach yet<br>• other experts' reviews and suggestions<br>(Appendix 5, Lithuania's IIR, p. 19) |
| Luxembourg | The IIR lists planned improvements (Luxembourg's IIR, p. 481); they mainly concern updating the methodology, activity data and emission factors, as well as notation key correction, reallocation of emissions and new emission sources (Appendix 5, Luxembourg's IIR) |
| Malta | Malta's inventory team is working to identify missing data sources and methods for improvement by reviewing the activity data required for missing sources and tier 1 estimations (Appendix 5, Malta's IIR, p. 19) |
| Netherlands | The planned source-specific improvements are described in the sectoral chapters There's an overview of the planned improvements available in Appendix 3 of the Netherlands' IIR (Appendix 5, Netherlands' IIR p. 179) |
| Poland | The planned improvement programme focuses on the following: gathering additional activity data to verify the trends for 1990-2019 and developing the methodology further by applying higher tier methods for the estimation methodology (Appendix 5, Poland's IIR, p. 166) |
| Portugal | Each source-specific section presents a detailed explanation of the planned sectoral improvements (Appendix 5, Portugal's IIR) |
| Romania | Romania has the following planned improvements for the next submission:<br>• studying the possibility of obtaining activity data for historical time series for the calculation of pollutant emissions using the tier 2 methodology for the solvents sector<br>• getting an estimation for NFR category '3B4gii — broilers', a key source of NMVOC emissions in 2019, with the tier 2 approach;<br>• introducing and applying country-specific data for all pollutants as far as possible to obtain a real estimation of emissions for the agriculture sector<br>(Appendix 5, Romania's IIR, p. 291) |
| Slovakia | Slovakia plans to improve the methodology and completeness of reporting in the next submission of gridded data in May 2021, with a focus on the key source categories. Several sector-specific chapters also provide information on planned improvements (Appendix 5, Slovakia's IIR, p. 386) |
| Slovenia | Slovenia intends to examine in more detail the definitions in the standard classification of activities and then verify the correctness of all the data used. It also |

| | |
|---|---|
| | intends to find the relevant activity data for the more accurate estimate of NMVOC emissions from DIY/buildings (Appendix 5, Slovenia's IIR, p. 284) |
| Spain | The principal areas for improvement are:<br>• completing the implementation of the inventory guidebook (EMEP/EEA, 2019)<br>• harmonising the inventory with other registers (EU ETS, E-PRTR, etc.)<br>• continuing the development of the external audit initiated in October 2017 (see Chapter 1, Section 1.6.8, for details of the scheduled QA activities)<br>• continuing the development of the inventory quality management tool described in Chapter 1, Section 1.6<br>New modules and functionalities of the tool are expected to be included in future editions. Detailed information on planned improvements is included in Section 8.4 of the IIR and in in the sectoral chapters (Appendix 5, Spain's IIR, p. 427) |
| Sweden | There is no detailed information about planned improvements in Sweden's IIR (Appendix 5, Sweden's IIR) |

**Note:** DIY, do-it-yourself; E-PRTR, European Pollutant Release and Transfer Register; ETS, Emissions Trading System; ISO, International Organization for Standardization; QA, quality assurance; QC, quality control.

# Units, symbols, abbreviations and acronyms

| | |
|---|---|
| Air Convention | UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) |
| As | Arsenic |
| B(a)P | Benzo(a)pyrene |
| B(b)F | Benzo(b)fluoranthene |
| BC | Black carbon |
| B(k)F | Benzo(k)fluoranthene |
| Cd | Cadmium |
| CDR | Central Data Repository |
| CEIP | Centre on Emission Inventories and Projections |
| $CH_4$ | Methane |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| COPERT | Computer program to calculate emissions from road transport |
| Cr | Chromium |
| Cu | Copper |
| DG | Directorate-General |
| EEA | European Environment Agency |
| EEA-5 | Non-EU EEA member countries (Iceland, Liechtenstein, Norway, Switzerland and Turkey) |
| Eionet | European Environment Information and Observation Network |
| EMEP | European Monitoring and Evaluation Programme (cooperative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe) |
| EPER | European Pollutant Emission Register |
| E-PRTR | European Pollutant Release and Transfer Register |
| ERT | Expert review team |
| ETC | European topic centre (of the EEA) |
| ETC/ACM | European Topic Centre on Air Pollution and Climate Change Mitigation (of the EEA) |
| ETC/ATNI | European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution (of the EEA) |
| ETS | Emissions Trading System |
| EU | European Union |
| FGD | Flue gas desulphurisation |
| Gg | 1 gigagram = $10^9$ g = 1 kilotonne (kt) |
| GNFR | Gridding nomenclature for reporting/UNECE nomenclature for reporting of air |
| HCB | Hexachlorobenzene |
| HCE | Hexachloroethane |
| HFC | Hydrofluorocarbon |
| Hg | Mercury |
| HM | Heavy metal |
| IE | Included elsewhere |
| IIR | Informative inventory report |
| IP | Indeno(1,2,3-cd)pyrene |
| I-Teq | International toxic equivalent |
| KCA | Key category analysis |
| kg | 1 kilogram = $10^3$ g (gram) |
| LPS | Large point source |
| LRTAP | Long-range Transboundary Air Pollution; (UNECE) Convention on LRTAP or Air Convention |
| LTO | Landing/take-off |
| Mg | 1 megagram = $10^6$ g = 1 tonne (t) |
| MMR | Monitoring Mechanism Regulation |

| | |
|---|---|
| MSW | Municipal solid waste |
| MWe | Megawatt electric |
| NA | Not applicable |
| $N_2O$ | Nitrous oxide |
| NE | Not estimated |
| NEC Directive | National Emission reduction Commitments (Directive 2016/2284/EU) |
| NFR | Nomenclature for reporting/UNECE nomenclature for reporting of air pollutants |
| NFR14 | Current format for reporting of air pollutants (Nomenclature for reporting) |
| $NH_3$ | Ammonia |
| Ni | Nickel |
| NILU | Norwegian Institute for Air Research |
| NMVOC | Non-methane volatile organic compound |
| NO | Not occurring |
| $NO_2$ | Nitrogen dioxide |
| $NO_X$ | Nitrogen oxides |
| NR | Not relevant |
| $O_3$ | Ozone |
| PAH | Polycyclic aromatic hydrocarbon |
| Pb | Lead |
| PCB | Polychlorinated biphenyl |
| PCDD/F | Polychlorinated dibenzodioxin/dibenzofuran |
| PFC | Perfluorocarbon |
| PM | Particulate matter |
| $PM_{2.5}$ | Particulate matter with a diameter of 2.5 µm or less |
| $PM_{10}$ | Particulate matter with a diameter of 10 µm or less |
| POP | Persistent organic pollutant |
| QA | Quality assurance |
| QC | Quality control |
| SCR | Selective catalytic reduction |
| Se | Selenium |
| SNCR | Selective non-catalytic reduction |
| $SO_2$ | Sulphur dioxide |
| $SO_X$ | Sulphur oxides |
| t | 1 tonne (metric) = 1 megagram (Mg) = $10^6$ g |
| TERT | Technical Expert Review Team |
| TFEIP | Task Force on Emission Inventories and Projections |
| TREMOD | Transport Emission Model |
| TSP | Total suspended particulate |
| UNECE | United Nations Economic Commission for Europe |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VOC | Volatile organic compound |
| WM | With measures (projections) |
| WaM | With additional measures (projections) |
| Zn | Zinc |

