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"Institutional strengthening support to scale up action on short-lived climate pollutants in the Republic of Moldova"

INFORMATIVE INVENTORY REPORT OF THE REPUBLIC OF MOLDOVA 1990-2017

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

2020

The 2019 Informative Inventory Report of the Republic of Moldova was developed by the Institute of Chemistry within the project "Institutional strengthening support to scale up action on short-lived climate pollutants in the Republic of Moldova". The United Nations Environment Programme and the Climate and Clean Air Coalition support the project to increase the level of action taken in Moldova to reduce air pollution, especially short-lived climate pollutants and report under the Convention on Long-range Transboundary Air Pollution (CLRTAP).

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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
CH_4	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
NH_3	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)
$PM_{2.5}$	Particulate matter (PM) or Particulates ≤ 2.5 µm (micrometres)
PM_{10}	Particulates ≤ 10 µm
POPs	Persistent Organic Pollutants
RM	Republic of Moldova
SA	Joint Stock Company
Se	Selenium
SEI	State Ecological Inspectorate
SO_2	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
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6.A	Other (included in national total for entire territory) (please specify in IIR)

Executive summary

The second Informative Inventory Report (IIR) of the Republic of Moldova (RM) for the period 1990-2017 was developed by the Institute of Chemistry of the Republic of Moldova under the leadership of the Ministry of Agriculture, Regional Development and Environment (MARDE), , in line with requirements of the Convention on Long-range Transboundary Air Pollution (CLRTAP), as the country's commitment. The purpose of this Informative Inventory Report is to relate the current state of emissions, calculated according to the EMEP/EEA air pollutant emission inventory guidebooks, collect new data and integrate them with the existing database. This was done with the substantial contributions of national experts and national entities, taking into consideration the proposals of the Moldova Review Report on the previous Nomenclature for Reporting (NFR).

The IIR of the Republic of Moldova for 1990-2017 contains detailed information on annual emission estimates of air quality pollutants by sources in the Republic of Moldova in the NFR format for all 25 pollutants:

- Main pollutants (5): CO, NH_3, NMVOC, NOx, SOx(SO_2);
- PM (4): $PM_{2.5}$, PM_{10}, TSP, BC;
- Heavy Metals (9): Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn;
- POPs (7): PCDD/F, Benzo(a) pyrene, Benzo(b)fluoranthene, Benzo(k) fluoranthene, Indeno(1,2,3-cd) pyrene, HCB, PCB.

The main book for this edition is EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, while for the next year the 2019 Guidebook will be used. The second IIR of Moldova follows the Annex II - Recommended Structure for Informative Inventory Report, UNECE.

Being aware that air pollution affects our health, environment and economy, that air pollutants come from multiple sources, the main commitment assumed under the CLRTAP is the inventory of emissions across sectors in the transboundary context. Moldova supports the Convention's activities, strategies, and declarations, particularly those activities covered by the signed protocols, and mobilizes internal human and financial resources, while developing the individual and institutional capacities. The second IIR was submitted to the Ministry of Agriculture, Regional Development and Environment and the CLRTAP Secretariat for further recommendations on emission inventory, planned measures for emission reduction and progress in air pollution control. The national inventory system for reporting under CLRTAP is created by the Institute of Chemistry and the Institute of Power Engineering. Since Moldova is not a member of the EU, it is not reporting under the National Emission Ceilings Directive.

The Institute of Chemistry as the entity responsible for the preparation of the inventory and the report to the CLRTAP, as well as the national experts' team appreciate the support of the Government of the Republic of Moldova and the Ministry of Agriculture, Regional Development and Environment. The research and reporting process were facilitated, while ensuring the communication and data accessibility, enhancing cooperation and dialog at the national and international levels.

The Ministry of Agriculture, Regional Development and Environment and the Institute of Chemistry highly appreciate the cooperation with the UN Environment Programme and the Climate and Clean Air Coalition for their support in the strengthening of institutional capacities for the integrated air quality monitoring and reporting to the CLRTAP.

CHAPTER 1. INTRODUCTION

1.1.National Inventory Background

Air quality is a world priority addressed by the United Nations and declared on the World Environment Day, June 5, 2019: "We Beat Air Pollution". Meanwhile, air pollution is not the number one ecological problem in the Republic of Moldova, however, it is a state priority with assumed commitments under the international treaties.

In order to secure the financial support for air quality inventory, Moldova, as a partner of the Climate and Clean Air Coalition (CCAC), responded to the call for expression of interest launched by the Coalition in June 2016 and received the institutional strengthening support provided by the Supporting National Action and Planning Initiative (SNAP) of the CCAC. In line with the objectives of the SNAP initiative, activities under the small-scale financial agreement (SSFA) aim to strengthen the national institutional capacity to promote integrated planning on air quality and climate and to develop the capacity for reporting to the CLRTAP.

The Ministry of Agriculture, Regional Development and Environment of Moldova designated the Institute of Chemistry as a host country institution to prepare the inventory for the 1990-2017 period and ensure capacity development. The activity started with the training on using LEAP-IBC to develop integrated air pollution and climate change analyses in LEAP-IBC (3 days). The Long-range Energy Alternatives Planning (LEAP) - Integrated Benefits Calculator (IBC) is an integrated planning tool to help governments jointly assess greenhouse gases, short-lived climate pollutants (SLCPs) and other air pollutant emissions, build mitigation scenarios, and understand how emission reductions benefit the climate, health and crops.

For the current estimation of emissions, the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 was used. The EMEP/EEA air pollutant emission methodology and LEAP will be further used for estimation of grid emissions, creating a spatial mapping of emissions, projections, compiling spatial emission datasets, focusing on suitable methods for generating and reporting spatial data that are consistent with nationally reported inventories under CLRTAP.

The transport sector is responsible for about a quarter of the consumption of energy and energy resources in the Republic of Moldova, generating a quarter of the greenhouse gas emissions from the combustion of fuels. LDV consume about 90% of all energy and energy resources in the transport sector. The national motor vehicle fleet is dominated by light passenger cars, which account for about three quarters of the total number of motor vehicles, with an upward trend of around 600 thousand units. There is an interdependence between the total number of motor vehicles, the consumption of petroleum products and the amount of emissions. The increase in the number of motor vehicles registered over the years has led to an increase in oil consumption and, respectively, to the increase in greenhouse gas emissions. In recent years, there has been a transformation of the national motor vehicle fleet. Until 2009, the number of registered new cars with a petrol engine prevailed. Currently, the number of registrations of diesel-based motor vehicles predominates significantly. Diesel engine vehicles are more efficient in terms of primary energy conversion, but their level of emissions is higher compared to those with gasoline engines. Over the past 10 years, there has been an increase in the number of registrations of LPG, LNG and CNG cars that are less polluting.

The LPG, LNG, CNG gas conversion efficiency is similar to that of gasoline. Promotion of CNG-fuelled vehicles with a lower pollution factor than those fuelled with petrol or diesel is due to low CO_2 emissions. Switching to CNG can contribute to mitigation of air pollution. LPG burns in a cleaner way, without soot and with very low sulphur emissions. It is not toxic, has no severe irritant potential, does not contain lead tetraethyl or other additives and has a high-octane value, burns cleaner than gasoline or diesel and does not contain non-carbonized particles. The advantage of LPG over CNG is that it requires a much lower compression, applicable in cities where the natural gas pipeline is available, requiring expensive compressing stations that could be financed or co-financed by the natural gas supplier. The current legal framework regulates the minimum proportions of blends of biofuels and traditional petroleum products.

At present, there is no evidence or statistics on volumes of bioethanol and biodiesel consumed in the Republic of Moldova. The number of newly registered hybrid and electric vehicles is growing, but the infrastructure for electric vehicles is still underdeveloped. Currently, only three power stations for such types of vehicles are installed in Chisinau. Engines with a cleaner internal combustion cost less than the cost of switching to cleaner technologies. Additional investments in the vehicle are marginal, while cleaner fuels or fuel infrastructure are often more expensive.

They have higher fuel consumption and real urban cycle emissions are higher than those measured in the lab. Electricity is a source of energy that can be converted into a domestic market from a wide variety of primary energy sources.

Local pollution by electric motors is zero. Thus, electric buses can be considered the cleanest vehicles for urban areas. In order to mitigate the impact of the transport sector on the air pollution, the national environmental policies should facilitate the implementation of various measures, as follows: partial substitution of traditional fuels with gaseous fuels and biofuels; use of blends of fuels and biofuels, labelling of tires, limitation of emission levels, limiting the import of old cars.

Improvements in the transport sector

The Republic of Moldova transposed the entire body of European standards for fuel quality in accordance with the provisions of the Association Agreement, but the testing of fuels is still carried out according to GOST standards. The use of ISO standards concurrently with GOST standards generates conflicting situations.

The transposition of ISO standards should be followed by the withdrawal from use of GOST standards that are not in line with European standards. Pursuant to the Law no. 20 of 04.03.2016 on national standardization, art. 4, letter e), art. 14, paragraph (1), the application of Moldovan standards is voluntary. Therefore, the introduction of minimum quality requirements for fuels should be carried out based on a normative act.

The adoption of European standards on fuel quality should be followed by the implementation of the fuel quality monitoring system in accordance with the standard EN 14274: 2017 „Automotive fuels. Assessment of gasoline and diesel quality. Fuel Quality Monitoring System (FQMS)". The availability of statistical information on local fuel consumption, as well as the amount of automotive fuel consumed in the country, may lead to the adoption of the „Non-Region Model C" for the FQMS.

The implementation of the gasoline and diesel quality monitoring system, regulated by the normative act transposing the Directive 98/70/EC entails the obligation to check the parameters for gasoline and diesel fuel, based on European standards adopted as Moldovan standards, under the Law no. 20 of 04.03.2016 on national standardization.

The inventory and reporting processes are still at the level of institutional capacity development for the CLRTAP. Pursuant to the Government Decision no. 549 of 13/06/2018 on the establishment, organization, and functioning of the Environmental Agency, the inventory of air quality and reporting under CLRTAP and UNFCCC should be done by the Environmental Agency. Historically, experts from national research institutes with trained staff and laboratories on air quality monitoring were involved in the inventory process.

1.2. Institutional arrangements

The Republic of Moldova has been a state party to the CLRTAP since June 9, 1995. A few years later, Moldova signed thee out of eight protocols:

- Protocol on Persistent Organic Pollutants (POPs, Aarhus, 1998), signed in 1998;
- Protocol on Heavy Metals (HMs, Aarhus, 1998), signed in 1998;
- Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg, 1999), signed in 2000.

Moldova ratified 2 protocols:

- Protocol on Heavy Metals and
  - Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone by Law of Parliament no. 1018 of 25.04.2002.

The institutional framework for reporting under the CLRTAP was proposed by the Ministry of Agriculture, Regional Development and Environment of Moldova, which designated the Institute of Chemistry for the implementation of the UNEP small-scale funding agreement for the institutional strengthening support provided by the Supporting National Action and Planning (SNAP) Initiative of the Climate and Clean Air Coalition. The aim of the small-scale funding agreement is to strengthen the national institutional capacity to promote integrated planning on air quality and climate and Short-Lived Climate Pollutants (SLCPs). The tasks consist in achieving the emission reductions, integrating the SLCPs into relevant national planning processes in order to contribute to the rapid and widespread emission reductions at national level, as well as to strengthen the capacity under the Convention on Long-range Transboundary Air Pollution.

As a result of national institutional reforms in Moldova implemented in 2018, the state research institutes, including the Institute of Chemistry, report to and are funded by the Ministry of Education, Culture and Research. The Ministry of Education, Culture and Research gave its approval for the creation of the institutional capacity for reporting under the CLRTAP within the frame of the Institute of Chemistry, due to its research status.

The Ministry of Agriculture, Regional Development and Environment of Moldova supports this initiative at the national and international levels. As part of this initiative, the Institute of Ecology and Geography is responsible for research and inventory in the Agriculture and Industry sectors, while the Institute of Power Engineering is responsible for investigations and reporting in the Energy and Waste sectors. We need to underline the necessity of the CLRTAP inventory and the foreign support to building institutional capacities and co-financing of the state budgets of research institutes involved in the inventory under CLRTAP.

Experts from all three research institutes are involved in the CLRTAP reporting: the Institute of Ecology and Geography and the Institute of Power Engineering, under the lead of the Institute of Chemistry, Laboratory of Environmental Quality Monitoring. UNEP and the Climate and Clean Air Coalition provided financial support for the period 2019-2020, while the inventory and reporting for the period 2021-2022 will be covered by the institutional capacity project of the Laboratory of Environmental Quality Monitoring of the Institute of Chemistry. Moldova has not yet established a National Centre for the implementation of CLRTAP work plans, nor for reporting under its protocols.

1.3. Inventory preparation process

Air and climate protection are a state priority for the Republic of Moldova. This is stipulated in the national legislation and policy framework.

Legal framework on air protection:

1. The Constitution of the Republic of Moldova adopted on 29/07/1994.
2. Law no. 1515 of 16/06/1993 on the protection of the environment.
3. Law no. 1236 of 03/07/1997 on the regime of harmful products and substances.
4. Law no. 1380 of 20/11/1997 on the customs tariff, which establishes mechanisms for limiting imports of old means of transport both by differentiating the customs duty for cars, according to their age, as well as by prohibiting the import of the means of transport used for over 10 years. This law contributes to the expansion of car parks with new vehicles and limitation of the use of old vehicles that do not meet national standards.
5. Decision of the Parliament no. 399 of 16/03/1995 for the accession of the Republic of Moldova to the UNECE Convention on Long-range Transboundary Air Pollution and its Protocols;
6. Decision of the Parliament no. 404-XIII of 16/03/1995 for the ratification of the UN Framework Convention on Climate Change;
7. Law no. 1422 of 17/12/1997 on atmospheric air protection. *A new law is being drafted.*
8. Law no. 1540 of 25/02/1998 on payment for environmental pollution.

9. Law no. 461 of 30/07/2001 on the petroleum products market.
10. Law no. 29 of 13/02/2003 for the accession of the Republic of Moldova to the Kyoto Protocol to the United Nations Framework Convention on Climate Change;
11. Law no. 78 of 04/05/2017 for the ratification of the Paris Agreement;
12. Government Decision no. 549 of 13/06/2018 on the establishment, organization, and functioning of the Environmental Agency.

The national policy on air and environment protection in Moldova is covered mainly by:

1. Law no. 166 of 11/07/2012 for the approval of the National Development Strategy "Moldova 2020";
2. Law no. 112 of 02/07/2014 for the ratification of the Association Agreement between the Republic of Moldova, of the one part, and the European Union and the European Atomic Energy Community and their Member States, of the other part;
3. Government Decision no. 827 of 28/10/2013 on the approval of the Transport and Logistics Strategy for the years 2013-2022;
4. Government Decision no. 301 of 24/04/2014 on the approval of the Environmental Strategy for 2014-2023 and the Action Plan for its implementation;
5. Government Decision no. 1009 of 10/12/2014 on the approval of the Republic of Moldova's Strategy for Adaptation to Climate Change by 2020 and the Action Plan for its implementation;
6. Government Decision no. 1470 of 30/12/2016 on the approval of the Low-Emission Development Strategy of the Republic of Moldova until 2030 and the Action Plan for its implementation.

The main commitment under the Convention is to conduct emission inventories in line with the methods and procedures for the technical review of air pollutant emission inventories reported under the Convention and its protocols approved by the Executive Body for the Convention, as well as to ensure the effective assessment of compliance with emission obligations under the Convention's protocols and to facilitate the harmonization of emission reporting under other relevant multilateral environmental agreements to which Moldova is a party. National inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases that are not controlled by the Montreal Protocol use comparable methodologies. In this respect, the emissions and recalculations are reported annually for the following:

A. National totals:
1. Main pollutants: SOx, NOx, NH_3, NMVOC, CO: 1990–2017.
2. Particulate matter: $PM_{2.5}$, PM_{10}, TSP: 1990–2017.
3. Heavy metals: Pb, Cd, Hg / (*As, Cr, Cu, Ni, Se, Zn):* 1990–2017.
4. POPs: 1990–2017.

B. Sector emissions:
1. Main pollutants: SOx, NOx, NH_3, NMVOC, CO: 1990–2017.
2. Particulate matter: $PM_{2.5}$, PM_{10}, TSP: 1990–2017.
3. Heavy metals: Pb, Cd, Hg / (*As, Cr, Cu, Ni, Se, Zn):* 1990–2017.
4. POPs: 1990–2017.
5. Activity data: 1990–2017.

The inventory management cycle represented in Figure 1.1 contains the following steps: data collection, inventory compilation, consolidation, data quality review. In order to collect and compile the inventory data, institutional arrangements are made between the Institute of Chemistry and other administrative structures such as: National Bureau of Statistics (NBS), Ministry of Economy and Infrastructure, Agency for Public Services, Customs Service, Environmental Agency, State Hydrometeorological Service, State Ecological Inspectorate with the support of the Ministry of Agriculture, Regional Development and Environment. The activity data provided by the NBS in the Statistical Yearbooks, Energy Balances, sectoral statistical publications and from the official websites, as part of the statistical database, are available for the whole territory of the Republic of Moldova until 1992 and only for the right bank of the Dniester River (without the breakaway region of Transnistria, further referred to as Administrative Territorial Units on the Left Bank of Dniester (ATULBD) since 1993.

The improvements are included in the current IIR for 1990-2017 taking into consideration the recommendation of the Moldova Review Report.

The inventory for 1990-2017 was done for the entire territory of the country, including Transnistrian region. Data for Transnistria were collected from official published books and websites, as well as by using the extrapolation and indirect data recovery methods. Reporting consists in the calculation of NFR as a set of standard reporting tables for specified substances, for sources per sector, and for a given reporting year. The MARDE supported the collection of mainly high-quality official data published by authorities as the key element for emission estimation. Inventories of emissions of indirect greenhouse gases (i.e. ozone precursors and sulphur dioxide) were carried out in line with the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The accuracy of the inventory data needs elevation by acquiring actual local data instead of using the default values.

The Verification, Quality Assurance (QA) and Quality Control (QC) are related to the activity data collection, calculation of emissions for completion of the inventory, establishing the reliability for the intended applications of the inventory. Uncertainties were calculated to clarify the inaccuracy of data and the used emission factors. EMEP/EEA 2016 methodology was followed, where uncertainties for activity data are based on national statistics with annual updates ranging from 0 to 2%. The value was slightly higher when using other statistical sources.

The reporting of NFR is presented annually before the 20th of February, while the IIR is prepared biannually. The second IIR for 1990-2017 is submitted to the MARDE and the CLRTAP Secretariat for further recommendations on emission inventory, planned measures for emission reductions and progress in air pollution control.

There are planned improvements for each of four sectors. These contain, primarily, compliance with the updated EMEP/EEA guidebooks; expanding the series of values and adding data for 2018; updating the series of values in case of errors; expanding the information sources and improving coverage; the use of national EFs for assessment of nitrogen content in agricultural plant residues; using the software for sections 3B-3D. There was mentioned the need for the training of national experts to use the updated tools and software. The inventory management cycle is shown in Figure 1.1.

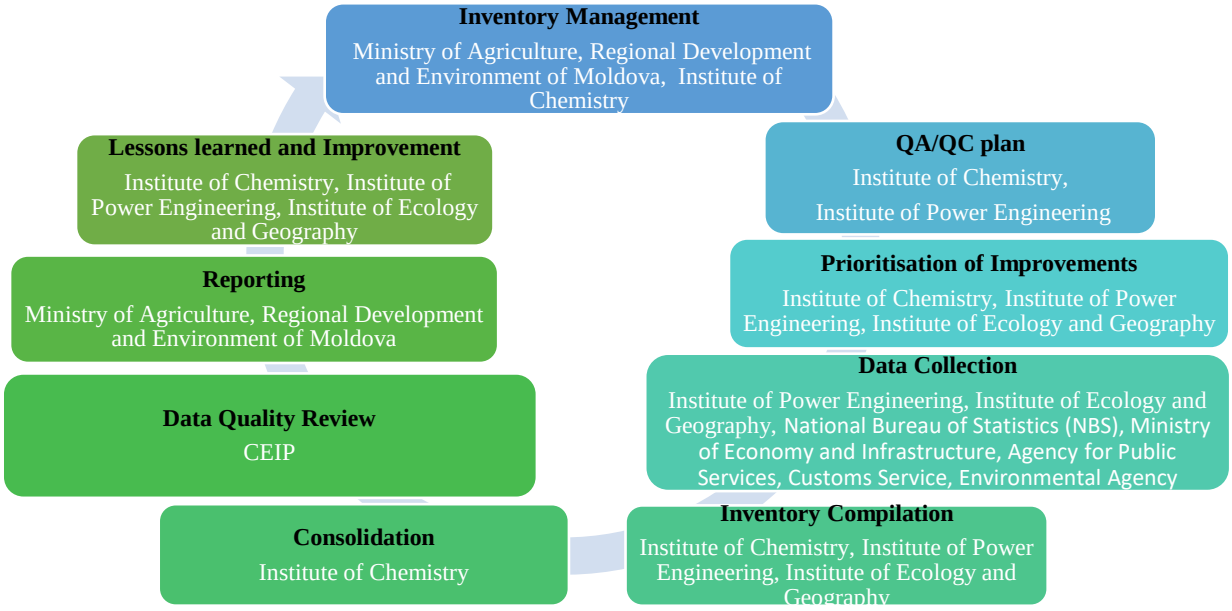


Figure 1.1. Inventory management cycle.

However, Moldova is not reporting completely to the CLRTAP due to the lack of activity data, nor to its Protocols due to the lack of institutional capacity. For reporting to the CLRTAP the Tiers 1 method

is used. To switch to the Tiers 2 and 3 there is a need for available data and measurements, especially for the following:

- Conduct a driving survey to estimate driving patterns, such as average vehicle speed, the driving ratio of acceleration/idling/deceleration. The results will be used as an input to the EMEP, COPERT and other models to improve the accuracy of emissions inventory. The location of traffic congestions and places of traffic flow are not identified. Method: GPS is attached to vehicles, and after driving for a certain period, the obtained data is analysed and calculations are made for the number of trips, daily average vehicle speed, daily average mileage, etc.
- Obtain the simple $PM_{2.5.}$ A sensor will be attached to the vehicle and measure the concentration along the roads and a $PM_{2.5}$ map will be developed.
- Develop gridded data of emissions for air quality simulation, with/without mitigation measures.
- Assess the air quality data by applying an air quality simulation model. Preparation of meteorological data for the simulation in the near future.
- Evaluate the effects of each measurement in terms of air pollutant emission/concentration of GHG, SLCPs.

Until nowadays, the Integrated Air Quality Monitoring System has not been created, because of the lack of activity data. In line with the global objectives to reduce air pollution at the national level, actions are taken to:

- strengthen the national institutional capacity to promote integrated planning on air quality and climate and SLCP emission reductions;
- integrate the SLCP emission reductions into relevant national planning processes to contribute to the rapid and widespread emission reductions at the national level;
- create the institutional and individual capacity under the CLRTAP;
- develop the capacity and continue to report under the UNFCCC.

The national experts proposed the integrated scheme of the inventory of air quality at the national level (figure 1.2).

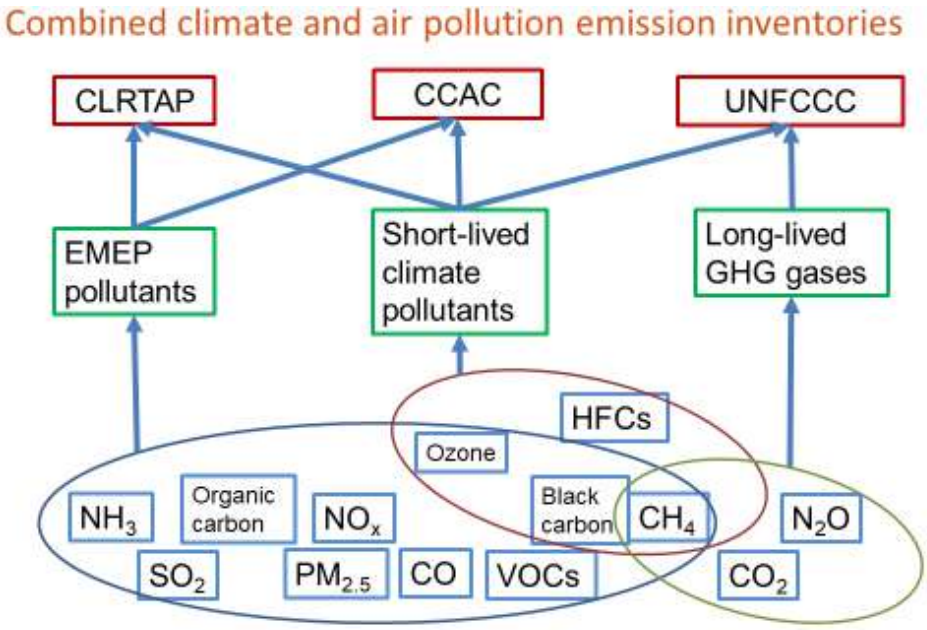


Figure 1.2. Integrated scheme of the inventory of air quality at the national level.

1.4. Methods and data sources

The methodology for estimating and reporting emissions is consistent with the "EMEP/EEA air pollutant emission inventory guidebook - 2016". The pollutants covered by this methodology guide are: SOx (SO_2), NOx, NH_3, NMVOC, CO, TSP, PM_{10}, $PM_{2.5}$, 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 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. The methodological guidance for air quality pollutant inventories is the 2016 EMEP/EEA Air Pollutant Emission Inventory Guidebook.

The sectoral experts are responsible for the choice of methods and emission factors. According to the recommendations of the EMEP/EEA 2016, the calculation methods are chosen by considering the technologies available in the Republic of Moldova whenever possible. The calculation of emissions is basically made by using the formula: AD x EF, where the activity data (AD) can be raw material or product or energy use etc. Part of the available data (e.g. production data) can directly be entered into the formula above; others required previous processing and conversion. For example, energy data 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 team. After other necessary QC/QA steps, NFR table is filled in and the respective chapters of the IIR are prepared.

The Republic of Moldova's IIR is prepared using a "top-down" approach, providing estimates at a sectoral level without inputs to individual emitters. Activity data used in this report are based on officially published data, such as national statistical publications, reports of central public authorities, public sector, scientific literature, and private sector.

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

The key categories were identified according to the EMEP/EEA Guidebook. The inventory was first disaggregated by source categories, which were further used to identify key categories.

Each year, the emission inventories are updated to include the latest data available and new research findings to improve the emission estimation methods. Improvements to the inventory methodology are made and backdated to ensure a consistent time series for emissions reporting. Methodological changes are made to take account of new data sources or new guidance from EMEP/EEA, relevant work by IPCC, new research or specific research programmes. Information on improvements and recalculations can be found throughout this report, in Chapters 3 to 7, which describe the methods used in different source sectors.

This section provides an overview of the RM inventory data and methods and provides further details for the two most significant data sources: (i) the RM energy statistics, and (ii) industrial emissions reported via the RM regulatory agencies. Finally, the planned improvements are summarized.

1.4.1. RM inventory data and methods overview

Overview information on primary data providers and methodologies has been included in the above sections. Table 1.1 indicates where RM-specific data are used in the emission inventory, and where methodologies that are more generic are used (i.e. where RM-specific information is not available). Please note that this table presents an overview only, by NFR category. Further details (e.g. EF sources from literature or RM research) are provided in the separate chapter sections, presenting methodological information for each inventory source within each NFR category.

Table 1.1. Republic of Moldova Emission Inventory Compilation Methodologies by NFR14 Category

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 (2016 EMEP/EEA)
1.A.2.a Iron & Steel	RM statistics (Energy balances) ATULBD statistics (Statistical yearbooks)	Fuel analysis or default EFs (2016 EMEP/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 (2016 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 (2016 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 (2016 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 (2016 EMEP/EEA, RM-specific research)
1.A.2.g.viii Other	RM statistics (Energy balances) ATULBD statistics (Statistical yearbooks)	Fuel analysis or default EFs (2016 EMEP/EEA, RM-specific research)
1.A.3.a.i(i) International Aviation (LTO)	RM statistics (Energy balances, NIR-1990-2016) and estimated	Fuel analysis or default EFs (2016 EMEP/EEA, RM-specific research)
1.A.3.a.ii(i) Civil Aviation (Domestic, LTO)	RM statistics (Energy balances, NIR-1990-2016) and estimated	Fuel analysis or default EFs (2016 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, Registru.md and data for COPERT, experimental calculations made when preparing the National Inventory Report 1990-2016 for 3 years (2014-2016), but not included.	Fuel analysis or default EFs (2016 EMEP/EEA, RM-specific research)
1.A.3.c Railways	RM statistics (Energy balances) ATULBD statistics (Statistical yearbooks)	Fuel analysis or default EFs (2016 EMEP/EEA, RM-specific research)
1.A.3.d.ii National Navigation	RM statistics (Energy balances, NIR 1990-2016)	Default EFs (2016 EMEP/EEA)
1.A.3.e Pipeline	RM statistics (Energy balances) and estimated	Default EFs (2016 EMEP/EEA)
1.A.3.b.v Road transport	As 1.A.3.b Road Transportation	Default EFs (2016 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 (2016 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 (2016 EMEP/EEA)
1.A.4.c.i Agriculture/Forestry/Fishing: Stationary	RM statistics (Energy balances)	Default EFs (2016 EMEP/EEA)
1.A.4.c.ii/iii Off-road Vehicles & Other Machinery	RM statistics (Energy balances)	Default EFs (2016 EMEP/EEA)
1.A.5.a Other, Stationary	RM statistics (Energy balances), ATULBD statistics (Statistical yearbooks)	Default EFs (2016 EMEP/EEA)
1.A.5.b Other, Mobile (Including military)	RM statistics (Energy balances)	Default EFs (2016 EMEP/EEA)

NFR log name	Activity Data	Emission Factors
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) National Inventory Report 1990-2016	Default EFs (2016 EMEP/EEA)
2.A Mineral Products	Industry & Estimated, RM Statistics (Statistical Yearbooks of ATULBD, SYs of RM, NIR 1990-2016), Official letter of the Inventory team no. 13-07/2815 from 06.08.2019	Default EFs (2016 EMEP/EEA)
2.B Chemical Industry	RM statistics (statistical yearbooks), ATULBD statistics (Statistical yearbooks), Official letter of the Inventory team no. 13-07/2815 from 06.08.2019	Default EFs (2016 EMEP/EEA)
2.C Metal Production	RM statistics (National Inventory Report 1990-2016. SYs of RM and SY of ATULBD)	Default EFs (2016 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 no. 13-07/2815 from 06.08.2019	Default EFs (2016 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 no. 13-07/2815 from 06.08.2019	Default EFs (2016 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 (2016 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	Default EFs (2016 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 (2016 EMEP/EEA), 2006 IPCC Guidelines and State Ecological Inspectorate annual reports
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 (2016 EMEP/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 (2016 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 (2016 EMEP/EEA)

NFR log name	Activity Data	Emission Factors
5.D Waste-Water Handling	RM statistics (StatBank)	Default EFs (2016 EMEP/EEA)
5.E Other Waste	RM statistics (National Bureau Statistics)	Default EFs (2016 EMEP/EEA)
6.A Other	NA	NA
1.A.3.a.i(ii) International aviation cruise (civil)	RM statistics (Energy balances)	Default EFs (2016 EMEP/EEA)
z_Memo1.A.3 Transport (fuel used)	Same as 1.A.3 Road	Default EFs (2016 EMEP/EEA)

The terms used to summarize the data and methods in the table above are defined as follows:

For activity data:

• RM Statistics: RM statistics, including energy statistics published annually. Almost all statistics are provided by the National Bureau of Statistics of the RM.

• Industry: Process operators or trade associations provide activity data directly, for example, Lafarge Ciment, Glass Container Company, Agency for Geology and Mineral Resources.

• Modelled: Activity data may need to be estimated by the Inventory Team of the project where RM statistics are not available or are available only for a limited number of years or sites. The modelled activity data estimates are commonly derived from published data or the best available proxy information.

For emission factors:

• Modelled: Emissions and/or emission factors may need to be estimated by the Inventory Team, based on parameters such as: plant design and abatement systems, reported solvent use, plant-specific operational data. Furthermore, to address data gaps and time series consistency, either emissions or emission factors may be modelled based on emissions (or emission trends) of other pollutants or activity data.

• Literature Sources: For many RM emission sources there may not be any specific data from RM sources or research, and in these cases, the Inventory team refers to literature sources for emission factors that best characterize the emissions. These literature sources are mainly from international guidance for inventory reporting, such as the 2016 EMEP/EEA Guidebook, the USEPA AP-42 and IPCC Guidelines or Good Practice Guidance (GPG). Other useful resources are sector-specific operator reporting guidance, such as best available techniques reference documents (BREF) produced by the EU IPPC Bureau, or the Air Pollution Inventory (API) Compendium for oil and gas emission estimates.

1.4.2. Population

The population of the country is an important factor for emission estimations. The National Bureau of Statistics is the main official source for population records. The last census that took place in 2014 reported 2 998,35 thousand inhabitants[1].

This source is incomplete, as the National Bureau of Statistics does not provide the data for the population from the left bank of the Dniester River, i.e. the self-proclaimed Transnistrian republic.

The Transnistrian Statistics Service Yearbook provides official data for the population on the left bank of the Dniester River. According to the last census from 2015, the total number of population in Transnistria was 475,37 thousand inhabitants[2].

To generate the whole picture of pollution in the Republic of Moldova, these two main sources were analysed and compared with the population data used in the previous Informative Inventory Report.

The information analysis shows a discrepancy between sources, which was considered for the estimation of the data uncertainty. Figure 1.3 demonstrates similar data for the period 1989 – 1998. Beyond 1998, there is a discrepancy between the official information for the 2004 census and the 2014 census.

[1] https://statistica.gov.md/newsview.php?l=ru&id=5583&idc=168
[2] http://newspmr.com/novosti-pmr/obshhestvo/15927

The trend in the population data was calculated using census information.

The total number of the population of the Republic of Moldova was obtained by compiling the information of the National Bureau of Statistics and that of the Statistics Service Yearbook.

For the NFR calculation, the population data from the entire country, i.e. 3473,72 inhabitants, was used.

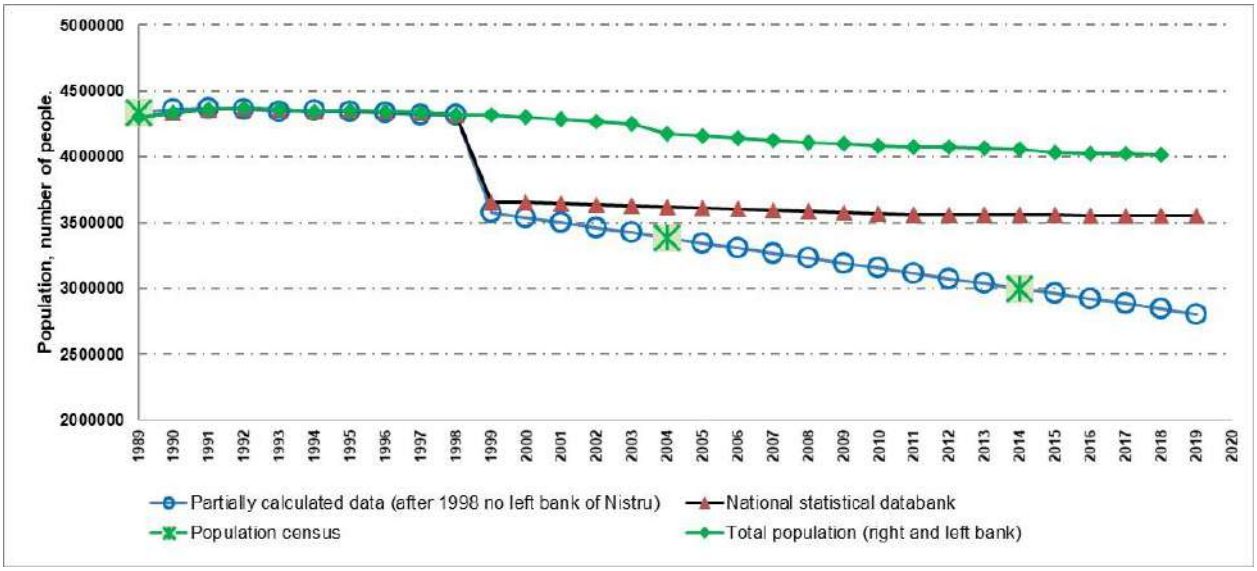


Figure 1.3. Population trend for the Republic of Moldova for the studied period

Table 1.2 contains data for the conclusions about the population of the Republic of Moldova from different sources.

Table 1.2. Information on population of the Republic of Moldova

Years	Number of population calculated for the right bank of Dniester River, up to 1998	Number of population provided by the National Bureau of Statistics for the right bank of Dniester River	Number of population provided by the Transnistrian State Statistics Service Yearbook, for the left bank of Dniester River	Total number of population for the right and left banks of Dniester River
1989	4335360	4303399		4303399
1990	4359377	4335360		4335360
1991	4364077	4359377		4359377
1992	4356877	4364077		4364077
1993	4345577	4356877		4356877
1994	4350485	4345577		4345577
1995	4345685	4350485		4350485
1996	4331870	4345685		4345685
1997	4317513	4331870		4331870
1998	4317513	4317513		4317513
1999	3575850	3655614	660000	4315614
2000	3537340	3649930	651800	4301730
2001	3498830	3644070	642500	4286570
2002	3460320	3635112	633600	4268712
2003	3421810	3627812	623800	4251612
2004	3383300	3618312	554400	4172712
2005	3344790	3607435	547500	4154935
2006	3306280	3600436	540600	4141036
2007	3267770	3589936	533500	4123436
2008	3229260	3581110	527500	4108610
2009	3190750	3572703	522500	4095203
2010	3152240	3567512	518000	4085512
2011	3113730	3563695	513400	4077095
2012	3075220	3560430	509400	4069830

Years	Number of population calculated for the right bank of Dniester River, up to 1998	Number of population provided by the National Bureau of Statistics for the right bank of Dniester River	Number of population provided by the Transnistrian State Statistics Service Yearbook, for the left bank of Dniester River	Total number of population for the right and left banks of Dniester River
2013	3036710	3559541	505200	4064741
2014	2998200	3559497	500700	4060197
2015	2959690	3557634	474500	4032134
2016	2921180	3555159	470600	4025759
2017	2882670	3553056	469000	4022056
2018	2844160	3550852	465100	4015952
2019	2805650	3547539		4303399

1.5.Key Categories

The purpose of analysis of key categories 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 calculated for each pollutant separately for the list of emission sources in the country for 2017 (*Level Assessment*) and for 1990/2017 (*Trend Assessment*). Calculations were performed using the algorithm described by EMEP/EEA 2016, Chapter "Key category analysis and methodological choice" Tier 1, which included the following steps:

1. Record a complete list of calculated categories, determine the total amount of pollutant emissions;
2. Determination of the share contribution of each category in the total amount of pollutant emissions;
3. Ranking of categories by the amount of contributions to the total amount of pollutant emissions in descending order;
4. Calculation of the cumulative % contribution of categories (summing with accumulation).
5. Separation of the list of categories that give a cumulative contribution of 80% or more. These categories are key.
6. The rest of categories make a small contribution to the pollutant emissions.

Tables 1.3 and 1.4 show key categories for Level and Trend Assessment. These tables indicate the name of the pollutant, the percent contribution of emissions from categories in the total amount, the percentage of the cumulative contribution for categories.

The value of cumulative contribution (80% and higher) is separately highlighted in the rightmost column.

An additional column is also available on the right side of tables, which indicates key categories that have a maximum contribution above 20% to the total emissions of pollutants.

Level Assessment

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

- 1.A.1 Public electricity and heat production: As 25,9%; Ni 54,1%;
- 1.A.3.b Road Transport: NOx 36,1%;
- 1.A.4.a Commercial/Institutional sector: SOx 51,0%; Pb 45,9%; Hg 47,0;
- 1.A.4.b Residential: Stationary:
    - $PM_{2.5}$ 76,9%; PM_{10} 56,8%; CO 76,9%; Cd 59,7%; Cr 62,4%; Se 46,3%; Zn 67,3%; PCDD 55,9%; Benzo(a)pyrene 78,0%; Benzo(b)fluoranthene 69,6%; Benzo(k)fluoranthene 4,7%; Indeno(1,2,3-cd)pyrene 87,4%; HCB -60,5%;
- 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery: Cu 45,0%;
- 2.C.1 Iron and steel production: PCBs 44,9%;
- 2.D.3.b Road paving with asphalt: TSP 28,6%;
- 3.D.a.2.b Sewage sludge applied to soils: NH_3 33,6%;

- 3.F Field burning of agricultural residues: BC 91,8%.

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.3.b Road Transport 36,1%;
- 3.D.a.2.b Sewage sludge applied to soils 17,9%;
- 1.A.1 Public electricity and heat production 16,5%;
- 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery 7,0%;
- 1.A.4.b Residential: Stationary 5,0%.

The cumulative contribution of these categories is 82.4% in NOx emissions.
The largest contribution (above 20%) is made by category 1.A.3.b Road Transport - 36,1%.

Table 1.3. Key Source Level Assessment, Cumulative %

Sources	Categories*									Category with maximum contribution above 20%	Cumulative Contribution, 80% and more
NOx	1A3b	3Da2b	1A1	1A4cii	1A4b					1A3b	
Contribution, %	36,1	17,9	16,5	7,0	5,0					36,1	
Cumulative Contribution %	*36,1*	*54,0*	*70,4*	*77,4*	*82,4*						***82,4***
NMVOC	1A4b	2H2	2D3d	3B1a	3B1b	2D3a	2D3g	5A	2D3i		
Contribution, %	19,7	18,5	11,1	7,6	6,4	5,8	5,2	4,0	3,4		
Cumulative Contribution %	*19,7*	*38,2*	*49,3*	*56,9*	*63,4*	*69,2*	*74,3*	*78,3*	*81,8*		***81,8***
SOx	1A4a	1A1	1A4b							1A4a	
Contribution, %	51,0	26,4	14,4							51,0	
Cumulative Contribution %	*51,0*	*77,4*	*91,8*								***91,8***
NH3	3Da2b	3B3	3Da2a	3B1a	3Da1	3Da2c				3Da2b	
Contribution, %	33,6	17,2	13,8	7,6	5,5	5,2				33,6	
Cumulative contribution %	*33,6*	*50,9*	*64,7*	*72,3*	*77,8*	*83,0*					***83,0***
PM2.5	1A4b	1A4a								1A4b	
Contribution, %	76,9	5,7								76,9	
Cumulative Contribution %	*76,9*	*82,7*									***82,7***
PM10	1A4b	2D3b	1A4a	2A2	3Dc					1A4b	
Contribution, %	56,8	14,3	4,5	4,3	3,6					56,8	
Cumulative Contribution %	*56,8*	*71,1*	*75,6*	*79,9*	*83,5*						***83,5***
TSP	2D3b	1A4b	2D3g	2A2						2D3b	
Contribution, %	28,6	25,7	24,5	4,7						28,6	
Cumulative Contribution %	*28,6*	*54,2*	*78,7*	*83,4*							***83,4***
BC	3F									3F	
Contribution, %	91,8									*91,8*	
Cumulative Contribution %	*91,8*										***91,8***
CO	1A4b	1A4a								1A4b	
Contribution, %	76,9	8,3								76,9	
Cumulative Contribution %	*76,9*	*85,2*									***85,2***

Sources	Categories*									Category with maximum contribution above 20%	Cumulative Contribution, 80% and more
Pb	1A4a	1A4b	2A3							1A4a	
Contribution, %	45,9	28,3	14,7							45,9	
Cumulative Contribution %	*45,9*	*74,2*	*88,9*								
Cd	1A4b	2G	3F							1A4b	
Contribution, %	59,7	12,4	9,0							59,7	
Cumulative Contribution %	*59,7*	*72,1*	*81,1*								***81,1***
Hg	1A4a	1A4b	2C1	1A1						1A4a	
Contribution, %	47,0	15,0	10,9	9,1						47,0	
Cumulative Contribution %	*47,0*	*62,1*	*73,0*	*82,0*							***82,0***
As	1A1	5C2	2A3	1A4a						1A1	
Contribution, %	25,9	22,6	21,9	20,0						25,9	
Cumulative Contribution %	*25,9*	*48,5*	*70,4*	*90,4*							***90,4***
Cr	1A4b	1A4a								1A4b	
Contribution, %	62,4	20,5								62,4	
Cumulative Contribution %	*62,4*	*82,9*									***82,9***
Cu	1A4cii	1A1	2G	1A2						1A4cii	
Contribution, %	45,0	16,2	14,9	6,5						45,0	
Cumulative Contribution %	*45,0*	*61,1*	*76,0*	*82,6*							***82,6***
Ni	1A1	2A3	2D3g							1A1	
Contribution, %	54,1	23,2	12,2							54,1	
Cumulative Contribution %	*54,1*	*77,3*	*89,5*								***89,5***
Se	1A4b	2A3	1A1							1A4b	
Contribution, %	46,3	31,5	17,3							46,3	
Cumulative Contribution %	*46,3*	*77,8*	*95,1*								***95,1***
Zn	1A4b	1A4a								1A4b	
Contribution, %	67,3	14,0								67,3	
Cumulative Contribution %	*67,3*	*81,3*									***81,3***
PCDD	1A4b	5C1biii								1A4b	
Contribution, %	55,9	25,1								55,9	
Cumulative Contribution %	*55,9*	*81,1*									***81,1***
Benzo(a)pyrene	1A4b									1A4b	
Contribution,%	*78,0*									*78,0*	
Cumulative Contribution %	*78,0*										***78,0***
B enzo(b)fluoranthene	1A4b	1A4a								1A4b	
Contribution, %	69,6	14,0								69,6	
Cumulative Contribution %	*69,6*	*83,5*									***83,5***
Benzo(k)fluoranthene	1A4b	5C2								1A4b	
Contribution, %	54,7	31,0								54,7	
Cumulative Contribution %	*54,7*	*85,7*									***85,7***
Indeno(1,2,3-cd)pyrene	1A4b									1A4b	
Contribution, %	87,4									*87,4*	

Sources	Categories*									Category with maximum contribution above 20%	Cumulative Contribution, 80% and more
Cumulative Contribution %	*87,4*										***87,4***
HCB	1A4b	1A1								1A4b	
Contribution, %	60,5	21,7								60,5	
Cumulative Contribution %	*60,5*	*82,2*									***82,2***
PCBs	2C1	1A4a								2C1	
Contribution, %	44,9	39,7								44,9	
Cumulative Contribution %	*44,9*	*84,7*									***84,7***

Categories Long name			
Energy sector	**Industry sector**	**Agriculture sector**	**Waste sector**
1A1a Public electricity and heat production 1A3b Road transport 1A4a Commercial /institutional: Stationary 1A4b Residential: Stationary 1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	2A2 Lime production 2A3 Glass production 2C1 Iron and steel production 2D3a Domestic solvent use including fungicides 2D3b Road paving with asphalt 2D3d Coating applications 2D3g Chemical products 2D3i Other solvent use 2G Other product use 2H2 Food and beverages industry	3B1a Manure management - Dairy cattle 3B1b Manure management - Non-dairy cattle 3B3 Manure management - Swine (Sows+ Fattening pigs) 3Da1 Inorganic N-fertilizers (also includes urea application) 3Da2a Animal manure applied to soils 3Da2b Sewage sludge applied to soils 3Da2c Other organic fertilizers applied to soils (including compost) 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products 3F Field burning of agricultural residues	5A Biological treatment of waste - Solid waste disposal on land 5C1biii Clinical waste incineration 5C2 Open burning of waste

Trend Assessment

Key categories were also calculated for Trend Assessment according to method 1. They were calculated for each pollutant separately according to the 1990/2017 ratio using the algorithm described in EMEP/EEA 2016, Chapter "Key category analysis and methodological choice". The algorithm is the same as that described for Level Assessment.

Key categories that contribute most to each pollutant emissions (Trend assessment) above 20%:

- 1.A.1 Public electricity and heat production: $PM_{2.5}$ 46,7%; As 48,4%; Cr 45,6%; Cu 49,6%; Ni 50,0%; Zn 44,6%; HCB 49,9%;
- 1.A.4.a Commercial/Institutional sector SOx 44,2%; Pb 36,5%; Hg 26,1%;
- 1.A.3.b Road Transport NOx 24,1%;
- 1.A.4.b Residential: Stationary PM_{10} 42,7%; TSP 40,7%; BC 37,0%; Cd 47,8%; Benzo(a)pyrene 47,4%; Benzo(b)fluoranthene 42,9%; Benzo(k)fluoranthene 49,3%; Indeno(1,2,3-cd)pyrene 46,4%; PCBs 48,8%;
- 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery CO 21,8%;
- 2.A.3 Glass production Se 40,4%;
- 2.D.3.i Other solvent use NMVOC 21,0%;
- 3.B.3 Manure management: Swine NH_3 23,0%;
- 5.C.1.b.iii Clinical waste incineration PCDD 50,0%.

The structure of the Table 1.4 on key categories of Trend Assessment is the same as the Table 1.3 for Level Assessment.

Analysis of the table can be carried out as follows:
Example: there are five key categories for NOx (in descending order of contribution to total emissions):

- 1.A.3.b Road Transport 36,1%;
- 3.D.a.2.b Sewage sludge applied to soils 17,9%
- 1.A.1 Public electricity and heat production 16,5%
- 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery 7,0%
- 1.A.4.b Residential: Stationary 5,0%.

The cumulative contribution of these categories is 81,1% in NOx emissions.
The largest contribution (above 20%) is made by category 1.A.3.b Road Transport, 36,1%.

Table 1.4. Key Source Trend Assessment, Cumulative %

Sources	Categories							Category's maximum contribution >20%	Cumulative Contribution, 80% and more
NOx	1A3b	1A1	3Da2b	1A2	1A3c			1A3b	
Contribution, %	24,1%	24,1%	16,1%	8,9%	7,9%			24,1%	
Cumulative Contribution %	24,1%	48,2%	64,2%	73,2%	81,1%				**81,1%**
NMVOC	2D3i	2D3d	2H2	3B1b	3B1a	1A4b		2D3i	
Contribution, %	21,0%	19,4%	18,0%	10,7%	7,6%	3,8%		21,0%	
Cumulative Contribution %	21,0%	40,3%	58,3%	69,0%	76,6%	80,4%			**80,4%**
SOx	1A4a	1A1						1A4a	
Contribution, %	44,2%	42,8%						44,2%	
Cumulative Contribution %	44,2%	87,0%							**87,0%**
NH_3	3B3	3Da2b	3Da3	3Da2a	3Da1	3B4f	3B1a	3B3	
Contribution, %	23,0%	19,8%	10,5%	9,7%	7,3%	6,9%	5,9%	23,0%	
Cumulative Contribution %	23,0%	42,8%	53,3%	63,0%	70,3%	77,2%	83,0%		**83,0%**
$PM_{2.5}$	1A1	1A2	1A3c	1A3d				1A1	
Contribution, %	46,7%	22,1%	6,0%	4,4%				46,7%	
Cumulative Contribution %	46,7%	68,8%	74,8%	79,3%					**79,3%**
PM_{10}	1A4b	1A1	2D3b	2A2	3Dc			1A4b	
Contribution, %	42,7%	16,6%	13,2%	5,0%	3,8%			42,7%	
Cumulative Contribution %	42,7%	59,3%	72,5%	77,5%	81,3%				**81,3%**
TSP	1A4b	2D3b	2D3g	1A1				1A4b	
Contribution, %	40,7%	16,4%	14,1%	8,8%				40,7%	
Cumulative Contribution %	40,7%	57,2%	71,2%	80,1%					**80,1%**
BC	1A4b	1A4cii	1A2	3F				1A4b	
Contribution, %	37,0%	22,8%	13,5%	12,6%				37,0%	
Cumulative Contribution %	37,0%	59,8%	73,3%	85,9%					**85,9%**
CO	1A4cii	1A4a	5C2	1A5	1A4b	3F		1A4cii	
Contribution, %	21,8%	19,2%	14,9%	9,5%	8,0%	6,7%		21,8%	
Cumulative Contribution %	21,8%	41,0%	55,9%	65,4%	73,3%	80,1%			**80,1%**
Pb	1A4a	1A4b	1A1					1A4a	
Contribution, %	36,5%	35,6%	84,8%					36,5%	
Cumulative Contribution %	36,5%	72,1%	84,8%						**84,8%**
Cd	1A4b	1A1						1A4b	
Contribution, %	47,8%	37,4%						47,8%	
Cumulative Contribution %	47,8%	85,2%							**85,2%**
Hg	1A4a	1A4b	1A1	5C1biii				1A4a	
Contribution, %	26,1%	25,4%	23,2%	14,8%				26,1%	
Cumulative Contribution %	26,1%	51,6%	74,8%	89,6%					**89,6%**
As	1A1	5C2	1A4a					1A1	
Contribution, %	48,4%	18,4%	16,8%					48,4%	
Cumulative Contribution %	48,4%	66,8%	83,6%						**83,6%**
Cr	1A1	1A4b	1A4a					1A1	
Contribution, %	45,6%	39,7%	8,5%					45,6%	
Cumulative Contribution %	45,6%	85,4%	93,9%						**93,9%**
Cu	1A1	5C1biii	1A4cii					1A1	

Sources	Categories							Category's maximum contribution >20%	Cumulative Contribution, 80% and more
Contribution, %	49,6%	21,8%	12,3%					49,6%	
Cumulative Contribution %	49,6%	71,5%	83,8%						**83,8%**
Ni	1A1	2A3						1A1	
Contribution, %	50,0%	30,6%						50,0%	
Cumulative Contribution %	50,0%	80,6%							**80,6%**
Se	2A3	1A4b	1A1					2A3	
Contribution, %	40,4%	31,2%	18,8%					40,4%	
Cumulative Contribution %	40,4%	71,6%	90,4%						**90,4%**
Zn	1A1	1A4b						1A1	
Contribution, %	44,6%	40,3%						44,6%	
Cumulative Contribution %	44,6%	84,9%							**84,9%**
PCDD	5C1biii	1A4b						5C1biii	
Contribution, %	50,0%	41,6%						50,0%	
Cumulative Contribution %	50,0%	91,6%							**91,6%**
Benzo(a)pyrene	1A4b	1A4a	5C2					1A4b	
Contribution, %	47,4%	29,2%	17,9%					47,4%	
Cumulative Contribution %	47,4%	76,6%	94,6%						**94,6%**
B enzo(b)fluoranthene	1A4b	1A4a	5C2					1A4b	
Contribution, %	42,9%	25,3%	22,7%					42,9%	
Cumulative Contribution %	42,9%	68,2%	90,9%						**90,9%**
Benzo(k)fluoranthene	1A4b	5C2						1A4b	
Contribution, %	49,3%	35,8%						49,3%	
Cumulative Contribution %	49,3%	85,1%							**85,1%**
Indeno(1,2,3-cd)pyrene	1A4b	1A4a						1A4b	
Contribution, %	46,4%	45,7%						46,4%	
Cumulative Contribution %	46,4%	92,1%							**92,1%**
HCB	1A1	1A4b						1A1	
Contribution, %	49,9%	29,2%						49,9%	
Cumulative Contribution %	49,9%	79,1%							**79,1%**
PCBs	1A4b	1A4a	2C1					1A4b	
Contribution, %	48,8%	28,3%	18,4%					48,8%	
Cumulative Contribution %	48,8%	77,1%	95,5%						**95,5%**

Categories Long name			
Energy sector	**Industry sector**	**Agriculture sector**	**Waste sector**
1A1a Public electricity and heat production 1A2 Stationary combustion in manufacturing industries and construction 1A3b Road transport 1A3c Railways 1A3dii National navigation (shipping) 1A4ai Commercial/institutional: Stationary 1A4bi Residential: Stationary 1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	2A2 Lime production 2A3 Glass production 2C1 Iron and steel production 2D3b Road paving with asphalt 2D3d Coating applications 2D3g Chemical products 2D3i Other solvent use (please specify in the IIR) 2H2 Food and beverages industry	3B1a Manure management - Dairy cattle 3B1b Manure management - Non-dairy cattle 3B4f Manure management - Other animals 3B3 Manure management - Swine (Sows+ Fattening pigs) 3Da1 Inorganic N-fertilizers (also includes urea application) 3Da2a Animal manure applied to soils 3Da2b Sewage sludge applied to soils 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products 3F Field burning of agricultural residues	5A Biological treatment of waste - Solid waste disposal on land 5C1biii Clinical waste incineration 5C2 Open burning of waste

Table 1.5 summarizes the key analysis results for both Level and Trend assessment.
In the table, the key categories identified by the Level assessment approach of method 1 are marked as L1, while those identified by the Trend assessment approach are marked as T1. For categories marked as L1, T1, it is necessary to apply higher-level calculation methods, if possible, in the future.

A summary table of key categories allows to identify categories that are the key (L1, T1) for most pollutants throughout 1990-2017: these are categories 1.A.4.b Residential: Stationary, 1.A.4.a Commercial/ Institutional sector, 1.A.1 Public electricity and heat production.

Table 1.5. Key category analysis. Level (L1) and Trend (T1) assessment (summary of results)

	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
1.A.1	L1, T1		L1, T1		T1	T1	T1			T1	T1	L1, T1
1.A.2	T1				T1			T1				
1.A.3.b	L1, T1											
1.A.3.c	T1				T1							
1.A.3.d					T1							
1.A.4.a			L1, T1		L1	L1	L1, T1		L1, T1	L1, T1	L1, T1	L1, T1
1.A.4.b		L1, T1			L1	L1, T1		T1	L1, T1	L1, T1		L1, T1
1.A.4.cii	L1							T1	T1			
2.A.2						L1, T1	L1					
2.A.3										L1		
2.C.1												L1
2.D.3.a		L1										
2.D.3.b						L1, T1	L1, T1					
2.D.3.d		L1, T1										
2.D.3.g		L1					L1, T1					
2.D.3i		L1, T1										
2.G											L1	
2.H.2		L1, T1										
3.B.1.a				L1, T1								
3.B.4.f				T1								
3.B.3				L1, T1								
3.D.a.1				L1, T1								
3.D.a.2.a		L1, T1		L1, T1								
3.D.a.2.b	L1, T1	L1, T1		L1, T1								
3.D.a.2.c				L1								
3.D.c						L1, T1						
3.F								L1, T1	T1			
5.A		L1										
5.C.2									T1			
5.C.1.biii												T1

continued

	As	Cr	Cu	Ni	Se	Zn	PCDD	B(a)	B(b)	B(k)	Id(1,2,3)	HCB	PCBs
1.A.1	L1, T1	T1	L1, T1	L1, T1	L1, T1	T1						L1, T1	
1.A.2			L1										
1.A.3.b													
1.A.3.c													
1.A.3.d													
1.A.4.a	L1, T1	L1, T1				L1, T1		T1	L1, T1		T1		L1, T1
1.A.4.b		L1, T1			L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	T1
1.A.4.cii			L1, T1										
2.A.2													
2.A.3	L1			L1, T1	L1, T1								
2.C.1													L1, T1
2.D.3.a													
2.D.3.b													
2.D.3.d													
2.D.3.g				L1									
2.D.3i													
2.G			L1										
2.H2.													
3.B.1.a													
3.B.4.f													
3.B.3													
3.D.a.1													
3.D.a.2.a													
3.D.a.2.b													
3.D.a.2.c													
3.D.c													

3.F						
5.A						
5.C.2	L1, T1			T1	T1	L1, T1
5.C1.biii		T1	L1, T1			

Conclusion

An analysis of key categories using the Level and Trend Assessment approaches revealed the categories that contribute more to emissions. The key categories in the period 1990-2017 (Trend Assessment approach) are as follows:

- 1.A.1 Public electricity and heat production,
- 1.A.4.a Commercial/Institutional sector,
- 1.A.3.b Road Transport,
- 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.3 Manure management: Swine,
- 5.C.1.b.iii Clinical waste incineration.

These categories provide the following contributions to pollutant emissions:

1) Almost half of all emissions of $PM_{2.5}$, As, Cr, Cu, Ni, Zn, HCB formed from category 1.A.1 Public electricity and heat production ($PM_{2.5}$ - 46,7%; As - 48,4%; Cr - 45,6%; Cu - 49,6%; Ni - 50,0%; Zn 44,6%; HCB -49,9%).
2) A significant part of the emissions of SOx, Pb, Hg emitted from fuel combustion in the category 1.A.4.a Commercial/Institutional sector (SOx – 44,2%; Pb – 36,5%; Hg -26,1%).
3) 24,1% of NOx emissions throw out from 1.A.3.b Road Transport;
4) Category 1.A.4.b Residential: Stationary emits about half of the emissions of the following pollutants PM_{10} - 42,7%; TSP - 40,7%; BC – 37,0%; Cd - 47,8%; Benzo(a)pyrene – 47,4%; Benzo(b)fluoranthene - 42,9%; Benzo(k)fluoranthene - 49,3%; Indeno(1,2,3-cd)pyrene - 46,4%; PCBs - 48,8%.
5) 21,8% of CO emissions formed from the burning of fuel by off-road vehicles in the category 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery.
6) The largest amount of Se emissions occurs in category 2.A.3 Glass production- Se 40,4%.
7) Category 2.D.3.i Other solvent makes up the largest contribution to NMVOC emissions of 21,0%.
8) Category 3.B.3 Manure management: Swine contributes 23,0 % in NH_3 emissions.
9) The largest amount of furan emissions occurs in category 5.C.1.b.iii Clinical waste incineration- PCDD 50,0%.

1.6. QA/QC and Verification methods

1.6.1. Requirements for control procedures and quality assurance

QA/QC procedures recommended in EMEP/EEA 2016 are carried out at all stages of the calculation of the entire list of pollutants. In contrast to the IPCC QA/QC 2006 procedures, the term “global warming potential” is not used. Pollutant emissions, according to CLRTAP goals, are expressed in absolute pollutant emissions.

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, the Right Bank and the Left Bank of the Dniester River, has significantly expanded.

New primary information for 2017 was collected, during which requests for information were sent to economic enterprises (a list is given in the Annex 1.4) and then the received answers were processed.
Timeliness: the Inventory team recalculated emissions based on updated activity data in the RM for the 1990-2017 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.
2. *Consistency:*
   - Identification of "outlier" points;
   - Comparison with data presented in other studies;
   - Comparison with independent statistical data.
3. *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.
4. *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.
5. *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.
- *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 2017 are described, a comparison with the base (1990) year is made.
- *Description of subsectors*: For sectors that are divided into subcategories, a description of the subcategories is performed, features of the calculation methodology of each subcategory are given.
- *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 by 2 approaches (Level and Trend, Tier 1), 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 in the current cycle. Answers to Review questions are also prepared in a separate document (Annex 2).

2. Consistency:

- *Identification of "outlier" points*: When analysing emission trends, values that significantly differed from the rest of the values were cross-checked, the primary data was refined and adjusted. For cases when the statistics had similar values, a description is made in the relevant categories.
- *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.

3. 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 2016 guidelines. 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.

4. Completeness:

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

- work was done to improve geographical coverage in the data on activities of the regions;
- the list of categories has also expanded significantly;
- drill down was made for several sectors that were previously represented by aggregated data; each such case is described;
- few categories are calculated for the first time in the 1.A.3 Transport sector.

5. Accuracy:

- *Use of more advanced techniques*: key categories were calculated using the Level, Trend Assessment Tier 1 approaches for all pollutants, and not just for main pollutants.
- *Reporting of uncertainties*: uncertainties are calculated according to the EMEP/EEA 2016 methodology, % of uncertainties of EF and AD documented in tables, calculation tables for all pollutants are given in the Annex 1.

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 1.4).

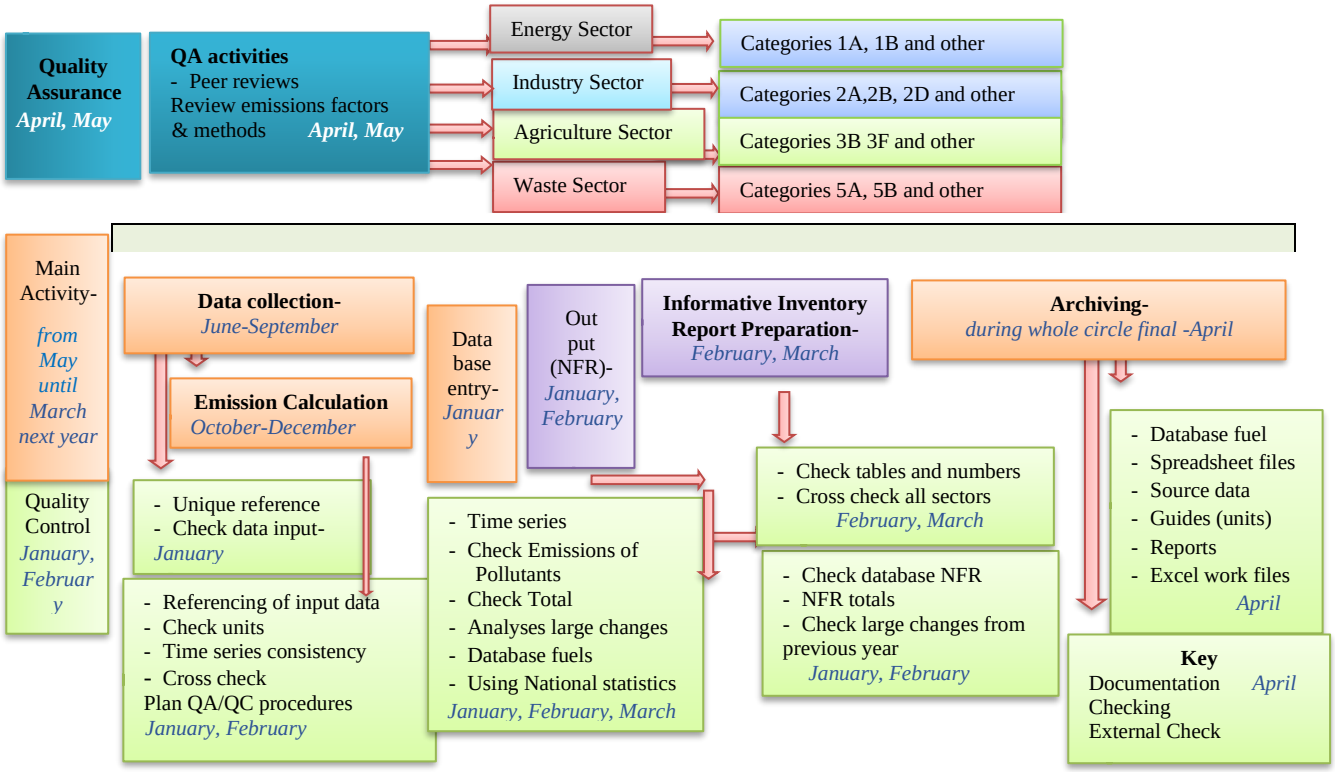


Figure 1.4. QA/QC plan process conducted in the current inventory cycle.

1.7. General uncertainty evaluation

Uncertainties were calculated according to the methodology described in Chapter 5 “Uncertainties” of the 2016 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 2016 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 2016, Table 3-1. Indicative error ranges in activity data for uncertainty analysis, Volume “Uncertainties”.

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 2016, Table 3-2. Rating definitions, Volume “Uncertainties”.

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

NFR	SOURCE CATEGORY	SO_2	NOx	VOC	CO	NH_3	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 2016, Table 3-3. Rating definitions, Volume "Uncertainties".

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	NH_3				CO		HM/POPs				PM	
1.A.1	Public power, cogeneration, and district heating	-	-	-	B	20-60%	20	D	100-300%	100	C	50-200%	50
1.A.2	Industrial combustion	-	-	-	B	20-60%	20	D	100-300%	100	C	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 sources 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	C	50-200%	50
3	Solvent use	E	order	300	-	-	-	E	order	300	D	100-300%	100

NFR	SOURCE CATEGORY	NH_3				CO		HM/POPs			PM		
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	C	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		NH_3		$PM_{2.5}$, PM_{10}, TSP		CO		Heavy metals, POPs	
	% AD	% EF	% AD	% EF	% AD	% EF	% AD	% EF	% AD	% EF	% AD	% EF	% AD	% EF
1.A.1	5	20	5	20	5	10			5	50	5	20	5	100
1.A.2	5	20	5	20	5	10			5	50	5	20	5	100
1.A.3.a	5	30	5	30	5	50			5	100	5	100	5	300
1.A.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.e	5	100	5	100	5	50			5	100	5	100	5	300
1.A.4.a	5	50	5	50	5	20			5	100	5	50	5	300
1.A.4.b	5	50	5	50	5	20			5	100	5	50	5	300
1.A.4.c.i	5	50	5	50	5	20			5	100	5	50	5	300
1.A.4.c.ii	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.B.2	5	50	5	50	5	50			5	100	5	50	5	300
2.A.1	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.A.2	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.A.3	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.A.5.a	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.A.5.b	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.A.5.c	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.A.6	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.1	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.2	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.3	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.5	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.6	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.7	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.10.a	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.B.10.b	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.1	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.2	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.3	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.4	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.5	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.6	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.7.a	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.7.b	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.7.c	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.C.7.d	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.D.3.a			5	20					5	100			5	300
2.D.3.b			5	20					5	100			5	300
2.D.3.c			5	20					5	100			5	300
2.D.3.d			5	20					5	100			5	300
2.D.3.e			5	20					5	100			5	300
2.D.3.f			5	20					5	100			5	300
2.D.3.g			5	20					5	100			5	300
2.D.3.h			5	20					5	100			5	300
2.D.3.i			5	20					5	100			5	300
2.G	5	50	5	20			5	300	5	100			5	300
2.H.1	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.H.2	5	50	5	50	5	20	5	300	5	50	5	50	5	300
2.H.3	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.a	5	100	5	100			5	100	5	300	5	100	5	300
3.B.1.b	5	100	5	100			5	100	5	300	5	100	5	300

Category	NOx		NMVOC		SOx		NH_3		$PM_{2.5}$, PM_{10}, TSP		CO		Heavy metals, POPs	
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	5	100	5	100			5	100	5	300	5	100	5	300
3.B.4.d	5	100	5	100			5	100	5	300	5	100	5	300
3.B.4.e	5	100	5	100			5	100	5	300	5	100	5	300
3.B.4.f	5	100	5	100			5	100	5	300	5	100	5	300
3.B.4.g.i	10	100	10	100			10	100	10	300	10	100	5	300
3.B.4.g.ii	10	100	10	100			10	100	10	300	10	100	5	300
3.B.4.g.iii	10	100	10	100			10	100	10	300	10	100	5	300
3.B.4.g.iv	10	100	10	100			10	100	10	300	10	100	5	300
3.B.4.h	10	100	10	100			10	100	10	300	10	100	5	300
3.D.a.1	5	100	5	100			5	100	5	300	5	100	5	300
3.D.a.2.a	5	100	5	100			5	100	5	300	5	100	5	300
3.D.a.2.b	5	100	5	100			5	100	5	300	5	100	5	300
3.D.a.2.c	5	100	5	100			5	100	5	300	5	100	5	300
3.D.a.3	5	100	5	100			5	100	5	300	5	100	5	300
3.D.a.4	5	100	5	100			5	100	5	300	5	100	5	300
3.D.b	5	100	5	100			5	100	5	300	5	100	5	300
3.D.c	5	100	5	100			5	100	5	300	5	100	5	300
3.D.d	5	100	5	100			5	100	5	300	5	100	5	300
3.D.e	5	100	5	100			5	100	5	300	5	100	5	300
3.D.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.1	5	20	5	20					5	50	5	50	5	100
5.B.2	5	20	5	20					5	50	5	50	5	100
5.C.1.a	5	50	5	50	5	50	5	300	5	50	5	50	5	300
5.C.1.b.i	5	50	5	50	5	50	5	300	5	50	5	50	5	300
5.C.1.b.ii	5	50	5	50	5	50	5	300	5	50	5	50	5	300
5.C.1.b.iii	5	50	5	50	5	50	5	300	5	50	5	50	5	300
5.C.1.b.iv	5	50	5	50	5	50	5	300	5	50	5	50	5	300
5.C.1.b.v	5	50	5	50	5	50	5	300	5	50	5	50	5	300
5.C.1.b.vi	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. 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.

Pollutant	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	18,849	3,759			
NMVOC	10,695	1,147	**Cr**	204,112	54,905
SOx	11,365	1,128	**Cu**	17,739	6,890
NH_3	3,705	3,165	**Ni**	69,113	0,487
$PM_{2.5}$	82,945	14,109	**Se**	158,760	4,039
PM_{10}	71,640	15,309	**Zn**	208,967	63,358
TSP	50,265	11,784	**PCDD**	106,540	98,737
BC	6,774	2,246	**Benzo(a)pyrene**	238,285	13,902
CO	39,432	2,898	**Benzo(b)fluoranthene**	214,919	15,118
Pb	169,882	38,395	**Benzo(k)fluoranthene**	171,544	27,003
Cd	207,262	133,552	**Indeno(1,2,3-cd)pyrene**	264,327	8,642
Hg	137,960	36,333	**HCB**	143,466	53,825
As	73,684	11,345	**PCBs**	144,379	53,144

Chapter 2: REPUBLIC OF MOLDOVA EMISSION TRENDS OF POLLUTANTS

Total emissions of pollutants for the 1990-2017 period are summarized in the Table 2.1.
Pollutant emissions were significantly reduced in 2017 compared to 1990 levels, namely:

- Main Pollutants:
- NOx decreases by 68% from 122,5 to 42 kt;
- NMVOC decrease by 51,2% from 105,7 to 60,6 kt;
- SOx decrease by 94,5% from 148,7 to 8,29 kt;
- NH_3 decrease by 35,6% from 85,3 to 51,77 kt;
- CO decrease by 71% from 332,6 to 124,48 kt.

The largest decrease in emissions for the Main Pollutants group occurred in SOx (by 94,5%), and the smallest in NH_3 (by 35,6%).

- Particulate Matter:
- $PM_{2,5}$ decrease by 48,2% from 23,7 to 17,10 kt;
- PM_{10} decrease by 50,4% from 31,9 to 21,08 kt;
- TSP decrease by 63,4% from 68,2 to 32,81 kt;
- BC decrease by 35,8% from 22,5 to 14,42 kt.

The largest reduction in emissions in the Particulate Matter group occurred in the TSP (by 63,4%), and the smallest in the BC (by 35,8%).

- Heavy metals (main):
- Pb decrease by 86% from 9,7 to 1,47 t;
- Cd decrease by 40,6% from 0,42 to 0,33 t;
- Hg decrease by 78,8% from 0,49 to 0,11 t.

The largest decrease in emissions in the Heavy metals group (main) was for Pb (by 86%), and the smallest for Cd (by 40,6%).

- Heavy metals (other):
- As decrease by 86,8% from 1,12 to 0,14 t;
- Cr decrease by 67,9% from 1,33 to 0,56 t;
- Cu decrease by 85,7% from 3,15 to 0,52 t;
- Ni decrease by 98,2% from 25,5 to 0,48 t;
- Se decrease by 92,3% from 6,21 to 0,52 t;
- Zn decrease by 61,2% from 24,2 to 12,61 t.

The largest decrease in emissions in the Heavy metals (other) group was observed for Ni (by 98,2%), and the smallest for Zn (by 61,2%).

- POPs
- PCDD/F increase by 4,3% from 43,53 to 44,16 g I-TEQ.
- Group PAHs:
  - Benzo(a)pyrene decrease by 76,1% from 9,21 to 3,04 t;
  - Benzo(b)fluoranthene decrease by 81,2% from13,66 to 3,40 t;
  - Benzo(k)fluoranthene decrease by 75,8% from 5,59 to 1,67 t;
  - Indeno(1,2,3-cd)pyrene decrease by 74,3% from 4,26 to 1,58 t;
- PAHs, Total decrease by 77,9% from 32,71 to 9,69 t;
- HCB decrease by 67,9% from 0,52 to 0,19 kg;
- PCBs decrease by 82,2% from 10,22 to 1,93 kg.

PCDD/F emissions increased by 4,3% in the POPs group, emissions of PAHs group decreased by 77,9%. The largest reduction in emissions by the POPs group was observed for PCBs (by 82,2%), the smallest decrease for HCB (by 67,9%).
The ranking average for 2017/1990 is shown in a separate column.

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

Pollutant	Unit	1990	1995	2000	2005	2010	2015	2017	2017/ 1990, %	Ranking, average
NOx	kt	122,5	45,0	27,4	33,4	37,5	38,6	42,0	*-68,5*	***22***
NMVOC	kt	105,7	48,2	31,6	49,4	44,0	51,5	60,6	*-51,2*	***23***
SOx	kt	148,7	31,3	4,1	4,7	8,6	8,25	8,29	*-94,5*	***21***
NH_3	kt	85,3	76,2	67,3	66,1	60,3	54,89	51,77	*-35,6*	***24***
$PM_{2.5}$	kt	23,7	5,6	4,5	5,2	5,2	12,29	17,10	*-48,2*	***17***
PM_{10}	kt	31,9	9,3	7,0	9,0	8,7	15,82	21,08	*-50,4*	***19***
TSP	kt	68,2	20,8	10,2	17,2	16,5	24,96	32,81	*-63,4*	***20***
BC	kt	22,5	15,1	8,6	11,3	9,9	14,42	20,46	*-35,8*	***18***
CO	kt	332,6	80,1	48,7	66,3	65,0	96,37	124,48	*-71,0*	***25***
Pb	t	9,7	1,3	0,8	1,0	0,9	1,35	1,47	*-86,0*	***12***
Cd	t	0,42	0,17	0,14	0,13	0,13	0,25	0,33	*-40,6*	***5***
Hg	t	0,49	0,13	0,08	0,10	0,08	0,10	0,11	*-78,8*	***4***
As	t	1,12	0,32	0,10	0,11	0,14	0,15	0,14	*-86,8*	***6***
Cr	t	1,33	0,32	0,15	0,17	0,19	0,43	0,56	*-67,9*	***7***
Cu	t	3,15	0,91	0,35	0,37	0,38	0,45	0,52	*-85,7*	***8***
Ni	t	25,58	3,89	0,67	0,36	0,64	0,47	0,48	*-98,2*	***15***
Se	t	6,21	0,88	0,29	0,40	0,51	0,48	0,52	**-92,3**	***10***
Zn	t	24,26	6,12	4,12	4,37	4,41	9,42	12,61	*-61,2*	***16***
PCDD/F	g I-TEQ	43,53	18,29	20,91	25,57	27,23	41,65	44,16	*4,3*	***1***
Benzo(a) pyrene	t	9,21	1,10	0,91	1,12	1,10	2,20	3,04	*-76,1*	***13***
Benzo(b) fluoranthene	t	13,66	1,85	1,46	1,66	1,69	2,56	3,40	*-81,2*	***14***
Benzo(k) fluoranthene	t	5,59	1,02	0,91	1,02	0,99	1,36	1,67	*-75,8*	***11***
Indeno(1,2,3-cd)pyrene	t	4,26	0,42	0,35	0,45	0,44	1,10	1,58	*-74,3*	***9***
PAHs, Total	t	32,71	4,39	3,63	4,25	4,22	7,21	9,69	*-77,9*	
HCB	kg	0,52	0,19	0,05	0,06	0,10	0,17	0,19	*-67,9*	***2***
PCBs	kg	10,22	2,60	2,81	3,39	1,26	1,82	1,93	*-82,2*	***3***

Emission reduction/growth (2017/1990) of each pollutant are shown in the Figure 2.1a.
Emission growth is available only for PCDD (by 4,3%). Emissions of other pollutants decreased. Emissions of SOx and Ni decreased most of all (by 94% and 98%), –while those of NH_3 and BC decreased least of all (by 36%).

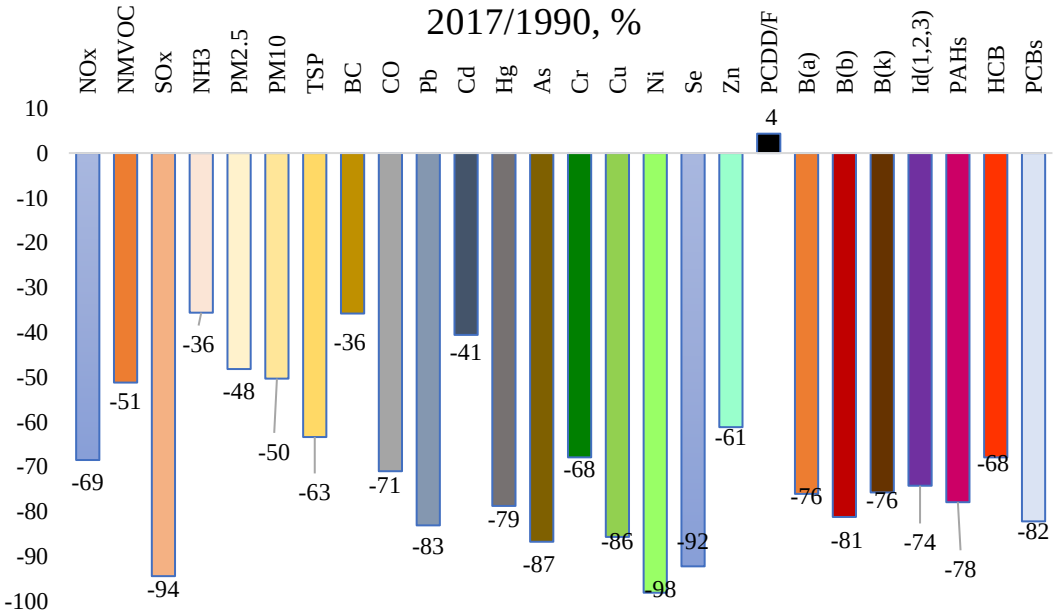


Figure 2.1a. Reduction of pollutant emissions in 2017 compared to 1990, %

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

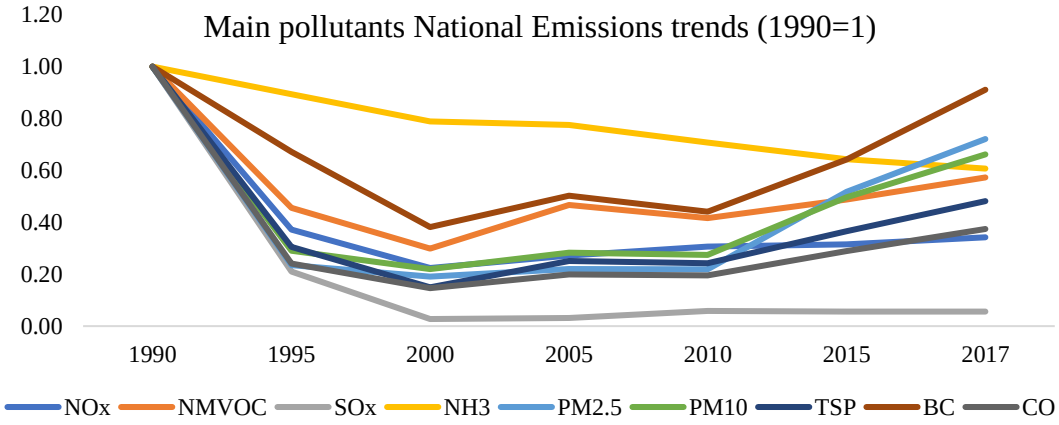


Figure 2.1b. Main pollutants National Emissions trends (1990=1).

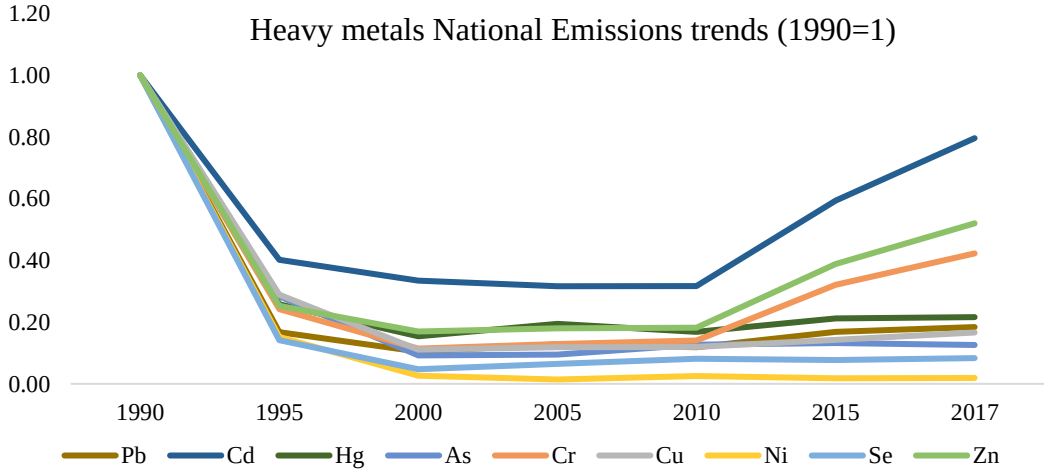


Figure 2.1c. Heavy metals National Emissions trends (1990=1).

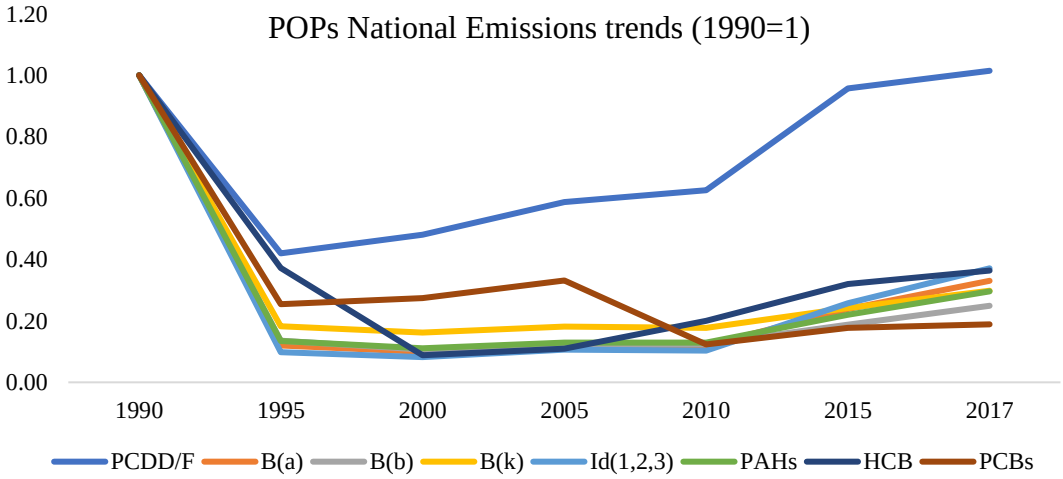


Figure 2.1d. POPs National Emissions trends (1990=1).

Emission Trends are of two types:
i) decrease in the whole time series;
ii) time series for 1990-2017 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 1990-2000 from 122,5 to 27,4 kt, then slowly increase from 2001 to 2017 to 42 kt NOx (2017) (Figure 2.2).

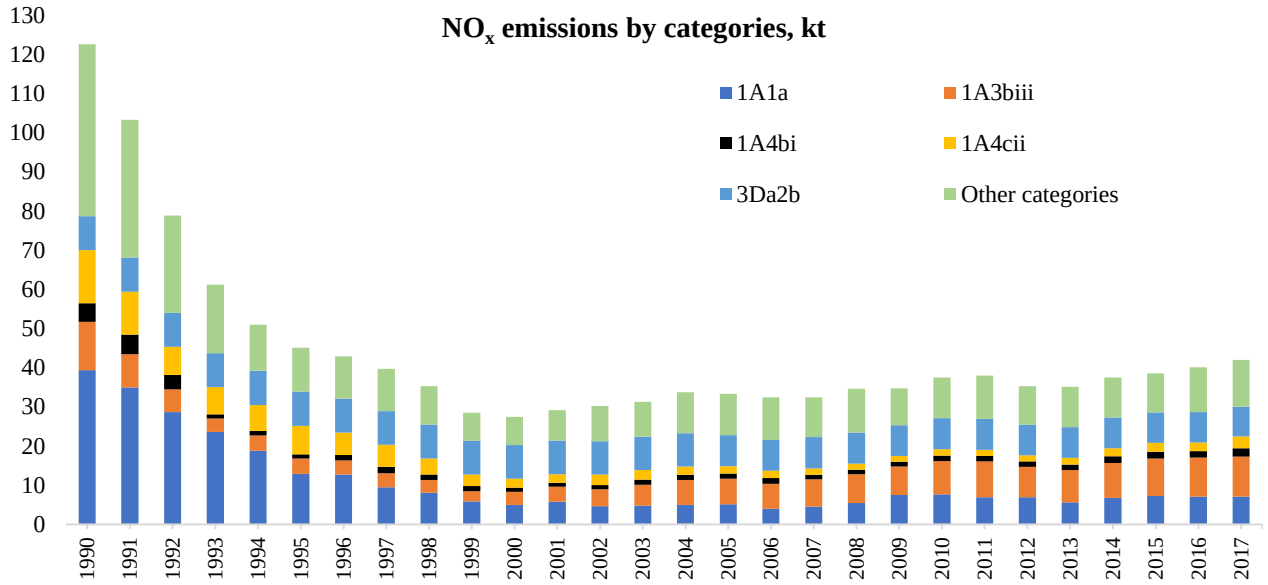


Figure 2.2. Trends in NOx emissions in the 1990-2017 period, by categories, kt.

The structure of category contributions has changed towards decreasing the share of *1.A.1.a Public electricity and heat production* from 36% to 22%, and increasing the share of *1.A.3.b.iii Road transport: Heavy duty vehicles and buses* (N2-N3 trucks, and M2-M3 buses) from 11% to 32% (1990/2017) (Figure 2.3).

The share of category *1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* decreased from 13% to 9% (1990/2017). All other categories make a total contribution to NOx emissions at approximately the same level - 40% (1990) and 37% (2017) (Figure 2.3).

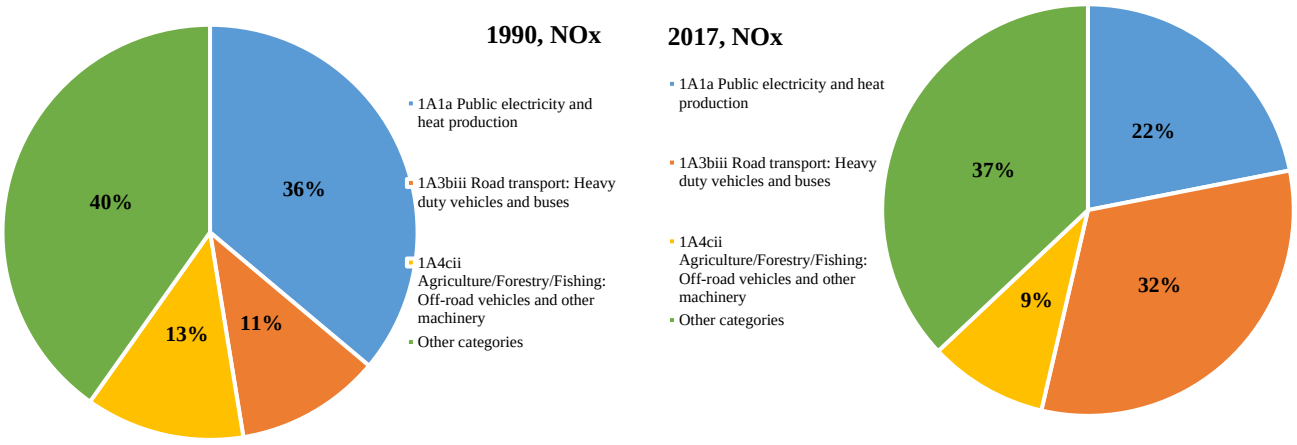


Figure 2.3. NOx emissions by sectors in 1990 and 2017.

Non-methane volatile organic compounds (NMVOC)

Total NMVOC emissions decreased by 57% from 105,7 kt to 60,67 kt (2017/1990). They had a declining trend between 1990 and 2000, followed by a slow growth (Figure 2.4).
The following categories make the largest contribution of NMVOC emissions:

1) with a growing trend in emissions:
   - *1.A.4.b.i Residential: Stationary* - 17% in 1990 and 20% in 2017;
   - *2.D.3.d Coating applications* - 10% (1990) and 19% (2017);
   - *2.D.3.i Other Solvents Use* - 3% (1990) and 13% (2017) - the largest increase (Fig. 2.5);
2) with a downward trend in emissions:
   - *2.H.2 Food and Beverages Industry* -16% (1990) and 8% (2017);
   - *3.B.1.a Manure Management*- daily cattle 16% in 1990 and 3% in 2017 (Fig. 2.5).

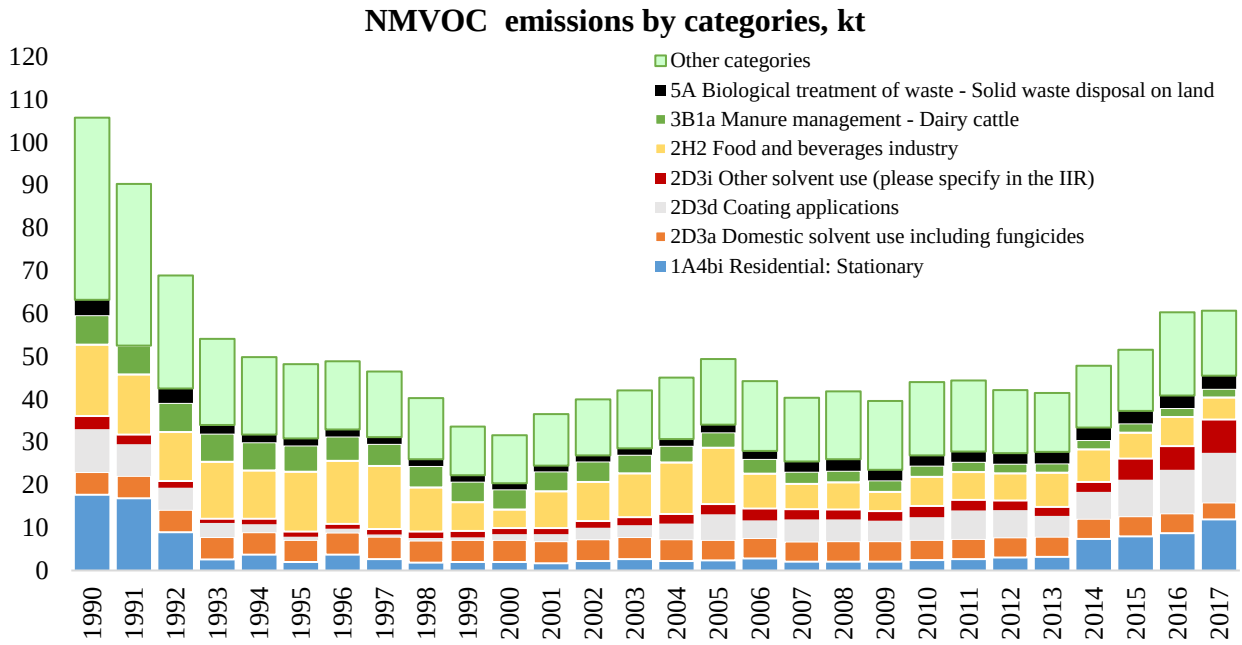


Figure 2.4. Trends in NMVOC emissions in the 1990-2017 period, by categories, kt.

All other categories have a total contribution of 40% of NMVOC emissions in 1990 and 25% in 2017.

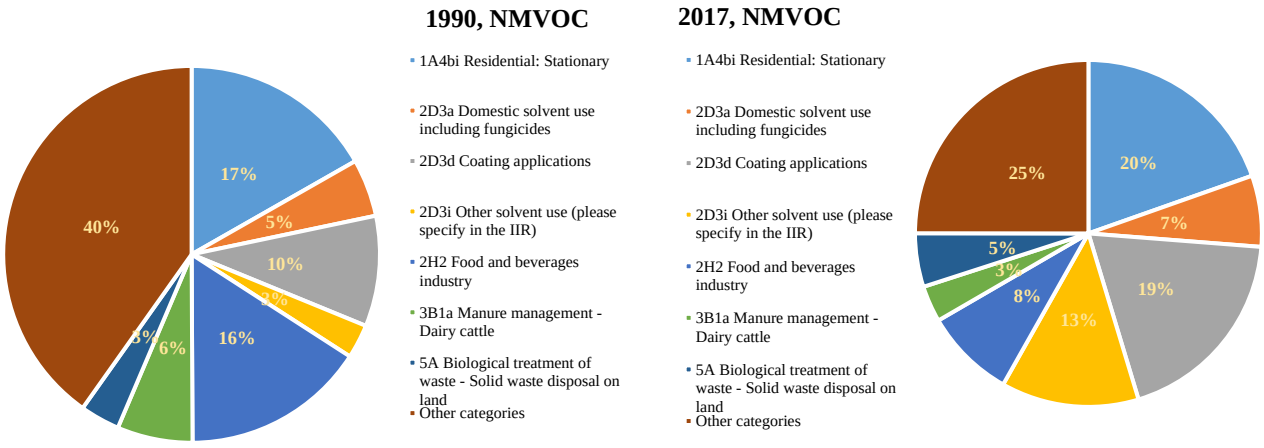


Figure 2.5. NMVOC emissions by sectors in 1990 and 2017.

Sulphur oxides (SOx)

SOx emissions decreased from 148,7 to 8,3 kt, or 17,9 times (1990/2017) (Fig. 2.6). The time series represent a declining trend (Figure 2.6).

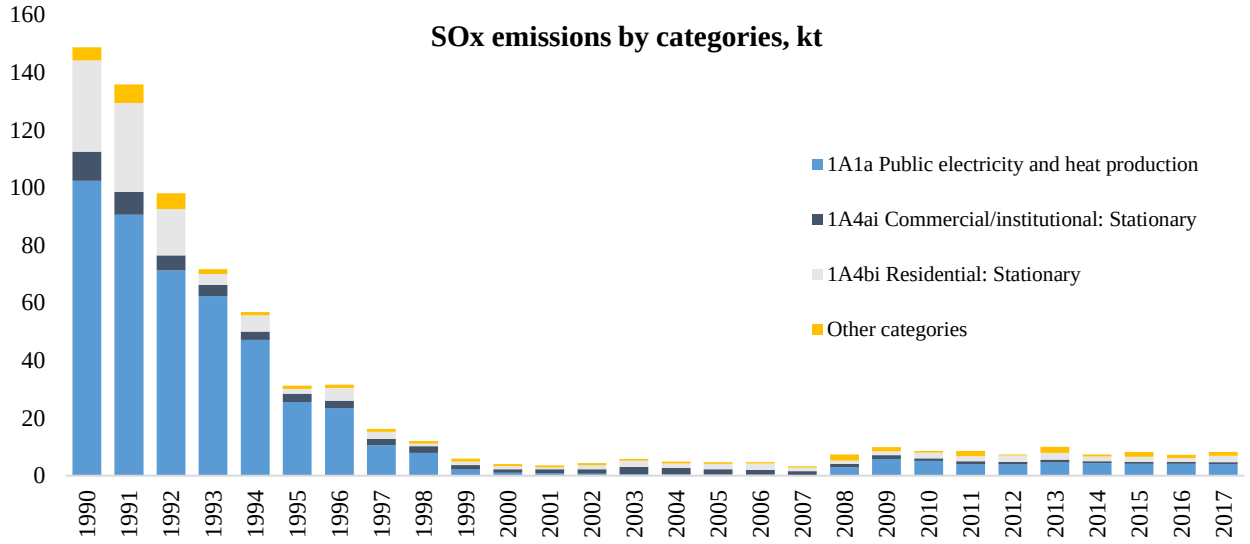


Figure 2.6. Trends in SOx emissions in the 1990-2017 period, by categories, kt

The structure of SOx emissions presented in pie charts allows us to see a decrease in the contribution of category 1.A.1a and an increase in the shares of 1.A.4.a.i, 1.A.4.b.i (Figure 2.7).

SOx emissions from all other categories amounted to 3% (1990) and 16% (2017).

The largest SOx emissions were 102,4 kt in 1990 in the *1.A.1.a Public Electricity* category, then they fell 25 times to 4,1 kt in 2017 (Fig. 2.7).
A multiple decrease in SOx emissions is also observed in the categories *1.A.4.a.i Commercial/institutional: Stationary*, *1.A.4.b.i Residential: Stationary* (14 and 15 times) (Fig. 2.7).
Compared to 1990, in 2017, the share of categories for the reporting period changed as follows: for 1.A.1.a from 69% to 49%, for 1.A.4.a.i from 7% to 8%, for 1.A.4.bi from 21% to 27% and for "other" from 3% to 16% (Figure 2.7).

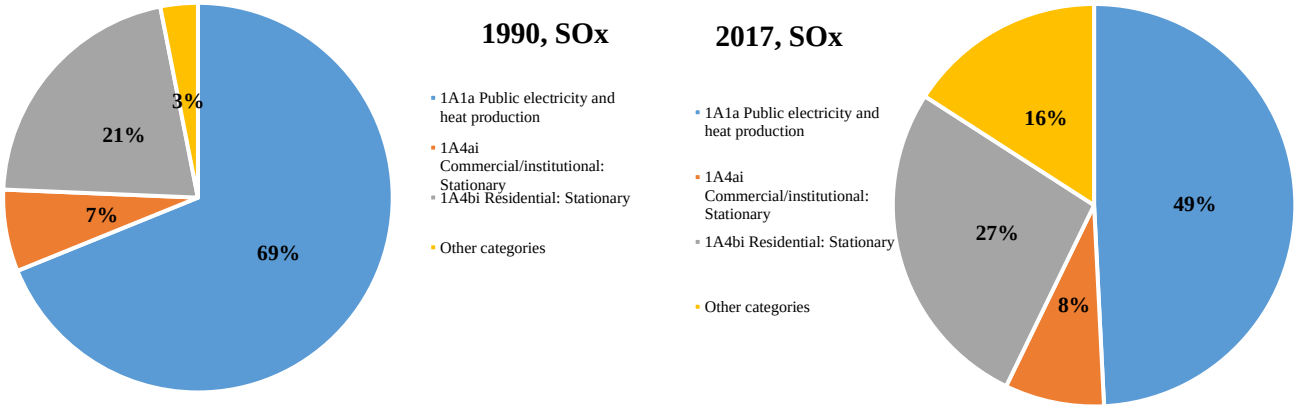


Figure 2.7. SOx emissions by sectors in 1990 and 2017

Ammonia (NH_3)

NH_3 emissions decreased 1,6 times from 85,3 to 51,8 kt (1990/2017) and have a gradual decline trend (Figure 2.8).

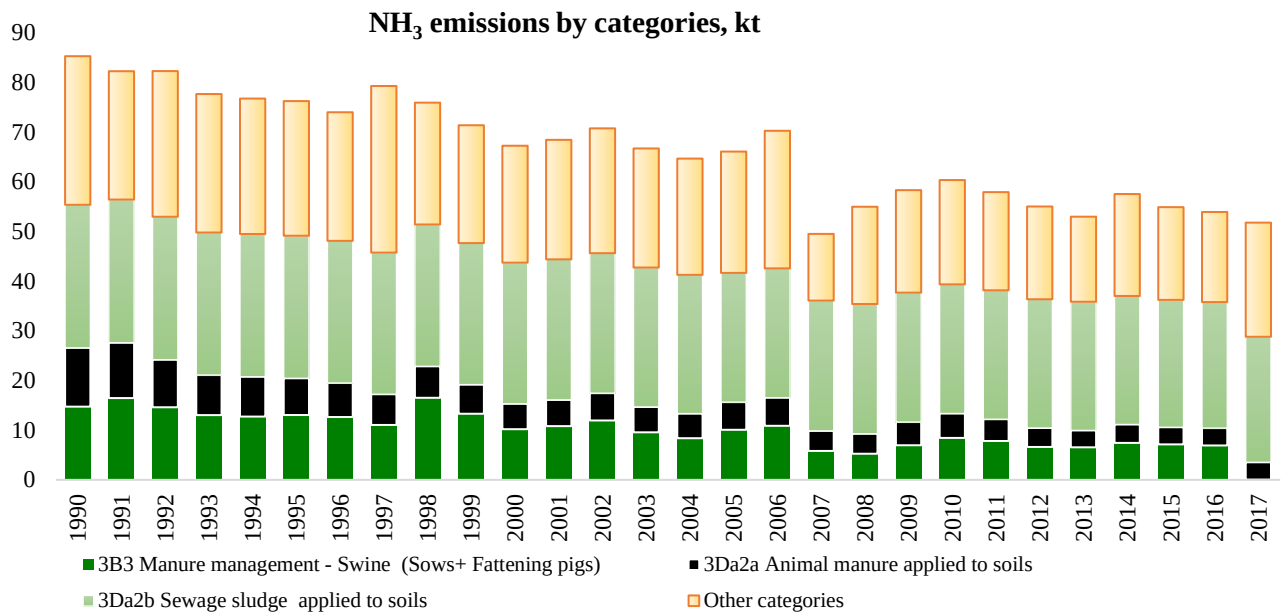


Figure 2.8. Trends in NH_3 emissions in the 1990-2017 period, by categories, kt

A multiple reduction in NH_3 emissions occurred in the *3.B.3 Manure Management-Swine* category (Fig. 2.9). In the *3.D.a.2.a Animal Manure Applied for Soils* category, the NH_3 emissions decreased 3,4 times, in the *3.D.a.2.b Sewage sludge Applied to Soils* category – 1,1 times; Other Categories in the aggregate – 1,3 times (Fig. 2.9).

The structural distribution of NH_3 emissions changed significantly in 2017: the share of 3.D.a.2.b *Sewage sludge Applied to Soils* increased to 49% compared to 34% in 1990; Other Categories – 41% in 2017 compared with 35% in 1990 (Figure 2.9).

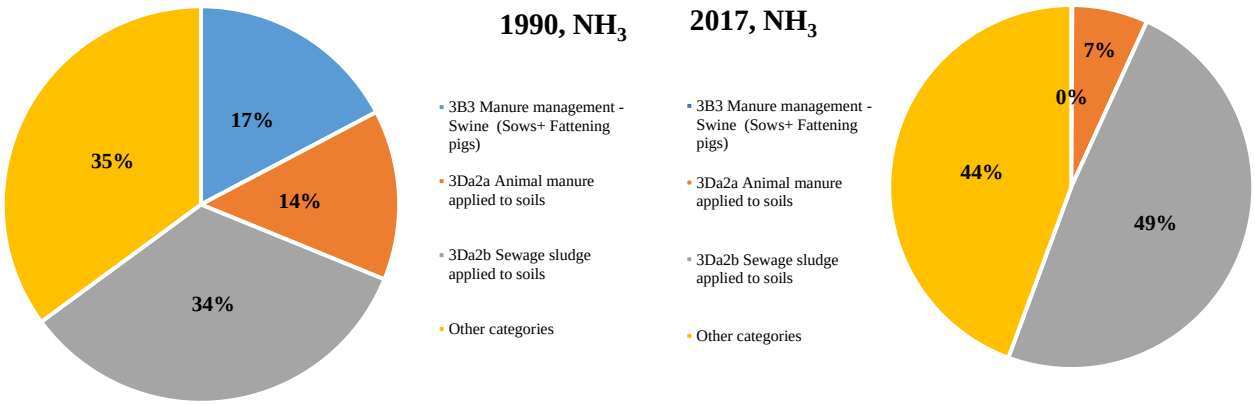


Figure 2.9. NH_3 emissions by sectors in 1990 and 2017

Particulate matter ($PM_{2.5}$)

The time series of $PM_{2.5}$ emissions has a trend with 3 sections: a sharp decline in the period 1990-1995 (from 23 to 5 kt), a constant trend with values in the range of 4-6 kt in the period 1996-2013, and an increase in emissions to 17 kt in 2017 (Figure 2.10).

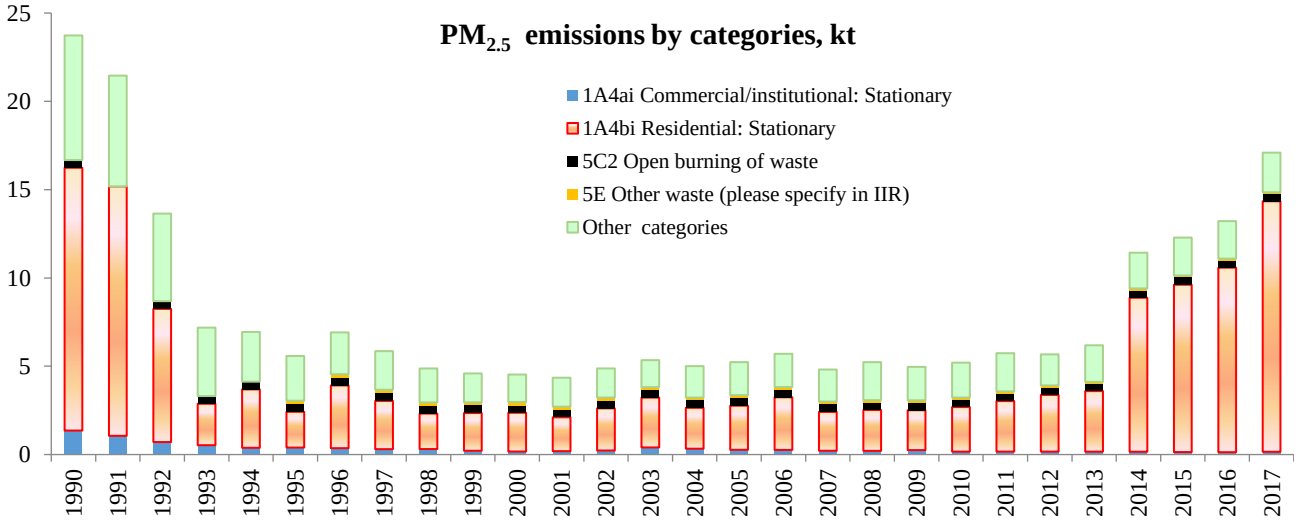


Figure 2.10. Trends in $PM_{2.5}$ emissions in the 1990-2017 period, by categories, kt

The largest number of $PM_{2.5}$ emissions come from the residential sector *1.A.4.b.i Residential: Stationary* - 62% and 83% in 1990 and 2017, respectively (Figure 2.11).
Other categories combined accounted for 30% of $PM_{2.5}$ emissions in 1990 and 13% in 2017 (Figure 2.11).
The gross emissions of $PM_{2.5}$ from the *1.A.4.b.i Residential: Stationary* sector in 1990 and 2017 amounted to approximately the same amount of 14,9 and 14,2 kt, emissions from all other categories decreased significantly, as can be seen in the pie charts (Figure 2.11).

Figure 2.11. $PM_{2.5}$ emissions by sectors in 1990 and 2017

Particulate matter (PM_{10})

PM_{10} emissions have a similar dynamic, accounting for 3 trend sections: a sharp decrease (from 30 kt in 1990 and 7 kt in 1998), then fluctuations in the range of 7-9 kt PM_{10} in the period 1999-2013, then an increase to 21 kt in 2017 (Figure 2.12).

