

# **Methodologies applied to the technical review of emission data 2024**

Technical report CEIP 05/2024

**Project management**

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## EXECUTIVE SUMMARY

The main guidance documents for reporting air emission inventories under the Air Convention (CLRTAP, Convention on long range transboundary air pollution) are the *UNECE Reporting Guidelines* (UNECE, 2025) and the *EMEP/EEA Inventory Guidebook* (EMEP/EEA, 2023).

### Reporting requirements

Parties are formally only required to report on the substances and for the years set forth in the Air Convention and the protocols and their amendments that they have ratified and that have entered into force for them (UNECE, 2025). Parties that have obligations to report emission inventories under Protocols that they have ratified and that are in force shall annually report emission inventories (UNECE, 2025). Annual reporting shall include national emissions and should include activity data for the sectors identified in Annex I to these Guidelines for the years indicated (UNECE, 2025). Parties are strongly encouraged to submit the Informative Inventory Report (IIR). The IIR should be submitted annually (UNECE, 2025). Parties to the Gothenburg Protocol within the geographical scope of EMEP shall regularly update their projections and report every four years from 2015 onward their updated projections, for the years 2025 and 2030 and, where available, also for 2040 and 2050. Parties to the other Protocols are encouraged to regularly update their projections and report every four years from 2015 (UNECE, 2025). Every four years from 2017 onward, Parties shall report for the year x-2 updated aggregated sectoral (GNFR) gridded emissions and LPS emissions (UNECE, 2025).

### The review process

Each year the air pollutant emission inventories are checked in a technical review that is performed in accordance with the review guidelines (UNECE, 2018) - hereafter referred to as the 'Review Guidelines 2018'. The aim of the review is to improve the quality of emission data and associated information reported to the Air Convention. The present report documents the review methods. Details on the review results can be found in the annual CEIP Inventory Review reports<sup>1</sup>.

The review process of the emission inventories is carried out in three stages. At each stage, national experts have the opportunity to clarify issues or provide additional information.

**The stage 1 review** (initial review) consists of automated tests which assess the timeliness, completeness and format of the submitted national inventories. Sectoral data as well as national total emissions are checked within these tests.

**The stage 2 review** (extended review) assesses the recalculations, time series consistency, key category analysis, inventory comparison and comparability of the submitted national inventories. Recalculations are checked to identify differences between national total emissions reported in the current and the previous submission. Key category analyses are made to identify the most important sources for each country. Inventories reported under the Air Convention and UNFCCC are compared. Inconsistencies of time series of sectoral data and national totals are highlighted.

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<sup>1</sup> <https://www.ceip.at/status-of-reporting-and-review-results>

**The stage 3 review** (in-depth review) is an in depth review of selected inventories. The aim is to check if inventories are consistent with EMEP/EEA inventory Guidebook, complete, consistent over time, properly documented, comparable between the countries and accurate. Annually, approximately ten Parties are reviewed by expert review teams<sup>2</sup> set-up by CEIP based on nominations by countries<sup>3</sup>. Alternatively, an ad hoc review may be performed to focus on specific aspects of inventory data quality or science (UNECE, 2018).

**The review of gridded data and LPS** information comprise a few standard tests. It is checked if sectoral gridded data or point sources for all pollutants/years are reported as requested by the UNECE Reporting Guidelines (UNECE, 2025). Within the tests, the position of the cells/LPS is checked. The grid-sum data on sectoral level (GNFR) is compared with sectoral emissions (aggregated from NFR to GNFR sector level) reported in the NFR table.

The officially reported emission data, gap-filled and gridded emission data are made available via the CEIP database<sup>4</sup>.

Review findings are annually published at the CEIP website and in the Inventory Review reports<sup>5</sup>.

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<sup>2</sup> <https://www.ceip.at/review-of-emission-inventories/in-depth-review-of-ae-inventories>

<sup>3</sup> <https://www.ceip.at/review-of-emission-inventories/review-process>

<sup>4</sup> <https://www.ceip.at/webdab-emission-database>

<sup>5</sup> <https://www.ceip.at/status-of-reporting-and-review-results>

## 1 INTRODUCTION

The review process of emission data has been developed on the basis of feedback from Parties and from the Task Force on Emission Inventories and Projections (TFEIP) and is seen by Parties as efficient tool to improve their national emission inventories.

**The technical review of national inventories** checks and assesses Parties' data submissions in accordance the 'Review Guidelines 2018' (UNECE, 2018)<sup>6</sup> in order to improve the quality of emission data and associated information reported to the Convention. In recent years, CEIP's regular inventory reviews have facilitated the identification of a number of inventory issues and contributed to inventory improvement.

### 1.1 Reporting obligations – Scope

#### 1.1.1 Substances and frequency of reporting

Parties are formally only required to report on the substances and for the years set forth in the Convention and the Protocols and their amendments that they have ratified and that have entered into force for them (UNECE, 2025).

Parties that have obligations to report emission inventories under protocols that they have ratified and that are in force shall annually report emission inventories (UNECE, 2025).

#### 1.1.2 Sectors

Annual reporting shall include national emissions and should include activity data for the sectors identified in Annex I to the UNECE Reporting Guidelines (UNECE, 2025). Annex I lists 127 "NFR sectors" that represent anthropogenic activities that cause air emissions. These 127 "NFR sectors" are summed up to the National Total. In addition eight "memo items" are listed. These "memo items" are not included in the National Total. Three of these "memo items" represent natural sources. The 127 "NFR sectors" that together sum up to the National Total are aggregated into 13 GNFR sectors (NFR Aggregation for Gridding and LPS sectors).

#### 1.1.3 Reporting of projected emission data, LPS emissions and gridded emissions

Parties to the Gothenburg Protocol within the geographical scope of EMEP shall regularly update their projections and report every four years from 2015 onward their updated projections, for the years 2025 and 2030 and, where available, also for 2040 and 2050. Parties to the other Protocols are encouraged to regularly update their projections and report every four years from 2015 (UNECE, 2025). Every four years from 2017 onward, Parties shall report for the year x-2 updated aggregated sectoral (GNFR) gridded emissions and LPS emissions (UNECE, 2025).

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<sup>6</sup> <https://www.ceip.at/review-of-emission-inventories/review-process>

#### 1.1.4 Geographical coverage

According to the definition given in the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP): "The geographical scope of EMEP means the area within which, coordinated by the international centres of EMEP, monitoring is carried out." (UNECE, 1984)<sup>7</sup> This definition has been referred to in all following Protocols to the Convention. The EMEP domain covers the geographic area between 30°N-82°N latitude and 30°W-90°E longitude.

#### 1.1.5 Transparency and Informative Inventory Reports (IIRs)

Transparency means that Parties provide clear documentation (IIR) and report emissions and activity data at a level of disaggregation, which provides sufficient understanding of how the inventory was compiled, assuring it meets good practice requirements.