**Key category source sector abbreviations referred to in the main text**

1A1a Public electricity and heat production
1A1b Petroleum refining
1A2a Stationary combustion in manufacturing industries and construction: Iron and steel
1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals
1A2c Stationary combustion in manufacturing industries and construction: Chemicals
1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals
1A2gvii Mobile combustion in manufacturing industries and construction
1A2gviii Stationary combustion in manufacturing industries and construction: Other
1A3bi Road transport: Passenger cars

1A3bii Road transport: Light duty vehicles
1A3biii Road transport: Heavy duty vehicles and buses
1A3biv Road transport: Mopeds and motorcycles
1A3bv Road transport: Gasoline evaporation
1A3bvi Road transport: Automobile tyre and brake wear
1A3bvii Road transport: Automobile road abrasion
1A3dii National navigation (shipping)
1A4ai Commercial/institutional: Stationary
1A4bi Residential: Stationary
1A4bii Residential: Household and gardening (mobile)
1A4ci Agriculture/forestry/fishing: Stationary
1A4cii Agriculture/forestry/fishing: Off-road vehicles and other machinery
1B2aiv Fugitive emissions oil: Refining/storage
1B2av Distribution of oil products
2A1 Cement production
2A3 Glass production
2A5a Quarrying and mining of minerals other than coal
2A5b Construction and demolition
2B10a Chemical industry: Other
2C1 Iron and steel production
2C3 Aluminium production
2C6 Zinc production
2C7a Copper production
2D3a Domestic solvent use including fungicides
2D3b Road paving with asphalt
2D3d Coating applications
2D3e Degreasing
2D3g Chemical products
2D3h Printing
2D3i Other solvent use
2G Other product use
2H2 Food and beverages industry
2K Consumption of POPs and heavy metals
2L Other production, consumption, storage, transportation or handling of bulk products
3B1a Manure management — Dairy cattle
3B1b Manure management — Non-dairy cattle
3B3 Manure management — Swine
3B4gi Manure management — Laying hens
3B4gii Manure management — Broilers
3Da1 Inorganic N-fertilisers (includes also urea application)
3Da2a Animal manure applied to soils
3Da3 Urine and dung deposited by grazing animals
3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products
3De Cultivated crops
3Df Use of pesticides
3F Field burning of agricultural residues
5C1bi Industrial waste incineration
5C1biii Clinical waste incineration
5C1bv Cremation
5C2 Open burning of waste
5E Other waste

**Country codes**

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

# References


CAMS, 2020, *Interim annual assessment report for 2018 — European air quality in 2019*, Copernicus Atmosphere Monitoring Service (https://policy.atmosphere.copernicus.eu/reports/CAMS71_IAR_2019_final.pdf) accessed 22 March 2021.

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

EEA, 2012, *Eionet connects — Sharing environmental information in Europe*, EEA Brochure No 1/2012, European Environment Agency (https://www.eea.europa.eu/publications/eionet-connects) accessed 26 May 2021.

EEA, 2014, *Effect of air pollution on European ecosystems*, EEA Technical Report No 11/2014, European Environment Agency (http://www.eea.europa.eu/publications/effects-of-air-pollution-on) accessed 26 May 2021.

EEA, 2017, European Union emission inventory report 1990-2015 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), EEA Report No 9/2017, European Environment Agency (https://www.eea.europa.eu/publications/annual-eu-emissions-inventory-report) accessed 22 March 2021.

EEA, 2019a, 'Emissions of primary $PM_{2.5}$ and $PM_{10}$ particulate matter (CSI 003)', European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/emissions-of-primary-particles-and-5) accessed 26 May 2021.

EEA, 2019b, 'Nitrogen oxides (NOx) emissions', European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/eea-32-nitrogen-oxides-nox-emissions-1/assessment.2010-08-19.0140149032-3) accessed 17 March 2019

EEA, 2020a, 'Air pollutant emissions data viewer (Gothenburg Protocol, Air Convention) 1990-2019', European Environment Agency (Air pollutant emissions data viewer (Gothenburg Protocol, LRTAP Convention) 1990-2019 — European Environment Agency (europa.eu)) accessed 17 March 2021.

EEA, 2020b, 'Emissions of the main air pollutants in Europe (CSI 040)', European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/main-anthropogenic-air-pollutant-emissions/assessment-6) accessed 17 March 2021.

EEA, 2020c, 'Heavy metal emissions (AIR 001)', European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/eea32-heavy-metal-hm-emissions-1/assessment-10) accessed 17 March 2021.

EEA, 2020d, *European Union emission inventory report 1990-2018 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)*, EEA Report No 5/2020, European Environment Agency (https://www.eea.europa.eu//publications/european-union-emission-inventory-report-1990-2018) accessed 22 March 2021.

EEA, forthcoming, *Reporting by EU Member States under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC*, EEA Briefing, European Environment Agency.

Eionet, 2021a, 'Eionet — European Environment Information and Observation Network', European Environment Information and Observation Network (http://eionet.europa.eu/) accessed 22 March 2021.

Eionet, 2021b, 'Eionet — Central Data Repository', European Environment Information and Observation Network (http://cdr.eionet.europa.eu/) accessed 22 March 2021.

EMEP CEIP, 2021a, 'Annexes to the reporting guidelines', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/reporting-instructions/annexes-to-the-2014-reporting-guidelines/) accessed 22 March 2021.

EMEP CEIP, 2021b, 'Introduction to the review process', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/review-of-emission-inventories/review-process) accessed 22 March 2021.

EMEP CEIP, 2021c, 'Review reports', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/review-of-emission-inventories/technical-review-reports) accessed 22 March 2021.

EMEP CEIP, 2021d, 'Review results', European Monitoring and Evaluation Programme Centre on Emission Inventories and Projections (https://www.ceip.at/review-of-emission-inventories/in-depth-review-of-ae-inventories) accessed 22 March 2021.

EMEP/EEA, 2019, *EMEP/EEA air pollutant emission inventory guidebook — 2019*, EEA Technical Report No 13/2019, European Environment Agency (https://www.eea.europa.eu/publications/emep-eea-guidebook-2019) accessed 15 March 2021.

EMEP/EEA, forthcoming, *Inventory review 2021: Review of emission data reported under the Air Convention stage 1 and 2 review*, Technical Report CEIP, European Monitoring and Evaluation Programme, Umweltbundesamt, Vienna, and European Environment Agency.

