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**INFORMATIVE INVENTORY REPORT OF THE**

**REPUBLIC OF MOLDOVA 1990-2023**

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**Submitted under the UNECE Convention on Long-range Transboundary Air Pollution**

**2025**

The Republic of Moldova Informative Inventory Report 2025 was developed by experts from the Institute of Chemistry, USM; Institute of Power Engineering, UTM, and Institute of Ecology and Geography, USM, under coordination of the Ministry of Environment.

The aim of the report is inventory of air pollutions as the reporting under the Convention on Long-range Transboundary Air Pollution (CLRTAP) for period 1990-2023.

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Acknowledgements

In 2019 five National Academies of Sciences and Medicine from South Africa, Brazil, Germany, and the United States of America have joined forces to issue an urgent call to action on harmful air pollution. They are calling for a new global compact to improve collaboration on the growing problem, and for governments, businesses and citizens to reduce air pollution in all countries. The academies launched their call with the publication of a science-policy statement, which was handed over in a ceremony at United Nations headquarters in New York, to senior UN representatives and high-level diplomats from South Africa, Brazil, Germany, and the United States of America. According to the statement private and public investments are insufficient and do not match the scale of the problem. Air pollution is preventable. With sufficient action suffering and deaths from dirty air can be avoided. Clean air is as vital to life on earth as clean water. Air pollution control and reduction must now be a priority for all countries. The clean air is much vital to life on earth as clean water. Air pollution control and reduction must now be a priority for all. With this, in 2019 was set up for the first time - 7 September the Day of the clean air with a blue sky. The Republic of Moldova celebrates September 7th through concrete measures and collaborates with the Climate and Clean Air Coalition to develop air protection policies.

Thus, the Action Plan for the reduction of short-lived pollutants (O3, HFC, CH4, BC and NOx) is currently being developed in Moldova.

The Climate and Clean Air Coalition supports continuous improvement of the emissions inventory development for air pollutants and Short-lived Climate Pollutants (SLCPs) in Moldova. These enhances the capacity of Moldova’s national institutions in the integrated assessment of air pollutants and SLCPs.

In the process of Moldova's accession to the European Union, the Ministry of Environment has set a series of European air directives to be transposed into national legislation by 2027:

1. Directive 2009/126/EC of the European Parliament and of the Council of 21 October 2009 on the second stage of recovery of petrol vapors during refueling of motor vehicles at petrol stations.

A new Regulation to be approved by Government Decision, by the end of 2025. The transposition will lay down measures aimed at reducing the amount of petrol vapor emitted in atmosphere during refueling of motor vehicles.

2. Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 on the quality of petrol and diesel and amending Directive 93/12/EEC of the Council.

A new Regulation to be approved by Government Decision in 2027. The transposition will set technical specifications on health and environmental grounds for fuels to be used for vehicles equipped with positive-ignition and compression-ignition engines.

3. The new AAQD sets binding air quality standards (limits and targets) for countries to achieve by 2030 for all major pollutants and specifically for particulate matter pollution (PM2. 5) and nitrogen dioxide (NO2) – double the ambition of the previous limits, which will replace Directive 2008/50/EC on ambient air quality and cleaner air for Europe. An amendment of the Law no 98/2022 on air quality to be planned for approval in 2027.

4. Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC.

A new Regulation to be approved by the Government Decision, end of 2025. A new Regulation will be applied to all engines falling within the categories set out in Article 4(1) which are installed in or are intended to be installed in non-road mobile machinery and, insofar as the emission limits for gaseous and particulate pollutants from those engines are concerned, to such non-road mobile machinery.

5. Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the sulphur content of certain liquid fuels. A new Regulation or amendment of the existing legal base to be approved by Government Decision end of 2026. The transposing will allow to reduce the emissions of sulphur dioxide resulting from the combustion of certain types of liquid fuels and thereby to reduce the harmful effects of such emissions on man and the environment. Reductions in emissions of sulphur dioxide resulting from the combustion of certain petroleum-derived liquid fuels shall be achieved by imposing limits on the sulphur content of such fuels as a condition for their use within Contracting Parties’ territory, territorial seas and exclusive economic zones or pollution control zones.

The launch of the Twinning project “Air Quality and Environment” in September 12, 2024 emphasizes the cooperation of the Ministry of Environment of Moldova with EU partner institutions, EU Delegation to the Republic of Moldova, Finnish, Lithuanian and Swedish Embassies. In the context of the accession of the Republic of Moldova to the EU, the Twinning project in the field of air quality aims to increase the approximation and implementation of the acquis communautaire in the fields of air quality and air pollution reduction, environmental information, circular economy/waste management and sustainable management of chemical substances. Within this two-year project, the Ministry of Environment, the Environmental Agency, the State Hydrometeorological Service and the Environmental Protection Inspectorate will benefit from the assistance of partner institutions from the European Union (EU), brought together in a consortium formed by the Finnish Meteorological Institute as the lead partner, the Lithuanian Environmental Project Management Agency (APVA) and the Swedish Chemicals Agency (KEMI) – as junior partners. This project will help the beneficiary institutions and other stakeholders to strengthen Moldova’s capacity to fulfil air-related commitments, in line with the EU-Republic of Moldova Association Agreement, the EU Integration process and international agreements. Having this support it will be done the Elaboration of the [National Air Pollution Control Programme. In the National Air Pollution Control Programme, Member States set out how they intend to achieve emission reduction commitments of the NEC Directive.](https://ym.fi/en/national-air-pollution-control-programme-2030)

In the current IIR are described the NFR 2025 emissions estimations for all 25 air pollutants, including Black Carbon as a harmful SLCPs. The report assesses air pollutants' emissions with trends and mitigation measures to reduce the SLCPs emissions', enhancing benefits for human health locally, and contributing to Moldova’s air quality achievement. Based on NFR and IIR done in 2025 it will be developed the grid emission report, initiated in 2024.

The 6th Informative Inventory Report (IIR) of the Republic of Moldova is developed by national experts of the Institute of Chemistry, State University of Moldova (SUM), the Institute of the Institute of Power Engineering, the Technical University of the Moldova (TUM), and the Institute of Ecology and Geography of SUM, in cooperation with the Ministry of Environment and technical support of the Climate and Clean Air Coalition. The beneficiary of the Informative Inventory Report is the Ministry of Environment.

The Ministry of Environment and the National Experts in inventory of air pollutants express gratitude to the Secretariat of the CCAC for the provided online and off-line training during 2024-2025. The trainings were focused on using the LEAP IBC tool for the estimation of emissions projections.

List of Acronyms, Abbreviations and Units

AD Activity Data

As Arsenic

ATULBD Administrative Territorial Units on the Left Bank of the Dniester

BC Black carbon

BREF Best available techniques reference documents

CCAC Climate and Clean Air Coalition

CCD Climb/cruise/descent

Cd Cadmium

CH4 Methane

CLRTAP Convention on Long-Range Transboundary Air Pollution, also LRTAP

Convention

CNG Compressed Natural Gas

CO Carbon Monoxide

Cr Chromium

Cu Copper

EB Energy Balance

EEA European Environment Agency

EF Emission Factor

EMEP CLRTAP European Monitoring and Evaluation Programme

EMEP/EEA EMEP/EEA Air Pollutant Emission Inventory Guidebook

EU European Union

FOD First Order Decay

FQMS Fuel Quality Monitoring System

GEF Global Environment Facility

GHG Greenhouse gases

GPG Good Practice Guidance

HCB Hexachlorobenzene

HCH Lindane (gamma-Hexachlocyclohexane)

HCFC Hydrochlorofluorocarbon

HDV Heavy-duty vehicle

HFCs Hydrofluorocarbons

Hg Mercury

IIR Informative Inventory Report

IPCC Intergovernmental Panel on Climate Change

IPPC Integrated Pollution Prevention and Control

Kt Kiloton

LDV Light-duty vehicle

LEAP-IBC Long-range Energy Alternatives Planning - Integrated Benefits Calculator

LNG Liquefied Natural Gas

LOSP Light Organic Solvent Preservative

LPG Liquefied Petroleum Gas

LTO Landing and Take-off Cycle

MCF Methane Correction Factors

MARDE Ministry of Agriculture, Regional Development and Environment

MSW Municipal Solid Waste

NBS National Bureau of Statistics

NFR Nomenclature for Reporting

NH3 Ammonia

Ni Nickel

NIR National Inventory Report

NMVOCs Non-Methane Volatile Organic Compounds

NOx Nitrogen Oxides

PAHs Polycyclic Aromatic Hydrocarbons

Pb Lead

PCBs Polychlorinated Biphenyls

PCDD/PCDF Polychlorinated dibenzo-dioxins (PCDDs) and Polychlorinated dibenzo-

furans (PCDFs)

PM2.5 Particulate matter (PM) or Particulates ≤2.5 µm (micrometres)

PM10 Particulates ≤10 µm

POPs Persistent Organic Pollutants

RM Republic of Moldova

SA Joint Stock Company

Se Selenium

SEI State Ecological Inspectorate

SO2 Sulphur Dioxide

SOx Sulphur oxides

SLCPs Short-lived Climate Pollutants

SNAP Supporting National Action and Planning on SLCPs

SRL Limited Liability Company

SSFA Small-Scale Funding Agreement

SWDS Solid waste disposal sites

SY Statistical Yearbook

QA/QC Quality assurance and quality control

TSP Total Suspended Particulates

Zn Zinc

UNFCCC United Nations Framework Convention on Climate Change

UNECE United Nations Economic Commission for Europe

UNEP United Nations Environment Programme

WBT Water Biological Treatment

**NFR Code** **Long name**

**1.A.1.a** **Public electricity and heat production**

1.A.1.b Petroleum refining

1.A.1.c Manufacture of solid fuels and other energy industries

1.A.2.a Stationary combustion in manufacturing industries and construction: Iron and steel

1.A.2.b Stationary combustion in manufacturing industries and construction: Non-ferrous metals

1.A.2.c Stationary combustion in manufacturing industries and construction: Chemicals

1.A.2.d Stationary combustion in manufacturing industries and construction: Pulp, Paper

and Print

1.A.2.e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco

1.A.2.f Stationary combustion in manufacturing industries and construction: Non-metallic minerals

1.A.2.g.vii Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)

1.A.2.g.viii Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)

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1.A.3.a.ii(i) Domestic aviation LTO (civil)

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1.A.3.b.ii Road transport: Light duty vehicles

1.A.3.b.iii Road transport: Heavy duty vehicles and buses

1.A.3.b.iv Road transport: Mopeds & motorcycles

1.A.3.b.v Road transport: Gasoline evaporation

1.A.3.b.vi Road transport: Automobile tyre and brake wear

1.A.3.b.vii Road transport: Automobile road abrasion

1.A.3.c Railways

1.A.3.d.i(ii) International inland waterways

1.A.3.d.ii National navigation (shipping)

1.A.3.e.i Pipeline transport

1.A.3.e.ii Other (please specify in the IIR)

1.A.4.a.i Commercial/institutional: Stationary

1.A.4.a.ii Commercial/institutional: Mobile

1.A.4.b.i Residential: Stationary

1.A.4.b.ii Residential: Household and gardening (mobile)

1.A.4.c.i Agriculture/Forestry/Fishing: Stationary

1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

1.A.4.c.iii Agriculture/Forestry/Fishing: National fishing

1.A.5.a Other stationary (including military)

1.A.5.b Other, Mobile (including military, land based and recreational boats)

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1.B.1.b Fugitive emission from solid fuels: Solid fuel transformation

1.B.1.c Other fugitive emissions from solid fuels

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2.B.10.b Storage, handling and transport of chemical products (please specify in the IIR)

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2.C.3 Aluminum production

2.C.4 Magnesium production

2.C.5 Lead production

2.C.6 Zinc production

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2.C.7.c Other metal production (please specify in the IIR)

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2.D.3.i Other solvent use (please specify in the IIR)

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2.K Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)

2.L Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)

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3.B.1.b Manure management - Non-dairy cattle

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3.B.3 Manure management - Swine (Sows+ Fattening pigs)

3.B.4.a Manure management - Buffalo

3.B.4.d Manure management - Goats

3.B.4.e Manure management - Horses

3.B.4.f Manure management - Mules and asses

3.B.4.g.i Manure management - Laying hens

3.B.4.g.ii Manure management - Broilers

3.B.4.g.iii Manure management - Turkeys

3.B.4.g.iv Manure management - Other poultry Ducks+geese

3.B.4.h Manure management - Other animals (please specify in IIR)

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3.D.a.2.b Sewage sludge applied to soils

3.D.a.2.c Other organic fertilizers applied to soils

(including compost)

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3.D.a.4 Crop residues applied to soils

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agricultural products

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5.C.1.b.iii Clinical waste incineration

5.C.1.b.iv Sewage sludge incineration

5.C.1.bv Cremation

5.C.1.b.vi Other waste incineration (please specify in the IIR)

5.C.2 Open burning of waste

5.D.1 Domestic wastewater handling

5.D.2 Industrial wastewater handling

5.D.3 Other wastewater handling

5.E Other waste (please specify in IIR)

6.A Other (included in national total for entire territory) (please specify in IIR)

Executive summary

The Nomenclature for Reporting (NFR) and the Informative Inventory Report 2025 (IIR 2025) contain results of emission inventories for the years from 1990 to 2023, including descriptions of trends, performed QA/QC activities, key categories and uncertainty analysis.

The IIR 2025 fulfils the reporting obligations and the country’s commitments to the UNECE Convention on Long-Range Transboundary Air Pollution. Emissions are recalculated for all categories according to the updated methodology during 2024, the EMEP/EEA air pollutant emission inventory guidebook 2023. The inventory results and the trend of emissions’ changes at the country level for air pollutants are presented in the **Table 1.**

**Table 1. Comparison of pollutant emissions in the period 1990-2023.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pollutant** | **Unit** | **1990** | **1995** | **2000** | **2005** | **2010** | **2015** | **2023** | **2023/ 1990, %** |
| **NOx** | kt | 102,2 | 35,2 | 17,6 | 17,6 | 25,3 | 26,8 | 32,0 | ***-69*** |
| **NMVOC** | kt | 111,7 | 50,8 | 36,9 | 36,9 | 46,1 | 54,2 | 70,2 | ***-37*** |
| **SOx** | kt | 149,3 | 31,5 | 4,1 | 4,1 | 4,0 | 4,11 | 4,80 | ***-97*** |
| **NH3** | kt | 52,9 | 31,9 | 25,9 | 25,9 | 21,8 | 17,94 | 17,21 | ***-67,5*** |
| **PM2.5** | kt | 23,8 | 5,5 | 4,4 | 4,4 | 4,9 | 11,69 | 19,98 | ***-16*** |
| **PM10** | kt | 32,1 | 9,0 | 6,6 | 6,6 | 8,1 | 14,75 | 23,51 | ***-27*** |
| **TSP** | kt | 71,8 | 21,9 | 12,1 | 12,1 | 18,2 | 23,88 | 43,46 | ***-40*** |
| **BC** | kt | 2,2 | 0,7 | 0,5 | 0,5 | 0,6 | 1,31 | 2,08 | ***-7*** |
| **CO** | kt | 313,3 | 82,8 | 48,5 | 48,5 | 59,7 | 90,31 | 123,28 | ***-61*** |
| **Pb** | t | 8,1 | 1,4 | 0,9 | 0,9 | 0,9 | 1,25 | 1,36 | ***-83*** |
| **Cd** | t | 0,45 | 0,19 | 0,14 | 0,14 | 0,14 | 0,23 | 0,36 | ***-21*** |
| **Hg** | t | 0,49 | 0,12 | 0,07 | 0,07 | 0,06 | 0,08 | 0,07 | ***-85,7*** |
| **As** | t | 1,13 | 0,32 | 0,11 | 0,11 | 0,10 | 0,10 | 0,11 | ***-90*** |
| **Cr** | t | 1,34 | 0,33 | 0,16 | 0,16 | 0,16 | 0,39 | 0,62 | ***-54*** |
| **Cu** | t | 3,14 | 0,90 | 0,32 | 0,32 | 0,31 | 0,34 | 0,44 | ***-86,0*** |
| **Ni** | t | 25,58 | 3,90 | 0,68 | 0,68 | 0,43 | 0,24 | 1,25 | ***-95*** |
| **Se** | t | 6,22 | 0,89 | 0,31 | 0,31 | 0,40 | 0,37 | 0,36 | ***-94*** |
| **Zn** | t | 24,32 | 6,11 | 4,12 | 4,12 | 4,27 | 8,83 | 13,69 | ***-44*** |
| **PCDD/F** | g I-TEQ | 41,68 | 10,34 | 10,14 | 10,14 | 8,49 | 16,40 | 20,77 | ***-50*** |
| **Benzo(a) pyrene** | t | 9,18 | 1,09 | 0,90 | 0,90 | 1,08 | 2,15 | 3,00 | ***-67,3*** |
| **Benzo(b) fluoranthene** | t | 13,35 | 1,59 | 1,29 | 1,29 | 1,53 | 2,43 | 3,16 | ***-76*** |
| **Benzo(k) fluoranthene** | t | 5,60 | 1,02 | 0,91 | 0,91 | 0,99 | 1,25 | 1,47 | ***-74*** |
| **Indeno(1,2,3-cd)pyrene** | t | 4,25 | 0,41 | 0,34 | 0,34 | 0,43 | 1,08 | 1,62 | ***-62*** |
| **PAHs, Total** | t | 32,39 | 4,11 | 3,44 | 3,44 | 4,03 | 6,91 | 9,25 | ***-71,5*** |
| **HCB** | kg | 0,52 | 0,19 | 0,05 | 0,05 | 0,07 | 0,13 | 0,15 | ***-70,7*** |
| **PCBs** | kg | 10,25 | 2,66 | 2,81 | 2,81 | 1,25 | 1,81 | 1,20 | ***-88*** |

Comparing the last 2023 year to the base 1990, the general trend of emissions is decreasing. In 2023 the range of emissions is decreasing from 7% to 97%.

CHAPTER 1. INTRODUCTION

The Informative Inventory Report 2025 contains information on country emissions inventory for the period 1990 – 2023. The emissions have been estimated for 25 air pollutants, in the obligatory reporting template (NFR 2014 format):

* Main pollutants (5): NOx, NMVOC, SOx .NH3, CO;
* PM (4): PM2.5, PM10, TSP, BC;
* НМ - Heavy Metals (9): main - Pb, Cd, Hg; other-As, Cr, Cu, Ni, Se, Zn;
* POPs (7): PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno (1,2,3-сd) pyrene, HCB, PCB.

The content of the report is compliant with the template of an Informative Inventory Report to CLRTAP.

For each sector, the report includes, inter alia:

* key categories analysis,
* trends of national totals and NFR key sectors,
* methodology and other information.

## National Inventory Background

The Informative Inventory Report 2025 is performed based on the official public data for the entire country, including the territory of the left bank of the Dniester River. This includes energy, agricultural, transport and industry statistics. The IPCC and international emission factors are used. The report neither contains the grid emissions nor projections. The grid emissions and projections will be presented as spare reports.

Emissions of pollutants from sectors in 2022 were in the following ratios:

Energy: Main Pollutants (5) -71,3%, PM-56,4%. HM-88,2%, PAHs-88,2%, HCB-72,1%, PCB-37,5%;

Industry: Main Pollutants (5) -12,4%, PM-36,8%. HM-3,6%, PCB-61,8%;

Agriculture: Main Pollutants (5) -10%, PM-5,4%;

Waste: Main Pollutants (5) -6,3%, PM-1,4%. HM-8,2%, PAHs-11,8%, HCB-27,9%, PCB-0,7%;

The emissions estimation per sectors are illustrated in the table 1.1, below.

**Table 1.1.** Rates of emissions per sectors in 2022.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Main Pollutants (5), kt | Particulate Matter (4), kt | Heavy metals (9), t | PCDD/ PCDF,  g I-TEQ | PAHs total (1-4), t | HCB,  kg | PCBs,  kg |
| Energy | 172,52 | 55,14 | 15,96 | 17,69 | 8,34 | 0,11 | 0,45 |
| Industry | 37,05 | 26,99 | 0,93 | 0,89 | 0,00 | 0,00 | 0,74 |
| Agriculture | 24,66 | 5,77 | 0,01 | 0,02 | 0,01 | 0,00 | 0,00 |
| Waste | 13,27 | 1,15 | 1,34 | 2,18 | 0,89 | 0,04 | 0,01 |
| **Total** | **247,51** | **89,04** | **18,25** | **20,77** | **9,25** | **0,15** | **1,20** |
| Energy | *69,7* | *61,9* | *87,5* | *85,1* | *90,2* | *73,6* | *37,4* |
| Industry | *15,0* | *30,3* | *5,1* | *4,3* | *0,0* | *0,0* | *61,9* |
| Agriculture | *10,0* | *6,5* | *0,0* | *0,1* | *0,1* | *0,0* | *0,0* |
| Waste | *5,4* | *1,3* | *7,4* | *10,5* | *9,6* | *26,4* | *0,7* |

Dynamics of emissions of Main Pollutants and Particulate Matter for all sectors for the period 1990-2023 with a step of 5 years shows a decreasing trends, in figure. 1.1.

|  |  |
| --- | --- |
|  |  |
|  |  |

**Figure 1.1**. Emissions estimation per sectors -Main pollutants and PM, kt.

Ratio of sector contributions to total emissions for HM and PAHs are shown in Figure 1.2.

|  |  |
| --- | --- |
|  |  |
|  |  |

**Figure 1.2.** Ratio of emissions from sectors (Energy, Industry, Agriculture, Waste) to total emissions for PAHs, HM

Emissions per 1 inhabitant for Main pollutants and PM are shown in Figure 1.3.

|  |  |
| --- | --- |
|  |  |

**Figure 1.3.** Emissions per 1 inhabitant for Main pollutants and PM.

Emissions per capita for HM and PAHs are shown in Figure 1.4.

|  |  |
| --- | --- |
|  |  |

**Figure 1.4.** Emissions per 1 inhabitant for pollutants - HM and PAHs.

## 1.2. Institutional arrangements

The Law on atmospheric air quality was approved by the Government and submitted for further approval by the Parliament. The law transposes partially the Directive 2008/50 / EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, and the Directive 2004/107 / EC of the European Parliament and of the Council of 15 December 2004 relating arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.