According to the UNECE Reporting Guidelines (UNECE, 2025) Parties should submit annually an IIR along with their emission data. The IIRs shall be submitted in one of the working languages of the UNECE (English, French or Russian), and where relevant, Parties are encouraged to submit also an English translation of their reports (UNECE, 2025). For the transparency of inventories, it is essential that information such as reasons for recalculations, new (or closed) large emission sources, explanation of trends and the implementation of country-specific methods/data are provided in a transparent manner (see Annex II to the UNECE Reporting Guidelines "Informative Inventory Report"). The provision of an IIR is essential for an efficient stage 3 review (in depth review).

#### 1.1.6 Reporting of adjusted inventories

Inventories shall be calculated without corrections or normalization relating, for example, to climate variations or trade patterns of electricity (UNECE, 2014a). Parties may apply to adjust their emission reduction commitments or inventory data in extraordinary circumstances, as defined in Executive Body decisions 2012/3 and 2012/4 (UNECE, 2012a, UNECE, 2012b) and amended in Executive Body decisions 2014/1 (UNECE, 2014a). Detailed instructions for reporting adjustments are given in the "Technical Guidance for Parties Making Adjustment Applications and for the Expert Review of Adjustment Applications (ECE/EB.Air/130)" and for emissions Inventory Adjustments under the Amended Gothenburg Protocol in the "Technical Guidance for Emissions Inventory Adjustments under the Amended Gothenburg Protocol: Inventory adjustments in the context of Emission Reduction Commitments" (TFEIP, 2022).

#### 1.1.7 Fuel sold fuel used

Paragraph 22 of the UNECE Reporting Guidelines (UNECE, 2025) specifies the basis for reporting 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*

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<sup>7</sup> See [http://www.unece.org/env/lrtap/emep\\_h1.html](http://www.unece.org/env/lrtap/emep_h1.html)

*road vehicles based on fuel used or kilometres driven in the geographic area of the Party and report in memo items. The method for the estimate(s) should be clearly specified in the IIR."*

**A summary of the reporting obligations can be downloaded from the CEIP website<sup>8</sup>.** The UNECE Reporting Guidelines (UNECE, 2025) give detailed instructions on the reporting in section VI. Reporting.

## 1.2 Quality parameters of the inventory

Parties shall as a minimum use the methodologies in the latest version of the EMEP/EEA Guidebook, as approved by the Executive Body to estimate emissions and projections for each source category. Parties can use, as an alternative to the EMEP/EEA Guidebook, national or international methodologies that they consider better able to reflect their national situation, provided that the methodologies produce more accurate estimates than the default methods, are scientifically based, are compatible with the EMEP/EEA Guidebook and are documented in their IIRs, as described in Annex II to these Guidelines (UNECE, 2025).

**It is considered good practice to report inventories which are complete, consistent, comparable, and transparent and neither overestimated nor underestimated according to the best judgement.**

The terms transparency, consistency, comparability, completeness and accuracy are defined in detail in the UNECE Reporting Guidelines (UNECE, 2025).

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<sup>8</sup> <https://www.ceip.at/reporting-instructions>

## 2 REVIEW PROCESS

### 2.1 Technical review

#### 2.1.1 Review under the LRTAP Convention

At the 38<sup>th</sup> session of Executive Body (EB) to EMEP (Geneva, December 2018) the document '**Updated methods and procedures for the review of emission inventories**' was adopted (Decision 2018/1). **The Appendix on Technical Revisions** provides guidance on the quantification of necessary technical corrections if the data are found to be inconsistent with recommended methodologies of the EMEP/EEA Guidebook or where the emission estimates are not provided for an NFR source category.

**The technical review of national inventories** checks and assesses Parties' data submissions in accordance with the 'Review Guidelines 2018' (UNECE, 2018)<sup>9</sup> in order to improve the quality of emission data and associated information reported to the Convention. The technical review is carried out annually by EMEP. It is performed in accordance with the 'Review Guidelines 2018' (UNECE, 2018). The process of determining and calculating Technical Revisions is described in the Appendix of this document.

The review process is carried out in three stages. The technical review of inventories is carried out in the following three stages:

- *initial review (stage 1):* An initial check of submissions for timeliness, completeness and formats;
- *extended review (stage 2):* A synthesis and assessment of all national submissions with respect to consistency, comparability, key categories, trends of data with recommendations for data quality improvement;
- *in-depth reviews (stage 3):* In-depth reviews of selected inventories, by pollutant, country or sector, as in the workplan approved by the EMEP Steering Body. Up to ten countries are checked annually by two review teams. Alternatively, an ad hoc review may be performed to focus on specific aspects of inventory data quality or science (UNECE, 2018).

At each stage, national experts have the opportunity to clarify issues or provide additional information. They may also express their views at meetings of the Task Force on Emission Inventories and Projections. **Nominated CEIP contact points** are provided with passwords which allow them to access the review findings. Parties are requested to respond within four weeks after the notification.

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<sup>9</sup> <https://www.ceip.at/review-of-emission-inventories/review-process>

## 2.2 Access to the data and review results

The review assesses emission data (including gridded data and LPS) reported under the CLRTAP to the UNECE Secretariat.

The information submitted by Parties during the reporting rounds can be accessed from the CEIP webpage.<sup>10</sup> In addition, the *officially reported emission data* are made available via the CEIP database<sup>11</sup>. *Gap-filled and gridded emission data* for modellers are also made available at the CEIP website<sup>12</sup>.

Review findings of the stage 1 and stage 2 review under CLRTAP are published at the CEIP website.<sup>13</sup> Summaries of findings are annually published in the *Inventory review report* (CEIP, 2024)<sup>14</sup>.

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<sup>10</sup> <https://www.ceip.at/status-of-reporting-and-review-results>

<sup>11</sup> <https://www.ceip.at/webdab-emission-database/reported-emissiondata>

<sup>12</sup> <https://www.ceip.at/the-emep-grid/gridded-emissions>

<sup>13</sup> <https://www.ceip.at/status-of-reporting-and-review-results/2024-submission>

<sup>14</sup> <https://www.ceip.at/ceip-reports>

### 3 INITIAL (STAGE I) REVIEW

The stage 1 review performed by CEIP consists of automated tests which assess the *timeliness*, *completeness and format* of the submitted national inventories. It presents results of these initial automated tests to countries and supports the subsequent stage 2 and stage 3 review process. Stage 1 tests are:

- Timeliness of reporting
- Format of submission
- Completeness per sector for emissions for 2022
- Completeness per pollutant for submitted time series (separately for, 1990-1999, and from 2000 to 2022).

Sectoral data as well as national total emissions were checked within these tests.

The results of these initial automated tests are presented online, in the form of individual country *Stage 1 Status reports* annually in March. Parties were invited to provide comments or re-submissions, if applicable, within two weeks.

#### Data included in tests:

- Emissions reported under the Convention on LRTAP.

#### 3.1 Timeliness

Example of feedback provided to country:

Date of submission of CLRTAP : 15.02.2024 , received within deadline 15.02.2024

#### 3.2 Format

The submissions were checked against the '**NFR19**' **format** agreed by the EMEP Executive Body (EB) at its 27<sup>th</sup> session and amended taking into account changes to the POPs Protocol.