ETC/ACM, 2015, *Proposed unification of the gap filling procedures for the EU Air Convention emission inventory and the EMEP Air Convention emission inventory*, Technical Paper, European Topic Centre on Air Pollution and Climate Change Mitigation (available upon request).

EU, 1998, Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC (OJ L 350, 28.12.1998, p. 58) (http://eur-lex.europa.eu/resource.html?uri=cellar:9cdbfc9b-d814-4e9e-b05d-49dbb7c97ba1.0008.02/DOC_1&format=PDF) accessed 26 May 2021.

EU, 1999, Council Regulation (EC) No 933/1999 of 29 April 1999 amending Regulation (EEC) No 1210/90 on the establishment of the European Environment Agency and the European Environment Information and Observation Network (OJ L 117, 5.5.1999, p. 1-4) (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:117:0001:0004:EN:PDF) accessed 26 May 2021.

EU, 2013, Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC (OJ L 165/13, 18.6.2013, p. 13-40) (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&from=EN) accessed 26 May 2021.

EU, 2016a, Directive (EU) 2016/646 of 20 April 2016 amending Regulation (EC) No 692/2008 as regards emissions from light passenger and commercial vehicles (Euro 6) (OJ L 109, 26.4.2016, p. 22) (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0646&from=EN) accessed 26 May 2021.

EU, 2016b, Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (OJ L 344, 17.12.2016, p. 31) (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2016:344:FULL&from=EN) accessed 19 March 2020.

TFEIP, 20210, '21st 22nd Joint EIONET & UNECE Task Force on Emission Inventories & Projections Meeting — Bratislava', Task Force on Emission Inventories and Projections (https://www.tfeip-secretariat.org/web-conference-2021https://tfeip-secretariat.org/meetings-2/future-meetings/2020-spring-slovakia/) accessed 26 May 2021.

UNECE, 1979, The 1979 Geneva Convention on Long-range Transboundary Air Pollution, United Nations Economic Commission for Europe (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:21979A1113(01) https://www.unece.org/fileadmin/DAM/env/lrtap/full text/1979.CLRTAP.e.pdf) accessed 26 May 2021.

UNECE, 1984, The 1984 Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/emep_h1.html) accessed 26 May 2021.

UNECE, 1985, The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/sulf_h1.html) accessed 26 May 2021.

UNECE, 1988, The 1988 Sofia Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/nitr_h1.html) accessed 26 May 2021.

UNECE, 1991, The 1991 Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/vola_h1.html) accessed 26 May 2021.

UNECE, 1994, The 1994 Oslo Protocol on Further Reduction of Sulphur Emissions, United Nations Economic Commission for Europe (https://unece.org/environment-policyair/protocol-further-reduction-sulphur-emissions) accessed 26 May 2021.

UNECE, 1998a, The 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs), United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/pops_h1.html) accessed 26 May 2021.

UNECE, 1998b, The 1998 Aarhus Protocol on Heavy Metals, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/hm_h1.html) accessed 26 May 2021.

UNECE, 1999, The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, United Nations Economic Commission for Europe (http://www.unece.org/env/lrtap/multi_h1.html) accessed 26 May 2021.

UNECE, 2006, Decision 2006/2: Implementation Committee, its structure and functions and procedure for review, United Nations Economic Commission for Europe (ECE/EB.AIR/2006/2) (http://www.unece.org/fileadmin/DAM/env/documents/2006/eb/EB/EB Decisions/Decision 2006.2.pdf) accessed 26 May 2021.

UNECE, 2009, *Guidelines for reporting emission data under the Convention on Long-range Transboundary Air Pollution*, United Nations Economic Commission for Europe (ECE/EB.AIR/97) (https://undocs.org/en/ECE/EB.AIR/97)http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf) accessed 26 May 2021.

UNECE, 2012a, Decision 2012/3: Adjustments under the Gothenburg Protocol to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them, United Nations Economic Commission for Europe (ECE/EB.AIR/111) (http://www.unece.org/fileadmin/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1__ENG_DECISION_3.pdf) accessed 26 May 2021.

UNECE, 2012b, Decision 2012/2: Amendment of the text of and annexes II to IX to the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone and the addition of new annexes X and XI ( https://unece.org/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1__ENG_DECISION_2.pdf ) accessed 17 March 2020.

UNECE, 2012c, Decision 2012/12: Guidance for adjustments under the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them, United Nations Economic Commission for Europe (ECE/EB.AIR/113) (http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/Decision_2012_12.pdf) accessed 26 May 2021.

UNECE, 2014a, *Guidelines for reporting emissions and projections data under the Convention on Long-range Transboundary Air Pollution*, United Nations Economic Commission for Europe (ECE/EB.AIR/125) (https://www.ceip.at/fileadmin/inhalte/ceip/1_reporting_guidelines2014/ece.eb.air.125_advance_version_reporting_guidelines_2014.pdf) accessed 15 March 2021.

UNECE, 2014b, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2014/10) (https://webdab01.umweltbundesamt.at/Inventory_Review_2020/Adjustments/00%20General/ece.eb.air.ge.1.2014.10.edited.ae_formatting%20accepted.ko.pdfhttp://www.ceip.at/fileadmin/inhalte/emep/pdf/2015/ece.eb.air.ge.1.2014.10.edited.ae_formatting_accepted.ko.pdf) accessed 26 May 2021.

UNECE, 2015, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2015/10-ECE/EB.AIR/WG.1/2015/13) (https://unece.org/fileadmin/DAM/env/documents/2015/AIR/EMEP/ECE_EB.AIR_GE.1_2015_10_ECE_EB.AIR_WG.1_2015_13_ENG.pdfhttp://www.ceip.at/fileadmin/inhalte/emep/Adjustments/ece.eb.air.ge.1.2015.10_ece.eb.air.wg.1.2015.13.AV.pdf) accessed 26 May 2021.

UNECE, 2016, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2016/10-ECE/EB.AIR/WG.1/2016/18) https://unece.org/fileadmin/DAM/env/documents/2016/AIR/EMEP/ece.eb.air.ge.1.2016.10_ece.eb.air.wg.1.2016.18.pdf(http://www.ceip.at/fileadmin/inhalte/emep/pdf/2016/ECE_EB.AIR_GE.1_2016_10_E.pdf) accessed 26 May 2021.

UNECE, 2017, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2017/10-ECE/EB.AIR/WG.1/2017/20) (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2017/advance_ece_eb_air_ge_1_2017_10_ece_eb_air_wg_1_2017.pdfhttp://www.ceip.at/fileadmin/inhalte/emep/pdf/2017/Advance_ece_eb_air_ge_1_2017_10_ece_eb_air_wg_1_2017.pdf) accessed 26 May 2021.