The inventory system currently existing in the Republic of Moldova is represented in the Figure 1.3.

Ministry of Environment

Institute of Environmental Agency

Institute of Chemistry, SUM; Institute of Power Engineering, TUM; Institute of Ecology and Geography, SUM

National Bureau of

Statistics

Customs Department

State Departments and institutions

Power&Heating Plants, Factories

Activity Data

**Figure 1.3.** Inventory system in the Republic of Moldova

## 1.3. Inventory preparation process

The emission estimates are based on methodologies elaborated by EMEP/EEA and the IPCC data Guidance [EMEP/EEA air pollutant emission inventory guidebook 2023](https://www.eea.europa.eu/publications/emep-eea-guidebook-2019) and its update categories versions during 2024 is used.

The inventory preparation can be described as follows:

* using the activity data from the official web pages of state institutions and/ or official public registers;
* collected data via official letters signed by the Ministry to the state agencies and entrepreneurs;
* using the research reports, or expert estimates;
* using the emission factors for all categories from EEA/EMEP Emission Inventory Guidebook and IPCC source. The domestic emission factors are not used.

The database is updated and extended to meet the changing requirements for emission reporting. After preparation per sectors, the emission inventory is compiled and verified by the Institute of Power Engineering, in cooperation with the Institute of Ecology and Geography and Institute of Chemistry.

## 1.4. Methods and data sources

***1.4.1. General issues***

The methodology for estimating and reporting emissions is consistent with the “EMEP/EEA air pollutant emission inventory guidebook - 2023”. The pollutants covered by this methodology guide are: SOx (SO2), NOx, NH3, NMVOC, CO, TSP, PM10, PM2.5, Heavy Metals (Cd, Pb, Hg, As, Cr, Cu, Ni, Se, Zn), POPs (HCB, PCB, dioxins / furans) and PAHs.

The annual inventory cycle is carried out in accordance with the principles and procedures which are set out in the UNECE Emission Reporting Guidelines (ECE/EB.AIR/128). The RM emission inventories are compiled according to international good practice guidance for national inventories.

According to the recommendations of the EMEP/EEA 2023 and its update categories versions during 2024, the calculation methods are chosen by considering the available technologies in the Republic of Moldova. The calculation of emissions (E) is basically made by using the formula: E=AD x EF, where the activity data (AD) (fuel consumption, raw material or product, etc.) and emission factors (EF) according Guidelines. Part of the available data (e.g. production data) can be directly entered into the formula above; others required previous processing and conversion. For example, fuel consumption are not always available in the required depth and resolution. After preliminary quality control of the basic data, the necessary calculations are carried out by the core experts’ team. After other necessary QC/QA steps, NFR table is filled and IIR are prepared.

The Republic of Moldova’s IIR is prepared using activity data based on officially published data, (national statistical publications, reports of central public authorities, public sector, scientific literature, and private sector).

The input data were processed in Excel NFR format by applying the reporting formats requested by the UNECE/CRLTAP Secretariat.

Each year, the emission inventories are updated to include the latest data available and new research findings to improve the emission estimation methods. Methodological changes are made to take account of new data sources or new guidance from EMEP/EEA 2023 and its update categories versions during 2024.

## 1.4.2. RM inventory data and methods overview

A summary of calculation methods, emission factors and primary data by sources, category for all sectors is provided in the table 1.2.

**Table 1.2.** Republic of Moldova Emissions’ Inventory Methodologies, NFR categories

| **NFR log name** | **Activity Data** | **Emission Factors** |
| --- | --- | --- |
| 1.A.1.a Public Electricity & Heat Production | RM statistics (Energy balances),  ATULBD statistics (Statistical yearbooks) | Default EFs (2023 EMEP/EEA) |
| 1.A.1.b. Petroleum refining | NE | NE |
| 1.A.1.c Manufacture of solid fuels and other energy industries | NE | NE |
| 1.A.2.a Iron & Steel | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023EMEP/EEA, RM-specific research) |
| 1.A.2.b Non-ferrous Metals | NO | NO |
| 1.A.2.c Chemicals | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.2.d Pulp, Paper & Print | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.2.e Food Processing, Beverages & Tobacco | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.2.f Non-metallic minerals | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.2.g.viii Other | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.3.a.i(i) International Aviation (LTO) | RM statistics (Energy balances, NIR-1990-2020) and estimated for 2020 | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.3.a.ii(i) Civil Aviation (Domestic, LTO) | RM statistics (Energy balances, NIR-1990-2020) and estimated for 2020 | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.3.b Road Transportation | RM statistics (Energy balances, Third National Environmental Indicators Survey (2010, prepared for UNECE), Statistical Yearbooks, ASP.gov.md | Fuel analysis or default EFs (2023 EMEP/EEA and update version from 2024, RM-specific research) |
| 1.A.3.c Railways | RM statistics (Energy balances)  ATULBD statistics (Statistical yearbooks) | Fuel analysis or default EFs (2023 EMEP/EEA, RM-specific research) |
| 1.A.3.d.ii National Navigation | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 1.A.3.e Pipeline | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 1.A.3.b.v Road transport | As 1.A.3.b Road Transportation | Default EFs (2023 EMEP/EEA) |
| 1.A.4.a Commercial / Institutional | RM statistics Energy balances and statistical publications “Social and Economic Development of Transnistria” and "Press- Release Housing". | Default EFs (2023 EMEP/EEA) |
| 1.A.4.b.i Residential | RM statistics Energy balances and statistical publications “Social and Economic Development of Transnistria” and "Press- Release Housing". | Default EFs (2023 EMEP/EEA) |
| 1.A.4.c.i Agriculture/Forestry/Fishing: Stationary | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 1.A.4.c.ii/iii Off-road Vehicles & Other Machinery | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 1.A.5.a Other, Stationary | RM statistics (Energy balances), ATULBD statistics (Statistical yearbooks) | Default EFs (2023 EMEP/EEA) |
| 1.A.5.b Other, Mobile (Including military) | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 1.B.1.a Coal Mining & Handling | NO | NO |
| 1.B.1.b Solid fuel transformation | NO | NO |
| 1.B.1.c Other | NO | NO |
| 1.B.2 Oil & natural gas | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 2.A Mineral Products | Industry & Estimated, RM Statistics (Statistical Yearbooks of ATULBD, SYs of RM, NIR 1990-2019), Official letter of the Inventory team | Default EFs (2023 EMEP/EEA) |
| 2.B Chemical Industry | RM statistics (statistical yearbooks), ATULBD statistics (Statistical yearbooks), Official letter of the Inventory team | Default EFs (2023 EMEP/EEA) |
| 2.C Metal Production | RM statistics (National Inventory Report 1990-2016. SYs of RM and SY of ATULBD) | Default EFs (2023 EMEP/EEA) |
| 2.D Solvents | National Inventory Report 1990-2016, Statistical yearbooks, Industry and state organizations  Statistical Reports PRODMOLD-A and estimated, Official letter of the Inventory team | Default EFs (2023 EMEP/EEA) |
| 2.G Other product use | National Inventory Report 1990-2016. Data collected from SY and estimated based on information on production and the quantity of tobacco in cigarettes and number of cigarettes, and use of footwear, Official letter of the Inventory team | Default EFs (2023 EMEP/EEA) |
| 2.H Pulp and paper industry, Food and beverages industry | National Inventory Report 1990-2016. Data collected from SY and estimated based on information on production | Default EFs (2023 EMEP/EEA) |
| 2.I Wood processing | NA | NA |
| 2.J Production of POPs | NA | NA |
| 2.K Consumption of POPs and heavy metals | NA | NA |
| 2.L Other production, consumption, storage, transportation or handling of bulk products | NA | NA |
| 3.B Manure Management | RM statistics: StatBank and Statistic Yearbooks of ATULBD | Default EFs (2023 EMEP/EEA) |
| 3.D Agricultural Soils | RM statistics (National Bureau of Statistics, Statistic Yearbooks of ATULBD, data from Ministry of Agriculture, Regional Development and Environment) | Default EFs (2023 EMEP/EEA), 2006 IPCC Guidelines |
| 3.F Field Burning of Agricultural Wastes | RM statistics (National Bureau of Statistics, Statistic Yearbooks of ATULBD, data from Ministry of Agriculture, Regional Development and Environment) | Default EFs (2023EMEP/EEA), 2006 IPCC Guidelines |
| 3.I Other | NA | NA |
| 5.A Solid Waste Disposal on Land | Statistical Yearbook of Moldova, Annual Reports on the Activities of the Ministry of Agriculture and Natural Resources of Transnistria | Default EFs (2023 EMEP/EEA) |
| 5.B Biological treatment of waste | NA | NA |
| 5.C Waste Incineration | National Mercury Emissions Inventory, the National Public Health Centre of the Ministry of Health of the Republic of Moldova | Default EFs (2023 EMEP/EEA) |
| 5.D Waste-Water Handling | RM statistics (StatBank) | Default EFs (2023 EMEP/EEA) |
| 5.E Other Waste | RM statistics (National Bureau Statistics) | Default EFs (2023 EMEP/EEA) |
| 6.A Other | NA | NA |
| 1.A.3.a.i(ii) International aviation cruise (civil) | RM statistics (Energy balances) | Default EFs (2023 EMEP/EEA) |
| 1.A.3.d.i(ii) International navigation | RM statistics (Energy balances) and NIR-1990-2020 | Default EFs (2023 EMEP/EEA) |
| Memo1.A.3 Transport (fuel used) | Same as 1.A.3 Road | Default EFs (2023 EMEP/EEA and update version from 2024) |

## 1.5. Key Categories

The purpose of key categories analysis is a quantitative analysis of fluctuations in emissions for one year (levels) and changes in the amount of emissions from year to year (trends) for all categories of sources in total emissions for each pollutant.

Key categories are verified via REPDAB system from the site www. ceip.at for each pollutant separately for all years 1990-2023. The tables for last year – 2023, and for the reference year -1990, are presented below.

1. **2023**

Key categories that contribute most to each pollutant emissions (Level assessment) (category with maximum contribution above 20%):

* 1.A.4.b *Residential: Stationary*: SОx 34,5%; NMVOC 10,3%; CO 71,9%; TSP 38.9%; PM10 68,6%; PM2.5 78.8%; Pb 57.5%; Cd 77,6%; PCDD/F 83,9%; PAHs-72,8%; НСВ -70,2%;
* 1.A.3.b.iii *Road transport: Heavy duty vehicles and buses* NOx 30,8%; CO-6,4%;
* 2.D.3.i *Other solvent use*: NMVOC 21,0 %;
* 3Da1: NH3 50,8%; 3Da2a: NH310,9%;
* 5.C.1.b.iii *Clinical waste incineration*: Hg 23,0%; НСВ -27,6%, table 1.3.

**Table 1.3**. Key Source for 2023 year, Cumulative %

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Component** | **Key categories (Sorted from high to low from left to right)** | | | | | | | **Total (%)** |
| **SOx** | 1A1a (48.3%) | 1A4bi (34.5%) |  |  |  |  |  | 82.6 |
| **NOx** | 1A3biii (30.8%) | 1A1a (20.9%) | 1A4cii (12.9%) | 1A4bi (10.3%) | 3Da1 (9.0%) |  |  | 83.1 |
| **NH3** | 3Da1 (50.8%) | 3Da2a (10.9%) | 3B3 (8.9%) | 3B1a (7.9%) | 5D1 (5.6%) |  |  | 84.1 |
| **NMVOC** | 2D3i (21.0%) | 1A4bi (18.6%) | 5A (11.7%) | 2D3d (10.7%) | 2H2 (9.1%) | 2D3g (5.5%) | 2D3a (5.2%) | 81.8 |
| **CO** | 1A4bi (71.9%) | 1A3bi (6.8%) | 1A3biii (6.4%) |  |  |  |  | 85.1 |
| **TSP** | 1A4bi (38.9%) | 2D3b (23.1%) | 2D3g (19.8%) |  |  |  |  | 81.7 |
| **PM10** | 1A4bi (68.6%) | 2D3b (9.2%) | 3Dс (8.1%) |  |  |  |  | 85.9 |
| **PM2.5** | 1A4bi (78.8%) | 2D3b (10.8%) |  |  |  |  |  | 89.6 |
| **Pb** | 1A4bi (57.5%) | 2A3 (28.6%) |  |  |  |  |  | 86.1 |
| **Hg** | 1A4bi (34.2%) | 5C1biii (23.0%) | 2C1 (12.4%) | 1A4ai (9.7%) | 1A1a (7.7%) |  |  | 87.0 |
| **Cd** | 1A4bi (77.6%) | 2A3 (8.0%) |  |  |  |  |  | 85.6 |
| **DIOX** | 1A4bi (83.9%) |  |  |  |  |  |  | 83.9 |
| **PAH** | 1A4bi (72.8%) | 2D3g (16.4%) |  |  |  |  |  | 89.3 |
| **HCB** | 1A4bi (70.2%) | 5C1biii (27.6%) |  |  |  |  |  | 97.8 |

The table also indicates other key categories, the contribution of which, although smaller, is still significant (presented in descending order of contribution). Together, these categories make 80% of emissions for each pollutant (cumulative contribution with accumulation), Table 1.3.

Analysis of the table can be carried out as follows:

For example, there are five key categories for NOx (in descending order of contribution to total emissions):

* 1.A.1.a *Public electricity and heat production* 20,9%,
* 1.A.4.c.ii *Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* 12,9%,
* 1.A.3.b.i *Road transport: Passenger cars* 10,3%,
* 1.A.4.b.i *Residential: Stationary* 10,3%,
* 3.D.a.1 *Inorganic N-fertilizers* 8,4%,
* 1.A.3.b.iii *Road transport: Heavy duty vehicles and buses* 30,8%.

The cumulative contribution of these categories is 82,8% in NOx emissions.

The largest contribution is made by category 1.A.3.b.iii *Road transport: Heavy duty vehicles and buses* 30,8%.

1. **1990**

**Table 1.4**. Key Source for 1990 year, Cumulative %

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Component** | **Key categories (Sorted from high to low from left to right)** | | | | | | | | | | | **Total (%)** |
| **SOx** | 1A1a (68.6%) | 1A4bi (21.1%) |  |  |  |  |  |  |  |  |  | 89.7 |
| **NOx** | 1A1a (38.6%) | 1A4cii (13.2%) | 1A3biii (9.4%) | 1A2f (7.2%) | 1A3c (6.6%) | 1A4bi (4.6%) | 3Da1 (3.6%) |  |  |  |  | 83.3 |
| **NH3** | 3Da2a (22.4%) | 3Da1 (14.9%) | 3B3 (14.8%) | 3B1a (13.6%) | 3B1b (10.3%) | 3Da2c (8.4%) |  |  |  |  |  | 84.3 |
| **NMVOC** | 1A4bi (15.8%) | 3B3 (12.4%) | 2H2 (11.9%) | 2D3d (9.0%) | 5A (7.4%) | 2D3a (4.7%) | 3B1a (4.7%) | 2D3g (4.2%) | 3B1b (4.0%) | 3B4gi (3.6%) | 1A3bi (3.4%) | 81.1 |
| **CO** | 1A4bi (53.1%) | 1A3bii (10.7%) | 1A3aii(i) (9.1%) | 1A3bi (7.6%) |  |  |  |  |  |  |  | 80.4 |
| **TSP** | 2D3b (23.8%) | 1A4bi (23.1%) | 2D3g (20.4%) | 3B4gi (6.5%) | 1A1a (5.8%) | 2A2 (4.5%) |  |  |  |  |  | 84.0 |
| **PM10** | 1A4bi (47.1%) | 2D3b (11.4%) | 1A1a (9.1%) | 1A4ai (4.6%) | 2A2 (3.9%) | 3B4gi (3.1%) | 3Dc (2.9%) |  |  |  |  | 82.1 |
| **PM2.5** | 1A4bi (62.6%) | 1A1a (8.7%) | 1A4ai (5.7%) | 1A4cii (3.1%) |  |  |  |  |  |  |  | 80.2 |
| **Pb** | 1A4bi (56.7%) | 1A4ai (19.9%) | 1A1a (11.6%) |  |  |  |  |  |  |  |  | 88.3 |
| **Hg** | 1A4bi (37.2%) | 1A1a (28.4%) | 1A4ai (19.3%) |  |  |  |  |  |  |  |  | 84.9 |
| **Cd** | 1A1a (39.0%) | 1A4bi (15.2%) | 2G (10.3%) | 1A4cii (8.6%) | 2A3 (7.9%) |  |  |  |  |  |  | 81.0 |
| **DIOX** | 1A4bi (69.6%) | 5E (11.3%) |  |  |  |  |  |  |  |  |  | 80.8 |
| **PAH** | 1A4bi (79.2%) | 2D3g (8.7%) |  |  |  |  |  |  |  |  |  | 88.0 |
| **HCB** | 1A1a (88.3%) |  |  |  |  |  |  |  |  |  |  | 88.3 |

The key categories in the period 1990-2023 are as follows:

* 1.A.1 *Public electricity and heat production*,
* 1.A.4.a *Commercial/Institutional sector*,
* 1.A.3.b *Road Transport*, *Heavy duty vehicles and buses*
* 1.A.4.b *Residential: Stationary*,
* 1.A.4.c.ii *Agriculture/Forestry/Fishing: Off-road vehicles and other machinery*,
* 2.A.3 *Glass production*,
* 2.D.3.i *Other solvent use*,
* 3.B.1. *Manure management - Dairy cattle*,
* 3.B.3 *Manure management - Swine (Sows+ Fattening pigs)*,
* 3.D.a.2.a *Animal manure applied to soils*.

## 1.6. QA/QC and Verification methods

### 1.6.1. Requirements for control procedures and quality assurance

QA/QC procedures recommended in EMEP/EEA 2023 and its update categories versions are carried out at all stages of the calculation of the entire list of pollutants. Pollutant emissions, according to CLRTAP goals, are expressed in absolute pollutant emissions, and presented in dynamics for the period 1990-2023.

The inventory has an annual reporting cycle. Primary data have a wide and diverse coverage and include:

* Energy statistics;
* Industry data (production, technology);
* Agricultural statistics;
* Transport statistics;
* Demographic data and other information.

Data was detailed for several categories previously represented by total values. The *geographical coverage* of the categories of emission sources in both regions (Right and the Left Bank of the Dniester River) has significantly expanded. A few categories of the Energy module IIR-1990-2023 include fact information on the Left Bank region, and set of data was reconstructed from indirect data using recovery methods according to EMEP-2023.

New primary information for 2023 was collected, during which requests for data collection were sent to the economic enterprises, and then the received answers were processed.

*Timeliness:* Inventory team recalculated emissions based on updated activity data in the RM for the 1990-2023 period.

The *key requirements* that must be met to achieve data quality objectives are as follows:

1. *Transparency:*

* Presence of reference to sources;
* Description of the method;
* Description of Trends;
* Description of subsectors;
* Carrying out a complete cycle of inventory;
* Considering recommendations of international experts.

1. *Consistency:*

* Identification of “outlier” points;
* Comparison with data presented in other studies;
* Comparison with independent statistical data.

1. *Comparability*:

* Analysis of results obtained by subsector and aggregates;
* Chart shares of sector’s contribution to overall pollution;
* Comparison of emission factors with other countries.

1. *Completeness:*

* Maximum consideration of all the recommendations on time series, factors;
* Correct designation of lacking figures in the tables using allowed symbols;
* Providing, where appropriate, sectorial background data.

1. *Accuracy:*

* Use of more advanced techniques;
* Reporting of uncertainties.