Parties were invited to submit entire time series in standard format to enable quality control of historical sector emissions, consistency of sectoral trends and a comparison of inventories between the Parties. It is highly recommended that Parties take advantage of consistency control via RepDab<sup>15</sup> of their emission data upon submission before the submission of their inventory to the UNECE secretariat, the EMEP Centre on Emission Inventories and Projections (CEIP) and/or the European Commission/European Environment Agency.

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<sup>15</sup> <https://www.ceip.at/repdab>

### 3.3 Completeness

The revised UNECE Reporting Guidelines (UNECE, 2025) ask Parties to submit emissions for 1980 – latest year for Main Pollutants, 1990 – latest year for HMs and POPs, and for 2000 – latest year for PM. It has to be noted that the pollutant-specific CLRTAP Protocols formally request reporting only from Parties which have ratified the Protocol for the Protocol base year, for the year after the entry into force of that Protocol and for subsequent years.

Parties to the Gothenburg Protocol shall report their latest available projections at least every four years, and provide any updated projections annually by 15 March. Parties to the Convention that are not Parties to the Gothenburg Protocol are encouraged to provide this information (UNECE, 2025).

#### 3.3.1 Example of completeness check results per sector for the current reporting year

“NE” in the figure below (Figure 3.1) shows for which sectors countries reported ‘Not Estimated’ for the year 2022. Only priority pollutants are included in this analysis. At the end of the table, the number of the notation key and the number of the notation key “NE” are given for each pollutant.

Completeness per sector for 2022

Sector	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	DIOX	PAH	HCB	PCB
1A3ai(i)																			NE	NE		
1A3aii(i)																			NE	NE		
2B10a																						NE
2B10b																						
2B2			NE																			
2B5					NE	NE	NE												NE	NE	NE	
2C2																						NE
2C3																						
2C5																			NE			
2C7a			NE																NE	NE	NE	
2C7c					NE	NE	NE												NE	NE	NE	
2D3i					NE	NE	NE															
2G																						NE
5E		NE	NE	NE															NE	NE	NE	
11B	NE	NE		NE	NE	NE	NE	NE											NE	NE	NE	NE
11C	NE	NE		NE	NE	NE	NE	NE											NE	NE	NE	NE
1A3ai(ii)																			NE	NE		
1A3aii(ii)																			NE	NE		
18 of 135 Sectors listed																						
Count of overall notation keys	82	67		97	81	68	68	68	142	97	93	94	97	142	142	142	142	142	101	103	103	108
Count of ‘NE’ notation keys	3	6		4	2	5	5	5	0	5	4	4	5	0	0	0	0	0	8	11	6	3

Figure 3.1: Example of findings: CLRTAP emission (completeness per sector for the current reporting year)

#### 3.3.2 Example of completeness check results per pollutant

The completeness of the data in the WebDab database (**Stage 1 review**) was evaluated on the basis of the criteria outlined in the UNECE Reporting Guidelines (UNECE, 2025). The table shows the fraction of total cells reported for the analysed interval for which a value, a zero or one of the defiend notation keys was reported (examples see Figure 3.2). Flagging occurs

- when the number of cells containing a value or a notation key is less than 80 % of the total number of cells,
- if there are more than 10 % zeroes reported,
- if 'Not Estimated' is reported in cells and/or
- if the number of values reported is less than 10 %.

The completeness of CLRTAP NFR Sectors is divided in three sections:

- completeness of NFR Sectors from 2000 to 2022 without National Totals
- completeness of NFR Sectors from 1990 to 1999 without National Totals
- completeness of National Totals from 1990 to 2022 including NFR and SNAP

### Completeness of NFR Sectors from 2000 to 2022 without National Totals

Component	%Value	%0	%NO	%NE	%NA	%IE	%C	%NR	%All
NOx	43.0	0.0	17.1	1.0	31.0	8.0	0.0	0.0	100.0
NMVOC	54.3	0.0	17.1	2.0	17.7	8.0	0.0	0.0	100.0
SOx	31.0	0.0	17.1	1.0	42.0	9.0	0.0	0.0	100.0
NH3	43.7	0.0	17.3	0.0	31.0	8.0	0.0	0.0	100.0
PM2.5	52.9	0.0	17.1	2.0	21.0	6.0	0.0	0.0	100.0
PM10	52.9	0.0	17.1	2.0	21.0	6.0	0.0	0.0	100.0
TSP	52.9	0.0	17.1	2.0	21.0	6.0	0.0	0.0	100.0
BC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
CO	31.0	0.0	17.1	2.0	43.0	6.0	0.0	0.0	100.0
Pb	33.9	0.0	17.1	2.0	42.0	6.0	0.0	0.0	100.0
Cd	32.9	0.0	17.1	2.0	43.0	6.0	0.0	0.0	100.0
Hg	31.0	0.0	17.3	2.0	43.0	6.0	0.0	0.0	100.0
As	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Cr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Cu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Ni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Se	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Zn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
DIOX	29.9	0.0	17.1	3.0	44.0	6.0	0.0	0.0	100.0
PAH	27.9	0.0	17.1	6.0	44.0	6.0	0.0	0.0	100.0
HCB	28.2	0.0	17.1	3.0	45.8	6.0	0.0	0.0	100.0
PCB	24.0	0.0	17.0	1.0	54.0	6.0	0.0	0.0	100.0

"Value" – the cell contains a number > 0.005

"0" – the cell contains 0 or a number < 0.005

"NO", "NE", "NA", "IE", "C" and "NR" are notation keys as defined in Reporting Guidelines and NFR (Annex B)

In certain cases the total percentage value may not be exactly the sum of the other columns because of rounding differences

**Figure 3.2: Example for the results of test, CLRTAP (completeness of NFR Sectors from 2000 to 2022 without National Totals)**

## 4 STAGE 2 REVIEW

The following stage 2 tests were performed:

- Recalculations
- Key category analysis – CLRTAP
- Inventory comparisons
- Time series
- Trends

Data included in the stage 2 review are the emissions submitted under the Air Convention and emissions reported under the UNFCCC and EEA. The results of the tests are published annually in the form of individual synthesis and assessment reports on the CEIP website<sup>16</sup>, usually in March and April (update). Parties are asked to respond within four weeks after notification.

### 4.1 Recalculations

Recalculations should be made if

- there are changes in methodologies
- changes in the manner in which emission factors and activity data are obtained or used
- or if estimates are provided for sources which have existed since the reference year but which were not accounted for in previous submissions.

Parties should apply any recalculations to every relevant year in the full time series to ensure consistency across years (UNECE, 2025). The aim of this test is to identify differences between national totals submitted by Parties in the present year and the latest available national totals submitted in previous reporting years.

It is important and necessary to identify inventory recalculations and to understand their origin in order to correctly evaluate the officially reported emission data.

- In this test, differences between national total emissions reported by Parties to the CLRTAP in the last and the last but one year are determined and variances larger than  $\pm 10\%$  are flagged<sup>17</sup>. An example for this test is given in Figure 4.1.
- a minus value indicates that the latest available emission submitted in previous years is higher
- blank cells indicates that data or notation keys in the present reporting year or in the previous reporting years are missing.
- 0 % is given when data (value or notation key) in the present reporting year and in the latest available previous reporting year are equal.
- if there is a number and a notation key reported, the difference is the number.