UNECE, 2018, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2018/10-ECE/EB.AIR/GE.1/2018/21) (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2018/adj_ece.eb.air.ge.1.2018.10-

ece.eb.air.wg.1.2018.21_advance.pdfhttp://www.ceip.at/fileadmin/inhalte/emep/pdf/2018/ADJ_ece.eb.air.ge.1.2018.10-ece.eb.air.wg.1.2018.21_advance.pdf) accessed 26 May 2021.

UNECE, 2019, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2019/10−ECE/EB.AIR/WG.1/2019/22) (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2019/ece_eb.air_ge.1_2019_10-1909789e.pdf) accessed 26 May 2021

UNECE, 2020, *Review of adjustment applications — Report by the Centre on Emission Inventories and Projections*, United Nations Economic Commission for Europe (ECE/EB.AIR/GE.1/2020/10−ECE/EB.AIR/WG.1/2020/21) (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020/adj-status_ece_eb.air_ge.1_2020_10-2008939e.pdf) accessed 24 May 2021

UNECE/CEIP, 202017, *Report for the stage 3 in-depth review of emission inventories submitted under the UNECE Air Convention and EU National Emissions Ceilings Directive for: European Union*, CEIP/S3.RR/2020/EU 24/11/2020CEIP/S3.RR/2017/EU, United Nations (https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020_s3/eu_s3_rr_2020_final.pdfhttp://www.ceip.at/fileadmin/inhalte/emep/pdf/2017_s3/EU-Stage3ReviewReport-2017.pdf) accessed 24 May 2021.

# Appendix 1 Notation keys

Where there are methodological or data gaps in the inventories, information on these gaps should be presented in a transparent manner. Parties should clearly indicate the sources that they have not considered in their inventories — although the inventory guidebook (EMEP/EEA, 2019) includes them — and explain the reason for excluding them. Similarly, each Party should indicate if it has excluded part of its territory and explain why. In addition, each Party should use the notations presented below to fill the blanks in all the tables in the nomenclature for reporting (NFR) inventory. This approach helps in assessing how complete the emission data reports are. The notations are as follows ([18]).

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

**NE** **'**Not estimated' means emissions occur but have not been estimated or reported. Where an inventory uses 'NE', the Party should indicate why it could not estimate emissions.

**NA** 'Not applicable' means that a source exists but relevant emissions are considered never to occur.

**IE** 'Included elsewhere' is for emissions that are estimated and included in the inventory but are not presented separately for the relevant source. Where it uses 'IE', the Party should indicate where the inventory includes the emissions from the displaced source category and should give the reasons for deviating from the expected category.

**C** 'Confidential' is for aggregated emissions that the inventory includes elsewhere because reporting at a disaggregated level could lead to the disclosure of confidential information. Where an inventory uses 'C', it should make reference to the protocol provision that authorises it.

**NR** 'Not relevant' eases reporting where different protocols do not strictly require details of the emissions. According to Article III paragraph 9 in the emission-reporting guidelines, emission inventory reporting should cover all years from 1980 onwards if data are available. However, for example, some Parties do not need to report emissions of non-methane volatile organic compounds (NMVOCs) prior to 1988.

If a Party estimates emissions from country-specific sources, it should explicitly describe which source categories these are, as well as which methodologies, emission factors and activity data it has used to estimate them.

([18]) Further explanation and guidance concerning the use of these notation codes are in the European Monitoring and Evaluation Programme (EMEP) emission-reporting guidelines (UNECE, 2014a).

# Appendix 2 Air Convention emission-reporting programme for 2021

Emission data should be submitted to the EMEP Centre on Emission Inventories and Projections (CEIP) by **15 February 2021**. Informative inventory reports (IIRs) should reach the centre no later than **15 March 2021**. Table A2.1 summarises information in the revised emission-reporting guidelines (UNECE, 2014a).

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

| Description of contents | Pollutant(s) | Reporting years ([a]) |
|---|---|---|
| **Yearly:** minimum (and additional) | | |
| **A. National total emissions** | | |
| 1. Main pollutants | $NO_X$, NMVOCs, $SO_X$, $NH_3$, CO | 1990-2019 |
| 2. Particulate matter ([b]) | $PM_{2.5}$, $PM_{10}$ (TSPs, BC) | 2000-2019 |
| 3. Heavy metals ([b]) | Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn) | 1990-2019 |
| 4. Persistent organic pollutants ([b]) | PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP) | 1990-2019 |
| **B. Emissions by NFR source category** | | |
| 1. Main pollutants | $NO_X$, NMVOCs, $SO_X$, $NH_3$, CO | 1990-2019 |
| 2. Particulate matter ([b]) | $PM_{2.5}$, $PM_{10}$, (TSPs, BC) | 2000-2019 |
| 3. Heavy metals ([b]) | Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn) | 1990-2019 |
| 4. Persistent organic pollutants ([b]) | PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP) | 1990-2019 |
| **C. Activity data** | $NO_X$, NMVOCs, $SO_X$, $NH_3$, CO | 1990-2019 |
| **4-yearly:** minimum reporting (from 2017 to the next reporting year: 2021) | | |
| **D. Gridded data in the EMEP 0.1 ° × 0.1 ° long/lat grid — sector emissions (GNFR14)** ([c]) **and national totals (optional)** | $NO_X$, NMVOCs, $SO_X$, $NH_3$, CO, $PM_{2.5}$, $PM_{10}$, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB, PCBs | 2015 (1990, 1995, 2000, 2005, 2010 if not previously reported) |
| **E. Emissions from LPSs** | $NO_X$, NMVOCs, $SO_X$, $NH_3$, CO, $PM_{2.5}$, $PM_{10}$, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB, PCBs | 2015 (1990, 1995, 2000, 2005, 2010 if not previously reported) |
| **F. Projected emissions and projected activity data** | | |
| 1. National total emission projections | $NO_X$, NMVOCs, $SO_X$, $NH_3$, $PM_{2.5}$, BC | 2020, 2025, 2030, where available 2040 and 2050 |
| 2. Emission projections by NFR14 | $NO_X$, NMVOCs, $SO_X$, $NH_3$, $PM_{2.5}$, BC | 2020, 2025, 2030, where available 2040 and 2050 |
| 3. Projected activity data by NFR14 | | 2020, 2025, 2030, where available 2040 and 2050 |
| **5-yearly:** additional reporting for review and assessment purposes | | |
| VOC speciation/height distribution/temporal distribution | | Parties are encouraged to review the information used for modelling at https://www.ceip.at/webdab-emission-database/emissions-as-used-in-emep-models (accessed 15 March 2021) |
| 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 NFR14.