### 1.6.2. Quality control procedures carried out in the current cycle

According to the list of key requirements, the following quality control procedures have been completed in the current cycle:

* + - 1. **Transparency**:
* *Presence of reference to sources*: Provides links to sources of primary data, applied emission factors, selected methods for calculating emissions.
* *Description of the method*: The methodology for calculating emissions is described for each category, the necessary formulas, algorithms, and links to sources are given. The methodologies and emission factors for EMEP/EEA -2023 and its last update versions from 2024 were used.
* *Description of Trends*: For all the categories, the series of primary data in the necessary units of measurement are built. There are several graphs that reflect the series of data on activity. Graphs and charts of calculated emissions are given for all categories, the dynamics of their changes, % reduction/growth of pollutant emissions, contribution to total quantities, shares of category emissions in 1990 and 2023 are described, a comparison with the base (1990) year is made.
* *Carrying out a complete cycle of inventory*: The inventory cycle was completed according to the plan and the main stages. A description of the categories was made. A choice of methodology for calculating emissions, a choice of emission factors, collection and preparation, double-checking data, preparing series of primary data, calculation of emissions for all categories, the implementation of the necessary auxiliary research work in the preparation of series of primary data (the use of several methods of recovering values), the calculation of uncertainties, calculations of key categories with REPDAB system, preparation of NFR, preparing IIR-books, documentation, archiving of all information by sector, identification of opportunities for further improvement of inventory in the future were made.
* *Considering recommendations of international experts*. The recommendations of international experts received in 2016, 2018 Review were studied, most of the recommendations were applied during three last circle. 
  + - 1. **Consistency:**
* *Completion of data series.* In the current cycle, the data for 2021-2023 have been collected, documented, systematized, used in the calculations. The data were checked for consistency with previous values in the time series for each category.
* *Comparison with data presented in other studies*: In preparing the work, the study of NFR, IIR of other countries was carried out, which allowed us to use the useful experience of other countries, to outline ways for further improvement in the future.
  + - 1. **Comparability:**
* *Analysis of results* obtained by subsector and aggregates: aggregation was performed for sectors with detailed data, for example, by type of fuel, by type of vehicle, etc., the national emission values of each pollutant were also summed for the 4 considered sectors.
* *Comparison* of emission factors *with other countries*: emission factors are used by default according to the EMEP/EEA 2023 guidelines and its update categories units. In the process of studying the IIR of other countries, a comparison was made of the applied methodology and emission factors, the useful experience of other countries was documented.
  + - 1. **Completeness:**

*Maximum consideration of all the recommendations on time series, factors:*

* the work was done to improve geographical coverage in the data on activities of the regions;
* the list of categories has also expanded additionally.
  + - 1. **Accuracy:**
* *Use of more advanced techniques*: key categories were calculated using REPDAB system.
* *Reporting of uncertainties*: uncertainties are calculated according to the EMEP/EEA 2023 methodology, % of uncertainties of EF and AD are documented in tables, and results of calculation tables for all pollutants are given in the special table below.

### 1.6.3. QA/QC Plan

The expert team conduced quality and technical procedures described in the Guidebook, Chapter “Inventory management, improvement and QA/QC”.

These actions are reflected in the diagram below in the form of a plan in which the quality assurance procedures, quality control procedures, the timeline of the inventory process for the months of the year (one cycle), documents for presenting the results, archiving procedures are highlighted (Figure 1.6).

**Quality Assurance**

*Januaty, February*

*April, May*

Categories 2A,2B, 2D and other

Categories 5A, 5B and other

Categories 3B 3F and other

Waste Sector

Agriculture Sector

Industry Sector

**QA activities**

* Peer reviews

Review emissions factors & methods ***April, May***

Quality Control

*January, February*

Main Activity-

*from May until* *March next year*

* Unique reference
* Check data input- *January, February*

* Referencing of input data
* Check units
* Time series consistency
* Cross check

Plan QA/QC procedures *January, February*

**Data collection-**

*June- September*

**Emission Calculation**

*July-September October-January December*

Data

base entry-*Jan-uary*

February

February

* Check database NFR
* NFR totals
* Check large changes from previous year

*January, February, March*

* Time series
* Check Emissions of

Pollutants

* Check Total
* Analyses large changes
* Database fuels
* Using National statistics

*January, February, March*

* Check tables and numbers
* Cross check all sectors

*February, March*

* Database fuel
* Spreadsheet files
* Source data
* Guides (units)
* Reports
* Excel work files

*April*

Out

put

(**NFR**)- *January-February*

**Informative Inventory**

**Report Preparation-**

*March*

**Archiving-**

*during whole circle final -April*

**Key**

Documentation *April*

Checking

External Check

Energy Sector

Categories 1А-1B

QA

Categories 1A,1B

**Figure 1.6.** QA/QC plan process conducted in the current inventory cycle

## 1.7. General uncertainty evaluation

Uncertainties were calculated according to the methodology described in Chapter 5 “Uncertainties” of the 2023 EMEP/EEA Guidebook and include estimates of uncertainties arising from imperfect emission factors (sensitivity of type A) and activity data (sensitivity of type B).

Calculation algorithm implemented in the form of a special calculation table, where for each category the uncertainty in the current year and the uncertainty trend for the study period are calculated.

The following are necessary for the calculation:

1) initial spread ranges for emission factors for each sector and category;

2) ranges showing the degree of accuracy of initial data.

They vary significantly across sectors and categories. Therefore, it is necessary to calculate the total aggregate uncertainties for the received emissions of each pollutant for the current year and trend. The determination of these quantities is the goal of calculating the uncertainties. According to the EMEP/EEA 2023 methodology, the uncertainties for activity data based on national statistics with annual updates are in the range of 0-2%. When using other statistical sources, this value is slightly higher (Table 1.6).

**Table 1.6.** Indicative error ranges in activity data for uncertainty analysis

|  |  |  |
| --- | --- | --- |
| **Data source** | **Error range** | **Remarks** |
| The national (official) statistics | 0-2% | The official statistics of a country may be reported with an uncertainty range, although it is also common for the data to be assumed to be ‘fixed’, with no uncertainty. However, for energy data an indication of the uncertainties could be derived from the entry under ‘statistical differences’, representing the mismatch between production and consumption. |
| An update of last year’s statistics, using gross economic growth factors | 0-2% | The economic system of a country will probably not shift more than a few per cent between successive years. Hence, if an update of last year’s data is used, an uncertainty of a few per cent seems reasonable. |
| IEA Energy statistics/balances | OECD: 2-3%,  non-OECD: 5-10% | The International Energy Agency (IEA) publishes national energy statistics and balances for many countries. For the Organization for Economic Co-operation and Development (OECD) countries, these statistics will ideally be equal to the official energy statistics. For other countries, the uncertainties could be expected to range from 5% to 10% (educated guess). |
| UN statistical databases | 5-10% | These data might have a similar uncertainty as the ones provided by IEA. |
| Default values, other sectors, and data sources | 30-100% |  |

Source: EMEP/EEA 2019, Table 2-1, p.8. Indicative error ranges in activity data for uncertainty analysis, Volume “A5 Uncertainties 2019”.

The ranges of variation in the emission factors vary significantly among pollutants (Table 1.7).

**Table 1.7**. Rating definitions

|  |  |  |
| --- | --- | --- |
| **Rating** | **Definition** | **Typical error range** |
| A | An estimate based on many measurements made at a large number of facilities or individual sources across a comprehensive range of operating conditions that fully represent the sector | 10 to 30% |
| B | An estimate based on many measurements made at a large number of facilities or individual sources across a range of operating conditions that represent a large part of the sector | 20 to 60% |
| C | An estimate based on a number of measurements made at a small number of representative facilities or individual sources across a smaller range of operating conditions, or an engineering judgement based on a number of relevant facts. An estimate based on a large number of measurements across a range of conditions for a source, which is complex and/or variable. | 50 to 200% |
| D | An estimate based on single measurements, or an engineering calculation derived from a number of relevant facts. An estimate based on a large number of measurements across a range of conditions for a source, which is particularly complex and/or variable. | 100 to 300% |
| E | An estimate based on an engineering calculation derived from assumptions only.  An estimate based on a limited number of measurements for a source, which is particularly complex and/or variable. | 0 |

Source: EMEP/EEA 2019, Table 2-2, p.9, Rating definitions, Volume “A5 Uncertainties 2019”.

**Table 1.8**. Uncertainty ranges for default emission factors by category and pollutant

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NFR** | **SOURCE CATEGORY** | **SO2** | **NOx** | **VOC** | **CO** | **NH3** | **PM** | **HM/POPs** |
| 1.A.1 | Public power, cogeneration, and district heating | A | B | C | B | E | C | D |
| 1.A.2 | Industrial combustion | A | B | C | B | E | C | D |
| 1.A.3.b | Road transport | A | C | C | C | E | C | E |
| 1.A.3.a, 1.A.3.c, 1.A.3.d, 1.A.3.e | Other mobile sources and machinery | B | D | D | D | E | D | E |
| 1.A.4 | Commercial, institutional, and residential combustion | A | C | C | C | E | D | E |
| 1.B | Extraction and distribution of fossil fuels | C | C | C | C | D | E | |
| 2 | Industrial processes | B | C | C | C | E | C | E |
| 3 | Solvent use | B | D | E | | | | |
| 4 | Agriculture activities | D | D | D | D | E | E | |
| 5.A, 5.B | Waste treatment | B | B | B | C | C | D | |
| 5.C | Waste disposal activities | C | C | C | C | E | C | E |

Source: EMEP/EEA 2019, Table2-3, p.10. Rating definitions, Volume “A5 Uncertainties 2019”.

**Table 1.9**. Main NFR source categories with applicable quality data ratings

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NFR** | **SOURCE CATEGORY** | **NOx** | | | **VOC** | | | **SOx** | | |
| 1.A.1 | Public power, cogeneration, and district heating | B | 20-60% | 20 | C | 50-200% | 50 | A | 10-30% | 10 |
| 1.A.2 | Industrial combustion | B | 20-60% | 20 | C | 50-200% | 50 | A | 10-30% | 10 |
| 1.A.3.b | Road transport | C | 50-200% | 50 | C | 50-200% | 50 | A | 50-200% | 50 |
| 1.A.3.a, 1.A.3.c, 1.A.3.d, 1.A.3.e | Other mobile sources and machinery | D | 100-300% | 100 | D | 100-300% | 100 | C | 50-200% | 50 |
| 1.A.4 | Commercial, institutional and residential combustion | C | 50-200% | 50 | C | 50-200% | 50 | B | 20-60% | 20 |
| 1.B | Extraction and distribution of fossil fuels | C | 50-200% | 50 | C | 50-200% | 50 | C | 50-200% | 50 |
| 2 | Industrial processes | C | 50-200% | 50 | C | 50-200% | 50 | B | 20-60% | 20 |
| 3 | Solvent use | C | 50-200% | 50 | B | 20-60% | 20 | - | - | - |
| 4 | Agriculture activities | D | 100-300% | 100 | D | 100-300% | 100 | - | - | - |
| 5.A ; 5.B | Waste treatment | B | 20-60% | 20 | B | 20-60% | 20 | - | - | - |
| 5.C | Waste disposal activities | C | 50-200% | 50 | C | 50-200% | 50 | C | 50-200% | 50 |

*continued*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NFR** | **SOURCE CATEGORY** | **NH3** | | | | | **CO** | | | **HM/POPs** | | | **РМ** | | | |
| 1.A.1 | Public power, cogeneration, and  district heating | - | - | - | B | 20-60% | | 20 | D | | 100-300% | 100 | | С | 50-200% | 50 |
| 1.A.2 | Industrial combustion | - | - | - | B | 20-60% | | 20 | D | | 100-300% | 100 | | С | 50-200% | 50 |
| 1.A.3.b | Road transport | E | order | 300 | C | 50-200% | | 50 | E | | order | 300 | | D | 100-300% | 100 |
| 1.A.3.a, 1.A.3.c, 1.A.3.d, 1.A.3.e | Other mobile source  s and machinery | - | - | - | D | 100-300% | | 100 | E | | order | 300 | | D | 100-300% | 100 |
| 1.A.4 | Commercial, institutional, and residential combustion | - | - | - | C | 50-200% | | 50 | E | | order | 300 | | D | 100-300% | 100 |
| 1.B | Extraction and distribution of fossil fuels | - | - | - | C | 50-200% | | 50 | E | | order | 300 | | D | 100-300% | 100 |
| 2 | Industrial processes | E | order | 300 | C | 50-200% | | 50 | E | | order | 300 | | С | 50-200% | 50 |
| 3 | Solvent use | E | order | 300 | - | - | | - | E | | order | 300 | | D | 100-300% | 100 |
| 4 | Agriculture activities | D | 100-300% | 100 | D | 100-300% | | 100 | E | | order | 300 | | E | order | 300 |
| 5.A; 5.B | Waste treatment | - | - | - | C | 50-200% | | 50 | D | | 100-300% | 100 | | С | 50-200% | 50 |

For some categories, there are special instructions on the application of values from the ranges of scatter for domestic aviation, railway transport (Table 1.10).

**Table 1.10.** Summary information on % of uncertainties in activity data and emission factors for a list of categories

| **Category** | **NOx** | | **NMVOC** | | **SOx** | | **NH3** | | **РМ2.5, PМ10, TSP** | | **CO** | | **Heavy metals, POPs** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | % AD | % EF | % AD | % EF | % AD | % EF | % AD | % EF | % AD | % EF | % AD | % EF | % AD | % EF |
| 1.А.1 | 5 | 20 | 5 | 20 | 5 | 10 |  |  | 5 | 50 | 5 | 20 | 5 | 100 |
| 1.А.2 | 5 | 20 | 5 | 20 | 5 | 10 |  |  | 5 | 50 | 5 | 20 | 5 | 100 |
| 1.А.3.а | 5 | 30 | 5 | 30 | 5 | 50 |  |  | 5 | 100 | 5 | 100 | 5 | 300 |
| 1.А.3.b | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 1.A.3.c | 5 | 100 | 5 | 100 | 5 | 50 |  |  | 5 | 100 | 5 | 100 | 5 | 300 |
| 1.A.3.d | 30 | 40 | 30 | 40 | 30 | 50 |  |  | 30 | 100 | 30 | 100 | 30 | 300 |
| 1.A.3.е | 5 | 100 | 5 | 100 | 5 | 50 |  |  | 5 | 100 | 5 | 100 | 5 | 300 |
| 1.A.4 | 5 | 50 | 5 | 50 | 5 | 20 |  |  | 5 | 100 | 5 | 50 | 5 | 300 |
| 1.A.5 | 5 | 50 | 5 | 50 | 5 | 20 |  |  | 5 | 100 | 5 | 50 | 5 | 300 |
| 1.В.2 | 5 | 50 | 5 | 50 | 5 | 50 |  |  | 5 | 100 | 5 | 50 | 5 | 300 |
| 2.A | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.B | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.C | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.D |  |  | 5 | 20 |  |  |  |  | 5 | 100 |  |  | 5 | 300 |
| 2.G | 5 | 50 | 5 | 20 |  |  | 5 | 300 | 5 | 100 |  |  | 5 | 300 |
| 2.H | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.I | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.J | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.K | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 2.L | 5 | 50 | 5 | 50 | 5 | 20 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 3.B.1 | 5 | 100 | 5 | 100 |  |  | 5 | 100 | 5 | 300 | 5 | 100 | 5 | 300 |
| 3.B.2 | 7 | 100 | 7 | 100 |  |  | 7 | 100 | 7 | 300 | 7 | 100 | 5 | 300 |
| 3.B.3 | 20 | 100 | 20 | 100 |  |  | 20 | 100 | 20 | 300 | 20 | 100 | 5 | 300 |
| 3.B.4.a-f | 5 | 100 | 5 | 100 |  |  | 5 | 100 | 5 | 300 | 5 | 100 | 5 | 300 |
| 3.B.4.g-h | 10 | 100 | 10 | 100 |  |  | 10 | 100 | 10 | 300 | 10 | 100 | 5 | 300 |
| 3.D.a-f | 5 | 100 | 5 | 100 |  |  | 5 | 100 | 5 | 300 | 5 | 100 | 5 | 300 |
| 3.F | 5 | 100 | 5 | 100 | 5 | 100 | 5 | 100 | 5 | 300 | 5 | 100 | 5 | 300 |
| 3.I | 5 | 100 | 5 | 100 |  |  | 5 | 100 | 5 | 300 | 5 | 100 | 5 | 300 |
| 5.A | 5 | 20 | 5 | 20 |  |  |  |  | 5 | 50 | 5 | 50 | 5 | 100 |
| 5.B | 5 | 20 | 5 | 20 |  |  |  |  | 5 | 50 | 5 | 50 | 5 | 100 |
| 5.C.1 | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 5.C.2 | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 5.D.1 | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 5.D.2 | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 5.D.3 | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 5.E | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |
| 6.A | 5 | 50 | 5 | 50 | 5 | 50 | 5 | 300 | 5 | 50 | 5 | 50 | 5 | 300 |

Uncertainty calculation tables are given in Annex 1.4. The generalized values of combined uncertainty and uncertainty introduced into the trend for all pollutants are given in Table 1.11.

**Table 1.11.** Calculated combined uncertainty and uncertainty introduced into the trend in total national emissions for all pollutants.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Pollu-**  **tant** | **Combined uncertainty as % of total national emissions in year t** | **Uncertainty introduced into the trend in total national emissions** | **Pollutant** | **Combined uncertainty as % of total national emissions in year t** | **Uncertainty introduced into the trend in total national emissions** |
|  | % | % |  | % | % |
| **NOx** | 18,442 | 4,116 |  |  |  |
| **NMVOC** | 12,478 | 7,279 | **Cr** | 235,384 | 68,239 |
| **SOx** | 11,013 | 0,231 | **Cu** | 162,900 | 10,455 |
| **NH3** | 56,491 | 13,118 | **Ni** | 86,252 | 1,467 |
| **PM2.5** | 78,456 | 16,571 | **Se** | 200,350 | 8,395 |
| **PM10** | 72,526 | 20,615 | **Zn** | 235,035 | 77,160 |
| **TSP** | 51,129 | 15,216 | **PCDD** | 249,999 | 27,037 |
| **BC** | 73,961 | 31,014 | **Benzo(a)pyrene** | 275,386 | 6,281 |
| **CO** | 36,037 | 5,601 | **Benzo(b)fluoranthene** | 256,322 | 5,969 |
| **Pb** | 178,692 | 12,632 | **Benzo(k)fluoranthene** | 224,149 | 16,712 |
| **Cd** | 224,045 | 144,359 | **Indeno(1,2,3-cd)pyrene** | 293,226 | 8,114 |
| **Hg** | 111,466 | 10,832 | **HCB** | 216,991 | 63,406 |
| **As** | 140,679 | 12,653 | **PCBs** | 196,157 | 21,064 |

Chapter 2: REPUBLIC OF MOLDOVA EMISSION TRENDS OF POLLUTANTS

Total emissions of pollutants for the 1990-2023 period are summarized in the Table 2.1.

Pollutant emissions were significantly reduced in 2023 compared to 1990 levels, namely:

* *Main Pollutants*:
* NOx decreased from 102 to 32 kt;
* NMVOC decreased from 111,7 to 70,2 kt;
* SOx decreased from 149,3 to 4,80 kt;
* NH3 decreased from 52,9 to 17,2 kt;
* CO decreased from 313,0 to 123,3 kt.
* *Particulate Matter:*
* PM2,5 decreased from 23,8 to 19,9 kt;
* PM10 decreased from 32,1 to 23,5 kt;
* TSP decreased from 71,8 to 43,5 kt;
* BC decreased from 2,2 to 2,08 kt.
* *Heavy metals (main):*
* Pb decreased from 8,1 to 1,36 t; Cd decreased from 0,45 to 0,36 t;
* Hg decreased from 0,49 to 0,07 t.
* *POPs*
* PCDD/F decreased from 41,7 to 20,8 g I-TEQ.
* Group PAHs:
* Benzo(a)pyrene decreased from 9,18 to 3,0 t;
* Benzo(b)fluoranthene decreased from13,3 to 3,1 t;
* Benzo(k)fluoranthene decreased from 5,60 to 1,47 t;
* Indeno(1,2,3-cd) pyrene decreased from 4,25 to 1,62 t;
* HCB decreased from 0,52 to 0,15 kg; PCBs decreased from 10,25 to 1,2 kg.

The ranking average for 2023/1990 is shown in a separate column.