<sup>16</sup> <https://www.ceip.at/status-of-reporting-and-review-results>

<sup>17</sup> The formula used to calculate the magnitude of recalculations is  $100 * [(X_{\text{present year}} - X_{\text{previous year}}) / X_{\text{previous year}}]$ , where  $X_{\text{present year}}$  is emissions reported in the present year and  $X_{\text{previous year}}$  represents emission reported in the previous year.

Year	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	DIOX	PAH	HCB	PCB
1990	-1.26%	-1.58%	0.00%	6.96%	0.24%	0.02%	0.17%		-0.03%	0.15%	0.08%	0.00%							-2.17%	-0.96%	0.00%	-5.50%
1991	-1.07%	-1.01%	0.00%	6.79%					-0.05%	0.29%	0.15%	0.00%							-0.72%	-0.75%	0.45%	-7.70%
1992	-1.20%	-1.37%	0.00%	6.83%					-0.07%	0.33%	0.15%	0.00%							-1.08%	-0.85%	0.23%	-6.98%
1993	0.03%	-1.28%	0.00%	6.41%					-0.10%	0.43%	0.16%	0.00%							-1.28%	-0.86%	0.10%	-5.75%
1994	0.01%	-1.60%	0.00%	6.22%					-0.12%	0.49%	0.14%	0.00%							-1.59%	-0.81%	-0.11%	-5.17%
1995	0.01%	-1.70%	0.00%	6.22%	0.16%	0.15%	0.14%		-0.16%	1.23%	0.14%	0.00%							-1.77%	-0.68%	-0.15%	-5.90%
1996	0.01%	-1.93%	0.00%	6.24%					-0.19%	1.87%	0.22%	0.00%							-1.55%	-0.68%	-0.13%	-5.77%
1997	0.01%	-1.95%	0.00%	6.28%					-0.21%	1.06%	0.13%	0.00%							-1.81%	-0.77%	-0.20%	-5.84%
1998	0.01%	-1.81%	0.00%	6.24%					-0.21%	2.37%	0.28%	0.00%							-1.95%	-0.83%	-0.29%	-5.60%
1999	0.00%	-2.00%	-0.04%	6.12%					-0.25%	1.56%	0.18%	0.00%							-2.04%	-0.86%	-0.26%	-6.66%
2000	0.01%	-2.30%	0.00%	6.09%	-0.46%	-0.49%	-0.52%		-0.24%	1.98%	0.23%	0.00%							-2.30%	-0.83%	-0.35%	-7.73%
2001	0.01%	-2.24%	0.00%	5.99%	-0.08%	-0.03%	0.01%		-0.26%	3.00%	0.34%	0.00%							-2.39%	-0.84%	-0.38%	-7.88%
2002	0.01%	-2.01%	0.00%	6.14%	1.02%	1.18%	1.33%		-0.27%	4.46%	0.52%	0.00%							-3.46%	-1.04%	-14.61%	-1.82%
2003	0.01%	-1.95%	0.00%	5.70%	1.93%	2.17%	2.37%		-0.26%	5.69%	0.65%	0.00%							-3.66%	-1.21%	-15.39%	-1.54%
2004	0.00%	-2.10%	0.00%	5.24%	2.41%	2.66%	2.88%		-0.26%	6.01%	0.73%	0.00%							-3.71%	-0.46%	-16.26%	-1.83%
2005	-0.01%	-1.98%	0.00%	5.29%	2.95%	3.28%	3.52%		-0.31%	6.24%	0.77%	0.00%							-3.23%	-0.24%	-18.11%	-1.46%
2006	-0.01%	-2.06%	0.00%	5.39%	3.00%	3.36%	3.61%		-0.33%	5.55%	0.69%	-0.01%							-3.14%	-0.09%	-17.50%	-2.22%
2007	0.00%	-2.08%	0.00%	5.42%	3.76%	4.07%	4.37%		-0.38%	10.72%	0.91%	0.00%							-3.37%	0.02%	-20.24%	-1.58%
2008	0.00%	-2.15%	0.00%	6.07%	3.49%	3.71%	3.89%		-0.41%	10.01%	0.88%	0.00%							-3.32%	0.31%	-20.75%	-0.95%
2009	-0.01%	-2.33%	-0.09%	5.77%	4.04%	4.35%	4.65%		-0.45%	11.33%	0.95%	-0.03%							-2.16%	0.74%	-16.37%	-0.64%
2010	-0.01%	-2.29%	-0.06%	5.04%	4.00%	4.30%	4.56%		-0.51%	10.78%	0.95%	-0.02%							-2.62%	1.05%	-17.91%	-0.99%
2011	-0.01%	-2.30%	0.00%	5.53%	4.06%	4.05%	3.93%		-0.48%	9.46%	0.91%	-0.01%							-2.75%	1.69%	-20.40%	-0.60%
2012	-0.01%	-2.34%	0.00%	5.61%	3.74%	3.81%	3.89%		-0.48%	9.48%	0.94%	-0.01%							-2.07%	2.18%	-8.20%	0.18%
2013	-0.01%	-2.42%	-0.01%	5.46%	3.79%	3.78%	3.70%		-0.48%	10.30%	1.03%	-0.01%							-2.52%	3.04%	-3.03%	-0.97%
2014	-0.01%	-2.53%	-0.01%	5.63%	3.78%	3.64%	3.64%		-0.45%	10.23%	1.05%	-0.01%							-2.63%	3.33%	-2.85%	-1.07%
2015	0.00%	-1.52%	-0.01%	5.83%	4.69%	4.42%	4.25%		-0.45%	11.16%	1.10%	-0.01%							-2.19%	4.17%	-21.88%	-0.39%
2016	-0.06%	-1.68%	-0.07%	5.93%	5.36%	4.96%	4.77%		-0.50%	10.73%	1.14%	-0.01%							-1.98%	4.79%	-20.35%	-0.74%
2017	0.02%	-1.79%	-0.01%	5.62%	5.83%	5.38%	5.24%		-0.49%	10.89%	1.16%	-0.01%							-2.02%	5.31%	-21.26%	-0.15%
2018	0.02%	-1.64%	-0.01%	5.36%	6.98%	6.31%	6.19%		-0.46%	11.85%	1.25%	-0.01%							-1.36%	5.44%	-19.78%	0.00%
2019	0.02%	-1.52%	-0.02%	4.91%	6.64%	5.91%	5.72%		-0.41%	12.65%	1.35%	-0.01%							-1.54%	6.01%	-20.23%	0.00%
2020	-0.04%	-2.36%	-0.05%	4.88%	2.67%	2.48%	2.47%		-0.21%	8.94%	0.77%	0.00%							-2.39%	1.16%	-22.13%	-0.08%
2021	0.47%	-2.51%	0.02%	5.01%	6.70%	4.93%	4.29%		2.76%	9.82%	2.70%	1.00%							0.04%	0.09%	-20.46%	-0.58%

**Figure 4.1: Results for recalculation check, example**

The recalculation of the entire time series usually indicates a revision of inventory methods and/or improvement of activity data. Recalculation of part of the time series or individual historical years might indicate the corrections of errors or inconsistent time series or only partial recalculation.