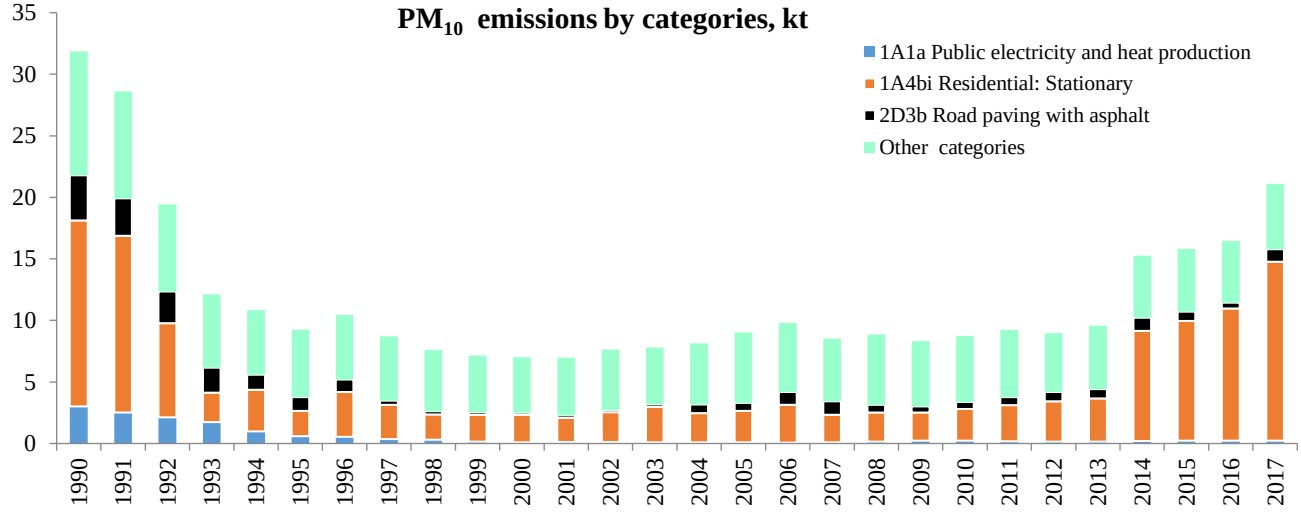


Figure 2.12. Trends in PM_{10} emissions in the 1990-2017 period, by categories, kt

The largest emissions come from the following categories:

- *1.A.1.a Public electricity and heat production* (in general, the trend is a gradual decrease from 9% in 1990 to 1% in 2017);
- *1.A.4.b.i Residential: Stationary* (47% and 69%),
- *2.D.3.b Road paving with asphalt* (12% and 5%).

The emissions of PM_{10} from all other categories from 23% (1990) to 60% in different years (in 1990 - 32%, in 2017 - 25%).
PM_{10} emissions from *1.A.4.b.i Residential: Stationary* in gross terms in 1990 and 2017 amounted to close values of - 15,1 and 14,6 kt PM_{10}, but in the share of their contribution increased from 47% in 1990 to 69% in 2017 (Figure 2.13).

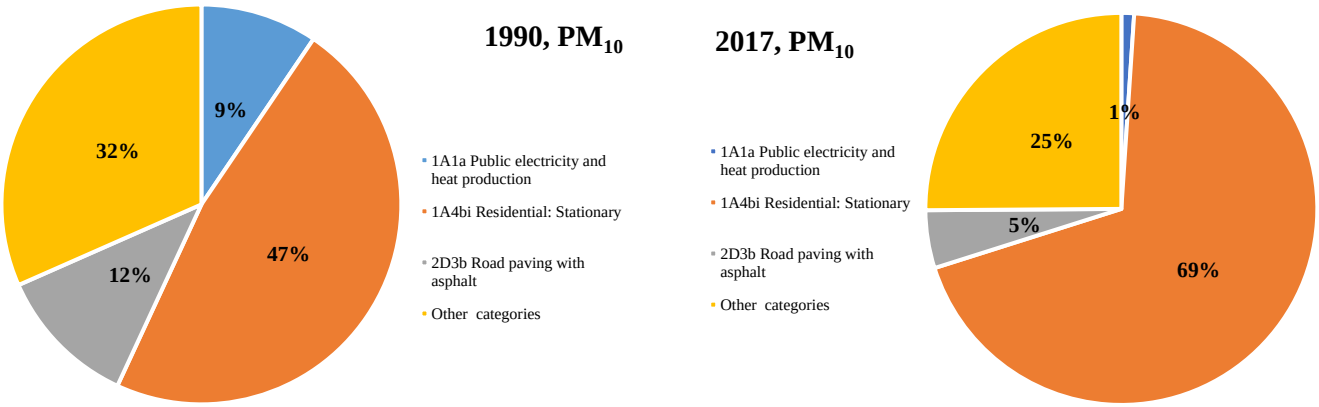


Figure 2.13. PM_{10} emissions by sectors in 1990 and 2017

Total suspended particulates (TSP)

TSP emissions decreased 2 times from 68,2 to 32,8 kt TSP (1990/2017). The time series also includes three different sections of the trend: a sharp decline from 68,2 to 10 kt (1990-1999), then fluctuations in the range of 10-18 kt (2000-2013), and growth to 32 kt in 2017 (Figure 2.14).

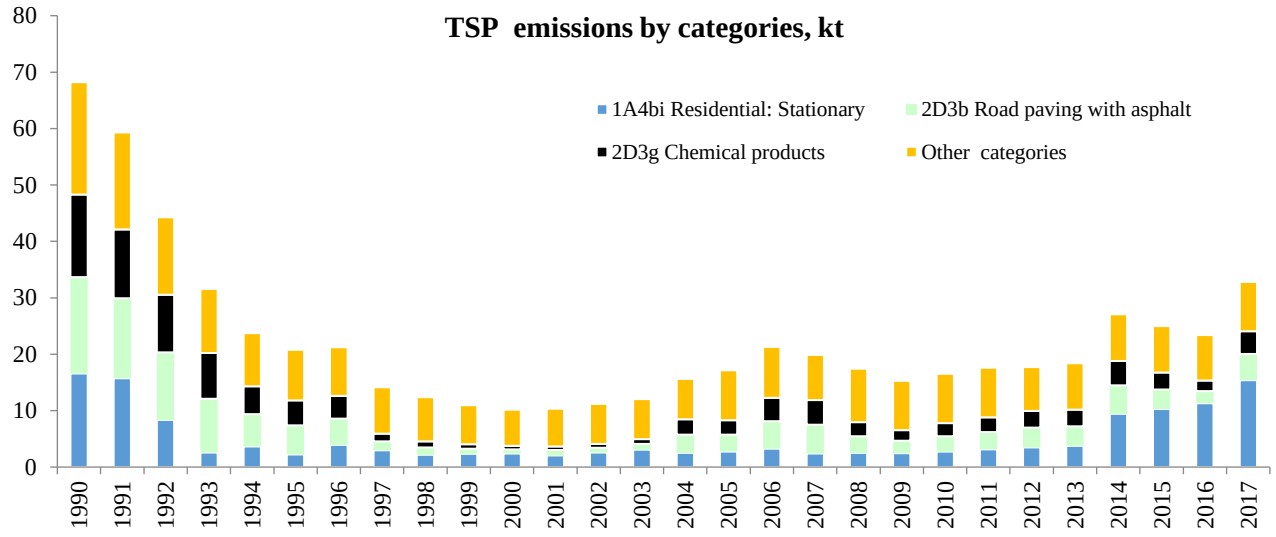


Figure 2.14. Trends in TSP emissions in the 1990-2017 period, by categories, kt

The largest emissions are observed from categories *1.A.4.b.ii Residential: Stationary, 2.D.3.b Road paving with asphalt, 2.D.3.g Chemical products*.

The emissions in these categories changed in 2017 compared to 1990, downward for:

- *2.D.3.g Chemical products* (from 22% to 12%)
- *2.D.3.b Road paving with asphalt* (from 29% to 14%).

The share emissions of category *1.A.4.b.i Residential: Stationary* increased in 2017 compared to 1990 (from 25% to 47%). All other categories accounted for 29% of TSP emissions in 1990 and 27% in 2017 (Figure 2.15).

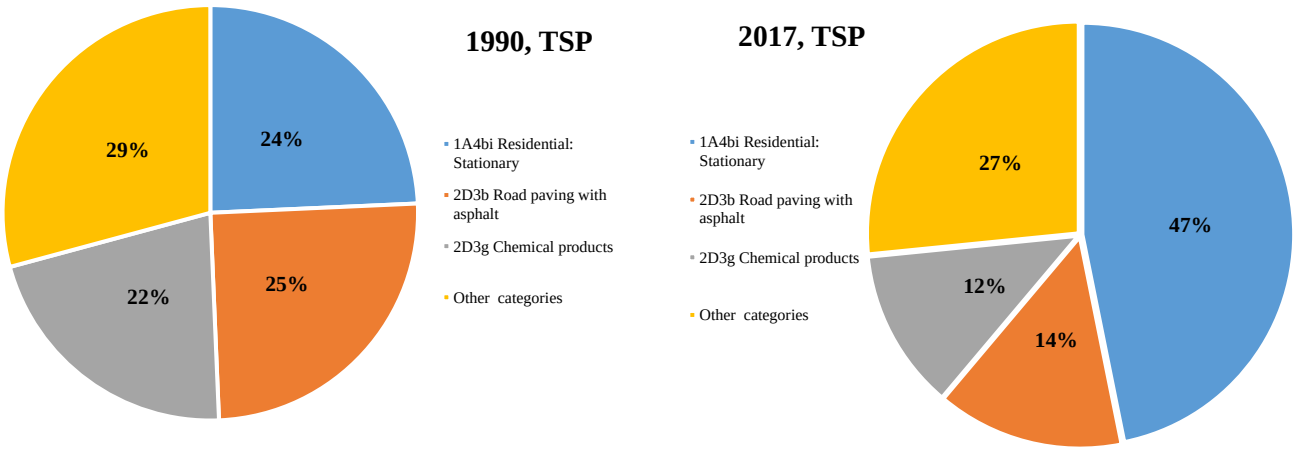


Figure 2.15. TSP emissions by sectors in 1990 and 2017

Black carbon (BC)

Emissions have a trend with fluctuations in the range of 5 - 20 kt BC (Figure 2.16).

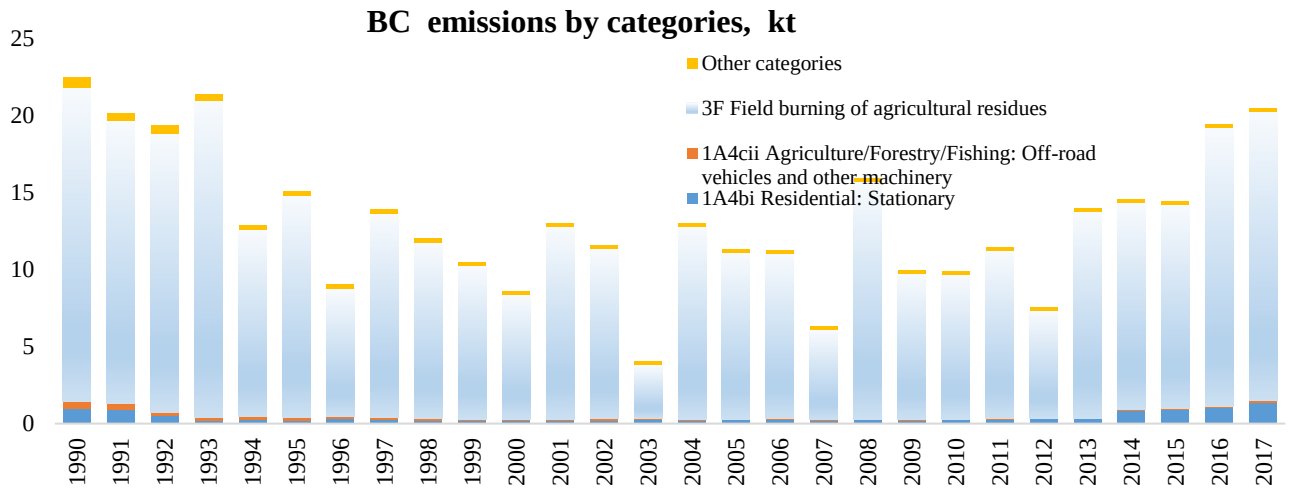


Figure 2.16. Trends in BC emissions in the 1990-2017 period, by categories, kt

The largest contribution is made by one category – *3.F Field burning of agricultural residues*, emissions from which amounted to 20,3 kt in 1990 and 18,7 kt in 2017, or more than 90% of the total quantities in each year of the time series (Figure 2.17). For the last years of the trend, there has been an increase in BC emissions.

Small emissions also come from fuel combustion in categories *1.A.4.b.i Residential: Stationary and 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* and all other categories. Observed fluctuations in the trend come from the *3.F Field burning of agricultural residues category* (Figure 2.17).

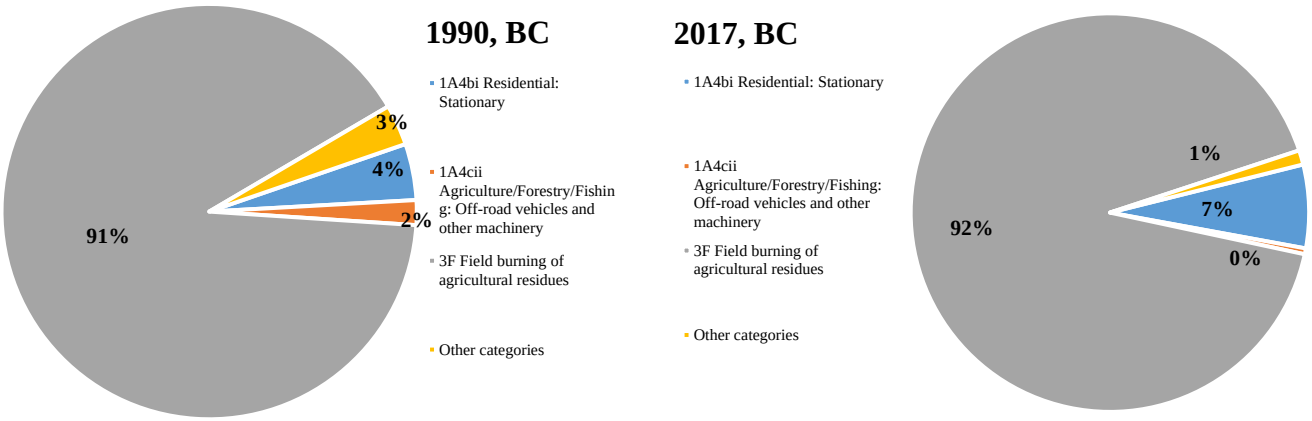


Figure 2.17. BC emissions by sectors in 1990 and 2017

Carbon monoxide (CO)

CO emissions decreased 2,7 times from 332,6 (1990) to 124,5 kt (2017) (Figure 2.18). The trend has a sharp decline in the period 1990-1993 from 332,6 to 83 kt, then fluctuations in the range of 50-60 kt (1994-2013), and growth to 124,5 kt (2017) (Figure 2.18).

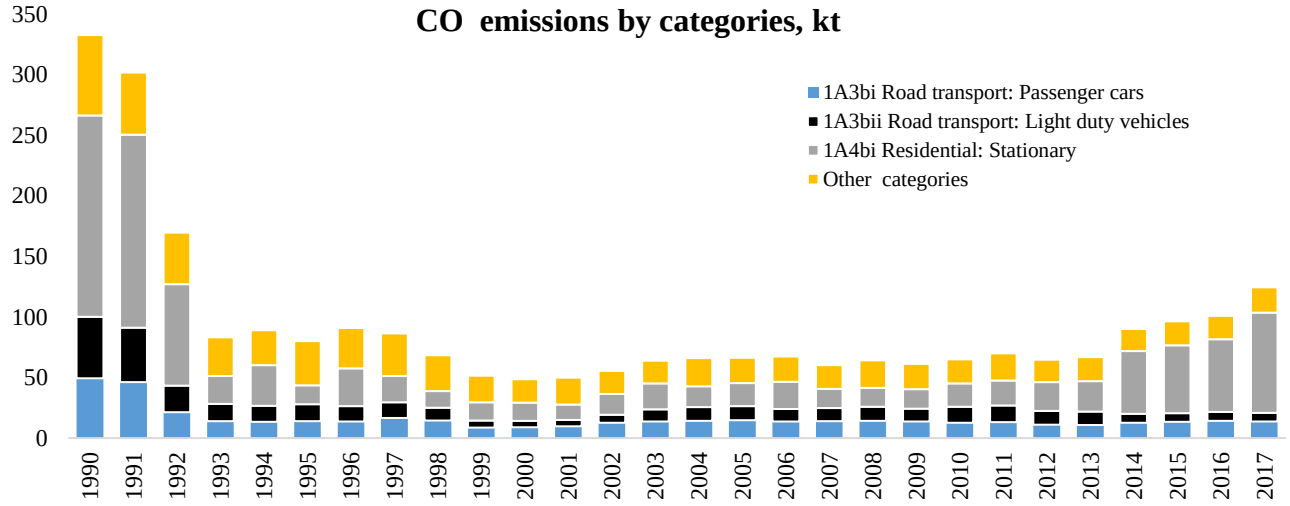


Figure 2.18. Trends in CO emissions in the 1990-2017 period, by categories, kt

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 (2017/1990):

- *1.A.3.b.i Road transport: Passenger cars* - 3,6 times from 49,5 to 13,7 kt CO;
- *1.A.3.b.ii Road transport: Light duty vehicles* - from 50.6 to 7,2 kt CO;
- *1.A.4.b.ii Residential: Stationary* - from 166,3 to 82,6 kt CO;
- Other categories together have a reduction in emissions from 60,2 to 21 kt CO.

The distribution of category contributions in total emissions in 1990/2017 changed to:

A) growth of emissions from stationary combustion in *1.A.4.b.i Residential: Stationary* (from 50% in 1990 to 66% in 2017) (Figure 2.19);

B) a decrease in the share of category *1.A.3.b.i Road transport: Passenger cars* from 15% in 1990 to 11% in 2017, and a share of *1.A.3.b.i Road transport: Light duty vehicles* from 15% in 1990 to 6% in 2017 (Figure 2.19).

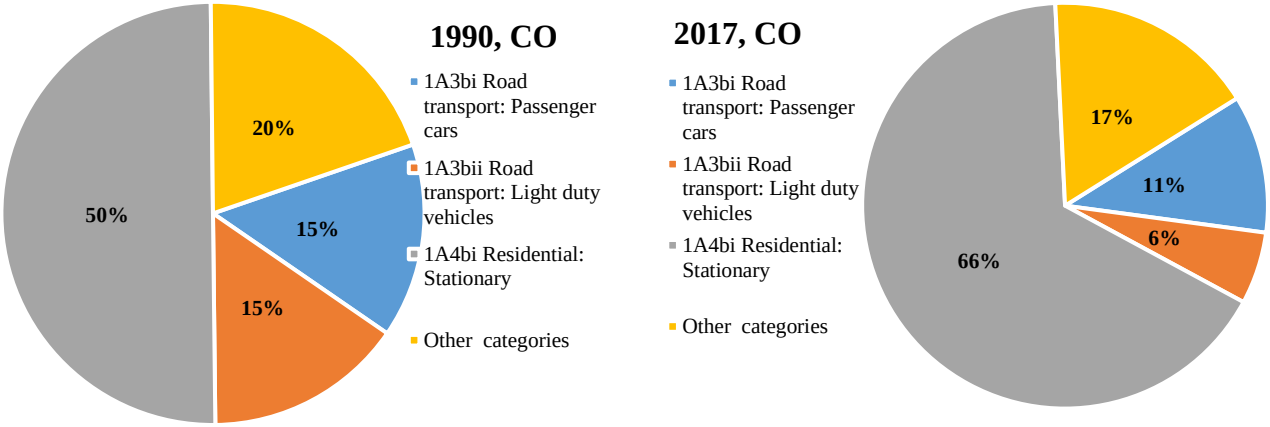


Figure 2.19. CO emissions by sectors in 1990 and 2017

Lead (Pb)

Pb emissions decreased 6,6 times with a sharp decline in the period 1990-1994 (from 9,7 to 2 tons) and a further gradual decrease to 1,5 tons in 2017 (Figure 2.20).

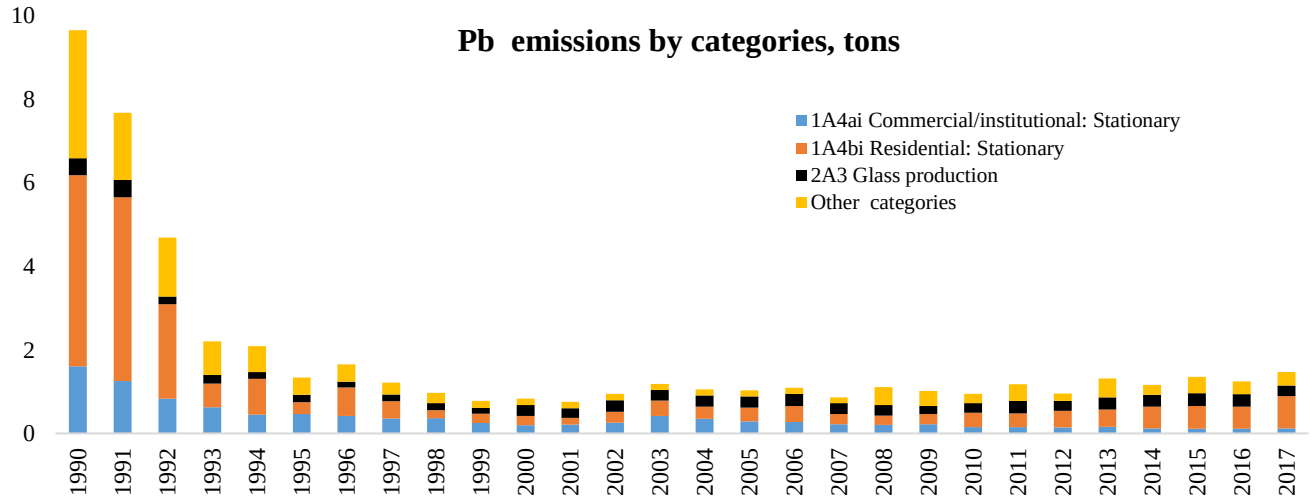


Figure 2.20. Trends in Pb emissions in the 1990-2017 period, by categories, tons

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 17% to 8% (1990/2017), while that of category *2.A.3 Glass production* increased from 4% to 17% (1990/2017).

The contribution of category *1.A.4.b.i Residential: Stationary* increased from 47% to 53% (1990/2017). Other categories together contributed 32% and 22% of Pb emissions (1990/2017) (Figure 2.21).

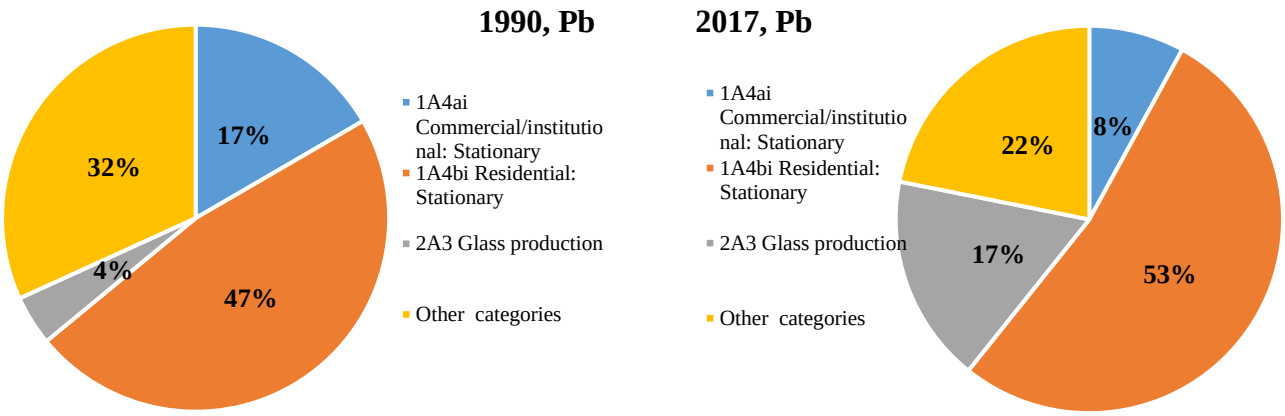


Figure 2.21. Pb emissions by sectors in 1990 and 2017

Cadmium (Cd)

Cd emissions have a trend of change in 3 sections - a decline in the period 1990-1994 (from 0,41 t to 0,19 t Cd), a constant trend in the range of 0,12-0,16 t in the period 1995-2013, and an increase to 0,33 t Cd in 2017 (Figure 2.22).

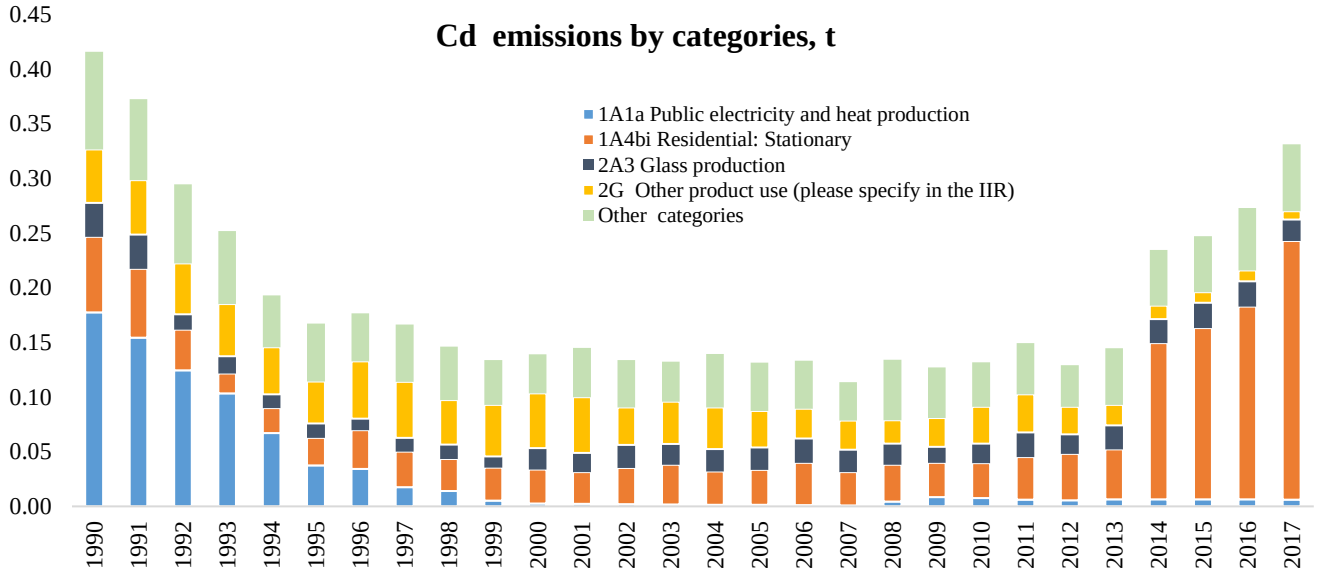


Figure 2.22. Trends in Cd emissions in the 1990-2017 period, by categories, tons

The total decrease in emissions was 1,3 times from 0,42 to 0,33 t Cd for the period 1990-2017. The largest emissions were in the following categories:

- *1.A.1.a Public electricity and heat production* - 43% in 1990 and 2% in 2017;
- *1.A.4.b.i Residential: Stationary* - 14% in 1990 and 71% in 2017;
- *2.A.3 Glass production* - 6% in 1990 and 6% in 2017;
  All other categories - 21% in 1990 and 19% in 2017 (Figure 2.23).

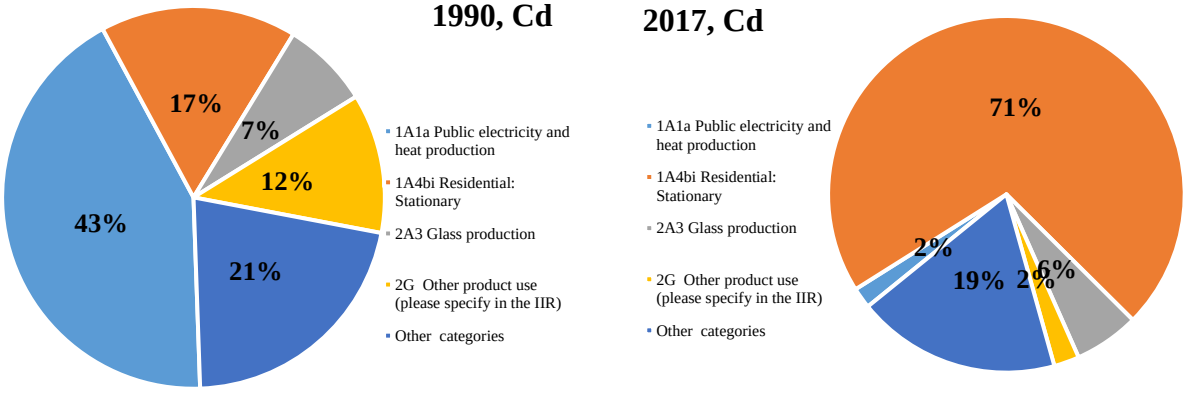


Figure 2.23. Cd emissions by sectors in 1990 and 2017

Mercury (Hg)

Mercury emissions tend to decrease gradually from 0,49 in 1990 to 0,1 tons in 2017.
The largest emissions were from *1.A.4.b.i Residential: Stationary* category - 37% in 1990 and 22% in 2017 (Figure 2.24).

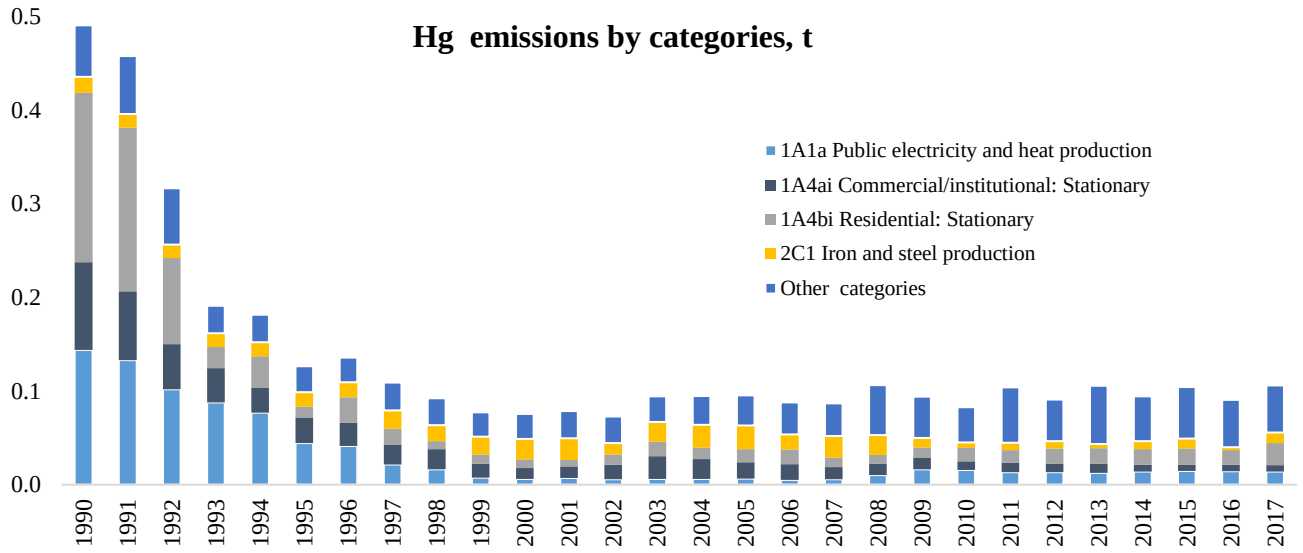


Figure 2.24. Trends in Hg emissions in the 1990-2017 period, by categories, tons

The share of the category *1.A.1.a Public electricity and heat production* contribution decreased from 29% in 1990 to 13% in 2017, while that of Category *1.A.4.a.i Commercial / institutional: Stationary* decreased from 19% in 1990 to 11% in 2017.

The share of category *2.C.1 Iron and steel production* increased from 4% in 1990 to 11% in 2017, while the share of other categories increased from 11% in 1990 to 47% in 2017 (Figure 2.25).

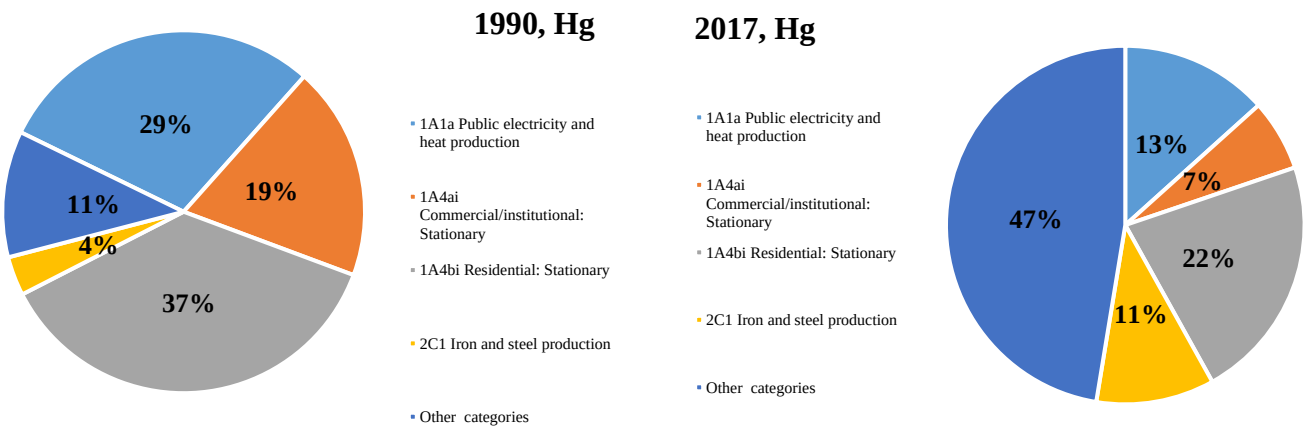


Figure 2.25. Hg emissions by sectors in 1990 and 2017

Arsenic (As)

As emissions have a gradual decline trend from 1,1 to 0,14 tons or 7,9 times (1990/2017) (Figure 2.26).

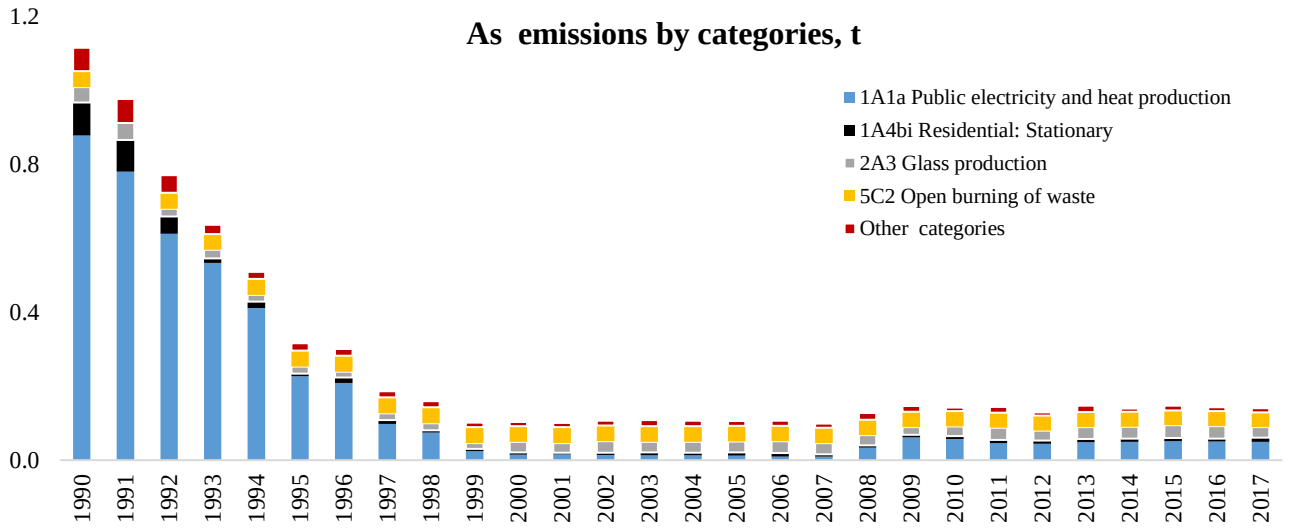


Figure 2.26. Trends in As emissions in the 1990-2017 period, tons

In 1990, the majority of As emissions came from category *1.A.1.a Public electricity and heat production* (78%). By 2017, the share of this category decreased to 35%.
In this regard, the structure of emissions has changed, and the shares of other categories have increased: *2.A.3 Glass production* from 4 to 20%, and *5.C.2 Open burning of waste* from 4 to 29%.
Categories *1.A.4.b.i Residential: Stationary* and all other categories maintained their contributions at almost the same level (8% and 8%; 6% and 8%, respectively) during the period 1990-2017 (Figure 2.27).

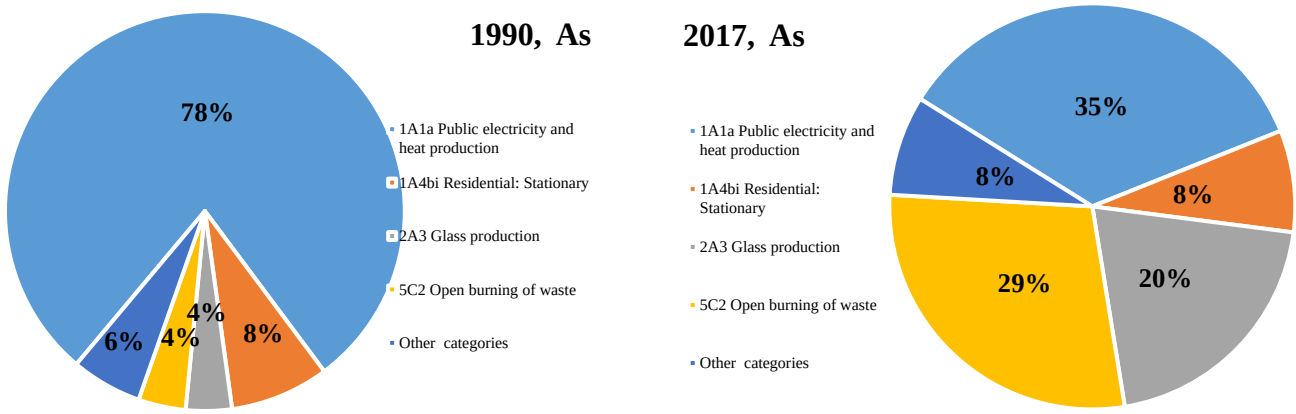


Figure 2.27. As emissions by sectors in 1990 and 2017

Chromium (Cr)

Cr emissions have a trend with 3 sections: a sharp decline from 1,32 tons to 0,2 tons (1990-1998), then constant dynamics in the range of 0,14-0,15 tons in the period 1999-2007, and growth to 0,56 tons in 2017. The overall decline was 2,4 times from 1,32 to 0,56 tons (1990/2017) (Figure 2.28).

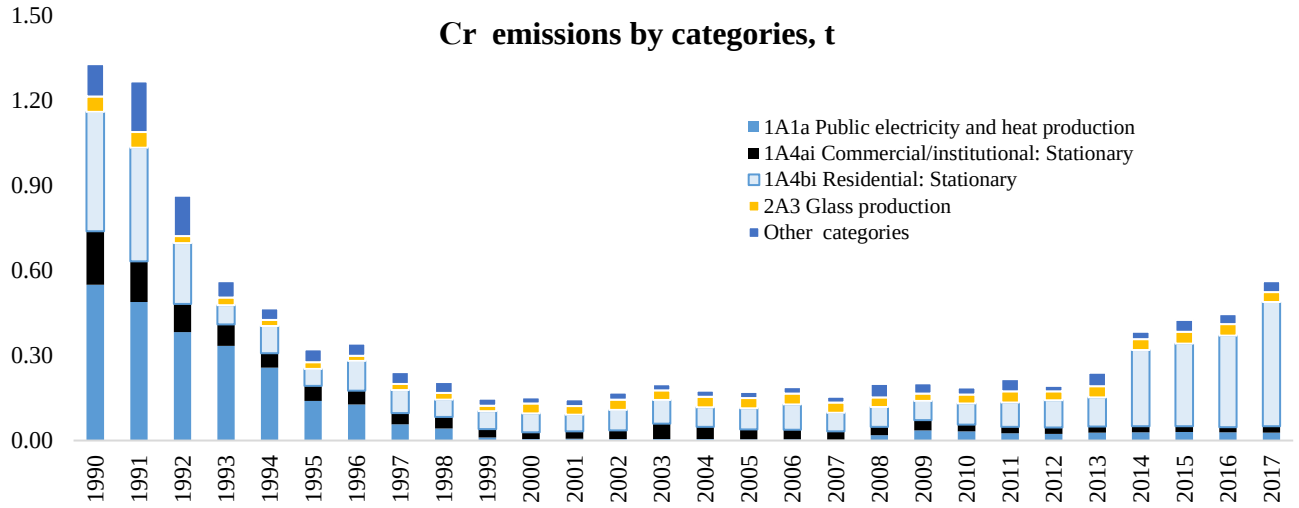


Figure 2.28. Trends in Cr emissions in the 1990-2017 period, by categories, tons

The largest contribution and the largest decrease (19,5 times) took place in category *1.A.1.a Public electricity and heat production* (from 0,55 tons in 1990 to 0,03 tons in 2017).
The *1.A.4.a.i Commercial/institutional: Stationary category* also dropped significantly from 0,19 to 0,02 tons (1990/2017). For categories *1.A.4.b.i Residential: Stationary and 2.A.3 Glass production*, emissions remained at the same level (Figure 2.29).

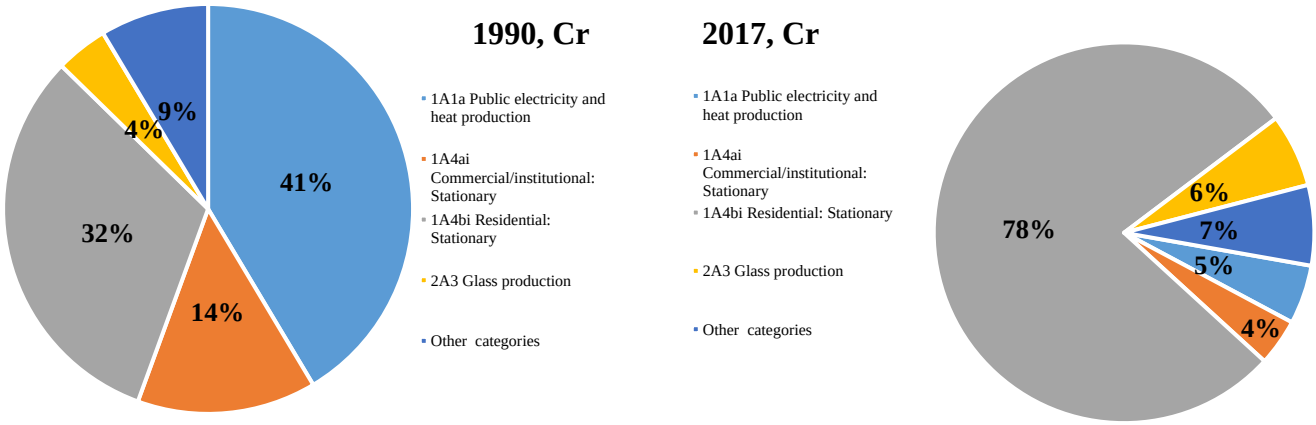


Figure 2.29. Cr emissions by sectors in 1990 and 2017

Copper (Cu)

Cu emissions had a gradual 6 times decrease from 3,15 tons (1990) to 0,52 tons (2017) (Figure 2.30).

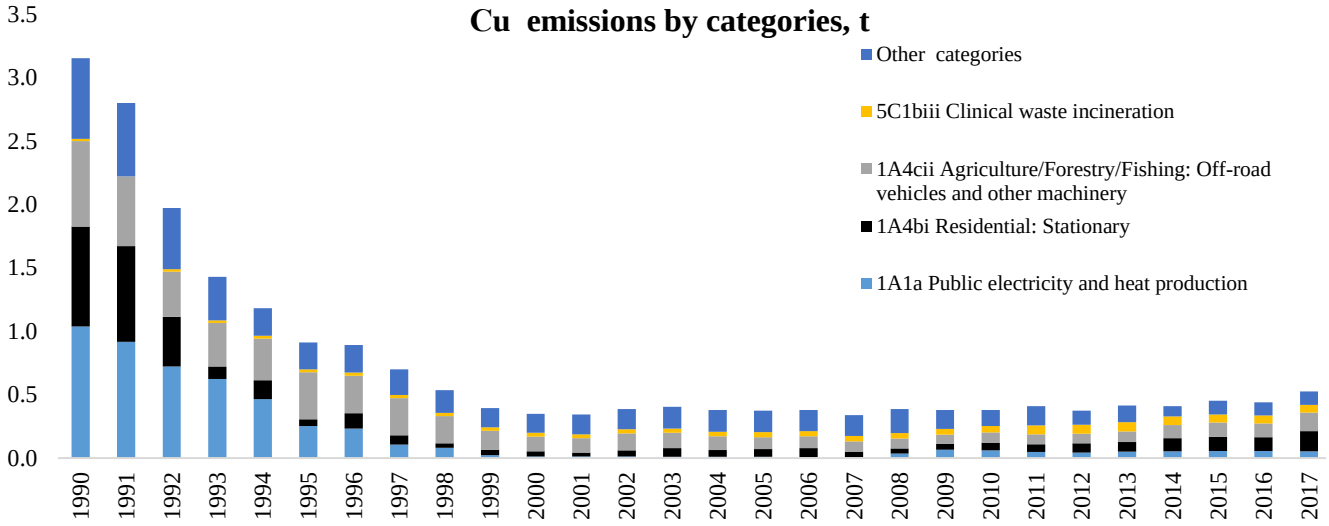


Figure 2.30. Trends in Cu emissions in 1990-2017, by categories, tons

Emissions from the sector *1.A.1.a Public electricity and heat production* decreased 19,5 times, those from *1.A.4.b.i Residential: Stationary* - 5 times, and those from *1.A.4.c.ii Agriculture / Forestry / Fishing: Off-road vehicles and other machinery* - 4,5 times.

Category contributions to total Cu emissions were as follows:

- *1.A.1.a Public electricity and heat production* - 33% in 1990 and 10% in 2017;
- *1.A.4.b.i Residential: Stationary* - 25% in 1990 and 30% in 2017;
- *1.A.4.c.ii Agriculture / Forestry / Fishing: Off-road vehicles and other machinery* - 21% in 1990 and 29% in 2017;
- *5.C.1.b.iii Clinical waste incineration* - 1% in 1990 and 11% in 2017 (Figure 2.31).

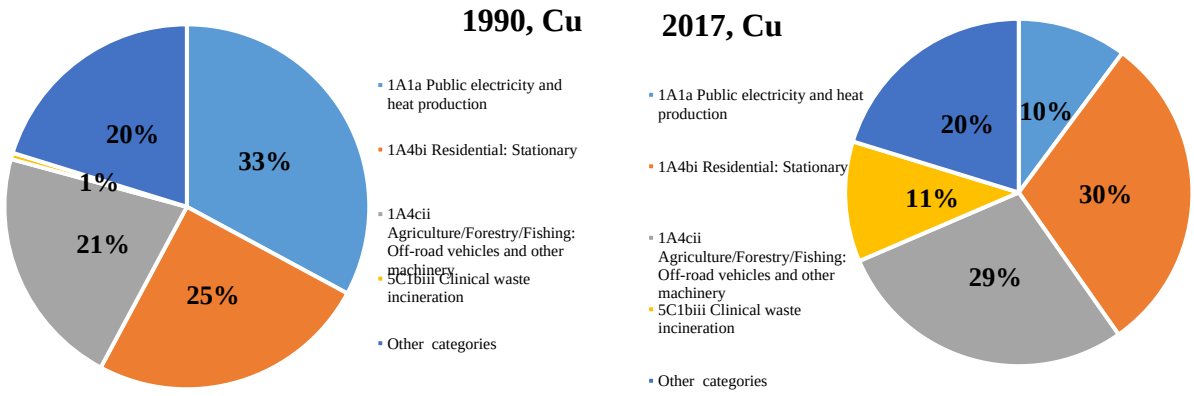


Figure 2.31. Cu emissions by sectors in 1990 and 2017

Nickel (Ni)

Ni emissions had a significant 53 times decrease, from 25,5 tons (1990) to 0,47 tons (2017) (Figure 2.32).

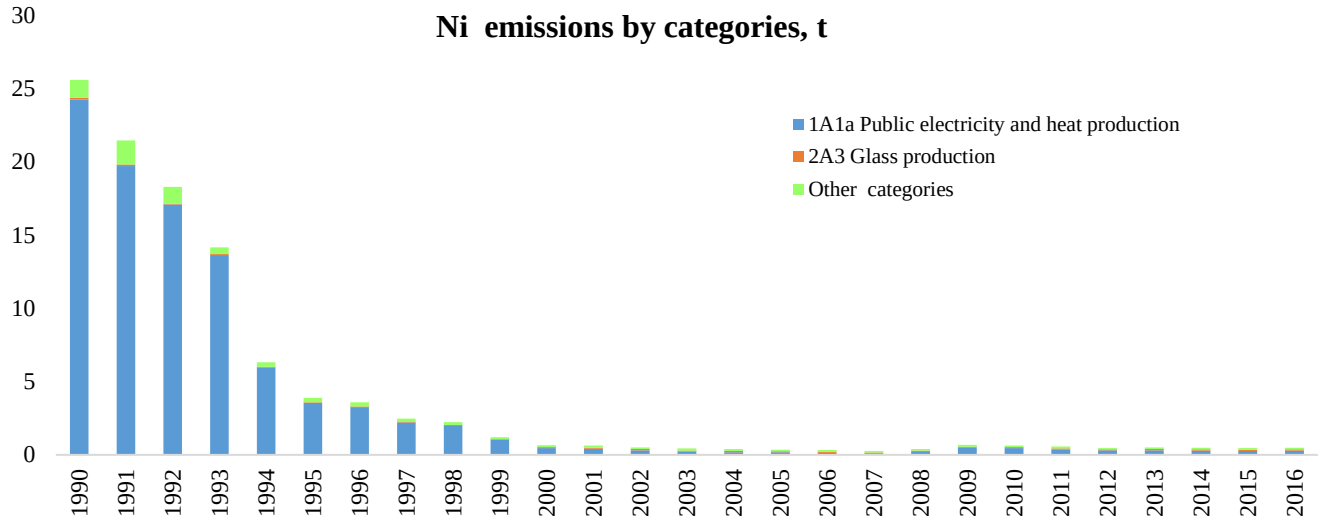


Figure 2.32. Trends in Ni emissions in 1990-2017, by categories, tons

The largest decline was from the sector *1.A.1.a Public electricity and heat production* from 24,2 tons (1990) to 0,3 tons (2017), or 89 times.

Due to such a large decrease, the structural distribution of category contributions to total emissions changed, and the share of category *2.A.3 Glass production* - 15% in 2017 became noticeable (Figure 2.33).

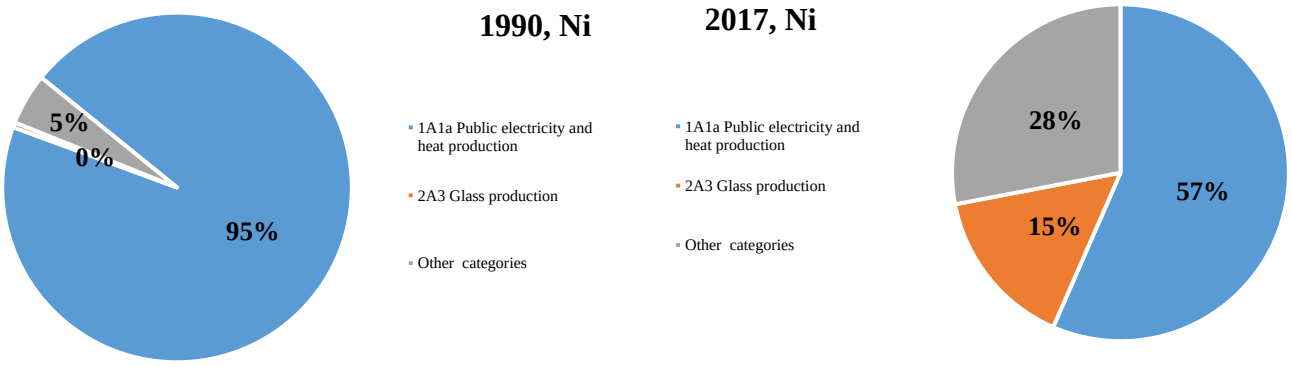


Figure 2.33. Ni emissions by sectors in 1990 and 2017

Selenium (Se)

Se emissions had a significant 12 times decrease, from 6,2 tons (1990) to 0,51 tons (2017) (Figure 2.34).

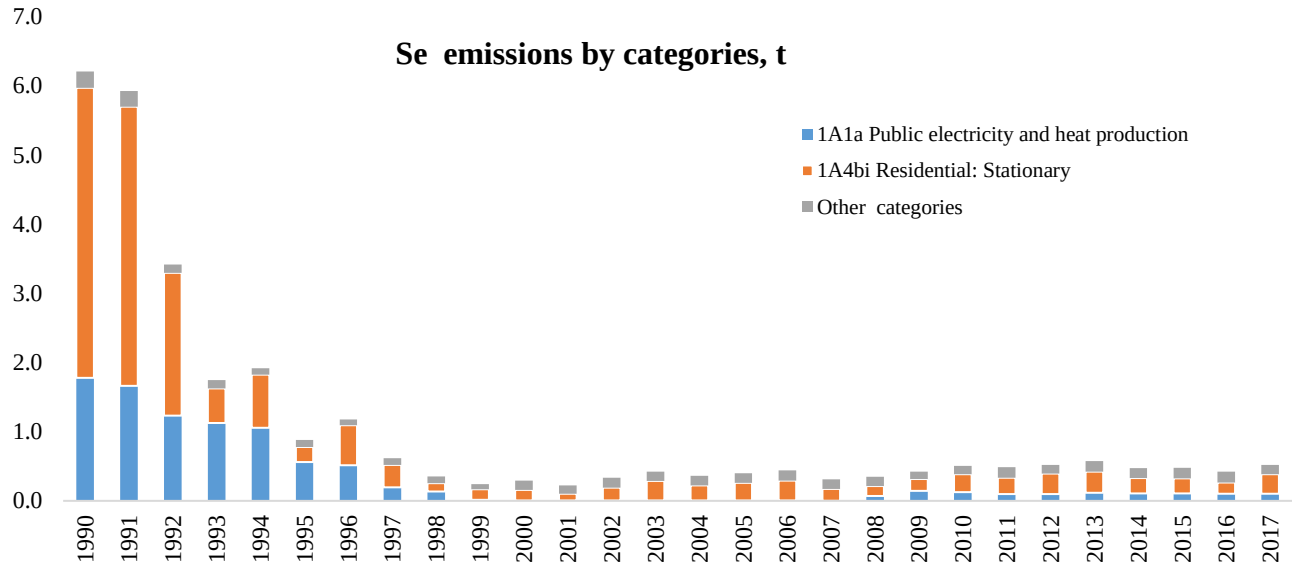


Figure 2.34. Trends in Se emissions in the 1990-2017 period, by categories, tons

In the structural distribution of emissions, there is a noticeable decrease in the share of the *1.A.4.b.i Residential: Stationary* category (from 67% in 1990 to 15% in 2017) and the share of *1.A.1.a Public electricity and heat production* (from 29% in 1990 to 20% in 2017) (Figure 2.35).

Figure 2.35. Se emissions by sectors in 1990 and 2017

Zinc (Zn)

Zn emissions trends could be broken down in 3 different sections:

- 1990-2000 - decrease from 24,2 to 4 tons;
- 2001-2013 - a constant trend at the level of 4 tons;
- 2014-2017 - growth to 12,6 tons in 2017.

The overall decline was 1,9 times from 24,2 (1990) to 12,6 tons (2017) (Figure 2.36).

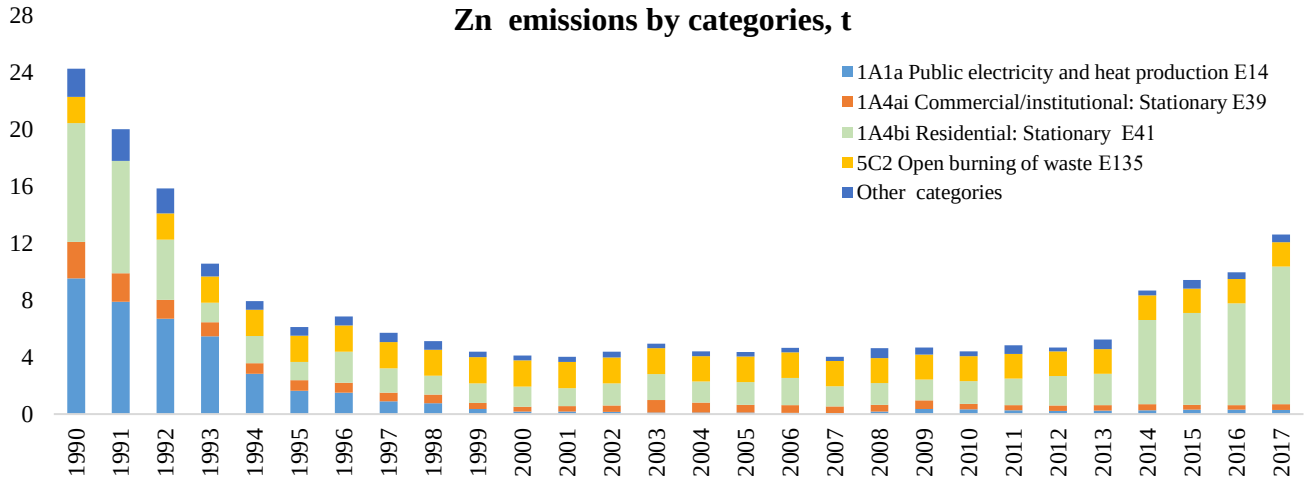


Figure 2.36. Trends in Zn emissions in the 1990-2017 period, by categories, tons

The structure of emissions by categories has changed significantly:

- The share of sectors *1.A.1.a Public electricity and heat production* and *1.A.4.a.i Commercial / institutional: Stationary* decreased;
- The share of the *1.A.4.b.i Residential: Stationary category* increased from 8,3 to 9,7 tons (1990/2017) (Figure 2.37).

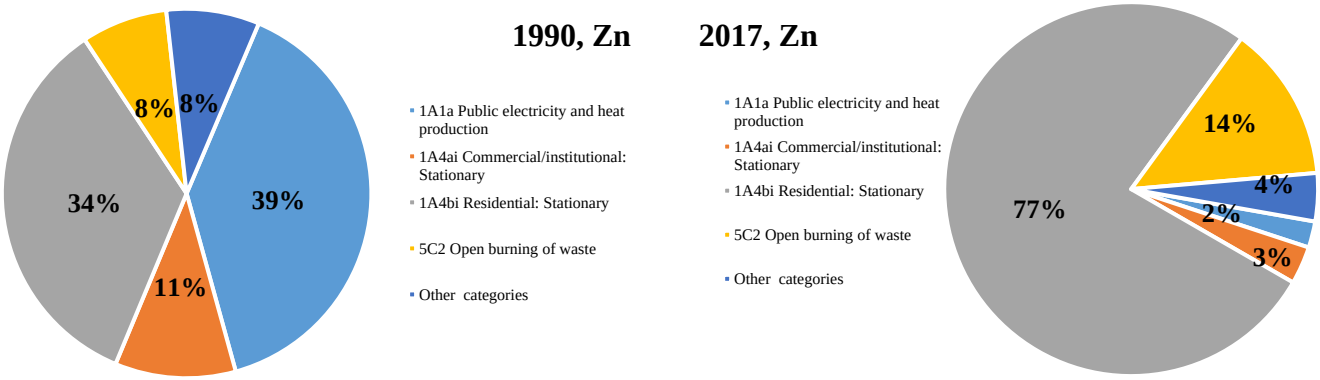


Figure 2.37. Zn emissions by sectors in 1990 and 2017

PCDD/F

PCDD/F emissions have a trend with 2 sections: a decrease from 43,5 g I-TEQ (1990) to 17,2 g I-TEQ (1993), then a constant increase to 44,1 g I-TEQ in 2017.
This pollutant has an increase in emissions from 43,5 g to 44,2 g I-TEQ (1990/2017) (Figure 2.38).

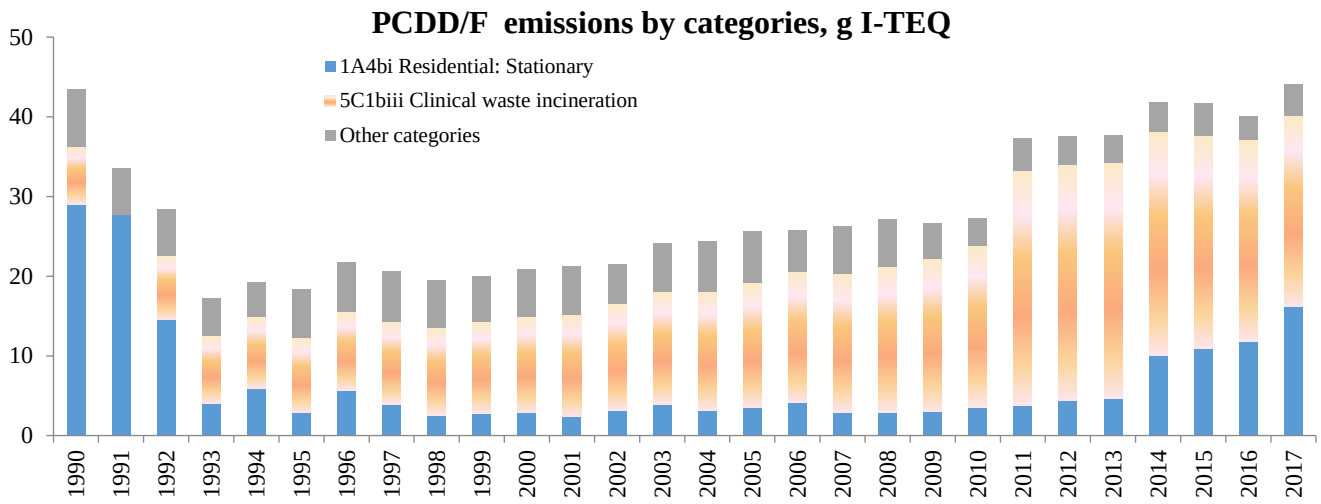


Figure 2.38. Trends in PCDD/F emissions in the 1990-2017 period, by categories, g I-TEQ

The share of *1.A.4.b.i Residential: Stationary* category decreased over the 1990-2017 period, being substituted by the *5.C.1.b.iii Clinical waste* category (Figure 2.39).
In the *1.A.4.b.i Residential: Stationary* category, there was a 1,8-fold decrease from 29 g to 16,2 g of I-TEQ (1990/2017), but in the *5.C.1.b.iii Clinical waste* incineration category, there was a more than 3-fold increase - from 7,3 g to 24 g I-TEQ or from 17% to 54% in 2017. (Figure 2.39).

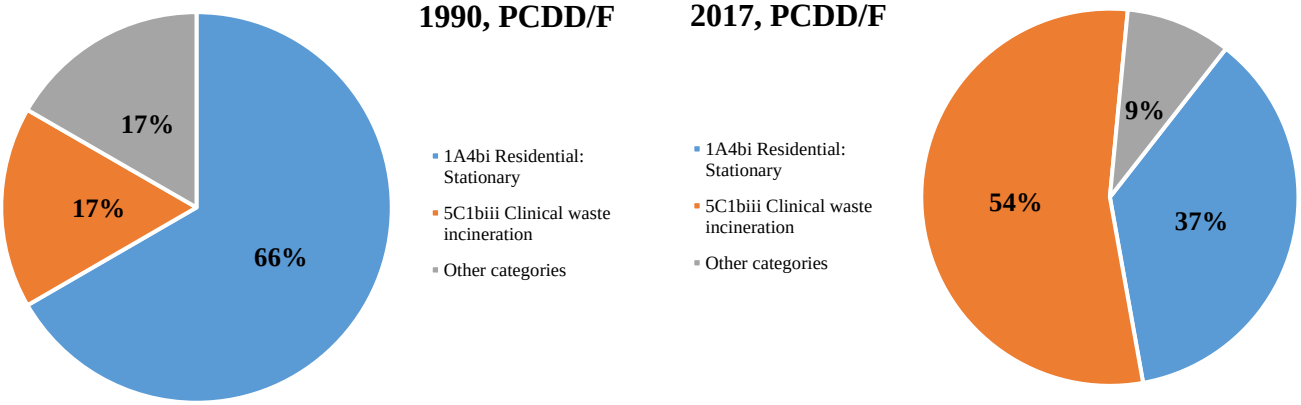


Figure 2.39. PCDD/F emissions by sectors in 1990 and 2017

Benzo(a)pyrene

Benzo(a)pyrene emissions have a 3-scale trend:
-1990-1993 - sharp decrease from 9,2 tons to 1,6 tons;
-1994-2013 - constant dynamics in the range of 0,79-1,38 tons;
-2014-2017 - growth to 3,04 tons in 2017.
The total reduction in gross emissions was 3 times, from 9,2 tons to 3,4 tons (1990/2017) (Figure 2.40).

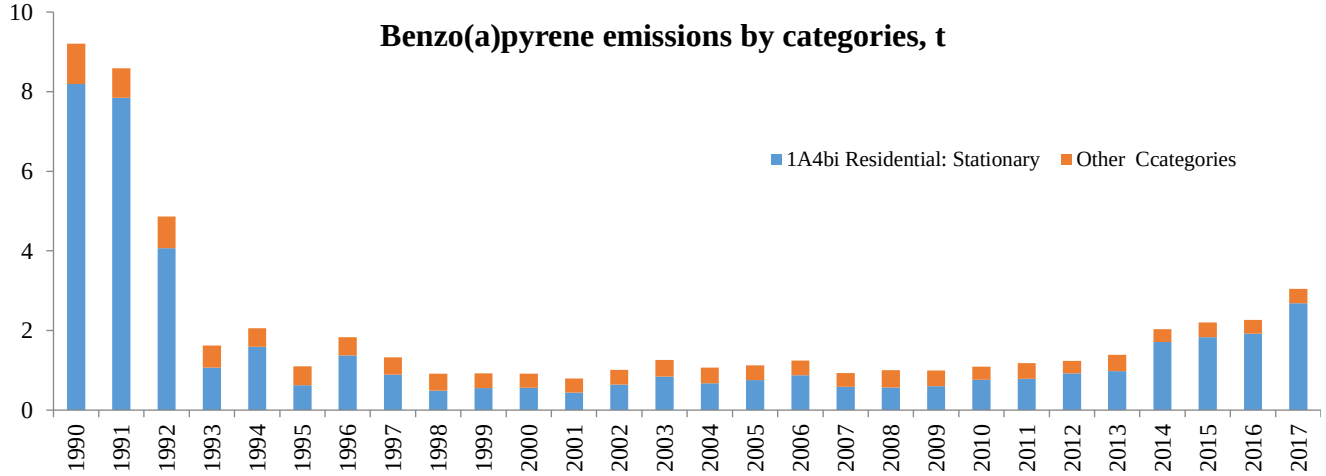


Figure 2.40. Trends in Benzo(a)pyrene emissions in the 1990-2017 period, by categories, tons

Large emission reductions occurred in category *1.A.4.b.i Residential: Stationary,* from 8,2 to 2,7 tons (1990/2017). Emissions from the remaining categories in aggregate also decreased from 1 ton to 0,4 tons (1990/2017) (Figure 2.41).

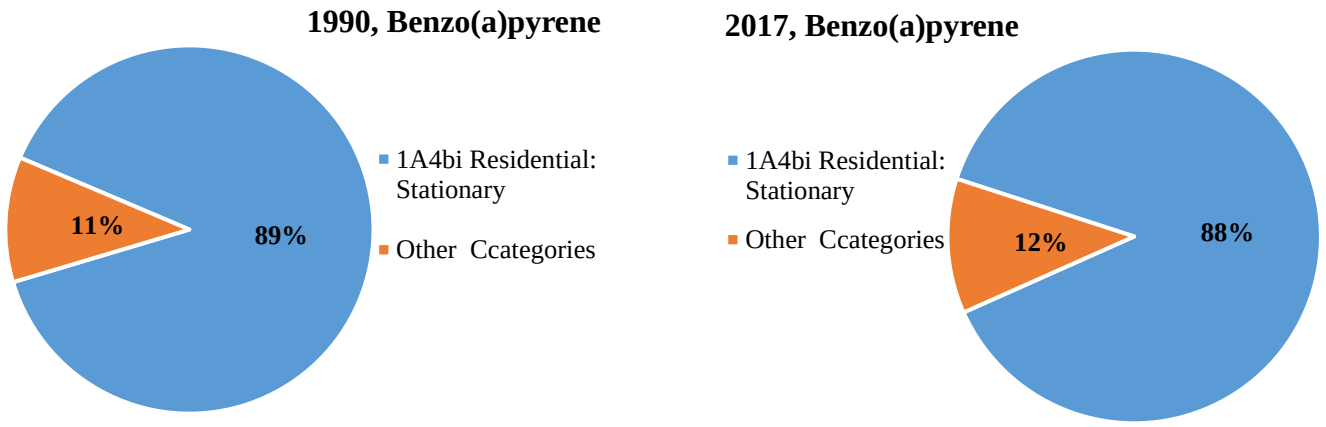


Figure 2.41. Benzo(a)pyrene emissions by sectors in 1990 and 2017

Benzo(b)fluoranthene

Benzo(b)fluoranthene emissions have a 3-scale trend:
-1990-1995 - sharp decrease from 13,6 tons to 1,8 tons;
-1996-2013 - constant dynamics in the range of 1,4-1,9 tons;
-2014-2017 - a slight increase to 3,4 tons in 2017.
The total reduction in gross emissions was 4 times, from 13,6 tons to 3,4 tons (1990/2017) (Figure 2.42).

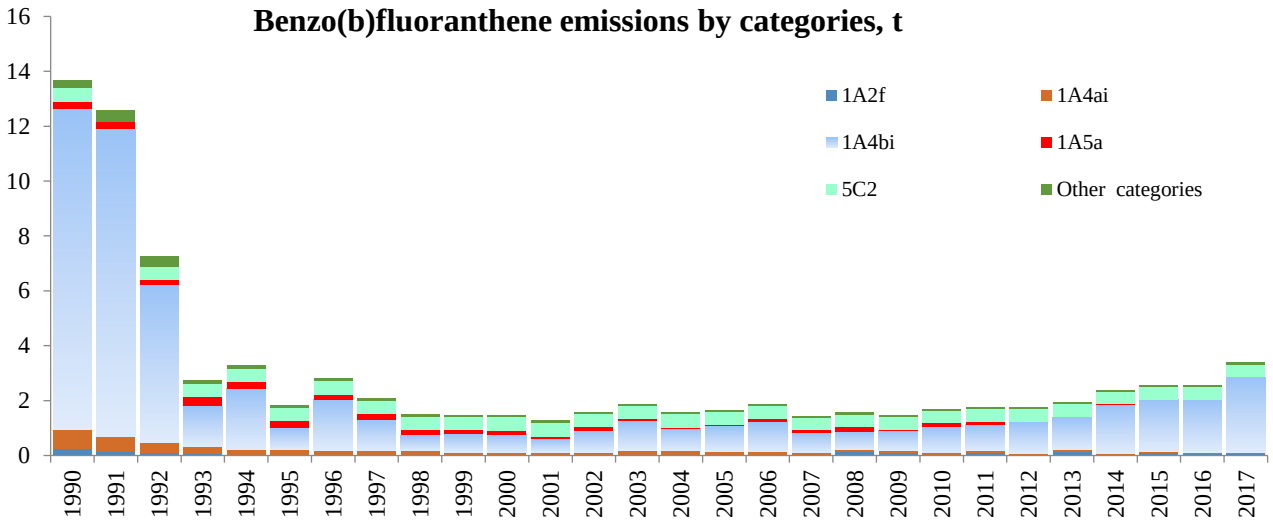


Figure 2.42. Trends in Benzo(b)fluoranthene emissions in the 1990-2017 period, by categories, t

The largest reduction in emissions took place in 3 categories:
- 1.A.4.a.ii - from 0,7 to 0,05 tons (1990/2017) - 13 times;
- 1.A.4.b.ii - from 11,7 to 2,73 tons (1990/2017) - 4 times;
- 1.A.5.a - from 0,29 to 0,01 tons (1990/2017) - 23 times (Figure 2.43).

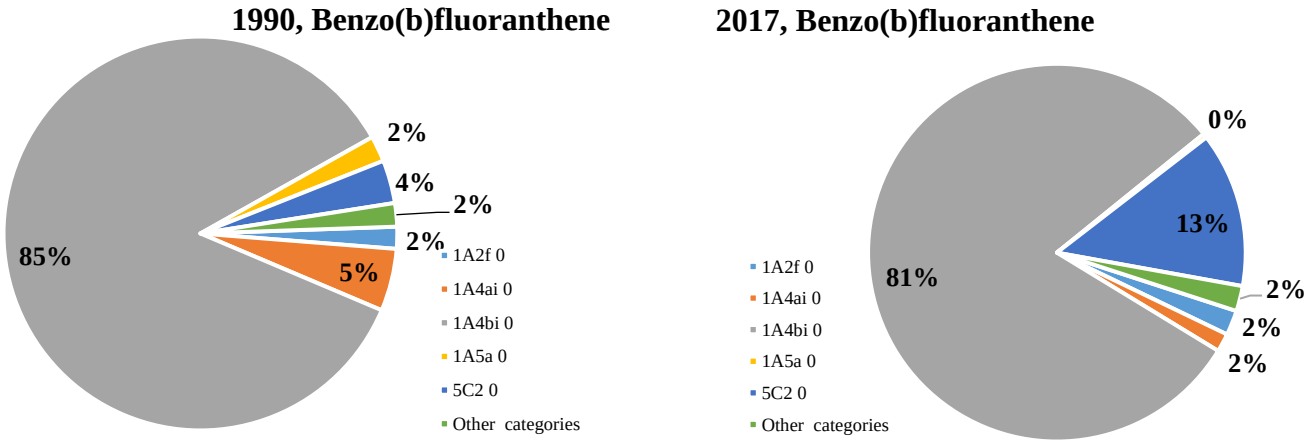


Figure 2.43. Benzo(b)fluoranthene emissions by sectors in 1990 and 2017

Benzo(k)fluoranthene

Benzo(k)fluoranthene emissions have a 3-scale trend:
-1990-1993 - sharp decline from 5,6 tons to 1 ton;
-1994-2013 - constant dynamics in the range of 0,9-1,1 tons;
-2014-2017 - a slight increase to 1,7 tons in 2017.
The total reduction in gross emissions was 3,3 times, from 5,6 tons to 1,7 tons (1990/2017) (Figure 2.44).

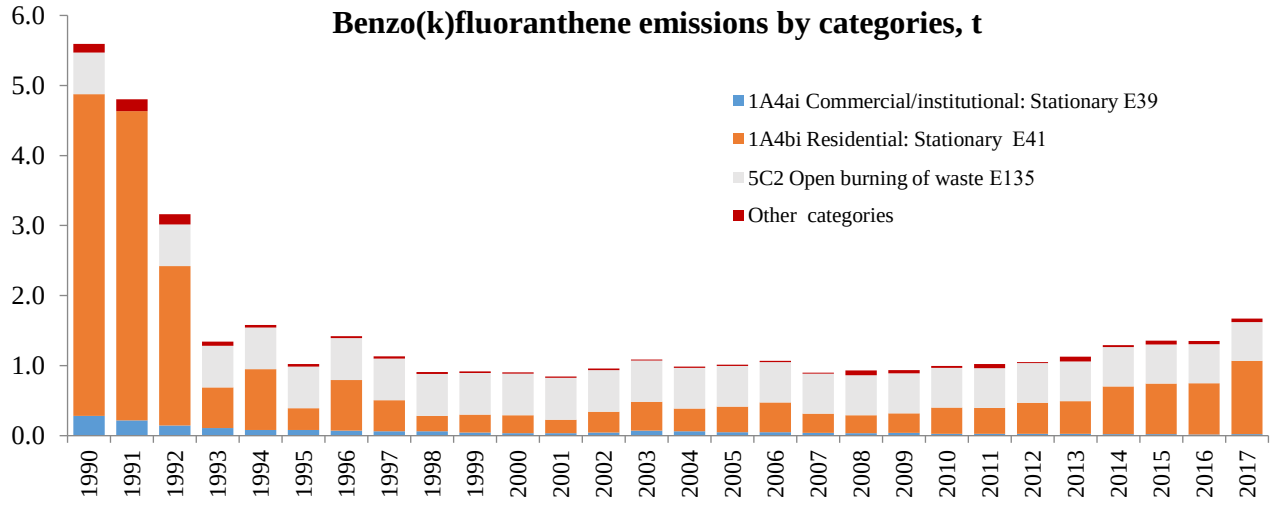


Figure 2.44. Trends in Benzo(k)fluoranthene emissions in the 1990-2017 period, by categories, t

The largest emission reductions took place in the following category:
- *1.A.4.b.i Residential: Stationary* 82% in 1990 and 63% in 2017 (Figure 2.45);
Despite the total gross reduction in emissions in this category from 4,6 to 1,05 tons (1990/2017), the share of emissions in the *5.C.2 Open burning of waste* category increased from 11% in 1990 to 33% in 2017 and became noticeable **(**Figure 2.45).

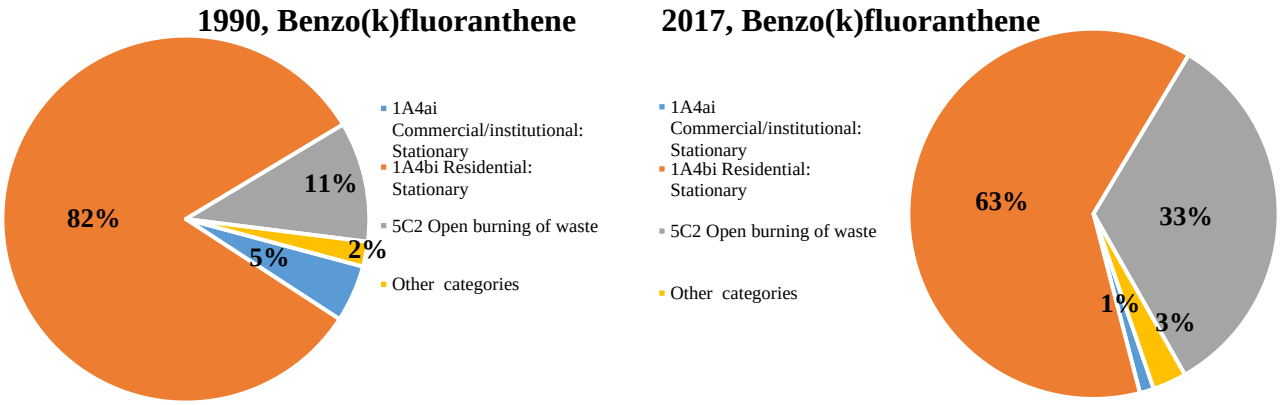


Figure 2.45. Benzo(k)fluoranthene emissions by sectors in 1990 and 2017

Indeno(1,2,3-cd)pyrene

Indeno(1,2,3-cd)pyrene emissions are trending with 3 plots:
-1990-1995 - decrease from 4,2 tons to 0,41 tons;
-1996-2013 - fluctuations in the range of 0,29-0,51 tons;
-2014-2017 - growth to 1,58 tons in 2017.
The total reduction in gross emissions was 2,7 times, from 4,2 (1990) tons to 1,58 tons (2017) (Figure 2.46).

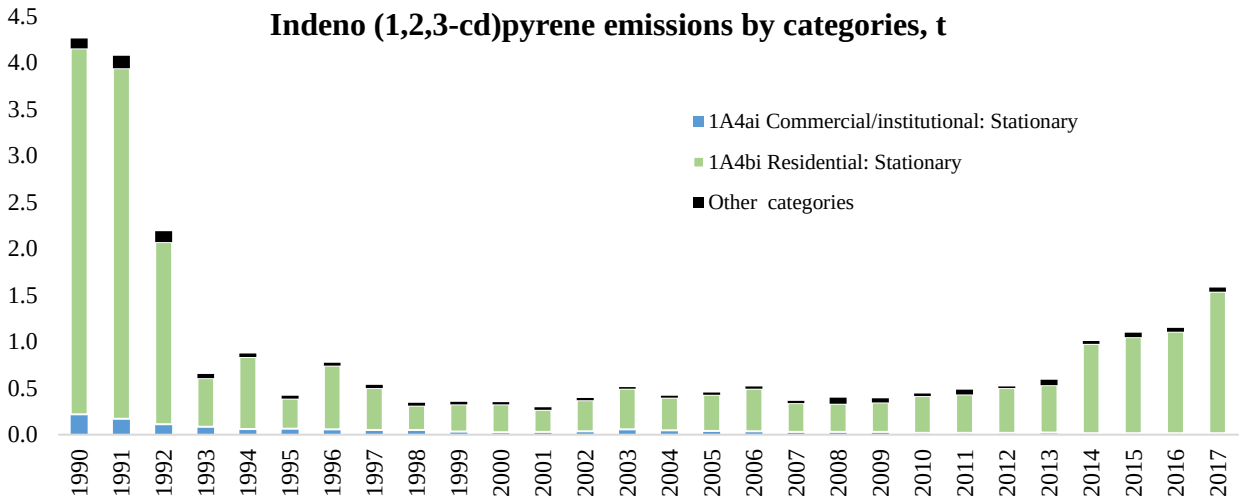


Figure 2.46. Trends in Indeno(1,2,3-cd)pyrene emissions in the 1990-2017 period, by categories, t

The largest contribution of emissions comes from the residential sector *1.A.4.b.i Residential: Stationary* 92% in 1990 and 96% in 2017, which has not changed overall in the 1990-2017 period (Figure 2.47).

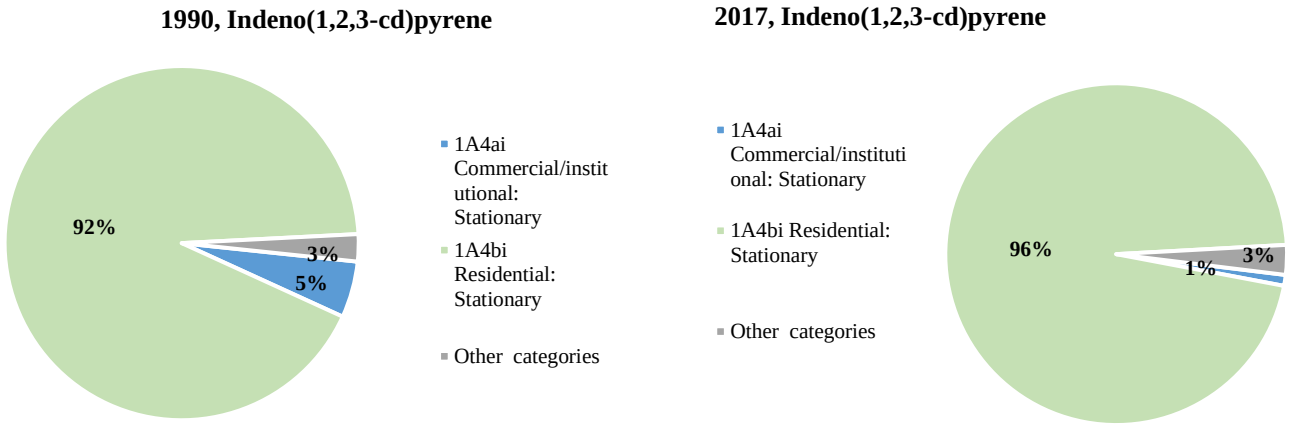


Figure 2.47. Indeno(1,2,3-cd)pyrene emissions by sectors in 1990 and 2017

Hexachlorobenzene (HCB)

HCB emissions had a 3-scale trend:
-1990-1999 - decrease from 0,52 kg to 0,04 kg of HCB;
-2000-2007 - constant dynamics in the range of 0,04-0,05 kg of HCB;
-growth to 0,19 kg of HCB in 2017.
The total decrease in gross emissions (1990/2017) was 2,7 times, from 0,52 to 0,19 kg of HCB (Figure 2.48).

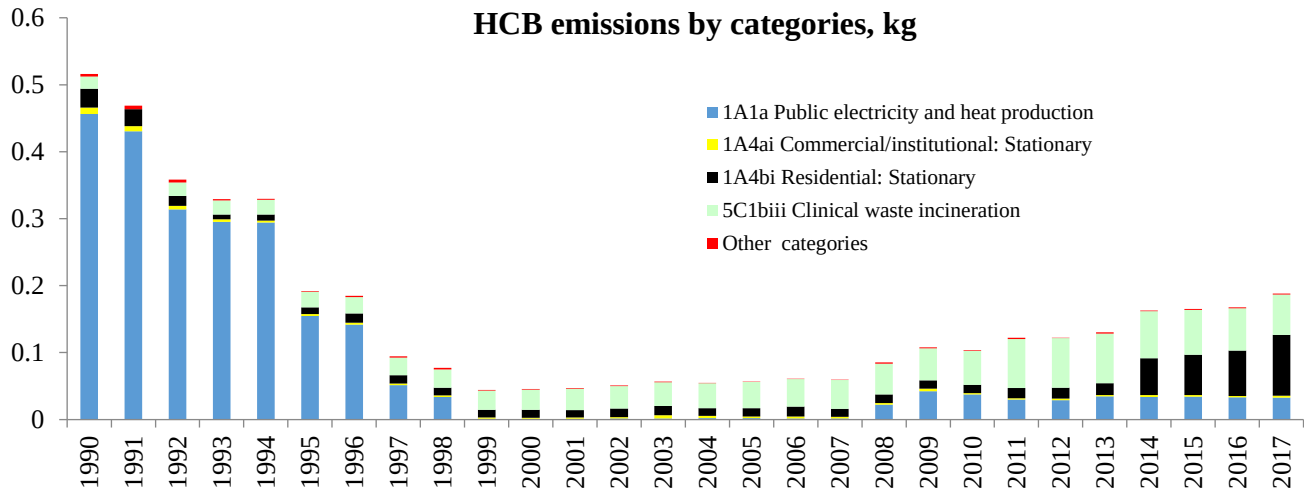


Figure 2.48. Trends in HCB emissions in the 1990-2017 period, by categories, kg

The structure of emission contributions by categories to total emissions has changed significantly:
- the share of emissions in category *1.A.1.a Public electricity and heat production* decreased from 88% to 17%,
- the share of *1.A.4.b.i Residential: Stationary* increased from 5% to 48% and
- the share of *5.C.1.biii Clinical waste* incineration increased from 4% to 33% (1990/2017) (Figure 2.49).

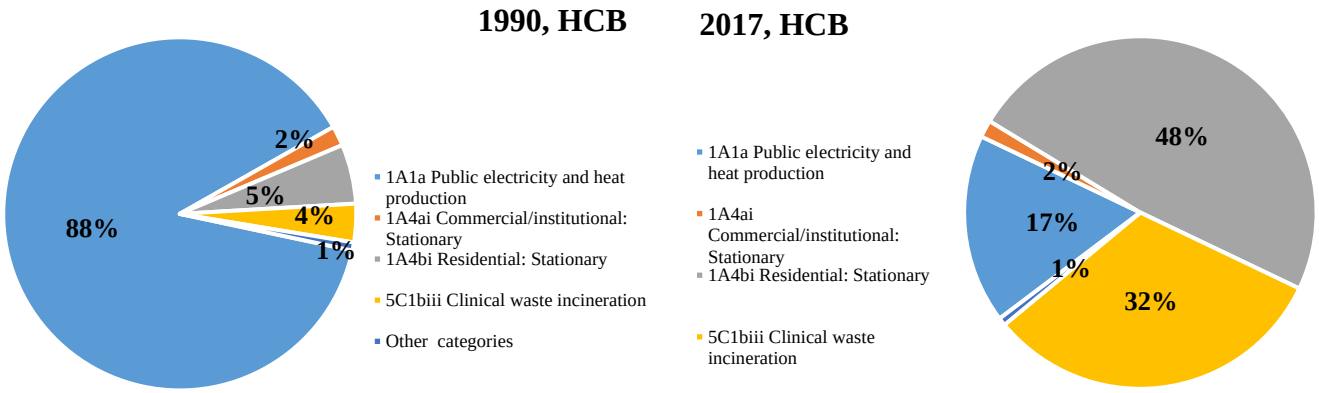


Figure 2.49. HCB emissions by sectors in 1990 and 2017

Polychlorinated biphenyls (PCB)

PCB emissions tend to decrease gradually from 10,2 kg (1990) to 1,9 kg in (2017) or 5,3 times (Figure 2.50).

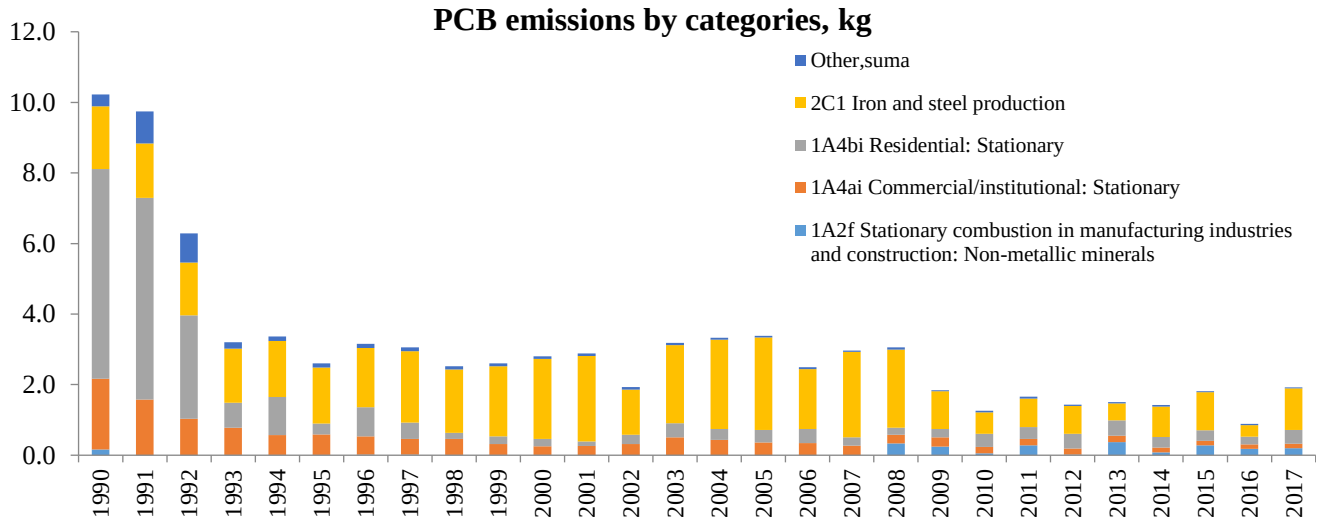


Figure 2.50. Trends in PCB emissions in 1990-2017, by categories, kg

The structure of category contributions to total emissions in 1990 and 2017 has changed significantly:

- the share of emissions in the *1.A.4.b.i Residential: Stationary* category decreased from 58% to 20%,
- the share of emissions in category *1.A.4.a.i Commercial/institutional: Stationary* decreased from 20% to 7%,
- the share of emissions in category *2.C.1 Iron and steel production* increased from 17% to 61% (Figure 2.51).

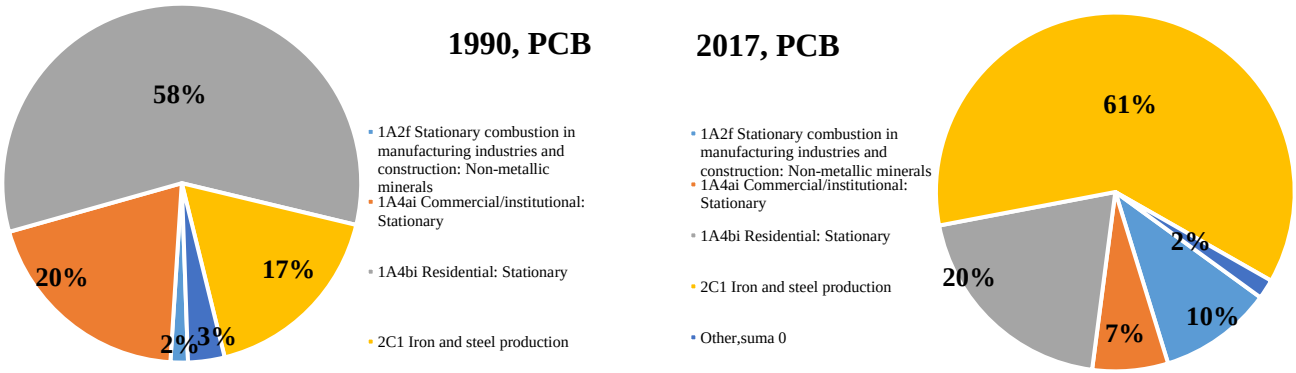


Figure 2.51. PCB emissions by sectors in 1990 and 2017

Chapters 3 – 7 SECTORAL METHODOLOGIES:

For the following 5 chapters (chapters 3 – 7), parties present category by category (NFR) details on methodologies for emission estimation, including data sources, assumptions, use of emission factors and uncertainties. Further information and detailed SNAP categories are also provided within each NFR category. Detailed descriptions of country-specific emission factors and detailed methods, as well as tables on activity data and emission factor trends are also provided.

Chapter 3: ENERGY (NFR sector 1)

3.1. Overview of the sector

The main source of primary data is Energy Balances, which are published annually by the National Bureau of Statistics.

The primary data arrays for calculating the emissions of greenhouse gases and pollutants are the same according to the requirements for the unification of primary information when reporting emissions across the country under different Conventions.

For cases when data is required from economic agents that were already collected earlier in the preparation of the Greenhouse Gas Inventory, primary data arrays were used from the 1990-2016 research for submission to IPCC published in 2018. For the Energy sector, this applies to the categories of water transport and air transport. They used the same data as for the NIR for the period 1990-2016. For more information on data sources, please see table 1.1.

Activity data for the period 1990-2017 was prepared based on:

The Right Bank Region

a) Energy balances for 1990, 1993 - 2017. The energy balance is compiled every year and published both electronically and on paper by the National Bureau for Statistics.

b) for the period of 1991 – 1992, data were restored by interpolation method.

The Left Bank Region

a) Statistical Yearbooks of ATULBD for 2002 - 2017 years.

b) Statistical books "Socio-economic development of ATULBD" 2009 - 2017. Books contain information on the consumption of coal, fuel oil in the region in the industry, including data for the energy sector, agriculture, and other sectors, as well as the amount of wood consumed.

c) Another source of information is the *National Inventory Report on Greenhouse Gas emissions* (2018) - NIR 1990 - 2016, in which attempts were made to consider the fuel in the Transnistria in sectors 1.A.1 Energy Industry, 1.A.4 Commercial, institutional and residential combustion, and 1.A.5 Other. They are also incomplete, but contain information on the consumption of natural gas and other fuels.

For the categories of sectors 1.A.2 Manufacturing industries and construction (combustion) and 1.A.3 Transport, the data on fuels were restored using indirect data.

The systematic information of primary evidence for the Left Bank region for 2017 is shown in the table 3.1.1.

Table 3.1.1. Fuel consumption in the Left Bank region in 2017 and availability of data by sector

	Units		1.A.1	1.A.2	1.A.3	1.A.4.c	1.A.5	1.A.4.a	1.A.4.b	Consumed
		Industry, Total	*Including:*		Trans-port	Agricul-ture	Other	Admin/instit sector	Resid.	Total
			Energy	Other Industry						1A1-1A5
Coal	tons	169134,5	*169101*	*33,5*		14	588,9	2,1		169739,5
Diesel fuel	tons									0
Gasoline	tons									0
Lubricating oils	tons									0
Fuel oil	tons	12961,3	*12600,7*	*360,6*				18,1		12979,4
Wood	stand. m^3								5370	5370
Natural gas	mln. m^3		1504*	120*	5*			18,0	190,7	1837,6978
for electricity	mln. m^3		1312*							1312
for heat energy	mln. m^3		192*							192
Liquefied gas	tons			13,3	374,4			1,6	143,9	533,2

*) data - at the level of the previous year.

Emission source categories and pollutants

Emission sources of the "Energy" module in Moldova are divided into emissions from fuel combustion at Stationary sources, Mobile sources and Fugitive emissions from oil and gas systems. Each sector includes several categories (Table 3.1.2).

Table 3.1.2. Categories and pollutants in Energy Sector in Moldova

NFR Code	Long name	Pollutants
Sector Stationary Combustion, 1.A.1 Energy Industries		
1.A.1.a	Public electricity and heat production	NOx (as NO_2), NMVOC, SOx (as SO_2), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene (coal, gaseous), Benzo(b)fluoranthene (coal, gaseous, heavy fuel oil), Benzo(k)fluoranthene (coal, gaseous, heavy fuel oil), Indeno(1,2,3)pyrene, HCB (biofuels), PCBs (biofuels)
1.A.1.b	Petroleum refining	NO
1.A.1.c	Manufacture of solid fuels and other energy industries	NO
Sector Stationary Combustion, 1.A.2 Manufacture Industries and Construction (combustion)		
1.A.2.a	Stationary combustion in manufacturing industries and construction: Iron and steel	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
1.A.2.b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NO
1.A.2.c	Stationary combustion in manufacturing industries and construction: Chemicals	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), PM2,5, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
1.A.2.d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
1.A.2.e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
1.A.2.f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
1.A.2.g.vii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	NO
1.A.2.g.viii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
Sector Mobile Combustion, 1.A.3 Transport		
1.A.3.a.i(i)	International aviation LTO (civil)	NOx (as NO_2), NMVOC, SOx (as SO_2), $PM_{2,5}$, PM_{10}, TSP, BC, CO
1.A.3.a.ii(i)	Domestic aviation LTO (civil)	NOx (as NO_2), NMVOC, SOx (as SO_2), CO
1.A.3.b.i	Road transport: Passenger cars M1	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn (metals – only for gasoline and diesel oil), Benzo(a)pyrene,

NFR Code	Long name	Pollutants
		Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, (PAHs- only for gasoline and diesel oil)
1.A.3.b.ii	Road transport: Light duty vehicles N1	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene
1.A.3.b.iii	Road transport: Heavy duty vehicles and buses N2-N3, M2-M3	*Diesel Oil*-NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene *CNG*-NOx (as NO_2), NMVOC, SOx (as SO_2), $PM_{2,5}$, PM_{10}, TSP, BC, CO
1.A.3.b.iv	Road transport: Mopeds & motorcycles L1-L7	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn (metals – only for gasoline and diesel oil), Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene
1.A.3.b.v	Road transport: Gasoline evaporation	NMVOC
1.A.3.b.vi	Road transport: Automobile tyre and brake wear	$PM_{2,5}$, PM_{10}, TSP
1.A.3.b.vii	Road transport: Automobile road abrasion	$PM_{2,5}$, PM_{10}, TSP
1.A.3.c	Railways	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene
1.A.3.d.i(ii)	International inland waterways	NO
1.A.3.d.ii	National navigation (shipping)	NOx (as NO_2), NMVOC, SOx (as SO_2), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCB, PCBs
1.A.3.e.i	Pipeline transport	NOx (as NO_2), NMVOC, SOx (as SO_2), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene
1.A.3.e.ii	Other (please specify in the IIR)	NO
Sector 1.A.4 Small Combustion		
1.A.4.a.i	Commercial/institutional: *Stationary*	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, liquid, biofuels), PCBs (solid, liquid, biofuels)
1.A.4.a.ii	Commercial/institutional: *Mobile*	NO
1.A.4.b.i	Residential: *Stationary*	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, biofuels), PCBs (solid, biofuels)
1.A.4.b.ii	Residential: Household and gardening (*mobile*)	NO
1.A.4.c.i	Agriculture/Forestry/Fishing: *Stationary*	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, liquid, biofuels), PCBs (solid, liquid, biofuels)
1.A.4.c.ii	Agriculture/Forestry/Fishing: *Off-road* vehicles and other machinery	*Diesel oil and Gasoline*: NOx (as NO_2), NMVOC, SOx (as SO_2) (liquid), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene; *LPG*- NOx (as NO_2), NMVOC, NH_3, $PM_{2,5}$, PM_{10}, TSP, BC, CO
1.A.4.c.iii	Agriculture/Forestry/Fishing: National fishing	IE
1.A.5.a	Other *stationary* (including military)	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (biomass), $PM_{2,5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F,

NFR Code	Long name	Pollutants
		Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3)pyrene, HCB (solid, liquid, biofuels), PCBs (solid, liquid, biofuels)
1.A.5.b	Other, *Mobile* (including military, land based and recreational boats)	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3 (diesel, gasoline 4-stroke), $PM_{2,5}$, PM_{10}, TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene
Sector 1.B Fugitive Emissions		
1.B.1.a	Fugitive emission from solid fuels: Coal mining and handling	NO
1.B.1.b	Fugitive emission from solid fuels: Solid fuel transformation	NO
1.B.1.c	Other fugitive emissions from solid fuels	NO
1.B.2.a.i	Fugitive emissions oil: Exploration, production, transport	NMVOC
1.B.2.a.iv	Fugitive emissions oil: Refining / storage	NOx (as NO_2), NMVOC, SOx (as SO_2), NH_3, $PM_{2,5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F
1.B.2.a.v	Distribution of oil products	NMVOC
1.B.2.b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	NMVOC
1.B.2.c	Venting and flaring (oil, gas, combined oil and gas)	NO
1.B.2.d	Other fugitive emissions from energy production	NO
***Memo Items* 1.A.3.a.i(ii)**	International aviation cruise (civil)	NOx (as NO_2), NMVOC, SOx (as SO_2), $PM_{2,5}$, PM_{10}, TSP, BC, CO
***Memo Items* 1.A.3**	Transport (fuel used)	

In this inventory cycle (IIR-2019), the coverage of categories of emission sources is significantly expanded compared to the previous IIR-2014 cycle (Table 3.1.3).

Table 3.1.3. Coverage of emission source categories in IIR-2019 compared to IIR-2014

IIR -2014	IIR -2019
Energy – 12 categories	Energy – 29 categories from 43. 14 are absent in RM.

Sources of emissions from the energy sector are geographically located in the Right Bank and the Left Bank regions. The current cycle considers a significantly larger number of categories of the Left Bank. The difficulties in the previous cycle were the lack of primary data for the Left Bank. Over the past period, the situation has improved, and additional sources of information have appeared. The list of available statistical publications of the Left Bank region has expanded.
For categories for which data is still not available, data recovery methods have been applied. Basically, this is a method of estimating values by using indirect data on the specific fuel consumption per person, under the assumption that a similar value is valid for the Left Bank region.

The main data sources are Energy Balances for 1990, 1993-2017. Data for 1991-1992 was restored by the interpolation method for all fuels for which there were values in the neighbouring years.

3.1.1. Trends in emissions

Nitrogen oxides (NOx)

NOx emissions from the sector *1.A Energy, Fuel Combustion* amounted to 30,56 kt in 2017 (Figure 3.1.1.1a). The main share of these emissions was stationary combustion (19,95 kt) and mobile combustion (10,1 kt) (Figure 3.1.1.1b).

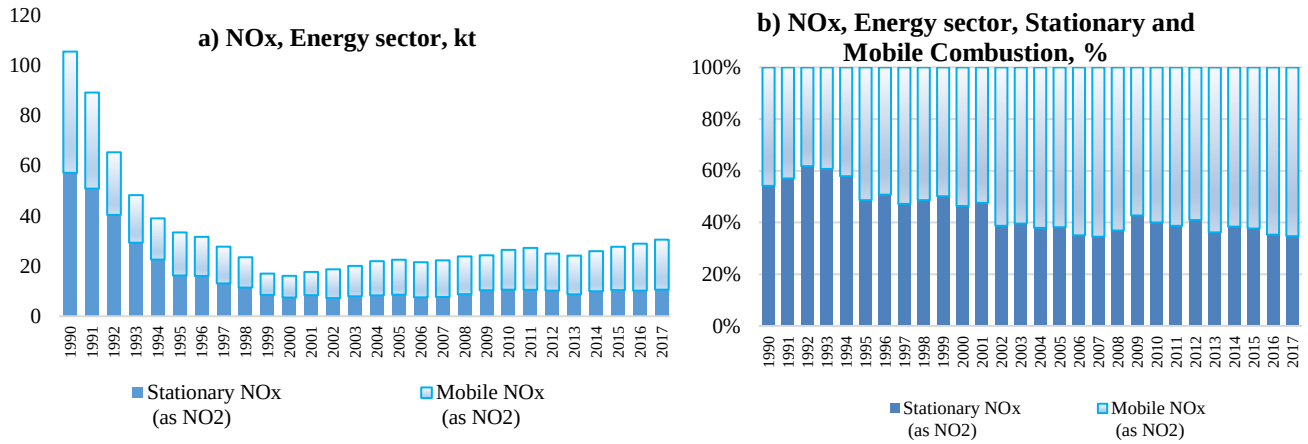


Figure 3.1.1.1 NOx Emissions in Energy Sector, 1990-2017, kt

The main sources of NOx emissions in the energy sector are the following categories:
a. stationary combustion:

- *1.A.1.a Public electricity and heat production* - 7,06 kt - 66,5%;
- *1.A.4.b Residential* - 2,01 kt - 20,2%;
- *1.A.4.a Commercial/institutional* - 0,53 kt - 5,0%.

b. mobile combustion:

- *1.A.3.b Road transport* - 15,47 kt - 77,6%;
- *1.A.4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* - 3,0 kt - 15,1%;
- *1.A.3.a.ii Domestic aviation* - 0,75 kt - 3,8%.

Non-methane volatile organic compounds (NMVOC)

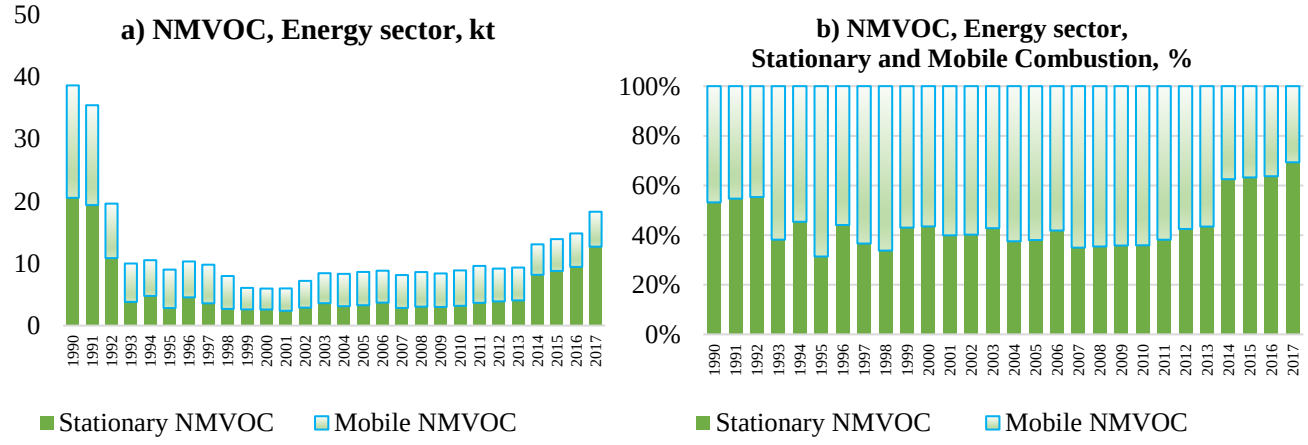


Figure 3.1.1.2. NMVOC Emissions in Energy Sector, 1990-2017, kt

NMVOC emissions from the sector *1.A Energy, Fuel combustion* amounted to 18,63 kt in 2017 (Figure 3.1.1.2a). The main parts of these emissions were stationary combustion - 12,7 kt (68.1%) and mobile combustion - 5,6 kt (30,1%) (Figure 3.1.1.2b). The main sources of NMVOC emissions in the energy sector are the following categories:
a. stationary combustion: *1.A.4.b Residential* - 11,88 kt - 93,6%.
b. mobile combustion: *1.A.3.b Road transport* - 5,2 kt - 92,6%.

Sulphur oxides (SOx)

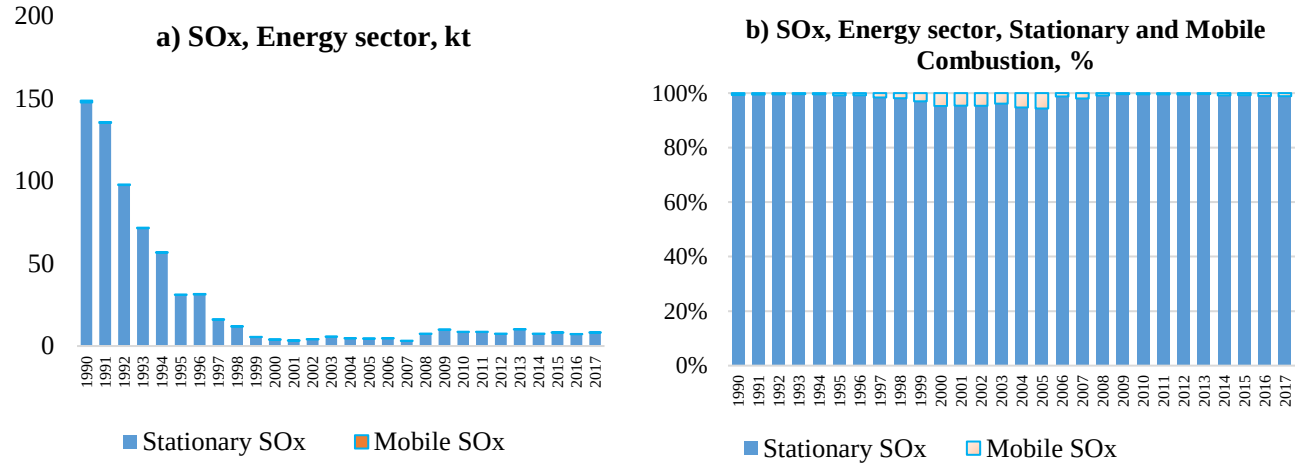


Figure 3.1.1.3. SOx Emissions in Energy Sector, 1990-2017, kt

SOx emissions from the sector *1.A Energy*, *Fuel Combustion* amounted to 8,23 kt in 2017 (Figure 3.1.1.3a). The main parts of these emissions were stationary combustion - 8,14 kt (98,8%) and mobile combustion - 0,09 kt (Figure 3.1.1.3b). The main sources of SOx emissions in the energy sector are the following categories:
stationary combustion: *1.A.1 Energy Industry* - 4,08 kt - 50,1%; *1.A.4.b Residential* - 2,23 kt - 27,4%; *1.A.2 Manufacturing industries and construction (combustion) Total* - 1,11 kt - 13,6 %.