As, arsenic; BC, black carbon; B(a)P, benzo(a)pyrene; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cd, cadmium; CO, carbon monoxide; Cr, chromium; Cu, copper; GNFR14, gridding nomenclature for reporting; HCB, hexachlorobenzene; Hg, mercury; IP, indeno(1,2,3-cd)pyrene; NMVOC, non-methane volatile organic compound; NOX, nitrogen oxides; $NH_3$, ammonia; Ni, nickel; LPSs, large point sources; Pb, lead; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; PCDD/Fs, polychlorinated dibenzodioxins/dibenzofurans; $PM_{2.5}$, particulate matter with a diameter of 2.5 µm or less; $PM_{10}$, particulate matter with a diameter of 10 µm or less; Se, selenium; $SO_X$, sulphur oxides; TSPs, total suspended particulates; VOC, volatile organic compound; Zn, zinc.

### Reporting format

Each Party should use the reporting format in Annex IV of the reporting guidelines (UNECE, 2014a) for its annual submissions. It should submit the information to the CEIP formally, preferably in electronic format, and notify the United Nations Economic Commission for Europe (UNECE) secretariat. The reporting format, including the nomenclature for reporting (NFR), is standardised for reporting estimates of emissions. It includes activity data, projected activity data, projected emissions and other relevant information. The reporting format aims to facilitate electronic submissions by making it easier to process emission information and prepare useful documentation about technical analysis and synthesis.

The new 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 European Union: country groupings

| |
|---|
| **EU-15** refers to the first 15 Member States of the EU: note that the United Kingdom is expected to provide its data directly. |
| **EU-28** refers to the first 28 Member States of the EU: note that the United Kingdom is expected to provide its data directly. |

# Appendix 3 Status of reporting and timeliness

**Table A3.1 EU Member State inventory submissions 2021: date received by the EEA, years covered, and information provided (as of 20 May 2021)**

| Country | Reporting date and format | | | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 15.02.2021 | | | | 29.04.2021 | 29.04.2021 | | 15.03.2021<br>29.04.2021 | 2019-1 | |
| Belgium | 15.02.2021 | 08.03.2021 | 15.02.2021 | 15.03.2021<br>26.03.2021 | 30.04.2021 | 30.04.2021 | | 15.03.2021<br>30.04.2021 | 2019-1 | |
| Bulgaria | 12.02.2021 | 15.03.2021<br>21.04.2021 | | 30.03.2021 | 01.05.2021<br>10.05.2021 | 21.04.2021 | | 15.03.2021<br>21.04.2021 | 2019-1 | |
| Croatia | 10.02.2021 | | | 12.03.2021 | 03.05.2021 | 28.04.2021<br>29.04.2021 | | 12.03.2021 | 2019-1 | |
| Cyprus | 15.02.2021 | 12.03.2021 | | 12.03.2021 | 29.04.2021 | 29.04.2021 | | 14.03.2021 | 2019-1 | |
| Czechia | 15.02.2021 | 10.03.2021<br>29.03.2021 | 21.01.2021<br>18.02.2021 | 15.03.2021 | 28.04.2021 | 30.04.2021 | | 15.03.2021<br>03.05.2021 | 2019-1 | |
| Denmark | 15.02.2021 | | 15.02.2021 | 15.03.2021 | 28.04.2021 | 28.04.2021 | | 15.03.2021 | 2014-1 | |
| Estonia | 09.02.2021 | 08.03.2021 | | 09.03.2021 | 03.05.2021 | 27.04.2021 | | 15.03.2021<br>03.05.2021 | 2019-1 | |
| Finland | 15.02.2021 | | 15.02.2021<br>14.03.2021 | 14.03.2021 | 30.04.2021<br>01.05.2021 | 29.04.2021 | | 14.03.2021 | 2019-1 | |
| France | 15.02.2021 | 07.04.2021 | 15.02.2021<br>08.04.2021 | | 30.04.2021 | 30.04.2021 | | 12.03.2021<br>30.04.2021 | 2019-1 | |
| Germany | 09.02.2021 | | 12.02.2021 | 15.04.2021 | 26.04.2021 | 28.04.2021 | | 15.03.2021 | 2019-1 | IR only online |
| Greece | 15.02.2021 | | | 16.03.2021 | 10.05.2021 | 10.05.2021 | | 16.03.2021 | 2019-1 | |
| Hungary | 15.02.2021 | 15.03.2021 | 23.02.2021 | 21.04.2021 | | 18.05.2021 | | 15.03.2021 | 2019-1 | |
| Ireland | 15.02.2021 | | | | | | | 15.03.2021 | 2019-1 | |
| Italy | 16.02.2021 | 15.03.2021 | | 15.03.2021 | | | | 17.03.2021 | 2019-1 | |
| Latvia | 15.02.2021 | 15.03.2021 | | 12.04.2021 | 30.04.2021 | 30.04.2021 | | 15.03.2021<br>12.04.2021 | 2019-1 | |
| Lithuania | 13.02.2021 | | | 14.03.2021 | | | | 16.03.2021 | 2019-1 | add file: 1A4bi Residential PM Condensable Lithuania 1990-2019 |
| Luxembourg | 16.02.2021 | 15.03.2021 | 16.02.2021<br>16.03.2021 | 15.03.2021 | 03.05.2021 | 03.05.2021 | | 15.03.2021 | 2019-1 | |
| Malta | 15.02.2021 | | | 15.03.2021 | | 10.05.2021 | | 16.03.2021 | 2019-1 | |
| Netherlands | 14.02.2021 | 15.03.2021 | 14.02.2021 | 15.03.2021 | 20.05.2021 | 19.05.2021 | | 15.03.2021<br>15.04.2021 | 2019-1 | |
| Poland | 15.02.2021 | | | 10.03.2021 | 30.04.2021 | 30.04.2021 | | 10.03.2021 | 2019-1 | |
| Portugal | 11.02.2021 | 15.03.2021 | | | 30.04.2021 | 30.04.2021 | | 15.03.2021<br>30.04.2021 | 2019-1 | |
| Romania | 12.02.2021 | 12.03.2021 | | | | | | 12.03.2021 | 2019-1 | |
| Slovakia | 15.02.2021 | 15.03.2021 | | 15.03.2021 | 30.04.2021 | 10.05.2021 | | 15.03.2021<br>15.04.2021 | 2019-1 | |
| Slovenia | 12.02.2021 | | | 11.03.2021 | 29.04.2021 | 14.04.2021 | | 14.03.2021 | 2019-1 | |
| Spain | 29.01.2021 | 17.03.2021 | 29.01.2021 | | 28.04.2021 | 30.04.2021 | | 12.03.2021 | 2019-1 | |
| Sweden | 12.02.2021 | | | 15.03.2021 | 27.04.2021<br>30.04.2021 | 12.04.2021 | | 02.03.2021 | 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.
The United Kingdom left the EU on 31 January 2020. Data are not included here, as these are expected to be provided directly by the United Kingdom.