## 4.2 Time series consistency

The time series is a central element of an air pollutant inventory as it provides information on historical emission trends and tracks the effects of emission reduction strategies at the national level. Emission trends should be neither over- nor underestimated. All emission estimates in a time series should be estimated consistently, i.e. the time series should, if possible, be calculated for all years using the same method and data sources. When different methods and data are used in a time series, the estimated emissions trend reflects not only the actual emissions changes but also the pattern of methodological refinements (EMEP/EEA, 2023).

The aim of these tests is to highlight inconsistencies in time series of sectoral data and national totals reported by Parties. Sudden changes in subsequent years often indicate an inconsistency of methods and/or of emissions factors and/or of activity data used in national inventories.

Color Key												
Indicates a dip in the time series data												
Indicates a jump in the time series data												
Indicates time series data with large sigma												
MAIN (Unit = Mg)												
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NOx	1A3ai(ii)	2406	2719	2971	3170	3326	3733	4116	4291	4451	4384	6254
NOx	1A4bi	15391	16740	15430	14985	13679	14574	15688	14101	14034	14144	13290
NOx	3Da1	5599	5581	5497	5208	5046	5095	5066	5142	5186	4940	4822
NMVOC	3B1b	11901	11887	11217	11871	11919	12908	12474	11880	11289	11401	11916
SOx	1A2d	4300	4912	2600	2246	2208	1971	1955	2022	1706	1295	1216
SOx	1A3ai(ii)	242	272	296	314	328	367	406	423	439	430	471
SOx	1B2b	2000	1300	2000	2100	1280	1530	1200	67	42	42	43
SOx	NATIONALTOTAL	73703	70728	54199	52820	47331	47306	43938	40379	35586	33700	31519
SOx	NTCOMPLIANCE	73703	70728	54199	52820	47331	47306	43938	40379	35586	33700	31519
NH3	3B3	9968	10059	9792	9498	9262	9213	8996	8986	9295	8354	8070

**Figure 4.2: Results from the time series check, example**

Only data in the NFR02, NFR09, NFR14 and NFR19 reporting format that were reported for at least three years were analyzed. All datasets where data was only available in NFR02 or NFR09 sectors were converted to NFR14/NFR19. Only the converted sectors are displayed in the time series analysis. The reported time series data were log 10-transformed prior to analysis to reduce intra-series variability and improve general time series linearity. A linear regression was subsequently applied to the log-transformed values for each time series. An individual value within the time series was identified as a dip/jump if the respective residual value (regression forecast value - reported value) was greater than 2 standard deviations from the mean of all residuals within the time series. Only time series for which the flagged data value contributed a significant fraction (>3%) of the national total for the respective year are included in this dataset for expert review.

Time series where sigma grows largely (i.e. larger than 20% of the time series mean value) because of extreme variation in the emission data are also flagged. Zero values indicate small numbers rounded to zero.

### 4.3 Trends

The trend figures of national total emissions visualise inconsistencies in the time series. All submitted data regardless of the reporting format chosen is used for the trendgraphs (e.g. SNAP sectors and NFR sectors as well (see examples in Figure 4.3).

#### Main Pollutants

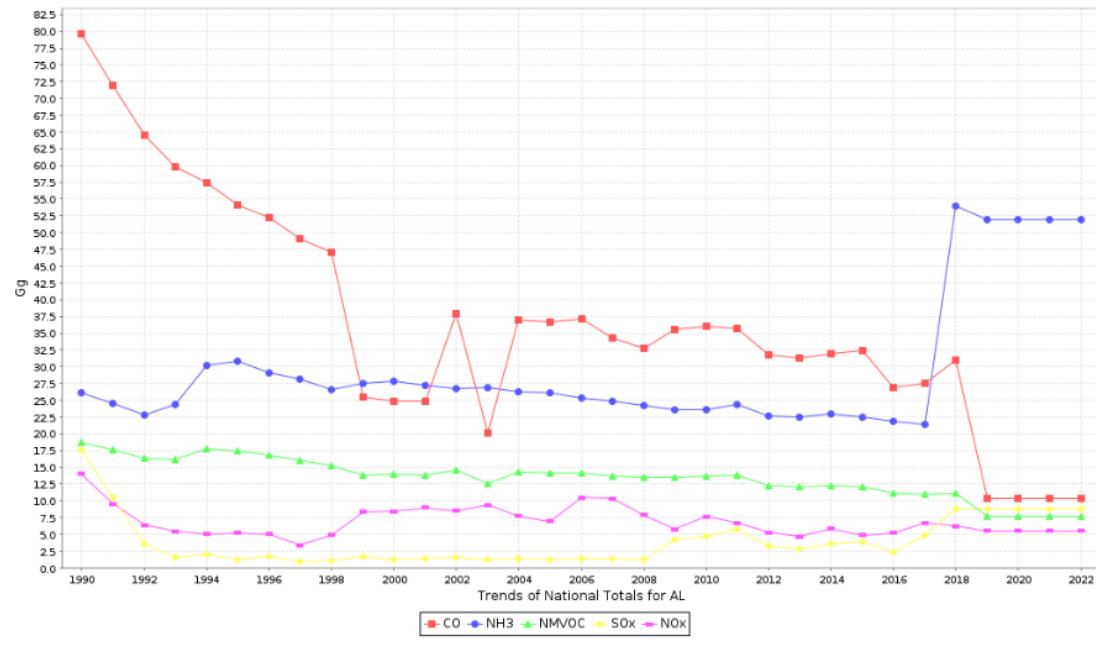


Figure 4.3: Example of a trend graph with dips and jumps highlighted in time series consistency tests.

#### 4.4 Key category analysis (KCA)

“Key category” for a given substance means a source category of emissions that has a significant influence on a Party’s total emissions in terms of the

- absolute level of emissions of that substance
- the trend in emissions over a given time period
- and/or, for a Tier 2 key category analysis, the uncertainty in the estimates for that Party.
- The concept of key categories is an important aspect in inventory development because it helps to identify priorities for resource allocation in data collection and compilation, quality assurance/quality control and reporting (UNECE, 2025).
- Following the revised EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2023), the key categories are those which, when summed up in descending order of magnitude, cumulatively add up to 80 % of the total level (EMEP/EEA, 2023).

**Key category analysis – Level assessment** is carried out for all Parties that submit relevant information. The KCA is performed at the level of NFR categories as provided in the reporting template (Table 1). Each air pollutant emitted from each category is considered separately.