**Table 2.1.** Total emission trends and pollutants average ranking (25- most polluting, 1-least)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pollutant** | **Unit** | **1990** | **1995** | **2000** | **2005** | **2010** | **2015** | **2023** | **2023/ 1990, %** | **Ranking** |
| **NOx** | kt | 102,2 | 35,2 | 17,6 | 17,6 | 25,3 | 26,8 | 32,0 | ***-69*** | 13 |
| **NMVOC** | kt | 111,7 | 50,8 | 36,9 | 36,9 | 46,1 | 54,2 | 70,2 | ***-37*** | 22 |
| **SOx** | kt | 149,3 | 31,5 | 4,1 | 4,1 | 4,0 | 4,11 | 4,80 | ***-97*** | 1 |
| **NH3** | kt | 52,9 | 31,9 | 25,9 | 25,9 | 21,8 | 17,94 | 17,21 | ***-67,5*** | 14 |
| **PM2.5** | kt | 23,8 | 5,5 | 4,4 | 4,4 | 4,9 | 11,69 | 19,98 | ***-16*** | 25 |
| **PM10** | kt | 32,1 | 9,0 | 6,6 | 6,6 | 8,1 | 14,75 | 23,51 | ***-27*** | 23 |
| **TSP** | kt | 71,8 | 21,9 | 12,1 | 12,1 | 18,2 | 23,88 | 43,46 | ***-40*** | 21 |
| **BC** | kt | 2,2 | 0,7 | 0,5 | 0,5 | 0,6 | 1,31 | 2,08 | ***-7*** | 26 |
| **CO** | kt | 313,3 | 82,8 | 48,5 | 48,5 | 59,7 | 90,31 | 123,28 | ***-61*** | 17 |
| **Pb** | t | 8,1 | 1,4 | 0,9 | 0,9 | 0,9 | 1,25 | 1,36 | ***-83*** | 8 |
| **Cd** | t | 0,45 | 0,19 | 0,14 | 0,14 | 0,14 | 0,23 | 0,36 | ***-21*** | 24 |
| **Hg** | t | 0,49 | 0,12 | 0,07 | 0,07 | 0,06 | 0,08 | 0,07 | ***-85,7*** | 7 |
| **As** | t | 1,13 | 0,32 | 0,11 | 0,11 | 0,10 | 0,10 | 0,11 | ***-90*** | 4 |
| **Cr** | t | 1,34 | 0,33 | 0,16 | 0,16 | 0,16 | 0,39 | 0,62 | ***-54*** | 18 |
| **Cu** | t | 3,14 | 0,90 | 0,32 | 0,32 | 0,31 | 0,34 | 0,44 | ***-86,0*** | 6 |
| **Ni** | t | 25,58 | 3,90 | 0,68 | 0,68 | 0,43 | 0,24 | 1,25 | ***-95*** | 2 |
| **Se** | t | 6,22 | 0,89 | 0,31 | 0,31 | 0,40 | 0,37 | 0,36 | ***-94*** | 3 |
| **Zn** | t | 24,32 | 6,11 | 4,12 | 4,12 | 4,27 | 8,83 | 13,69 | ***-44*** | 20 |
| **PCDD/F** | g I-TEQ | 41,68 | 10,34 | 10,14 | 10,14 | 8,49 | 16,40 | 20,77 | ***-50*** | 19 |
| **Benzo(a) pyrene** | t | 9,18 | 1,09 | 0,90 | 0,90 | 1,08 | 2,15 | 3,00 | ***-67,3*** | 15 |
| **Benzo(b) fluoranthene** | t | 13,35 | 1,59 | 1,29 | 1,29 | 1,53 | 2,43 | 3,16 | ***-76*** | 9 |
| **Benzo(k) fluoranthene** | t | 5,60 | 1,02 | 0,91 | 0,91 | 0,99 | 1,25 | 1,47 | ***-74*** | 10 |
| **Indeno(1,2,3-cd)pyrene** | t | 4,25 | 0,41 | 0,34 | 0,34 | 0,43 | 1,08 | 1,62 | ***-62*** | 16 |
| **PAHs, Total** | t | 32,39 | 4,11 | 3,44 | 3,44 | 4,03 | 6,91 | 9,25 | ***-71,5*** | 11 |
| **HCB** | kg | 0,52 | 0,19 | 0,05 | 0,05 | 0,07 | 0,13 | 0,15 | ***-70,7*** | 12 |
| **PCBs** | kg | 10,25 | 2,66 | 2,81 | 2,81 | 1,25 | 1,81 | 1,20 | ***-88*** | 5 |

\*) Reduction of PAHs emissions, Total (4 pollutants) in the aggregate has a rank of 13th place, but each substance separately (Benzo (a) pyrene Benzo (b) fluoranthene Benzo (k) fluoranthene Indeno (1,2,3-cd) pyrene) has its own rank shown in the table.

Emission reduction/growth (2023/1990) of each pollutant are shown in the Figure 2.1a.

|  |
| --- |
|  |
| **Figure 2.1a.** Reduction of pollutant emissions in 2023 compared to 1990, % |

The graphs below show the emission trends of pollutants by groups: main pollutants, heavy metals, POPs (Figures 2.1b, 2.1c and 2.1d).

|  |
| --- |
|  |
|  |
| **Figure 2.1b.** Main pollutants National Emissions trends (1990=1). |
| **Figure 2.1c**. Heavy metals National Emissions trends (1990=1). |
|  |
| **Figure 2.1d.** POPs National Emissions trends (1990=1). |

Emission Trends are of two types:

i) decrease in the whole time series;

ii) time series for 1990-2023 emissions are divided into 3 sections:

1st section is a trend of sharp decline,

2nd section is a constant trend of emissions in a certain quantitative range, and

3rd section is a growth trend.

### 

### Nitrogen oxides (NOx)

NOx emissions tend to fall sharply in the period 1990-2023 from 102 kt to 32,0 kt, (Fig. 2.2).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **NOx (as NO2),kt** | **NOx (as NO2),kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 39,5 | 6,0 | *18,8* |
| 1A3biii | Road transport: Heavy duty vehicles and buses | 9,6 | 8,9 | *27,6* |
| 1A4bi | Residential: Stationary | 4,7 | 2,0 | *6,2* |
| 1A4cii | Agriculture/Forestry/Fishing: Off-road vehicles and other machinery | 13,5 | 3,7 | *11,5* |
| Other | Other categories | 34,8 | 11,5 | *35,8* |
|  | Total | 102,2 | **32,0** | *100,0* |

**Figure 2.2.** Trends in NOx emissions in the 1990-2023 period, by categories, kt.

The structure of category contributions has changed towards decreasing the share of *1.A.1.a Public electricity and heat production* from 39,5% to 18,8% and decreasing the share of *1.A.3.b.iii Road transport: Heavy duty vehicles and buses* (N2-N3 trucks, and M2-M3 buses) from 9,6% to 8,9% (1990/2023).

The share of category *1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* decreased from 13,5% to 11,5% (1990/2023). All *other* categories make a total contribution to NOx emissions decreasing the share from 34,8% (1990) to 11,5% (2023) (Figure 2.3).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
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### Non-methane volatile organic compounds (NMVOC)

Total NMVOC emissions decreased from 111,7 kt to 70,0 kt (2023/1990).

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| --- | --- | --- | --- | --- |
|  |  | **NMVOC, kt** | **NMVOC, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4bi | Residential: Stationary | 17,7 | 12,8 | *18,2* |
| 2D3a | Domestic solvent use including fungicides | 5,2 | 3,5 | *5,0* |
| 2D3d | Coating applications | 10,0 | 7,3 | *10,4* |
| 2D3i | Other solvent use (please specify in the IIR) | 3,1 | 14,4 | *20,5* |
| 2H2 | Food and beverages industry | 13,3 | 6,2 | *8,9* |
| 3B1a | Manure management - Dairy cattle | 5,2 | 1,0 | *1,4* |
| 5A | Biological treatment of waste - Solid waste disposal on land | 8,3 | 8,0 | *11,5* |
| Other | Other categories | 48,9 | 16,8 | *24,0* |
|  | Total | 111,7 | 70,2 | *100,0* |

They had a declining trend between 1990 and 2023, followed by a slow growth (Figure 2.4).

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| **Figure 2.4.** Trends in NMVOC emissions in the 1990-2023 period, by categories, kt. |

The following categories make the largest contribution of NMVOC emissions (1990/2023):

1. with a growing trend in emissions:

* *2.D.3.i Other Solvents Use* – 3 kt and 14 kt - the largest increase;

1. with a downward trend in emissions:

* *1.A.4.b.i Residential: Stationary* – from 17,7 kt to 12,8 kt;
* *2.D.3.d Coating applications* – from 10 kt to 7 kt;
* *2.H.2 Food and Beverages Industry* – from 13 kt to 6 kt;
* *3.B.1.a Manure Management*- daily cattle from 5 kt to 1 kt (Fig. 2.5).

All *other* categories have a total contribution of 48,8 kt in 1990 and 16,8 kt of NMVOC emissions in 2023.

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**Figure 2.5.** NMVOC emissions by sectors in 1990 and 2023.

### Sulphur oxides (SOx)

SOx emissions decreased from 149,3 to 4,8 kt (1990/2023), Figure 2.6.

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| --- | --- | --- | --- | --- |
|  |  | **SOx, kt** | **SOx, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 102,4 | 1,99 | *41,3* |
| 1A4ai | Commercial/institutional: Stationary | 10,8 | 0,58 | *12,1* |
| 1A4bi | Residential: Stationary | 31,6 | 1,42 | *29,5* |
| Other | Other categories | 4,2 | 0,82 | *17,1* |
|  | Total | 149,3 | 4,8 | *100,0* |

**Figure 2.6.** Trends in SOx emissions in the 1990-2023 period, by categories, kt

The structure of SOx emissions presented in pie charts allows us to see a decrease in the contribution of category *1.A.1.a Public Electricity* and an increase in the shares of *1.A.4.a.i* *Commercial/institutional*, *1.A.4.b*i *Residential*. The value in 2013, which differs markedly from others in the category 1.A.1.a *Public Electricity*, is due to the fact that there was an increase in coal consumption at the Moldavian Thermal Power Station (only one year during 2000-2023).

The largest SOx emissions were 102,4 kt in 1990 in the *1.A.1.a Public Electricity* category to 1,99 kt in 2023.

The share of categories changed as follows (1990/2023): for *1.A.1.a* *Public Electricity* from 69% to 41%, for *1.A.4.a.i* *Commercial/institutional* from 7% to 12%, for *1.A.4.b*i *Residential* from 21% to 30% and for "*Other*" from 3% to 17% (Figure 2.7).

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| |  |  | | --- | --- | |  |  |   **Figure 2.7.** SOx emissions by sectors in 1990 and 2023 |

**Ammonia (NH3)**

NH3 emissions decreased from 52,9 to 17,2 kt (1990/2023) and have a gradual decline trend (Figure 2.8).

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| --- | --- | --- | --- | --- |
|  |  | **NH3, kt** | **NH3, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 3B3 | Manure management - Swine (Sows+ Fattening pigs) | 7,8 | 1,52 | *8,9* |
| 3Da2a | Animal manure applied to soils | 11,8 | 1,88 | *10,9* |
| Other | categories | 33,2 | 13,78 | *80,1* |
|  |  | 52,9 | 17,21 | *100,0* |

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| **Figure 2.8.** Trends in NH3 emissions in the 1990-2023 period, by categories, kt |

The structural distribution of NH3 emissions changed in 2023:

-3B3 *Manure management* - Swine (Sows+ Fattening pigs) decreased to 15% compared to 9%;

-the share of 3.D.a.2.a *Animal manure applied to soils* decreased to 22% compared to 13% in 1990; -*Other* Categories – decreased to 48% in 2023 compared with 33% in 1990 (Figure 2.9).

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**Figure 2.9.** NH3 emissions by sectors in 1990 and 2023

### Particulate matter (PM2.5)

The time series of PM2.5 emissions have decreasing trend from 23,8 to 19,98 kt (1990/2023), Figure 2.10.

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| --- | --- | --- | --- | --- |
|  |  | **PM2,5, kt** | **PM2,5, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4ai | Commercial/institutional: Stationary | 1,4 | 0,1 | *0,8* |
| 1A4bi | Residential: Stationary | 14,9 | 15,5 | *77,6* |
| 5C2 | Open burning of waste | 0,4 | 0,3 | *1,5* |
| 5E | Other waste (please specify in IIR) | 0,5 | 0,1 | *0,1* |
| Other | Other categories | 6,6 | 4,0 | *20,1* |
|  | Total | 23,8 | 19,98 | *100,0* |

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| **Figure 2.10.** Trends in PM2.5 emissions in the 1990-2023 period, by categories, kt |

The largest number of PM2.5 emissions comes from the residential sector *1.A.4.b.i Residential: Stationary* - 62% and 78% in 1990 and 2023, respectively. *Other* categories combined accounted for 28% of PM2.5 emissions in 1990 and 20% in 2023.

The gross emissions of PM2.5 from the *1.A.4.b.i Residential: Stationary* sector in 1990 and 2023 amounted to approximately the same amount of 14,9 and 15,5 kt, emissions from all other categories decreased significantly, as can be seen in the pie charts (Figure 2.11).

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**Figure 2.11.** PM2.5 emissions by sectors in 1990 and 2023

### Particulate matter (PM10)

PM10 emissions have decreasing dynamic from 32,1 to 23,5 kt (1990/2023), Figure 2.12.

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| --- | --- | --- | --- | --- |
|  |  | **PM10, kt** | **PM10, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 2,9 | 0,1 | *0,3* |
| 1A4bi | Residential: Stationary | 15,1 | 15,9 | *69,1* |
| 2D3b | Road paving with asphalt | 3,7 | 2,1 | *8,8* |
| Other | Other categories | 10,4 | 5,4 | *21,8* |
|  | Total | 32,1 | 23,5 | *100,0* |

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| **Figure 2.12.** Trends in PM10 emissions in the 1990-2023, by categories, kt |

The largest emissions come from the following categories:

* *1.A.1.a Public electricity and heat production* (trend is a gradual decrease from 9% in 1990 to 0% in 2023);
* *1.A.4.b.i Residential: Stationary* (47% and 68%),
* *2.D.3.b Road paving with asphalt* (12% and 9%).

The emissions of PM10 from all *other* categories decreased from 32% (1990) to 23% in 2023.

PM10 emissions from *1.A.4.b.i Residential: Stationary* in gross terms in 1990 and 2023 amounted to close values of 15,1 and 15,9 kt PM10, but the share of their contribution increased from 47% in 1990 to 68% in 2023 (Figure 2.13).

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**Figure 2.13.** PM10 emissions by sectors in 1990 and 2023

### Total suspended particulates (TSP)

TSP emissions decreased from 71,8 to 43,5 kt TSP (1990/2023). Figure 2.14.

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| --- | --- | --- | --- | --- |
|  |  | **TSP, kt** | **TSP, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4bi | Residential: Stationary | 16,6 | 16,8 | *40,0* |
| 2D3b | Road paving with asphalt | 17,1 | 10,0 | *22,7* |
| 2D3g | Chemical products | 14,6 | 8,5 | *19,4* |
| Other | Other categories | 23,5 | 8,2 | *17,9* |
|  | Total | 71,8 | 43,5 | *100* |

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| **Figure 2.14.** Trends in TSP emissions in the 1990-2023 period, by categories, kt |

The largest emissions are observed from category *1.A.4.b.ii Residential: Stationary*.

The emissions in categories that has changed in 2023 compared to 1990:

* *1.A.4.b.ii Residential: Stationary-* from 23% to 38%.
* *2.D.3.b Road paving with asphalt* (from 24% to 23%).
* *2.D.3.g Chemical products* (20%).
* *Other* categories *-*from 33% to 19%, (Figure 2.15).

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| **Figure 2.15.** TSP emissions by sectors in 1990 and 2023 | |

### Black carbon (BC)

ВС еmissions have a decrease trend from 2,2 kt to 2,08 kt (1990/2023), Figure 2.16.

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| --- | --- | --- | --- | --- |
|  |  | **BC, kt** | **BC, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4bi | Residential: Stationary | 0,99 | 1,53 | *73,5* |
| 1A4cii | Agriculture/Forestry/Fishing: Off-road vehicles and other machinery | 0,4 | 0,12 | *5,7* |
| 3F | Field burning of agricultural residues | 0,02 | 0,002 | *0,1* |
| Other | Other categories | 0,8 | 0,43 | *20,7* |
|  | Total | 2,2 | 2,08 | *100,0* |

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| **Figure 2.16.** Trends in BC emissions in the 1990-2023 period, by categories, kt |

The largest contribution within 1990-2001 is made by category *3.F Field burning of agricultural residues*, emissions from which amounted to 0,02 kt (1%) in 1990 and 0,002 kt (0%) in 2023.

Category *1.A.4.b.i Residential: Stationary* had the largest contribution of BC emissions dueto increasein biomass use from 0,99 (1990) to 1,53 (2023) kt. The second reason is also the change in the methodology for biomass consumption accounting by the National Bureau of Statistics in Energy Balances, which was introduced in 2013.

The share categories of BC emissions are following:

-*1.A.4.b.i Residential: Stationary* increased from 44% (1990) to 73% (2023);

*-1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* decreased from 19% (1990) to 6% (2023);

-*Other* - decreased from 0,8 kt (1990) to 0,43 kt (2023), (Figure 2.17).

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**Carbon monoxide (CO)**

СО emissions decreased from 313,3 (1990) to 123,3 kt (2023), Figure 2.18.

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| --- | --- | --- | --- | --- |
|  |  | **CO, kt** | **CO, kt** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A3bi | Road transport: Passenger cars | 23,7 | 8,2 | *6,7* |
| 1A3bii | Road transport: Light duty vehicles | 33,6 | 5,7 | *4,6* |
| 1A4bi | Residential: Stationary | 166,3 | 87,3 | *70,9* |
| Other | Other categories | 89,7 | 22,0 | *17,9* |
|  | Total | 313,3 | 123,3 | *100,0* |

**Figure 2.18.** Trends in CO emissions in the 1990-2023, by categories, kt

The largest amounts of CO emissions are generated during *mobile* combustion in the categories *1.A.3.b.i Road transport: Passenger cars, 1.A.3.b.ii Road transport: Light duty vehicles* and during *stationary* burning in the categories *1.A.4.b.i Residential: Stationary*. For each of these categories, the following dynamics of emission reduction is observed (1990/2023):

* *1.A.3.b.i Road transport: Passenger cars* - from 23,7 to 8,2 kt CO;
* *1.A.3.b.ii Road transport: Light duty vehicles* - from 33,6 to 5,7 kt CO;
* *1.A.4.b.ii Residential: Stationary* - from 166,3 to 87,3 kt CO;
* *Other* categories together have a reduction in emissions from 89,7 to 22,0 kt CO.

The distribution of category contributions in total emissions in 1990/2023 changed to:

a) growth of emissions from *stationary* combustion in *1.A.4.b.i Residential: Stationary* (from 53% in 1990 to 71% in 2023);

1. a decrease in the share of category *1.A.3.b.i Road transport: Passenger cars* - 7% (1990 and 2023), and a share of *1.A.3.b.i Road transport: Light duty vehicles* from 11% in 1990 to 4% in 2022 (Figure 2.19).

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| |  |  | | --- | --- | |  |  |   **Figure 2.19.** CO emissions by sectors in 1990 and 2023 | |

### Lead (Pb)

Pb emissions decreased from 8,1 to 1,4 tons (1990/2023), Figure 2.20.

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| --- | --- | --- | --- | --- |
|  |  | **Pb, t** | **Pb, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4ai | Commercial/institutional: Stationary | 1.6 | 0,1 | *7,2* |
| 1A4bi | Residential: Stationary | 4.6 | 0,7 | *52,9* |
| 2A3 | Glass production | 0.4 | 0,4 | *26,3* |
| Other | Other categories | 1.4 | 0,2 | *13,6* |
|  | Total | 8.1 | 1,4 | *100,0* |

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| **Figure 2.20.** Trends in Pb emissions in the 1990-2023 period, by categories, tons |

The largest emissions come from categories *1.A.4.a.i Commercial/institutional: Stationary, 1.A.4.b.i Residential: Stationary, 2.A.3 Glass production.*

The contribution of category *1.A.4.a.i Commercial/institutional: Stationary* decreased from 20% to 7% (1990/2023), while that of category *2.A.3 Glass production* increased from 5% to 26%.

The contribution of category *1.A.4.b.i Residential: Stationary* increased from 57% to 53% (1990/2023).

*Other* categories together contributed by 18% and 14% of Pb emissions (1990/2023) (Figure 2.21).

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| |  |  | | --- | --- | |  |  |   **Figure 2.21**. Pb emissions by sectors in 1990 and 2023, tons and % |

**Cadmium (Cd)**

Cd emissions have a decreased trend of change from 0,45 t (1990) to 0,36 t in 2023 (Figure 2.22).

The contribution of categories to Cd emissions changed significantly by 1990 compared to 2023. The share of category *1.A.4.b.i Residential: Stationary* increased significantly due to the increase in biomass use, Figure 2.22.

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| --- | --- | --- | --- | --- |
|  |  | **Cd, t** | **Cd, t** | **2022** |
|  |  | **1990** | **2022** | **%** |
| 1A1a | Public electricity and heat production | 0.18 | 0,003 | *1,3* |
| 1A4bi | Residential: Stationary | 0.07 | 0,26 | *74,1* |
| 2A3 | Glass production | 0.03 | 0,03 | *7,6* |
| 2G | Other product use (please specify in the IIR) | 0.05 | 0,01 | *3,7* |
| Other | Other categories | 0.12 | 0,05 | *13,3* |
|  | Total | 0.45 | 0,36 | *100,0* |

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| **Figure 2.22.** Trends in Cd emissions in the 1990-2023 period, by categories, tons |

The Cd emissions trends by categories has following dynamic:

* *1.A.1.a Public electricity and heat production* - 39% in 1990 and 1% in 2023;
* *1.A.4.b.i Residential: Stationary* - 15% in 1990 and 74% in 2023;
* *2.A.3 Glass production* - 8% in 1990 and 8% in 2023;

All *other* categories - 28% in 1990 and 13% in 2023 (Figure 2.23).

