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POLAND'S INFORMATIVE INVENTORY REPORT 2019

Submission under the UN ECE Convention

On Long-range Transboundary Air Pollution

and

the DIRECTIVE (EU) 2016/2284

Warsaw 2019

Poland`s Informative Inventory Report 2019

Submission under the UN ECE Convention on Long-range Transboundary Air Pollution and the Directive (EU) 2016/2284

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EXECUTIVE SUMMARY

Emission estimates in Poland account for sulphur dioxide, nitrogen oxides, ammonia, carbon monoxide, particulate matter (black carbon - BC, particulate matter - PM2.5 and PM10, and total suspended particulates - TSP), non-methane volatile organic compounds (NMVOCs), heavy metals (HMs) and persistent organic pollutants (POPs) including dioxins and furans (PCDD/F), hexachlorobenzene (HCB), polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH).

The Poland's Informative Inventory Report (IIR) 2019 contains information on the Poland's emission inventories for the years 1990 to 2017, including descriptions of methods, data sources, performed QA/QC activities and a trend analysis. Emission inventories have been reported in the NFR 2014-1 reporting format.

Referring to previous submissions methodology changes have been introduced; the major changes include verification of emission factors fin accordance to 2017 & 2018 Comprehensive Technical Review of National Emission Inventories. Summary of changes recommended during this review is presented in Annex 7.

Nevertheless, further inventory improvement is possible; planned programme of improvement is focused on the following tasks:

- verification of NMVOC emissions from the solvents use,
- gathering additional activity data to verify the trend 1990-2017,
- further methodology development by applying higher tier of estimation methodology.

Emission volumes in the years 2016 – 2017 for the particular pollutants are presented below (Table ES.1).

Table ES.1. Emission volumes in the years 2016 – 2017

Pollutant	2016	2017	2017/2016
	Mg		[%]
SO_2	590 663.8	582 655.8	-1.36
NO_x	742 167.9	803 661.4	8.29
NMLZO	674 158.3	690 737.1	2.46
NH_3	291 948.0	307 522.0	5.33
CO	2 456 467.8	2 543 251.4	3.53
TSP	335 210.3	340 604.3	1.61
PM10	240 632.3	246 309.5	2.36
PM2.5	141 874.8	147 281.2	3.81
BC	21 217.1	23 813.7	12.24
Cd	12.1	12.4	2.49
Pb	295.7	305.5	3.32
Hg	9.5	9.6	1.05
As	16.7	16.7	-0.01
Cr	40.2	41.6	3.60
Cu	188.5	203.6	8.05
Ni	92.1	90.4	-1.82
Zn	623.1	652.5	4.71
	kg		[%]
PCB	578.1	578.4	0.05
HCB	4.1	4.0	-2.00
PAH	153 535.3	151 575.1	-1.28
	g I-TEQ		[%]
PCDD/F	260.9	259.0	-0.71

Comparing 2017 to 2016, total emissions of most main pollutants have increased, especially NOx emissions - by about 8% and black carbon emissions – 12%.

Emissions of heavy metals changed most regarding Cu (emission increased by about 8%) and Zn (emission increased by about 5%).

Among POPs only for PCB a small increase was observed (by about 0.05%) while PAH emissions decreased by about 1.3%.

1 INTRODUCTION

The Poland's Informative Inventory Report (IIR) 2019 contains information on the Poland's emission inventories for the years 1990 to 2017, including descriptions of methods, data sources, performed QA/QC activities, key categories analysis and a trend analysis.

Emission estimates in Poland account for:

- sulphur dioxide (SO_2),
- nitrogen oxides (NOx),
- ammonia (NH_3),
- carbon monoxide (CO),
- particulate matter (black carbon - BC, particulate matter - PM2.5 and PM10 and total suspended particulates - TSP),
- non-methane volatile organic compounds (NMVOCs),
- heavy metals (HMs – Cd, Pb, Hg, As, Cr, Cu, Ni, Zn),
- persistent organic pollutants (POPs) including dioxins (PCDD/F), hexachlorobenzene (HCB), polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH).

Preparation of IIR Report fulfils Poland`s obligations deriving from:

- UN ECE Convention on Long-range Transboundary Air Pollution, signed in November 1979 in Geneva,
- Directive 2016/2284 of the European Parliament and the Council on National Emissions Ceilings (NECD).

Emission inventories have been reported in the present reporting template (NFR 2014-1 format), in accordance to revised guidelines for reporting emissions and projections data under the Convention.

The structure of the report is compliant with the template of an Informative Inventory Report to LRTAP. For each pollutant or group of pollutants the report includes inter alia:

- key categories analysis,
- trends of national totals and NFR key sectors,
- methodology of emission estimates.

1.1 National Inventory Background

Emission estimates are predominantly based on official Polish statistics, e.g. energy statistics, agricultural statistics, transport statistics, industry statistics and emission factors (nationally developed factors as well as internationally recommended ones).

Poland generally observes the Guidelines for Estimating and Reporting Emission Data for reporting to the Convention on Long-Range Transboundary Air Pollution (CLRTAP) under the Economic Commission for Europe (UNECE).

Some parts of the methodologies are implemented directly from the EMEP/EEA Emission Inventory Guidebook and international studies, other are nationally developed.

1.2 Institutional arrangements

The inventory system currently existing in Poland is presented in The inventory system currently existing in Poland is presented in Figure 1.1.

The Polish Ministry of the Environment takes the overall responsibility and submits the inventory report to CLRTAP and European Union. In 2010, as a result of introduced organizational changes[1], the inventory team was constituted as Emission Inventory and Reporting Unit (EIRU) and located in the National Centre for Emissions Management (NCEM; in Polish: KOBiZE), part of the Institute of Environmental Protection-National Research Institute. EIRU develops the inventory reports and is also responsible for the final quality control and quality assurance (QA/QC) of submitted data.

After completing the inventory it is reviewed by the Ministry of the Environment (MoE), officially approved by MoE and sent to CLRTAP and EEA. Emission inventories are the basis for preparation of Air Emissions Accounts (AEA) according to NACE classification which are sent via national statistical institute (GUS) to EUROSTAT.

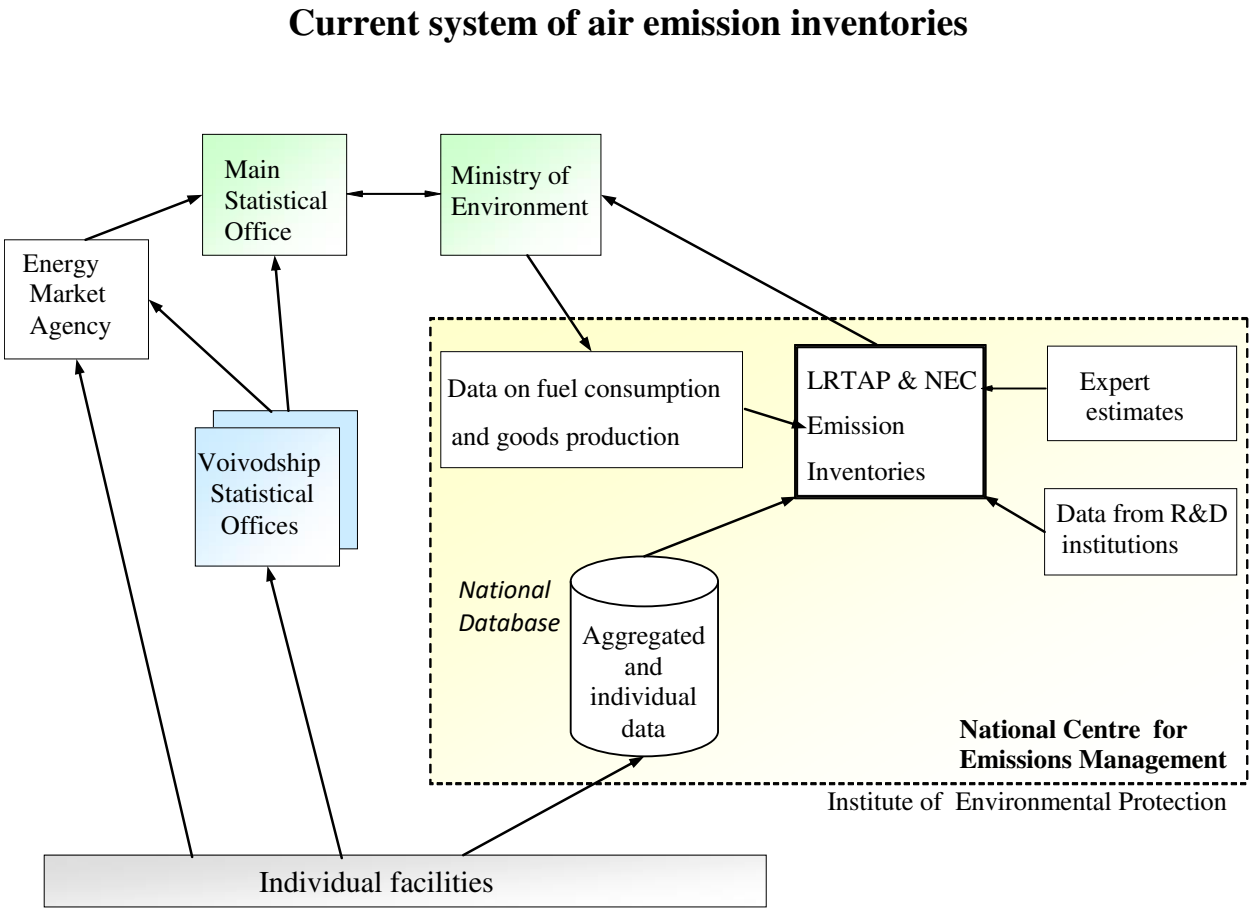

Figure 1.1. Current system of air emission inventories

[1] The Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances

1.3 Inventory preparation process

Basic information on activity data regarding particular emission source categories, is generally sourced from numerous official public statistics and Polish data in EUROSTAT database.

The activity data that are not available in public statistics, are developed by experts through studies commissioned by the Ministry of the Environment or by the Institute of Environmental Protection specifically for emission inventory purposes. Other input data are received upon request.

To prepare the emission inventory EIRU collaborates with a number of institutions as well as individual experts. Among the collaborating institutions there are: *Statistics Poland* (GUS), *Energy Market Agency* (ARE), *Institute of Technology and Life Sciences* (ITP) and the *National Research Institute of Animal Production* (IZ).

1.4 Methods and data sources

Emission factors for the emission sources are in most cases implemented from EMEP Inventory Guidebook 2016 or domestic research reports. The sources of particular emission factors are presented below in the sectoral chapters.

The inventory team (*Emission Inventory and Reporting Unit*), as a subunit of the NCEM (KOBiZE), has been provided an access to individual data of entities reporting to the National Database run by KOBiZE. This ensures availability of data concerning major sources of emissions in stationary combustion sectors (NFR 1.A.1, 1.A.2) as well as from specific industrial processes. Such data are - after verification - successively included into emission inventory where possible.

To ensure consistency with reports that are submitted to UNFCCC Convention, activity data (fuels use;, goods production) are harmonized with GHG inventories.

Estimation of main (including SO_2, NO_x, NH_3 and CO) and other pollutant emissions is based on various activity data obtained mainly from the Statistics Poland. They are as follows:

- national fuel consumption balance,
- data on production of goods and products and fuel consumption for their production,
- data on number of husbandry animal heads and consumption of fertilizers in agriculture, as well as plant production,
- data on industrial and municipal waste water and accumulated and generated solid wastes,
- other statistical data concerning industry, agriculture or forestry.

Activity data used in air emission inventories are presented in methodology chapters and Annex 5 and 2.

The estimated values of emissions for main pollutants have been obtained from calculations based on national and international (EMEP/EEA Emission Inventory Guidebook 2016, CORINAIR, etc.) emission factors.

All emission factors used for 2017 estimates are presented in Annex 6.

Individual and aggregated emission data of entities reporting to the National Database run by KOBiZE were verified and included into emission inventory, where possible.

Calculations for sector 1.A.3.b Road transport were conducted using model COPERT 5. All emission factors are default values from COPERT 5.

1.4.1 Sulphur dioxide emissions

General information on sulphur dioxide emissions estimation is presented below:

- Estimation of SO_2 emission from combustion processes in stationary sources was generally based on reported values of sulphur contents in solid and liquid fuels;
- For public power plants combination of individual data is included;
- Estimation of SO_2 emission from off-road mobile sources was based on standard concentration values for sulphur in liquid fuels while for road transport emissions with the use of COPERT 5 software.

1.4.2 Carbon oxide; Nitrogen oxides

General information on nitrogen oxides emissions estimation is presented below:

- For public power plants NOx emission is combination of individual data;
- For the category *Open burning of agricultural wastes* a country specific methodology was adopted. Carbon oxide and Nitrogen oxides emissions from burning of agricultural residues in fields were estimated based in general on methodology described in EMEP/EEA Emission Inventory Guidebook and Revised 1996 IPCC Guidelines for National GHG Inventories. For domestic purposes 43 crops were selected for which residues can potentially be burned [2]. Within this group certain plants for which residues can be composted or used as forage were excluded. Finally, 38 crops were selected (containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits) residues of which could be burned on fields. Activity data concerning crop production were sourced from [GUS 2018i]. Factors applied for emissions calculation were implemented from a country study in which experimental and literature data as well as default emission factors were used.
- Several emission factors for 1A4 sector have been verified and updated according to in EMEP/EEA Atmospheric Emission Inventory Guidebook. Other emission factors are country specific.

1.4.3 PM emissions

General information on PM emissions estimation is presented below:

- Estimated values of emissions are a result of calculations based on national activity data and appropriate emission factors;
- Activity data are obtained mainly from the Statistics Poland (GUS), including national fuel consumption balance, data on manufacturing of products and fuel consumption for their production, data on number of husbandry animal heads, data on industrial wastes utilization;
- Emission factors are sourced both from EMEP/EEA Emission Inventory Guidebook and country studies and surveys (factors verified and adapted to Polish conditions). The majority of these changes were the results of research conducted by the Institute for Ecology of Industrial Areas in Katowice in co-operation with the Institute for Chemical Processing of Coal in Zabrze.

[2] Łoboda (1994). Łoboda T., Pietkiewicz S. Estimation of amount of CH_4, CO, N_2O and NOx released to atmosphere from agricultural residues burning in 1992, Warsaw Agricultural University, 1994 (in Polish).

1.4.4 POPs emissions

General information on POPs emissions estimation is presented below:

- Estimation of emissions of dioxins/furans – PCDD/F, hexachlorobenzene - HCB, polychlorinated biphenyls - PCBs, and four polyaromatic hydrocarbons PAHs was based on national activity data including fuel statistics as well as on emission factors implemented from literature and domestic measurements;
- Several emission factors for 1A4 sector have been verified and updated according to in EMEP/EEA Atmospheric Emission Inventory Guidebook;
- The significant source of PCDD/F in category *Other* are landfill fires but emission estimate here is uncertain as it is difficult to estimate the mass of the wastes that are burnt.

1.4.5 NMVOC emissions

General information on NMVOV emissions estimation is presented below:

- Statistical data on production, consumption of fuels and raw materials and land use data, developed by the Statistics Poland (GUS) were used for national NMVOCs emission assessment;
- For some emission sources, default emission factors published in EMEP/EEA Atmospheric Emission Inventory Guidebook were applied. For other sources emission factors specific for processes in Poland were used.

1.4.6 HM emissions

General information on HM emissions estimation is presented below:

- The presented HM emission assessments were produced on the basis of the Statistics Poland (GUS) data on goods and materials production as well as on raw materials consumption in Poland. The natural HM emission sources were not considered in the presented emission inventory;
- Emission factors used in the report for the HM emission assessments the were based on:
  - data presented in the "EEA/EMEP Emission Inventory Guidebook", and
  - the emission factors specific for processes in Poland.
- EFs applied for Hg emission calculations have been based on a country study conducted in 2011-2013 by Polish Energy Group PGE, data from Polish emissions database and own analyses;
- EF for emissions from cement production (NFR 2.A.1) is based on official information from producers;
- In 2015 new emission factors for Cd emissions from hard coal has been developed, based on Cadmium content in Polish coals [35].

All emissions factors for the particular pollutants and emission source categories are presented in the tables in Annex 6 following NFR classification.

1.5 Key Categories

Key categories are sources that combined contribute up to 95% of the emission volume reported for Poland. In this report level assessments have been performed for the following pollutants: NO_x, CO, SO_2, NH_3, NMVOC, TSP, Heavy metals and POPs. The level assessment was performed for 2017 and 1990. The results of the key source category analysis are presented in Annex 1. Trends of key sectors according to NFR classification are presented in the chapter 2.

1.6 QA/QC and Verification methods

The programme for Quality Assurance and Quality Control has been elaborated to improve and assure high quality of the Polish annual greenhouse gas inventory. Rules of the programme apply also to the emissions inventory prepared for the UN ECE Convention on Long-range Transboundary Air Pollution. The QA/QC programme contains tasks, responsibilities as well as time schedule for performance of the QA/QC procedures. In 2009 QA/QC plan has been extended by automated back-up of inventory databases on separate server.

The Polish inventory is generated in two main steps. First calculations are conducted approximately 10–11 months after the end of the inventoried year (n–1) depending primarily on the availability of required activity data. Initial check of activity data and estimation procedures is then performed. As soon as the official statistics are available data is revised and final inventory is prepared.

The calculated emissions figures for a given year, are compared to the respective figures from previous years (time series), and outliers are scrutinized in more detail. After verification stage had been completed, the final inventory files are prepared together with the accompanying reports.

When finalized, the inventory is reviewed by the Ministry of the Environment (MoE), including internal consultations with ministry departments. Then inventory data are officially approved by MoE.

The national inventory team – *Emission Inventory and Reporting Unit* (EIRU) which is responsible for preparation of emission inventories, is also responsible for coordination and implementing the QA/QC activities.

These activities include Repdab check procedure and taking into account recommendations resulting from three stages of the CEIP technical review of submitted data. This is conducted to improve consistency and completeness of the inventories.

The present QA/QC programme has been elaborated in parallel to QA/QC programme for GHG inventories in line with the IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 2000 and is under implementation. Present QA/QC programme consists of double internal checking and external peer review conducted by the MoE. Since 2010 selected activities and emission volumes have derived from the National Emission Database (NED). For consistency maintenance, the data derived from the NED is verified or consulted with independent sectoral expert.

<u>Data management and archiving</u>

All activity data, emission factors and resulting emission data are stored in the inventory databases, which are constantly updated and extended to meet the requirements for emission reporting, with respect to UNFCCC and LTRAP as well as their protocols.

Inventory databases are automatically archived on separate backup server.

Access to emission data for selected years, sectors and pollutants is possible via Internet. Inventory results are accessible from the EEA EIONET Central Data Repository (CDR) at

http://cdr.eionet.europa.eu/pl/un/EMEP%20emissions%20data

Inventory reports are presented for downloading at NCEM website:

http://www.kobize.pl/pl/article/krajowa-inwentaryzacja-emisji/id/385/zanieczyszczenia-powietrza

1.7 General uncertainty evaluation

The most uncertain values of activity were assigned for field burning of agricultural residues (NFR 3F, 30%). The lowest uncertainty values were assigned to 1.A.1 Energy Industries (solid and liquid fuels - 2%, gaseous fuels - 1 %). In general Polish energy sector is covered with detailed national statistics, which allows to keep overall uncertainty of inventory at low level.

Implementing emission factors which derive from expert assessments or were obtained using small sample statistics, in each case strongly affect magnitude of uncertainty. In this report (see Annex 8) an assessment of uncertainty is presented for: SO_2, NOx, NMVOC, NH_3, and $PM_{2.5}$. It is carried out using Monte Carlo simulation (Tier2 methodology). For SO_2 and NOx emission data from 1.A.1.a (public power sector) were derived directly from emitters (bottom-up approach). The rest of uncertainty assessment represents indicative range of uncertainty for particular NFR categories and pollutants emissions determined using Tier1 approach.

For the purpose of the inventory information on uncertainties of activity data and emission factors is collected from sectoral experts and literature. Some experiences and conclusions from GHG uncertainty analysis were also taken into account. When conducting presented analysis the highest priority has been given to SO_2, NO_x, NMVOC, NH_3, and $PM_{2.5}$. Uncertainties of activity data (especially energy data) are of similar level as estimated for GHG inventory and comparable to previously submitted data.

Uncertainty estimates for the particular pollutants have been listed under particular NFR categories. All uncertainty estimates along with the uncertainty introduced into the trend are included in the Annex 8.

1.8 Assessment of Completeness

The Polish emission inventory includes calculation of emissions from all relevant sources recommended by the mandatory guidebook. The completeness for each pollutant and major sources is discussed briefly in the Annex 3.

In 2019 submission there is a larger scope of NFR categories and pollutants marked as ‘NE’ than reported in 2018. It is due to the recommendations from 2018 Review to change NA key (from the last submission) for NE key or insert NE key if there is no appropriate emission factor in the EEA/EMEP Emission Inventory Guidebook.

2 EXPLANATION OF KEY TRENDS

The description below applies to trends of emissions of several pollutants in the period 1990-2017. Recalculations of emission data performed from 1990 eliminate earlier time series inconsistencies though it seems that present emissions trends differ in a significant way only for some air pollutants. Due to the lack of direct statistical data for historical years some activity data were approximated based on interpolated data or those available for other years and may be subject to recalculation.

Improvements of methodology applied for 1990-2017 estimates are described in Chapters 3 - 7 (Sectoral Methodologies) and in Chapter 8 (Recalculations and Improvements). In some cases due to the methodology changes the level of country emission trend differs from the level reported in the 1990-2016 submission, which has been described in the relevant chapters.

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory, emission factors for several pollutants and emission sources have been updated to those published in EMEP/EEA EIG 2016. Main introduced changes are listed in Annex 7, with the reference to chapters of the IIR report. Explanation of NFR codes is presented in chapter 11 Abbreviations.

2.1 SO_2 emissions

Emissions of SO_2 decreased by about 78% between 1990 and 2017. Most of the reductions were caused by the decline of the heavy industry in the late 1980s and early 1990s. In late 1990s the emissions decreased because of the diminished share of coal (hard and brown) among fuels used for power and heat generation.

The trend of sulphur dioxide emissions is influenced mainly by the combustion processes in the sectors 1.A.1 Energy industries, 1.A.2. Manufacturing industries and construction and 1.A.4. Other sectors which contribute to approximately 100 % of total Poland's SO_2 emissions. It should be noted that during the mentioned period of time number of power plants equipped with desulphurization installations increased. The disaggregation of SO_2 emissions in NFR is given below in Table 2.1.

Compared to the year 2016, in 2017 emissions of sulphur dioxide decreased by about 1.4%. The most significant decreases were noted in combustion processes in the *Power Plants* and in industries. It has resulted from the improvement of technical parameters of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

Table 2.1. SO_2 emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	Gg	Gg
Total	**590.66**	**582.66**
1. Energy	578.64	570.40
A. Fuel combustion	568.32	561.75
1. Energy industries	286.44	273.34
2. Manufacturing industries and construction	108.01	116.81
3. Transport	0.59	0.68
4. Other sectors	173.28	170.92
B. Fugitive emissions from fuels	10.32	8.65
1. Solid fuels	2.68	2.67
2. Oil and natural gas	7.64	5.97
2. Industrial processes and product use	11.87	12.11
A. Mineral industry	2.97	2.89
B. Chemical industry	4.60	4.74
C. Metal industry	2.53	2.58
D. Other Production	0.00	0.00
G - L. Other	1.77	1.90
3. Agriculture	0.00	0.00
B. Manure management	0.00	0.00
D. Agricultural management	0.00	0.00
F. Field burning of agricultural residues	0.00	0.00
5. Waste	0.15	0.14
A. Biological treatment of waste	0.00	0.00
C. Incineration and open burning of waste	0.15	0.14
D. Wastewater handling	0.00	0.00
E. Other waste	0.00	0.00

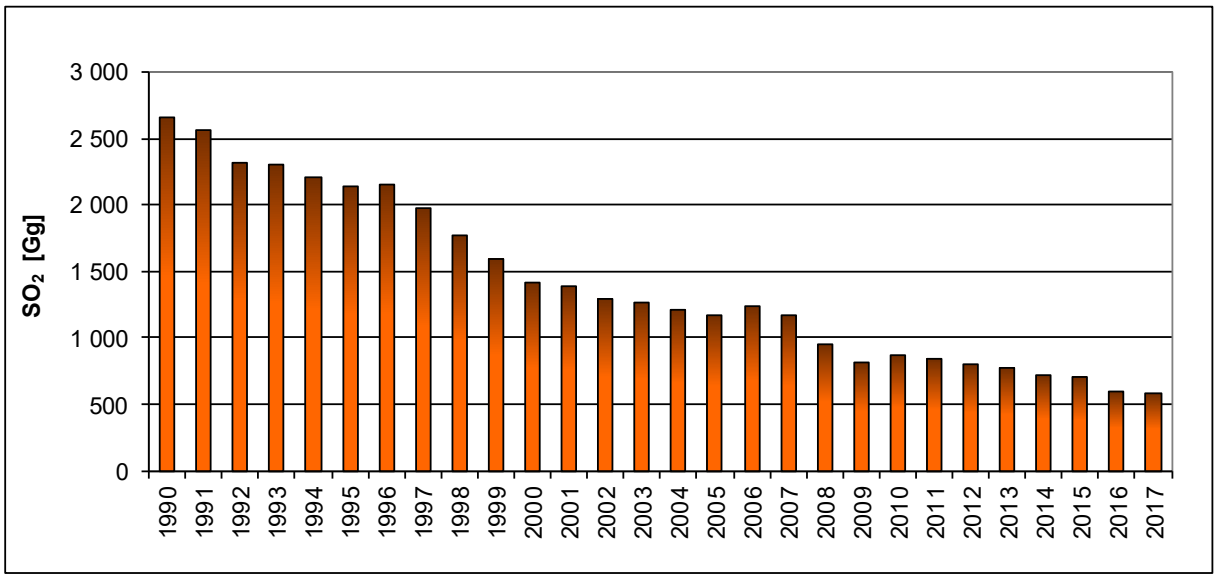

Figure 2.1. SO_2 emissions in 1990 - 2017

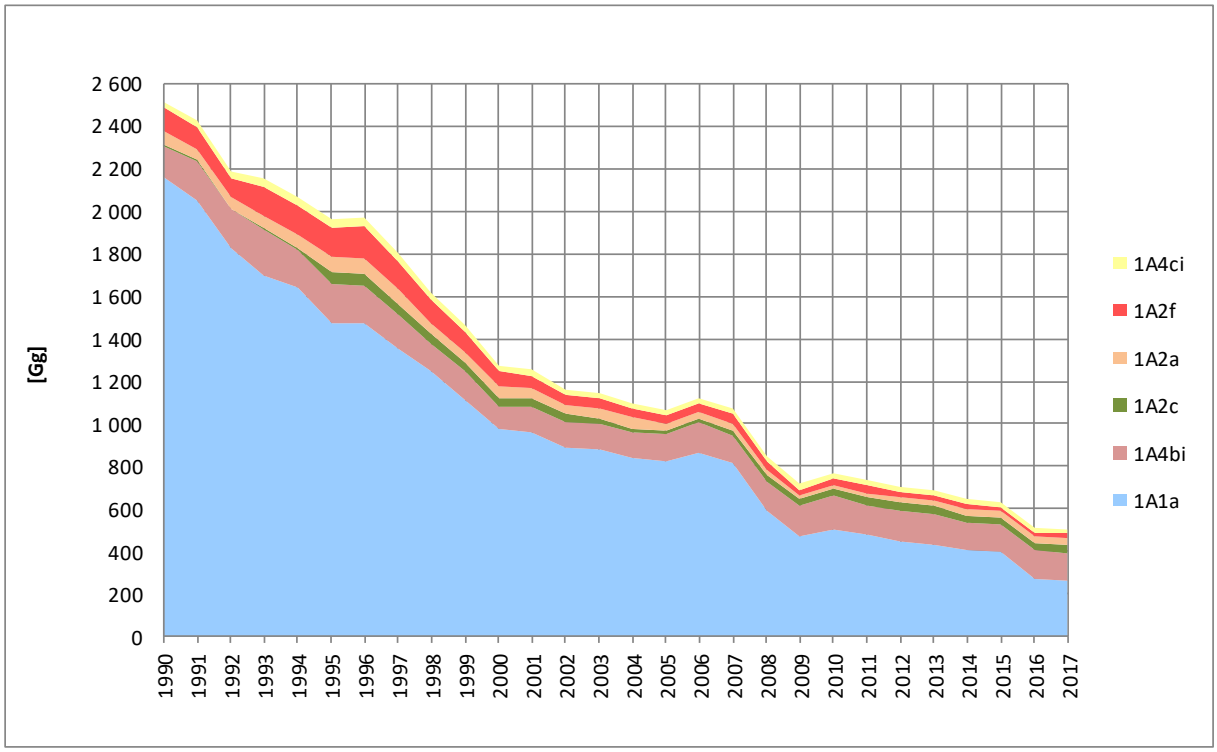

Figure 2.2. Trend of SO2 emissions for key NFR sectors

2.2 NO_x emissions

Estimated emissions are considered to be complete for the key sources. The major sources of emissions are road transport and stationary combustion of fuels for energy production in public power plants. The disaggregation of NOx emissions in NFR is given below in Table 2.2.

Emissions of NO_X decreased by over 26% between 1990 and 2017. Similarly to sulphur dioxide, most of the reductions were caused by the decline of the heavy industry and lower share of coal in combusted fuels in the late 1980s and early 1990s. Substantial emissions from road traffic contribute to the national total, and cause comparatively lower emission reductions than in case of SO_2.

Compared to the year 2016, in 2017 NO_2 emissions increased by 8%. This was caused by higher reported consumption of liquid fuels (about 19% growth for diesel oil and about 9% growth for gasoline). The additional factor adversely affecting the volume of emissions from this sector is a large share of old vehicles not meeting Euro quality standards in the total number of vehicles.