The contribution of each source category to the total national inventory level is calculated according to

**Key category level assessment =  $|source\ category\ estimate| / total\ contribution$**

$$L_{x,t} = E_{x,t} / \sum E_t$$

Where:

$L_{x,t}$  = level assessment for source  $x$  in latest inventory year (year  $t$ )

$E_{x,t}$  = value of emission estimate of source category  $x$  in year  $t$

$\sum E_t$  = total contribution, which is the sum of the emissions in year  $t$ , calculated using the aggregation level chosen by the country for the key category analysis

Key categories according to this equation are those, that – when summed together in descending order of magnitude – add up to 80 % of the sum of all  $L_{x,t}$ .

An example of the results of test “Key category analysis” is shown in Figure 4.4. The key sources for the 2022, 2010 and 2005 emissions, including the corresponding percentages, are available.

Component Year		Key categories (Sorted from high to low from left to right)												Total
NOx	2022	1A3bi (29.3%)	1A4bi (8.3%)	1A3biii (8.2%)	1A1a (6.8%)	1A3bii (5.5%)	1A2f (4.8%)	1A4cii (4.7%)	3Da2a (4.6%)	1A2gvii (3.9%)	1A2d (3.7%)	3Da1 (3.5%)		83.2%
NM VOC	2022	1A4bi (21.0%)	2D3a (17.1%)	3B1a (11.3%)	3B1b (10.1%)	2D3d (7.8%)	3Da2a (7.0%)	2H2 (3.1%)	2D3e (2.7%)					80.1%
SOx	2022	1A2a (43.5%)	1A2gvii (12.7%)	1A4bi (9.2%)	1A1a (6.5%)	1A2f (6.0%)	1A1b (4.6%)							82.6%
NH3	2022	3Da2a (35.6%)	3B1b (16.3%)	3B1a (13.4%)	3D1a (10.1%)	3B3 (8.3%)								83.6%
PM2.5	2022	1A4bi (40.3%)	1A3bvi (8.1%)	1A1a (6.4%)	1A3bvi (4.6%)	2A5a (4.0%)	2G (3.0%)	1A3bi (2.9%)	1A4cii (2.8%)	1A4ci (2.6%)	1A4ai (2.2%)	2A5b (2.2%)	5E (2.1%)	81.2%
PM10	2022	1A4bi (20.9%)	2A5a (16.8%)	3Dc (12.0%)	1A3bvi (10.7%)	2A5b (7.2%)	1A3bvi (4.2%)	1A3bvi (3.8%)	1A3c (2.0%)	2I (1.7%)	2I (1.5%)			80.8%
TSP	2022	2A5a (21.8%)	2A5b (21.6%)	1A4bi (13.6%)	3Dc (7.2%)	1A3bvi (5.9%)	1A3bvi (5.1%)	1A3c (3.4%)	2I (2.5%)					81.2%
CO	2022	1A4bi (40.6%)	1A2a (35.1%)	1A3bi (7.1%)										82.8%
Pb	2022	1A3bvi (40.3%)	1A1a (14.6%)	1A4bi (12.6%)	2G (6.5%)	2C5 (4.7%)	2C1 (4.6%)							83.4%
Cd	2022	1A4bi (24.9%)	1A1a (17.2%)	1A1b (16.2%)	2G (8.1%)	1A2gvii (5.9%)	2C1 (5.7%)	1A2d (5.5%)						83.5%
Hg	2022	2C1 (34.0%)	1A2f (15.9%)	1A1a (15.9%)	1A4bi (14.2%)	1A2d (8.2%)								88.2%
DIOX	2022	1A4bi (45.0%)	2C3 (11.0%)	5E (9.2%)	1A2gvii (5.9%)	1A1a (4.5%)	2C7a (4.2%)	1A4ci (3.9%)						83.7%
PAH	2022	1A4bi (74.6%)	1A4ci (10.1%)											84.7%
HCB	2022	1A4bi (58.2%)	2C3 (16.7%)	1A1a (4.8%)	1A4ci (4.7%)									84.4%
PCB	2022	2C1 (64.6%)	1A2f (15.5%)											80.1%

Figure 4.4: Example of results for Key category analysis

## 5 CHECKS AS PART OF THE REVIEW REPORT

As part of the review report (CEIP 2024) a few additional checks are performed. The results and methodological details of these checks are included in the review report and its Annexes<sup>18</sup>.

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<sup>18</sup> <https://www.ceip.at/review-of-emission-inventories/technical-review-reports/inventory-review-2024-dataviewer>

## 6 REVIEW OF GRIDDED DATA AND LPS

Every four years from 2017 onward, Parties shall report for the year x-2 updated aggregated sectoral (GNFR) gridded emissions in a grid of 0.1 x 0.1 degrees and LPS emissions.

### 6.1 Gridded data

It has to be noted that gridded emissions are used in models only on sectoral level (13 GNFRs) and therefore only submitted gridded sectoral emissions can be used.

During the annual review process CEIP performs a few standard tests:

- check if sectoral gridded data for all pollutants/years are reported as requested by the revised UNECE Reporting Guidelines (UNECE, 2025)
- compare sectoral grid-sum data with emissions reported in NFR table (aggregated to GNFR)
- check if all reported cells are inside the country (position of the cells)

### 6.2 Large Point Sources (LPS)

Large point sources (LPS) are defined as facilities<sup>19</sup> whose combined emissions, within the limited identifiable area of the site premises exceed the pollutant emission thresholds specified below. The pollutant emission thresholds have been extracted from the full list of pollutants in the E-PRTR Regulation (EC, 2006, Annex II) and listed in Table 6.1 below (UNECE, 2025).

**Table 6.1: List of pollutants to be reported for a LPS if the applicable threshold value is exceeded based on thresholds specified in E-PRTR Regulation (Annex II)**

Pollutants/Substances	Thresholds in kg/year
SO <sub>2</sub>	150 000
NO <sub>x</sub>	100 000
CO	500 000
NMVOCS	100 000
NH <sub>3</sub>	10 000
PM <sub>2.5</sub>	50 000
PM <sub>10</sub>	50 000
Pb	200
Cd	10
Hg	10
PAHs	50
PCDD/F	0.0001
HCB	10

<sup>19</sup> As defined in Article 2 (4) and (5) of the E-PRTR Regulation, “(4) ‘Facility’ means one or more installations on the same site that are operated by the same natural or legal person; (5) ‘Site’ means the geographical location of the facility;” (EC, 2006).

Parties that do not report combustion process emissions under any other international or EU wide protocols or decisions may limit their criteria for Combustion Process LPS selection to > 300 mw thermal capacity.

**Table 6.2: The stack height classes (physical height of stack) in the reporting templates**

Height class
1. Height class 1 < 45 metres;
2. 45 metres ≤ Height class 2 < 100 metres;
3. 100 metres ≤ Height class 3 < 150 metres;
4. 150 metres ≤ Height class 4 < 200 metres;
5. Height class 5 < 200 metres.

During the annual review process CEIP performs a few standard tests:

- check if point sources for all pollutants/years are reported as requested by the revised UNECE Reporting Guidelines (UNECE, 2025)
- check if all reported point sources are inside the country (position of the LPS)
- comparison with E-PRTR facilities (planned for the future)

## 7 CENTRALISED IN-DEPTH REVIEW (STAGE 3)

The mandate and overall objectives for the emission inventory review process under the Air Convention is given by the 'Review Guidelines 2018' (UNECE, 2018).