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| |  |  | | --- | --- | |  |  |   **Figure 2.23.** Cd emissions by sectors in 1990 and 2023, tons and % | |

### Mercury (Hg)

Mercury emissions trend to decrease gradually from 0,48 in 1990 to 0,07 tons in 2023 (Figure 2.24).

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| --- | --- | --- | --- | --- |
|  |  | **Hg, t** | **Hg, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 0.14 | 0,004 | *6,4* |
| 1A4ai | Commercial/institutional: Stationary | 0.09 | 0,01 | *8,1* |
| 1A4bi | Residential: Stationary | 0.18 | 0,02 | *28,4* |
| 2C1 | Iron and steel production | 0.02 | 0,01 | *10,3* |
| Other | Other categories | 0.06 | 0,03 | *46,8* |
|  | Total | 0.49 | 0,07 | *100,0* |

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**Figure 2.24.** Trends in Hg emissions in the 1990-2023 period, by categories, tons

The share of the category *1.A.1.a Public electricity and heat production* contribution decreased from 28% in 1990 to 7% in 2023, category *1.A.4.a.i Commercial / institutional: Stationary* decreased from 19% in 1990 to 7% in 2023.

The share of category *2.C.1 Iron and steel production* increased from 4% in 1990 to 10% in 2023, while the share of *other categories* increased from 12% in 1990 to 47% in 2023 (Figure 2.25)

The emissions from *1.A.4.b.i Residential: Stationary* category - 37% in 1990 and 28% in 2023.

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| |  |  | | --- | --- | |  |  |   **Figure 2.25.** Hg emissions by sectors in 1990 and 2023, tons and % |

### Arsenic (As)

As emissions have a gradual decline trend from 1,13 to 0,11 tons (1990/2023) (Figure 2.26).

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| --- | --- | --- | --- | --- |
|  |  | **As, t** | **As, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 0.88 | 0,02 | *21,6* |
| 1A4bi | Residential: Stationary | 0.09 | 0,01 | *7,1* |
| 2A3 | Glass production | 0.05 | 0,04 | *37,0* |
| 5C2 | Open burning of waste | 0.04 | 0,03 | *26,8* |
| Other | Other categories | 0.07 | 0,01 | *7,4* |
|  | Total | 1.13 | 0,11 | *100,0* |

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| **Figure 2.26.** Trends in As emissions in the 1990-2023 period, tons |

In 1990, the majority of As emissions came from category *1.A.1.a Public electricity and heat production* (78%). By 2022, the share of this category decreased to 22%. The increase in emissions in 2013 is associated with the increase of values of coal consumption for burning at the Moldavian Thermal Power Station.

The structure of emissions has changed, and the shares of other categories have increased: *2.A.3 Glass production* from 4% to 37%, and *5.C.2 Open burning of waste* from 4% to 27% (1990/2020).

Categories *1.A.4.b.i Residential: Stationary* and *all other categories* maintained their contributions at almost the same level (7% and 8%) during the period 1990-2023 (Figure 2.27).

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| |  |  | | --- | --- | |  |  |   **Figure 2.27.** As emissions by sectors in 1990 and 2023, tons and % | |

**Chromium (Cr)**

Cr emissions overall decline from 1,34 to 0,6 tons (1990/2023) (Figure 2.28).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Cr, t** | **Cr, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 0.55 | 0,01 | *1,7* |
| 1A4ai | Commercial/institutional: Stationary | 0.19 | 0,02 | *3,3* |
| 1A4bi | Residential: Stationary | 0.42 | 0,5 | *78,0* |
| 2A3 | Glass production | 0.06 | 0,1 | *7,8* |
| Other | Other categories | 0.12 | 0,1 | *9,2* |
|  | Total | 1.34 | 0,6 | *100,0* |

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| **Figure 2.28.** Trends in Cr emissions in the 1990-2023 period, by categories, tons |

The largest contribution and the largest decrease took place in category *1.A.1.a Public electricity and heat production* (from 0,5 tons in 1990 to 0,01 tons in 2023).

The *1.A.4.a.i Commercial/institutional: Stationary category* also dropped significantly from 14% to 2% (1990/2023). For category *1.A.4.b.i Residential: Stationary* emissions increased from 31% to 78% (reason- increase in biomass use). For category *2.A.3 Glass production*, emissions increased from 5% to 8%. Emissions from all *Other categories* -9% and 8%, (Figure 2.29).

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| |  |  | | --- | --- | |  |  |   **Figure 2.29.** Cr emissions by sectors in 1990 and 2023 | |

### Copper (Cu)

Cu emissions had decreased from 3,1 tons (1990) to 0,44 tons (2023) (Figure 2.30).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Cu, t** | **Cu, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 1.04 | 0.015 | *4,9* |
| 1A4bi | Residential: Stationary | 0.8 | 0.158 | *34,3* |
| 1A4cii | Agriculture/Forestry/Fishing: Off-road vehicles and other machinery | 0.7 | 0.182 | *41,6* |
| Other | Other categories | 0.6 | 0.081 | *19,2* |
|  |  | 3.1 | 0.437 | *100,0* |

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| **Figure 2.30.** Trends in Cu emissions in 1990-2023, by categories, tons |

Emissions from the sector *1.A.1.a Public electricity and heat production* decreased from 1,04 t to 0,02 kt.

Category contributions to total Cu emissions were as follows:

* *1.A.1.a Public electricity and heat production* - 33% in 1990 and 5% in 2023;
* *1.A.4.b.i Residential: Stationary* - 25% in 1990 and 34% in 2023;
* *1.A.4.c.ii Agriculture / Forestry / Fishing: Off-road vehicles and other machinery* - 22% in 1990 and 42% in 2023;
* *All Other categories*- 20% and 19% (Figure 2.31).

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| |  |  | | --- | --- | |  |  |   **Figure 2.31.** Cu emissions by sectors in 1990 and 2023 | |

### Nickel (Ni)

Ni emissions had a significant decrease from 25,6 tons (1990) to 1,25 tons (2023) (Figure 2.32).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Ni, t** | **Ni, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1А1а | Public electricity and heat production | 24.2 | 1,01 | *80,9* |
| 1А4а | Сommercial | 0.4 | 0,01 | *1,3* |
| 1А4b | Residential | 0.4 | 0,06 | *4,6* |
| 2А3 | Glass production | 0.1 | 0,10 | *8,2* |
| Other | Other categories | 0.4 | 0,06 | *5,1* |
|  |  | 25.6 | 1,25 | *100,0* |

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| **Figure 2.32.** Trends in Ni emissions in 1990-2023, by categories, tons |

The largest decline was from the sector *1.A.1.a Public electricity and heat production* from 24,2 tons (1990) to 0,7 tons (2020).

Due to such large decrease, the structural distribution of category contributions to total emissions has changed, and the share of categories became:

* *1.А.1.а Public electricity and heat production –* decrease from24,2 (1990) to 0,7 (2023) tons (95% and 81%),
* *1.А.4.а Сommercial/Institutional sector–* shareincrease from 2% to 1%*;*
* *1.А.4.b Residential sector -* shareincrease from 2% to 5%;
* *2.А.3 Glass production* *-* values decreased from 0,12 t to 0,10 t*,* butshare in structure share has become noticeable from 0% (1990) to 8% (2023);
* *Other* categories - values decreased from 0,4 t to 0,06 t*,* but in structure share has become noticeable too- from 1% (1990) to 5% (2023), (Figure 2.33).

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**Figure 2.33.** Ni emissions by sectors in 1990 and 2023, tons and %

### Selenium (Se)

Se emissions had a significant decrease from 6,2 tons (1990) to 0,35 tons (2023) (Figure 2.34).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Se, t** | **Se, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 1,78 | 0,009 | *2,5* |
| 1A4bi | Residential: Stationary | 4,19 | 0,169 | *47,3* |
| Other | Other categories | 0,25 | 0,179 | *50,2* |
|  | Total | 6,22 | 0,356 | *100,0* |

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| **Figure 2.34.** Trends in Se emissions in the 1990-2023 period, by categories, tons |

In the structural distribution of emissions, there is a noticeable decrease for the share of *1.A.1.a Public electricity and heat production* (from 29% in 1990 to 3% in 2023).

All *Other* categories increased from 4% to 50%.

The *1.A.4.b.i Residential: Stationary* category has the same values - 67% in 1990 to 47% in 2023. (Figure 2.35).

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| |  |  | | --- | --- | |  |  |   **Figure 2.35.** Se emissions by sectors in 1990 and 2023, tons and % | |

### Zinc (Zn)

Zn emissions decline from 23,3 (1990) to 13,7 tons (2023) (Figure 2.36).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Zn** | **Zn** | **2022** |
|  |  | **1990** | **2022** | **%** |
| 1A1a | Public electricity and heat production | 9,5 | 0,35 | *2,6* |
| 1A4ai | Commercial/institutional: Stationary | 2,6 | 0,38 | *2,8* |
| 1A4bi | Residential: Stationary | 8,3 | 10,64 | *77,7* |
| 5C2 | Open burning of waste | 1,8 | 1,24 | *9,0* |
| Other | Other categories | 2,0 | 1,08 | *7,9* |
|  |  | 24,3 | 13,69 | *100,0* |

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| **Figure 2.36.** Trends in Zn emissions in the 1990-2023 period, by categories, tons |

The structure of emissions by categories has changed significantly:

* The share of sectors *1.A.1.a Public electricity and heat production* decreased from 39% to 2%;
* *1.A.4.a.i Commercial / institutional: Stationary* decreased from 11% to 3% (1990/2023);
* The share of the *1.A.4.b.i Residential: Stationary category* increased from 34% to 78% (1990/2023). A large increase has been observed in the last 9 years. The reason is the change to the methodology for biomass accounting in Energy Balances of the National Bureau of Statistics.
* The share of all categories "*Other*" - 8%, Figure 2.37.

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| |  |  | | --- | --- | |  |  |   **Figure 2.37.** Zn emissions by sectors in 1990 and 2023 | |

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### PCDD/F

PCDD/F emissions decreased from 41,7 g I-TEQ (1990) to 20,8 g I-TEQ in 2023, (Figure 2.38)

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| --- | --- | --- | --- | --- |
|  |  | **PCDD, g I-TEQ** | **PCDD. g I-TEQ** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4bi | Residential: Stationary | 29,0 | 17,2 | *83,0* |
| 5C1biii | Clinical waste incineration | 0,5 | 1,2 | *5,8* |
| Other | Other categories | 119 | 2,3 | *11,2* |
|  | Total | 41,7 | 20,8 | *100,0* |

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| **Figure 2.38.** Trends in PCDD/F emissions in the 1990-2023 period, by categories, g I-TEQ |

The share of *1.A.4.b.i Residential: Stationary* category increased from 70% to 83% (1990-2023).

The category *5.C.1.b.iii Clinical waste* incineration category increased from 1% to 6% in 2023.

The share of all categories "*Other*" decreased from 29% to 11% (1990/2023) (Figure 2.39).

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| |  |  | | --- | --- | |  |  |   **Figure 2.39.** PCDD/F emissions by sectors in 1990 and 2023, g I-TEQ | |

### Benzo(a)pyrene

The total reduction in gross emissions was from 9,2 tons to 3,0 tons (1990/2023) (Figure 2.40).

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| --- | --- | --- | --- | --- |
|  |  | **Benzo(a) pyrene, t** | **Benzo(a) pyrene, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4bi | Residential: Stationary | 8,2 | 2,7 | *91,6* |
| Other | Other Categories | 1,0 | 0,3 | *8,4* |
|  | Total | 9,2 | 3,0 | *100,0* |

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| **Figure 2.40.** Trends in Benzo(a)pyrene emissions in the 1990-2023 period, by categories, tons |

Large emission reductions occurred in category *1.A.4.b.i Residential: Stationary* from 89% to 92% (1990/2023). Emissions from the remaining categories in aggregate decreased from 11% to 8% (Figure 2.41).

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| |  |  | | --- | --- | |  |  |   **Figure 2.41.** Benzo(a)pyrene emissions by sectors in 1990 and 2023, tons and % | |

### Benzo(b)fluoranthene

The total reduction in Benzo(b)fluoranthene gross emissions was from 13,35 tons to 3,16 tons (1990/2023), Figure 2.42.

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| --- | --- | --- | --- | --- |
|  |  | **Benzo(b) fluoranthene ,t** | **Benzo(b) fluoranthene ,t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A2f | Manufacturing industry: mineral | 0.25 | 0,05 | *1,7* |
| 1A4ai | Commercial/Institutional | 0.70 | 0,05 | *1,4* |
| 1A4bi | Residential | 11.67 | 2,68 | *84,8* |
| 1A5a | Other combustion | 0.02 | NO | *0* |
| 5C2 | Open burning of waste | 0.48 | 0,33 | *10,3* |
| Other | categories | 0.21 | 0,06 | *1,8* |
|  | Total | 13.35 | 3,16 | *100,0* |

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| **Figure 2.42.** Trends in Benzo(b)fluoranthene emissions in the 1990-2023, by categories, t |

The largest reduction in emissions took place in 3 categories (1990/2023):

* *1.A.4.a.ii Commercial/Institutional-* from 5% to 1%;
* *1.A.4.b.ii Residential-* from 87% and 85%;
* *5.C.2 Open burning of waste* from 4% to 10%;
* *Other* categories have small -2% (Figure 2.43).

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| |  |  | | --- | --- | |  |  |   **Figure 2.43.** Benzo(b)fluoranthene emissions by sectors in 1990 and 2023, tons and % | |

### Benzo(k)fluoranthene

Benzo(k)fluoranthene emissions decreased from 5,6 tons to 1,5 tons (1990/2023) (Figure 2.44).

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|  |  | **Benzo(k) fluoranthene, t** | **Benzo(k) fluoranthene, t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4ai | Commercial/institutional: Stationary | 0.28 | 0,02 | *1,2* |
| 1A4bi | Residential: Stationary | 4.60 | 1,0 | *69,5* |
| 5C2 | Open burning of waste | 0.59 | 0,4 | *27,3* |
| Other | categories | 0.13 | 0,03 | *2,0* |
|  |  | 5.60 | 1,5 | *100,0* |

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| **Figure 2.44.** Trends in Benzo(k)fluoranthene emissions in the 1990-2023, by categories, t |

The largest emission reductions took place in the following category:

* *1.A.4.b.i Residential: Stationary* - 82% in 1990 and 70% in 2023. Despite the total gross reduction in emissions in this category from 4,6 to 1,0 tons;
* The share of emissions in the *5.C.2 Open burning of waste* category increased from 11% in 1990 to 27% in 2023.
* *Other* categories in values -2% (1990, 2023) **(**Figure 2.45).

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| |  |  | | --- | --- | |  |  |   **Figure 2.45.** Benzo(k) fluoranthene emissions by sectors in 1990 and 2023 | |

**Indeno(1,2,3-cd)pyrene**

The total reduction in gross emissions was from 4,3 tons (1990) to 1,6 tons (2022) (Figure 2.46).

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|  |  | **Indeno (1,2,3-cd) pyrene ,t** | **Indeno (1,2,3-cd) pyrene ,t** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A4ai | Commercial/institutional: Stationary | 0,2 | 0,01 | *0,8* |
| 1A4bi | Residential: Stationary | 3,9 | 1,6 | *97,7* |
| Other | Other categories | 0,1 | 0,02 | *1,4* |
|  | Total | 4,3 | 1,6 | *100,0* |

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| **Figure 2.46.** Indeno(1,2,3-cd) pyrene emissions in the 1990-2023 by categories, t |

The largest contribution of emissions comes from the residential sector *1.A.4.b.i Residential: Stationary* - 93% in 1990 and 98% in 2023, shares of other categories are small (Figure 2.47).

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| |  |  | | --- | --- | |  |  |   **Figure 2.47.** Indeno(1,2,3-cd) pyrene emissions by sectors in 1990 and 2023 | |

### Hexachlorobenzene (HCB)

The total decrease in gross НСВ emissions (1990/2023) from 0,52 to 0,15 kg of НСВ (Figure 2.48).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **HCB, kg** | **HCB, kg** | **2022** |
|  |  | **1990** | **2023** | **%** |
| 1A1a | Public electricity and heat production | 0.46 | 0,00 | *0,1* |
| 1A4ai | Commercial/institutional: Stationary | 0.009 | 0,00 | *1,9* |
| 1A4bi | Residential: Stationary | 0.03 | 0,10 | *67,3* |
| 5C1biii | Clinical waste incineration | 0.02 | 0,04 | *26,4* |
| Other | Other categories | 0.005 | 0,01 | *4,4* |
|  | Total | 0.52 | 0,15 | *100* |

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| **Figure 2.48.** Trends in HCB emissions in the 1990-2023 period, by categories, kg |

The structure of emission contributions by categories to total emissions has changed significantly (1990/2023):

- the values of emissions in category *1.A.1.a Public electricity and heat production* decreased from 0,46 kg to 0,0001 kg or from 88% to 0%,

- the values of emissions in category *1.A.4.b.i Residential: Stationary* decreased from 0,03 kg to 0,1 kg, but the share in total structure increased from 5% to 67%,

- the share of *5.C.1.biii Clinical waste* *incineration* category increased from 4% to 27%,

- the share of all *Other* categories remains from 1% to 4% (1990/2023) (Figure 2.49).

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| |  |  | | --- | --- | |  |  |   **Figure 2.49.** HCB emissions by sectors in 1990 and 2023, kg and % |

### Polychlorinated biphenyls (PCB)

РСВ emissions tend to decrease gradually from 10,2 kg (1990) to 1,2 kg in (2023) (Figure 2.50).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **PCB, kg** | **PCB, kg** | **2023** |
|  |  | **1990** | **2023** | **%** |
| 1A2f | Stationary combustion in manufacturing industries and construction: Non-metallic minerals | 0.2 | 0,1 | *7,3* |
| 1A4ai | Commercial/institutional: Stationary | 2.0 | 0,1 | *9,3* |
| 1A4bi | Residential: Stationary | 5.9 | 0,3 | *19,5* |
| 2C1 | Iron and steel production | 1.8 | 0,8 | *64,0* |
| Other | Other categories | 0.4 | 0,0 | *0* |
|  | Total | 10.2 | 1,2 | *100,0* |

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| **Figure 2.50.** Trends in PCB emissions in 1990-2023, by categories, kg |

The structure of category contributions to total emissions in 1990 and 2023 has changed significantly:

* *1.A.4.b.i Residential: Stationary* category decreased from 58% to 20%,
* *1.A.4.a.i Commercial/institutional: Stationary* decreased from 20% to 9%,
* *2.C.1 Iron and steel production* decreased from 1,8 to 0,7 kg, but the share in total sum increased from 17% to 64%,
* all *Other* categories remains from 4% to 0% (1990/2023), (Figure 2.51).

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| |  |  | | --- | --- | |  |  |   **Figure 2.51.** PCB emissions by sectors in 1990 and 2023, kg and % | |

Chapter 3: RECALCULATIONS AND IMPROVEMENTS

## 3.1. Recalculations

***Energy Sector***

The EMEP/EEA 2023 recommendations describe the following reasons for recalculations:

* Use of updated emission factors;
* Use of an updated version of the Guidebook (2024);
* Emergence of new data for 2023;
* Transition of a category to a key status;
* Increased inventory potential (human, financial, training).

The reasons for recalculations in the current inventory cycle (2025) of pollutant emissions in the Republic of Moldova compared to the previous cycles (1990-2023) were:

* use of emission factors according to EMEP/EEA 2023 and its unit versions from 2024;
* development of the NFR settlement file system (type of software) for further permanent use;
* considering the recommendations of international experts expressed as part of the audit of IIR 2014 (Review in 2016 and Review in 2018).

Recommendations of international experts on the results of the IIR 2016 in the “Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings Directive, CEIP/S3.RR/2018/Moldova, 19/10/2018” were also implemented in the IIR 2019 (the actions performed are described in IIR-2019) and continued in current circle.

***Industrial processes Sector***

The emissions of CO, NH3, NMVOC, NOx, SOx (SO2); PMs (4: PM 2.5, PM10, TSP, BC); Heavy metals (9: Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn); POPs (8: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAH (HCB), PCBs) from source categories in the sector "Industrial Processes and Product Use" for the years 2021 and 2022 have been estimated for the first time. Recalculations of emissions in the "Industrial Processes and Product Use" sector were carried out following the use of an updated set of activity data available in the statistical publications of the administrative-territorial units on the left bank of the Nistru River and those of the Republic of Moldova, as well as the Statistical Reports "PROMOLD-A" "Total production, as a natural expression, in the republic, by types of products in the years 2005-2022", respectively, as a result of updating the values of emission factors specific to the national level.

***Agriculture sector***

Emissions for 1990-2022 for sector 3F have been recalculated because ADs have been updated.

***Waste Sector***

Pollutant emissions from category 5 Waste, more specifically from subcategory 5A Solid waste disposal, were recalculated for the 1990-2023 time series, due to the use of an updated set of activity data for industrial waste for the years 2000-2023. The information for 2020 – 2023 was calculated for the Right Bank, and extrapolations were made for the Left Bank due to the unavailability of information for Transnistria.