Ammonia (NH_3)

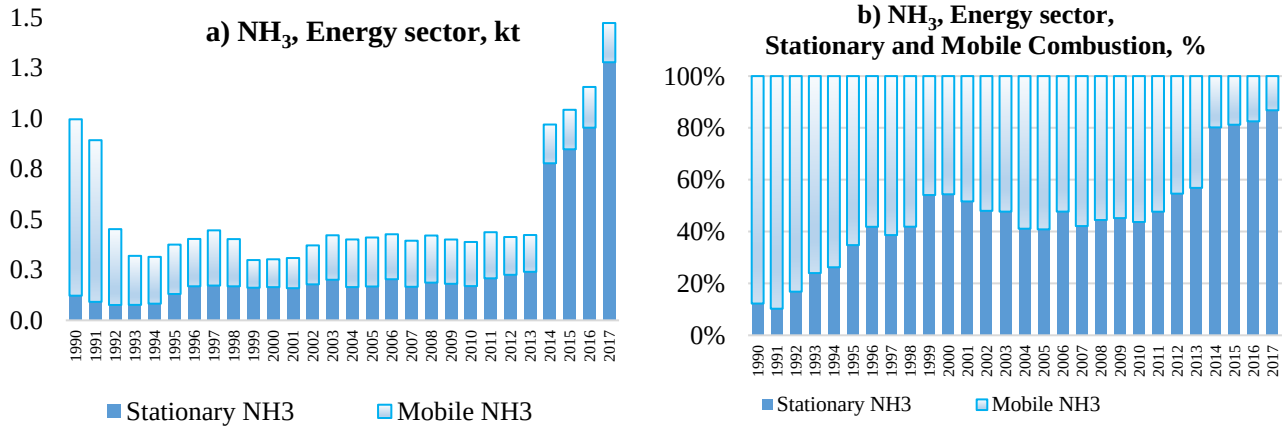


Figure 3.1.1.4. NH_3 Emissions in Energy Sector, 1990-2017, kt

NH_3 emissions from the sector *1.A Energy*, *Fuel Combustion* amounted to 1,47 kt in 2017 (Figure 3.1.1.4a). The main source of NH_3 emissions in the energy sector is the category *1.A.4.b residential* - 1,26 kt - 98,3 % (Figure 3.1.1.4b).

Particulate matter ($PM_{2,5}$)

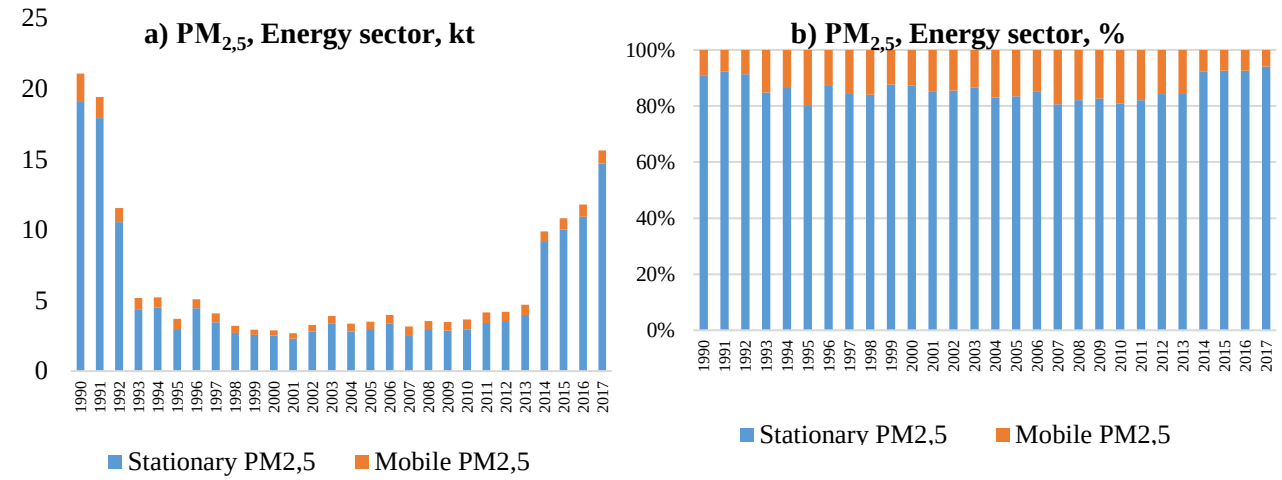


Figure 3.1.1.5. $PM_{2,5}$ Emissions in Energy Sector, 1990-2017, kt

$PM_{2,5}$ emissions from the sector *1.A Energy, Fuel Combustion* amounted to 15,6 kt in 2017 (Figure 3.1.1.5a). The main parts of these emissions were *stationary* combustion - 14,7 kt and *mobile* combustion - 0,9 kt (Figure 3.1.1.5b). The main sources of $PM_{2,5}$ emissions in the energy sector are the following categories: *1.A.4.b Residential* - 14,18 kt - 96,6% and *1.A.3.b Road transport* - 0,74 kt - 79 % (mobile combustion).

Particulate matter (PM_{10})

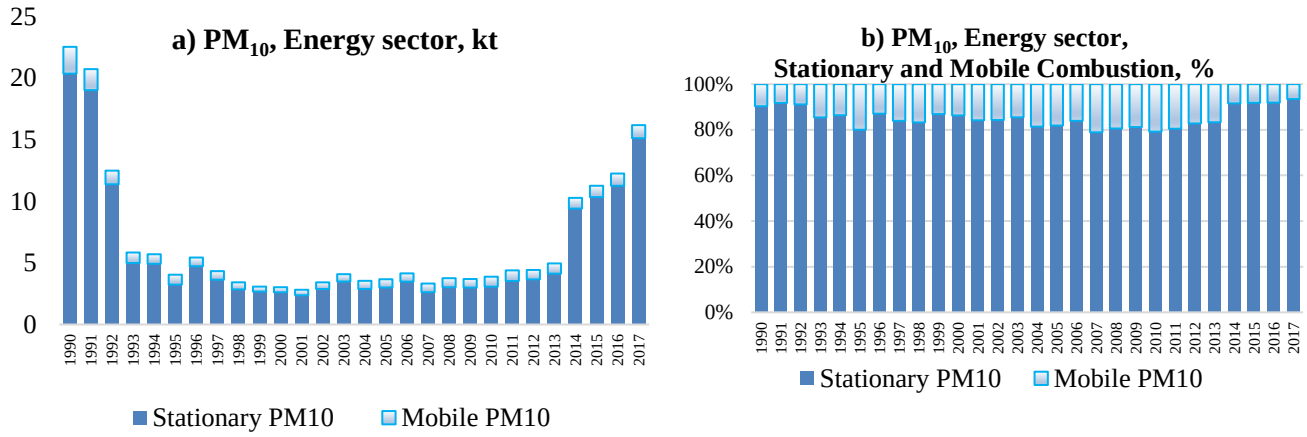


Figure 3.1.1.6. PM_{10} Emissions in Energy Sector, 1990-2017, kt

PM_{10} emissions from the sector *1.A Energy, Fuel Combustion* amounted to 16,18 kt in 2017 (Figure 3.1.1.6a). The main parts of these emissions were *stationary* combustion - 15,12 kt (93,5 %) and *mobile* combustion - 1,06 kt (6,5%) (Figure 3.1.1.6b). The main sources of PM_{10} emissions in the energy sector are the following categories: *1.A.4.b Residential* - 14,56 kt - 96,3% and *1.A.3.b Road transport*-0,86 kt - 81,7 % (mobile combustion).

Total suspended particulates (TSP)

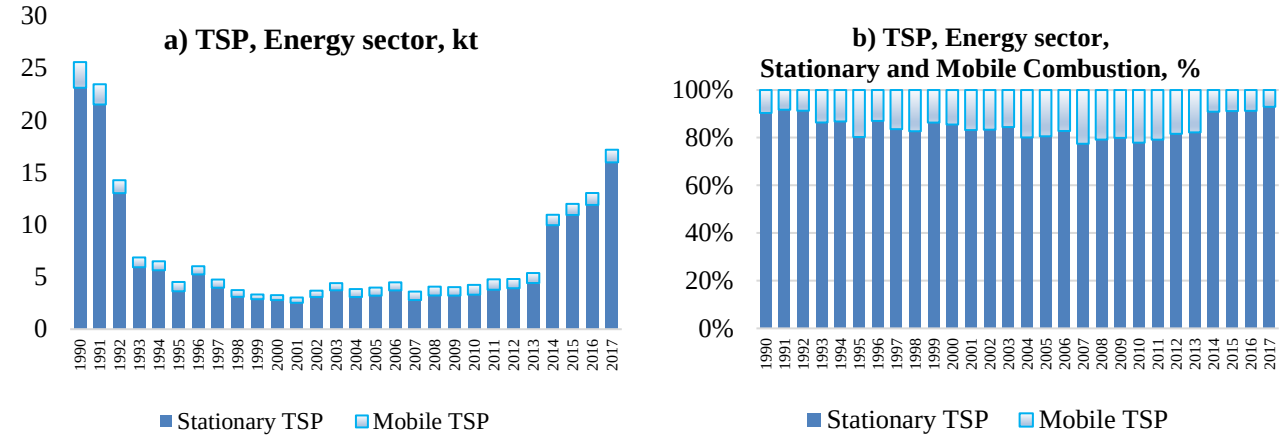


Figure 3.1.1.7. TSP Emissions in Energy Sector 1990-2017, kt

TSP emissions from the sector *1.A Energy, Fuel Combustion* amounted to 17,19 kt in 2017 (Figure 3.1.1.7a). The main parts of these emissions were *stationary* combustion - 15,98 kt (93%) and *mobile* combustion - 1,21 kt (7%) (Figure 3.1.1.7b). The main sources of TSP emissions in the energy sector are the following categories: 1.*A.4.b Residential*- 15,37 kt - 96% and *1.A.3.b Road transport*- 1,01 kt - 84% (mobile combustion).

Black carbon (BC)

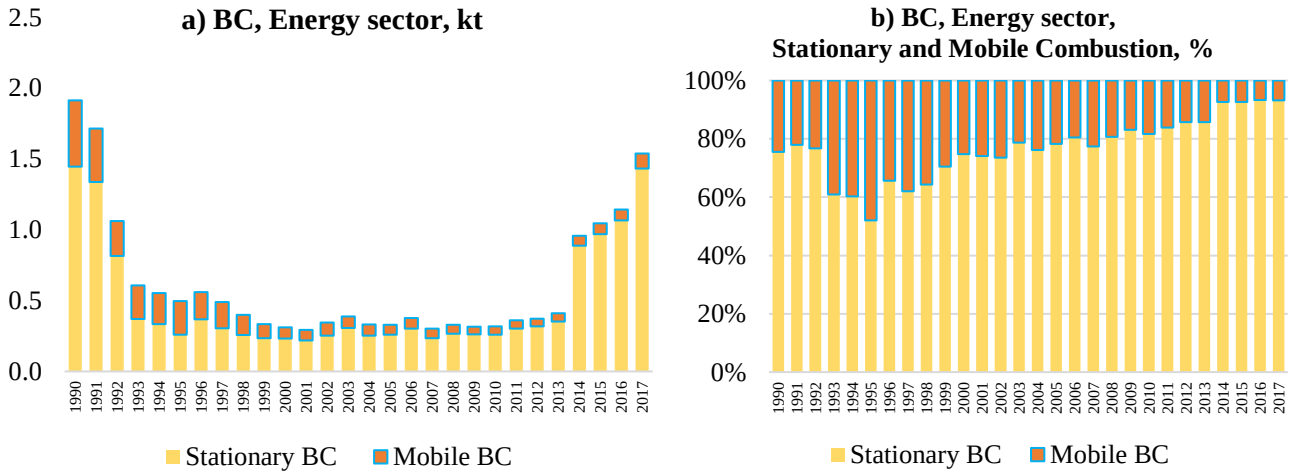


Figure 3.1.1.8. BC Emissions in Energy Sector 1990-2017, kt

BC emissions from the sector 1.*A Energy, Fuel Combustion* amounted to 1,54 kt in 2017 (Figure 3.1.1.8a). The main parts of these emissions were *stationary* combustion - 1,43 kt (93,2%) and *mobile* combustion - 0,1 kt (6,8%) (Figure 3.1.1.8b). The main sources of BC emissions in the energy sector are the following categories: *1.A.4.b Residential*- 1,39 kt - 96,7% and *1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* - 0,1 kt - 92,9% (mobile combustion).

Carbon monoxide (CO)

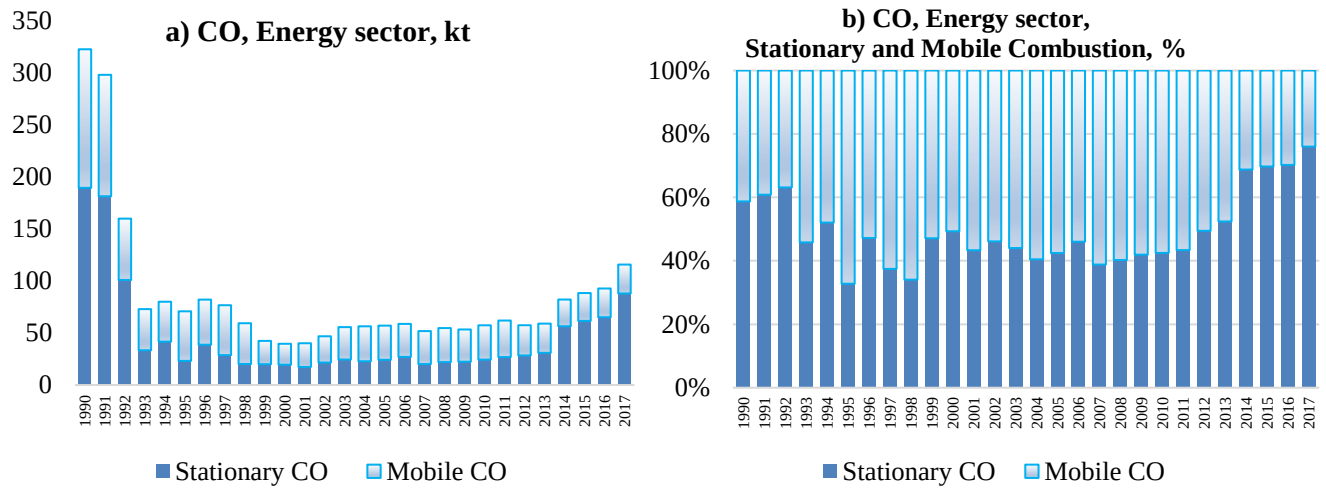


Figure 3.1.1.9. CO Emissions in Energy Sector 1990-2017, kt

CO emissions from the sector *1.A Energy, Fuel Combustion* amounted to 115,64 kt in 2017 (Figure 3.1.1.9a). The main parts of these emissions were stationary combustion (87,9 kt) and mobile combustion (27,7 kt) (Figure 3.1.1.9b). The main sources of CO emissions in the energy sector are the following categories:

a. *stationary combustion:*
   - *1.A.4.b Residential*- 82,59 kt - 94%;
   - *1.A.1 Energy industries*- 2,72 kt - 3,1%;
   - *1.A.2 Manufacture Industries and Construction (combustion)- Total* - 1,37 kt - 1,6%.

b. *mobile* combustion:
   - *1.A.3.b Road transport* - 26,23 kt - 94%;
   - *1.A.4. c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* - 1,0 kt - 3,6%.

Lead and arsenic (Pb, As)

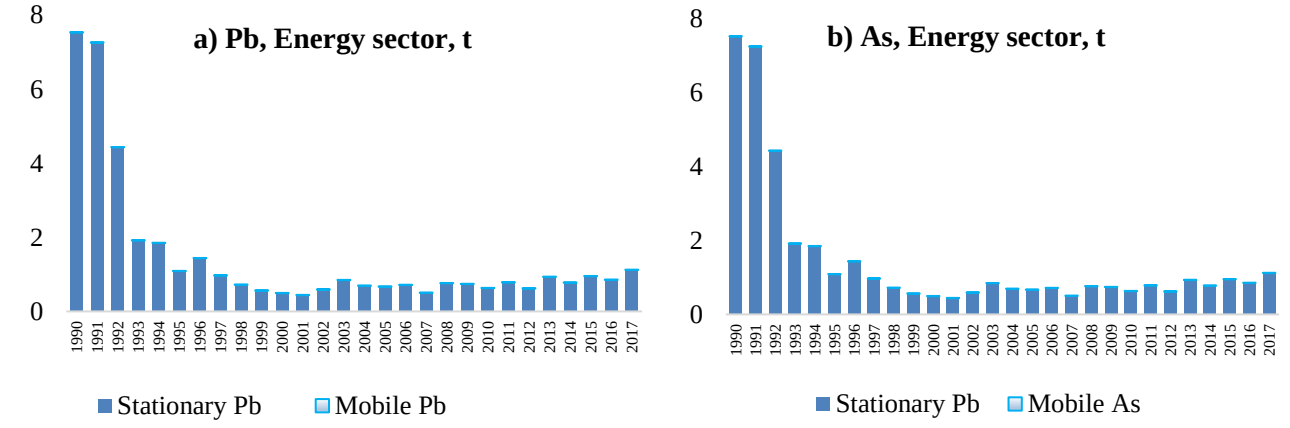


Figure 3.1.1.10. Pb and As Emissions in Energy Sector 1990-2017, t

Pb emissions from the sector *1.A Energy, Fuel Combustion* amounted to 1,12 t in 2017 (Figure 3.1.1.10a). **As** emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,07 t in 2017 (Figure 3.1.1.10b). The main sources of **Pb** emissions in the energy sector are the following categories: *1.A.4.b Residential* - 0,78 t - 69,5% and *1.A.2. Manufacture Industries and Construction (combustion)* - 0,16 t - 14,6%.

Cadmium (Cd)

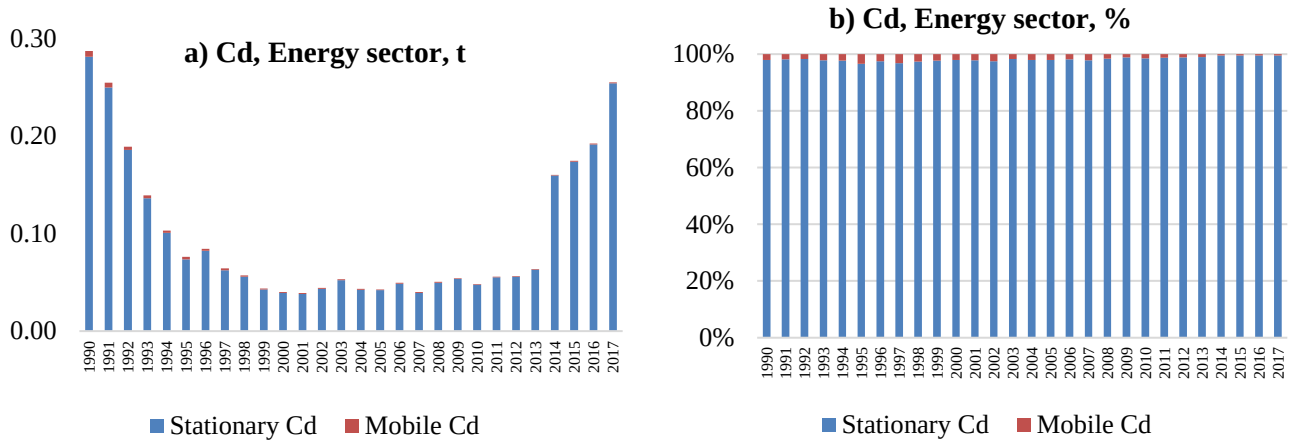


Figure 3.1.1.11. Cd Emissions in Energy Sector 1990-2017, t

Cd emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,26 t in 2017 (Figure 3.1.1.11a). The main source of Cd emissions in the energy sector is stationary combustion (99,6%) (Figure 3.1.1.11b), the category *1.A.4.b Residential*- 0,24 t - 93%.

Mercury (Hg)

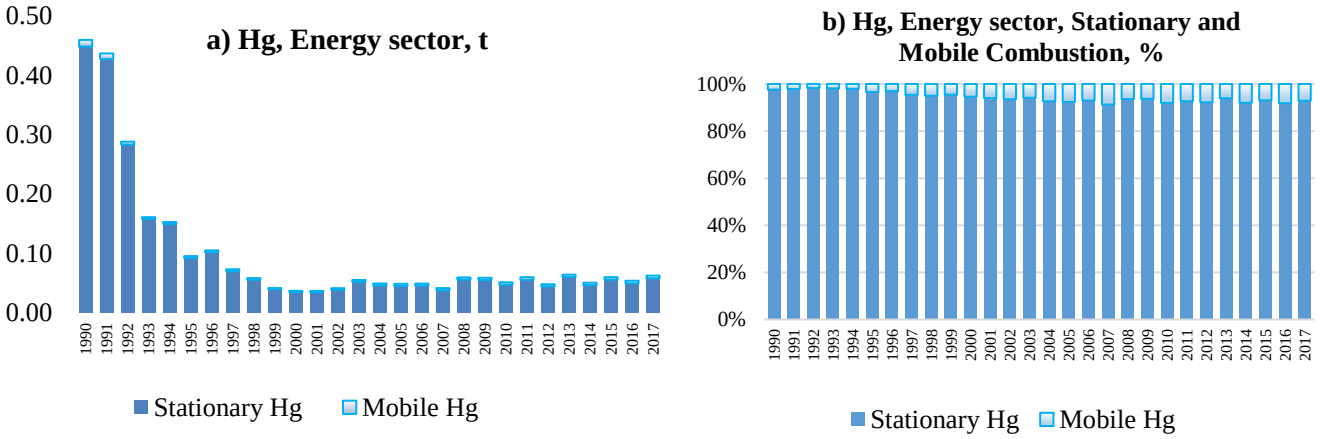


Figure 3.1.1.12. Hg Emissions in Energy Sector 1990-2017, t

Hg emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,06 t in 2017 (Figure 3.1.1.12a). The main source of Hg emissions in the energy sector is stationary combustion (92,9%) (Figure 3.1.1.12b).

Chromium (Cr)

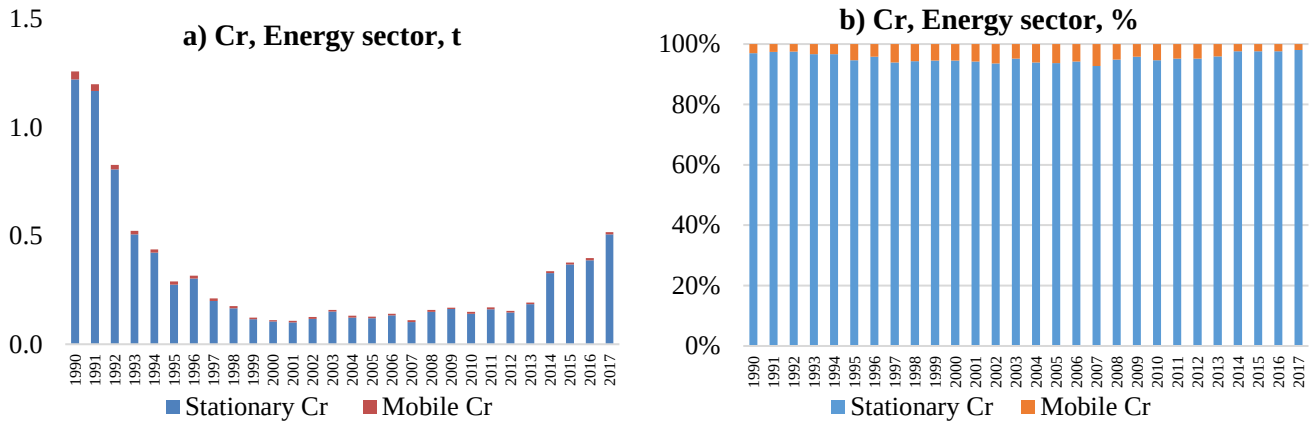


Figure 3.1.1.13. Cr Emissions in Energy Sector 1990-2017, t

Cr emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,52 t in 2017 (Figure 3.1.1.13a). The main source of Cr emissions in the energy sector is stationary combustion (98,2%) (Figure 3.1.1.13b).

Copper (Cu)

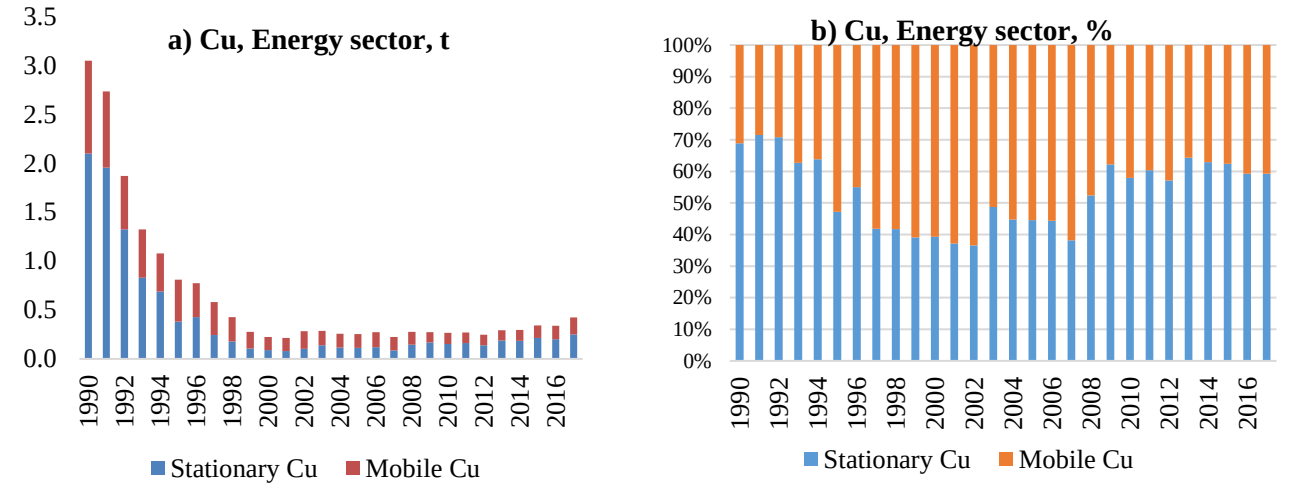


Figure 3.1.1.14. Cu Emissions in Energy Sector 1990-2017, t

Cu emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,42 t in 2017 (Figure 3.1.1.14a). The main parts of these emissions were stationary combustion - 0,25 t (59,2%) and mobile combustion - 0,17 t (40,8%) (Figure 3.1.1.14b). The main sources of Cu emissions in the energy sector are the following categories:

a. Stationary combustion:

- *1.A.4.b Residential* - 0,17 t - 62,9%;
- *1.A.1 Energy Industries* - 0,05 t - 21,3%.
- *b. Mobile* combustion:
- *1.A.4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* - 0,15 t - 86%;
- *1.A.3.c Railways* - 0,02 t - 11,2%.

Nickel (Ni)

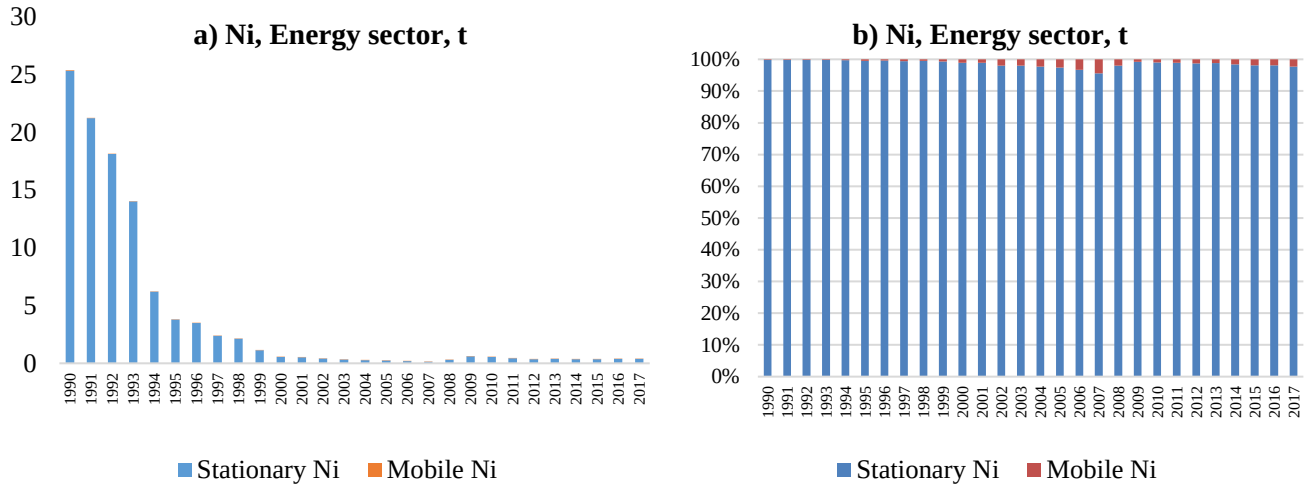


Figure 3.1.1.15. Ni Emissions in Energy Sector 1990-2017, t

Ni emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,38 t in 2017 (Figure 3.1.1.15a). The main source of Ni emissions in the energy sector is stationary combustion 0,37 t (97,7%) (Figure 3.1.1.15b).

Selenium (Se)

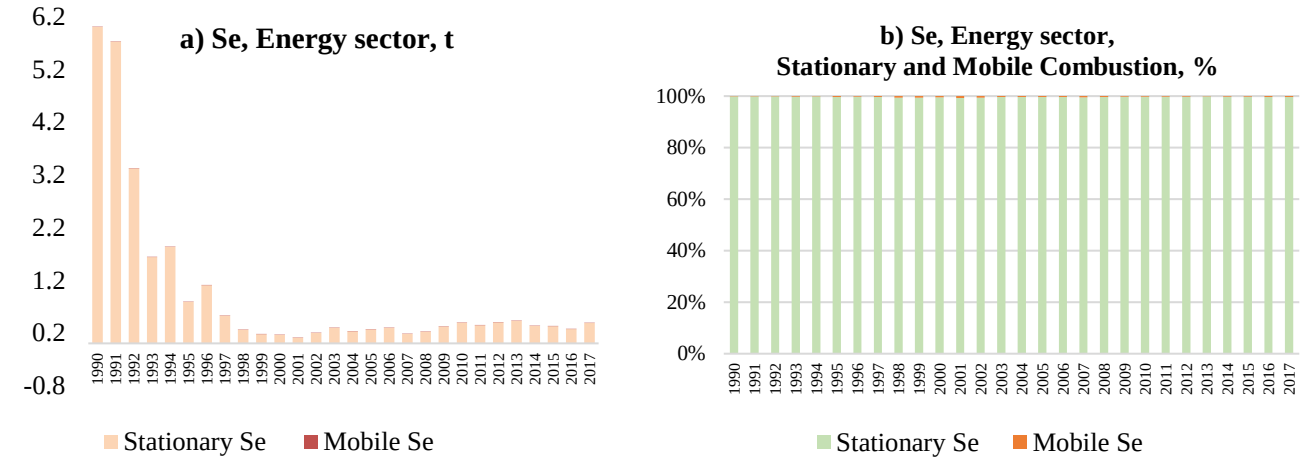


Figure 3.1.1.16. Se Emissions in Energy Sector 1990-2017, t

Se emissions from the sector 1.*A Energy, Fuel Combustion* amounted to 0,39 t in 2017 (Figure 3.1.1.16a). 99,7% is stationary combustion (Figure 3.1.1.16b).

Zinc (Zn)

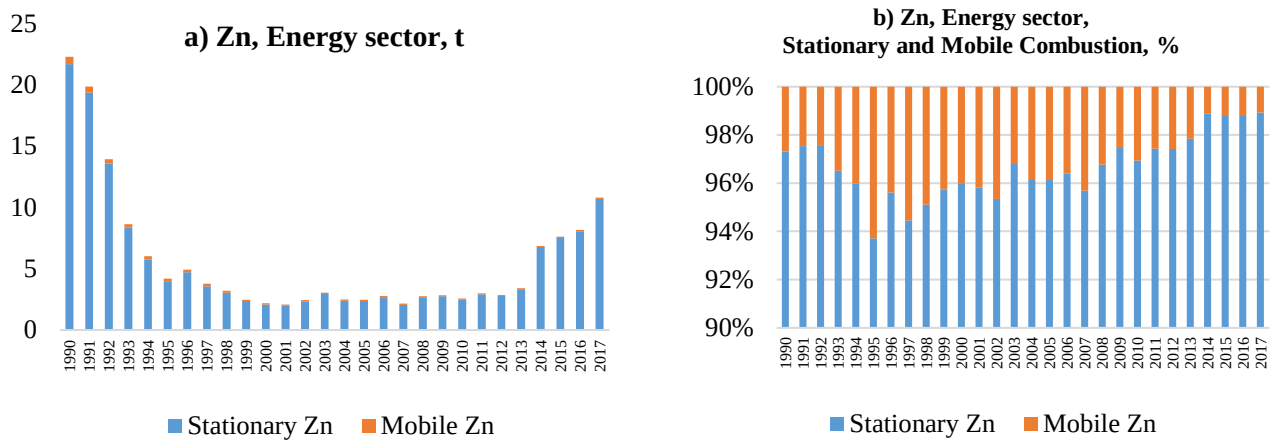


Figure 3.1.1.17. Zn Emissions in Energy Sector 1990-2017, t

Zn emissions from the sector *1.A Energy, Fuel Combustion* amounted to 10,81 t in 2017 (Figure 3.1.1.17a). The main parts of these emissions were stationary combustion - 10,69 t (98,9%) and mobile combustion - 0,12 t (1,1%) (Figure 3.1.1.17b). The main sources of Zn emissions in the energy sector are the following categories:

a. Stationary combustion:

- *1.A.4.b - Residential* - 9,67 t - 90,5%;
- *1.A.4.a Commercial/institutional* - 0,4 t - 3,9%.

b. Mobile combustion:

- *1.A.4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* - 0,09 t- 75,4%;
- *1.A.3.b Road transport* - 0,02 t- 13,4%;
- *1.A.3.c Railways* - 0,01 t- 9,8%.

PCDD/F

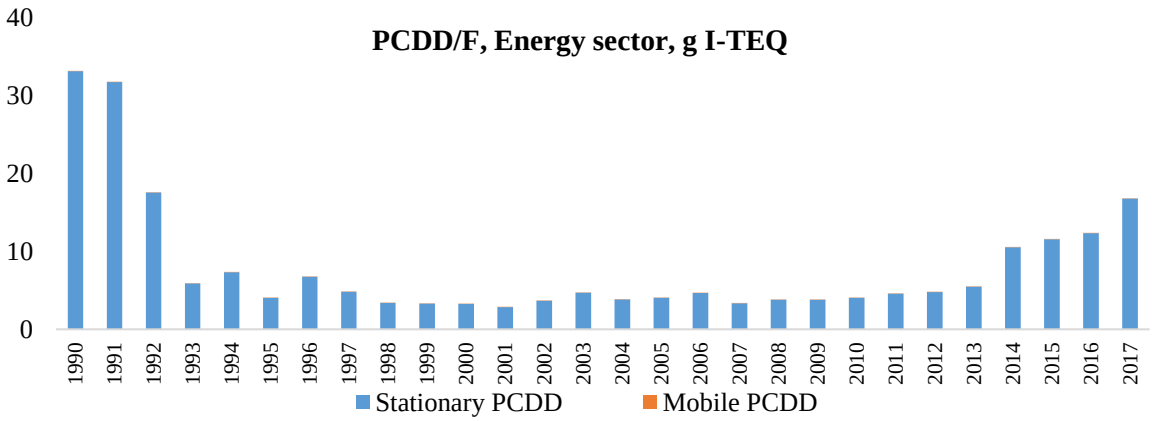


Figure 3.1.1.18. PCDD/F Emissions in Energy Sector 1990-2017, g I-TEQ

PCDD/F emissions from the sector *1.A Energy, Fuel Combustion* amounted to 16,77 g I-TEQ in 2017 (Figure 3.1.1.18). The main source of PCDD/F emissions in the energy sector is *1.A.4.b Residential* - 16,17 g I-TEQ - 96,5%.

Benzo(a)pyrene

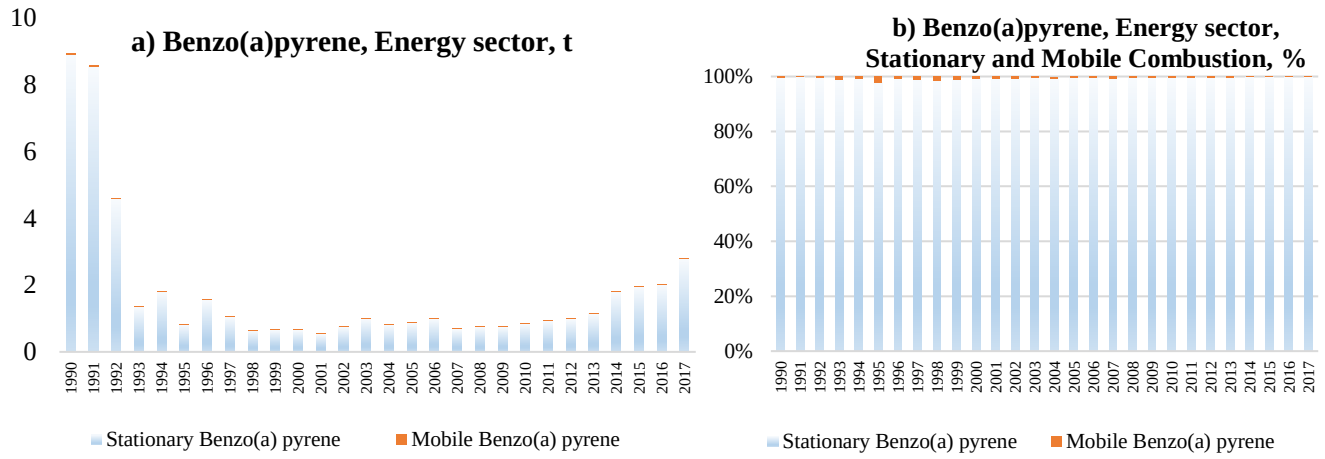


Figure 3.1.1.19. Benzo(a)pyrene Emissions in Energy Sector 1990-2017, t

Benzo(a) pyrene emissions from the sector 1.A Energy, Fuel Combustion amounted to 2,8 t in 2017 (Figure 3.1.1.19a). The main source of Benzo(a)pyrene emissions in the energy sector is the category *1.A.4.b Residential*- 2,69 t - 96,2% (Figure 3.1.1.19b).

Benzo(b)fluoranthene

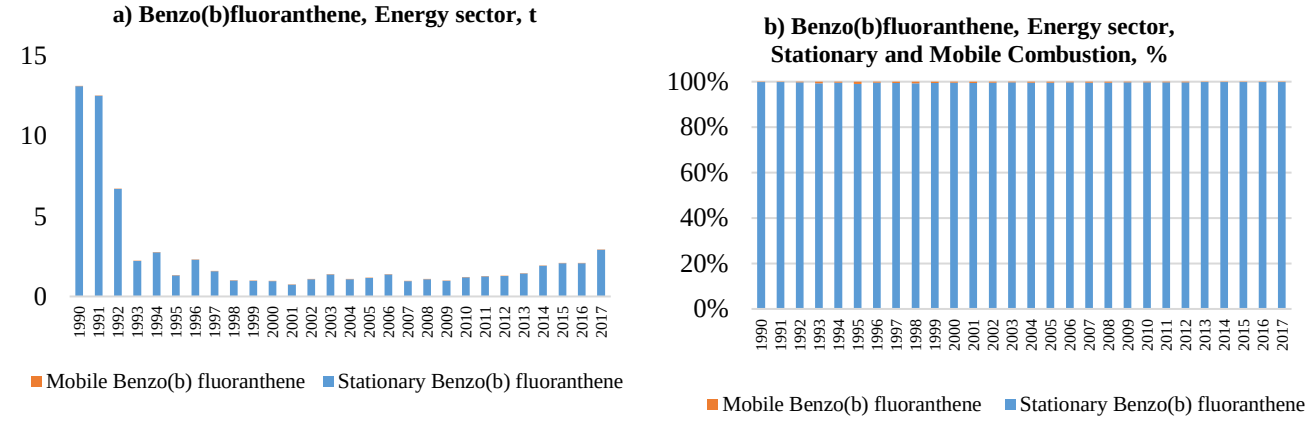


Figure 3.1.1.20. Benzo(b)fluoranthene Emissions in Energy Sector 1990-2017, t

Benzo(b)fluoranthene emissions from the sector *1.A Energy, Fuel Combustion* amounted to 2,9 t in 2017 (Figure 3.1.1.20a). The main source of Benzo(b)fluoranthene emissions in the energy sector is the category *1.A.4.b Residential*- 2,73 t – 94,3% (Figure 3.1.1.20b).

Benzo(k)fluoranthene and Indeno(1,2,3-cd)pyrene

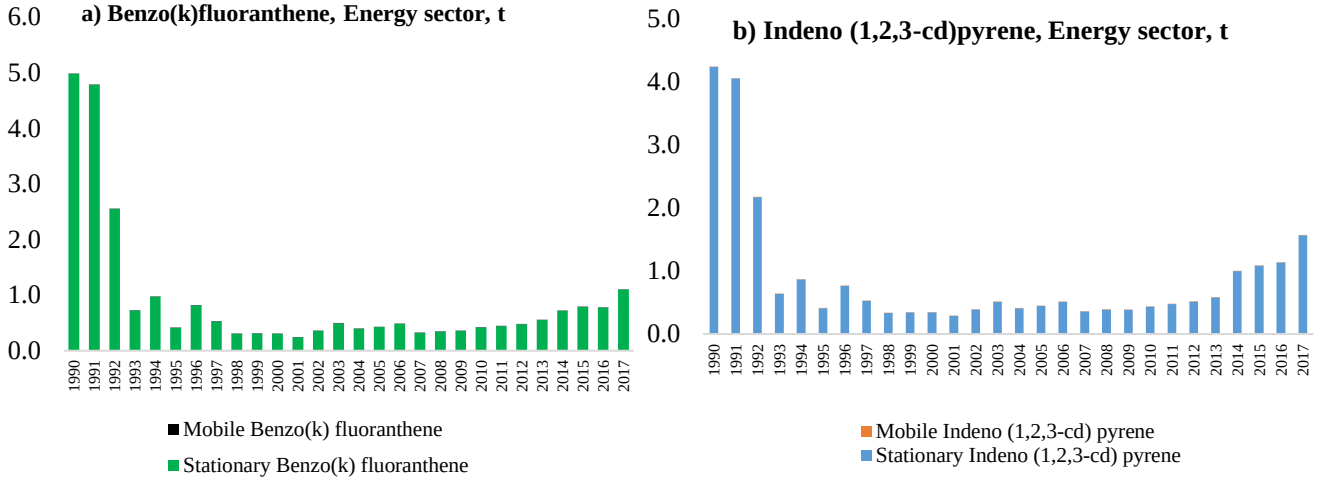


Figure 3.1.1.21. Benzo(k)fluoranthene and Indeno(1,2,3-cd)pyrene Emissions in Energy Sector 1990-2017, t

Benzo(k)fluoranthene emissions from the sector *1.A Energy, Fuel Combustion* amounted to 1,098 t (Figure 3.1.1.21a). The main source of emissions in the energy sector is the category *1.A.4.b Residential*- 1,046 t - 95,2%.
Indeno(1,2,3 - cd)pyrene emissions from the sector *1.A Energy, Fuel Combustion* amounted to 1,57 t (Figure 3.1.1.21b). The main source of emissions in the energy sector is the category *1.A.4.b Residential*- 1,52 t - 96,9%.

Hexachlorobenzene (HCB)

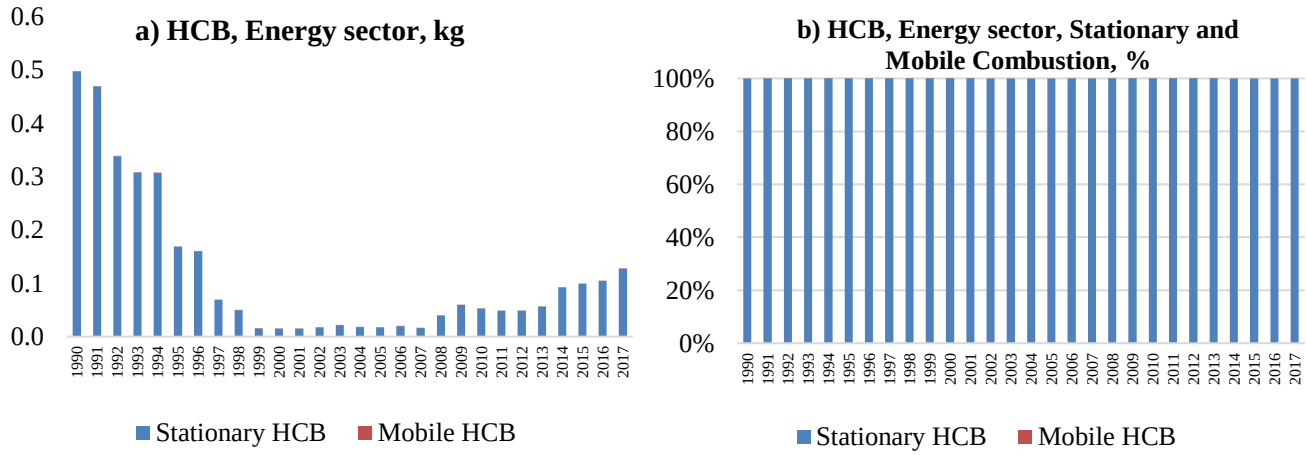


Figure 3.1.1.22. HCB Emissions in Energy Sector 1990-2017, kg

HCB emissions from the sector *1.A Energy, Fuel Combustion* amounted to 0,13 kg in 2017 (Figure 3.1.1.22a). The main share of these emissions was stationary combustion - 99,9% (Figure 3.1.1.22b). The main sources of HCB emissions in the energy sector are the following categories:

- *1.A.4.b Residential* - 0,09 kg - 71,2%;
- *1.A.1 Energy Industries* - 0,03 kg - 25,5%;
- *1.A.4.a Commercial/institutional* - 0,003 kg - 2,3%.

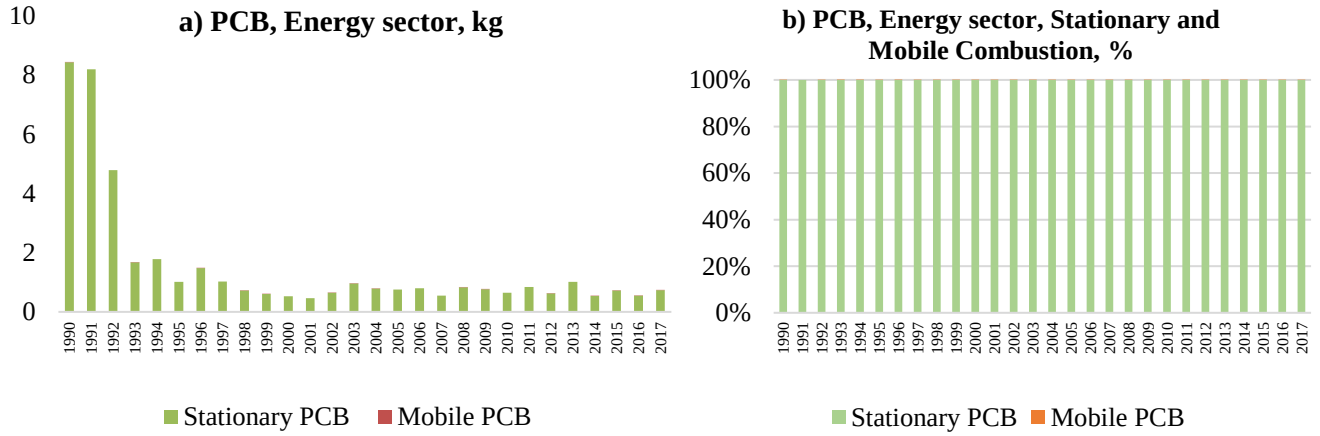


Figure 3.1.1.23. PCBs Emissions in Energy Sector 1990-2017, kg

PCBs emissions from the sector *1.A Energy*, *Fuel Combustion* amounted to 0,735 kg in 2017 (Figure 3.1.1.23a). The main share of PCB emissions in the Energy sector come from Stationary combustion (Figure 3.1.1.23b). Also, category shares are the following:

- *1.A.4.b Residential* - 0,38 kg - 52,3%;
- *1.A.2. Manufacture Industries and Construction (combustion)* - 0,21 kg - 28,1%;
- *1.A.4.a Commercial/institutional* - 0,13 kg - 17,9%.

3.1.2. Key categories

Key categories are calculated according to the methodology described in Section 5 ”Key category analysis and methodological choice” EMEP/EEA 2016. They are calculated for 2017 - method Level Assessment and for 1990, 2017 method Trend Assessment (Table 3.1.2.1).

Table 3.1.2.1. Key categories of Energy Sector - Level Assessment (L1) and Trend Assessment (T1)

Key categories	Level Assessment (L1)					Trend Assessment (T1)		
		Emissions		<80%-key			1990, 2017	
NO_x		2017	%	Cumulative %		**NO_x**	%	Cumulative %
		kt						<80%-key
1A3b Road transport	NOx	15,4735	*36,1*	*36,1*		1A3b Road transport	24%	24%
1A1 Energy Industries	NOx	7,0573	*16,5*	*70,4*		1A1 Energy Industries	24%	48%
1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NOx	3,0081	*7,0*	*77,4*		1A2 Manufacture Industries and Construction (combustion)	9%	73%
1A4b Residential	NOx	2,1488	*5,0*	*82,4*		1A3c Railways	8%	81%
Energy			*64,6*			Energy	65%	
NMVOC		kt	%	Cumulative %		**NMVOC**		
1A4b Residential	NMVOC	17,7118	*19,7*	*19,7*		1A4b Residential	4%	80%
Energy			19,7			Energy	4%	
SO_x		kt	%	Cumulative %		SO_x		
		kt						
1A4a Commercial/institutional	SO_x	7,8972	*51,0*	*51,0*		1A4a Commercial/institutional	44%	44%
1A1 Energy Industries	SO_x	4,0806	*26,4*	*77,4*		1A1 Energy Industries	43%	87%
1A4b Residential	SO_x	2,2308	*14,4*	*91,8*				
Energy			91,8			Energy	87%	
NH_3		Kt	%	Cumulative %		NH_3		
Energy			0					
$PM_{2.5}$		kt	%	Cumulative %		**$PM_{2.5}$**		

Key categories		Level Assessment (L1)				Trend Assessment (T1)		
1A4b Residential	$PM_{2.5}$	14,18653	*76,9*	*76,9*		1A1 Energy Industries	47%	47%
1A4a Commercial/institutional	$PM_{2.5}$	1,059917	*5,7*	*82,7*		1A2 Manufacture Industries and Construction (combustion)	22%	69%
						1A3c Railways	6%	75%
						1A3d Water -borne Navigation	4%	79%
Energy			*82,7*			Energy	79,26%	
PM_{10}		kt	%	Cumulative %		**PM_{10}**		
1A4b Residential	PM_{10}	14,5586	*56,8*	*56,8*		1A4b Residential	43%	43%
1A4a Commercial/institutional	PM_{10}	1,147843	*4,5*	*75,6*		1A1 Energy Industries	17%	59%
Energy			*61*			Energy	59%	
TSP		kt	%	Cumulative %		**TSP**		
1A4b Residential	TSP	15,36581	*25,7*	*54,2*		1A4b Residential	40,75%	40,75%
						1A1 Energy Industries	8,83%	80,08%
Energy			25,7			Energy	8,83%	
BC		kt	%	Cumulative %		**BC**		
	BC					1A4b Residential	36,98%	36,98%
						1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	22,82%	59,79%
						1A2 Manufacture Industries and Construction (combustion)	13,54%	73,34%
						Energy	73,34%	
CO		kt	%	Cumulative %		**CO**		
1A4b Residential	CO	82,58516	*76,9*	*76,9*		1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	21,82%	21,82%
1A4a Commercial/institutional	CO	8,9281	*8,3*	*85,2*		1A4a Commercial/institutional	19,21%	41,03%
						1A5 Other	9,46%	65,36%
						1A4b Residential	7,98%	73,35%
Energy			85,2			Energy	58,47%	
Pb		ton	%	Cumulative %		**Pb**		
1A4a Commercial/institutional	Pb	1,257097	*45,9*	*45,9*		1A4a Commercial/institutional	36,53%	36,53%
1A4b Residential	Pb	0,7770	*28,3*	*74,2*		1A4b Residential	35,61%	72,14%
						1A1 Energy Industries	12,71%	84,84%
Energy			74,2			Energy	84,84%	
Cd		ton	%	Cumulative %		**Cd**		
1A4b Residential	Cd	0,236439	*59,7*	*59,7*		1A4b Residential	47,81%	47,81%
						1A1 Energy Industries	37,36%	85,17%
Energy			59,7			Energy	85,17%	
Hg		ton	%	Cumulative %		**Hg**		
1A4a Commercial/institutional	Hg	0,0735	*47,0*	*47,0*		1A4a Commercial/institutional	26,14%	26,14%
1A4b Residential	Hg	0,0235	*15,0*	*62,1*		1A4b Residential	25,44%	51,58%
1A1 Energy Industries	Hg	0,0142	*9,1*	*82,0*		1A1 Energy Industries	23,24%	74,82%
Energy			71,1			Energy	74,82%	
As		ton	%	Cumulative %		**As**		
1A1 Energy Industries	As	0,0492	*25,9*	*25,9*		1A1 Energy Industries	48,39%	48,39%
1A4a Commercial/institutional	As	0,0379	*20,0*	*90,4*		1A4a Commercial/institutional	16,79%	83,63%
Energy			45,9			Energy	65,18%	
Cr		ton	%	Cumulative %		**Cr**		
1A4b Residential	Cr	0,4376	*62,4*	*62,4*		1A1 Energy Industries	45,64%	45,64%
1A4a Commercial/institutional	Cr	0,1438	*20,5*	*82,9*		1A4b Residential	39,72%	85,36%
Energy			82,9			1A4a Commercial/institutional	8,51%	93,87%
						Energy	93,87%	
Cu		ton	%	Cumulative %		**Cu**		
1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Cu	0,1484	*45,0*	*45,0*		1A1 Energy Industries	49,64%	49,64%
1A1 Energy Industries	Cu	0,0533	*16,2*	*61,1*		1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	12,27%	83,75%
1A2 Manufacture Industries and Construction (combustion)	Cu	0,0216	*6,5*	*82,6*				
Energy			61,1			Energy	61,91%	
Ni		ton	%	Cumulative %		**Ni**		
1A1 Energy Industries	Ni	0,2709	54,1	54,1		1A1 Energy Industries	50,00%	50,00%
Energy			54,1			Energy	50,00%	
Se		ton	%	Cumulative %		**Se**		
1A4b Residential	Se	0,2795	46,3	46,3		1A4b Residential	31,21%	71,64%

Key categories	Level Assessment (L1)					Trend Assessment (T1)		
1A1 Energy Industries	Se	0,1042	17,3	95,1		1A1 Energy Industries	18,77%	90,41%
Energy			63,6			Energy	49,98%	
Zn		ton	%	Cumulative %		**Zn**		
1A4b Residential	Zn	9,6745	67,3	67,3		1A1 Energy Industries	44,62%	44,62%
1A4a Commercial/institutional	Zn	2,0070	14,0	81,3		1A4b Residential	40,28%	84,90%
Energy			81,3			Energy	84,90%	
PCDD		g -TEQ	%	Cumulative %		**PCDD**		
1A4b Residential	PCDD	16,1738	55,9	55,9				
5C1biii	PCDD	7,2600	25,1	81,1		1A4b Residential	41,56%	91,56%
Energy			55,9			Energy	41,56%	
Benzo(a) pyrene		ton	%	Cumulative %		**Benzo(a) pyrene**		
1A4b Residential	BenzoAPyr	2,6874	78,0	78,0		1A4b Residential	47,40%	47,40%
						1A4a Commercial/institutional	29,21%	76,62%
Energy			78,0			Energy	76,62%	
Benzo(b) fluoranthene		ton	%	Cumulative %		**Benzo(b) fluoranthene**		
1A4b Residential	benzoBfluor	2,7334	69,6	69,6		1A4b Residential	42,94%	42,94%
1A4a Commercial/institutional	benzoBfluor	0,5491	14,0	83,5		1A4a Commercial/institutional	25,27%	68,20%
Energy			83,5			Energy	68,20%	
Benzo(k) fluoranthene		ton	%	Cumulative %		**Benzo(k) fluoranthene**		
1A4b Residential	benzoK	1,0459	54,7	54,7		1A4b Residential	49,33%	49,33%
Energy			54,7			Energy	49,33%	
Indeno (1,2,3-cd) pyrene		ton	%	Cumulative %		**Indeno (1,2,3-cd) pyrene**		
1A4b Residential	Indeno123pyren	1,5207	87,4	87,4		1A4b Residential	46,38%	46,38%
						1A4a Commercial/institutional	45,70%	92,09%
Energy			87,4			Energy	92,09%	
HCB		kg	%	Cumulative %		HCB		
1A4b Residential	HCB	0,0910	60,5	60,5		1A1 Energy Industries	49,90%	49,90%
1A1 Energy Industries	HCB	0,0327	21,7	82,2		1A4b Residential	29,23%	79,13%
Energy			82,2			Energy	79,13%	
PCBs		kg	%	Cumulative %		**PCBs**		
1A4a Commercial/institutional	PCBs	1,5730	39,7	84,7		1A4b Residential	48,78%	48,78%
						1A4a Commercial/institutional	28,29%	77,07%
Energy			39,7			Energy	77,07%	

Table 3.1.2.2. Key categories of Energy Sector - Level Assessment (L1) and Trend Assessment (T1) - Summary of Results

Category	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
1.A.1 Energy Industries	L1, T1		L1, T1		T1	T1	T1			T1	T1	L1, T1
1.A.2 Manufacture Industries and Construction (combustion)	T1				T1			T1				
1.A.3.b Road transport	L1,T1											
1.A.3.c Railways	T1				T1							
1.A.3.d Water -borne Navigation					T1							
1.A.4.a Commercial/institutional			L1, T1		L1	L1	L1, T1		L1, T1	L1, T1	L1, T1	L1, T1
1.A.4.b Residential		L1, T1			L1	L1, T1		T1	L1, T1	L1, T1		L1, T1
1.A.4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	L1							T1	T1			

continued

Category	As	Cr	Cu	Ni	Se	Zn	PCDD	B(a)	B(b)	B(k)	Id(1,2,3)	HCB	PCBs
1.A.1 Energy Industries	L1, T1	T1	L1, T1	L1, T1	L1, T1	T1						L1, T1	
1.A.2 Manufacture Industries and Construction (combustion)			L1										
1.A.3.b Road transport													
1.A.3.c Railways													

1.A3.d Water -borne Navigation																
1.A.4.a Commercial/institutional	L1, T1	L1, T1				L1, T1		T1	L1, T1			T1			L1, T1	
1.A.4.b Residential		L1, T1		L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	T1	
1.A4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery			L1, T1													

3.1.3. Methodological issues

Methodologies used for estimating emissions from this sector are based on and in compliance with Tier 1 as advised in the 2016 and 2019 EMEP/EEA Guidebooks.
The Tier 1 method is the main calculation method used to estimate emissions. Emission factors are used by default according to the 2016 EMEP/EEA Guidebook.
For several categories for the period 2016-2018 there were updates for the EMEP/EEA 2016: Update May 2017, Update June 2017, Update July 2017 etc. For such cases, the latest available version is used.

Mentions and references are provided in the emission factor tables by category.
An updated 2019 EMEP/EEA Guidebook was published in October 2019. But since the work on most of the categories has already been completed, a decision was made at the general expert meeting: in the current cycle to use the 2016 EMEP/EEA Guidebook with updated versions, and switch to the 2019 EMEP/EEA Guidebook in the next cycle.
Summarized information on accounting categories, regions, methods, and some features are given in the table 3.1.3.

Table 3.1.3. Emission Estimation Methodologies Used to Evaluate Emissions from "Energy" (IIR-2019) and Coverage of categories by region of Moldova

Category name	NFR Code	Long name	Moldova	Right Bank	Left Bank	Assessment Methodology	Emission Factors
A Public Power	1.A.1.a	Public electricity and heat production	+	+	+	T1	D
B Industry	1.A.1.b	Petroleum refining	NO	NO	NO	-	-
B Industry	1.A.1.c	Manufacture of solid fuels and other energy industries	NO	NO	NO	-	-
B Industry	1.A.2.a	Stationary combustion in manufacturing industries and construction: Iron and steel	+	+	*	T1	D
B Industry	1.A.2.b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NO	NO	NO	-	-
B Industry	1.A.2.c	Stationary combustion in manufacturing industries and construction: Chemicals	+	+	*	T1	D
B Industry	1.A.2.d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	+	+	*	T1	D
B Industry	1.A.2.e	Stationary combustion in	+	+	*	T1	D

Category name	NFR Code	Long name	Moldova	Right Bank	Left Bank	Assessment Methodology	Emission Factors
		manufacturing industries and construction: Food processing, beverages and tobacco					
B Industry	1.A.2.f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	+	+	*	T1	D
I Offroad	1.A.2.g.vii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	NO	NO	NO	T1	D
B Industry	1.A.2.g.viii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	+	+	* Include fuels 1.A.2 of Left Bank	T1	D
H Aviation	1.A.3.a.i(i)	International aviation LTO (civil)	+	+	-	T1	D
H Aviation	1.A.3.a.ii(i)	Domestic aviation LTO (civil)	+	+	-	T1	D
F Road	1.A.3.b.i	Road transport: Passenger cars M1	+	+	restored values	T1	D
F Road	1.A.3.b.ii	Road transport: Light duty vehicles N1	+	+	restored values	T1	D
F Road	1.A.3.b.iii	Road transport: Heavy duty vehicles and buses N2-N3, M2-M3	+	+	restored values	T1	D
F Road	1.A.3.b.iv	Road transport: Mopeds & motorcycles L1-L7	+	+	restored values	T1	D
F Road	1.A.3.b.v	Road transport: Gasoline evaporation	+	+	restored values	T1	D
F Road	1.A.3.b.vi	Road transport: Automobile tyre and brake wear	+	+	restored values	T1	D
F Road	1.A.3.b.vii	Road transport: Automobile road abrasion	+	+	restored values	T1	D
I Off-road	1.A.3.c	Railways	+	+	restored values	T1	D
G Shipping	1.A.3.d.i(ii)	International inland waterways	NO	NO	NO	-	-
G Shipping	1.A.3.d.ii	National navigation (shipping)	+	+	restored values	T1	D
I Offroad	1.A.3.e.i	Pipeline transport	+	+	restored values	T1	D

Category name	NFR Code	Long name	Moldova	Right Bank		Left Bank	Assessment Methodology	Emission Factors
I Offroad	1.A.3.e.ii	Other (please specify in the IIR)	NO	NO		NO	-	-
C Other Stationary Combustion	1.A.4.a.i	Commercial/institutional: Stationary		+	+	+	T1	D
I Offroad	1.A.4.a.ii	Commercial/institutional: Mobile		NO	NO	NO	-	-
C Other Stationary Combustion	1.A.4.b.i	Residential: Stationary		+	+	+	T1	D
I Offroad	1.A.4.b.ii	Residential: Household and gardening (mobile)		NO	NO	NO	-	-
C Other Stationary Combustion	1.A.4.c.i	Agriculture/Forestry/Fishing: Stationary		+	+	+	T1	D
I Offroad	1.A.4.c.ii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery		+	+	+	T1	D
I Offroad	1.A.4.c.iii	Agriculture/Forestry/Fishing: National fishing		IE	IE	+	T1	D
C Other Stationary Combustion	1.A.5.a	Other stationary (including military)		+	+	+	T1	D
I Offroad	1.A.5.b	Other, Mobile (including military, land based and recreational boats)		+	+	+	T1	D
D Fugitive	1.B.1.a	Fugitive emission from solid fuels: Coal mining and handling		NO	NO	NO	-	-
D Fugitive	1.B.1.b	Fugitive emission from solid fuels: Solid fuel transformation		NO	NO	NO	-	-
D Fugitive	1.B.1.c	Other fugitive emissions from solid fuels		NO	NO	NO	-	-
D Fugitive	1.B.2.a.i	Fugitive emissions **oil:** Exploration, production, transport		+	+	NO	T1	D
D Fugitive	1.B.2.a.iv	Fugitive emissions **oil:** Refining / storage		+	+	NO	T1	D
D Fugitive	1.B.2.a.v	Distribution of **oil** products		+	+	restored values	T1	D
D Fugitive	1.B.2.b	Fugitive emissions from **natural gas** (exploration, production, processing, transmission, storage, distribution and other)		+	+	NO	T1	D
D Fugitive	1.B.2.c	Venting and flaring (oil, gas, combined oil and gas)		NO	NO	NO	-	-
D Fugitive	1.B.2.d	Other fugitive emissions from energy production		NO	NO	NO	-	-

3.1.4. Assessment of Completeness

Each category of sources has its own list of pollutants that are released during fuel combustion.
There are pollutants that are not evaluated due to their absence in a specific category. They are marked as NA.
Pollutants that are not calculated due to the absence of emission factors, but which are emitted during combustion, are marked as NE.

If the source category is completely absent in the country due to the lack of an appropriate type of activity, then it is marked as NO.
There are cases when the data cannot be detailed, and they are considered by the sum in one category. For the energy module, this category is only one in the *1.A.4s* sector. It is marked IE.
Lists of pollutants that are not evaluated for the cases described above are listed in the tables for Stationary Combustion, Mobile Combustion, and Fugitive Emissions (Tables 3.1.4.1-3.1.4.4).

Table 3.1.4.1. Categories of the *Stationary* Combustion Sector with NE, NA

Category	Fuel	NE	NA	Table EMEP/EEA 2016
1.A.1.a Public electricity and heat production	Solid Hard coal Brown coal	NH_3 NH_3, (PCB, HCB – error in EMEP/EEA 2016 table for brown coal)	- -	T. 3-2, 1.A.1, T. 3-3, 1.A.1

Category	Fuel	NE	NA	Table EMEP/EEA 2016
	Heavy fuel oil, Diesel oil	NH_3, PCB_s, Benzo(a)pyrene, HCB, PCB NH_3, PCB_s, B(a), B(b) B(k), HCB, PCB	- -	T. 3-5, 1.A.1, T. 3-6, 1.A.1
	Gaseous Biofuels	NH_3, PCB_s, HCB NH_3	- -	T. 3-4, 1.A.1, T. 3-7, 1.A.1
1.A.2 Manufacture Industries and Construction (combustion)	Solid Liquid Gaseous Biofuels	NH_3, NH_3, PCB_s, HCB NH_3, PCB_s, HCB -	- - - -	T. 3-2, 1.A.2, T. 3-4, 1.A.2, T. 3-3, 1.A2, T. 3-5, 1.A.2.
1.A4.b Residential	Solid Liquid Gaseous Biofuels	- NH_3 NH_3 -	- PCB, HCB PCB, HCB -	T. 3-2, 1.A.4 T. 3-5, 1.A.4, T. 3-4, 1.A.4, T. 3-6, 1.A.4
1.A4.a Commercial/institutional**,** **1.A4.c** Agriculture/Forestry/Fishing **1.A5.a** Other	Solid Liquid Gaseous Biofuels	NH_3, NH_3 NH_3 -	- - PCB, HCB -	T. 3-7, 1.A.4, T. 3-9, 1.A.4, T. 3-8, 1.A.4, T. 3-10, 1.A.4

Table 3.1.4.2. Categories of the Mobile Combustion with NE, NA

Category	NE	NA	EMEP/EEA 2016
1.A.3.a.i (Domestic aviation**)**	NH_3, $PM_{2,5}$; PM_{10}, TSP, BC, All metals, PCDD/F, PAHs	HCB, PCB	T. 3-3, 1.A.3.a
	Calculated only (4): NO_x, CO, NMVOC, SO_x		
1.A.3.a.ii (International aviation**)**	Calculated only (7): SO_2, CO, NO_x, NMVOC, PM2,5; PM10, BC, Other - "NE"	HCB, PCB	About "NA" there are no special recommendations in EMEP, then as for domestic aviation
1.A.3.b (all sub-categories)	PAHs HCB, PCB	-	
1.A.3.c Railways	Pb, Hg, As, PCDD/F, B(k), Indeno(1, 2, 3)pyrene	HCB, PCB	T. 3-1, 1.A.3.c,
1.A.3.d Water - borne Navigation	NH_3, BC, B(a), B(b), B(k), Indeno(1, 2, 3)pyrene	-	T . 3-1, 1.A.3.d,
1.A.3.e Pipeline transport	as 1.A.4.a.i (gaseous): NH_3	PCB, HCB	As 1.A.4.a.i

Table 3.1.4.3. Categories of Fugitive emissions with NE, NA

Category	Calculated	NE	NA	EMEP/EEA 2016
1.B.2.a Fugitive emissions oil: Exploration, production, transport	NMVOC	SO_x, PCDD/F	NO_x, CO, NH_3, TSP, PM 10, PM 2,5; BC, All metals, PAHs, HCB, PCB	T. 3-1, 1.B.2.a.i, 1.B.2.b Fugitive
1.B.2.a.iv Fugitive emissions oil: Refining / storage	NO_x, NMVOC, SO_x NH_3, PM 2,5; PM 10, TSP, All metals, PCDD/F	-	BC, CO, HCB, PCB	T. 3-1, 1.B.2.a.iv, 1.B.2.a.iv
1.B.2.a.v Distribution of oil products	NMVOC	SO_x, PCDD/F	NO_x, CO, NH_3, TSP, PM 10, PM 2,5; BC, All metals, PAHs, HCB, PCB	T. 3-1, 1.B.2.a.v

Category	Calculated	NE	NA	EMEP/EEA 2016
1.B.2.b Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	NMVOC	SO_x, PCDD/F	NO_x, CO, NH_3, TSP, PM 10, PM 2,5; BC, All metals, PAHs, HCB, PCB	T. 3-2, 1.B.2.a.i, 1.B.2.b

Table 3.1.4.4. Categories of the module "Energy", in which there are "NO"

NFR Code	Category	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1.A.1.a	**Public electricity and heat production**	+	+	+	+
1.A.1.b	Petroleum refining	NO	NO	NO	NO
1.A.1.c	Manufacture of solid fuels and other energy industries	NO	NO	NO	NO
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	NO	NO	NO	NO
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.2e.	**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)	NO	NO	NO	NO
1.A.2.g.viii	**Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)**	+	+	+	+
1.A.3.a.i(i)	**International aviation LTO (civil)**	+	NO	NO	NO
1.A.3.a.ii(i)	Domestic aviation LTO (civil)	+	NO	NO	NO
1.A.3.b.i	Road transport: Passenger cars M1	+	NO	+	NO
1.A3.b.ii	Road transport: Light duty vehicles N1	+	NO	NO	NO
1.A.3.b.iii	Road transport: Heavy duty vehicles and buses N2-N3, M2-M3	+	NO	+	NO
1.A.3.b.iv	Road transport: Mopeds & motorcycles L1-L7	+	NO	NO	NO
1.A.3.b.v	Road transport: Gasoline evaporation	Fuel not used. Calculated by numbers of vehicles			
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	+	NO	NO	NO
1.A.3.d.i(ii)	International inland waterways	NO	NO	NO	NO
1.A.3.d.ii	National navigation (shipping)	+	NO	NO	NO
1.A.3.e.i	Pipeline transport	NO	NO	+	NO
1.A.3.e.ii	Other (please specify in the IIR)	NO	NO	NO	NO
1.A.4.a.i	**Commercial/institutional: Stationary**	+	+	+	+
1.A.4.a.ii	Commercial/institutional: Mobile	NO	NO	NO	NO
1.A.4.b.i	**Residential: Stationary**	+	+	+	+
1.A.4.b.ii	Residential: Household and gardening (mobile)	NO	NO	NO	NO
1.A.4.c.i	**Agriculture/Forestry/Fishing: Stationary**	+	+	+	+
1.A.4.c.ii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	+	NO	+	NO
1.A.4.c.iii	Agriculture/Forestry/Fishing: National fishing	IE	IE	IE	IE
1.A.5.a	**Other stationary (including military)**	+	+	+	+
1.A.5.b	Other, Mobile (including military, land based and recreational boats)	+	NO	NO	NO

NFR Code	Category	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1.B.1.a	Fugitive emission from solid fuels: Coal mining and handling	NO	NO	NO	NO
1.B.1.b	Fugitive emission from solid fuels: Solid fuel transformation	NO	NO	NO	NO
1.B.1.c	Other fugitive emissions from solid fuels	NO	NO	NO	NO
1.B.2.a.i	**Fugitive emissions oil: Exploration, production, transport**	+	NO	NO	NO
1.B.2.a.iv	Fugitive emissions oil: Refining / storage	+	NO	NO	NO
1.B.2.a.v	Distribution of oil products	+	NO	NO	NO
1.B.2.b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	NO	NO	+	NO
1.B.2.c	Venting and flaring (oil, gas, combined oil and gas)	NO	NO	NO	NO
1.B.2.d	Other fugitive emissions from energy production	NO	NO	NO	NO

3.1.5. Uncertainties Assessment and Time-Series Consistency

Uncertainties are calculated in Annex 1 and described in sub-chapter 1.7.

EMEP/EEA 2016 recommendations include the following items for analysing time series consistency:

- Estimates of emissions should be real, not overestimated or underestimated;

- Series of emissions must be calculated using the same method;

- Data gaps should be eliminated, if possible.

Checking the consistency of the time series includes checking "outlier" values, comparing with previous values, as well as finding out the causes of spasmodic changes in the series.

Recommendations of EMEP/EEA 2016, as in previous versions, have instructions on the need to restore values in series for cases of missing individual values by interpolation, missing values at the edges of time series by extrapolation, in case of inconsistency of values by the method Overlap. If there are no primary values in the category, but if there are indirect data that allow you to evaluate the values in the category, it is recommended to use the indirect estimation method.

The current report on the Energy module uses three methods of recovering values.

The *interpolation method* was used to restore the values for 1991-1992, for which the National Bureau of Statistics did not compile the Fuel and Energy Balance (EB), using the values of fuel consumed for 1990 and 1993, for which the EB is available (it is also available for all subsequent years). The interpolation method for the indicated years has been applied to all categories of the Energy module, for which data were available for both 1990 and 1993.

The *extrapolation method* is applied in isolated cases for which there are no data for 2017.

The method of estimating consumed fuels from *indirect data* was used to restore the values for the Left Bank region in sectors *1.A.2 Manufacture Industries and Construction (combustion)* and *1.A.3 Transport*. The values are restored under the assumption that the specific fuel consumption per capita for each category of sectors *1.A.2 Manufacture Industries and Construction (combustion)* and *1.A.3 Transport* is the same in both regions.

3.1.6. Quality Assurance and Quality Control

Quality control procedures are described in sub-chapter 1.6.

3.2. Combustion (NFR 1.A)

3.2.1. Energy industry (NFR 1.A.1)

3.2.1.1. Description of sources

In this sector, the source category *1.A.1.a Public electricity and heat production* is considered for RM. When considering fuel combustion in different installations, the emissions of the following pollutants were considered: Hydrogen sulphide, Ammonia, Dioxins, PCBs, HCB, PAHs, Mercury, cadmium, Metals and their compounds, NMVOC, Hydrogen chloride, Hydrogen fluoride, Carbon oxides, Nitrogen oxides, Sulphur oxides, $PM_{2.5}$, PM_{10}, TSP, BC.

Thermal cogeneration power plants (CHPP-1 and CHPP-2, Balti CHPP) in the Right Bank Region and a large Moldovan Thermal Condensation Power Plant in the Left Bank Region are the main emission sources for this category.
Various heat generation plants are emission sources for this category, too.
Natural gas, fuel oil, coal, biomass is used for Electricity and Heat Production.
Categories *1.A.1.b Petroleum refining* and *1.A.1.c Manufacture of solid fuels and other energy industries* are not available in the Republic of Moldova.

3.2.1.2. Methods and emission factors

Tier 1 approach uses following formula to calculate the pollutant emissions:

$$E_{pollutant} = AR_{fuel\ consumption} \times EF_{pollutant}, \quad (3.1)$$

where:
$E_{pollutant}$ - the annual emission of pollutants;
$AR_{fuel\ consumption}$ - activity in which the consumption of fuel occurs;
$EF_{pollutant}$ - emission factor for each pollutant.

This equation is used at the national level. Annual consumption of each type of fuel is taken from statistics (or other official sources).

Table 3.2.1. Emission factors for pollutants in *1.A.1 Energy Industries*-Biomass, Diesel Oil, Natural Gas

Emission Factors									
1.A.1 Biomass				***1.A.1 Diesel oil***				***1.A.1 Natural gas***		
NOx	*g /GJ*	81		**NOx**	*g /GJ*	65		**NOx**	*g /GJ*	89
NMVOC	*g /GJ*	7,31		**NMVOC**	*g /GJ*	0,8		**NMVOC**	*g /GJ*	2,6
SOx	*g /GJ*	10,8		**SOx**	*g /GJ*	46,5		**SOx**	*g /GJ*	0,281
NH3	*Unit*	*NE*		**NH3**	*Unit*	*NE*		**NH3**	*Unit*	NE
PM2,5	*g /GJ*	133		**PM2,5**	*g /GJ*	0,8		**PM2,5**	*g /GJ*	0,89
PM10	*g /GJ*	155		**PM10**	*g /GJ*	3,2		**PM10**	*g /GJ*	0,89
TSP	*g /GJ*	172		**TSP**	*g /GJ*	6,5		**TSP**	*g /GJ*	0,89
BC	*g /GJ*	4,389		**BC**	*g /GJ*	0,268		**BC**	*g /GJ*	0,02225
CO	*g /GJ*	90		**CO**	*g /GJ*	16,2		**CO**	*g /GJ*	39
Pb	*mg / GJ*	20,6		**Pb**	*mg / GJ*	4,07		**Pb**	*mg / GJ*	0,0015
Cd	*mg / GJ*	1,76		**Cd**	*mg / GJ*	1,36		**Cd**	*mg / GJ*	0,00025
Hg	*mg / GJ*	1,51		**Hg**	*mg / GJ*	1,36		**Hg**	*mg / GJ*	0,1
As	*mg / GJ*	9,46		**As**	*mg / GJ*	1,81		**As**	*mg / GJ*	0,12
Cr	*mg / GJ*	9,03		**Cr**	*mg / GJ*	1,36		**Cr**	*mg / GJ*	0,00076
Cu	*mg / GJ*	21,1		**Cu**	*mg / GJ*	2,72		**Cu**	*mg / GJ*	0,000076
Ni	*mg / GJ*	14,2		**Ni**	*mg / GJ*	1,36		**Ni**	*mg / GJ*	0,00051
Se	*mg / GJ*	1,2		**Se**	*mg / GJ*	6,79		**Se**	*mg / GJ*	0,0112
Zn	*mg / GJ*	181		**Zn**	*mg / GJ*	1,81		**Zn**	*mg / GJ*	0,0015
PCDD/ F (dioxins/ furans)	*ng I-TEQ / GJ*	50		**PCDD/F (dioxins/ furans)**	*ng I-TEQ / GJ*	0,5		**PCDD/ F (dioxins/ furans)**	*ng I-TEQ / GJ*	0,5
benzo(a)pyrene	*mg / GJ*	1,12		**benzo(a)pyrene**	*Unit*	*NE*		**benzo(a) pyrene**	*µg /GJ*	0,56
benzo(b)fluoranthene	*mg / GJ*	0,043		**benzo(b)fluoranthene**	*Unit*	*NE*		**benzo(b)fluoranthene**	*µg /GJ*	0,84
benzo(k)fluoranthene	*mg / GJ*	0,0155		**benzo(k) fluoranthene**	*Unit*	*NE*		**benzo(k)fluoranthene**	*µg /GJ*	0,84
Indeno(1,2,3-cd)pyrene	*mg / GJ*	0,0374		**Indeno (1,2,3-cd)pyrene**	*µg /GJ*	6,92		**Indeno(1,2,3-cd)pyrene**	*µg /GJ*	0,84
Total 1-4	*µg /GJ*			**Total 1-4**	*µg /GJ*			**Total 1-4**	*µg /GJ*	
HCB	*µg /GJ*	5		**HCB**	*Unit*	*NE*		**HCB**	*Unit*	NE
PCBs	*µg /GJ*	3,5		**PCBs**	*Unit*	*NE*		**PCBs**	*Unit*	NE

Table 3.2.2. Emissions Factors: 1.A.1 Energy Industries– Residual fuel oil, Brown Coal, Hard Coal

Emission Factors									
1.A.1 Residual fuel oil				**1.A.1 Brown Coal**				**1.A.1 Hard Coal**		
NOx	*g /GJ*	142		**NOx**	*g /GJ*	247		**NOx**	*g /GJ*	*209*
NMVOC	*g /GJ*	2,3		**NMVOC**	*g /GJ*	1,4		**NMVOC**	*g /GJ*	*1*
SOx	*g /GJ*	495		**SOx**	*g /GJ*	1680		**SOx**	*g /GJ*	*820*
NH3	*Unit*	*NE*		**NH3**	*Unit*	*NE*		**NH3**	*Unit*	*NE*
PM2,5	*g /GJ*	19,3		**PM2,5**	*g /GJ*	3,2		**PM2,5**	*g /GJ*	*3,4*
PM10	*g /GJ*	25,2		**PM10**	*g /GJ*	7,9		**PM10**	*g /GJ*	*7,7*
TSP	*g /GJ*	35,4		**TSP**	*g /GJ*	11,7		**TSP**	*g /GJ*	*11,4*
BC	*g /GJ*	1,0808		**BC**	*g /GJ*	0,032		**BC**	*g /GJ*	*0,0748*
CO	*g /GJ*	15,1		**CO**	*g /GJ*	8,7		**CO**	*g /GJ*	*8,7*
Pb	*mg / GJ*	4,56		**Pb**	*mg / GJ*	15		**Pb**	*mg / GJ*	*7,3*
Cd	*mg / GJ*	1,2		**Cd**	*mg / GJ*	1,8		**Cd**	*mg / GJ*	*0,9*
Hg	*mg / GJ*	0,341		**Hg**	*mg / GJ*	2,9		**Hg**	*mg / GJ*	*1,4*
As	*mg / GJ*	3,98		**As**	*mg / GJ*	14,3		**As**	*mg / GJ*	*7,1*
Cr	*mg / GJ*	2,55		**Cr**	*mg / GJ*	9,1		**Cr**	*mg / GJ*	*4,5*

Emission Factors										
Cu	*mg / GJ*	5,31		**Cu**	*mg / GJ*	1		**Cu**	*mg / GJ*	*7,8*
Ni	*mg / GJ*	255		**Ni**	*mg / GJ*	9,7		**Ni**	*mg / GJ*	*4,9*
Se	*mg / GJ*	2,06		**Se**	*mg / GJ*	45		**Se**	*mg / GJ*	*23*
Zn	*mg / GJ*	87,8		**Zn**	*mg / GJ*	8,8		**Zn**	*mg / GJ*	*19*
PCDD/ F (dioxins/ furans)	*ng I-TEQ / GJ*	2,5		**PCDD/ F (dioxins/ furans)**	*ng I-TEQ / GJ*	10		**PCDD/F (dioxins/ furans)**	*ng I-TEQ / GJ*	*10*
benzo(a) pyrene	*Unit*	*NE*		**benzo(a) pyrene**	*µg /GJ*	13		**benzo(a) pyrene**	*µg /GJ*	*0,7*
benzo(b) fluoranthene	*µg /GJ*	4,5		**benzo(b) fluoranthene**	*µg /GJ*	37		**benzo(b) fluoranthene**	*µg /GJ*	*37*
benzo(k) fluoranthene *	*µg /GJ*	4,5		**benzo(k) fluoranthene ***	*µg /GJ*	29		**benzo(k) fluoranthene ***	*µg /GJ*	*29*
Indeno (1,2,3-cd) pyrene*	*µg /GJ*	6,92		**Indeno (1,2,3-cd) pyrene***	*µg /GJ*	2,1		**Indeno (1,2,3-cd) pyrene***	*µg /GJ*	*1,1*
Total 1-4	*µg /GJ*			**Total 1-4**	*µg /GJ*			**Total 1-4**	*µg /GJ*	
HCB	*Unit*	*NE*		**HCB**	*µg /GJ*	6,7		**HCB**	*µg /GJ*	*6,7*
PCBs	*Unit*	*NE*		**PCBs**	*ng WHO-TEG / GJ*	3,3		**PCBs**	*ng WHO-TEG / GJ*	*3,3*

Emission factors for *1.A.1.a Public electricity and heat production* category are given in Table 3.2.1 and 3.2.2 (according to tables 3.2- 3.7 of 2016 EMEP/EEA Guidebook *1.A.1 Energy Industries*, pages 15 – 21, table 10 - 11 "Biomass, Diesel oil, Natural gas" and "Residual fuel oil, Brown Coal, Hard Coal").

3.2.1.3. Activity data

Data for the Right Bank Region are available in the Energy Balances for all years, except 1991-1992 (Table 12). For them, the data was restored using the interpolation method.

Data for the *1.A.1.a Public electricity and heat production* category from the Left Bank Region are available from Statistical yearbooks and other Statistical publications for the following types of fuel and time series analysis:

- Electricity production sector: Natural gas - for 1994-2017 years; Coal and black oil - for 2008-2017;
- Heat production sector: Natural gas - for 1994-2017 years.

Emission Factors are used from the 2016 EMEP/EEA Guidebook, with values expressed in kg/GJ, g/GJ etc. Thus, the fuel consumption should be provided in GJ (or TJ, assuming a ratio of 1000).

To convert the amount of each fuel type from natural units, the national calorific value was used, namely: Coal - 25,44 GJ/ton; Diesel fuel oil - 42,54 GJ/ton; Gasoline - 43,72 GJ/ton; Residual Fuel Oil - 40,2 GJ/ton; Wood - 12,32 GJ/tct; Natural gas - 33,86 GJ/10^3 m^3; Liquefied petroleum gas - 46,06 GJ/ton (Figure 3.2.1). Since wood is shown in solid m^3, it is necessary to count it first in t.c.t and multiply it by a factor of 0,2673.

Table 3.2.3. Fuel consumption data for *1.A.1.a Public electricity and heat production*, TJ

1A1	Fuels, TJ								
Year	Coal, Total	**Hard coal**	**Brown coal**	Liquid, Total	**Diesel oil**	**Residual fuel oil**	**Natural Gas**	**Biofuels**	TOTAL 1A1
1990	**68062**	68027	35	**96377**	2637	93739	131112	68	**295619**
1991	**64271**	64271		**79904**	3938	75965	118027		**262203**
1992	**46855**	46855		**68343**	2303	66039	105065		**220264**
1993	**44021**	43819	202	**52842**	256	52586	77465	56	**174385**
1994	**43817**	43758	59	**22779**	293	22486	71670	147	**138413**
1995	**23047**	23018,	29	**13753**	352	13401	69480	88	**106369**
1996	**21070**	21041	29	**12595**	234	12361	73205	88	**106958**
1997	**7639**	7610	29	**8722**	176	8546	74616	59	**91037**
1998	**5021**	4992	29	**7743**	88	7655	66531	29	**79324**
1999	**176**	176		**4108**	88	4020	58806	29	**63118**
2000	**117**	117		**1878**	88	1790	52997	59	**55050**
2001	**88**	88		**1701**	58	1643	62494	147	**64429**
2002	**88**	88		**1291**	59	1232	50009	235	**51623**
2003	**117**	117		**938**	88	850	52324	234	**53613**
2004	**137**	137		**804**	86	718	53759	245	**54945**
2005	**123**	123		**742**	94	648	56081	245	**57191**
2006	**100**	100		**541**	59	482	43387	217	**44245**
2007	**65**	65		**319**	33	286	50785	240	**51409**
2008	**3036**	3036		**759**	38	721	52328	375	**56497**
2009	**5996**	5996		**1842**	49	1793	66626	438	**74902**
2010	**5212**	5212		**1705**	48	1657	70605	518	**78039**
2011	**4156**	4156		**1348**	38	1310	65652	401	**71557**
2012	**4144**	4144		**1131**	28	1103	66284	230	**71789**
2013	**4928**	4928		**1132**	43	1089	49363	315	**55737**
2014	**4616**	4616		**1074**	29	1045	62839	551	**69080**

1A1	Fuels, TJ								
Year	Coal, Total	**Hard coal**	**Brown coal**	Liquid, Total	**Diesel oil**	**Residual fuel oil**	**Natural Gas**	**Biofuels**	TOTAL 1A1
2015	**4549**	4549		**888**	15	873	68432	790	**74658**
2016	**4376**	4376		**1054**	18	1036	67338	753	**73521**
2017	**4376**	4376		**957**	16	941	66897	670	**72900**

Figure 3.2.1 shows data on fuel consumption (in TJ) for *1.A.1 Energy Industries*, by type, respectively the share (in %) in the structure of total fuel consumption. During the 1990-2017 period, the share of solid fuels (coal) decreased from 23% to 6%; the share of liquid fuels (petroleum products) changed from 32,6% to circa 1,3%; the share of gaseous fuels (natural gases) increased from 44,4% to 91,8%; while the share of biofuels increased from 0,02% to 0,9% of the total. For the entire period, the total fuel consumption in this category decreased from 295619 TJ (1990) to 72900 TJ (2017).

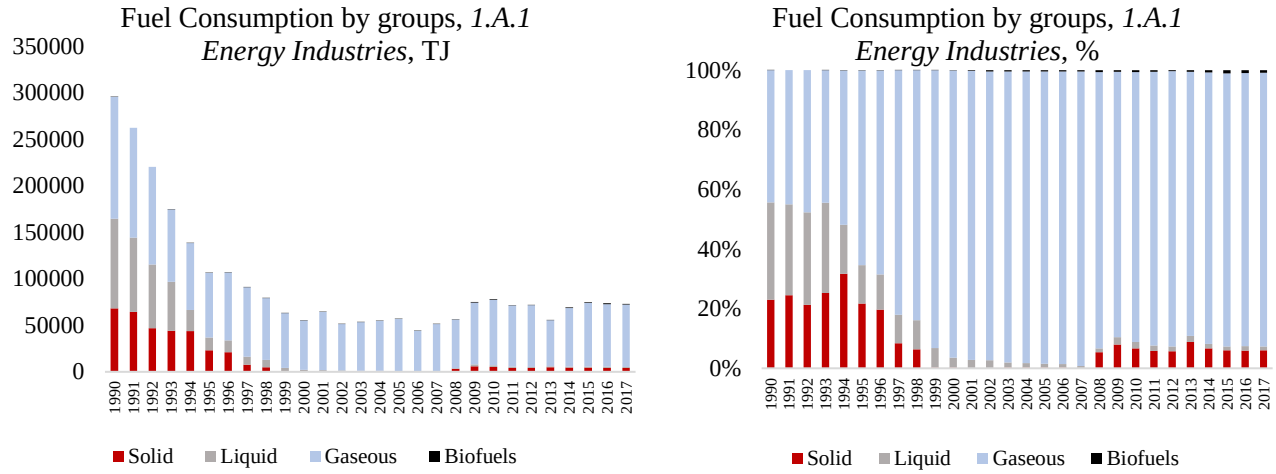


Figure 3.2.1. Fuel Consumption of category *1.A.1 Energy Industries*, GJ and %

3.2.2. Combustion in manufacturing industries and construction (NFR 1.A.2)

3.2.2.1. Description of sources

This sector covers emissions of pollutants from burning fuel for energy purposes in power plants in industry (but not emissions during technological processes) in the following categories (Table 3.2.4).

Table 3.2.4. Completeness of coverage of sector categories 1.A.2

Code	Long name	Coverage
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	NO
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)	NO
1.A.2.g.viii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	**1.A.2.g.viii=1.A.2.g+1.A.2.h+ 1.A.2.i+1.A.2.j+1.A.2.k+1.A.2.L + 1.A.2.m+ Left Bank**

Category *1.A.2.g.viii* includes categories: *1.A.2.g Production of trailers, semi-trailers and other means of transport, 1.A.2.h Machine building industry, 1.A.2.i Extractive industry, 1.A.2.j Wood processing and furniture production, 1.A.2.k Construction, 1.A.2.L Textile, 1.A.2.m Non-Specific Industry* and activity data of Left Bank Region.

3.2.2.2. Methods and emission factors

The Tier 1 method uses a formula in which emissions of each pollutant are calculated as the product of fuel burned (of each type) and the emission factor for each pollutant.

The emission factors are presented in Table 3.2.5.

Table 3.2.5. Emission factors for *1.A.2 Manufacture Industries and Construction*, according to 2016 EMEP/EEA Guidebook

Pollutant	*Units*	Solid	Liquid	Gaseous	Biofuel
NOx	*g /GJ*	173	513	74	91
NMVOC	*g /GJ*	88,8	25	23	300
SOx	*g /GJ*	900	47	0,67	11
NH3	*g /GJ*	NE	NE	NE	37
$PM_{2,5}$	*g /GJ*	108	20	0,78	140
PM_{10}	***g /GJ***	117	20	0,78	143
TSP	*g /GJ*	124	20	0,78	150
BC	*g /GJ*	6,912	11,2	0,0351	39,2
CO	*g /GJ*	931	66	29	570
Pb	*mg / GJ*	134	0,08	0,011	27
Cd	*mg / GJ*	1,8	0,006	0,0009	13
Hg	*mg / GJ*	7,9	0,12	0,54	0,56
As	*mg / GJ*	4	0,03	0,1	0,19
Cr	*mg / GJ*	13,5	0,2	0,013	23
Cu	*mg / GJ*	17,5	0,22	0,0026	6
Ni	*mg / GJ*	13	0,008	0,013	2
Se	*mg / GJ*	1,8	0,11	0,058	0,5
Zn	*mg / GJ*	200	29	0,73	512
PCDD/ F (dioxins/ furans)	*ng I-TEQ / GJ*	203	1,4	0,52	100
benzo(a)pyrene	*mg / GJ*	45,5	1,9	0,72	10
benzo(b)fluoranthene	*mg / GJ*	58,9	15	2,9	16
benzo(k)fluoranthene *	*mg / GJ*	23,7	1,7	0,0011*	5
Indeno(1,2,3-cd)pyrene	*mg / GJ*	18,5	1,5	1,08	4
HCB	*µg /GJ*	0,62	NE	NE	5
PCBs	*µg /GJ*	170	NE	NE	0,006

*) for *1.A.2* natural gas for benzo(k)fluoranthene in "µg / GJ", while for all other groups of fuels this substance has unit "mg / GJ". Since the formula uses the same multiplier for calculating emissions to be converted into the required total quantities in tons (10E-09), we immediately reduce the coefficient by 1000 times. We use the recording format = 1,1 / 1000 = 0,0011 (to maintain an accurate record of the emission factor, as in the table EMEP/EEA 2016, volume 1.A.2).

3.2.2.3. Activity data

Calculations were performed for two regions - the Right Bank and the Left Bank in the current cycle.

Table 3.2.6. Activity Data for *1.A.2.a-Iron and steel* and *1.A.2.c-Chemicals*

	1.A.2.a Iron and steel					1.A.2.c Chemicals				
Year	Solid	Liquid	Gaseous	Biofuel	**SUM 1.A.2.a fuels**	Solid	Liquid	Gaseous	Biofuel	**SUM 1.A.2.c fuels**
	GJ	GJ	GJ	GJ	**GJ**	GJ	GJ	GJ	GJ	**GJ**
1990	158460		2171278		**2329738**		80400	233830	0	**314230**
1991										
1992										
1993	9000				**9000**					
1994										
1995										
1996										
1997										
1998										
1999										
2000										
2001										
2002										
2003										
2004	3000				**3000**		1000	11000		**12000**
2005	5000				**5000**		10000	3000		**13000**
2006	6000				**6000**		12000	10000		**22000**
2007	5000				**5000**		1000	7000		**8000**
2008	3000	1000			**4000**		1000	39000		**40000**
2009							0	33860		**33860**
2010	3000				**3000**		0	4000		**4000**
2011	5000	1000			**6000**		19000	4000		**23000**
2012							0	13000		**13000**
2013	2000				**2000**		18000	2000	7000	**27000**
2014							0	29000	0	**29000**
2015							6000	21000	4000	**31000**

1.A.2.a Iron and steel						1.A.2.c Chemicals				
2016							11000	27000	0	**38000**
2017						100	0	29000	2000	**31100**

Calculations of the Left Bank were carried out according to indirect data, based on the share contribution of each industry to the total output and the actual amounts of fuel consumed in the industry, which are given in the statistical publications of the Left Bank region (Tables 3.2.6-3.2.8).

Table 3.2.7. Activity Data for *1.A.2.d - Pulp, Paper and Print* and *1.A.2.e - Food processing, beverages, and tobacco*

1.A.2.d Pulp, Paper and Print						1.A.2.e Food processing, beverages, and tobacco				
Year	Solid	Liquid	Gaseous	Biofuel	**SUM 1.A.2.d fuels**	Solid	Liquid	Gaseous	Biofuel	**SUM 1.A.2.e fuels**
	GJ	GJ	GJ	GJ	**GJ**	GJ	GJ	GJ	GJ	**GJ**
1990						713940	2444590	66808,56	125910,4	**3351249**
1991						604960	1967393	69872,37	104606,9	**2746833**
1992						495980	1490197	72936,19	83303,47	**2142416**
1993						390000	1016000	82000	62000	**1550000**
1994						336000	704000	29000	0	**1069000**
1995						368200	733000	117000	29000	**1247200**
1996						399760	733000	235000	29000	**1396760**
1997						343808	587000	323000	146000	**1399808**
1998						293000	704000	352000	171640	**1520640**
1999						234000	293000	293000	71320	**891320**
2000						205000	293000	323000	12320	**833320**
2001						264000	322000	293000	12320	**891320**
2002						212570	171340	304740	12320	**700970**
2003			30000		**30000**	176000	234000	674000	9660	**1093660**
2004			33000		**33000**	184000	303000	391000	40000	**918000**
2005			39000		**39000**	169000	270000	514000	20000	**973000**
2006			44000		**44000**	156000	234000	545000	5000	**940000**
2007			35000		**35000**	77000	139000	531000	6000	**753000**
2008			50000		**50000**	80000	181000	567000	5000	**833000**
2009			33860		**33860**	53400	42540	474040	0	**569980**
2010		1000	33000		**34000**	70000	94000	613000	4000	**781000**
2011			75000		**75000**	78000	89000	646000	6000	**819000**
2012			49000		**49000**	94000	83000	721000	8000	**906000**
2013						78000	85000	681000	15000	**859000**
2014			59000		**59000**	117000	95000	776000	12000	**1000000**
2015			55000		**55000**	56000	34000	876000	43000	**1009000**
2016			49000		**49000**	63000	82000	917000	28000	**1090000**
2017			11000		**11000**	49000	42000	1028000	33000	**1152000**

Table 3.2.8. Activity Data for *1.A.2.f- Non-metallic minerals* and *1.A.2.g.viii- Other*

1.A.2.f Non-metallic minerals						1.A.2.gviii=1.A.2.g+1.A.2.h+1.A.2.i+1.A.2.j+1.A.2.k+ +1.A.2.L + 1.A.2.m+Left Bank				
	Solid	Liquid	Gaseous	Biofuel	**1.A.2.f, Total**	Solid	Liquid	Gaseous	Biofuel	**1.A.2.gviii, Total**
	GJ	GJ	GJ	GJ	**GJ**	GJ	GJ	GJ	GJ	**GJ**
1990	945310	12216900	2538725	29340	**15730275**	185160	2074180	3621548	8994	**5889882**
1991	16010	9059245	2446794	0	**11522049**	124307	262573	709086		**1095966**
1992	20340	6117830	2354863	0	**8493033**	90153	314787	416043		**820983**
1993	24670	3176415	2262931	0	**5464016**	65000	1281000	182000	67000	**1595000**
1994	29000	235000	2171000	0	**2435000**		498000	9277517	29000	**9804517**
1995	29000	88000	2699000	0	**2816000**		381000	2659755		**3040755**
1996	117000	59000	1966000	0	**2142000**		351000	1886697		**2237697**
1997	88000	59000	2817000	0	**2964000**		351000	5206748		**5557748**
1998	29000	59000	2729000	58000	**2875000**		294000	5004595		**5298595**
1999	29000	0	2670000	0	**2699000**		146000	4661044		**4807044**
2000	29000	0	3227000	0	**3256000**		146000	4893671		**5039671**
2001	0	0	3491000	0	**3491000**		146000	5911203		**6057203**
2002	0	0	3893900	0	**3893900**		167820	2516590		**2684410**
2003	0	30000	3810000	0	**3840000**		117000	2705867		**2822867**
2004	14000	33000	4245000	0	**4292000**	6000	207000	2508506	8000	**2729506**
2005	14000	44000	5475000	0	**5533000**	4000	229000	3557676	7000	**3797676**
2006	1000	49000	5451000	0	**5501000**	5000	313000	4625661	3000	**4946661**
2007	2000	51000	5347000	0	**5400000**	7000	305000	7939308	5000	**8256308**
2008	1943000	30000	2698000	2000	**4673000**	5867	329038	8650638	14000	**8999544**
2009	1453280	40200	1388260	0	**2881740**	3765	193094	4187667		**4384527**
2010	320000	73000	1990000	0	**2383000**	4819	222896	4002621	23000	**4253336**
2011	1655000	38000	1984000	0	**3677000**	4803	234418	4350355	41000	**4630576**
2012	88000	29000	1834000	0	**1951000**	5137	243376	4710547	47000	**5006059**
2013	2168000	0	1589000	0	**3757000**	824	244926	3965353	13000	**4224103**
2014	468000	1000	1346000	0	**1815000**	1964	260926	4586552	17000	**4866442**
2015	1648000	18000	1469000	0	**3135000**	2631	228926	3812857	15000	**4059414**

	1.A.2.f Non-metallic minerals					1.A.2.gviii=1.A.2.g+1.A.2.h+1.A.2.i+1.A.2.j+1.A.2.k+ +1.A.2.L + 1.A.2.m+Left Bank				
2016	1057000	22000	1382000	0	**2461000**	4582	216926	4271549	10000	**4503058**
2017	1161000	15000	1318000	1000	2495000	2852	230496	4257222	7000	**4497571**

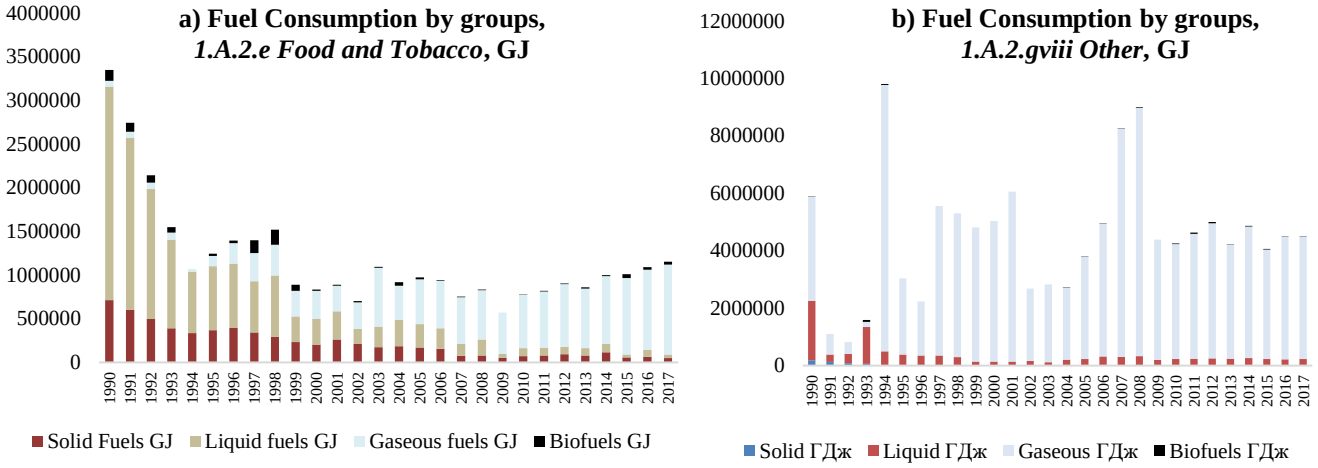


Figure 3.2.2. Fuel Consumption by categories *1.A.2.e* and *1.A.2.g.viii Other*

Figure 3.2.2 shows the dynamics of fuel consumption by groups for *1.A.2.e Food and Tobacco* and *1.A.2.g.viii Other* in the Republic of Moldova in the period 1990-2017. For both categories, natural gas is considered the most significant fuel, followed by liquid fuel. In the *1.A.2.e Food and Tobacco* category, the liquid fuels were the main fuels used since 1990, which decreased in 2017, and gaseous fuels being used more and more (Figure 3.2.2a). By comparison, gaseous fuels were and are the main type of fuels used in *1.A.2.g.viii Other* category (Figure 3.2.2b).

3.2.3. Transport (NFR 1.A.3)

3.2.3.1. Description of sources

This subsector covers the following source categories:

1. *1.A.3.a.i(i) International aviation* (Civil, LTO)
2. *1.A.3.a.ii(i) Domestic aviation* (Civil, LTO)
3. *1.A.3.b. i-iv Road transport*
4. *1.A.3.c Railways*
5. *1.A.3.d. Navigation (shipping)*
6. *1.A.3.e.i Pipeline transport*

Accounting for categories and types of fuel is given in the Table 3.2.9.

Table 3.2.9. Category coverage by sector *1.A.3- Transport*

NFR code	Category name	Liquid Fuels	Gaseous Fuels	Comments
1.A.3.a.i(i)	International aviation LTO (civil)	+	NO	
1.A.3.a.ii(i)	Domestic aviation LTO (civil)	+	NO	
1.A.3.b.i	Road transport: Passenger cars M1	+	+	
1.A.3.b.ii	Road transport: Light duty vehicles N1	+	NO	
1.A.3.b.iii	Road transport: Heavy duty vehicles and buses N2-N3, M2-M3	+	+	
1.A.3.b.iv	Road transport: Mopeds & motorcycles L1-L7	+	NO	
1.A.3.b.v	Road transport: Gasoline evaporation	NO	NO	Calculated by quantity M1, N1,L1-L5
1.A.3.b.vi	Road transport: Automobile tyre and brake wear	NO	NO	Calculated by quantity M1, N1,N2-N3, M2-M3, L1-L7
1.A.3.b.vii	Road transport: Automobile road abrasion	NO	NO	Calculated by quantity M1, N1,N2-N3, M2-M3, L1-L7
1.A.3c	Railways	+	NO	
1.A.3.d.i(ii)	International inland waterways	NO	NO	
1.A.3.d.ii	National navigation (shipping)	+	NO	
1.A.3.e.i	Pipeline transport	NO	+	
1.A.3.e.ii	Other (please specify in the IIR)	NO	NO	

1.A.3.b.i Road transport

There are different categories of vehicles in the Republic of Moldova - cars, buses, trucks, motorcycles. The fuel used is diesel, petrol, LPG, and compressed gas.

Classification of vehicles

(EMEP/EEA air pollutant emission inventory guidebook 2016, Update June 2017, 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv Passenger cars, light commercial trucks, heavy-duty vehicles including buses and motor cycles, pages 5-6):

Passenger vehicles

- M1: vehicles up to 8 people + the driver's seat; gasoline fuel, diesel fuel and LPG.
- M1: vehicles used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat.

Light commercial vehicles (LCV)

- N1 up to 3,5 tons - vehicles for the transportation of goods to 3,5 tons, which use gasoline and diesel fuel. N1: vehicles used for the carriage of goods and having a maximum weight not exceeding 3,5 tons.

Heavy duty vehicles (HDV):

N2- N3 diesel fuel and M2-M3 (buses) diesel fuel and CNG

- N2: vehicles used for the carriage of goods and having a maximum weight exceeding 3,5 tons but not exceeding 12 tons.
- N3: vehicles used for the carriage of goods and having a maximum weight exceeding 12 tons.
- M2: vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum weight not exceeding 5 tons.
- M3: vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum weight exceeding 5 tons.

L-Category**:**

This includes motorcycles L1 - L5 two-stroke, four-stroke starting from 50 cm^3 and up to > 750 cm^3, gasoline.

- L1e: Light two-wheel powered vehicles with an engine cylinder capacity not exceeding 50 cm^3, a maximum design speed not exceeding 45 km/h and a maximum continuous or net power ≤ 4000 W
- L2e: Three-wheel mopeds with a maximum design speed not exceeding 45 km/h, a maximum continuous rated or net power ≤ 4000 W and mass in running order ≤ 270 kg.
- L3e: Two-wheel motorcycle with an engine cylinder capacity exceeding 50 cm^3 or a design speed exceeding 45 km/h, or a maximum continuous or net power exceeding 4000 W.
- L4e: Two-wheel motorcycle with sidecar, with a maximum of four seating positions including the driver on the motorcycle, with side car and a maximum of two seating positions for passengers in the side car.
- L5e: Powered tricycle with mass in running order ≤ 1000 kg and three-wheel vehicle that cannot be classified as an L2e vehicle.
- L6e: Light quadricycle with maximum design vehicle speed ≤ 45 km/h and mass in running order ≤ 425 kg and engine capacity ≤ 50 cm^3 if a PI engine, or engine capacity ≤ 500 cm^3 if a CI engine.
- L7e: Heavy quadricycle with mass in running order ≤ 450 kg for the transport of passengers, or ≤ 600 kg for the transport of goods.

1.A.3.c Railways

Diesel engines are the main type of power equipment for railway transport.

1.A.3.d.i(ii) Domestic Navigation

In navigation, diesel engines are used and sometimes steam or gas turbines are employed (the latter account for less than 1%). The fuel (and emissions as well) is accounted for in the country where it was sold.

1.A.3.e Pipelines

The country has a gas transmission system with high, medium, and low-pressure gas pipelines.

1.A.3.b.v Road transport: Gasoline evaporation, 1.A.3.b.vi Road transport: Automobile tire and brake wear, 1.A.3.b.vii Road transport: Automobile road abrasion

Categories of emissions from vehicles that are not related to fuel, but are related to friction and abrasion of tires, brakes, pavement, as well as from gasoline fumes are also considered in sector *1.A.3 Transport*. These are described for the first time.
A table with a list of pollutants for these categories and the coverage of the regions is given under the number 3.2.10. The Left Bank region is considered due to the use of the restoration method based on indirect data.