## Table A3.2 EU Member State submissions of 2019 data (as of 20 May 2021)

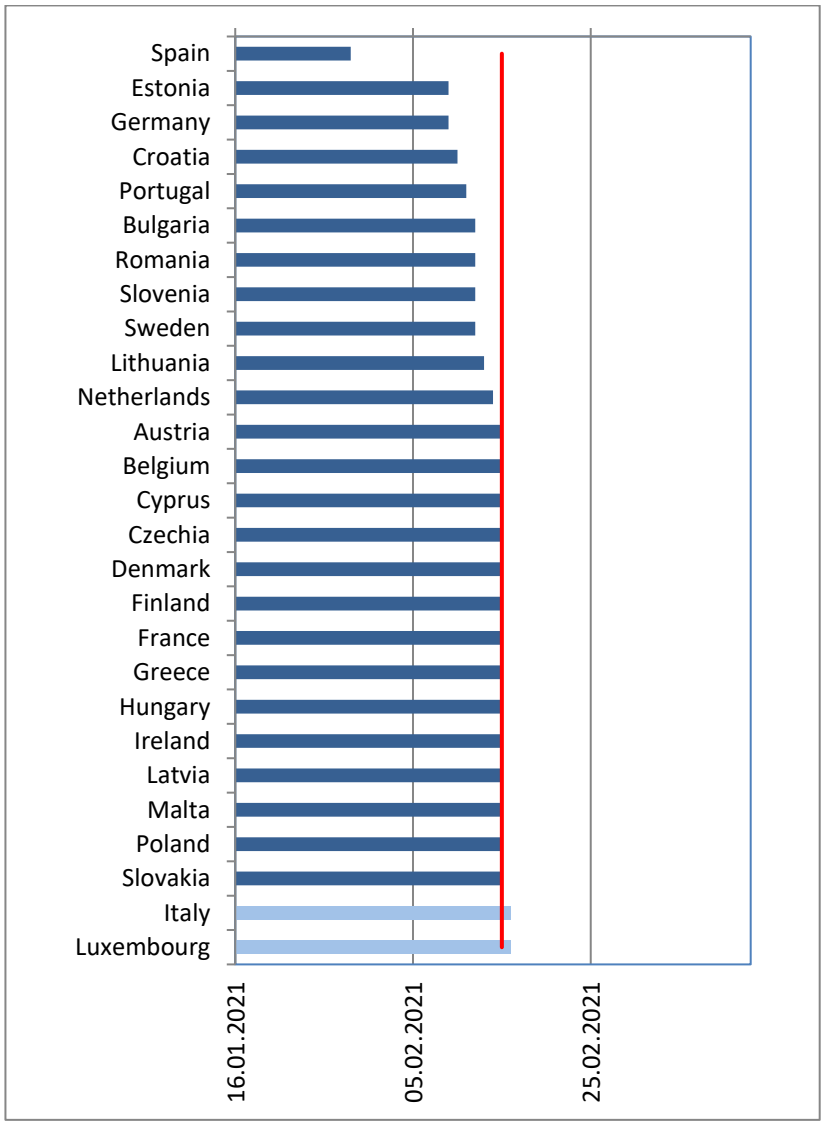
| Country | Years reported | | | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| Member State | $SO_2$, $NO_X$, CO, $NH_3$, NMVOC | Cd,Hg, Pb | additional HM | $PM_{2.5}$, $PM_{10}$ | TSP | BC | POPs: PAH DIOX HCB PCB | Additional PAHs: B(a)P, B(b)F, B(k)F, IP | Activity data | |
| Austria | 1990-2019 | 1990-2019 | | 1990, 1995, 2000-2019 | 1990, 1995, 2000-2019 | | 1990-2019 | 1990-2019 | 1990-2019 | |
| Belgium | 1990-2019 | 1990-2019 | 1990-2019 | 2000-2019 | 2000-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Bulgaria | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Croatia | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Cyprus | 1990-2019 | 1990-2019 | 1990-2019 | 2000-2019 | 2000-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Czechia | 1990-2019 | 1990-2019 | 1990-2019 | 1995-2019 | 1990-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Denmark | 1985-2019* | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1980-2019 | *SOx from 1980 |
| Estonia | 1990-2019 | 1990-2019 | 1990-2019 | 2000-2019 | 1990-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Finland | 1980-2019* | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1980-2019 | *NMVOC from 1987, CO from 1990 |
| France | 1980-2019* | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1980-2019 | *NMVOC from 1988 |
| Germany | 1990-2019 | 1990-2019 | 1990-2019 | 1995-2019 | 1990-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Greece | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Hungary | 1990-2019 | 1990-2019 | 1990-2019 | 2000-2019 | 2000-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Ireland | 1990-2019* | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | *SOx, NOx, NMVOC also 1987 |
| Italy | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Latvia | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Lithuania | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Luxembourg | 1990-2019 | 1990-2019 | | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Malta | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Netherlands | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Poland | 1990-2019 | 1990-2019 | 1990-2019* | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | *No Se reported |
| Portugal | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Romania | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Slovakia | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Slovenia | 1980-2019* | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | *NMVOC from 1990, NH3 from 1985 |
| Spain | 1990-2019 | 1990-2019 | 1990-2019 | 2000-2019 | 2000-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |
| Sweden | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 1990-2019 | 2000-2019 | 1990-2019 | 1990-2019 | 1990-2019 | |

**Notes:** Reporting of additional HMs is not mandatory.

EU Member States do not have to report TSPs if they report PM emissions.

BC, black carbon; B(a)P, benzo(a)pyrene; B(b)F, benzo(b)fluoranthene; B(k)F, benzo(k)fluoranthene; Cd, cadmium; CO, carbon monoxide; DIOX, Polychlorinated dibenzodioxin/dibenzofuran; HCB, hexachlorobenzene; Hg, mercury; HM, heavy metal; IP, indeno(1,2,3-cd)pyrene; $NH_3$, ammonia; NMVOC, non-methane volatile organic compound; $NO_X$, nitrogen oxides; PAH, polycyclic aromatic hydrocarbon; Pb, lead; PCB, polychlorinated biphenyl; $PM_{2.5}$, particulate matter with a diameter of 2.5 µm or less; $PM_{10}$, particulate matter with a diameter of 10 µm or less; POP, persistent organic pollutant; Se, selenium; $SO_2$, sulphur dioxide; TSP, total suspended particulate.

**Figure A3.1 Dates of first data submissions received from EU Member States (as of 16 February 2021)**



# Appendix 4 Conversion chart for aggregated sector groups

To enable the presentation of sectoral emission trends (Chapter 3), individual nomenclature for reporting (NFR) source categories for the EU-28 inventory were aggregated into the following main sector groups:

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

Table A4.1 provides a conversion chart showing which of the individual NFR source categories appeared in each of the aggregated sector groups.