## 

## 3.2. Planned improvements

The following improvements are planned in the next inventory cycle.

***Energy Sector***

1. Use of emission factors according to the new update versions by categories for the energy sector EMEP/EEA Guidebook-2023;

2. Expanding the series of values of consumed fuels and adding data for new years;

3. Analyzing approaches and opportunities for the application of higher-level methods for key categories;

4. Update of the series of values in case of errors.

***Industrial processes Sector***

1. Possible improvements could include activities aimed at specifying the activity data used in the evaluation of emissions from the categories within the "Industry" sector for the reporting period from previous inventory cycles, except for category 2D "Non-energy products from fossil fuels and solvent use", for which no improvements are planned.

2. Additionally, activity data regarding the consumption of pyrotechnic articles within category 2G "Production and use of other products" will need to be collected.

**Waste sector**

1. Expanding the series of values of consumed fuels and adding data for new years;

2. Improving the quality of calculations;

3. Updating the series of values in case of errors.

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4. For Solid Waste: <https://statbank.statistica.md/PxWeb/pxweb/ro/10%20Mediul%20inconjurator/10%20Mediul%20inconjurator__MED040__Intreprinderi/MED040800.px/table/tableViewLayout2/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>

5. For Waste Incineration: <https://statbank.statistica.md/PxWeb/pxweb/ro/20%20Populatia%20si%20procesele%20demografice/20%20Populatia%20si%20procesele%20demografice__POP010__POPro/POP010100rcl.px/table/tableViewLayout2/?rxid=9a62a0d7-86c4-45da-b7e4-fecc26003802>

6. For Waste Water Treatment: <http://statbank.statistica.md/PxWeb/pxweb/ro/30%20Statistica%20sociala/30%20Statistica%20sociala__04%20NIV__NIV040/NIV041300.px/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>

7. Waste Water Discharging: <http://statbank.statistica.md/PxWeb/pxweb/ro/10%20Mediul%20inconjurator/10%20Mediul%20inconjurator__MED020/MED020200.px/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774>

IIR Annexes

## Annex 1. Uncertainty Calculations for main pollutants

**Table 1-1. Uncertainty estimation of NOx emissions 1990 and 2023, Approach 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Gg | Gg | % | % | % | % | % | % | % | % | % |
| 1A1a | NOx (as NO2) | 39,4697 | 6,0164 | 5 | 20 | 20,62 | 14,995 | 0,062 | 0,059 | 1,240 | 0,416 | 1,711 |
| 1A2a | NOx (as NO2) | 0,1903 | 0,0992 | 5 | 20 | 20,62 | 0,004 | 0,001 | 0,001 | 0,011 | 0,007 | 0,000 |
| 1A2c | NOx (as NO2) | 0,0588 | 0,0048 | 5 | 20 | 20,62 | 0,000 | 0,000 | 0,000 | 0,001 | 0,001 | 0,000 |
| 1A2e | NOx (as NO2) | 1,0661 | 0,2051 | 5 | 20 | 20,62 | 0,017 | 0,001 | 0,001 | 0,026 | 0,007 | 0,001 |
| 1A2f | NOx (as NO2) | 7,3950 | 1,1758 | 5 | 20 | 20,62 | 0,573 | 0,011 | 0,012 | 0,224 | 0,081 | 0,057 |
| 1A2gviii | NOx (as NO2) | 0,2532 | 0,8821 | 5 | 20 | 20,62 | 0,322 | 0,008 | 0,009 | 0,157 | 0,061 | 0,028 |
| 1A3ai(i) | NOx (as NO2) | 0,0235 | 0,5699 | 5 | 30 | 30,41 | 0,293 | 0,006 | 0,006 | 0,165 | 0,039 | 0,029 |
| 1A3aii(i) | NOx (as NO2) | 0,0947 | 0,0001 | 5 | 30 | 30,41 | 0,000 | 0,000 | 0,000 | 0,006 | 0,000 | 0,000 |
| 1A3bi | NOx (as NO2) | 2,5504 | 2,9512 | 5 | 50 | 50,25 | 21,437 | 0,021 | 0,029 | 1,053 | 0,204 | 1,150 |
| 1A3bii | NOx (as NO2) | 3,2285 | 1,7876 | 5 | 50 | 50,25 | 7,864 | 0,008 | 0,017 | 0,379 | 0,124 | 0,159 |
| 1A3biii | NOx (as NO2) | 9,6089 | 8,8537 | 5 | 50 | 50,25 | 192,930 | 0,057 | 0,087 | 2,856 | 0,613 | 8,533 |
| 1A3biv | NOx (as NO2) | 0,1555 | 0,0754 | 5 | 50 | 50,25 | 0,014 | 0,000 | 0,001 | 0,013 | 0,005 | 0,000 |
| 1A3c | NOx (as NO2) | 6,7071 | 0,3012 | 5 | 100 | 100,12 | 0,886 | 0,018 | 0,003 | 1,763 | 0,021 | 3,107 |
| 1A3dii | NOx (as NO2) | 0,4331 | 0,0060 | 30 | 40 | 50,00 | 0,000 | 0,001 | 0,000 | 0,037 | 0,002 | 0,001 |
| 1A3ei | NOx (as NO2) | 0,2844 | 0,0013 | 5 | 100 | 100,12 | 0,000 | 0,001 | 0,000 | 0,062 | 0,000 | 0,004 |
| 1A4ai | NOx (as NO2) | 2,8346 | 0,4028 | 5 | 50 | 50,25 | 0,399 | 0,005 | 0,004 | 0,238 | 0,028 | 0,057 |
| 1A4bi | NOx (as NO2) | 4,7280 | 1,9782 | 5 | 50 | 50,25 | 9,631 | 0,005 | 0,019 | 0,243 | 0,137 | 0,078 |
| 1A4ci | NOx (as NO2) | 0,5222 | 0,0306 | 5 | 50 | 50,25 | 0,002 | 0,001 | 0,000 | 0,065 | 0,002 | 0,004 |
| 1A4cii | NOx (as NO2) | 13,5132 | 3,6982 | 5 | 50 | 50,25 | 33,661 | 0,005 | 0,036 | 0,263 | 0,256 | 0,135 |
| 2C1 | NOx (as NO2) | 0,0926 | 0,0386 | 5 | 50 | 50,25 | 0,007 | 0,000 | 0,000 | 0,009 | 0,003 | 0,000 |
| 2G | NOx (as NO2) | 0,0197 | 0,0056 | 5 | 50 | 50,25 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| 3B1a | NOx (as NO2) | 0,2128 | 0,0432 | 5 | 100 | 100,12 | 0,018 | 0,000 | 0,000 | 0,023 | 0,003 | 0,001 |
| 3B1b | NOx (as NO2) | 0,0600 | 0,0024 | 5 | 100 | 100,12 | 0,000 | 0,000 | 0,000 | 0,011 | 0,000 | 0,000 |
| 3B2 | NOx (as NO2) | 0,0157 | 0,0053 | 7 | 100 | 100,24 | 0,001 | 0,000 | 0,000 | 0,002 | 0,001 | 0,000 |
| 3B3 | NOx (as NO2) | 0,0124 | 0,0048 | 20 | 100 | 101,98 | 0,000 | 0,000 | 0,000 | 0,002 | 0,001 | 0,000 |
| 3B4d | NOx (as NO2) | 0,0004 | 0,0018 | 5 | 100 | 100,12 | 0,000 | 0,000 | 0,000 | 0,002 | 0,000 | 0,000 |
| 3B4e | NOx (as NO2) | 0,0115 | 0,0049 | 5 | 100 | 100,12 | 0,000 | 0,000 | 0,000 | 0,002 | 0,000 | 0,000 |
| 3B4gi | NOx (as NO2) | 0,0132 | 0,0031 | 10 | 100 | 100,50 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| 3B4h | NOx (as NO2) | 0,0002 | 0,0004 | 10 | 100 | 100,50 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| 3Da1 | NOx (as NO2) | 3,6840 | 2,4088 | 5 | 100 | 100,12 | 56,701 | 0,012 | 0,024 | 1,227 | 0,167 | 1,533 |
| 3Da2b | NOx (as NO2) | 0,0087 | 0,0059 | 5 | 100 | 100,12 | 0,001 | 0,000 | 0,000 | 0,004 | 0,000 | 0,000 |
| 3Da2c | NOx (as NO2) | 2,2190 | 0,1021 | 5 | 100 | 100,12 | 0,102 | 0,006 | 0,001 | 0,581 | 0,007 | 0,338 |
| 3Da4 | NOx (as NO2) | 0,5469 | 0,1215 | 5 | 100 | 100,12 | 0,144 | 0,000 | 0,001 | 0,049 | 0,008 | 0,002 |
| 3F | NOx (as NO2) | 0,0973 | 0,0104 | 5 | 100 | 100,12 | 0,000 | 0,000 | 0,000 | 0,015 | 0,000 | 0,000 |
| 5C1biii | NOx (as NO2) | 0,0005 | 0,0010 | 5 | 50 | 50,25 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| 5C2 | NOx (as NO2) | 0,3320 | 0,2243 | 5 | 50 | 50,25 | 0,124 | 0,001 | 0,002 | 0,059 | 0,016 | 0,004 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total |  | 102,155 | 32,030 |  |  |  | 340,125 |  |  |  |  | 16,938 |
|  |  |  |  |  |  |  | 18,442 |  |  |  |  | 4,116 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | |  |  |  |  |  |
| **Table 1-2. Uncertainty estimation of NMVOC emissions 1990 and 2023, Approach 1** | | | | | | | | | | | | |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| **Sector NFR** | **Pollutant** | **Base year emissions** | **Year t emissions** | **Activity data uncertainty** | **Emission factor uncertainty** | **Combined uncertainty** | **Combined uncertainty as % of total national emissions in year t** | **Type A sensitivity** | **Type B sensitivity** | **Uncertainty in trend in national emissions introduced by emission factor uncertainty** | **Uncertainty in trend in national emissions introduced by activity data uncertainty** | **Uncertainty introduced into the trend in total national emissions** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| 1A1a | NMVOC | 0,6298 | 0,1685 | 5 | 20 | 20,62 | 0,0024 | 0,0020 | 0,0015 | 0,0406 | 0,0107 | 0,0018 |
| 1A2a | NMVOC | 0,0647 | 0,0308 | 5 | 20 | 20,62 | 0,0001 | 0,0001 | 0,0003 | 0,0018 | 0,0020 | 0,0000 |
| 1A2c | NMVOC | 0,0075 | 0,0015 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0000 | 0,0006 | 0,0001 | 0,0000 |
| 1A2d | NMVOC | 0,0000 | 0,0018 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0000 | 0,0003 | 0,0001 | 0,0000 |
| 1A2e | NMVOC | 0,1479 | 0,1074 | 5 | 20 | 20,62 | 0,0010 | 0,0001 | 0,0010 | 0,0026 | 0,0068 | 0,0001 |
| 1A2f | NMVOC | 0,5436 | 0,1692 | 5 | 20 | 20,62 | 0,0025 | 0,0015 | 0,0015 | 0,0308 | 0,0107 | 0,0011 |
| 1A2gviii | NMVOC | 0,1125 | 0,4226 | 5 | 20 | 20,62 | 0,0154 | 0,0031 | 0,0038 | 0,0630 | 0,0267 | 0,0047 |
| 1A3ai(i) | NMVOC | 0,0014 | 0,0263 | 5 | 30 | 30,41 | 0,0001 | 0,0002 | 0,0002 | 0,0068 | 0,0017 | 0,0000 |
| 1A3aii(i) | NMVOC | 0,4497 | 0,0004 | 5 | 30 | 30,41 | 0,0000 | 0,0025 | 0,0000 | 0,0757 | 0,0000 | 0,0057 |
| 1A3bi | NMVOC | 3,8534 | 1,5436 | 5 | 50 | 50,25 | 1,2210 | 0,0078 | 0,0138 | 0,3922 | 0,0977 | 0,1634 |
| 1A3bii | NMVOC | 2,1970 | 0,4460 | 5 | 50 | 50,25 | 0,1019 | 0,0084 | 0,0040 | 0,4178 | 0,0282 | 0,1754 |
| 1A3biii | NMVOC | 0,3274 | 0,3041 | 5 | 50 | 50,25 | 0,0474 | 0,0009 | 0,0027 | 0,0441 | 0,0192 | 0,0023 |
| 1A3biv | NMVOC | 1,9949 | 0,9670 | 5 | 50 | 50,25 | 0,4792 | 0,0026 | 0,0087 | 0,1280 | 0,0612 | 0,0201 |
| 1A3bv | NMVOC | 0,6614 | 1,5394 | 5 | 50 | 50,25 | 1,2145 | 0,0101 | 0,0138 | 0,5029 | 0,0974 | 0,2624 |
| 1A3c | NMVOC | 0,5952 | 0,0267 | 5 | 100 | 100,12 | 0,0015 | 0,0031 | 0,0002 | 0,3106 | 0,0017 | 0,0965 |
| 1A3dii | NMVOC | 0,0105 | 0,0001 | 30 | 40 | 50,00 | 0,0000 | 0,0001 | 0,0000 | 0,0023 | 0,0001 | 0,0000 |
| 1A3ei | NMVOC | 0,0026 | 0,0000 | 5 | 100 | 100,12 | 0,0000 | 0,0000 | 0,0000 | 0,0015 | 0,0000 | 0,0000 |
| 1A4ai | NMVOC | 1,2276 | 0,2770 | 5 | 50 | 50,25 | 0,0393 | 0,0044 | 0,0025 | 0,2210 | 0,0175 | 0,0492 |
| 1A4bi | NMVOC | 17,7118 | 12,7982 | 5 | 50 | 50,25 | 83,9421 | 0,0149 | 0,1145 | 0,7474 | 0,8098 | 1,2144 |
| 1A4ci | NMVOC | 0,0894 | 0,0278 | 5 | 50 | 50,25 | 0,0004 | 0,0003 | 0,0002 | 0,0127 | 0,0018 | 0,0002 |
| 1A4cii | NMVOC | 1,5200 | 0,3851 | 5 | 50 | 50,25 | 0,0760 | 0,0051 | 0,0034 | 0,2548 | 0,0244 | 0,0655 |
| 1B2av | NMVOC | 1,7270 | 0,4684 | 5 | 50 | 50,25 | 0,1124 | 0,0055 | 0,0042 | 0,2757 | 0,0296 | 0,0769 |
| 2B10a | NMVOC | 0,0650 | 0,0191 | 5 | 50 | 50,25 | 0,0002 | 0,0002 | 0,0002 | 0,0097 | 0,0012 | 0,0001 |
| 2C1 | NMVOC | 0,0370 | 0,0151 | 5 | 50 | 50,25 | 0,0001 | 0,0001 | 0,0001 | 0,0037 | 0,0010 | 0,0000 |
| 2D3a | NMVOC | 5,2339 | 3,5425 | 5 | 20 | 20,62 | 1,0825 | 0,0023 | 0,0317 | 0,0456 | 0,2242 | 0,0523 |
| 2D3b | NMVOC | 0,0195 | 0,0114 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0001 | 0,0002 | 0,0007 | 0,0000 |
| 2D3d | NMVOC | 10,0303 | 7,3129 | 5 | 20 | 20,62 | 4,6131 | 0,0091 | 0,0654 | 0,1811 | 0,4627 | 0,2469 |
| 2D3e | NMVOC | 0,5444 | 0,2668 | 5 | 20 | 20,62 | 0,0061 | 0,0007 | 0,0024 | 0,0134 | 0,0169 | 0,0005 |
| 2D3f | NMVOC | 0,0255 | 0,0128 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0001 | 0,0006 | 0,0008 | 0,0000 |
| 2D3g | NMVOC | 4,6598 | 3,8033 | 5 | 20 | 20,62 | 1,2478 | 0,0078 | 0,0340 | 0,1568 | 0,2407 | 0,0825 |
| 2D3h | NMVOC | 0,2457 | 0,2350 | 5 | 20 | 20,62 | 0,0048 | 0,0007 | 0,0021 | 0,0144 | 0,0149 | 0,0004 |
| 2D3i | NMVOC | 3,0888 | 14,4054 | 5 | 20 | 20,62 | 17,9003 | 0,1115 | 0,1289 | 2,2303 | 0,9115 | 5,8051 |
| 2G | NMVOC | 1,5459 | 0,4298 | 5 | 20 | 20,62 | 0,0159 | 0,0048 | 0,0038 | 0,0968 | 0,0272 | 0,0101 |
| 2H2 | NMVOC | 13,2825 | 6,2311 | 5 | 50 | 50,25 | 19,8985 | 0,0189 | 0,0558 | 0,9438 | 0,3943 | 1,0462 |
| 3B1a | NMVOC | 5,2228 | 1,0058 | 5 | 100 | 100,12 | 2,0586 | 0,0203 | 0,0090 | 2,0346 | 0,0636 | 4,1435 |
| 3B1b | NMVOC | 4,4389 | 0,2722 | 5 | 100 | 100,12 | 0,1507 | 0,0225 | 0,0024 | 2,2506 | 0,0172 | 5,0653 |
| 3B2 | NMVOC | 2,2254 | 0,7475 | 7 | 100 | 100,24 | 1,1398 | 0,0058 | 0,0067 | 0,5818 | 0,0662 | 0,3429 |
| 3B3 | NMVOC | 13,8038 | 2,5330 | 20 | 100 | 101,98 | 13,5429 | 0,0549 | 0,0227 | 5,4853 | 0,6411 | 30,5000 |
| 3B4d | NMVOC | 0,0173 | 0,0800 | 5 | 100 | 100,12 | 0,0130 | 0,0006 | 0,0007 | 0,0619 | 0,0051 | 0,0039 |
| 3B4e | NMVOC | 0,1967 | 0,0838 | 5 | 100 | 100,12 | 0,0143 | 0,0004 | 0,0007 | 0,0356 | 0,0053 | 0,0013 |
| 3B4gi | NMVOC | 4,0631 | 0,6134 | 10 | 100 | 100,50 | 0,7713 | 0,0173 | 0,0055 | 1,7342 | 0,0776 | 3,0136 |
| 3B4h | NMVOC | 0,0147 | 0,0227 | 10 | 100 | 100,50 | 0,0011 | 0,0001 | 0,0002 | 0,0121 | 0,0029 | 0,0002 |
| 3De | NMVOC | 0,4536 | 0,4262 | 5 | 100 | 100,12 | 0,3696 | 0,0013 | 0,0038 | 0,1265 | 0,0270 | 0,0167 |
| 3F | NMVOC | 0,0204 | 0,0023 | 5 | 100 | 100,12 | 0,0000 | 0,0001 | 0,0000 | 0,0094 | 0,0001 | 0,0001 |
| 5A | NMVOC | 8,3215 | 8,0430 | 5 | 20 | 20,62 | 5,5802 | 0,0252 | 0,0720 | 0,5036 | 0,5089 | 0,5127 |
| 5C1biii | NMVOC | 0,0001 | 0,0003 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0001 | 0,0000 | 0,0000 |
| 5C2 | NMVOC | 0,1284 | 0,0868 | 5 | 50 | 50,25 | 0,0039 | 0,0001 | 0,0008 | 0,0027 | 0,0055 | 0,0000 |
| 5D2 | NMVOC | 0,0039 | 0,0011 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0006 | 0,0001 | 0,0000 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total |  | 111,750 | 70,192 |  |  |  | 155,711 |  |  |  |  | 52,984 |
|  |  |  |  |  |  |  | 12,478 |  |  |  |  | 7,279 |
|  | |  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 1-3. Uncertainty estimation of SOx emissions 1990 and 2023, Approach 1** | | | | | | | |  |  |  |  |  |
| A | B | C | D | E | F | G | H | I | J | K | L | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1A1a | SOx | 102,3750 | 1,9851 | 5 | 20 | 20,62 | 72,6029 | 0,0087 | 0,0133 | 0,1740 | 0,0940 | 0,0391 |
| 1A2a | SOx | 0,1441 | 0,0009 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0000 | 0,0005 | 0,0000 | 0,0000 |
| 1A2c | SOx | 0,0039 | 0,0000 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 |
| 1A2e | SOx | 0,7288 | 0,0676 | 5 | 20 | 20,62 | 0,0841 | 0,0003 | 0,0005 | 0,0059 | 0,0032 | 0,0000 |
| 1A2f | SOx | 1,4581 | 0,5274 | 5 | 20 | 20,62 | 5,1244 | 0,0032 | 0,0035 | 0,0643 | 0,0250 | 0,0048 |
| 1A2gviii | SOx | 0,3449 | 0,0664 | 5 | 20 | 20,62 | 0,0813 | 0,0004 | 0,0004 | 0,0074 | 0,0031 | 0,0001 |
| 1A3ai(i) | SOx | 0,0023 | 0,0329 | 5 | 50 | 50,25 | 0,1184 | 0,0002 | 0,0002 | 0,0110 | 0,0016 | 0,0001 |
| 1A3aii(i) | SOx | 0,0237 | 0,0000 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0002 | 0,0000 | 0,0000 |
| 1A3bi | SOx | 0,2002 | 0,0027 | 5 | 50 | 50,25 | 0,0008 | 0,0000 | 0,0000 | 0,0012 | 0,0001 | 0,0000 |
| 1A3bii | SOx | 0,1855 | 0,0011 | 5 | 50 | 50,25 | 0,0001 | 0,0000 | 0,0000 | 0,0016 | 0,0001 | 0,0000 |
| 1A3biii | SOx | 0,1194 | 0,0020 | 5 | 50 | 50,25 | 0,0004 | 0,0000 | 0,0000 | 0,0006 | 0,0001 | 0,0000 |
| 1A3biv | SOx | 0,0071 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 |
| 1A3dii | SOx | 0,0109 | 0,0002 | 30 | 50 | 58,31 | 0,0000 | 0,0000 | 0,0000 | 0,0001 | 0,0000 | 0,0000 |
| 1A4ai | SOx | 10,8124 | 0,5805 | 5 | 20 | 20,62 | 6,2088 | 0,0016 | 0,0039 | 0,0312 | 0,0275 | 0,0017 |
| 1A4bi | SOx | 31,5785 | 1,4152 | 5 | 20 | 20,62 | 36,8981 | 0,0027 | 0,0095 | 0,0534 | 0,0670 | 0,0073 |
| 1A4ci | SOx | 0,6332 | 0,0910 | 5 | 20 | 20,62 | 0,1526 | 0,0005 | 0,0006 | 0,0095 | 0,0043 | 0,0001 |
| 1A4cii | SOx | 0,3142 | 0,0000 | 5 | 20 | 20,62 | 0,0000 | 0,0001 | 0,0000 | 0,0014 | 0,0000 | 0,0000 |
| 2C1 | SOx | 0,0427 | 0,0178 | 5 | 20 | 20,62 | 0,0058 | 0,0001 | 0,0001 | 0,0022 | 0,0008 | 0,0000 |
| 3F | SOx | 0,0204 | 0,0023 | 5 | 100 | 100,12 | 0,0022 | 0,0000 | 0,0000 | 0,0011 | 0,0001 | 0,0000 |
| 5C1biii | SOx | 0,0001 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 |
| 5C2 | SOx | 0,0115 | 0,0078 | 5 | 50 | 50,25 | 0,0066 | 0,0000 | 0,0001 | 0,0025 | 0,0004 | 0,0000 |
| Total | | 149,326 | 4,803 |  |  |  | 121,287 |  |  |  |  | 0,053 |
|  | |  |  |  |  |  | 11,013 |  |  |  |  | 0,231 |
|  | |  |  |  |  |  |  |  |  |  |  |  |