Paragraph 7 (c) of the 'Review Guidelines 2018' (UNECE, 2018) defines that stage 3 reviews may be annual centralized reviews or ad hoc reviews. Paragraph 18 of the 'Review Guidelines 2018' further specifies that such ad hoc reviews could, for instance, focus on specific source sectors, specific pollutants such as heavy metals or persistent organic pollutants, gridded and projections data, or on other areas as requested by the Implementation Committee.

The in-depth review comprises four main phases:

1. Preparation for the review
2. Desk Review
3. Centralized Review
4. Preparation of the review reports

### 7.1 Preparation for the review

During the preparatory phase CEIP prepares a schedule for the review, composes the review team, prepares a checklist for the review, prepares a review report template, contacts Parties with the request to nominate contact points for the review, prepares initial checks and visualisation tools and prepares for the kick-off meeting/training meeting.

**Schedule for the review:** CEIP defines all major milestones.

**Composition of the review team:** CEIP contacts the nominated experts from the Parties and - depending on the availability of the experts- composes a review team that fulfills the needs of the current review

**Preparation of a checklist:** CEIP in cooperation with the lead reviewers prepares a checklist to facilitate consistency of the review and to ensure that all important topics are covered.

**Finding Country Contact Points:** To ensure smooth communication throughout the review CEIP contacts Parties with the request to nominate country contact points at the beginning of the review. These country contact points receive the questions from the expert review team and the draft review reports for commenting.

**Initial checks:** Each year a number of initial checks is performed to facilitate the work of the expert review team. The results of these checks are provided to the expert review team

**Visualisation tools:** Each year a set of visualisation tools is developed by CEIP. The content of the tools depends on the specific focus of the review. Typically, tools to visualize time series consistency and recalculations and tools that provide an overview of the key categories are provided.

**Preparation of the review report template:** Each year a review report template tailored to the focus of the review is prepared by CEIP.

**Training Meeting/Kick-off Meeting:** CEIP arranges a training meeting/kick-off meeting for the reviewers. After this meeting all reviewers are informed about the time schedule, the scope of

the review, communication procedures during the review, available material and tools and the composition of the review teams.

## 7.2 Desk Review

During the desk review the sector expert check and assess the inventories that are assigned to them. They base their checks on the initial checks, the tools designed for the review and assess in detail the inventory submission and the IIR. If the need arises they prepare questions to the Parties. These questions are checked by the sector expert counter part and the lead reviewer and then sent to the country via e-mail by CEIP. Member States are usually asked to send a reply within two weeks.

## 7.3 Centralized Review

The ERT meets centrally for five days to finalize the review. The ERT poses follow-up questions to Parties. These follow-up questions (and in exceptional cases new questions) are checked by the sector expert counter part and the lead reviewer and then sent to the country via e-mail by CEIP. Member States are usually asked to send a reply within two days during the centralized review. Then the sector experts draft conclusions, discuss difficult cases with lead reviewers and other sector experts and calculate technical corrections if needed and draft the review reports. The lead reviewers add to the review reports and quality control them and finalize them, optimally until the end of the centralized review.

### Technical corrections and revised estimates

In the 'Review Guidelines 2018' (UNECE, 2018) it is stated that if the ERT considers that emissions are significantly under- or overestimated, the Party is during the review invited to submit 'revised estimates' that address the issue raised. Should the Party decline to do this, or should it not be possible to agree on the quantification of a revised estimate i.e. the ERT does not accept a revised estimate provided by the Party, the ERT may calculate a 'technical correction'. The threshold for significance for a technical correction for the in-depth review in 2024 was set at 2% of the national total, i.e. a finding that has been identified to result in an over- or underestimate of emissions of more than 2% of the national total. The methods for calculating technical corrections are set up in the 'Review Guidelines 2018' (UNECE, 2018) and use the EMEP/EEA Emission 'Inventory Guidebook' as a reference for methods and emission factors.

## 7.4 Preparation of Review Reports

After the centralized review the lead reviewers provide the finalized draft review reports to CEIP for a final quality check. CEIP then sends the draft review reports to Parties. Parties are asked to provide comments within four weeks. If needed sector experts are consulted to resolve the comments from Parties. The final review reports are then made publicly accessible at CEIP's website<sup>20</sup>.

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<sup>20</sup> <https://www.ceip.at/status-of-reporting-and-review-results>

## 7.5 The key outcomes of the review are the:

- Record of questions and answers which contain all questions submitted to the countries plus detailed responses from the countries
- Review report which contains the public findings and recommendations
- Excel files with technical corrections

## 7.6 History of stage 3 in depth reviews of air emission inventories 2008-2022

The EMEP Steering Body approved the first schedule (2008-2013) for the centralised in-depth reviews at the 33<sup>rd</sup> session in September 2009 (see Table 7.1). The list was updated in the following years at the Steering Body meetings. The updated list is shown below (Table 7.1)

**Table 7.1: History<sup>21</sup> of stage 3 in depth reviews of inventories 2008-2021**

	Year	Countries
3 <sup>rd</sup> review round 2018-2021	<b>2021</b>	Kazakhstan, Liechtenstein, Monaco, Montenegro <i>Bosnia and Herzegovina did not provide any emission data to EMEP/CEIP yet.</i>
	<b>2020</b>	European Union, North Macedonia, Iceland, Kyrgyzstan, Switzerland. <i>Kazakhstan, Liechtenstein and Monaco did not submit data on time, review postponed to 2021.</i>
	<b>2019</b>	Albania, Georgia, Norway, Russian Federation, Serbia, Türkiye
	<b>2018</b>	Moldova, Armenia, Finland, Belarus, Ukraine, Azerbaijan
	<b>2017</b>	Albania**, Armenia*, Austria, Malta*, EU, Kazakhstan, Kyrgyzstan*, Liechtenstein*, Monaco*
	<b>2016</b>	Estonia, Georgia, Iceland, Luxembourg, FYR of Macedonia, Russian Federation, Serbia, Switzerland, Türkiye, United Kingdom
	<b>2015</b>	Azerbaijan, Belarus, Czech Rep., Ireland, Rep. of Moldova, The Netherlands, Slovakia, Slovenia and Ukraine
	<b>2014</b>	Belgium, Greece, Cyprus, Croatia, Denmark, Germany, Hungary, and Spain
	<b>2013</b>	Bulgaria, France, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Romania and Sweden
	<b>2012</b>	Albania*, Georgia*, European Community, Liechtenstein*, Malta*, Monaco*, Republic of Moldova*, Montenegro*, Serbia* and Türkiye**
2 <sup>nd</sup> review round 2013-2017	<b>2011</b>	Czech Republic, Belarus, Croatia, Estonia*, Greece*, Iceland, Luxembourg, The former Yugoslav Republic of Macedonia, Slovenia and Ukraine*
	<b>2010</b>	Austria, Cyprus, Germany, Italy, Netherlands, Romania, Russian Federation*, Slovakia, Switzerland and United Kingdom
	<b>2009</b>	Belgium, Bulgaria, Denmark, Finland, Hungary, Ireland, Latvia, Lithuania, Poland and Spain
	<b>2008</b>	France, Norway, Portugal and Sweden (voluntary)

**Note:**

\* Party did not submit a complete emission inventory in standard format or did not submit an IIR for the last three reporting rounds

\*\* Party did not submit neither inventory data nor an IIR for the last three reporting rounds

<sup>21</sup> The EMEP Steering Body approved the schedule (2008-2013) for centralised in-depth reviews at its 33<sup>rd</sup> session in September 2009.