At the same time there was a decrease of NOx emissions from *Public Power Plants*, which has resulted from the improvement of technical parameters of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

The 2010 ceiling for NOx has been exceeded slightly in year 2010 in 2019 Submission. This is due to the fact that methodologies covering NOx emissions from mineral fertilizers were not included in the EMEP/EEA Guidebook in time when the reduction commitments for 2010 were established. For the same reason NOx and NMVOC emissions from livestock manure management (NFR 3B) and agricultural soils (NFR 3D) will not be accounted for the purpose of complying with NECD since 2020.

Table 2.2. NOx emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	Gg	Gg
Total	**742.17**	**803.66**
1. Energy	663.14	718.96
A. Fuel combustion	654.09	710.05
1. Energy industries	195.04	183.94
2. Manufacturing industries and construction	54.07	58.32
3. Transport	252.74	305.94
4. Other sectors	152.24	161.85
B. Fugitive emissions from fuels	9.04	8.92
1. Solid fuels	4.82	5.13
2. Oil and natural gas	4.22	3.78
2. Industrial processes and product use	17.26	18.03
A. Mineral industry	0.00	0.00
B. Chemical industry	14.77	15.22
C. Metal industry	1.61	1.87
D. Other Production	0.00	0.00
G - L. Other	0.88	0.94
3. Agriculture	59.47	64.46
B. Manure management	2.08	2.17
D. Agricultural management	57.37	62.27
F. Field burning of agricultural residues	0.02	0.02
5. Waste	2.30	2.21
A. Biological treatment of waste	0.00	0.00
C. Incineration and open burning of waste	2.30	2.21
D. Wastewater handling	0.00	0.00
E. Other waste	0.00	0.00

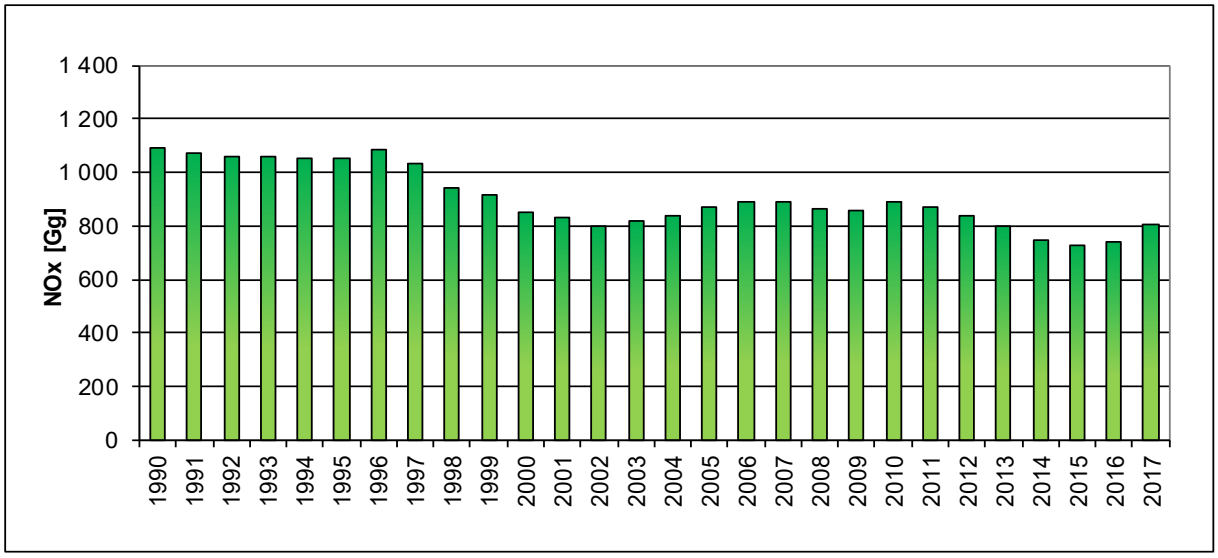

Figure 2.3. NOx emissions in 1990 - 2017

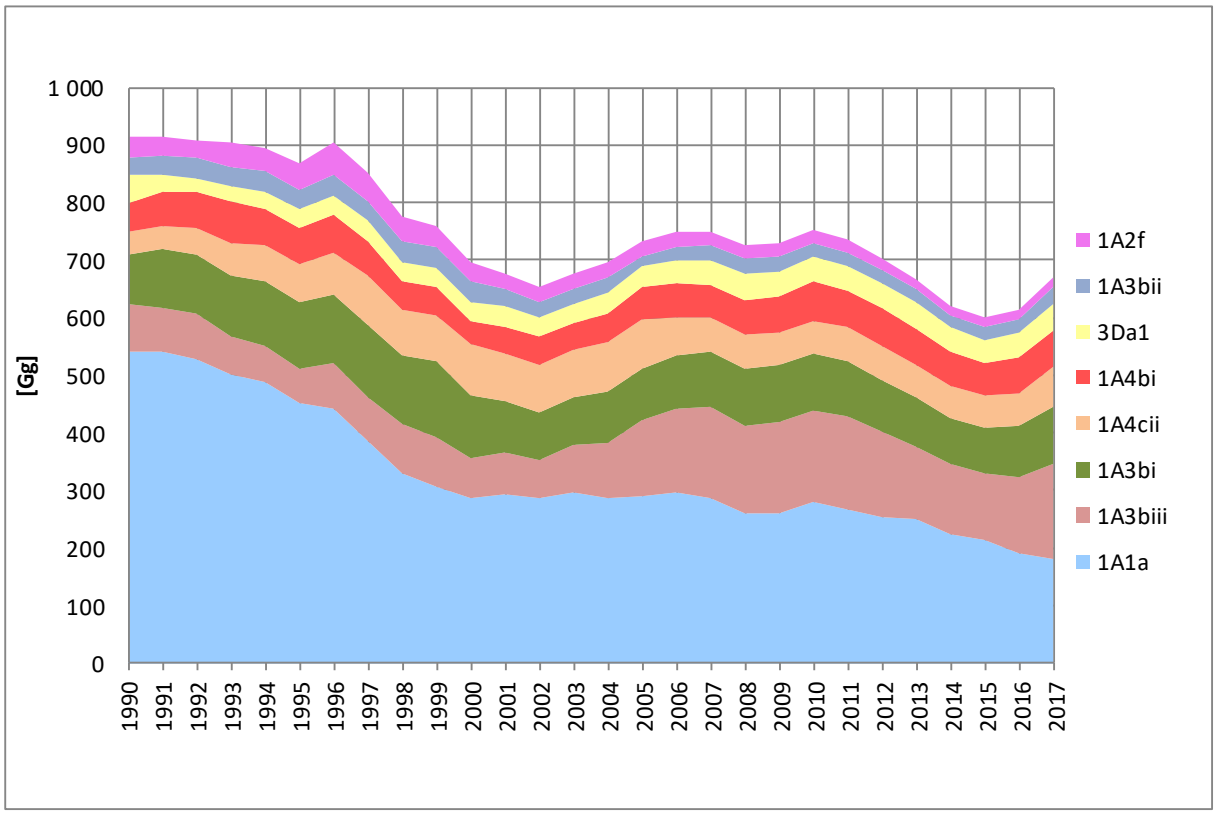

Figure 2.4. Trend of NOx emissions for key NFR sectors

2.3 CO emissions

Estimated emissions are considered to be complete for the key sources. The most significant (approximately 61% of national total) is a combustion of fuels in households. The second significant source of CO emissions is road transport – approximately 23% of country total. The disaggregation of CO emissions in NFR is given below in Table 2.3.

From 1990 to 2017 the emissions of CO have decreased by about 30%. Compared to the year 2016, in 2017 emission of CO increased by about 3.5% which was a result of higher consumption of liquid fuels in road transport (NFR 1.A.3.b).

Table 2.3. CO emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	Gg	Gg
Total	**2 456.47**	**2 543.25**
1. Energy	2 385.60	2 469.58
A. Fuel combustion	2 372.80	2 454.52
1. Energy industries	50.47	54.48
2. Manufacturing industries and construction	193.04	209.54
3. Transport	521.09	590.64
4. Other sectors	1 608.19	1 599.86
B. Fugitive emissions from fuels	12.80	15.06
1. Solid fuels	10.78	13.37
2. Oil and natural gas	2.01	1.69
2. Industrial processes and product use	49.50	53.46
A. Mineral industry	3.64	3.70
B. Chemical industry	16.16	16.31
C. Metal industry	24.83	28.23
D. Other Production	0.00	0.00
G - L. Other	4.88	5.22
3. Agriculture	0.48	0.54
B. Manure management	0.00	0.00
D. Agricultural management	0.00	0.00
F. Field burning of agricultural residues	0.48	0.54
5. Waste	20.89	19.66
A. Biological treatment of waste	0.00	0.00
C. Incineration and open burning of waste	20.89	19.66
D. Wastewater handling	0.00	0.00
E. Other waste	0.00	0.00

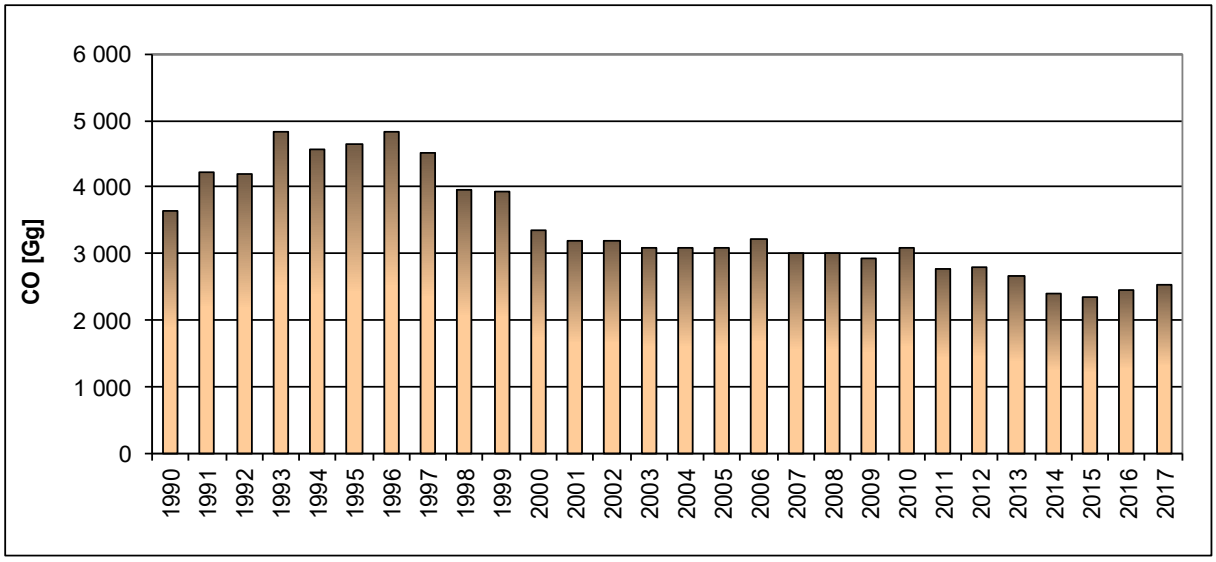

Figure 2.5. CO emissions in 1990 - 2017

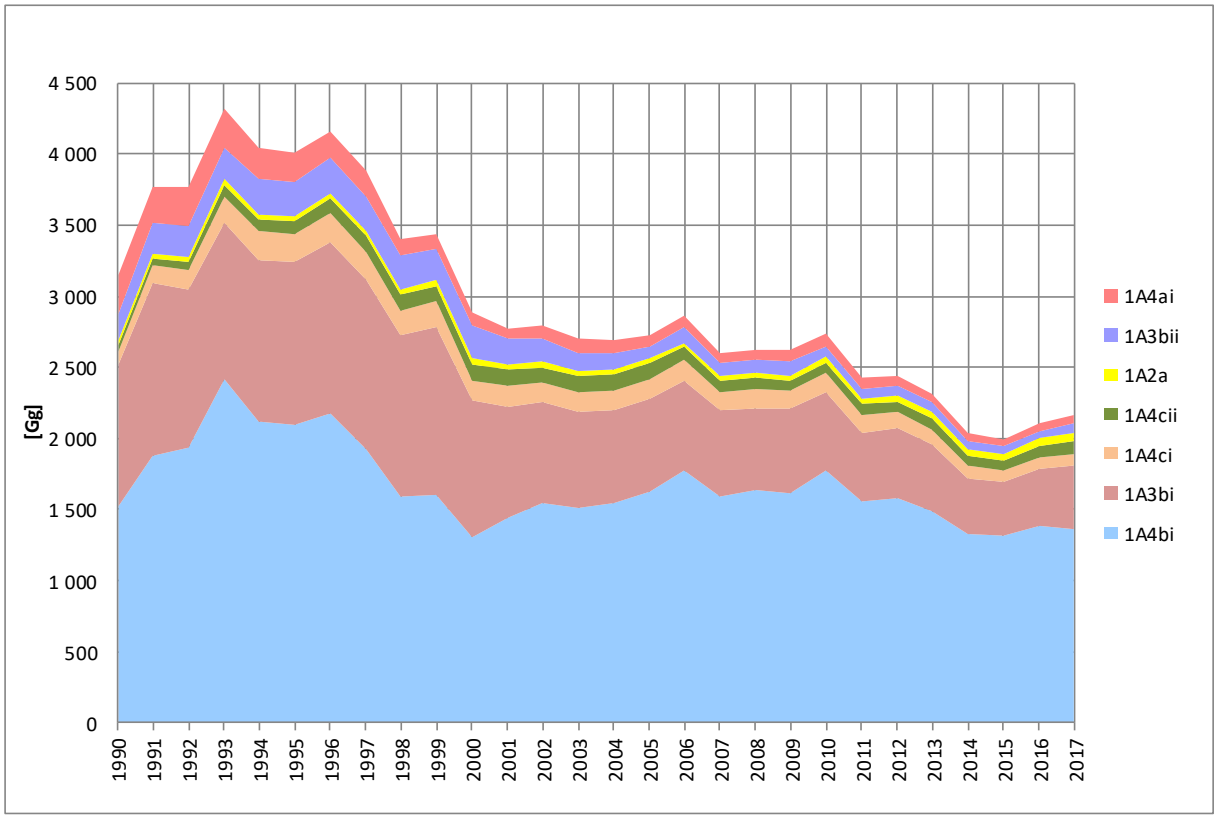

Figure 2.6. Trend of CO emissions for key NFR sectors

2.4 Ammonia emissions

Estimated emissions are considered to be complete for the key sources. The major source of emissions is Agriculture (94%), of which manure management accounts for 78% and mineral fertilizers 22%. The disaggregation of NH_3 emissions in NFR is given in Table 2.4.

The trend of ammonia emissions is influenced mainly by the agriculture sector, namely by a number of livestock and volume of mineral N fertilizers applied. A small increase by about 5% of NH_3 emissions in 2017 compared to 2016 was noted. The main impact on this interannual change had the higher use of mineral fertilizers by about 10% as well as increase in population of cattle and swine.

Table 2.4. NH_3 emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	Gg	Gg
Total	**291.95**	**307.52**
1. Energy	15.78	16.24
A. Fuel combustion	15.74	16.20
1. Energy industries	0.00	0.00
2. Manufacturing industries and construction	3.39	3.68
3. Transport	4.45	4.74
4. Other sectors	7.90	7.78
B. Fugitive emissions from fuels	0.05	0.05
1. Solid fuels	0.05	0.05
2. Oil and natural gas	0.00	0.00
2. Industrial processes and product use	1.29	1.32
A. Mineral industry	0.00	0.00
B. Chemical industry	1.27	1.31
C. Metal industry	0.00	0.00
D. Other Production	0.01	0.02
G - L. Other	0.00	0.00
3. Agriculture	272.84	287.91
B. Manure management	103.57	108.08
D. Agricultural management	169.26	179.82
F. Field burning of agricultural residues	0.02	0.02
5. Waste	2.04	2.04
A. Biological treatment of waste	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00
D. Wastewater handling	2.03	2.04
E. Other waste	0.00	0.00

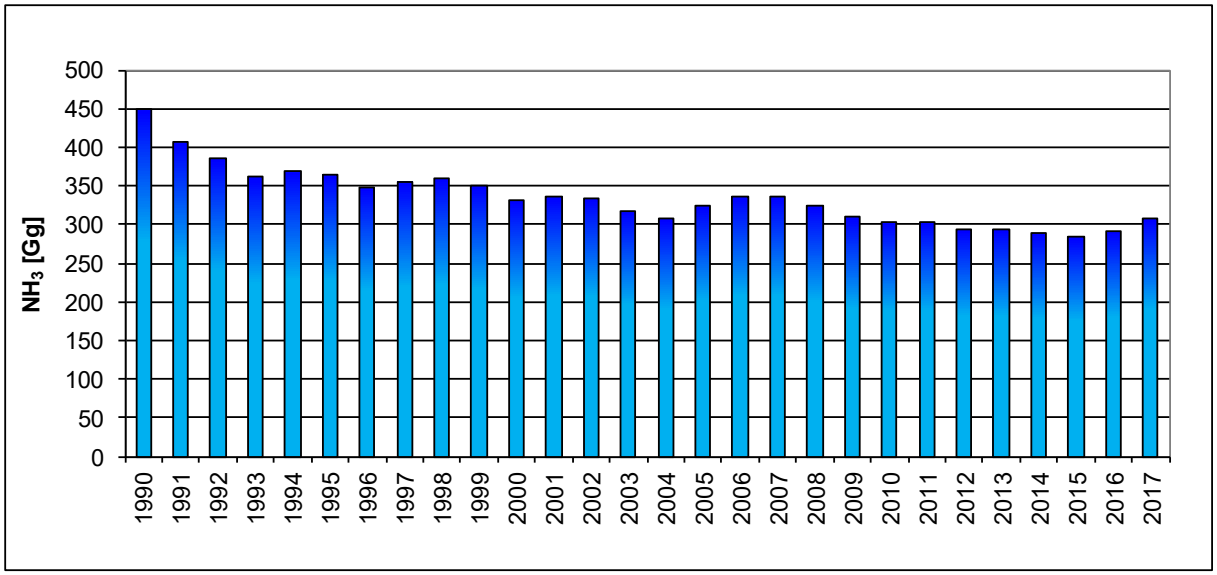

Figure 2.7. NH_3 emissions in 1990 - 2017

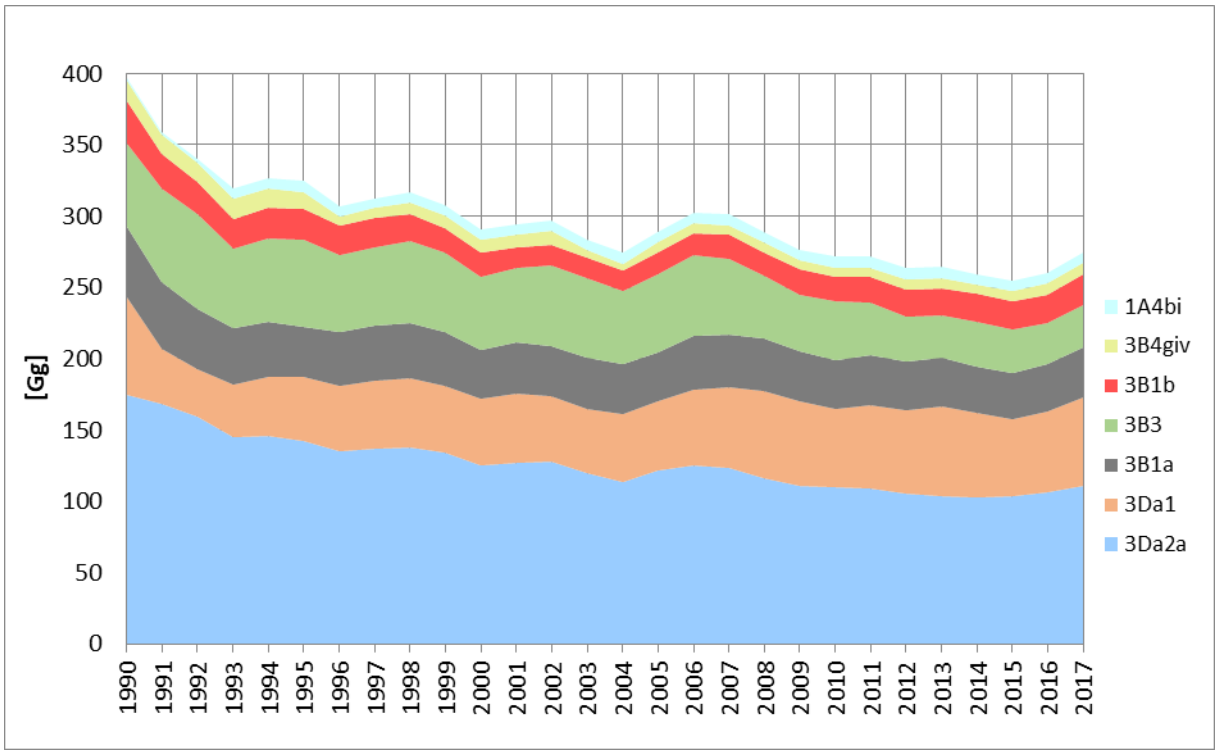

Figure 2.8. Trend of NH_3 emissions for key NFR sectors

2.5 PM emissions

Estimated emissions are considered to be complete for the key sources. The main source of TSP emissions in Poland are combustion processes in the stationary and mobile sources.

Category Residential – stationary combustion (NFR 1.A.4.b) has the highest share in the emission of TSP – in 2017 approximately 36%. Emissions from road transport and other vehicles and equipment accounted for approximately 10% of the national TSP emissions. . Large part of transport emissions (NFR 1.A.3.b) originates from automobile tire and brake wear. Table 2.5 shows the respective emission estimates in NFR classification.

Compared to estimates for the year 2016, emissions of TSP in 2017 slightly increased (by about 2%). The major increase was noted in the category *Non-Industrial Combustion Plants* due to a higher volume of used coal. There was also a growth of emissions in road transport, resulting from higher consumption of liquid fuels.

At the same time there was a decrease of TSP emissions from *Public Power Plants*, which has resulted from the improvement of technical parameters of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

Higher use of coal in households (NFR 1.A.4.bi) has also caused the growth of emissions of PM10 (by 2%) and PM2.5 (by 4%). Black Carbon emissions in 2017 increased (about 12%) compared to estimates for the year 2016 due to a higher consumption of liquid fuels in road transport (NFR 1.A.3.b).

Table 2.5. Particulate matter emissions in 2016-2017 according to NFR classification

NFR	BC		PM2.5		PM10		TSP	
	2016	2017	2016	2017	2016	2017	2016	2017
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
Total	**21,22**	**23,81**	**141,87**	**147,28**	**240,63**	**246,31**	**335,21**	**340,60**
1. Energy	20,59	23,22	128,11	133,69	192,79	198,22	247,28	251,71
A. Fuel combustion	20,11	22,76	126,37	132,00	184,06	189,76	231,64	236,55
1. Energy industries	0,26	0,26	7,81	7,93	13,42	13,53	17,35	16,36
2. Manufacturing industries and construction	0,76	0,82	26,84	29,12	28,50	30,92	30,06	32,62
3. Transport	6,07	7,26	12,99	15,54	16,51	19,75	20,60	24,61
4. Other sectors	13,02	14,42	78,73	79,42	125,63	125,56	163,63	162,96
B. Fugitive emissions from fuels	0,48	0,46	1,74	1,68	8,73	8,46	15,64	15,17
1. Solid fuels	0,48	0,46	1,62	1,58	8,48	8,22	15,23	14,77
2. Oil and natural gas	0,00	0,00	0,11	0,11	0,26	0,25	0,41	0,40
2. Industrial processes and product use	0,03	0,03	6,33	6,04	15,59	15,14	33,05	32,40
A. Mineral industry	0,00	0,00	1,14	1,15	4,56	4,62	8,81	8,94
B. Chemical industry	0,00	0,00	1,52	1,56	2,20	2,27	3,73	3,88
C. Metal industry	0,01	0,01	1,29	1,35	2,00	2,07	3,47	3,59
D. Other Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G - L. Other	0,02	0,02	2,38	1,98	6,83	6,18	17,04	15,99
3. Agriculture	0,00	0,00	3,06	3,16	27,76	28,45	49,50	51,27
B. Manure management	0,00	0,00	2,37	2,46	10,86	11,39	32,60	34,21
D. Agricultural management	0,00	0,00	0,65	0,65	16,86	17,02	16,86	17,02
F. Field burning of agricultural residues	0,00	0,00	0,04	0,04	0,04	0,05	0,04	0,05
5. Waste	0,59	0,55	4,38	4,39	4,49	4,49	5,38	5,22
A. Biological treatment of waste	0,00	0,00	0,00	0,00	0,01	0,00	0,01	0,01
C. Incineration and open burning of waste	0,59	0,55	1,37	1,28	1,47	1,38	2,35	2,11
D. Wastewater handling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Other waste	0,00	0,00	3,01	3,11	3,01	3,11	3,01	3,11

Figure 2.9 to Figure 2.12 show emission trend of TSP, PM10 and PM2.5 in the years 1990-2017. The volume of emissions in this period remained stable with small increases in 2005-2007, caused by a higher volume of combusted fuels.

Figure 2.13 and Figure 2.14 show trend of Black Carbon (BC) emissions in the years 1990-2017.