## Table A4.1 Conversion chart for aggregated sector groups

| NFR code | Full name | EEA aggregated sector name |
|---|---|---|
| 1A1a | Public electricity and heat production | Energy production and distribution |
| 1A1b | Petroleum refining | Energy production and distribution |
| 1A1c | Manufacture of solid fuels and other energy industries | Energy production and distribution |
| 1A2a | Stationary combustion in manufacturing industries and construction: Iron and steel | Energy use in industry |
| 1A2b | Stationary combustion in manufacturing industries and construction: Non-ferrous metals | Energy use in industry |
| 1A2c | Stationary combustion in manufacturing industries and construction: Chemicals | Energy use in industry |
| 1A2d | Stationary combustion in manufacturing industries and construction: Pulp, paper and print | Energy use in industry |
| 1A2e | Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco | Energy use in industry |
| 1A2f | Stationary combustion in manufacturing industries and construction: Non-metallic minerals | Energy use in industry |
| 1A2gvii | Mobile combustion in manufacturing industries and construction | Energy use in industry |
| 1A2gviii | Stationary combustion in manufacturing industries and construction: Other | Energy use in industry |
| 1A3ai(i) | International aviation LTO (civil) | Non-road transport |
| 1A3aii(i) | Domestic aviation LTO (civil) | Non-road transport |
| 1A3bi | Road transport: Passenger cars | Road transport |
| 1A3bii | Road transport: Light duty vehicles | Road transport |
| 1A3biii | Road transport: Heavy duty vehicles and buses | Road transport |
| 1A3biv | Road transport: Mopeds and motorcycles | Road transport |
| 1A3bv | Road transport: Gasoline evaporation | Road transport |
| 1A3bvi | Road transport: Automobile tyre and brake wear | Road transport |
| 1A3bvii | Road transport: Automobile road abrasion | Road transport |
| 1A3c | Railways | Non-road transport |
| 1A3di(ii) | International inland waterways | Non-road transport |
| 1A3dii | National navigation (shipping) | Non-road transport |
| 1A3ei | Pipeline transport | Non-road transport |
| 1A3eii | Other | Non-road transport |
| 1A4ai | Commercial/institutional: Stationary | Commercial, institutional and households |
| 1A4aii | Commercial/institutional: Mobile | Commercial, institutional and households |
| 1A4bi | Residential: Stationary | Commercial, institutional and households |
| 1A4bii | Residential: Household and gardening (mobile) | Commercial, institutional and households |
| 1A4ci | Agriculture/forestry/fishing: Stationary | Commercial, institutional and households |
| 1A4cii | Agriculture/forestry/fishing: Off-road vehicles and other machinery | Commercial, institutional and households |
| 1A4ciii | Agriculture/forestry/fishing: National fishing | Non-road transport |
| 1A5a | Other stationary (including military) | Commercial, institutional and households |
| 1A5b | Other, mobile (including military, land-based and recreational boats) | Commercial, institutional and households |
| 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 |

| NFR code | Full name | EEA aggregated sector name |
|---|---|---|
| 2A6 | Other mineral products | Industrial processes and product use |
| 2B1 | Ammonia production | Industrial processes and product use |
| 2B2 | Nitric acid production | Industrial processes and product use |
| 2B3 | Adipic acid production | Industrial processes and product use |
| 2B5 | Carbide production | Industrial processes and product use |
| 2B6 | Titanium dioxide production | Industrial processes and product use |
| 2B7 | Soda ash production | Industrial processes and product use |
| 2B10a | Chemical industry: Other | Industrial processes and product use |
| 2B10b | Storage, handling and transport of chemical products | Industrial processes and product use |
| 2C1 | Iron and steel production | Industrial processes and product use |
| 2C2 | Ferroalloys production | Industrial processes and product use |
| 2C3 | Aluminium production | Industrial processes and product use |
| 2C4 | Magnesium production | Industrial processes and product use |
| 2C5 | Lead production | Industrial processes and product use |
| 2C6 | Zinc production | Industrial processes and product use |
| 2C7a | Copper production | Industrial processes and product use |
| 2C7b | Nickel production | Industrial processes and product use |
| 2C7c | Other metal production | Industrial processes and product use |
| 2C7d | Storage, handling and transport of metal products | Industrial processes and product use |
| 2D3a | Domestic solvent use including fungicides | Industrial processes and product use |
| 2D3b | Road paving with asphalt | Industrial processes and product use |
| 2D3c | Asphalt roofing | Industrial processes and product use |
| 2D3d | Coating applications | Industrial processes and product use |
| 2D3e | Degreasing | Industrial processes and product use |
| 2D3f | Dry cleaning | Industrial processes and product use |
| 2D3g | Chemical products | Industrial processes and product use |
| 2D3h | Printing | Industrial processes and product use |
| 2D3i | Other solvent use | Industrial processes and product use |
| 2G | Other product use | Industrial processes and product use |
| 2H1 | Pulp and paper industry | Industrial processes and product use |
| 2H2 | Food and beverages industry | Industrial processes and product use |
| 2H3 | Other industrial processes | Industrial processes and product use |
| 2I | Wood processing | Industrial processes and product use |
| 2J | Production of POPs | Industrial processes and product use |
| 2K | Consumption of POPs and heavy metals (e.g. electrical and scientific equipment) | Industrial processes and product use |
| 2L | Other production, consumption, storage, transportation or handling of bulk products | Industrial processes and product use |
| 3B1a | Manure management — Dairy cattle | Agriculture |
| 3B1b | Manure management — Non-dairy cattle | Agriculture |
| 3B2 | Manure management — Sheep | Agriculture |
| 3B3 | Manure management — Swine | Agriculture |
| 3B4a | Manure management — Buffalo | Agriculture |
| 3B4d | Manure management — Goats | Agriculture |
| 3B4e | Manure management — Horses | Agriculture |
| 3B4f | Manure management — Mules and asses | Agriculture |
| 3B4gi | Manure management — Laying hens | Agriculture |
| 3B4gii | Manure management — Broilers | Agriculture |
| 3B4giii | Manure management — Turkeys | Agriculture |
| 3B4giv | Manure management — Other poultry | Agriculture |
| 3B4h | Manure management — Other animals | Agriculture |
| 3Da1 | Inorganic N-fertilisers (includes also urea application) | Agriculture |
| 3Da2a | Animal manure applied to soils | Agriculture |
| 3Da2b | Sewage sludge applied to soils | Agriculture |

| NFR code | Full name | EEA aggregated sector name |
|---|---|---|
| 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; POPs, persistent organic pollutants.