Table 3.2.10. Category *1.A.3.b.v, 1.A.3.b.vi, 1.A.3.b.vii*, pollutants and regional coverage

NFR code	Category name	Pollutants	Regions
1.A.3.b.v	Road transport: Gasoline evaporation	NMVOC	Right bank, Left Bank
1.A.3.b.vi	Road transport: Automobile tyre and brake wear	$PM_{2,5}$; PM_{10}; TSP	Right bank, Left Bank
1.A.3.b.vii	Road transport: Automobile road abrasion	$PM_{2,5}$; PM_{10}; TSP	Right bank, Left Bank

3.2.3.2. Methods and emission factors

1.A.3.a Aviation

Emissions in the Domestic Aviation category are calculated according to Tier 1 Method using data on fuel consumption.
Emissions in the International Aviation category are calculated according to Tier 1 Method using data on the number of Landing and Take-off (LTO) cycles and the amount of fuel consumed.
The algorithm for calculating emissions for international aviation according to Tier 1 Method includes the following steps:

1. Obtain the total amount of fuel sold for all aviation (in kt).
2. Obtain the amount of fuel used for domestic aviation only (in kt).
3. Calculate the total amount of fuel used for international aviation by subtracting the domestic aviation (step 2) from the total fuel sold (step 1).
4. Obtain the total number of LTOs carried out for international aviation.
5. Calculate the total fuel use for LTO activities for international aviation by multiplying the number of domestic LTOs by the domestic fuel use factors for one representative aircraft (quantity obtained in step 4 multiplied by fuel use for representative aircraft).
6. Calculate the fuel used for CCD activities for international aviation by subtracting the fuel used for LTO (step 5) from the total fuel used for international aviation (step 3).
7. Estimate the emissions related to international LTO activities by multiplying the emission values (per LTO) for international traffic by the number of LTOs for international traffic. Emission values are suggested for old and average-aged fleet by representative aircraft (see Annex 1: *1.A.3.a Aviation* – Annex 1 - LTO emissions calculator).
8. Estimate the emissions related to international CCD activities by multiplying the corresponding emission values (in emissions/fuel used) in Annex 1: 1.*A.3.a Aviation* – Annex 1 - LTO emissions calculator by the domestic CCD fuel use. Emission factors are suggested for an old and an average-aged fleet by representative aircraft.
9. For international flights, it is preferable to distinguish between short- (< 1 000 nm[3]) and long-distance (> 1 000 nm) flights. The latter is normally performed by large fuel-consuming aircraft compared with the shorter distance flights (e.g. within Europe). If this distinction cannot be made, the LTO emissions are expected to be largely overestimated in most countries.

Emission factors Tier 1 method for calculating emissions for 2 categories of aviation (*1.A.3.a.i(i) International aviation* and *1.A.3.a.ii.(i) Domestic aviation)* are presented in Table 3.2.11.

Table 3.2.11. Emission factors from fuel combustion in *international* aviation

[3] Where nm = nautical miles, 1nm = 1.852 km.

Jet kerosene	*NOx*	*NMVOC*	*SOx*	*NH_3*	*$PM_{2,5}$*	*PM_{10}*	*TSP*	*BC*	*CO*	Metals, PAHs, PCDD/F	*PCB, HCB*
Emission factors for LTO cycle, kg/LTO, Table 3-3, EMEP/EEA 2013	8,3	0,5	0,8	NE	0,07	0,08	0,09	0,0336	11,8	NE	NA
Emission factor for cruise, kg/ ton	17,6	0,8	1	NE	0,2	1,2	2,2	0,0960	1	NE	NA

Source: EMEP/EEA 2013 (Chapter "Aviation", Table 3-3), in EMEP/EEA 2016 such information is absent.

Table 3.2.12. Emission factors from fuel combustion in *domestic* aviation

	NOX, kg / t	*NMVOC, kg/t*	*SO_2, kg/t*	*CO kg/t*	*NH_3, PM, TSP, BC, Metals, PAHs, PCDD/F*	*PCB, HCB*
Emission factors, domestic, aviation gasoline	4	19	1	1200	NE	NA

Source: EMEP/EEA 2016 (Chapter "Aviation", Table 3-3).

1.A.3.b.i Road transport

Emission calculations use formula (1) for each category of vehicles. Emission Factors - default according to Volume *1.A.3 Mobile Combustion* EMEP/EEA 2016, Update June 2017 (Table 3.2.13).

Table 3.2.13. Emission Factors *1.A.3 b Road*

Pollutant	Unit	Petrol	Diesel fuels	LPG		Petrol	Diesel fuel		Diesel fuel	CNG		Petrol
		M1				**N1**			**N2-N3, M2-M3**			**L1-L5**
NOx	g /kg fuel	8,73	12,96	15,2		13,22	14,91		33,37	13		6,64
NMVOC	g /kg fuel	10,05	0,7	13,64		14,59	1,54		1,92	0,26		131,4
SOx	g /kg fuel	formula	formula	NE		formula	formula		formula	NE		formula
NH_3	g /kg fuel	1,106	0,065	0,08		0,667	0,038		0,013	NA		0,059
PM_{10}	g /kg fuel	0,03	1,1	NE		0,02	1,52		0,94	0,02		2,2
$PM_{2.5}$	g /kg fuel	0,03	1,1	NE		0,02	1,52		0,94	0,02		2,2
TSP	g /kg fuel	0,03	1,1	NE		0,02	1,52		0,94	0,02		2,2
BC	g /kg fuel	0,000036	0,00627	NE		0,00001	0,00836		0,004982	NE		0,00242
CO	g /kg fuel	84,7	3,33	84,7		152,3	7,4		7,58	5,7		497,7
Pb	g /kg fuel	0,000033	0,000052	NA		0,000033	0,000052		0,000052	NA		0,000033
Cd*	mg /kg fuel	0,0002	0,00005	NE		0,0002	0,00005		0,00005	NE		0,0002
Hg*	mg /kg fuel	0,0087	0,0053	NE		0,0087	0,0053		0,0053	NE		0,0002
As*	mg /kg fuel	0,0003	0,0001	NE		0,0003	0,0001		0,0001	NE		0,033
Cr*	mg /kg fuel	0,0063	0,0085	NE		0,0063	0,0085		0,0085	NE		0,0003
Cu*	mg /kg fuel	0,0045	0,0057	NE		0,0045	0,0057		0,0057	NE		0,0087
Ni*	mg /kg fuel	0,0023	0,0002	NE		0,0023	0,0002		0,0002	NE		0,0063
Se*	mg /kg fuel	0,0002	0,0001	NE		0,0002	0,0001		0,0001	NE		0,0045
Zn*	mg /kg fuel	0,033	0,018	NE		0,033	0,018		0,018	NE		0,0023
PCDD/F	NE	NE	NE	NE		NE	NE		NE	NE		NE
Benzo(a)pyrene	g /kg fuel	5,5E-06	2,14E-05	2E-07		4,2E-06	1,58E-05		5,1E-06	NA		8,4E-06
Benzo(b)fluoranthene	g /kg fuel	7,9E-06	2,24E-05	NE		6,1E-06	1,66E-05		3,08E-05	NA		9,4E-06
Benzo(k)fluoranthene	g /kg fuel	3,9E-06	1,18E-05	2E-07		0,000003	8,7E-06		3,44E-05	NA		6,8E-06
Indeno(1,2,3-cd)pyrene	g /kg fuel	8,9E-06	2,12E-05	2E-07		6,9E-06	1,58E-06		7,9E-06	NA		1,02E-05
HCB	NE	NE	NE	NE		NE	NE		NE	NE		NE
PCBs	NE	NE	NE	NE		NE	NE		NE	NE		NE
CO2	kg/kg fuel	3,18	3,14	3,017		3,18	3,14		3,14	2,75		3,18
Source:	EMEP/EEA 2016 Update June 2017, 1.A.3.b ROAD, Tier 1, page 23-24; For Metals*- page 93, Table 3.77: Heavy metal emission factors; SOx-calculated by formula E=2*k*AD, pages 25-26, Appendix 1.4.											

1.A.3.c Railways

Emissions from railway transport are calculated according to method 1 by formula (1). Emission factors are used by default according to the 2016 EMEP/EEA Guidebook (*1.A.3.c Railways*). Table 3.2.14 also covers emission factors of the next category - Navigation (*1.A.3.d*).

Table 3.2.14. Emission factors *1.A.3.c Railways* and *1.A.3.d Navigation*

Pollutant	Diesel oil	1.A.3.c Railways				Diesel oil	1.A.3.d Navigation		
		EF	*Final units*	Factor			EF	*Final units*	Factor
NOx	g /kg fuel	52,4	kt	0,000001	**NOx**	g /kg fuel	78,5	kt	0,000001
NMVOC	g /kg fuel	4,65	kt	0,000001	**NMVOC**	g /kg fuel	2,8	kt	0,000001
SOx	g /kg fuel	**NA**	kt	**NA**	**SOx**	g /kg fuel	20	kt	0,000001
NH_3	g /kg fuel	0,007	kt	0,000001	**NH_3**	g /kg fuel	NE	kt	NE
$PM_{2,5}$	g /kg fuel	1,37	kt	0,000001	**$PM_{2,5}$**	g /kg fuel	1,4	kt	0,000001

Pollutant	Diesel oil	1.A.3.c Railways				Diesel oil	1.A.3.d Navigation		
PM_{10}	g /kg fuel	1,44	kt	0,000001	**PM_{10}**	g /kg fuel	1,5	kt	0,000001
TSP	g /kg fuel	1,52	kt	0,000001	**TSP**	g /kg fuel	1,5	kt	0,000001
BC	g /kg fuel	0	kt	0,000001	**BC**	g /kg fuel	0	kt	0,000001
CO	g /kg fuel	10,7	kt	0,000001	**CO**	g /kg fuel	7,4	kt	0,000001
Pb	g /kg fuel	**NA**	ton	**NA**	**Pb**	g /kg fuel	0,13	ton	0,000001
Cd	mg /kg fuel	0,01	ton	0,000001	**Cd**	mg /kg fuel	0,01	ton	0,000001
Hg	mg /kg fuel	**NA**	ton	**NA**	**Hg**	mg /kg fuel	0,03	ton	0,000001
As	mg /kg fuel	**NA**	ton	**NA**	**As**	mg /kg fuel	0,04	ton	0,000001
Cr	mg /kg fuel	0,05	ton	0,000001	**Cr**	mg /kg fuel	0,05	ton	0,000001
Cu	mg /kg fuel	1,7	ton	0,000001	**Cu**	mg /kg fuel	0,88	ton	0,000001
Ni	mg /kg fuel	0,07	ton	0,000001	**Ni**	mg /kg fuel	1	ton	0,000001
Se	mg /kg fuel	0,01	ton	0,000001	**Se**	mg /kg fuel	0,1	ton	0,000001
Zn	mg /kg fuel	1	ton	0,000001	**Zn**	mg /kg fuel	1,2	ton	0,000001
PCDD/ F	**NA**	**NA**	g	NA	**PCDD/ F**	µg I-TEQ/ton	0,13	g	0,000001
benzo(a) pyrene	g/ton	0,03	ton	0,000001	**benzo(a) pyrene**	**NE**	**NE**	ton	**NE**
benzo(b) fluoranthene	g/ton	0,05	ton	0,000001	**benzo(b) fluoranthene**	**NE**	**NE**	ton	**NE**
benzo(k) fluoranthene	As N2-N3 g/kg fuel	0,0000344	ton	0,000001	**benzo(k) fluoranthene**	**NE**	**NE**	ton	**NE**
Indeno(1,2,3-cd) pyrene	As N2-N3, g/kg fuel	0,0000079	ton	0,000001	**Indeno (1,2,3-cd) pyrene**	**NE**	**NE**	ton	**NE**
Total 1-4			ton	0,000001	**Total 1-4**	**NE**	**NE**	ton	**NE**
HCB	**NE**	**NE**	kg	**NE**	**HCB**	mg /ton	0,08	kg	0,000001
PCBs	**NE**	**NE**	kg	**NE**	**PCBs**	mg /ton	0,038	kg	0,000001

1.A.3.d.i(ii) Domestic Navigation

In navigation, diesel engines are used and sometimes steam or gas turbines are employed (the latter account for less than 1%).

1.A.3.e Pipelines

The category of emissions from pipelines, according to the recommendations of EMEP/EEA 2016, is calculated using emission factors like those found in *1.A.4.a Commercial/institutional* for natural gas by formula 1.

All pollutants are calculated except for NH_3 ("NE") and HCB and PCBs ("NA"). The factor 10E-09 is used to convert to final units of measurement (Table 3.2.15).

Table 3.2.15. Emission factors *1.A.3.e Pipelines*

Pollutant	Units	Emission factors (as 1.A.4.a Gaseous)	Final units	Factor
NOx	g /GJ	74	kt	1E-09
NMVOC	g /GJ	23	kt	1E-09
SOx	g /GJ	0,67	kt	1E-09
NH_3	Unit	NE	kt	NE
$PM_{2,5}$	g /GJ	0,78	kt	1E-09
PM_{10}	g /GJ	0,78	kt	1E-09
TSP	g /GJ	0,78	kt	1E-09
BC	% from $PM_{2,5}$	0,0312	kt	1E-09
CO	g /GJ	29	kt	1E-09
Pb	mg / GJ	0,011	ton	1E-09
Cd	mg / GJ	0,0009	ton	1E-09
Hg	mg / GJ	0,1	ton	1E-09
As	mg / GJ	0,1	ton	1E-09
Cr	mg / GJ	0,013	ton	1E-09
Cu	mg / GJ	0,0026	ton	1E-09
Ni	mg / GJ	0,013	ton	1E-09
Se	mg / GJ	0,0058	ton	1E-09
Zn	mg / GJ	0,73	ton	1E-09
PCDD/ F (dioxins/ furans)	ng I-TEQ / GJ	0,52	g -TEQ / GJ	1E-09
benzo(a)pyrene	mg / GJ	0,00072	ton	1E-09
benzo(b)fluoranthene	mg / GJ	0,0029	ton	1E-09
benzo(k)fluoranthene *	mg / GJ	0,0011	ton	1E-09
Indeno(1,2,3-cd)pyrene*	mg / GJ	0,00108	ton	1E-09
Total 1-4	mg / GJ		ton	1E-09
HCB	µg /GJ	NA	kg	NA
PCBs	µg /GJ	NA	kg	NA

1.A.3.b.v Road transport: Gasoline evaporation. 1.A.3.b.vi Road transport: Automobile tire and brake wear. 1.A.3.b.vii Road transport: Automobile road abrasion.

For calculation of emissions in category *1.A.3.b.v Road transport: Gasoline evaporation*, one NMVOC pollutant is calculated - the following expression is used:

$$Emissions\ (NMVOC) = EF * M1 * 365/10^9 \qquad (3.2.1)$$

where M1 is the number of cars on gasoline,

365 is the number of days in a year.

The emission factor has a unit of measure "grams/vehicle per day", therefore, the factor includes the factor 10E09 - factor for converting emissions from grams to kilotons.

A similar formula is used to calculate emissions from light trucks up to 3,5 tons (N1) and motorcycles with different engine sizes (L1-L5).

For emission calculations for category *1.A.3.b.vi Road transport: Automobile tire and brake wear*, $PM_{2.5}$; PM_{10}; TSP are calculated for vehicles of all groups (M1, N1, N2-N3, M2-M3, L1-L5) and all types of fuel (gasoline, diesel, LPG, CNG) depending on the average distance travelled (AM) according to the formula (example for M1):

$$Emissions\ (PM_{2.5};\ PM_{10};\ TSP) = EF * M1 * AM / 10^9 \qquad (3.2.2)$$

where M1 is the number of cars,

AM is average mileage.

The emission factor has a unit of measure "g/km vehicle", therefore, the formula includes a factor - 10E09 - factor for converting emissions from grams to kilotons.

A similar formula is used to calculate emissions from light trucks up to 3,5 tons (N1) and other vehicles N2-N3, M2-M3, L1-L5.

Emission calculations for category *1.A.3.b.vii Road transport: Automobile road abrasion*

$PM_{2.5}$; PM_{10}; TSP are calculated for vehicles of all groups (M1, N1, N2-N3, M2-M3, L1-L5) and all types of fuel (gasoline, diesel, LPG, CNG) depending on the average distance travelled (AM) according to the formula (example for M1):

$$Emissions\ (PM_{2.5};\ PM_{10};\ TSP) = EF * M1 * AM / 10^9 \qquad (3.2.3)$$

where M1 is the number of cars,

AM is average mileage.

The emission factor has a unit of measure "g/km vehicle", therefore, the formula includes a factor - 10E09 - factor for converting emissions from grams to kilotons.

A similar formula is used to calculate emissions from light trucks up to 3,5 tons (N1) and other vehicles N2-N3, M2-M3, L1-L5.

Emission factors, formulas, and necessary comments for the three categories described are given in the Table 3.2.16.

Table 3.2.16. Emission factors for categories *1.A.3.b.v Road transport: Gasoline evaporation, 1.A.3.b.vi Road transport: Automobile tire and brake wear, 1.A.3.b.vii Road surface wear*

1.A.3.b.v Road transport: Gasoline evaporation			**1.A.3.b.v**
		Emission factor	
		NMVOC	
		Grams / vehicle per day	
M1	*Gasoline only*	7,8	
N1	*Gasoline only*	12,7	
L1-L5	*Gasoline*	4,6	
Formula: Emissions (NMVOC) = EF*M1*365/10^9 (and analogically for other groups)			
1.A.3.b.vi Road transport: Automobile tyre and brake wear	Emission factors		**1.A.3.b.vi**
	$PM_{2,5}$	**PM_{10}**	**TSP**
all fuels	g/ km vehicle	g/ km vehicle	g/ km vehicle
L1-L5	0,0034	0,0064	0,0083
M1	0,0074	0,0138	0,0182
N1	0,0117	0,0216	0,0286
N2-N3 and M2-M3	0,0316	0,059	0,0777
Formula:	Emissions ($PM_{2,5}$; PM_{10}; TSP) = EF*M1*AM/10^9 AM for all fuels type of M1: (M1(gasoline)* AM(gasoline)+M1(diesel)* AM(diesel)+M1(LPG)* AM(LPG))/ Number all M1 ; N1 and other-analogically		
1.A.3.b.vii Road surface wear			**1.A.3.b.vii**
	Emission factors		
	$PM_{2,5}$	**PM_{10}**	**TSP**
all fuels	g/ km vehicle	g/ km vehicle	g/ km vehicle

1.A.3.b.v Road transport: Gasoline evaporation			1.A.3.b.v
L1-L5	0,0016	0,003	0,006
M1	0,0041	0,0075	0,015
N1	0,0041	0,0075	0,015
N2-N3 and M2-M3	0,0205	0,038	0,076
Formula	Emissions ($PM_{2,5}$; PM_{10}; TSP) = EF*M1*AM/10^9 AM for all fuels type of M1: (M1(gasoline)* AM(gasoline)+M1(diesel)* AM(diesel)+M1(LPG)* AM(LPG))/ Number all M1; (Average mileage-AM); N1 and other-analogically		
Sources EF:	1.A.3.b.vi Road Vehicle tyre and brake wear and 1.A.3.b.vii Road surface wear, Table 3.1.		
	1.A.3.b.vi Road Vehicle tyre and brake wear and 1.A.3.b.vii Road surface wear, Table 3.2.		

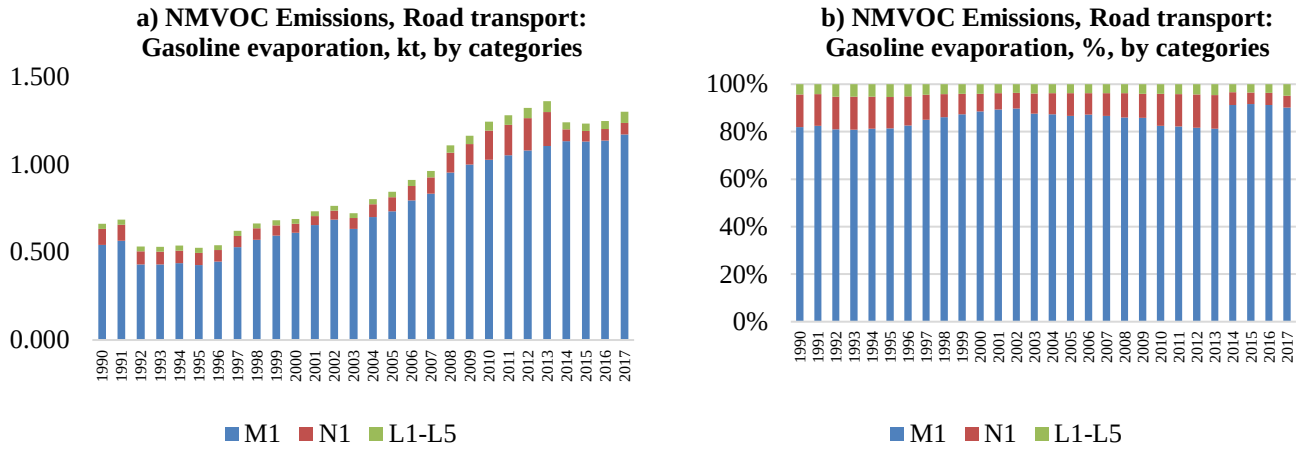


Figure 3.2.3. NMVOC Emissions by category *1.A.3.b.v Road transport: Gasoline evaporation*, 1990-2017

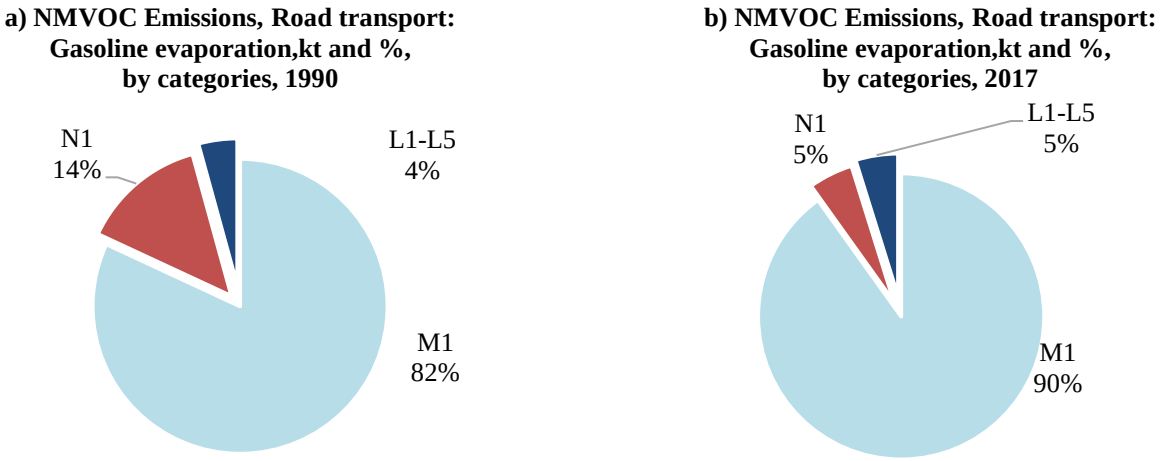


Figure 3.2.4. NMVOC Emissions by category *1.A.3.b.v Road transport: Gasoline evaporation* in 1990 and 2017

NMVOC emissions in category *1.A.3.b.v Road transport: Gasoline evaporation* are shown in the Figures 3.2.3 and 3.2.4.

The overall observed dynamics is an increase in emissions in the period 1990-2013, then a decrease (Figure 3.2.3a). The largest emissions are included in the category of M1 cars. The contribution of the M1 category in total emissions from gasoline evaporation was 82% in 1990 and 90% in 2017 (Figures 3.2.4a and b). The contribution of light trucks (N1) has significantly reduced from 14% in 1990 to 5% in 2017. The contribution of emissions from motorcycles remained at the level of 4-5% (Figure 3.2.4a and b).

Emissions in the categories *1.A.3.b.vi Road transport: Automobile tire and brake wear* and 1.*A.3.b.vii Road transport: Automobile road abrasion* have similar trends. In 1990-2000, there was a decrease in emissions (Figure 3.2.5.a, c, and e). In 2001-2017, there was a gradual growth. The main reason is the increase in the total number of cars in the country.

The largest contribution is made by trucks and buses (N2-N3, M2-M3), then passenger cars (M1). The share of motorcycles is insignificant in the total emissions of particulate matter from the wear of tires, brakes, and road surface (Figure 3.2.5 b, d, and f).
The charts in Figure 3.2.5.a-d show emission trends for each type of particulate matter separately ($PM_{2.5}$; PM_{10}; TSP) in kilotons (Figure 3.2.5.a, c and e) and in per cent (Figure 3.2.5 b, d and f) of contributions from each category of vehicles to total emissions for one category *1.A.3.b.vii Road transport: Automobile road abrasion.*

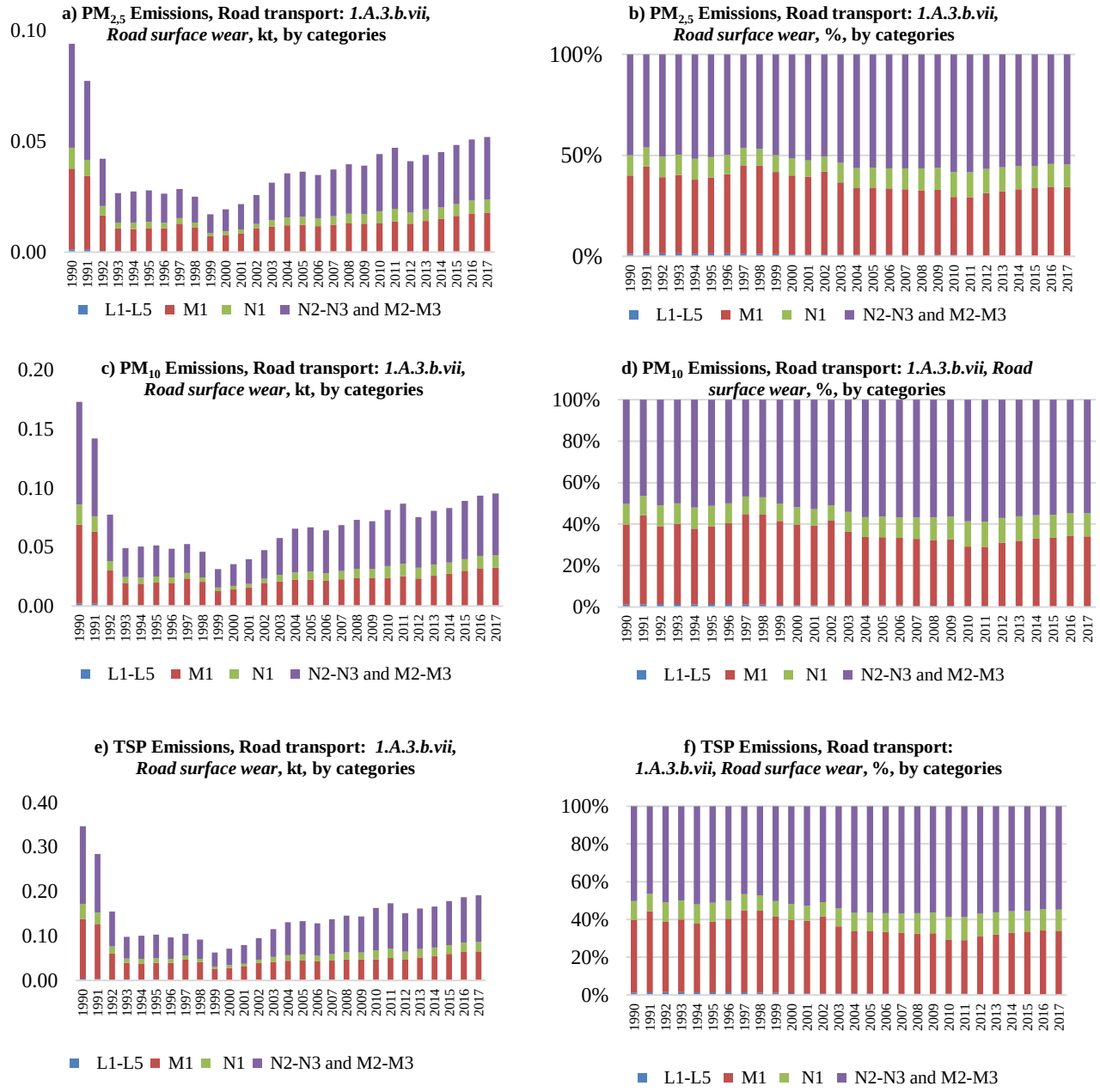


Figure 3.2.5. Emissions by category *1.A.3.b.vii Road surface wear*

3.2.3.3. Activity data

1.A.3.i Aviation

Fuel consumption in aviation from the Right Bank region is given in a separate column in Energy Balances for the years 1990 and 1993-2017. Data for *domestic* aviation are used from the NIR 1990-2016.

Fuel data for the years 1991-1992 are determined by interpolation. Data on the number of departures for the years 1990-1994 are taken according to the first known value in the series – as for 1995 (Table 3.2.17).

Table 3.2.17. Fuel Consumption in the International and Domestic Aviation Categories

Year	Total Fuel Consumption in Aviation sector Energy Balances, kt	Fuel Consumption in domestic Aviation, kt	Number of LTO, units
1990	69	2	2829
1991	53		2829
1992	39		2829
1993	19,7	0,2000	2829
1994	11		2829
1995	11		2829
1996	18		3592
1997	21		4634
1998	17		4743
1999	20		4503
2000	20		7455
2001	16	0,0321	8211
2002	19	0,0278	9170
2003	11	0,2146	10644
2004	11	0,1352	12860
2005	12	0,0369	13570
2006	12	0,0645	13344
2007	14	0,0411	11091
2008	14	0,0496	8210
2009	14	0,0249	7992
2010	13	0,0383	10017
2011	13	0,0395	7343
2012	15	0,0676	6232
2013	13	0,0643	9281
2014	17	0,0390	10206
2015	18	0,1019	11890
2016	32	0,0753	12058
2017	47		12058
Source: Energy Balance, NIR 1990-2016 (2001-2016)			

Table 3.2.18. Calculations of consumed fuel during landing and take - off, cruise flight and calculations of pollutant emissions in the category “International Aviation” according to method 1 - implementation of the algorithm

	1990	*units*		*units*	*source*							
Fuel, total aviation	**69 000**	ton			fact							
Fuel domestic aviation	**2000**	ton			fact							
Fuel international aviation	67000	ton			calculation							
Number fleets	**2829**	LTO			fact							
Fuel for LTO, kg/ circle LTO	825	Total Fuel for LTO:	2 334	ton	table 3-3, EMEP-2013, Aviation, average fleet							
cruise fuels	**64 666**	ton			calculation							
		1990	*NOx*	*NMVOC*	*SOx*	*NH_3*	*$PM_{2,5}$*	*PM_{10}*	*TSP*	*BC*	*CO*	
Emission factors for circle LTO, kg / LTO, table 3-3, EMEP-2013			8,3	0,5	0,8	NE	0,07	0,08	0,09	0,0336	11,8	
Emission factor for cruise kg/ ton			17,6	0,8	1	NE	0,2	1,2	2,2	0,0960	1	
		Emissions, kiloton										
number LTO	**2 829**	Emissions from LTO, kt	0,0235	0,0014	0,0023	NE	0,0002	0,0002	0,0003	0,0001	0,0334	
fuel cruise, ton	**64 666**	Emissions from cruise, kt	1,1381	0,0517	0,0647	NE	0,0129	0,0776	0,1423	0,0062	0,0647	
			Nox	*NMVOC*	*Sox*	*NH_3*	*$PM_{2,5}$*	*PM_{10}*	*TSP*	*BC*	*CO*	
Final	Total	Emissions, kt	**1,1616**	**0,0531**	**0,0669**	NE	**0,0131**	**0,0778**	**0,1425**	**0,0063**	**0,0980**	

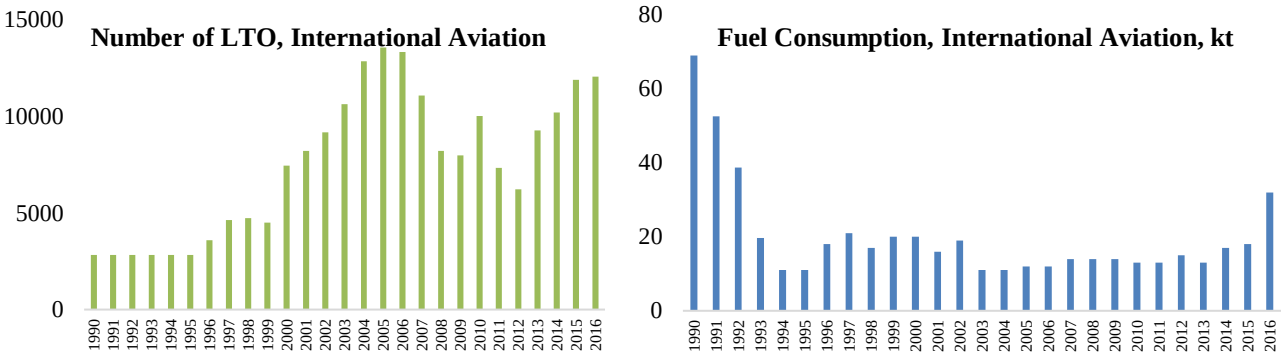


Figure 3.2.6. *1.A.3.a.i(i)* fuel consumption, international aviation and number of departures

According to Figure 3.2.6, the evolution of the number of LTO for International Aviation in the *1.A.3.a.i* category increased from 2829 in 1990 to 12058 in 2017. Between 1990 and 1994, fuel consumption tended to decrease, from 69 kt in 1990 to 11 kt in 1995, while later it slightly increased from 18 kt in 1996 to 47 kt in 2017.

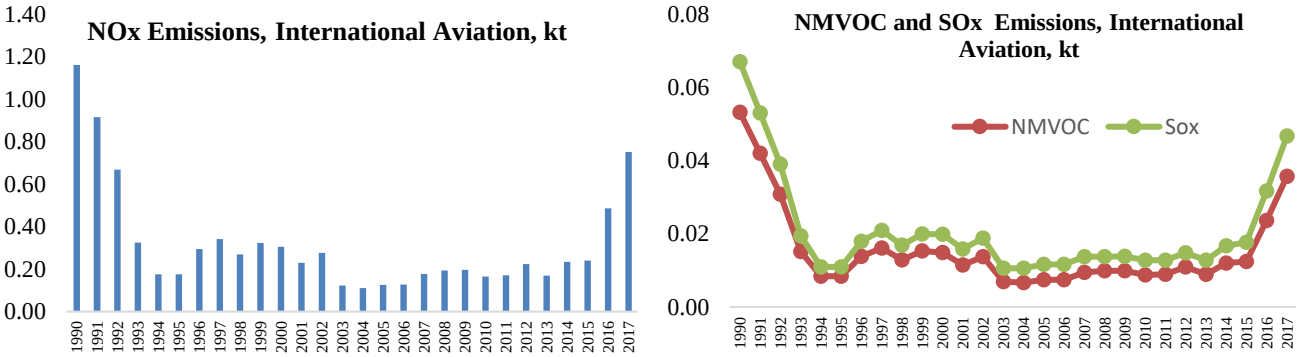


Figure 3.2.7. NO_x and NMVOC, SO_x Emissions by category *1.A.3.a.i(i) International Aviation*, kt

In the period 1990-2017, emissions had the same variable trend as fuel consumption: decrease from 1990 to 1995 and increase from 1996 to 2017. In comparison with the reference year, by 2017 the NOx, NMVOC and SOx emissions from *1.A.3.a.i Aviation* decreased as follows: NOx from 1,16 (1990) to 0,75 kt (2017), NMVOC from 0,0531 (1990) to 0,03 kt (2017) and SOx from 0,07 (1990) to 0,05 kt (2017) (Figure 3.2.7).

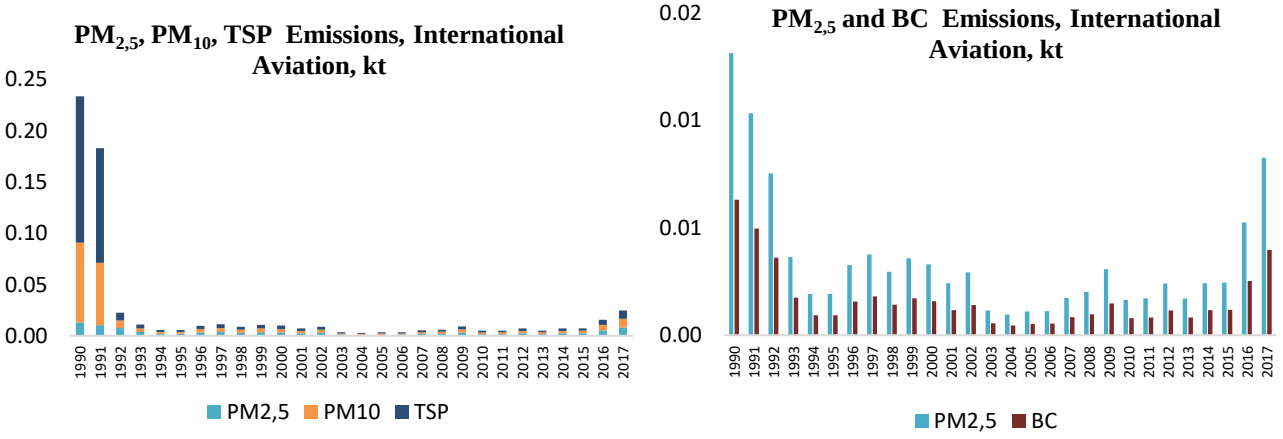


Figure 3.2.8. $PM_{2.5}$, PM_{10}, TSP, BC Emissions by category 1.*A.3.a.i(i) International Aviation*, kt

1.A.3.b.i Road transport (SNAP:0701)

The total fuel consumption in the Right Bank region in the transport sector is available in the Energy Balances for 1990 and 1993-2017. Data for 1991-1992 was restored by the interpolation method.
The data for the Left Bank region are calculated according to the recovery method by using indirect data. It was assumed that the specific fuel consumption of each type per person in the Right Bank region was the same as in the Left Bank region.
The categorization of vehicles was carried out using the following sources: Third National Environmental Indicators Survey (2010, prepared for UNECE), Statistical Yearbooks, Registru.md and data for COPERT, experimental calculations made while preparing the National Inventory Report 1990-2016 for 3 years (2014-2016), but not included in it. The results were published in 2 scientific articles in 2018.
The amounts of fuel consumed for each category are calculated according to the developed special author's algorithm using typical fuel consumption in accordance with EMEP/EEA air pollutant emission inventory guidebook 2016 - Last Update June 2017, p.26. The total amount of fuel for both regions is shown in the Table 3.2.19.

Table 3.2.19. Activity Data by *1.A.3.b Road,* kg

Year	M1 1.A.3.b.i Road transport				N1 1.A.3.b.ii Road transport			N2, N3, M2, M3 1.A.3.b.iii Road transport		L1-L5 1.A.3.b.iv Road transport
	Gasoline	Diesel fuel	LPG		Gasoline	Diesel fuel		Diesel fuel	LPG	Gasoline
1990	575230958	49629905	6955740		326718751	118539045		363982528	15420953	25411331
1991	534688663	35113562	8662728		291676787	80654759		247057279	18431821	22637328
1992	246192989	22886011	5113132		140316047	54939513		168195298	11364698	13670636
1993	158336227	13260928	6056308		91103780	32096119		98496177	13599486	8782553
1994	152221722	15919882	4118693		85073728	37341742		115076157	8994916	8296497
1995	161250197	15900930	3251518		89014070	36634517		114064884	7036118	8971081
1996	157810610	15684081	4102146		80441174	32834761		105277476	8270169	8391501
1997	191557306	18121956	4253461		82790024	31434730		105050351	7361599	8585916
1998	165635623	17155651	4488267		67635841	27381641		95877077	7440697	6864315
1999	98392275	14990786	4611044		35952216	20783836		76602009	6941994	3910670
2000	100809205	21463362	5020426		32096488	25573377		96495676	6629901	3904169
2001	109966309	25612676	4929081		33168721	27840965		111879582	6275240	3958584
2002	143355964	29371086	5558801		42015427	30469224		126106991	6931783	4922121
2003	153453520	29900924	5383217		64764574	47610027		158024491	3252692	5710573
2004	162979388	31691535	4548108		71095558	54788158		191788911	2796245	5891346
2005	166909314	30986271	4795421		74564807	57059571		193749609	2538634	6220164
2006	154579354	33121392	4755495		65290320	55654363		191507763	2569156	5645800
2007	156438262	39457289	6138708		68752874	62042512		206311022	3109404	5753155
2008	157911211	44052678	8483925		72661456	69174724		218098414	5344079	5842705
2009	148518979	49122320	10552232		66856469	69056555		215785246	6393610	5891545
2010	136929203	60747518	10920151		81778939	88757306		254118190	5534016	5781388
2011	142676982	68800053	9299394		85693760	95506457		272891022	3705545	6189567
2012	114738651	75007145	12792038		70980550	81288831		230992840	3630013	5181721
2013	109763941	97436732	14116674		68890840	87639848		247938332	2288105	5193850
2014	133698957	93347718	11509915		43561698	95996935		265238512	4877894	4116316
2015	136328282	103779485	18060458		42923832	88524516		284049527	7101710	4396795
2016	139685577	110876221	24478264		43610974	107390143		293713251	8806640	4689771
2017	133221649	120260942	24035574		41872315	105766962		303445534	6918868	6038707

1.A.3.c Railways

Diesel oil consumption by railway transport is shown in the Table 3.2.20. As shown in Figure 3.2.9, the diesel oil amount has decreased sharply since 1990

Table 3.2.20. Fuel Consumption in Railways

1A3c, ton	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fuel Consumption in Railways, ton	153 759	131 413	109 133	86 233	34 574	30 918	29 645	24 860	18 927	9 453
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Fuel Consumption in Railways, ton	10 615	11 767	25 842	14 069	18 459	25 345	32 216	32 171	29 839	16 050
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**%**	comment
Fuel Consumption in Railways, ton	16 035	14 875	16 004	10 281	1 141	6 802	14 722	11 321	-93	decrease

Source: Energy Balances, 1990, 1993-2017.

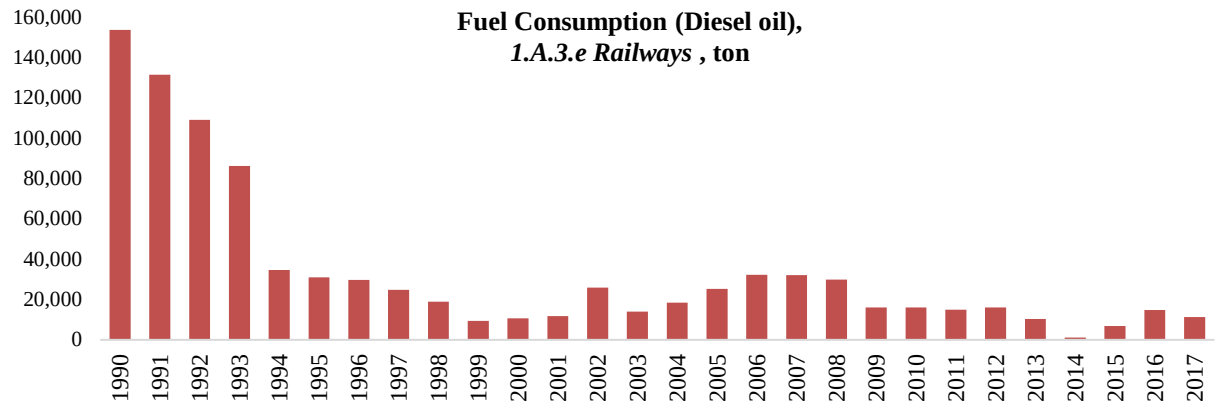


Figure 3.2.9. Fuel Consumption (Diesel oil), *1.A.3e Railways*, tons

In the period 1990-2017, the total consumption of diesel oil for *1.A.3.e Railways* decreased by circa 93% (from 153 759 tons in 1990 to 11 321 tons in 2017) (Figure 3.2.9).

1.A.3.d.i(ii) Domestic Navigation

Water transport in Moldova is represented by a small number of vessels and low fuel consumption in the Statistical Yearbook. There is a line "Navigation" use of diesel fuel in Energy Balance.
Tables from EMEP/EEA 2016 have two sets of emission factors - for diesel fuel and Bunker Fuel Oil.
To estimate emissions, the emission factors for *diesel fuel (marine diesel*) were used.
This fuel was selected, since in the fuel and Energy Balance values are available only for diesel fuel, and only for some years (1990, 1993, 2013-2017).
Energy balance data for water transport are available only for recent years and for 1990. Part of the fuel data can be used from the publication of the National Inventory Report 1990-2016, which provides data on fuel consumption based on letters from economic agents. These data are used for those years for which there are no values in Energy Balance (1991-1992, 1994-2017) (Table 3.2.21 and Figure 3.2.10).
In the future, it can be replaced by restored data, when there will be a longer series of actual values for fuel in the Energy Balance. According to Figure 3.2.10, the use of diesel oil in *1.A.3.d Navigation* category has been constant from 1991 to 2013.

Table 3.2.21. Fuel Consumption in Navigation

1.A.3.d, ton	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fuel Consumption in Navigation, tons	6000	76	65	75	59	57	62	67	42	70
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Fuel Consumption in Navigation, tons	31	56	130	118	120	102	86	99	109	86
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**%**	comment
Fuel Consumption in Navigation, tons	73	75,009	85,685	86,253	1000	1000	1000	1000	-93	decrease

Source: Energy Balances, 1990, 1993, 2013-2017, other data - NIR 1990-2016.

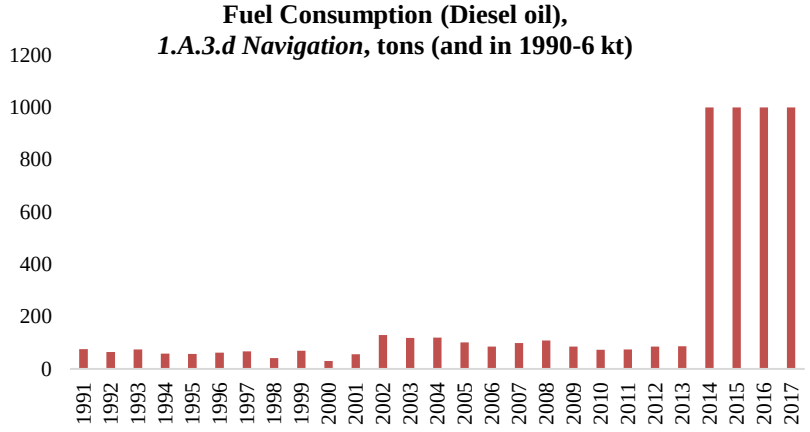


Figure 3.2.10. Diesel oil consumption by category *1.A.3.d Navigation*

Between 1991 and 2017, diesel oil consumption by category *1.A.3.d Navigation* tended to increase from 76 tons (1991) to 1000 tons (2017) (Figure 3.2.10). In the reference year 1990, the fuel consumption was 6000 tons (Table 3.2.21). Diesel oil consumption recorded a significant decrease, from circa 86,253 tons in 2013 to 1000 tons in 2017. In total, in 2017 fuel consumption in this category represented only 16,6% of the reference year level (1990).

1.A.3.e Pipeline

Activity data for this category are available in energy balances, line "Pipelines" (Table 3.2.22). Activity data are used in GJ since emission factors are measured in GJ.
The amount of fuel consumed is reflected in two graphs in Figure 3.2.11, which shows the dynamics of the total consumption of natural gas in each region.
The data for the Left Bank region were calculated using the indirect recovery method, based on the assumption that the specific fuel consumption for this category per inhabitant is the same for both regions.

Table 3.2.22. Fuel Consumption in Pipeline

	1.A.3.e Pipeline, GJ	Fuel Consumption								
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Gas, GJ	1 625 280	1 194 187	763 093	332 000	1 555 000	1 496 000	2 112 000	880 000	851 000	939 000
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gas, GJ	528 000	488 667	449 333	410 000	663 000	629 000	117 000	54 000	72 000	169 300
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**%**	comment
Gas, GJ	271 000	406 000	363 000	225 000	293 000	297 000	237 000	314 000	-80,68%	decrease

Source: Energy Balances, 1990, 1993-2017.

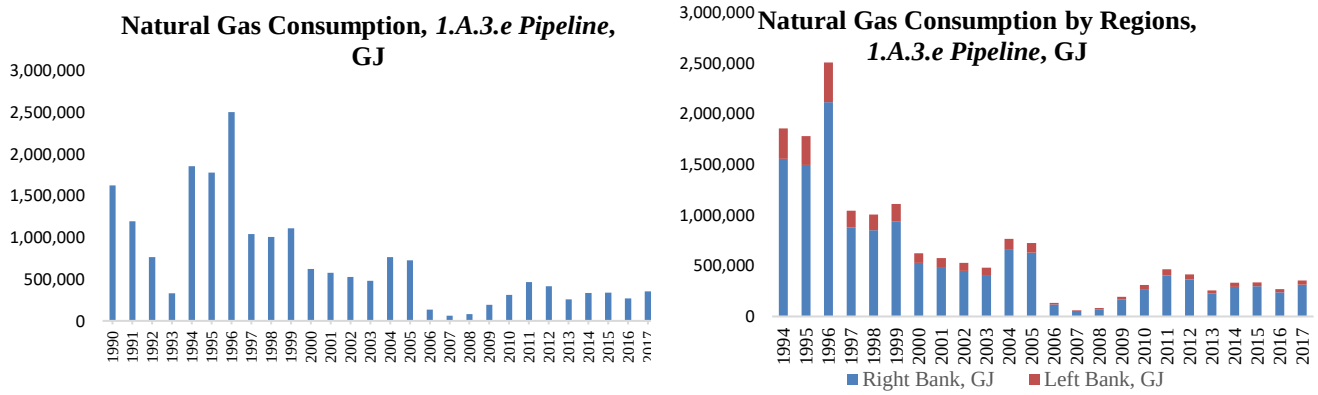


Figure 3.2.11. Natural Gas Consumption by category *1.A.3.e Pipeline*

The natural gas consumption by category *1.A.3.e Pipeline* significantly varied during the reference period, from a maximum of 2112000 GJ in 1996 to a minimum of 54000 in 2007. It should be noted that in comparison with the natural gas consumption in the Left Bank region, the Right Bank region has a larger share during all period under review (Figure 3.2.11).

3.2.4. Small combustion (NFR 1.A.4)

3.2.4.1. Description of sources

Category *1.A.4* includes emissions from commercial and institutional buildings, heating homes and water, household cooking and burning fuel in agriculture, forestry, and fisheries, as well as emissions from mobile sources related to these sectors.
The following source categories are included:

- 1.*A.4.a.i Commercial/institutional: Stationary;*
- *1.A.4.b.i Residential: Stationary plants;*
- *1.A.4.c.i Agriculture/Forestry/Fishing: Stationary;*
- *1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery.*

Categories *1.A.4.a.ii* and *1.A.4.b.ii* are not calculated separately, but are included in categories *1.A.4.a.i* and *1.A.4.b.i*.

Table 3.2.23. Source category description

NFR Code	Long name		Reporting aggregation
	Other Stationary Combustion		
1.A.4.a.i	Commercial/institutional: Stationary		Fuel combustion in commercial and institutional buildings (stationary)
1.A.4.a.ii	Commercial/institutional: Mobile	IE	Diesel and gasoline consumption in commercial/institutional sector. Reported together with **1.A.4.a.i**
1.A.4.b.i	Residential: Stationary		Fuel combustion in households (such as heating and water warming), except combustion of diesel and gasoline, which is allocated to **1.A.4.b.ii**
1.A.4.b.ii	Residential: Household and gardening (mobile)	IE	Combustion of diesel and gasoline in residential sector Reported together with **1.A.4.b.i**
1.A.4.c.i	Agriculture/Forestry/Fishing: Stationary		Stationary fuel combustion in agriculture, forestry and fishing industries
1.A.4.c.ii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery		Combustion of diesel, gasoline and LPG in Agriculture/Forestry/Fishing, in off-road vehicles and in forestry works.
1.A.4.c.iii	Agriculture/Forestry/Fishing: National fishing	IE	Reported together with **1.A.4.c.ii**

3.2.4.2. Methods and emission factors

The Tier 1 method and emission factors from the 2016 EMEP/EEA Guidebook were used to calculate emissions in sectoral categories *1.A.4 Small combustion.*

Below are tables with EFs for calculating emissions in the sector category Small-scale combustion.

Table 3.2.24. Emission factors for the combustion of fuel for sectors *1.A.4.a.i Commercial/institutional and 1.A.4.c.i Agriculture/Forestry/Fishing*

Pollutant	Unit	Hard Coal and Brown Coal	Gaseous Fuels	Liquid Fuels	Biomass
NOx	g/GJ	173	74	306	91
NMVOC	g/GJ	88,8	23	20	300
SOx	g/GJ	840	0,67	94	11
NH_3	g/GJ	NE	NE	NE	37
$PM_{2.5}$	g/GJ	108	0,78	18	140
PM_{10}	g/GJ	117	0,78	21	143
TSP	g/GJ	124	0,78	20	150
BC	% of $PM_{2.5}$	6,912	0,0312	10,08	39,2
CO	g/GJ	931	29	93	570
Pb	mg/GJ	134	0,011	8	27
Cd	mg/GJ	1,8	0,0009	0,15	13
Hg	mg/GJ	7,9	0,1	0,1	0,56
As	mg/GJ	4	0,1	0,5	0,19
Cr	mg/GJ	13,5	0,013	10	23
Cu	mg/GJ	17,5	0,0026	3	6
Ni	mg/GJ	13	0,013	125	2
Se	mg/GJ	1,8	0,058	0,1	0,5
Zn	mg/GJ	200	0,73	18	512
PCDD/F	ng I-TEQ/GJ	203	0,52	6	100
Benzo(a)pyrene	mg/GJ	45,5	0,00072	0,0019	10
Benzo(b)fluoranthene	mg/GJ	58,9	0,0029	0,015	16
Benzo(k)fluoranthene	mg/GJ	23,7	0,0011	0,0017	5
Indeno(1,2,3-cd)pyrene	mg/GJ	18,5	0,00108	0,0015	4
HCB	µg/GJ	0,62	NE	0,22	5
PCB	µg/GJ	170	NE	0,13	0,06

Source: EMEP/EEA air pollutant emission inventory guidebook 2016, 1.A.4 Small combustion, – Last update July 2017, Tab. 3.7-3.10, p.40-43, Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a.

Table 3.2.25. Emission factors, *1.A.4.b.i Residential*

Pollutant	Unit	Hard Coal and Brown Coal	Gaseous Fuels	Other Liquid fuel	Biomass
NOx	g/GJ	110	51	51	50
NMVOC	g/GJ	484	1,9	0,69	600
SOx	g/GJ	900	0,3	70	11
NH_3	g/GJ	0,3	NE	NE	70
$PM_{2.5}$	g/GJ	398	1,2	1,9	740
PM_{10}	g/GJ	404	1,2	1,9	760
TSP	g/GJ	444	1,2	1,9	800
BC	% of $PM_{2.5}$	25,472	0,0648	0,1615	74
CO	g/GJ	4600	26	57	4000
Pb	mg/GJ	130	0,0015	0,012	27
Cd	mg/GJ	1,5	0,00025	0,001	13
Hg	mg/GJ	5,1	0,68	0,12	0,56
As	mg/GJ	2,5	0,12	0,002	0,19

Pollutant	Unit	Hard Coal and Brown Coal	Gaseous Fuels	Other Liquid fuel	Biomass
Cr	mg/GJ	11,2	0,00076	0,2	23
Cu	mg/GJ	22,3	0,000076	0,13	6
Ni	mg/GJ	12,7	0,00051	0,005	2
Se	mg/GJ	1	0,011	0,002	0,5
Zn	mg/GJ	220	0,0015	0,42	512
PCDD/F	ng I-TEQ/GJ	800	1,5	5,9	800
Benzo(a)pyrene	mg/GJ	230	0,00056	0,08	121
Benzo(b)fluoranthene	mg/GJ	330	0,00084	0,04	111
Benzo(k)fluoranthene	mg/GJ	130	0,00084	0,07	42
Indeno(1,2,3-cd)pyrene	mg/GJ	110	0,00084	0,16	71
HCB	µg/GJ	0,62	NE	NE	5
PCB	µg/GJ	170	NE	NE	0,06

Source: EMEP/EEA air pollutant emission inventory guidebook 2016, 1.A.4 Small combustion – Last update July 2017 Tab. 3.3-3.6, p.36-39, Tier 1 emission factors for NFR source category 1.A.4.b.

Table 3.2.26. Emission factors, *1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery*

Pollutant	Unit	LPG	Diesel oil	Gasoline: four-stroke
NOx	g /t fuel	28571	34457	7117
NMVOC	g /t fuel	6720	3542	18893
SOx	g /t fuel	NE	Formula to SOx	Formula to SOx
NH_3	g /t fuel	10	8	4
$PM_{2.5}$	g /t fuel	225	1913	157
PM_{10}	g /t fuel	225	1913	157
TSP	g /t fuel	225	1913	157
BC	g /t fuel	11	1111	8
CO	g /t fuel	4823	11469	770368
Pb	mg /kg fuel	NE	NE	NE
Cd	mg /kg fuel		0,1	0,01
Hg	mg /kg fuel	NE	NE	NE
As	mg /kg fuel	NE	NE	NE
Cr	mg /kg fuel	NE	0,05	0,05
Cu	mg /kg fuel	NE	1,7	1,7
Ni	mg /kg fuel	NE	0,07	0,07
Se	mg /kg fuel	NE	0,01	0,01
Zn	mg /kg fuel	NE	1	1
PCDD/F		NE	NE	NE
Benzo(a)pyrene	µg /kg fuel	NE	80	75
Benzo(b)fluoranthene	µg /kg fuel	NE	50	40
Benzo(k)fluoranthene	µg /kg fuel	NE	NE	NE
Indeno(1,2,3-cd)pyrene	µg /kg fuel	NE	NE	NE
HCB		NA	NA	NA
PCB		NA	NA	NA

Source: EMEP/EEA air pollutant emission inventory guidebook 2016, 1.A.4 Non-road mobile machinery 2016, update May 2017, Tab. 3.3-3.6, p.36-39, Tier 1 emission factors for off-road machinery, p.23.

SOx emissions were calculated for *1.A.4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery* and for categories *1.A.3.b Road transport* (M1, N1, N2-N3-M2-M3, L1-L5), 1.A.5.b using the formula:

$$ESO_2 = 2 \Sigma\Sigma\, kS,l\; bj,l \qquad (3.2.4.1)$$

Where

kS,l = weight of sulphur content in fuel of type l [kg/kg],

bj,l = total annual consumption of fuel of type l [kg] by source category j.

Table 3.2.27. Typical sulphur content of fuel

Fuel	1996 Base fuel (Market average)	Fuel 2000	Fuel 2005	Fuel 2009 and later
Petrol	165 ppm	130 ppm	40 ppm	40 ppm
Diesel	400 ppm	300 ppm	40 ppm	8 ppm

Source: EMEP/EEA air pollutant emission inventory guidebook 2016, 1.A.3.b.i-iv Road transport July 2017, Table 3-14: Tier 1 — Typical sulphur content of fuel, p.26.

Details on SOx emission calculations can be found in Annex 1.2.

3.2.4.3. Activity data

Activity data are presented in the Energy balances of the Republic of Moldova and in the statistical publications “Social and Economic Development of Transnistria” and "Press-Release Housing".

For stationary combustion categories (*1.A.4.a.i /c.i and 1.A.4.b.i*), activity data were taken from the fuel and Energy Balance in TJ (Table 3.2.28).

Fuel data in the Agricultural sector were first divided into two subcategories: *1.A.4.ci Stationary Sources* (consumption of coal, fuel oil, natural gas, and other fuels) and *1.A.4.cii Mobile Sources* (diesel, gasoline, and LPG). Next, each category is discussed in more detail.
The use of liquid fuels in category *1.A.4.a Commercial/institutional* was significantly reduced: from 2,088 to 51 TJ (1990/2017) (Figure 3.2.12b).
Solid fuel consumption decreased by 93,4%: from 11,790 to 773 TJ (1990/2017) (Figure 3.2.12b).
At the same time, there was an increase in gaseous fuel consumption by 167%: from 1,698 to 4,528 TJ (1990/2017) (Figure 3.2.12a). The use of biofuels in 2017 amounted to 495 TJ.

Table 3.2.28. Data on fuel consumption, *1.A.4.a.i Commercial / institutional: Stationary*, TJ

Year	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	2088	11790	1698	333
1991	1295	9252	1621	258
1992	1329	6082	1858	184
1993	1064	4572	1182	115
1994	440	3315	616	117
1995	411	3433	616	117
1996	322	3051	793	176
1997	147	2641	763	117
1998	176	2699	616	117
1999	146	1848	726	88
2000	235	1438	868	88
2001	293	1526	1217	146
2002	117	1878	4204	147
2003	146	2990	4951	527
2004	171	2534	9976	334
2005	77	2091	8745	246
2006	54	1995	7940	282
2007	90	1588	3582	282
2008	181	1478	3813	313
2009	269	1508	5461	576
2010	237	1073	6287	286
2011	159	1085	12253	267
2012	31	1007	12051	350
2013	10	1100	6463	291
2014	7	784	7252	491
2015	163	749	4547	383
2016	71	761	4615	321
2017	51	773	4528	495

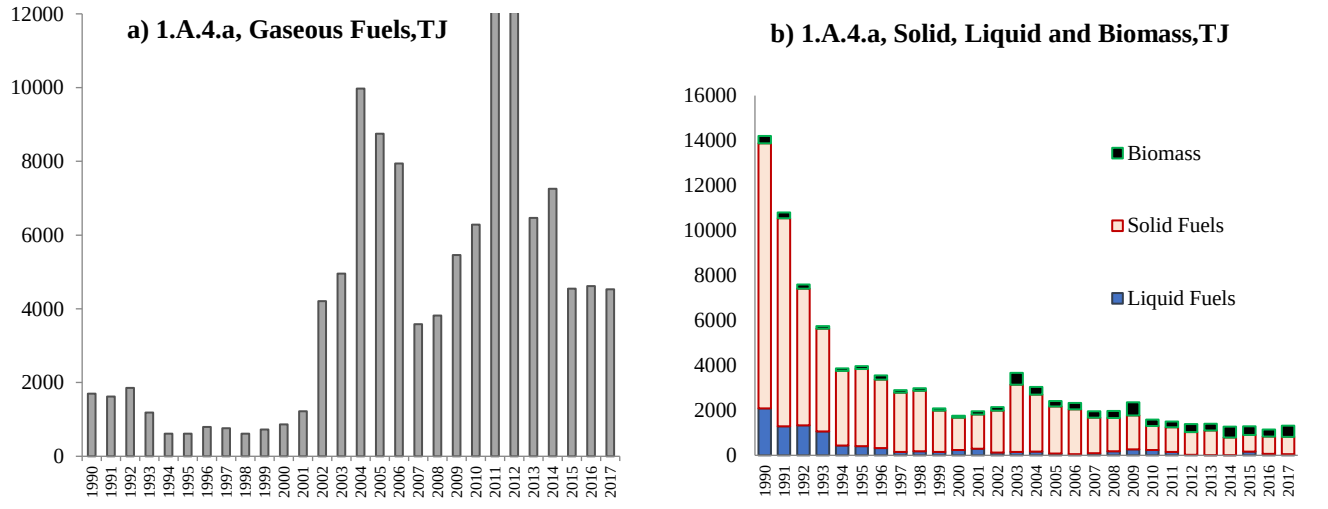


Figure 3.2.12. Fuel consumption, *1.A.4.a.i Commercial/institutional: Stationary*, TJ

Table 3.2.29 shows that:
• The consumption of liquid fuel decreased by 99,6% (from 1363 TJ in 1990 to 5 TJ in 2017),
• The consumption of solid fuel decreased by 91,4% (from 561 TJ in 1990 to 48 TJ in 2017),
• The use of gaseous fuels increased by 30% (from 68 TJ in 1990 to 88 TJ in 2017) (Figure 3.2.13a),
• The use of biofuels increased by 36% (from 36 TJ in 1990 to 49 TJ in 2017) (Figure 3.2.13b).

Table 3.2.29. Data on fuel consumption, *1.A.4.c.i Agriculture/Forestry/Fishing*, TJ

Year	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	1363	561	68	36,0
1991	5639	4315	67	27,0
1992	3832	4083	67	18,0
1993	681	232	67	41,0
1994	176	147	88	58
1995	29	88	147	29
1996	117	88	176	58
1997	117	29	352	146
1998	264	29	293	29
1999	117	0	176	0
2000	147	0	176	0
2001	205	0	117	29
2002	59	0	117	0
2003	29	0	177	29
2004	21	10	258	10
2005	14	6	110	22
2006	4	5	65	30
2007	0	2	29	15
2008	2	2	103	11
2009	3	2	74	21
2010	0	2	99	31
2011	3	6	89	15
2012	0	7	139	33
2013	3	21	148	32
2014	0	19	70	44
2015	1	30	89	29
2016	2	29	86	48
2017	5	48	88	49

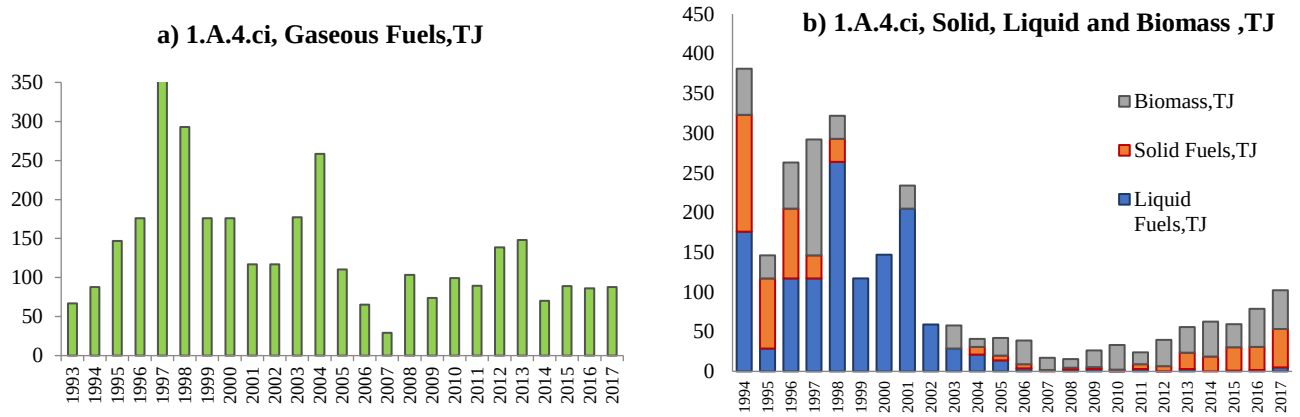


Figure 3.2.13. Fuel consumption for *1.A.4.c.i Agriculture/Forestry/Fishing*, TJ

Table 3.2.30. Data on fuel consumption, *1.A.4.b.i Residential: Stationary plants*, TJ

Year	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	1622	34941	14460	1287
1991	9658	33621	14808	957
1992	8267	17219	26652	861
1993	41	4161	10034	913
1994	29	6367	7863	1027
1995	0	1819	15712	1731
1996	29	4841	15569	2171
1997	0	2699	23946	2200
1998	29	998	21851	2142
1999	29	1262	20362	2171
2000	59	1262	16214	2259
2001	29	784	15575	2142
2002	0	1526	16008	2377
2003	0	2345	18164	2521
2004	0	1806	18279	2123
2005	12	2104	19735	2212
2006	1	2390	20130	2708
2007	3	1407	17785	2184
2008	1	1169	18294	2466
2009	3	1426	18802	2254
2010	0	2168	20073	2208

Year	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
2011	13	1955	20352	2780
2012	0	2463	19359	2977
2013	0	2548	18617	3231
2014	0	1767	18855	10799
2015	0	1741	18682	11835
2016	0	1282	17496	13401
2017	0	2253	19699	17927

As shown in Table 3.2.30, between 1990 and 2017, the following occurred in the sector *1.A.4.b.i Residential: Stationary*:

- liquid fuel consumption decreased (from 1622 TJ in 1990 to 13 TJ in 2011) (Figure 3.2.14b),
- solid fuel consumption decreased by 96% (from 34941 TJ in 1990 to 2253 TJ in 2017) (Figure 3.2.14b),
- the use of gaseous fuels increased by 21% (from 14460 TJ in 1990 to 19699 TJ in 2017) (Figure 3.2.14a),
- the use of biofuels increased significantly by more than 900% (from 1287 TJ in 1990 to 17927 TJ in 2017) (Figure 3.2.14b).

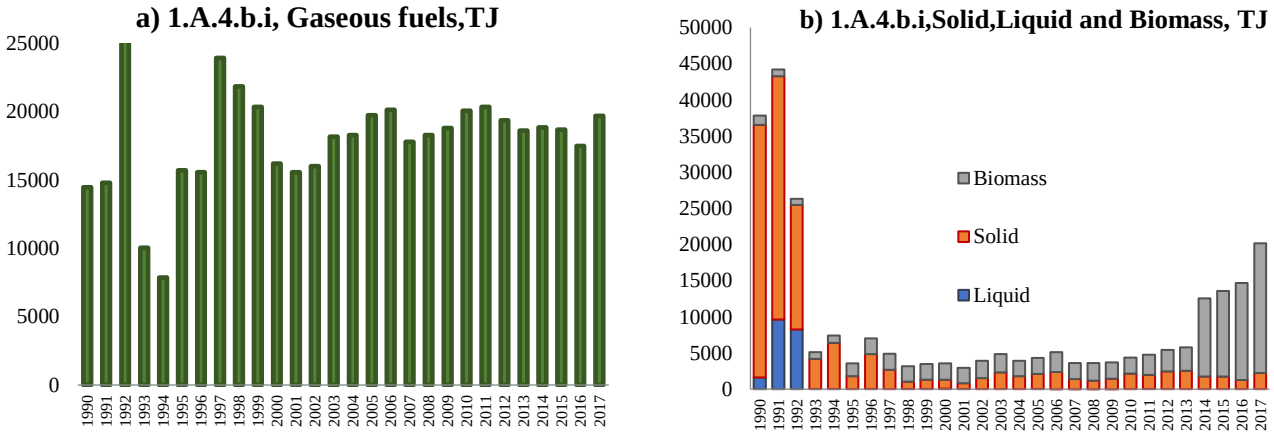


Figure 3.2.14. Fuel consumption for *1.A.4.b.i Residential*, TJ

Fuel consumption in the category 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other *machinery* (Table 3.2.31) has the following features: the amount of diesel fuel indicated in the fuel and energy budget for the column "Agriculture" is divided into 2 parts. One part (90%) is considered in this category as fuel burned in the fields (off-road). The second part (10%) is transferred to category *1.A.3.b Road Transport* and is considered as fuel burned during the movement of agricultural machinery on highways. This applies to activity data for both regions (Table 3.2.40).

Table 3.2.31. Data on fuel consumption, *1.A.4.cii*, tons

Year	Diesel Oil	Motor Gasoline	LPG
1990	389900	7000	1000
1991	316800	6400	
1992	206550	3800	
1993	201420	1300	326
1994	191700	2000	
1995	207673	11683	
1996	162737	11116	
1997	159996	11858	
1998	118397	7792	
1999	84303	4073	
2000	65858	2755	
2001	63854	2693	
2002	76864	1222	
2003	69841	1258	
2004	62737	781	43
2005	55255	612	43
2006	54424	574	43
2007	47033	398	22
2008	44951	334	65

Year	Diesel Oil	Motor Gasoline	LPG
2009	42204	423	130
2010	47012	646	195
2011	45293	582	174
2012	43445	613	109
2013	48297	848,5	130
2014	59747	721	152
2015	65517	643	109
2016	63900		87
2017	87300		

The total fuel consumption in the category *1.A.4.cii "Agriculture/Forestry/Fisheries* (mobile sources) for the study period decreased (Figure 3.2.15):
• diesel consumption by 77,6% (from 389,900 tons in 1990 to 87,300 tons in 2017) (Figure 3.2.15a),
• gasoline consumption decreased significantly by 91% (from 7000 tons in 1990 to 643 tons in 2015) (Figure 3.2.15b).

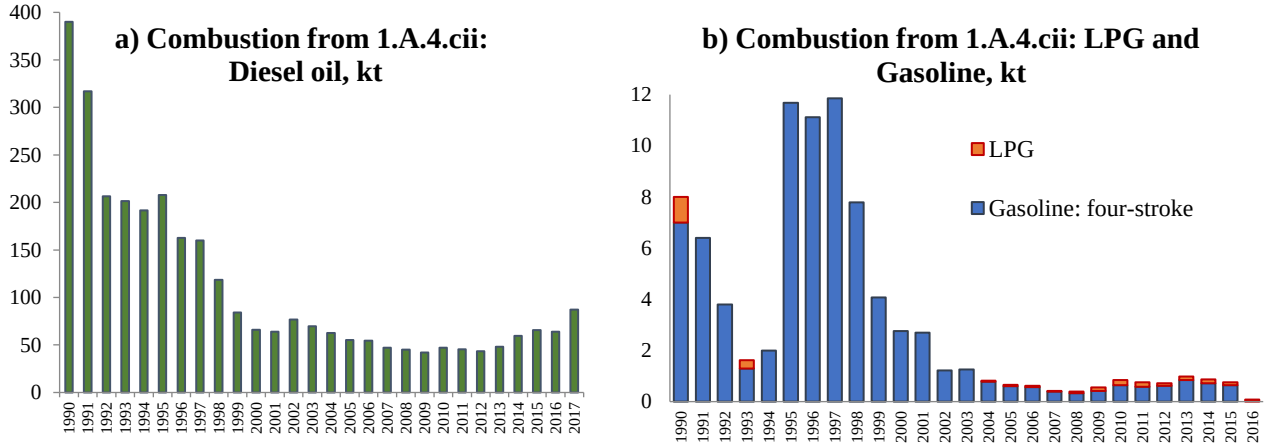


Figure 3.2.15. Fuel consumption, *1.A.4.cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery*

3.2.5. Other (NFR 1.A.5)

3.2.5.1. Description of sources

The category *1.A.5 Other* covers all remaining emissions from fuel combustion that are not specified elsewhere. It includes emissions from fuel delivered to the military in the country and the military of other countries that are not engaged in multilateral operations.
The following source categories are included:

- *1.A.5.a Other* (stationary combustion) - Emissions from fuel combustion in stationary sources that are not specified elsewhere and include all types of fuel, except diesel fuel, gasoline, aviation gasoline, kerosene;
- *1.A.5.b Other* (mobile combustion) - Emissions from vehicles and other machinery, marine and aviation (not included in *1.A.4.c.ii* or elsewhere).

1.A.5.b Mobile combustion includes two sources:

- *1.A.5.b.i Mobile (aviation component*) includes all remaining aviation emissions from fuel combustion that are not specified elsewhere (jet kerosene and aviation gasoline);
- *1.A.5.b.iii Mobile (other)* includes all remaining emissions from mobile sources not included elsewhere (diesel and gasoline).

3.2.5.2. Methods and emission factors

The fuel-based approach for estimating emissions from *1.A.5* was used. Default Tier 1 emission factors are provided in the EMEP/EEA air pollutant emission inventory guidebook 2016 – Last update July 2017 (Table 3.2.32).

Table 3.2.32. Emission factors for *1.A.5.a Stationary combustion for gaseous and liquid fuels, coal and biomass*

Pollutant	Units of measure	Gaseous fuel	Liquid fuel	Hard coal and brown coal	Solid biomass
NOx	*g /GJ*	74	306	173	91
NMVOC	*g /GJ*	23	20	88,8	300
SOx	*g /GJ*	0,67	94	840	11
NH_3	Unit	NE	NE	NE	37
$PM_{2,5}$	*g /GJ*	0,78	18	108	140
PM_{10}	*g /GJ*	0,78	21	117	143
TSP	*g /GJ*	0,78	20	124	150
BC	*g /GJ*	0,0312	10,08	6,912	39,2
CO	*g /GJ*	29	93	931	570
Pb	*mg / GJ*	0,011	8	134	27
Cd	*mg / GJ*	0,0009	0,15	1,8	13
Hg	*mg / GJ*	0,1	0,1	7,9	0,56
As	*mg / GJ*	0,1	0,5	4	0,19
Cr	*mg / GJ*	0,013	10	13,5	23
Cu	*mg / GJ*	0,0026	3	17,5	6
Ni	*mg / GJ*	0,013	125	13	2
Se	*mg / GJ*	0,0058	0,1	1,8	0,5
Zn	*mg / GJ*	0,73	18	200	512
PCDD/ F	*ng I-TEQ / GJ*	0,52	6	203	100
benzo(a) pyrene	*µg /GJ*	0,72	1,9	45,5	10
benzo(b) fluoranthene	*µg /GJ*	2,9	15	58,9	16
benzo(k) fluoranthene	*µg /GJ*	1,1	1,7	23,7	5
Indeno (1,2,3-cd) pyrene	*µg /GJ*	1,08	1,5	18,5	4
HCB	*µg /GJ*	NA	0,22	0,62	5
PCBs	*ng/GJ*	NA	0,13	170	0,06

Source: EMEP/EEA air pollutant emission inventory guidebook 2016 – Last update July 2017 1.A.4.a.i, 1.A.4.b.i, 1.A.4.c.i, 1.A.5.a Small combustion Tables 3.7, 3.8, 3.9, and 3.10.

Emission factors for *1.A.5.a Stationary combustion* for all types of fuels were used similarly as for categories *1.A.4.a.i, 1.A.4.b.i, 1.A.4.c.i* and the unit of measure was "g/GJ" (Table 3.2.33).
Emission factors for *1.A.5.b Mobile combustion for aviation* were used similarly as for the category *1.A.3.a*, and the unit of measure was "kg/ton fuel*"* (Table 3.2.33).

Table 3.2.33. Emission factors for *1.A.5.b Mobile combustion for aviation*

1.A.b.i Mobile combustion *for Aviation*				1.A.b.iii Mobile combustion *for Road*			
Pollutant	***Units***	***Jet Gasoline***	***Aviation Gasoline***	***Pollutant***	***Units***	***Gasoline***	***Diesel***
NOx	*kg /ton fuel*	*4*	*4*	**NOx**	*g /ton*	7117	32629
NMVOC	*kg /ton fuel*	*19*	*19*	**NMVOC**	*g /ton*	18893	3377
SOx	*kg /ton fuel*	*1*	*1*	**SOx**	*g /ton*	Formula	Formula to SOx
NH_3	*Unit*	*NE*	*NE*	**NH_3**	*g /ton*	4	8
$PM_{2,5}$	*Unit*	*NE*	*NE*	**$PM_{2,5}$**	*g /ton*	157	2104
TSP	*Unit*	*NE*	*NE*	**PM_{10}**	*g /ton*	157	2104
BC	*Unit*	*NE*	*NE*	**TSP**	*g /ton*	157	2104
CO	*Unit*	*NE*	*NE*	**BC**	*g /ton*	8	1306
Pb	*kg /tons fuel*	*1200*	*1200*	**CO**	*g /ton*	770368	10774
Cd	*Unit*	*NE*	*NE*	**Pb**	*Unit*	*NE*	*NE*
Hg	*Unit*	*NE*	*NE*	**Cd**	*mg / kg fuel*	0,01	0,010
As	*Unit*	*NE*	*NE*	**Hg**	*Unit*	*NE*	*NE*
Cr	*Unit*	*NE*	*NE*	**As**	*Unit*	*NE*	*NE*
Cu	*Unit*	*NE*	*NE*	**Cr**	*mg / kg fuel*	0,05	0,050
Ni	*Unit*	*NE*	*NE*	**Cu**	*mg / kg fuel*	1,7	1,700
Se	*Unit*	*NE*	*NE*	**Ni**	*mg / kg fuel*	0,07	0,070
Zn	*Unit*	*NE*	*NE*	**Se**	*mg / kg fuel*	0,01	0,010
PCDD/ F	*Unit*	*NE*	*NE*	**Zn**	*mg / kg fuel*	1	1,000
benzo(a) pyrene	*Unit*	*NE*	*NE*	***PCDD/ F***	*Unit*	*NE*	*NE*
benzo(b) fluoranthene	*Unit*	*NE*	*NE*	**benzo(a) pyrene**	*µg /kg fuel*	40	30,000
benzo(k) fluoranthene	*Unit*	*NE*	*NE*	**benzo(b) fluoranthene**	*µg /kg fuel*	40	50,000
Indeno (1,2,3-cd) pyrene	*Unit*	*NE*	*NE*	**benzo(k) fluoranthene**	*Unit*	*NE*	*NE*
HCB	*Unit*	*NE*	*NE*	**Indeno (1,2,3-cd) pyrene**	*Unit*	*NE*	*NE*
PCBs	*Unit*	*NA*	*NA*	**HCB**	*Unit*	*NA*	*NA*
	Unit	*NA*	*NA*	**PCBs**	*Unit*	*NA*	*NA*

Source: EMEP/EEA air pollutant emission inventory guidebook 2016 – Update July 2017, page 19, 1.A.3.a, 1.A.5.b Aviation; 1.A.2.g vii; 1.A.4.a.ii, 1.A.4.b ii; 1.A.4.c ii; 1.A.4.c iii; 1.A.5.b Non-road mobile sources and machinery.

Emission factors for *1.A.b.iii Mobile combustion for Road* were used similarly as for the category *1.A.2 g.vii, 1.A.4.cii Off-Road Transport* and the unit of measure was "kg/ton fuel*"*.

For land based military emissions, emission factors for *1.A.2.g.vii* were used, as no other data were available.

3.2.5.3. Activity data

For stationary combustion, the main source of activity data for the Right Bank region is the Energy Balance of RM (Tables 3.2.34 and 3.2.35). The information is provided in units of energy, TJ. Activity data regarding fuel consumption for the territory on the Left Bank of the Dniester River are available in the Statistical Yearbooks in natural units.

Table 3.2.34. Fuel Consumption by group for *1.A.5.a Stationary Combustion*, 1990–2017

Fuels, TJ	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
Solid	334,10	284,79	142,03	370,00	261,50	206,00	176,00	206,00	206,00	177,00
Liquid	83,33	273,36	349,74	274,00	382,00	909,00	499,00	293,00	308,50	118,00
Gaseous	46,06	35,37	24,69	114,00	294,00	235,00	60,00	161,50	118,00	88,00
Biofuel	44,97	-	-	25,00	31,00	60,00	149,00	61,00	117,50	88,00
Total, 1A5 a	**508,45**	**593,52**	**516,46**	**783,00**	**968,50**	**1410,00**	**884,00**	**721,50**	**750,00**	**471,00**
Fuels, TJ	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Solid	176,00	117,00	176,00	117,00	43,00	47,00	141,00	113,00	185,64	47,97
Liquid	31,00	60,00	42,00	82,00	8,00	6,00	9,00	9,00	20,93	22,31
Gaseous	119,00	207,00	90,00	59,00	117,00	118,00	129,00	106,00	106,00	70,00
Biofuel	58,00	59,00	145,00	75,00	27,00	31,00	33,00	37,00	27,00	14,50
Total, 1A5 a	384,00	443,00	453,00	333,00	195,00	202,00	312,00	265,00	339,57	154,78
Fuels, TJ	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*		
Solid	143,24	121,35	21,54	16,38	9,58	11,40	9,53	14,98		
Liquid	20,00	2,00	4,00	2,67	2,33	2,00	-	-		
Gaseous	188,00	102,00	48,00	-	-	-	-	-		
Biofuel	43,00	16,00	1,00	-	-	-	-	-		
Total, 1A5 a	**394,24**	**241,36**	**74,54**	**19,05**	**11,92**	**13,41**	**9,53**	**14,98**		

In 2017, only 14,98 TJ of fuel (solid fuel) was used for stationary combustion, which is 34 times less than in 1990 (Table 3.2.34) and only 0,3385 TJ for mobile combustion (Table 3.2.35).

Table 3.2.35. Fuel Consumption for *1.A.5.b Mobile Combustion*, 1990 – 2017

Fuel, kt	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
Diesel Oil	19,0000	15,0000	10,0000	8,4700	3,5200	4,4470	6,8670	3,6760	6,5050	1,5540
Gasoline: four-stroke	4,0000	2,5000	1,2000	2,0500	3,2500	3,2920	1,3800	2,5190	2,9040	1,4490
Aviation gasoline										
Aviation kerosene										
TOTAL, 1A5 b	**23,0000**	**17,5000**	**11,2000**	**10,5200**	**6,7700**	**7,7390**	**8,2470**	**6,1950**	**9,4090**	**3,0030**
Fuel, kt	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Diesel Oil	2,2730	2,3430	2,2870	2,2650	5,2670	6,2050	8,1970	10,2410	8,1740	2,2350
Gasoline: four-stroke	0,1360	2,1840	0,1850	1,2150	2,2200	0,1740	2,2070	1,1770	1,1690	1,2650
Aviation gasoline										
Aviation kerosene										
TOTAL, 1A5 b	**2,4090**	**4,5270**	**2,4720**	**3,4800**	**7,4870**	**6,3790**	**10,4040**	**11,4180**	**9,3430**	**3,5000**
Fuel, kt	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*		
Diesel Oil	2,1170	3,1880	1,1400	1,1500	0,2380	0,2220	0,2055	0,2055		
Gasoline: four-stroke	1,1450	2,1820	1,1170	0,1270	0,1720	0,1300	0,1330	0,1330		
Aviation gasoline		0,0210	0,0180	0,0076	0,0119	0,0100				
Aviation kerosene		0,0030	0,0020	0,0008	0,0021					
TOTAL, 1A5 b	**3,2620**	**5,3940**	**2,2770**	**1,2854**	**0,4240**	**0,3620**	**0,3385**	**0,3385**		

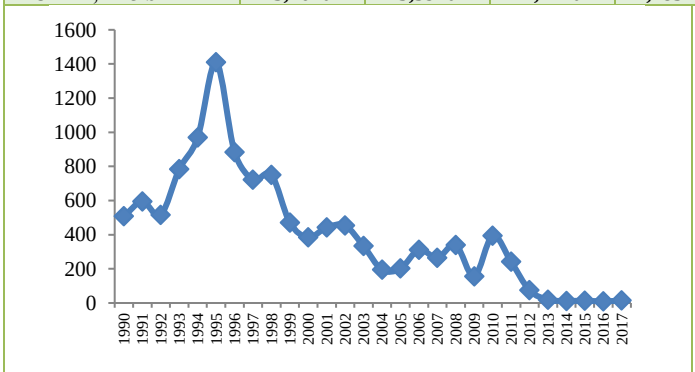


Figure 3.2.16. Fuel consumption dynamics for *1.A.5.a Other: Stationary Combustion* for RM, TJ

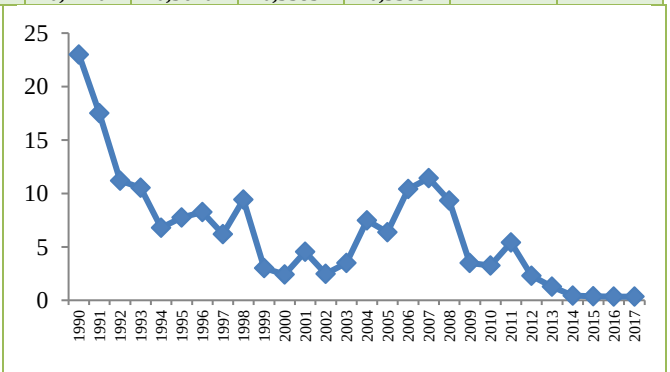


Figure 3.2.17. Fuel consumption dynamics for *1.A.5.b Other: Mobile Combustion* for RM, TJ

Fuel consumption for mobile combustion decreased from 23 kt in 1990 to 0,34 kt in 2017 (Figure 3.2.17). According to graphs 3.2.16 and 3.2.17, the fuel consumption for both stationary and mobile combustion tends to decrease.

3.3. Fugitive emissions (NFR 1.B.2)

3.3.1. Description of sources

Moldova has one oil field in Valeni and one natural gas field in Victorovca. Production volumes of oil and gas are small.
Oil has been produced since 2004, and gas since 2003.
A small refinery was built in Comrat town, which produces diesel fuel, residual fuel oil and some other petroleum products from crude oil. There are also imports of petroleum products and natural gas.
The distribution of natural gas is carried out through the main and distribution pipelines.
Emissions from activities that are carried out in the extraction, transportation, and refining of oil and gas are classified in 4 categories:

- *1.B.2.a.i Fugitive emissions oil: Exploration, production, transport,*
- *1.B.2.a.iv Fugitive emissions oil: Refining / storage,*
- *1.B.2.a.v Distribution of oil products,*
- *1.B.2.b Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other).*

3.3.2. Methods and emission factors

Emissions are calculated according to method 1 using formula (1). Emission factors are accepted by default according to the sections of the 2016 EMEP/EEA Guidebook. Primary data are provided in the required units of measurement. Explanations about this are covered in the sections on relevant categories.

3.3.2.1. Fugitive emissions oil: Exploration, production, transport 1.B.2.a.i

Oil production in Moldova has been carried out since 2003. The volume of oil production in Moldova is small. Primary data are used from Energy Balances.
Only one pollutant is calculated in this category - NMVOC.
To calculate emissions, the values of oil produced in physical units are necessary, since the emission factor is measured in kilograms/ton of crude oil. The emission factor and activity data are given in the Table 3.2.36.

Table 3.2.36. NMVOC emission factor, activity data and NMVOC emission for the category *1.B.2.a.i Fugitive emissions oil: Exploration, production, transport*

Year	1.B.2.a.i Fugitive emissions oil: Exploration, production, transport			1B2
	Exploration, production, transport			
	NMVOC	kg / Mg crude oil (kg /ton)		*Factor 0,000001*
	EF:	**0,2**		
	Activity data (Energy Balance)		**NMVOC Emissions**	
	kt	ton	kg	kt
2003	1	1000	200	0,0002
2004	8	8000	1600	0,0016
2005	5	5000	1000	0,001
2006	4	4000	800	0,0008
2007	8	8000	1600	0,0016
2008	15	15000	3000	0,003
2009	17	17000	3400	0,0034
2010	11	11000	2200	0,0022
2011	13	13000	2600	0,0026
2012	11	11000	2200	0,0022
2013	10	10000	2000	0,002
2014	8	8000	1600	0,0016
2015	7	7000	1400	0,0014
2016	6	6000	1200	0,0012
2017	5	5000	1000	0,001

3.3.2.2. Fugitive emissions oil: Refining / storage 1.B.2.a.iv

In this category, the main pollutants, metals, and furans are calculated. BC, PAHs, HCB, PCBs in this category are not applicable ("NA"). Emission factors for them are given in the Table 3.2.37.

Table 3.2.37. Pollutant emission factors for the category *1.B.2.a.iv Refining/storage of oil. Fugitive emissions oil: Refining/storage*

NOx	NMVOC	SOx	NH_3	$PM_{2,5}$	PM_{10}	TSP	BC	CO
kg / Mg crude oil (kg /ton)								kg / Mg crude oil (kg /ton)
0,24	0,2	0,62	0,0011	0,0043	0,0099	0,016	NA	0,09

continued

Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
g / Mg crude oil (gram / ton)								
0,0051	0,0051	0,0051	0,0051	0,0051	0,0051	0,0051	0,0051	0,0051

continued

PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene *	Indeno (1,2,3-cd) pyrene*	Total 1-4	HCB	PCBs
µg / Mg (1E-06 gram / ton crude oil)	*Unit*	*Unit*	*Unit*	*Unit*	*Unit*	*Unit*	*Unit*
0,0057	NA	NA	NA	NA	NA	NA	NA

*) Mg = ton

3.3.3. Activity Data

Primary data are used from energy balances. The volume of oil production in Moldova is small. Oil production in Moldova has been carried out since 2003.

Values in natural units of measurement are necessary for calculating emissions, since the emission factor is measured in kilograms/ton of crude oil (main pollutants) grams/ton of crude oil (metals), and µg/ton of crude oil (PCDD/PCDF dioxins/furans).

Activity Data in this category are the same as in the category *1.B.2.a Fugitive emissions: oil* and are given in the Table 3.2.38 and Figure 3.2.18.

The Figure 3.2.18 shows that between 2003 and 2009 the activity data for 1.*B.2.a.i Fugitive emissions Oil: Exploration, production, transport* and *1.B.2.a.iv Fugitive emissions Oil: Refining/storage* increased from 1 kt (2003) to 17 kt (2009). In the years 2009-2017, there was a decrease up to 5 kt in 2017.

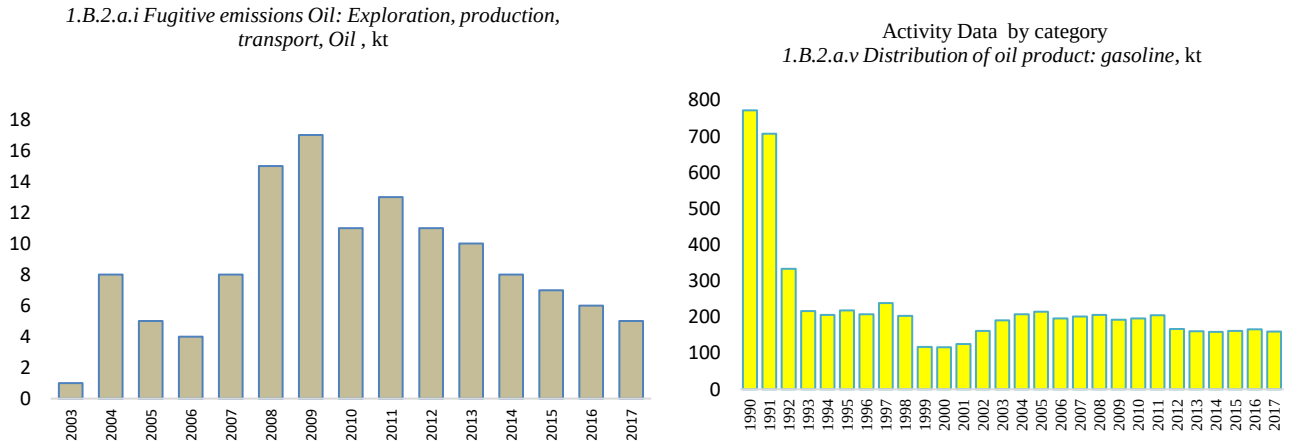


Figure 3.2.18. Activity Data for *1.B.2.a.i Fugitive emissions Oil: Exploration, production, transport* and *1.B.2.a.iv Fugitive emissions Oil: Refining / storage.*

1.B.2.a.v Distribution of oil products

Only NMVOCs are calculated in this category. Primary data on the total amount of oil products consumed are used according to energy balances in physical units.

Values in natural units of measurement are necessary for calculating emissions, since the emission factor is measured in kilograms/ton of crude oil (Figure 3.2.20c).

The multiplier "10E-06" is used to convert the NMVOC emissions from grams to kilotons, which are required as final units (Table 3.2.38). NMVOC emissions in this category are shown in Figure 3.2.20c.

Table 3.2.38. Emission Factors, Activity Data, Emissions by *1.B.2.a.v Distribution of oil products*

Year	1.B.2.a.v	Distribution of oil products	Only gasoline is considered!	1.B.2
	NMVOC	kg / Mg crude oil (kg / ton)	*Factor*	*0,000001*
	EF:	2		
	Fuel and Energy Balance, Right Bank	Consumed gasoline	Emission NMVOC	
	kt	ton	kg	kt
1990	772	772000	1544000	1,544
1991	707	707000	1414000	1,4140
1992	333,2	333200	666400	0,6664
1993	216,5	216500	433000	0,4330
1994	206	206000	412000	0,4120
1995	218	218000	436000	0,4360
1996	208	208000	416000	0,4160
1997	239	239000	478000	0,4780
1998	203	203000	406000	0,4060
1999	117	117000	234000	0,2340
2000	116	116000	232000	0,2320
2001	125	125000	250000	0,2500
2002	162	162000	324000	0,3240
2003	191	191000	382000	0,3820
2004	208	208000	416000	0,4160
2005	215	215000	430000	0,4300
2006	196	196000	392000	0,3920
2007	201	201000	402000	0,4020
2008	206	206000	412000	0,4120
2009	193	193000	386000	0,3860
2010	196	196000	392000	0,3920
2011	205	205000	410000	0,4100
2012	167	167000	334000	0,3340
2013	161	161000	322000	0,3220
2014	159	159000	318000	0,3180
2015	162	162000	324000	0,3240
2016	166	166000	332000	0,3320
2017	160	160000	320000	0,3200

1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading)

Only NMVOCs are calculated in this category. 2004 was the first year of natural gas exploration. Natural gas production in Moldova is very small. Therefore, data are shown only in the table with the fuel values in TJ in Energy Balance from the year 2004. Values in natural units of measurement are necessary to calculate emissions, since the emission factor is measured in gram of NMVOC/m^3. Calorific value of 33,86 TJ /million m^3 is used to convert the quantities of gas from TJ to m^3.

1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading)

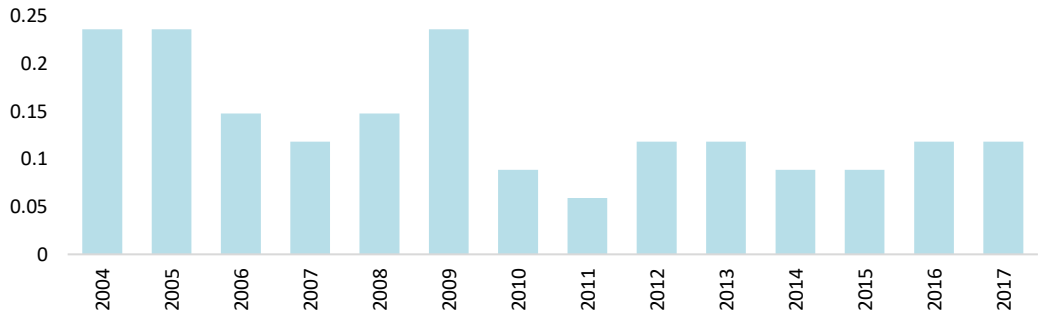


Figure 3.2.19. Activity Data for *1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading)*, mln m^3

As shown in Figure 3.2.19, the quantities of natural gas (Exploration, Production, Loading) decreased from 0,24 mln m^3 in 2004 to 0,12 mln m^3 in 2017.

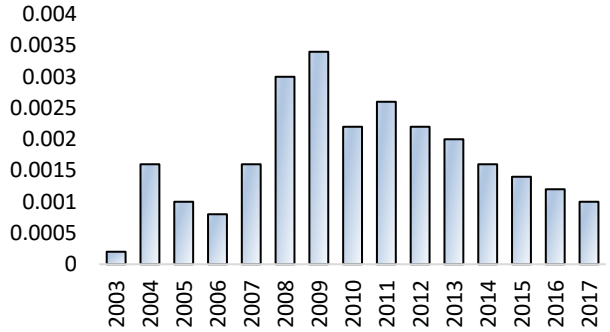
The multiplier "10E-09" was used to convert the NMVOC emissions from grams to kilotons, which are required as final units (Table 3.2.39). NMVOC emissions in this category are shown in Figure 3.2.20d.

Table 3.2.39. Emission Factors, Activity Data, Emissions, *1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading)*

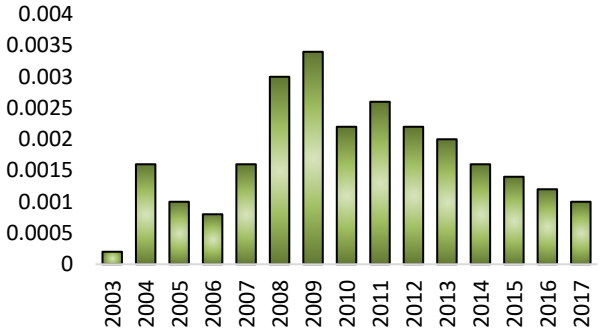
Year	1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading)						
	NMVOC	gram/m3 gas				*Factor*	
	EF:	0,1				*0,000000001*	
	Activity Data Fuel and Energy Balance, Right Bank					**NMVOC Emissions**	

Year	1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading)						
	TJ	NCV=33,86 TJ/ million m3	million m3	m3		gram	kt
2004	8	33,86	0,2363	236267		23626,7	2,36E-05
2005	8	33,86	0,2363	236267		23626,7	2,36E-05
2006	5	33,86	0,1477	147667		14766,7	1,48E-05
2007	4	33,86	0,1181	118133		11813,3	1,18E-05
2008	5	33,86	0,1477	147667		14766,7	1,48E-05
2009	8	33,86	0,2363	236267		23626,7	2,36E-05
2010	3	33,86	0,0886	88600		8860,0	8,86E-06
2011	2	33,86	0,0591	59067		5906,7	5,91E-06
2012	4	33,86	0,1181	118133		11813,3	1,18E-05
2013	4	33,86	0,1181	118133		11813,3	1,18E-05
2014	3	33,86	0,0886	88600		8860,0	8,86E-06
2015	3	33,86	0,0886	88600		8860,0	8,86E-06
2016	4	33,86	0,1181	118133		11813,3	1,18E-05
2017	4	33,86	0,1181	118133		11813,3	1,18E-05

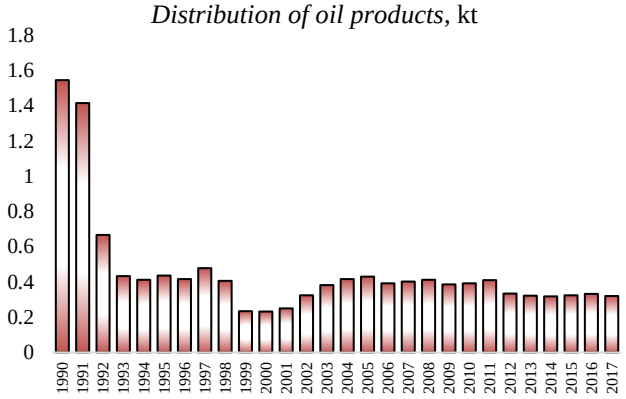
a) NMVOC, *1.B.2.a.i Fugitive emissions oil: Exploration, production, transport* ,kt



b) NMVOC, *1.B.2.a.iv Fugitive emissions oil: Refining / storage*, kt



c) NMVOC Emissions, *1.B.2.a.v Distribution of oil products*, kt



d) NMVOC, *1.B.2.b Fugitive emissions from natural gas (Exploration, Production, Loading),* kt

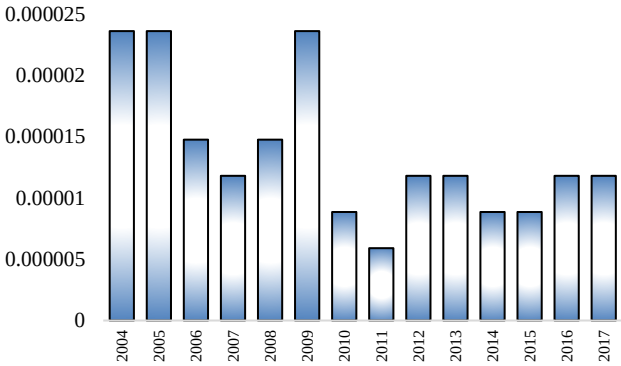


Figure 3.2.20. NMVOC Emissions by 4 categories of Sector *1.B.2 Fugitive Emissions*

The NMVOC emissions from categories *1.B.2.a.i Fugitive emissions oil: Exploration, production, transport* and 1.*B.2.a.iv Fugitive emissions oil: Refining/storage* had the same value from 2003 to 2017 (Figure 3.2.20 a and b). The largest volume was registered in 2009 (0,0034 kt NMVOC), while the lowest volume was registered in 2003 (0,0002 kt NMVOC) (Figure 3.2.20.d). For the *1.B.2.a.v* category, NMVOC emissions decreased significantly from 1,544 kt in 1990) to 0,32kt in 2017 (Figure 3.2.20c).

Energy Sector is one the most important source of long-range transboundary air pollutants in the Republic of Moldova. The categories that provide a significant contribution to pollutant emissions (in national total) are as follows:

- *1.A.1 Public electricity*: $PM_{2.5}$, As, Cr, Cu, Ni, Zn, HCB (namely: $PM_{2.5}$ - 46,7%; As - 48,4%; Cr - 45,6%; Cu - 49,6%; Ni - 50,0%; Zn - 44,6%; HCB - 49,9%);
- *1.A.4.a Commercial/Institutional sector*: SO_x, Pb, Hg (namely: SOx - 44,2%; Pb - 36,5%; Hg - 26,1%);
- *1.A.3.b Road Transport*: NO_x - 24,1%;

- *1.A.4.b Residential: Stationary*: PM_{10} - 42,7%, TSP - 40,7%; BC - 37,0%; Cd - 47,8%; Benzo(a)pyrene - 47,4%; Benzo(b)fluoranthene - 42,9%; Benzo(k)fluoranthene - 49,3%; Indeno(1,2,3-cd)pyrene - 46,4%; PCBs - 48,8%;
- *1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery*: CO - 21,8%.

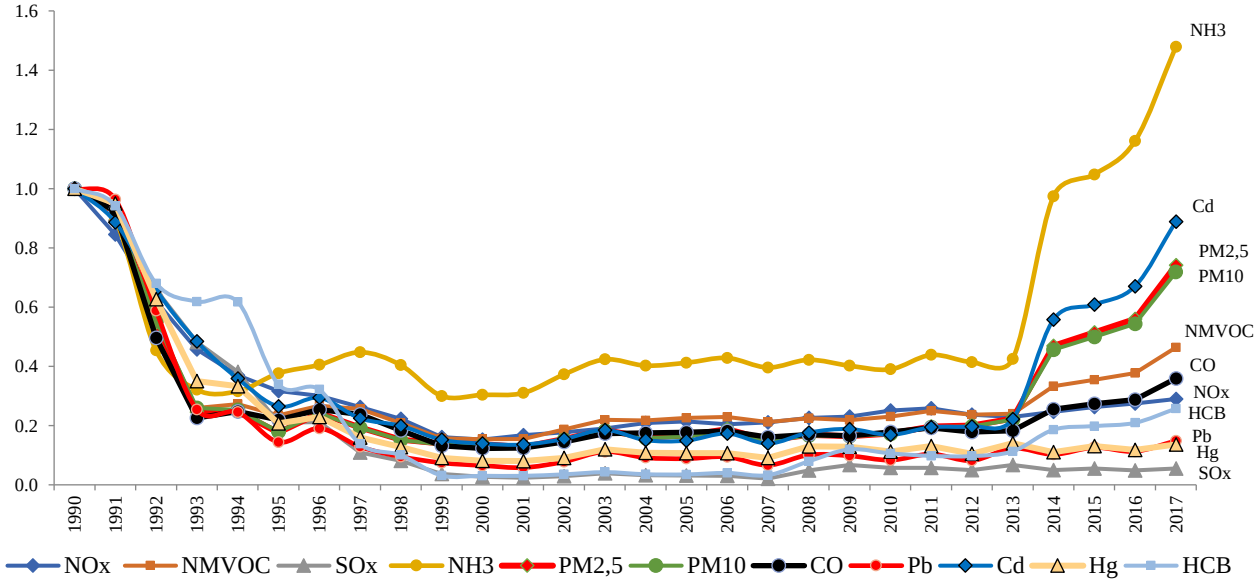


Figure 3.2.21. Emission trends for most air pollutants from the Energy sector, compared to 1990

Figure 3.2.21 shows the trends in emissions of several air pollutants (NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, CO, Pb, Hg, Cd, and HCB) from the energy sector compared to 1990, taken as 1.
Three sections are more prominent in the chart:
- reduction of emissions in the period 1990-1999;
- stagnation during the period 2000-2012;
- small growth in the period 2013-2017.

Emissions of NOx, Pb, Hg and SOx decreased compared to 1990 and remained almost unchanged between 2013 and 2017. They remained at the same level as in the period 2000-2012.
NH_3 emissions have increased since 1990. The increase in ammonia emissions is associated with significant changes in the primary biomass data in the household sector and improved accounting for national biomass consumption statistics.
Emissions of other pollutants such as Cd, $PM_{2.5}$, PM_{10}, NMVOC, CO and HCB in the period 2013-2017 tended to increase, but none of them reached the 1990 level.

Planned improvements

Potential improvements in estimates of emissions in the energy sector may become possible after updating available data on fuel consumption activities for the Left Bank of the Dniester River, the emergence of new statistical sources of information, the application of recovery methods to improve the quality of biomass data series, and the use of higher-level calculation methods for key categories.

Chapter 4: INDUSTRIAL PROCESSES AND PRODUCT USE (NFR sector 2)

4.1. Overview of the sector

The *Industrial processes and product use* Sector include historical emissions for the period 1990-2017. This section was last updated in 2014.

The "*Industrial Processes*" Sector includes emissions generated directly from non-energy industrial activities. Emissions from fuel combustion in the manufacturing industries are reported in the Energy chapter. The overall description of sources is presented in Table 4.1.1.