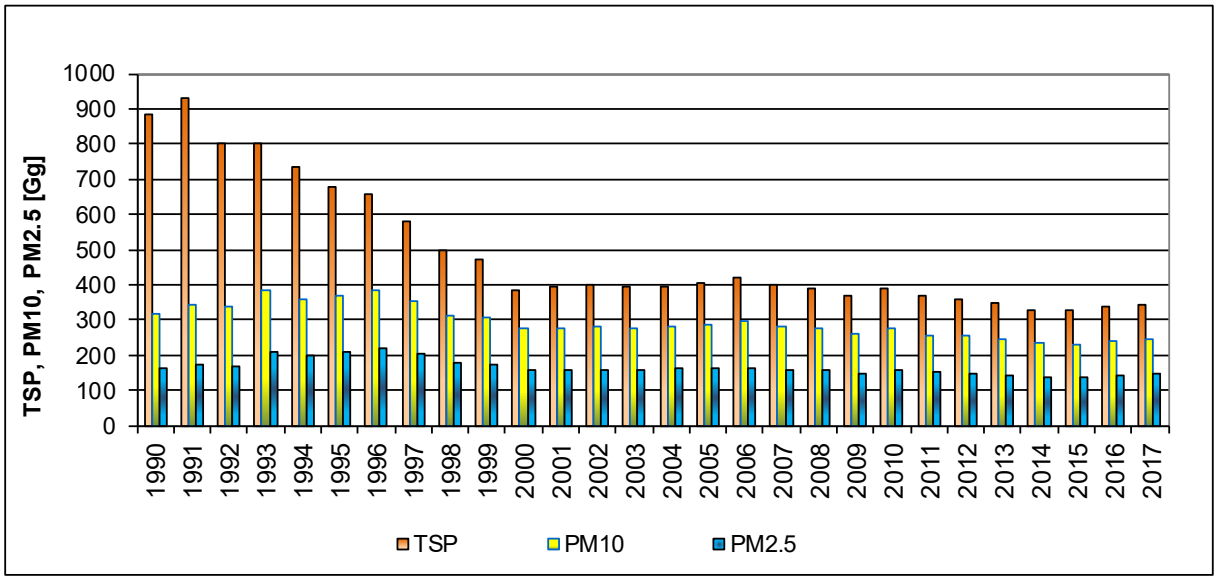

Figure 2.9. Emissions of particulate matter in 1990 – 2017

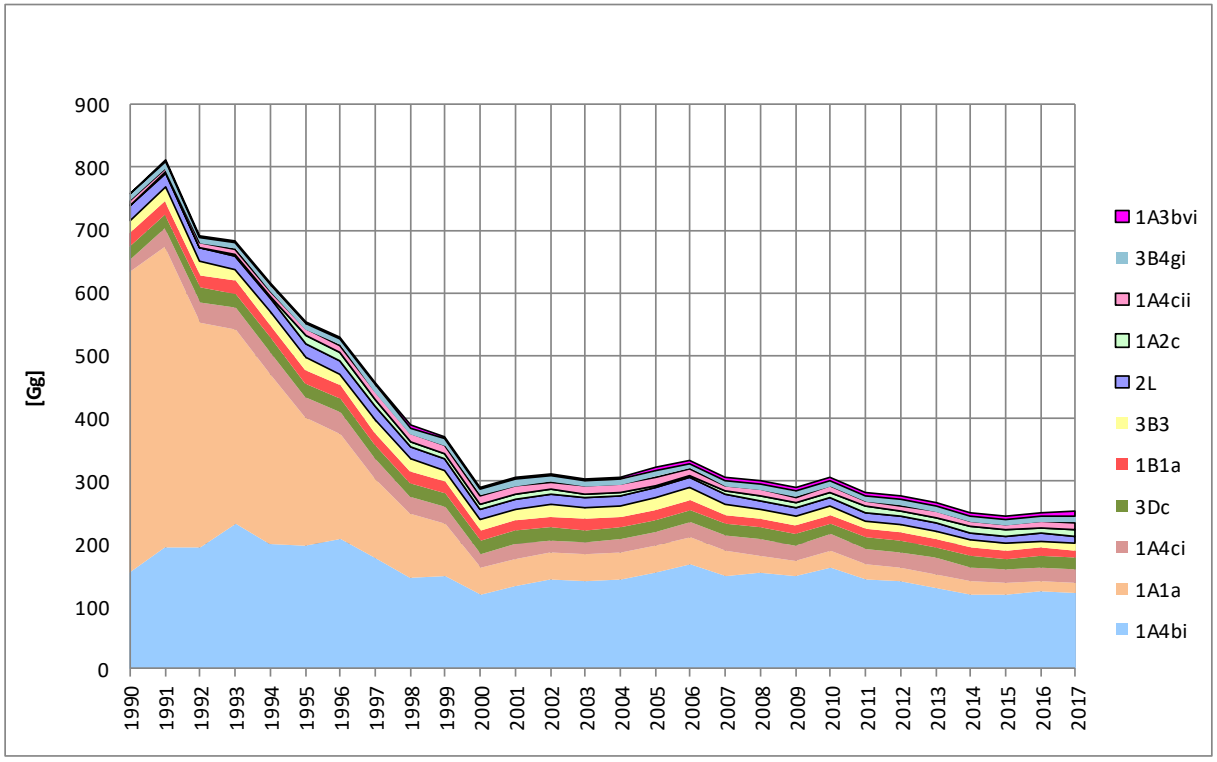

Figure 2.10. Emissions of TSP for key NFR sectors

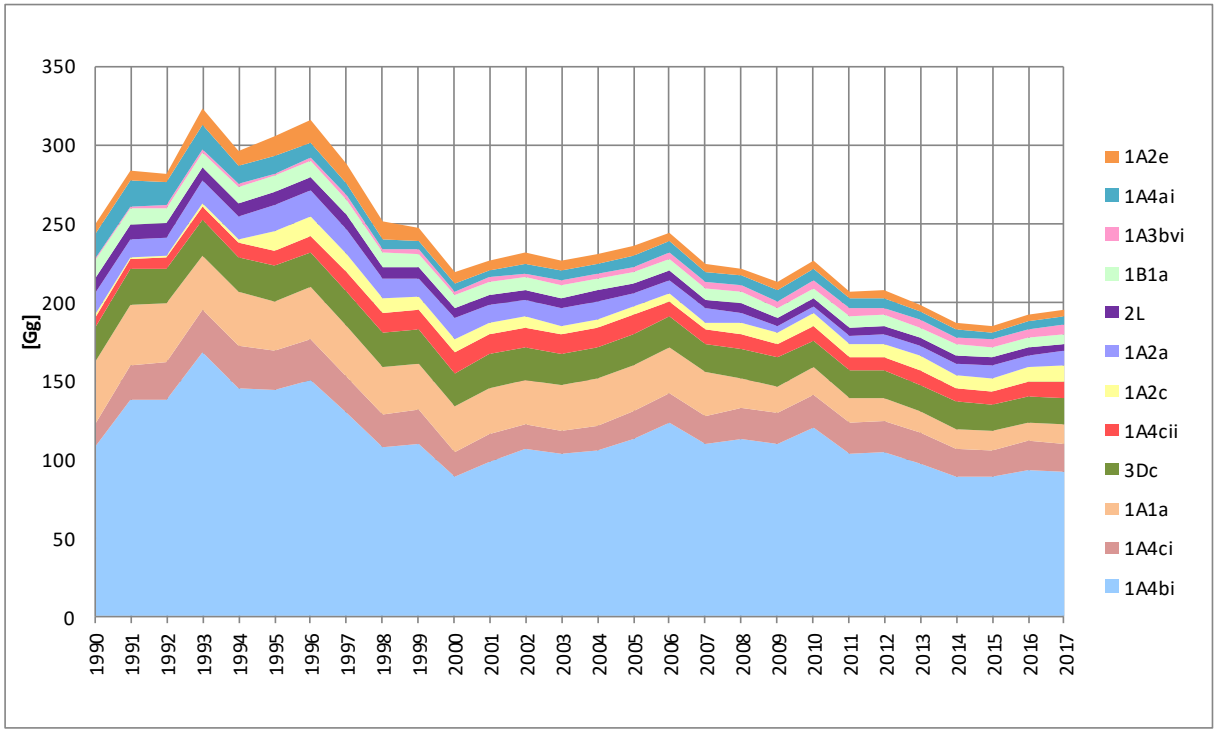

Figure 2.11. Trend of PM10 emissions for key NFR sectors

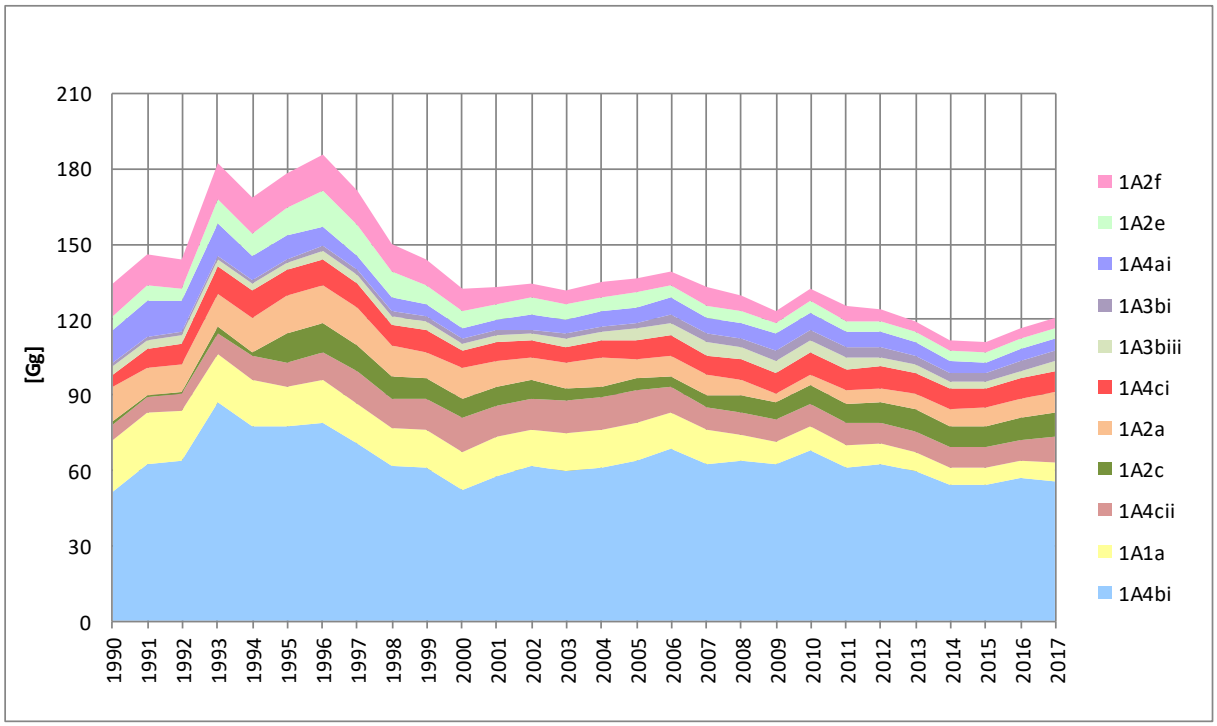

Figure 2.12. Trend of PM2.5 emissions for key NFR sectors

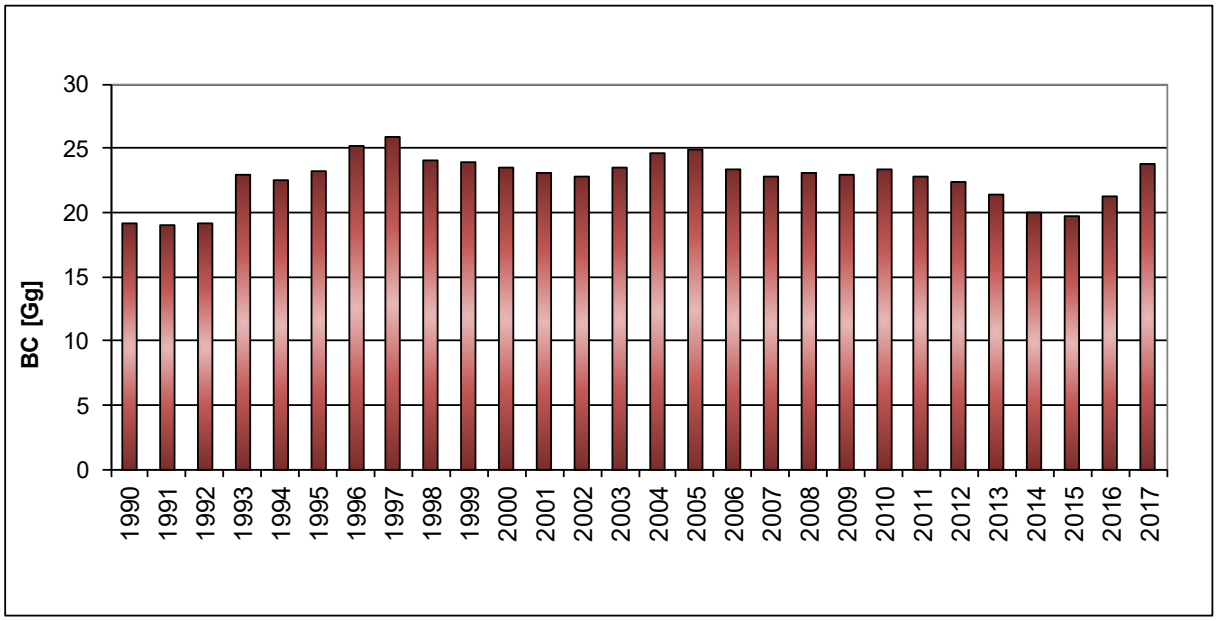

Figure 2.13. Emissions of Black Carbon in 1990 - 2017

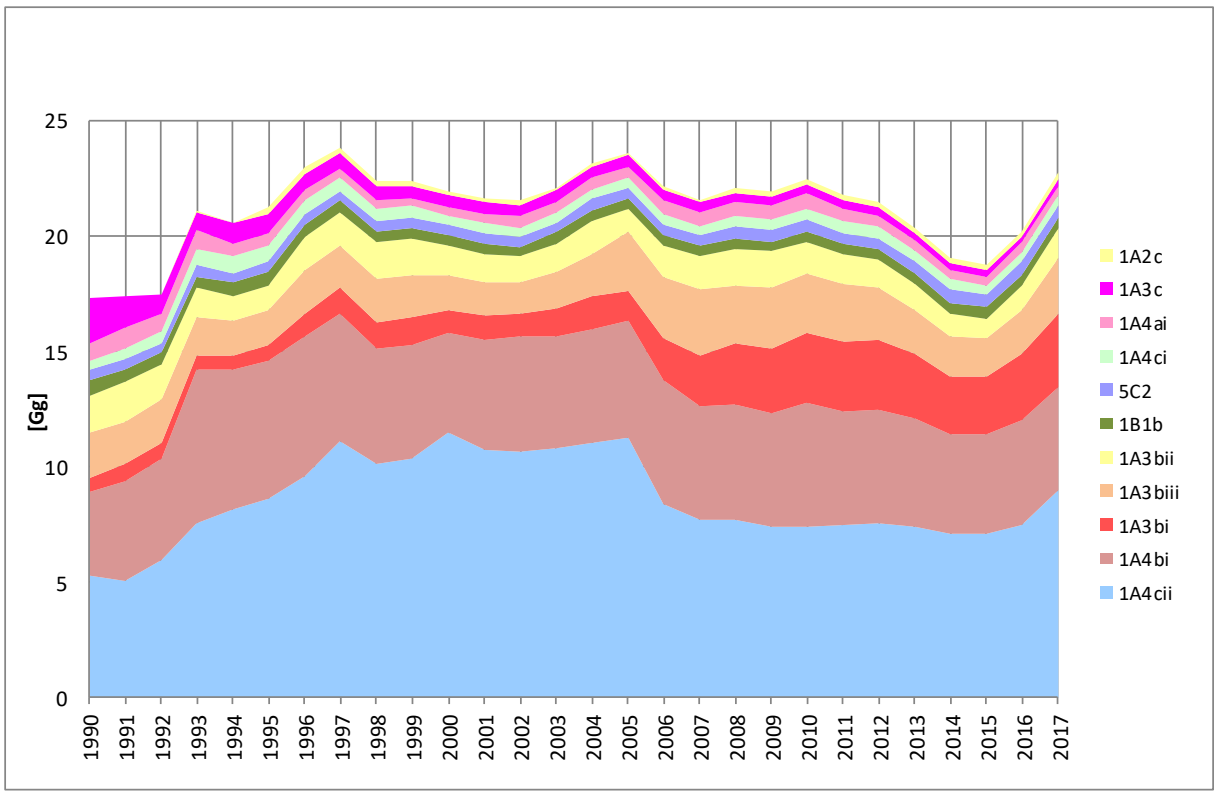

Figure 2.14. Trend of BC emissions for key NFR sectors

2.6 NMVOC emissions

Emissions of NMVOC decreased by about 2% between 1990 and 2017. According to calculations, the national total emission of NMVOCs in Poland in 2017 was 691 Gg. The assessed amount of NMVOC is higher by 2.5% compared to the respective figure for the year 2016.

The largest share in the increase of the national total emission was a result of higher consumption of liquid fuels in road transport (NFR 1.A.3.b).

Categories 2.D. *Other production* and 1.A.4.b *Household* have the highest share in the total emission of NMVOCs (respectively 30% and 18%). Other significant categories in the national emissions are *Agriculture* (NFR 3) with the share of approximately 15% and *Transport* (NFR 1.A.3) with the share of approximately 12%.

Finally, in 2017 natural sources – *Forest fires*, *Managed and unmanaged forestland* (NFR 11.B and 11.C), were a source of emission of 257 Gg of NMVOCs. Emissions from the natural sources are not included in the country total.

The disaggregation of NMVOC emissions in NFR is given below in Table 2.6.

Table 2.6. NMVOC emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	Gg	Gg
Total	**674.16**	**690.74**
1. Energy	298.41	310.59
A. Fuel combustion	243.79	254.96
1. Energy industries	2.85	2.77
2. Manufacturing industries and construction	37.75	41.06
3. Transport	77.36	86.36
4. Other sectors	125.83	124.78
B. Fugitive emissions from fuels	54.62	55.62
1. Solid fuels	19.16	18.85
2. Oil and natural gas	35.45	36.77
2. Industrial processes and product use	269.08	268.03
A. Mineral industry	0.00	0.00
B. Chemical industry	4.11	4.19
C. Metal industry	1.19	1.26
D. Other Production	213.29	210.95
G - L. Other	50.49	51.63
3. Agriculture	97.52	101.64
B. Manure management	91.25	94.67
D. Agricultural management	6.27	6.97
F. Field burning of agricultural residues	0.00	0.00
5. Waste	9.15	10.48
A. Biological treatment of waste	6.64	7.80
C. Incineration and open burning of waste	2.48	2.65
D. Wastewater handling	0.03	0.03
E. Other waste	0.00	0.00
11. Natural emissions (not included in Total)	256.28	257.03

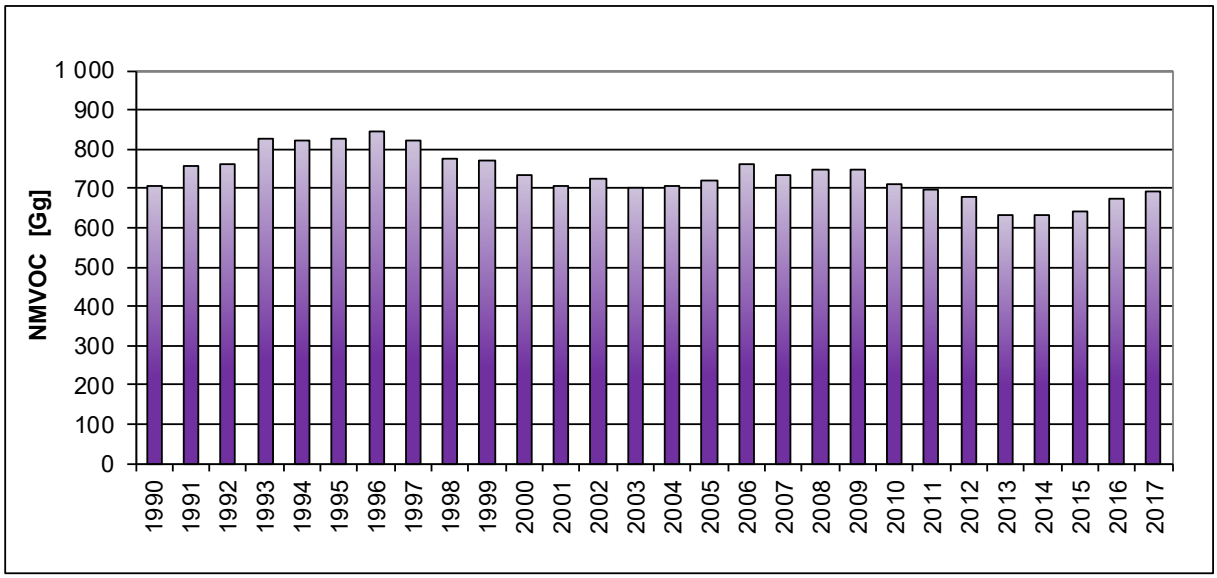

Figure 2.15. Emissions of NMVOC in 1990 – 2017

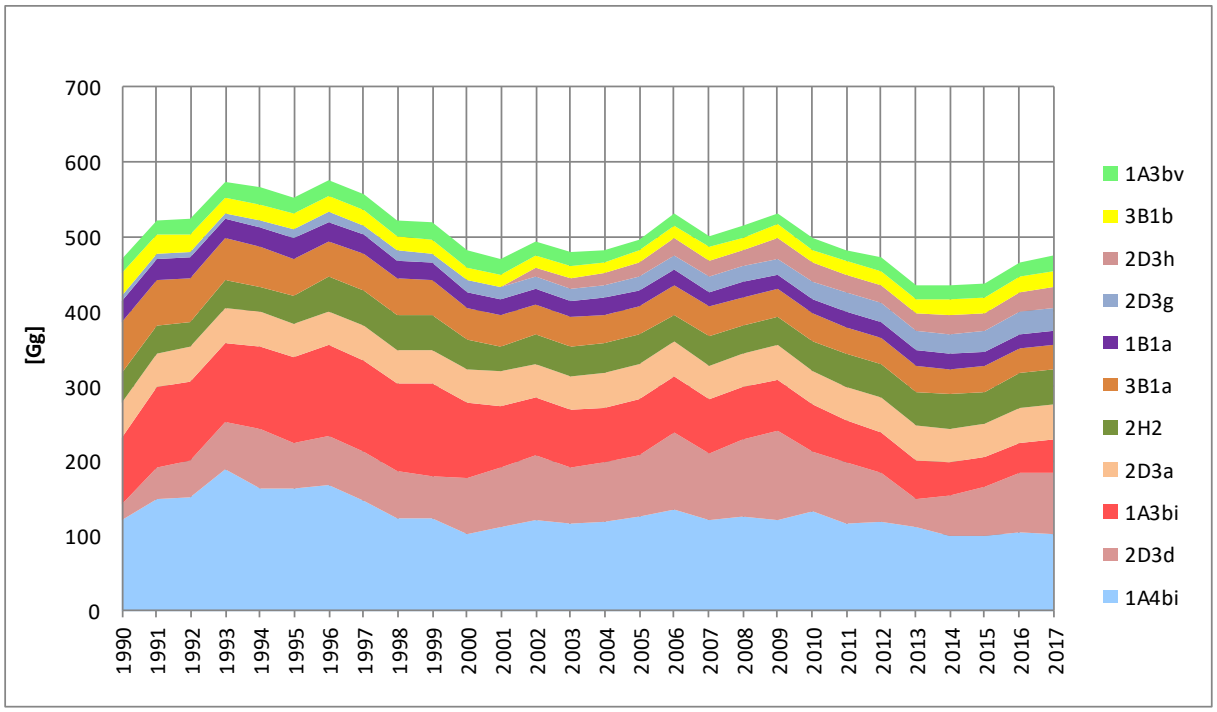

Figure 2.16. Trend of NMVOC emissions for key NFR sectors

2.7 Heavy metals emissions

Estimated emissions are considered to be complete for the key sources. Main share of HM emissions originates from sector 1.A. *Fuel combustion* and 2.C *Metal industry*. Table 2.7 and Table 2.8 below include emissions estimates for Pb, Cd, Hg, As, Cr, Cu, Ni and Zn in 2016 and 2017 according to NFR classification.

Table 2.7. Heavy metals emissions in 2016 according to NFR classification

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	Mg							
Total	**295.67**	**12.07**	**9.48**	**16.71**	**40.17**	**188.48**	**92.07**	**623.14**
1. Energy	126.50	7.46	6.76	11.45	23.02	144.81	75.13	347.84
A. Fuel combustion	124.36	7.46	6.75	11.25	21.36	143.94	74.50	345.70
1. Energy industries	28.20	1.72	5.28	5.55	6.99	20.58	36.89	104.97
2. Manufacturing industries and construction	27.24	4.44	0.43	2.16	3.92	14.51	15.69	113.06
3. Transport	7.07	0.04	0.10	0.01	2.76	58.04	0.48	22.77
4. Other sectors	61.84	1.26	0.94	3.54	7.70	50.80	21.44	104.90
B. Fugitive emissions from fuels	2.14	0.00	0.01	0.19	1.65	0.87	0.63	2.14
1. Solid fuels	2.14	0.00	0.01	0.19	1.65	0.87	0.63	2.14
2. Oil and natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial processes and product use	165.59	4.14	2.49	5.12	17.04	38.79	16.79	269.58
A. Mineral industry	8.54	0.41	0.32	0.78	0.91	0.02	2.10	4.23
B. Chemical industry	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00
C. Metal industry	152.26	3.48	2.16	4.33	16.03	36.04	14.50	263.75
D. Other Production	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01
G - L. Other	4.79	0.01	0.00	0.01	0.10	2.71	0.18	1.59
3. Agriculture	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Agricultural management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Field burning of agricultural residues	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5. Waste	3.58	0.45	0.24	0.15	0.11	4.87	0.15	5.72
A. Biological treatment of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	3.58	0.45	0.24	0.15	0.11	4.87	0.15	5.72
D. Wastewater handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2.8. Heavy metals emissions in 2017 according to NFR classification

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	Mg							
Total	**305.49**	**12.37**	**9.58**	**16.71**	**41.61**	**203.65**	**90.39**	**652.48**
1. Energy	128.81	7.66	6.82	11.34	23.43	156.69	72.80	357.81
A. Fuel combustion	126.74	7.66	6.82	11.15	21.82	155.84	72.19	355.74
1. Energy industries	27.78	1.56	5.30	5.28	6.70	19.90	33.39	102.53
2. Manufacturing industries and construction	29.61	4.81	0.47	2.38	4.26	15.83	16.86	122.93
3. Transport	8.46	0.05	0.11	0.00	3.30	69.44	0.57	27.06
4. Other sectors	60.89	1.24	0.93	3.48	7.57	50.67	21.36	103.22
B. Fugitive emissions from fuels	2.07	0.00	0.01	0.19	1.60	0.85	0.61	2.07
1. Solid fuels	2.07	0.00	0.01	0.19	1.60	0.85	0.61	2.07
2. Oil and natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial processes and product use	173.61	4.31	2.54	5.23	18.10	42.96	17.46	289.29
A. Mineral industry	8.94	0.43	0.35	0.80	0.94	0.02	2.26	4.52
B. Chemical industry	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
C. Metal industry	157.45	3.65	2.19	4.41	17.01	38.82	14.92	282.36
D. Other Production	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02
G - L. Other	7.22	0.01	0.00	0.01	0.14	4.09	0.28	2.40
3. Agriculture	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Agricultural management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Field burning of agricultural residues	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5. Waste	3.07	0.38	0.21	0.14	0.09	4.00	0.14	5.37
A. Biological treatment of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	3.07	0.38	0.21	0.14	0.09	4.00	0.14	5.37
D. Wastewater handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2.17 and Figure 2.18 show annual emissions of heavy metals in the years 1990 - 2017. Visible downward trend in the 1990s resulted from a drop in economic activity.

In 2017 the assessed national emission totals for heavy metals are mostly similar to values calculated for the previous year. The highest increase was noted for Cu – approximately 8%, due to the higher emissions from brakes and tires wear in road transport sector (as a result of increased mileage).

The highest decrease was noted for Ni – approximately 2%, due to lower emissions in *Energy industries* sector due to lower oil fuel consumption in refineries.

The methodology of HM emission estimates for small emission sources (NFR 1.A.4) has been verified, resulting in the new trend of emission factors [51; K. Kubica]. It has made the level of national emission of several HMs (Pb, As, Cr, Cu, Ni and Zn) to be decreased as compared to the one reported in the previous submission.