## 7.7 The Review in 2022

At its seventh joint session in September 2021 the Steering Body and the Working Group on Effects approved the plan to perform (in 2022) an in-depth review of  $PM_{2.5}$  emissions from residential heating and road transport, with a special focus on the topic of ‘condensable particulate matter’ (ad hoc review) and a follow-up review of the implementation of recommendations given as part of the review carried out in 2021. The Parties reviewed in 2021 were Kazakhstan, Liechtenstein, Monaco and Montenegro. All Parties that had submitted an IIR before the start of the desk review (40 Parties in total<sup>22</sup>) were reviewed. In addition a follow-up review assessing the implementation of recommendations given as part of the review carried out in 2021 was performed for Kazakhstan, Liechtenstein, Monaco and Montenegro.

## 7.8 The Review in 2023

At its eighth joint session in September 2022, the Steering Body and the Working Group on Effects approved the plan that the in-depth review in 2023 focuses on emissions from agriculture with a special emphasis on ammonia, NMVOC and  $NO_x$  emissions including gridded data. While the focus was set on  $NH_3$ , NMVOC and  $NO_x$  emissions, also all other pollutants covered by LRTAP Convention and its protocols (i.e.  $SO_x$ ,  $PM_{10}$ ,  $PM_{2.5}$ , BC, priority HMs and POPS) have been checked for the time series years 1990 – 2021 to the extent possible. For these other pollutants especially completeness of reporting was assessed. All Parties that had submitted emission data before the start of the desk review (41 Parties in total<sup>23</sup>) were reviewed.

The review was coordinated by the EMEP Centre on Emission Inventories and Projections (CEIP) acting as Review Secretariat. The review took place between April and June 2023 and was performed as a desk review between 31 March to 5 May 2023 and an in-person meeting between 22 of May 2023 and 26 May 2023 (centralized review). Seventeen experts from fifteen Parties to the Air Convention conducted the review. Initial checks performed by CEIP and visualisation tools developed by CEIP supported the work of the expert review team.

## 7.9 The Review in 2024

At its ninth joint session in September 2023, the Steering Body and the Working Group on Effects approved the plan that the in-depth review in 2024 focuses on the review of the sector ‘industrial processes and product use – solvents’ with a special emphasis on NMVOC emissions; including gridded data. While the focus was set on NMVOC emissions, also all other pollutants covered by Air Convention and its protocols (i.e.  $SO_2$ ,  $NO_x$ ,  $NH_3$ ,  $PM_{10}$ ,  $PM_{2.5}$ , BC, priority HMs and POPS) have been checked for the time series years 1990 – 2022 to the extent possible. For

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<sup>22</sup> Austria, Belarus, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Netherlands, Türkiye, Ukraine, United Kingdom

<sup>23</sup> Armenia, Albania, Austria, Belarus, Belgium, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Malta, Monaco, Montenegro, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Netherlands, Türkiye, Ukraine, United Kingdom

these other pollutants especially completeness of reporting was assessed. All Parties that had submitted emission data before the start of the desk review (47 Parties in total<sup>24</sup>) were reviewed.

The review was coordinated by the EMEP Centre on Emission Inventories and Projections (CEIP) acting as Review Secretariat. The review took place between April and June 2024 and was performed as a desk review between 15 April to 10 May 2024 and an in-person meeting between 3 and 7 June 2024 (centralized review). Twenty experts from seventeen Parties to the Air Convention conducted the review. Initial checks performed by CEIP and visualisation tools developed by CEIP supported the work of the expert review team.

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<sup>24</sup> Armenia, Albania, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, EU, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Netherlands, Türkiye, Ukraine, United Kingdom

## 8 UNITS AND ABBREVIATIONS

kg .....	1 kilogram = $10^3$ g (gram)
t .....	1 tonne (metric) = 1 megagram (Mg) = $10^6$ g
Mg .....	1 megagram = $10^6$ g = 1 tonne (t)
TJ .....	1 terajoule
kPa .....	1 kilopascal
K .....	1 Kelvin
$\mu\text{m}$ .....	1 micrometre
Cd .....	cadmium
CEIP .....	EMEP Centre on Emission Inventories and Projections
CLRTAP .....	Air Convention, Convention on Long Range Transboundary Air Pollution
CO .....	carbon monoxide
EEA .....	European Environment Agency
EMEP .....	Co-operative Programme for Monitoring and Evaluation of the Long-range Transmissions of Air Pollutants in Europe
E-PRTR .....	European Pollutant Release and Transfer Register
EU .....	European Union
GNFR .....	nomenclature for reporting of gridded data and LPS
HCB .....	hexachlorobenzene
Hg .....	mercury
HMs .....	heavy metals
IIR .....	informative inventory report
KC .....	key category
KCA .....	key category analysis
LRTAP Convention .....	UNECE Convention on Long-range Transboundary Air Pollution
LPS .....	large point source
Main pollutants .....	NO <sub>x</sub> , NMVOCs, SO <sub>x</sub> , NH <sub>3</sub> and CO
Main HMs .....	Cd, Hg and Pb
NFR .....	UNECE nomenclature for reporting of air pollutants
NH <sub>3</sub> .....	ammonia
NMVOCs .....	non-methane volatile organic compounds
NO <sub>2</sub> .....	nitrogen dioxide
NO <sub>x</sub> .....	nitrogen oxides
PAHs .....	polycyclic aromatic hydrocarbons
Pb .....	lead
PCDD/PCDF .....	dioxines and furanes
PM .....	particulate matter
PM <sub>10</sub> .....	particulate matter, with a 50 per cent efficiency cut-off at 10 $\mu\text{m}$ aerodynamic diameter or less

PM<sub>2.5</sub> ..... particulate matter, with a 50 per cent efficiency cut-off at 2.5 µm aerodynamic diameter or less

PM<sub>coarse</sub> ..... particulate matter, the difference between PM<sub>10</sub> and PM<sub>2.5</sub>

BC ..... black carbon

POPs ..... persistent organic pollutants

SNAP ..... selected nomenclature for air pollution

SO<sub>x</sub> ..... sulphur oxides

SO<sub>2</sub> ..... sulphur dioxide

SO<sub>3</sub> ..... sulphur trioxide

TFEIP ..... UNECE Task Force on Emission Inventories and Projections

TSP ..... total suspended particles

UNECE ..... United Nations Economic Commission for Europe

UNFCCC ..... United Nations Framework Convention on Climate Change

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