Table 4.1.1. Description of sources in the Industrial processes and product use

NFR	Source		Description	Pollutants
2 A	Mineral Products			
	2.A.1	Cement Production	Includes emissions from cement production. Data reported by one operator and collected from responses to the official letters and Statistical Yearbooks of the ATULBD (1998-2017)	TSP, PM_{10}, $PM_{2.5}$, BC
	2.A.2	Lime Production	Includes emissions from lime production. Data collected from SYs of the RM and SYs of the ATULBD, National Inventory Report 1990-2016	TSP, PM_{10}, $PM_{2.5}$, BC
	2.A.3	Glass Production	Includes emissions from glass production. Data collected from SYs of the RM and SYs of the ATULBD	TSP, PM_{10}, $PM_{2.5}$ BC, Pb, Cd, Hg, As Cr, Cu, Ni, Se, Zn
	2.A.5.a	Quarrying and mining of minerals other than coal	Emissions from the coal mining industry. Statistical Yearbooks of the Republic of Moldova for the years 2016-2018; Statistical Yearbooks of ATULBD for 2016-2018; National Bureau of Statistics, Statistical Data Bank	TSP, PM_{10}, $PM_{2.5}$
	2.A.5.b	Construction and demolition	Includes emissions from construction. Statistical Yearbooks of the Republic of Moldova for the years 2016-2018; Statistical Yearbooks of ATULBD for 2016-2018. National Bureau of Statistics, Statistical data bank, 2016-2018	TSP, PM_{10}, $PM_{2.5}$
	2.A.5c	Storage, handling and transport of mineral products	Includes emissions from transport of mineral products. Statistical Yearbooks of the Republic of Moldova for the years 2016-2018; Statistical Yearbooks of ATULBD for 2016-2018	TSP, PM_{10}, $PM_{2.5}$
2 B	Chemical industry			
	2.B.10a	Other chemical industry	Includes emission from Polyethylene, ABS synthetics and polystyrene production. Data offered by NBS and partially from SYs of the ATULBD.	NMVOC, TSP
2 C	Metal industry			
	2.C.1	Iron and steel production	Includes emission from iron and steel production. Data collected from National Inventory Report 1990-2016. SYs of RM and SYs of the ATULBD.	NMVOC, TSP, PM_{10}, $PM_{2.5}$, SO_2, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Sn, Zn, PCB, PCDD/F, Total 4 PAHs, PCBs.
2 D	Other Solvent and Product use			
	2.D.3.a	Domestic Solvent Use	Includes emissions from domestic solvent use. National Inventory Report 1990-2016	NMVOC
	2.D.3.b	Road Paving with Asphalt	Includes emissions from asphalt production. National Inventory Report 1990-2016	NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC

NFR	Source		Description	Pollutants
	2.D.3.c	Asphalt Roofing	Includes emissions from asphalt roofing production. Data collected from SY and National Inventory Report 1990-2016	CO, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC
	2.D.3.d	Coating applications	Includes emissions from paint application. Data collected from SY and National Inventory Report 1990-2016	NMVOC
	2.D.3.e	Degreasing	Includes emissions from metal degreasing and industrial cleaning. Data collected based on information on import of solvents.	NMVOC
	2.D.3.f	Dry cleaning	Includes emissions from solvent use in dry cleaning of clothes and other textiles from animal grease, oils, wax, resin, etc. data collected from information on import of solvents in the RM	NMVOC
	2.D.3.g	Chemical Products	Includes emissions from manufacturing different industrial commodities, including polyurethane and polystyrene products, refurbished tires and rubber soles, paints and varnishes, glues, inks, pharmaceutical products, shoes. Data collected from SY and information provided by Customs Service of the Republic of Moldova.	NMVOC, TSP, Cd, Cr, Ni, Se, PAH
	2.D.3.h	Printing	Includes emissions from use of inks in printing which may contain a proportion of organic solvents. Data collected from Statistical Reports PRODMOLD-A.	NMVOC
	2.D.3.i	Other solvent and product use (Seed oil extraction, Use of Glues and other Adhesives, Preservation of Wood,)	Includes emissions from use of solvents in seed oil extraction, production of adhesive tapes, composite foils, the transportation sector (passenger cars, commercial vehicles, mobile homes, rail vehicles and aircrafts), the manufacture of shoes and leather goods and the wood material and furniture industry, impregnation with, or immersion of timber to protect it. Data collected from SY and estimated based on information on production, import and export.	NMVOC, TSP, PM_{10}, $PM_{2.5}$, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,
2G	Other product use			
	2.G.4	Other product use	Data collected from the National Inventory Report 1990-2016. Data collected from SY and estimated based on information on production, the quantity of tobacco in cigarettes and cigarettes number, and use of footwear.	NOx, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO, Cd, Cu, Ni, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total PAHs.
2H	Other industry production			
	2.H.2	Food and beverages industry	Data collected from National Inventory Report 1990-2016. Data collected from SY and estimated based on information on production	NMVOC, PM_{10}.

The pollutants covered are the following:

- main pollutants (5) = CO, NH_3, NMVOC, NOx, SOx, (SO_2)
- PM (4) = $PM_{2.5}$, PM_{10}, 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.

4.1.1. Trends in emissions

Non-methane volatile organic compounds (NMVOC)

NMVOC emissions from the *Industrial Processes* Sector decreased by 22,6%, from 42,098 kt in 1990 to 32,573 kt in 2017 (Figure 4.1.1) mainly due to reduction of the industrial activity in the country. The minimum values of emissions were recorded in 2000, equal to 13,3573 kt, falling by 68% compared to 1990 levels. From 2000 to 2005, NMVOC emissions grew constantly in line with the economic development. The second considerable reduction of emissions is associated with the year 2009 and global financial crisis that affected the economy of the Republic of Moldova. Emission reduction reached 32,3% compared to the 2005 levels.

The largest source of emissions of NMVOC from the *Industrial Processes* sector is *2.H.2 Food and Beverage* category, accounting for 40% of the total emissions from the sector since 1990, and currently the category *2.D Solvents* has the largest share in emissions, due to the intense use of solvents in various areas of the national economy. Compared to the level of 2009, NMVOC emissions increased by 41% in 2017 (Figure 4.1.1).

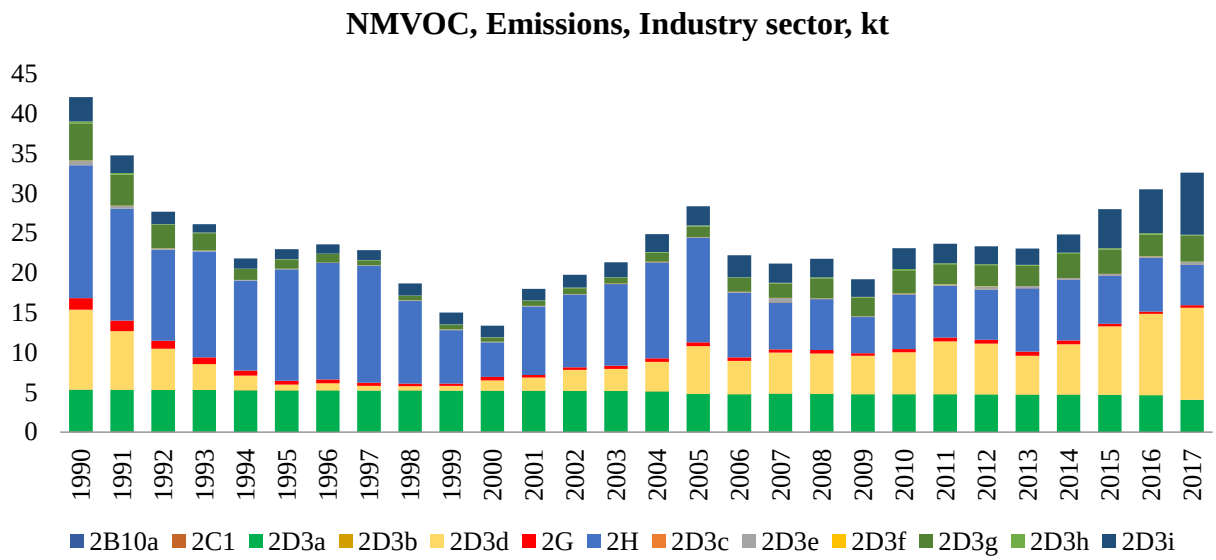


Figure 4.1.1. Dynamics of NMVOC emissions from the *Industrial Processes* Sector, 1990-2017, kt

Share of different categories in the overall NMVOC emissions from Industrial *Processes* Sector has changed over the 1990-2017 period (Figure 4.1.2).

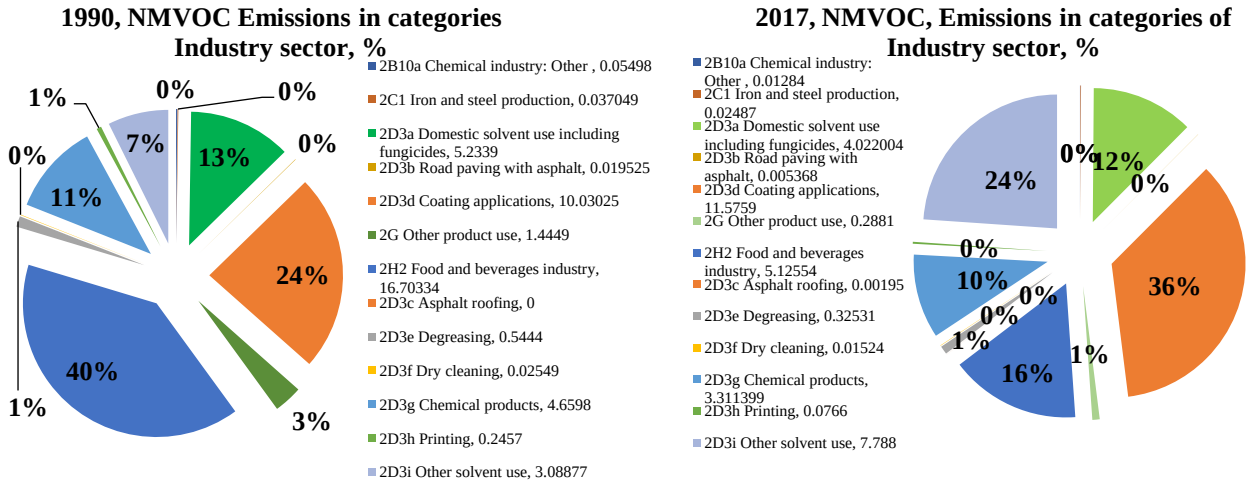


Figure 4.1.2. Share of different categories in the overall NMVOC emissions from the *Industrial Processes* Sector in 1990 and 2017

NMVOC emissions from *2.C.1 Iron and steel production* are insignificant in the *Industrial processes* sector, decreasing from 1990 to 2017 by 32,9%. NMVOC emissions from source category *2.B.10.a. Chemical industry: other* decreased by 80,2% over the period 1990-2017 (Figure 4.1.2).
Thus, the share of categories in the overall NMVOC emissions changed as follows:

- *Food and Drink (NFR 2.H.2)* – decreased from 40% in 1990 to 16% in 2017;
- *Other solvent use (NFR 2.D.3.i)* – increased from 7% in 1990 to 24% in 2017;
- *Coating applications (NFR 2.D.3.d)* – increased from 24% in 1990 to 36% in 2017;
- *Domestic solvent use including fungicides (NFR 2.D.3.a)* – decreased from 13% in 1990 to 12 % in 2017;
- *Chemical Product (NFR 2.D.3.g)* – decreased from 11% in 1990 to 10% in 2017.

Total suspended solids (TSP)

The TSP emissions from the *Industrial Processes* Sector have fallen by 66,1%: from 35,4998 kt in 1990 to 12,04952 kt in 2017 (Figure 4.1.3) due to reduction of the industrial activity in the country. From 1990 to 2000, TSP emissions reduced by 93%, reaching 2,474 kt. The maximum value of TSP emissions over the period 2000-2017 was reached in 2007, representing 34% from the 1990 level.
The largest source of TSP emissions from the *Industrial processes* Sector in 2017 was *2.D.3g Chemical products*, and *2.D.3.b Road paving with asphalt*, which represent 72,4% of total emissions in the sector.

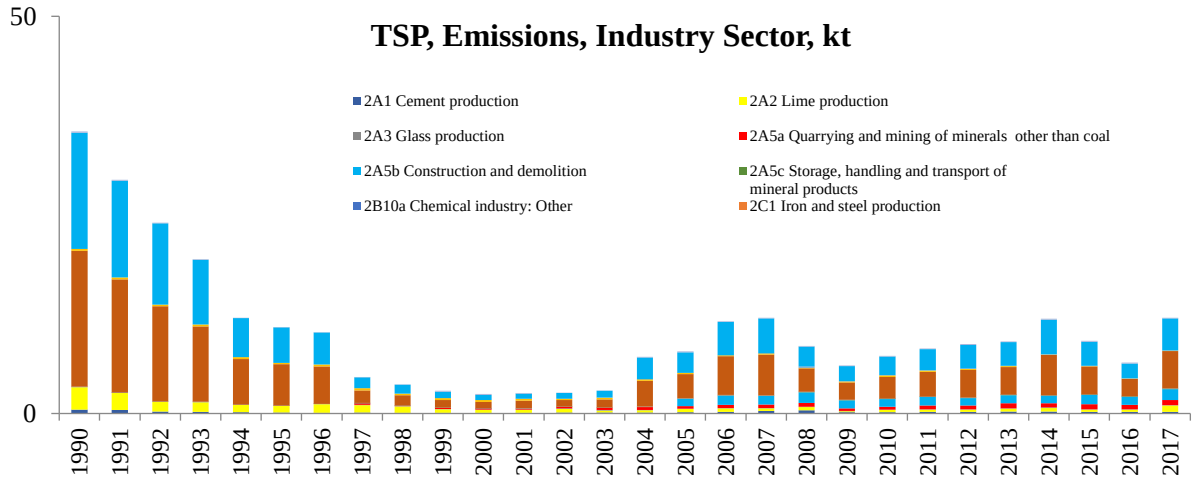


Figure 4.1.3 Dynamics of TSP emissions from the *Industrial Processes* Sector, 1990-2017, kt

Share of different categories in the overall TSP emissions from *Industrial Processes* Sector has changed from the year 1990 to the year 2017 (Figure 4.1.4).

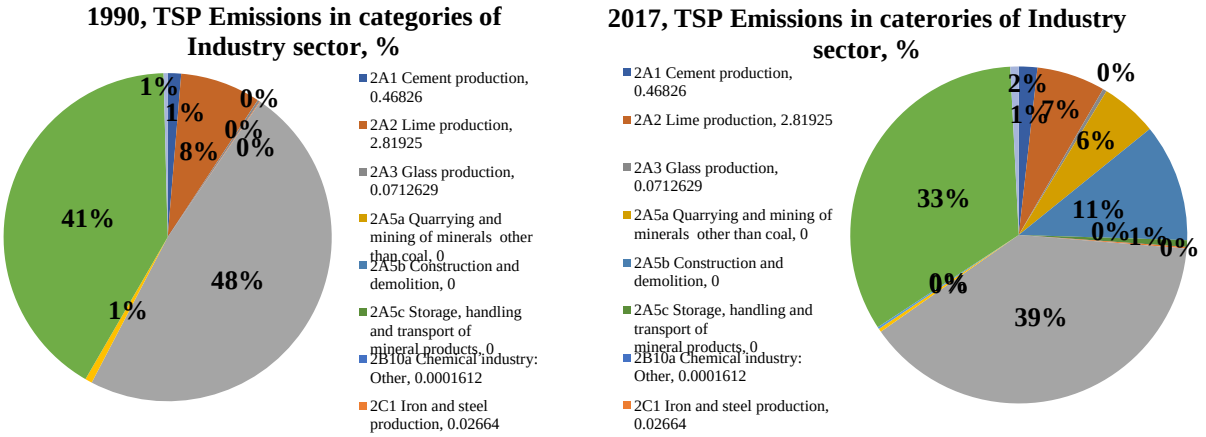


Figure 4.1.4 Share of different categories in the overall TSP emissions from the *Industrial Processes* Sector in 1990 and 2017

Thus, the share of categories in the overall TSP emissions changed as follows (Figure 4.1.4):

- *Road paving with asphalt (NFR 2.D.3.b)* – decreased from 48% in 1990 to 39% in 2017;
- *Chemical product (NFR 2.D.3.g)* – decreased from 41% in 1990 to 33 % in 2017;
- *Lime production (NFC 2.A.3)* – decreased from 8% in 1990 to 7% in 2017;
- *Cement production (NFR 2.A.1)* – increased from 1% in 1990 to 2% in 2017;
- Quarrying and mining of mineral, other than coal had a share of 6% in 2017.

Particulate matter (PM)

PM emissions from *Industrial Processes* Sector have fallen by 57,4 %, from 7,0087 kt in 1990 to 2,9871 kt in 2017 (Figure 4.1.5), due to reduction of industrial activity in the country. The minimum values of emissions were equal to 1,25 kt in 2002 and have fallen by 82,16 % as compared to 1990 level. From 2000 to 2008, PM emissions grew constantly in line with economic development (Figure 4.1.6). Starting with 2008, a continuous reduction of PM emissions can be observed, which reached in 2017 1,1% of the 2008 level.

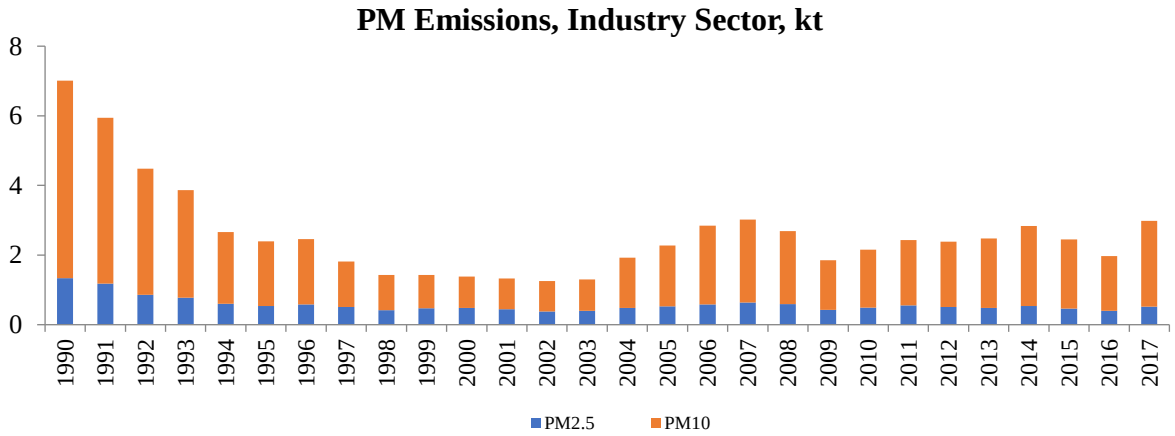


Figure 4.1.5 Dynamics of PM emissions from the *Industrial Processes* Sector, 1990-2017, kt

The largest sources of emissions of PM_{10} from *Industrial Processes* Sector are *2.A.1 Cement production, 2.A.2 Lime production, and 2.D.3.b Road paving with asphalt* sharing 91,3% of total sector emissions in 1990 and 39% in 2012 (Figure 4.1.6).

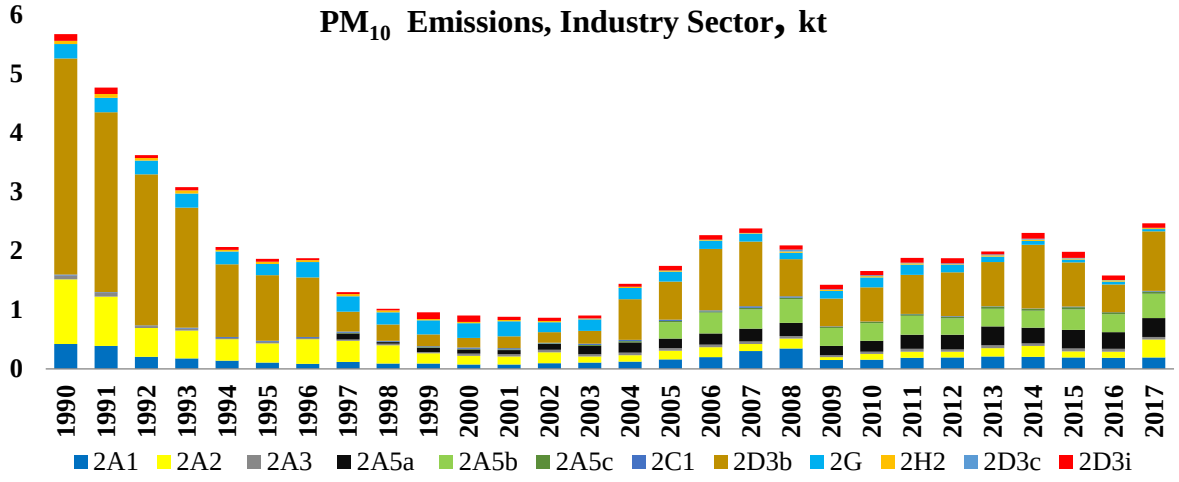


Figure 4.1.6. Dynamics of PM_{10} emissions from the *Industrial Processes* Sector, 1990-2017 and shares of source categories, kt

The share of different source categories in PM_{10} emissions from *Industrial Processes* Sector significantly changed over the period 1990-2017 (Figure 4.1.6):

- PM_{10} emissions from category *2.A.1 Cement production* decreased from 1990 to 2017 by 54,3%;
- those from *2.A.2 Lime production* decreased by 72% compared to 1990;

- emissions from category *2.D.3.b. Road paving with asphalt* decreased by 72,5%, from 3,661 kt in 1990 to 1,006 kt in 2017;
- emissions from *2.A.5.b. Construction and demolition* became evident towards 2017, due to the development of the construction environment, their impact was 32% compared to 2005.
- $PM_{2.5}$ emissions reduced by 61% from 1990 to 2017 due to the reduction of industrial activity in the country.

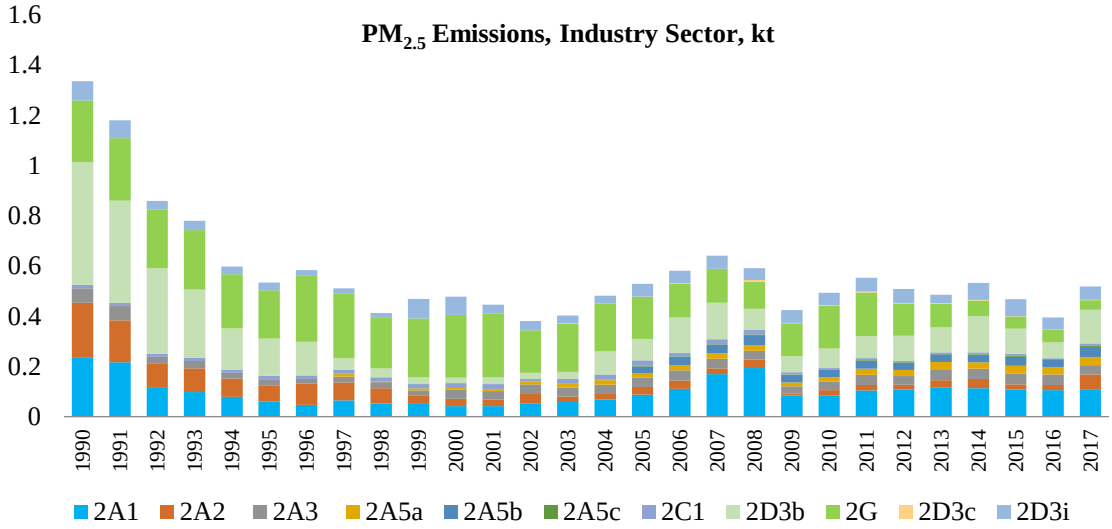


Figure 4.1.7. Dynamics of $PM_{2.5}$ emissions from the *Industrial Processes* Sector, 1990-2017 and shares of source categories, kt

The largest sources of emissions of $PM_{2.5}$ from *Industrial Processes* Sector were *2.A.1 Cement production, 2.D.3.b. Road paving with asphalt, and 2.G.Other product use* sharing 72,46% of total sector emissions in 1990 and 54 % in 2017 (Figure 4.1.7).

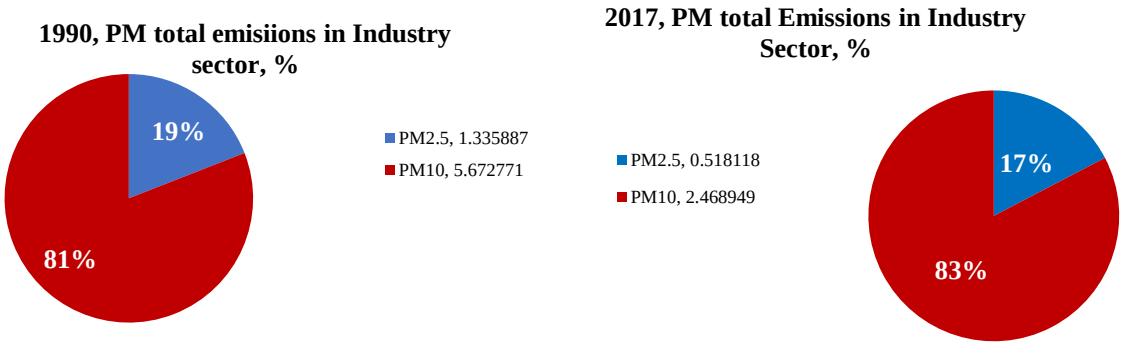


Figure 4.1.8. Share in the overall PM_{10} and $PM_{2.5}$ emissions from *Industrial Processes* Sector in 1990 and 2017

Share in the overall PM_{10} and $PM_{2.5}$ emissions from *Industrial Processes* Sector has changed from 1990 to 2017 (Figure 4.1.8).

Thus, the share of categories in the overall PM emissions changed as follows:

- PM_{10} emissions – increased from 81% in 1990 to 83% in 2017;
- $PM_{2.5}$ emissions – decreased from 19% in 1990 to 17 % in 2017.

Carbon monoxide (CO)

Carbon monoxide emissions arise only from *2.C.1 Iron and steel production, 2G Other product use* and *2.D.3c Asphalt roofing* source categories from *Industrial Processes* Sector (Figure 4.1.9).

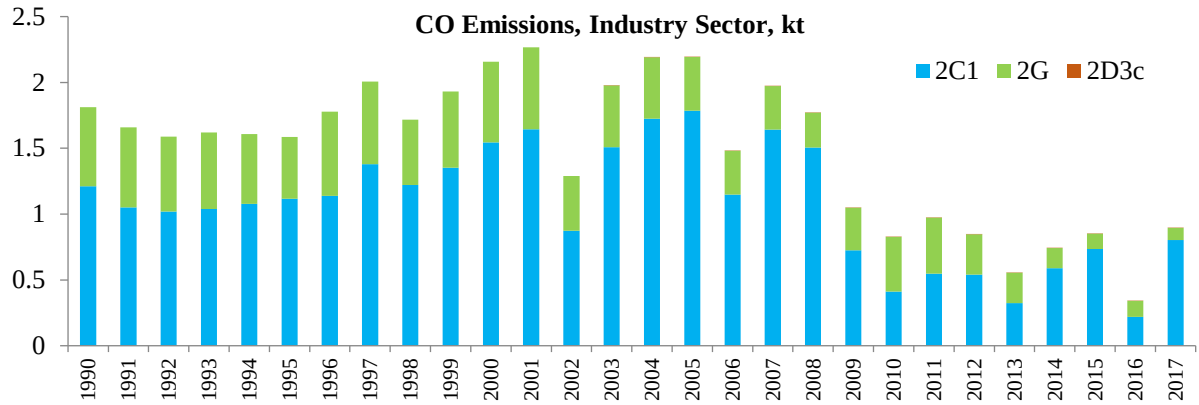


Figure 4.1.9. Dynamics of CO emissions from the *Industrial Processes* Sector over the period 1990-2017 and shares of source categories, kt

CO emissions from *Industrial Processes* Sector have fallen by 49,4 %, from 1,812 kt in 1990 to 0,89568 kt in 2017 (Figure 4.1.9), due to reduction of the industrial activity in the country. The first minimum values of emissions were equal to 1,2897 kt in 2002, which have fallen by 28,8% as compared to the 1990 level. The second reduction of emissions is associated with the year 2010 and the economic crisis that affected RM. Emission reduction reached 35,9% as compared to the 2002 level.
In 2017, the CO emissions increased by 62% compared to 2016, due to the increase of the production level in the *2.C.1. Iron and steel production* sector.

Black carbon (BC)

The BC emissions from the *Industrial Processes* Sector have fallen by 68,84%: from 0,03594 kt in 1990 to 0,0112 kt in 2017 (Figure 4.1.10), due to reduction of industrial activity in the country.

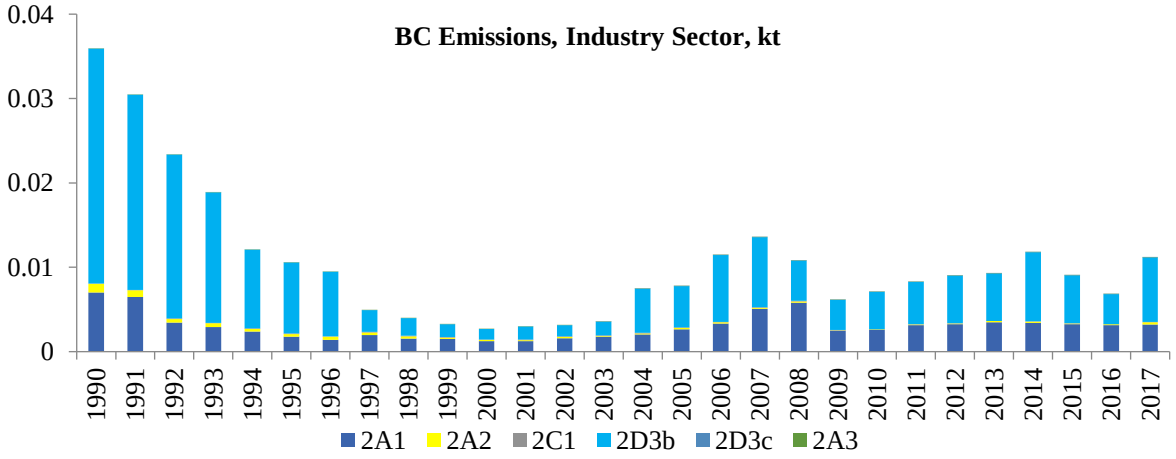


Figure 4.1.10. Dynamics of BC emissions from the *Industrial Processes* Sector over the period 1990-2017 and shares of source categories, kt

Sources of BC emissions are categories *2.A.1. Cement production* and *2.D.3.b. Road paving with asphalt*.

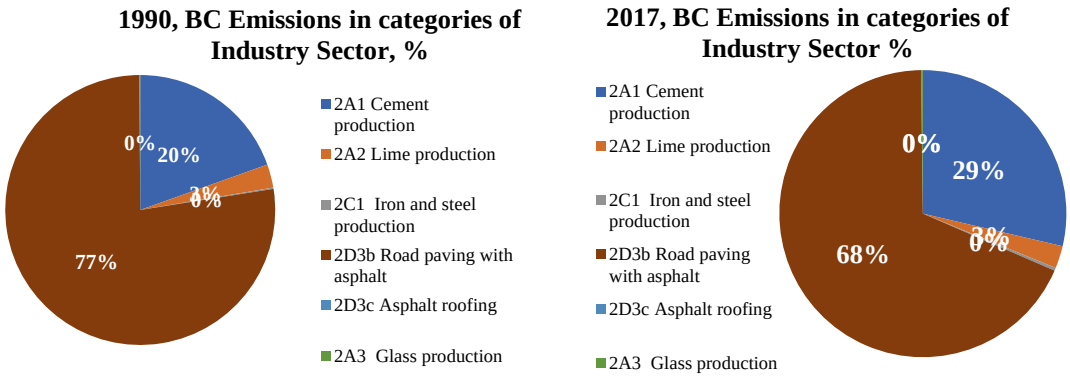


Figure 4.1.11. Share of different categories in the overall BC emissions from the *Industrial Processes* Sector in 1990 and 2017

Share in the overall BC emissions from *Industrial Processes* Sector has changed from 1990 to 2017 (Figure 4.1.11).

Thus, the share of categories in the overall BC emissions changed as follows:

- *Cement production (NFR 2.A.1)* – increased from 20% in 1990 to 29% in 2017;
- *Road paving with asphalt (NFR 2.D.3.b)* – decreased from 77% in 1990 to 68% in 2017;
- *Lime production (NFC 2.A.3)* – remained at 3% from 1990 to 2017.

The largest source of BC emissions from the *Industrial processes* Sector were *2.A.1 Cement production*, and *2.D.3.b Road paving with asphalt*, which represent 97% of total emissions.

Persistent organic pollutants (POPs)

Emissions of POPs from *Industrial Processes* Sector have fallen. Those of PAHs decreased by 68,74: from 3,464 t in 1990 to 1,0829 t in 2017 (Figure 4.1.12).

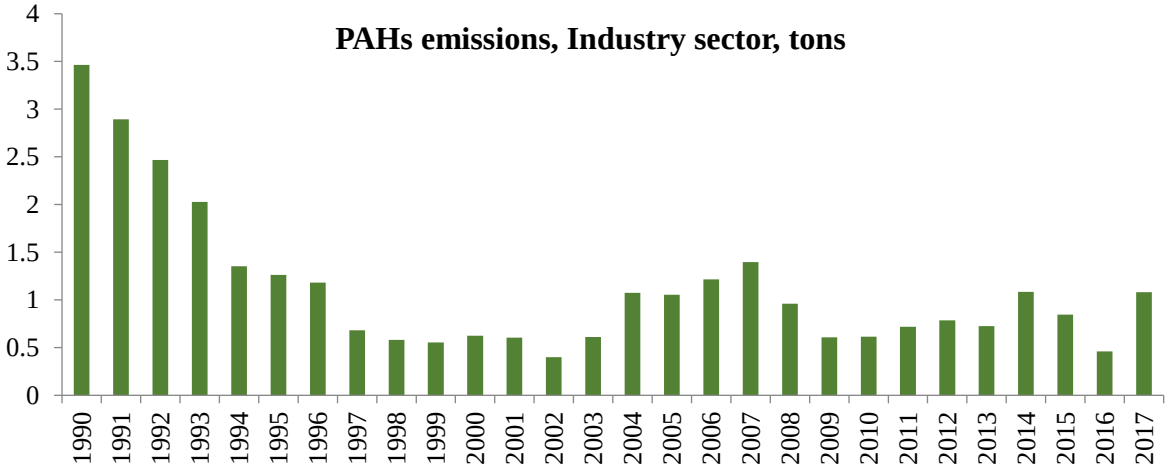


Figure 4.1.12. Dynamics of PAHs emissions from the *Industrial Processes* Sector over the period 1990-2017 and shares of source categories, tons

But if comparison is done with other emissions from this sector, POPs emissions are the only ones that have reached a level higher than in 1990: in 2005 they registered an increase to 147,4% - PCDD/PCDF of the 1990 emissions level and 146,1% for PCB (Figures 4.1.12 and 4.1.13).

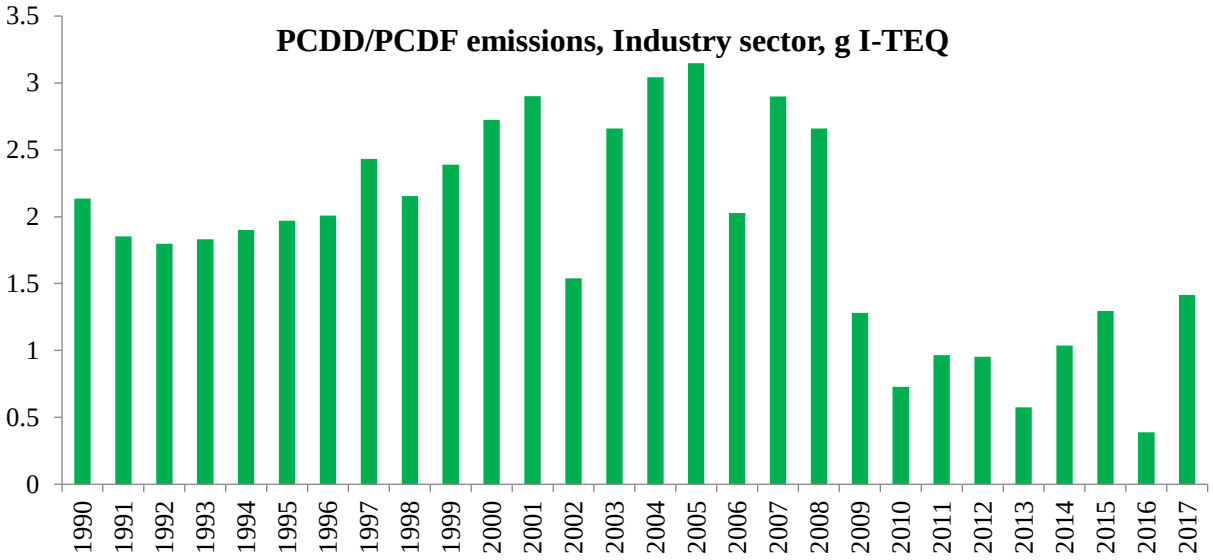


Figure 4.1.13. Dynamics of PCDD/PCDF emissions from the *Industrial Processes* Sector over the period 1990-2017 and shares of source categories, g I-TEQ

From 2005 to 2017, emissions of PCDD/PCDF and PCB reduced by about 55% because of the economic decline in the country (Figures 4.1.13 and 4.1.14).

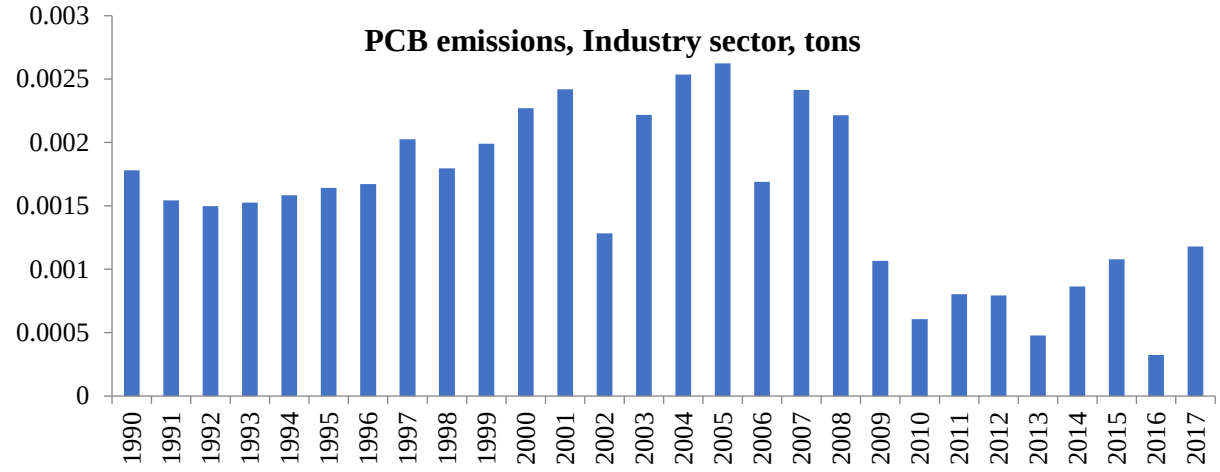


Figure 4.1.14. Dynamics of PCB emissions from the *Industrial Processes* Sector over the period 1990-2017 and shares of source categories, tons

Other pollutants

Emissions of non-metals (Se), metalloids (As) and metals (the rest) from the *Industrial Processes* Sector have fallen by 43,7%: from 1,207 t in 1990 to 0,6797 t in 2017 (Figure 4.1.15), due to reduction of industrial activity in the country.

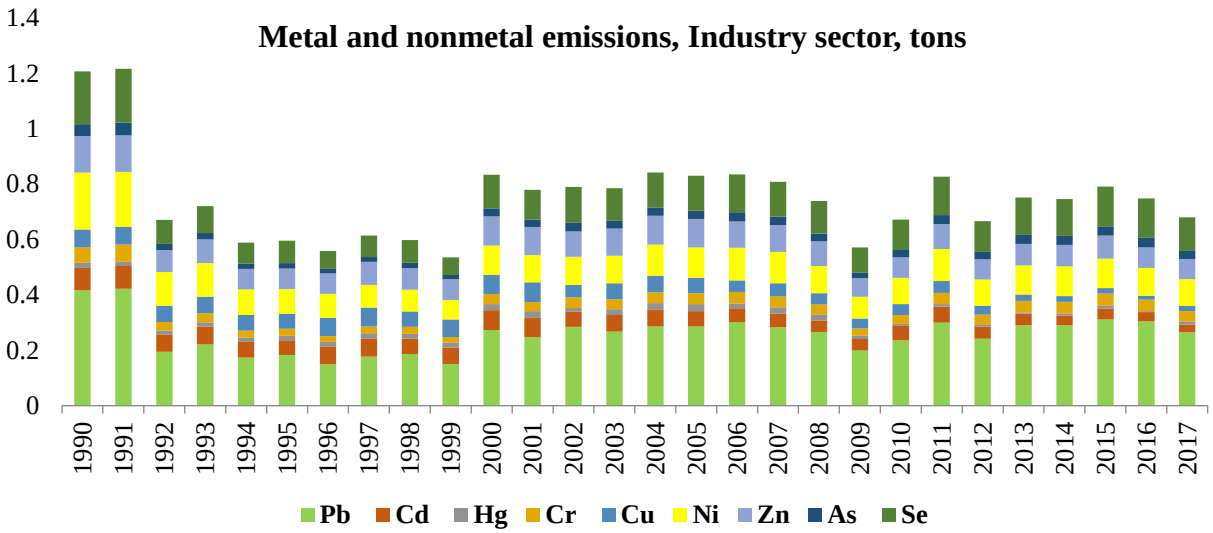


Figure 4.1.15. Dynamics of metal and non-metal emissions from the *Industrial Processes* Sector over the period 1990-2017, tons

The emissions of metals, non-metals and metalloids arise from source categories *2.A.3 Glass products*, *2.C.1 Iron and steel production*, *2.D.3.g Chemical products* and *2.G Other product use*. The main shares of Pb, Zn, Ni and Se are shown in Figure 4.1.15.

4.1.2. Key categories

The following sections are an outline of the main key categories in the *Industrial Processes* Sector. Table 4.1.2 highlights the key categories identified in the sector.

Table 4.1.2. Key categories

Pollutant	2.A.1	2.A.2	2.A.3	2.A.5	2.B.10.a	2.C.1	2.D.3.a-2.D.3.i	2.G	2.H.2
NMVOC					0,039	0,076	83,26	0,88	15,74
$PM_{2.5}$	20,6	11,9	6,97	14,85		1,9	36,4	7,4	
PM_{10}	7,8	12,5	1,65	31,2		0,46	44,2	1,54	0,66
TSP	1,77	6,57	0,37	17,4	0,001	0,15	73,4	0,32	
Pb			96,8			3,2			
Cd			70,1			2,5	0,12	27,25	
Hg			3,8			96,2			
As			99,3			0,16	0,58		
Cr			93			1,63	5,35		
Cu			6			52,0		42	
Ni			76			2,5	17,3	3,93	
Se			99,86				0,14		
Zn			77,2			17,6		5,2	
PCDD						100			
PAH_S						20,92	79,04	0,04	
PCB_S						100			

Iron and steel production (2.C.1) are the main sources of PCDD and PCBs in the sector, as well as a main source of heavy metals, accounting for about 52% of copper and 96,2% of mercury emissions. *2.D.3.g Chemical products* and *2.D.3i Consumption of glue and other adhesives* is the main source of PAHs, accounting for about 79,04%. The category *Mineral products industry (2.A.1-2.A.5)* is also a key category for PM_{10} and $PM_{2,5}$ emissions, with a share of 53,15 % and 54,32%, respectively.
Solvents (2.D.3.a-2.D.3.i) is the main source of NMVOC, accounting for 83,26% of the sector.

4.1.3. Methods and emission factors

All source categories covered by *Industrial Processes* Sector were estimated based on the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, and default and/or specific emission factors. Methodologies used for estimating emissions from this sector are following Tier 1 and Tier 2, as advised in the 2016 and 2019 EMEP/EEA Guidebooks.
The emission factors used for calculations were in compliance with EMEP/EEA-2016-2019 (Table 4.1.3).
A more detailed description of estimation methodologies and emission factors used in this inventory cycle is available in sub-chapters 4.2 of the IIR.

Table 4.1.3. Emission estimation methodologies used to evaluate emissions from *Industrial Processes* sector

NFR	Products group	Assessment Methodology	Emission Factors
2.A.1	Cement production, kt	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.A.2	Lime production, kt	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.A.3	Glass production, kt	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.A.5.a	Quarrying and mining of minerals other than coal, kt	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.A.5.b	Construction and demolition, m^2	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.A.5.c	Storage, handling and transport of mineral products, kt	*Tier 2; EMEP/EEA Guidebook 2016*	D
2.B.10.a	Chemical industry: Other (please specify in the IIR)	*Tier 2; EMEP/EEA Guidebook 2016*	D
2.C.1	Iron and steel production	*Tier 2; EMEP/EEA Guidebook 2016*	D
2.D.3.a	Domestic solvent use including fungicides	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.D.3.b	Road paving with asphalt	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.D.3.c	Asphalt roofing	*Tier 1; EMEP/EEA Guidebook 2016*	D

NFR	Products group	Assessment Methodology	Emission Factors
2.D.3.d	Coating applications	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.D.3.e	Degreasing	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.D.3.f	Dry cleaning	*Tier 1; EMEP/EEA Guidebook 2019*	D
2.D.3.g	Chemical products	*Tier 2; EMEP/EEA Guidebook 2016*	D
2.D.3.h	Printing	*Tier 1; EMEP/EEA Guidebook 2016*	D
2.D.3.i	Other solvent use (please specify in the IIR)	*Tier 2; EMEP/EEA Guidebook 2016*	D
2.G	Other product use (please specify in the IIR)	*Tier 2; EMEP/EEA Guidebook 2016*	D
2.H.2	Food and beverages industry	*Tier 2; EMEP/EEA Guidebook 2016*	D

Abbreviations: T1 – Tier 1; T2 – Tier 2; T3 – Tier 3; D – Default.

4.1.4. Uncertainties Assessment and Time Series Consistency

The cumulative uncertainties associated with the emission factors were about ± 3%. The uncertainties associated with the activity data were also reduced, ± 2%, those associated with the data obtained directly from the company were ±1%, while those associated with statistical data collected from statistical publications were ± 3%. To ensure the stability in time of the obtained results, the same methodology was used for the entire study period in accordance with the sustainable practices applied to the inventory of emissions.

Uncertainties

The primary factors that affect the uncertainties relate to the evaluation methodology, the emission factors used to calculate the emissions from the source category *2.H.2 Food and beverages*, and the quality of the available activity data. The uncertainties associated with the emission factors used by default when calculating NMVOC emissions from this source category can be of magnitude two. Uncertainties associated with activity data related to the production of bread and other food and alcoholic beverages in the Republic of Moldova are reduced, being estimated at about ±5%. To ensure the stability in time of the obtained results, the same methodology was used for the entire study period in accordance with the sustainable practices applied to the inventory of emissions.

4.1.5. Quality Assurance and Quality Control

For each category of sources, a standard form of verification and quality control of the categories of individual sources was completed, according to the evaluation methodology of Tier 1, for some - Tier 2.

The activity data and the methods used to evaluate emissions from the sector *Industrial processes and product use* are documented and archived both on paper and in electronic format.

To identify the errors related to data entry, those related to the emission assessment process, procedures for verifying and controlling the quality of the data used and the applied emission factors are carried out permanently.

In accordance with sustainable practices, activity data and emission factors from official reference sources were used to evaluate emissions.

4.2. Mineral Products (NFR 2A)

4.2.1. Description of sources

Category *2A Mineral Products* includes activity data and emissions from the following processes:

- *2.A.1. Cement production.*
- *2.A.2. Lime production.*
- *2.A.3. Glass production.*
- *2.A.5.a. Quarrying and mining of minerals other than coal.*
- *2.A.5.b. Construction and demolition.*
- *2.A.5.c. Storage, handling, and transport of mineral products.*

2.A.1 Cement Production

Cement manufacture is a major mineral commodity industry. During the manufacturing process, natural raw materials are finely ground and then transformed into cement clinker in a kiln system at high temperatures. The clinkers are cooled and ground together with additions into a fine powder known as cement.

The main constituents of the exit gases are nitrogen and excess oxygen from the combustion air, and carbon dioxide and water from the raw materials and the combustion process. The exit gases also contain small quantities of dust, sulphur dioxide, nitrogen oxides, carbon monoxide, chlorides, fluorides, ammonia, and still smaller quantities of organic compounds and heavy metals.

There have been two cement factories in the Republic of Moldova: one on the right bank of the Dniester River (Lafarge Cement (Moldova) JSC in Rezina) and another one on the left bank of Dniester River (Cement and Slate Combined Works in Ribnita).

2.A.2 Lime Production

The only lime producing plant on the right bank of the Dniester River was in Vatra ("Var-Nest" SA), currently not operating. On the left bank of the Dniester River, lime is produced at the Cement and Slate Combined Works in Ribnita. Lime is also produced at sugar mills. In 1990s, there were 9 sugar plants in the Republic of Moldova, of which only 5 sugar plants are currently operational (Drochia, Floresti, Donduseni, Cupcini and Glodeni).

2.A.3 Glass Production

Under this source category, pollutant emissions originated from the production of different types of glass (flat window glass, multi-layer insulating glass, glassware, glass for recipients (containers), glass for tableware, specialty glass etc.) are covered. Glass is produced from a raw material mix containing silica (SiO_2), sodium (Na_2O), lime (CaO) or other carbonates ($CaCO_3$, $CaMg(CO_3)_2$, Na_2CO_3, $BaCO_3$, K_2CO_3, $SrCO_3$ etc.), with small admixture of aluminium (Al_2O_3) and alkaline substances, plus other minor ingredients. Glass production process allows for a small quantity of recycled glass (cullet) to be used (its share can vary between 10 and 80 per cent of the total raw material used). The melting process for glass of different types is similar. Glass production process implies the following phases: selection and preparation of the raw material, melting, moulding, hardening, quenching, and finishing. The main emission from the production of glass is carbon dioxide, originating mainly from the carbonization process. Other emitted pollutants include micro pollutants, heavy metals, black carbon, and dust. Emission factors are given for process and combustion emissions together, since it is not straightforward to separate the two. However, large variations may apply depending on the glass composition, fuel type and furnace type and care should be taken in applying these factors.

Four glass plants used to produce glass in the RM: the SOE 'Chisinau Glass Factory' and 'Glass Container Company' (since 1997) in Chisinau, 'Cristal-Flor' Glass Factory in Floresti and the Glass Factory in Tiraspol (ATULBD), but the last two plants ceased their activity.

2.A.5.a Quarrying and mining of minerals other than coal

Emissions from the coal mining industry are not specific for the Republic of Moldova. This category covers the exploitation and extraction of minerals other than coal, e.g. extraction of construction stone (limestone and granite), construction sand, gravel, pile, and clay to produce bricks and tiles.

2.A.5.b Construction and demolition

This chapter discusses emissions from the construction sector. It has long been recognized that the construction of infrastructure and buildings constitutes an important source of fugitive particulate matter (PM) emissions. Frequently, elevated ambient PM_{10} concentrations are observed at and around construction works. A significant proportion of construction activities takes place in urban and other densely populated areas. Consequently, many people may be exposed to PM emitted from construction activities. Besides being a source of fugitive PM emissions, construction activities may emit other pollutants as well. This mostly concerns combustion products such as NOx, soot, and CO_2, and fugitive NMVOC emissions resulting from the use of products. In emission inventories, however, all combustion and product use emissions are estimated elsewhere, either as a component of emissions from mobile machinery, or as a component of solvent/product use emissions. This chapter only considers fugitive

PM emissions. The Eurostat Structural Business Statistics divide the construction sector in the following branches for reporting (regional) economic activities according to the NACE code Description:
F41 Construction of buildings: F411 Development of building projects;
F412 Construction of residential and non-residential buildings;
F42 Civil engineering: F421 Construction of roads and railways;
F422 Construction of utility projects;
F429 Construction of other civil engineering projects;
F43 Specialised construction activities: F431 Demolition and site preparation;
F432 Electrical, plumbing, and other construction installation activities;
F433 Building completion and finishing;
F439 Other specialised construction activities.
From an emission point of view, a different classification is usually needed and the reported economic activity is only of limited use. For emissions, activities are classified either based on the type of building constructed, or by considering the emission mechanism of the type of machinery used.
There are many construction activities that may generate air pollutant emissions. For instance, the following construction activities are relevant sources of fugitive PM emissions:

- Land clearing and demolition;
- Earth moving and cut and fill operations;
- Equipment movements;
- Mobile debris crushing equipment;
- Vehicular transport (loading, unloading, and hauling of materials, track out of dirt on paved roads and subsequent dust resuspension);
- Further site preparation activities;
- Specific building activities such as concrete, mortar and plaster mixing, drilling, milling, cutting, grinding, sanding, welding, and sandblasting activities;
- Various finishing activities;
- Windblown dust from temporary unpaved roads and bare construction sites. Fugitive PM emissions are largely of mineral composition and mechanical origin, with soil dust typically comprising a significant part. The resuspension of soil dust by hauling traffic is a major contributor according to the literature, but since resuspension by road transport may also be estimated elsewhere, there is a danger of double counting of emissions.

2.A.5.c Storage, handling, and transport of mineral products

This chapter discusses emissions from storage, handling, and transport of mineral products. These emissions can occur before, during and after the activities described in the mineral industry (NFR sector 2.A). Exploitation and mining of minerals lead to particulate emissions. TSP, PM_{10}, $PM_{2.5}$ will be determined.

This category provides emission factors for storage, handling, and transport in Tier 1. At this level, it is assumed that these emissions are accounted for in the relevant mineral chapter. For example, emissions from storage, handling, and transport of cement during the cement production are covered by the Tier 1 emission factors for cement production. At Tier 2 level, this chapter provides default emission factors for particulate emissions from storage, handling, and transport of mineral products. In the Tier 1 default approach, the emissions from storage, handling and transport of mineral products are covered by the technical chapters describing the activities. If in the relevant process chapters (such as *2.A.1 Cement Production*) a Tier 1 or 2 methodology is applied, the storage, handling and transport is already included in the applied emission factors. Therefore, it is good practice not to report emissions from storage, handling, and transport separately. In this case, it is good practice to use a Tier 1 approach for this source category. In the Tier 2 methodology, general emission factors are provided for emissions from storage, handling, and transport of mineral products. It is good practice to check the tier methods applied in other chapters in the mineral industry (sector 2.A), to avoid double counting of emissions from storage, handling, and transport.

2.A.6 Other mineral products

The contribution of this source category is thought to be insignificant, i.e. less than 1% of the national emissions of any pollutant.

4.2.2. Methods and emission factors

2.A.1 Cement production

The Tier 2 approach for pollutant emissions from cement uses the general equation (4.1) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.A.1 Cement production, page 11, section 3.3 'Tier 2 technology-specific approach':

$$E_{technology,\ pollutant} = AR_{production,\ technology} \times EF_{technology,\ pollutant} \quad (4.1)$$

Where:

$E_{technology,\ pollutant}$ is the emission of a pollutant (kg);
$AR_{production,\ technology}$ is the annual production of cement (tons);
$EF_{technology,\ pollutant}$ is the emission factor of the relevant pollutant (kg pollutant / ton cement).

2.A.2 Lime Production

The Tier 2 approach for pollutant emissions from lime production uses the general equation (4.2) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.A.2 Lime production, page 9, section 3.3 'Tier 2 technology-specific approach':

$$E_{technology,\ pollutant} = AR_{production,\ technology} \times EF_{technology,\ pollutant} \quad (4.2)$$

Where:

$E_{technology,\ pollutant}$ is the emission of a pollutant (kg);
$AR_{production,\ technology}$ is the annual production of lime (tons);
$EF_{technology,\ pollutant}$ is the emission factor of the relevant pollutant (kg pollutant / ton lime).

2.A.3 Glass Production

The Tier 2 approach for pollutant emissions from glass production uses the general equation (4.3) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.A.3 Glass production, page 15, section 3.3 'Tier 2 technology-specific approach':

$$E_{technology,\ pollutant} = AR_{production,\ technology} \times EF_{technology,\ pollutant} \quad (4.3)$$

Where:

$E_{technology,\ pollutant}$ is the emission of a pollutant (kg);
$AR_{production,\ technology}$ is the annual production of glass (tons);
$EF_{technology,\ pollutant}$ is the emission factor of the relevant pollutant (kg pollutant / ton glass).

Emission Factors

Emission factors are expressed as the quantity of emissions per unit of production per pollutant and are presented in Table 4.2.1. Emission factors for source category *2.A.1 Cement production* were applied in accordance with the 2016 EMEP/EEA Guidebook and are expressed as pollutant emission per unit of cement produced.

For the activity *2.A.2 Lime Production* the recommended Tier 1 emission factors from the 2016 EMEP/EEA Guidebook were used.

For the activity *2.A.3 Glass Production* the recommended Tier 1 emission factors from the 2016 EMEP/EEA Guidebook were used.

For the activity *2.A.5.a Quarrying and mining of minerals other than coal* the recommended Tier 1 emission factors from the 2016 EMEP/EEA Guidebook were used.

For the activity *2.A.5.b Construction and demolition*, the recommended Tier 1 emission factors from the 2016 EMEP/EEA Guidebook were used.

PE	32
Estimated duration (year)	0,75 (9 months)
Soil type - clay	Silt content (%) - 29
CE	0

For the activity *2.A.5.c Storage, handling and transport of mineral products*, the recommended Tier 2 emission factors from the 2016 EMEP/EEA Guidebook were used.

Table 4.2.1. Emission factors for the *Mineral products* category

Pollutant	Value	Unit
2.A.1 Cement Production		
TSP	260	g/Mg clinker
PM_{10}	234	g/Mg clinker
$PM_{2.5}$	130	g/Mg clinker
BC	3	% of $PM_{2.5}$
2.A.2. Lime Production		
TSP	9	kg/Mg lime produced
PM_{10}	3,5	kg/Mg lime produced
$PM_{2.5}$	0,7	kg/Mg lime produced
BC	0,46	% of $PM_{2.5}$
2.A.3. Glass Production		
TSP	300	g/Mg glass
PM_{10}	270	g/Mg glass
$PM_{2.5}$	240	g/Mg glass
BC	0,062	% of $PM_{2.5}$
Pb	1,7	g/Mg glass
Cd	0,13	g/Mg glass
Hg	0,003	g/Mg glass
As	0,19	g/Mg glass
Cr	0,23	g/Mg glass
Cu	0,007	g/Mg glass
Ni	0,49	g/Mg glass
Se	0,8	g/Mg glass
Zn	0,37	g/Mg glass
2.A.5.a Quarrying and mining of minerals other than coal		
TSP	102	g/Mg mineral
PM_{10}	50	g/Mg mineral
$PM_{2.5}$	5,0	g/Mg mineral
2.A.5.b Construction and demolition		
TSP	1,0	kg/[m^2·year]
PM_{10}	0,30	kg/[m^2·year]
$PM_{2.5}$	0,030	kg/[m^2·year]
2.A.5c. Storage, handling and transport of mineral products		
TSP	12	g/ton
PM_{10}	6	g/ton
$PM_{2.5}$	0,6	g/ton

4.2.3. Activity data

2.A.1 Cement production

Information on cement production was received directly from the main producer in the RM, which is Lafarge Cement SA in Rezina, while activity data on cement production at Cement and Slate Combined Works in Ribnita were obtained from the Statistical Yearbooks of the ATULBD.

For other years, following the GPG recommendations (IPCC, 2000), activity data on clinker production at Cement and Slate Combined Works in Ribnita were inferred from statistical data on cement production, by using the equation below:

Clinker Production = Cement Production * Clinker Fraction in Cement (4.4)

In conformity with the technological documentation for Portland type cement production, to produce one ton of cement, cement plants in the RM use approximately 786,9 kg of clinker.

The information provided by Lafarge Cement SA in Rezina through the Official Letter No. 446 as of 16/08/2019 was qualified as "trade secret with commercial value", which is in accordance with the Articles 1, 2 and 5, paragraph (1) of the Law "On Commercial Secrets" No. 171-XII dated 06/07/1994. Under these circumstances, the activity data used to calculate pollutant emissions from the source category *2.A.1 Cement Production* is presented below only aggregated at the national level (Table 4.2.2).

Table 4.2.2. Activity Data on Cement and Clinker Production in the RM, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Cement Production	2288,0	1800,0	1088,2	960,3	769,1	518,8	494,4
Clinker Production	1801,3	1666,6	879,3	752,5	608,6	459,7	357,3
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Cement Production	611,8	493,0	462,0	431,9	402,1	477,0	484,4
Clinker Production	500,2	397,8	390,4	320,3	321,9	406,8	452,7

	2004	2005	2006	2007	2008	2009	2010
Cement Production	667,6	772,8	1051,1	1531,0	1775,9	869,4	861,4
Clinker Production	525,7	678,7	850,6	1302,2	1486,6	641,3	655,6
	2011	2012	2013	2014	2015	2016	2017
Cement Production	1018,216	1051,213	1095,3	1086,2	1122,8	900,2	1045,5
Clinker Production	794,50	810,13	897,6	871,9	830,9	809	822,724

2.A.2 Lime Production

The statistical publications of the Republic of Moldova contain aggregated activity data at national level regarding the production of lime until 1992. For the years 1993-2017, activity data regarding the production of commercial lime are separated for the right and the left banks of the Dniester River. Statistical publications of the Republic of Moldova and ATULBD are official reference sources.

Table 4.2.3. Activity data on the production of lime in the Republic of Moldova, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Commercial lime produced	204,300	178,600	87,800	78,000	60,900	38,800	53,900
Lime produced by self-producers	108,95	59,225	52,000	57,550	41,675	54,675	66,125
Total lime produced in RM	**313,2500**	**237,8250**	**139,8000**	**135,5500**	**102,5750**	**93,4750**	**120,0250**
	1997	1998	1999	2000	2001	2002	2003
Commercial lime produced	48,700	38,700	24,200	15,100	5,300	11,300	2,900
Lime produced by self-producers	53,325	48,625	25,125	26,350	33,150	41,900	26,775
Total lime produced in RM	**102,0250**	**87,3250**	**49,3250**	**41,4500**	**38,4500**	**53,2000**	**29,6750**
	2004	2005	2006	2007	2008	2009	2010
Commercial lime produced	3,100	9,076	10,153	15,135	14,344	4,614	3,369
Lime produced by self-producers	27,275	33,368	37,262	18,491	33,492	9,593	25,802
Total lime produced in RM	**30,8250**	**42,444**	**47,415**	**33,6261**	**47,8352**	**14,2069**	**29,171**
	2011	2012	2013	2014	2015	2016	2017
Commercial lime produced	7,615	6,971	5,569	8,378	8,181	4,075	33,475
Lime produced by self-producers	22,109	20,860	35,074	44,424	21,130	25,000	54,505
Total lime produced in RM	**29,723**	**27,831**	**40,643**	**52,802**	**29,310**	**29,075**	**87,980**

As the quantity of hydrated lime produced in the RM is not known (the unhydrated lime is transformed into hydrated lime, that is to say $Ca(OH)_2$ or $Ca(OH)_2 \bullet Mg(OH)_2$), according to good practice, this value was deduced from the activity data regarding the total quantity of lime produced in RM (Table 4.2.3), by multiplying it by a correction coefficient (the default value used was 0,97).

Concomitantly, the amount of lime with high calcium content and that of dolomitic lime was deduced from the activity data regarding the amount of lime quenched by using the default ratio of 85/15 (Table 4.2.4).

Table 4.2.4. Activity Data on quenched Lime Production in the period 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Lime with high content of calcium	266,6250	178,6000	87,8000	78,0000	60,9000	38,8000	53,9000
Dolomitic lime	46,9875	59,2250	52,0000	57,5500	41,6760	54,6750	66,1250
RM: total	**313,2500**	**237,8250**	**139,8000**	**135,5500**	**102,5750**	**93,4750**	**120,0250**
	1997	1998	1999	2000	2001	2002	2003
Lime with high content of calcium	48,7000	74,2263	41,9263	35,2325	32,6825	45,2200	25,2238
Dolomitic lime	53,3250	13,0988	7,3988	6,2175	5,7675	7,9800	4,4513
RM: total	**102,0250**	**87,3250**	**49,3250**	**41,4500**	**38,4500**	**53,2000**	**29,6750**
	2004	2005	2006	2007	2008	2009	2010
Lime with high content of calcium	26,2013	36,0772	40,3022	28,5822	40,6599	12,0758	24,7953
Dolomitic lime	4,6238	6,3666	7,1121	5,0439	7,1753	2,1310	4,3756
RM: total	**30,8250**	**42,4438**	**47,4143**	**33,6261**	**47,8352**	**14,2069**	**29,171**
	2011	2012	2013	2014	2015	2016	2017
Lime with high content of calcium	25,2649	23,6560	34,5468	44,8815	24,9138	24,7134	74,7800
Dolomitic lime	4,4585	4,1746	6,0965	7,9203	4,3966	4,3612	13,1970
RM: total	**29,7235**	**27,8306**	**40,6433**	**52,8017**	**29,3104**	**29,0746**	**87,980**

2.A.3 Glass production

Activity data regarding the production of glass and glass articles are available in the statistical publications of the Republic of Moldova and those of the ATULBD, as well as the statistical reports ”Promold-A”, ”Total production, as a natural expression, in the republic, by product types”. With reference to the national specific values of the share of recyclable glass in the process of producing different glass products, the information was received from questionnaires provided by the state enterprise „Chisinau Glass Factory”, respectively from glass factories, „Glass Container Company” and „Glass Container PRIM”. The activity data regarding glass production in the Republic of Moldova are available in the table below (Table 4.2.5).

Table 4.2.5. Activity Data on Glass Production in the period 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Total glass produced in RM	237,543	241,726	108,144	121,651	95,537	100,970	80,936
	1997	1998	1999	2000	2001	2002	2003
Total glass produced in RM	95,646	102,363	79,986	151,065	135,369	161,673	147,945
	2004	2005	2006	2007	2008	2009	2010
Total glass produced in RM	157,260	157,260	170,379	156,420	147,161	112,904	136,617
	2011	2012	2013	2014	2015	2016	2017
Total glass produced in RM	173,179	139,293	169,221	167,067	178,564	177,751	150,676

2.A.5.a Quarrying and mining of minerals other than coal

Activity data is collected from Statistical Yearbooks of Moldova.

It has not been possible to collect data from ATULBD.

It should be mentioned that so far we failed to collect all sets of data required by this category of sources. The difficulty consists in the access to previous data.

For the 1990-1996 period, no activity data were found regarding mining and quarrying in Statistical sources. The estimate was made considering only activity data that were available at that moment (Table 4.2.6).

Table 4.2.6. Activity Data regarding material quarried in the period 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Total minerals	-	-	-	-	-	-	-
	1997	1998	1999	2000	2001	2002	2003
Total minerals	1988,55	608,305	1454,145	1396,42	1471,695	1932,535	2813,62
	2004	2005	2006	2007	2008	2009	2010
Total minerals	3499,695	3298,8	3805,9	4393,5	4548,6	3206,2	3659,3
	2011	2012	2013	2014	2015	2016	2017
Total minerals	4765,5	5020,5	6239,1	5274,3	6322,6	5668,5	6446,5

2.A.5.b Construction and demolition

In this sector, the collection of activity data was rather difficult.

The data is not available for the years 1990 - 2004. Thus, emissions for these years were not calculated.

Activity data for ATULBD were available only for the period 2006-2012.

Thus, calculation of emission from *2.A.5.b Construction and demolition* were carried out based on above-mentioned aspects (Table 4.2.7).

Table 4.2.7. Activity Data for constructed/demolished floor space, in the period 2005-2017

	1990	1991	1992	1993	1994	1995	1996
The total area of the houses built and put into operation, right bank of Dniester River, thousands m^2	-	-	-	-	-	-	-
The total area of the houses built and put into operation, left bank of Dniester River, thousands m^2	-	-	-	-	-	-	-
Total, m^2							
	1997	1998	1999	2000	2001	2002	2003
The total area of the houses built and put into operation, right bank of Dniester River, thousands m^2	-	-	-	-	-	-	-
The total area of the houses built and put into operation, left bank of Dniester River, thousands m^2	-	-	-	-	-	-	-
Total, m^2							
	2004	2005	2006	2007	2008	2009	2010
The total area of the houses built and put into operation, right bank of Dniester River, thousands m^2	-	461,1	579	558	679,8	502	546,2
The total area of the houses built and put into operation, left bank of Dniester River, thousands m^2	-	48,4	67,4	41,2	54,7	53	48,3
Total, m^2		**509500**	**646400**	**599200**	**734500**	**555000**	**546200**
	2011	2012	2013	2014	2015	2016	2017
The total area of the houses built and put into operation, right bank of Dniester River, thousands m^2	589,3	502,5	515,0	497,3	609,7	515,5	700,4
The total area of the houses built and put into operation, left bank of Dniester River, thousands m^2	46,3	36,2	42,1	31,4	27,7	39,7	52,4
Total, m^2	**589300**	**502500**	**557100**	**528700**	**637400**	**555200**	**752800**

2.A.5.c Storage, handling, and transport of mineral products

Activity data is collected from Statistical Yearbooks of Moldova.

It has not been possible to collect data from ATULBD.

It should be mentioned that so far we failed to collect all sets of data required by this category of sources. The difficulty consists in the access to previous data.

For the period 1990-1996, no activity data were found regarding mining and quarrying in Statistical sources. The estimate was made considering only activity data that were available at that moment (Table 4.2.8).

Table 4.2.8. Activity Data regarding material quarried in the period 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Total minerals	-	-	-	-	-	-	-
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total minerals	1988,55	608,305	1454,145	1396,42	1471,695	1932,535	2813,62
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total minerals	3499,695	3298,8	3805,9	4393,5	4548,6	3206,2	3659,3
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total minerals	4765,5	5020,5	6239,1	5274,3	6322,6	5668,5	6446,5

4.3. Chemical industry (NFR 2B)

4.3.1. Description of sources

This category includes the following sub-categories:

- *2.B.1 Ammonia production,*
- *2.B.2 Nitric acid production,*
- *2.B.3 Adipic acid production,*
- *2.B.5 Carbide production,*
- *2.B.6 Titanium dioxide production,*
- *2.B.7 Soda ash production,*
- *2.B.10.a Chemical industry: Other,*
- *2.B.10.b Storage, handling, and transport of chemical products.*

No emissions were recorded under source categories *2.B.1-2.B.7*. In Category *2.B.10*, the emissions of NMVOC from the following emission sources were evaluated: polyethylene production, ABS synthetics and polystyrene production.

4.3.2. Methods and emission factors

Methodological issues for calculation of NMVOC and TSP emissions from polyethylene production, ABS production and polystyrene production are addressed in the EMEP/EEA air pollutant emission inventory guidebooks 2016-2019. Tier 2 method was used.

Emission factors

Emission factors for the *2B Chemical industry* category for calculation of NMVOC and TSP emissions are presented in Table 4.3.1.

Table 4.3.1. Emission factors for the *2.B.10.a Chemical industry: Other category*

Pollutant	Value	Unit
2.B.10.a Chemical industry: Other		
Production of low-density polyethylene [13]		
NMVOC	2,4	kg/ton produced
TSP	31	g/ton produced
ABS production [14]		
NMVOC	3	kg/ton produced
Polystyrene production [15]		
NMVOC	120	g/ton produced
TSP	4	g/ton produced

4.3.3. Activity data

The activity data regarding Polyethylene production, ABS resin production and polystyrene production in the Republic of Moldova is available in the Table 4.3.2.

Table 4.3.2. Activity Data on Polyethylene Production, ABS Resin Production and Polystyrene Production in the Republic of Moldova in the period 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Production of polyethylene	5,200	4,400	2,615	2,301	1,178	0,729	1,848
Production of ABS resins	17,500	14,600	5,839	4,792	1,510	1,104	0,040
Polystyrene product	-	-	-	-	-	-	-
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Production of polyethylene	1,253	1,238	0,684	1,723	2,091	3,348	4,236
Production of ABS resins	0,228	0,416	0,603	0,791	0,979	0,776	0,708
Polystyrene product	-	-	-	-	-	-	-
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Production of polyethylene	3,783	4,618	3,899	3,990	3,651	2,926	3,827
Production of ABS resins	0,910	1,048	0,825	1,026	0,961	0,777	1,516
Polystyrene product	-	0,459	1,131	1,242	0,794	1,837	1,975
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Production of polyethylene	4,221	3,760	4,099	4,532	3,581	3,527	3,563
Production of ABS resins	1,657	1,774	1,842	1,739	0,929	1,453	1,346
Polystyrene product	2,262	2,155	2,194	2,532	2,844	2,474	2,054

4.4. Metal production (NFR 2C)

4.4.1. Description of sources

There are no iron, aluminium, magnesium, lead, zinc, copper, and nickel alloys in the Republic of Moldova. That is why, emissions are recorded only from the category *2C1 Iron and steel production*.

2.C.1 Iron and Steel Production

Iron and steel production can occur at primary integrated facilities, by reducing the iron ore with metallurgical coke and at secondary facilities, by melting the recycled steel scrap using electrical energy imparted to the charge through carbon electrodes.

Metallurgical Integrated Works in Ribnita on the left bank of the Dniester River is one of the two mini-metallurgical works (the second is located in Jlobino, Belarus) bought by the USSR in the early 1980's on „dollar for oil" account. These plants were, at the time, at the level of Western European plants, well provided with advanced equipment and efficient technologies. Production capacity at the launch, in 1985, represented about 684 kt of steel and 500 kt of rolling mills. By 2004/2005, steel production reached 1 million tons of steel and 800 thousand tons of rolling mills. The Metallurgical Integrated Works in Ribnita uses scrap metal collected mainly in the Republic of Moldova, but also from the neighbouring countries, especially from Ukraine. At the same time, there are a number of enterprises on the right bank of the Dniester River (such as "Incomaș" SA, "Fiting" SA, Pipe Plant "Protos" SA owned by the company IM "Orvento Metall Trading Co" SRL, etc.) that use low-capacity electric arc furnaces (less than 50 tons). The steel production of these enterprises is insignificant compared to that of the Metallurgical Integrated Works in Ribnita.

4.4.2. Methods and emission factors

NFR 2.C.1 Iron and steel production, section 3.3 "Tier 2 technology-specific approach" [17-18]:

$$E_{pollutant} = AR_{production\ technology} \times EF_{technology\ pollutant} \quad (4.4.)$$

Where:

$E_{pollutant}$ is the emission of a pollutant (kg);

$AR_{production\ technology}$ is the annual production of iron and steel (tons);

$EF_{technology\ pollutant}$ is the emission factor of the relevant pollutant (kg pollutant/ton iron and steel).

Emission factors

Tier 2 emission factors from the 2016 EMEP/EEA Guidebook were used for source category *2.C.1 Iron and Steel Production* (Table 4.4.1).

Table 4.4.1. Emission factors for the *2.C.1 Iron and Steel Production category*

Pollutant	Value	Unit
	Iron and steel production, steel making, electric arc furnace [19]	
NO_X	130	g/Mg steel
CO	1,7	kg/Mg steel
NMVOC	46	g/Mg steel
SO_2	60	g/Mg steel

Pollutant	Value	Unit
TSP	30	g/Mg steel
PM_{10}	24	g/Mg steel
$PM_{2.5}$	21	g/Mg steel
BC	0,36	% of $PM_{2.5}$
Pb	0,018	g/Mg steel
Cd	0,0015	g/Mg steel
Hg	0,024	g/Mg steel
As	0,0001	g/Mg steel
Cr	0,0013	g/Mg steel
Cu	0,02	g/Mg steel
Ni	0,005	g/Mg steel
Zn	0,027	g/Mg steel
PCB	2,5	mg/Mg steel
PCDD/F	3,0	µg I-TEQ/Mg steel
Total 4 PAHs	0,48	g/Mg steel
Production of laminates [20]		
NMVOC	7	g/Mg steel
TSP	9	g/Mg steel

4.4.3. Activity data

The activity data regarding *Steel Production* in the Republic of Moldova are available in the Table 4.4.2.

Table 4.4.2. Activity Data on Steel Production over the period 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Steel production (RM: Right Bank of Dniester)	3.500	2,860	2,220	1,580	0,940	0,299	0,199
Steel production (RM: Left Bank of Dniester)	708,400	614,900	597,400	609,200	632,800	656,500	668,900
Steel production (RM: total)	**711,900**	**617,760**	**599,620**	**610,780**	**633,740**	**656,799**	**669,099**
Production of laminates (RM: total)	**614,200**	**561,300**	**547,600**	**487,200**	**438,000**	**357,000**	**341,000**
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Steel production (RM: Right Bank of Dniester)	0,255	0,120	0,067	0,097	0,133	0,252	0,727
Steel production (RM: Left Bank of Dniester)	810,400	718,000	796,000	908,000	967,000	513,000	886,000
Steel production (RM: total)	**810,655**	**718,120**	**796,067**	**908,097**	**967,133**	**513,252**	**886,727**
Production of laminates (RM: total)	**407,000**	**588,000**	**593,000**	**636,000**	**791,000**	**381,000**	**693,000**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Steel production (RM: Right Bank of Dniester)	0,862	1,354	1,005	1,215	1,145	0,845	0,890
Steel production (RM: Left Bank of Dniester)	1013,000	1048,000	675,000	965,000	884,958	425,943	241,501
Steel production (RM: total)	**1013,862**	**1049,354**	**676,005**	**966,215**	**886,103**	**426,788**	**242,391**
Production of laminates (RM: total)	**791,000**	**890,000**	**633,000**	**914,000**	**818,035**	**437,515**	**237,710**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Steel production (RM: Right Bank of Dniester)	0,876	0,828	1,087	1,401	1,778	2,098	2,412
Steel production (RM: Left Bank of Dniester)	320,574	316,682	190,086	344,590	429,976	127,549	469,446
Steel production (RM: total)	**321,450**	**317,510**	**191,173**	**345,991**	**431,754**	**129,647**	**471,858**
Production of laminates (RM: total)	**302,162**	**360,402**	**173,146**	**389,260**	**318,840**	**222,489**	**451,393**

4.5. Other solvent and product use (NFR 2D-2L)

4.5.1. Description of sources

2.D.3.a Domestic Solvent Use

There are no recorded statistical data on domestic solvent use in the Republic of Moldova. AD for certain applications can be generated indirectly based on the information on production, import and export of domestic products containing solvents. It should be noted that the domestic solvent production in the country is relatively low (see Table 4-63 from the National Inventory Report 1990-2016. Greenhouse Gas Sources and Sinks in the Republic of Moldova). It should also be noted that the Statistical Reports PRODMOLD-A "Total production, as a natural expression, in the Republic, by product type" include relevant data only for the period 2005-2016 and, therefore, cannot be considered complete for the entire period under review. Also, activity data are not always available in tons or litres, which implies the use of conversion factors. Customs Service of the Republic of Moldova is a primary source of information on national import operations (see Table 4-64 from the National Inventory Report 1990-2016. Greenhouse Gas Sources and Sinks in the Republic of Moldova). Though AD on the production and imports of certain household products are available, the share of solvents in these products is unknown.

2.D.3.b Road Paving with Asphalt

In the Republic of Moldova, the data related to asphalt production were provided by the Ministry of Transport and Road Infrastructure for the 1990-2002 period, respectively by the National Bureau of Statistics for the 2003-2016 period (see Table 4-68 from the National Inventory Report 1990-2016. Greenhouse Gas Sources and Sinks in the Republic of Moldova).

2.D.3.c Asphalt Roofing

In the Republic of Moldova, the data related to asphalt roofing production were provided by the National Bureau of Statistics for the 2003-2016 period (see Table 4-70 from the National Inventory Report 1990-2016. Greenhouse Gas Sources and Sinks in the Republic of Moldova). Before 2003, no domestic asphalt roofing production was recorded in the Republic of Moldova, as the respective production was imported.

2.D.3.d Paint Application

This category includes:

- decorative coating application, in construction (SNAP 060103) and domestic paint application (SNAP 060104);
- industrial coating application, in particular from manufacture of automobiles (SNAP 060101), car repairing (SNAP 060102), coil coating (SNAP 060105), painting ships and boats (SNAP 060106), wood treatment and painting (SNAP 060107), other industrial application (painting aircrafts, carriages, steel bridges, military vehicles, engines, pumps, tanks, office equipment, plastic articles, toys etc.) (SNAP 060108);
- other non-industrial paint application (paint or varnish application to protect large metal construction from corrosion, for road marking etc.) (SNAP 060109).

For most activities involving paint application, no statistics is available for activity data. Under such circumstances, it was considered that the share of paints in decorative coating application represents 50% of the total national consumption, the share of paints in industrial coating application is 40%, while their share in other coating applications is 10%.

2.D.3.e Degreasing

Indirect CO_2 emissions from solvent use in the industry are monitored in the *2.D.3.e Degreasing* source category, especially for metal degreasing (SNAP 060201), electronic component manufacturing (SNAP 060203), as well as other industrial cleaning (SNAP 060204).

Typically, the solvents used for degreasing are obtained by distillation of fossil fuels. For example, chlorinated solvents, including trichloroethylene (TRI) (code 2903 22 000), tetrachloroethylene (PER) (code 2903 23 000) and dichloromethane (MC) (code 2903 12 000) are widely used in the industrial sector for cleaning metal articles, electronic products and other industrial products (in closed type cleaning equipment). 1,1,1-trichloroethane (TCA) (2903 19 100) was particularly used until recently, when it was replaced by trichloroethylene (TRI). As for the open type cleaning equipment, the most used solvents are those obtained from white spirit (code 2710 11 210) and alcohols, such as propylene glycol (2905 32 000).

For most activities involving **use of organic solvents for degreasing** in the RM there are no statistical data.

Under such circumstances, the total consumption of solvents used for degreasing will be estimated based on **information on import of solvents,** because internal production of solvents is insignificant. Also, it was assumed that such substances are not re-exported.

Since the same substances are widely used for both degreasing and dry cleaning, it was accepted that out of the total amount consumed, 65% were used for degreasing, while 35% – for dry cleaning.

2.D.3.f Dry Cleaning

Under the *2.D.3.f Dry Cleaning category*, the indirect CO_2 emissions from solvent use in dry cleaning of clothes and other textiles from animal grease, oils, wax, resin, etc. (SNAP 060202) are monitored. Tetrachloroethylene (PER) (code 2903 23 000) is the most widely used solvent for dry cleaning. 1,1,1-

trichloroethane (TCA) (2903 19 100) was particularly used until recently, when it was replaced by trichloroethylene (TRI).
For most activities involving use of organic solvents for dry cleaning in the RM there are no statistical data.
Under such circumstances, the total consumption of solvents used for dry cleaning will be estimated based on information on import of solvents in the RM, because internal production of solvents is insignificant. Also, it was assumed that such substances are not re-exported.
Since the same substances are widely used for both degreasing and dry cleaning, it was accepted that out of the total amount consumed, 65% were used for degreasing, while 35% – for dry cleaning.

2.D.3.g Chemical Products

Under the *2.D.3.g Chemical Products* category, indirect CO_2 emissions from polyester processing (SNAP 060301); polyurethane foam processing (SNAP 060303) and polystyrene foam processing (SNAP 060304); rubber processing (SNAP 060305); pharmaceutical products manufacturing (SNAP 060306); paint manufacturing (SNAP 060307); ink manufacturing (SNAP 060308); glue and adhesive product manufacturing (SNAP 060309); asphalt blowing (SNAP 060310); adhesive, magnetic tapes, films and photographs (SNAP 060311); textile finishing (SNAP 060312); leather tanning (SNAP 060313) are reported.
Statistical publications of the RM provide activity data on the manufacturing of different industrial commodities, including polyurethane and polystyrene products, refurbished tires and rubber soles, paints and varnishes, glues, inks, pharmaceutical products, shoes.
The Customs Service of the Republic of Moldova is a primary source of information on import and export operations regarding primary polyurethane products (code 3909 50); polyurethane products (code 3921 13); primary polystyrene products (code 3903 11), and styrene polymer products (code 3921 11).
In order to convert AD to mass metric units (tons), the following conversion coefficients were used: a car tire weighs about 7,1 kg; a minibus and light-duty truck tire – about 11,1 kg; bus and heavy-duty truck tire – 46,0 kg; a tractor tire – about 69,9 kg.

2.D.3.h Printing

Printing involves the use of inks, which may contain a proportion of organic solvents. These inks may then be subsequently diluted before use. Different inks have different proportions of organic solvents and require dilution to different extents. Printing can also require the use of cleaning solvents and organic dampeners. Ink solvents, diluents, cleaners, and dampeners may all make a significant contribution to emissions from industrial printing.
No statistical data on solvents and/or printing inks used are available in the RM.
Under such circumstances, the total ink consumption will be estimated considering statistical data on production, import and export. According to the Statistical Reports PRODMOLD-A “Total production, as a natural expression, by product type, for 2005-2016”, inks were produced only during 2011-2013; there are no information on the export of inks during the reporting period.

2.D.3.i Other Solvent and Product Use (Seed Oil Extraction)

A certain amount of solvents, hexane, is used in extracting oil from seeds (mechanical extraction does not require the use of solvents). The cleaned and prepared seeds are washed several times in warm hexane solvent until all the oil is extracted, while the remaining seeds residue is treated with steam to capture the solvent and oil that remains in it. After drying, the remaining seed residue may be used as animal feed (it has a content rich in proteins and mineral salts). The oil is separated from the oil-enriched wash solvent and from the steamed-out solvent. The solvent (hexane) is recovered and re-used. Recovery efficiency is quite high, although it is dictated by some economic aspects specific to the enterprises in this branch. The oil is further refined.
To estimate emissions, statistical data on the amount of **oil extracted at the Moldovan enterprises are used**. At the national level, there are over 100 enterprises specialized in oil production, the largest being “Floarea-Soarelui” SA in Balti. Current technologies used in seed oil extraction by use of solvents allow

to obtain around 450 kg of oil per one ton of seeds. This conversion factor was used to estimate the quantity of seeds consumed for oil extraction (National Inventory Report 1990-2016. Greenhouse Gas Sources and Sinks in the Republic of Moldova).

2.D.3.i Other Solvent and Product Use (Use of Glues and Other Adhesives)

Relevant sectors for these categories are the production of adhesive tapes, composite foils, the transportation sector (passenger cars, commercial vehicles, mobile homes, rail vehicles and aircrafts), the manufacture of shoes and leather goods and the wood material and furniture industry. Adhesive tape consists of a substrate, a coupling agent, a pressure-sensitive adhesive and releasing agents. The selection of the adhesive system depends on the technical application of the adhesive tape. At the European level, packaging adhesive tapes have a proportion of 74% and coating adhesive tapes only 10%. Solvent-based adhesives (acrylate for double-sided adhesive tapes, natural rubber for packaging and cover adhesive tapes) have a share of 49% in the European adhesive tape production. Hot melts (acrylate for double-sided adhesive tapes and synthetic rubber for packaging, cover, and double-sided tapes) have a share of 33%, while dispersions (acrylate for double-sided and packaging adhesive tapes) have a share of 18%.
For most activities related to other solvent and product use in the Republic of Moldova, **there are no reliable statistical sources of reference**.
Under such circumstances, the total consumption of glues and other adhesives was estimated based on information on production, import and export. It should be noted that production of glues and other adhesives in the Republic of Moldova was insignificant and that it has been recorded only since 2003, though it increased in the recent years (National Inventory Report 1990-2016. Greenhouse Gas Sources and Sinks in the Republic of Moldova).

2.D.3.i Other Solvent and Product Use (Preservation of Wood)

This activity considers industrial processes for the impregnation or immersion of timber to protect it against fungal and insect attack and against weathering. There are three main types of preservatives: creosote, organic solvent-based preservative (often referred to as “light organic solvent preservative (LOSP)”) and water-borne preservative.
The specialised literature reveals that about 50% of the total timber is used in construction, 15% in the furniture industry and other finished wood products, 15% in the packaging industry and 20% for other purposes. Since the share of timber treated with preservatives is unknown (it is assumed that in the RM preservatives are creosote-based), it is admitted that this corresponds to the share of timber used in the furniture industry and other finished wood products (15% of the total).
The statistical data on the total amount of timber produced at the Moldovan enterprises will be used, based on Statistical Reports PRODMOLD-A „Total production, as a natural expression, in the Republic of Moldova, by product type, for 2005-2016”, as well as the Statistical Yearbooks of the ATULBD for 2000.
Current technologies for wood preservation by creosote impregnation imply the use of approx. 75 kg of creosote in order to treat one cubic meter of wood, while for the same volume of wood, 24 kg of organic solvents can be used (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, source category 2.D.3.i ‘Other Solvent and Product Use’, SNAP 060406 ‘Preservation of Wood’, page 14).

2.D.3.i Other Solvent and Product Use (Underseal Treatment and Conservation of Vehicles)

This category addresses the application of protective coatings to the undersides of cars. This is only a very small source of emissions and can nowadays be considered negligible.

2.D.3.i Other Solvent and Product Use (Vehicle Dewaxing)

This category addresses the application of protective coatings to the undersides of cars. This is only a very small source of emissions and can nowadays be considered negligible.

2.G Other product use

Within the *2G Other product use* category, the GHG emissions from the following sources are evaluated:

- *2.G.1 Electrical equipment,*
- *2.G.3 Use of N_2O in medical applications*
- *2.G.4 Other (tobacco burning and shoe use).*

2.G.4 Other

Within this category, emissions from burning of tobacco (SNAP 060602) and use of footwear (SNAP 060603) are monitored.

4.5.2. Methods and emission factors

2.D.3.a Domestic Solvent Use

The Tier 1 approach for NMVOC emissions from domestic solvent use applies the general equation (4.5) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.D.3.a Domestic solvent use, including fungicides, section 3.1 Tier 1 default approach [22,23]:

$$E_{pollutant} = (P \times EF_{pollutant}) / 10^3 \qquad (4.5)$$

Where:

$E_{pollutant}$ – Pollutant gas emissions from domestic solvents use, t/year;
P – Population, thousand inhabitants/year;
$EF_{pollutant}$ – Emission Factor for this pollutant gas, kg/person/year.

2.D.3.b Road Paving with Asphalt

The Tier 1 approach for emissions from road paving with asphalt uses the general equation (4.6) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.D.3.b Road paving with asphalt, section 3.1 Tier 1 default approach [24,25]:

$$E_{pollutant} = (A \times EF_{pollutant}) / 10^6 \qquad (4.6)$$

Where:

$E_{pollutant}$ – NMVOC, CO, NO_x and SO_x emissions, kt/year;
A – Annual production of asphalt, kt/year;
$EF_{pollutant}$ – Default Emission Factor, g/t.

2.D.3.c Asphalt Roofing

The Tier 1 approach for emissions from asphalt roofing production uses the general equation (4.7) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.D.3.c Asphalt Roofing, section 3.1 Tier 1 default approach [26,27]:

$$E_{pollutant} = (A \times EF_{pollutant}) / 10^6 \qquad (4.7)$$

Where:

$E_{pollutant}$ – pollutant emissions, kt/year;
A – annual production of asphalt roofing, kt/year;
$EF_{pollutant}$ – default emission factor, g/t.

2.D.3.d Coating Application

The Tier 1 approach for NMVOC emissions from paint application uses the general equation (4.8) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, NFR 2.D.3.d Paint Application, section 3.2 Tier 1 default approach [28,29]:

$$E_{pollutant} = (AR_{product} \bullet EF_{pollutant}) / 10^3 \qquad (4.8)$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant, t/year;
$AR_{product}$ – the activity rate for the coating application (consumption of paint), t/year;
$EF_{pollutant}$ – the emission factor for the pollutant, kg/t.

2.G.4 Other

The Tier 2 approach for emissions from burning of tobacco (SNAP 060602) and use of footwear (SNAP 060603) uses the general equation (4.9) from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, Tier 2 default approach [29]:

$$E_{pollutant} = (AR_{product} \bullet EF_{polluting\ technology}) / 10^3 \qquad (4.9)$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant, t/year;

$AR_{product}$ – the activity rate for the coating application (consumption of paint), t/year;

$EF_{polluting\ technology}$ – the emission factor for the polluting technology, kg/t.

Emission factors

Tier 1 and 2 emission factors from the 2016 EMEP/EEA Guidebook for source category *2.D Solvents* were used (Table 4.5.1).

Table 4.5.1. Emission factors for the *2.D Solvents* category

Pollutant	Value	Unit
2.D.3.a Domestic solvent use including fungicides [30]		
NMVOC	1,2	kg/capita
2.D.3.b Road paving with asphalt [31]		
NMVOC	16	g/Mg asphalt
TSP	14 000	g/Mg asphalt
PM_{10}	3 000	g/Mg asphalt
$PM_{2.5}$	400	g/Mg asphalt
BC	5,7	% of $PM_{2.5}$
2.D.3.c Asphalt roofing [32]		
CO	9,5	g/Mg shingle
NMVOC	130	g/Mg shingle
TSP	16 000	g/Mg shingle
PM_{10}	4 00	g/Mg shingle
$PM_{2.5}$	80	g/Mg shingle
BC	0,013	% of $PM_{2.5}$
2.D.3.d Coating applications		
Decorative coating application [33]		
NMVOC	150	g/kg paint applied
Industrial coating application [34]		
NMVOC	400	g/kg paint applied
Other coating application [35]		
NMVOC	200	g/kg paint applied
2.D.3e Degreasing [36]		
NMVOC	460	g/kg cleaning products
2.D.3f Dry cleaning [37]		
NMVOC	40	g/kg textile treated
2.D.3g Chemical products		
Processing of polyurethane products [38]		
NMVOC	120	g/kg foam processed
Processing of polystyrene products [39]		
NMVOC	60	g/kg polystyrene
Processing of rubber products [40]		
NMVOC	8	g/kg rubber produced
Processing of pharmaceutical production [41]		
NMVOC	300	g/kg solvents used
Production of varnishes and paints [42]		
NMVOC	11	g/kg product
Production of glue [43]		
NMVOC	11	g/kg product
Production of asphalt concrete [44]		
NMVOC	17100	g/Mg asphalt
TSP	12000	g/Mg asphalt
Cd	0,0001	g/Mg asphalt
As	0,0005	g/Mg asphalt
Cr	0,006	g/Mg asphalt
Ni	0,05	g/Mg asphalt
Se	0,0005	g/Mg asphalt
PAH	2,5	
Tires restored [45]		
NMVOC	10	g/kg tyres
Manufacture of shoes [46]		
NMVOC	0,045	kg/pair of shoes

Pollutant	Value	Unit
2.D.3h Printing [47]		
NMVOC	500	g/kg ink
2.D.3i Other solvents		
Fat, edible and non-edible oil extraction [48]		
NMVOC	1,57	g/kg/ seed
TSP	1,1	g/kg/ seed
PM_{10}	0,9	g/kg/ seed
$PM_{2,5}$	0,6	g/kg/ seed
Wood preservation, Creosote preservative type [49]		
NMVOC	105	g/kg creosote
Benzo(a)pyrene	1,05	mg/kg creosote
Benzo(b)fluoranthene	0,53	mg/kg creosote
Benzo(k)fluoranthene	0,53	mg/kg creosote
Indeno(1,2,3-cd)pyrene	0,53	mg/kg creosote
Consumption of glue and other adhesives [50]		
NMVOC	522	g/kg adhesives
Vehicles dewaxing [51]		
NMVOC	1,0	kg/car
Under seal treatment and conservation of vehicles [52]		
NMVOC	0,2	kg/person
2G Other product use. 2.G.4 Other		
Use of tobacco [53]		
NOx	1,8	kg/Mg tobacco
CO	55,1	kg/Mg tobacco
NMVOC	4,84	kg/Mg tobacco
NH_3	4,15	kg/Mg tobacco
TSP	27,0	mg/Mg cigarette
PM_{10}	27,0	mg/Mg cigarette
$PM_{2,5}$	27,0	mg/Mg cigarette
Cd	5,4	µg/Mg cigarette
Cu	5,4	µg/Mg cigarette
Ni	2,7	µg/Mg cigarette
Zn	2,7	µg/Mg cigarette
PCDD/F	3,0	µg I-TEQ/Mg tobacco
Benzo(a)pyrene	0,111	g/Mg tobacco
Benzo(b)fluoranthene	0,045	g/Mg tobacco
Benzo(k)fluoranthene	0,045	g/Mg tobacco
Indeno(1,2,3-cd)pyrene	0,045	g/Mg tobacco
Use of Shoes [54]		
NMVOC	60	g/pair

4.5.3. Activity data

2.D.3.a Domestic Solvent Use

Activity data on *Domestic Solvent Use, including fungicide* in the Republic of Moldova are available in Table 4.5.2.

Table 4.5.2. Republic of Moldova's Population in the period 1990-2017

	1990	1991	1992	1993	1994	1995	1996
Population, including (ATULBD), inhabitants	4361600,0	4366300,0	4359100,0	4347800,0	4352700,0	4347900,0	4334400,0
	1997	1998	1999	2000	2001	2002	2003
Population, including (ATULBD), inhabitants	4320000,0	4325800,0	4315000,0	4303500,0	4286300,0	4261612,0	4251300,0
	2004	2005	2006	2007	2008	2009	2010
Population, including (ATULBD), inhabitants	4230600,0	3940400,0	3943100,0	3973400,0	3957900,0	3946900,0	3938100,0
	2011	2012	2013	2014	2015	2016	2017
Population, including (ATULBD), inhabitants	3938100,0	3925800,0	3923700,0	3918400,0	3884800,0	3843600,0	3351670,0

2.D.3.b Road Paving with Asphalt

The annual data related to asphalt production were provided by the Ministry of Transport and Road Infrastructure and are available in Table 4.5.3.

Table 4.5.3. Activity Data regarding Road Paving with Asphalt in the period 1990-2017

	1990	1991	1992	1993	1994	1995	1996
Production of asphalt concrete	1220,305	1014,808	853,000	678,000	410,000	370,000	335,600
	1997	1998	1999	2000	2001	2002	2003
Production of asphalt concrete	113,727	92,328	66,477	53,791	67,343	58,925	72,200

	2004	2005	2006	2007	2008	2009	2010
Production of asphalt concrete	229,300	215,073	347,899	365,390	209,351	156,931	194,440
	2011	2012	2013	2014	2015	2016	2017
Production of asphalt concrete	219,812	248,191	248,339	360,090	250,423	155,724	335,480

2.D.3.c Asphalt Roofing

AD regarding asphalt roofing production was provided by the NBS of the RM (Table 4.5.4). According to these data, until 2003, no domestic asphalt roofing production was recorded, the respective asphalt roofing production was imported.

Table 4.5.4. Activity Data on Asphalt Roofing Production, 2003-2017

	1990	1991	1992	1993	1994	1995	1996
Production of asphalt or similar material, exclusively in rolls	-	-	-	-	-	-	-
	1997	1998	1999	2000	2001	2002	2003
Production of asphalt or similar material, exclusively in rolls	-	-	-	-	-	-	8,800
	2004	2005	2006	2007	2008	2009	2010
Production of asphalt or similar material, exclusively in rolls	6,700	6,900	10,400	11,200	90,500	17,600	37,300
	2011	2012	2013	2014	2015	2016	2017
Production of asphalt or similar material, exclusively in rolls	34,200	39,600	40,900	32,200	23,600	15,000	15,000

2.D.3.d Paint Application

Activity data on the consumption of varnishes and paints in the Republic of Moldova resulted from information on the production and import of varnishes and paints (during the reference period, the export of the respective products was not recorded) (Table 4.5.5).

Table 4.5.5. Activity Data on consumption of varnishes and paints, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Production of varnishes and paints based on polyesters and polymers dissolved in an aqueous environment	26,622	20,439	14,671	9,417	5,653	2,432	3,126
Production of varnishes and paints based on polymers dispersed or dissolved in an aqueous environment	12,712	8,425	5,604	3,386	1,555	0,312	0,324
Total varnishes and paints consumed	**39,334**	**28,864**	**20,275**	**12,803**	**7,208**	**2,743**	**3,450**
	1997	1998	1999	2000	2001	2002	2003
Production of varnishes and paints based on polyesters and polymers dissolved in an aqueous environment	1,852	1,731	1,737	3,878	4,379	7,097	7,105
Production of varnishes and paints based on polymers dispersed or dissolved in an aqueous environment	0,371	0,446	0,563	1,190	2,061	3,304	3,800
Total varnishes and paints consumed	**2,224**	**2,177**	**2,300**	**5,068**	**6,440**	**10,401**	**10,905**
	2004	2005	2006	2007	2008	2009	2010
Production of varnishes and paints based on polyesters and polymers dissolved in an aqueous environment	11,003	20,728	12,275	15,058	13,964	12,904	14,799
Production of varnishes and paints based on polymers dispersed or dissolved in an aqueous environment	3,515	3,452	4,028	5,106	5,876	6,063	5,934
Total varnishes and paints consumed	**14,518**	**24,180**	**16,303**	**20,164**	**19,840**	**18,967**	**20,733**
	2011	2012	2013	2014	2015	2016	2017
Production of varnishes and paints based on polyesters and polymers dissolved in an aqueous environment	17,802	17,565	13,142	17,444	24,246	29,577	33,593
Production of varnishes and paints based on polymers dispersed or dissolved in an aqueous environment	8,181	7,406	5,886	7,221	9,407	10,475	11,803
Total varnishes and paints consumed	**25,983**	**24,972**	**19,028**	**24,665**	**33,653**	**40,052**	**45,396**

There are no statistical data on the use of varnishes and paints in various applications. Under these circumstances, it was admitted that the share of varnishes and paints applied for decorative purposes constitutes 50% of the total consumption in the country, the share of varnishes and paints applied in the industrial sector - 40%, and the share of varnishes and paints used in applications - 10% accordingly (Table 4.5.6).

Table 4.5.6. Activity data regarding the consumption of varnishes and paints in various applications, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Use of varnishes and paints for decorative purposes	19,667	14,432	10,137	6,402	3,604	1,372	1,725
Use of varnishes and paints in the industrial sector	15,734	11,546	8,110	5,121	2,883	1,097	1,380
Use of varnishes and paints in other applications	3,933	2,886	2,025	1,280	0,721	0,274	0,345
Total consumption of varnishes and paints	**39,334**	**28,864**	**20,275**	**12,803**	**7,208**	**2,743**	**3,450**

	1997	1998	1999	2000	2001	2002	2003
Use of varnishes and paints for decorative purposes	1,088	1,150	2,534	3,220	5,201	5,453	7,259
Use of varnishes and paints in the industrial sector	0,871	0,920	2,027	2,576	4,160	4,362	5,807
Use of varnishes and paints in other applications	0,218	0,230	0,507	0,644	1,040	1,090	1,452
Total consumption of varnishes and paints	**2,177**	**2,300**	**5,068**	**6,440**	**10,401**	**10,905**	**14,518**
	2004	2005	2006	2007	2008	2009	2010
Use of varnishes and paints for decorative purposes	12,090	8,152	10,082	9,920	9,483	10,367	12,992
Use of varnishes and paints in the industrial sector	9,672	6,521	8,065	7,936	7,587	8,293	10,393
Use of varnishes and paints in other applications	2,418	1,630	2,016	1,984	1,897	2,073	2,598
Total consumption of varnishes and paints	**24,180**	**16,303**	**20,164**	**19,840**	**18,967**	**20,733**	**25,983**
	2011	2012	2013	2014	2015	2016	2017
Use of varnishes and paints for decorative purposes	12,486	9,514	12,3325	16,826	20,026	22,698	12,486
Use of varnishes and paints in the industrial sector	9,989	7,611	9,8660	13,461	16,021	18,158	9,989
Use of varnishes and paints in other applications	2,497	1,903	2,4665	3,365	4,005	4,540	2,497
Total consumption of varnishes and paints	**24,972**	**19,028**	**24,665**	**33,652**	**40,052**	**45,396**	**24,972**

2.D.3.e Degreasing

For the activities involving the use of solvents, the activity data used in chemical degreasing was estimated based on information on the import of solvents into the Republic of Moldova (domestic solvent production is insignificant; it was admitted that these substances are not subject to re-export). The Customs Service is the primary source of information regarding the import and export operations of solvents by economic agents in the Republic of Moldova (Table 4.5.7).

Table 4.5.7. Activity Data on Consumption of Solvents Used in *Degreasing* and *Dry cleaning*, 2003-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Cyclic and acyclic hydrocarbons	1,2254	0,7601	0,4932	0,3530	0,2559	0,2852	0,0586
Alcohols	0,5952	0,2761	0,0930	0,0304	0,0304	0,0383	0,0494
Total solvents used	**1,8205**	**1,0363**	**0,5862**	**0,3834**	**0,2863**	**0,3235**	**0,1080**
	1997	1998	1999	2000	2001	2002	2003
Cyclic and acyclic hydrocarbons	0,1109	0,1241	0,0282	0,1537	0,0604	0,1700	0,1197
Alcohols	0,0441	0,1956	0,2495	0,1247	0,2251	0,2401	0,1131
Total solvents used	**0,1550**	**0,3197**	**0,2777**	**0,2784**	**0,2854**	**0,4101**	**0,2328**
	2004	2005	2006	2007	2008	2009	2010
Cyclic and acyclic hydrocarbons	0,1907	0,1089	0,1259	0,1273	0,1115	0,1165	0,1752
Alcohols	0,1158	0,1838	0,2837	0,2495	0,2649	0,2325	0,2534
Total solvents used	**0,3064**	**0,2927**	**0,4096**	**0,3768**	**0,3764**	**0,3489**	**0,4285**
	2011	2012	2013	2014	2015	2016	2017
Cyclic and acyclic hydrocarbons	0,2036	0,9318	0,3641	0,1567	0,1937	0,1173	0,5007
Alcohols	0,2746	0,4277	0,5214	0,6126	0,4500	0,4253	0,5872
Total solvents used	**0,4782**	**1,3596**	**0,8855**	**0,7694**	**0,6438**	**0,5425**	**1,0879**

As the same chemicals are used largely for both chemical degreasing and dry cleaning, it was admitted that out of the total amount consumed, 65% were used for chemical degreasing and 35% for dry cleaning (Table 4.5.8).

Table 4.5.8. Activity Data on Consumption of Solvents Used in *Degreasing*, 2003-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Cyclic and acyclic hydrocarbons	0,7965	0,4941	0,3206	0,2294	0,1663	0,1854	0,0381
Alcohols	0,3869	0,1795	0,0604	0,0198	0,0198	0,0249	0,0321
Total solvents used	**1,1834**	**0,6736**	**0,3811**	**0,2492**	**0,1861**	**0,2103**	**0,0702**
	1997	1998	1999	2000	2001	2002	2003
Cyclic and acyclic hydrocarbons	0,0721	0,0807	0,0183	0,0999	0,0392	0,1105	0,0778
Alcohols	0,0287	0,1272	0,1622	0,0811	0,1463	0,1561	0,0735
Total solvents used	**0,1008**	**0,2078**	**0,1805**	**0,1810**	**0,1855**	**0,2665**	**0,1513**
	2004	2005	2006	2007	2008	2009	2010
Cyclic and acyclic hydrocarbons	0,1239	0,0708	0,0819	0,0827	0,0725	0,0757	0,1138
Alcohols	0,0753	0,1195	0,1844	0,1622	0,1722	0,1511	0,1647
Total solvents used	**0,1992**	**0,1903**	**0,2663**	**0,2449**	**0,2446**	**0,2268**	**0,2785**
	2011	2012	2013	2014	2015	2016	2017
Cyclic and acyclic hydrocarbons	0,1323	0,6057	0,2367	0,1019	0,1259	0,0762	0,3254
Alcohols	0,1785	0,2780	0,3389	0,3982	0,2925	0,2764	0,3817
Total solvents used	**0,3108**	**0,8837**	**0,5756**	**0,5001**	**0,4185**	**0,3526**	**0,7071**

2.D.3.f Dry cleaning

There are no statistical data for the activities that involve the use of solvents for dry cleaning. Under these circumstances, the total consumption of solvents used in dry cleaning was estimated based on information on the import of solvents in the Republic of Moldova (domestic solvent production is insignificant; it was admitted that these substances are not subject to re-export).

As the same chemicals are used largely for both chemical degreasing and dry cleaning, it was admitted that out of the total amount consumed (Table 4.5.6), 65% were used for chemical degreasing and 35% for dry cleaning (Table 4.5.9).

Table 4.5.9. Activity Data on Consumption of Solvents Used in *Dry cleaning*, 2003-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Cyclic and acyclic hydrocarbons	0,4289	0,2660	0,1726	0,1235	0,0896	0,0998	0,0205
Alcohols	0,2083	0,0966	0,0325	0,0106	0,0106	0,0134	0,0173
Total solvents used	**0,6372**	**0,3627**	**0,2052**	**0,1342**	**0,1002**	**0,1132**	**0,0378**
	1997	1998	1999	2000	2001	2002	2003
Cyclic and acyclic hydrocarbons	0,0388	0,0434	0,0099	0,0538	0,0211	0,0595	0,0419
Alcohols	0,0154	0,0685	0,0873	0,0436	0,0788	0,0840	0,0396
Total solvents used	**0,0543**	**0,1119**	**0,0972**	**0,0975**	**0,0999**	**0,1435**	**0,0815**
	2004	2005	2006	2007	2008	2009	2010
Cyclic and acyclic hydrocarbons	0,0667	0,0381	0,0441	0,0445	0,0390	0,0408	0,0613
Alcohols	0,0405	0,0643	0,0993	0,0873	0,0927	0,0814	0,0887
Total solvents used	**0,1073**	**0,1025**	**0,1434**	**0,1319**	**0,1317**	**0,1221**	**0,1500**
	2011	2012	2013	2014	2015	2016	2017
Cyclic and acyclic hydrocarbons	0,0712	0,3261	0,1274	0,0549	0,0678	0,0411	0,1755
Alcohols	0,0961	0,1497	0,1825	0,2144	0,1575	0,1488	0,2055
Total solvents used	**0,1674**	**0,4758**	**0,3099**	**0,2693**	**0,2253**	**0,1899**	**0,3810**

2.D.3.g Chemical products

In the statistical publications there are activity data on the production of various industrial products in the Republic of Moldova, including: polyurethane and polystyrene products, restored tires and rubber soles, varnishes and paints, glues, printing inks and others, pharmaceuticals, footwear (Table 4.5.10).

Table 4.5.10. Selective activity data on chemical processing, 2003-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Processing of polyurethane products	0,83	0,699	0,589	0,496	0,418	0,352	0,286
Processing of polystyrene products	5,917	3,707	2,323	1,455	0,912	0,571	0,231
Processing of rubber products	46,9	44,3	20,7	4,2	0,9	1,4	1,512
Processing of pharmaceutical production	1,853	1,648	1,069	0,683	0,334	0,321	0,289
Production of varnishes and paints	11,7	8,8	6	3,1	1,2	0,8	0,7
Production of glue	-	-	-	-	-	-	-
Production of asphalt concrete	1220,305	1014,808	853	678	410	370	335,6
Tires restored	1,443	1,401	0,768	0,029	0,086	0,126	0,153
Shoes, millions of pairs	23,2	20,8	16,268	13,197	9,467	7,606	6,926
	1997	1998	1999	2000	2001	2002	2003
Processing of polyurethane products	0,179	0,116	0,154	0,187	0,225	0,438	0,596
Processing of polystyrene products	0,206	0,216	0,187	0,41	0,391	0,75	1,29
Processing of rubber products	1,361	1,234	0,853	1,598	1,801	3,071	2,425
Processing of pharmaceutical production	0,315	0,45	0,76	0,512	0,646	0,726	0,522
Production of varnishes and paints	0,509	0,37	0,674	2,054	2,87	4,095	3,443
Production of glue	-	-	-	-	-	-	-
Production of asphalt concrete	113,727	92,328	66,477	53,791	53,791	58,925	72,2
Tires restored	0,188	0,136	0,136	0,195	0,134	0,176	0,088
Shoes, millions of pairs	6,193	4,591	4,591	3,747	5,912	4,944	4,925
	2004	2005	2006	2007	2008	2009	2010
Processing of polyurethane products	0,755	1,536	1,691	2,215	2,551	2,134	2,376
Processing of polystyrene products	1,388	2,881	4,141	4,494	4,449	4,889	5,711
Processing of rubber products	2,259	0,061	0,296	0,511	0,189	0,036	0,058
Processing of pharmaceutical production	0,628	0,701	0,76	1,261	3,713	3,832	4,994
Production of varnishes and paints	5,136	6,269	8,319	11,045	11,557	11,822	12,864
Production of glue	0,361	0,655	0,853	1,465	0,58	0,921	1,373
Production of asphalt concrete	229,3	215,073	347,899	365,39	209,351	156,931	194,44
Tires restored	0,115	0,088	0,061	0,054	0,055	0,08	0,161
Shoes, millions of pairs	6,038	6,633	7,45	6,774	7,083	4,829	6,247
	2011	2012	2013	2014	2015	2016	2017
Processing of polyurethane products	2,22	1,583	1,593	1,51	2,557	1,576	2,2121
Processing of polystyrene products	5,944	6,141	6,209	7,019	7,839	7,439	7,382
Processing of rubber products	0,063	0,07	0,072	0,066	0,049	0,048	0,042
Processing of pharmaceutical production	3,347	3,745	3,347	4,101	4,063	3,814	4,353
Production of varnishes and paints	18,011	17,907	12,345	17,685	26,858	32,746	30,069
Production of glue	1,323	1,077	0,953	1,118	5,997	7,607	12,263
Production of asphalt concrete	219,812	248,191	248,339	360,09	250,423	155,724	335,48
Tires restored	0,157	0,248	0,268	0,2	0,139	0,156	0,1373
Shoes, millions of pairs	7,692	7,448	8,329	7,607	5,547	5,156	5,691

2.D.3.h Printing

In the Republic of Moldova, there are no activity data regarding the consumption of solvents and/or inks used for printing paper.