**Table 1-4. Uncertainty estimation of NH3 emissions 1990 and 2023, Approach 1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1A2e | NH3 | 0,0002 | 0,0002 | 5 | 300 | 300,04 | 0,0000 | 0,0000 | 0,0000 | 0,0010 | 0,0000 | 0,0000 |
| 1A2f | NH3 | 0,0000 | 0,0000 | 5 | 300 | 300,04 | 0,0000 | 0,0000 | 0,0000 | 0,0001 | 0,0000 | 0,0000 |
| 1A2gviii | NH3 | 0,0002 | 0,0012 | 5 | 300 | 300,04 | 0,0004 | 0,0000 | 0,0000 | 0,0064 | 0,0002 | 0,0000 |
| 1A3bi | NH3 | 0,4159 | 0,1607 | 5 | 300 | 300,04 | 7,8515 | 0,0005 | 0,0030 | 0,1444 | 0,0215 | 0,0213 |
| 1A3bii | NH3 | 0,2141 | 0,0328 | 5 | 300 | 300,04 | 0,3274 | 0,0007 | 0,0006 | 0,2086 | 0,0044 | 0,0435 |
| 1A3biii | NH3 | 0,0072 | 0,0067 | 5 | 300 | 300,04 | 0,0138 | 0,0001 | 0,0001 | 0,0249 | 0,0009 | 0,0006 |
| 1A3biv | NH3 | 0,0011 | 0,0005 | 5 | 300 | 300,04 | 0,0001 | 0,0000 | 0,0000 | 0,0010 | 0,0001 | 0,0000 |
| 1A3c | NH3 | 0,0009 | 0,0000 | 5 | 300 | 300,04 | 0,0000 | 0,0000 | 0,0000 | 0,0014 | 0,0000 | 0,0000 |
| 1A4ai | NH3 | 0,0003 | 0,0005 | 5 | 300 | 300,04 | 0,0001 | 0,0000 | 0,0000 | 0,0022 | 0,0001 | 0,0000 |
| 1A4bi | NH3 | 0,0208 | 0,1621 | 5 | 300 | 300,04 | 7,9919 | 0,0029 | 0,0031 | 0,8806 | 0,0217 | 0,7759 |
| 1A4ci | NH3 | 0,0000 | 0,0001 | 5 | 300 | 300,04 | 0,0000 | 0,0000 | 0,0000 | 0,0002 | 0,0000 | 0,0000 |
| 1A4cii | NH3 | 0,0032 | 0,0009 | 5 | 300 | 300,04 | 0,0002 | 0,0000 | 0,0000 | 0,0010 | 0,0001 | 0,0000 |
| 2G | NH3 | 0,0453 | 0,0129 | 5 | 300 | 300,04 | 0,0505 | 0,0000 | 0,0002 | 0,0104 | 0,0017 | 0,0001 |
| 3B1a | NH3 | 7,1837 | 1,3661 | 5 | 100 | 100,12 | 63,2021 | 0,0183 | 0,0258 | 1,8287 | 0,1825 | 3,3776 |
| 3B1b | NH3 | 5,4642 | 0,3136 | 5 | 100 | 100,12 | 3,3305 | 0,0276 | 0,0059 | 2,7608 | 0,0419 | 7,6240 |
| 3B2 | NH3 | 0,5224 | 0,1755 | 7 | 100 | 100,24 | 1,0453 | 0,0001 | 0,0033 | 0,0107 | 0,0328 | 0,0012 |
| 3B3 | NH3 | 7,8426 | 1,5235 | 20 | 100 | 101,98 | 81,5440 | 0,0194 | 0,0288 | 1,9357 | 0,8142 | 4,4096 |
| 3B4d | NH3 | 0,0128 | 0,0591 | 5 | 100 | 100,12 | 0,1181 | 0,0010 | 0,0011 | 0,1037 | 0,0079 | 0,0108 |
| 3B4e | NH3 | 0,3220 | 0,1372 | 5 | 100 | 100,12 | 0,6375 | 0,0006 | 0,0026 | 0,0614 | 0,0183 | 0,0041 |
| 3B4f | NH3 |  | 0,0077 | 5 | 100 | 100,12 | 0,0020 | 0,0001 | 0,0001 | 0,0145 | 0,0010 | 0,0002 |
| 3B4gi | NH3 | 3,8021 | 0,5809 | 10 | 100 | 100,50 | 11,5111 | 0,0124 | 0,0110 | 1,2370 | 0,1552 | 1,5542 |
| 3B4h | NH3 | 0,0050 | 0,0077 | 10 | 100 | 100,50 | 0,0020 | 0,0001 | 0,0001 | 0,0115 | 0,0021 | 0,0001 |
| 3Da1 | NH3 | 7,8686 | 8,7332 | 5 | 100 | 100,12 | 2582,7891 | 0,1165 | 0,1650 | 11,6502 | 1,1668 | 137,0893 |
| 3Da2a | NH3 | 11,8427 | 1,8830 | 5 | 100 | 100,12 | 120,0705 | 0,0371 | 0,0356 | 3,7080 | 0,2516 | 13,8128 |
| 3Da2b | NH3 | 0,0297 | 0,0195 | 5 | 100 | 100,12 | 0,0128 | 0,0002 | 0,0004 | 0,0185 | 0,0026 | 0,0004 |
| 3Da2c | NH3 | 4,4380 | 0,8171 | 5 | 100 | 100,12 | 22,6120 | 0,0118 | 0,0154 | 1,1810 | 0,1092 | 1,4067 |
| 3Da3 | NH3 | 0,5534 | 0,2217 | 5 | 100 | 100,12 | 1,6638 | 0,0008 | 0,0042 | 0,0789 | 0,0296 | 0,0071 |
| 3F | NH3 | 0,0977 | 0,0108 | 5 | 100 | 100,12 | 0,0040 | 0,0004 | 0,0002 | 0,0396 | 0,0014 | 0,0016 |
| 5D1 | NH3 | 2,2320 | 0,9705 | 5 | 300 | 300,04 | 286,4252 | 0,0046 | 0,0183 | 1,3876 | 0,1297 | 1,9422 |
| Total |  | 52,926 | 17,206 |  |  |  | 3191,206 |  |  |  |  | 172,083 |
|  |  |  |  |  |  |  | 56,491 |  |  |  |  | 13,118 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 1-5. Uncertainty estimation of PM2.5 emissions 1990 and 2023, Approach 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
| 1A1a | PM2,5 | 2,0694 | 0,0870 | 5 | 50 | 50,25 | 0,0478 | 0,0694 | 0,0037 | 3,4705 | 0,0259 | 12,0449 |
| 1A2a | PM2,5 | 0,0188 | 0,0010 | 5 | 50 | 50,25 | 0,0000 | 0,0006 | 0,0000 | 0,0311 | 0,0003 | 0,0010 |
| 1A2c | PM2,5 | 0,0018 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0001 | 0,0000 | 0,0031 | 0,0000 | 0,0000 |
| 1A2e | PM2,5 | 0,1309 | 0,0359 | 5 | 50 | 50,25 | 0,0082 | 0,0031 | 0,0015 | 0,1558 | 0,0107 | 0,0244 |
| 1A2f | PM2,5 | 0,3744 | 0,0890 | 5 | 50 | 50,25 | 0,0501 | 0,0095 | 0,0037 | 0,4743 | 0,0265 | 0,2256 |
| 1A2gviii | PM2,5 | 0,0662 | 0,1619 | 5 | 50 | 50,25 | 0,1658 | 0,0045 | 0,0068 | 0,2235 | 0,0481 | 0,0523 |
| 1A3ai(i) | PM2,5 | 0,0002 | 0,0066 | 5 | 100 | 100,12 | 0,0011 | 0,0003 | 0,0003 | 0,0270 | 0,0020 | 0,0007 |
| 1A3bi | PM2,5 | 0,0482 | 0,1486 | 5 | 50 | 50,25 | 0,1397 | 0,0045 | 0,0062 | 0,2273 | 0,0442 | 0,0536 |
| 1A3bii | PM2,5 | 0,1493 | 0,1405 | 5 | 50 | 50,25 | 0,1249 | 0,0006 | 0,0059 | 0,0317 | 0,0418 | 0,0028 |
| 1A3biii | PM2,5 | 0,2190 | 0,2053 | 5 | 50 | 50,25 | 0,2666 | 0,0009 | 0,0086 | 0,0447 | 0,0611 | 0,0057 |
| 1A3biv | PM2,5 | 0,0110 | 0,0053 | 5 | 50 | 50,25 | 0,0002 | 0,0002 | 0,0002 | 0,0082 | 0,0016 | 0,0001 |
| 1A3bvi | PM2,5 | 0,2057 | 0,1217 | 5 | 50 | 50,25 | 0,0936 | 0,0022 | 0,0051 | 0,1076 | 0,0362 | 0,0129 |
| 1A3bvii | PM2,5 | 0,1067 | 0,0629 | 5 | 50 | 50,25 | 0,0251 | 0,0011 | 0,0026 | 0,0561 | 0,0187 | 0,0035 |
| 1A3c | PM2,5 | 0,1754 | 0,0079 | 5 | 100 | 100,12 | 0,0016 | 0,0059 | 0,0003 | 0,5865 | 0,0023 | 0,3440 |
| 1A4ai | PM2,5 | 1,3655 | 0,1503 | 5 | 100 | 100,12 | 0,5671 | 0,0419 | 0,0063 | 4,1911 | 0,0447 | 17,5670 |
| 1A4bi | PM2,5 | 14,8789 | 15,5034 | 5 | 100 | 100,12 | 6034,5819 | 0,1254 | 0,6520 | 12,5389 | 4,6101 | 178,4781 |
| 1A4ci | PM2,5 | 0,0909 | 0,0197 | 5 | 100 | 100,12 | 0,0098 | 0,0024 | 0,0008 | 0,2382 | 0,0059 | 0,0568 |
| 1A4cii | PM2,5 | 0,7472 | 0,2050 | 5 | 100 | 100,12 | 1,0548 | 0,0178 | 0,0086 | 1,7780 | 0,0609 | 3,1649 |
| 2A1 | PM2,5 | 0,2341 | 0,0907 | 5 | 50 | 50,25 | 0,0520 | 0,0045 | 0,0038 | 0,2229 | 0,0270 | 0,0504 |
| 2A2 | PM2,5 | 0,2493 | 0,0215 | 5 | 50 | 50,25 | 0,0029 | 0,0079 | 0,0009 | 0,3953 | 0,0064 | 0,1563 |
| 2A3 | PM2,5 | 0,0622 | 0,0503 | 5 | 50 | 50,25 | 0,0160 | 0,0001 | 0,0021 | 0,0040 | 0,0150 | 0,0002 |
| 2C1 | PM2,5 | 0,0150 | 0,0062 | 5 | 50 | 50,25 | 0,0002 | 0,0003 | 0,0003 | 0,0133 | 0,0019 | 0,0002 |
| 2D3b | PM2,5 | 0,4881 | 2,1331 | 5 | 100 | 100,12 | 114,2420 | 0,0724 | 0,0897 | 7,2441 | 0,6343 | 52,8787 |
| 2D3i | PM2,5 | 0,0767 | 0,0648 | 5 | 100 | 100,12 | 0,1055 | 0,0000 | 0,0027 | 0,0015 | 0,0193 | 0,0004 |
| 2G | PM2,5 | 0,2334 | 0,0664 | 5 | 100 | 100,12 | 0,1108 | 0,0055 | 0,0028 | 0,5455 | 0,0198 | 0,2979 |
| 3B1a | PM2,5 | 0,1648 | 0,0317 | 5 | 300 | 300,04 | 0,2272 | 0,0045 | 0,0013 | 1,3468 | 0,0094 | 1,8139 |
| 3B1b | PM2,5 | 0,1491 | 0,0091 | 5 | 300 | 300,04 | 0,0188 | 0,0049 | 0,0004 | 1,4653 | 0,0027 | 2,1470 |
| 3B2 | PM2,5 | 0,0261 | 0,0088 | 7 | 300 | 300,08 | 0,0174 | 0,0006 | 0,0004 | 0,1662 | 0,0037 | 0,0276 |
| 3B3 | PM2,5 | 0,0164 | 0,0030 | 20 | 300 | 300,67 | 0,0020 | 0,0005 | 0,0001 | 0,1356 | 0,0036 | 0,0184 |
| 3B4d | PM2,5 | 0,0006 | 0,0030 | 5 | 300 | 300,04 | 0,0020 | 0,0001 | 0,0001 | 0,0305 | 0,0009 | 0,0009 |
| 3B4e | PM2,5 | 0,0064 | 0,0027 | 5 | 300 | 300,04 | 0,0017 | 0,0001 | 0,0001 | 0,0337 | 0,0008 | 0,0011 |
| 3B4gi | PM2,5 | 0,0739 | 0,0112 | 10 | 300 | 300,17 | 0,0281 | 0,0021 | 0,0005 | 0,6425 | 0,0066 | 0,4128 |
| 3B4h | PM2,5 | 0,0010 | 0,0015 | 10 | 300 | 300,17 | 0,0005 | 0,0000 | 0,0001 | 0,0089 | 0,0009 | 0,0001 |
| 3Dc | PM2,5 | 0,1101 | 0,1074 | 5 | 300 | 300,04 | 2,6020 | 0,0006 | 0,0045 | 0,1882 | 0,0319 | 0,0364 |
| 3F | PM2,5 | 0,2199 | 0,0244 | 5 | 300 | 300,04 | 0,1339 | 0,0067 | 0,0010 | 2,0234 | 0,0072 | 4,0944 |
| 5A | PM2,5 | 0,0001 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 |
| 5C2 | PM2,5 | 0,4375 | 0,2956 | 5 | 50 | 50,25 | 0,5524 | 0,0030 | 0,0124 | 0,1515 | 0,0879 | 0,0307 |
| 5E | PM2,5 | 0,4699 | 0,0263 | 5 | 50 | 50,25 | 0,0044 | 0,0155 | 0,0011 | 0,7747 | 0,0078 | 0,6003 |
| Total |  | 23,779 | 19,982 |  |  |  | 6155,273 |  |  |  |  | 274,606 |
|  |  |  |  |  |  |  | 78,456 |  |  |  |  | 16,571 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 1-6. Uncertainty estimation of PM10 emissions 1990 and 2023, Approach 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year  emissions | Year t e  missions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined  uncertainty as % of total national  emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty  in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
| 1A1a | PM10 | 2,9227 | 0,1107 | 5 | 50 | 50,25 | 0,0560 | 0,0633 | 0,0035 | 3,1628 | 0,0244 | 10,0039 |
| 1A2a | PM10 | 0,0203 | 0,0010 | 5 | 50 | 50,25 | 0,0000 | 0,0004 | 0,0000 | 0,0215 | 0,0002 | 0,0005 |
| 1A2c | PM10 | 0,0018 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0020 | 0,0000 | 0,0000 |
| 1A2e | PM10 | 0,1377 | 0,0371 | 5 | 50 | 50,25 | 0,0063 | 0,0020 | 0,0012 | 0,0995 | 0,0082 | 0,0100 |
| 1A2f | PM10 | 0,3827 | 0,0935 | 5 | 50 | 50,25 | 0,0399 | 0,0058 | 0,0029 | 0,2914 | 0,0206 | 0,0853 |
| 1A2gviii | PM10 | 0,0700 | 0,1650 | 5 | 50 | 50,25 | 0,1243 | 0,0035 | 0,0051 | 0,1772 | 0,0364 | 0,0327 |
| 1A3ai(i) | PM10 | 0,0002 | 0,0066 | 5 | 100 | 100,12 | 0,0008 | 0,0002 | 0,0002 | 0,0200 | 0,0014 | 0,0004 |
| 1A3bi | PM10 | 0,0482 | 0,1486 | 5 | 50 | 50,25 | 0,1009 | 0,0035 | 0,0046 | 0,1765 | 0,0328 | 0,0322 |
| 1A3bii | PM10 | 0,1493 | 0,1405 | 5 | 50 | 50,25 | 0,0902 | 0,0010 | 0,0044 | 0,0485 | 0,0310 | 0,0033 |
| 1A3biii | PM10 | 0,2190 | 0,2053 | 5 | 50 | 50,25 | 0,1925 | 0,0014 | 0,0064 | 0,0698 | 0,0452 | 0,0069 |
| 1A3biv | PM10 | 0,0110 | 0,0053 | 5 | 50 | 50,25 | 0,0001 | 0,0001 | 0,0002 | 0,0042 | 0,0012 | 0,0000 |
| 1A3bvi | PM10 | 0,3967 | 0,2348 | 5 | 50 | 50,25 | 0,2517 | 0,0017 | 0,0073 | 0,0872 | 0,0517 | 0,0103 |
| 1A3bvii | PM10 | 0,1966 | 0,1160 | 5 | 50 | 50,25 | 0,0615 | 0,0009 | 0,0036 | 0,0438 | 0,0256 | 0,0026 |
| 1A3c | PM10 | 0,1843 | 0,0083 | 5 | 100 | 100,12 | 0,0012 | 0,0040 | 0,0003 | 0,3952 | 0,0018 | 0,1562 |
| 1A3dii | PM10 | 0,0064 | 0,0001 | 30 | 100 | 104,40 | 0,0000 | 0,0001 | 0,0000 | 0,0144 | 0,0001 | 0,0002 |
| 1A4ai | PM10 | 1,4789 | 0,1576 | 5 | 100 | 100,12 | 0,4503 | 0,0289 | 0,0049 | 2,8858 | 0,0347 | 8,3291 |
| 1A4bi | PM10 | 15,1143 | 15,9156 | 5 | 100 | 100,12 | 4592,4636 | 0,1501 | 0,4961 | 15,0087 | 3,5077 | 237,5645 |
| 1A4ci | PM10 | 0,1001 | 0,0208 | 5 | 100 | 100,12 | 0,0078 | 0,0016 | 0,0006 | 0,1639 | 0,0046 | 0,0269 |
| 1A4cii | PM10 | 0,7472 | 0,2050 | 5 | 100 | 100,12 | 0,7617 | 0,0107 | 0,0064 | 1,0678 | 0,0452 | 1,1423 |
| 2A1 | PM10 | 0,4214 | 0,1633 | 5 | 50 | 50,25 | 0,1217 | 0,0045 | 0,0051 | 0,2269 | 0,0360 | 0,0528 |
| 2A2 | PM10 | 1,2464 | 0,1074 | 5 | 50 | 50,25 | 0,0527 | 0,0251 | 0,0033 | 1,2558 | 0,0237 | 1,5775 |
| 2A3 | PM10 | 0,0699 | 0,0566 | 5 | 50 | 50,25 | 0,0146 | 0,0002 | 0,0018 | 0,0084 | 0,0125 | 0,0002 |
| 2C1 | PM10 | 0,0171 | 0,0071 | 5 | 50 | 50,25 | 0,0002 | 0,0002 | 0,0002 | 0,0084 | 0,0016 | 0,0001 |
| 2D3b | PM10 | 3,6609 | 2,1331 | 5 | 100 | 100,12 | 82,4958 | 0,0171 | 0,0665 | 1,7124 | 0,4701 | 3,1534 |
| 2D3i | PM10 | 0,1150 | 0,0972 | 5 | 100 | 100,12 | 0,1714 | 0,0004 | 0,0030 | 0,0402 | 0,0214 | 0,0021 |
| 2G | PM10 | 0,2457 | 0,0664 | 5 | 100 | 100,12 | 0,0800 | 0,0035 | 0,0021 | 0,3542 | 0,0146 | 0,1257 |
| 2H2 | PM10 | 0,0521 | 0,0193 | 5 | 50 | 50,25 | 0,0017 | 0,0006 | 0,0006 | 0,0294 | 0,0043 | 0,0009 |
| 3B1a | PM10 | 0,2533 | 0,0488 | 5 | 300 | 300,04 | 0,3873 | 0,0043 | 0,0015 | 1,2795 | 0,0107 | 1,6372 |
| 3B1b | PM10 | 0,1527 | 0,0094 | 5 | 300 | 300,04 | 0,0143 | 0,0032 | 0,0003 | 0,9586 | 0,0021 | 0,9189 |
| 3B2 | PM10 | 0,0784 | 0,0263 | 7 | 300 | 300,08 | 0,1128 | 0,0010 | 0,0008 | 0,2909 | 0,0081 | 0,0847 |