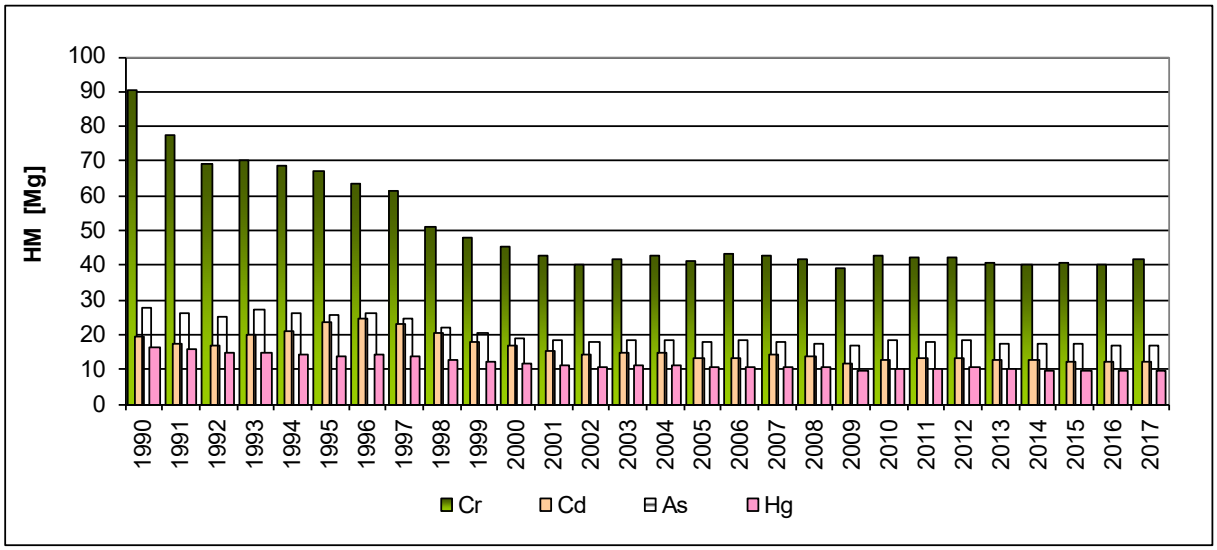

Figure 2.17. Emissions of chrome, cadmium, arsenic and mercury

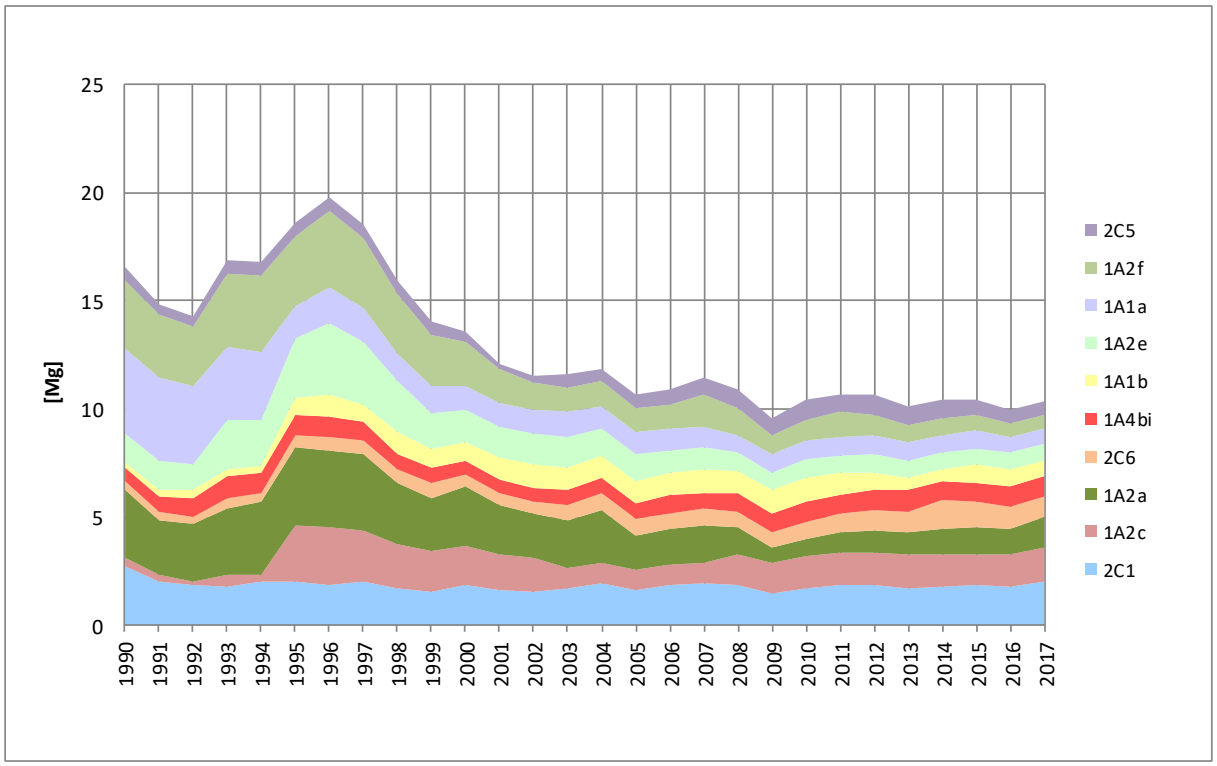

Figure 2.18. Trend of Cd emissions for key NFR sectors

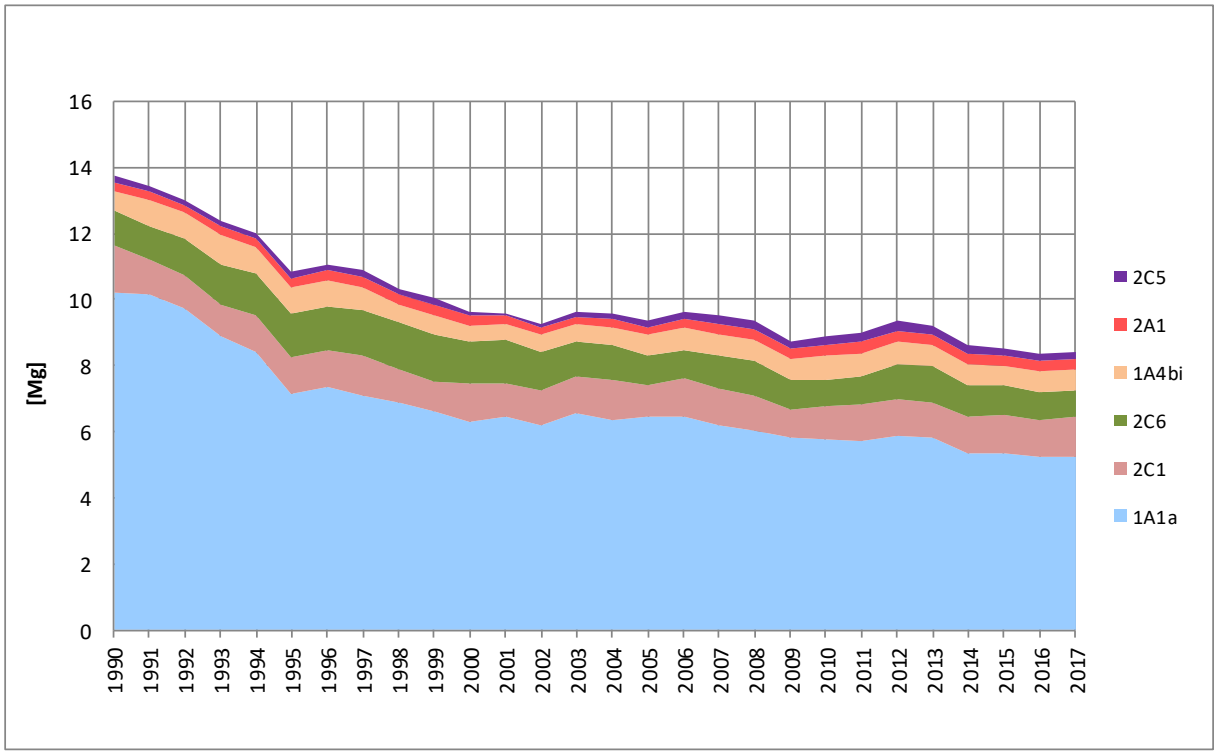

Figure 2.19. Trend of Hg emissions for key NFR sectors

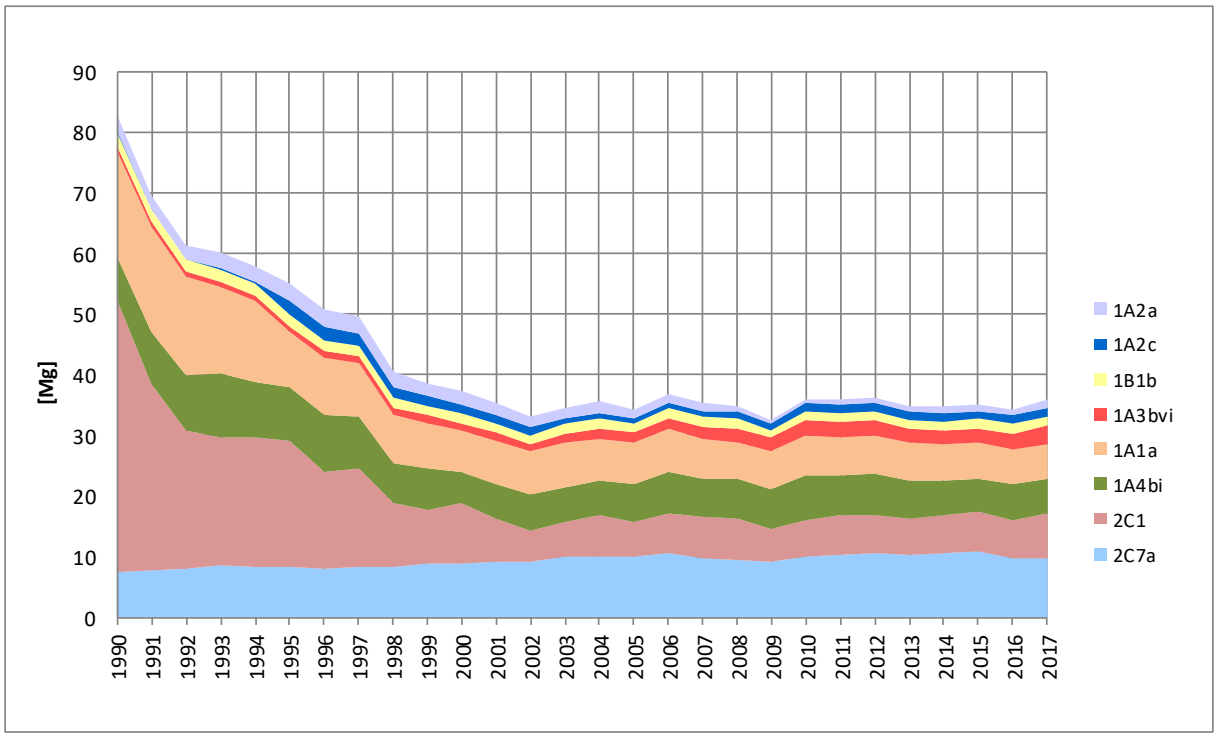

Figure 2.20. Trend of Cr emissions for key NFR sectors

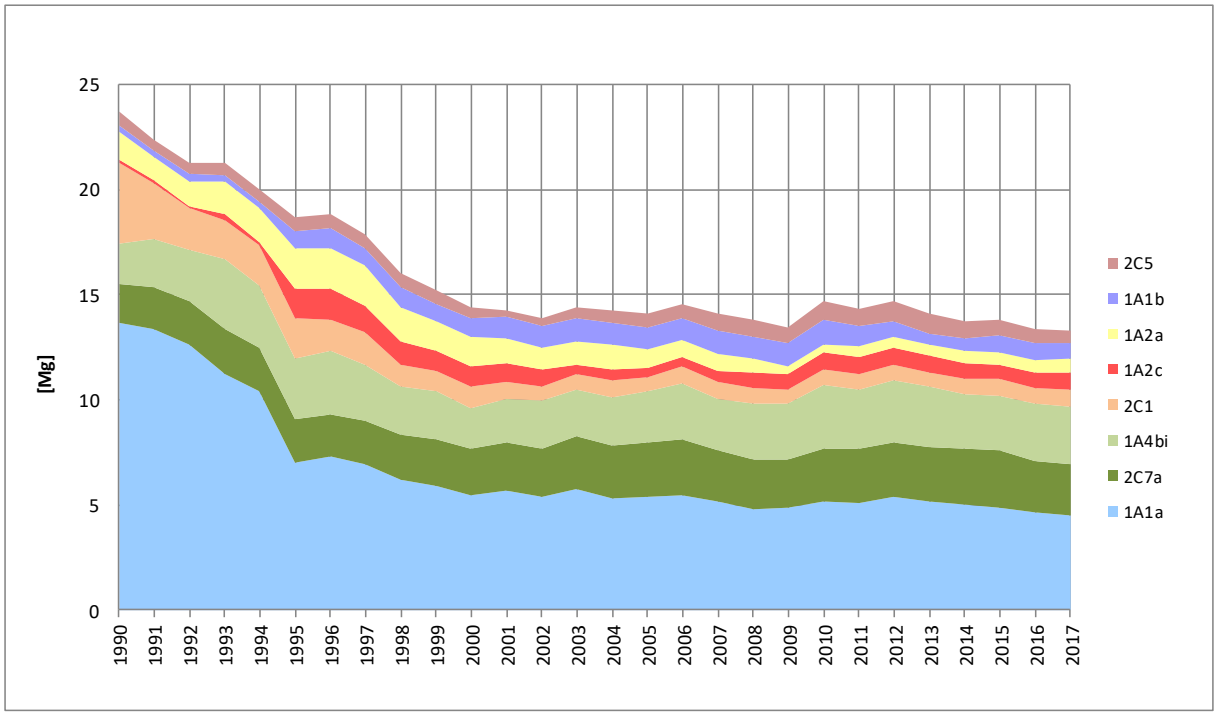

Figure 2.21. Trend of As emissions for key NFR sectors

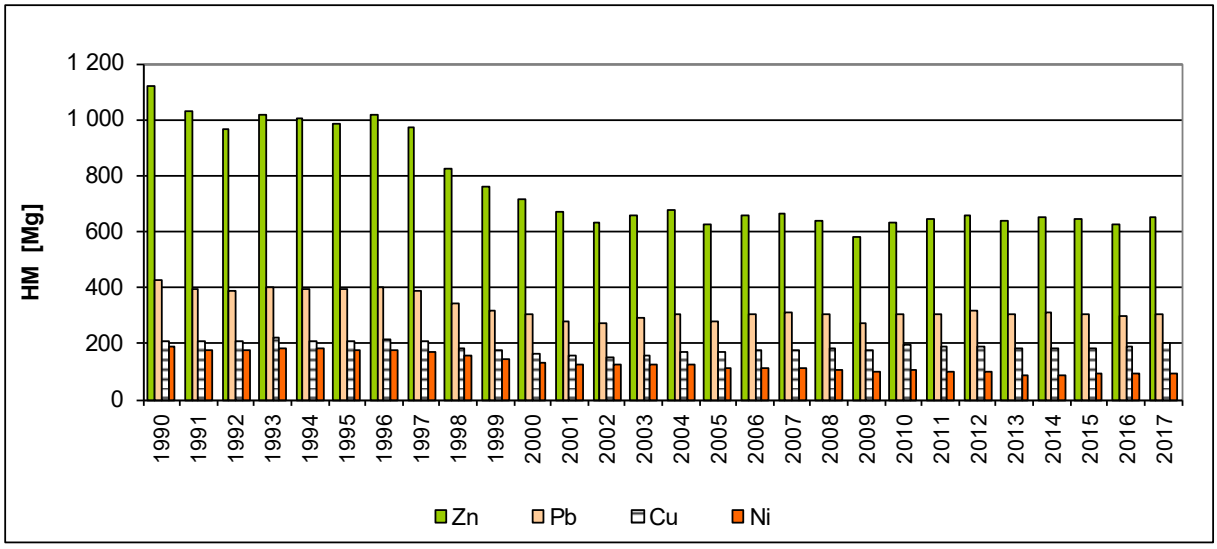

Figure 2.22. Emissions of zinc, lead, copper and nickel

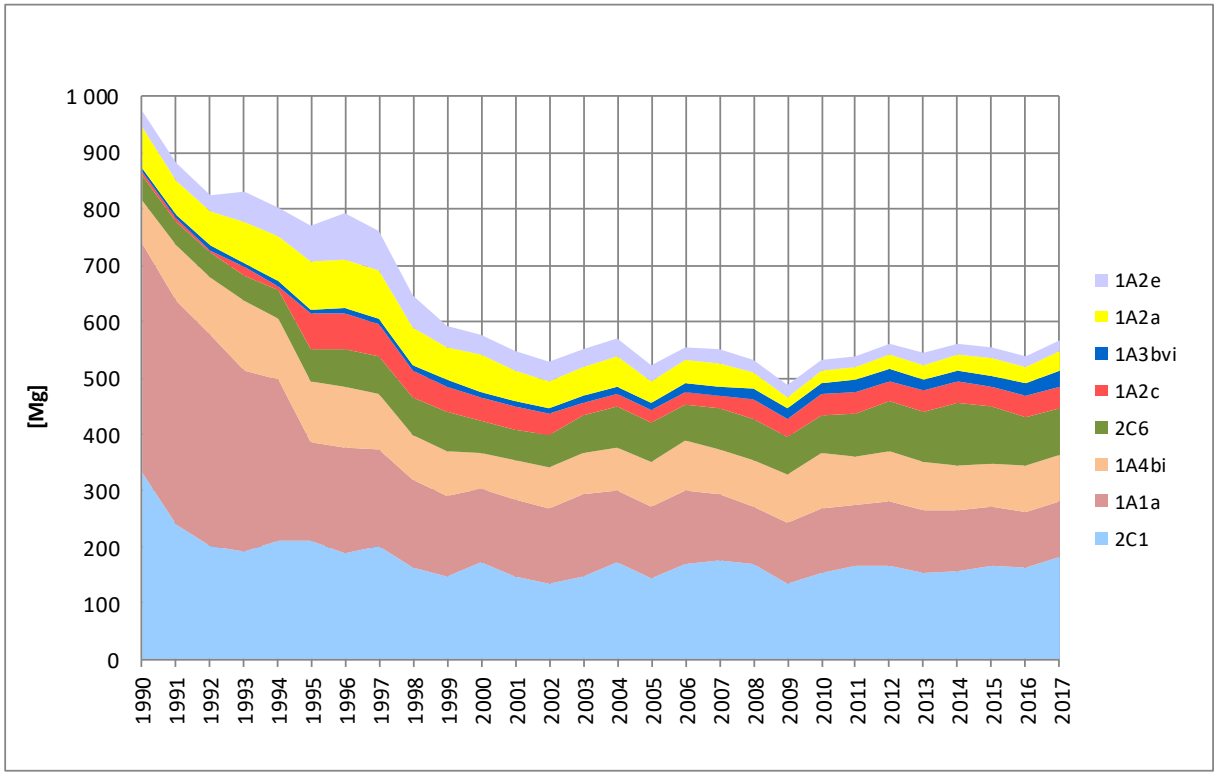

Figure 2.23. Trend of Zn emissions for key NFR sectors

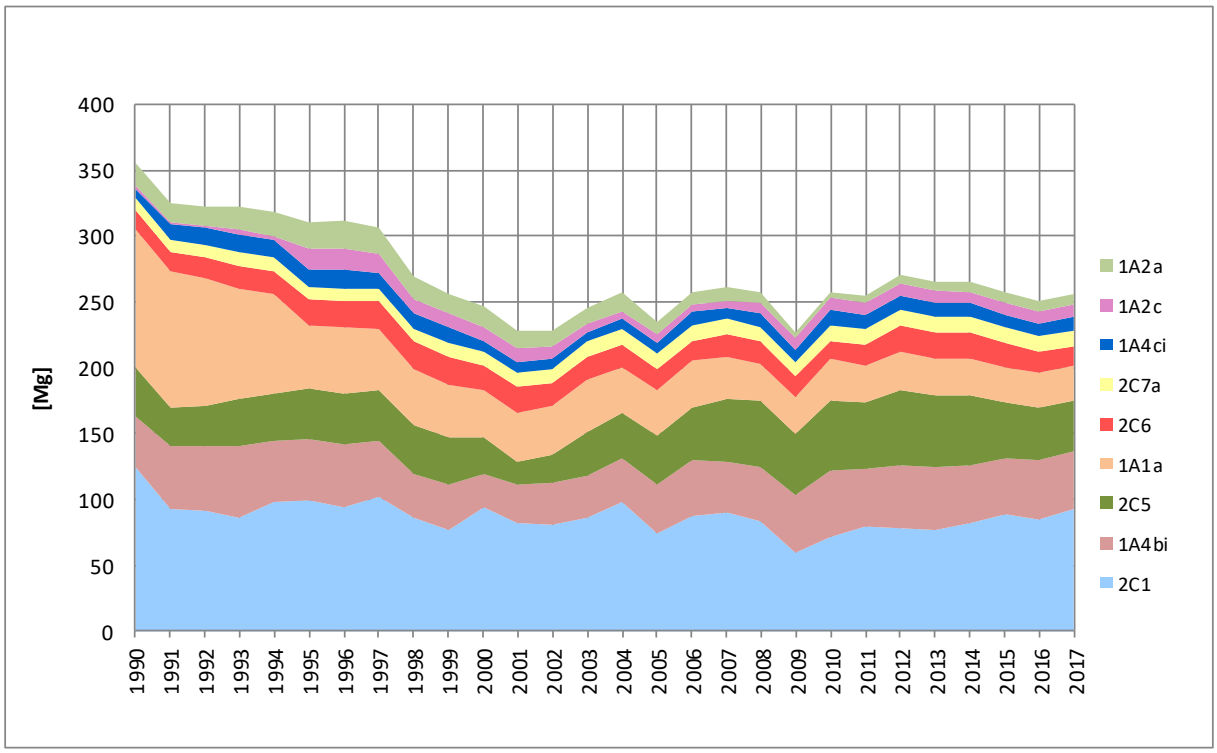

Figure 2.24. Trend of Pb emissions for key NFR sectors

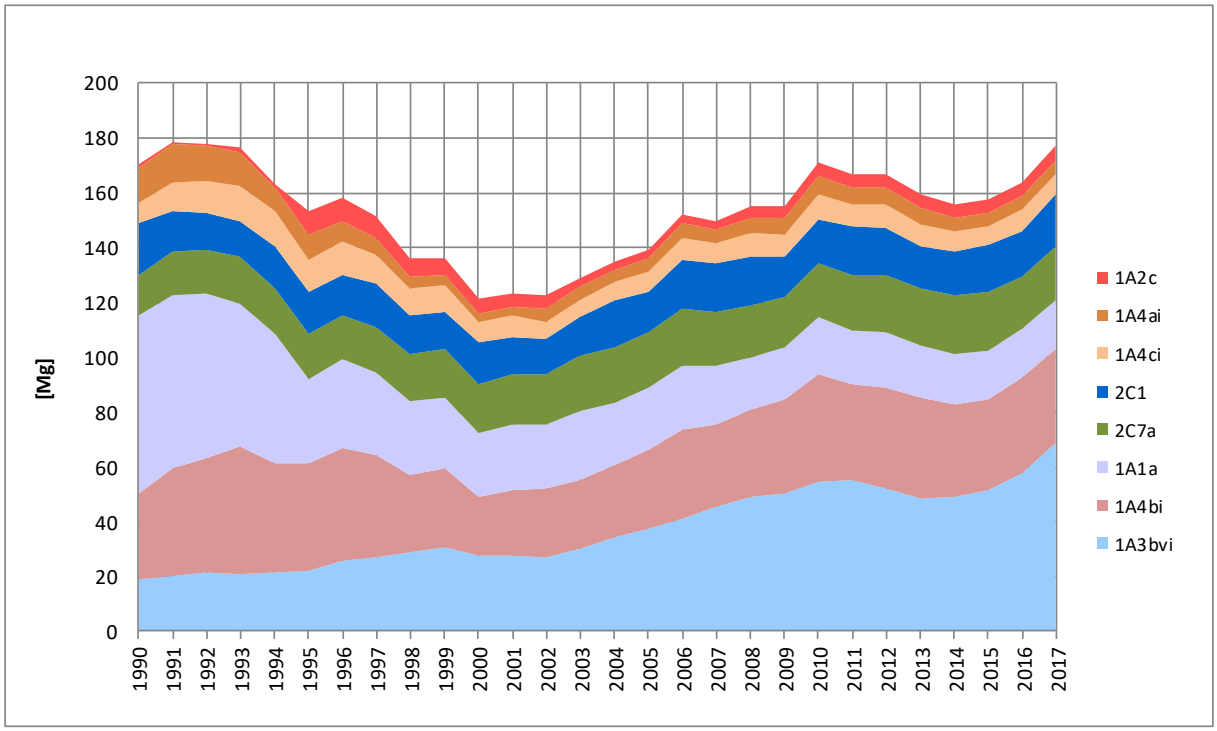

Figure 2.25. Trend of Cu emissions for key NFR sectors

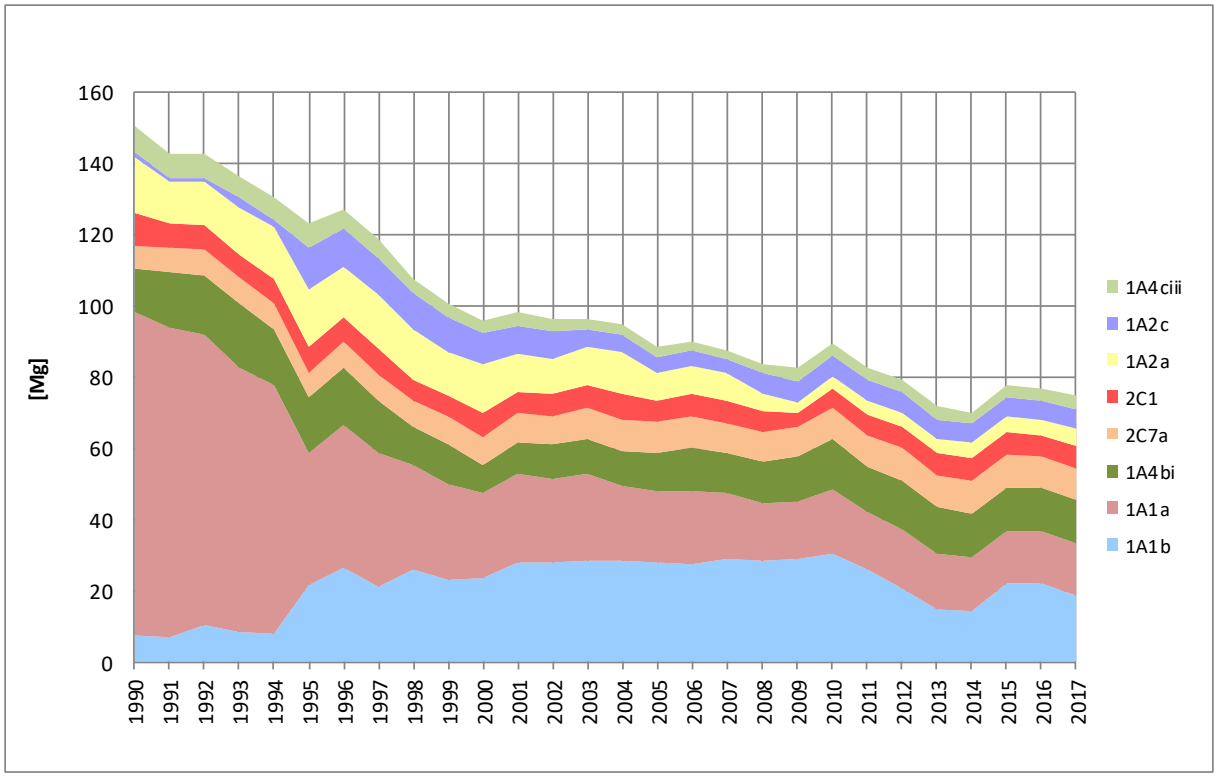

Figure 2.26. Trend of Ni emissions for key NFR sectors

2.8 PCDD/F emissions

Estimated emissions are considered to be complete for the key sources.

The main source (approximately 56%) of PCDD/F emissions comes from combustion processes sector 1.A.4. *Other sectors.* Within this category the dominant source is *Residential: stationary plants*, which covers combustion processes in household boilers and furnaces. Significant share (about 22%) of total PCDD/F emissions in 2017 is attributed to sector 5. Waste.

Table 2.9 shows the respective emission estimates in NFR classification.

Table 2.9. PCDD/F emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	g I-TEQ	g I-TEQ
Total	**260.88**	**259.02**
1. Energy	175.56	173.58
A. Fuel combustion	172.65	170.75
1. Energy industries	12.28	11.08
2. Manufacturing industries and construction	4.88	5.29
3. Transport	7.78	9.03
4. Other sectors	147.70	145.36
B. Fugitive emissions from fuels	2.92	2.83
1. Solid fuels	2.92	2.83
2. Oil and natural gas	0.00	0.00
2. Industrial processes and product use	24.95	27.30
A. Mineral industry	0.58	0.58
B. Chemical industry	0.00	0.00
C. Metal industry	21.55	23.93
D. Other Production	0.00	0.00
G - L. Other	2.83	2.79
3. Agriculture	0.00	0.00
B. Manure management	0.00	0.00
D. Agricultural management	0.00	0.00
F. Field burning of agricultural residues	0.00	0.00
5. Waste	60.36	58.13
A. Biological treatment of waste	0.00	0.00
C. Incineration and open burning of waste	12.23	10.83
D. Wastewater handling	0.00	0.00
E. Other waste	48.12	47.30

Figure 2.27 shows changes in dioxin emissions in the years 1990-2017. The trend of PCDD/F emissions is influenced mainly by the combustion processes in residential and commercial installations and by industry. Compared to the year 2016, in 2017 emissions of PCDD/F decreased by 0.7%.

Changes in emissions between 2016 and 2017 in individual sectors for these pollutants result from changes in activity and emission factors. The largest increase in emissions occurred in the Industrial processes and product use sector (NFR 2 - about 2.3 g I-TEQ), due to higher production in the iron and steel metallurgy sub-sector. The largest decrease in PCDD/F emissions occurred as a result of the

lower consumption of hard coal and wood in households (NFR 1.A.4.bi).

Compared to 2016, the decrease in PCDD/F emissions from the waste management sector in 2017 (by approx. 3.7%) resulted from the lower number of landfill fires.

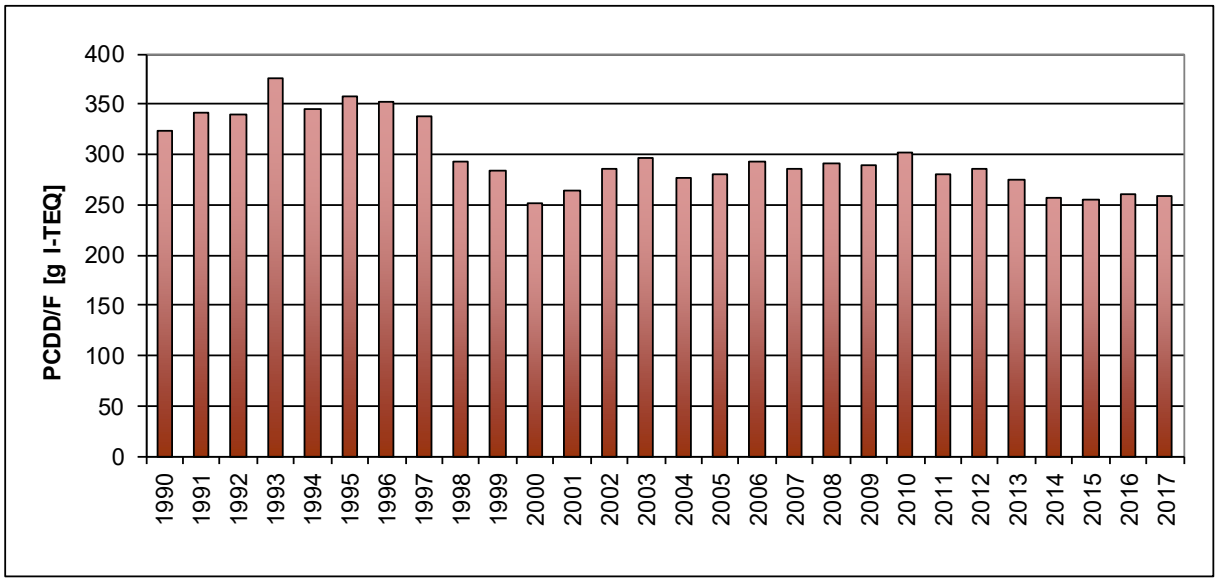

Figure 2.27. Emissions of dioxins

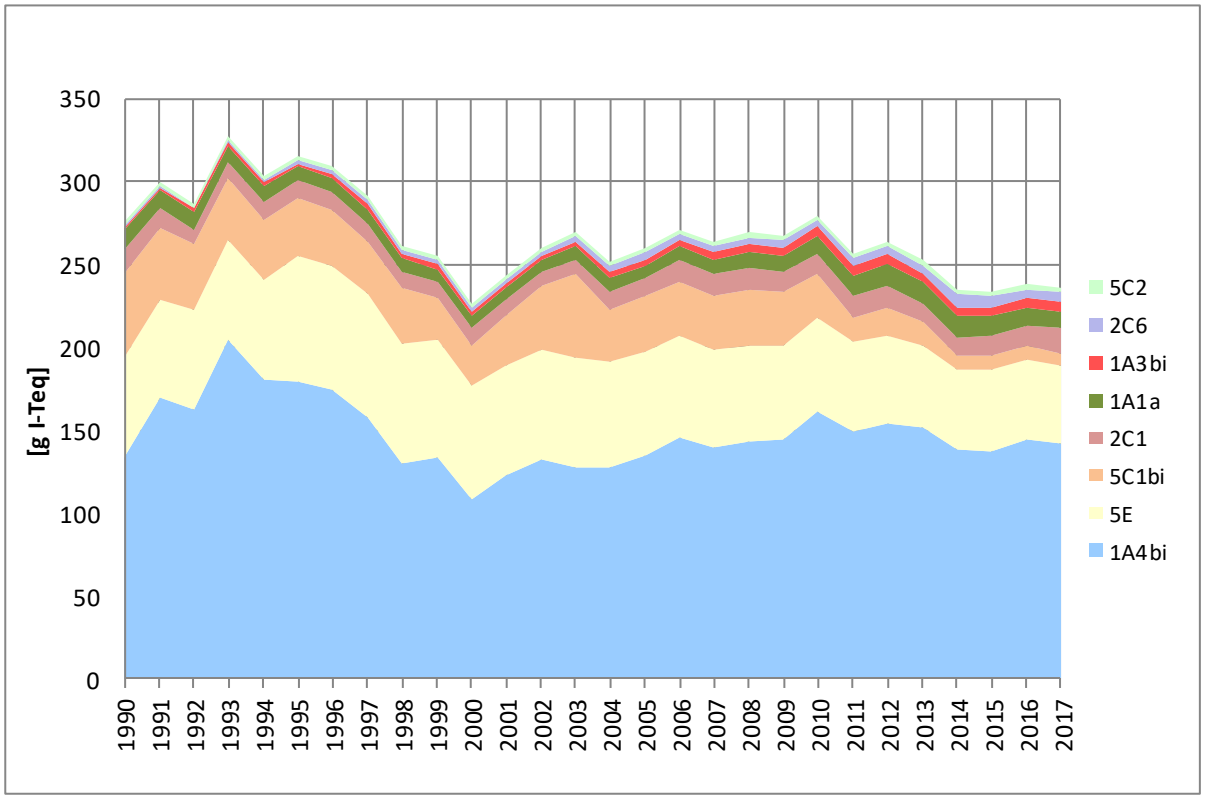

Figure 2.28. Trend of PCDD/F emissions for key NFR sectors

2.9 HCB emissions

Estimated emissions are considered to be complete for the key sources.

The largest (46%) contribution to the national total of HCB emissions comes from category Combustion processes in Non-industrial combustion plants, especially from coal combustion in households (NFR 1.A.4.b). Second major (24%) sector is *Incineration and open burning of waste* (NFR 5.C). Table 2.10 shows the respective emission estimates in NFR classification.