Table 4.5.11. Activity data on the import of inks, 2003-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Printing, writing or drawing inks and other inks	0,3557	0,2214	0,1427	0,1026	0,0788	0,0405	0,0577
Colours for artistic painting, for didactic use, painting companies, changing shades, fun and similar colours	0,1358	0,1086	0,0836	0,0607	0,0438	0,0306	0,0297
Total inks	**0,4914**	**0,3301**	**0,1131**	**0,1633**	**0,1226**	**0,0711**	**0,0874**
	1997	1998	1999	2000	2001	2002	2003
Printing, writing or drawing inks and other inks	0,0604	0,0596	0,0444	0,0553	0,0838	0,1024	0,1175
Colours for artistic painting, for didactic use, painting companies, changing shades, fun and similar colours	0,0035	0,0197	0,0142	0,0152	0,0164	0,0259	0,0278
Total inks	**0,0639**	**0,0793**	**0,0586**	**0,0706**	**0,1002**	**0,1284**	**0,1453**
	2004	2005	2006	2007	2008	2009	2010
Printing, writing or drawing inks and other inks	0,1568	0,2260	0,1502	0,1925	0,1906	0,1721	0,2209
Colours for artistic painting, for didactic use, painting companies, changing shades, fun and similar colours	0,0330	0,0306	0,0462	0,0356	0,0505	0,0441	0,0479
Total inks	**0,1898**	**0,2566**	**0,1964**	**0,2281**	**0,2411**	**0,2162**	**0,2688**
	2011	2012	2013	2014	2015	2016	2017
Printing, writing or drawing inks and other inks	0,2108	0,1949	0,2273	0,2112	0,2979	0,2207	0,0677
Colours for artistic painting, for didactic use, painting companies, changing shades, fun and similar colours	0,0524	0,0546	0,0623	0,0706	0,0698	0,0774	0,0854
Total inks	**0,2533**	**0,2335**	**0,2631**	**0,2818**	**0,3677**	**0,2981**	**0,1531**

Thus, the total ink consumption was estimated taking into account the statistical data on their production (Table 4.5.10), import and export (Table 4.5.11) (according to the Statistical Reports PROMOLD-A ”Total production, as a natural expression, in the republic, by type of products” for the years 2005-2017, inks were produced in the RM only in the period 2011-2013; there is no information regarding the export of inks from the RM in the reference period).

The Customs Service of the Republic of Moldova represents the primary source of information for import and export operations (including printing, writing or drawing inks and other inks; as well as colours for artistic painting, teaching, business painting, entertainment and similar colours), carried out by economic agents.

2.D.3.i Other solvent use

Vegetable oil extraction of oilseeds

This activity includes solvent extraction of edible oils from oilseeds and drying of leftover seeds before resale as animal feed.

The extraction of oil from the seeds is performed either mechanically or through the use of solvents, or both. Where solvent is used, it is generally recovered and cleaned for reuse. The seed may be subjected to solvent treatment many times before all the oil is extracted. The remaining seed residue is then dried and may be used as an animal feed. In Moldova, a certain amount of solvents, hexane in particular, is used to extract oil from seeds.

In conformity with the information received from the Ministry of Agriculture and Food Industry of the RM, there are more than 100 enterprises specialized in oil production, the largest being “Floarea-Soarelui” SA in Balti. Current technologies used in the RM for seed oil extraction by use of solvents allow to obtain around 450 kg of oil per one ton of seeds. This particular conversion factor was used to estimate the quantity of seeds consumed for oil extraction (Table 4.5.12).

Table 4.5.12. Activity Data on Oil Production and Quantity of Seeds Used for Oil Extraction, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996
Total non-chemically modified crude vegetable oils	125,600	117,900	57,317	60,271	50,439	50,715	39,374
Total non-chemically modified refined vegetable oils	57,525	53,998	26,251	27,604	23,101	23,227	18,033
The quantity of seeds from which refined oils were extracted	**127,833**	**119,996**	**58,336**	**61,342**	**51,336**	**51,617**	**40,074**
	1997	1998	1999	2000	2001	2002	2003
Total non-chemically modified crude vegetable oils	35,168	28,747	125,600	117,900	57,317	60,271	50,439
Total non-chemically modified refined vegetable oils	16,107	13,166	57,525	53,998	26,251	27,604	23,101
The quantity of seeds from which refined oils were extracted	**35,793**	**29,258**	**127,833**	**119,996**	**58,336**	**61,342**	**51,336**
	2004	2005	2006	2007	2008	2009	2010

Total non-chemically modified crude vegetable oils	50,715	83,200	81,200	84,700	79,200	83,700	80,710
Total non-chemically modified refined vegetable oils	23,227	38,110	37,190	38,793	35,274	38,335	36,970
The quantity of seeds from which refined oils were extracted	**51,617**	**84,667**	**82,644**	**86,210**	**78,387**	**85,189**	**82,156**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total non-chemically modified crude vegetable oils	89,787	93,500	53,900	109,600	109,500	79,900	86,800
Total non-chemically modified refined vegetable oils	41,122	42,823	24,686	50,197	50,151	36,594	39,754
The quantity of seeds from which refined oils were extracted	**91,382**	**95,162**	**54,858**	**111,550**	**111,447**	**81,320**	**88,342**

Consumption of glue and other adhesives

The consumption of glues and other products used as adhesives was estimated based on the available information on the production, import and export of these products. Production of glue and adhesives in the Republic of Moldova was reduced, being registered only in 2003. However, in recent years the respective production has registered significant increases (Table 4.5.13). The Customs Service of the Republic of Moldova represents the main source of information for the import operations of glue and other adhesives by economic agents in the country (during the reporting period, there was no export of the respective production from the Republic of Moldova).

Table 4.5.13. Activity data on the production, import and consumption of glue and other adhesives, 1990-2017, kt

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Production of glue and other adhesives	NO	NO	NO	NO	NO	NO	NO
Import of glue and other adhesives	3,2508	1,7106	0,9162	0,6208	0,5598	0,4962	0,3323
Consumption of glue and other adhesives	**3,2508**	**1,7106**	**0,9162**	**0,6208**	**0,5598**	**0,4962**	**0,3323**
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Production of glue and other adhesives	NO	NO	NO	NO	NO	NO	0,3611
Import of glue and other adhesives	0,6172	1,0852	0,7549	0,7264	0,8643	1,2217	1,3874
Consumption of glue and other adhesives	**0,6172**	**1,0852**	**0,7549**	**0,7264**	**0,8643**	**1,2217**	**1,7485**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Production of glue and other adhesives	0,6552	0,8533	1,4646	0,7735	0,5797	0,9211	1,3725
Import of glue and other adhesives	1,7522	1,9457	1,9679	1,9609	1,9713	1,4342	1,8004
Consumption of glue and other adhesives	**2,4074**	**2,7990**	**3,4326**	**2,7344**	**2,5509**	**2,3552**	**3,1729**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Production of glue and other adhesives	1,3234	1,0774	0,9527	1,1179	5,9971	7,6074	12,2630
Import of glue and other adhesives	1,5226	1,4106	1,2544	1,4043	1,4872	1,1646	1,0514
Consumption of glue and other adhesives	**2,8460**	**2,4880**	**2,2070**	**2,5222**	**7,4843**	**8,7719**	**13,3144**

Wood preservation

The activity data correspond to the statistical data regarding the total quantity of timber produced at the relevant companies in the Republic of Moldova.

Table 4.5.14. Activity data on the production of timber and creosote use in wood preservation, 1990-2017, thousand m^3 and kt

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Total timber production, thousands	265,00	215,00	106,00	55,00	32,00	25,10	21,20
Lumber impregnated with creosote preservatives	39,80	32,30	15,90	8,30	4,80	3,80	3,20
Amount of creosote used for wood preservation, kt	**2,9813**	**2,4188**	**1,1925**	**0,6188**	**0,3600**	**0,2824**	**0,2385**
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total timber production, thousands	17,20	15,20	21,20	14,90	16,20	17,10	17,20
Lumber impregnated with creosote preservatives	2,60	2,30	3,20	2,20	2,40	2,60	2,60
Amount of creosote used for wood preservation, kt	**0,1935**	**0,1710**	**0,2385**	**0,1676**	**0,1823**	**0,1924**	**0,1935**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total timber production, thousands	24,10	23,10	27,00	31,80	46,50	34,00	25,60
Lumber impregnated with creosote preservatives	3,60	3,50	4,00	4,80	7,00	5,10	3,80
Amount of creosote used for wood preservation, kt	**0,2711**	**0,2596**	**0,3032**	**0,3580**	**0,5228**	**0,3822**	**0,2880**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total timber production, thousands	18,50	19,40	16,70	15,80	16,50	14,30	17,1450
Lumber impregnated with creosote preservatives	2,80	2,90	2,50	2,40	2,50	2,20	2,49
Amount of creosote used for wood preservation, kt	**0,2081**	**0,2183**	**0,1884**	**0,1780**	**0,1856**	**0,1614**	**0,1929**

From the specialized literature, it is known that about 50% of the total quantity of timber is used in the construction sector, 15% in the furniture industry, 15% in the packaging industry and 20% for other purposes. As the weight of the timber treated with preservatives is not known (in the Republic of Moldova it was assumed that the preservatives are based on creosote), it was admitted that this corresponds to the quantity of timber used in the furniture industry and other finished wood products (15% of the total). The current technologies used for wood preservation by creosote impregnation

involve the use of about 75 kg of creosote when treating a cubic meter of wood. The respective conversion coefficient was used in the calculation of the quantity of creosote used to treat the timber in the relevant companies in the Republic of Moldova (Table 4.5.14).

Vehicle Dewaxing

This section dwells on the removal from cars of temporary covering that are applied to protect the car paintwork during transportation.

There are a number of methods for applying covering for protection during transportation. Traditionally, a hydrocarbon wax was used, which had to be removed using a mixture of hot water, kerosene and detergent.

No vehicles are produced in the RM. The Customs Service of the Republic of Moldova is a primary source of information on national import operations (Table 4.5.15).

Table 4.5.15. Activity data on new cars import, 1990-2017

	1990	1991	1992	1993	1994	1995	1996
New vehicles imported, total units	5803	4836	4030	3358	2798	2332	2334
	1997	1998	1999	2000	2001	2002	2003
New vehicles imported, total units	1922	1947	3281	1161	1841	3503	8431
	2004	2005	2006	2007	2008	2009	2010
New vehicles imported, total units	7768	10300	7477	10523	14368	7832	7923
	2011	2012	2013	2014	2015	2016	2017
New vehicles imported, total units	8237	7171	9869	22103	32373	14998	9254

Anti-corrosive treatment and conservation of vehicles

Because the quantities of anticorrosive agent used and/or the amount of organic solvents used for the treatment and preservation of cars are unknown, as an alternative to the activity data, the data about population in the RM were used (Table 4.5.16).

Table 4.5.16. Republic of Moldova's Population, 1990-2017

	1990	1991	1992	1993	1994	1995	1996
Population, including (ATULBD), inhabitants	4361600	4366300	4359100	4347800	4352700	4347900	4334400
	1997	1998	1999	2000	2001	2002	2003
Population, including (ATULBD), inhabitants	4320000	4325800	4315000	4303500	4286300	4261612	4251300
	2004	2005	2006	2007	2008	2009	2010
Population, including (ATULBD), inhabitants	4230600	3940400	3943100	3973400	3957900	3946900	3938100
	2011	2012	2013	2014	2015	2016	2017
Population, including (ATULBD), inhabitants	3938100	3925800	3923700	3918400	3884800	3843600	3351670

2G Other product use

2.G.4 Other

Tobacco combustion and Use of footwear

The statistical data of tobacco and cigarette production are available in the statistical publications of the Republic of Moldova, statistical reports PROMOLD-A ”Total production, as a natural expression, in the republic, by product types”, as well as in the statistical database, which can be accessed on-line on the website of the National Bureau of Statistics of the Republic of Moldova (Table 4.5.17).

Table 4.5.17. Activity Data of tobacco in cigarettes and the use of footwear, 1990-2017

	1990	1991	1992	1993	1994	1995	1996
The quantity of tobacco in cigarettes, Kt	10,920	11,040	10,320	10,560	9,600	8,520	11,640
cigarettes, billions of pieces	9,1	9,2	8,6	8,8	8	7,1	9,7
use of footwear, millions of pairs	23,200	20,800	16,268	13,197	9,467	7,606	6,929
	1997	1998	1999	2000	2001	2002	2003
The quantity of tobacco in cigarettes, Kt	11,400	9,014	10,477	11,114	11,305	7,572	8,551
cigarettes, billions of pieces	9,5	7,512	8,731	9,262	9,421	6,31	7,126
use of footwear, millions of pairs	6,193	4,591	3,747	5,912	4,944	4,925	6,038
	2004	2005	2006	2007	2008	2009	2010
The quantity of tobacco in cigarettes, Kt	8,460	7,434	6,037	5,970	4,788	5,853	7,513
cigarettes, billions of pieces	7,05	6,195	5,031	4,975	3,99	4,878	6,261
use of footwear, millions of pairs	6,633	7,450	6,774	6,696	7,083	4,829	6,247
	2011	2012	2013	2014	2015	2016	2017

The quantity of tobacco in cigarettes, Kt	7,754	5,587	4,166	2,787	2,131	2,206	1,69325
cigarettes, billions of pieces	6,462	4,656	3,472	2,322	1,776	1,839	1,411
use of footwear, millions of pairs	7,692	7,448	8,329	7,607	5,547	5,156	4,665

4.6. Other industry production (NFR 2H)

4.6.1. Description of sources

2.H.1 Pulp and paper industry

There is no pulp and paper produced in the Republic of Moldova, i.e. no GHG emissions from the *2.H.1* category.

2.H.2 Food and beverages industry

Under the category 2.*H.2 Food and beverages industry*, NMVOC emissions are monitored. These data come from:

- sub-category *2.H.2.a Bread and other food production*
- sub-category *2.H.2.b Production of alcoholic beverages*.

2.H.3 Other industrial processes

This source category provided "catch all" for other industrial processes. All emissions that cannot be placed under a specific source category can be put in this chapter. Thus, this may be a very extensive chapter covering lots of different activities. The contribution of this source category is thought to be insignificant, i.e. less than 1% of the national emissions of any pollutant. Therefore, no further information regarding emissions is provided in this chapter.

4.6.2. Methods and emission factors

2.H.2 Food and beverages industry

The methodological issues related to the calculation of NMVOC emissions from the production of bread and other food, as well as the production of alcoholic beverages are addressed in the EMEP/EEA Guidebook for the Emission Inventory.

The calculation method is based on the multiplication of the values of emission factors used implicitly with the activity data related to the production of bread and other foodstuffs, as well as the production of alcoholic beverages available in the national statistics of the RM and the ATULBD.

Emission factors

Emission factors used for emission calculation in the *2.H.2 Food and beverages industry* category are presented in Table 4.6.1.

Table 4.6.1. Emission factors for the Other industry production category

Pollutant	Value	Unit
2.H.2 Food and beverages industry		
Meat [67]		
NMVOC	0,33	kg/t meat
Fish [68]		
NMVOC	1,0	kg/Mg fish
Dried cereals in elevator [69]		
NMVOC	1,3	kg/Mg grain dried
PM_{10}	24	g/ton
Sugar [70]		
NMVOC	10	kg/t sugar
Margarine [71]		
NMVOC	10	kg/Mg product
Confectionery, flour [72]		
NMVOC	1	kg/Mg product
Bread [73]		
NMVOC	4,5	kg/Mg bread
Ready-made animal feed [74]		
NMVOC	1	kg/Mg feed
White grape wines [75]		
NMVOC	0,035	kg/hl wine
Red grape wines [76]		
NMVOC	0,08	kg/hl wine
Wines of Porto, Madeira, Sherry, Tokay, Sparkling wines and others [77]		
NMVOC	15	kg/hl alcohol
Production of the divine (cognac) [78]		
NMVOC	3,5	kg/hl alcohol

Pollutant	Value	Unit
Scrubs and liqueurs, Vodka [79]		
NMVOC	7,5	kg/hl alcohol
Beer production [80]		
NMVOC	0,035	kg/hl beer

4.6.3. Activity data

2.H.2 Food and beverages industry

The activity data on the quantity of dried grain in the elevators were deduced from the information available in the national statistics of the RM and those of ATULBD.

The statistical data of **„Food and beverages industry"** are available in the statistical publications of the Republic of Moldova, statistical reports PROMOLD-A "Total production, as a natural expression, in the republic, by product types", as well as in the statistical database, which can be accessed on-line on the website of the National Bureau of Statistics of the Republic of Moldova and Statistical Yearbooks of the ATULBD (Tables 4.6.2, 4.6.3).

Table 4.6.2 Activity data on bread making and other food, 1990-2012, kt

	1990	1991	1992	1993	1994	1995	1996
Meat	257,9	218,5	136,0	114,20	85,90	58,40	52,60
Fish, t	9,5	5,2	6,5	9,0	2,1	0,0	0,0
Dried cereals in elevator, t	2167,76	2539,6	1725,894	2374,223	1241,296	1581,116	1264,628
Sugar, t	435,8	236,9	192,2	230,2	166,7	218,7	264,5
Confectionery, flour, t	24,3	23,5	12,0	10,08	5,0	5,17	5,15
Bread, t	601,9	528,3	468,6	431,7	325,2	268,4	252,5
Ready-made animal feed, t	1037,292	946,192	867,504	440,21	309,794	333,628	350,394
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Meat, , t	50,8	27,3	25,717	13,351	7,301	11,262	14,855
Fish, t	0,9	0,8	1,0	1,9	2,3	2,7	2,7
Dried cereals in elevator, t	1692,411	1339,292	985,796	899,624	860,243	876,056	618,92
Sugar, t	213,3	194,5	100,5	105,4	132,6	167,6	107,1
Margarine, t	-	-	-	0,024	1,034	2,616	3,301
Confectionery, flour, t	5,55	9,2	8,423	8,745	12,834	15,852	18,036
Bread, t	221,9	180,2	147,045	138,126	133,280	130,779	144,650
Ready-made animal feed, t	231,89	221,176	108,604	59,791	31,441	41,381	28,095
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Meat, , t	10,180	6,651	10,228	16,122	12,809	16,260	24,699
Fish, t	2,7	3,0	2,5	2,3	4,6	3,7	1,3
Dried cereals in elevator, t	849,187	814,747	678,433	282,590	920,742	658,146	764,898
Sugar, t	110,9	133,472	149,046	73,964	133,966	38,373	103,209
Margarine, t	3,515	3,39	2,624	2,225	1,940	1,657	1,274
Confectionery, flour, t	17,876	20,726	21,692	22,284	22,910	23,629	27,718
Bread, t	145,830	142,026	144,848	154,774	169,806	161,564	160,406
Ready-made animal feed, t	46,062	50,840	64,340	46,422	51,043	60,143	74,405
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Meat, , t	28,509	31,597	35,495	44,072	45,958	45,9	54,3
Fish, t	7,578	7,732	8,490	8,774	9,241	9,241	9,241
Dried cereals in elevator, t	803,125	405,367	882,585	955,221	724,700	987,601	681,0
Sugar, t	88,436	83,44	140,297	177,695	84,519	99,999	129,0
Margarine, t	1,119	0,484	0,706	C	C	C	C
Confectionery, flour, t	29,383	31,332	34,633	34,875	34,255	35,156	35,4
Bread, t	162,916	161,765	16,545	160,259	161,328	157,684	130,1
Ready-made animal feed, t	75,405	96,284	97,787	98,472	80,118	96,371	87,5

Note: c - does not occur.

Table 4.6.3 Activity Data on Alcoholic Beverages Production, 1990-2017, thousand hl

	1990	1991	1992	1993	1994	1995	1996
White grape wines	764,5	670,7	431,5	530,0	458,6	467,5	683,8
Red grape wines	865,5	759,3	488,5	600,0	519,2	529,4	774,2
Wines of Porto, Madeira, Sheary, Tokay and others	217,7	189,0	126,0	156,7	135,4	141,5	216,1
Sparkling wines	80,4	78,3	85,4	88,8	74,2	94,8	141,9
Production of the divine (cognac)	139,4	140,2	750,0	74,0	793,0	102,7	45,7
Scrubs and liqueurs	55,9	55,6	67,6	139,4	264,70	412,7	335,8
Vodka	21,5	21,4	267,0	544,0	992,0	146,6	103,9
Beer production	760,0	660,0	430,0	360,0	285,0	302,9	256,0
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
White grape wines	910,6	581,4	323,7	512,3	733,6	700,7	901,3
Red grape wines	1030,9	658,2	366,4	580,0	830,6	793,3	1010,5
Wines of Porto, Madeira, Sheary, Tokay and others	290,7	182,6	101,6	163,30	235,2	225,3	289,9
Sparkling wines	134,5	51,9	67,5	41,6	58,4	61,3	73,9
Production of the divine (cognac)	58,6	49,7	48,6	71,8	95,6	103,8	136,1

Scrubs and liqueurs	237,0	174,1	87,0	48,9	59,4	77,9	139,8
Vodka	82,0	74,6	34,4	18,0	24,4	34,9	69,6
Beer production	262,7	300,1	220,9	257,9	336,2	462,4	599,1
	2004	2005	2006	2007	2008	2009	2010
White grape wines	1571,8	1710,2	983,0	717,9	814,4	600,4	591,7
Red grape wines	1779,6	1933,3	903,8	540,2	738,6	662,7	693,8
Wines of Porto, Madeira, Sheary, Tokay and others	301,8	323,8	133,7	75,3	92,2	69,3	105,1
Sparkling wines	938,0	105,1	40,2	54,1	57,3	50,0	55,6
Production of the divine (cognac)	142,8	171,1	79,1	82,4	103,7	59,8	74,6
Scrubs and liqueurs	212,9	238,8	196,3	172,2	129,1	110,8	127,1
Vodka	109,8	122,6	65,6	50,5	35,4	26,5	32,2
Beer production	695,7	777,8	913,3	1014,6	866,6	781,7	952,6
	2011	2012	2013	2014	2015	2016	2017
White grape wines	664,3	679,2	694,3	765,1	622,5	576,2	764,47
Red grape wines	596,3	742,8	857,4	644,3	734,0	769,6	865,53
Wines of Porto, Madeira, Sheary, Tokay and others	111,2	52,8	65,1	34,8	37,1	47,0	42,83
Sparkling wines	68,6	65,4	60,0	52,2	50,2	63,3	64,24
Production of the divine (cognac)	91,2	109,4	118,0	93,9	70,2	50,1	234,38
Scrubs and liqueurs	140,2	165,9	196,1	183,4	162,3	162,8	28,21
Vodka	49,2	65,0	84,5	81,6	68,4	65,8	25,169
Beer production	1068,1	1118,40	1029,3	984,8	994,5	847,8	866,47

4.7. Wood processing (NFR 2I)

Emissions from this sector were not estimated, because the data on creosote wood processing were included in the category *2.D.3.i Consumption of glue and other adhesives*. The emissions for particles from this source category, however, are assumed to be small, i.e. less than 1% of the national emissions for particulates.

4.8. Production of POPs (NFR 2J)

This chapter deals with the production of persistent organic pollutants (POPs) and pesticides. Emissions from this source category are not significant, since the contribution to the total national emissions is less than 1% of the national emissions of any pollutant. Compared to the use of POPs, the production of POPs is not a key category, since the production processes are mostly highly controlled to manage health and environmental effects. In addition, no emission factors are available to produce POPs. There is no production of Persistent Organic Pollutants in the Republic of Moldova.

4.9. Consumption of POPs and heavy metals (NFR 2K)

Emissions from the consumption of persistent organic pollutants (POPs) and heavy metals are, in many cases, insignificant (their contribution to the total national emissions is less than 1% of national emissions). The same is true for the use of POP pesticides in the agriculture sector.

4.10. Other production, consumption, storage, transportation, and handling of bulk products (NFR 2L)

This source category provides a “catch all” for other processes concerning bulk products. All emissions that cannot be placed under a specific source category can be put in this chapter. Thus, this may be a very extensive chapter covering lots of different activities. The contribution of this source category is thought to be insignificant, i.e. less than 1% of the national emissions of any pollutant.

Chapter 5: AGRICULTURE (NFR sector 3)

5.1. Overview of the sector

Agriculture has traditionally been regarded as the main pillar of the Republic of Moldova's national economy, with agricultural output accounting for over 12,2% of its GDP (NBS, 2017), or 30% if combined with the food processing industry. The sector represents approximately 50% of Moldova's total exports, utilizing over 33% of the country's labour force. Agriculture is the dominant sector of land use in Moldova. In the agriculture sector, the plant production accounted for a relatively large share – 69,5 %, animal breeding – for 28,9 %, while services – for circa 1,6% (NBS, 2017). More than 33,7% of active population is employed in this sector (NBS, 2017).

In 2017, the total area of the land constituted 3384,6 thousand ha, including 465,3 thousand ha (13,8%) - forests and lands with forest vegetation; 96,1 thousand ha (2,8%) - aquatic basins and other lands; 2499,8 thousand ha (73,9%) - agricultural land; of which 1827,3 thousand ha (73,0%) - arable land, 288,8 thousand ha (11,6%) - multiannual plantations, 383,7 thousand ha (15,3%) - meadows and pastures, (NBS, 2017). The use of the land fund for agricultural purpose by basic land holders was the following: 74 state agricultural enterprises with the surface of 8,8% of the total area; 258 agricultural cooperatives with the surface of 4,5%; 364 thousand peasant households with the surface of 26,4%; 33,7 thousand limited liability companies with an area of 36,8%; 788,3 thousand lands worked by private owners with an area of 11,4% of the total area.

By far the most significant land use is arable land for annual crop production. High quality soil resources, along with various microclimates, support a wide array of annual and perennial crop production across the country. By area, the major annual crops grown are maize, wheat, sunflower and barley. Vineyards and fruit trees are the main perennial crops.

Earlier assessments of GHG and other noxious emissions for the periods 1990-2012 and 1990-2016 were reported in Reports [1-4] and presented in the Climate Change Convention and the LRTAP Convention. In this sector, emissions are reported for the 1990-2017 period. The trend for ammonia, NMVOC, NOx and particulate matter (TSP, PM_{10} and $PM_{2.5}$) emissions in the Agriculture sector shows a continuous decline. One of the driving forces to this is a decreasing agricultural sector in Republic of Moldova, which has undergone radical structural changes and has resulted in a decrease in agricultural land (1990-2017) and decreasing livestock.

The Agriculture Sector includes the historical emissions for the 1990-2017 period. Year 2014 is the last year when this section was updated.

The Agriculture Sector includes emissions generated directly from agricultural activities. The overview of pollutants, categories and sources are presented in the Table 5.1.

Table 5.1. Source categories for agriculture used in the inventory

NFR	Source		Description	Pollutants
3.B	3.B.1.a	Manure management - Dairy cattle	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.1.b	Manure management - Non-dairy cattle	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.2	Manure management - Sheep	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.3	Manure management - Pigs	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.d	Manure management - Goats	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.e	Manure management - Horses	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.f	Manure management -Mules and asses	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.gi	Manure management - Laying hens	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.gii	Manure management - Broilers	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP

NFR	Source		Description	Pollutants
	3.B.4.giii	Manure management - Turkeys	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.giv	Manure management - Other poultry	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
	3.B.4.h	Manure management - Other animals	NBS on-line database, for 1990-2017. ATULBD Yearbooks Official Letter of the MARDE	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP
3.D	3.D.a.1	Inorganic N-fertilizers (includes also urea application)	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NH_3, NOx
	3.D.a.2.a	Livestock manure applied to soils	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NH_3
	3.D.a.2.b	Sewage sludge applied to soils	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NH_3, NO_x
	3.D.a.2.c	Other organic fertilizers applied to soils (including compost)	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NH_3, NO_x,
	3.D.a.3	Urine and dung deposited by grazing animals	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NH_3, NOx
	3.D.4.a	Crop residues applied to soils	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NO_x,
	3.D.b	Indirect emissions from managed soils	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NO_x,
	3.D.c	Farm-level agricultural operations including storage, handling and transport of agricultural products	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	$PM_{2.5}$, PM_{10}, TSP
	3.D.e	Cultivated crops	NBS on-line database, Section Gross Harvest of Agricultural Crops, 1990-2017. Statistical Yearbooks for ATULBD (1998-2018)	NMVOC
3.F	3.F	Field burning of agricultural residues	State Ecological Inspectorate/Ministry of Environment (2018), SEI Yearbook „Environment Protection in the Republic of Moldova"; Ch.: Pontos, 2016 and ed. 2008-2018	NH_3, NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, PAHs,

The pollutants covered are the following:

- main pollutants (3) = NH_3, NMVOC, NOx.
- Other pollutants (2): CO, SOx, (SO_2)
- PM (4) = $PM_{2.5}$, PM_{10}, TSP, BC.
- Heavy metals (9) = Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn.
- PAHs (4) = benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene.

5.1.1. Trends in emissions

Ammonia NH_3

NH_3 emissions from the Agriculture Sector decreased by 41,2%, from 82,098 kt in 1990 to 48,25 kt in 2017 (Figure 5.1.1). The minimum values of emissions were recorded in 2007, equal to 45,58 kt, falling by 44,42% compared to the 1990 levels. From 2007 to 2017, NH_3 emissions grew constantly in line with the economic development. However, in the livestock sector (animals and birds) the reduction of NH_3 emissions is 63,8% (reduced from 43,95 kt in 1990 to 15,91 kt ammonia in 2017).

The largest source of NH_3 emissions from the Agriculture sector is *3.D.a.2.B Sewage sludge applied to soils* category, sharing 35% of the total emissions from the sector in 1990 and 52% in 2017 (Figure 5.1.2).

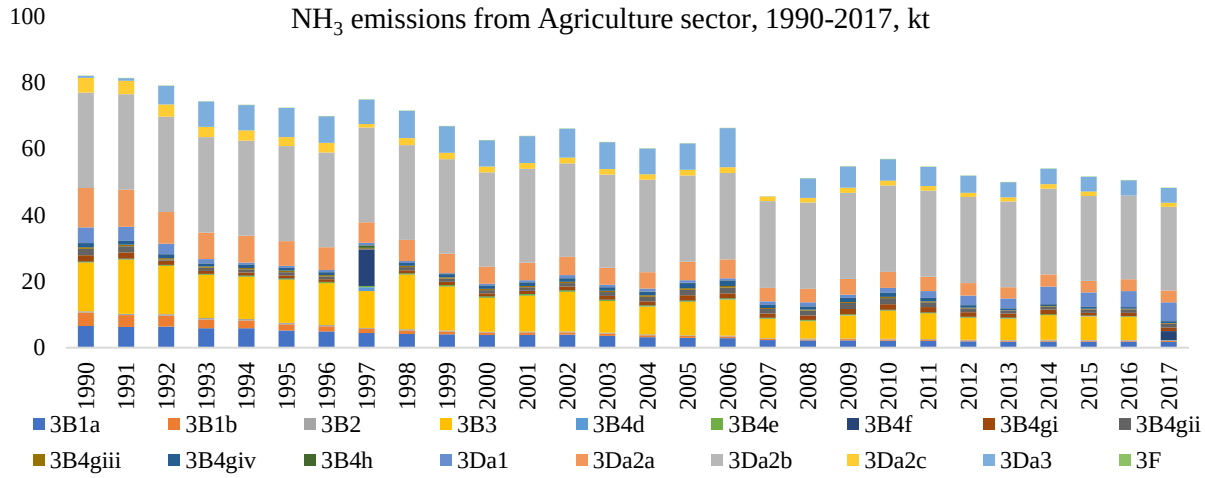


Figure 5.1.1. Trends in NH_3 emissions from the Agriculture sector, 1990-2017, kt

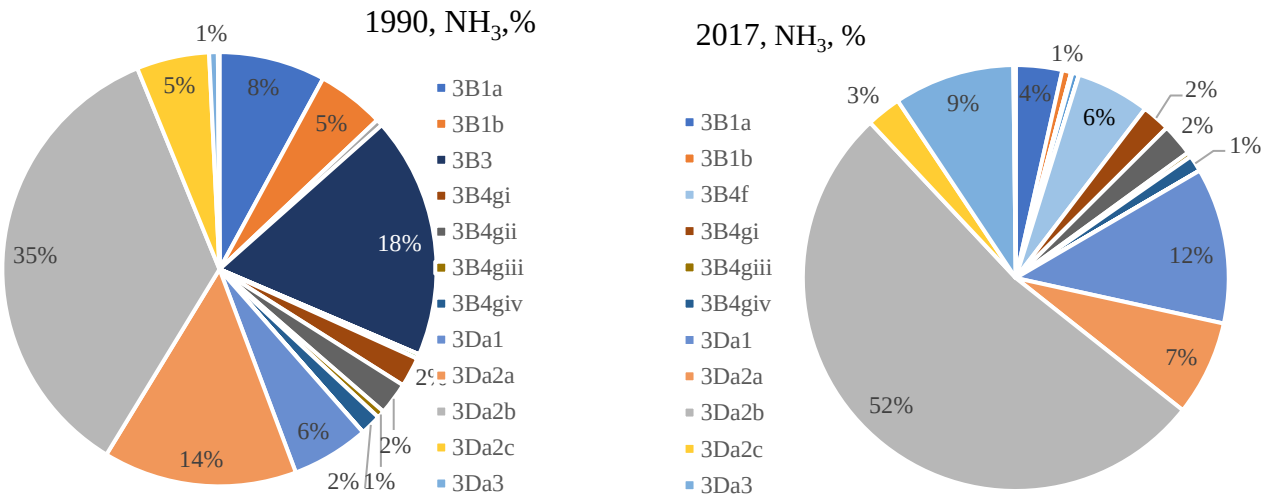


Figure 5.1.2. Share of different categories in the overall NH_3 emissions from the Agriculture Sector in 1990 and 2017

Thus, the share of categories in the overall NH_3 emissions changed as follows (Figure 5.1.2):

- *3.D.a.2.b Sewage sludge applied to soils* – increased from 35% in 1990 to 52% in 2017;
- *3.D.a.2.a Animal manure applied to soils* – decreased from 14% in 1990 to 7% in 2017;
- *3.D.a.1 Inorganic N-fertilizers* (also includes urea application) – increased from 6% in 1990 to 12% in 2017;
- *3.B.3 Manure management - Swine (Sows + Fattening pigs)* – decreased from 18% in 1990 to 0% in 2017;
- *3.D.a.3 Urine and dung deposited by grazing animals* – increased from 1% in 1990 to 9% in 2017.

Nitrogen oxides (NOx)

NOx emissions from Agriculture Sector have fallen by 33,1%: from 16,54 kt in 1990 to 11,07 kt in 2017 in the country (Figure 5.1.3).

Nitrous oxides emissions arise mainly from *3.D.a.2.b Sewage sludge applied to soils, 3.D.a.2.c Other organic fertilizers applied to soils* source categories from Agriculture Sector (Figure 5.1.4).

The largest source of emissions of NOx from the Agriculture sector is *3.D.a.2.b Sewage sludge applied to soils* category, sharing 53% of the total emissions from the sector in 1990 and 69% in 2017 (Figure 5.1.4).

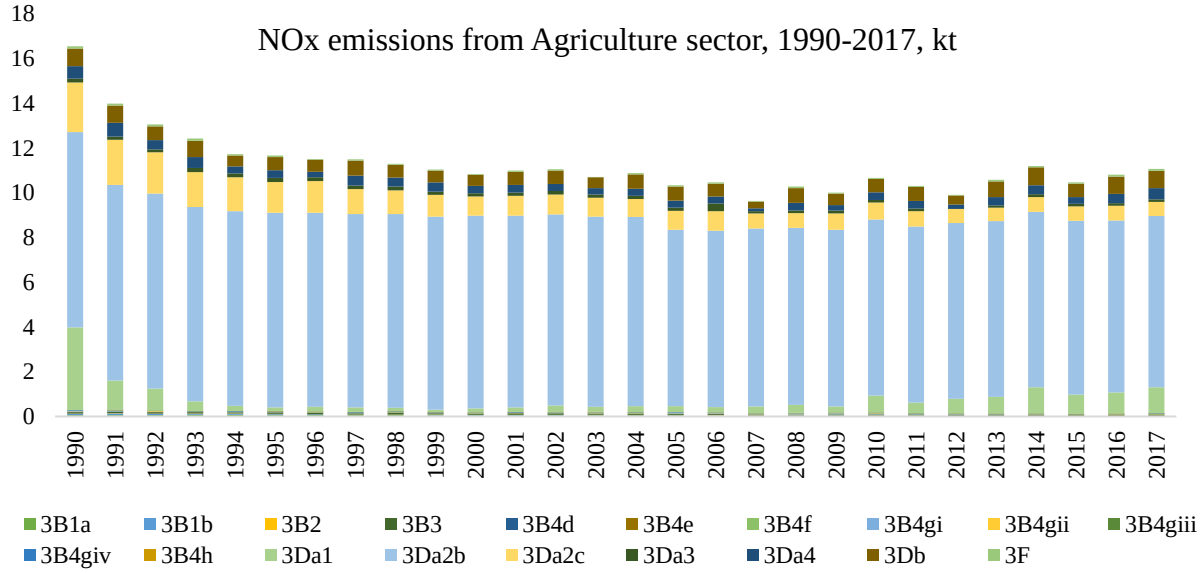


Figure 5.1.3. Trends in NOx emissions from the Agriculture sector, 1990-2017, kt

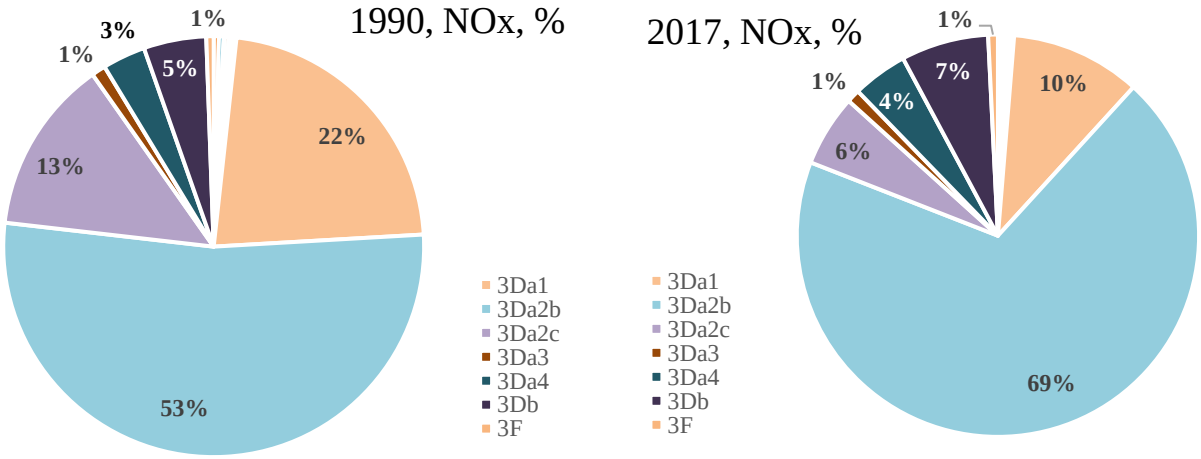


Figure 5.1.4. Share of different categories in the overall NOx emissions from the Agriculture Sector in 1990 and 2017

The share of categories in the overall NOx emissions changed as follows (Figure 5.1.4):

- *3.D.a.2.b Sewage sludge applied to soils* – increased from 53% in 1990 to 69% in 2017;
- *3.D.a.1 Inorganic N-fertilizers* (also includes urea application) – decreased from 22% in 1990 to 10% in 2017;
- *3.D.a.2.c Other organic fertilizers applied to soils* (including compost) – decreased from 13% in 1990 to 6% in 2017;
- *3.D.b Indirect emissions from managed soils* – increased from 5% in 1990 to 7% in 2017.

Non-methane volatile organic compounds (NMVOC)

NMVOC emissions from the Agriculture Sector decreased by 41,86%, from 19,69 kt in 1990 to 6,266 kt in 2017 (Figure 5.1.5).

The largest source of NMVOC emissions from the Agriculture sector is *3.B.1.a Manure management-dairy cattle* category, sharing 35% of the total emissions from the sector since 1990, and currently 33%.

Share of different categories in the overall NMVOC emissions from Agriculture Sector has changed in 1990 and 2017 (Figure 5.1.6).

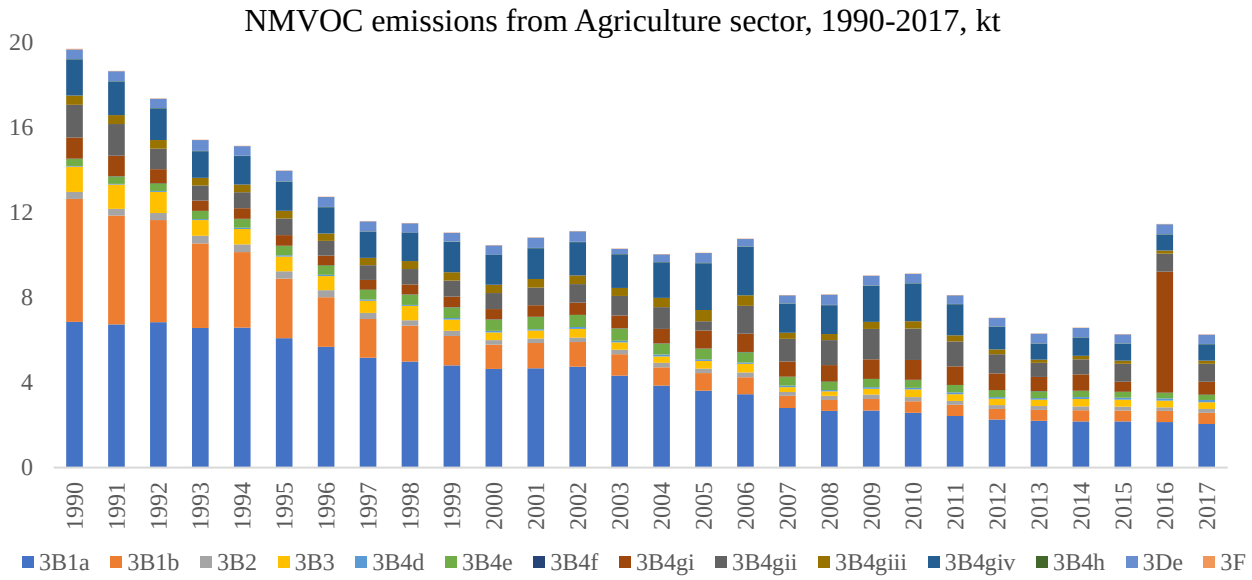


Figure 5.1.5. Trend in NMVOC emissions from the Agriculture sector, 1990-2017, kt

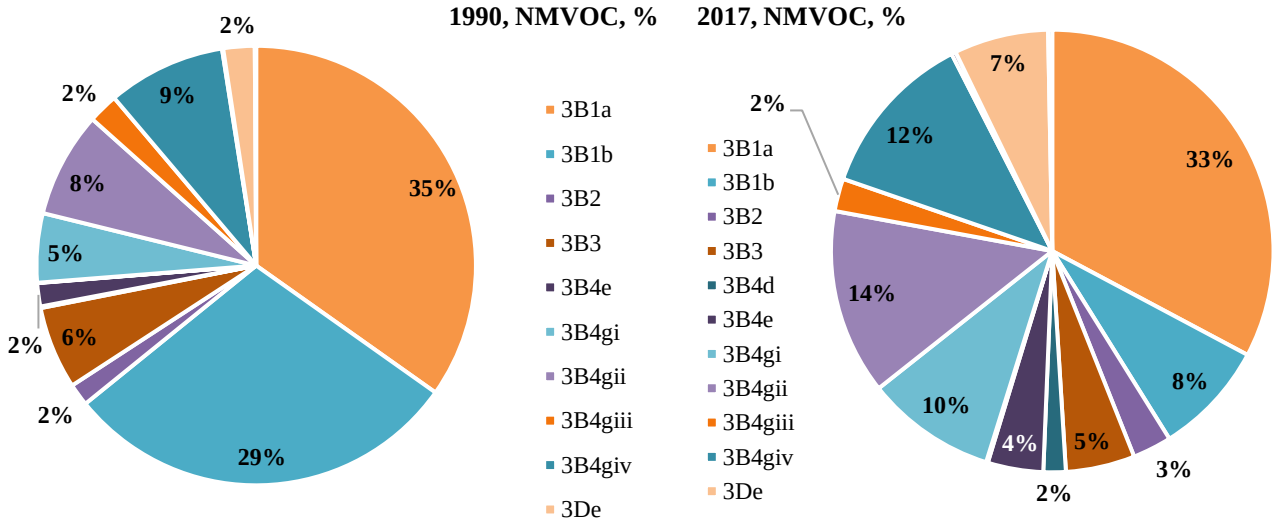


Figure 5.1.6. Share of different categories in the overall NOx emissions from the Agriculture Sector in 1990 and 2017

The share of categories in the overall NMVOC emissions changed as follows (Figure 5.1.6):

- *3.B.1.a Manure management - Dairy cattle* – decreased from 35% in 1990 to 33% in 2017;
- *3.B.1.b Manure management - Non-dairy cattle* – decreased from 29% in 1990 to 8% in 2017;
- *3.B.4.giv Manure management - Other poultry (Ducks and geese)* – increased from 9% in 1990 to 12% in 2017;
- *3.B.4.gii Manure management - Broilers* – increased from 8% in 1990 to 14 % in 2017;
- *3.B.4.gi Manure management - Laying hens* – increased from 5% in 1990 to 10% in 2017.

Particulate matter ($PM_{2.5}$)

PM emissions from the Agriculture Sector have fallen by 41,7%: from 0,896 kt in 1990 to 0,522 kt in 2017 (Figure 5.1.7). The minimum values of emissions in 2012 were equal to 0,412 kt, which have fallen by 53,68 % as compared to the 1990 level.

The largest sources of $PM_{2.5}$ emissions from the Agriculture Sector are *3.F Field burning of agricultural residues*, *3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products*, *and 3.B.1.a Manure management - Dairy cattle*, sharing 55% of the total sector emissions in 1990 and 75 % in 2017 (Figure 5.1.8).

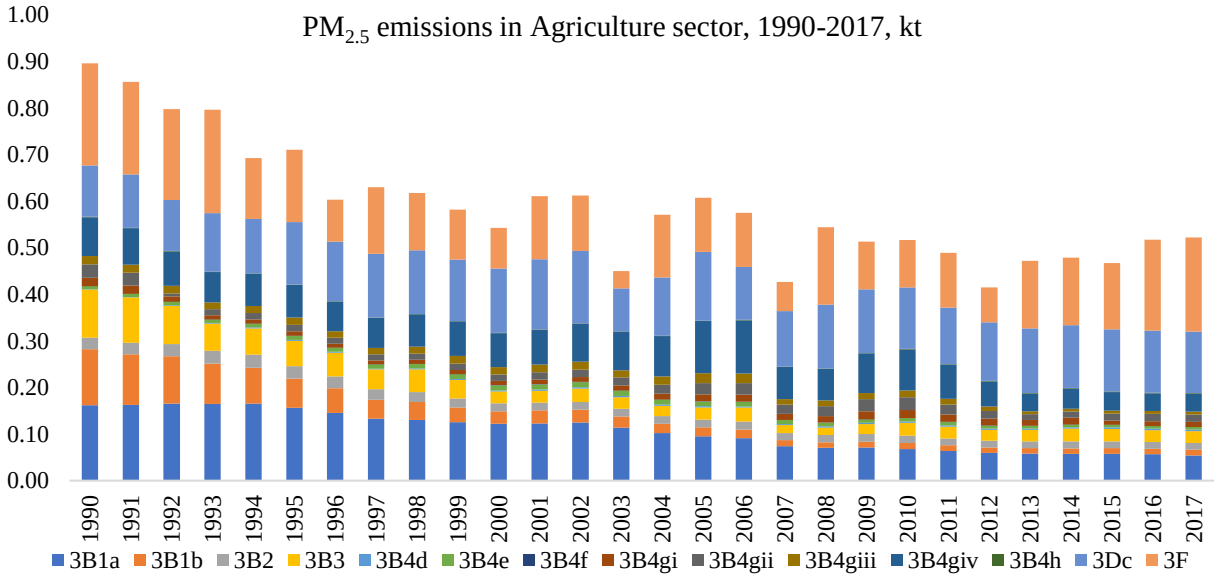


Figure 5.1.7. Trend in $PM_{2.5}$ emissions from the Agriculture sector, 1990-2017, kt

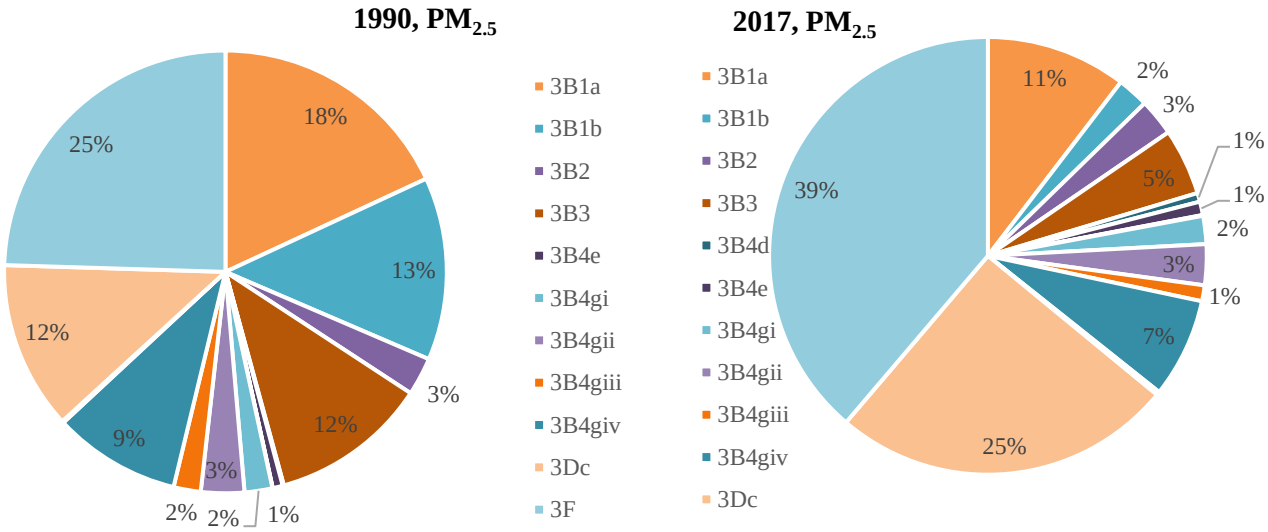


Figure 5.1.8. Share of different categories in the overall $PM_{2.5}$ emissions from the Agriculture Sector in 1990 and 2017

Particulate Matter (PM_{10})

PM emissions from the Agriculture Sector have fallen by 34,39%: from 3,195 kt in 1990 to 2,097 kt in 2017 (Figure 5.1.9).

The largest sources of PM_{10} emissions from the Agriculture Sector are *3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products, and 3.B.4.g.iv Manure management - Other poultry (Ducks and geese)*, sharing 49% of total sector emissions in 1990 and 63% in 2017 (Figure 5.1.10).

The share of different source categories in PM_{10} emissions from the Agriculture Sector significantly changed from 1990 to 2017 (Figure 5.1.10):

- PM_{10} emissions from the category *3.D.c Farm-level agricultural operations including storage, handling and transport* increased from 29% to 49%;
- those from *3.B.4.giv Manure-management - Other poultry (Ducks and geese)* decreased from 20% to 14%;
- emissions from *3.F Field burning of agricultural residues* increased from 7% to 10%.

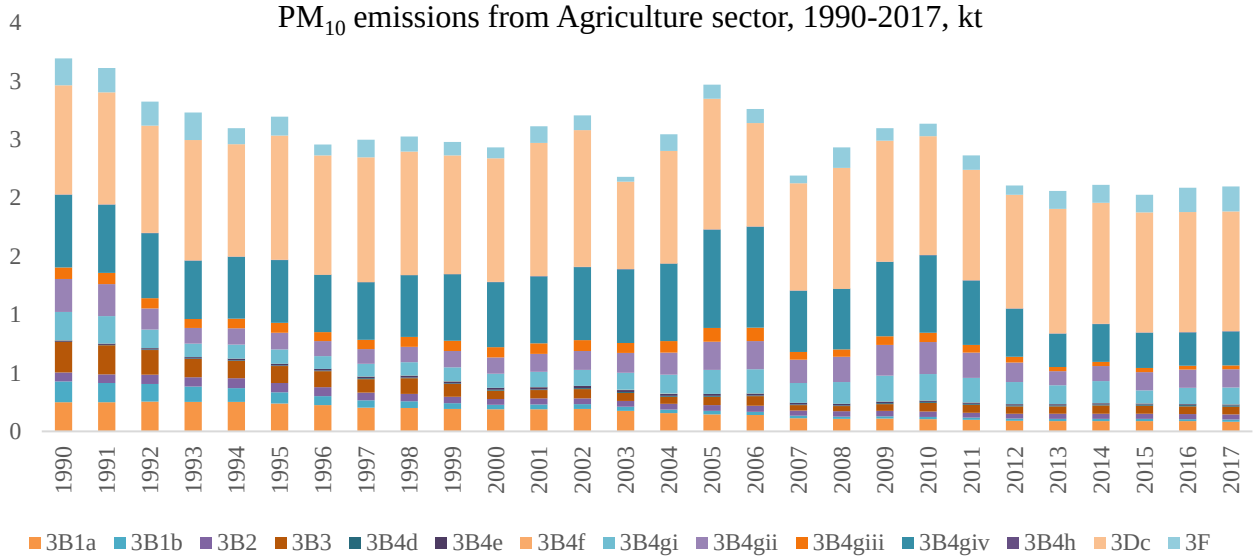


Figure 5.1.9. Trend in PM_{10} emissions from the Agriculture sector, 1990-2017, kt

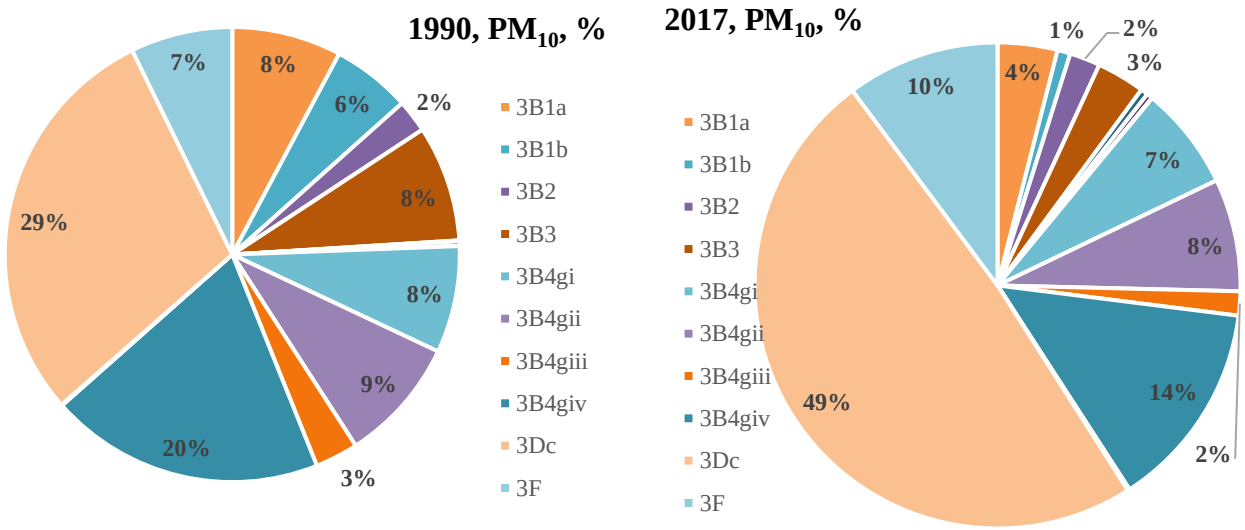


Figure 5.1.10. Share of different categories in the overall PM_{10} emissions from the Agriculture Sector in 1990 and 2017

Total suspended solids (TSP)

The TSP emissions from the Agriculture Sector have fallen by 46,6%: from 6,63 kt in 1990 to 3,406 kt in 2017 (Figure 5.1.11). From 1990 to 2000, TSP emissions reduced by 42,66%, reaching 3,802 kt. The maximum value of TSP emissions over the period 2000-2017 was reached in 2005, representing 29% from the 1990 level.

The largest sources of TSP emissions from the Agriculture Sector in 2017 are *3.B.3 Manure management - Swine (Sows and Fattening pigs), 3.B.4.g.i - Manure management - Laying hens, and 3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products*, which represented 64% of total emissions in the sector in 2017 and 59% in 1990.

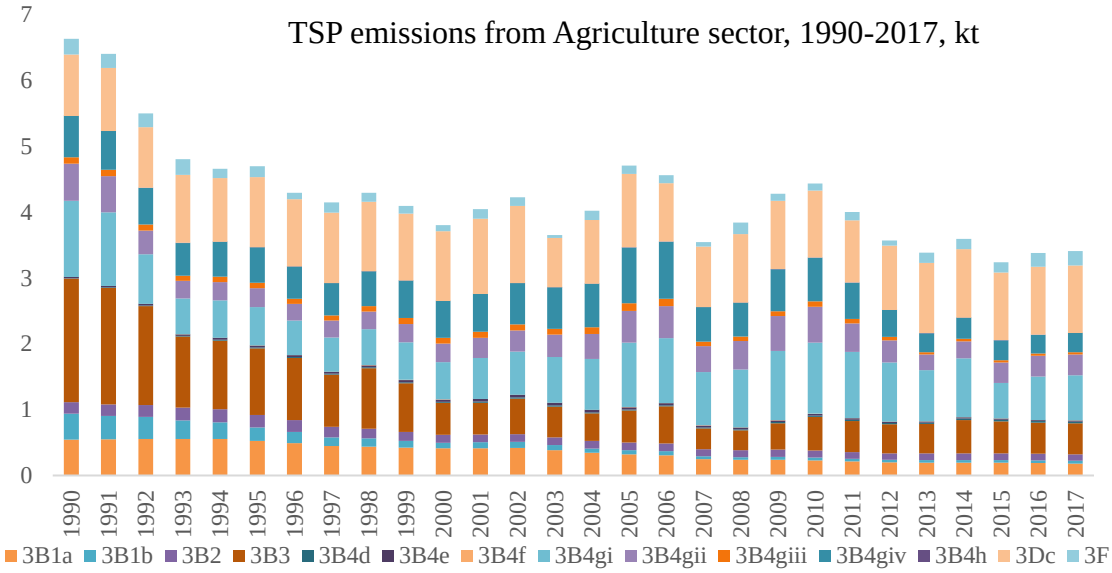


Figure 5.1.11. Trend in TSP emissions from the Agriculture sector, 1990-2017, kt

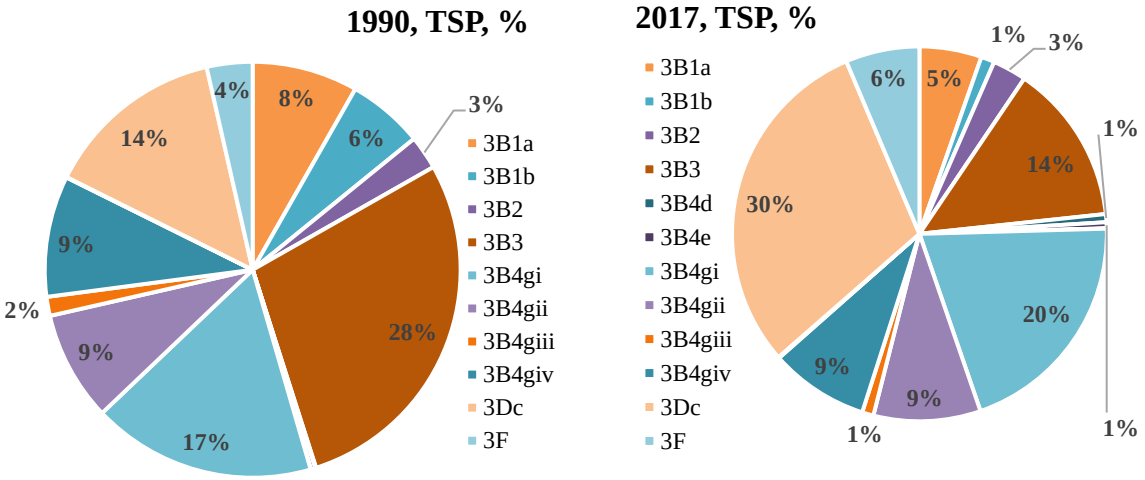


Figure 5.1.12. Share of different categories in the overall TSP emissions from the Agriculture Sector in 1990 and 2017

The share of categories in the overall TSP emissions changed as follows (Figure 5.1.12):

- *3.B.3 Manure management - Swine (Sows and fattening pigs)* – decreased from 28% in 1990 to 14% in 2017;
- *3.B.4.g.i Manure management - Laying hens* – increased from 17% in 1990 to 20% in 2017;
- *3.D.c Farm-level agricultural operations, including storage, handling, and transport of agricultural products* – increased from 14% in 1990 to 30% in 2017;
- *3.B.1.b Manure management - Non-dairy cattle* – decreased from 6% in 1990 to 1% in 2017;
- *3.F Field burning of agricultural residues* – increased from 4% in 1990 to 6% in 2017.

5.1.2. *Key categories*

In accordance with the 2016 EMEP/EEA Guidebook, the *Agriculture* sector includes the following source subcategories:

- *3.B Manure management*
- *3.D Crop production and agricultural soils*
- *3.D.f Use of pesticides*
- *3.I Agriculture other, including use of pesticides*
- *3.F Field burning of agricultural wastes*

Table 5.1.2 shows an outline of the weight of different categories for each pollutant.

Table 5.1.2. Outline of the weight of different categories for each pollutant in the agriculture sector

Pollutants	3.B.1.a	3.B.2	3.B.4.f	3.D.a.1	3.D.a.2.b	3.D.a.2.c	3.D.a.3	3.D.c	3.D.e	3.F
NO_x (kt)	0,0231	0,0057	0,0006	**1,1605**	**7,6548**	0,637	0,1166	-	-	0,0862
NMVOC (kt)	**2,054**	0,1783	0,0078	-	-	-	-	-	0,4323	0,0187
SO_x (kt)	-	-	-	-	-	-	-	-	-	**0,0187**
NH_3 (kt)	1,6939	0	2,6869	**5,7152**	**25,2608**	1,273	4,4209		-	0,09
$PM_{2,5}$ (kt)	0,0543	0,0142	0,0003	-	-	-	-	**0,1319**	-	**0,2024**
PM_{10} (kt)	0,0834	0,0427	0,0005	-	-	-	-	**1,0237**	-	0,2136
TSP (kt)	0,1827	0,0997	0,001	-	-	-	-	**1,0237**	-	0,2174
BC (kt)	-	-	-	-	-	-	-	-	-	**18,7410**
CO (kt)	-	-	-	-	-	-	-	-	-	**2,50**
Pb (t)	-	-	-	-	-	-	-	-	-	**0,041**
Cd (t)	-	-	-	-	-	-	-	-	-	**0,033**
Hg (t)	-	-	-	-	-	-	-	-	-	**0,0052**
As (t)	-	-	-	-	-	-	-	-	-	**0,0002**
Cr (t)	-	-	-	-	-	-	-	-	-	**0,003**
Cu (t)	-	-	-	-	-	-	-	-	-	**0,0027**
Ni (t)	-	-	-	-	-	-	-	-	-	**0,0019**
Se (t)	-	-	-	-	-	-	-	-	-	**0,0008**
Zn (t)	-	-	-	-	-	-	-	-	-	**0,021**
Benzo(a) pyrene (t)	-	-	-	-	-	-	-	-	-	**0,0147**
Benzo(b) fluoranthene (t)	-	-	-	-	-	-	-	-	-	**0,0411**
Benzo(k) fluoranthene (t)	-	-	-	-	-	-	-	-	-	**0,0175**
Indeno (1,2,3-cd) pyrene (t)	-	-	-	-	-	-	-	-	-	**0,0126**
Total PAHs (t)	-	-	-	-	-	-	-	-	-	**0,086**

Thus, the key categories in the sector are as follows:

- *3.D.a.2.b Sewage sludge applied to soils* - 69% for **NOx**,
- *3.D.a.2.b Sewage sludge applied to soils* - 52% for **NH_3**,
- *3.B.1.a Manure Management - Dairy cattle* - 33% for **NMVOC**,
- *3.D.c Farm-level agricultural operations, including storage, handling, and transport of agricultural products*, 49% and 30% for **PM_{10} and TSP**,
- *3.F Field burning of agricultural residues*, 100%, 39% and 100% for **SOx, $PM_{2.5}$** and **BC**.

The *3.F* category (Field burning of agricultural residues) is the key source of majority of pollutants of the Agriculture sector, but the highest share of emissions occurs from the category *3.D.a.2.b* (Sewage sludge applied to soils).

5.1.3. Methods and emission factors

Selection of coefficients and methods for calculating the emissions from the Agricultural sector was done according to the 2016 EMEP/EEA guidebook (Table 5.1.3).

Table 5.1.3. Emissions estimation methodologies used to evaluate emissions from the Agriculture Sector

NFR	Products group	Assessment Methodology	Emission Factors
3.B.1.a	Manure management - Dairy cattle	*Tier 1; EMEP/EEA 2016*	D
3.B.1.b	Manure management - Non-dairy cattle	*Tier 1; EMEP/EEA 2016*	D
3.B.2	Manure management - Sheep	*Tier 1; EMEP/EEA 2016*	D
3.B.3	Manure management - Swine (Sows+ Fattening pigs)	*Tier 1; EMEP/EEA 2016*	D
3.B.4.d	Manure management - Goats	*Tier 1; EMEP/EEA 2016*	D
3.B.4.e	Manure management - Horses	*Tier 1; EMEP/EEA 2016*	D
3.B.4.f	Manure management - Mules and asses	*Tier 1; EMEP/EEA 2016*	D
3.B.4.gi	Manure management - Laying hens	*Tier 1; EMEP/EEA 2016*	D
3.B.4.gii	Manure management - Broilers	*Tier 1; EMEP/EEA 2016*	D
3.B.4.giii	Manure management - Turkeys	*Tier 1; EMEP/EEA 2016*	D
3.B.4.giv	Manure management - Other poultry Ducks+geese	*Tier 1; EMEP/EEA 2016*	D
3.B.4.h	Manure management - Other animals (please specify in IIR)	*Tier 1; EMEP/EEA 2016*	D
3.D.a.1	Inorganic N-fertilizers (includes also urea application)	*Tier 1; EMEP/EEA 2019*	D
3.D.a.2.a	Animal manure applied to soils	*Tier 1; EMEP/EEA 2016*	D
3.D.a.2.b	Sewage sludge applied to soils	*Tier 1; EMEP/EEA 2016*	D
3.D.a.2.c	Other organic fertilisers applied to soils (including compost)	*Tier 1; EMEP/EEA 2016*	D
3.D.a.3	Urine and dung deposited by grazing animals	*Tier 1; EMEP/EEA 2016*	D
3.D.a.4	Crop residues applied to soils	*Tier 1; EMEP/EEA 2016*	D
3.D.b	Indirect emissions from managed soils	*Tier 1; EMEP/EEA 2016*	D
3.D.c	Farm-level agricultural operations including storage, handling and transport of agricultural products	*Tier 1; EMEP/EEA 2016*	D
3.D.e	Cultivated crops	*Tier 1; EMEP/EEA 2016*	D
3.F	Field burning of agricultural residues	*Tier 1; EMEP/EEA 2016*	D

Abbreviations: T1 – Tier 1; T2 – Tier 2; T3 – Tier 3; D – Default.

The Tier 1 methodology is a simplified approach based on use of default EFs multiplied by the national AD on the animal population data. A more detailed description of estimation methodologies and emission factors used in this inventory cycle is available in the sub-chapter 5.2 of the IIR.

Nitrous Oxide Emissions

The calculation of direct N_2O emissions from manure management is based on the following Equation 10.25 from the 2006 IPCC Guidelines.

$$N_2O_{D(mm)} = [\sum(S)\,[\sum(T)\,(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)})] \bullet FE_{3(S)}] \bullet 44/28 \qquad (5.1)$$

Where:

$N_2O_{D(mm)}$ – direct N_2O emissions from Manure Management in the country (kg of N_2O/year);

$N_{(T)}$ – number of head of livestock species/category T in the country;

$Nex_{(T)}$ – annual average N excretion per head of species/category T in the country (kg N/animal/year);

$MS_{(T,S)}$ – fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless;

$FE_{3(S)}$ – emission factor for direct N_2O emissions from manure management system S in the country, (kg N_2O-N/kg N in manure management system S); S – manure management system;

T – species/category of livestock. 44/28 – conversion factor from (N_2O-N) (mm) emissions to N_2O(mm) emissions.

$Nex_{(T)}$ - calculation of the average N excretion rates, Nex(T), Volume 4, Chapter 10, Equation 10.30):

$$\mathbf{Nex_{(T)} = Nrate(T) \bullet (TAM\ /1000) \bullet 365} \qquad (5.2)$$

Nrate (T) – default N excretion rate, kg N (1000 kg animal mass)/day;

TAM (T) – typical animal mass for livestock category T, kg/animal/year.

Rates of annual N excretion for each livestock species/category Nex (T) were estimated using Equation 10.31 from the 2006 IPCC Guidelines.

$$\mathbf{Nex(T) = N\ intake\ (T) \bullet (1 - N\ retention\ (T))} \quad (5.3)$$

Where:

$N_{intake\ (T)}$ – the annual N intake per head of animal of species/category T (kg N/animal/year);

$N_{retention\ (T)}$ – fraction of annual N intake that is retained by animal of species/category T, dimensionless.

Nex(T) values were calculated based on information on the typical (average) weight of livestock and poultry in the Eastern European countries and default values of nitrogen excretion rate (kg N/1000 kg of animal mass/year) characteristic for the same region, country specific.

Emissions of NMVOC and Particulate matter (PM_{10}, $PM_{2.5}$, TSP) for 3B NFR

NMVOC emissions without silage and with silage and Particulate matter (PM_{10}, $PM_{2.5}$, TSP) emissions were estimated using the EMEP/EEA 2016 Methodology, section 3B, Table 3.4 and Table 3.5 respectively (Figure 2.3). Tier 1 method was used according to the 2016 EMEP/EEA Guidebook, section 3D, p.14 (The calculation - from default emissions factors EFs=0,05kg/kg N fertiliser applied) and EF=0,159kg/kg urea, 2016 EMEP/EEA Guidebook, section 3D, Table 3.2.

5.1.4. Uncertainties Assessment and Time Series Consistency

The estimated uncertainty interval for the activity data for a specific emission category in *3D* is 15%-30%. Uncertainty intervals for the different emission factor are estimated at: 50% for NH_3, 200% for NMVOC, 80%-400% for NOx; 150%-200% for PM.

5.1.5. Quality Assurance and Quality Control

QA/QC procedures:

- All categories of livestock were accounted for.
- Cross-checks of different databases were done.
- Double counting of the manure was avoided.

Annual increase or decrease is verified for the whole time series for all subsources for the Republic of Moldova to decide that all annual changes are reasonable. The times series for the emission are compared with the time series for the activity data to confirm that those data are in agreement.

5.2. Manure management (NFR 3.B)

5.2.1. Description of sources

This section covers the following NFR sub-categories: 3.*B.1.a Dairy cattle*, *3.B.1.b Non-dairy cattle*, *3.B.2 Sheep*, *3.B.3 Swine (Sows and Fattening Pigs)*, *3.B.4.d Goats*, *3.B.4.e Horses*, *3.B.4.f Mules and asses*, *3.B.4.g.i Laying hens*, *3.B.4.g.ii Broilers*, *3.B.4.g.iii Turkeys*, *3.B.4.g.iv Other poultry: Geese and Ducks*, *3.B.4.h other animals*. Two housing types were distinguished for cattle, swine (sows and fattening pigs) and laying hens - liquid (slurry-based) and solid-manure-based housing. The characteristic manure type for each livestock was determined according to the manure management system distribution data.

5.2.2. Methods and emission factors

The Tier 1 methodologies of the 2016 EMEP/EEA Guidebook were applied. Emissions from agriculture, including Manure management were calculated for the 1990 through 2017 time series, due to the application of EMEP/EEA 2016. Emission factors were taken from Tables 3.2-3.5 of the 2016 EMEP/EEA Guidebook using a Tier 1 methodology.

5.2.3. Activity data

The activity data was provided by the National Bureau of Statistics of the RM in the Statistical Yearbooks, sectoral statistical publications and on its website. Data from the statistical database are available for the period until 1992 for the whole territory of the Republic of the Moldova, while since

1993 only for the Right Bank of Dniester, without Administrative Territorial Units on the Left Bank of Dniester (ATULBD). The statistical data for the Left Bank of Dniester are collected by the State Statistical Service under the Ministry of Economy of the ATULBD, and are published in the Statistical Yearbooks and other periodic statistical publications available on the website of the Ministry of Economy of the Administrative Territorial Units on the Left Bank of Dniester.

Table 5.2.3.1. Animal Population Data in the Republic of Moldova, 1990-2017, thousand heads

	1990	1991	1992	1993	1994	1995	1996
Cattle total, including:	1060,7	1000,5	970,1	882,6	832,0	729,5	646,3
Dairy Cows	395,2	397,1	403,2	401,8	402,6	380,8	355,4
Other Cattle	665,5	603,4	566,9	480,7	429,4	348,7	290,9
Sheep and Goats total, including:	1281,9	1288,8	1357,2	1437,3	1501,9	1423,0	1372,4
Sheep	1244,8	1239,3	1294,3	1362,5	1410,4	1328,2	1273,7
Goats	37,1	49,5	62,9	74,7	91,5	94,7	98,7
Horses	47,2	48,4	51,4	54,5	58,2	61,6	63,3
Asses and Mules	1,7	1,8	2,1	2,2	2,9	3,2	3,1
Swine	1850,1	1753,0	1487,4	1082,3	1046,8	1014,6	950,1
Poultry total, including:	24625,0	23715,0	17128,0	12809,2	13448,3	13744,9	12364,9
Chickens	20234,4	19607,1	13271,0	9516,6	9957,4	10199,5	9137,4
Geese	1335,5	1321,8	1300,4	1378,9	1457,0	1487,2	1357,9
Ducks	2165,7	1914,7	1736,5	1198,9	1284,8	1293,1	1166,6
Turkeys	889,3	871,3	820,2	714,8	749,0	765,1	703,0
Rabbits	283,0	250,8	298,5	262,4	237,2	209,3	189,8
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Cattle total, including:	549,7	532,4	482,4	445,4	453,6	454,7	409,1
Dairy Cows	323,7	318,4	306,9	298,5	300,1	304,8	277,7
Other Cattle	226,0	214,0	175,5	146,9	153,5	149,9	131,5
Sheep and Goats total, including:	1235,3	1147,2	1055,5	962,1	971,7	978,4	958,4
Sheep	1139,3	1050,5	953,2	850,7	857,0	849,1	834,8
Goats	95,9	96,7	102,4	111,4	114,6	129,2	123,6
Horses	65,4	68,5	72,0	76,0	81,6	82,6	81,4
Asses and Mules	3,0	3,2	3,4	3,8	4,3	4,0	4,3
Swine	797,5	928,0	751,3	492,7	489,2	550,1	476,4
Poultry total, including:	12363,9	13046,0	13730,1	13624,9	14730,4	15525,5	16194,2
Chickens	9112,0	9557,0	9992,5	9952,9	10947,5	11474,7	12182,9
Geese	1372,3	1470,0	1581,6	1550,6	1589,2	1777,4	1780,2
Ducks	1169,5	1264,8	1349,4	1325,3	1367,5	1423,3	1461,9
Turkeys	710,1	754,2	806,6	796,2	826,2	850,1	769,3
Rabbits	176,8	185,9	182,6	161,3	191,4	190,7	205,4
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Cattle total, including:	359,5	339,8	326,9	253,7	238,4	243,0	236,4
Dairy Cows	249,0	233,1	222,0	180,8	171,8	173,2	166,1
Other Cattle	110,5	106,7	104,9	72,9	66,6	69,8	70,3
Sheep and Goats total, including:	959,8	954,3	962,5	866,4	879,6	929,7	920,6
Sheep	838,1	832,8	848,7	765,5	774,0	816,7	801,2
Goats	121,7	121,5	113,8	100,9	105,6	112,9	119,4
Horses	75,8	72,0	69,3	60,5	57,4	56,1	53,6
Asses and Mules	4,0	3,7	3,6	3,1	3,2	2,9	2,8
Swine	422,3	493,0	568,3	320,8	302,9	403,6	511,7
Poultry total, including:	17881,6	22771,6	23014,6	17500,6	18652,1	22880,2	23671,7
Chickens	13556,7	17193,3	17318,1	14118,4	15285,5	18729,6	19338,4
Geese	1828,0	2120,3	2111,5	1342,2	1277,2	1497,4	1600,2
Ducks	1592,6	2394,1	2551,0	1435,5	1501,7	1981,8	2013,6
Turkeys	904,4	1063,9	1034,0	604,5	587,8	671,4	719,5
Rabbits	239,1	278,9	326,0	263,4	248,5	274,5	277,0
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Cattle total, including:	224,4	210,6	208,0	210,7	204,5	199,8	199,9
Dairy Cows	156,0	145,5	141,6	140,6	137,6	132,3	132,3
Other Cattle	68,4	65,1	66,4	70,1	66,8	70,1	67,2
Sheep and Goats total, including:	846,2	836,9	861,9	887,8	880,8	881,8	921,9
Sheep	722,0	706,4	724,9	733,5	722,2	714,8	754,9
Goats	124,2	130,4	137,1	153,4	158,6	167,0	167,0
Horses	50,9	47,5	46,0	42,8	40,2	43,2	46,3
Asses and Mules	2,5	2,4	2,1	2,2	2,0	2,0	2,0
Swine	471,7	438,4	444,5	504,7	484,5	469,7	469,8
Poultry total, including:	19669,2	15766,3	11931,9	12520,0	12520,6	13172,2	3614,0
Chickens	16096,5	13121,2	10080,5	10438,5	10655,6	11337,5	7864,0
Geese	1351,6	1028,5	718,6	768,0	734,0	700,2	720,1
Ducks	1622,1	1166,9	822,3	986,1	894,5	829,9	842,6
Turkeys	599,0	449,6	310,6	327,4	306,5	304,7	306,1
Rabbits	277,4	267,0	296,2	326,1	350,2	366,7	336,7

Source: Statistical Annual Report No. 24-agr „Animal Breeding Sector", the number of livestock and poultry in all Households Categories as of 1st of January (annual reports for 1990-2016); Statistical Yearbooks of ATULBD for 1998 (page 224), 2002 (page 118), 2006 (page 109), 2010 (page 110), 2014 (page 104), 2017 (page 117), 2018.

Manure production depends on the number of livestock and poultry (Table 5.2.3.1), and on the average amount of waste produced per animal per year. The share of manure that decomposes anaerobically depends on how the manure is managed – collected, stored, and used. When manure is stored or treated as a liquid (e.g. in lagoons, ponds, tanks, or pits), it decomposes anaerobically. When manure is handled

as a solid (e.g. in stacks or piles) or when it is deposited on pastures and paddocks, it tends to decompose under more aerobic conditions. In order to estimate emissions from manure management, the total animal population was divided in subgroups to better reflect the average amount of waste produced per animal or poultry per year, as well as the way manure is managed (Table 5.2.3.2). Average emission rates were calculated for existent animal and poultry categories based on typical manure management systems, as well as based on default emission factors for livestock and poultry categories.
It should be mentioned that, according to the official data the ratio of solid-to-liquid manure management systems in the RM in the period 2017-2019 was 50%/50%. However, for data continuity and according to the 2018 report provided under the UN Framework Convention, data for 2017 from Table 5.2.3.2 were reported as those for 2016.

Table 5.2.3.2. Manure management systems usage (MS%) in the RM, 1990-2017

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cows: Pasture/	6	10	10	16	16	20	20	20	23	23
…Liquid/Slurry	24	20	20	12	12	7	7	7	3	3
…Solid Storage	70	70	70	72	72	73	73	73	74	74
Other cattle: Pasture/	4	8	8	12	12	16	16	16	20	20
…Liquid/Slurry	34	26	26	18	18	10	10	10	4	4
…Solid Storage	62	66	66	70	70	74	74	74	76	76
Swine: Liquid/Slurry	73	65	65	60	60	55	55	55	40	40
…Solid Storage	27	35	35	40	40	45	45	45	60	60
Sheep and Goats: Pasture	18	18	18	20	20	20	20	20	22	22
…Solid Storage	82	82	82	80	80	80	80	80	78	78
Horses, Asses and Mules: …Pasture	18	18	18	20	20	20	20	20	22	22
…Solid Storage	82	82	82	80	80	80	80	80	78	78
Poultry: Pasture	7	7	7	7	7	8	8	8	8	8
…Solid Storage	93	93	93	93	93	92	92	92	92	92
Rabbits -Solid storage	100	100	100	100	100	100	100	100	100	100
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Dairy cows; Pasture/	24	24	24	24	24,50	24,50	24,50	24,50	24,50	24,50
…Liquid/Slurry	1	1	1	1	1,50	1,50	1,50	1,50	1,50	1,50
…Solid Storage	75	75	75	75	74	74	74	74	74	74
Other cattle; Pasture/	22	22	22	22	22	22	22	22	22	22
…Liquid/Slurry	4	4	4	4	6	6	6	6	6	6
…Solid Storage	74	74	74	74	72	72	72	72	72	72
Swine: Liquid/Slurry	30	30	30	30	32	32	32	32	35	35
…Solid Storage	70	70	70	70	68	68	68	68	65	65
Sheep and Goats: Pasture	22	22	24	24	24	24	24	24	26	26
…Solid Storage	78	78	76	76	76	76	76	76	74	74
Horses, Asses and Mules: …Pasture	22	22	24	24	24	24	24	24	26	26
…Solid Storage	78	78	76	76	76	76	76	76	74	74
Poultry: Pasture	8	8	9	9	9	9	9	9	10	10
…Solid Storage	92	92	91	91	91	91	91	91	90	90
Rabbits -Solid	100	100	100	100	100	100	100	100	100	100
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**		
Dairy cows: Pasture/	24,5	24,5	24,5	24,50	24,50	24,5	24,50	24,50		
…Liquid/Slurry	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50		
…Solid Storage	74	74	74	74	74	74	74	74		
Other cattle: Pasture/	22	22	22	22	22	22	22	22		
…Liquid/Slurry	6	6	6	6	6	6	6	6		
…Solid Storage	72	72	72	72	72	72	72	72		
Swine: Liquid/Slurry	35	35	37	37	37	37	37	37		
…Solid Storage	65	65	63	63	63	63	63	63		
Sheep and Goats: Pasture	26	26	26	26	26	26	26	26		
…Solid Storage	74	74	74	74	74	74	74	74		
Horses, Asses and Mules: …Pasture	26	26	26	26	26	26	26	26		
…Solid Storage	74	74	74	74	74	74	74	74		
Poultry: Pasture	10	10	10	10	10	10	10	10		
…Solid Storage	90	90	90	90	90	90	90	90		
Rabbits -Solid storage	100	100	100	100	100	100	100	100		

5.3. Crop production and agricultural soils (NFR 3.D)

5.3.1. Description of sources

NFR sector 3.D contains NH_3 emissions from sewage sludge applied to soil and fertilizer application, PM emissions from farm-level agricultural operations, including storage, handling and transport of

agricultural products, NOx emissions from soil microbial processes. Emissions from Inorganic N-fertilizers and Crop production and agricultural soils, including storage, handling and transport of agricultural products are reported under the 3.D sector in the NFR tables.
Ammonium, nitrous oxide and particulate matter emissions from crop production and agricultural soils is a key source in the Agriculture sector in Republic of Moldova.
There are four main sources of emissions from crop production and agricultural soils:

- mineral N fertiliser, livestock manure and organic waste application (NH_3);
- soil microbial processes (NO);
- crop processes (NH_3 and NMVOCs);
- soil cultivation and crop harvesting (PM).

5.3.2. Methods and emission factors

Estimations for the 3.D category have been prepared in accordance with the 2016 EMEP/EEA Guidebook. NH_3 emissions from fertilizer application are estimated using Tier 1 methodologies. Although it is a key category, data limitations impose the use of simpler methodologies. Method Tier 1 from the 2016 EMEP/EEA Guidebook was used for Category 3D, Tables 3.1 and 3.2 (The calculation of default emissions factors was based on EF=0,05kg/kg fertiliser applied). The detailed methods are described in the following sub-chapters.

3.D.a.1 Inorganic N fertilizers (including urea)

The calculation of default emissions factors for inorganic N fertilizer (including urea):
EF (NH_3) = 0,05 kg/kg inorganic fertiliser applied;
EF (NH_3) for urea = 0,159 g/kg urea applied;
EF (NO reported as NO_2 for N fertiliser) = 0,04 kg/kg N fertiliser applied.

3.D.a.2.a Livestock manure applied to soils

NH_3 are calculated according to the chapter 3.B Manure Management - Activity data to calculate emission of NH_3 from **Livestock manure applied to soils.**
Calculation Algorithm
Step 1. Define appropriate livestock categories and obtain the annual average number of animals in each category (see subsection 5.3.3. Activity data). The aim of this categorization is to group the types of livestock that are managed similarly (typical examples are shown in Table 5.3.3.2).
Step 2. Decide for each livestock category whether manure is typically handled as slurry or solid.
Step 3. Find the default EF for each livestock category from subsection 5.3.2., 3.B Manure Management column 6.
Step 4. Calculate the pollutant emissions (E pollutant_animal) for each livestock category, using the corresponding annual average population for each category (AAP animal) and the relevant EF (EF $_{pollutant_animal}$):

$$E_{pollutant_animal} = AAP_{animal} \times EF_{pollutant_animal} \qquad (5.3.2.1)$$

where AAP $_{animal}$ is the number of animals of a category that are present, on average, within the year (for a more detailed explanation, see IPCC, 2006, section 10.2).

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

For emissions from *3.D.a.2.b sewage sludge applied to soils* (Esludge$_{_NH3;}$ kg a–1 NH_3), no Tier 2 method is proposed. The Tier 1 estimate should be used. Emission factors are estimated according to Table 3.1, Chapter 3D, p. 14, 2016 EMEP/EEA Guidebook, according to the number of inhabitants as kg NH_3/capita -1/years.

3.D.a.2.c Other organic fertilizers applied to soils (including compost)

Emission from other organic fertilizers applied to soils are estimated according to Table 3.1 Chapter 3D, p. 14, 2016 EMEP/EEA Guidebook, according to the annual amount/year in the Republic of Moldova (EF=0,008 kg NH_3/kg organic fertilizers).

Organic Nitrogen Fertilizers

N_2O emissions from applied organic N fertilizers were estimated using a Tier 1 methodology and Equation 11.2 from the 2006 IPCC Guidelines.

$$N_2O_{ON} = F_{ON} \bullet EF_1 \bullet 44/28 \qquad (5.3.2.2)$$

Where:

N_2O_{ON} – N_2O emissions from applied organic N fertilizers (kt/year);

$F_{ON} = (F_{AM} + F_{SEW} + F_{COMP} + F_{OOA})$, total annual amount of organic N fertilizers applied to soils other than by grazing animals (kg N/year);

F_{AM} – annual amount of animal manure N applied to soils (kg N/year);

F_{SEW} – annual amount of total sewage N applied to soils (kg N/year);

F_{COMP} – annual amount of total compost N applied to soils (kg N/year);

F_{OOA} – annual amount of other organic amendments used as fertilizers (kg N/year);

EF_1 – default EF: 0,01 kg N_2O-N/kg N applied (range: 0,003-0,03 kg N_2O-N/kg N);

[44/28] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

3.D.a.3 Urine and dung deposited by grazing livestock

NH_3 emissions from urine and dung deposited by grazing animals were calculated using the EF according to the 2016 EMEP/EEA Guidebook, Table 3.2, Chapter 3B.

Direct N_2O emissions from urine and dung deposited by grazing animals were estimated using a Tier 1 methodology, by applying Equations 11.1 and 11.2 from the 2006 IPCC Guidelines:

$$N_2O_{PRP} = F_{PRP} \bullet EF_{3PRP} \bullet 44/28 \qquad (5.3.2.3)$$

Where:

N_2O_{PRP} – N_2O emissions from urine and dung deposited by grazing animals.

F_{PRP} – annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/year).

$$F_{PRP} = \sum (s) [(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T, PRP)}] \qquad (5.3.2.4)$$

Where:

$N_{(T)}$ – number of head of livestock species/category T in the country (see 3A source category).

$Nex_{(T)}$ – annual average N excretion per animal of species/category T in the country (kg N/animal/year) (see 3B source category).

$MS_{(T, PRP)}$ – fraction of annual amount of urine and dung N deposited by grazing animals on pasture, range, and paddock/number of head of livestock species/category T (see 3B source category).

$EF_{3(PRP)}$ – default emission factor values are: 0,02 kg N_2O-N/kg N for cattle, swine, and poultry; 0,01 kg N 2 O-N/kg N for other animal categories.

[44/28] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

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

Methodological Issues, Emission Factors and Data Sources for N_2O emissions from this source category were estimated using the "Methodology of determining the carbon balance in agricultural soils to assess the GHG emissions" (see Annex A3-4.2).

Equation 11.2 from the 2006 IPCC Guidelines was applied**:**

$$N_2O_{CR} = F_{CR} \bullet EF_1 \bullet 44/28 \qquad (5.3.2.5)$$

Where:

F_{CR} – annual amount of N in crop residues returned to soils annually, t N/year;

EF_1 – default value of emission factor is 0,01 kg N_2O-N/kg N.

[44/28] – stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

The total amount of N in crop residues returned to soils was estimated using the following equation:

$$F_{CR} = \{(C_{rop(T)} \bullet R_{AG(T)} \bullet (1\text{-}Frac_{Remove\ (T)}) + Crop_{(T)} \bullet R_{BG(T)})\} \bullet (P_{CR}/10^2) \bullet (k_6/10^2) \qquad (5.3.2.6)$$

Where:

$Crop_{(T)}$ – harvested annual dry matter yield for crop T t.d.m./ha.

$$Crop_{(T)} = \text{Yield Fresh}_{(T)} \bullet \text{DRY} \qquad (5.3.2.7)$$

$Yield\ Fresh_{(T)}$ – harvested fresh yield for crop T, t/ha.

DRY – dry matter fraction of harvested crop T, kg dm/t of yield (see Table 5.3.2.1).

$R_{AG(T)}$ – ratio of above-ground residues dry matter to harvested yield for crop T (Crop(T)), t.d.m AG /t.d.m; k_6=0,25 (see Table 5.3.2.1).

Table 5.3.2.1 Additional coefficients for calculated emissions to Crop residues applied to soils

Cereals and leguminous crops	DRY-	R_{AG}	Frac	R_{BG}	Crop P_{CR}, k 6% (s,a,)
Wheat (Winter and Spring)	0,89	1,4	0,75	0,23	**0,5**
Winter rye	0,88	1,3	0,75	0,5	**1,05**
Barley (Winter and Spring)	0,89	1,17	0,75	0,22	**0,8**
Oat	0,89	1,17	0,75	0,25	**0,6**
Millet	0,88	1,17	0,4	0,22	**1,25**
Buckwheat	0,88	1,17	0,75	0,25	**0,6**
Leguminous crops	0,9	1,3	0,4	0,19	**2,08**
Grain maize	0,87	1,17	0,7	0,22	**1,08**
Grain sorghum	0,89	1,17	0,5	0,22	**1**
Other cereal crops	0,88	1,3	0,75	0,22	**0,6**
Sugar beet	0,22	0,29	0	0,2	**1,65**
Sunflower	0,9	3,8	0,4	0,22	**0,95**
Soybeans	0,91	1,3	0	0,19	**2,08**
Tobacco	0,9	5,77	0	0,19	**1,3**
Grain rapeseed	0,88	1,17	0	0,22	**1,05**
Potatoes	0,22	0,17	0	0,2	**0,4**
Vegetables	0,22	0,17	0	0,2	**2,09**
Melons and gourds	0,22	0,17	0	0,2	**1,19**
Forage roots	0,22	0,14	0	0,2	**1,65**
Maize for silo and green fodder	0,23	0,25	0,77	0,22	**1,08**
Perennial grasses for green fodder, silage and fodder	0,26	0,25	0,74	0,4	**2,48**
Annual grasses for green fodder	0,22	0,25	0,78	0,4	**1,6**

3.D.c Farm-level agricultural operations, including storage handling and transport of agricultural products

Emissions from agricultural crop operations are estimated based on cultivated area for different crops. Statistics on crop areas and data on agricultural crop operations for different cops are used according to the default Tier 2 model. The frequency of soil cultivation, harvesting, cleaning, and drying has been set to one time per year for all crops, except for grass for hay making. For this category, soil cultivation is assumed to take place every third year and harvest on average 2.4 times per year. Emission factors used to estimate emissions from 3Dc category are presented in Table 5.3.2.2.

Table 5.3.2.2. Tier 2 Emission factors used to estimate emissions from crop production (kg/ha/year) for wet climate conditions

Crop	EF for PM_{10}				EF for $PM_{2,5}$			
	Soil Cultivation	Harvesting	cleaning	Drying	Soil Cultivation	Harvesting	cleaning	Drying
Wheat	0,25	0,49	0,19	0,56	0,015	0,02	0,009	0,168
Barley	0,25	0,16	0,16	0,37	0,015	0,015	0,008	0,111
Rye	0,25	0,16	0,16	0,43	0,015	0,016	0,008	0,129
Oat	0,25	0,25	0,25	0,66	0,015	25	0,0125	0,198
Rape	0	0	0	0	0	0	0	0
Other arable	0,25	0	0	0	0,015	0,01	0	0

3.D.e Cultivated crops

Emissions of NMVOCs from plants have usually been associated with woodlands, which predominantly emit isoprene and terpenes (König et al., 1995).

Emission from cultivated crops are estimated according to Tier 1, Table 3.1, Chapter 3D, p. 14, 2016 EMEP/EEA Guidebook, according to the area sown with wheat, rye, oat, rape, and grass.

5.3.3. Activity data

3.D.a.1 Inorganic N fertilizers (includes urea)

Activity data for NH_3 and NO emission calculation are available according to the information on the amounts of applied synthetic N fertilizers (active substance) on arable soils in the RM (Tables 5.3.3.1 and 5.3.3.2), while data on area covered by crops and average yield are available in the in Statistical Yearbooks of the RM and those of the ATULBD.

Table 5.3.3.1. Applied Synthetic and Organic Fertilizers in the RM, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Synthetic fertilizers (a,s,), kt	232,4	191,4	127,6	44,9	20,0	12,5	14,3	12,1	10,3	6,1	10,3	12,8	18,4	15,4
nitrogen	92,1	82,7	61,8	26,4	14,1	10,5	13,2	11,4	10,2	5,9	10,2	12,7	18,0	14,6
phosphorus	85,7	75,2	43,4	12,7	8,0	1,4	0,7	0,5	0,1	0,1	0,1	0,1	0,3	0,6
potassium	54,6	33,5	22,4	5,8	1,6	0,6	0,3	0,2	0,0	0,0	0,0	0,0	0,1	0,2

continued

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Synthetic fertilizers (a,s,), kt	17,5	18,0	16,6	22,4	24,7	19,9	25,5	30,9	43,9	54,8	84,5	52,4	58,8	62,3
nitrogen	16,1	16,1	13,8	18,8	21,9	17,0	20,6	25,0	34,1	42,1	61,1	38,7	43,4	55,7
phosphorus	1,0	1,5	2,0	2,4	1,7	2,0	3,3	4,1	7,1	9,6	19,4	10,8	11,6	19,2
potassium	0,4	0,5	0,8	1,1	1,1	0,9	1,6	1,8	2,8	3,1	4,0	2,9	3,8	6,4

Table 5.3.3.2. Applied Urea in the RM, 1990-2017, kt

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0,794	0,713	0,533	0,174	0,073	0,083	0,124	1,499	0,371	0,005	0,599	0,204	0,064	0,325
2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
0,500	0,237	0,199	0,359	1,159	0,799	2,386	5,022	7,634	5,705	13,917	15,328	16,738	18,149

3.D.a.2.a Livestock manure applied to soils

NH_3 are calculated according the chapter 3B Manure Management. Activity data to calculate emission of NH_3 are taken from the category Livestock manure applied to soils.

3.D.a.3 Urine and dung deposited by grazing livestock

To estimate the amount of nitrogen from urine and dung deposited by grazing animals, activity data on the total population of livestock and poultry were used. The source of activity data was the Statistical Annual Report No. 24-agr 'Animal Breeding Sector': 'The Number of Livestock and Poultry in all Households Categories as of the 1st of January (issued annually for the period 1990-2016), Statistical Yearbooks of the ATULBD (AD are identical to those used under the 3A 'Enteric Fermentation' and 3B 'Manure Management'), country specific data on nitrogen excretion rate Nex(T) (in kg N/head/year) and country specific values of the different manure management systems usage in the Republic of Moldova (identical to those used under the 3B 'Manure Management').

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

To estimate emissions from the *3.D.a.4* category, the data for gross harvest of agricultural crops were used (Table 5.3.3.3).

Table 5.3.3.3. Gross Harvest of Agricultural Crops, 1990-2017, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cereals and leguminous crops	**2538,6**	**3105,9**	**2099,8**	**3340,2**	**1753,8**	**2638,6**	**1981,2**	**3512,3**	**2751,9**	**2375**
Wheat	1129	1056,5	925,8	1392,6	658,8	1126,4	673,7	1152,6	951,9	797,8
Winter rye	1,9	1,6	1,4	2,8	2,7	5,9	9,9	10,9	7	6,3
Barley	417,9	427	405	481	324,9	311,3	136,7	256,9	242,2	203,1
Oat	3,8	5	6,8	10,7	7,1	9,8	4,2	10,3	9,5	5,9
Millet	0,1	0,1	0	0,1	0,1	0,3	0,2	0,5	0,1	0
Buckwheat	1,8	5	2,3	5,5	3,5	2,2	3	4,8	4,3	6,1
Leguminous crops	97,1	105,7	121,8	121,6	70,2	55,5	31,6	63,2	76,9	61,6
Grain maize	885,5	1501,2	635,6	1324,5	629,3	948,6	1006,6	1788	1272,7	1151,3
Grain sorghum	1,2	3,1	1,1	1,4	1,1	0,8	0,1	0,5	0,2	0,3
Other cereal crops	0,3	0,7	0,01	0	56,1	0,3	0,2	0	4,7	6
Sugar beet	2374,5	1988,6	1783,4	2048,3	1526,7	1877,9	1682,1	1674,8	1356,8	956,4
Sunflower	252,2	151,4	176,2	173,7	149,2	208,1	0	174,3	196,4	291,6
Soybeans	23,8	33,4	7,9	9,3	4	3,1	2,5	2,7	6	13,7
Tobacco	66,2	62,8	42,4	50,2	41,5	39,7	51,3	168,8	169,6	196,8
Grain rapeseed	0	0	0	0	0	0	0	0	0	1,2
Potatoes	295,3	290,6	310,8	726	474,7	385,3	344,3	392,6	372,5	330,6
Vegetables	1177,3	989,2	787,5	777,2	598,5	529,3	362,4	393,6	570,8	535,8
Melons and gourds	34,4	35,6	9,3	18,6	12,6	21,6	23,3	30,4	25,9	33,9
Forage roots	1171,8	1416,4	922,5	988,6	547	545,6	336,5	310,2	286,4	170,1
Maize for silo and green fodder	4509	4979,1	3025,9	3358,7	2285,7	1766	1212,1	1065	856,5	428,6
Perennial grasses for green fodder, silage, and fodder	4456,1	6053,5	3401,4	3514,6	2013,8	1704,7	1027,2	855,6	498,5	506,8
Annual grasses for green fodder	288,9	420,7	339	339,1	190,7	222,3	143,4	96,7	106,6	53,7

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cereals and leguminous crops	**2070,2**	**2823,6**	**2791,2**	**1654,4**	**3178**	**2954,3**	**2371,2**	**932,5**	**3261,6**	**2375,5**
Wheat	725	1180,8	1113,1	102,4	861,2	1047,7	682,3	406,5	1286,5	738,9
Winter rye	5	9,1	5,9	0,8	5,1	3,6	1,1	0,8	2	3,4
Barley	152,3	246,9	241,7	74,4	284,1	226,7	214,6	125,7	362,3	290,5
Oat	3,5	6,4	4,7	4	10,3	7,4	6,1	1,4	3,9	1,6
Millet	0,1	0	0,1	0,1	0,3	0,2	0	0,1	0,5	0,7
Buckwheat	8	5,6	1,4	1,6	1,2	1	0,5	0,4	0,5	0,6
Leguminous crops	30,8	79,1	50,2	30,2	51	66,4	68,4	14,4	38	32
Grain maize	1050,4	1134,3	1206,3	1440,2	1845,1	1502,7	1327,6	363,2	1484,1	1159,6
Grain sorghum	0,5	1,1	0,5	4,4	3,4	0,3	0,5	0,1	0,1	0,2
Other cereal crops	3,2	5,7	4,2	0,7	3,7	12,3	15,2	1,1	8,1	5,3
Sugar beet	982,5	1117,8	1157,4	660,3	911,3	996,2	1177,3	612,3	960,7	337,4
Sun flower	305,1	275,6	340,9	421,4	354,8	347,7	396,1	158,7	387,2	310,2
Soybeans	11,6	9,5	12,6	19,4	40,2	66,1	80,2	40	58,8	50,1
Tobacco	121,4	105,7	69	36,5	7,9	6,7	4,9	3,6	3,9	4,4
Grain rapeseed	1,1	1	1	1,2	1,1	3,3	6,9	34,9	100,1	81,6
Potatoes	330,4	385,3	326	303,2	321,8	388,9	384,1	200,9	273,7	264,8
Vegetables	396,1	472,9	408,4	371,7	328,7	405,9	490,6	226,6	389,4	322,8
Melons and gourds	31,7	38,8	29	72,7	57,3	48,7	92,6	41,2	69,9	102,4
Forage roots	125	63,4	67,9	55,7	52,7	40,9	34,9	13,8	26,4	20
Maize for silo and green fodder	350,7	306,7	322,8	327,9	219,4	178,6	153,3	104,6	113	106,4
Perennial grasses for green fodder, silage and fodder	317,4	201,5	173,4	145,4	206,7	183,8	194,9	177	364,2	213,4
Annual grasses for green fodder	28,8	19,3	16	12,6	12,6	16,3	13,6	7,4	15,3	7,9
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**		
Cereals and leguminous crops	**2674,3**	**2794,6**	**1359**	**3130,4**	3341	2587	3531,9	3813,4		
Wheat	749	797,1	496,9	1009,2	1002,6	927,4	1302,4	1549,3		
Winter rye	2,4	1	2,6	5,7	1,4	1	1,8	1,2		
Barley	240,7	218,9	139,3	241,6	244,7	199,1	273,9	281,1		
Oat	2,9	3,6	2	3,8	2,9	1,6	2,8	0,2		
Millet	0,3	0,1	0,1	0,1	0,1	0,1	0,2	0,2		
Buckwheat	0,5	0,4	0,3	0,5	0,4	0,2	0,8	0,6		
Leguminous crops	39,7	33	17,2	24	32,9	25,5	45,1	75,2		
Grain maize	1462,1	1547,2	587,2	1546,8	1642,1	1133,6	1485,7	1871,0		
Grain sorghum	0,2	0,1	0,1	0,1	0,3	0,2	0,3	0,3		
Other cereal crops	7,7	4,8	2,1	5,7	8,3	2,8	9,2	0,5		
Sugar beet	837,6	588,6	587	1009	1356,2	537,5	664,8	876,3		
Sunflower	434,3	489,9	335,1	592,1	627,1	562,3	789,4	925,1		
Soybeans	112,9	80,2	48,8	67,5	111,4	49,2	43,8	48,5		
Tobacco	7,6	5,4	2,9	2,2	1,4	1,2	0,9	1,0		
Grain rapeseed	50,9	67,5	8,1	58,1	90,2	25,6	52,4	89,9		
Potatoes	286,4	362,7	191	243,4	275,7	163,8	220,3	201,7		
Vegetables	361,5	394,8	250,7	317	352,3	266,9	320,6	353,6		
Melons and gourds	104,5	84,8	52,1	55,7	48,3	56,7	69,3	59,6		
Forage roots	31,7	23,1	10,6	22,2	26,1	14,6	21,3	21,4		
Maize for silo and green fodder	140,7	120,6	109,4	165,6	135,7	91,7	139,6	111,7		
Perennial grasses for green fodder, silage and fodder	323,9	238,5	97,6	198,6	275	118,5	144,2	145,2		
Annual grasses for green fodder	10,9	11,3	6,3	9,6	13,4	8,8	9	9,1		

3.D.c Farm-level agricultural operations, including storage, handling and transport of agricultural products

Average number of harvests is estimated based on data from the Republic of Moldova survey on nitrogen and phosphorus balances for agricultural land. Emissions from agricultural crop operations are estimated based on cultivated area for different crops.

3.D.e Cultivated crops

Activity data on areas sown with crops and average yield per ha for the main crops (Table 5.3.3.4) is available in Statistical Yearbooks of the RM and those of the ATULBD.

Table 5.3.3.4. Data on crop areas, thousand ha

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Wheat	286,7	303	281,7	345,9	300,4	394,1	380,9	410,3	405,8	392,1	423,8	490	502,8	213,2	342,4	456,1
Rye	0,9	0,8	0,7	1,1	1,7	2,7	4,7	3,9	3,7	3,9	3,8	5,5	3,6	1,3	2,6	3,2
Oat	2,1	3	3	4	5	5,8	3,7	6,5	6,1	4,9	4,2	4,8	4,3	4,6	5,9	6,4
Rape	0,001	0	0	0	0	0	0	0	0	1	1	1	1	1	0,9	2,4
Grass	237,7	232	217,9	231	219,8	174	151	119,4	92,5	75,2	64,4	56,5	58,7	62,2	59,7	68,3
Total	527,401	538,8	503,3	582	526,9	576,6	540,3	540,1	508,1	477,1	497,2	557,8	570,4	282,3	411,5	536,4

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017				
Wheat	316,1	333,6	429,6	395,8	380,8	353,2	374,2	432,7	415	416,9	454,8	408,1				
Rye	0,7	0,8	1	1,9	1,6	0,6	1,3	2	0,5	0,4	0,6	0,52				
Oat	4,5	4,4	2,8	2,4	3	2,2	2,3	2,6	2,1	1,7	1,4	2,9				
Rape	7,1	41,3	53,5	67,4	48,9	53,8	8,2	36	38,2	13,3	22,4	36,2				
Grass	69,3	74	64,8	65	73,4	66,6	60,6	62,1	58,5	56	57,2	55				
Total	397,7	454,1	551,7	532,5	507,7	476,4	446,6	535,4	514,3	488,3	536,4	502,72				

5.4. Use of pesticides and limestone (NFR 3.D.f-3.I)

No limestone was used for soil neutralization in the Republic of Moldova during the period 1990-2017. Pesticides monitored by the LRTAP Convention are not used.

5.5. Field burning of agricultural residues (NFR 3.F)

5.5.1. Description of sources

The source of emissions is burning of agricultural residues - spices (burning of myrrh).

5.5.2. Methods and emission factors

The Tier 1 approach for emissions from field burning of agricultural residues uses the general equation (EMEP/EEA 2016):

$$E_{pollutant} = AR_{residue_burnt} \times EF_{pollutant} \quad (5.5.1)$$

$E_{pollutant}$ = emission (E) of pollutant (kg),

$AR_{residue_burnt}$ = activity rate (AR), mass of residue burnt (kg dry matter),

$EF_{pollutant}$ = emission factor (EF) for pollutant (kg dry matter).

This equation is applied at the national level, using annual national total amount of residue burnt. Note that $AR_{residue\ burnt}$ = A x Mb x Cf using the IPCC (2006) terminology, where A is the area burnt in hectares, Mb is the mass of fuel available for combustion, in tons per hectare and Cf is a combustion factor (dimensionless). Calculations are based on both the methodology of 2006 IPCC Guidelines, Vol. 4, Chapter 2, Table 2.6, and results (improvements) used in the National Inventory Report 1990-2016, Chisinau 2018, developed under the UN Framework Convention on Climate Change. PCDD/ PCDF (dioxins/furans), HCB, HCH, PCBs are Not estimated. The emission factors used in the calculations are presented in Table 5.5.2.1.

Table 5.5.2.1. Emission Factors for Field burning of agricultural waste

Compound	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	CO	BC	Pb	Cr
EF	0,002300	0,0005	0,0005	0,0024	0,0054	0,0667	500	0,11	0,08

Compound	Cu	Ni	Se	Zn	Indeno(1,2,3-cd) pyrene	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene
EF	0,073	0,052	0,02	0,56	0,336	0,393	1,097	0,468

5.5.3. Activity data

Activity data include estimates of land areas for each crop type, which are then used to estimate residues that are commonly burnt, the fraction of residue burnt and the dry matter content of residue (Table 5.5.3.1). When evaluating the agricultural residues related to burning in the fields, arithmetic mean of wheat and barley harvested depending on the average production per ha is used (Table 5.5.3.2).

Table 5.5.3.1. Field burning of agricultural waste, thousand ha

	1990	1991	1992	1993	1994	1995	1996
Total burned area	12,213	13,110	12,141	14,547	13,422	15,800	18,600
	1997	1998	1999	2000	2001	2002	2003
Total burned area	20,700	21,500	24,000	11,50	9,50	1,96	0,100
	2004	2005	2006	2007	2008	2009	2010
Total burned area	0,400	2,2	0,89	2,65	4,465	0,892	0,627
	2011	2012	2013	2014	2015	2016	2017
Total burned area	0,475	0,106	0,575	0,400	0,346	0,321	0,110

Table 5.5.3.2. Average harvested crops, t/ha

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Wheat, t/ha	3,94	3,49	3,29	4,03	2,19	2,93	1,77	2,81	2,35	2,04	1,71	2,41	2,21	0,48
Barely, t/ha	3,47	3,19	3,29	3,46	2,21	2,31	1,26	1,98	1,81	1,58	1,22	2,15	1,81	0,78
Mean, t/ha	3,7	3,34	3,29	3,74	2,2	2,62	1,51	2,4	2,08	1,81	1,47	2,28	2,01	0,63
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Weet, t/ha	2,52	2,30	2,16	1,22	3,00	1,87	1,97	2,26	1,33	2,76	3,17	2,67	3,49	3,73
Barely, t/ha	2,02	1,63	1,74	0,91	2,60	1,57	1,46	1,71	1,22	2,11	2,29	2,12	3,09	3,09
Mean, t/ha	2,27	1,96	1,95	1,06	2,8	1,72	1,71	1,98	1,27	2,44	2,73	2,4	3,29	3,41

Agriculture Sector is one the most important source of the ammonia emissions as long-range transboundary air pollutants in the Republic of Moldova. The categories that provide a significant contribution to pollutant emissions (in national total) are as follows:

1) Category *3.B.3 Manure management: Swine* contributes by 23,0 % to NH_3 emissions.
2) Category *3.D.a.2.b Sewage sludge applied to soils* contributes by 16,1% to NOx emissions and by 19,8% to NH_3 emissions;
3) Category *3.F Field burning of agricultural residues* contributes by 12,6% to BC emissions and by 6,7% to CO emissions;
4) Category *3.B.1.b Manure management - Non-dairy cattle* contributes by 10,7% to NMVOC emissions;
5) Category *3.D.a.3 Urine and dung deposited by grazing* contributes by 10,5% to NH_3 emissions.
6) Category *3.B.1.a Manure management - Dairy cattle* contributes by 7,6% to NMVOC emissions and by 5,9% to NH_3 emissions.

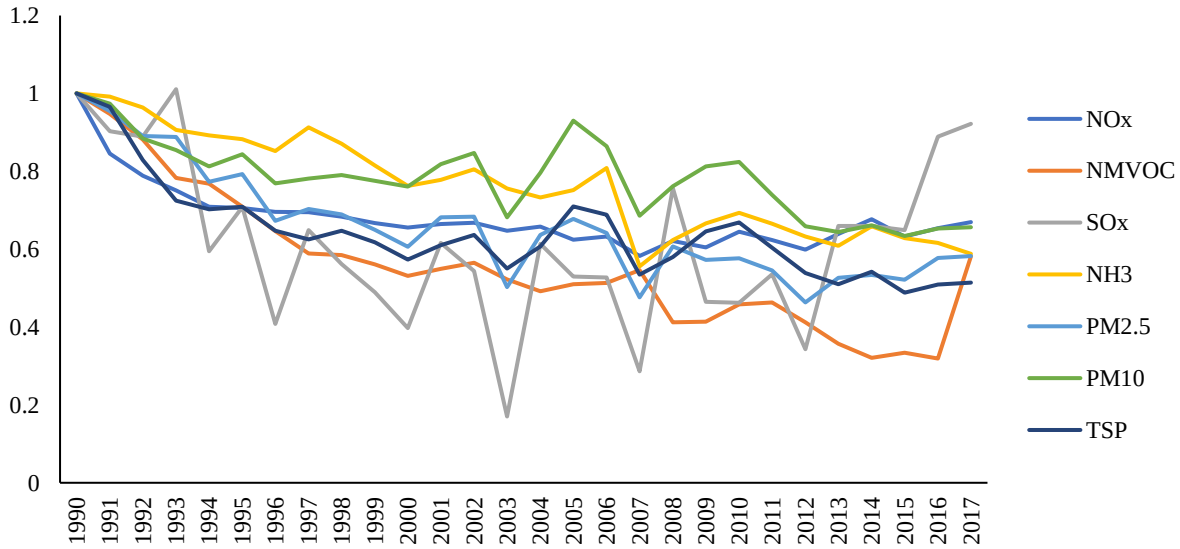


Figure 5.5.1. Emission trends for most air pollutants from the Agriculture sector, compared to 1990 (1990=1).

Figure 5.5.1 shows the trends in emissions of several air pollutants (NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP) from the agriculture sector compared to 1990, taken as 1.

Charts show an evident reduction of emissions in the period 1990-1999, then a slight increase in the period 2000-2012 and a relatively steady trend in 2013-2017.

All emissions decreased as compared to 1990 and remained almost unchanged between 2013 and 2017. Only for NMVOC and SOx emissions an increase has been observed since 2016, but none of them reached the 1990 level.

Chapter 6: WASTE (NFR sector 5)

6.1. Overview of the sector

The waste sector in the Republic of Moldova includes emissions related to solid waste disposal on land (5.A), clinical waste incineration (5.C.1.b.iii), open burning of waste (5.C.2), wastewater treatment and discharging (5.D) and various types of fires, such as apartment and industrial building fire, detached and undetached house fire (5.E).
Republic of Moldova reports for the source categories of the NFR, as included in the Table 6.1.

Table 6.1. Source categories of the NFR 5 Waste reported by the Republic of Moldova

NFR Code	Long name	Description	
5.A	**Solid waste disposal on land**	+	Managed waste disposal on land Unmanaged waste disposal on land
5.B.1	**Biological treatment of waste - Composting**	NE	Emission occur, but have not been estimated due to lack of statistical data
5.B.2	**Biological treatment of waste - Anaerobic digestion at biogas facilities**	NE	Emission occur, but have not been estimated due to lack of statistical data
5.C.1.a	**Municipal waste incineration**	NO	There are no authorized facilities for the incineration of municipal waste in the Republic of Moldova
5.C.1.b.i	**Industrial waste incineration**	NO	There are no authorized facilities for the incineration of industrial waste in the Republic of Moldova
5.C.1.b.ii	**Hazardous waste incineration**	NO	There are no authorized facilities for the incineration of hazardous waste in the Republic of Moldova
5.C.1.b.iii	**Clinical waste incineration**	+	Clinical waste incineration
5.C.1.b.iv	**Sewage sludge incineration**	NO	Incineration of sewage sludge is not used in the Republic of Moldova
5.C.1.b.v	**Cremation**	NO	Cremation does not exist in the Republic of Moldova
5.C.1.b.vi	**Other waste incineration**	NE	
5.C.2.	**Open burning of waste**	+	
5.D.1	**Domestic wastewater handling**	+	Latrines
5.D.2	**Industrial wastewater handling**	+	Wastewater treatment in industry Wastewater treatment in residential/commercial sectors
5.D.3	**Other wastewater handling**	NA	
5.E	**Other waste**	+	Apartment building fire Industrial building fire Detached house fire Undetached house fire
6.E	**Other (included in national total for entire territory)**	NA	

In the Republic of Moldova, the increase in consumption contributes to the increase in solid waste. Most types of waste can be recycled, but most of these types is solid waste. The lifestyle determined by the increase in the wellbeing of the population caused a quantitative and qualitative increase in the process of waste generation.
There are specialized services of waste collection and disposal in municipalities and in all district centres. Municipal waste management is carried out in an organized manner through these services, working on a contract basis with private clients. Only a small part of rural settlements, those in immediate proximity of district centres are served by organized waste management services.
In the Republic of Moldova, in the last years, there is a large capacity of waste generation per capita. In rural localities, it is 0,5 - 0,7 kg/capita/day. In the small urban localities and in the district centres, it is 0,9 kg/capita/day. In the municipalities of Balti and Chisinau, it is 1,3-1,5 kg/capita/day.
The current sewage system is underdeveloped and has a reduced capacity to provide full access of the population to qualitative sewerage services. The rate of connection of the population to the centralized sewerage systems differs from the connection rate at the country level, which is estimated at 22,2%.
The purification of the domestic wastewater is carried out partially in most of the urban localities of the Republic of Moldova.

6.1.1. Trends in emissions

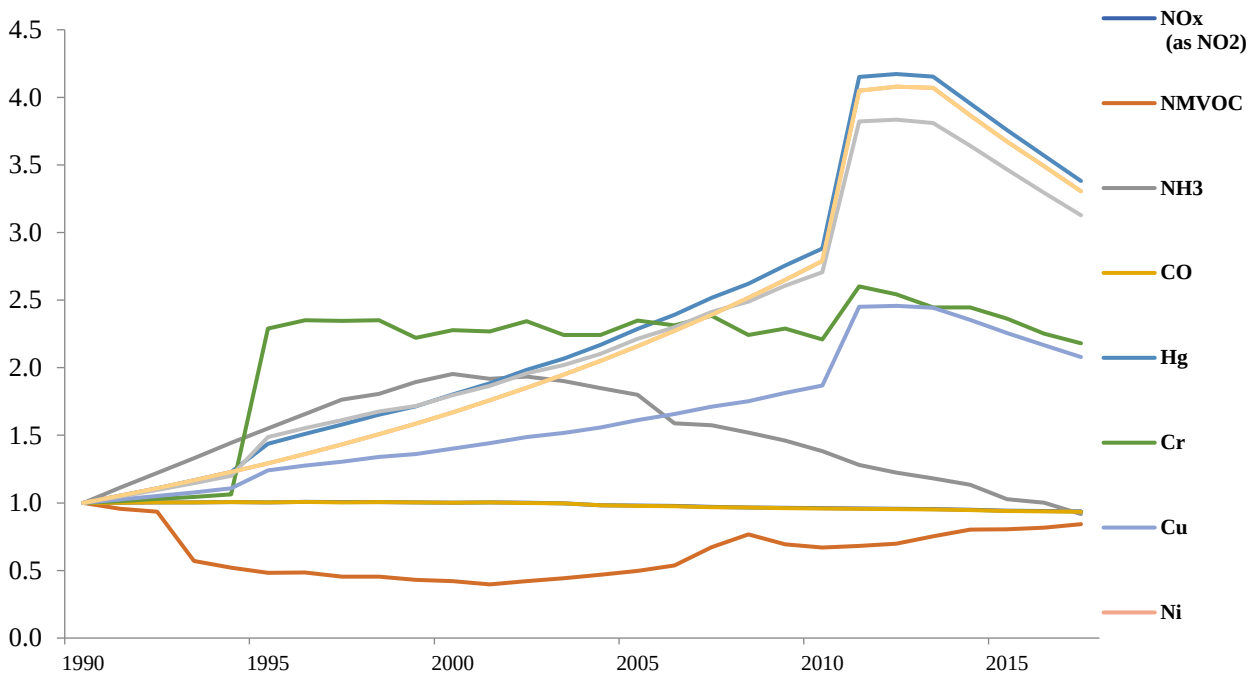


Figure 6.1.1 Emissions trends for most air pollutants from waste, compared to 1990

Figure 6.1.1 shows the emission trends for most of the long-range transboundary air pollutants from waste, compared to 1990. NOx, NH_3, CO and NMVOC emissions decreased as compared to 1990, while emissions of POPs and Heavy Metals increased as compared to 1990.

Ammonia (NH_3)

NH_3 emissions from the sector *5.D.1* amounted to 2,05 kt in 2017 (Figure 6.1.1.1)

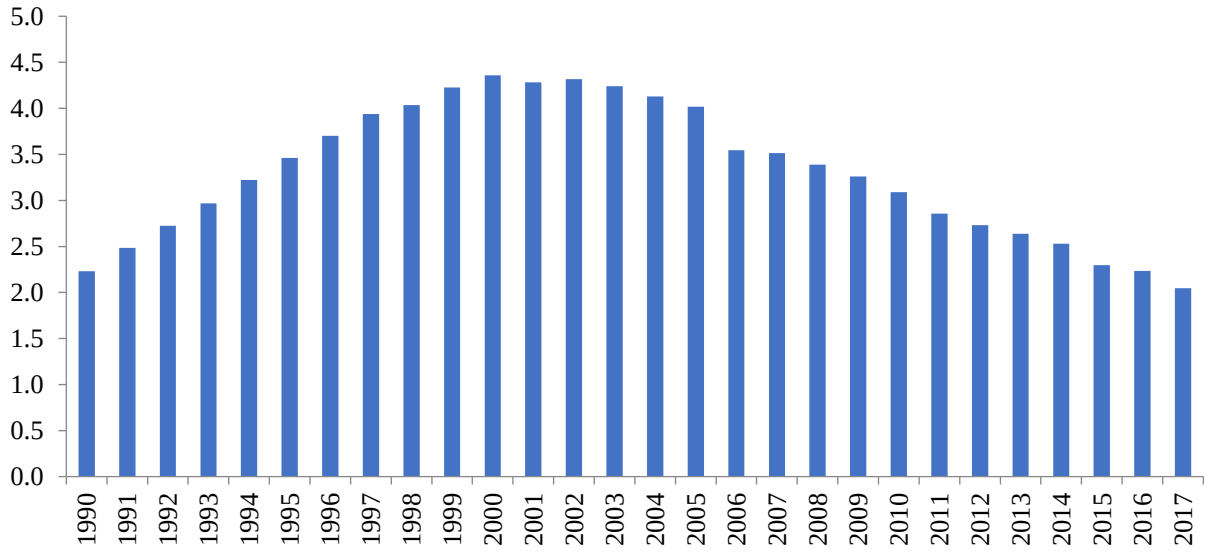


Figure 6.1.1.1. Trends in NH_3 emissions in the period 1990-2017, kt

Non-methane volatile organic compounds (NMVOC)

NMVOC emissions from the Waste sector amounted to 3,15 kt in 2017 (Figure 6.1.12a). The main sources of these emissions were categories *5.A* (96%) and *5.C.2* (4%) (Figure 6.1.1.2b).

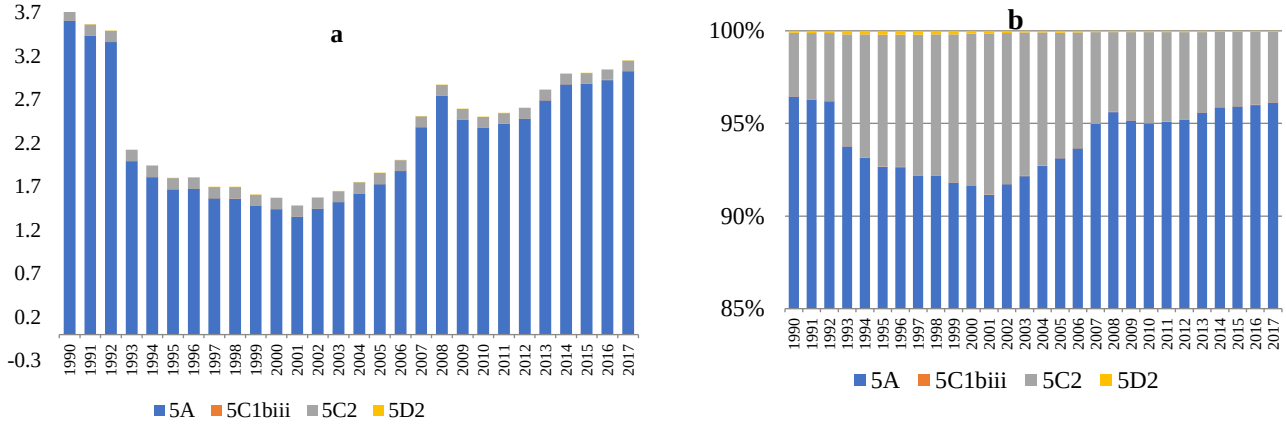


Figure 6.1.1.2. Trend in NMVOC emissions in the period 1990-2017, kt

Particulate Matter ($PM_{2.5}$, PM_{10}, TSP)

TSP emissions from the Waste sector amounted to 0,5639 kt in 2017 (Figure 6.1.1.3a).The main sources of TSP emissions in the waste sector are the following categories: 5.C.2 (0,45kt, 80,3%), and 5E (0,1kt, 17,8%) (Figure 6.1.1.3b).

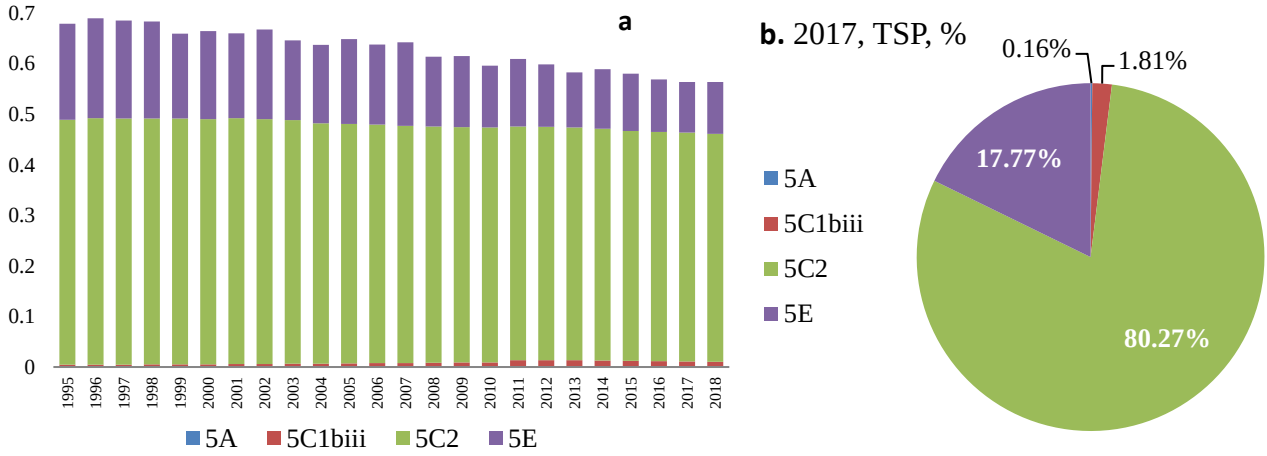


Figure 6.1.1.3. Trend in TSP emissions in the period 1990-2017, kt

Carbon monoxide (CO)

CO emissions from the Waste sector amounted to 5,45 kt in 2017 (Figure 6.1.1.4). The main source of CO emissions is the category *5.C.2*.

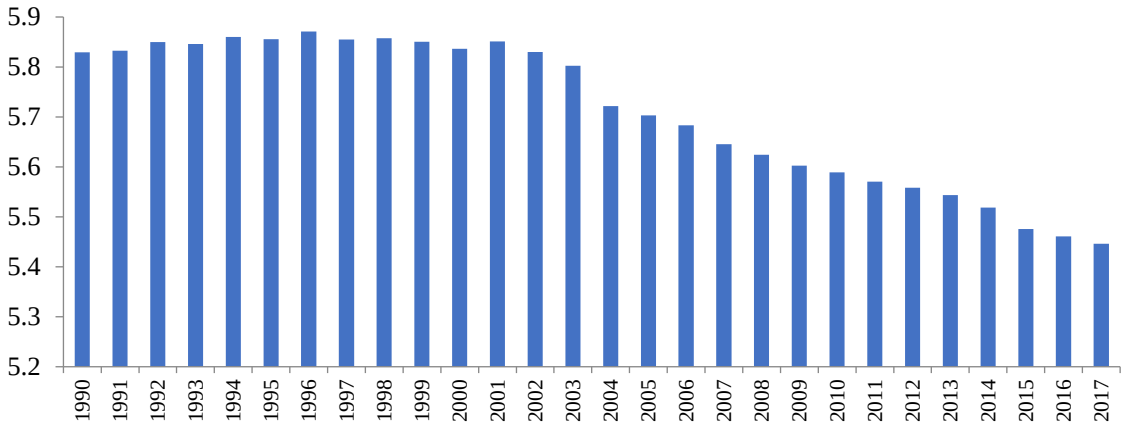


Figure 6.1.1.4. Trend in CO emissions from waste in the period 1990-2017, kt

POPs and Heavy Metals

PCDD/PCDF emissions from the Waste sector amounted to 25,98 g I-TEQ in 2017 (Figure 6.1.1.4a). The main sources of PCDD/PCDF emissions in the sector are the following categories: *5.C.1.b.iii* (24 g I-TEQ, 92%), *5.E* (1 g I-TEQ, 3,9%); *5.C.2* (0,98 g I-TEQ, 3,8%) (Figure 6.1.1.4a).

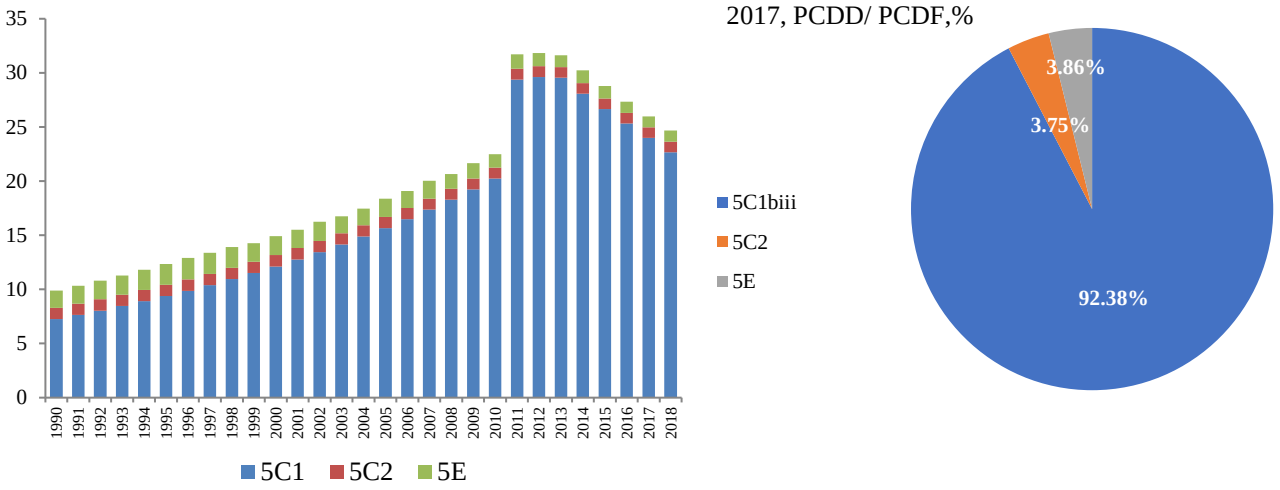


Figure 6.1.1.4a. Trend in PCDD/F emissions from waste in the period 1990-2017, g I-TEQ

Heavy Metals emissions from the Waste sector amounted to 1,97 t in 2017 (Figure 6.1.1.4b). The main sources of Heavy Metals emissions in the sector are the categories *5.C.1.b.iii* and *5.C.2* (Figure 6.1.1.4b).

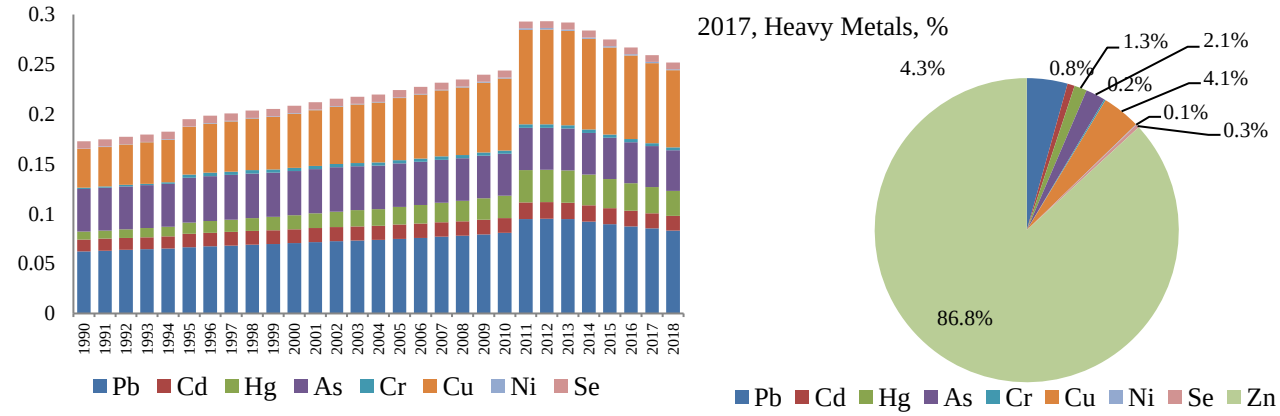


Figure 6.1.1.4b. Trend in Heavy Metals emissions in the period 1990-2017, t

6.1.2. Key categories

The following table presents an outline of the weight of different categories for each pollutant in the waste sector (Table 6.1.2a).

Table 6.1.2a. Outline of the weight of different categories for each pollutant in the waste sector

Pollutants	5.A Solid waste disposal on land	5.C.1.b.iii Clinical waste incineration	5.C.2 Open burning of waste	5.D.1 Wastewater treatment	5.D.2 Wastewater discharging	5.E Other waste
NO_x (kt)	-	0,001380	0,3102	-	-	-
NMVOC (kt)	3,0284	0,00042	0,1200	-	0,0018	-
SO_x (kt)	-	0,000324	0,0107	-	-	-
NH_3 (kt)	-	-	-	2,04798	-	-
$PM_{2,5}$ (kt)	0,000064	-	0,4087	-	-	0,10018
PM_{10} (kt)	0,000425	-	0,4399	-	-	0,10018
TSP (kt)	0,000899	0,0102	0,4526	-	-	0,10018
BC (kt)	-	0,00023	0,1717	-	-	-
CO (kt)	-	0,000114	5,4460	-	-	-
Pb (t)	-	0,0372	0,0478	-	-	0,00029
Cd (t)	-	0,0048	0,0098	-	-	0,00059
Hg (t)	-	0,0258	-	-	-	0,00059
As (t)	-	0,00012	0,0400	-	-	0,00094
Cr (t)	-	0,0012	0,0010	-	-	0,00089
Cu (t)	-	0,0588	0,0195	-	-	0,00208
Ni (t)	-	0,0012	-	-	-	-
Se (t)	-	-	0,0068	-	-	-
Zn (t)	-	-	1,71	-	-	-
PCDD/F (g I-TEQ)	-	24	0,9755	-	-	1,00402
Benzo(a) pyrene (t)	-	-	0,2273	-	-	-
Benzo(b) fluoranthene (t)	-	-	0,4516	-	-	-
Benzo(k) fluoranthene (t)	-	-	0,5541	-	-	-
Indeno (1,2,3-cd) pyrene (t)	-	-	-	-	-	-
Total PAHs (t)	-	0,000000025	1,2330	-	-	-
HCB (kg)	-	0,06	-	-	-	-
PCBs (kg)	-	0,012	-	-	-	-

Table 6.1.2b. Level and Trend assessment from Waste Category (2017)

Pollutants	5.A	5.C.1.biii	5.C.2
NMVOC (kt)	**L1**		
CO (kt)			**T1**
Hg (t)		**T1**	
As (t)			**L1, T1**
Cu (t)		**T1**	
PCDD/F (g I-TEQ)		**L1, T1**	
Benzo(a) pyrene (t)			**T1**
Benzo(b) fluoranthene (t)			**T1**
Benzo(k) fluoranthene (t)			**L1, T1**

Thus, as shown in Table 6.1.2b, the key categories (% from National Total) are as follows:

- *5.A Solid waste disposal on land*: 4% for NMVOC,
- *5.C1 b.iii Clinical waste incineration*: 25,1% for PCDD/F,
- *5.C2 Open burning of waste*: 22,6% for As, and 31% for B(k).

The *5.C.2 category (Open burning of waste)* is the key source of majority of pollutants in the Waste sector.

6.1.3. Methods and emission factors

Emissions originated from the waste source categories were estimated using both, the Tier 1 and Tier 2 methodological approach and default emission factors.

A summary description of methods used to estimate emissions by source categories is provided in the Table 6.1.3, while a more detailed description is available in the sub-chapter categories.

Table 6.1.3. Emission Estimation Methodologies Used to Estimate Emissions from the Waste Sector

NFR	Products group	Assessment Methodology	Emission Factors
5.A.	Solid waste disposal on land	T1 (EMEP/EEA 2016)	D
5.C.1.b.iii	Clinical waste incineration	T1 (EMEP/EEA 2016)	D
5.C.2.	Open burning of waste	T1 (EMEP/EEA 2016)	D
5.D.1	Wastewater treatment	T2 (EMEP/EEA 2016)	D
5.D.2	Wastewater discharging	T1, T2 (EMEP/EEA 2016)	D
5.E.	Other waste	T2 (EMEP/EEA 2016)	D

Abbreviations: T1 – Tier 1; T2 – Tier 2; T3 – Tier 3; D – Default.

6.1.4. Assessment of Completeness

The current inventory covers air pollutant emissions from four source categories under the Republic of Moldova's Waste Sector:

- *5A – Solid Waste Disposal on Land;*
- *5C – Waste incineration (Clinical waste incineration and Open burning of waste);*
- *5D – Wastewater handling;*
- *5E – Other Waste.*

Tables 6.1.4a and 6.1.4.b present the assessment of completeness for the waste sector.

Table 6.1.4a. Assessment of completeness, Waste Sector

NFR Category (5)	Pollutants											
	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
5.A.	NA	+	NA	NE	+	+	+	NA	NE	NA	NA	NE
5.C.1.	+	+	+	NE	NE	NE	+	+	+	+	+	+
5.C.2.	+	+	+	NE	+	+	+	+	+	+	+	NE
5.D.1	NA	NE	NA	+	NE	NE	NE	NE	NA	NE	NE	NE
5.D.2	NA	+	NA	NE	NE	NE	NE	NE	NA	NE	NE	NE
5.E.	NE	NE	NE	NA	+	+	+	NE	NE	+	+	+

Table 6.1.4b. Assessment of completeness, Waste Sector

NFR Category (5)	Pollutants													
	As	Cr	Cu	Ni	Se	Zn	PCDD/F	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Indeno (1,2,3-cd) pyrene	Total 4PAHs	HCB	PCBs
5.A.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.C.1.	+	+	+	+	NE	NE	+	NE	NE	NE	NE	+	+	+
5.C.2.	+	+	+	NE	+	+	+	+	+	+	NE	+	NE	NA
5.D.1	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA
5.D.2	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA
5.E.	+	+	+	NE	NE	NE	+	NE	NE	NE	NE	NE	NE	NE

6.1.5. Uncertainties Assessment and Time Series Consistency

Uncertainties in the waste sector are described in Chapter 1.

6.1.6. Source-specific QA/QC and verification

Standard verification and quality control forms and checklists were filled in for the respective category under each sector, following Tier 1 and Tier 2 approaches. The Activity Data and methods used for estimating pollutant emissions under each category were documented and archived both in hard copies and electronically. Verification was focused on ensuring correct use of the default EFs available in the EMEP/EEA Emission Inventory Guidebook 2016 and the correct use of Activity Data obtained from different sources (i.e. National Bureau of Statistics), etc.

6.2. Solid Waste disposal on Land (NFR 5.A.)

6.2.1. Description of sources

The current situation in the management of Municipal Solid Waste (MSW) in the Republic of Moldova is similar to that in other developing countries. It is in the emerging stage and includes two basic elements: municipal solid waste generating sources and landfills. The most widely used method of MSW management is their disposal on the site, which is often a major source of soil pollution and groundwater contamination.

In the RM, the landfills are organized and managed in a way that is far from meeting environmental requirements.

6.2.2. Methods and emission factors

NMVOC, $PM_{2,5}$, PM_{10} and TSP emission factors are available. Tier 1 emission factors for NMVOC (1,56 kg/Mg solid matter), $PM_{2,5}$ (0,033 g/Mg solid matter), PM_{10} (0,219 g/Mg solid matter), TSP (0,463 g/Mg solid matter) are presented in the EMEP/EEA Emission Inventory Guidebook 2016.

The following formula is used to calculate NMVOC emissions:

$$\text{NMVOC Emissions} = W \times EF \times 10^{-6} \qquad (6.1)$$

where

NMVOC Emissions – NMVOC Emissions in the cadastral year, thousand T/year;
W – amount of solid waste removed, T/year;
EF – emission factor, default value is 1,56 kg NMVOC/t of solid matter;
10^{-6} – conversion factor, from kg to kt.

6.2.3. Activity Data

Activity data are represented for the whole Republic of Moldova (Table 6.2.3). Activity data of the Right Bank of the Dniester River on waste generation and disposal at the SWDS were provided in [3] and Statistical Yearbooks of Moldova for 2002-2018. Activity data of the Left Bank of the Dniester River (Transnistria) on waste generation and disposal at the SWDS were provided in [3], as well as in the Annual Reports on Activities of the Ministry of Agriculture and Natural Resources of Transnistria [19], Annual reports on activities of administrations of territorial administrative units from the Left Bank of the Dniester River [18].

Table 6.2.3. Activity data on solid waste amount disposed on land in the RM, 1990-2017, t

	1990	**1991**	**1992**	**1993**	**1994**	**1995**
Amount of solid waste removed, t	2311520	2204580	2156320	1279310	1161605	1070975
	1996	**1997**	**1998**	**1999**	**2000**	**2001**
Amount of solid waste removed, t	1074330	1003895	1003730	947860	924490	867285
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
Amount of solid waste removed, t	926260	975775	1041425	1109600	1205790	1529065
	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Amount of solid waste removed, t	1759445	1582905	1526240	1554275	1590840	1726610
	2014	**2015**	**2016**	**2017**		%
Amount of solid waste removed, t	1844960	1850440	1876680	1941265		-17,9

As shown in Figure 6.2.3, the total amount of household solid waste disposed on land has decreased between 1990 and 2001, and then has increased from 2001 to 2017. The amount of total industrial solid waste disposed on land has decreased between 1990 and 1999 and then again from 2008 to 2011. Between 2011 and 2017, the increase in industrial waste has been approximately by the same rate.

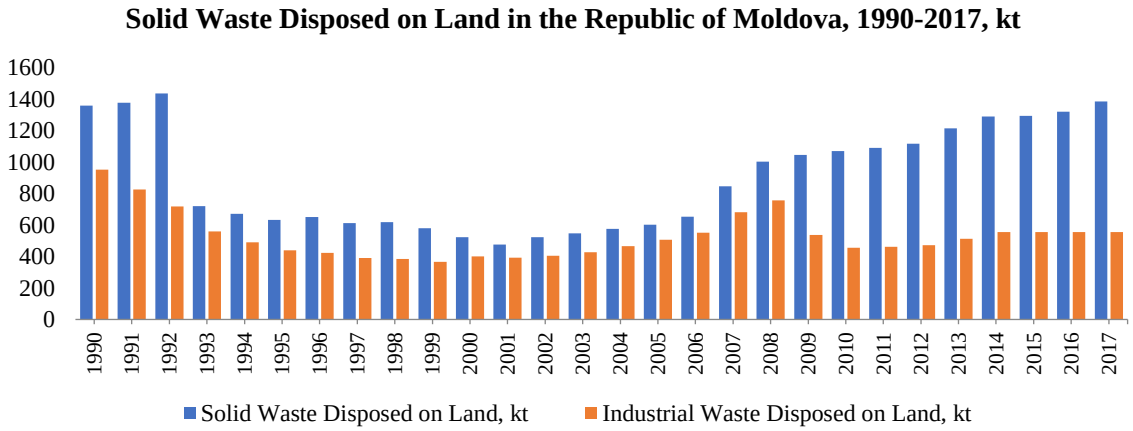


Figure 6.2.3. Total quantity of solid waste disposed on land in the Republic of Moldova, 1990-2017, kt

6.3. Waste incineration (NFR 5.C)

6.3.1. 5.C.1 Clinical waste incineration

6.3.1.1. Emission factors

Emission factors for the estimation of emissions from Clinical waste incineration category are presented in Table 6.3.1.1.

Table 6.3.1.1 Emission factors for Clinical waste incineration

Substance	Emission factor value	Emission factor unit
NOx	2,3	kg/Mg
NMVOC	0,7	kg/Mg
SOx	0,54	kg/Mg
NH_3	NE	kg/Mg
$PM_{2,5}$	NE	kg/Mg
PM_{10}	NE	kg/Mg
TSP	17	kg/Mg
BC	0,391	2.3% of TSP
CO	0,19	kg/Mg
Pb	62	g/Mg
Cd	8	g/Mg
Hg	43	g/Mg
As	0,2	g/Mg
Cr	2	g/Mg
Cu	98	g/Mg
Ni	2	g/Mg
Se	NE	g/Mg
Zn	NE	g/Mg
PCDD/ PCDF	40	mg I-TEQ/Mg
benzo(a) pyrene	NE	mg/Mg
benzo(b) fluoranthene	NE	mg/Mg
benzo(k) fluoranthene *	NE	mg/Mg
Indeno (1,2,3-cd) pyrene*	NE	mg/Mg
Total 1-4	0,04	mg/Mg
HCB	0,1	g/Mg
PCBs	0,02	**g/Mg**

6.3.1.2. Activity Data

Although there are no authorized incinerators in the Republic of Moldova for the incineration of clinical waste, a certain category of plastic clinical waste generated by several medical institutions in the country is treated through the pyrolysis method by the "TRISUMG" SRL. Medical institutions in the RM practice the burning of clinical waste by three methods: 1) open burning; 2) closed burning in heating boilers or metal barrels; and 3) transport for pyrolysis treatment. Activity data for the estimation

of direct GHG emissions (CO_2, CH_4 and N_2O) and indirect emissions (NO_x, CO, NMVOC and SO_2) from the open burning of clinical waste were available in the National Mercury Emission Inventory. The National Public Health Centre of the Ministry of Health of the Republic of Moldova provided data on clinical waste treated by medical institutions across the country through the three methods mentioned above. Historical data for the period 1990-2009 have been deduced from the data provided for the 2010-2016 time series (Table 6.3.1.2) [7].

Table 6.3.1.2. Activity data on burned clinical waste amount, 1990-2017, t

	1990	1991	1992	1993	1994	1995	1996
Amount of clinical waste burned, t	181,5	191,1	201,1	211,7	222,8	234,6	246,9
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Amount of clinical waste burned, t	259,9	273,6	288	303,1	319,1	335,9	353,6
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Amount of clinical waste burned, t	372,2	391,8	412,4	434,1	456,9	481	506,3
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Amount of clinical waste burned, t	734,8	740,3	738,7	701,7	666,6	633,3	600

6.3.2. 5.C.2 Open burning of waste

6.3.2.1. Description of Sources

This chapter covers the reduction of volume of small-scale (agricultural) waste by open burning. It does not include stubble burning (covered under the NFR source category *4.F Field burning of agricultural wastes*) or forest fires (not covered by the Guidebook).

The open burning of rubber tires or waste oil on farms has not been included either.

6.3.2.2. Emission factors

Emission factors for the estimation of emissions from Open burning of waste category are presented in Table 6.3.2.1.

Table 6.3.2.1. Emission factors for Open burning of waste

Substance	Emission factor value	Emission factor unit
NOx	3,18	kg/Mg
NMVOC	1,23	kg/Mg
SOx	0,11	kg/Mg
NH_3	NE	kg/Mg
$PM_{2,5}$	4,19	kg/Mg
PM_{10}	4,51	kg/Mg
TSP	4,64	kg/Mg
BC	1,7598	% of $PM_{2.5}$
CO	55,83	kg/Mg
Pb	0,49	g/Mg
Cd	0,1	g/Mg
Hg	NE	g/Mg
As	0,41	g/Mg
Cr	0,01	g/Mg
Cu	0,2	g/Mg
Ni	NE	g/Mg
Se	0,07	g/Mg
Zn	17,53	g/Mg
PCDD/ PCDF	10	µg I-TEQ/Mg
benzo(a) pyrene	2,33	g/Mg
benzo(b) fluoranthene	4,63	g/Mg
benzo(k) fluoranthene *	5,68	g/Mg
Indeno (1,2,3-cd) pyrene*		g/Mg
Total 1-4	12,64	g/Mg
HCB	NE	
PCBs	NA	

6.3.2.3. Activity Data

The amount of waste open-burned each year (Table 6.3.2.2) was estimated using Equation 5.7 from the 2006 IPCC Guidelines (Vol. 5, Chapter 5.3.2, page 5.16):

$$MSW_B(T) = P \times P_{frac} \times MSW_P \times B_{frac} \times 365 \times 10^{-3} \qquad (6.2)$$

Where:

$MSW_B(T)$ – total amount of municipal solid waste open-burned, t/year;

P – population, capita;

P_{frac}– fraction of population burning waste (fraction);

MSW_P – per capita waste generation, kg waste/capita/day;

B_{frac} – fraction of the waste amount that is burned as a share of the total amount of waste treated (fraction);

365 – number of days per year

10^{-3} – conversion factor from kg to t.

According to the 2006 IPCC Guidelines, open burning includes regular burning and sporadic burning. Regular burning means that this is the only practice used to eliminate waste. Sporadic burning means that this practice is used in addition to other practices and, therefore, open burning is not the only practice used to eliminate waste. For countries that have well-functioning waste collection systems in place, it is good practice to investigate whether any fossil carbon is open burned.

The practice of waste incineration is predominantly characteristic of rural areas, both in households and on landfills in order to reduce the volume of solid waste disposed, mainly by burning organic waste (paper, cardboard, plastics and vegetable waste). In the case of the RM, the share of population that burn waste in the open air (P_{frac}) is equivalent to the rural population ($P_{frac\ rural}$) plus the urban population ($P_{frac\ urban}$) that do not benefit from waste collection services ($P_{frac} = P_{frac\ rural} + P_{frac\ urban}$).

It is worth mentioning that specialized waste collection and disposal services exist in the municipalities of the country, as well as in the district centres, but this system covers only about 60-90% of the total urban population generating municipal solid waste. Therefore, the share of the population that does not benefit from waste collection services is about 10-30%, or about 20% on average. In the absence of official data on per capita waste generation, we used the value of 0,5 kg/capita/day for rural population ($MSW_{P\ rural}$), and respectively 0,9 kg/capita/day for urban population ($MSW_{P\ urban}$) of the Republic of Moldova.

It was assumed that circa 20% of the urban population that does not benefit from waste disposal services burns in the open air the organogenic solid waste, while the fraction for solid waste burned (B_{frac}) from the total amount of treated waste in urban areas represents 0,15 (i.e. 15% of the total) ($B_{frac\ urban}$). In rural areas, it was assumed that 40% of the population burns in the open air the organogenic solid waste, and the B_{frac} represents 0,2 (i.e. 20% of the total) ($B_{frac\ rural}$). The total amount of MSW burned in the open air by the population was estimated by using the following equation:

$$MSW_B(T) = MSW_{B\ rural}(T) + MSW_{B\ urban}(T) \quad (6.3)$$

where:

$$MSW_{B\ rural}(T) = MSW_{B\ rural}(\text{Right Bank}) + MSW_{B\ rural}(\text{Left Bank}) \quad (6.4)$$

$$MSW_{B\ urban}(T) = MSW_{B\ urban}(\text{Right Bank}) + MSW_{B\ urban}(\text{Left Bank}) \quad (6.5)$$

where:

$$MSW_{B\ rural}(\text{Right Bank}) = P_{RB} \times P_{frac\ rural} \times MSW_{P\ rural} \times B_{frac\ rural} \times 365 \times 10^{-3} \quad (6.6)$$

$$MSW_{B\ rural}(\text{Left Bank}) = P_{LB} \times P_{frac\ rural} \times MSW_{P\ rural} \times B_{frac\ rural} \times 365 \times 10^{-3} \quad (6.7)$$

$$MSW_{B\ urban}(\text{Right Bank}) = P_{RB} \times P_{frac\ urban} \times MSW_{P\ urban} \times B_{frac\ urban} \times 365 \times 10^{-3} \quad (6.8)$$

$$MSW_{B\ urban}(\text{Left Bank}) = P_{LB} \times P_{frac\ urban} \times MSW_{P\ urban} \times B_{frac\ urban} \times 365 \times 10^{-3} \quad (6.9)$$

where:

P_{RB} – population from the Right Bank of the Dniester River, capita

P_{LB} – population from the Left Bank of the Dniester River, capita

$P_{frac\ rural}$ – Share of rural population from the Right Bank of the Dniester River (or from the Left Bank), %

$P_{frac\ urban}$ – Share of urban population that burns waste in the total population, %

$MSW_{p\ rural}$ = 0,5 kg waste/capita/day

$MSW_{p\ rural}$ = 0,9 kg waste/capita/day

$B_{frac\ rural}$ = 20%=0,2

$B_{frac\ urban}$ = 15%=0,15.

According to the National Mercury Emission Inventory (2014), the share of the rural population ($P_{frac\ rural}$(RB)) was estimated at 60% of the total population in the Republic of Moldova, and at about 30% in the ATULBD ($P_{frac\ rural}$ (LB)).

In the calculations made currently (2019) for the period 1990-2017, the share of the rural population ($P_{frac\ rural}$) for the Right Bank and the Left Bank (ATULBD) of the Dniester River was estimated with a higher accuracy.

According to the National Mercury Emission Inventory (2014), the share of the population that burns waste in urban areas ($P_{frac\ urban}$) in the total population of the Republic of Moldova was estimated at about 8% or 0,08.

At this stage, calculations have been made for the Right Bank and the Left Bank (ATULBD) of the Dniester River: the share of urban population burning waste (20%) and the share of urban population burning waste in the total population.

The resulting estimations were summed up. The percentage differs from that indicated in the National Mercury Emission Inventory (2014) [25] and varies from year to year.

Table 6.3.2.2. Activity data on the total open-burned municipal solid waste, 1990-2017, t

	1990	1991	1992	1993	1994	1995	1996
MSW_B(T), tons	104413,42	104470,40	104777,80	104711,74	104959,20	104879,92	105154,29
	1997	1998	1999	2000	2001	2002	2003
MSW_B(T), tons	104875,72	104922,58	104795,42	104533,62	104806,31	104420,17	103934,69
	2004	2005	2006	2007	2008	2009	2010
MSW_B(T), tons	102479,78	102145,64	101795,64	101116,20	100734,26	100354,59	100111,45
	2011	2012	2013	2014	2015	2016	2017
MSW_B(T), tons	99772,02	99551,74	99298,27	98849,37	98078,00	97816,63	97545,58

It is obvious that the amount of the municipal solid waste that is open burned decreased from 1990 to 2017 (Figure 6.3.2).

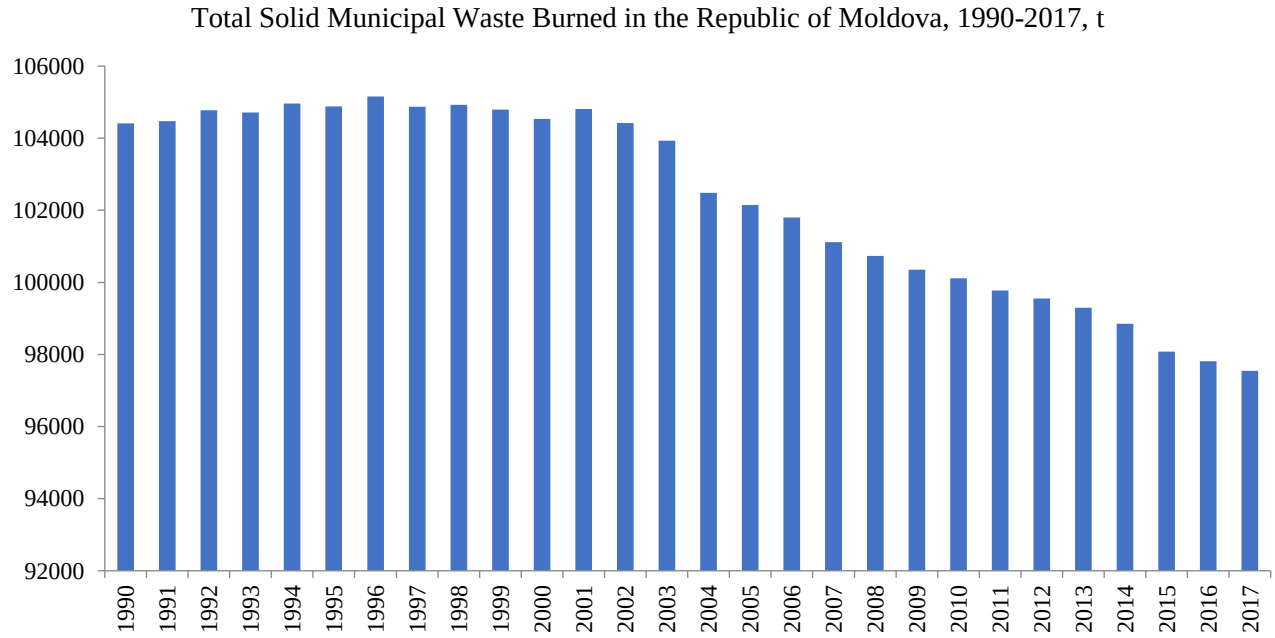


Figure 6.3.2. Amount of municipal solid waste open-burned, 1990-2017, t

6.4. Wastewater treatment and discharging (NFR 5.D)

6.4.1. 5.D.1 Wastewater treatment

6.4.1.1. Description of sources

This chapter covers emissions from wastewater handling. In most cases, this will be an insignificant source of air pollutants. However, in urban areas, non-methane volatile organic compounds (NMVOC) emissions from wastewater treatment plants are of local importance.

Activities considered in this sector are biological treatment plants and latrines (storage tanks of human excreta, located under naturally ventilated wooden shelters).

Biological treatment plants are only of minor importance for air emissions, and the most important of these emissions are greenhouse gases (CO_2, CH_4 and N_2O). Air pollutants include NMVOC and NH_3. However, their contribution to the total emissions is only minor and only of local importance.

Latrines are generally only a minor source of emissions (mainly NH_3). Reducing ammonia emissions from latrines is possible by running water and sewage systems, which is especially possible in cities [10].

6.4.1.2. Methods and emission factors

In line with the EMEP/EEA Emission Inventory Guidebook 2016, NH_3 emissions from latrines are considered. The resulting emissions are almost negligible. According to the methodology, activity data are multiplied by respective emission factors (Table 6.4.1.2) to calculate emissions, and methodologies are Tier 2 methods and are used with default emission factors.

Table 6.4.1.2. Emission factors for wastewater treatment

Substance	Source of activity data	Emission factor value	Emission factor unit
NH_3	Population using latrines	1,6	kg/pers/year

6.4.1.3. Activity Data

For the calculation of NH_3 emissions (Table 6.4.1.3b), the relevant activity data is the number of people using septic tank pits (latrines). Population using latrines was calculated as the difference between entire national population and number of populations served by urban wastewater treatment plants (Table 6.4.1.3a).

Table 6.4.1.3 a. Number of Population Connected to Sewage Systems and without Sewage Systems

	1990	1991	1992	1993	1994	1995	1996
Total population	4359377	4364077	4356877	4345577	4350485	4345685	4331870
Inhabitants with sewage systems	2964376,4	2810465,6	2653338,1	2490015,6	2336210,4	2181533,9	2018651,4
Inhabitants without sewage systems	1395000,6	1553611,4	1703538,9	1855561,4	2014274,6	2164151,1	2313218,6
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total population	4317513	4321314	4309930	4295870	4277612	4261412	4242112
Inhabitants with sewage systems	1856530,6	1799789,9	1667384,9	1570721,8	1602231,7	1563409,6	1591528,0
Inhabitants without sewage systems	2460982,4	2521524,1	2642545,1	2725148,2	2675380,3	2698002,4	2650584,0
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total population	4161835	4147936	4130536	4114610	4100203	4090012	4081695
Inhabitants with sewage systems	1581062,9	1637630,2	1915909,4	1918348,8	1981402,8	2051688,2	2151781,4
Inhabitants without sewage systems	2580772,1	2510305,8	2214626,6	2196261,2	2118800,2	2038323,8	1929913,6
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total population	4073830	4068941	4064697	4058334	4029659	4023656	4019852
Inhabitants with sewage systems	2288486,2	2361092,2	2415668,5	2477612,6	2594881,1	2626882,5	2739864,2
Inhabitants without sewage systems	1785343,8	1707848,8	1649028,5	1580721,4	1434777,9	1396773,5	1279987,8

Table 6.4.1.3b. NH_3 emissions from *5.D.1 Wastewater treatment*, kt

	1990	1991	1992	1993	1994	1995	1996
NH_3 emissions, kt	2,232001	2,4857783	2,7256623	2,9688982	3,2228393	3,462642	3,7011497
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NH_3 emissions, kt	3,9375719	4,0344385	4,2280722	4,3602371	4,280608	4,3168038	4,2409343
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NH_3 emissions, kt	4,1292354	4,0164893	3,5434025	3,514018	3,3900804	3,261318	3,0878618
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NH_3 emissions, kt	2,8565501	2,7325581	2,638446	2,5291542	2,2956446	2,2348375	2,0479805

6.4.2. Wastewater discharging (NFR 5.D2)

6.4.2.1. Description of Sources

Untreated or insufficiently treated wastewater from sewage plants and its discharge directly into the natural receivers have a big impact on the quality of natural waters. The largest volumes of untreated wastewater come from the domestic sewage systems.

Wastewater treatment plants play a key role in water resources protection systems. Insufficient volume of wastewater and excessive concentration of noxious substances received disturb the optimal functioning of the wastewater treatment plants.

A critical issue in the wastewater treatment process that greatly affects the environment is the lack of modern sludge processing facilities within the wastewater plants.

In the RM, the industrial wastewater is released into municipal sewer lines, where it is combined with domestic wastewater. Wastewater (a mix of industrial and domestic wastewater) is treated by classical aerobic methods (mechanical and biological).

This section covers emissions from wastewater handling. Activities considered in this sector are biological treatment plants and latrines (storage tanks of human excreta, located under naturally ventilated wooden shelters).

6.4.2.2. Methods and Emission factors

In line with the EMEP/EEA Emission Inventory Guidebook 2016, NMVOC emissions are calculated from wastewater handling. According to the methodology, activity data are multiplied by respective emission factors (Table 6.4.2.2) to calculate emissions, and Tier 1 methods are applied with default emission factors.

Table 6.4.2.2. Emission factors for wastewater discharge

Substance	Source of activity data	Emission factor value	Emission factor unit
NMVOC	Amount of wastewater produced and discharged	15	mg/m^3 wastewater

For the calculation of NMVOC emissions (Table 6.4.3.3b), treated wastewater according to normative requirements and 1/2 of insufficiently treated wastewater (in m^3) were used as activity data. Thus, only at least biologically treated wastewater was considered (Table 6.4.2.3a).

6.4.2.3. Activity Data

Table 6.4.2.3a. Wastewater discharged into surface basins, million m^3

		1990	1991	1992	1993
Total discharged wastewater, *m^3*		2731	2486	2231	1993
Conventional pure water (untreated), *m^3*		2424	2173	1935	1717
Polluted wastewater		90	69	41	21
Polluted water (untreated)		1,0	1,0	0,0	0,0
Insufficiently treated water	**Total**	89,0	68,0	41,0	21,0
	1/2	**44,50**	**34,00**	**20,50**	**10,50**
Treated water according to normative requirements		216	244	255	255
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		70	78	86	92
Water+1/2 Insufficiently treated water		260,50	278,00	275,50	265,50
		1994	**1995**	**1996**	**1997**
Total discharged wastewater, *m^3*		1810	1381	1384	1239
Conventional pure water (untreated), *m^3*		1547	1120	1133	1007
Polluted wastewater		16	15	12	11
Polluted water (untreated)		0,4	0,4	0,5	0,3
Insufficiently treated water	**Total**	15,6	14,6	11,5	10,7
	1/2	**7,80**	**7,30**	**5,75**	**5,35**
Treated water according to normative requirements		247	245	238	222
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		94	94	95	95
Water+1/2 Insufficiently treated water		254,80	252,30	243,75	227,35
		1998	**1999**	**2000**	**2001**
Total discharged wastewater, *m^3*		1030	794	740	708
Conventional pure water (untreated), *m^3*		802	593	569	557
Polluted wastewater		12	10	9	13
Polluted water (untreated)		0,4	0,4	0,5	0,3
Insufficiently treated water	**Total**	11,6	9,6	8,5	12,7
	1/2	**5,80**	**4,80**	**4,25**	**6,35**
Treated water according to normative requirements		215	191	162	138
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		94	95	95	91
Water+1/2 Insufficiently treated water		220,80	195,80	166,25	144,35
		2002	**2003**	**2004**	**2005**
Total discharged waste water, *m^3*		695	685	688	689
Conventional pure water (untreated), *m^3*		560	558	561	556
Polluted waste water		19	48	42	9

Polluted water (untreated)		0,5	0,8	0,5	0,6
Insufficiently treated water	**Total**	18,5	47,2	41,5	8,4
	1/2	**9,25**	**23,60**	**20,75**	**4,20**
Treated water according to normative requirements		116	79	85	124
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		86	62	67	93
Water+1/2 Insufficiently treated water		125,25	102,60	105,75	128,20
		2006	**2007**	**2008**	**2009**
Total discharged wastewater, m^3		688	680	679	678
Conventional pure water (untreated), m^3		562	551	550	552
Polluted wastewater		7	10	14	10
Polluted water (untreated)		0,5	0,7	0,8	0,8
Insufficiently treated water	**Total**	6,5	9,3	13,2	9,2
	1/2	**3,25**	**4,65**	**6,60**	**4,60**
Treated water according to normative requirements		119	119	115	116
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		94	92	89	92
Water+1/2 Insufficiently treated water		122,25	123,65	121,60	120,60
		2010	**2011**	**2012**	**2013**
Total discharged wastewater, m^3		683	679	675	672
Conventional pure water (untreated), m^3		556	555	553	551
Polluted wastewater		8	8	9	9
Polluted water (untreated)		0,9	1,0	1,5	1,0
Insufficiently treated water	**Total**	7,1	7,0	7,5	8,0
	1/2	**3,55**	**3,50**	**3,75**	**4,00**
Treated water according to normative requirements		119	115	113	113
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		94	93	93	93
Water+1/2 Insufficiently treated water		122,55	118,50	116,75	117,00
		2014	**2015**	**2016**	**2017**
Total discharged wastewater, m^3		664	666	666	667
Conventional pure water (untreated), m^3		545	546	544	544
Polluted wastewater		10	8	28	8
Polluted water (untreated)		1,4	1,0	2,0	1,0
Insufficiently treated water	**Total**	8,6	7,0	26,0	7,0
	1/2	**4,30**	**3,50**	**13,00**	**3,50**
Treated water according to normative requirements		109	112	94	115
Treated water according to normative, in % compared to the total volume of wastewater needing treatment		92	93	77	93
Water+1/2 Insufficiently treated water		113,30	115,50	107,00	118,50

Table 6.4.2.3b NMVOC emissions from *5.D.2 Wastewater discharge*, kt

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NMVOC	0,00391	0,00417	0,00413	0,00398	0,00382	0,00378	0,00366	0,00341	0,00331	0,00294
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
NMVOC	0,00249	0,00217	0,00188	0,00154	0,00159	0,00192	0,00183	0,00185	0,00182	0,00181
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**		
NMVOC	0,00184	0,00178	0,00175	0,00176	0,00170	0,00173	0,00161	0,00178		

6.5. Other waste (NFR 5.E)

6.5.1. Description of sources

This category covers the emissions from other waste. The activities that will be discussed are diverse house fires, which include mostly unwanted fires in various types of houses.

6.5.2. Methods and Emission factors

In the sector *Other Waste* emissions of TSP, PM_{10}, $PM_{2,5}$, PCDD/F, Metals: Pb, Cd, Hg, As, Cr, Cu were calculated. The activity data for this chapter are the data on the number and type of incident, the fire and rescue services are required to attend every year. The National Bureau Statistics provided the information on the number of accidental fires for the Republic of Moldova from 1995 to 2018 (Statistical Yearbooks of the Republic of Moldova 2002-2018).

Applying the expert approach, fires have been disaggregated to various types of incidental fires. The data do not specify the quantity of material destroyed. The most detailed statistics are available for the 1995-2018 period for the Republic of Moldova. The Tier 2 methodology was used by applying specific emission factors (Table 6.5.2) for each type of fires.

Table 6.5.2. Emission factors from *5.E Other Waste* according to EMEP/EEA 2016

Pollutants	Unit	Detached house fire	Undetached house fire	Apartment building fire	Industrial building fire
TSP	kg/fire	143,82	61,62	43,78	27,23
PM_{10}	kg/fire	143,82	61,62	43,78	27,23
$PM_{2,5}$	kg/fire	143,82	61,62	43,78	27,23
Pb	g/fire	0,42	0,18	0,13	0,08
Cd	g/fire	0,85	0,36	0,26	0,16
Hg	g/fire	0,85	0,36	0,26	0,16
As	g/fire	1,35	0,58	0,41	0,25
Cr	g/fire	1,29	0,55	0,39	0,24
Cu	g/fire	2,99	1,28	0,91	0,57
PCDD/F	mg/fire	1,44	0,62	0,44	0,27

6.5.3. Activity Data

The approach followed a Tier 2 method as follows.

$$E_{pollutant} = \Sigma AR\ Number\ of\ disaggregated\ fires \times EF_{technology,\ pollutant}$$

The total number of disaggregated fires are presented in Table 6.5.3.

Table 6.5.3. Number of total and disaggregated cases of incidental fires, 1995 – 2017

Year	Total number of fires, 100%	Apartment building fire 50%	Industrial building fire 20%	Detached house fire 20%	Undetached house fire 10%
1995	3062	1531,0	612,4	612,4	306,2
1996	3170	1585,0	634,0	634,0	317,0
1997	3116	1558,0	623,2	623,2	311,6
1998	3079	1539,5	615,8	615,8	307,9
1999	2702	1351,0	540,4	540,4	270,2
2000	2794	1397,0	558,8	558,8	279,4
2001	2706	1353,0	541,2	541,2	270,6
2002	2846	1423,0	569,2	569,2	284,6
2003	2531	1265,5	506,2	506,2	253,1
2004	2493	1246,5	498,6	498,6	249,3
2005	2700	1350,0	540,0	540,0	270,0
2006	2541	1270,5	508,2	508,2	254,1
2007	2652	1326,0	530,4	530,4	265,2
2008	2217	1108,5	443,4	443,4	221,7
2009	2259	1129,5	451,8	451,8	225,9
2010	1970	985,0	394,0	394,0	197,0
2011	2146	1073,0	429,2	429,2	214,6
2012	1984	992,0	396,8	396,8	198,4
2013	1746	873,0	349,2	349,2	174,6
2014	1890	945,0	378,0	378,0	189,0
2015	1816	908,0	363,2	363,2	181,6
2016	1664	832,0	332,8	332,8	166,4
2017	1609	804,5	321,8	321,8	160,9

A decrease in the number of fires is observed since 1990 (Figure 6.5.3). There was only a slight decrease in the share of apartment fires, and a more significant decrease in the detached house fires.

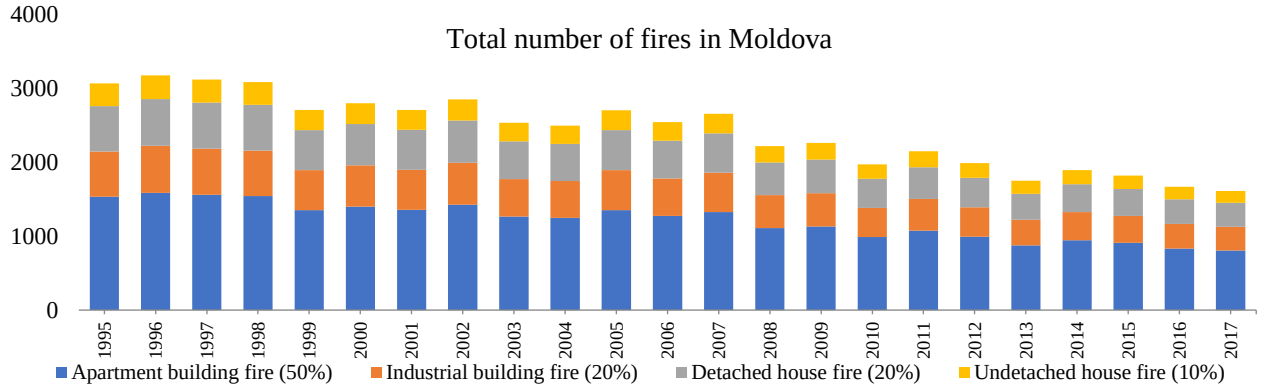


Figure 6.5.3. Number of fires in the Republic of Moldova, 1995-2017

Chapter 7: RECALCULATIONS AND IMPROVEMENTS

7.1. Recalculations

Energy Sector

The EMEP/EEA 2016 recommendations describe the following reasons for recalculations:

- Use of a higher-level calculation method when calculating a category;
- Use of updated emission factors;
- Use of an updated version of the Guidebook;
- Emergence of new data, correction of errors;
- Transition of a category to a key status;
- Adding new categories;
- Increased inventory potential (human, financial, training).

The reasons for recalculations in the current inventory cycle (2019) of pollutant emissions in the Republic of Moldova compared to the previous cycles (2014, 2016) were:

- use of emission factors according to EMEP/EEA 2016, instead of EMEP/EEA 2009, or 2013;
- increasing the completeness of coverage of the categories: calculations were made for the sector *1.B.2* (4 categories) for the first time; categories for gasoline evaporation, abrasion of tires, brakes, roads in the sector *1.A.3* (previously, these categories were not calculated);
- adding data for sectors and categories of the Energy module in the Left Bank region;
- details were added for vehicle sector (M1, N1, N2-N3, M2-M3, L1-L7) and industry sector (*1.A.2.a, 1.A.2.c, 1.A.2.d, 1.A.2.e, 1.A.2.f, 1.A.2.g.viii*); previously, these categories were represented in the total numbers;
- correction of calculations for international aviation, the emissions of which were calculated by emission factors for domestic aviation;
- 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) (see Annex 2).

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 Annex 2.

Industrial processes Sector

The recalculations of emissions from the sector „Industrial processes and product use" 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 Dniester 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 product types in the years 2005-2017", respectively, as a result of updating the values of nationally specific emission factors, coefficients and parameters.

Agriculture sector

For the 2019 submission, all emissions from 3.B were revised on the basis of emission factors from the 2016 EMEP/EEA Guidebook and the use of an updated set of activity data on animal population (available in the Statistical Yearbooks of the RM and those of the Administrative-Territorial Units on the Left Bank of Dniester, and Statistical Sectoral Reports).

A summary of major improvements of results for the 1990-2012 period that was presented in 2014 to the CLRTAP secretariat, compared to the emissions estimated in the current report, is presented below:

The emissions for the years 1990-2017 were recalculated for all the compartments required by the methodology of the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 - Agriculture

sector, using Tier 1 methodologies. For many emission sources, the database of activities in the Republic of Moldova has been revised and improved (e.g. the number of domestic animals in the field of manure management: surfaces, crops, and others).

The methodology for estimating 3D emissions has been improved. Emissions for the period 1990-2017 were calculated in the compartments that were missing in the previous report (IIR 2014 for the years 1990-2012 of the Republic of Moldova, Table 7.2).

Three new components have been included: BC, HCB, and PCB.

Table 7.2. Data calculated in the previous reports and specifically recalculated and calculated for the years 2013-2017

NFR Code	Long name	IIR 2014	Source-specific recalculations, according to EMEP/EEA 2016, and new categories evaluated for 1990-2017
3.B.1.a	Manure management - Dairy cattle	+	+
3.B.1.b	Manure management - Non-dairy cattle	+	+
3.B.2.	Manure management - Sheep	+	+
3.B.3	Manure management - Swine	+	+
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	+	+
3.B.4.h	Manure management - Other animals	+	+
3.D.a.1	Inorganic N-fertilizers (includes also urea application)	+	+
3.D.a.2.a	Animal manure applied to soils	-	+
3.D.a.2.b	Sewage sludge applied to soils	-	+
3.D.a.2.c	Other organic fertilisers applied to soils (including compost)	+	+
3.D.a.3	Urine and dung deposited by grazing animals	-	+
3.D.a.4	Crop residues applied to soils	-	+
3.D.b	Indirect emissions from managed soils	-	+
3.D.c	Farm-level agricultural operations including storage, handling, and transport of agricultural products	-	+
3.D.d	Off-farm storage, handling, and transport of bulk agricultural products	-	+
3.D.e	Cultivated crops	-	+
3.D.f	Use of pesticides	-	+
3.F	Field burning of agricultural residues	+	+

Waste Sector

The emissions of pollutants from category 5 Waste were recalculated for the 1990 through 2017 time series, due to the use of updated set of activity data, including the data from the Left Bank of Dniester River.

7.2. Planned improvements

The following improvements are planned in the next inventory cycle.

Energy Sector

1. Using emission factors according to the 2019 EMEP/EEA Guidebook for the energy sector;
2. Expanding the series of values of consumed fuels and adding data for 2018;

3. Using recovery methods for biomass. Its number of values has been growing significantly in the last 4 years, which may indicate an underestimation of the quantity and an underestimation of emissions in previous years;
4. Analysing approaches and opportunities for the application of higher-level methods for key categories;
5. Updating the series of values in case of errors.

Industrial processes Sector

1. Using emission factors from the 2019 EMEP/EEA Guidebook for industry;
2. Expanding the series of values of consumed fuels and adding data for 2018;
3. Updating the series of values in case of errors.

Agriculture Sector

1. Calculating emissions from category 3B according to the 2019 methodology, using EF according to Tier 2, but not according to the number of animals;
2. In the data collection stage for category *3.D.a.1 - Inorganic N-fertilizers (includes also urea application)*, based on the primary information, the total quantity of N-fertilizers should be estimated according to their specificity and type;
3. Improving the use of national EFs for nitrogen content assessment in agricultural plant residues, nationally and internationally, the unique computing software for the 3B-3D categories needs to be refined, because it is currently only developed for category 3B and national experts should be trained to use this software.

Waste sector

1. Using emission factors from the 2019 EMEP/EEA Guidebook for the Waste sector;
2. Expanding the series of values of consumed fuels and adding data for 2018;
3. Updating the series of values in case of errors;
4. Expanding information sources and improving the coverage of category 5E;
5. Collecting data about car fires (for activity *5E Other Waste* in one of the next reports).

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Industrial processes sector

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IIR Annexes

Annex 1. Uncertainty Calculations

Table 1-1. Uncertainty estimation of NOx emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	NO_x	39,3833	7,0573	5	20	20,62	11,520	-0,056	0,058	-1,126	0,411	1,436
1A2	NO_x	9,6269	0,8528	5	20	20,62	0,168	-0,021	0,007	-0,419	0,050	0,178
1A3a	NO_x	0,0080	0,0003	5	30	30,41	0,000	0,000	0,000	-0,001	0,000	0,000
1A3b	NO_x	24,3726	15,4735	5	50	50,25	329,016	0,056	0,127	2,823	0,902	8,780
1A3c	NO_x	8,0570	0,5932	5	100	100,12	1,920	-0,019	0,005	-1,855	0,035	3,442
1A3d	NO_x	0,4710	0,0889	30	40	50,00	0,011	-0,001	0,001	-0,026	0,031	0,002
1A3e	NO_x	0,1203	0,0263	5	100	100,12	0,004	0,000	0,000	-0,013	0,002	0,000
1A4a	NO_x	2,8346	2,1402	5	50	50,25	6,295	0,009	0,018	0,469	0,125	0,236
1A4b	NO_x	4,7280	2,1488	5	50	50,25	6,345	0,004	0,018	0,197	0,125	0,055
1A4ci	NO_x	0,5222	0,0208	5	50	50,25	0,001	-0,001	0,000	-0,067	0,001	0,005
1A4cii	NO_x	13,5132	3,0081	5	50	50,25	12,434	-0,015	0,025	-0,726	0,175	0,558
1A5	NO_x	0,7392	0,0102	5	50	50,25	0,000	-0,002	0,000	-0,103	0,001	0,011
1B2	NO_x	0,0000	0,0012	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
2C1	NO_x	0,0926	0,0613	5	50	50,25	0,005	0,000	0,001	0,012	0,004	0,000
2G	NO_x	0,0197	0,0030	5	50	50,25	0,000	0,000	0,000	-0,002	0,000	0,000
3B1a	NO_x	0,0663	0,0231	5	100	100,12	0,003	0,000	0,000	0,000	0,001	0,000
3B1b	NO_x	0,0601	0,0091	5	100	100,12	0,000	0,000	0,000	-0,010	0,001	0,000
3B2	NO_x	0,0100	0,0057	7	100	100,24	0,000	0,000	0,000	0,002	0,000	0,000
3B3	NO_x	0,0525	0,0316	20	100	101,98	0,006	0,000	0,000	0,011	0,007	0,000
3B4d	NO_x	0,0003	0,0014	5	100	100,12	0,000	0,000	0,000	0,001	0,000	0,000
3B4e	NO_x	0,0095	0,0074	5	100	100,12	0,000	0,000	0,000	0,003	0,000	0,000
3B4f	NO_x	0,0003	0,0006	5	100	100,12	0,000	0,000	0,000	0,000	0,000	0,000
3B4gi	NO_x	0,0282	0,0163	10	100	100,50	0,001	0,000	0,000	0,005	0,002	0,000
3B4gii	NO_x	0,0263	0,0142	10	100	100,50	0,001	0,000	0,000	0,004	0,002	0,000
3B4giii	NO_x	0,0065	0,0065	10	100	100,50	0,000	0,000	0,000	0,003	0,001	0,000
3B4giv	NO_x	0,0252	0,0252	10	100	100,50	0,003	0,000	0,000	0,013	0,003	0,000
3B4h	NO_x	0,0019	0,0019	10	100	100,50	0,000	0,000	0,000	0,001	0,000	0,000
3Da1	NO_x	3,6965	1,1605	5	100	100,12	7,348	-0,001	0,010	-0,120	0,068	0,019
3Da2b	NO_x	8,7232	7,6548	5	100	100,12	319,691	0,038	0,063	3,766	0,446	14,381
3Da2c	NO_x	2,2190	0,6370	5	100	100,12	2,214	-0,001	0,005	-0,121	0,037	0,016
3Da3	NO_x	0,1788	0,1166	5	100	100,12	0,074	0,000	0,001	0,044	0,007	0,002
3Da4	NO_x	0,5469	0,4908	5	100	100,12	1,314	0,002	0,004	0,245	0,029	0,061
3Db	NO_x	0,7954	0,7793	5	100	100,12	3,313	0,004	0,006	0,411	0,045	0,171
3F	NO_x	0,0935	0,0862	5	100	100,12	0,041	0,000	0,001	0,044	0,005	0,002
5C1biii	NO_x	0,0004	0,0014	5	50	50,25	0,000	0,000	0,000	0,001	0,000	0,000
5C2	NO_x	0,3320	0,3102	5	50	50,25	0,132	0,002	0,003	0,079	0,018	0,007
		121,361	**42,866**				**355,279**					**14,133**
							18,849					**3,759**
							$\sqrt{\sum_H}$					$\sqrt{\sum_M}$

Table 1-1. Uncertainty estimation of NMVOC emissions 1990 and 2017, 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
						$\sqrt{sE^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	NMVOC	0,6272	0,1854	5	20	20,62	0,005	-0,002	0,002	-0,045	0,015	0,002
1A2	NMVOC	0,8461	0,2806	5	20	20,62	0,011	-0,003	0,003	-0,055	0,022	0,003
1A3a	NMVOC	0,0380	0,0014	5	30	30,41	0,000	0,000	0,000	-0,007	0,000	0,000
1A3b	NMVOC	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	NMVOC	0,7150	0,0526	5	100	100,12	0,009	-0,004	0,001	-0,435	0,004	0,189
1A3d	NMVOC	0,0168	0,0032	30	40	50,00	0,000	0,000	0,000	-0,003	0,001	0,000
1A3e	NMVOC	0,0374	0,0082	5	100	100,12	0,000	0,000	0,000	-0,017	0,001	0,000
1A4a	NMVOC	1,2276	0,9622	5	50	50,25	0,745	0,002	0,011	0,110	0,076	0,018
1A4b	NMVOC	17,7118	11,8843	5	50	50,25	113,617	0,010	0,132	0,482	0,933	1,102
1A4ci	NMVOC	0,0894	0,0211	5	50	50,25	0,000	0,000	0,000	-0,019	0,002	0,000
1A4cii	NMVOC	1,5200	0,3092	5	50	50,25	0,077	-0,007	0,003	-0,353	0,024	0,125
1A5	NMVOC	0,1856	0,0045	5	50	50,25	0,000	-0,001	0,000	-0,062	0,000	0,004
1B2	NMVOC	1,5440	0,3220	5	50	50,25	0,083	-0,007	0,004	-0,354	0,025	0,126
10a	NMVOC	0,0650	0,0128	5	50	50,25	0,000	0,000	0,000	-0,015	0,001	0,000
2C1	NMVOC	0,0370	0,0249	5	50	50,25	0,000	0,000	0,000	0,001	0,002	0,000
2D3a	NMVOC	5,2339	4,0220	5	20	20,62	2,190	0,009	0,045	0,170	0,316	0,129
2D3b	NMVOC	0,0195	0,0054	5	20	20,62	0,000	0,000	0,000	-0,002	0,000	0,000
2D3d	NMVOC	10,0303	11,5760	5	20	20,62	18,144	0,059	0,128	1,184	0,909	2,227
2D3e	NMVOC	0,5444	0,3253	5	20	20,62	0,014	0,000	0,004	-0,003	0,026	0,001
2D3f	NMVOC	0,0255	0,0152	5	20	20,62	0,000	0,000	0,000	0,000	0,001	0,000
2D3g	NMVOC	4,6598	3,3114	5	20	20,62	1,485	0,005	0,037	0,092	0,260	0,076
2D3h	NMVOC	0,2457	0,0770	5	20	20,62	0,001	-0,001	0,001	-0,017	0,006	0,000
2D3i	NMVOC	3,0888	7,7880	5	20	20,62	8,213	0,065	0,086	1,302	0,611	2,069
2G	NMVOC	1,4449	0,2881	5	20	20,62	0,011	-0,007	0,003	-0,136	0,023	0,019
2H2	NMVOC	16,7033	5,1255	5	50	50,25	21,134	-0,058	0,057	-2,915	0,402	8,660
3B1a	NMVOC	6,8542	2,0540	5	100	100,12	13,475	-0,024	0,023	-2,450	0,161	6,027
3B1b	NMVOC	5,7829	0,5226	5	100	100,12	0,872	-0,034	0,006	-3,410	0,041	11,629
3B2	NMVOC	0,3227	0,1783	7	100	100,24	0,102	0,000	0,002	-0,025	0,020	0,001
3B3	NMVOC	1,1986	0,3163	20	100	101,98	0,331	-0,005	0,004	-0,476	0,099	0,237
3B4d	NMVOC	0,0226	0,1025	5	100	100,12	0,034	0,001	0,001	0,098	0,008	0,010
3B4e	NMVOC	0,3375	0,2542	5	100	100,12	0,206	0,000	0,003	0,049	0,020	0,003
3B4f	NMVOC	0,0047	0,0078	5	100	100,12	0,000	0,000	0,000	0,005	0,001	0,000
3B4gi	NMVOC	1,0016	0,5963	10	100	100,50	1,144	0,000	0,007	-0,029	0,094	0,010
3B4gii	NMVOC	1,5297	0,8493	10	100	100,50	2,321	-0,001	0,009	-0,113	0,133	0,031
3B4giii	NMVOC	0,4349	0,1497	10	100	100,50	0,072	-0,001	0,002	-0,134	0,023	0,019
3B4giv	NMVOC	1,7121	0,7642	10	100	100,50	1,879	-0,003	0,008	-0,334	0,120	0,126
3B4h	NMVOC	0,0167	0,0199	10	100	100,50	0,001	0,000	0,000	0,011	0,003	0,000
3De	NMVOC	0,4536	0,4323	5	100	100,12	0,597	0,002	0,005	0,167	0,034	0,029
3F	NMVOC	0,0203	0,0187	5	100	100,12	0,001	0,000	0,000	0,007	0,001	0,000
5A	NMVOC	3,6060	3,0284	5	20	20,62	1,242	0,009	0,034	0,174	0,238	0,087
5C1biii	NMVOC	0,0001	0,0004	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C2	NMVOC	0,1284	0,1200	5	50	50,25	0,012	0,000	0,001	0,022	0,009	0,001
5D2	NMVOC	0,0039	0,0018	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
		90,087	**56,025**				**114,386**					**1,316**
							10,695					1,147
		$\sum_C$	$\sum_D$				$\sqrt{\sum_H}$					$\sqrt{\sum_M}$

Table 1-1. Uncertainty estimation of SOx emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**SOx**	102,4024	4,0806	5	10	11,18	8,712	-0,044	0,028	-0,445	0,195	0,236
1A2	**SOx**	2,6005	1,1101	5	10	11,18	0,645	0,006	0,008	0,057	0,053	0,006
1A3a	**SOx**	0,0020	0,0001	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	**SOx**	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**SOx**	0,1230	0,0002	5	50	50,25	0,000	0,000	0,000	-0,004	0,000	0,000
1A3d	**SOx**	0,1200	0,0226	30	50	58,31	0,007	0,000	0,000	0,003	0,006	0,000
1A3e	**SOx**	0,0011	0,0002	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**SOx**	10,1050	7,8972	5	20	20,62	110,939	0,046	0,053	0,924	0,378	0,997
1A4b	**SOx**	31,5785	2,2308	5	20	20,62	8,852	-0,007	0,015	-0,144	0,107	0,032
1A4ci	**SOx**	0,5995	0,0414	5	20	20,62	0,003	0,000	0,000	-0,003	0,002	0,000
1A5	**SOx**	0,2890	0,0126	5	20	20,62	0,000	0,000	0,000	-0,002	0,001	0,000
1B2	**SOx**	0,0000	0,0031	5	50	50,25	0,000	0,000	0,000	0,001	0,000	0,000
2C1	**SOx**	0,0427	0,0283	5	20	20,62	0,001	0,000	0,000	0,003	0,001	0,000
3F	**SOx**	0,0203	0,0187	5	100	100,12	0,015	0,000	0,000	0,011	0,001	0,000
5C1biii	**SOx**	0,0001	0,0003	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C2	**SOx**	0,0115	0,0107	5	50	50,25	0,001	0,000	0,000	0,003	0,001	0,000
		147,896	**15,457**				**129,158**					**1,271**
							11,365					**1,128**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of NH_3 emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A2	**NH_3**	0,0061	0,0016	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	**NH_3**	0,0000	0,0000	5	5	7,07	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**NH_3**	0,0011	0,0001	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**NH_3**	0,0123	0,0096	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
1A4b	**NH_3**	0,1005	1,2556	0	0	0,00	0,000	0,014	0,015	0,000	0,000	0,000
1A4ci	**NH_3**	0,0013	0,0018	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
1A4cii	**NH_3**	0,0032	0,0007	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
1A5	**NH_3**	0,0018	0,0000	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
1B2	**NH_3**	0,0000	0,0000	0	0	0,00	0,000	0,000	0,000	0,000	0,000	0,000
2G	**NH_3**	0,0453	0,0070	5	5	7,07	0,000	0,000	0,000	-0,001	0,001	0,000
3B1a	**NH_3**	6,4963	1,6939	5	5	7,07	0,054	-0,027	0,020	-0,135	0,142	0,038
3B1b	**NH_3**	4,1194	0,3278	5	5	7,07	0,002	-0,026	0,004	-0,130	0,027	0,018
3B2	**NH_3**	0,4083	0,0000	7	7	9,90	0,000	-0,003	0,000	-0,021	0,000	0,000
3B3	**NH_3**	14,7344	0,0494	20	20	28,28	0,001	-0,106	0,001	-2,118	0,017	4,484
3B4d	**NH_3**	0,0122	0,2398	5	5	7,07	0,001	0,003	0,003	0,014	0,020	0,001
3B4e	**NH_3**	0,2709	0,0104	5	5	7,07	0,000	-0,002	0,000	-0,009	0,001	0,000
3B4f	**NH_3**	0,0098	2,6869	5	5	7,07	0,136	0,032	0,032	0,159	0,225	0,076
3B4gi	**NH_3**	1,8064	1,0408	10	10	14,14	0,081	-0,001	0,012	-0,007	0,174	0,030
3B4gii	**NH_3**	1,9759	1,1796	10	10	14,14	0,105	0,000	0,014	-0,003	0,198	0,039
3B4giii	**NH_3**	0,4631	0,1714	10	10	14,14	0,002	-0,001	0,002	-0,013	0,029	0,001
3B4giv	**NH_3**	1,2789	0,5952	10	10	14,14	0,027	-0,002	0,007	-0,022	0,100	0,010
3B4h	**NH_3**	0,0053	0,0067	10	10	14,14	0,000	0,000	0,000	0,000	0,001	0,000
3Da1	**NH_3**	4,7312	5,7152	5	5	7,07	0,614	0,033	0,068	0,167	0,479	0,257
3Da2a	**NH_3**	11,8427	3,4866	5	5	7,07	0,229	-0,044	0,041	-0,222	0,292	0,134
3Da2b	**NH_3**	28,7866	25,2608	5	5	7,07	11,996	0,091	0,299	0,453	2,116	4,683
3Da2c	**NH_3**	4,4380	1,2730	5	5	7,07	0,030	-0,017	0,015	-0,085	0,107	0,019
3Da3	**NH_3**	0,5302	4,4209	5	5	7,07	0,367	0,049	0,052	0,243	0,370	0,196
3F	**NH_3**	0,0976	0,0900	5	5	7,07	0,000	0,000	0,001	0,002	0,008	0,000
5D1	**NH_3**	2,2320	2,0480	5	5	7,07	0,079	0,008	0,024	0,041	0,172	0,031
			51,573				**13,724**					**10,019**
							3,705					**3,165**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of $PM_{2.5}$ emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**$PM_{2.5}$**	2,1684	0,1817	5	50	50,25	0,280	-0,064	0,008	-3,196	0,056	10,221
1A2	**$PM_{2.5}$**	0,5824	0,1480	5	50	50,25	0,186	-0,013	0,006	-0,642	0,046	0,414
1A3b	**$PM_{2.5}$**	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**$PM_{2.5}$**	0,2107	0,0155	5	100	100,12	0,008	-0,006	0,001	-0,631	0,005	0,398
1A3d	**$PM_{2.5}$**	0,0084	0,0016	30	100	104,40	0,000	0,000	0,000	-0,021	0,003	0,000
1A3e	**$PM_{2.5}$**	0,0013	0,0003	5	100	100,12	0,000	0,000	0,000	-0,003	0,000	0,000
1A4a	**$PM_{2.5}$**	1,3589	1,0599	5	100	100,12	37,842	0,001	0,046	0,139	0,329	0,127
1A4b	**$PM_{2.5}$**	14,8789	14,1865	5	100	100,12	6779,350	0,128	0,622	12,762	4,400	182,221
1A4ci	**$PM_{2.5}$**	0,0902	0,0122	5	100	100,12	0,005	-0,002	0,001	-0,246	0,004	0,060
1A4cii	**$PM_{2.5}$**	0,7472	0,1670	5	100	100,12	0,939	-0,017	0,007	-1,747	0,052	3,053
1A5	**$PM_{2.5}$**	0,0845	0,0021	5	100	100,12	0,000	-0,003	0,000	-0,271	0,001	0,074
1B2	**$PM_{2.5}$**	0,0000	0,0000	5	100	100,12	0,000	0,000	0,000	0,000	0,000	0,000
2A1	**$PM_{2.5}$**	0,2342	0,0579	5	50	50,25	0,028	-0,005	0,003	-0,262	0,018	0,069
2A2	**$PM_{2.5}$**	0,2193	0,0382	5	50	50,25	0,012	-0,006	0,002	-0,280	0,012	0,079
2A3	**$PM_{2.5}$**	0,0570	0,0362	5	50	50,25	0,011	0,000	0,002	-0,015	0,011	0,000
2C1	**$PM_{2.5}$**	0,0150	0,0099	5	50	50,25	0,001	0,000	0,000	-0,003	0,003	0,000
2D3b	**$PM_{2.5}$**	0,4881	0,1342	5	100	100,12	0,607	-0,010	0,006	-1,031	0,042	1,065
2D3i	**$PM_{2.5}$**	0,0767	0,0530	5	100	100,12	0,095	0,000	0,002	-0,022	0,016	0,001
2G	**$PM_{2.5}$**	0,2457	0,0381	5	100	100,12	0,049	-0,006	0,002	-0,648	0,012	0,420
3B1a	**$PM_{2.5}$**	0,1620	0,0543	5	300	300,04	0,891	-0,003	0,002	-0,899	0,017	0,808
3B1b	**$PM_{2.5}$**	0,1198	0,0121	5	300	300,04	0,044	-0,003	0,001	-1,033	0,004	1,068
3B2	**$PM_{2.5}$**	0,0249	0,0142	7	300	300,08	0,061	0,000	0,001	-0,060	0,006	0,004
3B3	**$PM_{2.5}$**	0,1032	0,0257	20	300	300,67	0,201	-0,002	0,001	-0,690	0,032	0,476
3B4d	**$PM_{2.5}$**	0,0007	0,0034	5	300	300,04	0,003	0,000	0,000	0,037	0,001	0,001
3B4e	**$PM_{2.5}$**	0,0066	0,0052	5	300	300,04	0,008	0,000	0,000	0,002	0,002	0,000
3B4f	**$PM_{2.5}$**	0,0002	0,0003	5	300	300,04	0,000	0,000	0,000	0,002	0,000	0,000
3B4gi	**$PM_{2.5}$**	0,0182	0,0108	10	300	300,17	0,036	0,000	0,000	-0,039	0,007	0,002
3B4gii	**$PM_{2.5}$**	0,0283	0,0157	10	300	300,17	0,075	0,000	0,001	-0,075	0,010	0,006
3B4giii	**$PM_{2.5}$**	0,0178	0,0061	10	300	300,17	0,011	0,000	0,000	-0,097	0,004	0,009
3B4giv	**$PM_{2.5}$**	0,0834	0,0385	10	300	300,17	0,448	-0,001	0,002	-0,324	0,024	0,106
3B4h	**$PM_{2.5}$**	0,0011	0,0013	10	300	300,17	0,001	0,000	0,000	0,006	0,001	0,000
3Dc	**$PM_{2.5}$**	0,1101	0,1319	5	300	300,04	5,266	0,002	0,006	0,640	0,041	0,411
3F	**$PM_{2.5}$**	0,2196	0,2024	5	300	300,04	12,392	0,002	0,009	0,477	0,063	0,231
5A	**$PM_{2.5}$**	0,0001	0,0001	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C2	**$PM_{2.5}$**	0,4375	0,4087	5	50	50,25	1,417	0,003	0,018	0,170	0,127	0,045
5E	**$PM_{2.5}$**	0,0000	0,1002	5	50	50,25	0,085	0,004	0,004	0,220	0,031	0,049
		22,800	**17,173**				**6879,912**					**199,059**
							82,945					**14,109**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of PM_{10} emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**PM_{10}**	3,0220	0,2208	5	50	50,25	0,274	-0,061	0,007	-3,031	0,051	9,189
1A2	**PM_{10}**	0,6009	0,1590	5	50	50,25	0,142	-0,008	0,005	-0,416	0,037	0,174
1A3b	**PM_{10}**	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**PM_{10}**	0,2214	0,0163	5	100	100,12	0,006	-0,004	0,001	-0,444	0,004	0,197
1A3d	**PM_{10}**	0,0090	0,0017	30	100	104,40	0,000	0,000	0,000	-0,015	0,002	0,000
1A3e	**PM_{10}**	0,0013	0,0003	5	100	100,12	0,000	0,000	0,000	-0,002	0,000	0,000
1A4a	**PM_{10}**	1,4722	1,1478	5	100	100,12	29,424	0,004	0,037	0,431	0,264	0,255
1A4b	**PM_{10}**	15,1143	14,5586	5	100	100,12	4733,373	0,134	0,474	13,389	3,352	190,507
1A4ci	**PM_{10}**	0,0994	0,0128	5	100	100,12	0,004	-0,002	0,000	-0,182	0,003	0,033
1A4cii	**PM_{10}**	0,7472	0,1670	5	100	100,12	0,623	-0,011	0,005	-1,134	0,038	1,288
1A5	**PM_{10}**	0,0879	0,0022	5	100	100,12	0,000	-0,002	0,000	-0,190	0,001	0,036
1B2	**PM_{10}**	0,0000	0,0000	5	100	100,12	0,000	0,000	0,000	0,000	0,000	0,000
2A1	**PM_{10}**	0,4215	0,1042	5	50	50,25	0,061	-0,006	0,003	-0,304	0,024	0,093
2A2	**PM_{10}**	1,0964	0,1908	5	50	50,25	0,205	-0,018	0,006	-0,920	0,044	0,849
2A3	**PM_{10}**	0,0641	0,0407	5	50	50,25	0,009	0,000	0,001	-0,006	0,009	0,000
2C1	**PM_{10}**	0,0171	0,0113	5	50	50,25	0,001	0,000	0,000	-0,001	0,003	0,000
2D3b	**PM_{10}**	3,6609	1,0064	5	100	100,12	22,621	-0,049	0,033	-4,939	0,232	24,448
2D3i	**PM_{10}**	0,1150	0,0795	5	100	100,12	0,141	0,000	0,003	0,000	0,018	0,000
2G	**PM_{10}**	0,2457	0,0381	5	100	100,12	0,032	-0,004	0,001	-0,428	0,009	0,183
2H2	**PM_{10}**	0,0521	0,0163	5	50	50,25	0,002	-0,001	0,001	-0,032	0,004	0,001
3B1a	**PM_{10}**	0,2490	0,0834	5	300	300,04	1,395	-0,003	0,003	-0,863	0,019	0,745
3B1b	**PM_{10}**	0,1797	0,0181	5	300	300,04	0,066	-0,003	0,001	-1,033	0,004	1,068
3B2	**PM_{10}**	0,0747	0,0427	7	300	300,08	0,366	0,000	0,001	-0,086	0,014	0,008
3B3	**PM_{10}**	0,2637	0,0673	20	300	300,67	0,911	-0,004	0,002	-1,119	0,062	1,257
3B4d	**PM_{10}**	0,0022	0,0102	5	300	300,04	0,021	0,000	0,000	0,085	0,002	0,007
3B4e	**PM_{10}**	0,0104	0,0081	5	300	300,04	0,013	0,000	0,000	0,010	0,002	0,000
3B4f	**PM_{10}**	0,0003	0,0005	5	300	300,04	0,000	0,000	0,000	0,003	0,000	0,000
3B4gi	**PM_{10}**	0,2428	0,1446	10	300	300,17	4,194	-0,001	0,005	-0,224	0,067	0,055
3B4gii	**PM_{10}**	0,2833	0,1573	10	300	300,17	4,965	-0,001	0,005	-0,372	0,072	0,144
3B4giii	**PM_{10}**	0,0978	0,0337	10	300	300,17	0,228	-0,001	0,001	-0,330	0,016	0,109
3B4giv	**PM_{10}**	0,6237	0,2908	10	300	300,17	16,972	-0,005	0,009	-1,362	0,134	1,872
3B4h	**PM_{10}**	0,0023	0,0027	10	300	300,17	0,001	0,000	0,000	0,011	0,001	0,000
3Dc	**PM_{10}**	0,9337	1,0237	5	300	300,04	210,149	0,012	0,033	3,706	0,236	13,791
3F	**PM_{10}**	0,2318	0,2136	5	300	300,04	9,154	0,002	0,007	0,525	0,049	0,278
5A	**PM_{10}**	0,0005	0,0004	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C2	**PM_{10}**	0,4709	0,4399	5	50	50,25	1,089	0,004	0,014	0,187	0,101	0,045
5E	**PM_{10}**	0,0000	0,1002	5	50	50,25	0,056	0,003	0,003	0,163	0,023	0,027
		30,715	**21,187**				**4763,223**					**200,356**
							69,016					**14,155**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of TSP emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**TSP**	4,2398	0,2581	5	50	50,25	0,156	-0,027	0,004	-1,367	0,027	1,868
1A2	**TSP**	0,6160	0,1678	5	50	50,25	0,066	-0,002	0,003	-0,101	0,018	0,011
1A3b	**TSP**	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**TSP**	0,2337	0,0172	5	100	100,12	0,003	-0,001	0,000	-0,146	0,002	0,021
1A3d	**TSP**	0,0090	0,0017	30	100	104,40	0,000	0,000	0,000	-0,004	0,001	0,000
1A3e	**TSP**	0,0013	0,0003	5	100	100,12	0,000	0,000	0,000	-0,001	0,000	0,000
1A4a	**TSP**	1,5550	1,2131	5	100	100,12	13,691	0,007	0,018	0,672	0,128	0,468
1A4b	**TSP**	16,5633	15,3658	5	100	100,12	2196,493	0,108	0,230	10,790	1,627	119,080
1A4ci	**TSP**	0,1022	0,0135	5	100	100,12	0,002	-0,001	0,000	-0,055	0,001	0,003
1A4cii	**TSP**	0,7472	0,1670	5	100	100,12	0,259	-0,003	0,003	-0,300	0,018	0,090
1A5	**TSP**	0,0905	0,0023	5	100	100,12	0,000	-0,001	0,000	-0,063	0,000	0,004
1B2	**TSP**	0,0000	0,0001	5	100	100,12	0,000	0,000	0,000	0,000	0,000	0,000
2A1	**TSP**	0,4683	0,1158	5	50	50,25	0,031	-0,002	0,002	-0,086	0,012	0,007
2A2	**TSP**	2,8193	0,4910	5	50	50,25	0,565	-0,013	0,007	-0,670	0,052	0,451
2A3	**TSP**	0,0713	0,0452	5	50	50,25	0,005	0,000	0,001	0,008	0,005	0,000
2B10a	**TSP**	0,0002	0,0001	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
2C1	**TSP**	0,0266	0,0183	5	50	50,25	0,001	0,000	0,000	0,004	0,002	0,000
2D3b	**TSP**	17,0843	4,6967	5	100	100,12	205,215	-0,055	0,070	-5,530	0,497	30,823
2D3g	**TSP**	14,6437	4,0258	5	100	100,12	150,770	-0,047	0,060	-4,741	0,426	22,662
2D3i	**TSP**	0,1406	0,0972	5	100	100,12	0,088	0,000	0,001	0,042	0,010	0,002
2G	**TSP**	0,2457	0,0381	5	100	100,12	0,014	-0,001	0,001	-0,124	0,004	0,015
3B1a	**TSP**	0,5454	0,1827	5	300	300,04	2,789	-0,001	0,003	-0,384	0,019	0,148
3B1b	**TSP**	0,3927	0,0397	5	300	300,04	0,131	-0,002	0,001	-0,689	0,004	0,475
3B2	**TSP**	0,1743	0,0997	7	300	300,08	0,831	0,000	0,001	0,063	0,015	0,004
3B3	**TSP**	1,8758	0,4719	20	300	300,67	18,681	-0,007	0,007	-2,022	0,200	4,129
3B4d	**TSP**	0,0052	0,0236	5	300	300,04	0,047	0,000	0,000	0,095	0,003	0,009
3B4e	**TSP**	0,0227	0,0178	5	300	300,04	0,026	0,000	0,000	0,030	0,002	0,001
3B4f	**TSP**	0,0006	0,0010	5	300	300,04	0,000	0,000	0,000	0,003	0,000	0,000
3B4gi	**TSP**	1,1533	0,6867	10	300	300,17	39,422	0,002	0,010	0,538	0,145	0,310
3B4gii	**TSP**	0,5666	0,3146	10	300	300,17	8,273	0,001	0,005	0,162	0,067	0,031
3B4giii	**TSP**	0,0978	0,0337	10	300	300,17	0,095	0,000	0,001	-0,065	0,007	0,004
3B4giv	**TSP**	0,6237	0,2908	10	300	300,17	7,070	0,000	0,004	-0,071	0,062	0,009
3B4h	**TSP**	0,0023	0,0027	10	300	300,17	0,001	0,000	0,000	0,007	0,001	0,000
3Dc	**TSP**	0,9337	1,0237	5	300	300,04	87,542	0,008	0,015	2,536	0,108	6,445
3F	**TSP**	0,2359	0,2174	5	300	300,04	3,948	0,002	0,003	0,456	0,023	0,208
5A	**TSP**	0,0011	0,0009	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C1biii	**TSP**	0,0031	0,0102	5	50	50,25	0,000	0,000	0,000	0,007	0,001	0,000
5C2	**TSP**	0,4845	0,4526	5	50	50,25	0,480	0,003	0,007	0,161	0,048	0,028
5E	**TSP**	0,0000	0,1002	5	50	50,25	0,024	0,002	0,002	0,075	0,011	0,006
		66,776	**30,705**				**2526,553**					**138,874**
							50,265					**11,784**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of BC emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**BC**	0,1103	0,0058	5	50	50,25	0,000	-0,004	0,000	-0,212	0,002	0,045
1A2	**BC**	0,2089	0,0135	5	50	50,25	0,001	-0,008	0,001	-0,395	0,004	0,156
1A3b	**BC**	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**BC**	0,0000	0,0000	5	100	100,12	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**BC**	0,0000	0,0000	30	100	104,40	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	**BC**	0,0001	0,0000	5	100	100,12	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**BC**	0,1156	0,0872	5	100	100,12	0,181	-0,001	0,004	-0,082	0,027	0,008
1A4b	**BC**	0,9864	1,3853	5	100	100,12	45,706	0,022	0,062	2,155	0,436	4,834
1A4ci	**BC**	0,0190	0,0023	5	100	100,12	0,000	-0,001	0,000	-0,067	0,001	0,005
1A4cii	**BC**	0,4332	0,0970	5	100	100,12	0,224	-0,013	0,004	-1,330	0,031	1,770
1A5	**BC**	0,0298	0,0004	5	100	100,12	0,000	-0,001	0,000	-0,119	0,000	0,014
2A1	**BC**	0,0070	0,0017	5	50	50,25	0,000	0,000	0,000	-0,010	0,001	0,000
2A2	**BC**	0,0010	0,0002	5	50	50,25	0,000	0,000	0,000	-0,002	0,000	0,000
2A3	**BC**	0,0000	0,0022	5	50	50,25	0,000	0,000	0,000	0,005	0,001	0,000
2C1	**BC**	0,0001	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
2D3b	**BC**	0,0278	0,0076	5	100	100,12	0,001	-0,001	0,000	-0,079	0,002	0,006
3F	**BC**	20,3350	18,7410	5	300	300,04	75120,036	0,007	0,834	2,176	5,901	39,553
5C1biii	**BC**	0,0001	0,0002	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C2	**BC**	0,1837	0,1717	5	50	50,25	0,177	0,000	0,008	0,008	0,054	0,003
		22,458	**20,516**				**45,888**					**5,046**
							6,774					**2,246**
			$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1 Uncertainty estimation of CO emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**CO**	7,1698	2,7218	5	20	20,62	0,281	-0,004	0,013	-0,072	0,089	0,013
1A2	**CO**	3,3185	1,3654	5	20	20,62	0,071	-0,001	0,006	-0,023	0,045	0,003
1A3a	**CO**	2,4000	0,0904	5	100	100,12	0,007	-0,005	0,000	-0,498	0,003	0,248
1A3b	**CO**	0,0000	0,0000	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**CO**	1,6452	0,1211	5	100	100,12	0,013	-0,003	0,001	-0,314	0,004	0,099
1A3d	**CO**	0,0444	0,0084	30	100	104,40	0,000	0,000	0,000	-0,006	0,002	0,000
1A3e	**CO**	0,0471	0,0103	5	100	100,12	0,000	0,000	0,000	-0,006	0,000	0,000
1A4a	**CO**	11,4100	8,9281	5	50	50,25	17,958	0,015	0,041	0,774	0,291	0,684
1A4b	**CO**	166,3414	82,5852	5	50	50,25	1536,518	0,006	0,381	0,319	2,692	7,350
1A4ci	**CO**	0,6712	0,0756	5	50	50,25	0,001	-0,001	0,000	-0,058	0,002	0,003
1A4cii	**CO**	9,8692	1,0012	5	50	50,25	0,226	-0,018	0,005	-0,879	0,033	0,774
1A5	**CO**	3,6319	0,1186	5	50	50,25	0,003	-0,008	0,001	-0,381	0,004	0,145
2C1	**CO**	1,2103	0,8022	5	50	50,25	0,145	0,001	0,004	0,049	0,026	0,003
2G	**CO**	0,6017	0,0933	0	0	0,00	0,000	-0,001	0,000	0,000	0,000	0,000
3F	**CO**	2,7126	2,5000	5	100	100,12	5,590	0,005	0,012	0,542	0,082	0,301
5C1biii	**CO**	0,0000	0,0001	5	50	50,25	0,000	0,000	0,000	0,000	0,000	0,000
5C2	**CO**	5,8294	5,4460	5	50	50,25	6,682	0,012	0,025	0,599	0,178	0,391
		216,903	**105,868**				**1554,850**					**8,400**
							39,432					**2,898**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Pb emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**Pb**	0,9369	0,0502	5	100	100,12	3,703	-0,032	0,006	-3,182	0,044	10,129
1A2	**Pb**	0,2743	0,1638	5	100	100,12	39,418	0,009	0,020	0,928	0,145	0,882
1A3b	**Pb**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**Pb**	0,0008	0,0001	30	300	301,50	0,000	0,000	0,000	-0,004	0,001	0,000
1A3e	**Pb**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Pb**	1,6056	1,2571	5	300	300,04	20850,975	0,091	0,157	27,415	1,109	752,824
1A4b	**Pb**	4,5770	0,7770	5	300	300,04	7964,929	-0,089	0,097	-26,632	0,686	709,729
1A4ci	**Pb**	0,0870	0,0078	5	300	300,04	0,802	-0,003	0,001	-0,770	0,007	0,593
1A5	**Pb**	0,0467	0,0020	5	300	300,04	0,053	-0,002	0,000	-0,494	0,002	0,244
1B2	**Pb**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,001	0,000	0,000
2A3	**Pb**	0,4038	0,2562	5	300	300,04	865,719	0,016	0,032	4,659	0,226	21,760
2C1	**Pb**	0,0128	0,0085	5	300	300,04	0,952	0,001	0,001	0,162	0,007	0,026
3F	**Pb**	0,0045	0,0041	5	300	300,04	0,224	0,000	0,001	0,100	0,004	0,010
5C1biii	**Pb**	0,0113	0,0372	5	300	300,04	18,259	0,004	0,005	1,256	0,033	1,577
5C2	**Pb**	0,0512	0,0478	5	300	300,04	30,144	0,004	0,006	1,165	0,042	1,359
5E	**Pb**	0,0000	0,0003	5	300	300,04	0,001	0,000	0,000	0,011	0,000	0,000
		8,012	**2,612**				**28859,827**					**1474,157**
							169,882					**38,395**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Cd emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**Cd**	0,1775	0,0063	5	100	100,12	3,355	-0,336	0,015	-33,633	0,107	1131,208
1A2	**Cd**	0,0058	0,0028	5	100	100,12	0,642	-0,005	0,007	-0,501	0,047	0,253
1A3b	**Cd**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Cd**	0,0015	0,0001	5	300	300,04	0,010	-0,003	0,000	-0,835	0,002	0,698
1A3d	**Cd**	0,0001	0,0000	30	300	301,50	0,000	0,000	0,000	-0,028	0,001	0,001
1A3e	**Cd**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	-0,001	0,000	0,000
1A4a	**Cd**	0,0259	0,0202	5	300	300,04	311,406	-0,003	0,049	-0,843	0,344	0,828
1A4b	**Cd**	0,0691	0,2364	5	300	300,04	42641,643	0,431	0,569	129,178	4,022	16703,042
1A4ci	**Cd**	0,0017	0,0007	5	300	300,04	0,400	-0,002	0,002	-0,480	0,012	0,231
1A4cii	**Cd**	0,0040	0,0009	5	300	300,04	0,581	-0,006	0,002	-1,737	0,015	3,017
1A5	**Cd**	0,0012	0,0000	5	300	300,04	0,001	-0,002	0,000	-0,695	0,000	0,484
1B2	**Cd**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,018	0,000	0,000
2A3	**Cd**	0,0309	0,0196	5	300	300,04	293,026	-0,014	0,047	-4,269	0,333	18,337
2C1	**Cd**	0,0011	0,0007	5	300	300,04	0,382	0,000	0,002	-0,126	0,012	0,016
2D3g	**Cd**	0,0001	0,0000	5	300	300,04	0,001	0,000	0,000	-0,049	0,001	0,002
2G	**Cd**	0,0491	0,0076	5	300	300,04	44,283	-0,079	0,018	-23,779	0,130	565,476
3F	**Cd**	0,0358	0,0330	5	300	300,04	829,853	0,008	0,079	2,457	0,561	6,352
5C1biii	**Cd**	0,0015	0,0048	5	300	300,04	17,574	0,009	0,012	2,598	0,082	6,756
5C2	**Cd**	0,0104	0,0098	5	300	300,04	72,579	0,003	0,023	0,812	0,166	0,687
5E	**Cd**	0,0000	0,0006	5	300	300,04	0,267	0,001	0,001	0,427	0,010	0,183
		0,416	**0,344**				**42957,455**					**17836,260**
							207,262					**133,552**
		$\sum_C$	$\sum_D$				$\sqrt{\sum_H}$					$\sqrt{\sum_M}$

Table 1-1. Uncertainty estimation of Hg emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**Hg**	0,1441	0,0142	5	100	100,12	70,926	-0,076	0,030	-7,566	0,209	57,291
1A2	**Hg**	0,0226	0,0132	5	100	100,12	61,810	0,011	0,028	1,103	0,195	1,255
1A3b	**Hg**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**Hg**	0,0002	0,0000	30	300	301,50	0,004	0,000	0,000	-0,018	0,003	0,000
1A3e	**Hg**	0,0002	0,0000	5	300	300,04	0,004	0,000	0,000	-0,013	0,001	0,000
1A4a	**Hg**	0,0937	0,0735	5	300	300,04	17147,985	0,084	0,153	25,349	1,083	643,767
1A4b	**Hg**	0,1806	0,0235	5	300	300,04	1751,656	-0,083	0,049	-24,841	0,346	617,191
1A4ci	**Hg**	0,0046	0,0004	5	300	300,04	0,549	-0,002	0,001	-0,748	0,006	0,559
1A5	**Hg**	0,0027	0,0001	5	300	300,04	0,044	-0,002	0,000	-0,514	0,002	0,264
1B2	**Hg**	0,0000	0,0000	5	300	300,04	0,002	0,000	0,000	0,016	0,000	0,000
2A3	**Hg**	0,0007	0,0005	5	300	300,04	0,642	0,000	0,001	0,125	0,007	0,016
2C1	**Hg**	0,0171	0,0113	5	300	300,04	406,826	0,011	0,024	3,326	0,167	11,089
3F	**Hg**	0,0057	0,0052	5	300	300,04	87,328	0,007	0,011	2,030	0,077	4,128
5C1biii	**Hg**	0,0078	0,0258	5	300	300,04	2111,405	0,048	0,054	14,414	0,380	207,895
5E	**Hg**	0,0000	0,0006	5	300	300,04	1,112	0,001	0,001	0,370	0,009	0,137
		0,480	**0,168**				**19032,934**					**1320,064**
							137,960					**36,333**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of As emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**As**	0,8777	0,0492	5	100	100,12	796,950	-0,078	0,044	-7,847	0,312	61,678
1A2	**As**	0,0094	0,0055	5	100	100,12	10,076	0,004	0,005	0,364	0,035	0,134
1A3b	**As**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**As**	0,0002	0,0000	30	300	301,50	0,006	0,000	0,000	0,002	0,002	0,000
1A3e	**As**	0,0002	0,0000	5	300	300,04	0,004	0,000	0,000	0,003	0,000	0,000
1A4a	**As**	0,0484	0,0379	5	300	300,04	4237,900	0,027	0,034	8,145	0,240	66,397
1A4b	**As**	0,0893	0,0114	5	300	300,04	384,288	-0,002	0,010	-0,694	0,072	0,487
1A4ci	**As**	0,0029	0,0002	5	300	300,04	0,134	0,000	0,000	-0,067	0,001	0,004
1A5	**As**	0,0014	0,0001	5	300	300,04	0,011	0,000	0,000	-0,042	0,000	0,002
1B2	**As**	0,0000	0,0000	5	300	300,04	0,002	0,000	0,000	0,007	0,000	0,000
2A3	**As**	0,0415	0,0286	5	300	300,04	2422,667	0,020	0,026	5,952	0,182	35,460
2C1	**As**	0,0001	0,0000	5	300	300,04	0,007	0,000	0,000	0,010	0,000	0,000
2D3g	**As**	0,0006	0,0002	5	300	300,04	0,083	0,000	0,000	0,019	0,001	0,000
3F	**As**	0,0003	0,0002	5	300	300,04	0,170	0,000	0,000	0,054	0,002	0,003
5C1biii	**As**	0,0000	0,0001	5	300	300,04	0,043	0,000	0,000	0,031	0,001	0,001
5C2	**As**	0,0428	0,0400	5	300	300,04	4727,526	0,030	0,036	8,955	0,254	80,249
5E	**As**	0,0000	0,0009	5	300	300,04	2,601	0,001	0,001	0,252	0,006	0,064
		1,115	**0,175**				**5429,357**					**128,700**
							73,684					
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Cr emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**Cr**	0,5498	0,0282	5	100	100,12	17,396	-0,192	0,021	-19,249	0,151	370,564
1A2	**Cr**	0,0343	0,0175	5	100	100,12	6,699	0,000	0,013	-0,010	0,094	0,009
1A3b	**Cr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Cr**	0,0077	0,0000	5	300	300,04	0,000	-0,003	0,000	-0,901	0,000	0,811
1A3d	**Cr**	0,0003	0,0001	30	300	301,50	0,001	0,000	0,000	-0,022	0,002	0,000
1A3e	**Cr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	-0,001	0,000	0,000
1A4a	**Cr**	0,1877	0,1438	5	300	300,04	4058,727	0,036	0,109	10,751	0,772	116,173
1A4b	**Cr**	0,4213	0,4376	5	300	300,04	37578,133	0,167	0,332	50,167	2,350	2522,277
1A4ci	**Cr**	0,0220	0,0018	5	300	300,04	0,654	-0,007	0,001	-2,164	0,010	4,683
1A4cii	**Cr**	0,0198	0,0044	5	300	300,04	3,739	-0,004	0,003	-1,331	0,023	1,771
1A5	**Cr**	0,0064	0,0002	5	300	300,04	0,008	-0,002	0,000	-0,701	0,001	0,492
1B2	**Cr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,006	0,000	0,000
2A3	**Cr**	0,0546	0,0350	5	300	300,04	240,416	0,005	0,027	1,571	0,188	2,505
2C1	**Cr**	0,0009	0,0006	5	300	300,04	0,074	0,000	0,000	0,031	0,003	0,001
2D3g	**Cr**	0,0073	0,0020	5	300	300,04	0,795	-0,001	0,002	-0,399	0,011	0,160
3F	**Cr**	0,0033	0,0030	5	300	300,04	1,765	0,001	0,002	0,302	0,016	0,091
5C1bi ii	**Cr**	0,0004	0,0012	5	300	300,04	0,283	0,001	0,001	0,231	0,006	0,053
5C2	**Cr**	0,0010	0,0010	5	300	300,04	0,187	0,000	0,001	0,100	0,005	0,010
5E	**Cr**	0,0000	0,0009	5	300	300,04	0,157	0,001	0,001	0,204	0,005	0,042
		1,317	**0,677**				**41661,611**					**3014,519**
							204,112					**54,905**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Ni emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**Ni**	24,2419	0,2709	5	100	100,12	4760,155	-0,005	0,011	-0,477	0,078	0,233
1A2	**Ni**	0,0266	0,0159	5	100	100,12	16,493	0,001	0,001	0,063	0,005	0,004
1A3b	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**Ni**	0,0000	0,0000	30	300	301,50	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4b	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4ci	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4cii	**Ni**	0,0278	0,0061	5	300	300,04	21,760	0,000	0,000	0,069	0,002	0,005
1A5	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1B2	**Ni**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
2A3	**Ni**	0,1164	0,0740	5	300	300,04	3190,804	0,003	0,003	0,883	0,021	0,780
2C1	**Ni**	0,0036	0,0024	5	300	300,04	3,356	0,000	0,000	0,029	0,001	0,001
2D3g	**Ni**	0,0610	0,0168	5	300	300,04	163,949	0,001	0,001	0,193	0,005	0,037
2G	**Ni**	0,0246	0,0038	5	300	300,04	8,457	0,000	0,000	0,042	0,001	0,002
3F	**Ni**	0,0021	0,0019	5	300	300,04	2,213	0,000	0,000	0,023	0,001	0,001
5C1biii	**Ni**	0,0004	0,0012	5	300	300,04	0,839	0,000	0,000	0,015	0,000	0,000
		24,504	**0,393**				**4776,648**					**0,238**
							69,113					**0,487**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Se emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**Se**	1,7788	0,1042	5	100	100,12	382,994	-0,008	0,017	-0,781	0,119	0,624
1A2	**Se**	0,0060	0,0026	5	100	100,12	0,242	0,000	0,000	0,034	0,003	0,001
1A3b	**Se**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Se**	0,0015	0,0001	5	300	300,04	0,004	0,000	0,000	-0,001	0,000	0,000
1A3d	**Se**	0,0006	0,0001	30	300	301,50	0,004	0,000	0,000	0,003	0,001	0,000
1A3e	**Se**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Se**	0,0216	0,0169	5	300	300,04	90,620	0,002	0,003	0,728	0,019	0,531
1A4b	**Se**	4,1937	0,2795	5	300	300,04	24731,028	-0,013	0,045	-3,880	0,318	15,157
1A4ci	**Se**	0,0012	0,0001	5	300	300,04	0,004	0,000	0,000	0,001	0,000	0,000
1A4cii	**Se**	0,0040	0,0009	5	300	300,04	0,241	0,000	0,000	0,026	0,001	0,001
1A5	**Se**	0,0006	0,0000	5	300	300,04	0,000	0,000	0,000	-0,001	0,000	0,000
1B2	**Se**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,001	0,000	0,000
2A3	**Se**	0,1900	0,1210	5	300	300,04	4633,658	0,017	0,019	5,058	0,138	25,599
2D3g	**Se**	0,0006	0,0002	5	300	300,04	0,009	0,000	0,000	0,006	0,000	0,000
3F	**Se**	0,0008	0,0008	5	300	300,04	0,178	0,000	0,000	0,033	0,001	0,001
5C2	**Se**	0,0073	0,0068	5	300	300,04	14,756	0,001	0,001	0,300	0,008	0,090
		6,207	**0,533**				**25204,895**					**16,312**
							158,760					**4,039**
		$\sum_C$	$\sum_D$				$\sqrt{\sum_H}$					$\sqrt{\sum_M}$

Table 1-1. Uncertainty estimation of Zn emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**Zn**	9,5405	0,2871	5	100	100,12	4,106	-0,218	0,012	-21,798	0,084	475,155
1A2	**Zn**	0,9786	0,2778	5	100	100,12	3,843	-0,012	0,011	-1,219	0,081	1,493
1A3b	**Zn**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Zn**	0,1538	0,0113	5	300	300,04	0,057	-0,003	0,000	-0,975	0,003	0,951
1A3d	**Zn**	0,0072	0,0014	30	300	301,50	0,001	0,000	0,000	-0,035	0,002	0,001
1A3e	**Zn**	0,0012	0,0003	5	300	300,04	0,000	0,000	0,000	-0,005	0,000	0,000
1A4a	**Zn**	2,5673	2,0070	5	300	300,04	1801,499	0,021	0,083	6,227	0,586	39,121
1A4b	**Zn**	8,3464	9,6745	5	300	300,04	41857,358	0,197	0,399	59,068	2,824	3496,991
1A4ci	**Zn**	0,1551	0,0348	5	300	300,04	0,543	-0,002	0,001	-0,694	0,010	0,481
1A4cii	**Zn**	0,3969	0,0873	5	300	300,04	3,408	-0,006	0,004	-1,798	0,025	3,232
1A5	**Zn**	0,0914	0,0030	5	300	300,04	0,004	-0,002	0,000	-0,626	0,001	0,392
1B2	**Zn**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
2A3	**Zn**	0,0879	0,0560	5	300	300,04	1,402	0,000	0,002	0,056	0,016	0,003
2C1	**Zn**	0,0192	0,0127	5	300	300,04	0,073	0,000	0,001	0,018	0,004	0,000
2G	**Zn**	0,0246	0,0038	5	300	300,04	0,006	0,000	0,000	-0,131	0,001	0,017
3F	**Zn**	0,0228	0,0210	5	300	300,04	0,197	0,000	0,001	0,095	0,006	0,009
5C2	**Zn**	1,8304	1,7100	5	300	300,04	1307,666	0,026	0,071	7,894	0,499	62,567
		24,223	**14,188**				**43667,407**					**4014,193**
							208,967					**63,358**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of PCDD/F emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**PCDD/F**	0,9852	0,1131	5	100	100,12	0,061	-0,021	0,003	-2,125	0,018	4,515
1A2	**PCDD/F**	0,4510	0,2544	5	100	100,12	0,308	-0,005	0,006	-0,507	0,041	0,259
1A3b	**PCDD/F**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**PCDD/F**	0,0008	0,0001	30	300	301,50	0,000	0,000	0,000	-0,005	0,000	0,000
1A3e	**PCDD/F**	0,0008	0,0002	5	300	300,04	0,000	0,000	0,000	-0,005	0,000	0,000
1A4a	**PCDD/F**	2,4401	1,9126	5	300	300,04	156,525	-0,015	0,044	-4,537	0,311	20,679
1A4b	**PCDD/F**	29,0130	16,1738	5	300	300,04	11193,822	-0,329	0,372	-98,570	2,627	9722,855
1A4ci	**PCDD/F**	0,1256	0,0147	5	300	300,04	0,009	-0,003	0,000	-0,811	0,002	0,658
1A5	**PCDD/F**	0,0728	0,0030	5	300	300,04	0,000	-0,002	0,000	-0,508	0,000	0,258
1B2	**PCDD/F**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
2C1	**PCDD/F**	2,1357	1,4160	5	300	300,04	85,799	-0,019	0,033	-5,748	0,230	33,091
5C1biii	**PCDD/F**	7,2600	24,0000	5	300	300,04	24647,765	0,375	0,551	112,495	3,899	12670,400
5C2	**PCDD/F**	1,0441	0,9755	5	300	300,04	40,716	-0,003	0,022	-0,860	0,158	0,764
5E	**PCDD/F**	0,0000	1,0040	5	300	300,04	43,136	0,023	0,023	6,920	0,163	47,907
		43,529	**45,867**				**11350,726**					**9748,965**
							106,540					**98,737**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Benzo (a)pyrene emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**Benzo (a)pyr**	0,0002	0,0008	5	100	100,12	0,001	0,000	0,000	0,008	0,001	0,000
1A2	**Benzo (a)pyr**	0,1309	0,0609	5	100	100,12	3,173	0,001	0,007	0,133	0,047	0,020
1A3b	**Benzo (a)pyr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Benzo (a)pyr**	0,0046	0,0003	5	300	300,04	0,001	0,000	0,000	-0,045	0,000	0,002
1A3e	**Benzo (a)pyr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Benzo (a)pyr**	0,5398	0,4235	5	300	300,04	1376,085	0,024	0,046	7,252	0,325	52,700
1A4b	**Benzo (a)pyr**	8,1921	2,6874	5	300	300,04	55400,190	-0,039	0,292	-11,672	2,064	140,496
1A4ci	**Benzo (a)pyr**	0,0259	0,0027	5	300	300,04	0,055	-0,001	0,000	-0,227	0,002	0,051
1A4cii	**Benzo (a)pyr**	0,0317	0,0070	5	300	300,04	0,374	-0,001	0,001	-0,157	0,005	0,025
1A5	**Benzo (a)pyr**	0,0164	0,0007	5	300	300,04	0,004	-0,001	0,000	-0,176	0,001	0,031
2D3i	**Benzo (a)pyr**	0,0031	0,0002	5	300	300,04	0,000	0,000	0,000	-0,032	0,000	0,001
2G	**Benzo (a)pyr**	0,0012	0,0002	5	300	300,04	0,000	0,000	0,000	-0,009	0,000	0,000
3F	**Benzo (a)pyr**	0,0160	0,0147	5	300	300,04	1,664	0,001	0,002	0,286	0,011	0,082
5C2	**Benzo (a)pyr**	0,2433	0,2273	5	300	300,04	396,253	0,015	0,025	4,455	0,175	19,880
		9,205	**3,426**				**56779,505**					**193,269**
							238,285					**13,902**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Benzo(b)fluoranthene emissions 1990 and 2017, 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
						$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I*F$	$J*E*\sqrt{2}$	K^2+L^2
		Gg	Gg	%	%	%	%	%	%	%	%	%
1A1	**Benzo(b)fluor**	0,0031	0,0003	5	100	100,12	0,000	0,000	0,000	-0,005	0,000	0,000
1A2	**Benzo(b)fluor**	0,3979	0,0957	5	100	100,12	6,061	-0,001	0,007	-0,130	0,050	0,019
1A3b	**Benzo(b)fluor**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	**Benzo(b)fluor**	0,0077	0,0006	5	300	300,04	0,002	0,000	0,000	-0,036	0,000	0,001
1A3e	**Benzo(b)fluor**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Benzo(b)fluor**	0,6998	0,5491	5	300	300,04	1791,348	0,026	0,040	7,677	0,284	59,012
1A4b	**Benzo(b)fluor**	11,6733	2,7334	5	300	300,04	44392,627	-0,043	0,200	-12,942	1,415	169,495
1A4ci	**Benzo(b)fluor**	0,0336	0,0036	5	300	300,04	0,077	0,000	0,000	-0,131	0,002	0,017
1A4cii	**Benzo(b)fluor**	0,0198	0,0044	5	300	300,04	0,113	0,000	0,000	-0,028	0,002	0,001
1A5	**Benzo(b)fluor**	0,2901	0,0126	5	300	300,04	0,943	-0,005	0,001	-1,540	0,007	2,371
2D3i	**Benzo(b)fluor**	0,0016	0,0001	5	300	300,04	0,000	0,000	0,000	-0,008	0,000	0,000
2G	**Benzo(b)fluor**	0,0005	0,0001	5	300	300,04	0,000	0,000	0,000	-0,001	0,000	0,000
3F	**Benzo(b)fluor**	0,0446	0,0411	5	300	300,04	10,045	0,002	0,003	0,624	0,021	0,390
5C2	**Benzo(b)fluor**	0,4834	0,4516	5	300	300,04	1211,909	0,023	0,033	6,892	0,234	47,557
		13,655	**3,893**				**46190,115**					**228,544**
							214,919					**15,118**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Benzo(k)fluoranthene emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**Benzo(k)fluor**	0,0025	0,0002	5	100	100,12	0,000	0,000	0,000	-0,011	0,000	0,000
1A2	**Benzo(k)fluor**	0,0769	0,0295	5	100	100,12	2,489	0,001	0,005	0,067	0,037	0,006
1A3b	**Benzo(k)fluor**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	**Benzo(k)fluor**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Benzo(k)fluor**	0,2811	0,2206	5	300	300,04	1252,974	0,023	0,039	6,787	0,279	46,144
1A4b	**Benzo(k)fluor**	4,5964	1,0459	5	300	300,04	28171,726	-0,087	0,187	-26,100	1,322	682,964
1A4ci	**Benzo(k)fluor**	0,0135	0,0014	5	300	300,04	0,049	-0,001	0,000	-0,167	0,002	0,028
1A5	**Benzo(k)fluor**	0,0081	0,0004	5	300	300,04	0,003	0,000	0,000	-0,127	0,000	0,016
2D3i	**Benzo(k)fluor**	0,0016	0,0001	5	300	300,04	0,000	0,000	0,000	-0,023	0,000	0,001
2G	**Benzo(k)fluor**	0,0005	0,0001	5	300	300,04	0,000	0,000	0,000	-0,005	0,000	0,000
3F	**Benzo(k)fluor**	0,0190	0,0175	5	300	300,04	7,925	0,002	0,003	0,600	0,022	0,360
5C2	**Benzo(k)fluor**	0,5934	0,5541	5	300	300,04	7906,495	0,064	0,099	19,059	0,700	363,742
		5,593	**1,870**				**29427,238**					**729,142**
							171,544					**27,003**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of Indeno(1,2,3-cd) pyrene emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**Indeno(1,2,3-cd)pyr**	0,0009	0,0001	5	100	100,12	0,000	0,000	0,000	-0,006	0,000	0,000
1A2	**Indeno(1,2,3-cd)pyr**	0,0723	0,0302	5	100	100,12	3,033	0,000	0,007	0,018	0,050	0,003
1A3b	**Indeno(1,2,3-cd)pyr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	**Indeno(1,2,3-cd)pyr**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A4a	**Indeno(1,2,3-cd)pyr**	0,2195	0,1722	5	300	300,04	884,501	0,019	0,040	5,821	0,286	33,966
1A4b	**Indeno(1,2,3-cd)pyr**	3,9351	1,5207	5	300	300,04	68981,154	-0,020	0,357	-5,856	2,524	40,668
1A4ci	**Indeno(1,2,3-cd)pyr**	0,0105	0,0011	5	300	300,04	0,035	-0,001	0,000	-0,226	0,002	0,051
1A5	**Indeno(1,2,3-cd)pyr**	0,0064	0,0003	5	300	300,04	0,002	-0,001	0,000	-0,163	0,000	0,027
2D3g	**Indeno(1,2,3-cd)pyr**	0,0016	0,0000	5	300	300,04	0,000	0,000	0,000	-0,045	0,000	0,002
2D3h	**Indeno(1,2,3-cd)pyr**	0,0005	0,0001	5	300	300,04	0,000	0,000	0,000	-0,009	0,000	0,000
3F	**Indeno(1,2,3-cd)pyr**	0,0137	0,0126	5	300	300,04	4,731	0,002	0,003	0,494	0,021	0,245
		4,260	**1,737**				**69868,723**					**74,688**
							264,327					**8,642**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of HCB emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**HCB**	0,4564	0,0327	5	100	100,12	289,157	-0,264	0,063	-26,421	0,448	698,280
1A2	**HCB**	0,0021	0,0010	5	100	100,12	0,253	0,000	0,002	0,038	0,013	0,002
1A3b	**HCB**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**HCB**	0,0005	0,0001	30	300	301,50	0,020	0,000	0,000	-0,051	0,007	0,003
1A4a	**HCB**	0,0094	0,0073	5	300	300,04	130,079	0,007	0,014	2,206	0,100	4,878
1A4b	**HCB**	0,0281	0,0910	5	300	300,04	20162,734	0,156	0,176	46,823	1,248	2193,929
1A4ci	**HCB**	0,0008	0,0003	5	300	300,04	0,185	0,000	0,001	-0,019	0,004	0,000
1A5	**HCB**	0,0005	0,0000	5	300	300,04	0,000	0,000	0,000	-0,092	0,000	0,009
5C1biii	**HCB**	0,0182	0,0600	5	300	300,04	8758,928	0,103	0,116	30,947	0,822	958,371
		0,516	**0,192**				**20582,429**					**2897,092**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Table 1-1. Uncertainty estimation of PCBs emissions 1990 and 2017, 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
						$\sqrt{E^2 + F^2}$	$\frac{(G * D)^2}{(\sum D)^2}$		$\frac{D}{\sum C}$	$I * F$	$J * E * \sqrt{2}$	$K^2 + L^2$
		Gg	**Gg**	%	%	%	%	%	%	%	%	%
1A1	**PCBs**	0,0005	0,0024	5	100	100,12	0,005	0,000	0,000	0,022	0,002	0,000
1A2	**PCBs**	0,3405	0,2062	5	100	100,12	37,576	0,009	0,020	0,919	0,143	0,866
1A3b	**PCBs**	0,0000	0,0000	5	300	300,04	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	**PCBs**	0,0002	0,0000	30	300	301,50	0,000	0,000	0,000	-0,001	0,000	0,000
1A4a	**PCBs**	2,0047	1,5730	5	300	300,04	19636,488	0,089	0,154	26,728	1,088	715,568
1A4b	**PCBs**	5,9400	0,3841	5	300	300,04	1170,743	-0,153	0,038	-45,905	0,266	2107,363
1A4ci	**PCBs**	0,0955	0,0082	5	300	300,04	0,529	-0,002	0,001	-0,684	0,006	0,468
1A5	**PCBs**	0,0568	0,0025	5	300	300,04	0,051	-0,002	0,000	-0,475	0,002	0,225
2C1	**PCBs**	1,7798	1,1797	5	300	300,04	11043,629	0,058	0,115	17,380	0,816	302,728
5C1biii	**PCBs**	0,0036	0,0120	5	300	300,04	1,143	0,001	0,001	0,317	0,008	0,101
		10,222	**3,368**				**20845,341**					**2824,264**
							144,379					**52,144**
		$\sum C$	$\sum D$				$\sqrt{\sum H}$					$\sqrt{\sum M}$

Annex 1.2. SOx calculation for mobile combustion

For mobile combustion categories (**1.A.3.b, 1.A.3.c, 1.A.4.cii, 1.A.5**) there are no emission factors. But there is a recommendation to make calculations according to a special formula. Methodology and emissions for the indicated categories are described in this paragraph.

SOx Calculation Formula:
$E(SO_2)=2*k*AD$,
k-weight related to Sulphur content in fuel of type m [g/g fuel],
1 ppm = 1E-06 g/g fuel or 1 ppm = 1 mg/kg fuel.

Fuel Sulphur - **k** (table 3-13, p. 24, EMEP-2016, 1.A.3.bi Road):

1) **1990-1996-2000** fuel according to the 1996 standard -165/1000000 grams of sulphur in a gram of gasoline and 400/1000000 grams of sulphur in a gram of diesel fuel;
2) **2001-2005** fuel according to the 2000 standard -130/1000000 grams of sulphur in a gram of gasoline and 300/1000000 grams of sulphur in a gram of diesel fuel;
3) **2006-2009** fuel according to the 2005 standard - 40/1000000 grams of sulphur in a gram of gasoline and 40/1000000 grams of sulphur in a gram of diesel fuel;
4) **2010-2017** fuel according to the 2009 standard - 40/1000000 grams of sulphur in a gram of gasoline and 8/1000000 grams of sulphur in a gram of diesel fuel.

Table 1.2-1. The values of the coefficient of sulphur content in the fuel **k.**

k		Standard 1996 year								
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
mg/kg fuel	petrol	165	165	165	165	165	165	165	165	165
	diesel oil	400	400	400	400	400	400	400	400	400

continue

k		Standard 1996 year		Standard 2000 year				
		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
mg/kg fuel	petrol	165	165	130	130	130	130	130
	diesel oil	400	400	300	300	300	300	300

continue

k		Standard 2005 year			Standard 2009 year								
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
mg/kg fuel	petrol	40	40	40	40	40	40	40	40	40	40	40	40
	diesel oil	40	40	40	8	8	8	8	8	8	8	8	8
					EMEP-2016 Update July 2017 for fuel 2009 and later, page 26, table 3-14								

Table 1.2-2. Emissions of SO_2 for *1.A.3.bi* -calculation for M1, kt.

	Emissions SO_2, kt			
	M1, Fuels, kg		M1, Emissions, kt	
	petrol	*diesel oil*	*petrol*	*diesel oil*
1990	575230958	49629905	0,1898	0,0397
1991	534688663	35113562	0,1764	0,0281
1992	246192989	22886011	0,0812	0,0183
1993	158336227	13260928	0,0523	0,0106
1994	152221722	15919882	0,0502	0,0127
1995	161250197	15900930	0,0532	0,0127
1996	157810610	15684081	0,0521	0,0125
1997	191557306	18121956	0,0632	0,0145
1998	165635623	17155651	0,0547	0,0137
1999	98392275	14990786	0,0325	0,0120
2000	100809205	21463362	0,0333	0,0172
2001	109966309	25612676	0,0286	0,0154
2002	143355964	29371086	0,0373	0,0176
2003	153453520	29900924	0,0399	0,0179
2004	162979388	31691535	0,0424	0,0190
2005	166909314	30986271	0,0434	0,0186
2006	154579354	33121392	0,0124	0,0026
2007	156438262	39457289	0,0125	0,0032
2008	157911211	44052678	0,0126	0,0035
2009	148518979	49122320	0,0119	0,0008
2010	136929203	60747518	0,0110	0,0010
2011	142676982	68800053	0,0114	0,0011
2012	114738651	75007145	0,0092	0,0012
2013	109763941	97436732	0,0088	0,0016
2014	133698957	93347718	0,0107	0,0015
2015	136328282	103779485	0,0109	0,0017
2016	139685577	110876221	0,0112	0,0018
2017	133221649	120260942	0,0107	0,0019

Table 1.2-3. Emissions of SO_2 of Mobile Categories Energy Sector, kt.

	M1		N2		N2-N3-M2-M3	L1-L5	1A3c		1.A.4.cii	1.A.5.b
	petrol	diesel oil	petrol	diesel oil	diesel oil	petrol	diesel oil	diesel	gasoline: four-stroke	motor gasoline
1990	0,1898	0,0397	0,1078	0,0948	0,2912	0,0084	0,1230	0,0056	0,1287	0,0013
1991	0,1764	0,0281	0,0963	0,0645	0,1976	0,0075	0,1051	0,1045	0,0051	0,0008
1992	0,0812	0,0183	0,0463	0,0440	0,1346	0,0045	0,0873	0,0682	0,0030	0,0004
1993	0,0523	0,0106	0,0301	0,0257	0,0788	0,0029	0,0690	0,0665	0,0010	0,0007
1994	0,0502	0,0127	0,0281	0,0299	0,0921	0,0027	0,0277	0,0633	0,0016	0,0011
1995	0,0532	0,0127	0,0294	0,0293	0,0913	0,0030	0,0247	0,0685	0,0093	0,0011
1996	0,0521	0,0125	0,0265	0,0263	0,0842	0,0028	0,0237	0,0537	0,0089	0,0005
1997	0,0632	0,0145	0,0273	0,0251	0,0840	0,0028	0,0199	0,0528	0,0095	0,0008
1998	0,0547	0,0137	0,0223	0,0219	0,0767	0,0023	0,0151	0,0391	0,0062	0,0010
1999	0,0325	0,0120	0,0119	0,0166	0,0613	0,0013	0,0076	0,0278	0,0033	0,0005
2000	0,0333	0,0172	0,0106	0,0205	0,0772	0,0013	0,0085	0,0217	0,0022	0,0000
2001	0,0286	0,0154	0,0086	0,0167	0,0671	0,0010	0,0071	0,0166	0,0016	0,0006
2002	0,0373	0,0176	0,0109	0,0183	0,0757	0,0013	0,0155	0,0200	0,0007	0,0000
2003	0,0399	0,0179	0,0168	0,0286	0,0948	0,0015	0,0084	0,0182	0,0008	0,0003
2004	0,0424	0,0190	0,0185	0,0329	0,1151	0,0015	0,0111	0,0163	0,0005	0,0006
2005	0,0434	0,0186	0,0194	0,0342	0,1162	0,0016	0,0152	0,0144	0,0004	0,0000
2006	0,0124	0,0026	0,0052	0,0045	0,0153	0,0005	0,0026	0,0044	0,0000	0,0002
2007	0,0125	0,0032	0,0055	0,0050	0,0165	0,0005	0,0026	0,0038	0,0000	0,0001
2008	0,0126	0,0035	0,0058	0,0055	0,0174	0,0005	0,0024	0,0036	0,0000	0,0001
2009	0,0015	0,0003	0,0053	0,0011	0,0035	0,0005	0,0003	0,0034	0,0000	0,0001
2010	0,0014	0,0004	0,0065	0,0014	0,0041	0,0005	0,0003	0,0038	0,0000	0,0001
2011	0,0014	0,0004	0,0069	0,0015	0,0044	0,0005	0,0002	0,0036	0,0000	0,0000
2012	0,0011	0,0005	0,0057	0,0013	0,0037	0,0004	0,0003	0,0035	0,0000	0,0000
2013	0,0011	0,0006	0,0055	0,0014	0,0040	0,0004	0,0002	0,0039	0,0000	0,0000
2014	0,0013	0,0006	0,0035	0,0015	0,0042	0,0003	0,0000	0,0048	0,0000	0,0000
2015	0,0014	0,0006	0,0034	0,0014	0,0045	0,0004	0,0001	0,0052	0,0000	0,0000
2016	0,0014	0,0007	0,0035	0,0017	0,0047	0,0004	0,0002	0,0051	0,0000	0,0000
2017	0,0013	0,0007	0,0033	0,0017	0,0049	0,0005	0,0002	0,0070	0,0000	0,0000

Annex 1.3. Heavy metals calculation for 1.A.3.b.i

For mobile combustion category *1.A.3.bi* there are no emission factors. But there is a recommendation to make calculations according to a special formula. Methodology and emission factors for category are described in this paragraph.

$$E(metals)=k*AD,$$

Where:
k-weight-related content of heavy metal *i* in fuel type *m* [mg/kg fuel].
1 ppm = 1E-06 g/g fuel or 1 ppm = 1 mg/kg fuel

Table 5.3-1. Heavy metal Emission Factors for all vehicle categories.
EMEP-2016 Update July 2017, 1.A.3.b, page 51.

K=EF	M1		N1		N2-N3-M2-M3		L1-L5
mg/kg fuel	petrol	diesel oil	petrol	diesel oil	petrol	diesel oil	petrol
Pb	0,0016	0,0005	0,0016	0,0005	0,0016	0,0005	0,0016
Cd	0,0002	5 E-05	0,0002	5 E-05	0,0002	5 E-05	0,0002
Cu	0,0045	0,0057	0,0045	0,0057	0,0045	0,0057	0,0045
Cr	0,0063	0,0085	0,0063	0,0085	0,0063	0,0085	0,0063
Ni	0,0023	0,0002	0,0023	0,0002	0,0023	0,0002	0,0023
Se	0,0002	0,0001	0,0002	0,0001	0,0002	0,0001	0,0002
Zn	0,033	0,018	0,033	0,018	0,033	0,018	0,033
Hg	0,0087	0,0053	0,0087	0,0053	0,0087	0,0053	0,0087
As	0,0003	0,0001	0,0003	0,0001	0,0003	0,0001	0,0003

Table 5.3-2. Heavy metal Emission Factors for all vehicle categories in the sequence of pollutants in the NFR.

EF, mg/kg fuel		*Cd*	*Hg*	*As*	*Cr*	*Cu*	*Ni*	*Se*	*Zn*
M1	petrol	0,0002	0,0087	0,0003	0,0063	0,0045	0,0023	0,0002	0,033
	diesel oil	0,00005	0,0053	0,0001	0,0085	0,0057	0,0002	0,0001	0,018
N1	petrol	0,0002	0,0087	0,0003	0,0063	0,0045	0,0023	0,0002	0,033
	diesel oil	0,00005	0,0053	0,0001	0,0085	0,0057	0,0002	0,0001	0,018
N2-N3-M2-M3	petrol	0,0002	0,0087	0,0003	0,0063	0,0045	0,0023	0,0002	0,033
	diesel oil	0,00005	0,0053	0,0001	0,0085	0,0057	0,0002	0,0001	0,018
L1-L5	petrol	0,0002	0,0087	0,0003	0,0063	0,0045	0,0023	0,0002	0,033

Annex 1.4. The list of request letters to the organizations.

No	Date	Letter registration number	The Intermediate and Final Recipient	Theme	Notes (if received, date)
1.	06.08.2019	13-07/2815	Ministry of Economy and Infrastructure of the Republic of Moldova	production and use of asphalt concrete in 2017-2018	Letter nr. 11-6425 din 30.09.2019
2.	06.08.2019	13-07/2815	IM Glass Container Company	information on the quantity of glass produced and the use of the raw material at IM Glass Container Company SA in Chisinau in 2017 and 2018	Letter from 06.09.2019
3.	06.08.2019	13-07/2815	National Bureau of Statistics	• PRODMOLD-A statistical report "Production in natural expression in the industry of the Republic of Moldova for the years 2017, 2018"; • Statistical report Nr. 9-agr "Use of phytosanitary products and introduction of chemical and natural fertilizers for fruit of the year 2017, 2018"; • Statistical report Nr. 29-agr "Production obtained from crops harvested from the entire area sown in 2017, 2018"; • Statistical report No. 1-ozone "The commercial regime and the regulation of the use of halogenated hydrocarbons that destroy the ozone layer in 2017, 2018";	
4.	06.08.2019	13-07/2815	Agency for Public Services	Information on the number of transport units registered in the Republic of Moldova in 2017, and 2018 (the situation on January 1 of the respective years), by category and the year of production, according to the records of the State Transport Register, as well as the number of units of transport imported into the Republic of Moldova in 2017, and 2018 (the situation on January 1 of the respective years), by category and the year of production, according to	

No	Date	Letter registration number	The Intermediate and Final Recipient	Theme	Notes (if received, date)
				the data of the State Transport Register	
5.	06.08.2019	13-07/2815	MACON S.A., Combined Building Materials from Chisinau.	the quantity of brick produced at the "MACON" S.A. the amount of expanded clay (kerchite) produced, quantity of tiles produced, quantity of architectural ceramics produced use of raw material to produce brick, ceramic, ceramic blocks and ceramics for construction and architecture	
6.	06.08.2019	13-07/2815	"Lafarge Ciment (Moldova)" S.A. Rezina.	annual production of cement (by type and assortment group) and clinker, use of raw materials, as well as fossil fuels at the enterprise annual consumption of matter on the annual consumption of raw materials and additional material resources by type of production (in kg per ton of cement or clinker, to be indicated)	Letter 446 din 16.08.2019
7.	06.08.2019	13-07/2815	RED NORD- VEST S.A. Dondușeni.	installation in 2017 and 2018 of high voltage electrical devices in which sulphur hexafluoride (SF6) and perfluorocarbons (PFC) are used as insulating gas	
8.	06.08.2019	13-07/2815	Î.C.S. „Gas Natural Fenosa Furnizare Energie" S.R.L. Î.C.S. RED UNION FENOSA S.A. Chișinău.	Information on the installation in 2017-2018 of medium and high voltage electrical devices	ÎS Gas Natural Fenosa Furnizare Energie SRL does not have electrical distribution systems, redirected to ICS Red Union Fenosa SA Letter 20190809-24299 from 30.08.2019
9.	06.08.2019	13-07/2815	RED NORD S.A. Bălți.	installation in 2017 and 2018 of high voltage electrical devices in which sulfur hexafluoride (SF6) and perfluorocarbons (PFC) are used as insulating gas	
10.	06.08.2019	13-07/2815	The state-owned enterprise "MOLDELECTRICA" Chisinau.	installation in 2017 and 2018 of high voltage electrical devices in which sulphur hexafluoride (SF6)	

No	Date	Letter registration number	The Intermediate and Final Recipient	Theme	Notes (if received, date)
				and perfluorocarbons (PFC) are used as insulating gas	
11.	06.08.2019	13-07/2815	The state-owned enterprise "Chisinau glass factory".	information on the quantity of glass produced and the use of the raw material in the SI Chisinau Glass Factory in 2017 and 2018	Letter din 20.08.2019
12.	06.08.2019	13-07/2815	State Enterprise "State Road Administration".	Information on the production and use of asphalt concrete for the period 2017-2018	Letter 08-02/3179 din 06.09.2019
13.	06.08.2019	13-07/2815	State Enterprise "Center for State Information Resources" Registry ".	the number of transport units registered in the Republic of Moldova in 2017, and 2018 (the situation on January 1 of the respective years), by category and the year of production, according to the records of the State Transport Register, the number of transport units imported to the Republic of Moldova in 2017, and 2018 (the situation on January 1 of the respective years), by category and the year of production, according to the records of the State Transport Register	
14.	06.08.2019	13-07/2815	Agency of Medicines and Medical Devices.	Presentation of information regarding the evaluation of the annual consumption of pressurized aerosols dosed with the use as propellant of hydrofluorocarbons (HFC-134a),	
15.	06.08.2019	13-07/2815	Agency for Geology and Mineral Resources.	Presentation of information regarding the extracted amount of calcium carbonate and clay, calcite, and dolomite, as well as the chemical characteristic, for the years 2017, 2018	Letter 606/04 from 16.08.2019
16.	06.08.2019	13-07/2815	Customs Service of the Republic of Moldova.	the import and export of bituminous materials in 2017 and 2018, import and export of limestone non-metallic ores, lime, cement, limestone inorganic chemicals, as well as glass clippings and scrap, in	

No	Date	Letter registration number	The Intermediate and Final Recipient	Theme	Notes (if received, date)
				2017 and 2018, import and export of organic chemicals in 2017 and 2018, import and export in 2017 and 2018 of soaps, organic surface agents, washing preparations, lubricating preparations, artificial waxes, polishes and cleaners, candles and the like, import and export for the period 2017-2018 of the various products of the chemical industry, import of refrigeration equipment, as well as fire extinguishers for the period 2017-2018, import and export of nitrogenous and complex mineral or chemical fertilizers in 2017 and 2018, import and export in 2017 and 2018 of pairs of shoes	
17.	06.08.2019	13-07/2815	Ministry of Health, Labour and Social Protection of the Republic of Moldova.	evaluation of the annual consumption of pressurized aerosols dosed with the use as propellant of hydrofluorocarbons (HFC-134a)	

Annex 2. Answers to 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

Ref: CEIP/S3.RR/2018/Moldova

19/10/2018

Answers

to the Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings Directive

for:
STAGE 3 REVIEW REPORT MOLDOVA

Chișinău, Republic of Moldova

2020

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Introduction

The mandate and overall objectives for the emission inventory review process under the LRTAP Convention is given by the UNECE document 'Methods and Procedures for the Technical Review of Air Pollutant Emission Inventories reported under the Convention and its Protocols'(1) – hereafter referred to as the 'Methods and Procedures' document.

This report covers the answers and commentaries for the Stage 3 centralized reviews of the UNECE LRTAP Convention and EU NEC Directive inventories of Moldova coordinated by the EMEP emission center CEIP acting as review secretariat. The review took place from 18th June 2018 to 21th June 2018 in Copenhagen Denmark and was hosted by the European Environment Agency (EEA).

The following team of experts has given answers and commentaries to the key findings of the Review Report: Energy - Elena Bykova, Tatiana Kirilova, Industry and Solvents- Anatol Tarita, Elena Mosanu, Agriculture – Vladimir Brega, Regina Fasola, Waste - Elena Kuznetova.

Nr.	Commentaries in RR	Adjustments in IIR-2019
PART A: KEY REVIEW FINDINGS		
8.	The ERT notes that Moldova used the 2013 Guidebook version, while the Reporting Guidelines request the use of the latest version of the Guidebook, currently 2016. The ERT notes that the Russian translation of the 2016 version of the Guidebook was not available during the preparation of the inventory. The ERT invites Moldova to consider options to use methods and EFs consistent with latest version of Inventory Guidebook.	The IIR-2019 used the EMEP-2016 Guide and its versions (for categories that were updated during the period 2017-2018).
9	The ERT recommends Moldova to document and justify the methods used to calculate the emissions and to also provide the reference linking to the source of the information, if other methods than the Guidebook are used.	Methods are described in the sections of the IIR-2019, links are given.
10	The ERT found that there is a need for further effort to enhance the completeness and time series' consistency bearing in mind that activity data were missing for the whole territory for some of the sectors.	Work was done to improve the coverage of the territory - for many categories, the Left Bank Region (LBR) values were restored using the indirect data method.
12	The ERT used the IIR submitted in 2017 to support the review. The ERT noted that the IIR was partly in line with the requirements set down in Annex II for the revised 2014 Reporting Guidelines. However, the ERT encourages Moldova to use the IIR reported in 2014 as a basis for the preparation of future annual IIRs, due to the fact that the 2014 IIR was completely in line with the requirements set down in Annex II of the reporting guidelines and the provided information was well documented in the 2014 version of the IIR.	In preparing the IIR-2019, the IIR-2014 was used, the sections on energy and agriculture from the IIR-2015, as well as the recommendations of international experts received in 2016 and 2018.
13	The ERT notes, that Moldova's participation in the 2018 centralized Stage 3 review was unfortunately limited due to the fact that Moldova only provided responses to the ERT's questions for the energy and transport sectors. The ERT	Recommendation accepted.

	would have needed clarifications for several issues in order to have been able to provide more detailed recommendations for future submissions. The ERT strongly recommends Moldova to engage more in the review process by providing answers during future reviews in order to enable the ERT to review the inventory in detail and to provide useful recommendations to further develop the inventory.	
INVENTORY SUBMISSION		
15	In 2018 Moldova did not submit emission data for the year 2016. The last submission was provided on 10.02.2017, after the reporting deadline of the 2015 data on 15.02.2017. The Party reported the whole time series i.e. 1990-2015 emissions in NFR-2014-2 format.	NFR-2020 is presented on time in 2020 with data for 1990-2017.
17	Moldova did not submit gridded data, LPS data or projections. The ERT asked Moldova on the status and plans for providing projections but did not receive a response to the question. The ERT recommends Moldova to report projected emissions for both, with and without measures, scenarios together with the associated social economic data for 2015 and 2020 until 2050 as well as LPS and gridded data in the next submission.	Work on the preparation of sections on mapping, calculation of point sources will be performed in the future. To present the forecasts, the group was trained in LEAP in 2019, and is preparing primary data under the guidance of lecturer Chris Miley and scenario development. Work is scheduled to be completed in 2020.
KEY CATEGORIES		
18	Moldova has compiled and presented a level Key Category Analysis (KCA) for the following pollutants in its IIR: NO_X, CO, NMVOC, SO_X, NH_3, TSP, PM_{10}, $PM_{2.5}$ heavy metals and POP compounds for the year 2014 but taken into account only data from the energy and agriculture sectors. The ERT, however, notes that the key category analysis provided in Moldova's 2014 IIR takes into account all sectors, therefore the ERT recommends Moldova to use that approach for future calculations of the KCA.	In IIR 2020, key categories are calculated for all 4 sectors.
Transparency		
20	The ERT recognizes the level of effort undertaken by Moldova in providing an IIR which includes information on methods and activity data used in the energy, industry and agriculture sectors. The ERT wants to compliment Moldova for the excellent work done in the IIR for the agriculture sector. However, the ERT also encourages Moldova to complete the IIR by including the missing chapters as outlined in Annex II or the 2014 Reporting Guidelines, such as general chapters related to introduction, trend analysis, uncertainty analysis, projections, and sector-specific chapters for waste and solvents, as already included in the IIR reported	IIR 2020 includes all 4 sectors, the recommendation has been implemented.

	in 2014. The ERT asked the Party for additional information and for a possible plan to introduce the missing chapters in future IIRs, but did not receive a response.	
21	The ERT noted that Moldova uses empty fields for activity data in the NFR tables for the energy and transport sectors, and for both, activity data and emissions, in the waste sector for the years 1990-2015. The ERT recommends Moldova to use the appropriate notation keys (e.g. "NO" where emissions are "Not Occurring", "NE" where emissions are "Not Estimated", "IE" where emissions are "Included Elsewhere" and "NA" where estimates are not available or necessary).	In NFR-2020, all cells are filled. For cells in which there are no numerical values, "NO", "NE", "IE", "NA" were used in accordance with the reason for the lack of data. There is a separate description of these designations and tables that indicate the reasons for their use. Recommendation implemented.
23	According to the IIR an expert judgement was applied for gap-filling several industry categories. The ERT asked Moldova to provide additional information on which methods for gap filings have been used to fill the data gaps in the industry sector, but did not receive a response to the question.	In IIR-2019, data restoration was performed in many categories. The methods described in the EMEP-2016 Guide in the "Time Series" section is used. For each category in which the restoration of values is performed, there is a special description of the applied method. Recommendation implemented.
24	Moldova provided limited information in the IIR on QA/QC procedures implemented. The ERT commends Moldova on applying QA/QC checks per sector as indicated in the IIR. However, the ERT notes that no QA/QC plan or a summary of planned improvements is provided in the IIR, and recommends Moldova to add these in the next version of the IIR.	In IIR-2019, control and quality assurance procedures were carried out, a QA/QC procedure plan was drawn up, further possible inventory improvements were formulated.
Completeness		
25	The inventory is complete regarding the pollutants. However, the geographical coverage is not complete due to the missing data from Transnistria for the energy sector and due to missing data from the Left Bank region for the transport sector. The ERT asked the Party if it plans to estimate these emissions using alternative methods to fill data gaps for the energy sector, but did not receive a response to the question.	In preparing the IIR-2019, much work has been done to expand the geographical coverage of emission sources. Data recovery methods were applied for the Left-Bank region in the "Energy" sector for categories 1A2, 1A3.
26	The ERT commends Moldova for information included in the IIR with regards to data gaps, and plans to improve data completeness in the sectors energy, industry and the solvents and agriculture sector. The ERT noted that Moldova, however, did not provide any information on why the waste	IIR-2019 covers all 4 sectors, including the "Waste» sector". Recommendation fulfilled.

	sector is not included in the 2017 IIR and if the Party has the intention to include this sector in future IIR submissions, especially due to the fact that the waste sector was included in the 2014 IIR and in the NFR09 tables up to 2013 while no emissions for the waste sector were included in the following submissions.	
Consistency, including recalculations and time-series		
27	The ERT acknowledges the work of Moldova to prepare recalculations for the whole time series as it was recommended in the previous Stage 3 Review Report. The reasons for the recalculations are described in the IIR and have resulted in an improved inventory due to the fact that 2013 EMEP/EEA Guidebook instead of 2009 Guidebook has been used, as well as sectors aggregated in the previous submission were disaggregated between NFRs. Still the ERT encourages Moldova to provide information about the recalculations on the sector level, including information on the impact of the recalculations on the sector emissions.	In IIR-2019, recalculations were performed for all categories in connection with the use of updated emission factors for EMEP-2016 Guidelines.
28	The ERT noted that the Moldavian time series remains inconsistent due to missing activity data and emissions for some years for all sectors. The ERT understands the difficulties in the process of data gathering but encourages the country to continue with the process of gathering missing data and to improve the completeness of the data coverage if possible. Additionally, the ERT asked Moldova to provide information on the methodology used for the calculation of the year 2015 emissions, due to the fact that emission data for 2015 were not included in the IIR, with the exception of the industry sector, but did not receive a response to this question. The ERT also asked for additional information on the dips and jumps in the Cd trend emissions but did not receive a response	The trend describing the total emissions of Cd has a smooth character, which is divided into 3 sections - reduction, constant emissions and growth.
Comparability		
29	The inventory of Moldova is comparable with the inventories of other reporting Parties in terms of the reporting format and allocation of source categories as Moldova uses the latest NFR format (2014-02) and the allocation of source categories follows that of the UNECE Reporting Guidelines. However, the methodologies are consistent with the 2013 Guidebook while according to the Reporting Guidelines the latest version of the Guidebook (2016) should be used (see also paragraph 7 above). The ERT notes that the translation of the latest (2016) version of the Guidebook will be finalized only during summer 2018. The ERT recommends Moldova to always update the default EFs according to the latest Guidebook version, or to document and justify other methods and to	The calculations in the current cycle presented in the NFR and IIR-2019 were performed using the default emission factors according to the EMEP-2016 Guidelines and its updated versions for certain categories in the period 2017-2018.

	provide references for these, to increase the comparability of the inventory with other Parties.	
Accuracy and uncertainties		
31	The ERT notes that Moldova did not provide an uncertainty analysis in the last reported IIR (2017) with exception of the agriculture sector where an uncertainty analysis was included, and commends the Party for this effort. According to the last Stage 3 Review Report Moldova indicated a quantitative uncertainty analysis as one of the areas for further improvement. During the review the ERT asked Moldova for more information on those plans but did not receive a response.	In IIR-2019, uncertainties were calculated for all pollutants and all categories using the recommendations outlined in the Uncertainties Section.
Verification and quality assurance/quality control approaches		
32	The ERT notes that for most sectors Tier 1 methodologies and default EFs from Guidebook 2013 are used. Tier 2 methods have only been used for the agriculture sector for NFR 3B4giv - manure management - other animals as well as for most of the animal categories under manure management are estimated using a country-specific methodology (Tier 2) as the manure type for each animal livestock was determined according to the manure management system distribution data. The ERT recommends Moldova to improve its inventory in the other sectors by implementing higher tier methodologies for key categories and to investigate the possibility to develop national EFs also for the other sectors to increase the accuracy of the inventory. The ERT notes that Moldova has provided limited information on its general quality assurance/ quality control (QA/QC) activities. Moldova has provided sector-specific information on QA/QC procedures for the energy sector and the agriculture sector. The ERT recommends Moldova to implement QA/QC activities also for the other sectors. The ERT notes that Moldova did not provide information on the question if a QA/QC plan is available in accordance with the Guidebook and recommends Moldova to prepare such a plan and to report upon it in the following submissions.	IIR-2019 describes quality control and quality assurance procedures for all sectors, compiles a plan of quality control and verification procedures.
33	Moreover, the ERT asked Moldova if it considers ways to implement external verification of the inventory, but did not receive any response to the question.	At the moment, recommendations of international experts in 2016 and 2018 have been studied, most of which have been implemented.
FOLLOW-UP TO PREVIOUS REVIEWS		
35	The ERT used the results from the Stage 1 and Stage 2 reviews on the 1990-2015 emissions in this Stage 3 review. The ERT invites Moldova to also refer to these previous	35. The IIR-2019 presents the results of the analysis of reviews of international experts

	reviews when examining this review report and when updating its improvement plans.	and describes what recommendations were used in the current cycle.
AREAS FOR IMPROVEMENTS IDENTIFIED BY MOLDOVA		
36	The IIR identifies the following areas for improvement as it is stated in the 2017 version of the Informative Inventory Report. Moldova indicates that it is planning: a) to improve its data on emissions from energy sector, to review the activity data, with focus on better coverage for the entire territory of the country. b) provide data for the NFR category 1A3a to complete the time series of the Right bank region; c) to improve estimations for the NFR category 1A3b by providing more detailed primary data; d) to complete the emission data for the NFR category 1A3b-d for the Left bank region; e) to collect additional data in order to apply Tier 2 methodology for the category 3B -manure management which is a relevant source of NH3, N2O, NMVOC and PM emissions in the Republic of Moldova. f) to calculate PM emissions coming from the NFR category 3D - crop production and agricultural soils including storage, handling and transport of agricultural products by developing and using technology specific emission factors for the emission calculations, g) to collect additional data in order to apply Tier 2 methodology for the NFR category 3F which is a relevant source for CO, SOX, POPs and heavy metal emissions	In the IIR-2019, the following recommendations are currently implemented: a) Improved energy sector data by incorporating evidence from the Left Bank region. b) a number of primary data on domestic aviation have been added and emissions for this category have been calculated; c) detailing by categories of the motor transport sector has been performed for all groups of vehicles: M1, N1, N2-N3, M2-M3, L1-L7 for the Right Bank region; d) data for the Left-Bank region were restored using the indirect method as recommended by the EMEP-2016 Guide; f) The recommendation has been taken into account.
TECHNICAL CORRECTIONS CONSIDERED AND OR CALCULATED BY THE ERT		
37	The ERT identified gaps and inconsistencies in the inventory and proposed the Party potential technical corrections (PTC) as presented in the table below: a) TSP, PM10 and PM2.5 emissions from the NFRs 1A3bvi tyre and brake wear and 1A3bvii road abrasion and b) TSP and PM10 emissions from NFR 2D3b road paving with asphalt	a) TSP, PM10 and PM2.5 emissions from Automobile tire wear and brakes NFR 1A3bvi and road abrasion 1A3bvii were made for the first time; b) Tire and road wear is calculated in category 1A3bi.
38	Detailed information on the technical corrections and revised estimates is provided under the sector specific chapters below and in the file “TCMoldova_1A3b_2_REVIEW2018”.	38. Many thanks to the experts who performed the calculation example for the country by category of the motor transport sector for gasoline vapor and tire, brake and road abrasion
PART B: RECOMMENDATIONS FOR IMPROVEMENTS TO THE PARTY **CROSS CUTTING IMPROVEMENTS IDENTIFIED BY THE ERT**		
40	The ERT identifies the following cross-cutting issues for improvement for Moldova:	40. In the current cycle, expert groups for each sector were

	(a) to ensure sufficient resources for the inventory work in order to enable the preparation and reporting of emission inventories according to the reporting requirements presented in the Reporting Guidelines and the EMEP/EEA Emission Inventory Guidebook (b) to improve the completeness of the inventory (c) by including missing sources, to report whole time series of emissions since 1990 (except particles since 2000) and an IIR on annual basis; (d) to make efforts to estimate emissions from all activities occurring in the country including all subcategories in the waste and solvent and other product use sectors; (e) to complete the activity data for all sectors in order to improve the emissions coverage of the entire territory of the country and to incorporate emission estimates also from the Left Bank territory in its future submissions; (f) to replace the empty fields in the inventory (with regards to activity data for the waste, energy and transport sector, and emissions for the waste sector and NFR category 1A3ei) with actual values or to use the appropriate notation keys e.g. "NO" where emissions are "Not Occurring", "NE" where emissions are "Not Estimated", "IE" where emissions/activity data are "Included Elsewhere" or "NA"	involved in the calculations, the potential was significantly improved, and resources were provided for preparing the inventory. The work was carried out according to the plan under the guidance of managers and according to the reporting requirements of the EMEP-2016 Guide - on NFR and IIR. Sections on mapping, point sources an-d forecasting will be performed in subsequent work cycles. c) the list of categories presented in IIR-2019 has been significantly expanded (compared to IIR-2014 with subsequent reports for individual sectors). D) Recommendation fulfilled. E) the data on the left-bank region were significantly improved, many gaps were eliminated. The method of recovering values from indirect data according to the recommendations of EMEP-2016 was used. f) The recommendation has been taken into account.
41	to improve the accuracy of the inventory by (a) applying higher tier methodologies for all key categories; (b) performing and presenting an uncertainty analysis which takes all sectors into account and to use it to as a tool to focus on planned improvements for the key categories; (c) including explanations of emission trends in the IIR; (d) to include information on the reasons for the use of the notation keys; (e) to reduce the use of the notation key "IE" by reporting emissions disaggregated under the relevant NFR categories	a) calculated key categories; b) uncertainties are calculated for all pollutants and all sectors; c) descriptions of trends in each pollutant in sectors and total values are made; d) The recommendation has been taken into account. e) the number of categories marked IE is reduced. Detailing for sector 1A3b was completed.
42	to improve the transparency of the inventory by	The preparation of IIR-2019 was carried out in accordance

	(a) preparing an IIR according to the outline and contents presented in Annex II of the 2014 revised Reporting Guidelines (e.g. by utilizing the IIR reported in 2014, which already followed the requested structure); (b) completing the IIR by providing more information on activities included, activity data, explanations of emission trends and to improve the completeness and transparency of documentation (as an example the current version of the 2017 IIR chapter for agriculture); (c) always updating the default EFs according to the latest Guidebook version; or if other methods are used, to document these, reference their sources and justify the use of these methods; (d) carrying out a key category analysis on the level of NFR subcategories for all pollutants	with the reporting requirements of Appendix 2 of EMEP-2016. b) The recommendation has been taken into account. c) emission factors are used according to the EMEP-2016 Guidelines and its updated versions for certain categories (2017 and 2018) d) analysis of the key categories performed at the category level.
43	to recalculate emissions due to possible underestimations/ overestimations noted by the ERT as described in detail in the sector chapters: 1.A.4.b.i – Residential stationary plants – (all pollutants) – 1990-2013; 1.A – Energy sector – (NH3) – all years; 1.A.3 – Transport sector (SOx and BC) – all years; 1.A.3.bi-biv – Road transport (PCDD/ PCDF (dioxins/ furans), HCB and PCBs); 1.A.3.bv –Road transport: Gasoline evaporation (NMVOC); 1.A.3.bvi-vii – Road transport: Automobile tyre and brake wear, Automobile road abrasion –(PM2.5, PM10, TSP). 2.A.1 – Cement production – (TSP, PM10, PM2.5, BC) 3.D.e – Cultivated crops – (NMVOC and PM10) – 2002 3.F – Field burning of agricultural residues – (BC) –2002 3.F – Field burning of agricultural residues – (NOx, SO2, NMVOC, NH3, PM and HM)	43. Recalculations were performed for 1990-2017 in the following categories: 1.A.4.b.i 1.A1, 1A2 (all categories); 1.A.3-all categories; 1.A.3.bi-biv-all categories; 1.A.3.bv1.A.3.bvi-vii - emissions are calculated for the first time; Recommendation fulfilled. This objection was taken into account and all emissions were calculated as EMEP 2016 for category 2A1Cement production.
44	replace zero values by using the notation key “NE”, or report the correct emission values: 1.A.3.b.iv –Road transport: Automobile tyre and brake wear – (PM2.5, PM10 and TSP); 1.A.3.a.ii(i) – Domestic aviation LTO (civil): (HCB and PBCs); 1.B.1 – Fugitive emissions from fuels – (all pollutants); 1.B.2 – Fugitive emissions from fuels – (all pollutants); 2.D.3.a – Domestic solvent use including fungicides – (NMVOC, Hg); 2.D.3.d, g, i, h and 2.G – (all pollutants); 2.B.7 - Soda ash production – (CO, NH3, TSP) 2.D.3.b – Road paving with asphalt – (NOX, SO2, CO, PCDD/F, PAHs, HCB)	1.A.3.biv - emissions calculated for the first time; 1B1-NO 1B2 all pollutants - calculated for the first time; Recommendation fulfilled. The given objection was taken into account and all the emissions were correctly calculated. Thanks for the objection

	3.D.f – Use of pesticides – (HCB) 3.D.c – Farm-level agricultural operations including storage, handling and transport of agricultural products – (PM) 3.D.d – Off-farm storage, handling and transport of bulk agricultural products – (PM) 5.B – Biological treatment of waste – (all pollutants); 5.C.1 – All waste incineration – (all pollutants); 5.C.2 – Open burning of waste – (all pollutants); 5.D – All waste water handlings – (NH3).	
SECTOR SPECIFIC RECOMMENDATIONS FOR IMPROVEMENTS IDENTIFIED BY ERT **ENERGY** **General recommendations on cross cutting issues** **Transparency**		
46	The IIR 2017 presents emission factors and activity data by fuels, or by groups of fuels for all years. The IIR also includes sources of emission factors, i.e. the EMEP/EEA air pollutant emission inventory Guidebook 2013.	EMEP 2016 Guide was used.
47	The ERT noted that in the IIR emission data are presented for the years 1990 – 2014, while in the NFR tables there are values for the years 1990 – 2015. To ERT recommends Moldova to improve the consistency of the NFR tables and the IIR.	In the NFR and IIR-2019 indicate the same time series 1990-2017 for all categories and pollutants.
48	Moldova reports many of the energy sector source categories as ”IE”. The ERT recommends Moldova to make an effort to estimate emissions from all subcategories occurring in the country or to include explanations in the IIR on where the emissions are allocated.	The number of categories marked IE has been significantly reduced, detailing has been done for sectors 1A2 and 1A2b
49	The IIR 2017 includes general trend descriptions for the main categories. However, the trend explanation does not include information about the reasons for the changes in fuel consumption, e. g. it is not clear what has caused a significant rise of the emissions in 2014 (NMVOC, NH3, PM2.5, CO). The ERT recommends Moldova to provide reasons for the emissions trends in its future submissions.	Descriptions of all emission trends have been made. 5.B- NE 5.C.1biii – all pollutants were calculated, for all other categories: 5.C.1- NO 5.D- NH3 and NMVOC are calculated.
50	The ERT notes that the NFR category 1A4ci includes rather high levels of liquid fuel consumption, which could refer to diesel oil used for mobile machinery. On the question raised during the review, Moldova clarified that the values of fuels used for mobile sources and for stationary combustion are used as the sum of fuels and are not considered separately. The ERT recommends Moldova to make an effort to estimate the emissions from these categories separately in its future submissions and to provide the fuel consumptions separately for future IIRs.	Recommendation fulfilled. Calculation for categories 1A4ci and 1A4cii have been made.

Completeness		
52	According to the IIR data are not available for the Left Bank of the Nistru River in a consistent way to be used in the inventory for the whole time series. To the question raised during the review Moldova replied, that official statistics are not available for the left-bank region. The ERT notes, that this situation might lead to the underestimation of the inventory in energy sector. The ERT recommends Moldova to continue with the efforts to obtain the relevant data and to include respective emission estimates in its future submissions. If this would not be successful, the ERT encourages Moldova to explain this in the IIR.	In the current cycle, significant efforts have been made to improve geographical coverage.
53	The ERT notes, that emissions from sector 1B are reported as "NE". No information about these emission sources was presented in the IIR 2017. To the question raised during the review Moldova replied, that calculations in the sector 1B were not carried out, since it would require additional human resources. The ERT notes, that there are no solid fuel mines occurring in Moldova. The ERT further noted, that greenhouse gas emissions from 1B2 were reported in the national inventory report accompanying the 1st Biennial Update report of Moldova for the time series of 1990 – 2013. The ERT recommends Moldova to use available activity data for 1B2 from the greenhouse gas inventory and to estimate emissions also for the LRTAP inventory in its future submissions.	Category 1B1 is not available in the country. Category 1B2 is calculated for 4 positions that are available in the country. The series of primary data used in IPCC and NFR are the same.
Consistency including recalculation and time series		
55	Moldova has carried out a number of recalculations in the energy sector. A short description of the recalculations is provided in the IIR 2017. Further, the ERT recommends Moldova to provide information about the recalculations on sectoral level, including the impact of the recalculations on sectoral emissions.	In IIR-2019, recalculations were again carried out for two reasons: switching to updated emission factors for EMEP-2016 and adding data for the Left Bank region.
56	In the IIR 2017 the reported planned improvement was to obtain relevant data to cover the whole territory of the country. The ERT welcomes these efforts and recommends Moldova to incorporate emission estimates also from the Left Bank territory in its future submissions. The ERT encourages Moldova to incorporate encouragements and recommendations from the previous reviews, which were not addressed in the inventory submitted in 2017, in the IIR of the next submission.	The recommendations of the previous reviews have been taken into account: the details on 1A2, 1A3b are made, for the first time, categories for tire and road abrasion, gasoline evaporation, and fugitive emissions are calculated.
Comparability		
57	Moldova reports emissions from the energy sector using Tier 1 methods from the 2013 Guidebook. As the Reporting Guidelines request the use of the latest version of the Guidebook (i.e. 2016) the ERT recommends Moldova to use	Calculations for the Energy sector were performed according to the

	that version of the Guidebook, or to document and justify the use of other methods in the IIR.	recommendations of EMEP-2016.
Accuracy and uncertainties		
58	ERT recommends Moldova to develop higher tier methods to estimate emissions from key categories.	IIR 2020 defines key categories. In the next cycle, attempts will be made to use method 2 or 3 to some key categories
59	The ERT encourages Moldova to undertake an uncertainty analysis for the energy sector in order to help inform the improvement process and to provide an indication of the reliability of the inventory data.	Uncertainties calculated for 4 sectors.
Improvement		
62	In the last inventory cycle Moldova planned to improve statistical data on activity data from the energy sector in order to cover the whole territory of the country better. The ERT recommends Moldova to report on the progress of the issue and implement data from the whole territory when the data becomes available.	In the IIR2020, the series of primary data were significantly improved by including data on the left-bank region.
Sub-Sector Specific Recommendations **Category issue 1: 1.A stationary sources - SOx**		
65	Following the recommendation from the previous review report, SOX emissions were estimated using EMEP 2013 Guidebook. The ERT commends Moldova for this improvement. However, Moldova was also recommended to investigate the sulphur content of the solid and liquid fuels used within the country in order to be able to develop country specific emission factors, which would increase the accuracy of the SOX emissions. During the review Moldova did not respond to the question on the issue and did not present any results of such efforts. The ERT reiterates recommendation of the previous ERT to investigate sulphur content of solid and liquid fuels used.	SOx calculations were performed for categories of mobile combustion according to the recommendations of EMEP-2016 (special formula). The recommendation has been completed.
Category issue 2: 1.B.1 fugitive emissions from fuels – solid fuels – all pollutants		
66	Moldova reports all emission from 1B as "NE" (not estimated). However, the ERT noted, that emissions from 1B1 would most likely not be occurring in Moldova, since no mining areas are in the country's territory. The ERT recommends Moldova to check the notation key used for NFR 1B1 and to justify the use of all notation keys in the IIR of the next submission.	Since 1B1 is not available in the country, NO in the NFR - 2020 cells in this category is used.
Category issue 3: 1.B.2 fugitive emissions from fuels – oil, natural gas – all pollutants		
67	The ERT noted, that emissions from 1B2 are reported as "NE". To the question raised during the review, Moldova replied, that emission calculations in the 1B sector were not carried out. However, in the greenhouse gas inventory	Category 1B2 is calculated for the first time on 4 positions according to the

	submitted together with the first Biennial Update Report of Moldova, emissions from 1B2 were estimated. The ERT recommends Moldova to use available activity data e.g. from the greenhouse gas inventory to also estimate air pollutant emissions in its next submission.	recommendations of EMEP-2016.
Category issue 4: 1.A.4.b.i Residential stationary plants – biomass		
68	The ERT noted, that the amount of reported biomass use under NFR 1A4bi significantly increased in 2014. No explanation about this trend was presented in the IIR 2017. Since Moldova has a large rural area, there is a possibility, that biomass consumption is underestimated for the previous years. The ERT recommends Moldova to investigate the completeness of the biomass data reported for the years 1990 – 2013.	This recommendation has not yet been implemented, but is planned in the next cycle.
69	The ERT encourages Moldova to include appropriate explanation of all emission trends with information on the driving forces of emissions in its next submission.	A description is made of the trends in emissions of all pollutants.
Category issue 5: 1A stationary sources – NH3		
70	Following the description in the IIR 2017 the ERT noted, that NH3 emissions are estimated only from some of the fuels reported, mostly biomass, in some sectors also from hard coal and brown coal. The ERT notes, that this could lead to underestimation of the emissions and recommends Moldova to estimate NH3 emission from all fuels used in the energy subsectors according to the methods provided in the EMEP/EEA Guidebook.	NH3 is calculated for all categories for which emission factors in EMEP-2016 are indicated.
TRANSPORT **General recommendations on cross cutting issues** **Transparency**		
72	The ERT noted that in the IIR is there is no data from the Left Bank region. The ERT encourages Moldova to try to collect activity data and to estimate emissions for the mobile sources sector for future submissions, when feasible.	In IIR-2019, data on the Left-Bank Region are added. They are determined by the method of recovery from indirect data.
73	The ERT noted that the Party did not complete the NFR "additional info" sheet to explain the use of notation keys in the NFR tables. The ERT recommends Moldova to provide this information for the mobile sources sector in future submissions, or alternatively to provide this information in the IIR.	The "Additional Information" section is filled out in 2 lines — for international aviation and 1A3б emissions from fuel combustion in 1A3б (minus emissions from tire abrasion, roads and gasoline evaporation).
75	The ERT noted that there was a dip in the activities and emissions from the transport sector for the years between 1995 and 2002, which was not explained in the IIR. The ERT	All fuel trends in transport sector are described.

	encourages Moldova to provide explanations for emission trends in the next IIR.	
Completeness		
76	The ERT considers the transport sector to be nearly complete. However, the ERT notes that the Republic of Moldova has not estimated emissions from the following sources and pollutants: - SOX and BC emissions for 1A3ai(i), 1A3aii(i), 1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3bv, 1A3bvi, 1A3bvii. During the review, the Party explained that the emissions were not calculate because there are no emission factors for BC for the Tier 1 method in the EMEP-2013 Guidelines and for SOX the calculation was not carried out. The ERT recommends Moldova to use the latest version of the 2016 EMEP/EEA Emission Inventory Guidebook to estimate the BC and SOX for the 1A3ai(i), 1A3aii(i), 1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3bv, 1A3bvi, 1A3bvii for all years. PCDD/F (dioxins/ furans), HCB and PCB emissions for 1A3bi, 1A3bii, 1A3biii, 1A3biv. During the review, the Party explained that the emissions were not calculated because the calculation methods were not studied. However, the 2016 EMEP/EEA Emission Inventory Guidebook states that there are emission factors for this category. So, the Party can report the same values for PCDD/ PCDF (dioxins/ furans), HCB and PCBs for 1A3bi, 1A3bii, 1A3biii, 1A3biv in future submissions. - NMVOC emissions for 1A3bv. During the review, the Party explained that the emissions were not calculated because the calculation methods were not studied. However, the 2016 EMEP/EEA Emission Inventory Guidebook states that there are emission factors for this category, please see the technical corrections chapter. So, the Party can report the same values for NMVOC for 1A3bv in future submissions. - PM2.5, PM10 and TSP emissions for 1A3bvi and 1A3bvii. During the review, the Party explained that the emissions were not calculated because the calculation methods were not studied. However, the 2016 EMEP/EEA Emission Inventory Guidebook provides emission factors for this category, which have been used for technical corrections for Moldova. The ERT notes that the same value as presented for TSP can also be used for PM2.5, PM10 and TSP for 1A3bvi and 1A3bvii in future submissions. - The ERT notes that no emissions are reported from NFRs 1A3bv, 1A3bvi and 1A3bvii categories. The ERT recommends the Party collect activity data and estimate the emissions.	Emissions for the indicated categories are calculated. We thank the drafters of the EMEP-2016 Guide and international experts who reviewed and analyzed previous IIR for calculation examples.
Consistency including recalculation and time series		

78	The ERT noted an inconsistent use of notation keys by the Republic of Moldova for the following sectors in the NFR emission reporting tables: - A3aii(i): In the NFR tables emissions from A3aii(i) - Domestic aviation LTO (civil) for HCB and PBCs are marked as "NE", but according to the Guidebook 2016 the notation key "NA" would apply. During the review, Moldova confirmed that "NA" should be used. - 1A3biv, 1A3di(ii), 1A4aii, 1A4bii and 1A4cii: In the NFR tables emissions from 1A3biv - mopeds & motorcycles, 1A3di(ii) - international inland waterways, 1A4aii - commercial/institutional: Mobile, 1A4bii - residential: household and gardening (mobile) and 1A4cii - agriculture/forestry/fishing: off-road vehicles and other machinery are noted as "IE" without an explanation in what category the values are included. The ERT recommends that Moldova documents the category where the emissions are included.	The recommendation has been implemented.
79	The ERT noted that there was a dip in the activities and emissions from the transport sector for the years between 1995 and 2002. The ERT notes that the reason for the dip was not provided in the IIR. The ERT encourages Moldova to explain the dip in the next IIR.	Trends in fuel consumption in the transport sector are described in the chapter Energy for each category.
Accuracy and uncertainties		
81	The ERT could not check for uncertainties because no uncertainty analysis was available. The ERT recommends Moldova to provide an uncertainty analysis and to use the results to inform the improvement process.	Uncertainties are calculated for all categories in IIR2020.
Improvement		
82	The ERT notes that the Party has made no improvements in the transport sector chapter of the IIR since the last Stage 3 review. The ERT recommends the Party to check that the notation keys are used according to the Reporting Guidelines and to include explanations for the use of the notation keys in the IIR, as well as to estimate the missing emissions.	Categories are detailed according to 1A3 in the current circle IIR-2019.
Potential Technical Corrections		
83	The ERT notes that there is an underestimation of particle emissions because Moldova does not report emissions from NFRs 1A3bv, 1A3bvi and 1A3bvii.	Emissions for the indicated categories are calculated.
84	The ERT prepared technical corrections for NFRs 1A3bvi and 1A3bvii for the years presented in the table below using information from Moldovia's IIR and methods from the 2016 EMEP/EEA Guidebook. The technical corrections are presented in details in the file "TC_Moldova_Review2018.xlsx". The ERT recommends the Party to include emissions from these sources into the next	Experts from the country thank international experts for examples of calculations for these categories.

	submission. In the calculation file emissions for the years 2009- 2014 are calculated as examples.	
85	The ERT also calculated NMVOC emissions from 1A3bv gasoline evaporation, as these were missing in the inventory. The contributions of these emissions to the national total NMVOC emissions are below 5% and are thus not regarded as technical corrections, but presented to the Party as guidance on how to calculate these emissions in the file "TC_Moldova_Review2018.xlsx".	Emissions for this category are calculated; experts thank international experts for the assistance provided.
Sub-Sector Specific Recommendations 1A3 Transport – All Pollutants		
86	The ERT notes that Moldova is currently using Tier 1 emission factors from the 2013 Guidebook to estimate emissions for all mobile sources. The ERT recommends that Moldova uses the latest version (2016) of the EMEP/EEA Emission Inventory Guidebook which contains the most up-to-date emission factors for the relevant sources.	The calculations were performed according to the recommendations of EMEP-2016 and its updated versions for certain categories (in 2017 and 2018). References to specific issues of the Guide are indicated in each table with emission factors
1A3ai(i) and 1A3aii(i) International aviation LTO – all pollutants		
87	During the review, the Party explained that emissions are not calculated because "the calculation methods were not studied". The ERT notes that the 2016 Guidebook provides emission factors for this category and that activity data are available in the Eurocontrol database. For information the Party can contact fuelandemissionsinventory@eurocontrol.int. The ERT recommends that Moldova estimates these emissions to the next submission.	The calculations were performed according to the categories of the motor transport sector for gasoline evaporation, road abrasion, tyre and brake abrasion. The methodology has been mastered; a series of primary data has been prepared for 1990-2017. Data for the Left Bank region are calculated using the indirect data method.
1.A.3.b Road transport – All Pollutants		
88	The ERT notes that for the road transport sector (1A3b) the Party used Tier 1 methods. The ERT recommends Moldova to use Tier 2 or a higher tier methodology to estimate emissions for 1A3b, as it is a key source of NOX, CO and PM10. The ERT also recommends Moldova to use the COPERT V model. The ERT informs that in the latest version of COPERT V there is the possibility to use the Tier 2 method to calculate emissions.	The COPERT program has been mastered, a group of experts (3 people) trained in its use. The difficulties lie in the inaccessibility of such a detailed list of vehicles, which is required in the program. However, further attempts to collect such information are planned.

89	The ERT notes that Moldova reports emissions from motorcycles and mopeds (1A3biv) using the notation key "IE". The ERT recommends the Party to calculate emissions from motorcycles and mopeds (1A3biv) separately and not as a part of emissions from passenger cars (1A3bi).	Emissions from fuel combustion of motorcycles are calculated.
INDUSTRIAL PROCESSES **General recommendations on cross cutting issues** **Transparency**		
90	The emission inventory for the industrial processes sector was detailed and transparent and the estimates were provided at the most detailed level for most of the sub-sectors. Also, the industrial processes sector was well described with good levels of detail in the methodology descriptions of the IIR. However, the ERT recommends Moldova to include more information on the activity variable evolution and the reasons for existing dips and jumps in trends of the activity data and the corresponding emissions for all emission source categories within the industrial processes sector.	Recommendation fulfilled. Republic Moldova thanks you for the recommendations submitted that improved the quality of the report in 2020.
Completeness		
92	The ERT notes that in the 2017 submission Moldova reported emissions and activity data rates for all categories in the scope of the industrial processes sector in NFR14 tables for all historic years, and also provided an IIR. However, as Moldova did not submit an inventory in 2018, neither an IIR nor NFR tables for 1990 – 2016 in 2018, the ERT recommends Moldova to provide its inventory, along with details for the industrial processes sector, on annual basis.	The objection was taken into consideration and in the following report the Republic of Moldova will present detailed information on the industrial processes by years.
Consistency including recalculation and time series		
96	The ERT noticed drops and peaks in activity data trends and consequently in the corresponding emissions with no explanations for them (please see sub-sector specific recommendations). The ERT encourages Moldova to include explanations for all outliers that occur in the pollutant emission trends and in activity data trends in its IIR.	The objection was taken into consideration and in the following report the Republic of Moldova will present detailed information on the evolution of emissions.
Comparability		
98	The ERT also considers the methods used for the emission calculations to be consistent with those presented in the 2013 Guidebook. However, the methods used are not consistent with those proposed in the 2016 version of the Guidebook, and the ERT considers that this may lead to potential overestimation or underestimation of emissions. The ERT recommends Moldova to check the use of methods according to the sub-sector specific recommendations presented below.	This objection was taken into account and in the IIR-2019g report the EMEP 2016 methods are used.
Accuracy and uncertainties		
99	The ERT recommends Moldova to undertake an uncertainty analysis for the industrial production sector in order to help	The objection was taken into account and in the IIR-2019

	inform the improvement process and to provide an indication of the reliability of the inventory data.	report uncertainties for the Industry sector are calculated.
Potential Technical Corrections		
102	The ERT noted that in the NFR14 tables in the category 2D3b there is a possible underestimation of TSP, PM10, PM2.5, BC emissions for the years 2005, 2010, 2015 due to a possible error in the unit conversion. The ERT prepared technical corrections for TSP and PM10 as presented in the table below using activity data reported by Moldova in the NFR tables, along with default Tier 1 emission factors from the 2016 Guidebook. The technical corrections are presented in detail in the file "TC_Moldova_Review2018.xlsx". The ERT recommends the Party to include emissions from these sources into the next submission.	This objection was taken into account and in the IIR-2019 report the emissions for category 2D3b are calculated according to the EMEP 2016 guide.
103	The contributions of the corrections for the pollutants PM10 (for other years than 2010), PM2.5 and BC, presented in the file "TC_Moldova_Review2018.xlsx", to the national total emissions are below 5% and these are therefore not proposed as technical corrections but as guidance on how to calculate these emissions.	This objection was taken into account in the IIR-2019 report.
Sub-Sector Specific Recommendations **Category issue 1: 2.A.1 Cement production - TSP, PM10, PM2.5, BC**		
104	The ERT notes that Moldova states on p.32 of the IIR submitted in 2017, that emissions from cement production were estimated using a Tier 2 methodology according to the 2013 Guidebook. The abatement efficiencies that Moldova is using for the source category 2A1 cement production for the period 1990-2010 are 98% for TSP, 80% for PM10, 73% for PM2.5 and for the period 2011-2014 93% for TSP, 34% for PM10, 40% for PM2.5. In the table with values of abatement efficiencies on p.33 of Moldova's IIR 2017, Moldova is stating that abatement efficiencies for the period 1990-2010 are 93% for TSP, 34% for PM10, 40% for PM2.5 and for the period 2011-2014 98% for TSP, 80% for PM10, 73% for PM2.5. The ERT asked Moldova to explain why there is a difference between these tables, and which values for the observed periods are correct. The ERT recommends Moldova to revise and to correct the corresponding data in its IIR.	This objection was taken into consideration and the IIR-2019 report the necessary corrections are made. Thanks for the objection.
105	There are several drops and peaks in clinker production and consequently in the corresponding TSP, PM10, PM2.5 and BC emissions (peaks in 1990 and 2008, drops in 1991 and 2009). In the IIR, there is no information on the activity variable evolution and the reasons for these drops and jumps in the trend of the activity data and corresponding emissions. The ERT encourages Moldova to include explanations for all outliers that occur in the pollutant emission trends in its IIR.	This objection was taken into account in the IIR-2019 report oscillations emitted from clinker production related to economic market demand were explained.
Category issue 2: 2.A.2 - TSP, PM10, PM2.5, BC		

106	During the review, the ERT noted that there are several drops and peaks in lime production and consequently in the corresponding TSP, PM10, PM2.5 and BC emissions (peaks in 1990, 1996, 2007, and drops in 1992, 1995, 2003, 2009). In the IIR, there is no information on the activity variable evolution and the reasons for these drops and jumps in the trend of the activity data and corresponding emissions. The ERT encourages Moldova to include explanations for all outliers that occur in the pollutant emission trends in its IIR.	Production from category 2A2 Lime production, depends on several factors, production, import and consumption both in the territory of the Republic of Moldova and in the ATULBD. The oscillations of production are explained by the specific of the economic market of the Republic.
Category issue 3: 2.A.3 - all		
107	During the review, the ERT noted that on p.38 of the IIR submitted in 2017, Moldova states that emissions from 2A3 glass production were estimated using Tier 1 method of the 2013 Guidebook. The ERT notes that this source category is a key source of Pb, Cd, As, Ni and Se emissions in 2015. Moreover, the ERT saw that Moldova has stratified glass production by the different technologies (flat glass, container glass and mineral wool) in the IIR. The ERT encourages Moldova to implement the Tier 2 methodology according to the 2016 Guidebook for the emission calculation.	The objection made was taken into account and in the IIR-2019 report Tier 2 method was used, according to the EMEP 2016 guide.
Category issue 4: 2.A.5.c - TSP, PM10, PM2.5		
108	During the review, the ERT noted that Moldova estimates emissions from 2A5c using the Tier 2 method of the EMEP/EEA Guidebook 2013 (p.45 of the Moldova´s IIR), in addition to using Tier 2 for 2A1 (p.31), using Tier 1 for 2A2 (p.35), using Tier 1 for 2A3 (p.37), using Tier 1 for 2A.a (p.41) and using Tier 1 for 2A5b (p.44). According to EMEP/EEA Guidebook 2016 (chapter 2.A.5.c) if for the relevant process chapters (such as 2A1) a Tier 1 or 2 methodology is applied, then emissions from storage, handling and transport are already included in the applied emission factors. Therefore, emissions from storage, handling and transport should not be reported separately. In this case, it is good practice to use a Tier 1 approach for this source category and to check the tier methods applied for the other chapters within the mineral industry (sector 2A), to avoid double counting of emissions from storage, handling and transport. If a Tier 2 method is applied for this source category (2A5c), it should be verified that the methods applied in the processes of the mineral industry do not include these emissions. Therefore, the ERT recommends Moldova to check that there is no double counting of TSP, PM10 and PM2.5 emissions from 2A5c including other 2A source categories.	The rigorous checks have been made and there is no duplicate emission calculation.
Category issue 5: 2.B.7 - CO, NH3, TSP		

109	During the review, the ERT noted that on p.48 of the IIR 2017, Moldova states that no soda ash or sodium carbonate (Na2CO3) is produced. However, Moldova calculates CO, NH3 and TSP emissions from this source category. In the 2016 Guidebook (also in the 2013 Guidebook), a methodology for production of soda is given. The ERT asked Moldova to provide the rationale for CO, NH3 and TSP emission calculations from soda ash production considering the fact that soda ash or sodium carbonate are not produced in Moldova. The ERT recommends Moldova to use the notation key "NO" (Not occurring) for source category 2B7.	In the Republic of Moldova there is no production of calcined soda, it is imported and used in the production of glass, soap, detergents and waste water treatment.
Category issue 6: 2.C.1, 2.C.7.d - TSP, PM10, PM2.5		
110	During the review, the ERT noted that on p.55 of the IIR submitted in 2017, Moldova states that emissions from iron and steel production were estimated using a Tier 1 methodology according to Guidebook 2013. In the 2016 Guidebook Chapter "2.C.7.d, 3 Methods": "If in the relevant process chapters (such as 2.C.1 Iron and Steel Production and 2.C.2 Ferroalloys Production) a Tier 1 methodology is applied,(1) the storage, handling and transport is already included in the applied emission factors. In this case an "included elsewhere" ("IE") notation key should be used for reporting under this NFR category 2.C.7.d to avoid double counting. Where higher tiers are used in the relevant process chapters, a separate estimate for the handling and storage should be made using the methods described below. In Tier 2, general emission factors are provided for emissions from storage, handling and transport of metal products. One should look carefully at the tiers applied in other chapters within subsector 2.C Metal Industry to avoid double counting of emissions from storage, handling and transport." The ERT recommends Moldova to check that there is no double counting of TSP, PM10 and PM2.5 emissions from NFR 2C7d including emissions from the NFR 2C1 source category.	For the IIR-2019 report in category 2C1, the Tier 2 method according to the EMEP 2016 guide, was used.
Category issue 7: 2.D.3.b - NOX, SO2, CO, PCDD/F, PAHs, HCB		
111	During the review, the ERT noted that Moldova uses the notation key "NE" – "Not estimated" for the reporting of NOX, SO2, CO, PCDD/F, PAHs, HCB emissions. According to the Guidebook 2016 (as well as the Guidebook 2013), Chapter "2.D.3.b": "Emissions of nitrogen oxides (NOx), sulphur oxides (SOx) and carbon monoxide (CO) are expected to originate mainly from combustion and are therefore addressed in chapter 1.A.2.g.viii." The ERT recommends Moldova to check this issue and to move all emissions, which are expected to originate mainly from combustion, from NFR 2D3b to the NFR 1A2gviii stationary	The objections were taken into account and the emissions for the 2D3b category were calculated correctly. NOX, SO2, CO emissions were included in 1A2g viii.

	combustion in manufacturing industries and construction: other.	
112	There are two peaks in 2D3b road paving with asphalt and consequently in the corresponding emissions (a larger peak in 1990 and a smaller one in 2007). In the IIR, there is no information that would explain these drops and jumps in the trend of the activity data and the corresponding emissions. The ERT encourages Moldova to include explanations for all outliers that occur in the emission trends in its IIR. The ERT recommends Moldova to check if the peak in 1990 and the smaller one in 2007 are related with the construction of big roads in Moldova and to provide information of that in its IIR.	The objections were taken into account and the peaks of 1990 and 2007 are related to the stages of road construction in the Republic of Moldova.
SOLVENTS **General recommendations on cross cutting issues** **Transparency**		
113	Moldova has provided a transparent emission inventory, considering NFR tables, as estimates are provided for all categories in the scope of the solvent sector. In the IIR, submitted in 2017, the chapter for the solvent sector is, however, missing. Moldova has reported emissions and activity data rates for all categories in the scope of the solvent sector in the NFR tables, but not in the IIR. The ERT was therefore not able to assess transparency between data in the NFR table and in the IIR. The ERT was neither able to assess the rationale for choices of data, methods and other inventory parameters, as well as the reasons for dips and jumps in emission trends.	All the information is presented in the IIR-2019 report, for verification.
114	The ERT encourages Moldova to include in its IIR general descriptions of activities falling under the source categories in Moldova as well as descriptions of methodologies, emission factors and activity data used for emission estimation. In addition, information on recalculations and improvements made and planned should be included in the IIR. The ERT recommends Moldova to put this activity in the short time-scale planned improvements in order to achieve transparency, comparability and consistency of the inventory for the solvent Sector and to report an IIR for the solvent sector on an annual basis.	Moldova included in its IIR-2019 report general descriptions of activities that fall under the source categories in Moldova, as well as descriptions of methodologies, emission factors and activity data used to estimate emissions.
115	Moldova uses appropriate notation keys in its NFR14 tables for the solvent sector. The use of the notation key “IE” where emissions are “Included Elsewhere” is limited, only for one source category (NFR 2D3f Dry cleaning) in the solvent Sector.	The objections were taken into account and the necessary corrections were made in the new report.
Completeness		

116	The ERT consider the Solvent sector to be complete and comprehensive. In the 2017 submission, Moldova has reported emissions for the solvent sector for 1990 - 2015 in the latest NFR14 format. The ERT commends Moldova for reporting emissions from the solvent sector for all historic years and recommends Moldova to continue the good practice.	Thank you for your appreciation and we are willing to continue working together.
Consistency including recalculation and time series		
117	Moldova has not reported on recalculations made its inventory for the solvent sector. The ERT encourages Moldova to provide information on recalculations, including the rationale and the impact on the solvent sector and on the implication of recalculations to trends for the solvent sector in its IIR.	Moldova provided information on recalculations, including justification and impact on the solvent sector, as well as the consequences of recalculations on trends in the development of the solvent sector in the IIR-2019 report.
118	The ERT noted dips and jumps in historic trends of the activity data and the respective pollutant emissions for NFR categories 2D3d, 2D3g, 2D3h, 2D3i and 2.G. In the IIR submitted in 2017, no information is provided on the fluctuations of the time series. The ERT encourages Moldova to include in its IIR the information on the reasons for fluctuations in the activity rates and emissions along with other missing information as explained under "Transparency".	The Republic of Moldova is a developing country, resulting in its retail market being influenced by different economic and social factors, creating conditions of variation in the demand and consumption of solvents.
Comparability		
119	The ERT considers that the methods used for the emission calculation are consistent with those proposed in the 2013 Guidebook. To ensure consistency with other reporting Parties, the ERT recommends Moldova to move to the 2016 version of the Guidebook in its next submission when the translation of the 2016 Guidebook into Russia is finalized (scheduled for summer 2018). In case other methods are used than those presented in the Guidebook, the ERT recommends Moldova to document the methods and to provide references to data and information sources used, to increase comparability of the inventory to those of the other reporting Parties.	The IIR-2019 report used the methods according to the EMEP 2016 guide.
Accuracy and uncertainties		
120	The ERT recommends Moldova to undertake an uncertainty analysis for the solvent sector in order to help inform the improvement process and to provide an indication of the reliability of the inventory data.	Recommendation fulfilled.
121	The ERT encourages Moldova to further develop QA/QC procedures and to implement sector specific OA/QC	Recommendation fulfilled.

	procedures for the solvent sector in order to ensure the accuracy of the inventory.	
Improvement		
122	The ERT recommends Moldova to include an improvement plan with schedules for the solvent sector to the next submission, and to include in the plan recommendations from the inventory reviews.	Recommendation fulfilled.
Sub-Sector Specific Recommendations Category issue 2: 2.D.3.a, 2.D.3.d, 2.D.3.g, 2.D.3.h, 2.D.3.i, 2.G – all		
123	During the review, the ERT noted that in the IIR submitted in 2017, there is no information for NFR source categories 2D3a, 2D3d, 2D3g, 2D3h, 2D3i and 2G regarding the description of the activities as well as for the description of methodologies, emission factors and activity data used for estimation of emissions. In addition, no information is provided on recalculations and improvements made nor on the planned improvements in the solvent sector. The ERT encourages Moldova to include all this information in its IIR of the next submission.	Moldova described activities and also described methodologies, emission factors and activity data used to estimate emissions. In addition, information on recalculations and improvements made in the solvent sector were provided in the IIR-2019 report.
Category issue 1: 2.D.3.a – NMVOC, Hg		
124	During the review, the ERT noted that Moldova reports NMVOC emissions from category 2D3a and for Hg emissions, Moldova uses the notation key "NE" – "Not estimated". According to the 2016 Guidebook (and also the 2013 version of the Guidebook) activity data for Tier 1 emission calculation is the population rate in the country. The 2016 Guidebook provides a Tier 1 emission factor for Hg (which is the same as for Tier 2). The ERT recommends Moldova to use population data along with the Tier 1 emission factor to calculate Hg emissions from fluorescent tubes and to report these emissions in the NFR tables and to document the calculation in the IIR.	The objections were taken into account and in the IIR-2019 report the calculations were made based on the population number Tier 1, guide EMEP 2016.
125	In the IIR submitted in 2017, there is no information on the use of the 2013 Guidebook methodology for NMVOC emission calculation. The ERT concludes from the data reported in the NFR tables that Moldova uses Tier 1 methodology. As the source category 2D3a is a key category for NMVOC emissions in almost all countries and also in Moldova, the ERT recommends Moldova to calculate these emissions using a Tier 2 method from the 2016 Guidebook. According to the Reporting Guidelines, emissions from key categories shall be estimated using a Tier 2 or higher method to increase the accuracy of the estimates.	Due to the lack of statistical data regarding the import, consumption and the production of solvents is very small, the Tier 1 method, according to guide EMEP 2016 was used in the IIR-2019 report.
Category issue 2: 2.D.3.d, 2.D.3.g, 2.D.3.h, 2.D.3.i, 2.G – all		
126	During the review, the ERT noted dips and jumps in trends of the activity data and the corresponding NMVOC emissions	Moldova included in its IIR-2019 information on the causes

	for NFR categories 2D3d, 2D3g, 2D3h, 2D3i and 2G. In the IIR submitted in 2017, no information is provided on the fluctuations of the time series. The ERT recommends Moldova to include in its IIR information on the reasons for fluctuations in the activity rates and emissions.	of fluctuations in activity and emissions.
Category issue 3: 2.D.3.f – NMVOC		
127	During the review, the ERT noted that Moldova uses the notation key "IE" – "Included elsewhere" for the source category 2D3f in the NFR tables. The ERT encourages Moldova to provide information in which source category and why the emissions are included, in the IIR of the next submission.	In the IIR-2019 report there are not such notes.
Category issue 4: 2.D.3.i, 2.G – all		
128	During the review, the ERT noted that Moldova reports emissions from 2D3i other solvent use and 2G other product use. In the IIR submitted in 2017, there is no information on which activities are included in these two categories. The ERT encourages Moldova to include information of activities reported under categories 2D3i and 2G in the IIR of the next submission. The ERT recommends Moldova to use the mapping table (ConversionTableReportingCodes_October2015) available on link: http://www.ceip.at/ms/ceip_home1/ceip_home/reporting_instructions/ for stratification of activities between the categories 2D3i and 2G. According to the mapping table, use of fireworks, tobacco combustion, use of shoes, use of concrete additive, cooling lubricant, lubricant, pesticide, aeroplane de-icing agent are in the scope of NFR 2G other product use. Moreover, emissions from fat and edible oil extraction, glass wool enduction, mineral wool enduction, application of glues and adhesives, preservation of wood, underseal treatment and conservation of vehicles, vehicles dewaxing and other (preservation of seeds etc.) fall under category 2D3i other solvent use.	The IIR-2019 report included the activities for categories 2Di and 2G4 according to the EMEP 2016 guide: 2.Di: SNAP: 060404; 060405; 060406; 060 407; 060409. 2.G4: SNAP:060602; 060603.
129	The ERT considers that most of the activities listed under NFR 2G exist in Moldova. The ERT recommends Moldova to collect statistical data for all the activities listed above, to estimate all relevant emissions, and to include all emissions in the NFR tables and to document the calculations in the IIR of the next submission.	Recommendation fulfilled.
130	The ERT considers that most of activities falling under NFR 2D3i exist in Moldova. The ERT recommends Moldova to collect statistical data for all listed activities, to estimate all relevant emissions, and to include the emissions in the NFR tables and to document all calculations in the IIR of the next submission.	Recommendation fulfilled.

AGRICULTURE **General recommendations on cross cutting issues** **Transparency**		
131	The Republic of Moldova has provided a relatively detailed and generally transparent emission inventory for the agriculture sector. Emission estimates of NOX, NMVOC, NH3 and PMs from most of the sources within the sector are reported for the time-series 1990-2015. In addition, emissions estimates of HMs and POPs from field burning of agricultural residues (3F) are also given. However, the Party did not report emission estimates for the year 2016. A separate chapter on the agriculture sector in the IIR (submission 2017) is provided. The ERT recommends that the Republic of Moldova includes emissions from the whole time series as requested in the Reporting Guidelines, including emissions for the year 2016 data in the next submission.	Recommendation fulfilled in IIR-2019.
132	The ERT considers the methodologies used in the preparation of the agriculture inventory to be well-described in the IIR. The ERT commends the Republic of Moldova for the efforts to make the inventory transparent. However, the ERT encourages the Republic of Moldova to continue enhancing the transparency of the agriculture inventory, by including more details of the national circumstances that impact the emissions in future submissions.	The recommendation has been taken into account.
Completeness		
133	The ERT considers the agriculture inventory of the Republic of Moldova to be generally complete as it covers many pollutants from to the most important emission sources. The ERT commends the Republic of Moldova for the generally complete inventory and the good level of detail for the methodology descriptions. The ERT recommends that the Party uses the correct notation keys to report emissions in the NFR tables, for more details see the sub-sector specific recommendations.	The recommendation has been taken into account.
134	However, the Party did not estimate PM emissions from off-farm storage, handling and transport of bulk agricultural products (3Dd) and instead used the notation key "Not occurring" ("NO"). The ERT recommends that the Party uses the correct notation key "Not estimated" ("NE") instead of "NO" to report PM emissions from this source.	NE notation key was used instead of NO in the NFR and IIR-2019.
135	Similarly, the ERT also noted that emission of hexachlorobenzene (HCB) from the use of pesticides (3Df) is reported as "NO", although efforts have been made by the Party to estimate emission from this source as indicated in the IIR.	In IIR-2019, HCB from the 3Df category is not estimated (NE).
Consistency including recalculation and time series		

136	The Republic of Moldova has used consistent methodologies, i.e. Tier 1 and Tier 2 methods, from the 2013 Guidebook to calculate emissions from manure management for the time series 1990-2015. The Party has indicated in its IIR that emissions from manure management (3B) have been revised using the 2013 Guidebook and an updated set of activity data of animal population. The ERT commends the Party for the efforts to make the inventory consistent and for the latest recalculation work. However, the ERT encourages the Party to further improve the time series consistency by providing more detailed explanations of the recalculations, including the rationale for them, the impact on the emissions of the sector and the implication of the total emission trends in the next annual submission. For details see the sub-sector specific recommendations.	The recommendation has been taken into account.
Comparability		
137	The ERT notes that the inventory of Moldova is almost comparable with those of other reporting Parties as the methods used for estimating emissions from the agriculture sector are consistent with those proposed in the 2013 Guidebook. The ERT notes that the Reporting Guidelines request the use of the latest version of the Guidebook, currently the 2016 version, however, the translation of the 2016 Guidebook will only be finalized only during summer 2018. If other methods would be used, the ERT therefore recommends the Party to document these in the IIR to enable comparability with other reporting Parties.	The recommendation has been taken into account. The inventory IIR-2019 was made according to the 2016 Guidebook.
138	The ERT notes that emissions from most of the animal categories under 3B have been estimated using a country-specific methodology (Tier 2), as the manure type for each animal livestock was determined according to the manure management system distribution data. The ERT commends the Republic of Moldova for applying Tier 2 methodologies and documenting these in the IIR.	Recommendation has been taken into account. In the IIR-2019 report, emissions from the 3B categories have been estimated by the Tier 1 method, according to the EMEP/EEA 2016 Guidebook.
139	The ERT notes that NH3 emissions from NFR 3D, i.e. 3Da2 (Inorganic N-fertilizers) is a key category and therefore recommends the Party to apply Tier 2 methodologies for estimating these emissions. According to the Reporting Guidelines Tier 2 or higher tier methods should be used to estimate emissions from key categories.	In IIR-2019 Tier 1 method, according to EMEP/EEA 2016 Guide was used, due to limited initial datasets available from country statistics.
Accuracy and uncertainties		
140	The Republic of Moldova has prepared an uncertainty analysis for its agriculture inventory based on the recommended error ranges of emission factors provided in the 2013 Guidebook. The ERT commends the Party for estimating uncertainties for the sector and recommends that	The recommendation has been taken into account. The inventory IIR-2019 was made according to the 2016 Guidebook.

	the Party uses information on uncertainties from the 2016 Guidebook in its next annual submission.	
141	The ERT noted that sector-specific QA/QC procedures are described in the IIR and that detailed QA/QC checks have been performed for the sector. The ERT commends Republic of Moldova for undertaking OA/QC procedures.	The recommendation has been taken into account. The inventory IIR-2019 was made according to the 2016 Guidebook.
Improvement		
142	The Republic of Moldova has indicated in its IIR that a number of improvements are planned in the future: - Category 3B manure management is a key source of NH3, N2O, NMVOC and PM emissions in the Republic of Moldova. For the next inventory cycle the possibility to collect additional data in order to apply Tier 2 methodology. - Development of technology specific emission factors for the calculation of PM emissions from 3D crop production and agricultural soils including storage, handling and transport of agricultural products.	The recommendation has been taken into account.
143	Category 3F is a relevant source of CO, SO2, POPs, heavy metal emissions. For the next inventory cycle the possibility to collect additional data in order to apply Tier 2 methodology.	The recommendation has been taken into account for the inventory IIR-2019.
144	The ERT commends the Party for the improvements in the inventory provided in the submission in 2017. However, the ERT recommends the Party to implement the planned improvements in the next submission in order to enhance the quality of the inventory.	The recommendation has been taken into account for the inventory IIR-2019.
Sub-Sector Specific Recommendations **Category issue 1: Other poultry (3B4giv) and Turkeys (3B4giii) - NH3**		
146	The ERT noted that there is a strong dip in the NH3 emission trend between 2001 and 2003 for other poultry (3B4giv) and a large decline in NH3 emission trend between 2012 and 2014 for turkeys (3B4giii). No explanation has been given in the IIR. The ERT asked the Party during the review to explain these deviations. The Party did not respond to the question raised by the ERT. The ERT recommends that the Republic of Moldova explains these issues in the next submission to enhance the transparency of its inventory.	The recommendation has been taken into account. The inventory IIR-2019 was made according to the 2016 Guidebook, and the right values are entered. According to the statistical data, in the mentioned period there was a decline in the Republic of Moldova population due to work migration of the people.
Category issue 2: Cultivated crops (3De) - NMVOC and PM10		
147	The ERT noted that emission estimates for NMVOC and PM10 in 2002 are very low in relation to the general emission trends of the entire time-series. The ERT asked the Party during the review to explain this issue. The Party did not	The time series and the initial data were updated in the IIR-2019. There are no such trends

	respond to the question raised by the ERT. The ERT recommends that the Republic of Moldova explains the observed deviation in the emission trend of these two pollutants in the next submission to enhance the transparency of the inventory.	in the estimated emissions in the IIR-2019.
Category issue 3: Farm-level agricultural operations including storage, handling and transport of agricultural products (3Dc) and Off-farm storage, handling and transport of bulk agricultural products (3Dd) - PM10 and PM2.5		
148	The Republic of Moldova reported emissions of PM from 3Dc and 3Dd as "NO". The ERT recommends that the Party uses the correct notation key "NE" ("Not Estimated") instead of "NO" ("Not Occurring") to report PM emissions from this source and recommends the Party to collect activity data and to estimate and report these emissions in the next submission.	The recommendation has been taken into account in the IIR-2019.
Category issue 4: Use of pesticides (3Df) – HCB		
149	The Republic of Moldova did not estimate HCB emissions from NFR 3Df although efforts have been made to calculate the emission from this source as indicated in the IIR. Emissions of HCB from this category are reported as "NO". The ERT reminds the Party that the use of pesticides in agriculture can be a source of POP emissions due to the presence of HCB in some pesticides as a contaminant. The ERT recommends that the Party uses the correct notation key "NE" instead of "NO" to report emission of HCB from this source and to study if HCB occurs as an impurity in any of the pesticides used in the country, and to estimate the related emissions.	The recommendation has been taken into account. The NE notation key was used in IIR-2019.
Category issue 5: Field burning of agricultural residues (3F) - NOX, SO2, NMVOC, NH3, PMs and HMs		
150	The ERT noted that the aggregated emission estimates of some air pollutants from NFR 3F are extremely small (e.g., NOX 0,000003240999 kt or about 3 kg and PM2.5 emissions 0.000000719226 kt or about 0.72 kg). The ERT asked the Party during the review to provide an explanation on this issue. The Party did not respond to the question raised by the ERT. The ERT recommends that the Republic of Moldova checks the units of the activity data, emission factors and in the results of the calculation of emissions, and enhances the use of QA/QC procedures in its inventory to avoid errors, or explains the reason behind the low emission estimates of these pollutants (e.g. the low level of activity) from this source in its next submission.	The recommendation has been taken into account in the IIR-2019.
Category issue 6: Field burning of agricultural residues (3F) - BC		
151	The Republic of Moldova has reported emissions of black carbon from NFR 3F. However, the ERT noted that the reported emission estimate for BC in 2002 deviates strongly from the general emission trend in the time series. The ERT	The recommendation has been taken into account.

	asked the Party during the review process to comment on this issue. The Party did not respond to the question raised by the ERT. The ERT encourages the Republic of Moldova to explain the deviation in the emission trend in the next submission in order to promote the transparency of the inventory.	
Category issue 7: Inconsistency in the reported emission in the reporting templates (NFR) and IIR - NH3, NMVOC, NOX and PM2.5		
152	The ERT noted that the emission estimates of some pollutants (e.g., NH3, NMVOC, NOX and PM2.5) for 2015 in the NFR tables differ from those provided in the IIR (e.g., NH3 emission from 3B in the NFR table is 17.59 kt while in the IIR is 16.79 kt (p.70) and NH3 emission from 3Da1 is 4.2 kt in NFR tables while it is 4.93 kt in the IIR). The ERT asked the Republic of Moldova during the review to explain the observed inconsistency between the IIR and the NFR table. The Party did not respond to the question raised by the ERT. The ERT recommends that the Party enhances the use of QA/QC procedures for its inventory to avoid such errors in the future.	The recommendation has been taken into account. The inventory IIR-2019 was made according to the 2016 Guidebook, and the right values are entered.
Category issue 8: Inconsistency in reporting NFR codes in IIR		
153	The ERT noted that the Party has used incorrect NFR codes to describe many animal categories in its IIR (Agriculture chapter, page 4), such as 3B2 other cattle, 3B4 sows, 3B5 sheep and also horses, laying hens, broilers, other poultry, goats, fur animals, and mules. The ERT strongly encourages that the Party uses the correct NFR codes in the IIR as in the NFR tables in its next submission.	The recommendation has been taken into account. The inventory IIR-2019 was made according to the 2016 Guidebook and correct NFR codes were used.
WASTE **General recommendations on cross cutting issues**		
154	Moldova reported emission estimates for some sources and pollutants in its 2013 NFR submission. Since then, including the 2017 submission, Moldova has not included waste sector estimates in its submission. The 2017 IIR does not include information on the waste sector. Moldova has not responded to a request for information on the waste sector as part of the review. The ERT strongly recommends that Moldova reports a complete waste sector emission inventory in its next submission. The ERT encourages Moldova to document the activities included and the methods used to estimate emissions in its next IIR.	Moldova presented a complete inventory of emissions in the waste sector in the IIR-2019, the included activities and methods used to estimate emissions are documented.
Transparency, Completeness, Consistency, Comparability and Accuracy		
155	During the review the ERT asked Moldova to provide any available information on past or present emission estimates or any supporting information in the waste sector that may be available. The ERT didn't receive an answer to the question and therefore it was not possible to conduct a thorough	Moldova provided emissions estimates for the waste sector in IIR-2019.

	review. In order for the ERT to be able to provide any support to Moldova, or to assess the completeness, consistency, comparability and accuracy of the waste sector inventory, Moldova needs to provide waste sector emission estimates and to outline the methods in the IIR.	
Improvement		
156	Moldova has not provided an overview of the progress made as a result of any previous ERT recommendations. Given the lack of response to the question on the issue, the ERT encourages Moldova to report on improvements already made and to present an inventory improvement plan with schedules in the next IIR submission.	Recommendation fulfilled in IIR-2019.
Potential Technical Corrections		
157	No potential technical corrections (PTCs) were prepared due to the lack of activity data or emission estimates available for the waste sector. Moldova neither provided response to the ERT on the questions raised during the review. The ERT strongly recommends that Moldova provides estimates of waste sector emissions across sources and pollutants with methodologies included in the Guidebook in its next submission.	Moldova provided estimates of emissions from the waste sector by source and pollutant with methodologies included in the Guidelines in the IIR-2019.
Sub-Sector Specific Recommendations **Category issue 1: 5A Solid waste disposal on land – All pollutants**		
158	The last emission estimates provided by Moldova for this category were made for NMVOC in the 2013 submission. More recent submissions did not include emission estimates and no response was received related to the lack of reporting during the centralized review. The ERT recommends that Moldova includes estimates of NMVOC and NH3 (where Guidebook methodologies are available) from this category as part of its next inventory.	Recommendation fulfilled in IIR-2019.
Category issue 2: 5B1 and 5B2 Biological treatment of waste - all pollutants		
159	The ERT notes that Moldova has not provided emission estimates or notation key information in its NFR for categories under the waste sector 5B. The ERT recommends calculating and reporting emissions from these sources in the NFR tables and providing a description of methodology, AD and EFs used in the IIR of the next submission. Alternatively, if the activity does not occur in Moldova, the appropriate notation key "NO" should be applied in Moldova's next NFR submission.	The NO notation key was used for the waste sector 5B in IIR-2019.
Category issue 3: 5C1 All waste incineration – all pollutants		

160	The last emission estimates provided by Moldova for waste incineration were made for Pb and PCDD/F only for the sub-category 6Ca clinical waste incineration (NFR09 format) in the 2013 submission. More recent submissions did not include estimates and no response was received related to the lack of reporting as part of this centralized review. The ERT recommends that Moldova includes estimates of all applicable pollutants from this sub-category as part of its next inventory, as well as provides emission estimates or appropriate notation keys for all other waste incineration sub-categories in its next NFR submission.	Recommendation fulfilled in IIR-2019.
Category issue 4: 5C2 Open burning of waste – all pollutants		
161	The last emission estimates provided by Moldova for this category were for NOx, SOx, TSP and CO only under sub-category 6D other waste (NFR09 format) in the 2013 submission. More recent submissions have not included estimates and no response has been received related to the lack of reporting as part of this centralized review. The ERT recommends that Moldova includes estimates of all applicable pollutants from this sub-category in the current NRF14-02 format as part of its next inventory.	Recommendation fulfilled in IIR-2019.
Category issue 5: 5D All waste water handlings – all pollutants		
162	The last emission estimates provided by Moldova for this category were made for NH3 in the 2013 submission. More recent submissions have not included estimates and no response has been received to the questions related to the lack of reporting as part of this centralized review. The ERT recommends that Moldova includes estimates of NMVOC and NH3 (where Guidebook methodologies are available) from this category as part of its next inventory.	Recommendation fulfilled in IIR-2019.