# Appendix 5 EU Member State informative inventory reports (IIRs)

**Table A5.1 List of submitted IIRs including source and date of submission (as of 20 May 2021)**

| Country code | Title of IIR | Source | Date of submission |
|---|---|---|---|
| AT | Austria's Informative Inventory Report (IIR) 2021 Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants | https://cdr.eionet.europa.eu/at/un/clrtap/iir/envyilxfw/AT_IIR2021_REP0762.pdf/manage_document | 29.04.2021 |
| BE | Informative Inventory Report about Belgium's air emissions submitted under the Convention on Long-range Transboundary Air Pollution LRTAP and the National Emission Ceilings Directive NECD. March 2021 | https://cdr.eionet.europa.eu/be/un/clrtap/iir/envyen2q | 15.03.2021 |
| BG | Bulgaria's Informative Inventory Report 2021 (IIR). Submission under the UNECE Convention on Long-Range Transboundary Air Pollution | https://cdr.eionet.europa.eu/bg/un/clrtap/iir/envyickuq/BG_IIR_2021-resubmission.pdf/manage_document | 21.04.2021 |
| CY | Cyprus Informative Inventory Report for 2019 | https://cdr.eionet.europa.eu/cy/un/clrtap/iir/envyeslga | 14.03.2021 |
| CZ | Czech Informative Inventory Report 2021 Submission under the UNECE Convention on Long-range Transboundary Air Pollution | https://cdr.eionet.europa.eu/cz/un/clrtap/iir/envyiax0g/CZ_IIR_2021_v2.pdf/manage_document | 03.05.2021 |
| DE | German Informative Inventory Report 2021 | https://thg.thuenen.de/iir-de/start | 15.03.2021 |
| DK | Annual Danish Informative Inventory Report to UNECE. Emission inventories from the base year of the protocols to year 2019 | https://cdr.eionet.europa.eu/dk/un/clrtap/iir/envye3kua | 15.03.2021 |
| EE | Estonian Informative Inventory Report 1990-2019. Submitted under the Convention on Long-Range Transboundary Air Pollution. Tallinn 2021 | https://cdr.eionet.europa.eu/ee/un/clrtap/iir/envyjae8a/Estonian_Informative_Inventory_Report_2021_ | 03.05.2021 |
| EL | Greece's Informative Inventory Report (IIR) 2021 | https://cdr.eionet.europa.eu/gr/un/clrtap/iir/envyfcvaq | 16.03.2021 |
| ES | Spain — March 2021. Edition 2021 (1990-2019). Informative Inventory Report. Submission to the Secretariat of the Geneva Convention and EMEP Programme | https://cdr.eionet.europa.eu/es/un/clrtap/iir/envye_zqq | 12.03.2021 |
| FI | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part I — General A. March 2020 Draft | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_1A_General_.pdf/manage_document | 14.03.2021 |
| | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part 1B — General. March 2021 | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_1B_General_.pdf/manage_document | 14.03.2021 |

| | | | |
|---|---|---|---|
| | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part 2 — Energy. March 2021 | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_2_Energy.pdf/manage_document | 14.03.2021 |
| | Finland's Informative Inventory Report 2021. under the UNECE CLRTAP and the EU NECD. Air Pollutant Emissions 1980-2019. Part 3 — Transport. March 2021 | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_3_Transport.pdf/manage_document | 14.03.2021 |
| | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part 4 — IPPU. March 2021 | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_4_IPPU.pdf/manage_document | 14.03.2021 |
| | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part 5 — Agriculture | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_5_Agriculture.pdf/manage_document | 14.03.2021 |
| | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part 6 — Waste | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_6_Waste.pdf/manage_document | 14.03.2021 |
| | Finland's Informative Inventory Report 2021. Air Pollutant Emissions 1980-2019 under the UNECE CLRTAP and the EU NECD. Part 7 — Annexes. March 2021 | https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envyeuqnq/FI_IIR_2021_Part_7_Annexes.pdf/manage_document | 14.03.2021 |
| 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 2021 | https://cdr.eionet.europa.eu/fr/un/clrtap/iir/envyd9pqw | 12.03.2021 |
| HR | Republic of Croatia 2021 Informative Inventory Report (1990-2019). Submission under the Convention on Long-range Transboundary Air Pollution (CLRTAP) and National Emission Ceilings Directive (NECD 2016/2284/EU) | https://cdr.eionet.europa.eu/hr/un/clrtap/iir/envyetovw | 12.03.2021 |
| HU | Informative Inventory Report — Hungary 2019 | https://cdr.eionet.europa.eu/hu/un/clrtap/iir/envye_wa | 15.03.2021 |
| IE | Ireland Informative Inventory Report 2021. Air Pollutant Emissions in Ireland 1990-2019 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/envxmuzha | 15.03.2021 |
| IT | Italian Emission Inventory 1990-2019 — Informative Inventory Report 2021 | https://cdr.eionet.europa.eu/it/un/clrtap/iir/envyfi3eg | 17.03.2021 |

| | | | |
|---|---|---|---|
| LT | Lithuanian Pollutants Emission Inventory for period 1990-2019 | https://cdr.eionet.europa.eu/lt/un/clrtap/iir/envye5_w | 16. 03.2021 |
| LU | Luxembourg's Informative Inventory Report 1990-2019. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution | https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envyivifw/IIR_2021_LV_30042021.pdf/manage_document | 30.04.2021 |
| LV | 2021. Latvia's Informative Inventory Report. Submitted under the Convention on Long-Range Transboundary Air Pollution | https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envye_sya | 15.03.2021 |
| MT | Informative Inventory Report for Malta 2019 | https://cdr.eionet.europa.eu/mt/un/clrtap/iir/envyfbh6w | 16.03.2021 |
| NL | Informative Inventory Report 2021. Emissions of transboundary air pollutants in the Netherlands 1990-2019 | https://cdr.eionet.europa.eu/nl/un/clrtap/iir/envyhg35q/NL_Informative_Inventory_Report_2021.pdf/manage_document | 15.04.2021 |
| PL | Poland's Informative Inventory Report 2021<br>Submission under the UNECE CLRTAP and NEC Directive. Air pollutant emissions in Poland 1990–2019. Warsaw 2021 | https://cdr.eionet.europa.eu/pl/un/clrtap/iir/envyei65g | 10.03.2021 |
| PT | National Informative Inventory Report 2021 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/envyiwmhq/IIR2021_April30.pdf | 30.04.2021 |
| RO | Romania's Informative Inventory Report 2021. Submission under the UNECE Convention on Long Range Transboundary Air Pollution | https://cdr.eionet.europa.eu/ro/un/clrtap/iir/envyetytw | 12.03.2021 |
| SE | Informative Inventory Report Sweden 2021. Submitted under the Convention on Long-range Transboundary Air Pollution | https://cdr.eionet.europa.eu/se/un/clrtap/iir/envyd4oia | 02.03.2021 |
| SI | Slovenian Informative Inventory Report 2021 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/envye43lq | 14.03.2021 |
| SK | Slovak Republic. Informative Inventory Report 2021. Submission under the Air Convention and under the NEC Directive | https://cdr.eionet.europa.eu/sk/un/clrtap/iir/envyhhojg/SK_IIR_2021_v2.pdf/manage_documenthttps | 15.04.2021 |

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

European Environment Agency

**European Union emission inventory report 1990-2019**
under the UNECE Convention on Long-range Transboundary Air Pollution
(Air Convention)

2021 — 156 pp. — 21 x 29.7 cm

978-92-9480-375-7
doi:10.2800/701303

TH-AL-21-005-EN-N
doi:10.2800/701303

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

Publications Office
of the European Union