Similarly to other reported POPs, changes in HCB emissions between 2016 and 2017 in individual sectors result from changes in activity. Decrease of emissions in Combustion processes in the production and energy transformation sector (NFR 1.A.1) had the decisive influence on the change in the national emission volume (due to the smaller amount of wood burned in the power industry).

Figure 2.29 shows changes of HCB emissions in the years 1990-2017. Compared to the year 2016, in 2017 emissions of HCB decreased by 2%.

Table 2.10. HCB emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	kg	kg
Total	**4.116**	**4.034**
1. Energy	3.076	3.016
A. Fuel combustion	3.076	3.016
1. Energy industries	0.868	0.805
2. Manufacturing industries and construction	0.311	0.339
3. Transport	0.007	0.008
4. Other sectors	1.889	1.864
B. Fugitive emissions from fuels	0.000	0.000
1. Solid fuels	0.000	0.000
2. Oil and natural gas	0.000	0.000
2. Industrial processes and product use	0.078	0.054
A. Mineral industry	0.000	0.000
B. Chemical industry	0.000	0.000
C. Metal industry	0.078	0.054
D. Other Production	0.000	0.000
G - L. Other	0.000	0.000
3. Agriculture	0.000	0.000
B. Manure management	0.000	0.000
D. Agricultural management	0.000	0.000
F. Field burning of agricultural residues	0.000	0.000
5. Waste	0.962	0.963
A. Biological treatment of waste	0.000	0.000
C. Incineration and open burning of waste	0.962	0.963
D. Wastewater handling	0.000	0.000
E. Other waste	0.000	0.000

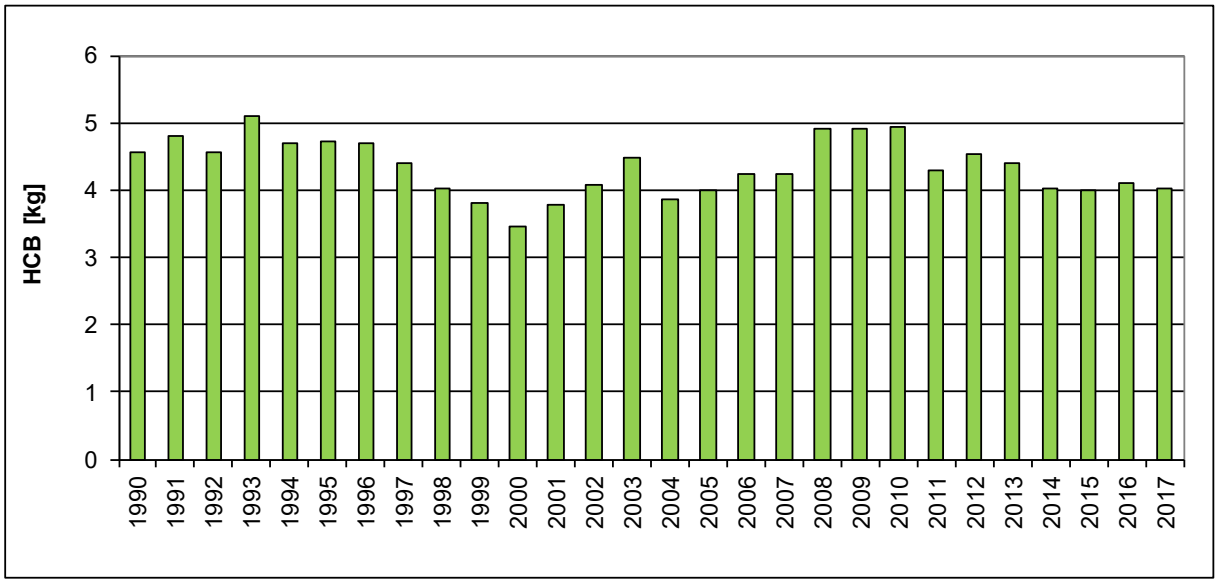

Figure 2.29. Emissions of HCB

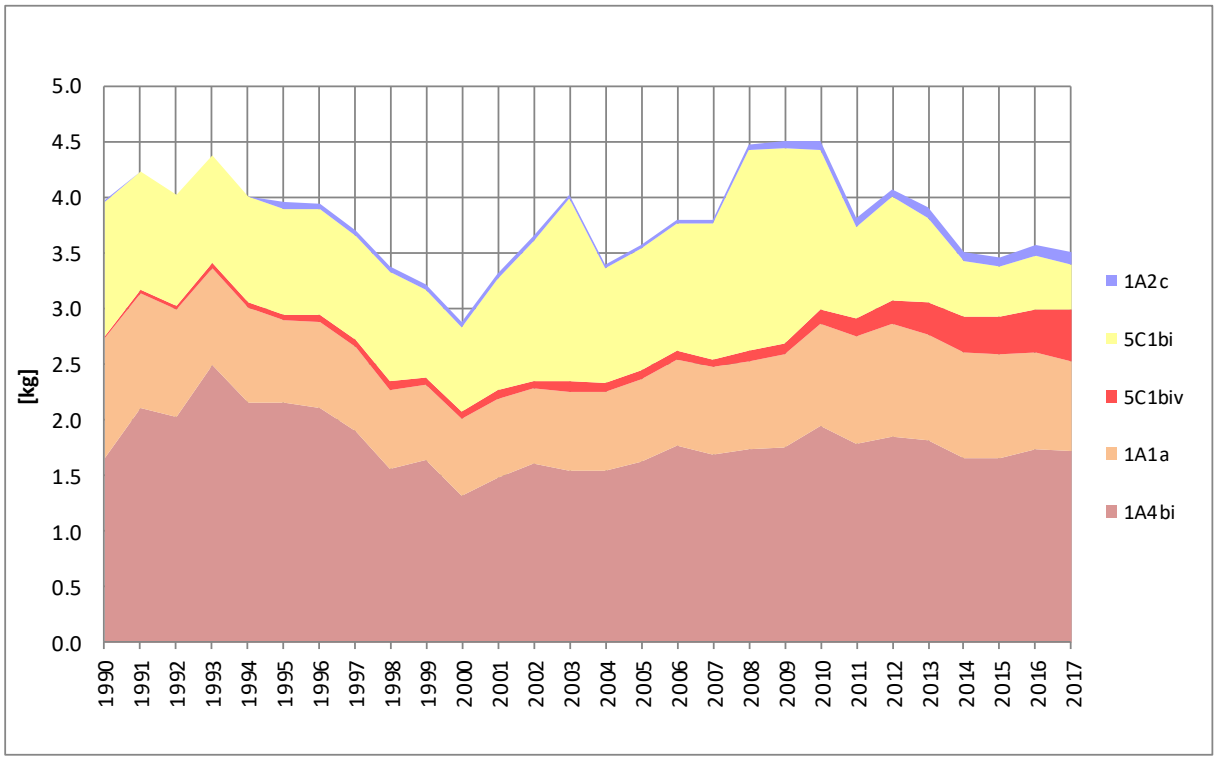

Figure 2.30. Trend of HCB emissions for key NFR sectors

2.10 PCB emissions

Estimated emissions are considered to be complete for the key sources.

The dominant source of PCB emissions (68%) are is residential fuels combustion (NFR 1.A.4.b). The other important source is combustion in energy (NFR 1.A.1) – about 20%. The increase in production of iron and steel sub-sector was decisive regarding the increase of the country total.

Table 2.11 shows the respective emission estimates in NFR classification.

Figure 2.31 shows changes of PCB emissions in the years 1990-2017. Compared to 2016, PCB emissions in 2017 slightly increased (by about 0.1%).

The increase in production of iron and steel sub-sector was decisive regarding the increase of the country total.

Table 2.11. PCB emissions in 2016-2017 according to NFR classification

NFR	2016	2017
	kg	kg
Total	**578.05**	**578.36**
1. Energy	541.01	535.66
A. Fuel combustion	541.01	535.66
1. Energy industries	126.37	126.66
2. Manufacturing industries and construction	12.30	13.14
3. Transport	0.00	0.00
4. Other sectors	402.34	395.86
B. Fugitive emissions from fuels	0.00	0.00
1. Solid fuels	0.00	0.00
2. Oil and natural gas	0.00	0.00
2. Industrial processes and product use	36.47	42.22
A. Mineral industry	0.00	0.00
B. Chemical industry	0.00	0.00
C. Metal industry	36.47	42.22
D. Other Production	0.00	0.00
G - L. Other	0.00	0.00
3. Agriculture	0.00	0.00
B. Manure management	0.00	0.00
D. Agricultural management	0.00	0.00
F. Field burning of agricultural residues	0.00	0.00
5. Waste	0.57	0.49
A. Biological treatment of waste	0.00	0.00
C. Incineration and open burning of waste	0.57	0.49
D. Wastewater handling	0.00	0.00
E. Other waste	0.00	0.00

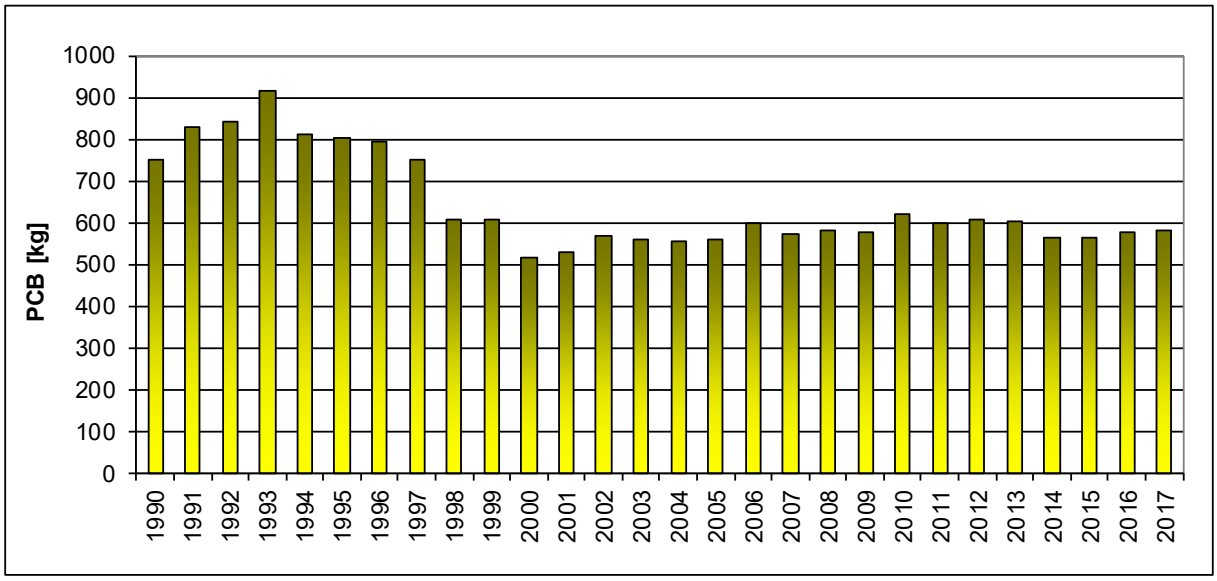

Figure 2.31. Emissions of PCB

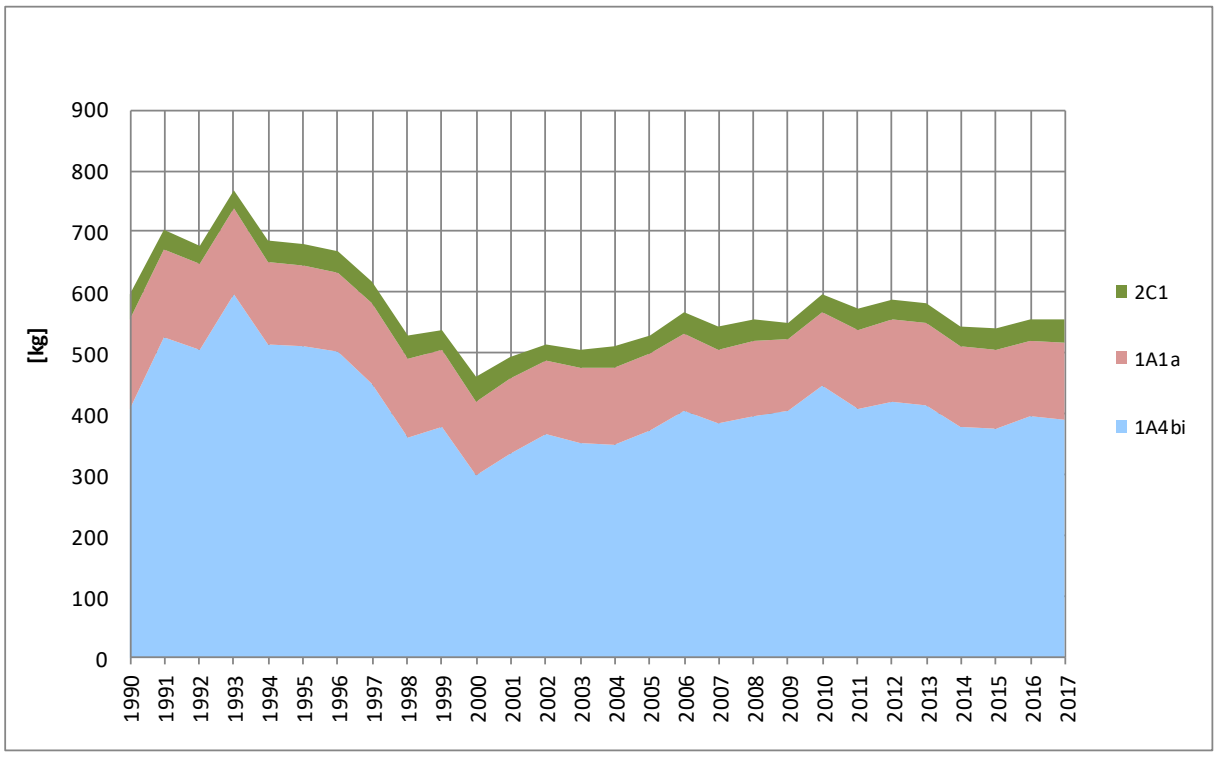

Figure 2.32. Trend of PCB emissions for key NFR sectors

2.11 PAH emissions

Estimated emissions are considered to be complete for the key sources.

The main source of PAHs emission (84%) in Poland is sector 1.A.4. *Other sectors* (mostly residential plants). The second major (10%) source of national emissions is sector 1.B.1 *Fugitive emissions from solid fuels*. Table 2.12 shows the respective emission estimates in NFR classification.

Table 2.12. PAH emissions in 2016-2017 according to NFR classification

NFR	BaP		BbF		BkF		IP		Total	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
Total	**43.52**	**42.94**	**47.26**	**46.70**	**14.52**	**14.35**	**48.23**	**47.58**	**153.54**	**151.58**
1. Energy	42.27	41.67	44.38	43.75	12.09	11.95	47.81	47.11	146.54	144.49
A. Fuel combustion	34.98	34.61	41.95	41.40	9.66	9.60	44.90	44.29	131.48	129.89
1. Energy industries	0.01	0.00	0.13	0.11	0.14	0.11	0.03	0.03	0.31	0.26
2. Manufacturing industries and construction	0.00	0.00	0.19	0.21	0.37	0.40	0.09	0.10	0.65	0.71
3. Transport	0.24	0.28	0.38	0.46	0.34	0.41	0.24	0.29	1.20	1.44
4. Other sectors	34.73	34.32	41.25	40.62	8.81	8.67	44.53	43.87	129.32	127.48
B. Fugitive emissions from fuels	7.29	7.06	2.43	2.35	2.43	2.35	2.92	2.83	15.06	14.60
1. Solid fuels	7.29	7.06	2.43	2.35	2.43	2.35	2.92	2.83	15.06	14.60
2. Oil and natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial processes and product use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
A. Mineral industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Chemical industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Metal industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
G - L. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Agriculture	0.49	0.55	1.37	1.54	0.58	0.66	0.42	0.47	2.86	3.21
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Agricultural management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Field burning of agricultural residues	0.49	0.55	1.37	1.54	0.58	0.66	0.42	0.47	2.86	3.21
5. Waste	0.76	0.71	1.51	1.41	1.85	1.74	0.00	0.00	4.12	3.87
A. Biological treatment of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.76	0.71	1.51	1.41	1.85	1.74	0.00	0.00	4.12	3.87
D. Wastewater handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2.33 shows changes of PAH emissions in the years 1990-2017. Changes in volume of PAH emissions are usually a result of changes in the amount of combusted fuels. The 2017 emissions are 1.3% smaller than the estimate for 2016.

A drop in emissions from the sector of combustion processes outside the industry (1.A.4) caused the biggest change in the national emissions of PAH. A drop in emissions is associated with a reduction in hard coal and wood consumption in households.

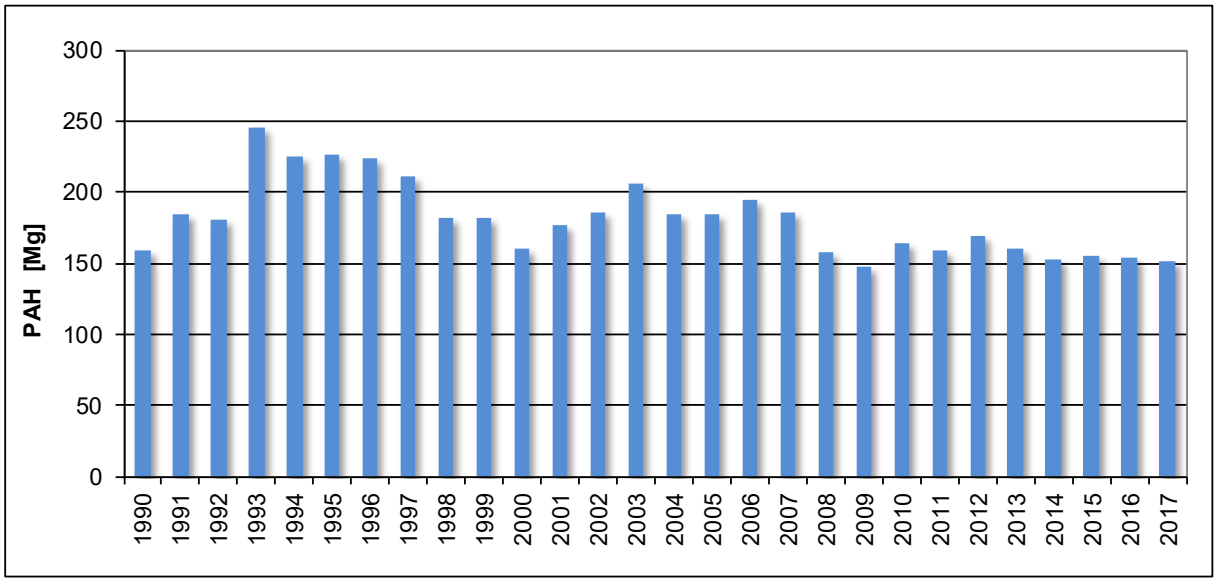

Figure 2.33. Emissions of PAH

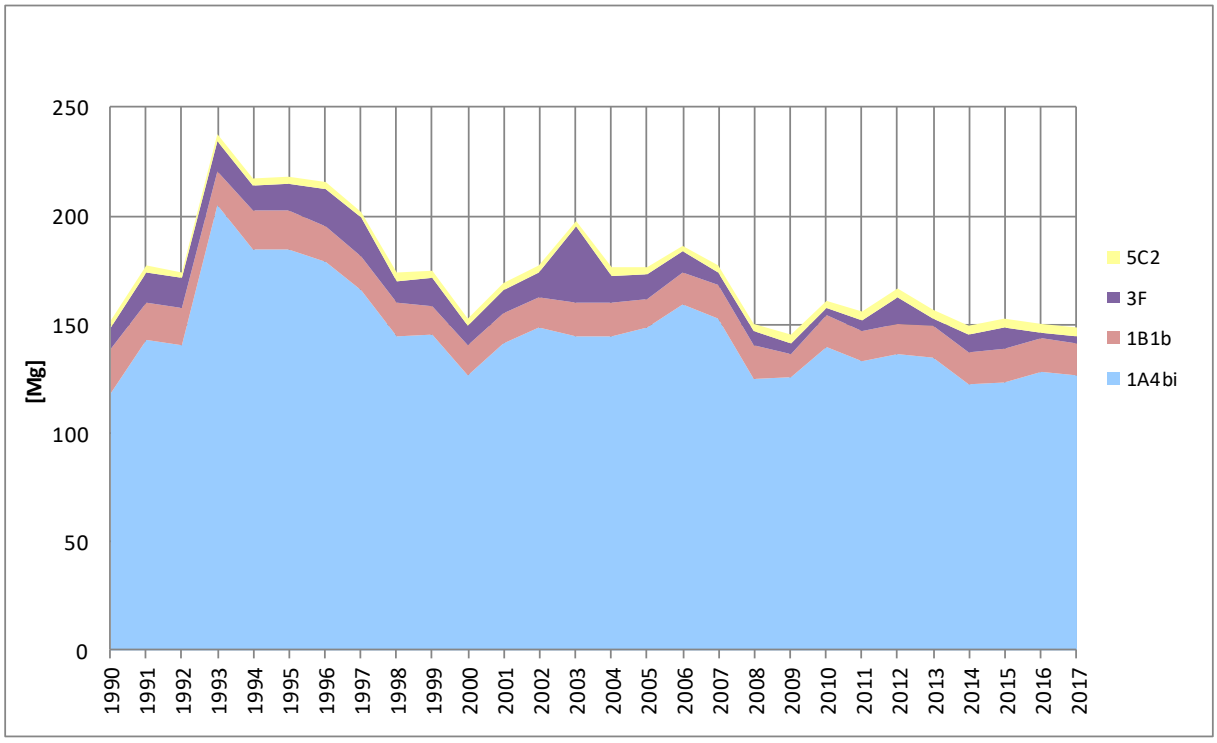

Figure 2.34. Trend of PAH emissions for key NFR sectors

3 ENERGY (NFR SECTOR 1)

Energy sector consists of the following main subcategories:

- 1.A Fuels combustion;
- 1.B Fugitive emissions.

The Energy sector, especially *Fuels combustion* (NFR 1 A), is one of the most important sources of pollutant emissions.

Shares of emissions from the 1 A category in the country total for the particular pollutants in 2017 are shown on the Figure 3.1.

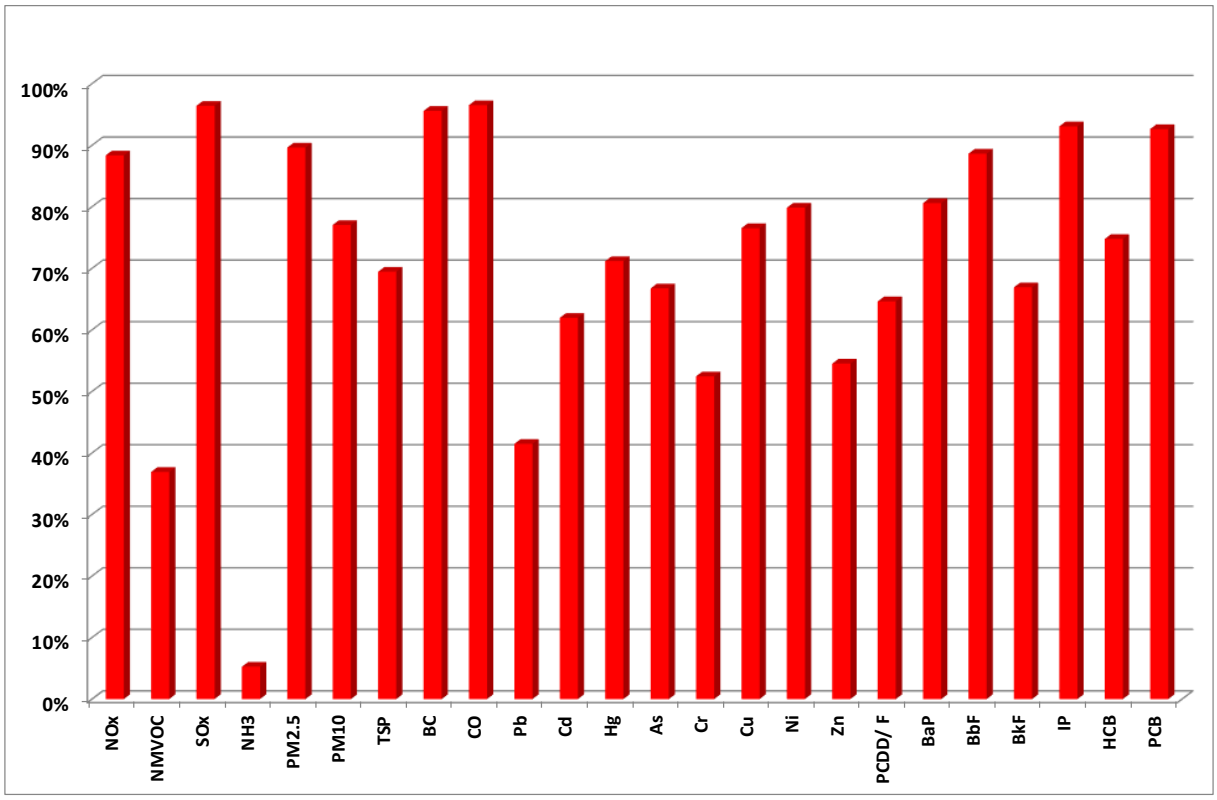

Figure 3.1. Shares of emissions from the 1 A category in the country total

Emissions of pollutants from fuel combustion (NFR sector 1.A) are mostly estimated on fuel quantities according to data included in the energy balance submitted by GUS to Eurostat (Eurostat database) and the relevant emission factors. Energy balance for 2017 is presented in Annex 4. Energy data are harmonized with the Poland's GHG inventory for the UN FCCC Convention.

Generally, the emission calculations were based on the following equation:

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

where:

E - emission
EF - emission factor
A - fuel consumption
a - fuel type,
b – sector.

Activity data (fuel use) for this sector come from energy statistics. For some pollutants (SO_2, NOx, CO) aggregated emission data from power plants reports to National Database are included in the inventory, without use of emission factors.

Similar method was used for off-road forms of transport. For road transport COPERT 5 software has been used.

Combustion as a source of pollutant emissions occurs in the following category groups:

- 1.A.1. Energy industries
- 1.A.2. Manufacturing industries and construction
- 1.A.3. Transport
- 1.A.4. Other sectors:
  - a. Commercial/Institutional
  - b. Residential
  - c. Agriculture/Forestry/Fishing
- 1.A.5.b. Other, Mobile (including military, land based and recreational boats).

As specific activity data for category 1.A.5b are difficult to obtain (especially with respect to potential confidentiality issues), emissions from this category have been included in the category 1.A.3b. Further effort into making these data available will be put in the future.

3.1 Energy Industries (NFR sector 1.A.1)

3.1.1 Source category description of Energy Industries (NFR sector 1.A.1.)

Emissions in 1.A.1 *Energy Industries* category are estimated for each sub-category as follows:

- 1.A.1.a *Public Electricity and Heat Production*
- 1.A.1.b *Petroleum Refining*
- 1.A.1.c *Manufacture of Solid Fuels and Other Energy Industries.*

Shares of emissions from the 1.A.1 category in the country total for the particular pollutants in 2017 are shown on the Figure 3.2.

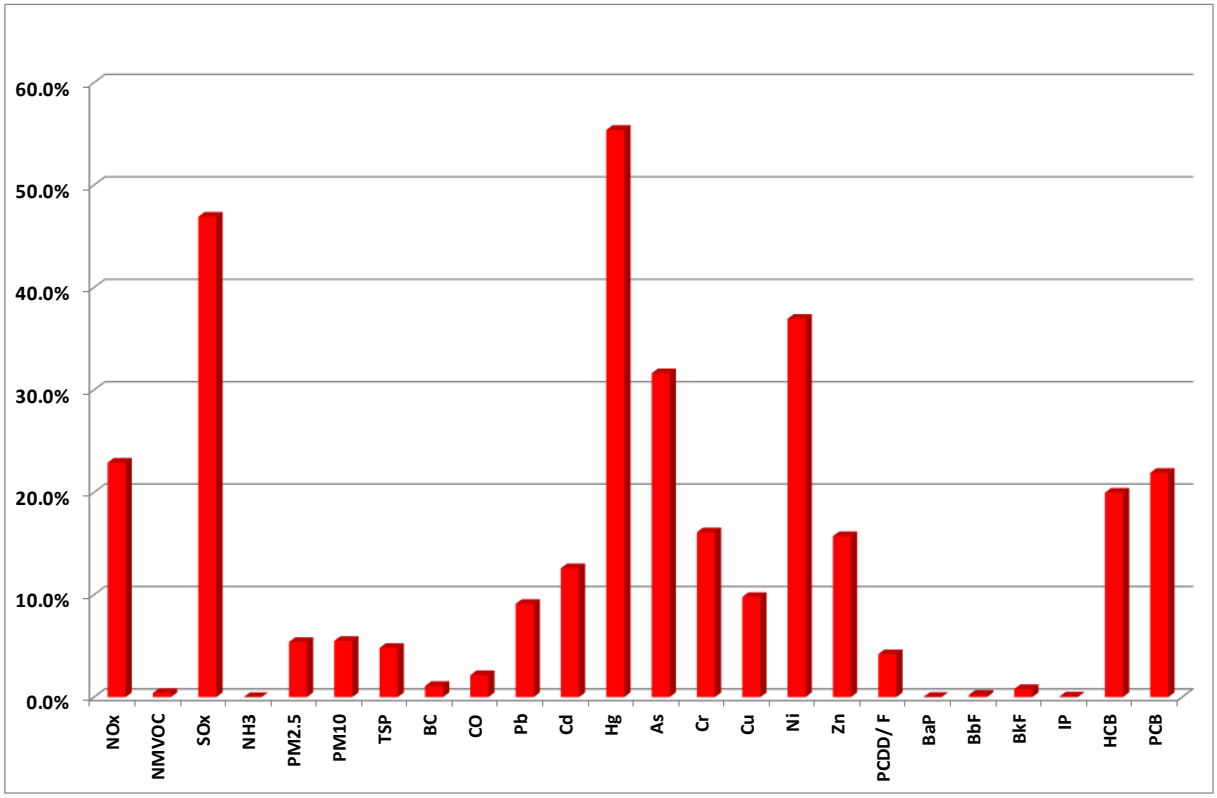

Figure 3.2. Shares of emissions from the 1.A.1 category in the country total

Public electricity and heat production (NFR sector 1.A.1.a)

Category Public Electricity and Heat Production consists of:

- public thermal power plants and cogeneration power plants (CHP)
- industrial cogeneration power plants
- district heating plants.

This category corresponds to categories SNAP 0101, SNAP 0301 and SNAP 0102.

Annex 5 present the amounts of fuels used in the sub-category 1.A.1.a for the years 1990-2017. The data in tables show that the use of solid fuels is dominant in sector 1.A.1.a – mainly hard coal. Applied emission factors for subcategory 1.A.1.a are presented in Annex 6.

For public power plants, emissions of SO_2 and NOx, as aggregated individual data, were taken from reports to the National Database.

Petroleum Refining (NFR sector 1.A.1.b)

This category corresponds to category SNAP 0103.

Annex 5 shows fuels consumption data in sub-category 1.A.1.b *Petroleum Refining* for the years 1990-2017. Applied emission factors for subcategory 1.A.1.a are presented in Annex 6.

Emissions of SO_2 and NOx, as aggregated individual data, were taken from reports to the National Database.

Manufacture of Solid Fuels and Other Energy Industries (NFR sector 1.A.1.c)

Category Manufacture of Solid Fuels and Other Energy Industries consists of:

- coke-oven and gas-works plants
- mines and patent fuel/briquetting plants
- other energy industries (oil and gas extraction; own use in Electricity, CHP and heat plants).

This category corresponds to categories SNAP 0104 and SNAP 0105.

Annex 5 show the fuels use data in the sub-category 1.A.1.c category - Manufacture of solid fuels and other energy industries (including coal-mines) over the period 1990-2017. Applied emission factors for subcategory 1.A.1.c are presented in Annex 6.

For coking plants amounts of emissions of SO_2 and NOx, as aggregated individual data, were taken from reports to National Database.

3.1.2 Methodological issues

Methodology of emission estimation in 1.A.1 subcategory corresponds with methodology described above for fuel combustion in stationary sources (chapter 3). Detailed information on fuel consumption and applied emission factors for emission source subcategories are presented in Annex 5 and 6.

3.1.3 Emission trends for the NFR sector 1.A.1

Volumes and trend of pollutant emissions for Public electricity and heat production are shown on figures below (Figure 3.3 - Figure 3.8).

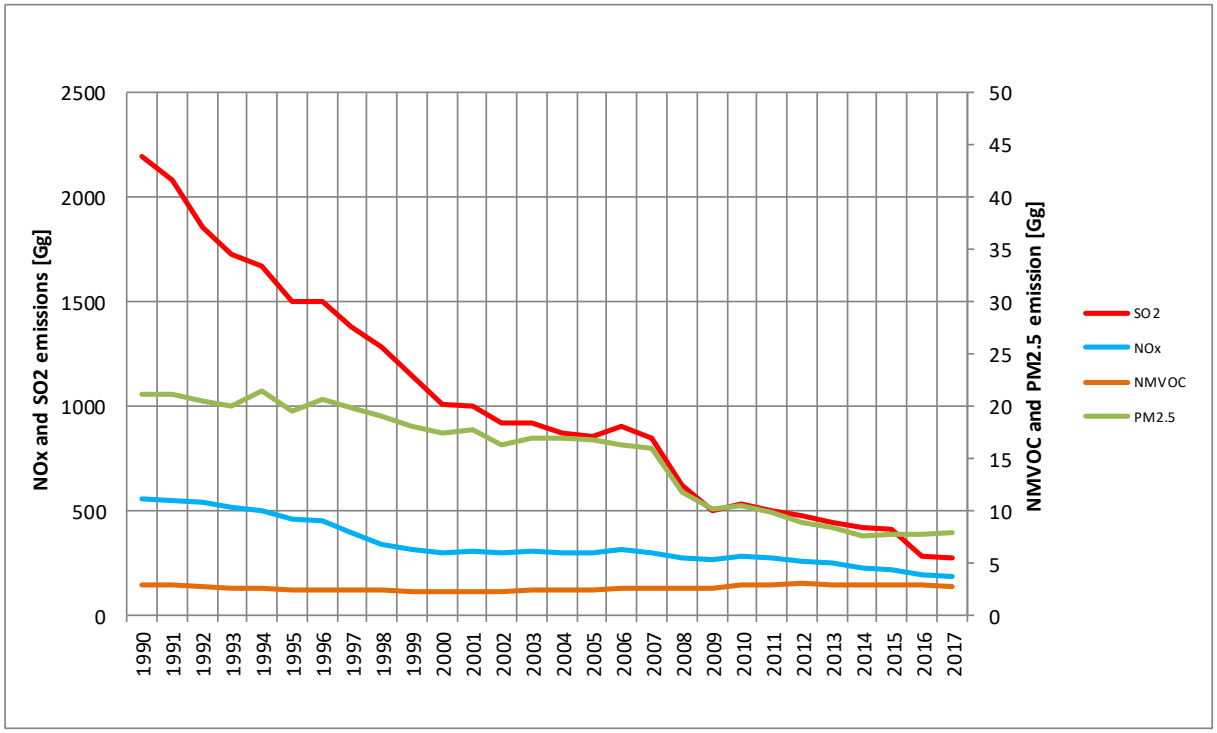

Figure 3.3. SO_2, NOx, PM2.5 and NMVOC emissions for 1.A.1 category in 1990-2017

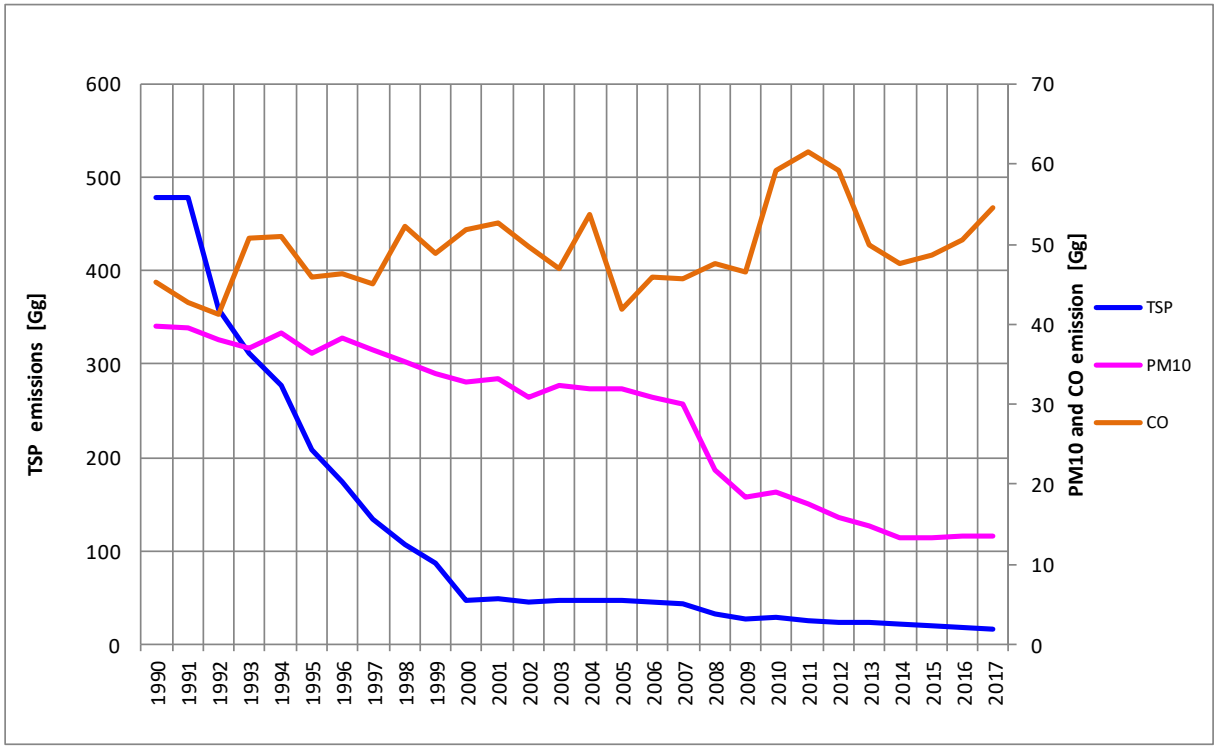

Figure 3.4. Particulates and CO emissions for 1.A.1 category in 1990-2017

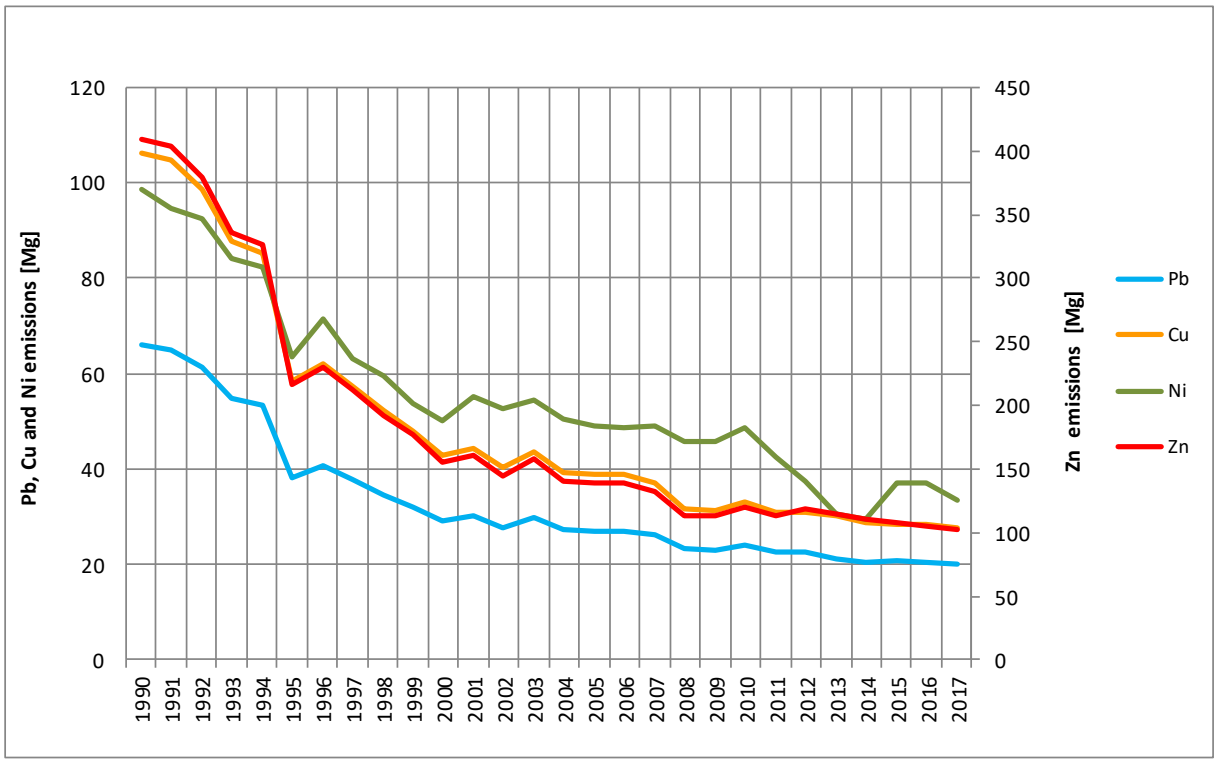

Figure 3.5. Pb, Cu, Ni and Zn emissions for 1.A.1 category in 1990-2017

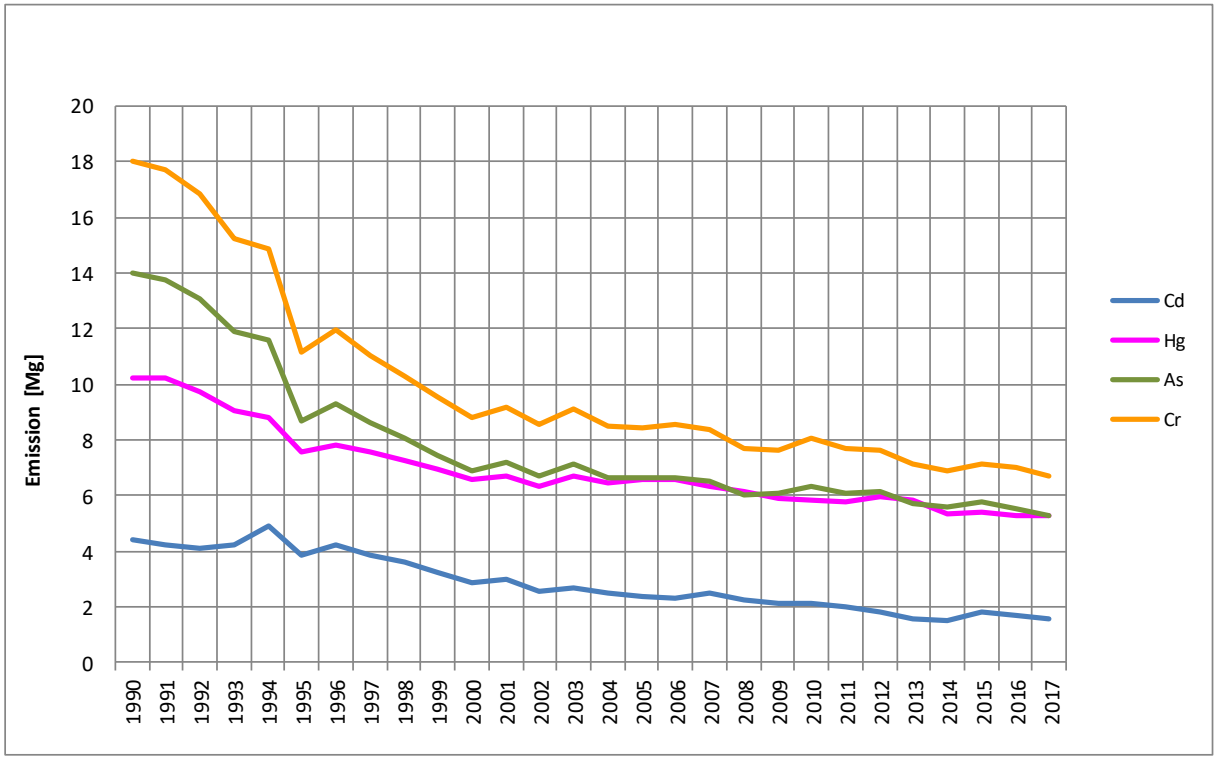

Figure 3.6. Cd, Hg, As and Cr emissions for 1.A.1 category in 1990-2017

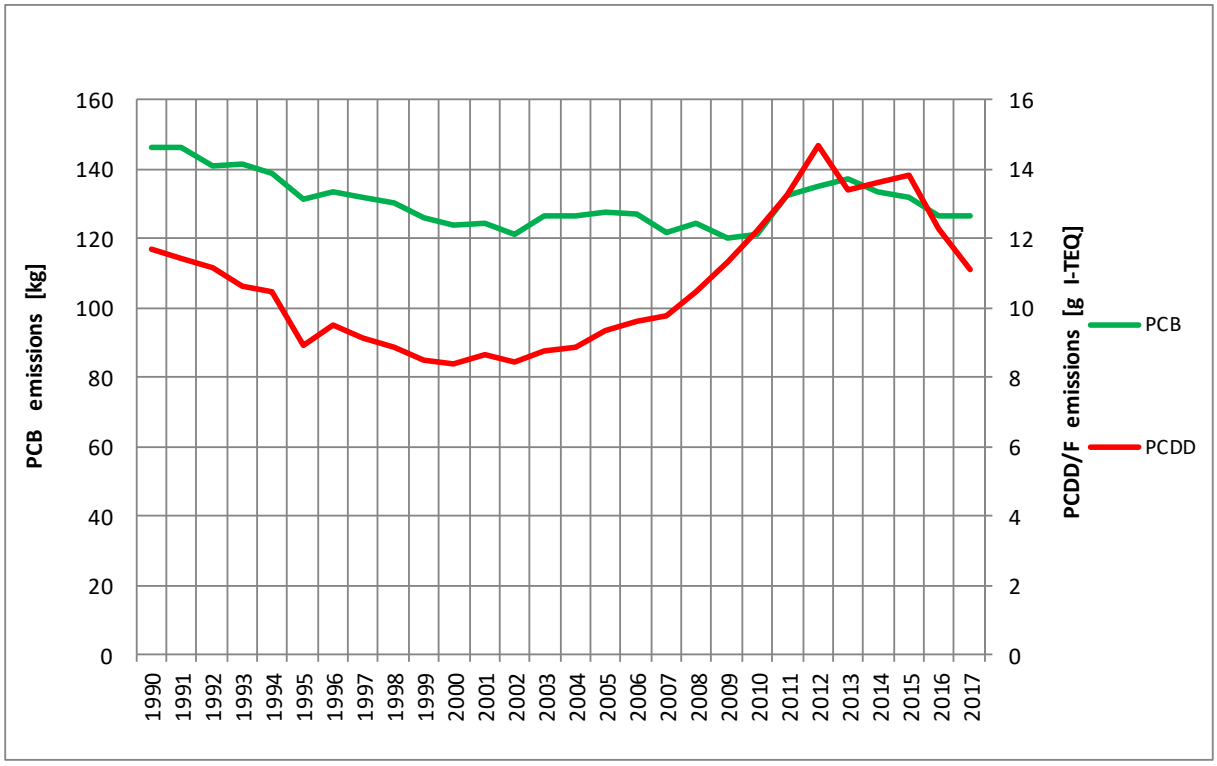

Figure 3.7. PCB and PCDD/F emissions for 1.A.1 category in 1990-2017

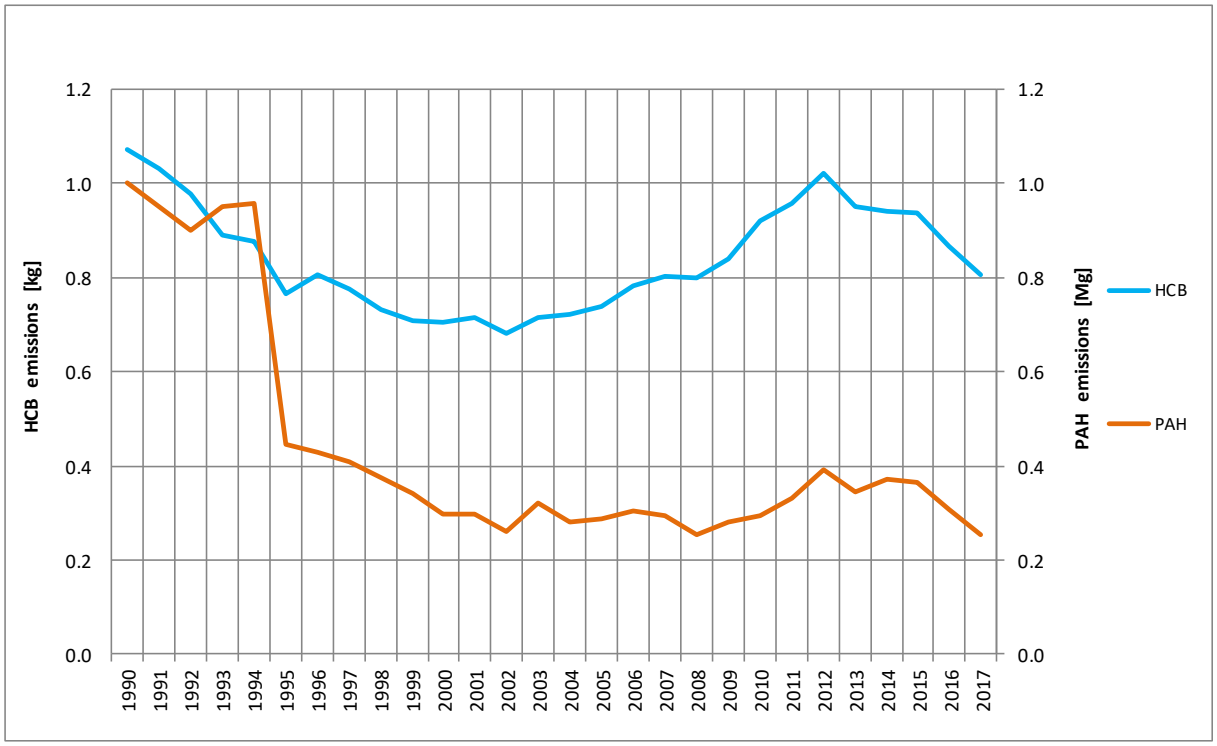

Figure 3.8. HCB and PAH emissions for 1.A.1 category in 1990-2017

3.1.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector *1.A.1* was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). More detailed calculations (including qualitative uncertainty estimation for the most of pollutants and Monte-Carlo analysis for SO_X and NO_X emissions from NFR 1.A.1 sector) are also included in Annex 8. Results of the sectoral uncertainty analysis for NFR sector *1.A.1* are given below.

Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 3.1. Results of the uncertainty analysis for NFR sector 1.A.1

NFR sector		NOx	NMVOC	SO_2	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAH
1A1a	Public electricity and heat production	22%	26%	12%	41%	26%	27%	30%	36%	26%	57%	54%	54%	54%
1A1b	Petroleum refining	30%	26%	20%	50%	50%	50%	50%	56%	64%	48%	97%	97%	97%
1A1c	Manufacture of solid fuels and other energy industries	30%	31%	20%	50%	50%	50%	50%	50%	39%	41%	83%	83%	83%

3.1.5 Source-specific QA/QC and verification

Activity data used in the AP inventory concerning energy sector come from Eurostat Database which is fed by the Statistics Poland (GUS). It should be underlined that data in this database is fully consistent and based on the questionnaires sent by Polish national statistics. GUS is responsible for QA/QC of collected and published data. Activity data applied in AP inventory are regularly checked and updated if necessary according to adjustments made in Eurostat Database.

The source of data on the consumption of fuels and energy for national statistics are based on reports, which enterprises are obliged to report to the Statistics Poland (GUS). This is done through

the reporting portal. The forms for all statistical reports are available on GUS website:

http://form.stat.gov.pl/formularze/2018/index.htm.

The main energy forms are G-03 and G-02. Based on the data collected via the reporting portal, a database is created from which information for national energy balances elaboration and filling out questionnaires reporting Polish energy data to international statistical institutions (Eurostat, IEA, OECD) are taken. This ensures data consistency. Data from individual reports are subject to cross-check procedures. There are also algorithms comparing the data from the reporting year with the previous submission. Questionnaires with data on fuel and energy consumption reported to Eurostat, IEA and OECD are also subject to verification by these institutions. The questions regarding data from the entire long-term time series are directed to GUS. Doubts are clarified and, if necessary, the data is corrected (the entire adjusted trend is submitted in the questionnaire to the above-mentioned statistical organizations). Therefore the data in the mentioned databases can be treated as consistent, coherent and verified.

One of the quality control elements of activity data check in national AP inventories is preparation of fuel balances (see Annex 4). For the main fuels (i.e. coal, lignite) calorific values are analysed for avoiding significant errors. Close cooperation is developed between inventory experts and institutions responsible for energy data. Any doubtful fuel consumption values are systematically verified - it is often required to obtain additional confirmation of data by installations/entities submitting the energy questionnaire. In case of any doubts energy data are also validated based on Statistics Poland's Energy Statistics published annually.

Calculations in energy sector were examined with focus on formulas, units and trends consistency.

3.1.6 Source-specific recalculations

Activity data on fuel consumption for years 1990-2016 were updated due to changes made in EUROSTAT database.

Emission factors were updated (where appropriate) based on EMEP/EEA Inventory Guidebook 2016:

- In category 1.A.1.a:
  - NMVOC and PM2.5 emission factors for all fuels - following 2018 Review recommendation;
  - NOx, CO, PM10 and TSP emission factors for all fuels;
  - PCDD/F and PAHs emission factors for gaseous fuels;
- In category 1.A.1.b:
  - NMVOC and PM2.5, PM10 and TSP emission factors for all fuels;
  - PAHs emission factors for gaseous fuels;
- In category 1.A.1.c:
  - PM2.5, PM10 and TSP emission factors for all fuels.

Moreover, PM emission factors from hard coal and coke for *Heating plants* were updated based on national publications.

Detailed information on fuel consumption and applied emission factors for subcategories listed below are presented in Annex 5 and 6.

3.1.7 Source-specific planned improvements

Further developing of cooperation with institutions responsible for compilation of Polish energy balances in order to explain and verify time-trends of activity data in 1.A category.

3.2 Manufacturing Industries and Construction (NFR sector 1.A.2)

3.2.1 Source category description

Category *Manufacturing Industries and Construction* consists of detailed sub-categories as follows:

- Iron and Steel - 1.A.2.a
- Non-Ferrous Metals - 1.A.2.b
- *Chemicals* - 1.A.2.c
- Pulp, Paper and Print - 1.A.2.d
- Food Processing, Beverages and Tobacco - 1.A.2.e
- Non-metallic minerals - 1.A.2.f
- *Other* - 1.A.2.g (manufacturing industries and construction not included elsewhere).

Category NFR 1.A.2 corresponds to category SNAP 03.

Shares of emissions from the 1.A.2 category in the country total for the particular pollutants in 2017 are shown on the Figure 3.9.

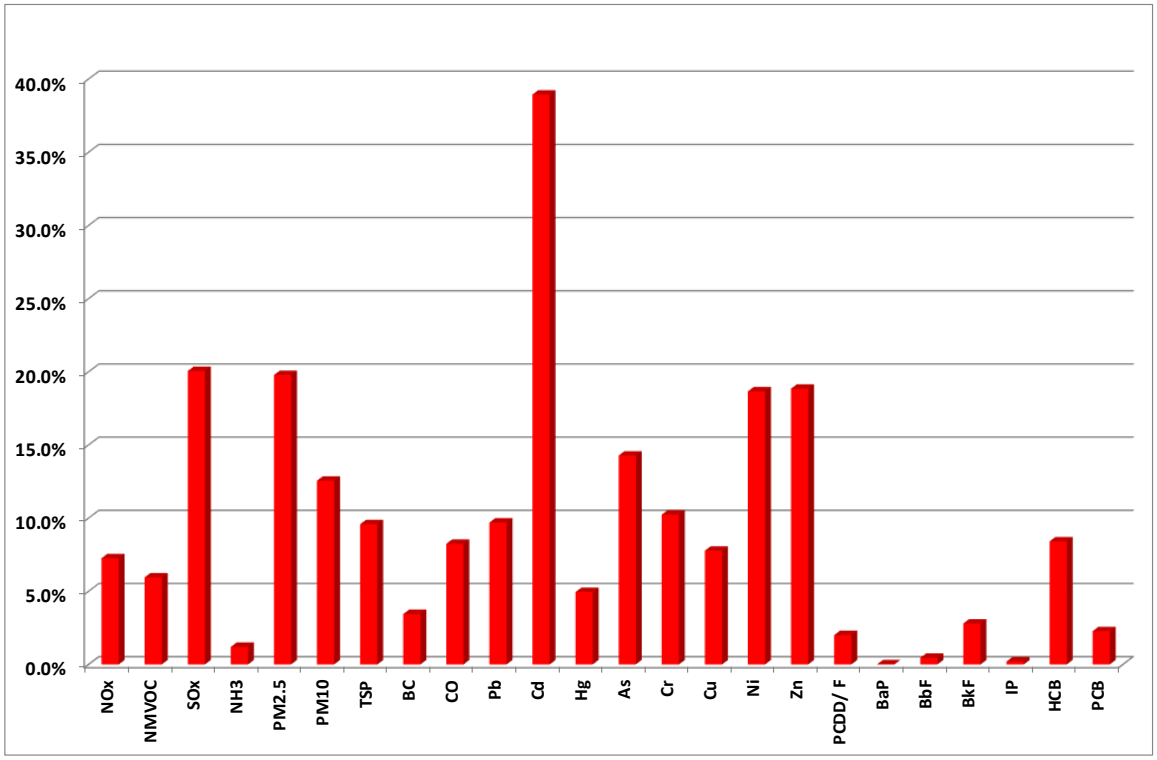

Figure 3.9. Shares of emissions from the 1.A.2 category in the country total

Detailed information on fuel consumption and applied emission factors for subcategories listed below are presented in Annex 5, 2 and 3.

Iron and Steel (NFR sector 1.A.2.a)

Detailed data on fuel consumptions in the subcategory 1.A.2.a *Iron and Steel* for the period 1990-2017 was presented in Annex 5.

Applied emission factors for subcategory 1.A.2.a are presented in Annex 6.

Non-Ferrous Metals (NFR sector 1.A.2.b)

Heavy metals emissions from combustion processes (1.A.2.b) are moved to processes in production of: lead (2.C.5), zinc (2.C.6), copper (2.C.7a) and relevant 2.C categories.

Detailed data concerning fuel consumption in the sub-category 1.A.2.b *Non-Ferrous Metals* over the 1990-2017 period are presented in Annex 5. Applied emission factors for subcategory 1.A.2.b are presented in Annex 6.

Chemicals (NFR sector 1.A.2.c)

The data on fuels consumption in 1.A.2.c subcategory for the entire period 1990-2017 was presented in Annex 5. Emission factors for subcategory 1.A.2.c are presented in Annex 6.

Pulp, Paper and Print (NFR sector 1.A.2.d)

The detailed data on fuels use in the sub-category 1.A.2.d *Pulp, Paper and Print* over the 1990-2017 period are presented in Annex 5. Emission factors for subcategory 1.A.2.d are presented in Annex 6.

Food Processing, Beverages and Tobacco (NFR sector 1.A.2.e)

The detailed data on fuels use in the sub-category 1.A.2.e *Food Processing, Beverages and Tobacco* over the 1990-2017 period are presented in Annex 5. Emission factors for subcategory 1.A.2.e are presented in Annex 6.

Non-metallic minerals (NFR sector 1.A.2.f)

The detailed data on fuels use in the sub-category 1.A.2.f Non-metallic minerals (and other industries) over the 1990-2016 period are presented in Annex 5. Emission factors for subcategory 1.A.2.f are presented in Annex 6.

Other (NFR sector 1.A.2.g)

This category is generally a part of the category SNAP 03, however no stationary emission sources were identified and included in it (NFR sector 1.A.2.g viii).

According to the currently applied methodology for inventory preparation, diesel oil consumed for mobile combustion (off-road vehicles and other machinery) in industry and construction sub-sectors is included in subsectors of NFR 1.A.3.b *Road transport*. Therefore for NFR sector 1.A.2.g vii notation key `IE` has been applied.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory Poland will check, whether fuel consumption data for NFR sector 1.A.2.g vii could be modelled based on other statistical data.

3.2.2 Methodological issues

Methodology of emission estimation in 1.A.2 subcategory corresponds with methodology described for fuel combustion in stationary sources (chapter 3). Activity data on fuel use for this sector come from energy statistics.

3.2.3 Emission trends for the NFR sector 1.A.2

Volumes and trend of pollutant emissions for Manufacturing Industries and Construction (stationary) are shown below on figures below (Figure 3.10 - Figure 3.15).

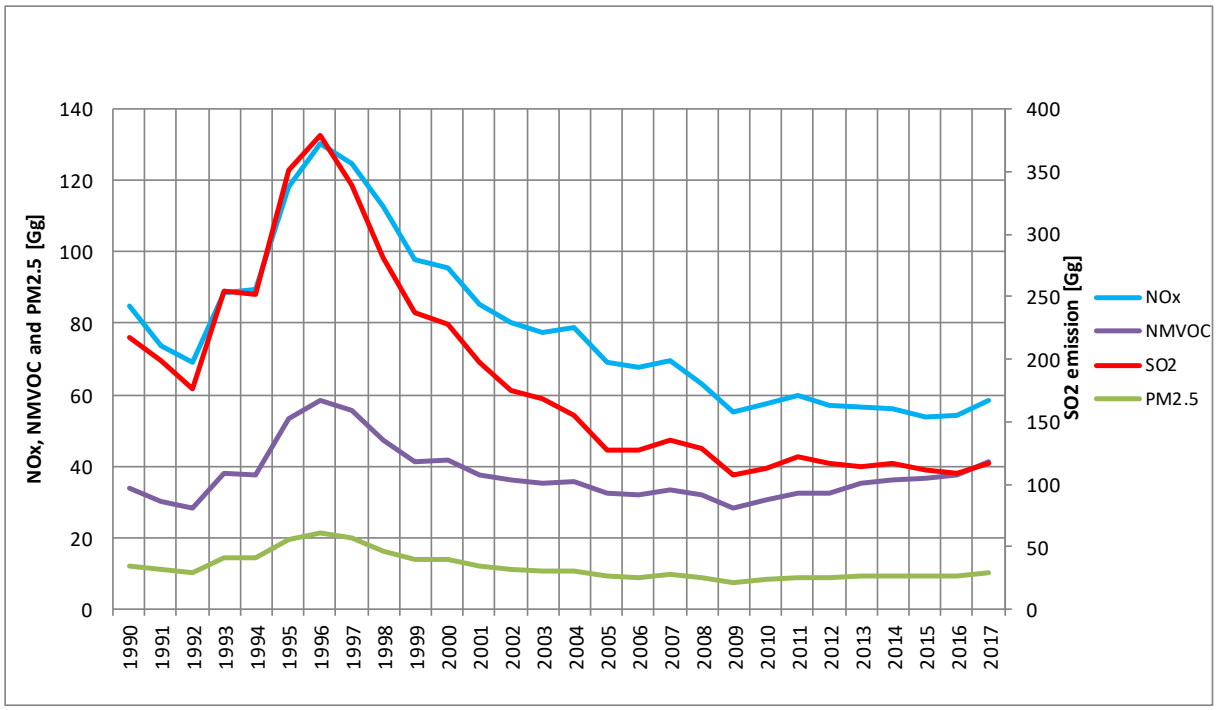

Figure 3.10. SO_2, NOx, PM2.5 and NMVOC emissions for 1.A.2 category in 1990-2017

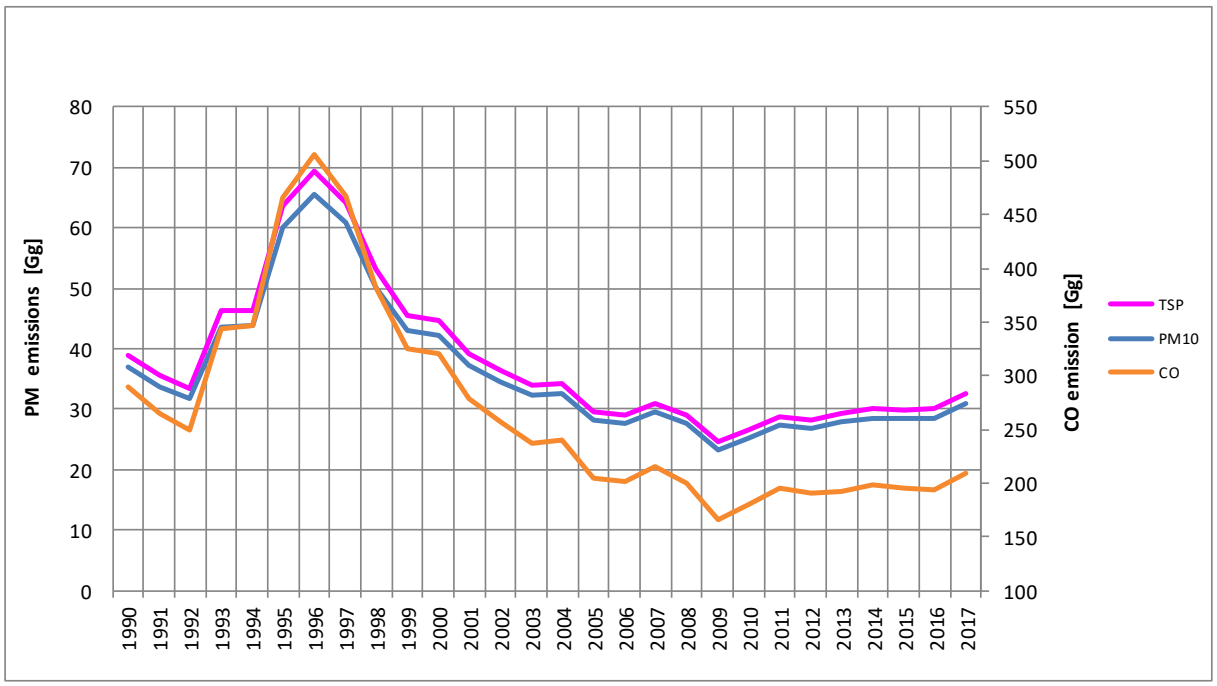

Figure 3.11. Particulates and CO emissions for 1.A.2 category in 1990-2017

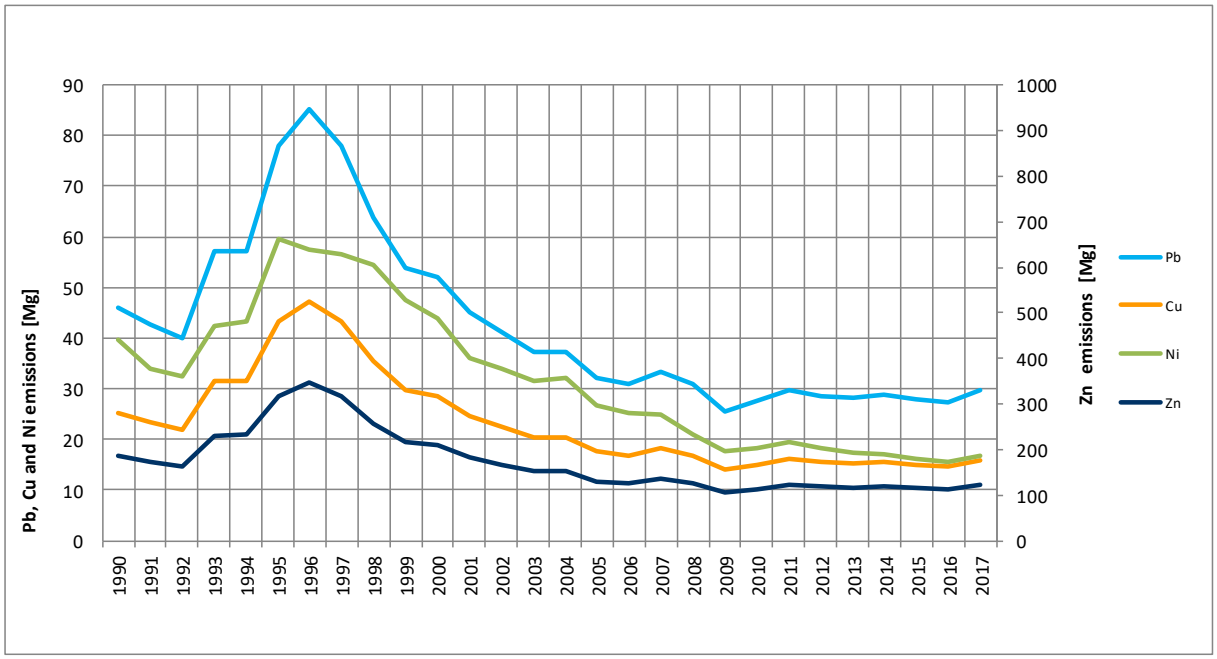

Figure 3.12. Pb, Cu, Ni and Zn emissions for 1.A.2 category in 1990-2017

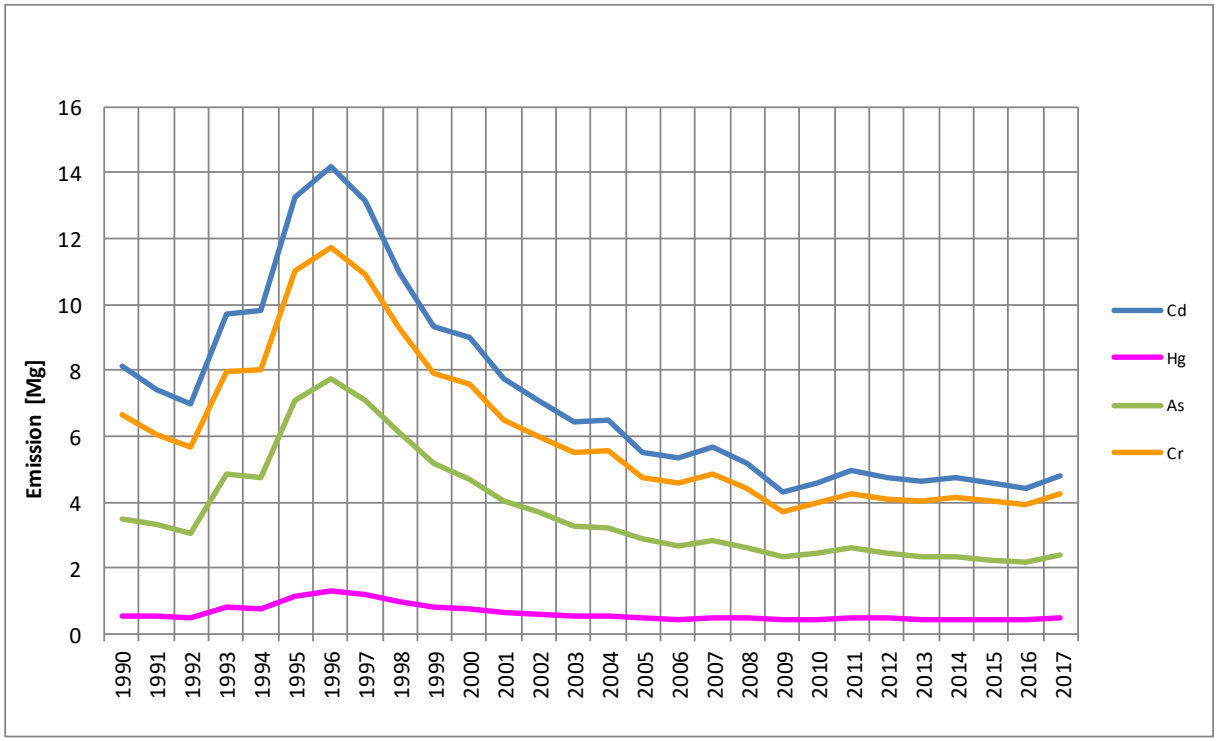

Figure 3.13. Cd, Hg, As and Cr emissions for 1.A.2 category in 1990-2017

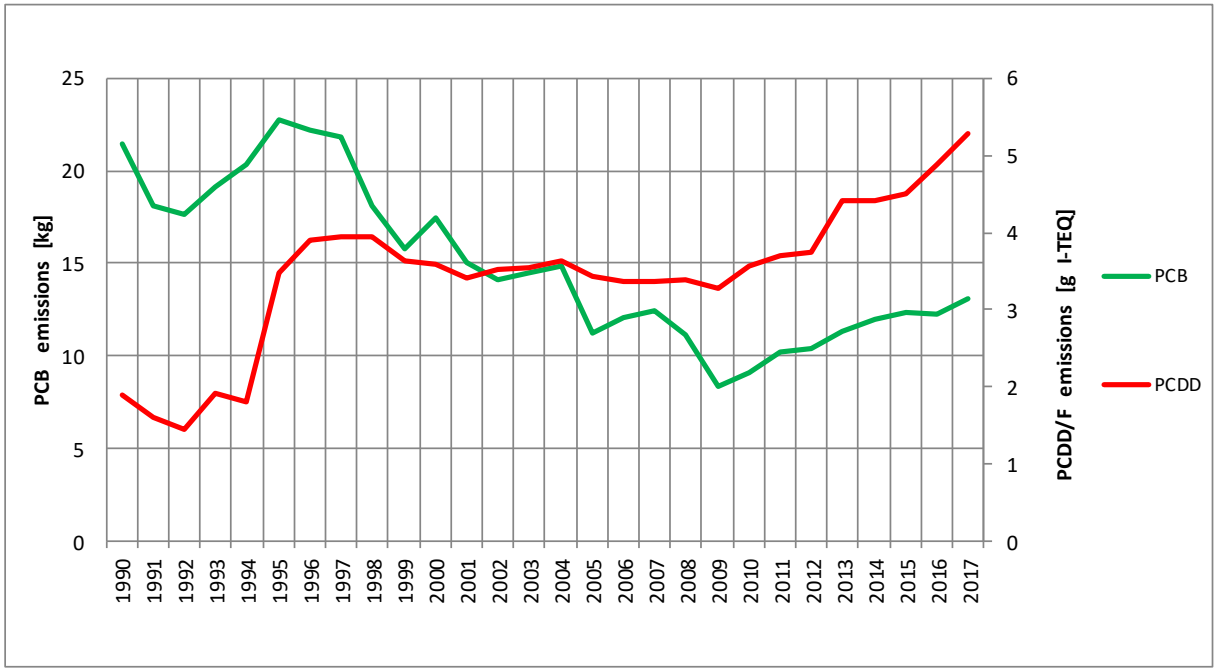

Figure 3.14. PCB and PCDD/F emissions for 1.A.2 category in 1990-2017

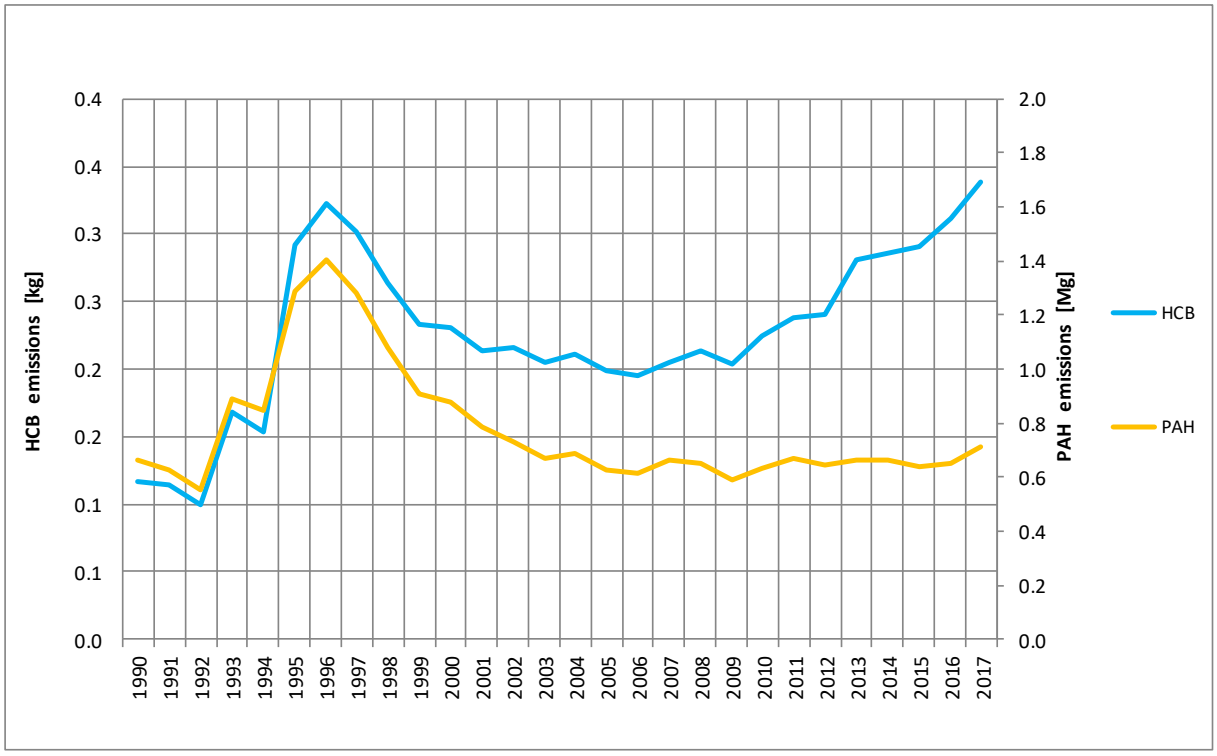

Figure 3.15. HCB and PAH emissions for 1.A.2 category in 1990-2017

3.2.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector *1.A.2* was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector *1.A.2* are given below.

Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 3.2. Results of the uncertainty analysis for NFR sector 1.A.2

NFR subsector		NOX	NMVOC	SO_2	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAH
1A2a	Iron and steel	28%	50%	15%	70%	70%	70%	70%	90%	90%	90%	100%	100%	100%
1A2b	Non-ferrous metals	6%	50%	10%	70%	70%	70%	70%	90%	90%	90%	100%	100%	100%
1A2c	Chemicals	30%	50%	20%	70%	70%	70%	70%	90%	90%	90%	100%	100%	100%
1A2d	Pulp, Paper and Print	30%	50%	20%	70%	70%	70%	70%	90%	90%	90%	100%	100%	100%
1A2e	Food processing, beverages and tobacco	30%	50%	20%	70%	70%	70%	70%	90%	90%	90%	100%	100%	100%
1A2f	Non-metallic minerals	27%	50%	14%	29%	50%	50%	50%	90%	90%	90%	85%	85%	85%

3.2.5 Source-specific QA/QC and verification

For further details please see chapter 3.1.5.

3.2.6 Source-specific recalculations

- Activity data on fuel consumption for years 1990-2016 were updated due to changes made in EUROSTAT database.
- Emission factors for NOx, NMVOC, CO, PM, WWA were updated (where appropriate) based on EMEP/EEA Inventory Guidebook 2016.
- NH3 emission from subcategory 1.A.2.d from biomass burning was recalculated.
- HM, PCDD/F and PAH emissions from combustion processes (1.A.2.b) are moved to processes in production in relevant 2.C categories.
- Erroneous AD for category 1.A.2gviii have been removed from NFR tables.
- To avoid double counting and keep the statistical consistency the emission of air pollutants from grey iron foundries has been included in fuel combustion sector 1A2a.

3.2.7 Source-specific planned improvements

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory Poland will check, whether fuel consumption data for NFR sector 1.A.2.g vii could be modelled based on other statistical data.

Poland is investigating appropriate waste calorific values in order to apply the EFs on a mass basis to the activity data on an energy basis. Estimates of emissions from combustion of waste in sector 1.A.2 will be included in the inventory in the next submission (if available).

3.3 Transport (NFR sector 1.A.3)

3.3.1 Source category description

Estimation of emissions in 1.A.3 *Transport* are carried out for each fuel in sub-categories listed below:

- Civil and International Aviation 1.A.3.a
- Road Transportation 1.A.3.b
- Railways 1.A.3.c
- Navigation 1.A.3.d
- Other Transportation 1.A.3.e

Shares of emissions from the 1.A.3 category in the country total for the particular pollutants in 2017 are shown on the Figure 3.16.

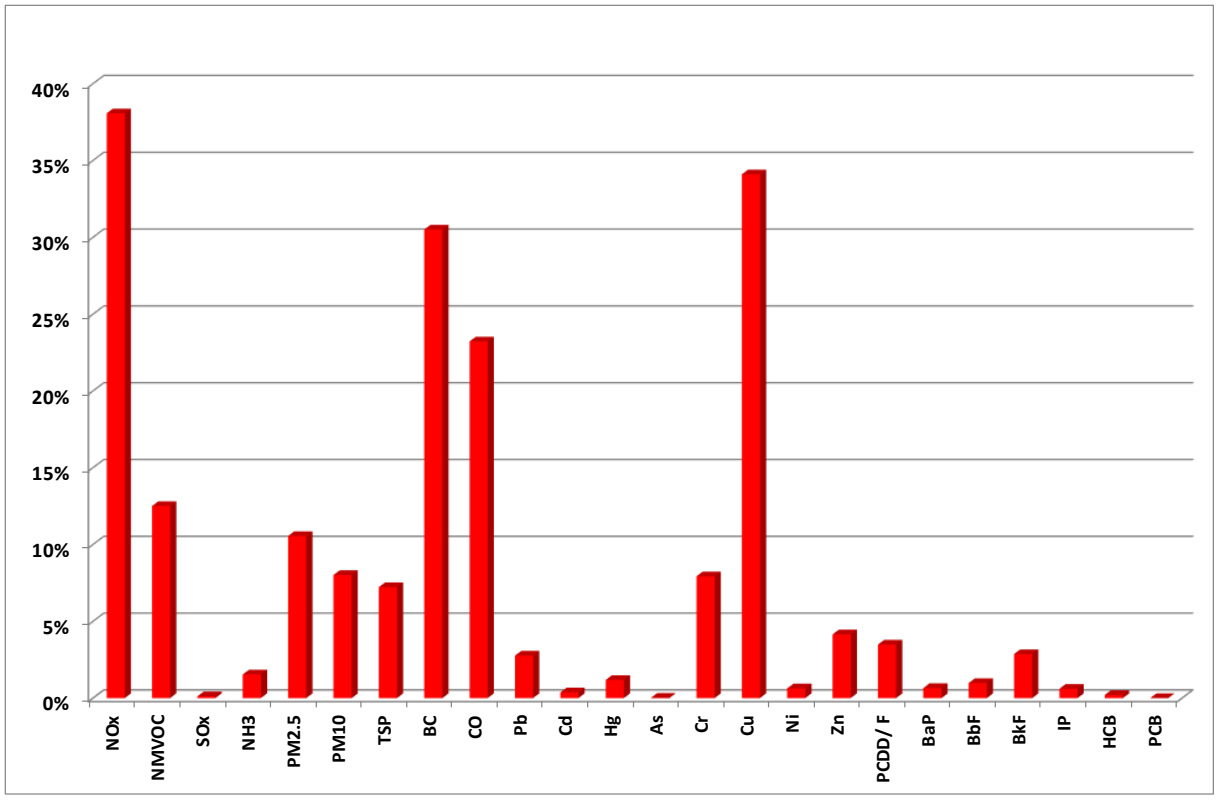

Figure 3.16. Shares of emissions from the 1.A.3 category in the country total

3.3.1.1 International Aviation (NFR sector 1.A.3.a i)

This category include emissions from flights that depart in one country and arrive in a different country.

For the years 1990-2017 data related to jet kerosene are those of the Eurostat database. Jet kerosene given in Polish energy statistics is reported as International aviation although includes whole amount of jet kerosene used for domestic and international purposes. To split jet kerosene use Eurocontrol data were applied. The total amount of jet kerosene used by Poland – calculated by

Eurocontrol is similar to this reported by Poland to Eurostat. To stay in line with Eurostat database (and Polish statistics) only the share of domestic and international fuel use were used based on Eurocontrol data. In the Table 3.3 there are given Eurocontrol data of jet kerosene used in Poland for international and domestic purposes, the share of domestic and international use with the Eurostat data for comparison.

Table 3.3. Eurocontrol and Eurostat data of jet kerosene used in Poland and the share of domestic and international use

Jet kerosene use	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Eurocontrol														
- domestic	Gg	22.96	25.90	28.21	27.68	25.38	29.53	32.59	46.91	34.89	39.01	34.72	34.58	38.28
- international	Gg	302.91	383.71	455.13	514.95	453.34	477.98	480.00	495.69	519.19	550.39	587.60	668.11	781.72
Total	Gg	325.87	409.61	483.34	542.63	478.72	507.51	512.59	542.60	554.08	589.40	622.32	702.69	820.00
Eurostat	Gg	311.00	415.00	432.00	519.00	470.00	495.00	485.00	537.00	524.00	590.00	646.00	685.00	851.60
Share		7.04	6.32	5.84	5.10	5.30	5.82	6.36	8.65	6.30	6.62	5.58	4.92	4.67
- domestic	%	92.96	93.68	94.16	94.90	94.70	94.18	93.64	91.35	93.70	93.38	94.42	95.08	95.33
- international	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Due to the lack of Eurocontrol data for the years before 2005, the share for years 1988-2004 was assumed as a 5-years average from Eurocontrol data for years 2005-2009. The 5-years average, taken from the nearest years to data lack period, was evaluated as the most representative in consultations with experts in the area of transport and energy. The share 94.07% was then accepted for the whole period before 2005. Such assumption seems to be reliable and not affecting accuracy of the inventory.

Table 3.4 presents the amounts of fuels used in the sub-category 1.A.3.a.i - International Aviation for the years 1990-2017. For the LTO cycle it was initially assumed that 13% of the fuel use is used for that part of flight.

Table 3.4. Jet kerosene consumption in the sub-category 1.A.3.a.i - International Aviation for the years 1990-2017 [Gg]

Year	Jet kerosene	Year	Jet kerosene
1990	215	**2004**	274
1991	222	**2005**	311
1992	241	**2006**	415
1993	240	**2007**	432
1994	243	**2008**	519
1995	262	**2009**	470
1996	308	**2010**	495
1997	276	**2011**	485
1998	281	**2012**	537
1999	251	**2013**	524
2000	267	**2014**	590
2001	263	**2015**	646
2002	258	**2016**	685
2003	279	**2017**	852

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory emission factors from the 2016 EMEP/EEA Guidebook were implemented for those pollutants for which are available. All emission factors applied for International Aviation are shown in the Annex 6.

3.3.1.2 Civil Aviation (NFR sector 1.A.3.a ii)

This category includes emissions from passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.). It excludes use of fuel at airports for ground transport and fuel for stationary combustion at airports.

For the years 1990-2017 data related to aviation gasoline and jet kerosene are those of the Eurostat database. The methodology to split jet kerosene used for domestic and international purposes is described above in chapter 3.3.1.1. For the LTO cycle it was initially assumed that 30 % of the fuel use is used for that part of flight. Table 3.5 presents the amounts of fuels used in the sub-category 1.A.3.a ii - Civil Aviation for the years 1990-2017.

Table 3.5. Amounts of fuels used in the sub-category 1.A.3.a ii - Civil Aviation for the years 1990-2017 [Gg]

Fuel	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Jet kerosene	12.73	13.15	14.27	14.21	14.39	15.51	18.24	16.34	16.64
Aviation gasoline	8.00	5.00	2.00	4.00	10.00	7.00	4.00	6.00	4.00
Fuel	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Jet kerosene	14.86	15.81	15.57	15.28	16.52	16.22	21.91	26.24	25.21
Aviation gasoline	3.00	3.00	3.00	4.00	4.00	3.00	3.00	3.00	4.00
Fuel	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Jet kerosene	26.48	24.92	28.80	30.84	46.43	33.00	39.05	36.04	33.71
Aviation gasoline	3.00	4.00	4.00	5.00	5.00	4.00	5.00	4.00	4.00
Fuel	**2017**								
Jet kerosene	39.76								
Aviation gasoline	3.34								

Referring to recommendations from 2018 NECD Comprehensive Review of Polish inventory:

- notation key for NH_3 has been changed from “NA” to “NE”,
- values in the NFR tables have been revised.

Poland will attempt to collect additional data on lead content in aviation gasoline.

All emission factors applied for Civil Aviation are shown in the Annex 6.

3.3.1.3 Road Transportation (NFR sector 1.A.3.b)

This category includes emissions from all types of vehicles such as: passenger cars, light and heavy duty vehicles, buses, motorcycles and mopeds. Poland applied software COPERT to the official reporting of national emissions within the framework cooperation in the European Union. COPERT 5 is an program aiming at the calculation of air pollutant emissions from road transport and the methodology applied is part of the EMEP/CORINAIR Emission Inventory Guidebook. The use of COPERT allows for estimating emissions in accordance with the requirements of international conventions and protocols and EU legislation.

Calculations for the year 2017 and recalculations of 1990-2016 data were made by model COPERT 5 version 5.2.0. All emission factors are default values from COPERT 5.

Emission estimates for this category are based on:

- fuel consumption,
- number of vehicles per vehicle category, weight or engine size and emission control

technology,

- the mileage per vehicle class,
- mileage share per road class (urban, rural and highways),
- the average speed per vehicle type and per road class,
- monthly temperature (min and max),
- fuel characteristics.

Data on fuel consumption for the years 1990-2017 comes from Eurostat database. Consumption of each type of fuel (used in road transport) in energy statistics is given without distinguishing on individual vehicle type. Therefore, for the purpose of emission inventory, fuel consumption was disaggregated based on COPERT 5 calculations – mass of statistical and calculated fuel consumption is equal.