| 3B3 | PM10 | 0,3886 | 0,0713 | 20 | 300 | 300,67 | 0,8311 | 0,0067 | 0,0022 | 1,9959 | 0,0629 | 3,9875 |
| 3B4d | PM10 | 0,0019 | 0,0089 | 5 | 300 | 300,04 | 0,0128 | 0,0002 | 0,0003 | 0,0697 | 0,0020 | 0,0049 |
| 3B4e | PM10 | 0,0101 | 0,0043 | 5 | 300 | 300,04 | 0,0030 | 0,0001 | 0,0001 | 0,0290 | 0,0010 | 0,0008 |
| 3B4gi | PM10 | 0,9850 | 0,1487 | 10 | 300 | 300,17 | 3,6031 | 0,0179 | 0,0046 | 5,3583 | 0,0655 | 28,7157 |
| 3B4h | PM10 | 0,0020 | 0,0031 | 10 | 300 | 300,17 | 0,0015 | 0,0001 | 0,0001 | 0,0151 | 0,0014 | 0,0002 |
| 3Dc | PM10 | 0,9337 | 1,8806 | 5 | 300 | 300,04 | 575,8073 | 0,0373 | 0,0586 | 11,1823 | 0,4145 | 125,2160 |
| 3F | PM10 | 0,2321 | 0,0257 | 5 | 300 | 300,04 | 0,1077 | 0,0045 | 0,0008 | 1,3500 | 0,0057 | 1,8225 |
| 5A | PM10 | 0,0005 | 0,0005 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0002 | 0,0001 | 0,0000 |
| 5C2 | PM10 | 0,4709 | 0,3181 | 5 | 50 | 50,25 | 0,4622 | 0,0008 | 0,0099 | 0,0421 | 0,0701 | 0,0067 |
| 5E | PM10 | 0,4699 | 0,0263 | 5 | 50 | 50,25 | 0,0032 | 0,0099 | 0,0008 | 0,4956 | 0,0058 | 0,2457 |
| Total |  | 32,084 | 23,515 |  |  |  | 5259,953 |  |  |  |  | 424,972 |
|  |  |  |  |  |  |  | 72,526 |  |  |  |  | 20,615 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 1-7. Uncertainty estimation of TSP emissions 1990 and 2023, Approach 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
| 1A1a | TSP | 4,1400 | 0,1516 | 5 | 50 | 50,25 | 0,0307 | 0,0327 | 0,0021 | 1,6367 | 0,0149 | 2,6790 |
| 1A2a | TSP | 0,0214 | 0,0010 | 5 | 50 | 50,25 | 0,0000 | 0,0002 | 0,0000 | 0,0083 | 0,0001 | 0,0001 |
| 1A2c | TSP | 0,0018 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0007 | 0,0000 | 0,0000 |
| 1A2e | TSP | 0,1436 | 0,0388 | 5 | 50 | 50,25 | 0,0020 | 0,0007 | 0,0005 | 0,0334 | 0,0038 | 0,0011 |
| 1A2f | TSP | 0,3894 | 0,0970 | 5 | 50 | 50,25 | 0,0126 | 0,0019 | 0,0014 | 0,0964 | 0,0096 | 0,0094 |
| 1A2gviii | TSP | 0,0737 | 0,1720 | 5 | 50 | 50,25 | 0,0396 | 0,0018 | 0,0024 | 0,0887 | 0,0169 | 0,0082 |
| 1A3ai(i) | TSP | 0,0002 | 0,0066 | 5 | 100 | 100,12 | 0,0002 | 0,0001 | 0,0001 | 0,0090 | 0,0006 | 0,0001 |
| 1A3bi | TSP | 0,0482 | 0,1486 | 5 | 50 | 50,25 | 0,0295 | 0,0017 | 0,0021 | 0,0831 | 0,0146 | 0,0071 |
| 1A3bii | TSP | 0,1493 | 0,1405 | 5 | 50 | 50,25 | 0,0264 | 0,0007 | 0,0020 | 0,0349 | 0,0138 | 0,0014 |
| 1A3biii | TSP | 0,2190 | 0,2053 | 5 | 50 | 50,25 | 0,0563 | 0,0010 | 0,0029 | 0,0507 | 0,0202 | 0,0030 |
| 1A3biv | TSP | 0,0110 | 0,0053 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0001 | 0,0009 | 0,0005 | 0,0000 |
| 1A3bvi | TSP | 0,5064 | 0,2995 | 5 | 50 | 50,25 | 0,1199 | 0,0001 | 0,0042 | 0,0047 | 0,0295 | 0,0009 |
| 1A3bvii | TSP | 0,3933 | 0,2321 | 5 | 50 | 50,25 | 0,0720 | 0,0001 | 0,0032 | 0,0041 | 0,0228 | 0,0005 |
| 1A3c | TSP | 0,1946 | 0,0087 | 5 | 100 | 100,12 | 0,0004 | 0,0015 | 0,0001 | 0,1517 | 0,0009 | 0,0230 |
| 1A4ai | TSP | 1,5637 | 0,1655 | 5 | 100 | 100,12 | 0,1453 | 0,0109 | 0,0023 | 1,0863 | 0,0163 | 1,1802 |
| 1A4bi | TSP | 16,5633 | 16,7769 | 5 | 100 | 100,12 | 1493,6306 | 0,0938 | 0,2335 | 9,3826 | 1,6512 | 90,7605 |
| 1A4ci | TSP | 0,1043 | 0,0219 | 5 | 100 | 100,12 | 0,0025 | 0,0006 | 0,0003 | 0,0574 | 0,0022 | 0,0033 |
| 1A4cii | TSP | 0,7472 | 0,2050 | 5 | 100 | 100,12 | 0,2229 | 0,0034 | 0,0029 | 0,3439 | 0,0202 | 0,1187 |
| 2A1 | TSP | 0,4683 | 0,1814 | 5 | 50 | 50,25 | 0,0440 | 0,0014 | 0,0025 | 0,0709 | 0,0179 | 0,0053 |
| 2A2 | TSP | 3,2050 | 0,2762 | 5 | 50 | 50,25 | 0,1020 | 0,0231 | 0,0038 | 1,1567 | 0,0272 | 1,3387 |
| 2A3 | TSP | 0,0777 | 0,0629 | 5 | 50 | 50,25 | 0,0053 | 0,0002 | 0,0009 | 0,0111 | 0,0062 | 0,0002 |
| 2C1 | TSP | 0,0266 | 0,0107 | 5 | 50 | 50,25 | 0,0002 | 0,0001 | 0,0001 | 0,0037 | 0,0011 | 0,0000 |
| 2D3b | TSP | 17,0843 | 9,9546 | 5 | 100 | 100,12 | 525,8495 | 0,0053 | 0,1386 | 0,5293 | 0,9798 | 1,2400 |
| 2D3g | TSP | 14,6437 | 8,5325 | 5 | 100 | 100,12 | 386,3384 | 0,0045 | 0,1188 | 0,4538 | 0,8398 | 0,9112 |
| 2D3i | TSP | 0,1406 | 0,1188 | 5 | 100 | 100,12 | 0,0749 | 0,0005 | 0,0017 | 0,0470 | 0,0117 | 0,0023 |
| 2G | TSP | 0,2334 | 0,0664 | 5 | 100 | 100,12 | 0,0234 | 0,0010 | 0,0009 | 0,1041 | 0,0065 | 0,0109 |
| 3B1a | TSP | 0,5548 | 0,1068 | 5 | 300 | 300,04 | 0,5440 | 0,0032 | 0,0015 | 0,9553 | 0,0105 | 0,9126 |
| 3B1b | TSP | 0,3302 | 0,0202 | 5 | 300 | 300,04 | 0,0195 | 0,0025 | 0,0003 | 0,7495 | 0,0020 | 0,5617 |
| 3B2 | TSP | 0,1828 | 0,0614 | 7 | 300 | 300,08 | 0,1798 | 0,0007 | 0,0009 | 0,2054 | 0,0085 | 0,0423 |
| 3B3 | TSP | 2,6994 | 0,4953 | 20 | 300 | 300,67 | 11,7408 | 0,0158 | 0,0069 | 4,7492 | 0,1950 | 22,5928 |
| 3B4d | TSP | 0,0045 | 0,0207 | 5 | 300 | 300,04 | 0,0204 | 0,0002 | 0,0003 | 0,0750 | 0,0020 | 0,0056 |
| 3B4e | TSP | 0,0221 | 0,0094 | 5 | 300 | 300,04 | 0,0042 | 0,0001 | 0,0001 | 0,0165 | 0,0009 | 0,0003 |
| 3B4gi | TSP | 4,6788 | 0,7063 | 10 | 300 | 300,17 | 23,7949 | 0,0295 | 0,0098 | 8,8644 | 0,1390 | 78,5973 |
| 3B4h | TSP | 0,0045 | 0,0069 | 10 | 300 | 300,17 | 0,0023 | 0,0001 | 0,0001 | 0,0176 | 0,0014 | 0,0003 |
| 3Dc | TSP | 0,9337 | 1,8806 | 5 | 300 | 300,04 | 168,5362 | 0,0183 | 0,0262 | 5,4933 | 0,1851 | 30,2109 |
| 3F | TSP | 0,2362 | 0,0262 | 5 | 300 | 300,04 | 0,0326 | 0,0016 | 0,0004 | 0,4873 | 0,0026 | 0,2375 |
| 5C2 | TSP | 0,4845 | 0,3273 | 5 | 50 | 50,25 | 0,1432 | 0,0005 | 0,0046 | 0,0238 | 0,0322 | 0,0016 |
| 5E | TSP | 0,4699 | 0,0263 | 5 | 50 | 50,25 | 0,0009 | 0,0036 | 0,0004 | 0,1795 | 0,0026 | 0,0322 |
| Total |  | 71,844 | 43,464 |  |  |  | 2614,153 |  |  |  |  | 231,517 |
|  |  |  |  |  |  |  | 51,129 |  |  |  |  | 15,216 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 1-8. Uncertainty estimation of BC emissions 1990 and 2023, Approach 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1A1a | BC | 0,1074 | 0,0044 | 5 | 50 | 50,25 | 0,0111 | 0,0422 | 0,0019 | 2,1120 | 0,0137 | 4,4606 |
| 1A2c | BC | 0,0009 | 0,0000 | 5 | 50 | 50,25 | 0,0000 | 0,0004 | 0,0000 | 0,0186 | 0,0000 | 0,0003 |
| 1A2e | BC | 0,0301 | 0,0085 | 5 | 50 | 50,25 | 0,0418 | 0,0086 | 0,0038 | 0,4310 | 0,0266 | 0,1865 |
| 1A2f | BC | 0,1572 | 0,0215 | 5 | 50 | 50,25 | 0,2693 | 0,0551 | 0,0096 | 2,7556 | 0,0676 | 7,5981 |
| 1A2gviii | BC | 0,0105 | 0,0493 | 5 | 50 | 50,25 | 1,4183 | 0,0176 | 0,0219 | 0,8805 | 0,1552 | 0,7993 |
| 1A3ai(i) | BC | 0,0001 | 0,0032 | 5 | 100 | 100,12 | 0,0231 | 0,0014 | 0,0014 | 0,1365 | 0,0099 | 0,0187 |
| 1A3bi | BC | 0,0231 | 0,0833 | 5 | 50 | 50,25 | 4,0376 | 0,0275 | 0,0370 | 1,3754 | 0,2618 | 1,9603 |
| 1A3bii | BC | 0,0793 | 0,0769 | 5 | 50 | 50,25 | 3,4426 | 0,0015 | 0,0342 | 0,0761 | 0,2417 | 0,0642 |
| 1A3biii | BC | 0,0100 | 0,0093 | 5 | 50 | 50,25 | 0,0500 | 0,0000 | 0,0041 | 0,0012 | 0,0291 | 0,0009 |
| 1A3biv | BC | 0,0012 | 0,0006 | 5 | 50 | 50,25 | 0,0002 | 0,0002 | 0,0003 | 0,0118 | 0,0018 | 0,0001 |
| 1A3c | BC | 0,0011 | 0,0001 | 5 | 100 | 100,12 | 0,0000 | 0,0004 | 0,0000 | 0,0446 | 0,0002 | 0,0020 |
| 1A4ai | BC | 0,1175 | 0,0270 | 5 | 100 | 100,12 | 1,6904 | 0,0363 | 0,0120 | 3,6331 | 0,0850 | 13,2066 |
| 1A4bi | BC | 0,9864 | 1,5305 | 5 | 100 | 100,12 | 5416,8276 | 0,2733 | 0,6806 | 27,3275 | 4,8122 | 769,9520 |
| 1A4ci | BC | 0,0192 | 0,0032 | 5 | 100 | 100,12 | 0,0234 | 0,0065 | 0,0014 | 0,6500 | 0,0100 | 0,4225 |
| 1A4cii | BC | 0,4332 | 0,1190 | 5 | 100 | 100,12 | 32,7414 | 0,1252 | 0,0529 | 12,5203 | 0,3741 | 156,8980 |
| 2A1 | BC | 0,0070 | 0,0027 | 5 | 50 | 50,25 | 0,0043 | 0,0017 | 0,0012 | 0,0841 | 0,0086 | 0,0071 |
| 2A2 | BC | 0,0011 | 0,0001 | 5 | 50 | 50,25 | 0,0000 | 0,0004 | 0,0000 | 0,0214 | 0,0003 | 0,0005 |
| 2D3b | BC | 0,0278 | 0,0162 | 5 | 100 | 100,12 | 0,6077 | 0,0042 | 0,0072 | 0,4245 | 0,0510 | 0,1828 |
| 3F | BC | 0,0204 | 0,0023 | 5 | 300 | 300,04 | 0,1057 | 0,0074 | 0,0010 | 2,2132 | 0,0071 | 4,8984 |
| 5C2 | BC | 0,1837 | 0,1241 | 5 | 50 | 50,25 | 8,9752 | 0,0204 | 0,0552 | 1,0214 | 0,3903 | 1,1956 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total |  | 2,249 | 2,082 |  |  |  | 5470,270 |  |  |  |  | 961,855 |
|  | |  |  |  |  |  | 73,961 |  |  |  |  | 31,014 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 1-9 Uncertainty estimation of CO emissions 1990 and 2023, Approach 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
| Sector NFR | Pollutant | Base year emissions | Year t emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions Sin year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Gg** | **Gg** | % | % | % | % | % | % | % | % | % |
| 1A1a | CO | 7,2099 | 2,4494 | 5 | 20 | 20,62 | 0,1678 | 0,0012 | 0,0078 | 0,0247 | 0,0553 | 0,0037 |
| 1A2a | CO | 0,2114 | 0,0389 | 5 | 20 | 20,62 | 0,0000 | 0,0001 | 0,0001 | 0,0028 | 0,0009 | 0,0000 |
| 1A2c | CO | 0,0122 | 0,0019 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0000 | 0,0002 | 0,0000 | 0,0000 |
| 1A2d | CO | 0,0000 | 0,0023 | 5 | 20 | 20,62 | 0,0000 | 0,0000 | 0,0000 | 0,0001 | 0,0001 | 0,0000 |
| 1A2e | CO | 0,8576 | 0,2286 | 5 | 20 | 20,62 | 0,0015 | 0,0003 | 0,0007 | 0,0069 | 0,0052 | 0,0001 |
| 1A2f | CO | 1,9037 | 0,6782 | 5 | 20 | 20,62 | 0,0129 | 0,0002 | 0,0022 | 0,0045 | 0,0153 | 0,0003 |
| 1A2gviii | CO | 0,4820 | 0,7637 | 5 | 20 | 20,62 | 0,0163 | 0,0018 | 0,0024 | 0,0366 | 0,0172 | 0,0016 |
| 1A3ai(i) | CO | 0,0334 | 0,0329 | 5 | 100 | 100,12 | 0,0007 | 0,0001 | 0,0001 | 0,0063 | 0,0007 | 0,0000 |
| 1A3aii(i) | CO | 28,4009 | 0,0276 | 5 | 100 | 100,12 | 0,0005 | 0,0355 | 0,0001 | 3,5544 | 0,0006 | 12,6337 |
| 1A3bi | CO | 23,6666 | 8,2487 | 5 | 50 | 50,25 | 11,3039 | 0,0034 | 0,0263 | 0,1695 | 0,1862 | 0,0634 |
| 1A3bii | CO | 33,6306 | 5,6612 | 5 | 50 | 50,25 | 5,3244 | 0,0241 | 0,0181 | 1,2069 | 0,1278 | 1,4729 |
| 1A3biii | CO | 7,9071 | 7,7552 | 5 | 50 | 50,25 | 9,9918 | 0,0148 | 0,0248 | 0,7409 | 0,1750 | 0,5796 |
| 1A3biv | CO | 5,2675 | 2,5532 | 5 | 50 | 50,25 | 1,0830 | 0,0015 | 0,0081 | 0,0767 | 0,0576 | 0,0092 |
| 1A3c | CO | 1,3696 | 0,0615 | 5 | 100 | 100,12 | 0,0025 | 0,0015 | 0,0002 | 0,1523 | 0,0014 | 0,0232 |
| 1A3dii | CO | 0,0230 | 0,0003 | 30 | 100 | 104,40 | 0,0000 | 0,0000 | 0,0000 | 0,0028 | 0,0000 | 0,0000 |
| 1A3ei | CO | 0,0731 | 0,0002 | 5 | 100 | 100,12 | 0,0000 | 0,0001 | 0,0000 | 0,0091 | 0,0000 | 0,0001 |
| 1A4ai | CO | 11,4100 | 0,9641 | 5 | 50 | 50,25 | 0,1544 | 0,0112 | 0,0031 | 0,5623 | 0,0218 | 0,3167 |
| 1A4bi | CO | 166,3414 | 87,3488 | 5 | 50 | 50,25 | 1267,5662 | 0,0695 | 0,2788 | 3,4763 | 1,9712 | 15,9703 |
| 1A4ci | CO | 0,6712 | 0,1278 | 5 | 50 | 50,25 | 0,0027 | 0,0004 | 0,0004 | 0,0218 | 0,0029 | 0,0005 |
| 1A4cii | CO | 9,8692 | 1,4056 | 5 | 50 | 50,25 | 0,3282 | 0,0079 | 0,0045 | 0,3952 | 0,0317 | 0,1572 |
| 2C1 | CO | 1,2103 | 0,5043 | 5 | 50 | 50,25 | 0,0422 | 0,0001 | 0,0016 | 0,0045 | 0,0114 | 0,0001 |
| 2G | CO | 0,6017 | 0,1726 | 5 | 50 | 50,25 | 0,0049 | 0,0002 | 0,0006 | 0,0102 | 0,0039 | 0,0001 |
| 3F | CO | 2,7159 | 0,3010 | 5 | 100 | 100,12 | 0,0598 | 0,0024 | 0,0010 | 0,2450 | 0,0068 | 0,0601 |
| 5C1biii | CO | 0,0000 | 0,0000 | 5 | 50 | 50,25 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 | 0,0000 |
| 5C2 | CO | 5,8294 | 3,9383 | 5 | 50 | 50,25 | 2,5768 | 0,0052 | 0,0126 | 0,2624 | 0,0889 | 0,0768 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total |  | 313,330 | 123,283 |  |  |  | 1298,641 |  |  |  |  | 31,369 |
|  |  |  |  |  |  |  | 36,037 |  |  |  |  | 5,601 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |