MINISTRY OF ENVIRONMENTAL PROTECTION
AND NATURAL RESOURCES OF UKRAINE

UKRAINE'S INFORMATIVE INVENTORY REPORT 2021

Submission under the UNECE CLRTAP

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Ukraine's Informative Inventory Report 2021

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

Report elaborated by:

Ministry of Environmental Protection and Natural Resources of Ukraine

State Statistics Service of Ukraine

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Photo on the front page depicts Carpathian mountains. Author: Dmytro Averin

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EXECUTIVE SUMMARY

This Informative Inventory Report (IIR) of Ukraine presents and describes data submission 2021 under the Gothenburg Protocol under the United Nations Economic Commission for Europe (UNECE) Convention on Long- Range Transboundary Air Pollution (CLRTAP).

The report contains information on emission inventories in Ukraine from 1990 to 2019. The report contains descriptions of methods, data sources, data quality assurance measures, the analysis of key categories and the analysis of trends.

The estimation of emissions in Ukraine takes into account nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), sulfur oxides (SOx), ammonia (NH_3), particulate matter ($PM_{2.5}$ and PM_{10}), total suspended particles (TSP), black carbon (BC), carbon monoxide (CO), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn), persistent organic pollutants, including PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs).

The report is prepared in fulfillment of Ukraine's obligations under the UNECE Convention on Long-Range Transboundary Air Pollution.

The structure of the report is in line with the template of the Informative Inventory Report attached to the Convention on Long-range Transboundary Air Pollution.

From 1991 to 2000, there was a tendency to reduce emissions of all air pollutants due to a decrease in energy production, industrial, agricultural production and waste generation resulting from the changes in production structure. From 2000 to 2019 there was a gradual increase in emissions of SO_2, CO, dust, Pb, Zn, Cd, Hg, As, Cr, Se, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1 ,2,3-cd)pyrene, HCB and PCB due to the increased use of coal for electricity and heat production and the growth of industrial and agricultural production in Ukraine.

1 INTRODUCTION

1.1 National Inventory Background

The estimation of air pollutant emissions in Ukraine is mainly based on official statistics on fuel use, production, pollutant emissions from enterprises etc., and emission factors. When calculating the emissions of air pollutants, Ukraine follows the recommendations of the EMEP/EEA Emission Inventory Guidebook [4].

1.2 Institutional arrangements

The Ministry of Environmental Protection and Natural Resources of Ukraine is responsible for the preparation of reports under the Convention on Long-range Transboundary Air Pollution and its protocols. The Ministry is responsible for institutional, legal and procedural measures, as well as for strategic planning to improve the process of monitoring, reporting and developing the inventory of air pollutant emissions.

In addition to the Ministry of Environmental Protection and Natural Resources of Ukraine and the State Statistics Service of Ukraine, the following institutions take part in the preparation of the inventory:

- central executive bodies;
- local authorities;
- research institutes of the National Academy of Sciences of Ukraine and other state research institutes;
- independent experts.

The structure of interdepartmental interaction in compiling the emission inventory is shown in Figure 1.2.1.

To improve the interdepartmental cooperation and the process of inventory preparation in Ukraine, it is necessary to introduce new institutional arrangements and develop legislation to improve data quality, the process of data sharing and inventory compilation, introduce modern software, etc.

During 2021-2022 it is planned to create a database of emissions and activity data of the Ministry of Environmental Protection and Natural Resources of Ukraine as well as to develop and implement software for the automatization of the reporting process on the Convention on Long-range Transboundary Air Pollution and its protocols in the course of the implementation of the pilot project as part of the project "Support to Ukraine in the approximation of the EU Environmental Acquis" supported by the EU.

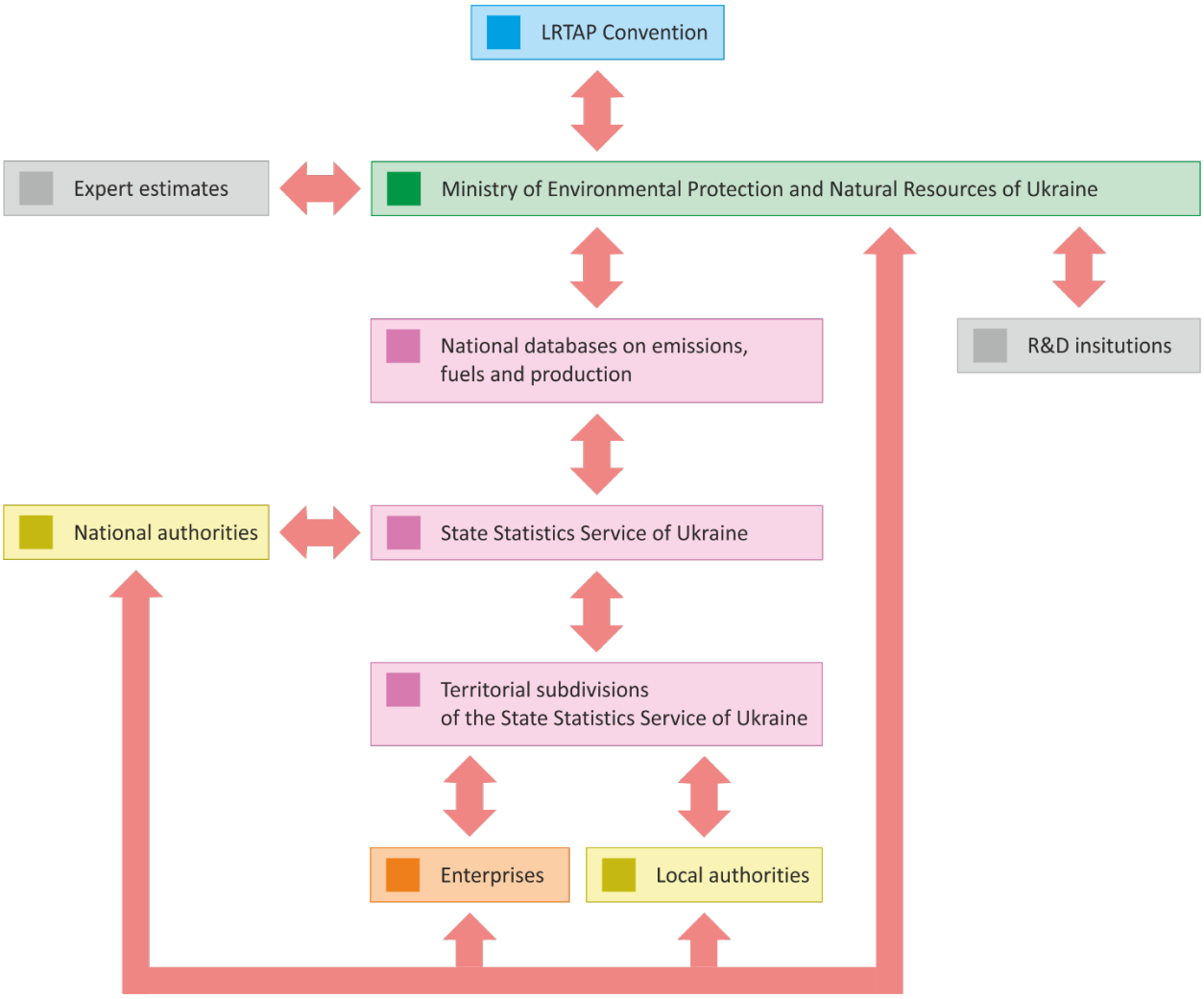

Figure 1.2.1. The structure of interdepartmental interaction in developing the emission inventory

1.3 Inventory preparation process

The estimation of emissions by category is based on the methodology developed by EMEP/EEA [4]. Where necessary and possible, national methodologies and emission factors that reflect country-specific conditions are developed.

The activity data are mostly obtained from official statistical reports of the State Statistics Service of Ukraine. Where the statistical reports do not cover the necessary information, the data are obtained by the method of expert assessments or from research reports prepared by state research institutions.

The emission data are stored in the database of the State Statistics Service of Ukraine and processed by experts responsible for the preparation of the Informative Inventory Report (IIR).

The database is constantly updated and expanded to meet modern emission reporting requirements.

To prepare the emission inventory, the Ministry of Environmental Protection and Natural Resources of Ukraine cooperates with a number of institutions, such as the State Statistics Service of Ukraine, the National Emission Center, local administrations, research institutes etc., as well as with individual experts.

1.4 Methods and data sources

The emission inventory presented in this report is in line with the recommendations of the EMEP/EEA Emission Inventory Guidebook [4]. In accordance with these recommendations, T1, T2 and T3 emission estimation methods were used in Ukraine. Where appropriate and possible, more accurate calculation methods were used, especially for key categories. For categories where emissions do not occur or are not estimated, the corresponding abbreviations were used in the tables. A more detailed description of the methodologies used to prepare the emission inventory is provided in sections 3–7 of this report. The data used in this report are based on officially published data, such as national statistical publications, reports of central executive bodies, scientific publications and expert assessments.

Due to the shortcomings of statistics collection system for air pollutant emissions data collected from the respondents on the basis of 2-TP forms for state statistical observation (air)(annual) "Report on stationary sources emissions of air pollutants and greenhouse gases" [5] and Methodological guidelines for the organization of state statistical observation of air pollutant emissions and greenhouse gases from stationary emission sources [6] (e.g., lack of reporting on $PM_{2,5}$ and PM_{10} from some respondents, lack of statistical reporting from small enterprises and households) T1/T2 methods were used to calculate most of the key categories.

NFR Category 1 emissions were estimated on the basis of fuel consumption data and relevant emission factors. Stationary sources fuel consumption data by type and category of fuel were obtained from the official energy balance and the Report on fuel use and supplies by industries [1,2] prepared by the State Statistics Service of Ukraine.

NFR Category 2 pollutant emissions are mostly estimated by the amount of products produced in accordance with the data of the State Statistics Service of Ukraine and the Statistical guidebook "Industrial production by type" [10].

To calculate agricultural emissions the data from the State Statistics Service of Ukraine on the number of livestock animals [11] and the data collected from respondents on the basis of 2-TP forms for state statistical observation (air)(annual) "Report on stationary sources emissions of air pollutants and greenhouse gases" [5] were used.

To calculate waste management emissions mostly the data from the State Statistics Service of Ukraine collected on the basis of 2-TP forms for state statistical observation (air)(annual) "Report on stationary sources emissions of air pollutants and greenhouse gases" [5] were used.

When calculating T3 level, the national categories of production and technological processes, technological equipment (plants) described in sections 2-7 and listed in Annex 3 of this report were used.

The emission factors used to estimate the emissions in 2019 are presented in Annex 2.

1.5 Key categories

The analysis of key categories of air pollutant emissions is based on the EMEP / EEA Emission Inventory Guidebook [4]. The basic approach to key categories estimation is based on the calculation of each category's contribution to the national emission level. According to this approach, the key categories are the sources accounting for up to 80% of total national emissions.

This report contains the assessment of the levels of the following pollutants: NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, basic heavy metals, PCDD/PCDF, benzo(a)pyrene, HCB and PCBs.

Table 1.5.1 presents general information on key categories in the national emission inventory for 2019. Category 1A is the main source of most pollutant emissions. Categories 1A and 2C are the main sources of Pb, Cd and Hg emissions. Agriculture (3B, 3D) is the main source of NH3 and HCB emissions.

Table 1.5.1. Key categories in the national emission inventory for 2019

Pollutant	Category [1]											Total
NOx	1A1a 35,7%	1A3bi 10,0%	1A2a 7,5%	1A3bii 5,3%	1A4bi 4,7%	1A4ci 3,8%	1A5a 3,4%	2B2 3,3%	1A1c 3,1%	1A3biii 2,7%	1A1b 2,3%	81,8%
NMVOC	1A4bi 20,1%	3B1b 20,0%	1A1a 12,0%	2H2 9,1%	1A3bi 7,2%	1B2aiv 4,3%	1A2a 4,2%	5C1bi 2,3%	1A5a 2,1%			81,5%
SOx	1A1a 67,3%	1A2a 11,5%	1A1c 7,5%									86,3%
NH_3	3B1b 68,2%	3B4e 20,0%										88,2%
$PM_{2.5}$	1A4bi 34,4%	1A1a 22,7%	1A1c 19,9%	1A2a 6,3%								83,3%
PM_{10}	1A4bi 26,4%	1A1c 21,4%	1A1a 18,7%	1A2a 5,1%	2A5a 4,4%	2A6 3,2%	2C1 3,0%					82,1%
TSP	1A4bi 23,7%	1A1c 18,8%	1A1a 16,9%	2A5a 7,5%	1A2a 4,6%	2C1 4,2%	2A2 3,9%	2A6 2,8%				82,4%
BC	1A4bi 47,0%	1A1a 25,0%	1A2a 7,5%	1A2gviii 5,1%								84,6%

[1] Energy IPPU Agriculture Waste

CO	1A4bi 25,6%	1A3aii(i) 21,0%	1A1a 19,0%	1A3bi 10,8%	1A2a 6,6%		83,0%
Pb	2C1 63,2%	1A1a 18,1%					81,3%
Cd	1A1a 24,3%	1A1c 19,9%	1A4bi 19,0%	2C1 15,1%	1A1b 4,1%		82,3%
Hg	1A1c 65,7%	2C1 13,3%	1A1a 13,2%				92,1%
PCDD/ PCDF	5C1bi 48,1%	2C1 19,6%	1A4bi 12,0%	1A1a 10,9%			90,7%
BaP	1B2av 42,1%	2A6 23,7%	1A1c 13,2%	1B1b 10,5%			89,5%
HCB	3Dc 62,7%	5C1a 25,8%					88,5%
PCBs	2C1 46,0%	1A1a 30,6%	1A2a 7,9%				84,5%

1.6 QA/QC and verification methods

To ensure the quality of data obtained by collecting information directly from respondents, the State Statistics Service of Ukraine monitors the level of reporting by respondents and analyzes the reasons for failures to provide such data.

The State Statistics Service of Ukraine uses the following methods of data quality assurance:

- analysis of data over time (comparison of data for the reporting year with the previous year);
- geographical analysis of data (comparison of data by regions);
- analysis of data distribution (analysis of the data that diverge significantly from the main data distribution).

In addition, to verify the quality of data calculated at T1/T2 levels, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of air pollutants and greenhouse gases from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of air pollutants and greenhouse gases from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Annex 3.

On completion of the NFR table, experts analyze and compare the data with the previous years and compare the data with other countries with a similar production structure.

More detailed quality assurance information is summarized for each emission category in sections 3-7 of this report.

1.7 General uncertainty evaluation

The overall uncertainty relates to the uncertainty of activity data (fuel consumption, production and other activities, processes, etc.) and to the emission factor uncertainty. The uncertainty of the emission sources is defined during data collection and data processing.

The uncertainty of the sum of emissions from point sources and activity data from national statistics is expected to be below 5 % (e.g., emissions from large combustion sources), the uncertainty of emission data based on a model (e.g., emissions from household heating or exhaust emissions from transport) are expected to range between 25–30 %.

Emission factors estimated according to the methodology of the EMEP/EEA emission inventory guidebook ranges from 50 up to 200 % (in this way emissions e.g., from the use of solvents, animal production and non-combustion emissions from transport can be estimated).

Also, other methods for uncertainty assessment can be used, for example statistical subtraction, on basis on differences between the production, import, export and consumption of fuels, through expert assessments, etc.

The uncertainty of the emission factors depends on the origin of the factors applied. If emission factors are not known the information from the EMEP/EEA air pollutant emission inventory guidebook can be used.

Ukraine plans within QA/QC to estimate Uncertainty for each source category and also to calculate the total Uncertainty of the inventory. It will be presented in the next submissions. At the moment Tier 1 uncertainty analysis is implemented in the GHGs inventory under UNFCCC. The determination of the Uncertainty of the UNECE/CLRTAP inventory will be in compliance with the Uncertainty calculations for UNFCCC.

1.8 Assessment of completeness

The emission inventory includes the calculation of emissions from all relevant sources recommended by the EMEP / EEA Emission Inventory Guidebook [4]. The completeness assessment of the main emission sources is briefly summarized for each emission category in sections 3-7 of this report.

In the data estimation and reporting of Ukraine submisson, it was not always possible to report emissions for all pollutants for all categories according to reporting templates. This was due to insufficient input data, or insufficient source methodology detail in the input data. In these cases appropriate Notation Keys are used.

The two main uses of Notation Keys in the submission were:

- NE ("Not Estimated"): where there were data gaps in source information for pollutant estimates;
- IE ("Included Elsewhere"): where emissions were estimated but were not reported within the expected source category but were included in other categories;
- NA ("Not Applicable"): where there were no or negligible emissions in the respective category.

"NE" is for example reported for NFR categories 1A3ei (Pipeline transport), 2A5b (Construction and demolition), 2A5c (Storage, handling and transport of mineral products), 2B10b (Storage, handling and transport of chemical products) or 2K (Consumption of POPs and heavy metals) , where there are currently no activity data available.

"IE" is reported for NFR categories 1A4aii (Commercial/Institutional: Mobile), 1A4bii (Residential: Household and gardening (mobile)) which is included in other categories.

"NA" is mostly reported only for certain pollutants in respective NFR categories which are produced in very low amount or not produced at all, e.g. pollutants other than PM (TSP) for 1A3bvi (Road transport: Automobile tyre and brake wear) and 1A3bvii (Road transport: Automobile road abrasion), pollutants other than NOx and CO for 2B1 (Ammonia production), pollutants other than NOx for 2B2 (Nitric acid production), etc.

For more detailed information see the descriptions of emission categories in sections 3-7 and Appendix 2.

2 KEY TRENDS

From 1991 to 2000, there was a tendency to reduce emissions of all air pollutants due to a decrease in energy production, industrial, agricultural production and waste generation resulting from Ukraine's withdrawal from the USSR and the changes in the production structure. From 2000 to 2019 there was a gradual increase in emissions of SO_2, CO, dust, Pb, Zn, Cd, Hg, As, Cr, Se, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, HCB and PCBs due to the increased use of coal for electricity and heat production and the growth of industrial and agricultural production in Ukraine.

In 2009-2010, there was a decrease in pollutant emissions due to a decline in industrial and agricultural production resulting from the global financial crisis. In 2014-2015, there was a decrease in emissions of all pollutants due to the loss of state control over some industrial enterprises in Donetsk and Luhansk regions and the Autonomous Republic of Crimea, collapse of industrial production due to armed aggression in the eastern Ukraine and the annexation of the Autonomous Republic of Crimea by the Russian Federation.

Since 2016, there has been a gradual recovery of energy production, industrial and agricultural production and waste generation resulting in an increase in pollutant emissions.

For more detailed information on pollutant emission trends see the descriptions of emission categories in sections 3-7.

Due to the use of different calculation methods in the previous years, it is not possible to directly compare the emissions for some categories of emission sources. With the help of EMEP pilot project as part of the project "Support to Ukraine in the approximation of the EU Environmental Acquis" implemented with the support of the EU, in 2021-2022 it is planned to recalculate some categories of emissions and assess key trends in major pollutant emissions from 1990 to 2020.

3 ENERGY

3.1 Source category description and the general methodology

The energy sector includes the following key subcategories:

- 1A. Combustion;
- 1B. Fugitive emission from solid fuels

Fuel combustion (sector 1A) is one of the most significant sources of pollutant emissions. Combustion as a source of pollutant emissions comprises the following categories:

- 1A1. Energy industries;
- 1A2. Manufacturing industries and construction;
- 1A3. Transport;
- 1A4. Other sectors;
- 1A5. Other stationary and mobile sources.

Fugitive emission from solid fuels (sector 1B) include the following subcategories:

- 1B1. Fugitive emission from solid fuels;
- 1B2. Fugitive emissions from oil and natural gas extraction, transportation, processing and storage.

Pollutant emissions in sectors 1A and 1B are mostly estimated by the amount of fuel based on the State Statistics Service of Ukraine data, according to the energy balance of Ukraine for 2019 [1] and the Report on fuel use and supplies by industries for 2019 [2] prepared in accordance with the Methodological guidelines for the organization of state statistical observation "The Use and Supplies of Fuel" [3]. Ukraine's energy balance for 2019 is provided in Annex 1.

As a rule, emissions are calculated according to the following formula:

$$E = \sum(EF_{ab}A_{ab}),$$

where:

- E – volume of emissions,
- EF – emission factor,
- A – fuel consumption,
- a – type of fuel,
- b – category.

To calculate the emissions, emission factors recommended for use in the EMEP/EEA Emission Inventory Guidebook [4] and national emission factors were used.

The share of emissions under categories 1A and 1B for some pollutants in 2019 is shown in Figure 3.1.1.

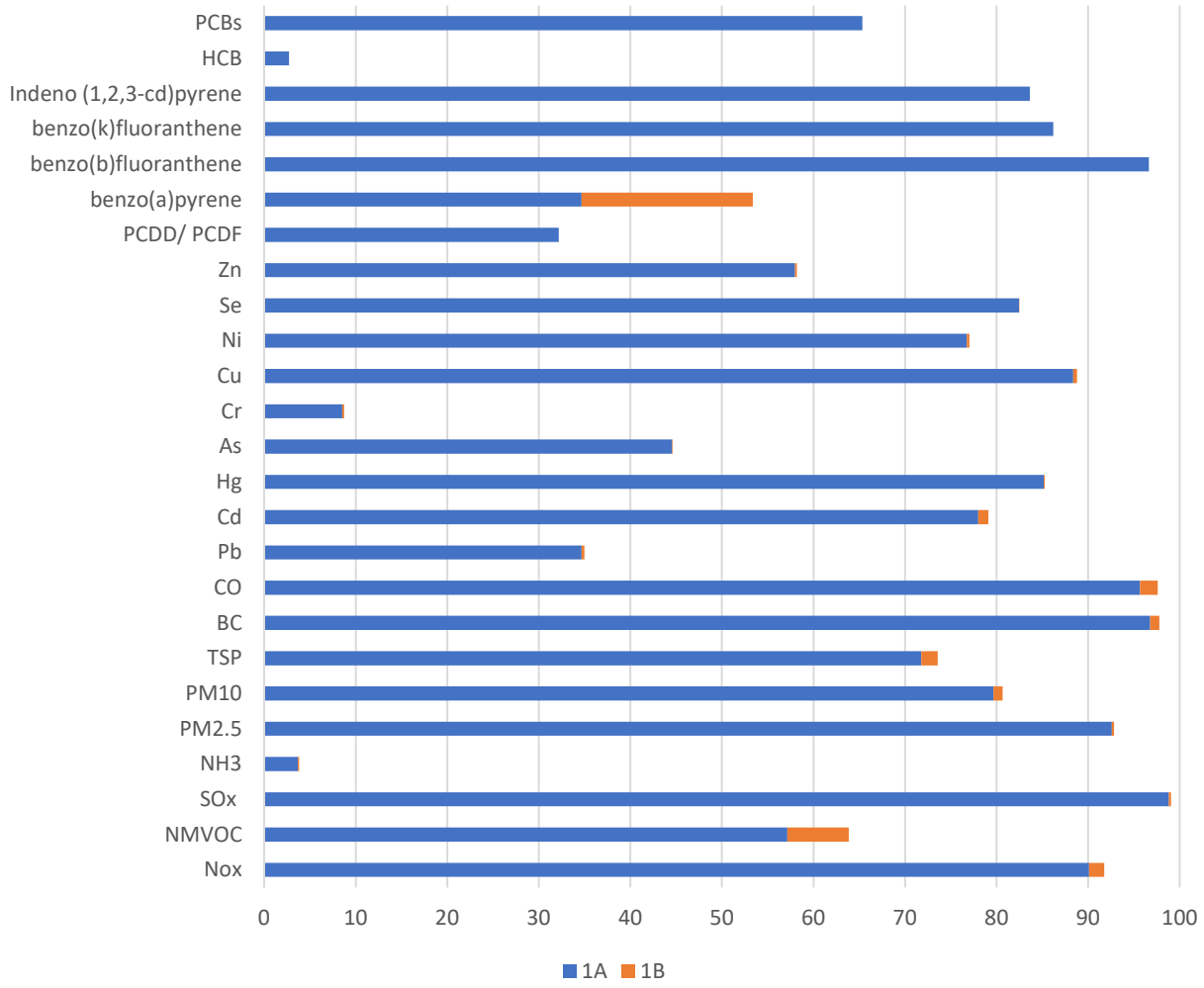

Figure 3.1.1. Share of emissions under categories 1A and 1B for some pollutants in 2019 as a percentage of total national emissions

To verify the estimated data, where possible, the data from the database of the State Statistics Service of Ukraine on emissions of air pollutants prepared on the basis of 2-TP forms for state statistical observation (air)(annual) "Report on stationary sources emissions of pollutants and greenhouse gases into the air" were used. They are provided by enterprises and organizations in accordance with the Order of the State Statistics Service of Ukraine №405 of December 18,

2019 "On approval of 2-TP form for state statistical observation (air) (annual) "Report on stationary sources emissions of air pollutants and greenhouse gases" [5].

3.2 Energy industries (category 1A1)

3.2.1 Source category description

The emissions under category 1A1. Energy industries are calculated for each subcategory as follows:

- 1A1a. Public electricity and heat production;
- 1A1b. Petroleum refining;
- 1A1c. Manufacture of solid fuels and other energy industries.

Subcategories in sector 1A1 are established by the methods listed in Table 3.2.1.

Table 3.2.1. Methods used to calculate and verify the emission data for NFR 1A1 subcategories (for emission data reporting only T1/T2 were used due to shortcamings in the collection of data for T3, see Chapter 3.2.4)

NFR Code	Title	Calculation method	EF[2]	Pollutants
1A1a	Public electricity and heat production	T1/T2/T3	D/CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB, PCBs
1A1b	Petroleum refining	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF
1A1c	Manufacture of solid fuels and other energy industries	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene

The share of emissions under category 1A1 for some pollutants in 2019 is shown in Figure 3.2.1.

Since 1990, the use of coal has been gradually increasing and the use of gaseous fuel and heavy fuel oil has been decreasing for category 1A1a in Ukraine, as shown in Figures 3.2.2-3.2.3. During the period between 1990 and 2019 the use of fuel for energy production was reduced by more than two thirds.

[2] CS – country specific; D - default

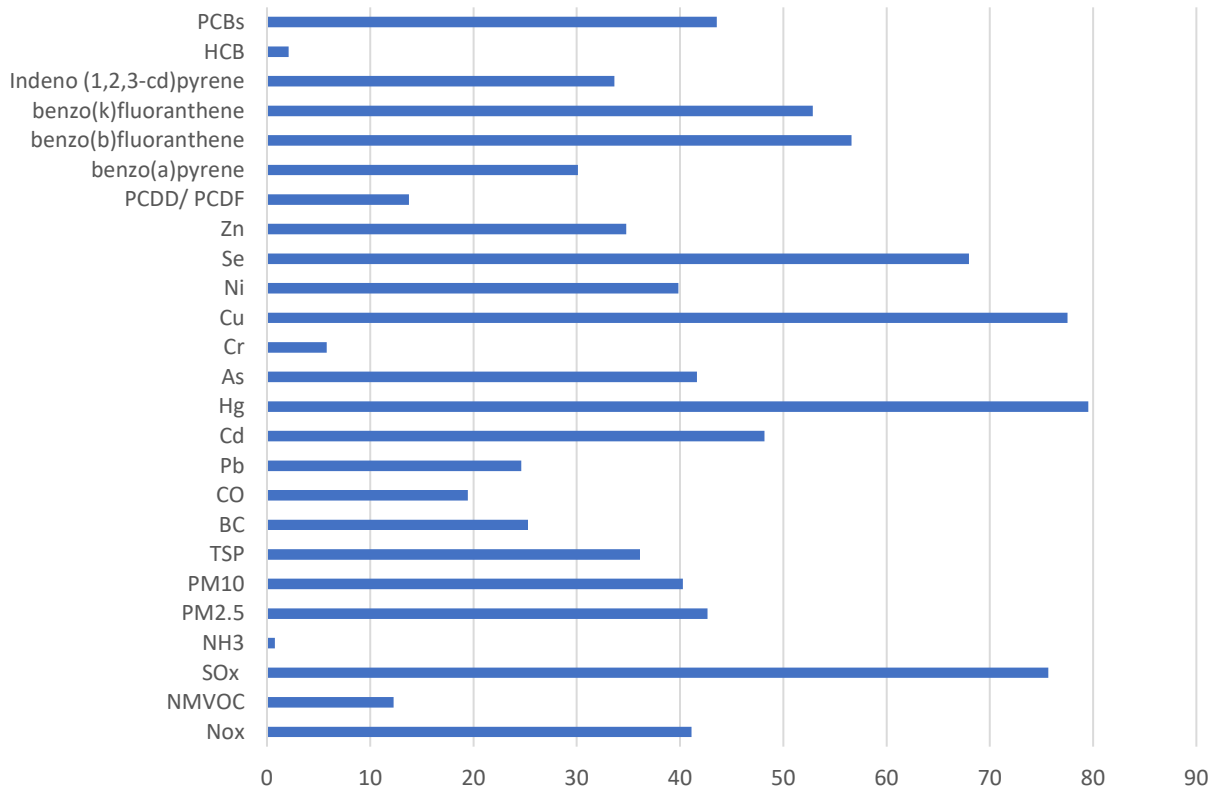

Figure 3.2.1. Share of emissions under category 1A1 for some pollutants in 2019 as a percentage of total national emissions

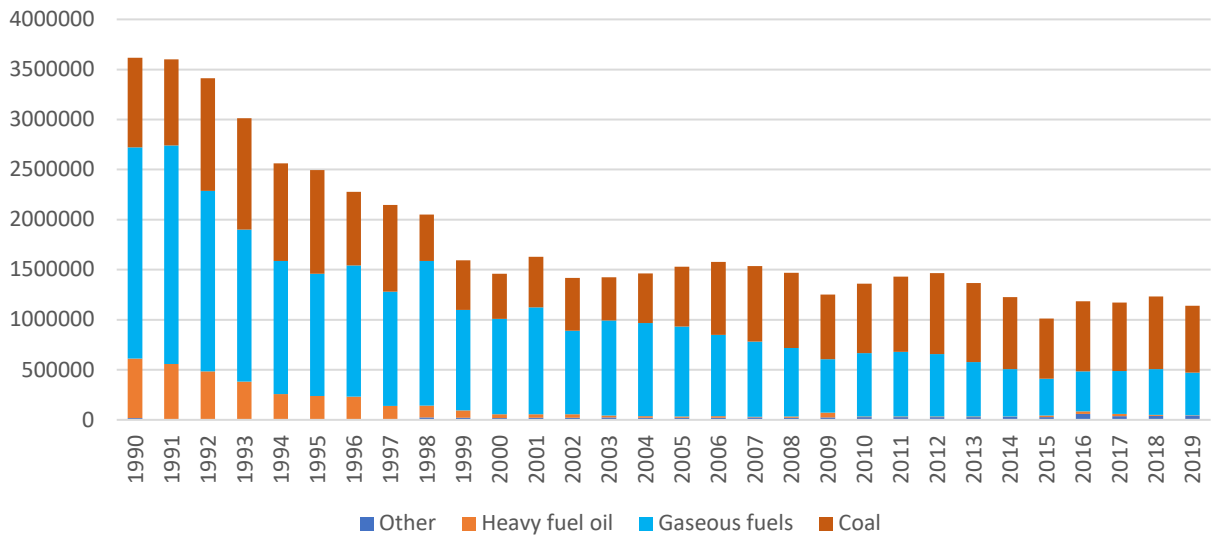

Figure 3.2.2. The amount of energy obtained from the combustion of certain fuels for category 1A1a, TJ

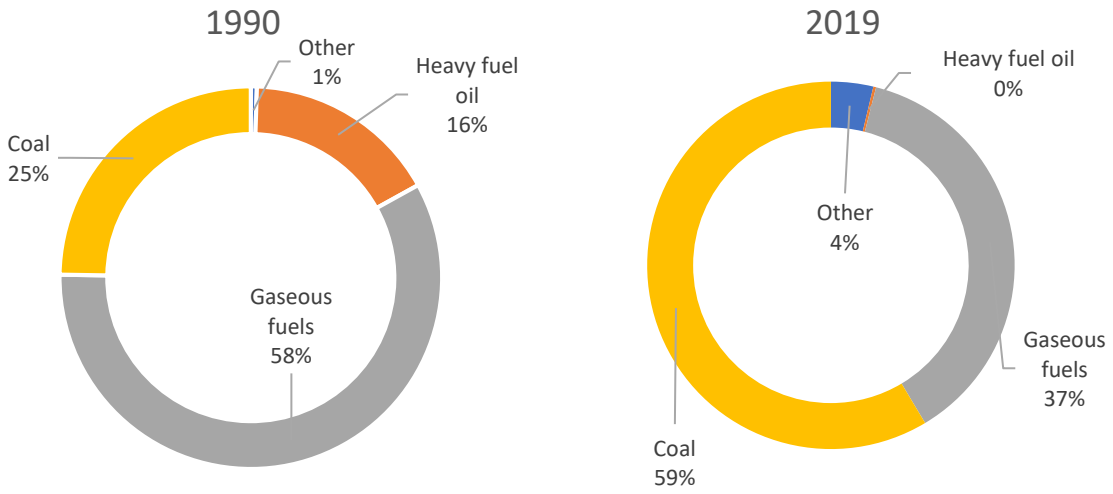

Figure 3.2.3. Comparison of consumption of certain fuels in 1990 and 2019 for category 1A1a

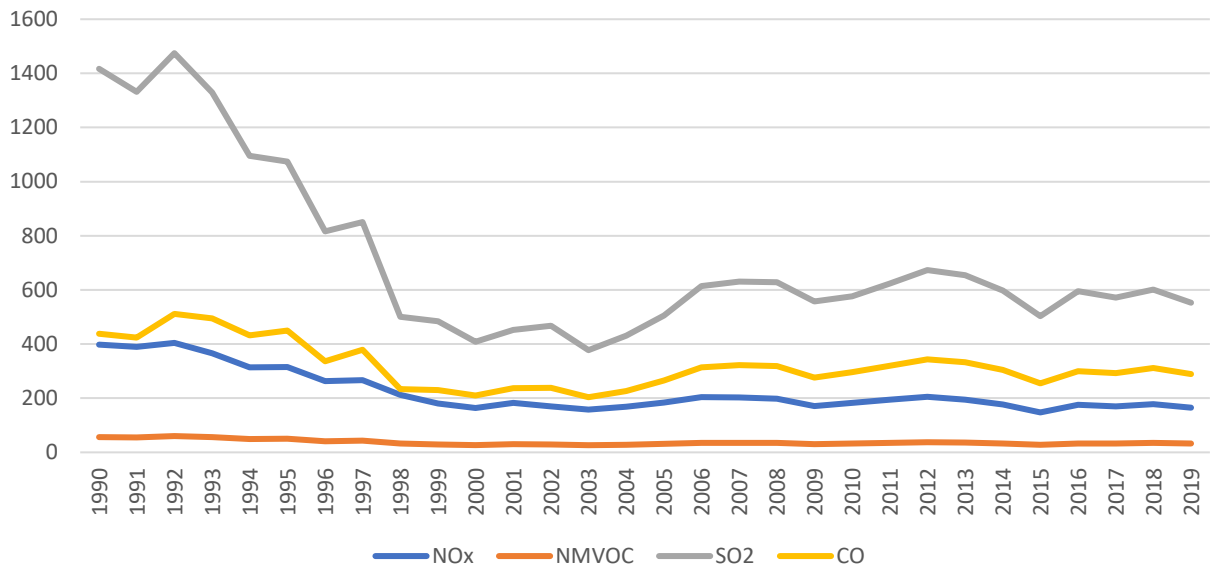

Figure 3.2.4. SO_2, NO_x, CO and NMVOC emissions for category 1A1a in 1990-2019, thousand tons

The share of emissions under categories 1A1a, 1A1b and 1A1c for some pollutants in 2019 as a percentage of total national emissions is shown in figures 3.2.5 – 3.2.7.

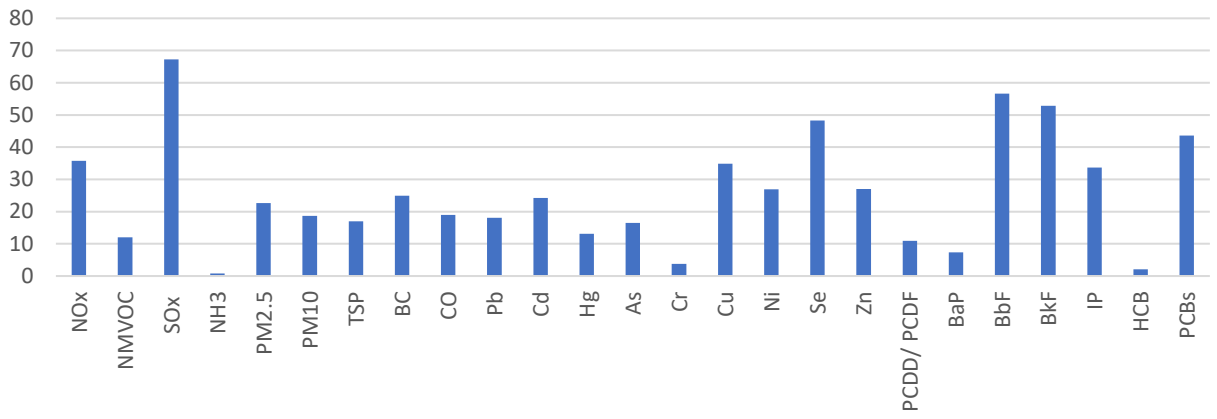

Figure 3.2.5. Share of emissions under category 1A1a for some pollutants in 2019 as a percentage of total national emissions

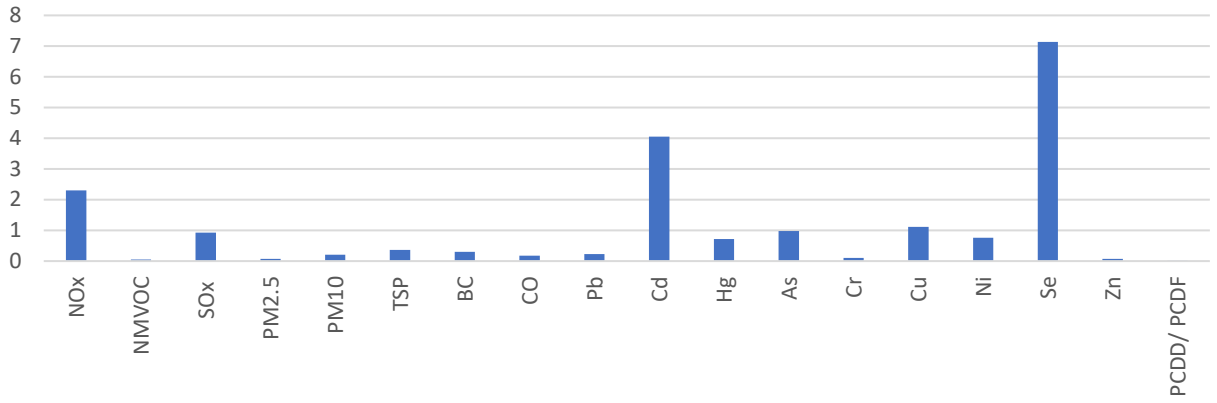

Figure 3.2.6. Share of emissions under category 1A1b for some pollutants in 2019 as a percentage of total national emissions

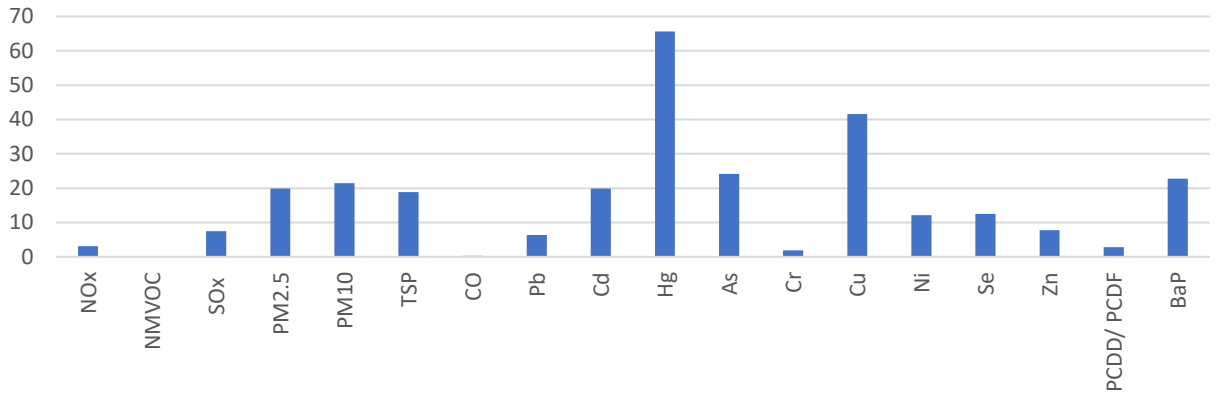

Figure 3.2.7. Share of emissions under category 1A1c for some pollutants in 2019 as a percentage of total national emissions

3.2.2 Methodological issues

The methodology of emission calculation for category 1A1 is in line with the methodology described in section 3.1 for stationary fuel combustion. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method.

For detailed information on the emission factors used for the emission sources see Annex 2.

3.2.3 Emission trends

Trends in pollutant emissions for category 1A1a as the most significant category of air pollutant emissions are shown in Figures 3.2.8-3.2.11.

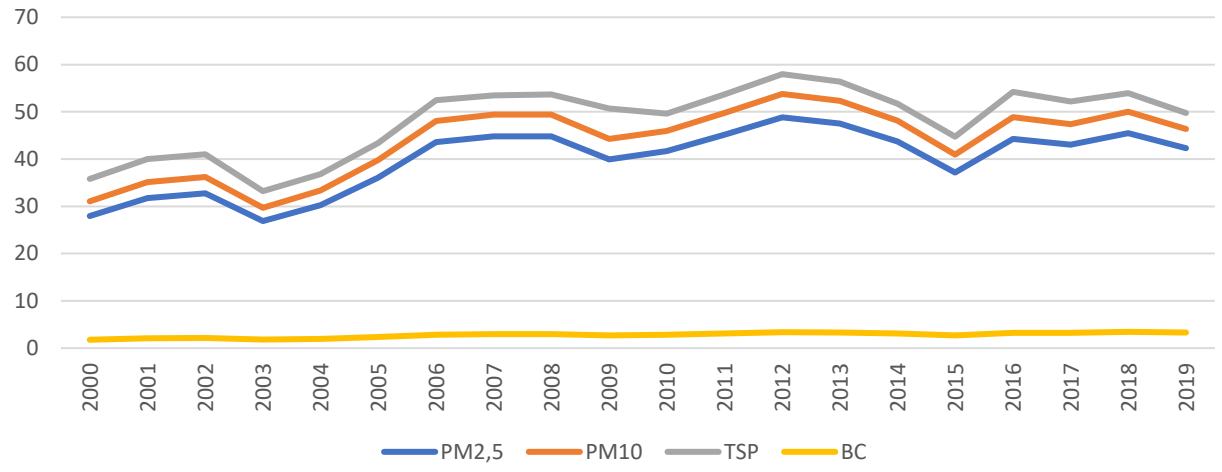

Figure 3.2.8. Dust emissions for category 1A1a in 2000-2019, thousand tons

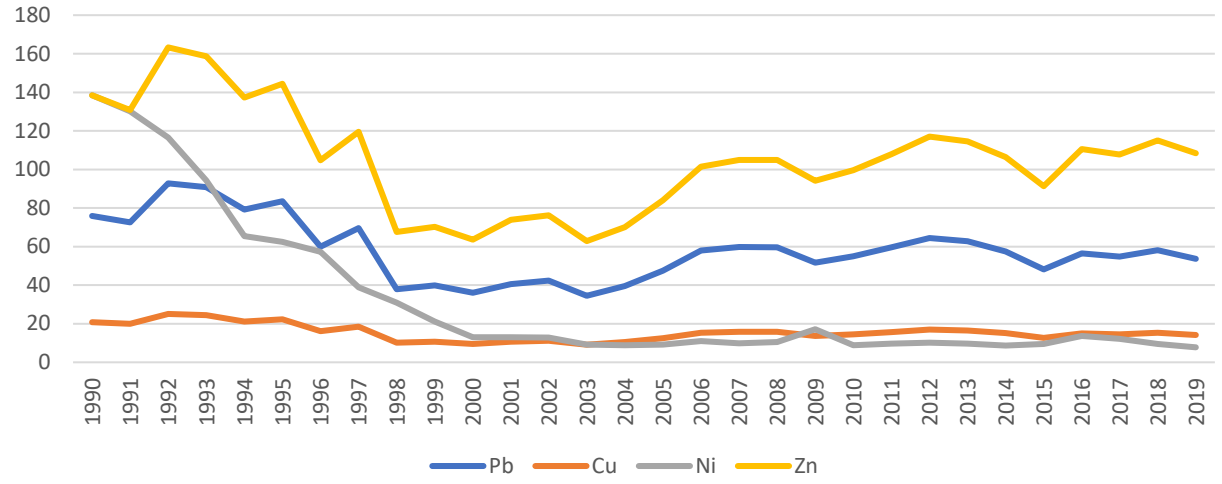

Figure 3.2.9. Pb, Cu, Ni and Zn emissions for category 1A1a in 1990-2019, tons

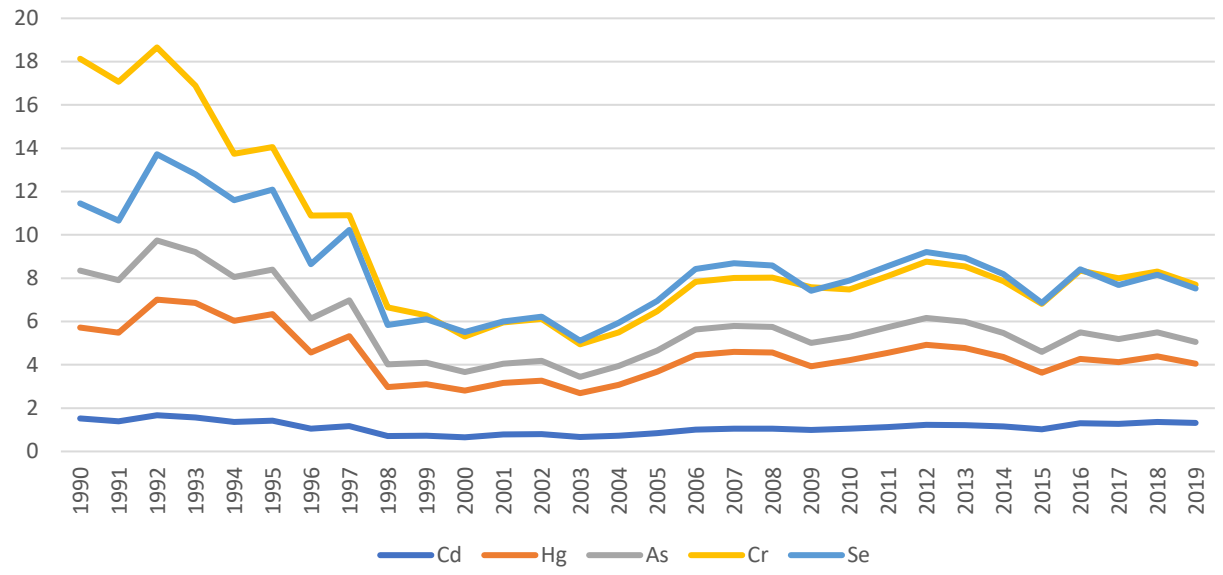

Figure 3.2.10. Cd, Hg, As, Cr and Se emissions for category 1A1a in 1990-2019, tons

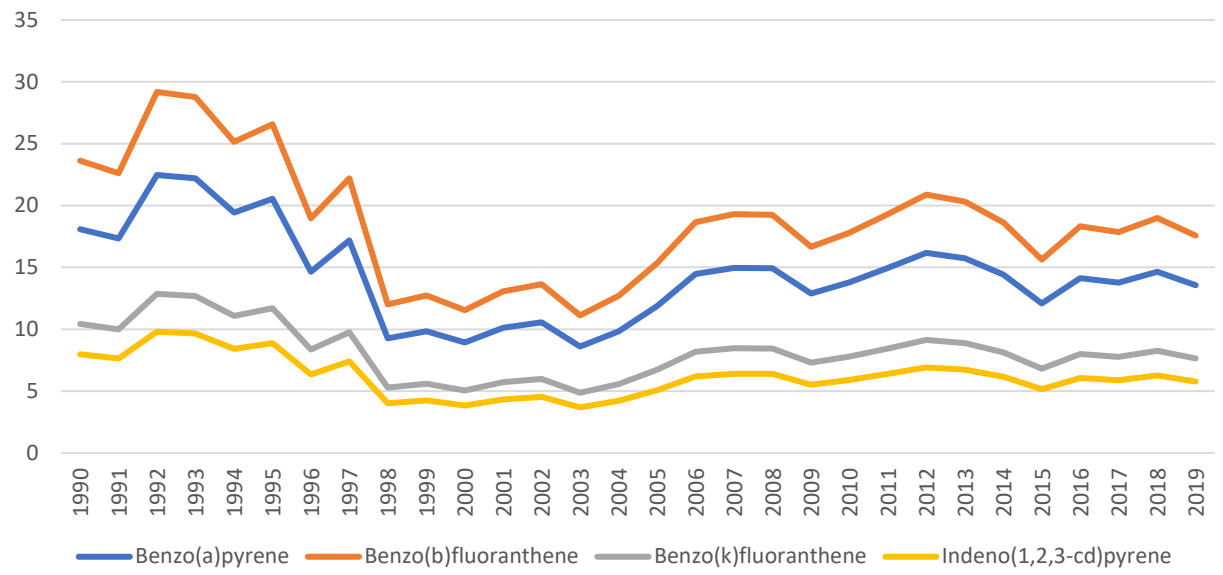

Figure 3.2.11. benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene emissions for category 1A1a in 1990-2019, tons

As can be seen from Figures 3.2.8-3.2.11, in 1990-2000 there was a trend to reduce emissions of all air pollutants due to a decrease in energy production. Since 2000, there has been an increase in emissions of SO_2, CO, dust, Pb, Zn, Cd, Hg, As, Cr, Se, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, HCB and PCBs due to the increased use of coal for electricity and heat production in Ukraine.

In 2014-2015, there was a decrease in emissions of all pollutants due to the decline in industrial production resulting from the armed aggression in the eastern Ukraine and the annexation of Crimea by Russia. Since 2016, there has been a partial increase in pollutant emissions.

3.2.4 Source specific QA/QC and verification

To ensure the quality of data obtained by collecting information directly from respondents, the State Statistics Service of Ukraine monitors the level of reporting by respondents and analyzes the reasons for failures to provide such data.

The State Statistics Service of Ukraine uses the following methods for the verification of data:

- analysis of data over time (comparison of data for the reporting year with the previous year);
- geographical analysis of data (comparison of data by regions);
- analysis of data distribution (analysis of the data that diverge significantly from the main data distribution).

In addition, to verify the quality of data calculated at T1 / T2 levels for category 1A1, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 3.2.2.

Table 3.2.2. List of production and technological processes, technological equipment (plants) for category 1A1

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
1A1a	Public electricity and heat production	**Public power**	
		110101	Combustion plants >= 300 MW (boilers)
		110102	Combustion plants >= 50 and < 300 MW (boilers)
		110103	Combustion plants < 50 MW (boilers)
		110104	Gas turbines
		110105	Stationary engines

		District heating plants:	
		110201	Combustion plants >= 300 MW (boilers)
		110202	Combustion plants >= 50 and < 300 MW (boilers)
		110203	Combustion plants < 50 MW (boilers)
		110204	Gas turbines
		110205	Stationary engines
1A1b	Petroleum refining	**Petroleum refining plants**	
		110301	Combustion plants >= 300 MW (boilers)
		110302	Combustion plants >= 50 and < 300 MW (boilers)
		110303	Combustion plants < 50 MW (boilers)
		110304	Gas turbines
		110305	Stationary engines
		110306	Process furnaces
1A1c	Manufacture of solid fuels and other energy industries	**Solid fuel plants**	
		110401	Combustion plants >= 300 MW (boilers)
		110402	Combustion plants >= 50 and < 300 MW (boilers)
		110403	Combustion plants < 50 MW (boilers)
		110404	Gas turbines
		110405	Stationary engines
		110406	Coke ovens
		110407	Other (coal gasification, liquefaction etc.)
		District heating plants:	
		110501	Combustion plants >= 300 MW (boilers)
		110502	Combustion plants >= 50 and < 300 MW (boilers)
		110503	Combustion plants < 50 MW (boilers)
		110504	Gas turbines
		110505	Stationary engines

For comparison of T1/T2 and T3 calculations for category 1A1 see table 3.2.3.

According to the table, the data on the most significant pollutant emissions (nitrogen oxides, sulfur oxides and TSP) correlate.

Table 3.2.3. Comparison of T1/T2 and T3 calculations for category 1A1

Pollutant	**Emissions**	
	T3 calculation method	**T1/T2 calculation method**
NOx, kt	129,65	189,94
NMVOC, kt	5,20	33,46
SOx, kt	614,84	621,48
NH_3, kt	18,30	1,42
$PM_{2.5}$, kt	26,82	79,47

PM_{10}, kt	117,24	100,15
TSP, kt	0,75	106,04
BC, kt	27,69	3,32
CO, kt	26,67	296,29
Pb, t	0,00	73,27
Cd, t	3,00	2,62
Hg, t	29,30	24,49
As, t	29,26	12,77
Cr, t	21,45	11,76
Cu, t	24,96	31,43
Ni, t	0,00	11,49
Se, t	78,22	10,58
Zn, t	129,65	139,67

Due to the shortcomings of statistics collection system for air pollutant emissions (eg, lack of reporting on $PM_{2.5}$ and PM_{10} by some respondents, underreporting of emissions volumes by respondents, lack of information about the methodology, etc.) the data used for category 1A1 of NFR table were obtained by T1/T2 calculation methods. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method.

3.3 Manufacturing industries and construction (category 1A2)

3.3.1 Source category description

Emissions for category 1A2. Manufacturing industries and construction are calculated for each subcategory as follows:

- 1A2a. Stationary combustion in manufacturing industries and construction: Iron and steel;
- 1A2b. Stationary combustion in manufacturing industries and construction: Non-ferrous metals;
- 1A2c. Stationary combustion in manufacturing industries and construction: Chemicals;
- 1A2d. Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print;
- 1A2e. Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco;
- 1A2f. Stationary combustion in manufacturing industries and construction: Non-metallic minerals;
- 1A2gvii. Mobile combustion in manufacturing industries and construction;
- 1A2gviii. Stationary combustion in manufacturing industries and construction: Other.

For methods of emissions calculation in category 1A2 subcategories see Table 3.3.1.

Table 3.3.1. Methods used to calculate and verify the emission data for NFR 1A2 subcategories (for emission data reporting only T1 was used due to shortcamings in the collection of data for T3, see Chapter 3.3.4)

NFR Code	Name	Calculation method	EF[3]	Pollutants
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, benzo(b)fluoranthene, HCB, PCBs
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, PCBs
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	T1	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Hg, Zn, PCDD/ PCDF, PCBs
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Zn
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	T1	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/ PCDF, PCBs
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, HCB, PCBs
1A2gvii	Mobile combustion in manufacturing industries and construction	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, HCB, PCBs

The share of emissions under category 1A2 for some pollutants in 2019 is shown in Figure 3.3.1.

[3] CS – country specific; D - default

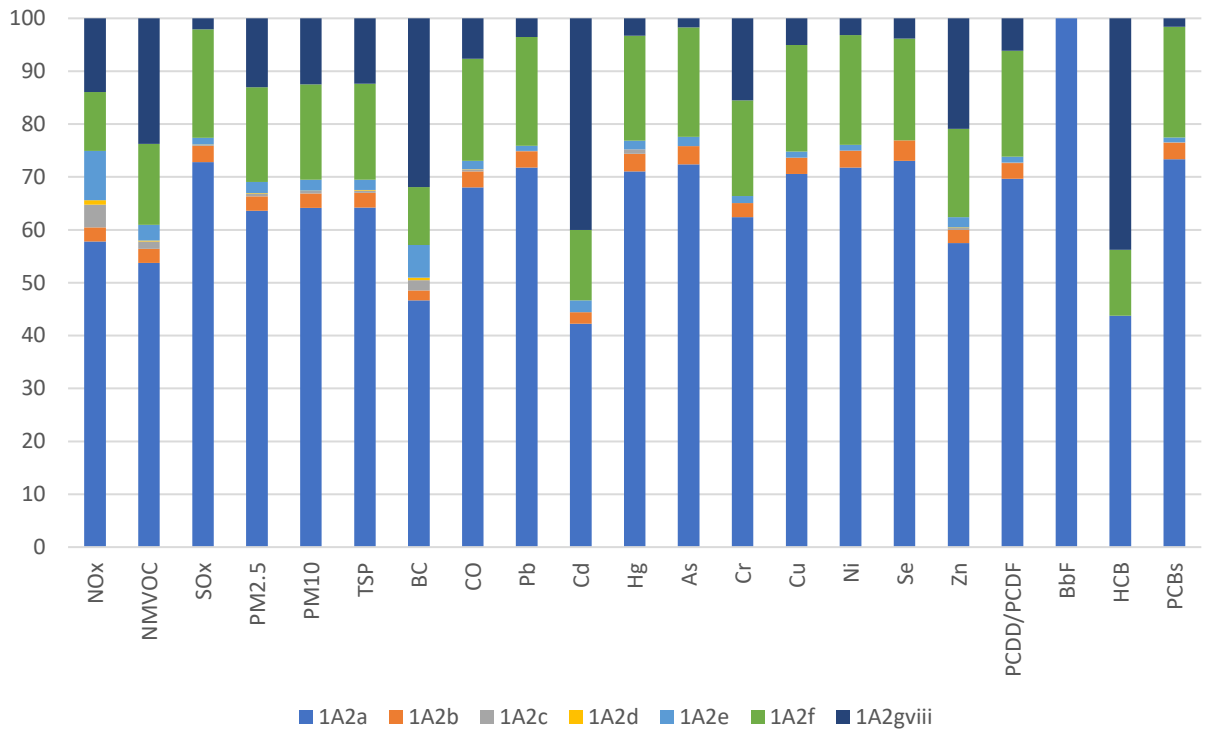

Figure 3.3.1. Share of emissions under category 1A2 for some pollutants in 2019

The share of emissions under categories 1A2a, 1A2b and 1A2c, 1A2d, 1A2e, 1A2f and 1A2gviii for some pollutants in 2019 as a percentage of total national emissions is shown in Figures 3.3.2 – 3.3.8.

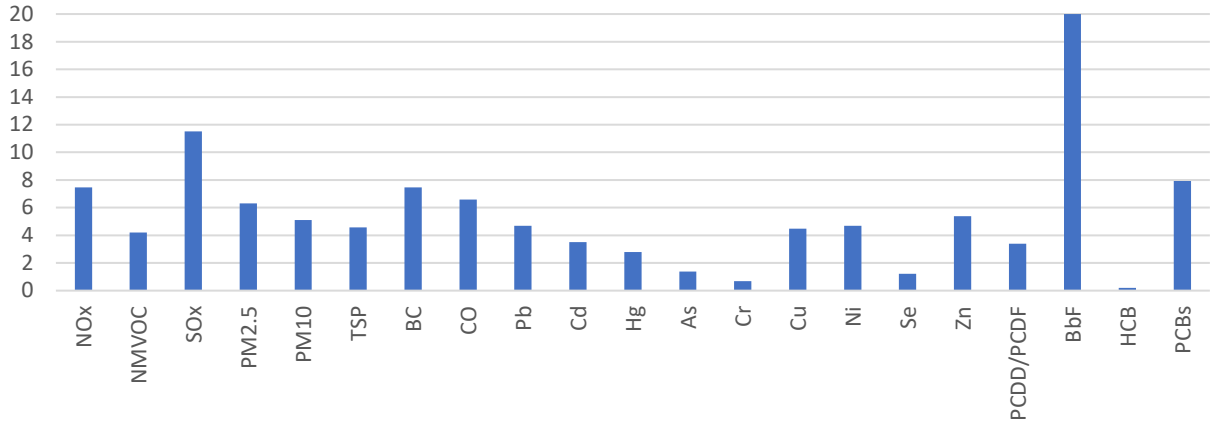

Figure 3.3.2. The share of emissions under category 1A2a for some pollutants in 2019 as a percentage of total national emissions

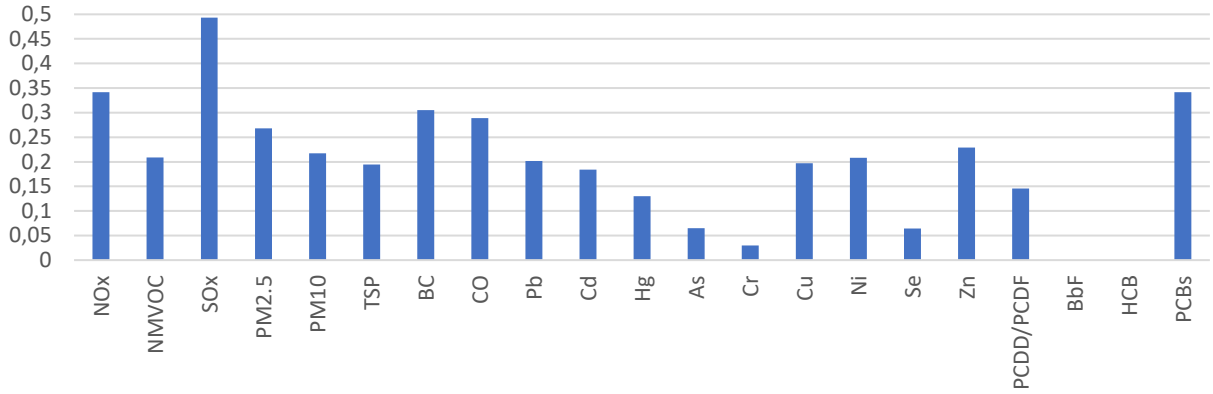

Figure 3.3.3. The share of emissions under category 1A2b for some pollutants in 2019 as a percentage of total national emissions

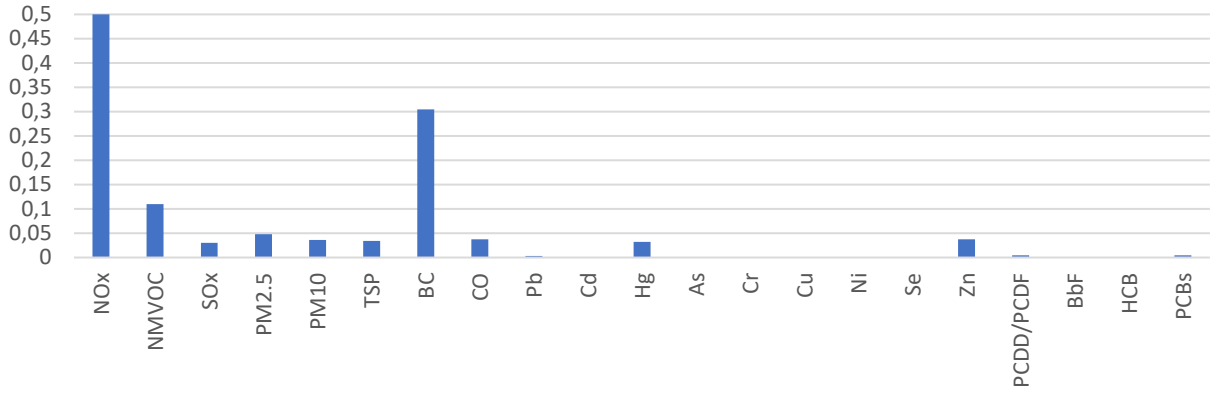

Figure 3.3.4. The share of emissions under category 1A2c for some pollutants in 2019 as a percentage of total national emissions

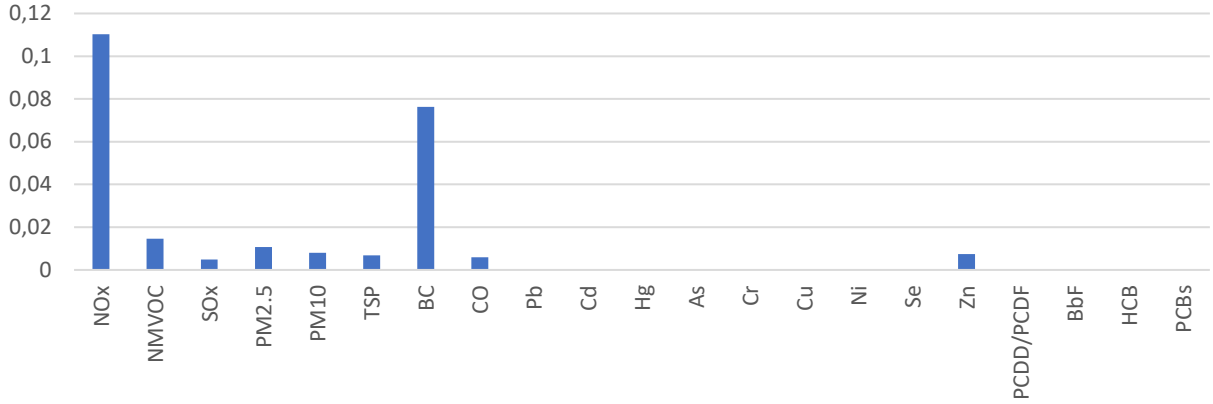

Figure 3.3.5. The share of emissions under category 1A2d for some pollutants in 2019 as a percentage of total national emissions

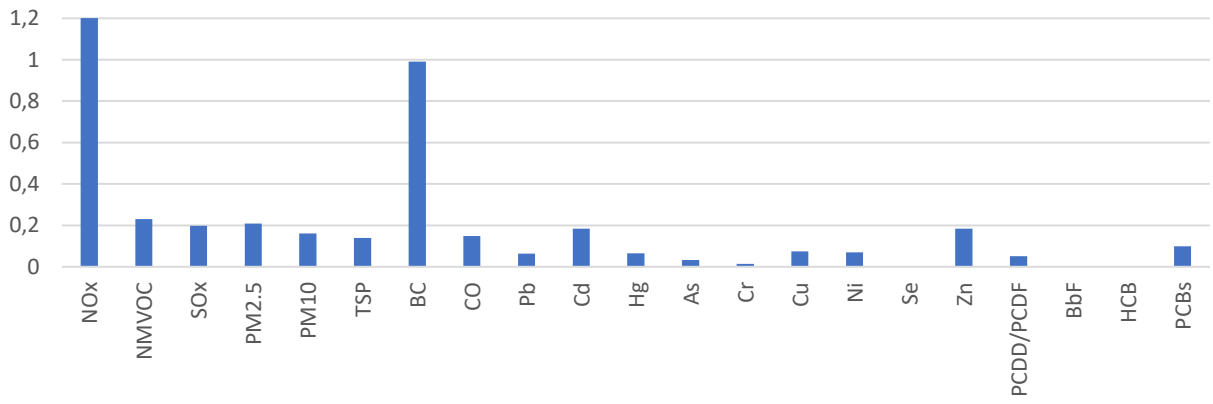

Figure 3.3.6. The share of emissions under category 1A2e for some pollutants in 2019 as a percentage of total national emissions

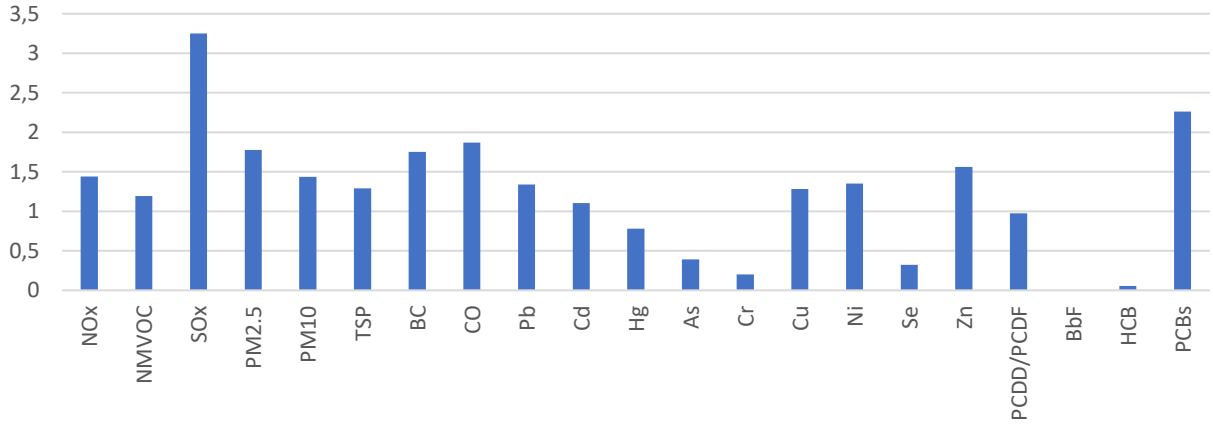

Figure 3.3.7. The share of emissions under category 1A2f for some pollutants in 2019 as a percentage of total national emissions

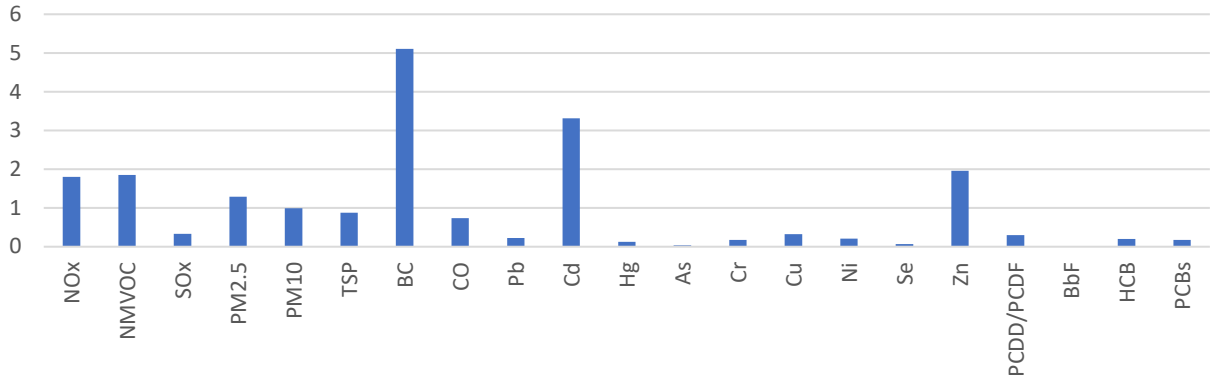

Figure 3.3.8. The share of emissions under category 1A2gviii for some pollutants in 2019 as a percentage of total national emissions

3.2.2 Methodological issues

The methodology of emission calculation for category 1A2 is in line with the methodology described in section 3.1 for stationary fuel combustion. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method for the most of the categories (see Table 3.3.1).

For detailed information on the emission factors used for the emission sources see Annex 2.

3.3.3 Emission trends

In 1990-2000 there was a decrease in the emission of all air pollutants due to a decline in industrial production.

In 2014-2015, there was a decrease in emissions of all pollutants due to a decline in industrial production resulting from the armed aggression in the eastern Ukraine and the annexation of Crimea by Russia. Since 2016, there has been a partial increase in pollutant emissions.

3.3.4 Source specific QA/QC and verification

For general information on data quality assurance see section 3.2.4

To verify the quality of data calculated at T1 level for category 1A2, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 3.3.2.

Table 3.3.2. List of production and technological processes, technological equipment (plants) for category 1A2

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	**Process furnaces**	
		130203	Blast furnace cowpers
		Contact technological processes	
		130301	Sinter and pelletizing plants

		130302	Reheating furnaces steel and iron
		130303	Grey iron foundries
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	**Contact technological processes**	
		130304	Primary lead production
		130305	Primary zinc production
		130306	Primary copper production
		130324	Nickel production (thermal process)
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	**Contact technological processes**	
		130321	Paper-mill industry (drying processes)
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	**Process furnaces**	
		130204	Plaster furnaces
		Contact technological processes	
		130311	Cement
		130312	Lime
		130313	Asphalt concrete plants
		130314	Flat glass
		130315	Container glass
		130316	Fiber glass
		130317	Other glass (including special purpose glass)
		130318	Rock wool
		130319	Bricks and tiles
		130320	Fine ceramic materials
		130322	Alum earth (clay)
		130323	Magnesium production (dolomite processing)
		130325	Enamel production
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	**Combustion processes in boilers, gas turbines and stationary engines**	
		130101	Combustion plants >= 300 MW (boilers)
		130102	Combustion plants >= 50 and < 300 MW (boilers)
		130103	Combustion plants < 50 MW (boilers)
		130104	Gas turbines
		130105	Stationary engines
		130106	Other stationary equipment
		Process furnaces	
		130205	Other furnaces
		Contact technological processes	
		130326	Metal welding
		130327	Other

For comparison of T1 and T3 calculations for category 1A2 see table 3.3.3.

According to the table, the data on the most significant pollutant emissions (nitrogen oxides, TSP and carbon oxide) correlate.

Table 3.3.3. Comparison of T1 and T3 calculations for category 1A2

Pollutant	Emissions	
	T3 calculation method	T1 calculation method
NOx, kt	38,81	59,75
NMVOC, kt	2,29	21,29
SOx, kt	16,84	129,89
$PM_{2.5}$, kt	1,04	18,48
PM_{10}, kt	3,90	19,78
TSP, kt	20,04	20,89
BC, kt	0,51	2,1
CO, kt	224,11	147,36
Pb, t	5,24	19,39
Cd, t	0,97	0,45
Hg, t	0,73	1,21
As, t	1,05	0,58
Cr, t	6,96	2,26
Cu, t	4,75	2,58
Ni, t	2,89	1,88
Se, t	3,16	0,26
Zn, t	12,43	37,61

Due to the shortcomings of statistics collection system for air pollutant emissions (eg, lack of reporting on PM2.5 and PM10 by some respondents, lack of statistical reporting on PCBs and HCB, underreporting of emissions volumes by respondents, lack of information about the methodology, etc.) the data used for category 1A2 of NFR table were obtained by T1 calculation method.

3.4 Transport (category1A3)

3.4.1 Source category description

Emissions in category 1A3 Energy industries are calculated for every subcategory as follows:

- 1A3a. Domestic and international aviation LTO (civil);
- 1A3b. Road transport;
- 1A3c. Railways;
- 1A3d. Navigation (shipping);
- 1A3ei. Other transport.

Category 1A3 subcategories are calculated by methods listed in Table 3.4.1.

Table 3.4.1. Methods used to calculate and verify the emission data for NFR 1A3 subcategories

NFR Code	Name	Calculation method	EF[4]	Pollutants
1A3ai(i)	International aviation LTO (civil)	Not calculated due to the lack of statistical information for T1 calculation method. Emissions under this category are included into category 1A3aii(i)		
1A3aii(i)	Domestic aviation LTO (civil)	T1	D	NO_x, NMVOC, SO_x, CO
1A3bi	Road transport: Passenger cars	T1/T2	D	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO
1A3bii	Road transport: Light duty vehicles	T1/T2	D	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO
1A3biii	Road transport: Heavy duty vehicles and buses	T1/T2	D	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO
1A3biv	Road transport: Mopeds & motorcycles	T1/T2	D	NO_x, NMVOC, CO
1A3bv	Road transport: Gasoline evaporation	T1	D	NMVOC
1A3bvi	Road transport: Automobile tyre and brake wear	T1	D	$PM_{2.5}$, PM_{10}, TSP
1A3bvii	Road transport: Automobile road abrasion	T1	D	$PM_{2.5}$, PM_{10}, TSP
1A3c	Railways	T1	D	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO
1A3di(ii)	International inland waterways	Not calculated due to the lack of statistical information for T1 calculation method.		
1A3dii	National navigation (shipping)	T1	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, As, Cr, Cu, Ni, Zn, PCDD/PCDF, HCB, PCBs
1A3ei	Pipeline transport	Not calculated due to the lack of statistical information for T1 calculation method.		
1A3eii	Other transport	Not calculated due to the lack of statistical information for T1 calculation method.		

The share of emissions under category 1A3 for some pollutants in 2019 is shown in Figure 3.4.1.

[4] CS – country specific; D - default

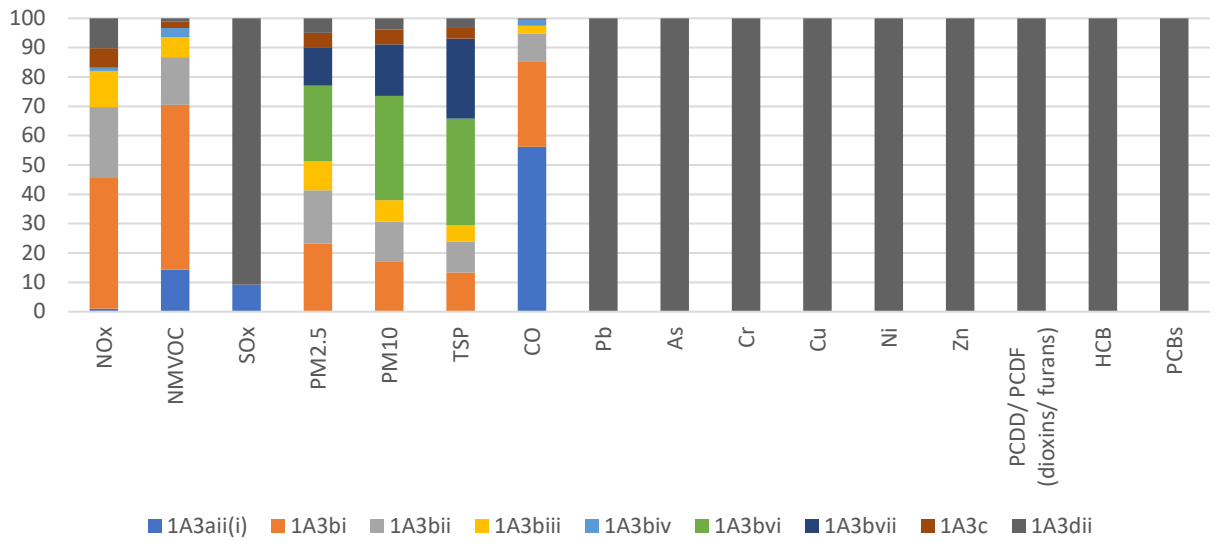

Figure 3.4.1. The share of emissions under category 1A3 for some pollutants in 2019

Since 2005, the number of passenger and commercial vehicles in Ukraine has been gradually increasing, as shown in Figure 3.4.2. According to OICA [7,8] and the Ministry of Infrastructure of Ukraine [9], in 2019 the largest share of road transport was formed by passenger cars (75%) and light duty commercial vehicles (16%), as shown in Figure 3.4.3.

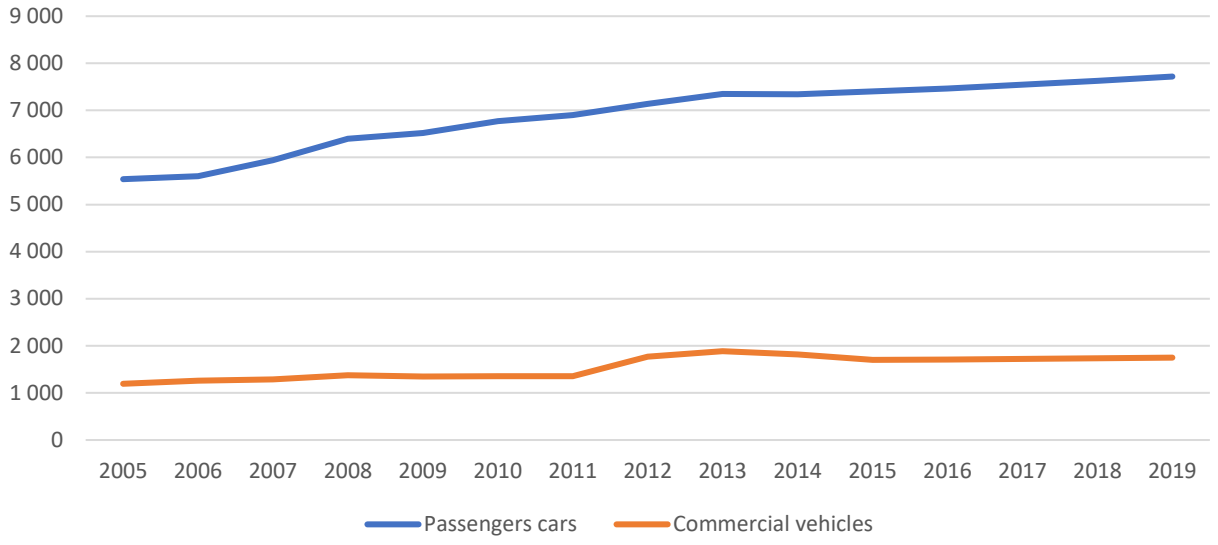

Figure 3.4.2. Number of passenger cars and commercial vehicles in Ukraine, thousand

Expert assessment of the distribution of Ukraine's road transport by type of engine in 2019 is shown in Figure 3.4.3. Statistical information by type of engine is not collected in Ukraine.

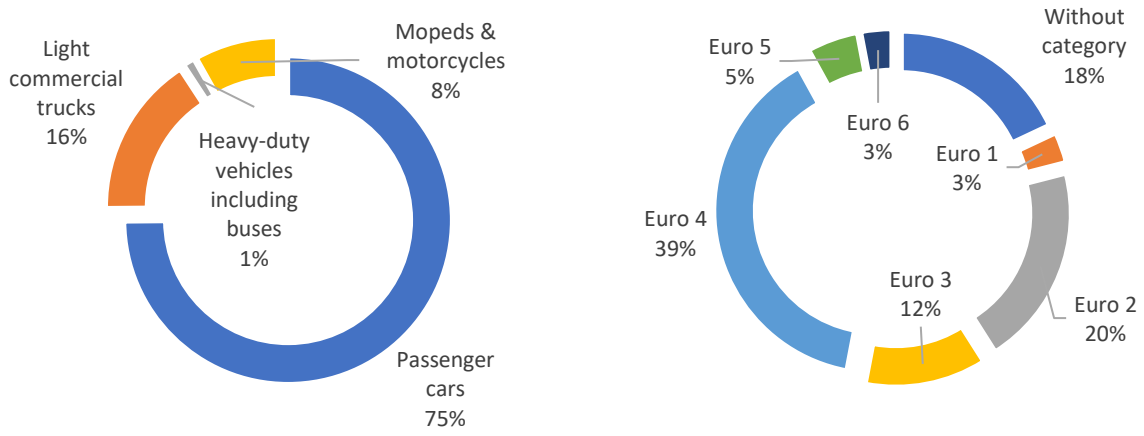

Figure 3.4.3. Distribution of Ukraine's road transport by type of vehicle and type of engine in 2019

The share of emissions under categories 1A3aii(i), 1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3bvi, 1A3bvii, 1A3c and 1A3dii for some pollutants in 2019 as a percentage of total national emissions is shown in Figures 3.4.4. – 3.4.12.

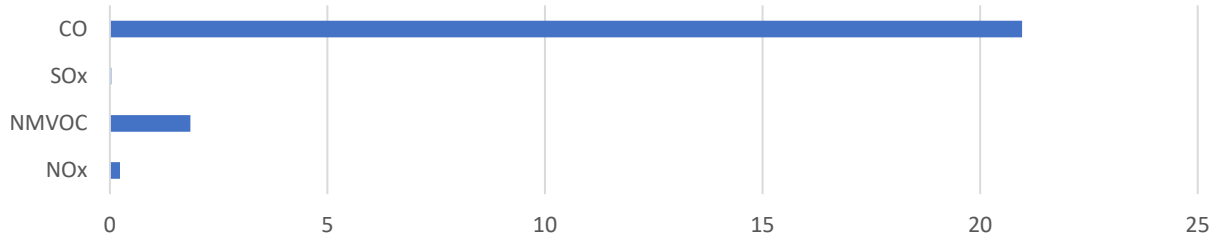

Figure 3.4.4. The share of emissions under category 1A3aii(i) for some pollutants in 2019 as a percentage of total national emissions

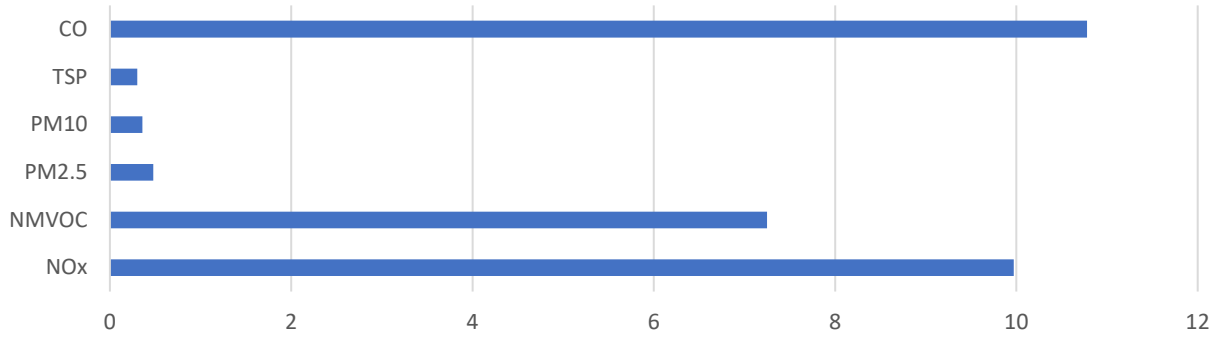

Figure 3.4.5. The share of emissions under category 1A3bi for some pollutants in 2019 as a percentage of total national emissions

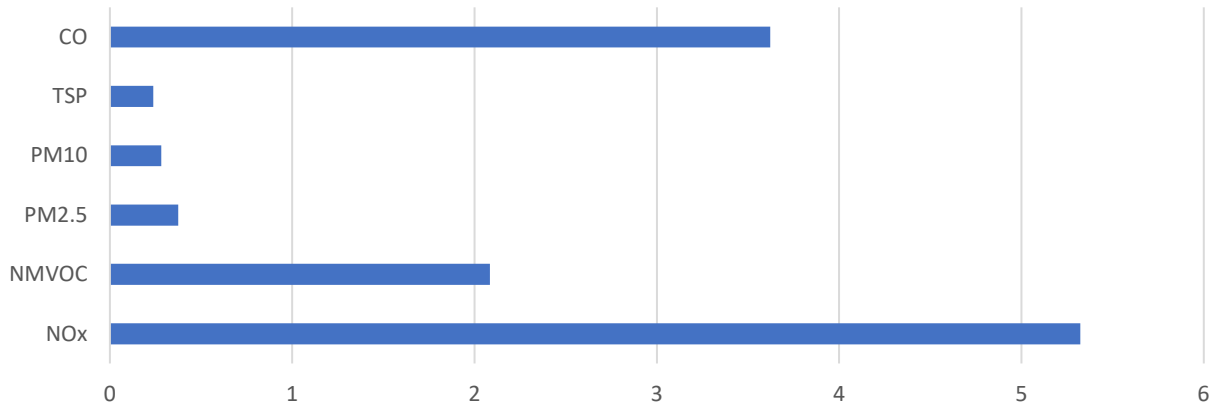

Figure 3.4.6. The share of emissions under category 1A3bii for some pollutants in 2019 as a percentage of total national emissions

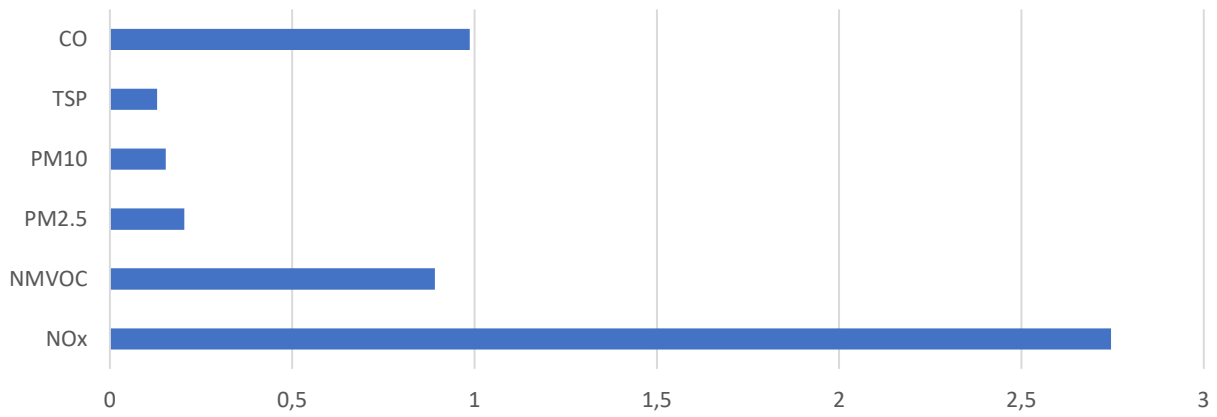

Figure 3.4.7. The share of emissions under category 1A3biii for some pollutants in 2019 as a percentage of total national emissions

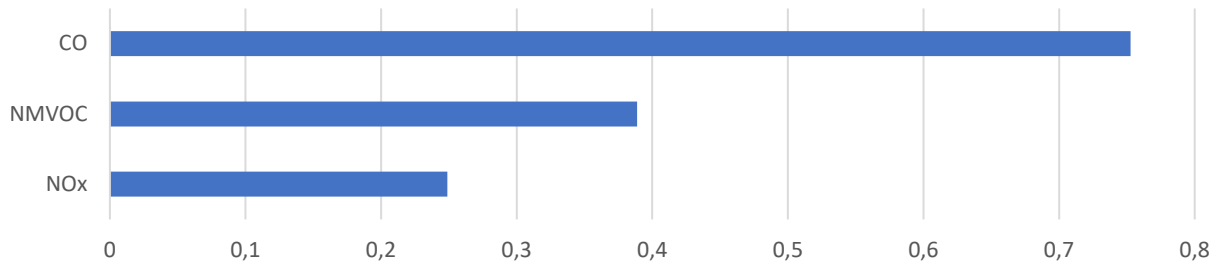

Figure 3.4.8. The share of emissions under category 1A3biv for some pollutants in 2019 as a percentage of total national emissions

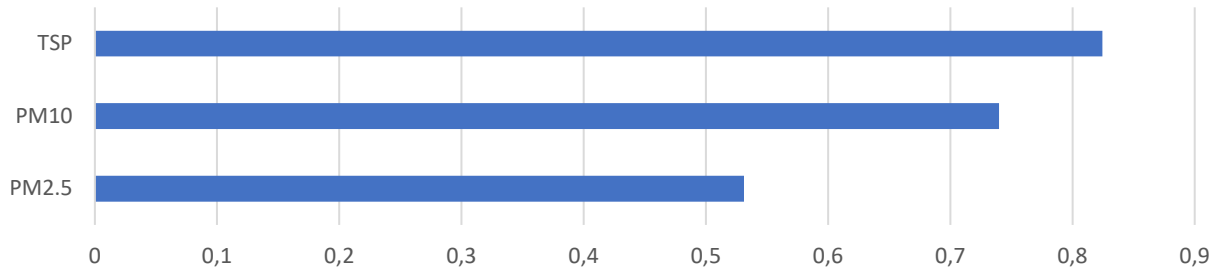

Figure 3.4.9. The share of emissions under category 1A3bv for some pollutants in 2019 as a percentage of total national emissions

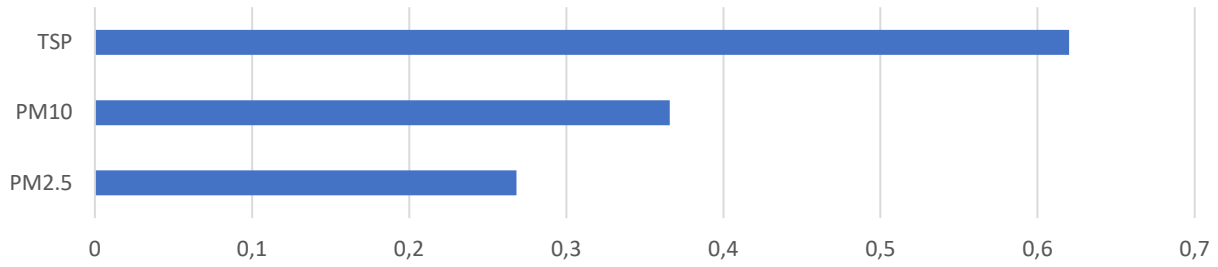

Figure 3.4.10. The share of emissions under category 1A3bvi for some pollutants in 2019 as a percentage of total national emissions

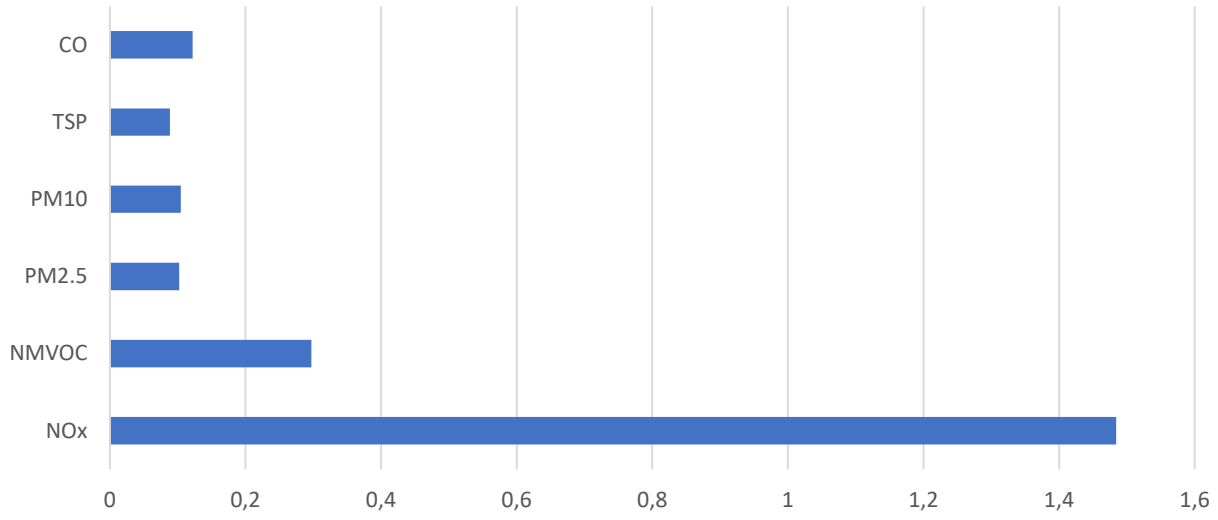

Figure 3.4.11. The share of emissions under category 1A3bvii for some pollutants in 2019 as a percentage of total national emissions

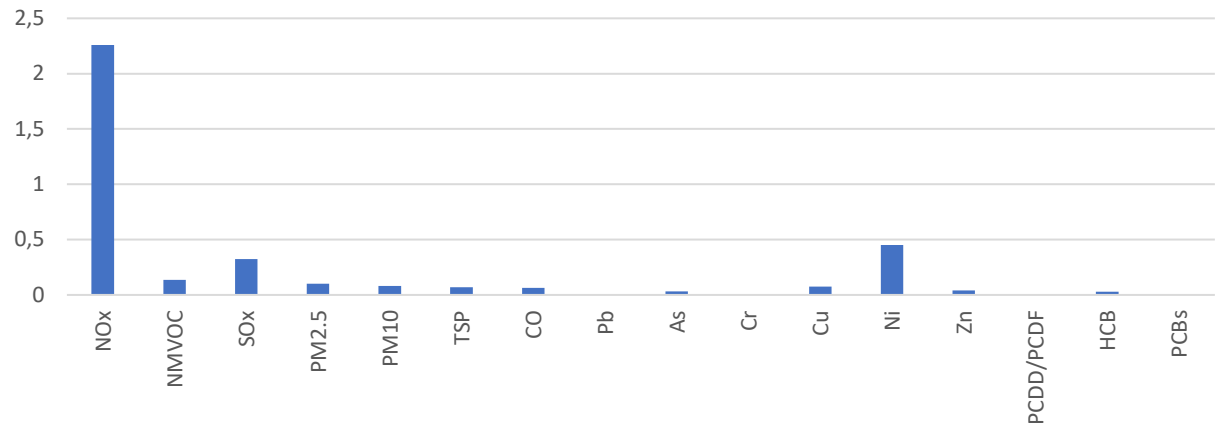

Figure 3.4.12. The share of emissions under category 1A3dii for some pollutants in 2019 as a percentage of total national emissions

3.2.2 Methodological issues

Methodological approach comprises combination of Tier 1 and Tier 2 described in EMEP/EEA air pollutant emission inventory guidebook 2019 – Update Oct. 2020 *(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).*

The amount of different fuels sold in 2019, provided by State Statistic Servise of Ukraine, presented in Figure 3.4.13, was disaggregated according to the four vehicle categories in line with the Tier 1 methodology. This breakdown is based on the data which is illustrated in Figures 3.4.2 and Figure 3.4.3 (left chart).

Further disaggregation, inherent to Tier 2, was performed in accordance to the distribution by environmental class shown in Figure 3.4.3 (right chart).

In order to convert the fuel amount into milleage (km/year for each sub-category), Tier 1 data on typical fuel consumption was used. Emissions from categories 1A3bv and 1A3bvi were calculated by using T1 aproach to the respective milleage.

Tier 2 emission factors were used to calculate the emissions, which involves additional averaging by expert assumptions, where needed.

The plans for the next submission involve using COPERT 5 with the support of an EU Technical Assistance Project.

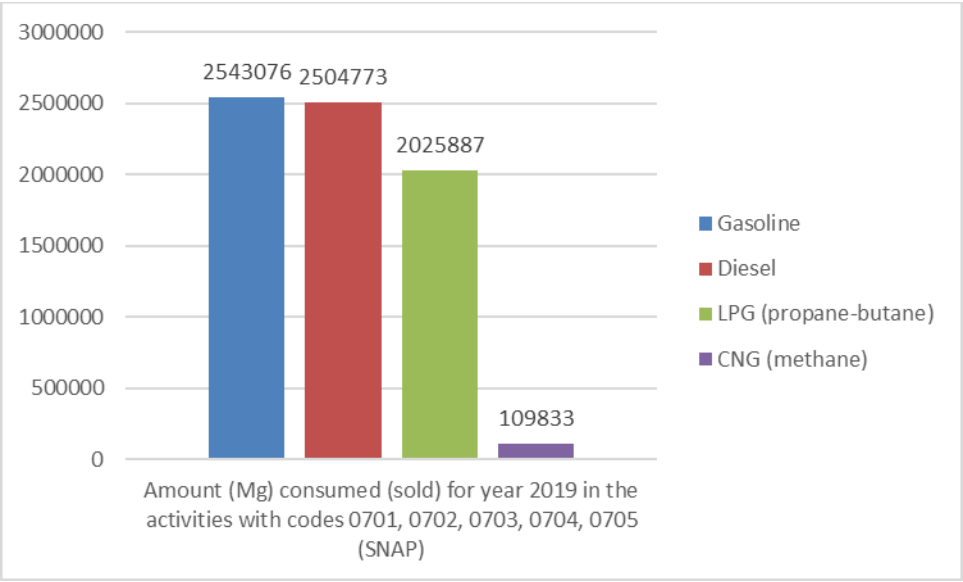

Figure 3.4.13. Amount (Mg) consumed (sold) for year 2019 in the activities with codes 0701, 0702, 0703, 0704, 0705 (SNAP)

3.3.3 Emission trends

In 2005 – 2019, there was an increase in the emissions of air pollutants in category 1A3 due to an increase in the number of vehicles in Ukraine.

3.3.4 Source specific QA/QC and verification

For general information on data quality assurance see Section 3.2.5.

3.5 Combustion and other sectors (categories 1A4, 1A5)

3.5.1 Source category description

Emissions in category 1A4 Combustion and other sectors are calculated for every subcategory as follows:

- 1A4ai. Commercial/Institutional: Stationary;
- 1A4aii. Commercial/Institutional: Mobile;
- 1A4bi. Residential: Stationary;
- 1A4bii. Residential: Household and gardening (mobile);
- 1A4ci. Agriculture/Forestry/Fishing: Stationary;
- 1A4cii. Agriculture/Forestry/Fishing: Off-road vehicles and other machinery;
- 1A4ciii. Agriculture/Forestry/Fishing: National fishing;
- 1A5a. Other stationary (including military);
- 1A5b. Other, Mobile (including military, land based and recreational boats).

Subcategories in sectors 1A4-1A5 are defined by methods listed in Table 3.5.1.

Table 3.5.1. Methods used to calculate and verify the emission data for the subcategories of NFR Categories 1A4 – 1A5 (for emission data reporting only T1 was used due to shortcamings in the collection of data for T3, see Chapter 3.3.4).

NFR code	Name	Calculation method	EF[5]	Pollutants
1A4ai	Commercial/Institutional: Stationary	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, HCB, PCBs
1A4aii	Commercial/Institutional: Mobile	Not calculated due to the lack of statistical information for T1 or T3 calculation methods. Partially included in category 1A3		
1A4bi	Residential: Stationary	T1/T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB, PCBs
1A4bii	Residential: Household and gardening (mobile)	Not calculated due to the lack of statistical information for T1 or T3 calculation methods. Partially included in category 1A3		
1A4ci	Agriculture/Forestry/Fishing: Stationary	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, HCB, PCBs
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Not calculated due to the lack of statistical information for T1 or T3 calculation methods. Partially included in category 1A3		
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Not calculated due to the lack of statistical information for T1 or T3 calculation methods. Partially included in category 1A3		
1A5a	Other stationary (including military)	T1	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, HCB, PCBs
1A5b	Other, Mobile (including military, land based and recreational boats).	Not calculated due to the lack of statistical information for T1 or T3 calculation methods. Partially included in category 1A3		

The share of emissions under category 1A4 for some pollutants in 2019 is shown in Figure 3.5.1.

[5] CS – country specific; D - default

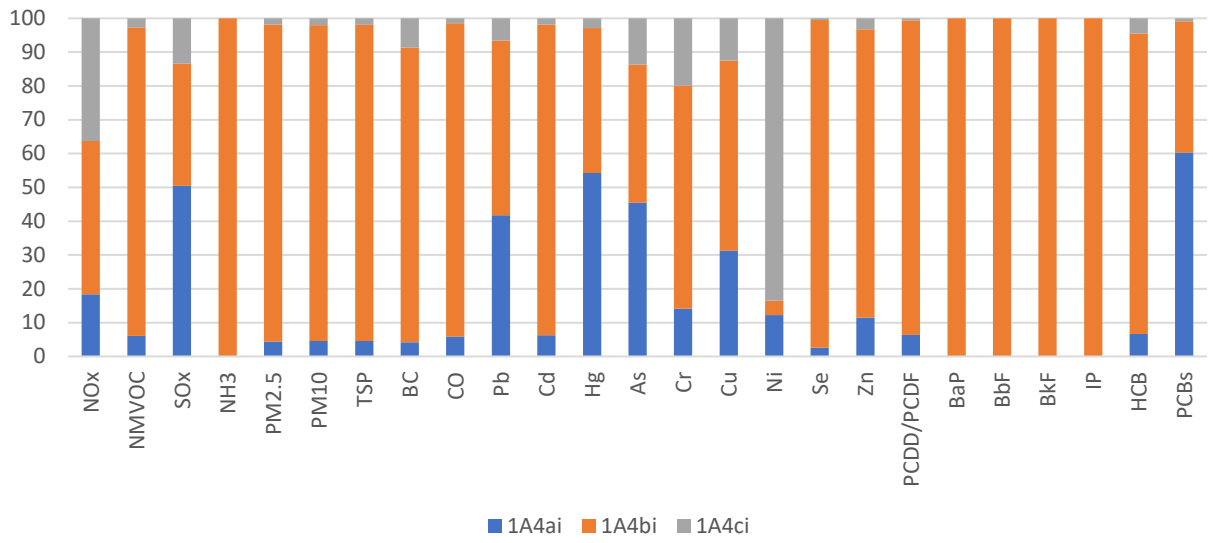

Figure 3.5.1. The share of emissions under category 1A4 for some pollutants in 2019

The share of emissions under categories 1A4ai, 1A4bi, 1A4ci and 1A5a for some pollutants in 2019 as a percentage of total national emissions is shown in Figures 3.5.2. – 3.5.5.

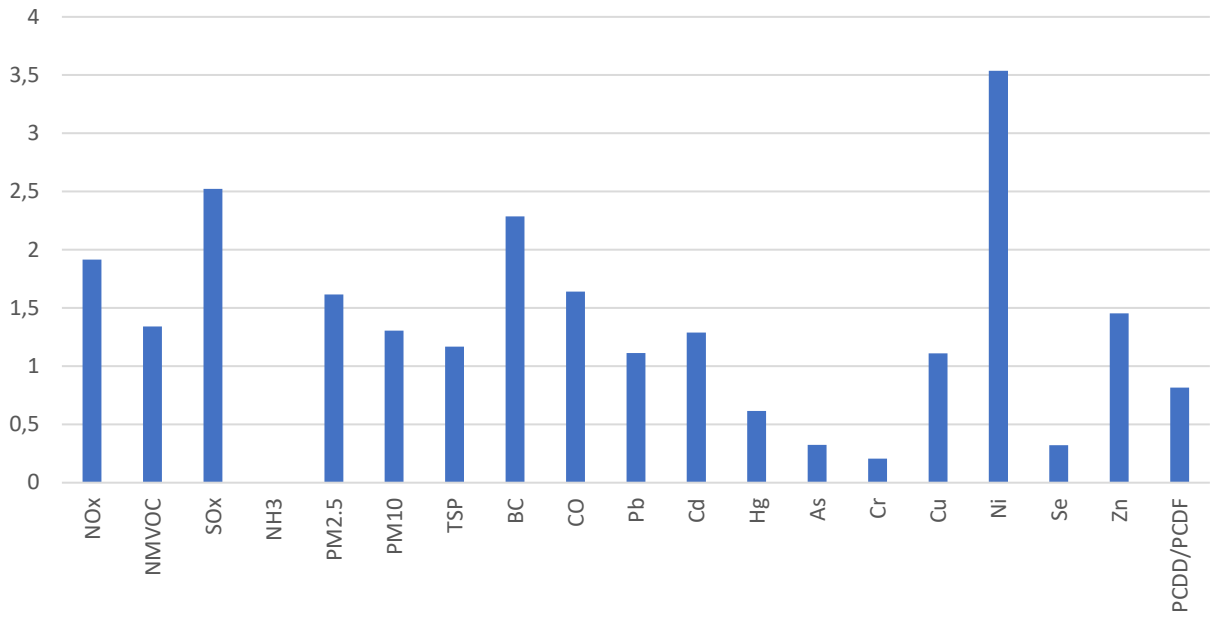

Figure 3.5.2. The share of emissions under category 1A4ai for some pollutants in 2019 as a percentage of total national emissions

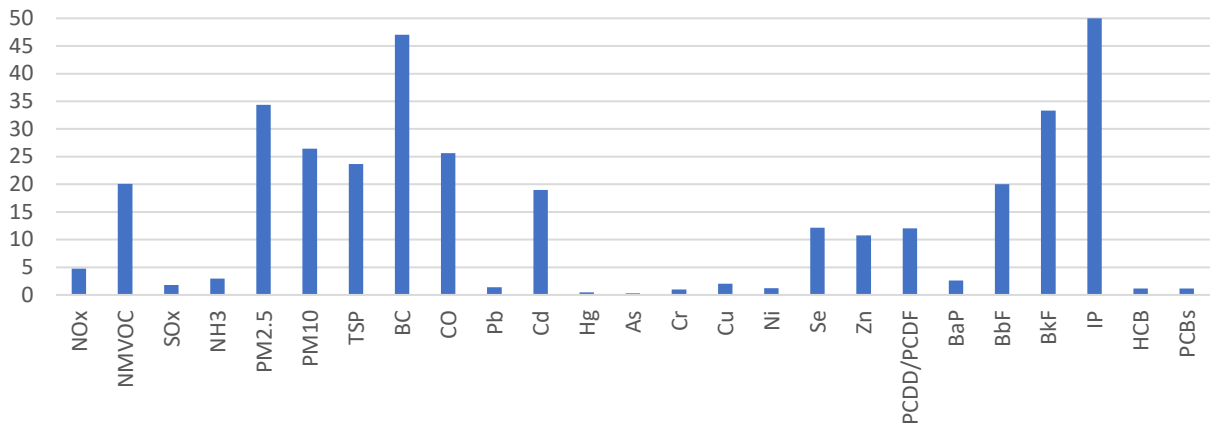

Figure 3.5.3. The share of emissions under category 1A4bi for some pollutants in 2019 as a percentage of total national emissions

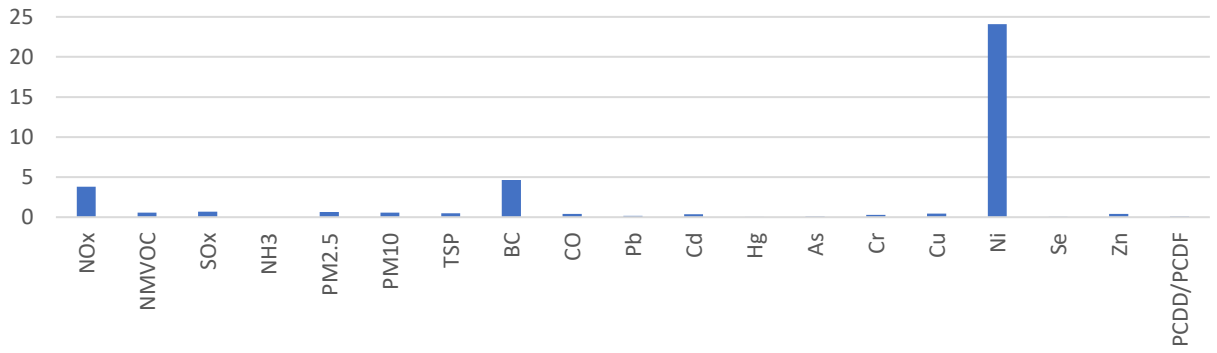

Figure 3.5.4. The share of emissions under category 1A4ci for some pollutants in 2019 as a percentage of total national emissions

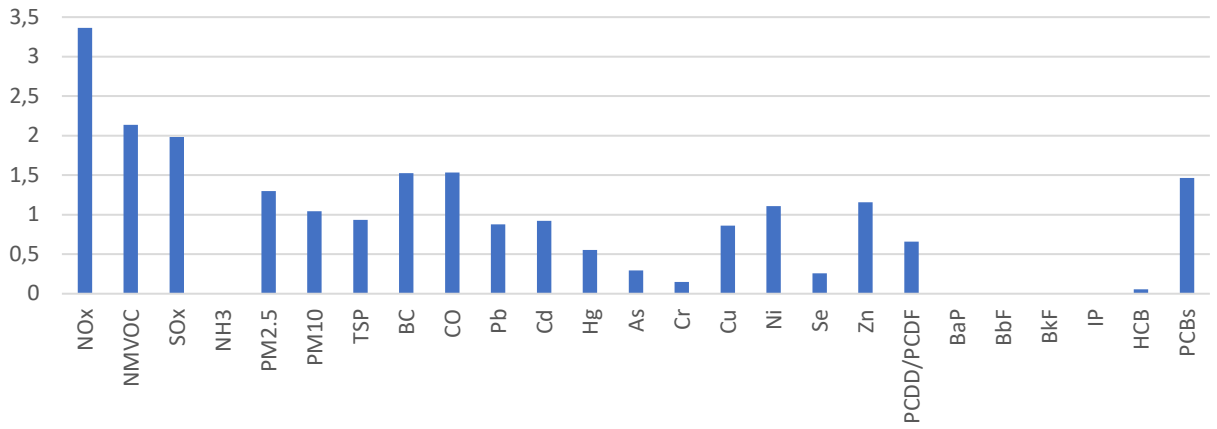

Figure 3.5.5. The share of emissions under category 1A5a for some pollutants in 2019 as a percentage of total national emissions

3.5.2 Methodological issues

The methodology of emission calculation for categories 1A4 – 1A5 is in line with the methodology described in section 3.1 for stationary fuel combustion. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method for the most of the categories (see Table 3.5.1).

For detailed information on the emission factors used for the emission sources see Annex 2.

3.5.3 Emission trends

Trends in pollutant emissions for category 1A1a as the most significant category of air pollutant emissions are shown in Figures 3.2.8-3.2.11.

In 1990-2000 there was a decrease in the emissions of air pollutants due to a decline in agricultural production

In 2014-2015, there was a decrease in the emissions of all pollutants due to a decline in agricultural production resulting from the armed aggression in the eastern Ukraine and the annexation of Crimea by Russia. Since 2016, there has been a partial increase in pollutant emissions in categories 1A4 and 1A5.

3.5.4 Source specific QA/QC and verification

For general information on data quality assurance see Section 3.2.4.

To verify the quality of data calculated at T1 level for category 1A4, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of air pollutants and greenhouse gases from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 3.5.2.

For comparison of T1 and T3 calculations for category 1A4 see table 3.5.3.

According to the table, the data on pollutant emissions calculated by T1 and T3 methods do not correlate. This is due to the lack of collection of statistical reports from small enterprises, which make up the majority of agricultural enterprises, and the population.

Table 3.5.2. List of production and technological processes, technological equipment (plants) for category 1A4

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
1A4ai	Commercial/Institutional: Stationary	**Combustion plants in commercial enterprises and institutions**	
		120102	Combustion plants >= 50 and < 300 MW (boilers)
		120103	Combustion plants < 50 MW (boilers)
		120104	Stationary gas turbines
		120105	Stationary engines
		120106	Other stationary equipment
1A4bi	Residential: stationary	**Combustion plants in residential sector**	
		120201	Combustion plants >= 50 and < 300 MW (boilers)
		120202	Combustion plants < 50 MW (boilers)
		120203	Stationary gas turbines
		120204	Stationary engines
		120205	Other stationary equipment
1A4ci	Agriculture/Forestry/Fishing: Stationary	**Combustion plants in agriculture, forestry and aquatic organisms cultivation sector**	
		120301	Combustion plants >= 50 and < 300 MW (boilers)
		120302	Combustion plants < 50 MW (boilers)
		120303	Stationary gas turbines
		120304	Stationary engines
		120305	Other stationary equipment

Table 3.5.3. Comparison of T1 and T3 calculations for category 1A4

Pollutant	Emissions	
	T3 calculation method	T1 calculation method
NOx, kt	4,88	48,24
NMVOC, kt	1,29	60,01
SOx, kt	8,99	41,04
NH_3	0,11	5,45
$PM_{2.5}$, kt	1,06	68,32
PM_{10}, kt	3,36	70,38
TSP, kt	3,89	74,3
BC, kt	3,71	7,08
CO, kt	16,27	421,65

Pb, t	0,95	7,93
Cd, t	0,01	1,12
Hg, t	0,06	0,35
As, t	2,08	0,22
Cr, t	1,77	2,97
Cu, t	1,53	1,44
Ni, t	1,13	8,31
Se, t	0	1,95
Zn, t	7,56	50,73
PCDD/PCDF, g I-TEQ	0	80,66
benzo(a)pyrene, t	0	0,01
benzo(b)fluoranthene, t	0	0,01
benzo(k)fluoranthene, t	0	0,01
Indeno(1,2,3-cd)pyrene, t	0	0,01

Due to the shortcomings of statistics collection system for air pollutant emissions (eg, lack of reporting on $PM_{2.5}$ and PM_{10} by some respondents, lack of statistical reporting on PCBs and HCB, underreporting of emissions volumes by respondents, lack of information about the methodology, etc.) the data used for category 1A4 of NFR table were obtained by T1 calculation method.

3.6 Fugitive emissions from fuels (category 1B)

3.6.1 Source category description

Emissions in category 1B Fugitive emissions from fuels are calculated for every subcategory as follows:

- 1B1a. Fugitive emission from solid fuels: Coal mining and handling;
- 1B1b. Fugitive emission from solid fuels: Solid fuel transformation;
- 1B1c. Other fugitive emissions from solid fuels;
- 1B2ai. Fugitive emissions oil: Exploration, production, transport;
- 1B2aiv. Fugitive emissions oil: Refining and storage;
- 1B2av. Distribution of oil products;
- 1B2b. Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other);
- 1B2c. Venting and flaring (oil, gas, combined oil and gas);
- 1B2d. Other fugitive emissions from energy production.

Subcategories in sectors 1B1-1B2 are defined by methods listed in Table 3.6.1.

Table 3.6.1. Methods used to calculate and verify the emission data for the subcategories of NFR Categories 1B1 – 1B2

NFR code	Name	Calculation method	EF[6]	Pollutants
1B1a	Fugitive emission from solid fuels: Coal mining and handling	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
1B1c	Other fugitive emissions from solid fuels	Not calculated due to the lack of statistical information for T3 calculation method		
1B2ai	Fugitive emissions oil: Exploration, production, transport	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
1B2aiv	Fugitive emissions oil: Refining and storage	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
1B2av	Distribution of oil products	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

[6] CS – country specific; D - default

1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
1B2c	Venting and flaring (oil, gas, combined oil and gas)	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
1B2d	Other fugitive emissions from energy production	Not calculated due to the lack of statistical information for T3 calculation method		

The share of emissions under categories 1B1 and 1B2 for some pollutants in 2019 is shown in Figures 3.6.1-3.6.2.

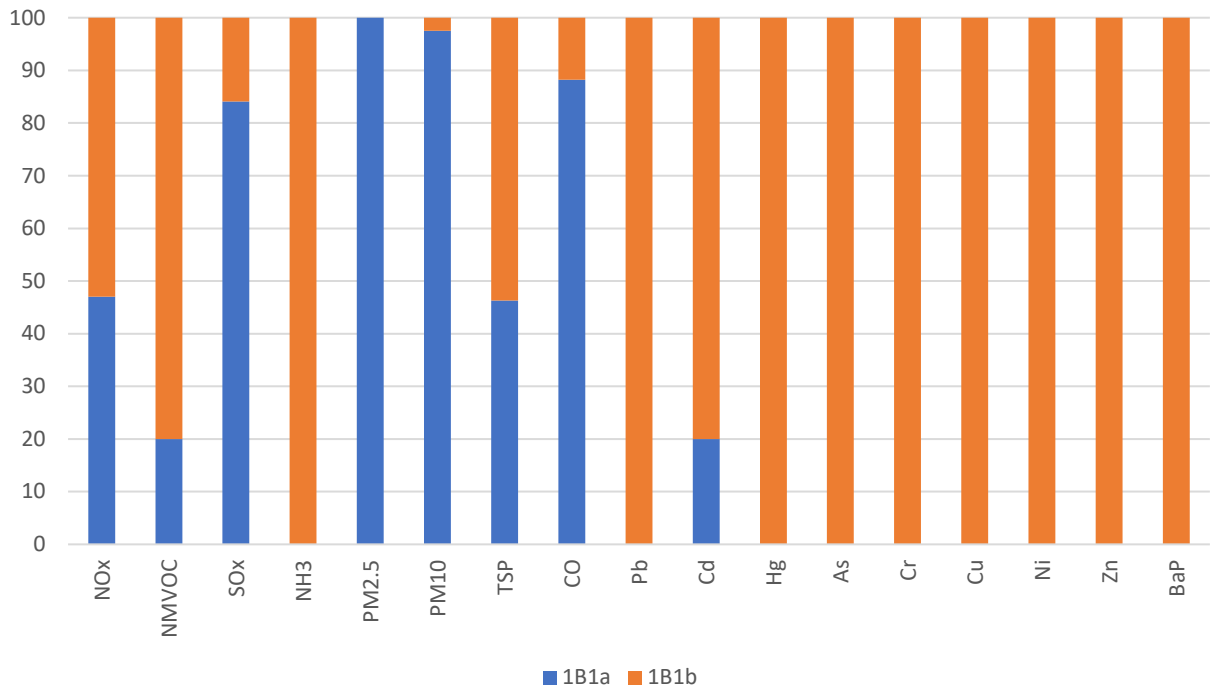

Figure 3.6.1. The share of emissions under category 1B1 for some pollutants in 2019

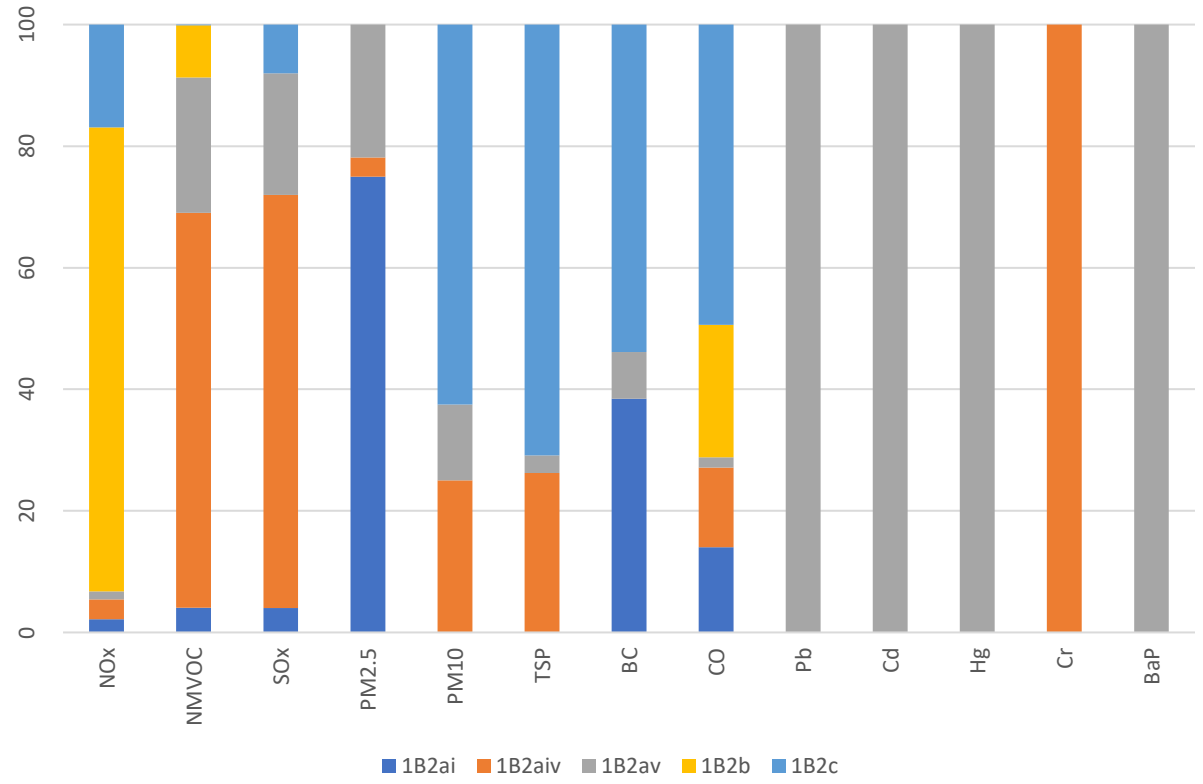

Figure 3.6.2. The share of emissions under category 1B2 for some pollutants in 2019

The share of emissions under categories 1B1a, 1B1b, 1B2ai, 1B2aiv, 1B2av, 1B2b and 1B2c for some pollutants in 2019 as a percentage of total national emissions is shown in Figures 3.6.3. – 3.6.9.

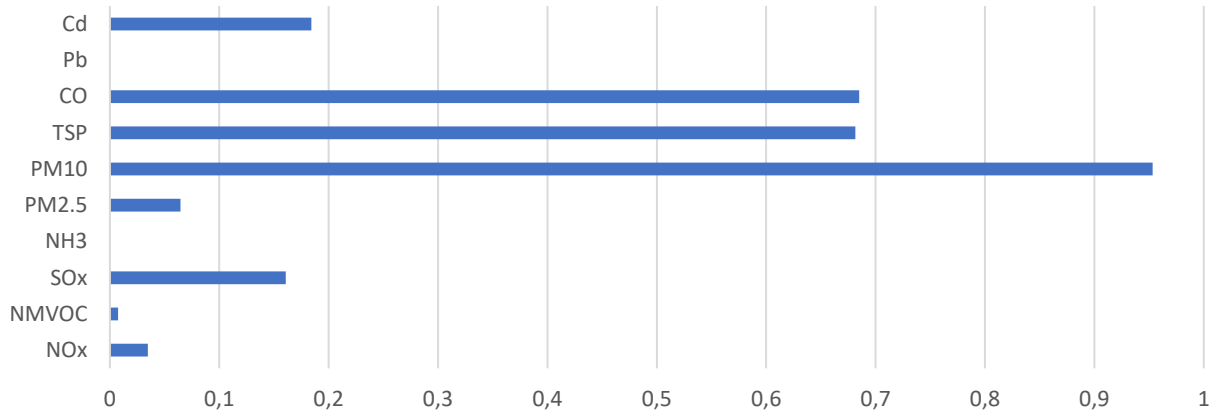

Figure 3.6.3. The share of emissions under category 1B1a for some pollutants in 2019 as a percentage of total national emissions

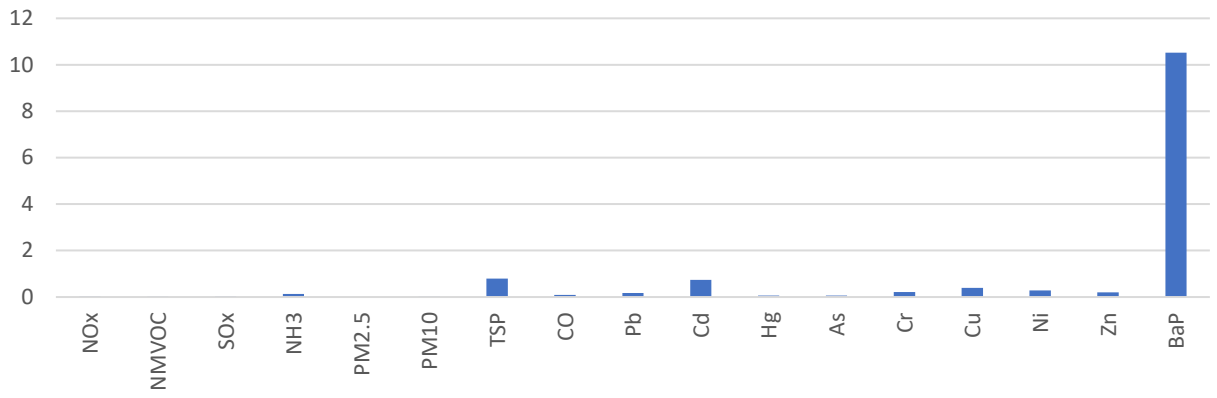

Figure 3.6.4. The share of emissions under category 1B1b for some pollutants in 2019 as a percentage of total national emissions

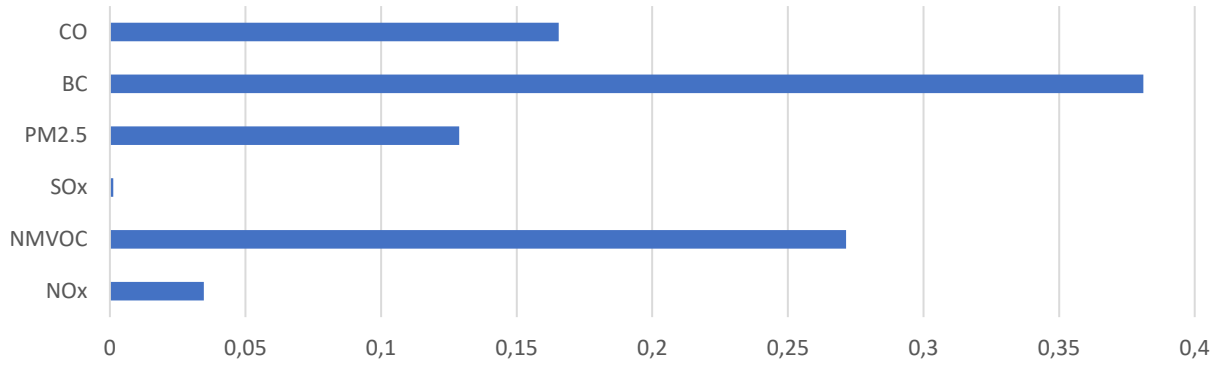

Figure 3.6.5. The share of emissions under category 1B2ai for some pollutants in 2019 as a percentage of total national emissions

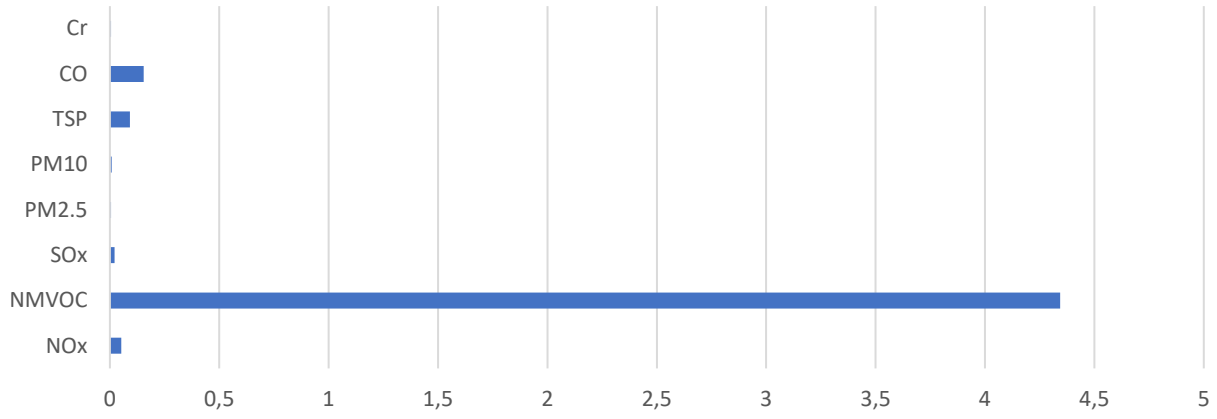

Figure 3.6.6. The share of emissions under category 1B2aiv for some pollutants in 2019 as a percentage of total national emissions

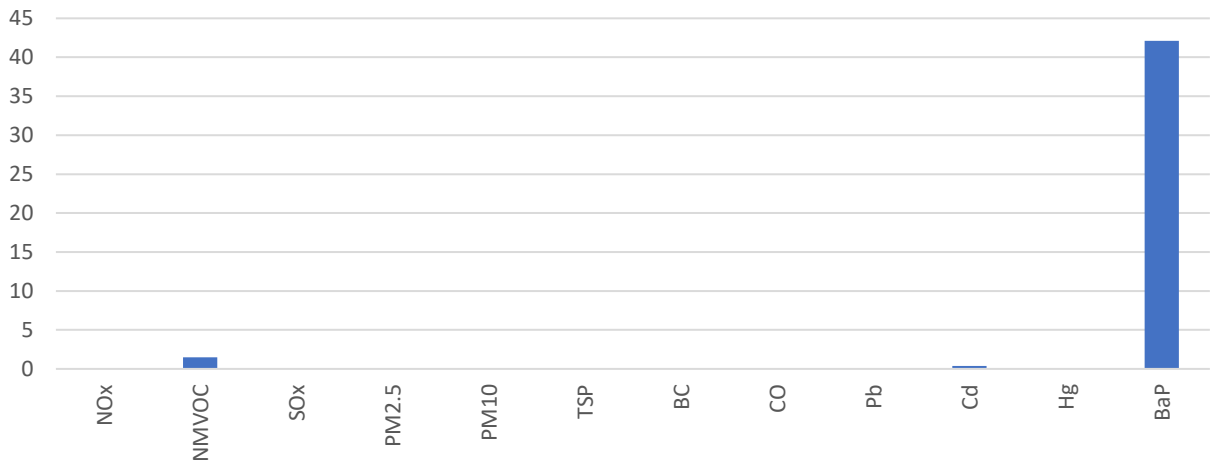

Figure 3.6.7. The share of emissions under category 1B2av for some pollutants in 2019 as a percentage of total national emissions

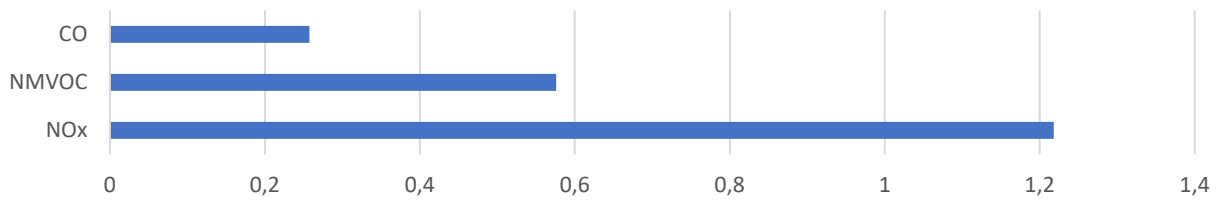

Figure 3.6.8. The share of emissions under category 1B2b for some pollutants in 2019 as a percentage of total national emissions

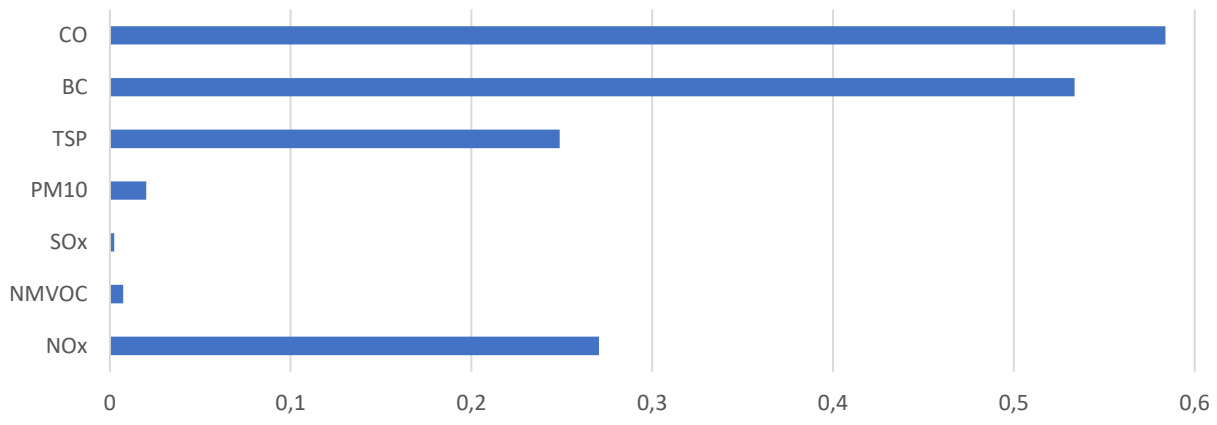

Figure 3.6.9. The share of emissions under category 1B2c for some pollutants in 2019 as a percentage of total national emissions

3.6.2 Methodological issues

To calculate 1B1 and 1B2 categories, the data from the database of the State Statistics Service of Ukraine on emissions of air pollutants prepared on the basis of 2-TP forms for state statistical observation (air)(annual) "Report on stationary sources emissions of pollutants and greenhouse gases into the air" [5] (T3 method) were used as well as Methodological guidelines for the organization of state statistical observation of pollutant emissions and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 3.6.2.

Table 3.6.2. List of production and technological processes, technological equipment (plants) for categories 1B1 and 1B2

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
1B1a	Fugitive emission from solid fuels: Coal mining and handling	**Mining and primary processing of solid fossil fuels**	
		310101	Open cast mining
		310102	Underground mining
		310103	Storage of solid fuel
		310104	Other
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	**Technological processes in ferrous metallurgy and coal industry**	
		210201	Coke oven batteries (indoor leaking and extinguishing)
		210204	Solid smokeless fuel
1B2ai	Fugitive emissions oil: Exploration, production, transport	**Extraction, primary processing and loading of liquid fossil fuels**	
		310201	Land-based activities
		310202	Off-shore activities
		310203	Other
1B2aiv	Fugitive emissions oil: Refining and storage	**Technological processes in oil industry**	
		210101	Petroleum products processing
		210102	Catalytic cracking
		210103	Sulphur recovery plants
		210104	Storage and handling of petroleum production in refinery
		210105	Other
1B2av	Distribution of oil products	**Liquid fuel distribution (other than gasoline)**	
		310401	Off-shore terminals (tankers, transportation and storage)
		310402	Other transportation and storage (including pipelines)
		Gasoline distribution	

		310501	Refinery dispatch station
		310502	Transport and depots
		310503	Service stations (including car refueling)
		310504	Other
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	**Extraction, primary processing and loading of gaseous fossil fuels**	
		310301	Land-based activities (desulfurization)
		310302	Land-based activities (other than desulfurization)
		310303	Off-shore activities
		310304	Other
		Gas distribution networks	
		310601	Pipelines
		310602	Pipeline compressor stations
		310603	Distribution networks
1B2c	Venting and flaring (oil, gas, combined oil and gas)	**Waste combustion**	
		510203	Flaring in oil refinery
		510206	Flaring in oil and gas extraction

3.6.3 Emission trends

In 1990-2019 there was a decrease in the emissions of air pollutants under category 1B1 due to a significant decline in coal mining. At the same time, there has been an increase in 1B2 emissions in recent years.

Trends in pollutant emissions for categories 1B1 and 1B2 over the past three years are shown in Figures 3.6.10-3.6.3.

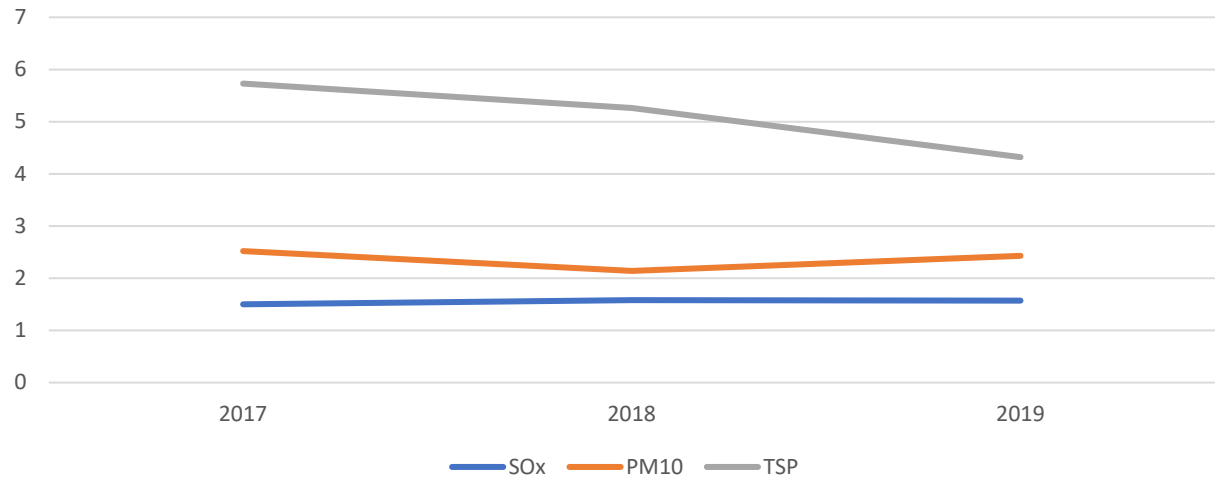

Figure 3.6.10. SOx, PM_{10} and TSP emissions for category 1B1 in 2017-2019, thousand tons

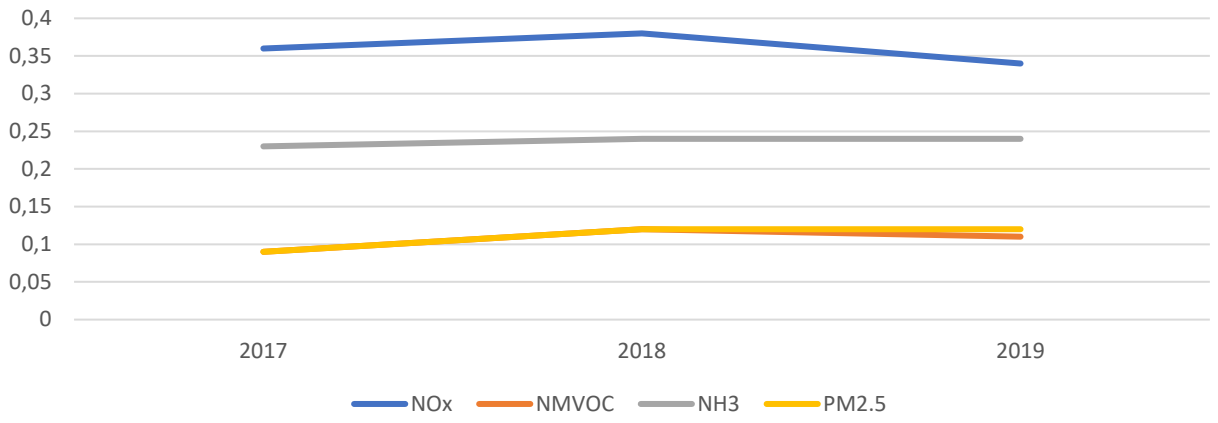

Figure 3.6.11. NOx, NMVOC, NH_3 and $PM_{2.5}$ emissions for category 1B1 in 2017-2019, thousand tons

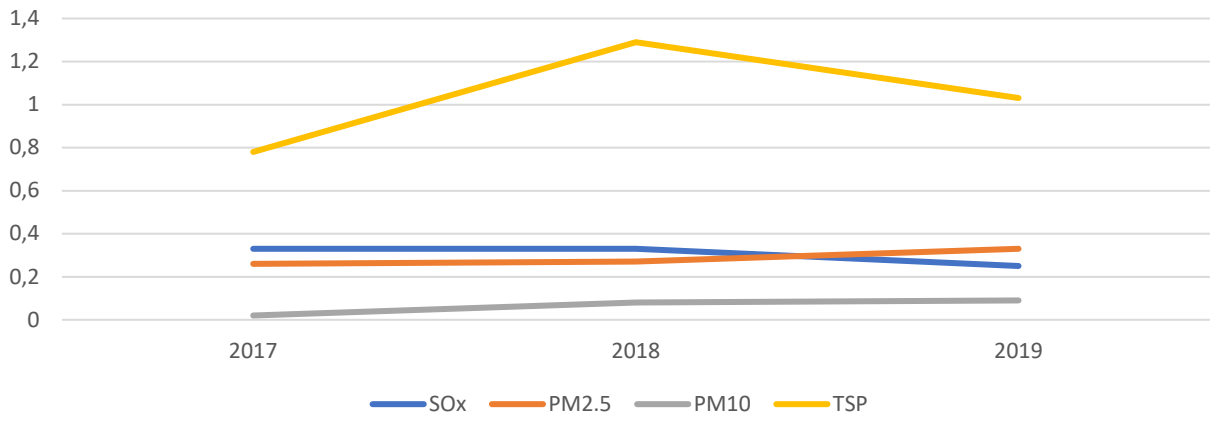

Figure 3.6.12. SOx, $PM_{2.5}$, PM_{10} and TSP emissions for category 1B2 in 2017-2019, thousand tons

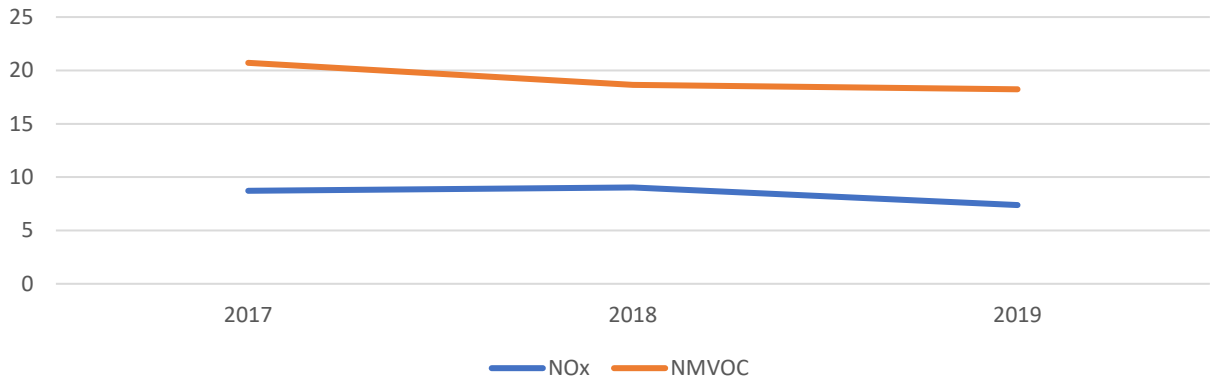

Figure 3.6.13. NOx and NMVOC emissions for category 1B2 in 2017-2019, thousand tons

As can be seen from Figures 3.6.10-3.6.11, there has been an increase in NMVOC, NH_3 and $PM_{2.5}$ emissions and a decrease in NOx and TSP emissions for category 1B1 over the recent years.

For category 1B2 there has been an increase in TSP, $PM_{2.5}$ and PM_{10} emissions and a decrease in NOx, SOx and NMVOC emissions (Figure 3.6.12-3.6.13).

3.6.4 Source specific QA/QC and verification

For general information on data quality assurance see Section 3.2.4.

4 INDUSTRIAL PROCESSES AND PRODUCT USAGE

4.1 Source category description and the general methodology

Sources of pollutant emissions in the industrial processes and product use (IPPU) category include:

- 2A. Mineral products;
- 2B. Chemical industry;
- 2C. Metalworking industry;
- 2D. Use of solvents and products;
- 2G. Other uses of solvents and chemicals;
- 2H. Other industrial production;
- 2I. Woodworking industry;
- 2J. Production of persistent organic pollutants.

Category 2L emissions (other production, consumption, storage, transportation or handling of bulk materials) are not considered separately and are included in other categories (e.g., 2A1, 1B1a, etc.).

Emissions of pollutants in Category 2 are mainly estimated by the amount of products produced according to the State Statistics Service of Ukraine according to the Statistical Compendium "Production of Industrial Products by Type" [10].

Typically, emission calculations are calculated using the below formula:

$$E = \sum(EF_{ab}A_{ab}),$$

where:

- E - amount of emissions,
- EF - emission factor,
- A - gross output,
- a - product type,
- b - category.

Emission factors recommended in the EMEP/EEA emission inventory guide [4] and domestic emission factors were used for emission calculations.

The IPPU category is a significant source of NMVOC and heavy metal emissions due to solvent use and industrial processes in the metalworking industry. The share of emissions for Category 2 for some pollutants in 2019 is shown in Fig. 4.1.1.

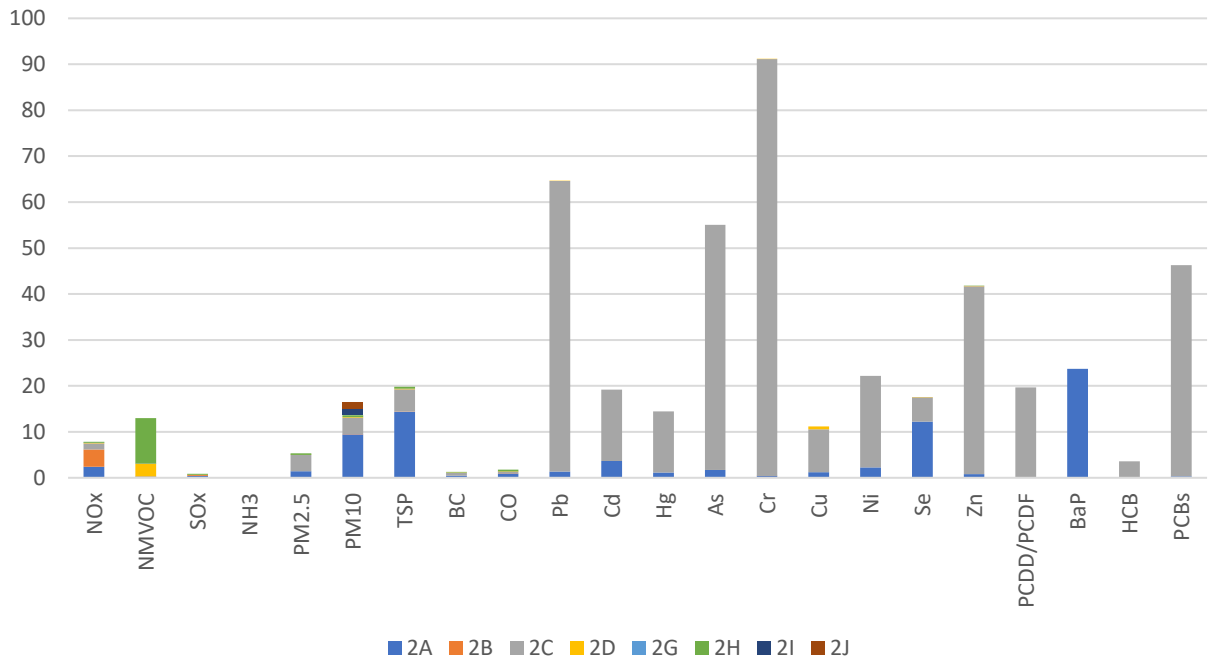

Fig. 4.1.1. Share of NFR Category 2 emissions for some pollutants in 2019 as a percentage of total national emissions

The distribution of emissions of certain pollutants in Category 2 is shown in Fig. 4.1.2.

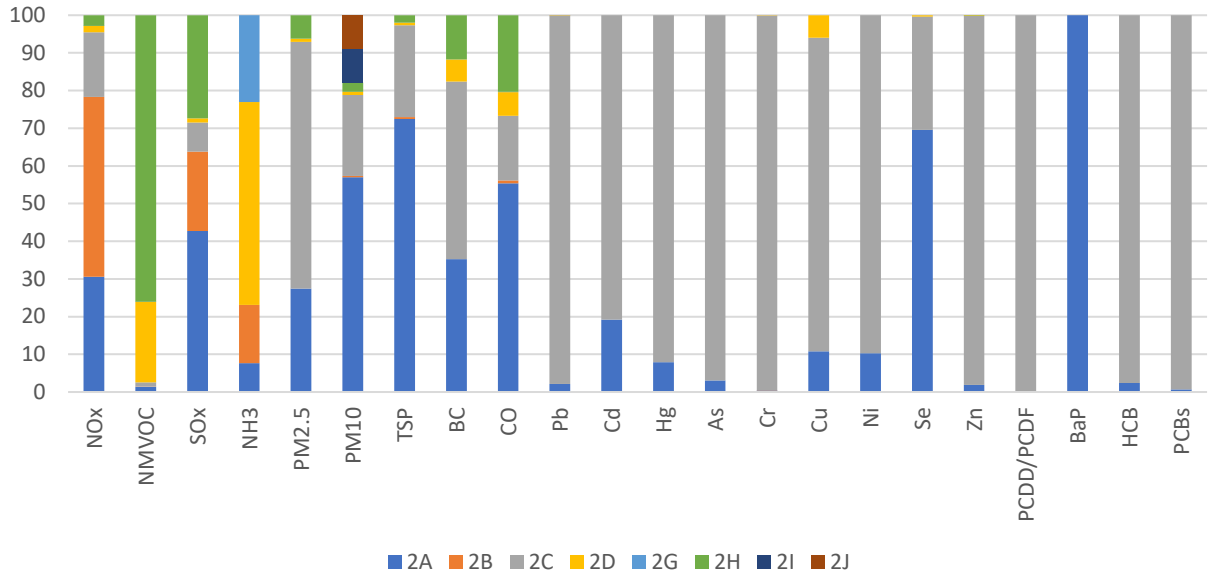

Fig. 4.1.2. Distribution of emissions from NFR Category 2 for some pollutants in 2019, %

4.2 Mineral Products (Category 2A)

4.2.1 Source category description

Emissions in Category 2A. Mineral products are evaluated for each subcategory as follows:

- 2A1. Cement production;
- 2A2. Lime production;
- 2A3. Glass production;
- 2A5a. Quarries and mining operations for the extraction of minerals, except for coal.
- 2a5b. Construction and dismantling;
- 2A5c. Storage, processing and transportation of minerals;
- 2A6. Other minerals.

Subcategories in Sector 2A are defined by the methods shown in Table 4.2.1.

Table 4.2.1. Methods used to calculate and verify emissions data for Category 2A subcategories

Код NFR	Назва	Метод розрахунку	EF[7]	Забруднювачі
2A1	Cement production	T1/ T3	D	NO_x, NMVOC, SO_x, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB, PCBs
2A2	Lime production	T2/T3	CS	$PM_{2.5}$, PM_{10}, TSP
2A3	Glass production	T2/T3	CS	NO_x, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn
2A5a	Quarries and mining operations for the extraction of minerals, except coal	T1	D	$PM_{2.5}$, PM_{10}, TSP
2A5b	Construction and dismantling	Not evaluated due to the lack of statistical information for calculation using the T1 or T3 methods		
2A5c	Storage, processing and transportation of minerals	Not evaluated due to the lack of statistical information for calculation using the T1 or T3 methods		
2A6	Other minerals	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

[7] CS – country specific; D - default

The distribution of emissions of certain pollutants in Category 2A is shown in Fig. 4.2.1.

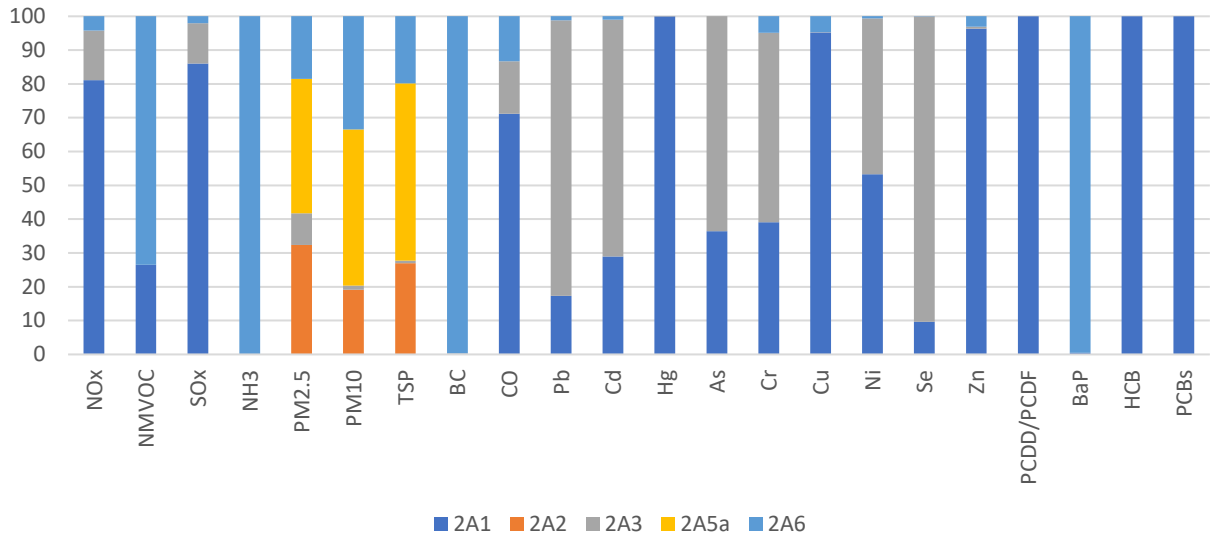

Fig. 4.2.1. Distribution of emissions in Category 2A for some pollutants in 2019, %

Since 1990, the production of clinker products and Lime has been gradually decreasing in Ukraine. From 2000 to 2008, there was an increase in production volumes. In 2009, due to the consequences of the global financial recession, the production of these products significantly decreased, as shown in Fig. 4.2.2.

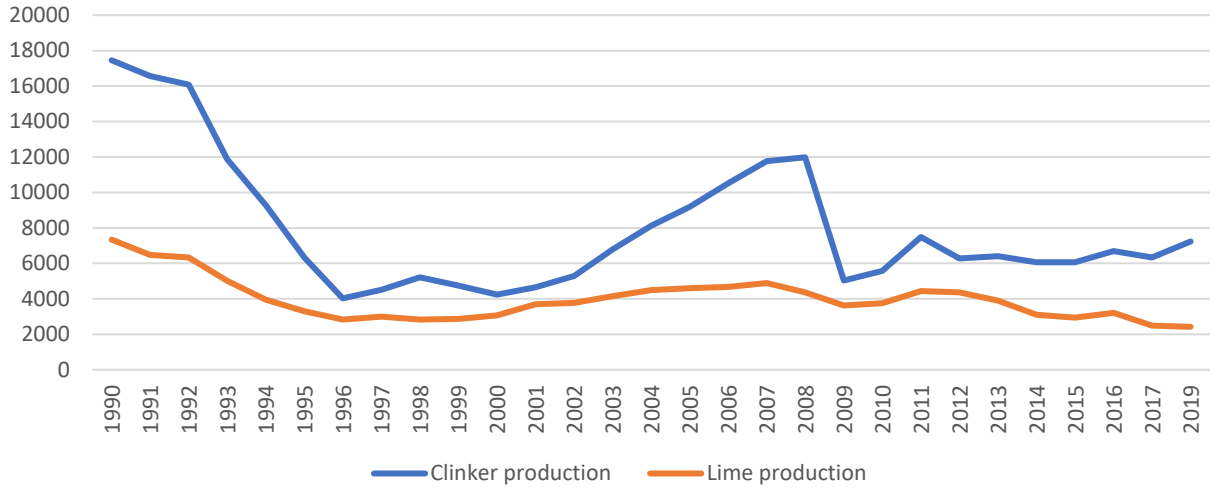

Fig. 4.2.2. Clinker products and lime, thous. tons

Since 1990, the production of flat glass in Ukraine has gradually decreased and the production of glass cans and bottles has increased, which is associated with a change in the nature of consumption of the population. The decline in production was observed in 2009, which is associated with the consequences of the global financial recession (Fig. 4.2.3).

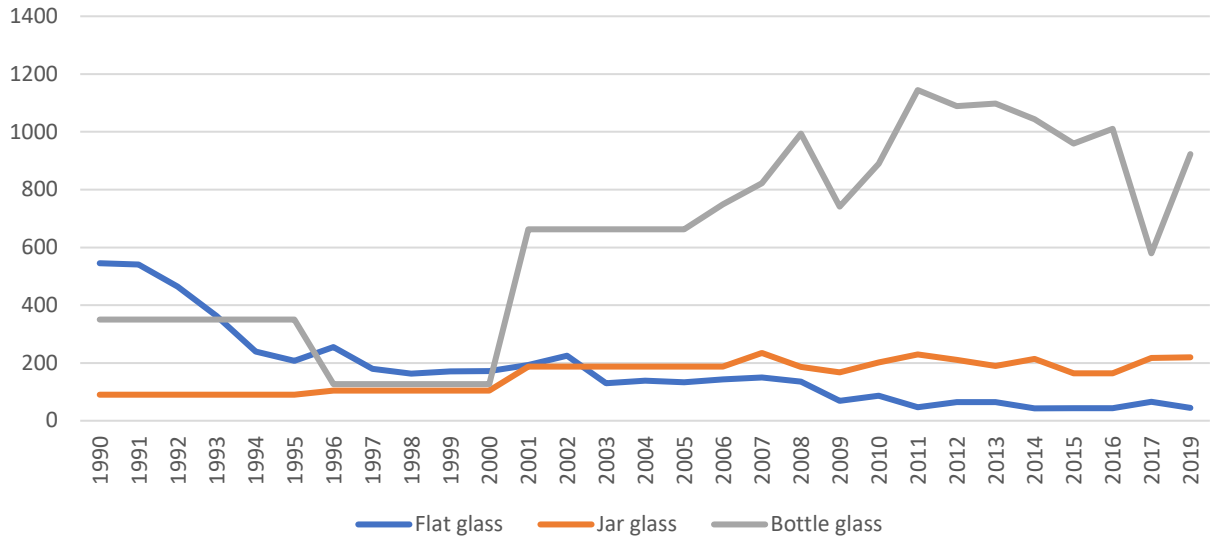

Fig. 4.2.3. Glass production, thous. tons

Since 2003, Ukraine has seen a decrease in the production of limestone and agglomerated iron ore concentrates and an increase in the production of non-agglomerated iron ore concentrates, sand, pebbles, gravel, ballast and crushed stone. The decline in production was observed in 2009, which is associated with the consequences of the global financial recession (Fig. 4.2.4).

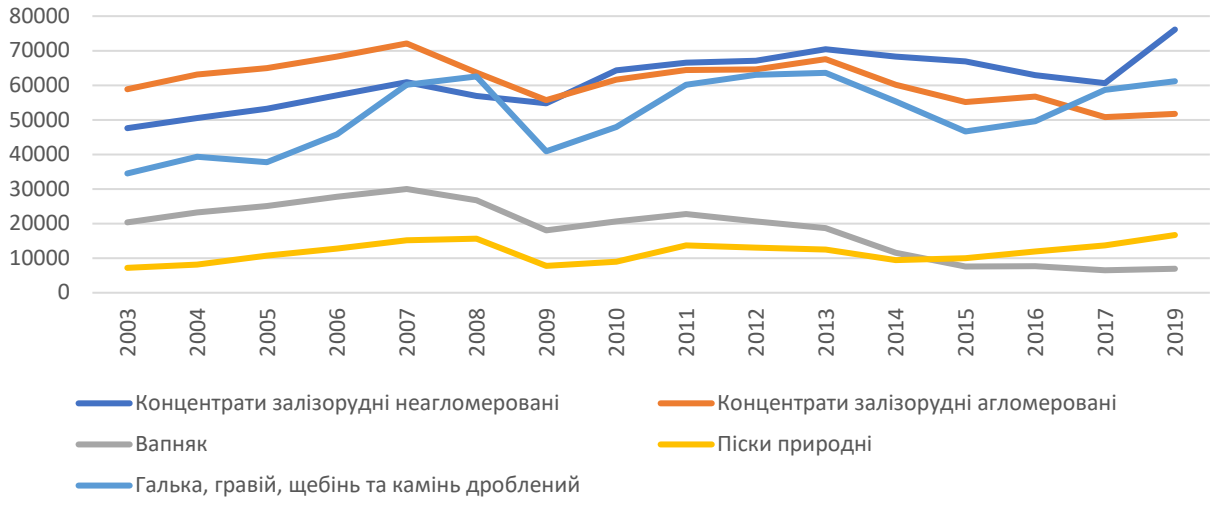

Fig. 4.2.4. Mining operations, thous. tons

4.2.2 Methodological issues

The emission estimation methodology for categories 2A1-2a3 and 2a5a is consistent with the one described in Section 4.1.

Detailed information on applicable emission factors for emission sources is provided in Annex 2.

To calculate Category 2A6 using the T3 method, the national categories of production and technological processes, technological equipment (installations) are used, as shown in Table 4.2.2.

Table 4.2.2. List of production and engineering processes, technological equipment (installations) for category 2A6

NFR Code	NFR name	Коди виробничих та технологічних процесів, технологічного устаткування (установок)	Найменування виробничих та технологічних процесів, технологічного устаткування (установок)
2A6	Other minerals	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210615	Battery manufacturing
		210616	Mineral output
		210617	Other (including fiber asbestos production)
		210618	Use of limestone and dolomite

4.2.3 Emission trends

Trends in pollutant emissions for categories 2A are shown in Fig. 4.2.5-4.2.8.

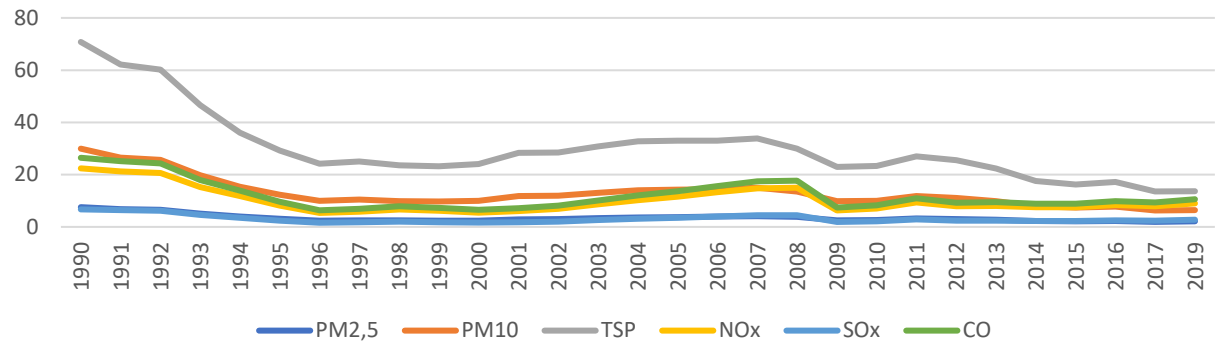

Fig. 4.2.5. Emissions of dust, nitrogen and sulfur oxides and carbon monoxide for categories 2A1-2a3 in 2000-2019, thous. tons

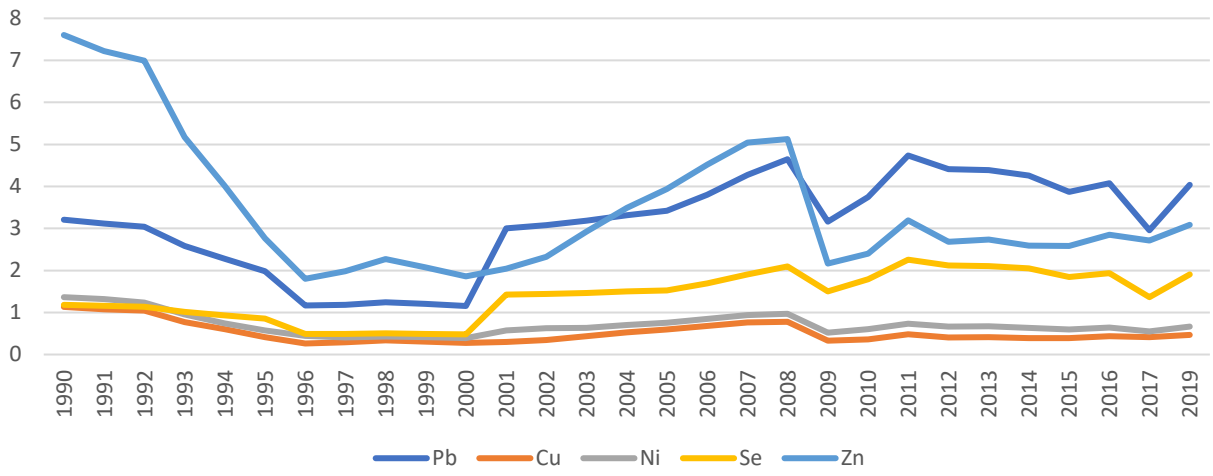

Fig. 4.2.6. Emissions of Pb, Cu, Ni, Se and Zn for categories 2A1-2a3 in 2000-2019, t

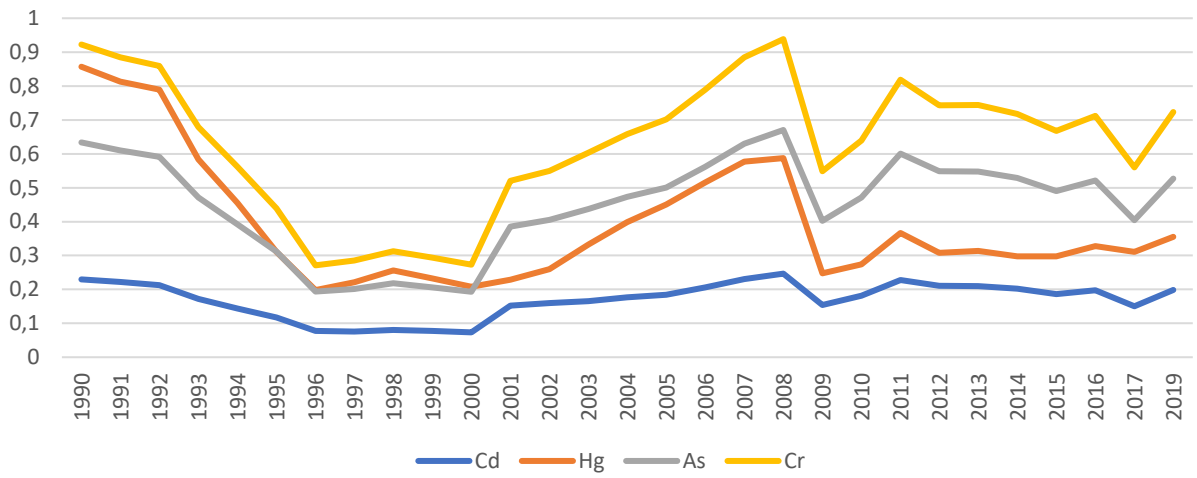

Fig. 4.2.7. CD, Hg, As and Cr emissions for Categories 2A1-2a3 in 2000-2019, t

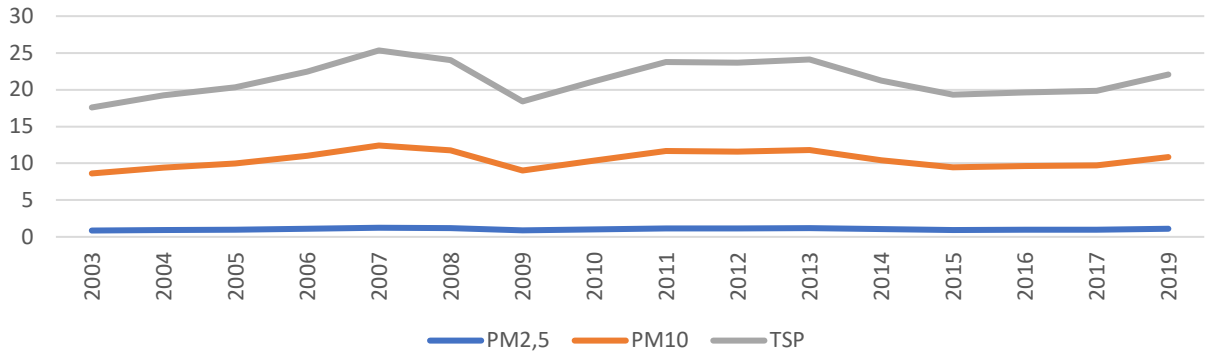

Fig. 4.2.8. Dust emissions for Category 2A5a in 1990-2019, thous. tons

As seen from Figures 4.2.4-4.2.8, from 1990 to 2000, there is emission downward trend which is associated with a decrease in production volumes. Since 2000, there has been an increase in heavy metal emissions and a slight decrease in dust emissions.

4.2.4 Source specific QA/QC and verification

To ensure the quality of data obtained by collecting information directly from respondents, the state statistics service of Ukraine monitors the level of submission of reports by respondents and analyzes the reasons for their failure to provide.

When generating reports the State Statistics Service of Ukraine utilizes the following methods of quality control of results:

- data analysis over time (comparison of data from the reporting year with the previous year);
- spatial data analysis (comparison of data by region);
- data distribution analysis (analysis of data that differs significantly from the distribution of the main part of the data).

In addition, to verify the quality of data calculated at T1/T2 levels for Categories 2A1-2A3, a comparison of the calculated data with the data of the database of the State Statistics Service of Ukraine on emissions of pollutants into the atmospheric air, collected from respondents according to the forms of State Statistical Observation No. 2-TP (air)(Annual) "Report on emissions of pollutants and greenhouse gases into the atmospheric air from stationary sources of emissions" [5] (T3 method) and methodological provisions for the organization of State statistical observation on emissions of pollutants and greenhouse gases into the atmospheric air from stationary sources of emissions [6].

To calculate using the T3 method, the national categories of production and technological processes, technological equipment (installations) are used, as shown in Table 4.2.3.

Table 4.2.3. List of production and engineering processes, technological equipment (installations) for categories 2A1-2A3

NFR Code	NFR name	Codes of production and engineering processes, technological equipment (installations)	Name of production and engineering processes, technological equipment (installations)
2A1	Cement production	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210612	Cement

2A2	Lime production	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210614	Lime
2A3	Glass production	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210613	Glass

A comparison of calculations using the T1/T2 and T3 methods for Category 2A1-2A3 is shown in Table 4.2.4.

Table 4.2.4. Comparison of calculations using the T1/T2 and T3 methods for Category 2A1-2A3

Pollutant	**Emissions**	
	Calculation method T3	**Calculation method T1/T2**
NOx, kt	0,94	10,61
NMVOC, kt	0,02	0,13
SOx, kt	0,09	3,08
$PM_{2.5}$, kt	0,03	1,14
PM_{10}, kt	1,53	4,77
TSP, kt	0,42	11,71
CO, kt	0,49	12,84
Pb, t	0,07	4,04
Cd, t	0,01	0,2
Hg, t	0	0,36
As, t	0,07	0,53
Cr, t	0,12	0,72
Cu, t	0,08	0,47
Ni, t	0,08	0,66
Se, t	0	1,9
Zn, t	0,15	3,09

Due to the shortcomings of the system for collecting statistical information on emissions of pollutants into the air (e.g., the lack of reporting for PM2,5 and PM10 from a some respondents, the lack of statistical reporting for PCBs and HCB, underreporting of emissions by respondents, lack of information about the methodology, etc.), data obtained by calculation methods T1/T2 were used to form Categories 2A1-2a3 of the NFR table. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method (see Table 4.2.1.).

4.3 Chemical industry (category 2B)

4.3.1 Source category description

Emissions in category 2B. The chemical industry is evaluated for each subcategory as follows:

- 2B1. Ammonia production;
- 2B2. Nitric acid production;
- 2B3. Adipic acid production;
- 2B5. Carbide production.
- 2B6. Titanium dioxide production;
- 2B7. Soda ash production;
- 2B10a. Chemical industry: other;
- 2B10b. Storage, processing and transportation of chemical products.

Subcategories in Sector 2b are defined by the methods shown in Table 4.3.1.

Table 4.3.1. Methods used to calculate and verify emissions data for category 2B subcategories (for emission data reporting of 2B1, 2B2 and 2B10a only T1 was used due to shortcamings in the collection of data for T3, see Chapter 4.3.4)

NFR code	Name	Calculation method	EF[8]	Pollutants
2B1	Ammonia production	T1/ T3	D	NO_x, NH_3, CO
2B2	Nitric acid production	T1/T3	D	NO_x
2B3	Adipic acid production	N/A		
2B5	Carbide production	N/A		
2B6	Titanium dioxide production	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
2B7	Soda ash production	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
2B10a	Chemical industry: other	T1/T3	D	NMVOC, TSP

[8] CS – country specific; D - default

2B10b	Storage, processing and transportation of chemical products	Not evaluated due to the lack of statistical information to calculate using the T1 or T3 methods. Partially accounted for in Category 2b10a using the T3 method

The distribution of emissions of certain pollutants in category 2B is shown in Fig. 4.3.1.

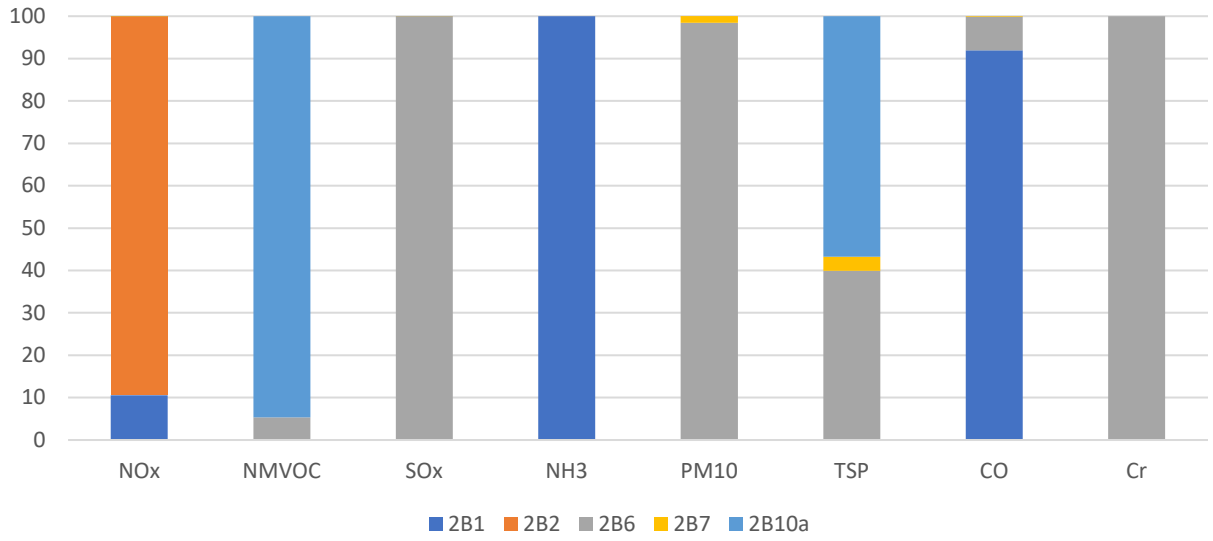

Fig. 4.3.1. Distribution of category 2B emissions for some pollutants in 2019, %

4.3.2 Methodological issues

The emission estimation methodology for Categories 2B1, 2b2, and 2b10a is consistent with the one described in Section 4.1. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method.

Detailed information on applicable emission factors for emission sources is provided in Annex 2.

To calculate category 2B6 and 2B7 using the T3 method, the national categories of production and technological processes, technological equipment (installations) are used, as shown in Table 4.2.2.

4.3.3 Emission trends

Since 1990, Ukraine has seen trends in reducing the manufacture of chemical products, and as a result – a decrease in emissions of pollutants into the atmospheric air.

Table 4.3.2. List of production and engineering processes, technological equipment (installations) for categories 2B6-2B77

NFR Code	NFR name	Codes of production and engineering processes, technological equipment (installations)	Name of production and engineering processes, technological equipment (installations)
2B6	Titanium dioxide production	**Inorganic chemicals manufacturing process flow in industry**	
		210410	Titanium dioxide
2B7	Soda ash production	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210619	Production and use of soda

4.3.4 Source specific QA/QC and verification

For general information on Data Quality Control, see Section 4.2.4.

To verify the quality of data calculated at T1 level for category 2B1, 2B2 and 2B10a, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 4.3.3.

Table 4.3.3. List of production and technological processes, technological equipment (plants) for category 2B1, 2B2 and 2B10a

NFR Code	NFR name	Codes of production and engineering processes, technological equipment (installations)	Name of production and engineering processes, technological equipment (installations)
2B1	Ammonia production	**Inorganic chemicals manufacturing process flow in industry**	
		210403	Ammonia
2B2	Nitric acid production	**Inorganic chemicals manufacturing process flow in industry**	
		210402	Nitric acid production

		Inorganic chemicals manufacturing process flow in industry	
		210401	Production of sulfuric acid
		210404	Ammonium sulfate
		210405	Ammonium nitrate
		210406	Ammonium phosphate
		210407	NPK fertilizers
		210408	Urea
		210409	Soot
		210411	Graphite
		210413	Chlorine production
		210414	Phosphate fertilizers
		210415	Storage of inorganic chemical products
		210416	Other
		Technological processes in the industry for the production of organic chemicals	
		210501	Ethylene
		210502	Propylene
		210503	1,2-dichloroethane
		210504	Vinyl chloride
		210505	1,2-dichloroethane and vinyl chloride (balanced process)
2B10a	Chemical industry: other	210506	Low-density polyethylene
		210507	High-density polyethylene
		210508	Polyvinyl chloride
		210509	Polypropylene
		210510	Styrene
		210511	Polystyrene
		210512	Styrene butadiene
		210513	Styrene-butadiene latex
		210514	Styrene-butadiene rubber
		210515	Acrylonitrile butadiene styrene
		210516	Ethylene oxide
		210517	Formaldehyde
		210518	Ethylbenzene
		210519	Phthalic anhydride
		210520	Acrylonitrile
		210522	Storage of organic chemicals
		210523	Glyoxylic acid
		210524	Production of halogenated hydrocarbons
		210525	Pesticide production
		210526	Production of persistent organic compounds
		210527	Other

A comparison of calculations using the T1 and T3 methods for categories 2B1, 2B2 and 2B10a is shown in Table 4.3.4.

Table 4.3.4. Comparison of calculations using the T1 and T3 methods for categories 2B1, 2B2 and 2B10a

Pollutant	Emissions	
	Calculation method T3	Calculation method T1
NOx, kt	2,53	17,28
NMVOC, kt	1,02	0,02
SOx, kt	1,72	NA
NH_3, kt	3,1	0,02
$PM_{2.5}$, kt	0,07	NA
PM_{10}, kt	2,31	NA
TSP, kt	1,1	0,15
CO, kt	0,02	NA
Pb, t	1,82	0,18
Cd, t	0,12	NA
Hg, t	0	NA
As, t	0	NA
Cr, t	0	NA
Cu, t	0,01	NA
Ni, t	0	NA
Se, t	0	NA
Zn, t	0	NA

Due to the shortcomings of statistics collection system for air pollutant emissions (e.g., lack of reporting on PM2.5 and PM10 by some respondents, lack of statistical reporting on PCBs and HCB, underreporting of emissions volumes by respondents, lack of information about the methodology, etc.) the data used for NFR category 2B1, 2B2 and 2B10a were obtained by T1 calculation method. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method (see Table 4.3.1.)

4.4 Metalworking industry (Category 2C)

4.4.1 Source category description

Emissions in category 2C. The metalworking industry is evaluated for each subcategory as follows:

- 2C1. Cast iron and steel production;
- 2C2. Ferroalloy production;
- 2C3. Aluminum production;

- 2C4. Magnesium production;
- 2C5. Lead production;
- 2C6. Zinc production;
- 2C7a. Copper production;
- 2C7b. Nickel production;
- 2C7c. Production of other metals;
- 2C7d. Storage, processing and transportation of metal products.

Table 4.4.1. Methods used to calculate and verify emissions data for NFR 2C subcategories (where T1/T3 displayed, for emission data reporting only T1 was used due to shortcamings in the collection of data for T3, see Chapter 4.4.4)

NFR code	Name	Calculation method	EF[9]	Pollutants
2C1	Cast iron and steel production	T1/ T3	D	NO_x, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, HCB, PCBs
2C2	Ferroalloy production	T1/T3	D	$PM_{2.5}$, PM_{10}, TSP, BC
2C3	Aluminum production	T1/T3	D	NO_x, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
2C4	Magnesium production	N/A		
2C5	Lead production	T1/T3	D	SO_x, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Zn, PCBs
2C6	Zinc production	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
2C7a	Copper production	T1/T3	D	SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, PCDD/PCDF, PCBs
2C7b	Nickel production	N/A		
2C7c	Production of other metals	T1/T3	D	SO_x, TSP
2C7d	Storage, processing and transportation of metal products	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

[9] CS – country specific; D - default

Subcategories in Sector 2C are defined by the methods shown in Table 4.4.1.

The share of emissions under category 2C is shown in Fig. 4.4.1.

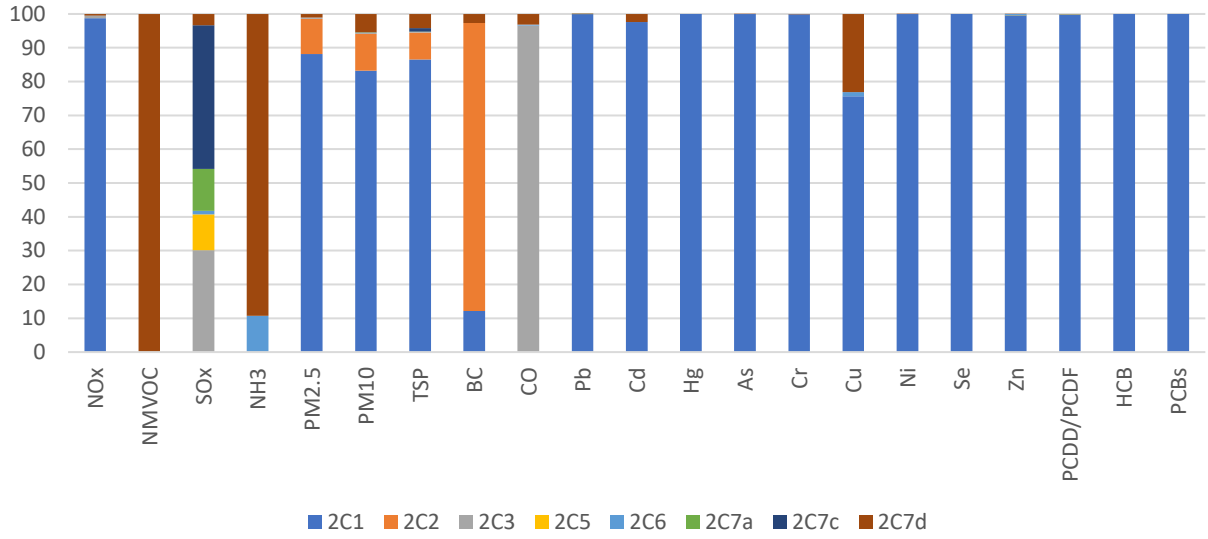

Fig. 4.4.1. The share of emissions under category 2C for some pollutants in 2019, %

4.4.2 Methodological issues

The methodology of emission calculation for categories categories 2C1-2C3, 2C5, 2C7a and 2C7c is in line with the methodology described in Section 4.1. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method.

Detailed information on applicable emission factors for emission sources is provided in Annex 2.

To calculate categories 2C6 and 2C7d using the T3 method, the national categories of production and technological processes, technological equipment (plats) are used, which are shown in Table 4.4.2.

Table 4.4.2. List of production and technological processes, technological equipment (plants) for categories 2C6 and 2C7d

NFR Code	NFR name	Коди виробничих та технологічних процесів, технологічного устаткування (установок)	Найменування виробничих та технологічних процесів, технологічного устаткування (установок)
2C6	Zinc production	**Contact technological processes**	
		130308	Secondary zinc production

2C7d	Storage, processing and transportation of metal products	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210620	Mechanical engineering (mechanical metal-working)

4.4.3 Emission trends

Since 1990, Ukraine has seen trends in reducing the production of products in the metalworking industry, and as a result – a decrease in emissions of pollutants into the atmospheric air. Since 2000, production and emissions have tended to increase, but are significantly lower than in 1990.

4.4.4 Source specific QA/QC and verification

For general information on Data Quality Control, see Section 4.2.4.

To verify the quality of data calculated at T1 level for category 2B1, 2b2 and 2b10a, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 4.4.3.

For comparison of T1 and T3 calculations for categories 2C1-2C3, 2C5, 2C7a and 2C7c see Table 4.4.4.

Table 4.4.3. List of production and technological processes, technological equipment (plants) for categories 2C1-2C3, 2C5, 2C7a and 2C7c

NFR Code	NFR name	Codes of production and engineering processes, technological equipment (installations)	Name of production and engineering processes, technological equipment (installations)
2C1	Cast iron and steel production	**Technological processes in ferrous metallurgy and coal industry**	
		210202	Blast furnace loading
		210203	Melting of cast iron and casting of ingots
		210205	Open-hearth furnace

		210206	Oxygen converter at the steel production plant
		210207	Steel production in an electric furnace
		210208	Rolling mills
		210209	Sintering plant
		210210	Other
2C2	Ferroalloy production	**Technological processes in non-ferrous metallurgy**	
		210302	Ferroalloys
2C3	Aluminum production	**Contact technological processes**	
		130310	Secondary aluminum production
		Technological processes in non-ferrous metallurgy	
		210301	Aluminum production (electrolysis)
2C5	Lead production	**Contact technological processes**	
		130307	Secondary lead production
2C7a	Copper production	**Contact technological processes**	
		130309	Secondary copper production
2C7c	Production of other metals	**Technological processes in non-ferrous metallurgy**	
		210303	Silicon production
		210306	Production of alloyed metals
		210307	Electroplating
		210308	Electrogalvanization
		210309	Other

Table 4.4.4. Comparison of T1 and T3 calculations for categories 2C1-2C3, 2C5, 2C7a and 2C7c

Pollutant	**Emissions**	
	Calculation method T3	**Calculation method T1**
NOx, kt	17,52	6,18
NMVOC, kt	0,42	NA
SOx, kt	29,11	0,54
NH_3, kt	0,08	NA
$PM_{2.5}$, kt	0,12	6,43
PM_{10}, kt	9,71	8,36
TSP, kt	42,47	13,59
CO, kt	0	0,08
Pb, t	429,72	4,44
Cd, t	33,49	188,19
Hg, t	1,67	0,82
As, t	0,92	4,09
Cr, t	1,19	16,36
Cu, t	10,74	184,05
Ni, t	38,21	2,86
Se, t	11,66	5,73

Zn, t	0	0,82
PCDD/PCDF	56,93	163,62
Benzo(a)pyrene	0	122,83
HCB	NA	0
PCBs	NA	1,23

Due to the shortcomings of statistics collection system for air pollutant emissions (eg, lack of reporting on $PM_{2.5}$ and PM_{10} by some respondents, lack of statistical reporting on PCBs and HCB, underreporting of emissions volumes by respondents, lack of information about the methodology, etc.) the data used for NFR categories 2C1-2C3, 2C5, 2C7a and 2C7c were obtained by T1 calculation method. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method (see Table 4.4.1.).

4.5 Use of solvents (category 2D)

4.5.1 Source category description

Emissions in the 2D category. Solvent use is evaluated for each subcategory as follows:

- 2D3a. Domestic use of solvents, including antifungal agents (fungicides);
- 2D3b. Roadway asphalting;
- 2D3c. Bitumen roofing materials;
- 2D3d. Application of coatings;
- 2D3e. Degreasing;
- 2D3f. Chemical (dry) cleaning;
- 2D3g. Chemical products;
- 2D3h. Printing;
- 2D3i. Other use of solvents.

Subcategories in Sector 2D are determined by the T3 method for NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene.

The share of emissions of certain pollutants in category 2D is shown in Fig. 4.5.1.

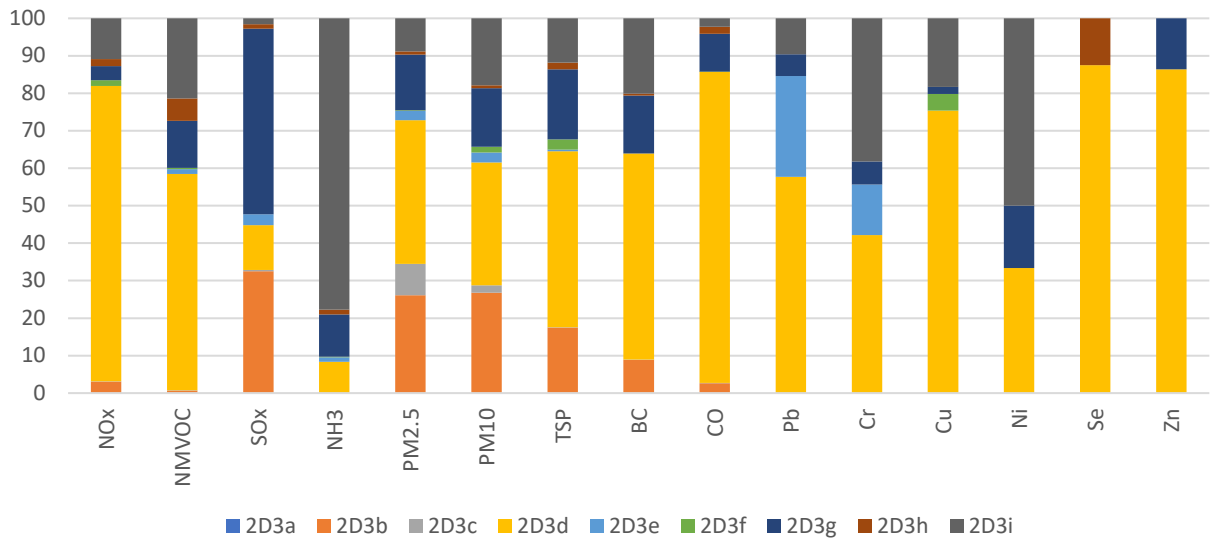

Fig. 4.5.1. The share of emissions in category 2D for some pollutants in 2019, %

4.5.2 Methodological issues

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 4.5.1.

Table 4.5.1. List of production and technological processes, technological equipment (plants) for category 2D

NFR Code	NFR name	Codes of production and engineering processes, technological equipment (installations)	Name of production and engineering processes, technological equipment (installations)
2D3a	Domestic use of solvents, including antifungal agents (fungicides)	**Other solvent uses and related activities**	
		410408	Domestic use of solvents (except paints)
2D3b	Roadway asphalting	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210611	Road asphalt pavement
2D3c	Bitumen roofing materials	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210610	Bitumen roofing materials
2D3d	Application of coatings	**Use of solvents and other products**	
		410101	Car manufacturing
		410102	Car repairs

		410103	Construction and finishing of buildings
		410104	Domestic use
		410105	Painting of rolled products
		410106	Shipbuilding
		410107	Timber
		410108	Other types of industrial use of paints
		410109	Other types of non-industrial use of paints
2D3e	Degreasing	**Degreasing, dry cleaning and electronic equipment**	
		410201	Metal degreasing
2D3f	Chemical (dry) cleaning	**Degreasing, dry cleaning and electronic equipment**	
		410202	Chemical cleaning
2D3g	Chemical products	**Production or processing of chemical products**	
		410301	Polyester processing
		410302	Polyvinyl chloride processing
		410303	Polyurethane foam processing
		410304	Styrofoam processing
		410305	Rubber processing
		410306	Manufacture of pharmaceutical products
		410307	Paint production
		410308	Ink production
		410309	Production of adhesives
		410310	Bitumen purging
		410311	Production of adhesive, magnetic tapes, photographic films and photographs
		410312	Textile finishing
		410313	Skin curing
		410314	Other
2D3h	Printing	**Other solvent uses and related activities**	
		410403	Printing industry
2D3i	Other uses of solvents	**Degreasing, dry cleaning and electronic equipment**	
		410203	Production of electronic parts
		410204	Other industrial cleaning services
		Other solvent uses and related activities	
		410401	Glass wool production
		410402	Slag wool production
		410404	Extraction of fats, food and non-food oils
		410405	Application of adhesives and adhesive tapes
		410406	Wood conservation
		410407	Anti-corrosion treatment and preservation of vehicles
		410409	Dewaxing of vehicles
		410410	Manufacture of pharmaceutical products
		410411	Other

4.5.3 Emission trends

Since 1990, Ukraine has seen trends in reducing the use of solvents, and as a result – a decrease in emissions of pollutants into the atmospheric air.

4.5.4 Source specific QA/QC and verification

For general information on Data Quality Control, see Section 4.2.4.

4.6 Other product use and industrial production (categories 2G, 2H, 2I, 2J)

4.6.1 Source category description

Emissions in this section are calculated for each category as follows:

- 2G. Other product uses;
- 2H1. Cellulose and paper industry;
- 2H2. Food and beverage production;
- 2H3. Other industrial production;
- 2I. Woodworking industry;
- 2J. Production of persistent organic pollutants.

The categories in this section are defined by the methods specified in Table 4.6.1.

Table 4.6.1. Methods used to calculate and verify emission data for categories 2G, 2H1, 2H2, 2H3, 2I, 2J (where, T1/T3, for emission data reporting only T1 was used due to shortcamings in the collection of data for T3, see Chapter 4.6.4)

NFR code	Name	Calculation method	EF[10]	Pollutants
2G	Other product uses	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
2H1	Cellulose and paper industry	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO
2H2	Food and beverage production	T1/T3	D	NMVOC, SO_x
2H3	Other industrial production	T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni,

[10] CS – country specific; D - default

				Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
2I	Woodworking industry	T1/T3	D	NO_x, NMVOC, PM_{10}, PCBs
2J	Production of persistent organic pollutants	Not evaluated due to the lack of statistical information for calculation using the T1 or T3 methods		
2K	Consumption of persistent organic pollutants and heavy metals (e.g. electrical and scientific equipment	Not evaluated due to the lack of statistical information for calculation using the T1 or T3 methods		
2L	Other production, consumption, storage, transportation or processing of bulk materials	Not evaluated due to the lack of statistical information for calculation using the T1 or T3 methods		

The share of emissions of certain pollutants under categories 2G, 2H1, 2H2, 2H3, 2I, 2J is shown in Fig. 4.6.1.

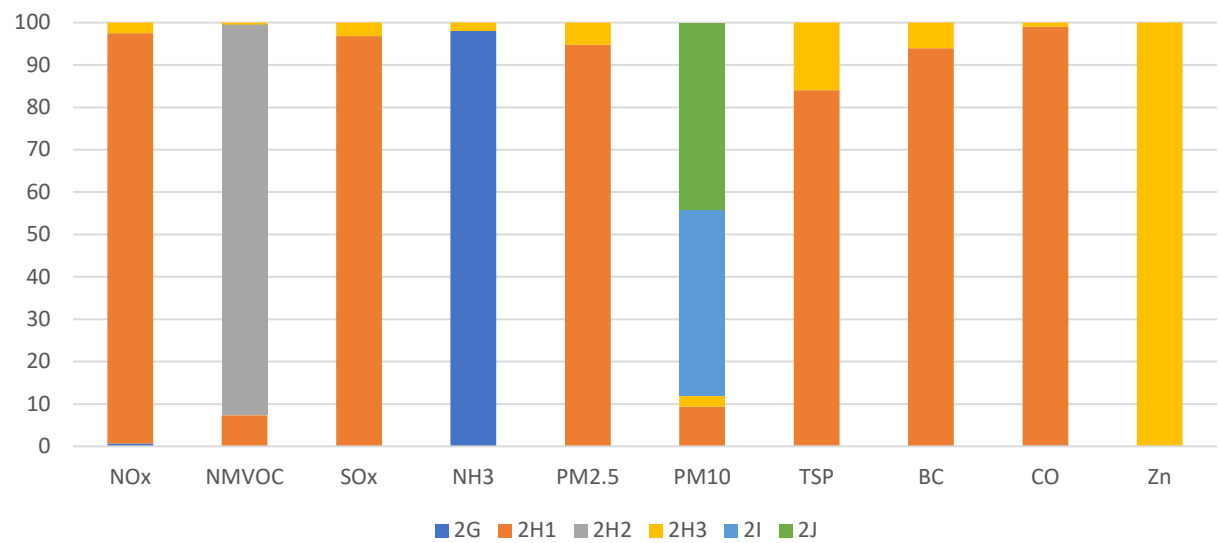

Fig. 4.6.1. The share of emissions under categories 2G, 2H1, 2H2, 2H3, 2I, 2J for some pollutants in 2019, %

4.6.2 Methodological issues

The methodology of emission calculation for categories 2H1, 2H2, 2I and 2J is consistent with the methodology described in Section 4.1. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method.

Detailed information on applicable emission factors for emission sources is provided in Annex 2.

The T3 calculation for categories 2G and 2H3 is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 4.6.2.

Table 4.6.2. List of production and technological processes, technological equipment (plants) for categories 2G and 2H3

NFR Code	NFR name	Коди виробничих та технологічних процесів, технологічного устаткування (установок)	Найменування виробничих та технологічних процесів, технологічного устаткування (установок)
2G	Other product uses	**Use of HFCS, N_2O, NH_3, PFCs and SF_6**	
		410501	Use of N_2O for anesthesia
		410502	Equipment for freezing and air conditioning when using halocarbons
		410503	Equipment for freezing and air conditioning when using products other than halocarbons
		410504	Foam leakage
		410505	Fire extinguishers
		410506	Aerosols
		410507	Electrical equipment
		410508	Other
2H3	Other industrial production	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210622	Light and processing industry

4.6.3 Emission trends

Since 1990, Ukraine has seen trends in reducing the manufacture of industrial products, and as a result – a decrease in emission of air pollutants. Since 2000, production and emissions from food and beverage production have tended to increase.

4.6.4 Source specific QA/QC and verification

For general information on Data Quality Control, see Section 4.2.4.

To verify the quality of data calculated at T1 level for categories 2H1, 2H2 and 2I, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions"[5] (method T3) and

Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 4.6.3.

Table 4.6.3. List of production and technological processes, technological equipment (plants) for categories 2H1, 2H2 and 2I

NFR Code	NFR name	Codes of production and engineering processes, technological equipment (installations)	Name of production and engineering processes, technological equipment (installations)
2H1	Cellulose and paper industry	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210602	Pulp and paper production (kraft)
		210603	Pulp and paper production (sulfite cooking)
		210604	Cellulose production (neutral sulfite polychemic process)
2H2	Food and beverage production	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210605	Bread industry
		210606	Wine
		210607	Beer
		210608	Liquor
		210609	Other branches of the food industry
2I	Woodworking industry	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210601	Chipboard (chipboard)

For comparison of T1 and T3 calculations for categories 2H1, 2H2, and 2I see Table 4.6.4.

Table 4.6.4. Comparison of T1 and T3 calculations for categories 2H1, 2H2 and 2

Pollutant	Emission volumes	
	Calculation method T3	Calculation method T1
NOx, kt	0,64	0,98
NMVOC, kt	3,36	26,83
SOx, kt	0,3	1,96
NH_3, kt	0,24	NA

$PM_{2.5}$, kt	0,25	0,59
PM_{10}, kt	0,78	4,46
TSP, kt	0,84	0,98
CO, kt	0,02	0,02
Pb, t	4,1	5,38
Cd, t	0,01	NA
Hg, t	0	NA
As, t	0,1	NA
Cr, t	0	NA
Cu, t	0,01	NA
Ni, t	0	NA
Se, t	0	NA
Zn, t	0	NA

Due to the shortcomings of the system for collecting statistical information on emissions of pollutants into the air (for example, the lack of reporting on PM2,5 and PM10 from some respondents, the lack of statistical reporting on PCBs and HCB, underestimation of emissions by respondents, the lack of statistical reporting from small businesses, etc.), data obtained by the calculation method T1 was used to form categories 2H1, 2H2 and 2I of the NFR table. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method (see Table 4.6.1.)

5 AGRICULTURE

5.1 Source category description and the general methodology

Pollutant emission sources in Agriculture include:

- 3B. Manure management;
- 3D. Crop production and agricultural soils;
- 3F. Field burning of agricultural residues;
- 3I. Other agriculture.

Category 3F is calculated by T3 method in line with the data collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of air pollutants and greenhouse gases from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of air pollutants and greenhouse gases from stationary emission sources [6].
Due to the minimum amount of pollutant emissions and the ban on field burning of agricultural residues, category 3F is not considered separately. Category 3I is not calculated due to the lack of statistical information for calculation by T1 or T3 methods.

To calculate the emissions under categories 3B and 3D, mostly emission factors recommended for use in the EMEP / EEA Emission Inventory Guidebook [4] were used. For NFR categories 3B2, 3B4a and 3B4gii CS EF were utilized.

The share of category 3 emissions for some pollutants in 2019 is shown in Figure 5.1.1.

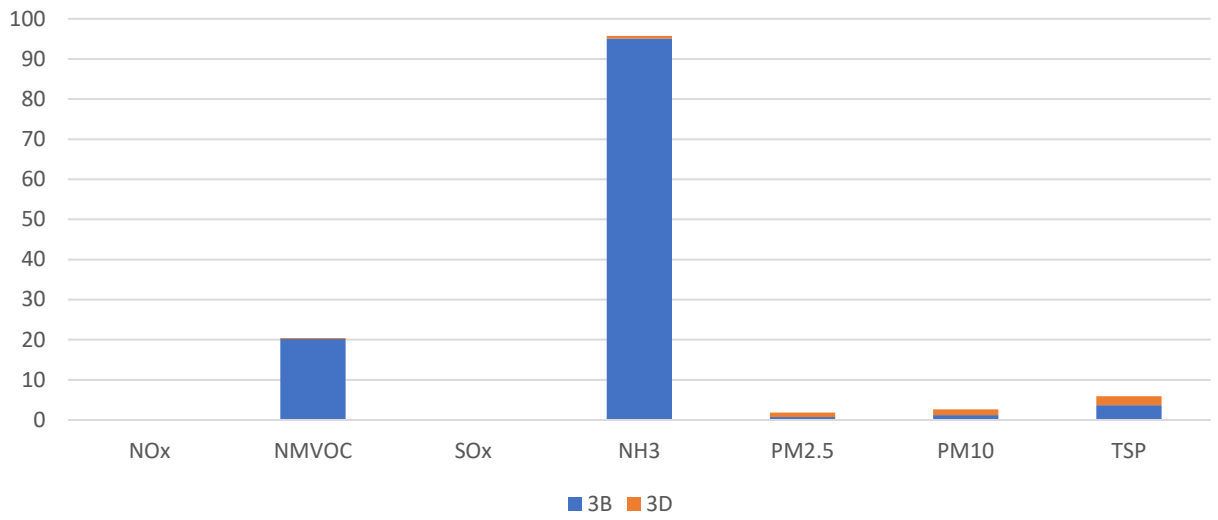

Figure 5.1.1. Share of emissions under category 3 for some pollutants in 2019 as a percentage of total national emissions

5.2 Manure management (category 3B)

5.2.1 Source category description

The emissions under category 3B are calculated for each subcategory as follows:

- 3B1a. Manure management – Dairy cattle;
- 3B1b. Manure management – Non-dairy cattle;
- 3B2. Manure management – Sheep;
- 3B3. Manure management – Swine;
- 3B4a. Manure management – Buffalo;
- 3B4d. Manure management – Goats;
- 3B4e. Manure management – Horses;
- 3B4f. Manure management – Mules and Asses;
- 3B4gi. Manure management – Laying hens;
- 3B4gii. Manure management – Broilers;
- 3B4giii. Manure management – Turkeys;
- 3B4giv. Manure management – Other poultry;
- 3B4h. Manure management – Other animals.

Categories in this section are defined by methods listed in Table 5.2.1.

Table 5.2.1. Methods used to calculate and verify the emission data for Category 3B (where T1/T3, for emission data reporting only T1 was used due to shortcamings in the collection of data for T3, see Chapter 5.2.4)

NFR Code	Name	Calculation method	EF[11]	Pollutants
3B1a	Manure management – Dairy cattle	T1/T3	D	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC
3B1b	Manure management – Non-dairy cattle	T1/T3	D	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP
3B2	Manure management – Sheep	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
3B3	Manure management – Swine	T1/T3	D	NO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP

[11] CS – country specific; D - default

3B4a	Manure management – Buffalo	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
3B4d	Manure management – Goats	T1/T3	D	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP
3B4e	Manure management – Horses	T1/ T3	D	NO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP
3B4f	Manure management – Mules and asses	Included in category 3B4h		
3B4gi	Manure management – Laying hens	T1/T3	D	NO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP
3B4gii	Manure management – Broilers	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
3B4giii	Manure management – Turkeys	Included in category 3B4giv		
3B4giv	Manure management – Other poultry	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
3B4h	Manure management – Other animals	T1/T3	D	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP

Emission distribution for some pollutants in category 3B is shown in Figure 5.2.1.

5.2.2 Methodological issues

The calculation of pollutant emissions for each category of livestock takes into account the corresponding annual average numbers for each category of livestock and the corresponding emission factor:

$$E = EF_b A_b,$$

where:

- E – emission volumes,

- EF – emission factor,
- A – annual average numbers of animals for each category,
- b – category.

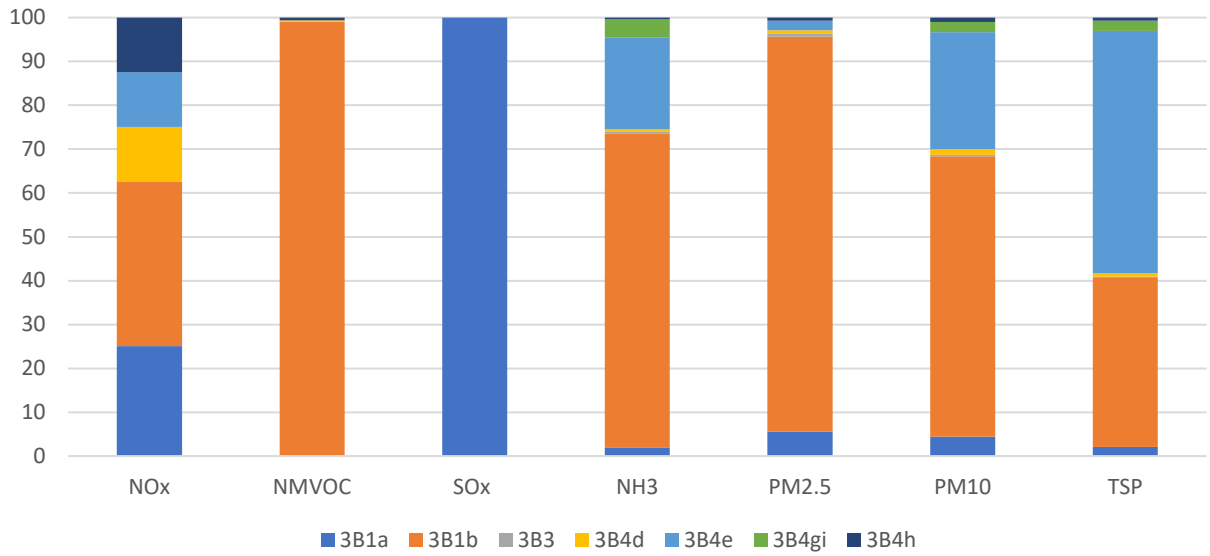

Figure 5.2.1. Emission distribution for some pollutants in category 3B in 2019, %

To calculate the emissions, the data from the State Statistics Service of Ukraine on the number of livestock animals [11] and the emission factors recommended in the EMEP / EEA Emission Inventory Guidebook [4] were used. The NFR categories 3B1a, 3B1b, 3B3, 3B4d, 3B4e, 3B4gi and 3B4h were estimated by T1 method. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method.

For detailed information on the emission factors used for emission sources see Annex 2.

The T3 calculation for categories 3B2, 3B4a, 3B4gii and 3B4giv is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 5.2.2.

Table 5.2.2. List of production and technological processes, technological equipment (plants) for categories 3B2, 3B4a, 3B4gii and 3B4giv

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
3B2	Manure management: Sheep	**Enteral (intestinal) fermentation**	

		610403	Sheep
		Collection, storage and use of manure and organic compounds	
		610505	Sheep
3B4a	Manure management: Buffalo	**Enteral (intestinal) fermentation**	
		610414	Buffalo
		Collection, storage and use of manure and organic compounds	
		610514	Buffalo
3B4gii	Manure management: broilers	**Enteral (intestinal) fermentation**	
		610409	Broilers
		Collection, storage and use of manure and organic compounds	
		610508	Broilers
3B4giv	Manure management: other poultry	**Enteral (intestinal) fermentation**	
		610410	Other poultry (duck, geese etc.)
		Collection, storage and use of manure and organic compounds	
		610509	Other poultry (duck, geese etc.)

5.2.3 Emission trends

Since 1990, there has been a decline in livestock production other than laying hens and broilers, and as a result, reduced emissions of air pollutants. Since 2000, production and emissions from livestock production have tended to increase.

5.2.4 Source specific QA/QC and verification

To ensure the quality of data obtained by collecting information directly from respondents, the State Statistics Service of Ukraine monitors the level of reporting by respondents and analyzes the reasons for failures to provide such data.

The State Statistics Service of Ukraine uses the following methods of data quality assurance:

- analysis of data over time (comparison of data for the reporting year with the previous year);
- geographical analysis of data (comparison of data by regions);
- analysis of data distribution (analysis of the data that diverge significantly from the main data distribution).

To verify the quality of data calculated at T1 level for categories 3B1a, 3B1b, 3B3, 3B4d, 3B4e, 3B4gi and 3B4h, a comparison of the calculated data with the database of the State Statistics Service of Ukraine on air pollutant emissions was used. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 5.2.3.

Table 5.2.3. List of production and technological processes, technological equipment (plants) for categories 3B1a, 3B1b 3B3, 3B4d, 3B4e, 3B4gi and 3B4h

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
3B1a	Manure management: dairy cattle	**Enteral (intestinal) fermentation**	
		610401	Dairy cows
		Collection, storage and use of manure and organic compounds	
		610501	Dairy cows
3B1b	Manure management: non-dairy cattle	**Enteral (intestinal) fermentation**	
		610402	Other cattle
		Collection, storage and use of manure and organic compounds	
		610502	Other cattle
3B3	Manure management: swine	**Enteral (intestinal) fermentation**	
		610404	Fattening pigs
		610412	Sows
		Collection, storage and use of manure and organic compounds	
		610503	Fattening pigs
		610504	Sows
3B4d	Manure management: goats	**Enteral (intestinal) fermentation**	
		610407	Goats
		Collection, storage and use of manure and organic compounds	
		610511	Goats
3B4e	Manure management: horses	**Enteral (intestinal) fermentation**	
		610405	Horses
		Collection, storage and use of manure and organic compounds	
		610506	Horses
3B4gi	Manure management: laying hens	**Enteral (intestinal) fermentation**	
		610408	Laying hens
		Collection, storage and use of manure and organic compounds	
		610507	Laying hens
3B4h	Manure management: other animals	**Enteral (intestinal) fermentation**	
		610411	Fur animals
		610415	Other
		Collection, storage and use of manure and organic compounds	
		610510	Fur animals
		610515	Other

For comparison of T1 and T3 calculations for categories 3B1a, 3B1b, 3B3, 3B4d, 3B4e, 3B4gi and 3B4h see table 5.2.4.

Table 5.2.4. Comparison of T1 and T3 calculations for categories 3B1a, 3B1b, 3B3, 3B4d, 3B4e, 3B4gi and 3B4h

Pollutant	Emissions	
	Calculation method T3	Calculation method T1
NOx, kt	0,1	0,08
NMVOC, kt	0,33	55,1
SOx, kt	0,03	0
NH_3, kt	9,32	177,18
$PM_{2.5}$, kt	0,51	1,39
PM_{10}, kt	1,65	3
TSP, kt	1,93	10,88
BC, kt	0,48	0
CO, kt	0,42	NA

Due to the shortcomings of statistics collection system for air pollutant emissions (eg, lack of reporting on $PM_{2.5}$ and PM_{10} by some respondents, lack of statistical reporting on PCBs and HCB, underreporting of emissions volumes by respondents, lack of statistical reporting from small enterprises, etc.) the data used for NFR categories 3B1a, 3B1b, 3B3, 3B4d, 3B4e, 3B4gi and 3B4h were obtained by T1 calculation method. In the next submission it is planned to assure the verification of all source data for T3 and to report these data utilizing T3 method (see Table 5.2.1.).

5.3 Crop production and agricultural soils (category 3D)

5.3.1 Source category description

The emissions under category 3D are calculated for each subcategory as follows:

- 3Da1. Inorganic N-fertilizers (includes also urea application);
- 3Da2a. Animal manure applied to soils;
- 3Da2b. Sewage sludge applied to soils;
- 3Da2c. Other organic fertilisers applied to soils (including compost);
- 3Da3. Urine and dung deposited by grazing animals;
- 3Da4. Crop residues applied to soils;
- 3Db. Indirect emissions from managed soils;
- 3Dc. Farm-level agricultural operations including storage, handling and transport of agricultural products;
- 3Dd. Off-farm storage, handling and transport of bulk agricultural products;

- 3De. Cultivated crops;
- 3Df. Use of pesticides.

Categories in this section are defined by methods listed in Table 5.3.1.

Table 5.3.1. Methods used to calculate and verify the emission data for Category 3D

NFR code	Name	Calculation method	EF[12]	Pollutants
3Da1	Inorganic N-fertilizers (includes also urea application)	T1	D	NO_x, NH_3
3Da2a	Animal manure applied to soils	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
3Da2b	Sewage sludge applied to soils	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
3Da2c	Other organic fertilisers applied to soils (including compost)	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
3Da3	Urine and dung deposited by grazing animals	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
3Da4	Crop residues applied to soils	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
3Db	Indirect emissions from managed soils	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
3Dd	Off-farm storage, handling and transport of bulk agricultural products	Not calculated due to the lack of statistical information for T1 or T3 calculation methods		
3De	Cultivated crops	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

[12] CS – country specific; D - default

3Df	Use of pesticides	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

Emission distribution for some pollutants in category 3D is shown in Figure 5.3.1.

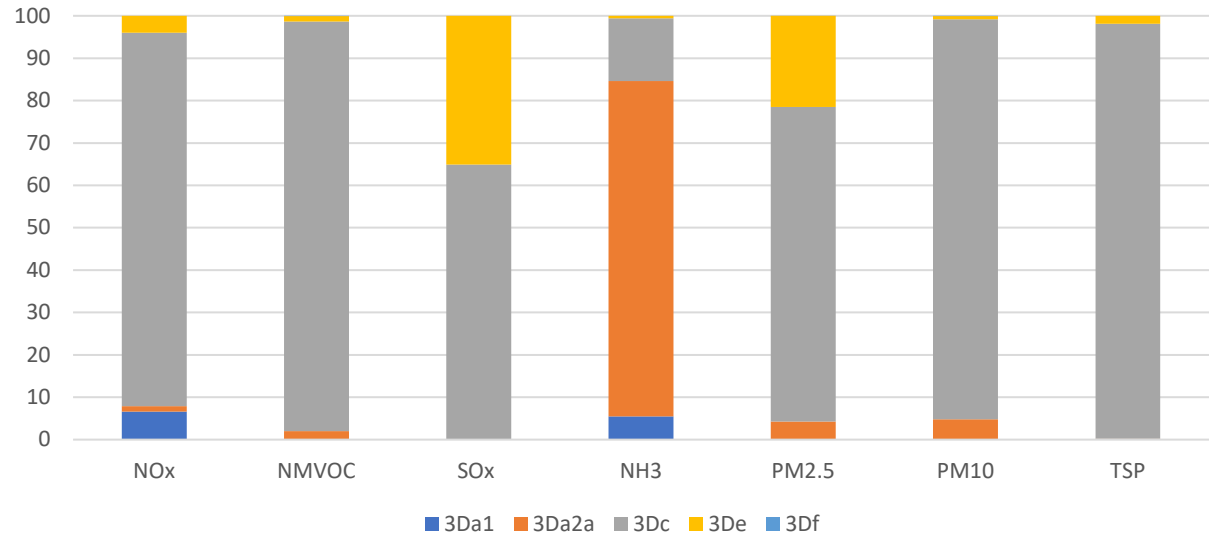

Figure 5.3.1. Emission distribution for some pollutants in category 3D in 2019, %

5.3.2 Methodological issues

For the calculation of NH_3 and NO emissions from crop production and agricultural crops the following basic formula is used:

$$E = EF \cdot A,$$

where:

- E – emissions volume,
- EF – emissions factor,
- A – amount of nitrogen applied with fertilizers or organic waste.

To calculate the emissions, the data from the State Statistics Service of Ukraine on crop production [12], the use of fertilizers and pesticides for the 2019 crop yield [13], the application of mineral and organic fertilizers (1990-2019) [14] and emission factors recommended in the

EMEP / EEA Emission Inventory Guidebook [4] were mostly used. For livestock manure (3Da2a) and for pesticides (3Df) CS EFs were utilized.

For detailed information on the emission factors used for emission sources see Annex 2.

The T3 calculation for categories 3Da2a, 3Dc, 3De and 3Df is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 5.3.2.

Table 5.3.2. List of production and technological processes, technological equipment (plants) for categories 3Da2a, 3Dc, 3De and 3Df

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
3Da2a	Animal manure applied to soils	**Collection, storage and use of manure and nitrogen compounds**	
		610900	Collection, storage and use of manure and nitrogen compounds
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	**Technological processes in mechanical engineering, woodworking, pulp and paper, food and beverage industry and other sectors**	
		210621	Agricultural products processing
3De	Cultivated crops	**Crop cultivation with the use of fertilizers (other than manure)**	
		610101	Permanent crops
		610102	Agricultural crops
		610103	Rice fields
		610104	Gardening
		610105	Grassland
		610106	Fallow land
		Crop cultivation without fertilizers	
		610201	Permanent crops
		610202	Agricultural crops
		610203	Rice fields
		610204	Gardening
		610205	Grass land
		610206	Fallow land
3Df	Use of pesticides	**Use of pesticides and limestone**	
		610600	Use of pesticides and limestone

5.3.3 Emission trends

In 1990-2000, there was a decrease in crop production in Ukraine, which resulted in reduced emissions of air pollutants. Since 2000, production of and emissions from crop production and application of fertilizers have tended to increase.

5.3.4 Source specific QA/QC and verification

For general information on data quality assurance see Section 5.2.4.

6 WASTE

6.1 Source category description

Pollutant emission sources in category WASTE include:

- 5A. Solid waste disposal on land;
- 5B. Biological treatment of waste;
- 5C. Waste incineration;
- 5D. Wastewater handling;
- 5E. Other waste.

To calculate the emissions for category 5, the emission factors recommended in the EMEP / EEA Emission Inventory Guidebook [4] were used.

Emission share for some pollutants in category 5 in 2019 is shown in Figure 6.1.1.

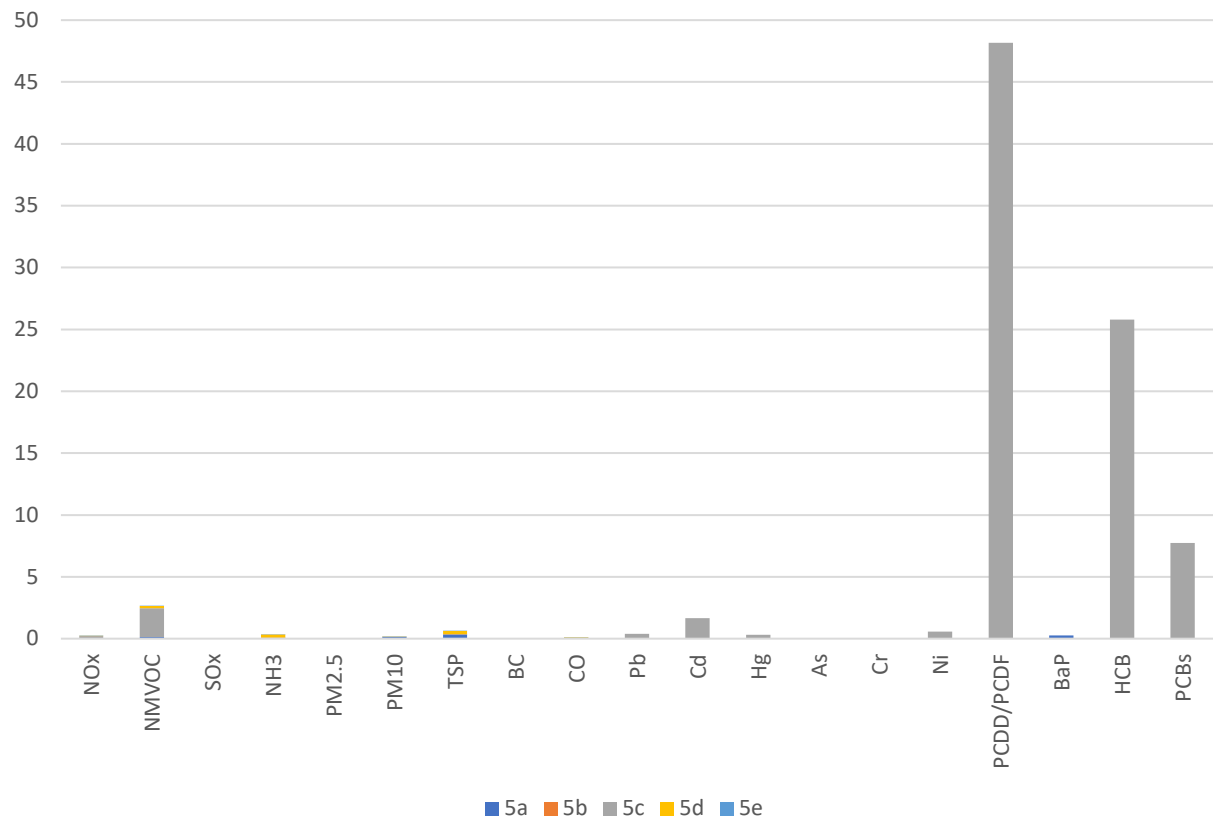

Figure 6.1.1. Share of emissions under category 5 for some pollutants in 2019 as a percentage of total national emissions

6.2 Solid waste disposal on land (category 5A)

6.2.1 Sourse category description

Category 5A is calculated by T3 method for NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene.

6.2.2 Methodological issues

The T3 calculation for category 5A is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 6.2.2.

The emission calculations are obtained from the database of the State Statistics Service of Ukraine on air pollutant emissions. The database data are collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of pollutants and greenhouse gases into the air from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of pollutants and greenhouse gases into the air from stationary emission sources [6].

Table 6.2.2. List of production and technological processes, technological equipment (plants) for category 5A

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
5A	Solid waste disposal on land	**Elimination of solid waste on land**	
		510401	Elimination of controlled waste on land
		510402	Elimination of uncontrolled waste on land
		510403	Other
		Other waste treatment	
		511004	Disposal of waste in the ground

6.2.3 Emission trends

Since 1990, there has been a decrease in industrial waste disposal and an increase in municipal waste disposal in Ukraine.

6.2.4 Data quality assurance

To ensure the quality of data obtained by collecting information directly from respondents, the State Statistics Service of Ukraine monitors the level of reporting by respondents and analyzes the reasons for failures to provide such data.

The State Statistics Service of Ukraine uses the following methods of data quality assurance:

- analysis of data over time (comparison of data for the reporting year with the previous year);
- geographical analysis of data (comparison of data by regions);
- analysis of data distribution (analysis of the data that diverge significantly from the main data distribution).

6.3 Biological treatment of waste (category 5B)

6.3.1 Source category description

Emissions in category 5B are calculated for each subcategory as follows:

- 5B1. Biological treatment of waste - Composting;
- 5B2. Biological treatment of waste - Anaerobic digestion at biogas facilities.

Categories in this section are defined by methods listed in Table 6.3.1.

Table 6.3.1. Methods used to calculate and verify the emission data for Category 5B

NFR Code	Name	Calculation method	EF[13]	Pollutants
5B1	Biological treatment of waste - Composting	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

Emissions in category 5B are not significant as compared with total national emissions.

[13] CS – country specific; D - default

6.3.2 Methodological issues

The T3 calculation is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 6.3.2. Remark: We could put more info about activity data sources and also on CS EFs (e.g. references to publications or web sites).

Table 6.3.2. List of production and technological processes, technological equipment (plants) for category 5B

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
5B1	Biological treatment of waste - Composting	**Other waste treatment**	
		511005	Compost production
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	**Other waste treatment**	
		511006	Biogas production

6.3.3 Emission trends

Since 1990, there has been an increase in air pollutant emissions from biological waste treatment in Ukraine.

6.3.4 Data quality assurance

For general information on data quality assurance see Section 6.2.4.

6.4 Waste incineration (category 5C)

6.4.1 Source category description

Emissions in category 5C are calculated for each subcategory as follows:

- 5C1a. Municipal waste incineration;
- 5C1bi. Industrial waste incineration;
- 5C1bii. Hazardous waste incineration;
- 5C1biii. Clinical waste incineration;
- 5C1biv. Sewage sludge incineration;
- 5C1bv. Cremation;
- 5C1bvi. Other waste incineration;
- 5C2. Open burning of waste.

Categories in this section are defined by methods listed in Table 6.4.1.

Table 6.4.1. Methods used to calculate and verify the emission data for Category 5C

NFR code	Name	Calculation method	EF[14]	Pollutants
5C1a	Municipal waste incineration	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5C1bi	Industrial waste incineration	T1/T3	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Ni, PCDD/PCDF, PCBs
5C1bii	Hazardous waste incineration	T1	D	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Ni, PCDD/PCDF, PCBs
5C1biii	Clinical waste incineration	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5C1biv	Sewage sludge incineration	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5C1bv	Cremation	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5C1bvi	Other waste incineration	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5C2	Open burning of waste	N/A		

[14] CS – country specific; D - default

Emission distribution for some pollutants in category 5C is shown in Figure 6.4.1.

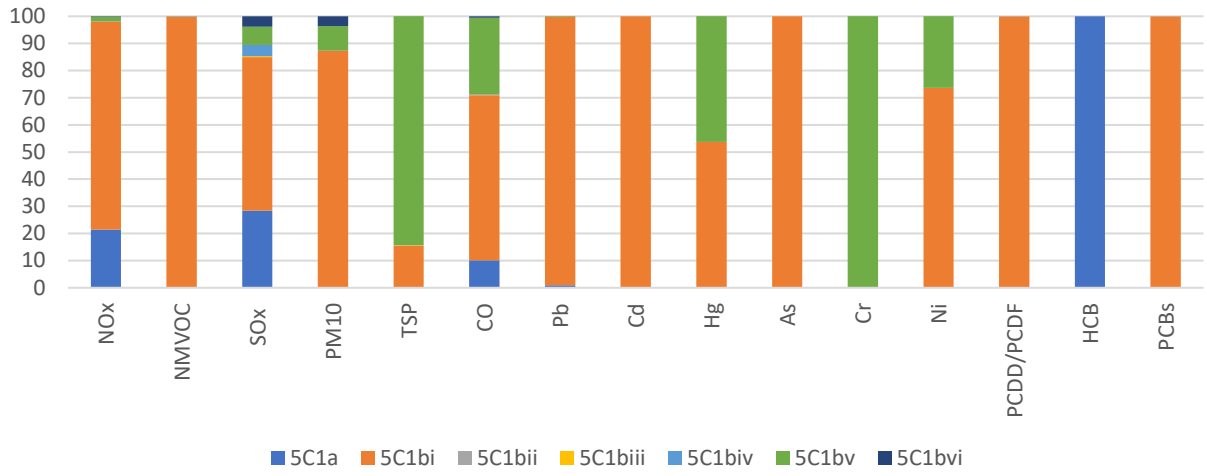

Figure 6.4.1. Emission distribution for some pollutants in category 5C in 2019, %

6.4.2 Methodological issues

For the calculation of pollutant emissions for categories 5C1bi and 5C1bii the following formula is used:

$$E = EF \cdot A,$$

where:

- E – emissions volume,
- EF – emissions factor,
- A – amount of waste incinerated.

To calculate the emissions, the data from the State Statistics Service of Ukraine on waste management by classification groups of the State Waste Classifier in 2019 [15] and emission factors recommended in the EMEP / EEA Emission Inventory Guidebook [4] were used.
For detailed information on the emission factors used for emission sources see Annex 2.

The T3 calculation for categories 5C1a, 5C1biii, 5C1biv and 5C1bv is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 6.4.2.

Table 6.4.2. List of production and technological processes, technological equipment (plants) for categories 5C1a, 5C1biii, 5C1biv and 5C1bv

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
5C1a	Municipal waste incineration	**Waste incineration**	
		510201	Domestic or municipal waste incineration
5C1biii	Clinical waste incineration	**Waste incineration**	
		510207	Burning of waste from hospitals
5C1biv	Sewage sludge incineration	**Waste incineration**	
		510205	Sewage sludge incineration
5C1bv	Cremation	**Cremation**	
		510901	Burning of cadavers
		510902	Burning of animal carcasses
5C1bvi	Other waste incineration	**Waste incineration**	
		510208	Burning of used oil

6.4.3 Emission trends

Since 1990, there has been an increase in waste incineration in Ukraine resulting in an increase of air pollutant emissions.

6.3.4 Data quality assurance

For general information on date quality assurance see Section 6.2.4.

6.5 Wastewater handling and other waste (categories 5D and 5E)

6.5.1 Source category description

Emissions in this category are calculated for each subcategory as follows:

- 5D1. Domestic wastewater handling;
- 5D2. Industrial wastewater handling;
- 5D3. Other wastewater handling;
- 5E. Other waste.

Categories in this section are defined by methods listed in Table 6.5.1.

Table 6.5.1. Methods used to calculate and verify the emission data for Categories 5D and 5E

NFR Code	Name	Calculation method	EF[15]	Pollutants
5D1	Domestic wastewater handling	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5D2	Industrial wastewater handling	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5D3	Other wastewater handling	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene
5E	Other waste	T3	CS	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene

Emission distribution for some pollutants in categories 5D and 5E is shown in Figure 6.5.1.

6.5.2 Methodological issues

The T3 calculation for categories 5D and 5E is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 6.5.2.

[15] CS – country specific; D - default

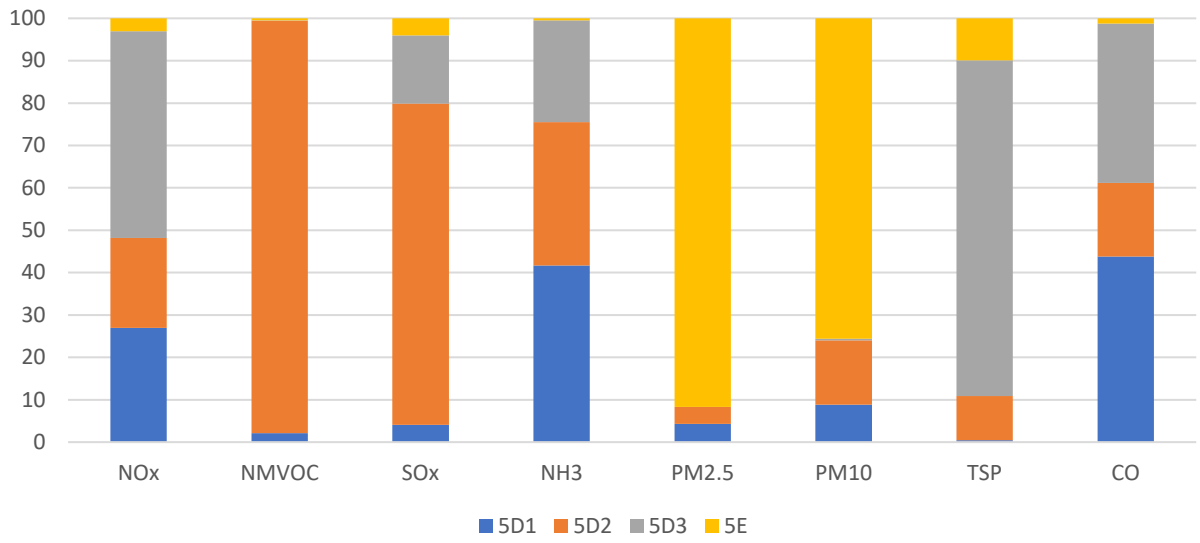

Figure 6.5.1. Emission distribution for some pollutants in categories 5D and 5E in 2019, %

Table 6.5.2. List of production and technological processes, technological equipment (plants) for categories 5D and 5E

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
5D1	Domestic wastewater handling	**Other waste handling**	
		511002	Wastewater treatment in residential and commercial sectors
5D2	Industrial wastewater handling	**Other waste handling**	
		511001	Industrial wastewater treatment
5D3	Other wastewater handling	**Other waste handling**	
		511003	Wastewater sludge disposal
5E	Other waste	**Other waste handling**	
		511007	Production of meat and bone meal
		511008	Other fuel production (spent fuel residues)

6.5.3 Emission trends

Since 1990, there has been a decrease in wastewater and other waste handling in Ukraine resulting in the reduction of air pollutant emissions.

6.3.4 Data quality assurance

For general information on data quality assurance see Section 6.2.4.

7 OTHER SOURCES

7.1 Source category description

Category 6A is calculated by T3 method for NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene.

7.2 Methodological issues

The T3 calculation for category 6A is based on the national categories of production and technological processes, technological equipment (plants) listed in Table 7.1.

The emission data are obtained from the State Statistics Service of Ukraine database on air pollutant emissions collected from respondents according to 2-TP forms of state statistical observation (air) (annual) "Report on emissions of air pollutants and greenhouse gases from stationary sources of emissions" [5] (method T3) and Methodological guidelines for the organization of state statistical observation of emissions of air pollutants and greenhouse gases from stationary emission sources [6].

Table 7.1 . List of production and technological processes, technological equipment (plants) for category 6A

NFR Code	NFR name	Коди виробничих та технологічних процесів, технологічного устаткування (установок)	Найменування виробничих та технологічних процесів, технологічного устаткування (установок)
6A	Other sources	210700	Refrigeration units
		210800	Production of halocarbons and sulfur hexafluoride

7.3 Emission trends

Since 1990, there has been a decrease in emissions from refrigeration units and the production of halocarbons and sulfur hexafluoride in Ukraine

7.4 Data quality assurance

To ensure the quality of data obtained by collecting information directly from respondents, the State Statistics Service of Ukraine monitors the level of reporting by respondents and analyzes the reasons for failures to provide such data.

The State Statistics Service of Ukraine uses the following methods of data quality assurance:

- analysis of data over time (comparison of data for the reporting year with the previous year);
- geographical analysis of data (comparison of data by regions);
- analysis of data distribution (analysis of the data that diverge significantly from the main data distribution).

8 RECALCULATIONS AND IMPROVEMENTS

In 2021, the time series for categories 1A1a. Public electricity and heat production, 2A2. Lime production, 2A3. Glass production were recalculated by T2 method starting from 1990.

The time series 2A1. Cement production was recalculated from 1990 and 2A5a. Quarrying and mining of minerals other than coal from 2003 by T1 method.

Due to the shortcomings of the system for collecting statistical information on air pollutant emissions (for example, lack of reporting on $PM_{2.5}$ and PM_{10} from some respondents, underreporting of emissions by respondents, lack of reporting from small enterprises) the following categories were recalculated by T1 method for 2019:

- 1A1b. Petroleum refining;
- 1A1c. Manufacture of solid fuels and other energy industries;
- 1A2a. Stationary combustion in manufacturing industries and construction: Iron and steel;
- 1A2b. Stationary combustion in manufacturing industries and construction: Non-ferrous metals;
- 1A2c. Stationary combustion in manufacturing industries and construction: Chemicals;
- 1A2d. Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print;
- 1A2e. Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco;
- 1A2f. Stationary combustion in manufacturing industries and construction: Non-metallic minerals;
- 1A2gviii. Stationary combustion in manufacturing industries and construction: Other;
- 1A4ai. Commercial/Institutional: Stationary;
- 1A4bi. Residential: Stationary;
- 1A4ci. Agriculture/Forestry/Fishing: Stationary;
- 1A5a. Other stationary (including military);
- 2B1. Ammonia production;
- 2B2. Nitric acid production;
- 2B10a. Chemical industry: Other;
- 2C1. Iron and steel production;
- 2C2. Ferroalloys production;
- 2C3. Aluminium production;
- 2C5. Lead production;
- 2C7a. Copper production;
- 2C7c. Other metal production;

- 2H1. Pulp and paper industry;
- 2H2. Food and beverages industry;
- 2I. Wood processing;
- 2J. Production of POPs;
- 3B1a. Manure management - Dairy cattle;
- 3B1b. Manure management - Non-dairy cattle;
- 3B3. Manure management - Swine;
- 3B4d. Manure management - Goats;
- 3B4e. Manure management - Horses;
- 3B4gi. Manure management - Laying hens;
- 3B4h. Manure management - Other animals;
- 3Da1. Inorganic N-fertilizers (includes also urea application);
- 5C1bi. Industrial waste incineration;
- 5C1bii. Hazardous waste incineration.

Due to the use of different calculation methods in the previous years, in 2021-2022 it is planned to recalculate all the above categories of emissions for the period mainly from 1990 to 2020. It is planned to achieve this goal with EMEP pilot project as part of the project "Support to Ukraine in the approximation of the EU Environmental Acquis" supported by the EU.

In the course of the implementation of this pilot project it is planned to use T2 methods to estimate certain emission categories, improve the transparency, completeness, consistency and comparability of national emission inventories, and automate the process of NFR tables and IIR development for the Ministry of Environmental Protection and Natural Resources of Ukraine.

9 PROJECTIONS

Given that Ukraine is not a party to the Gothenburg Protocol to the Convention on Long-range Transboundary Air Pollution of 1979 and has no obligation to implement Directive 2016/2284/EU of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain air pollutants, the country does not submit the part of the report on certain air pollutant emissions projections for 2020, 2025 and 2030 and – If available – for 2040 and 2050.

At the same time, it is planned to carry out gap analysis of the current state of implementation of the Convention on Long-range Transboundary Air Pollution and its protocols in Ukraine and develop a roadmap for the preparation of the National Plan for Ukraine to achieve the requirements of Gothenburg Protocol in 2021 within the project "Support to Ukraine in the approximation of the EU Environmental Acquis" supported by the EU.

In addition, during the implementation of EMEP pilot project in 2021-2022 as part of the project "Support to Ukraine in the approximation of the EU Environmental Acquis" it is planned to forecast emissions of individual air pollutants for 2025 and 2030.

For projections in the energy sector (1A1 and 1A2) it is expected to use an energy model (e.g. TIMES). In the first stage the availability of all necessary input data will be checked and institutional arrangements and responsibilities will be set. A procedure for development and organization of projections will be establish.

Emissions from transport sector (1A3) are expected to be estimated with the model COPERT 5 and this model or its results can be further used also for projections reflecting further vehicle fleet developmen.

For domestic and commercial sectors (1A4) a separate model can be utilized with input information regarding population and housing as well as heating system types development. A basic information can be taken from the National census.

Estimates of emission projection from industrial processes (NFR 2) can be included in the model or can be calculated separatedly depending on the development of industrial activities.

For the agriculture sector crutial will be the forecast of livestock numbers and fertilizer-N (manure-N) application.

For the waste sector a separate model can be used taking account of population and GDP development.

For all sectors abatement measures will be reflected and a database of national emission factors (EF) will be developed.

10 REPORTING OF GRIDDED EMISSIONS

Given that Ukraine is not a party to the Gothenburg Protocol to the Convention on Long-range Transboundary Air Pollution of 1979 and has no obligation to implement Directive 2016/2284/EU of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain air pollutants, the country does not submit the part of the report on the correlation of individual air pollutant emissions with the geographical grid.

At the same time, it is planned to implement an EMEP pilot project and to estimate emissions in the new EMEP grid resolution. (0.1° x 0.1°) in 2021-2022 as part of the project "Support to Ukraine in the approximation of the EU Environmental Acquis" supported by the EU.

Regarding reporting of gridded emissions and LPS current reporting of individual industrial facilities will be checked and validated so that gridded data of all required point sources and large point sources can be reported. The compliance with the E-PRTR reporting will be also assured. Further, a methodology for the estimation of area (diffuse) sources will be developed.

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APPENDIX 1. NATIONAL ENERGY BALANCE FOR 2019

SUPPLY AND CONSUMPTION	Coal (kt)				Coal gases (TJ)*		
	Coking coal	Other bit. coal / anth. / sub-bit. Coal	Coke / tar	Pat. Fuel / BKB	Gas works gas	Coke oven gas	Recovered gases (incl. work gas)
Production	5783	19747	10651	574	-	72116	96734
From other sources	-	258	-	-	-	-	-
Imports	9083	12000	877	-	-	-	-
Exports	-29	-32	-15	-	-	-	-
Intl. bunkers	-	-	-	-	-	-	-
Stock changes	-835	-1736	-37	-110	-	-	-
DOMESTIC SUPPLY	**14002**	**30237**	**11476**	**464**	**-**	**72116**	**96734**
Transfers	-	-	-	-	-	-	-
Statistical differences	-	-	321	-	-	-	-
TRANSFORMATION	**14002**	**24988**	**8828**	**79**	**-**	**17402**	**27725**
Electricity plants	-	21990	-	-	-	-	-
CHP plants	7	2048	-	9	-	14515	24685
Heat plants	-	692	-	70	-	2887	3040
Blast furnaces	-	-	8287	-	-	-	-
Gas works	-	-	61	-	-	-	-
Coke /pat. Fuel / BKB / PB plants	13995	258	334	-	-	-	-
Other transformation	-	-	146	-	-	-	-
ENERGY IND. OWN USE	**-**	**237**	**-**	**-**	**-**	**23666**	**-**
Fuel mining and extraction	-	3	-	-	-	-	-
Oil refineries	-	-	-	-	-	-	-
Elec., CHP and heat plants	-	234	-	-	-	-	-
Pumped storage plants	-	-	-	-	-	-	-
Other energy ind. own use	-	-	-	-	-	23666	-
Losses	-	4	-	1	-	-	22299
FINAL CONSUMPTION	**-**	**5008**	**2969**	**384**	**-**	**31048**	**46710**
INDUSTRY	-	**3485**	**2403**	**10**	**-**	**31048**	46587
Iron and steel	-	2023	2303	-	-	31048	46587
Chemical and petrochemical	-	3	-	-	-	-	-
Non-ferrous metals	-	186	-	-	-	-	-
Non-metallic minerals	-	1207	22	5	-	-	-
Transport equipment	-	-	1	-	-	-	-
Machinery	-	4	4	-	-	-	-
Mining and quarrying	-	11	70	1	-	-	-
Food and tobacco	-	48	3	3	-	-	-

Paper, pulp and print	-	-	-	-	-	-	-
Wood and wood products	-	-	-	-	-	-	-
Construction	-	3	-	1	-	-	-
Textile and leather	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-
TRANSPORT	**-**	**9**	**-**	**-**	**-**	**-**	**-**
Road	-	-	-	-	-	-	-
Railway	-	9	-	-	-	-	-
Pipeline transport	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-
OTHER	**-**	**1281**	**-**	**374**	**-**	**-**	**-**
Residential	-	289	-	353	-	-	-
Comm. and public services	-	981	-	19	-	-	-
Agriculture/forestry	-	11	-	2	-	-	-
Fishing	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-
NON-ENERGY USE	**-**	**233**	**566**	**-**	**-**	**-**	**123**
in industry / transf. / energy	-	233	566	-	-	-	123
of which: chem. / petrochem.	-	-	-	-	-	-	-
in transport	-	-	-	-	-	-	-
SUPPLY AND CONSUMPTION	**Peat (fuel), kt**	**Natural gas, TJ**	**Oil (kt)**				
			Crude oil	**NGL**	**Feed-stocks**	**Additives**	**Refinery gas**
Production	540	759092	1719	735	-	15	41
From other sources	-	-	149	-	-	-	-
Imports	35	442225	790	1	510	-	-
Exports	-9	-	-	-	-50	-	-
Intl. bunkers	-	-	-	-	-	-	-
Stock changes	-13	-113553	16	4	-	-	-
DOMESTIC SUPPLY	**553**	**1087764**	**2674**	**740**	**460**	**15**	**41**
Transfers	-	-	-149	-	-	-	-
Statistical differences	-	-13230	-	-	-	-	-
TRANSFORMATION	**505**	**382130**	**2510**	**737**	**460**	**15**	**-**
Electricity plants	-	14355	-	-	-	-	-
CHP plants	-	150802	-	-	-	-	-
Heat plants	35	216973	-	-	-	-	-
Gas works	-	-	-	-	-	-	-
Coke /pat. Fuel / BKB / PB plants	470	-	-	-	-	-	-
Other transformation	-	-	2510	737	460	15	-
ENERGY IND. OWN USE	**18**	**32998**	**3**	**-**	**-**	**-**	**41**
Fuel mining and extraction	-	28558	-	-	-	-	-
Oil refineries	-	479	3	-	-	-	-
Elec., CHP and heat plants	-	420	-	-	-	-	-
Pumped storage plants	-	-	-	-	-	-	-
Other energy ind. own use	18	3541	-	-	-	-	41

Losses	4	32371	6	-	-	-	-
FINAL CONSUMPTION	**26**	**627035**	**6**	**3**	**-**	**-**	**-**
INDUSTRY	4	**126387**	**-**	**1**	**-**	**-**	**-**
Iron and steel	4	65601	-	-	-	-	-
Chemical and petrochemical	-	8246	-	-	-	-	-
Non-ferrous metals	-	6921	-	-	-	-	-
Non-metallic minerals	-	18495	-	-	-	-	-
Transport equipment	-	792	-	-	-	-	-
Machinery	-	4950	-	-	-	-	-
Mining and quarrying	-	12388	-	-	-	-	-
Food and tobacco	-	7250	-	-	-	-	-
Paper, pulp and print	-	850	-	-	-	-	-
Wood and wood products	-	43	-	-	-	-	-
Construction	-	394	-	-	-	-	-
Textile and leather	-	254	-	-	-	-	-
Non-specified	-	203	-	1	-	-	-
TRANSPORT	**-**	**71457**	**-**	**-**	**-**	**-**	**-**
Domestic aviation	-	-	-	-	-	-	-
Road	-	936	-	-	-	-	-
Railway	-	-	-	-	-	-	-
Pipeline transport	-	70481	-	-	-	-	-
Domestic navigation	-		-	-	-	-	-
Non-specified	-	40	-	-	-	-	-
OTHER	**22**	**360238**	**-**	**-**	**-**	**-**	**-**
Residential	22	317785	-	-	-	-	-
Comm. and public services	-	38008	-	-	-	-	-
Agriculture / forestry	-	4443	-	-	-	-	-
Fishing	-	2	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-
NON-ENERGY USE	**-**	**68953**	**6**	**2**	**-**	**-**	**-**
in industry/transf./energy	-	68953	5	2	-	-	-
of which: chem. / petrochem.	-	*64406*	-	-	-	-	-
in transport	-	-	-	-	-	-	-
Non-specified	-	-	1	-	-	-	-
SUPPLY AND CONSUMPTION	**Oil cont. (kt)**						
	LPG*,**	**Motor gasoline**	**Oth. kerosene**	**Gas / diesel**	**Fuel oil**	**Petroleum coke**	**Other oil products**
Production	409	к	-	к	74	-	605
From other sources			-			-	-
Imports	1466	1042	-	6257	1	-	1435
Exports	-59	-	-	-264	-13	-	-431
Intl. bunkers	-	-	-	-	-	-	-127
Stock changes	35	30	-	38	31	-	48
DOMESTIC SUPPLY	**1851**	**1072**	**-**	**6127**	**93**	**-**	**1530**

Transfers	-	-	-	-	-	-	149
Statistical differences	38	507	-	-336	-6	-	-515
TRANSFORMATION	**1**	**-**	**-**	**10**	**68**	**-**	**117**
Electricity plants	-	-	-	9	32	-	83
CHP plants	1	-	-	-	15	-	24
Heat plants	-	-	-	1	21	-	10
Other transformation	-	-	-	-	-	-	-
ENERGY IND. OWN USE	**2**	**-**	**-**	**10**	**6**	**-**	**-**
Fuel mining and extraction	-	-	-	3	-	-	-
Oil refineries	1	-	-	2	-	-	-
Elec., CHP and heat plants	1	-	-	3	2	-	-
Pumped storage plants	-	-	-	-	-	-	-
Other energy ind. own use	-	-	-	2	4	-	-
Losses	-	-	-	-	-	-	-
FINAL CONSUMPTION	**1886**	**1579**	**-**	**5771**	**13**	**-**	**1047**
INDUSTRY	**38**	**-**	**-**	**452**	**7**	**-**	**12**
Iron and steel	3	-	-	79	-	-	1
Chemical and petrochemical	10	-	-	2	1	-	-
Non-ferrous metals	1	-	-	3	-	-	1
Non-metallic minerals	17	-	-	32	3	-	2
Transport equipment	-	-	-	2	-	-	5
Machinery	1	-	-	6	-	-	-
Mining and quarrying	1	-	-	204	-	-	-
Food and tobacco	2	-	-	17	-	-	-
Paper, pulp and print	-	-	-	1	-	-	-
Wood and wood products	-	-	-	6	3	-	-
Construction	3	-	-	97	-	-	2
Textile and leather	-	-	-	1	-	-	-
Non-specified	-	-	-	2	-	-	1
TRANSPORT	**1800**	**1579**	**-**	**3979**	**-**	**-**	**191**
Domestic aviation	-	-	-	-	-	-	191
Road	1800	1579	-	3819	-	-	-
Railway	-	-	-	27	-	-	-
Pipeline transport	-	-	-	-	-	-	-
Domestic navigation	-	-	-	133	-	-	-
Non-specified	-	-	-	-	-	-	-
OTHER	**48**	**-**	**-**	**1340**	**5**	**-**	**7**
Residential	25	-	-	-	-	-	-
Comm. and public services	6	-	-	123	5	-	7
Agriculture/forestry	17	-	-	1216	-	-	-
Fishing	-	-	-	1	-	-	-
Non-specified	-	-	-	-	-	-	-
NON-ENERGY USE	**-**	**-**	**-**	**-**	**1**	**-**	**837**
in industry/transf./energy	-	-	-	-	1	-	403

of which: chem./petrochem.	-	-	-	-	-	-	*111*
in transport	-	-	-	-	-	-	11
Non-specified	-	-	-	-	-	-	423
SUPPLY AND CONSUMPTION	**Biofuels and waste**					**Electricity, GWh**	**Heat**, TJ**
	Solid biofuel, TJ	**Liquid biofuel, kt**	**Biogases, TJ**	**Waste / Other, TJ**			
Production	154563	70	2028	-		154141	382083
From other sources	-	-	-	-		-	-
Imports	59	70	-	-		2238	-
Exports	-18326	-7	-	-		-6283	-
Intl. bunkers		-		-		-	-
Stock changes	-1798	-	-	-		-	-
DOMESTIC SUPPLY	**134498**	**133**	**2028**	**-**		**150096**	**382083**
Transfers	-	-	-	-		-	-
Statistical differences	-	-	-	-		-	-
TRANSFORMATION	**50658**	**-**	**2028**	**-**		**-**	**2067**
Electricity plants	995	-	-	-		-	2067
CHP plants	4692	-	1768	-		-	-
Heat plants	32804	-	260	-		-	-
Coke / pat. Fuel / BKB / PB plants	-	-	-	-		-	-
Other transformation	12167	-	-	-		-	-
ENERGY IND. OWN USE	**1**	**-**	**-**	**-**		**16973**	**37540**
Fuel mining and extraction	1	-	-	-		2053	2737
Oil refineries	-	-	-	-		601	1913
Elec., CHP and heat plants	-	-	-	-		11608	20144
Pumped storage plants	-	-	-	-		1835	-
Other energy ind. own use	-	-	-	-		876	12746
Losses	-	-	-	-		16434	41893
FINAL CONSUMPTION	**83839**	**133**	**-**	**-**		**116689**	**300583**
INDUSTRY	**3095**	**-**	**-**	**-**		**48592**	**146928**
Iron and steel	310	-	-	-		17082	49971
Chemical and petrochemical	31	-	-	-		3747	28203
Non-ferrous metals	8	-	-	-		1550	12159
Non-metallic minerals	640	-	-	-		2504	2934
Transport equipment	21	-	-	-		794	1627
Machinery	124	-	-	-		2683	3073
Mining and quarrying	71	-	-	-		9340	3266
Food and tobacco	395	-	-	-		4549	33571
Paper, pulp and print	9	-	-	-		922	5716
Wood and wood products	1318	-	-	-		789	3444
Construction	96	-	-	-		967	597
Textile and leather	55	-	-	-		374	854
Non-specified	17	-	-	-		3291	1513
TRANSPORT	**-**	**133**	**-**	**-**		**6603**	**-**

Domestic aviation	-	-	-	-	-	-
Road	-	133	-	-	-	-
Railway	-	-	-	-	5352	-
Pipeline transport	-	-	-	-	250	-
Domestic navigation	-	-	-	-	-	-
Non-specified	-	-	-	-	1001	-
OTHER	**80744**	**-**	**-**	**-**	**61494**	**153655**
Residential	77807	-	-	-	35236	82892
Comm. and public services	1781	-	-	-	22548	62905
Agriculture/forestry	1156	-	-	-	3675	7854
Fishing	-	-	-	-	35	4
Non-specified	-	-	-	-	-	-
NON-ENERGY USE	**-**	**-**	**-**	**-**	**-**	**-**
in industry / transf. / energy	-	-	-	-	-	-
of which: chem. / petrochem.	-	-	-	-	-	-
in transport	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-

APPENDIX 2. EMISSION FACTORS*

1A1a												
Coal furnaces with dry ash removal with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
209	1	820	NE	3,4	7,7	11,4	0,0748	8,7	7,3	0,9	1,4	7,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
4,5	7,8	4,9	23	19	10		0,7	37	29	1,1	6,7	0,0033
Coal furnaces with dry ash removal with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
244	0,7	820	NE	3,1	6	8	0,0682	8,7	7,3	0,9	1,4	7,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
4,5	9	4,9	23	90	10		0,7	37	29	1,1	6,7	0,0033
Coal furnaces with a fluidized bed with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
82,5	0,9	820	NE	5,2	7,7	8,4	0,1144	313	7,3	0,9	1,4	7,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
4,5	9	4,9	23	90	10		0,7	37	29	1,1	6,7	0,0033
Gas furnaces with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
89	2,6	0,281	NE	0,89	0,89	0,89	0,02225	39	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,0112	0,0015	0,5		0,56	0,84	0,84	0,84	NE	NE
Gas turbines with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
48	1,6	0,281	NE	0,2	0,2	0,2	0,005	4,8	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,0112	0,0015	NE		0,56	1,58	1,11	8,36	NE	NE
Reciprocating gas engine power plants with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
135	89	0,5	NE	2	2	2	0,05	56	0,04	0,003	0,1	0,05
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,05	0,01	0,05	0,2	2,91	0,57		1,2	9	1,7	1,8	NE	NE
Fuel oil furnaces with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
142	2,3	495	NE	19,3	25,2	35,4	1,0808	15,1	4,56	1,2	0,341	3,98

Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
2,55	5,31	255	2,06	87,8	2,5		NE	4,5	4,5	6,92	NE	NE
Gas-oil operated turbines with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
398	0,19	46,5	NE	1,95	1,95	1,95	0,65325	1,49	0,0069	0,0012	0,053	0,0023
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,28	0,17	0,0023	0,0023	0,44	NE		NE	NE	NE	NE	NE	NE
Large gas-oil reciprocating engines with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
942	37,1	46,5	NE	21,7	22,4	28,1	16,926	130	4,07	1,36	1,36	1,81
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
1,36	2,72	1,36	6,79	1,81	0,99		116	502	98,7	187	0,22	0,00013
Biomass furnaces with dry ash removal with a rated thermal input of 50 MW or more												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
81	7,31	10,8	NE	133	155	172	4,389	90	20,6	1,76	1,51	9,46
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
9,03	21,1	14,2	1,2	181	50		1120	43	15,5	37,4	5	3,5
Peat furnaces												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
209	1	820	NE	3,4	7,7	11,4	0,0748	8,7	7,3	0,9	1,4	7,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
4,5	7,8	4,9	23	19	10		0,7	37	29	1,1	6,7	0,0033
Coal furnaces with a rated thermal input of 1 to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
180	20	900	NE	72	76	80	4,608	200	100	1	9	4
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
15	10	10	2	150	100		13	17	9	6	0,62	170
Coal furnaces with a rated thermal input of 50 kW to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
160	200	900	NE	170	190	200	10,88	2000	200	3	7	5
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
15	30	20	2	300	400		100	130	50	40	0,62	170
Furnaces fired manually with coal using modern combustion methods with a rated thermal input up to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
200	100	450	NE	130	140	150	8,32	1500	150	2	6	4

Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
10	15	15	2	200	200		90	110	50	40	0,62	170
Automatic coal-fired furnaces using modern combustion methods with a rated thermal input up to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
165	23	450	NE	70	78	82	4,48	350	167	1	16	46
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
6	192	37	17	201	40		0,079	1,244	0,845	0,617	0,62	170
Gas furnaces with a rated thermal input from 50 KW to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
40	2	0,3	NE	0,45	0,45	0,45	0,0243	30	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,011	0,0015	0,5		0,00056	0,00084	0,00084	0,00084	NE	NE
Gas furnaces with a rated thermal input from 1 MW to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
40	2	0,3	NE	0,45	0,45	0,45	0,0243	30	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,011	0,0015	0,5		0,00056	0,00084	0,00084	0,00084	NE	NE
Gas furnaces with a rated thermal input from 50 KW to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
40	2	0,3	NE	0,45	0,45	0,45	0,0243	30	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,011	0,0015	0,5		0,00056	0,00084	0,00084	0,00084	NE	NE
Gas turbines with a rated thermal input of up to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
48	1,6	0,5	NE	0,2	0,2	0,2	0,005	4,8	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,011	0,0015	0,5		0,00056	0,00084	0,00084	0,00084	NE	NE
Gas reciprocating engine power plants with a rated thermal input up to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
135	89	0,5	NE	2	2	2	0,05	56	0,04	0,003	0,1	0,05
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,05	0,01	0,05	0,2	2,9	0,57		0,0012	0,009	0,0017	0,0018	NE	NE
Fuel oil furnaces with a rated thermal input from 1MW to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
100	5	140	NE	30	40	140	NE	40	10	0,3	0,1	1

Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
20	3	200	NE	5	10		1	2	1	1	NE	NE
Distillate fuel furnaces with a rated thermal input up to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
100	15	140	NE	3	3	3	NE	40	20	0,3	0,1	1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
20	10	300	NE	10	10		8	9	6	3	NE	NE
Gas-oil turbines with a rated thermal input of up to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
83	0,18	46	NE	9,5	9,5	9,5	3,1825	2,6	0,012	0,001	0,12	0,002
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,2	0,13	0,005	0,002	0,42	1,8		NE	NE	NE	NE	NE	NE
Large gas-oil reciprocating engines with a rated thermal input of up to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
942	50	48	NE	30	30	30	23,4	130	0,15	0,01	0,11	0,06
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,2	0,3	0,01	0,22	58	0,99		0,0019	0,015	0,0017	0,0015	0,00022	0,00013
Biomass boilers with capacity from 1 MW to 50 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
210	12	11	37	37	38	40	5,55	300	27	13	0,56	0,19
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	100		10	16	5	4	5	0,007
Biomass furnaces with a rated thermal input of up to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
91	156	11	37	98,5	100,5	105	25,61	435	27	13	0,56	0,19
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	100		10	16	5	4	5	0,03
Manual biomass furnaces using modern combustion methods with a rated thermal input of up to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
91	300	11	37	160	163	170	44,8	570	27	13	0,56	0,19
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng l-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	100		10	16	5	4	5	0,06
Automatic biomass boilers using modern combustion methods with a rated thermal input of up to 1 MW												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, g/GJ**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
91	12	11	37	37	38	40	5,55	300	27	13	0,56	0,19

Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	100		10	16	5	4	5	0,007
1A1b												
Refinery gas												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
63	2,58	0,281	NE	0,89	0,89	0,89	18,4	39,3	1,79	0,712	0,086	0,343
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
2,74	2,22	3,6	0,42	25,5	NE		0,669	1,14	0,631	0,631	NE	NE
Gasoil												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
65	0,8	46,5	NE	0,8	3,2	6,5	33,5	16,2	4,07	1,36	1,36	1,81
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
1,36	2,72	1,36	6,79	1,81	0,5		NE	NE	NE	NE	NE	NE
1A1c												
Coal												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
21	0,8	91	NE	55	79	82	NE	6	28	1,6	30	11
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
5,7	25	5,2	2,9	46	26		0,29	0,003	0,001	0,001	NE	NE
1A2												
Solid Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
173	88,8	900	NE	108	117	124	6,4	931	134	1,8	7,9	4
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
13,5	17,5	13	1,8	200	203		45,5	58,9	23,7	18,5	0,62	170
Gaseous fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
74	23	0,67	NE	0,78	0,78	0,78	4	29	0,011	0,0009	0,54	0,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,013	0,0026	0,013	0,058	0,73	0,52		0,72	2,9	1,1	1,08	NE	NE
Liquid Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC,**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**

							% of $PM_{2.5}$					
513	25	47	NE	20	20	20	56	66	0,08	0,006	0,12	0,03
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,2	0,22	0,008	0,11	29	1,4		1,9	15	1,7	1,5	NE	NE
Biomass												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
91	300	11	1,2	140	143	150	28	570	27	13	0,56	0,19
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	100		10	16	5	4	5	0,06
1A4a												
Coal												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
173	88,8	840	NE	108	117	124	6,4	931	134	1,8	7,9	4
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
13,5	17,5	13	1,8	200	203		45,5	58,9	23,7	18,5	0,62	170
Gaseous Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
74	23	0,67	NE	0,78	0,78	0,78	4	29	0,011	0,0009	0,1	0,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,013	0,0026	0,013	0,058	0,73	0,52		0,72	2,9	1,1	1,08	NA	NA
Liquid Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
306	20	94	NE	18	21	21	56	93	8	0,15	0,1	0,5
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
10	3	125	0,1	18	6		1,9	15	1,7	1,5	0,22	0,13
Solid biomass												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
91	300	11	NE	160	163	170	28	570	27	13	0,56	0,19
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	100		10	16	5	4	5	0,06
1A4b												
Coal												

NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
110	484	900	0,3	398	404	444	6,4	4600	130	1,5	5,1	2,5
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
11,2	22,3	12,7	120	220	800		230	330	130	110	0,62	170
Gaseous Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
51	1,9	0,3	NE	1,2	1,2	1,2	5,4	26	0,0015	0,00025	0,1	0,12
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,00076	0,000076	0,00051	0,011	0,0015	1,5		0,56	0,84	0,84	0,84	NA	NA
Liquid Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
51	0,69	70	NE	1,9	1,9	1,9	8,5	57	0,012	0,001	0,12	51
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
0,2	0,13	0,005	0,002	0,42	5,9		80	40	70	160	NA	NA
Solid biomass												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
50	600	11	70	740	760	800	10	4000	27	13	0,56	0,19
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
23	6	2	0,5	512	800		121	111	42	71	5	0,06
1A4c												
Coal												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
173	88,8	840	NE	108	117	124	6,4	931	134	1,8	7,9	4
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
13,5	17,5	13	1,8	200	203		45,5	58,9	23,7	18,5	0,62	170
Gaseous Fuels												
NOx, g/GJ	**NMVOC, g/GJ**	**SOx, g/GJ**	**NH_3, g/GJ**	**$PM_{2.5}$, g/GJ**	**PM10, g/GJ**	**TSP, g/GJ**	**BC, % of $PM_{2.5}$**	**CO, g/GJ**	**Pb, mg/GJ**	**Cd, mg/GJ**	**Hg, mg/GJ**	**As, mg/GJ**
74	23	0,67	NE	0,78	0,78	0,78	4	29	0,011	0,0009	0,1	0,1
Cr, mg/GJ	**Cu, mg/GJ**	**Ni, mg/GJ**	**Se, mg/GJ**	**Zn, mg/GJ**	**PCDD/PCDF, ng I-TEQ/GJ**		**BaP, µg/GJ**	**BbF, µg/GJ**	**BkF, µg/GJ**	**IP, µg/GJ**	**HCB, µg/GJ**	**PCBs, µg/GJ**
13,5	17,5	13	1,8	200	203		45,5	58,9	23,7	18,5	NA	NA
Liquid Fuels												

NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
306	20	94	NE	18	21	21	56	93	8	0,15	0,1	0,5
Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
10	3	125	0,1	18	6		1,9	15	1,7	1,5	0,22	0,13
Solid biomass												
NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
91	300	11	NE	160	163	170	28	570	27	13	0,56	0,19
Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
23	6	2	0,5	512	100		10	16	5	4	5	0,06
1A5a												
Coal												
NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
173	88,8	840	NE	108	117	124	6,4	931	134	1,8	7,9	4
Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
13,5	17,5	13	1,8	200	203		45,5	58,9	23,7	18,5	0,62	170
Gaseous Fuels												
NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
74	23	0,67	NE	0,78	0,78	0,78	4	29	0,011	0,0009	0,1	0,1
Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
0,013	0,0026	0,013	0,058	0,73	0,52		0,72	2,9	1,1	1,08	NA	NA
Liquid Fuels												
NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
306	20	94	NE	18	21	21	56	93	8	0,15	0,1	0,5
Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
10	3	125	0,1	18	6		1,9	15	1,7	1,5	0,22	0,13
Solid biomass												
NOx, g/GJ	NMVOC, g/GJ	SOx, g/GJ	NH_3, g/GJ	$PM_{2.5}$, g/GJ	PM10, g/GJ	TSP, g/GJ	BC, % of $PM_{2.5}$	CO, g/GJ	Pb, mg/GJ	Cd, mg/GJ	Hg, mg/GJ	As, mg/GJ
91	300	11	NE	160	163	170	28	570	27	13	0,56	0,19
Cr, mg/GJ	Cu, mg/GJ	Ni, mg/GJ	Se, mg/GJ	Zn, mg/GJ	PCDD/PCDF, ng I-TEQ/GJ		BaP, µg/GJ	BbF, µg/GJ	BkF, µg/GJ	IP, µg/GJ	HCB, µg/GJ	PCBs, µg/GJ
23	6	2	0,5	512	100		10	16	5	4	5	0,06
2A1												

NOx, g/Mg	NMVOC, g/Mg	SOx, g/Mg	NH_3, g/Mg	$PM_{2.5}$, g/Mg	PM10, g/Mg	TSP, g/Mg	BC, g/Mg	CO, g/GJ	Pb, g/Mg	Cd, g/Mg	Hg, g/Mg	As, g/Mg
1241	18	374	NE	130	234	260	3,9	1455	0,098	0,008	0,049	0,0265
Cr, g/Mg	Cu, g/Mg	Ni, g/Mg	Se, g/Mg	Zn, g/Mg	PCDD/PCDF, ng I-TEQ/Mg		BaP, g/Mg	BbF, g/Mg	BkF, g/Mg	IP, g/Mg	HCB, µg/Mg	PCBs, µg/Mg
0,041	0,0647	0,049	0,0253	0,424	4,1		0,000065	0,00028	0,000077	0,000043	4,6	NA
2A2												
Production without cleaning system												
NOx, g/Mg	NMVOC, g/Mg	SOx, g/Mg	NH_3, g/Mg	$PM_{2.5}$, g/Mg	PM10, g/Mg	TSP, g/Mg	BC, g/Mg	CO, g/GJ	Pb, g/Mg	Cd, g/Mg	Hg, g/Mg	As, g/Mg
NE	NE	NE	NA	700	3500	9000	3,22	NE	NE	NE	NE	NA
Cr, g/Mg	Cu, g/Mg	Ni, g/Mg	Se, g/Mg	Zn, g/Mg	PCDD/PCDF, ng I-TEQ/Mg		BaP, g/Mg	BbF, g/Mg	BkF, g/Mg	IP, g/Mg	HCB, µg/Mg	PCBs, µg/Mg
NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Production with cleaning system												
NOx, g/Mg	NMVOC, g/Mg	SOx, g/Mg	NH_3, g/Mg	$PM_{2.5}$, g/Mg	PM10, g/Mg	TSP, g/Mg	BC, g/Mg	CO, g/GJ	Pb, g/Mg	Cd, g/Mg	Hg, g/Mg	As, g/Mg
NE	NE	NE	NA	30	200	400	0,138	NE	NE	NE	NE	NA
Cr, g/Mg	Cu, g/Mg	Ni, g/Mg	Se, g/Mg	Zn, g/Mg	PCDD/PCDF, ng I-TEQ/Mg		BaP, g/Mg	BbF, g/Mg	BkF, g/Mg	IP, g/Mg	HCB, µg/Mg	PCBs, µg/Mg
NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
2A3												
Sheet glass production												
NOx, g/Mg	NMVOC, g/Mg	SOx, g/Mg	NH_3, g/Mg	$PM_{2.5}$, g/Mg	PM10, g/Mg	TSP, g/Mg	BC, % of $PM_{2,5}$	CO, g/GJ	Pb, g/Mg	Cd, g/Mg	Hg, g/Mg	As, g/Mg
1369	NE	316	NE	100	120	130	0,062	1940	0,4	0,068	0,003	0,08
Cr, g/Mg	Cu, g/Mg	Ni, g/Mg	Se, g/Mg	Zn, g/Mg	PCDD/PCDF, ng I-TEQ/Mg		BaP, g/Mg	BbF, g/Mg	BkF, g/Mg	IP, g/Mg	HCB, µg/Mg	PCBs, µg/Mg
0,08	0,007	0,74	0,15	0,37	NE		NE	NE	NE	NE	NA	NA
Production of container glass												
NOx, g/Mg	NMVOC, g/Mg	SOx, g/Mg	NH_3, g/Mg	$PM_{2.5}$, g/Mg	PM10, g/Mg	TSP, g/Mg	BC, % of $PM_{2,5}$	CO, g/GJ	Pb, g/Mg	Cd, g/Mg	Hg, g/Mg	As, g/Mg
1369	NE	16	NE	220	250	280	0,1364	1940	2,9	0,12	NE	0,29
Cr, g/Mg	Cu, g/Mg	Ni, g/Mg	Se, g/Mg	Zn, g/Mg	PCDD/PCDF, ng I-TEQ/Mg		BaP, g/Mg	BbF, g/Mg	BkF, g/Mg	IP, g/Mg	HCB, µg/Mg	PCBs, µg/Mg
0,37	NE	0,24	1,5	NE	NE		NE	NE	NE	NE	NA	NA
2A5a												
NOx, g/Mg	NMVOC, g/Mg	SOx, g/Mg	NH_3, g/Mg	$PM_{2.5}$, g/Mg	PM10, g/Mg	TSP, g/Mg	BC, % of $PM_{2,5}$	CO, g/GJ	Pb, g/Mg	Cd, g/Mg	Hg, g/Mg	As, g/Mg
NA	NA	NA	NA	5	50	102	NA	NA	NA	NA	NA	NA
Cr, g/Mg	Cu, g/Mg	Ni, g/Mg	Se, g/Mg	Zn, g/Mg	PCDD/PCDF, ng I-TEQ/Mg		BaP, g/Mg	BbF, g/Mg	BkF, g/Mg	IP, g/Mg	HCB, µg/Mg	PCBs, µg/Mg
NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA

* Emission factors for categories 2B1, 2B2, 2B10a, 2C1, 2C2, 2C3, 2C5, 2C7a, 2C7c, 2H1, 2H2, 2I, 2J, 3B1a, 3B1b, 3B3, 3B4d, 3B4e, 3B4gi, 3B4h, 3Da1, 5C1bi, 5C1bii are used in accordance with emission factors for Tier 1 of the EMEP/EEA Emission Inventory Guidebook [4].

APPENDIX 3. NATIONAL CATEGORY OF INDUSTRIAL AND TECHNOLOGICAL PROCESSES, PROCESS EQUIPMENT (UNITS)

NFR Code	NFR name	Codes of production and technological processes, technological equipment (plants)	Names of production and technological processes, technological equipment (plants)
1A1a	**Public electricity and heat production**	**Public power**	
		110101	Combustion plants >= 300 MW (boilers)
		110102	Combustion plants >= 50 and < 300 MW (boilers)
		110103	Combustion plants < 50 MW (boilers)
		110104	Gas turbines
		110105	Stationary engines
		District heating plants:	
		110201	Combustion plants >= 300 MW (boilers)
		110202	Combustion plants >= 50 and < 300 MW (boilers)
		110203	Combustion plants < 50 MW (boilers)
		110204	Gas turbines
		110205	Stationary engines
1A1b	**Petroleum refining**	**Petroleum refining plants**	
		110301	Combustion plants >= 300 MW (boilers)
		110302	Combustion plants >= 50 and < 300 MW (boilers)
		110303	Combustion plants < 50 MW (boilers)
		110304	Gas turbines
		110305	Stationary engines
		110306	Process furnaces
1A1c	**Manufacture of solid fuels and other energy industries**	**Solid fuel plants**	
		110401	Combustion plants >= 300 MW (boilers)
		110402	Combustion plants >= 50 and < 300 MW (boilers)
		110403	Combustion plants < 50 MW (boilers)
		110404	Gas turbines
		110405	Stationary engines
		110406	Coke ovens
		110407	Other (coal gasification, liquefaction etc.)
		District heating plants:	
		110501	Combustion plants >= 300 MW (boilers)
		110502	Combustion plants >= 50 and < 300 MW (boilers)
		110503	Combustion plants < 50 MW (boilers)
		110504	Gas turbines
		110505	Stationary engines
1A2a		**Process furnaces**	

	Stationary combustion in manufacturing industries and construction: Iron and steel	130203	Blast furnace cowpers
		Contact technological processes	
		130301	Sinter and pelletizing plants
		130302	Reheating furnaces steel and iron
		130303	Grey iron foundries
1A2b	**Stationary combustion in manufacturing industries and construction: Non-ferrous metals**	**Contact technological processes**	
		130304	Primary lead production
		130305	Primary zinc production
		130306	Primary copper production
		130324	Nickel production (thermal process)
1A2d	**Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print**	**Contact technological processes**	
		130321	Paper-mill industry (drying processes)
1A2f	**Stationary combustion in manufacturing industries and construction: Non-metallic minerals**	**Process furnaces**	
		130204	Plaster furnaces
		Contact technological processes	
		130311	Cement
		130312	Lime
		130313	Asphalt concrete plants
		130314	Flat glass
		130315	Container glass
		130316	Fiber glass
		130317	Other glass (including special purpose glass)
		130318	Rock wool
		130319	Bricks and tiles
		130320	Fine ceramic materials
		130322	Alum earth (clay)
		130323	Magnesium production (dolomite processing)
		130325	Enamel production
1A2gviii	**Stationary combustion in manufacturing industries and construction: Other**	**Combustion processes in boilers, gas turbines and stationary engines**	
		130101	Combustion plants >= 300 MW (boilers)
		130102	Combustion plants >= 50 and < 300 MW (boilers)
		130103	Combustion plants < 50 MW (boilers)
		130104	Gas turbines
		130105	Stationary engines
		130106	Other stationary equipment
		Process furnaces	
		130205	Other furnaces
		Contact technological processes	
		130326	Metal welding
		130327	Other
1A4ai	**Commercial/Institutional: Stationary**	**Combustion plants in commercial enterprises and institutions**	
		120102	Combustion plants >= 50 and < 300 MW (boilers)
		120103	Combustion plants < 50 MW (boilers)

		120104	Stationary gas turbines
		120105	Stationary engines
		120106	Other stationary equipment
1A4bi	**Residential: stationary**	**Combustion plants in residential sector**	
		120201	Combustion plants >= 50 and < 300 MW (boilers)
		120202	Combustion plants < 50 MW (boilers)
		120203	Stationary gas turbines
		120204	Stationary engines
		120205	Other stationary equipment
1A4ci	**Agriculture/Forestry/Fishing: Stationary**	**Combustion plants in agriculture, forestry and aquatic organisms cultivation sector**	
		120301	Combustion plants >= 50 and < 300 MW (boilers)
		120302	Combustion plants < 50 MW (boilers)
		120303	Stationary gas turbines
		120304	Stationary engines
		120305	Other stationary equipment
1B1a	**Fugitive emission from solid fuels: Coal mining and handling**	**Mining and primary processing of solid fossil fuels**	
		310101	Open cast mining
		310102	Underground mining
		310103	Storage of solid fuel
		310104	Other
1B1b	**Fugitive emission from solid fuels: Solid fuel transformation**	**Technological processes in ferrous metallurgy and coal industry**	
		210201	Coke oven batteries (indoor leaking and extinguishing)
		210204	Solid smokeless fuel
1B2ai	**Fugitive emissions oil: Exploration, production, transport**	**Extraction, primary processing and loading of liquid fossil fuels**	
		310201	Land-based activities
		310202	Off-shore activities
		310203	Other
1B2aiv	**Fugitive emissions oil: Refining and storage**	**Technological processes in oil industry**	
		210101	Petroleum products processing
		210102	Catalytic cracking
		210103	Sulphur recovery plants
		210104	Storage and handling of petroleum production in refinery
		210105	Other
1B2av	**Distribution of oil products**	**Liquid fuel distribution (other than gasoline)**	
		310401	Off-shore terminals (tankers, transportation and storage)
		310402	Other transportation and storage (including pipelines)
		Gasoline distribution	
		310501	Refinery dispatch station
		310502	Transport and depots
		310503	Service stations (including car refueling)
		310504	Other
1B2b		**Extraction, primary processing and loading of gaseous fossil fuels**	

	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	**310301**	Land-based activities (desulfurization)
		310302	Land-based activities (other than desulfurization)
		310303	Off-shore activities
		310304	Other
		Gas distribution networks	
		310601	Pipelines
		310602	Pipeline compressor stations
		310603	Distribution networks
1B2c	**Venting and flaring (oil, gas, combined oil and gas)**	**Waste combustion**	
		510203	Flaring in oil refinery
		510206	Flaring in oil and gas extraction
2A1	**Cement production**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210612	Cement
2A2	**Lime production**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210614	Lime
2A3	**Glass production**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210613	Glass
2A6	**Other minerals**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210615	Battery manufacturing
		210616	Mineral output
		210617	Other (including fiber asbestos production)
		210618	Use of limestone and dolomite
2B1	**Ammonia production**	**Inorganic chemicals manufacturing process flow in industry**	
		210403	Ammonia
2B2	**Nitric acid production**	**Inorganic chemicals manufacturing process flow in industry**	
		210402	Nitric acid production
2B6	**Titanium dioxide production**	**Inorganic chemicals manufacturing process flow in industry**	
		210410	Titanium dioxide
2B7	**Soda ash production**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210619	Production and use of soda
2B10a	**Chemical industry: other**	**Inorganic chemicals manufacturing process flow in industry**	
		210401	Production of sulfuric acid
		210404	Ammonium sulfate
		210405	Ammonium nitrate
		210406	Ammonium phosphate
		210407	NPK fertilizers
		210408	Urea
		210409	Soot

		210411	Graphite
		210413	Chlorine production
		210414	Phosphate fertilizers
		210415	Storage of inorganic chemical products
		210416	Other
		Technological processes in the industry for the production of organic chemicals	
		210501	Ethylene
		210502	Propylene
		210503	1,2-dichloroethane
		210504	Vinyl chloride
		210505	1,2-dichloroethane and vinyl chloride (balanced process)
		210506	Low-density polyethylene
		210507	High-density polyethylene
		210508	Polyvinyl chloride
		210509	Polypropylene
		210510	Styrene
		210511	Polystyrene
		210512	Styrene butadiene
		210513	Styrene-butadiene latex
		210514	Styrene-butadiene rubber
		210515	Acrylonitrile butadiene styrene
		210516	Ethylene oxide
		210517	Formaldehyde
		210518	Ethylbenzene
		210519	Phthalic anhydride
		210520	Acrylonitrile
		210522	Storage of organic chemicals
		210523	Glyoxylic acid
		210524	Production of halogenated hydrocarbons
		210525	Pesticide production
		210526	Production of persistent organic compounds
		210527	Other
2C1	**Cast iron and steel production**	**Technological processes in ferrous metallurgy and coal industry**	
		210202	Blast furnace loading
		210203	Melting of cast iron and casting of ingots
		210205	Open-hearth furnace
		210206	Oxygen converter at the steel production plant
		210207	Steel production in an electric furnace
		210208	Rolling mills
		210209	Sintering plant
		210210	Other
2C2	**Ferroalloy production**	**Technological processes in non-ferrous metallurgy**	
		210302	Ferroalloys
2C3	**Aluminum production**	**Contact technological processes**	
		130310	Secondary aluminum production

		Technological processes in non-ferrous metallurgy	
		210301	Aluminum production (electrolysis)
2C5	**Lead production**	**Contact technological processes**	
		130307	Secondary lead production
2C6	**Zinc production**	**Contact technological processes**	
		130308	Secondary zinc production
2C7a	**Copper production**	**Contact technological processes**	
		130309	Secondary copper production
2C7c	**Production of other metals**	**Technological processes in non-ferrous metallurgy**	
		210303	Silicon production
		210306	Production of alloyed metals
		210307	Electroplating
		210308	Electrogalvanization
		210309	Other
2C7d	**Storage, processing and transportation of metal products**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210620	Mechanical engineering (mechanical metal-working)
2D3a	**Domestic use of solvents, including antifungal agents (fungicides)**	**Other solvent uses and related activities**	
		410408	Domestic use of solvents (except paints)
2D3b	**Roadway asphalting**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210611	Road asphalt pavement
2D3c	**Bitumen roofing materials**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210610	Bitumen roofing materials
2D3d	**Application of coatings**	**Use of solvents and other products**	
		410101	Car manufacturing
		410102	Car repairs
		410103	Construction and finishing of buildings
		410104	Domestic use
		410105	Painting of rolled products
		410106	Shipbuilding
		410107	Timber
		410108	Other types of industrial use of paints
		410109	Other types of non-industrial use of paints
2D3e	**Degreasing**	**Degreasing, dry cleaning and electronic equipment**	
		410201	Metal degreasing
2D3f	**Chemical (dry) cleaning**	**Degreasing, dry cleaning and electronic equipment**	
		410202	Chemical cleaning
2D3g	**Chemical products**	**Production or processing of chemical products**	
		410301	Polyester processing
		410302	Polyvinyl chloride processing
		410303	Polyurethane foam processing
		410304	Styrofoam processing

		410305	Rubber processing
		410306	Manufacture of pharmaceutical products
		410307	Paint production
		410308	Ink production
		410309	Production of adhesives
		410310	Bitumen purging
		410311	Production of adhesive, magnetic tapes, photographic films and photographs
		410312	Textile finishing
		410313	Skin curing
		410314	Other
2D3h	**Printing**	**Other solvent uses and related activities**	
		410403	Printing industry
2D3i	**Other uses of solvents**	**Degreasing, dry cleaning and electronic equipment**	
		410203	Production of electronic parts
		410204	Other industrial cleaning services
		Other solvent uses and related activities	
		410401	Glass wool production
		410402	Slag wool production
		410404	Extraction of fats, food and non-food oils
		410405	Application of adhesives and adhesive tapes
		410406	Wood conservation
		410407	Anti-corrosion treatment and preservation of vehicles
		410409	Dewaxing of vehicles
		410410	Manufacture of pharmaceutical products
		410411	Other
2G	**Other product uses**	**Use of HFCS, N_2O, NH_3, PFCs and SF_6**	
		410501	Use of N_2O for anesthesia
		410502	Equipment for freezing and air conditioning when using halocarbons
		410503	Equipment for freezing and air conditioning when using products other than halocarbons
		410504	Foam leakage
		410505	Fire extinguishers
		410506	Aerosols
		410507	Electrical equipment
		410508	Other
2H1	**Cellulose and paper industry**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210602	Pulp and paper production (kraft)
		210603	Pulp and paper production (sulfite cooking)
		210604	Cellulose production (neutral sulfite polychemic process)

2H2	**Food and beverage production**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210605	Bread industry
		210606	Wine
		210607	Beer
		210608	Liquor
		210609	Other branches of the food industry
2H3	**Other industrial production**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210622	Light and processing industry
2I	**Woodworking industry**	**Technological processes in mechanical engineering, woodworking, pulp and paper and food processing, beverage industry and other sectors**	
		210601	Chipboard (chipboard)
3B1a	**Manure management: dairy cattle**	**Enteral (intestinal) fermentation**	
		610401	Dairy cows
		Collection, storage and use of manure and organic compounds	
		610501	Dairy cows
3B1b	**Manure management: non-dairy cattle**	**Enteral (intestinal) fermentation**	
		610402	Other cattle
		Collection, storage and use of manure and organic compounds	
		610502	Other cattle
3B2	**Manure management: Sheep**	**Enteral (intestinal) fermentation**	
		610403	Sheep
		Collection, storage and use of manure and organic compounds	
		610505	Sheep
3B3	**Manure management: swine**	**Enteral (intestinal) fermentation**	
		610404	Fattening pigs
		610412	Sows
		Collection, storage and use of manure and organic compounds	
		610503	Fattening pigs
		610504	Sows
3B4a	**Manure management: Buffalo**	**Enteral (intestinal) fermentation**	
		610414	Buffalo
		Collection, storage and use of manure and organic compounds	
		610514	Buffalo
3B4d	**Manure management: goats**	**Enteral (intestinal) fermentation**	
		610407	Goats
		Collection, storage and use of manure and organic compounds	
		610511	Goats
3B4e	**Manure management: horses**	**Enteral (intestinal) fermentation**	
		610405	Horses
		Collection, storage and use of manure and organic compounds	
		610506	Horses
3B4gi	**Manure management: laying hens**	**Enteral (intestinal) fermentation**	
		610408	Laying hens
		Collection, storage and use of manure and organic compounds	

		610507	Laying hens
3B4gii	**Manure management: broilers**	**Enteral (intestinal) fermentation**	
		610409	Broilers
		Collection, storage and use of manure and organic compounds	
		610508	Broilers
3B4giv	**Manure management: other poultry**	**Enteral (intestinal) fermentation**	
		610410	Other poultry (duck, geese etc.)
		Collection, storage and use of manure and organic compounds	
		610509	Other poultry (duck, geese etc.)
3B4h	**Manure management: other animals**	**Enteral (intestinal) fermentation**	
		610411	Fur animals
		610415	Other
		Collection, storage and use of manure and organic compounds	
		610510	Fur animals
		610515	Other
3Da2a	**Animal manure applied to soils**	**Collection, storage and use of manure and nitrogen compounds**	
		610900	Collection, storage and use of manure and nitrogen compounds
3Dc	**Farm-level agricultural operations including storage, handling and transport of agricultural products**	**Technological processes in mechanical engineering, woodworking, pulp and paper, food and beverage industry and other sectors**	
		210621	Agricultural products processing
3De	**Cultivated crops**	**Crop cultivation with the use of fertilizers (other than manure)**	
		610101	Permanent crops
		610102	Agricultural crops
		610103	Rice fields
		610104	Gardening
		610105	Grassland
		610106	Fallow land
		Crop cultivation without fertilizers	
		610201	Permanent crops
		610202	Agricultural crops
		610203	Rice fields
		610204	Gardening
		610205	Grass land
		610206	Fallow land
3Df	**Use of pesticides**	**Use of pesticides and limestone**	
		610600	Use of pesticides and limestone
5A	**Solid waste disposal on land**	**Elimination of solid waste on land**	
		510401	Elimination of controlled waste on land
		510402	Elimination of uncontrolled waste on land
		510403	Other
		Other waste treatment	
		511004	Disposal of waste in the ground
5B1	**Biological treatment of waste - Composting**	**Other waste treatment**	
		511005	Compost production
5B2	**Biological treatment of waste - Anaerobic digestion at biogas facilities**	**Other waste treatment**	
		511006	Biogas production

5C1a	**Municipal waste incineration**	**Waste incineration**	
		510201	Domestic or municipal waste incineration
5C1biii	**Clinical waste incineration**	**Waste incineration**	
		510207	Burning of waste from hospitals
5C1biv	**Sewage sludge incineration**	**Waste incineration**	
		510205	Sewage sludge incineration
5C1bv	**Cremation**	**Cremation**	
		510901	Burning of cadavers
		510902	Burning of animal carcasses
5C1bvi	**Other waste incineration**	**Waste incineration**	
		510208	Burning of used oil
5D1	**Domestic wastewater handling**	**Other waste handling**	
		511002	Wastewater treatment in residential and commercial sectors
5D2	**Industrial wastewater handling**	**Other waste handling**	
		511001	Industrial wastewater treatment
5D3	**Other wastewater handling**	**Other waste handling**	
		511003	Wastewater sludge disposal
5E	**Other waste**	**Other waste handling**	
		511007	Production of meat and bone meal
		511008	Other fuel production (spent fuel residues)
6A	**Other sources**	210700	Refrigeration units
		210800	Production of halocarbons and sulfur hexafluoride