Consumption of main fuels in road transport (gasoline, diesel oil and LPG) in 1990-2017 period is shown in Table 3.6. Consumption of CNG/LNG by buses was published for the first time last year in national statistics (with data started from year 2015). Therefore GHG emissions from this new vehicle category was reported for the first time in previous submission. Taking into account that the number of CNG/LNG buses in Poland is still relatively small (482 buses in 2015, 481 buses in 2016 and 723 buses in 2017) therefore, it can be assumed that emission in years before 2015 was rather insignificant.

Table 3.6. Amount of fuels consumption in road transport in years 1990-2017 [Gg]

Fuel	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Gasoline	136 137	158 811	168 420	172 057	190 421	193 025	201 781	217 900	222 165
Diesel oil	117 846	116 774	118 147	107 851	101 416	104 890	136 465	139 253	155 341
LPG	0	0	0	1 104	3 266	8 096	11 638	15 456	16 100
Fuel	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Gasoline	247 130	222 704	206 585	189 164	180 678	183 416	177 041	181 620	181 351
Diesel oil	162 076	134 792	140 583	134 835	164 178	200 986	229 815	268 768	323 209
LPG	21 482	19 550	26 956	38 134	49 220	61 686	71 254	78 200	80 500
Fuel	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Gasoline	179 196	179 775	177 660	168 030	160 830	153 225	148 020	152 994	161 594
Diesel oil	352 552	365 972	402 820	421 915	401 954	369 436	379 221	407 382	484 266
LPG	79 074	76 038	76 360	73 968	73 876	73 278	73 830	74 980	79 396
CNG/LNG								669	611

Fuel	**2017**
Gasoline	176 617
Diesel oil	578 072
LPG	84 275
CNG/LNG	466

The number of vehicles per vehicle category, weight or engine size and emission control technology comes from Polish Central Vehicle and Driver Register system (CEPiK) and Statistics Poland [GUS 2018d]. The amount of vehicles according to categories and fuel type is shown in the Figure 3.17.

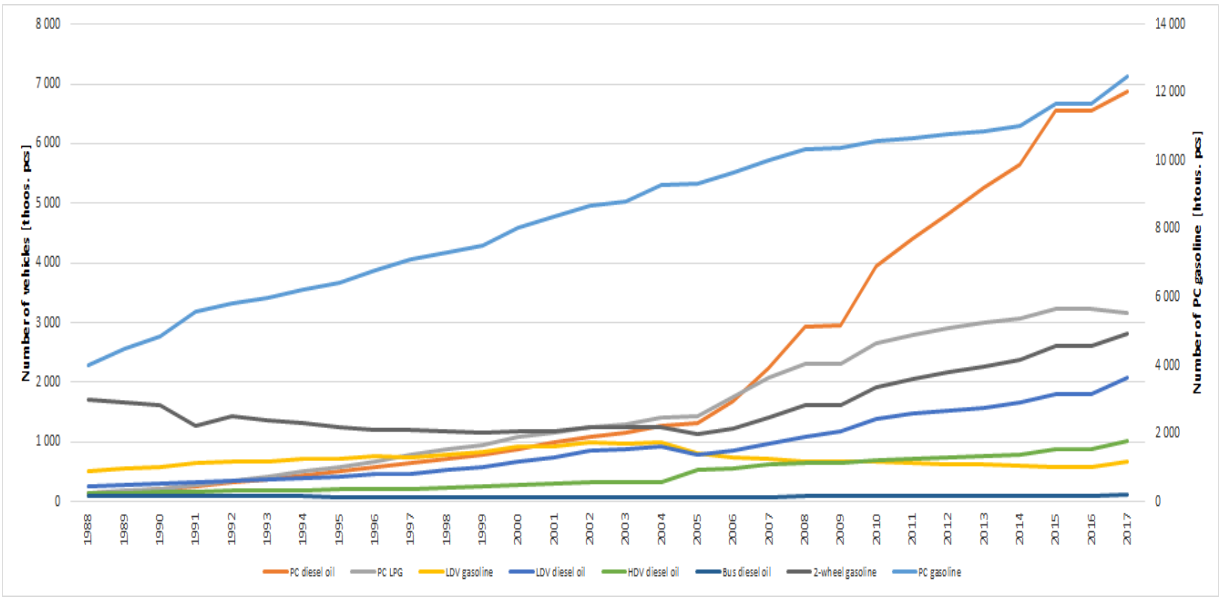

Figure 3.17. Number of vehicles in 1990-2017.

Annual mileage for main vehicle categories, speed and share in different travel conditions comes from literature and on the basis of own research. Estimations was based on the results of balancing the consumption of fuel in road transport as well as the results of data from surveys carried out by the vehicle inspection stations, tonne-kilometers, number of registered vehicles and the technical and operational average values characterizing the work of motor transport (eg. average number of people in car, average utilization rate of the fleet, etc.).

To determine the annual mileage of vehicle for particular ecological categories a model of the intensity of use of vehicles was developed [53]. This model was created on the basis of functional similarity and on the structure of vehicles at the particular categories. These data were determined using INFRAS software. Average annual mileage for main categories in 2017 are presented in Figure 3.18. Mileage share and speed per road class are shown in Figure 3.19. and Figure 3.20. Estimations were made using information from Chłopek [48 – 50].

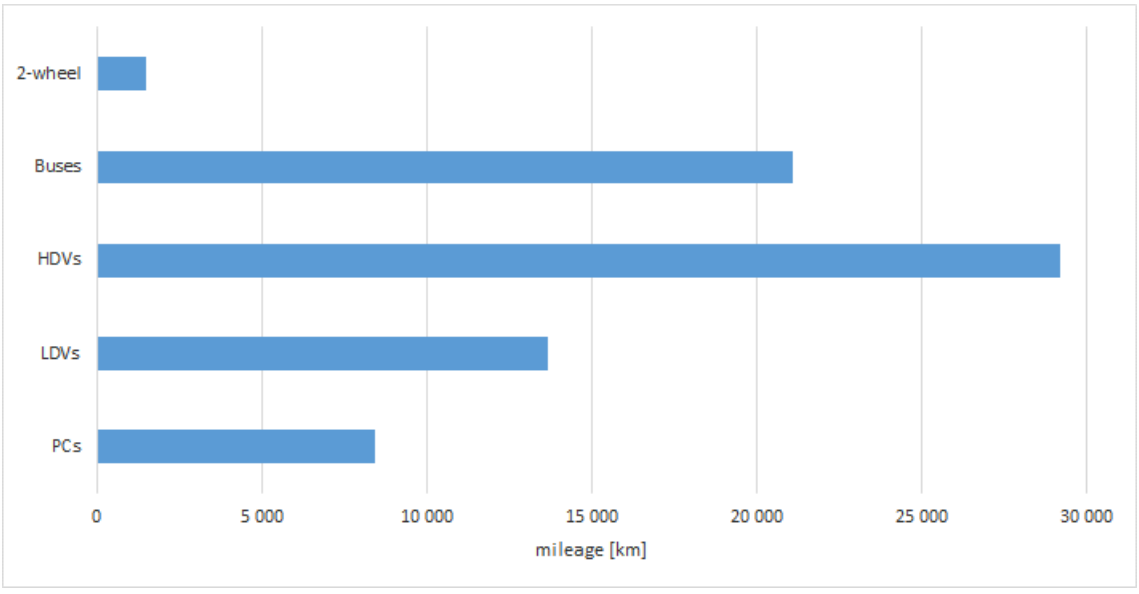

Figure 3.18. Annual mileage driven by vehicles in 2017

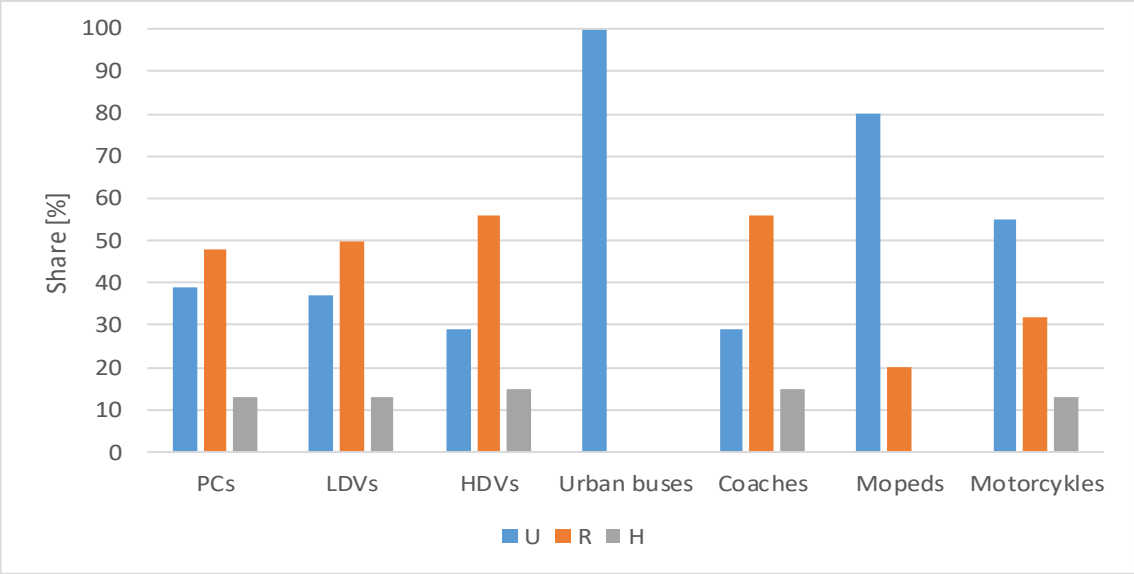

Figure 3.19. Mileage share per road class (urban, rural and highways) in 2017

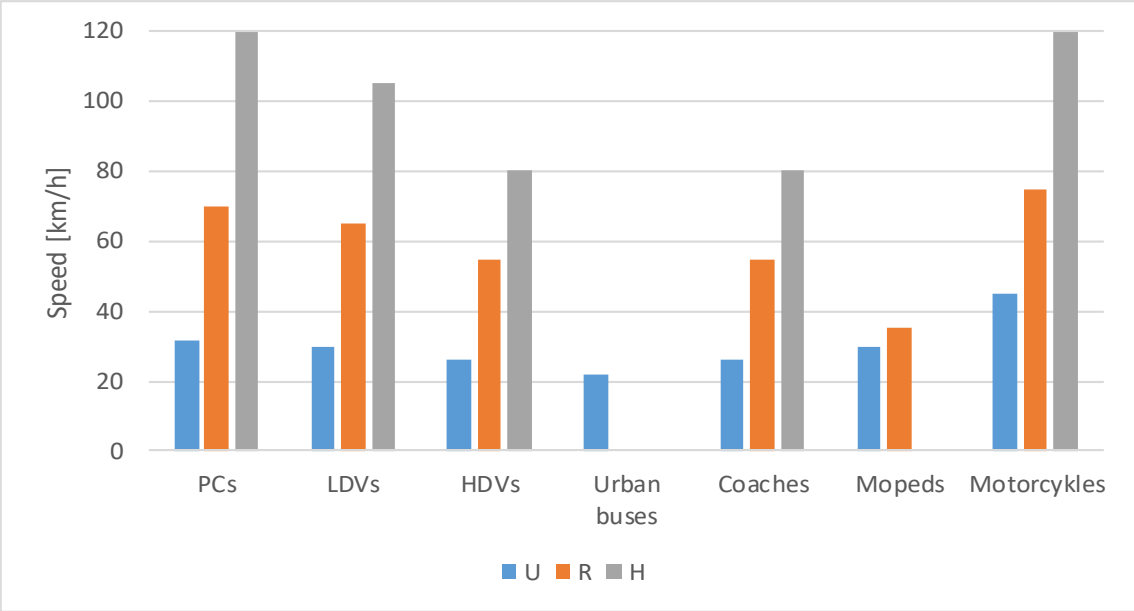

Figure 3.20. The average speed per road class (urban, rural and highways) in 2017

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory:

- the assumptions to estimate NMVOC emissions from NFR 1A3bv Road Transport: Gasoline Evaporation have been checked and revised,
- particulates emissions from road abrasion have been estimated by COPERT 5,
- all HM and POP emissions have been calculated by COPERT 5. Pb emission has been estimated including new activity data according to the recommendation,
- pollutants emissions from lubricants use have been estimated by COPERT 5 (see category 2.D.3.i),
- all values in the NFR tables have been revised.

3.3.1.4 Railways (NFR sector 1.A.3.c)

This category includes emissions from railway transport for both freight and passenger traffic routes. Railway locomotives used in Poland are diesel and electric. With reference to the question raised during 2018 Review, Poland explained that steam locomotives were in use in Poland only up to year 1998, therefore for later years 'NO' notation key has been used for emission from solid fuels use. Also national statistics confirm this state as no data concerning coal use by locomotives is reported.

Electric locomotives are powered by electricity generated at stationary power plants as well as other sources. The corresponding emissions are covered under the Stationary Combustion sector.

The amounts of fuels used in railway transport in the 1990-2017 period are shown in Table 3.7.

Table 3.7. Amounts of fuels used in railway transport in the 1990-2017 [Gg]

Fuel	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Diesel oil	414.00	316.00	247.00	243.00	275.00	268.00	225.00	202.00	190.00
Hard coal	141.00	75.00	15.00	13.00	7.00	6.00	8.00	8.00	6.00
Fuel	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Diesel oil	180.00	165.00	161.00	153.00	161.00	161.00	158.00	145.00	143.00
Hard coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Diesel oil	125.00	120.00	111.00	115.00	107.00	99.00	89.00	82.00	82.00
Hard coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel	**2017**								
Diesel oil	106.50								
Hard coal	0.00								

Emission factors applied for Railways are shown in the Annex 6.

3.3.1.5 Navigation (NFR sector 1.A.3.d)

This category relates to inland and marine domestic navigation and include emissions from fuels used by vessels of all flags that depart and arrive in the same country (excluding fishing). Due to very limited number of vessels, emission from International maritime navigation under Polish flag is small as compared to other countries. To ensure completeness fuel use data for International maritime navigation (Memo Item) already available in Polish energy statistics has been used to estimate these emissions.

The structure of fuels used in Navigation has been calculated based on G-03 energy questionnaires and statistical data on levels of international vs. domestic shipping activity. The amounts of fuels (diesel and fuel oil) used in both inland water and maritime navigation in the 1990-2017 period are shown in the Table 3.8. All emission factors applied for National navigation are shown in the Annex 6.

Table 3.8. The amounts of fuels used in navigation in the 1990-2017 [Gg]

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998
Inland navigation - Diesel Oil	20.00	16.00	19.00	16.00	7.00	16.00	16.00	15.00	9.00
Marine - Diesel oil	5.50	4.34	2.82	1.94	2.32	2.21	1.66	0.65	0.62
Marine - fuel oil	22.55	20.67	13.68	8.54	10.69	10.75	9.94	3.21	3.93
Fuel	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Inland navigation - Diesel Oil	7.00	6.00	6.00	5.00	7.00	6.00	5.00	6.00	5.00
Marine - Diesel oil	0.58	0.57	0.46	0.45	0.73	0.53	0.70	0.73	0.56
Marine - fuel oil	3.51	3.41	3.28	3.27	4.46	2.11	1.50	1.99	1.62
Fuel	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Inland navigation - Diesel Oil	5.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00
Marine - Diesel oil	0.61	0.38	0.21	0.24	0.23	0.31	0.17	1.59*	4.75*
Marine - fuel oil	1.60	0.94	0.31	0.35	0.26	0.56	0.29	0.00*	0.00*
Fuel	**2017**								
Inland navigation - Diesel Oil	4.57								
Marine - Diesel oil	2.20*								
Marine - fuel oil	0.00*								

*Due to the changes in regulations regarding MARPOL Convention 1973/78/97 and implementation of Directive 2012/33/EU of the European parliament and of the council of 21 November 2012 amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels, high sulphur fuel oil was withdrawn from use. Instead low sulphur marine diesel oil (MDO) is used.

Following 2018 Review recommendation emissions estimates from International maritime navigation (Memo Item) have been prepared.

3.3.1.6 Other transportation (NFR sector 1.A.3.e)

Pipeline transport contains combustion related emissions from the operation of pump stations and maintenance of pipelines. From year 2000, when gas pipeline Jamal was completed, the amount of this fuel increased sharply. The emission data for some pollutants reported in the 1.A.3.e.i category from 2011 was derived from the National Emissions Database (individual data). And now emissions from gas burned in compressors' stations have been estimated based on gas use (from 1994) and 2016 Guidebook.

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory emissions for the whole time series was recalculated based on available activity data (since 1994).

3.3.2 Methodological issues

The methodology used for estimation of pollutant emissions in the national inventory for mobile sources for the entire time series 1990-2017 is factor based – data on fuel used are multiplied by the corresponding emission factors. Partly erroneous [TJ] values provided for aviation in the NFR tables in the previous submission have been revised.

Emissions from sector 1.A.3.b. Road transport has been calculated with the use of software COPERT 5. All emission factors are default values from COPERT 5.

Other emission factors for mobile sources were taken from EMEP/EEA guidebook or other international publications. All emission factors used are shown in the Annex 6.

3.3.3 Emission trends for the NFR sector 1.A.3

Volumes and trend of pollutant emissions for Transport are shown below on figures below (Figure 3.22 - Figure 3.26). Drop of SO_2 emissions results from new limit of sulphur contents in fuels.

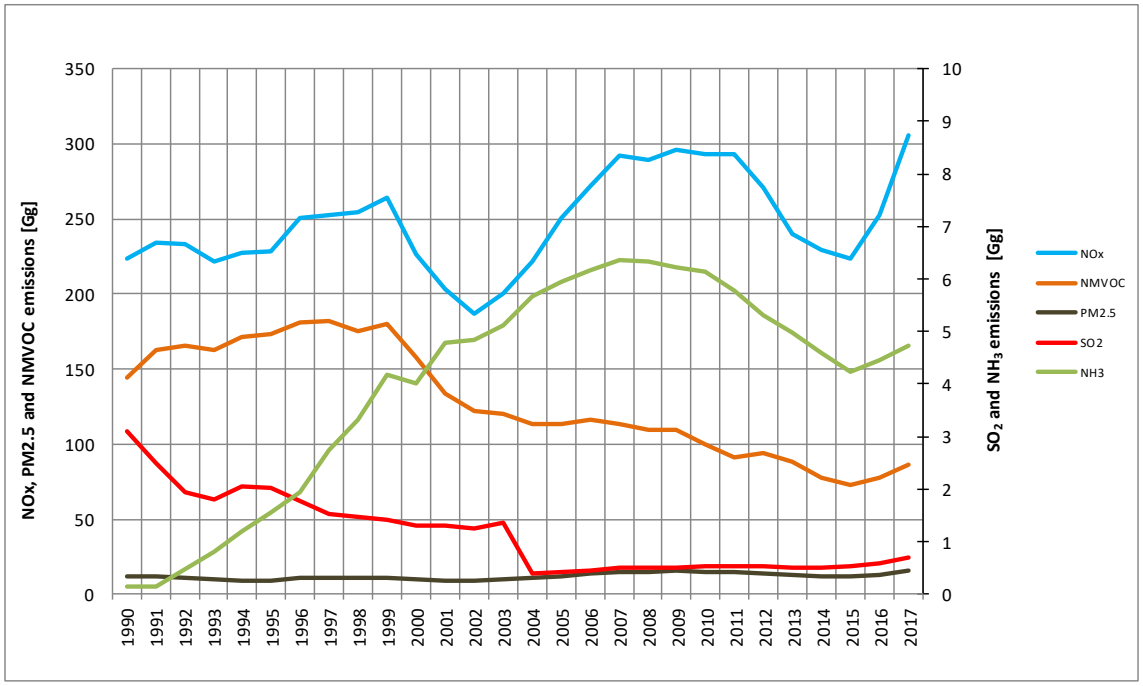

Figure 3.21. SO_2, NOx, NH_3, PM2.5 and NMVOC emissions for 1.A.3 category in 1990-2017

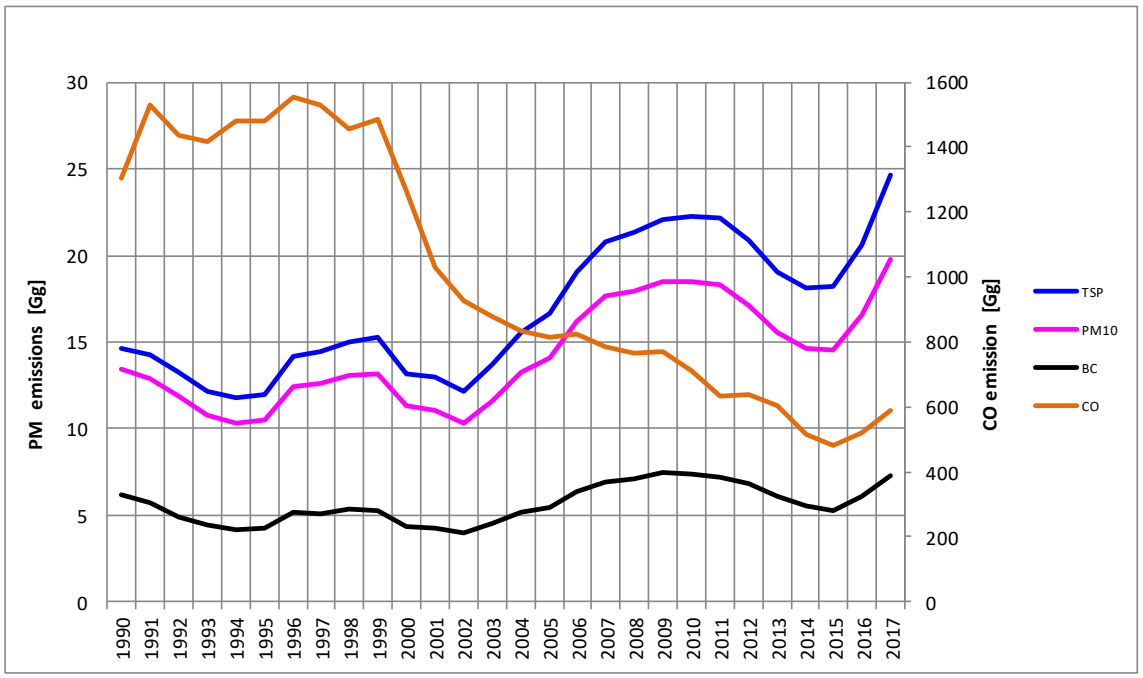

Figure 3.22. Particulates and CO emissions for 1.A.3 category in 1990-2017

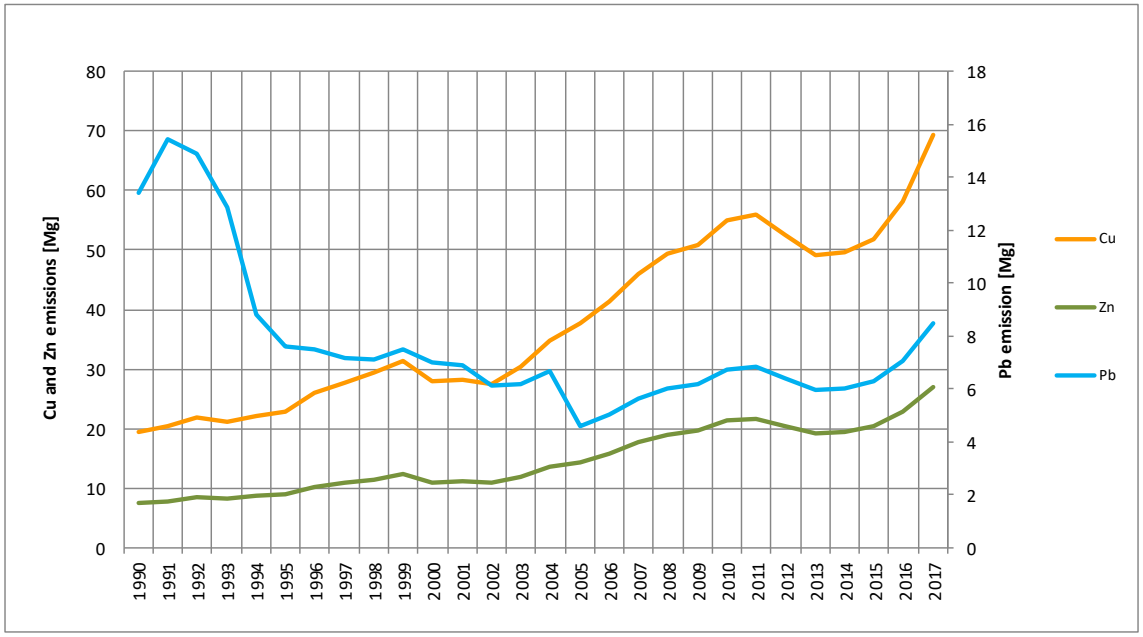

Figure 3.23. Pb, Cu and Zn emissions for 1.A.3 category in 1990-2017

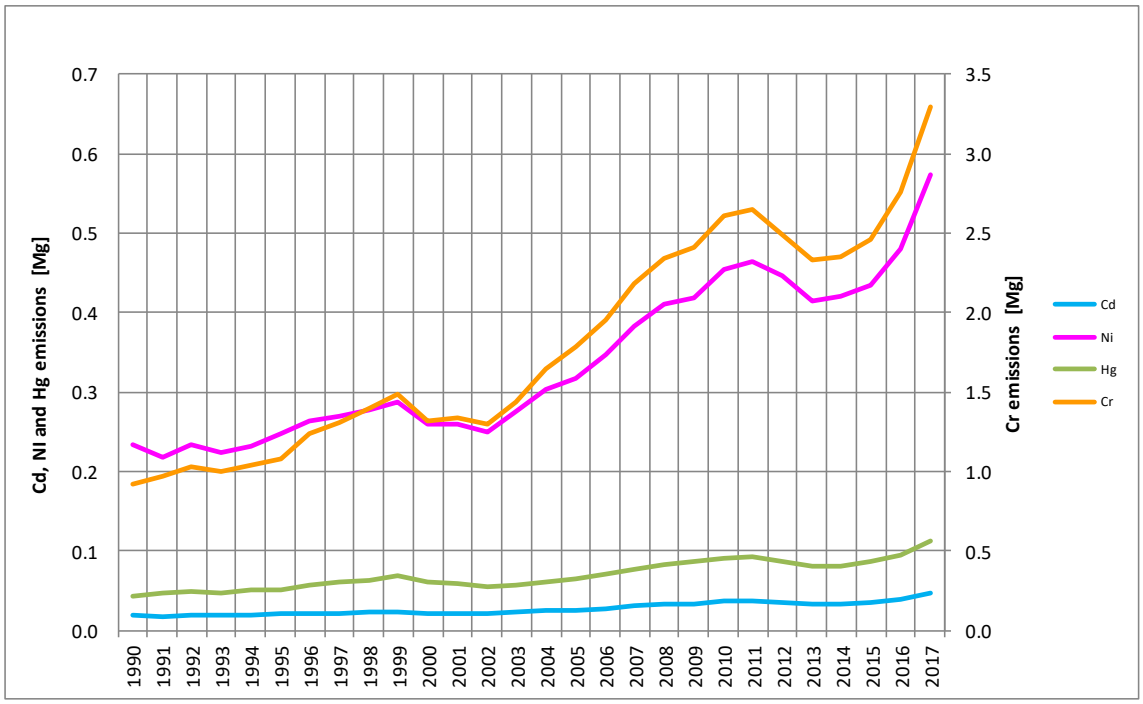

Figure 3.24. Cd, Ni, Hg and Cr emissions for 1.A.3 category in 1990-2017

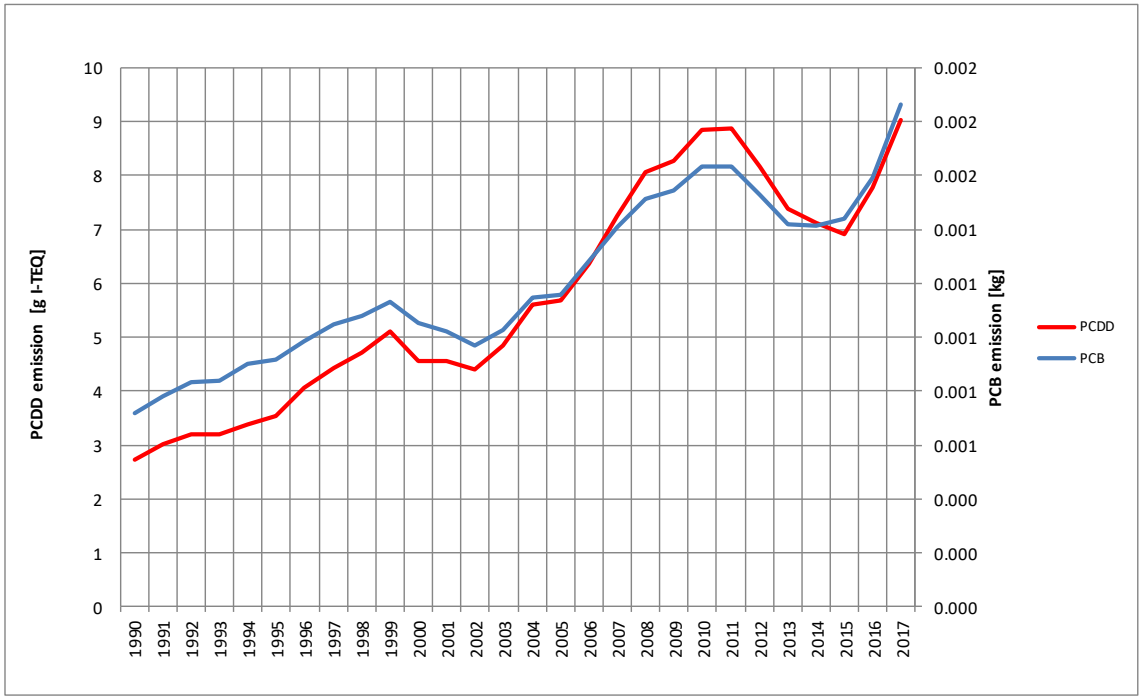

Figure 3.25. PCDD/F and PCB emissions for 1.A.3 category in 1990-2017

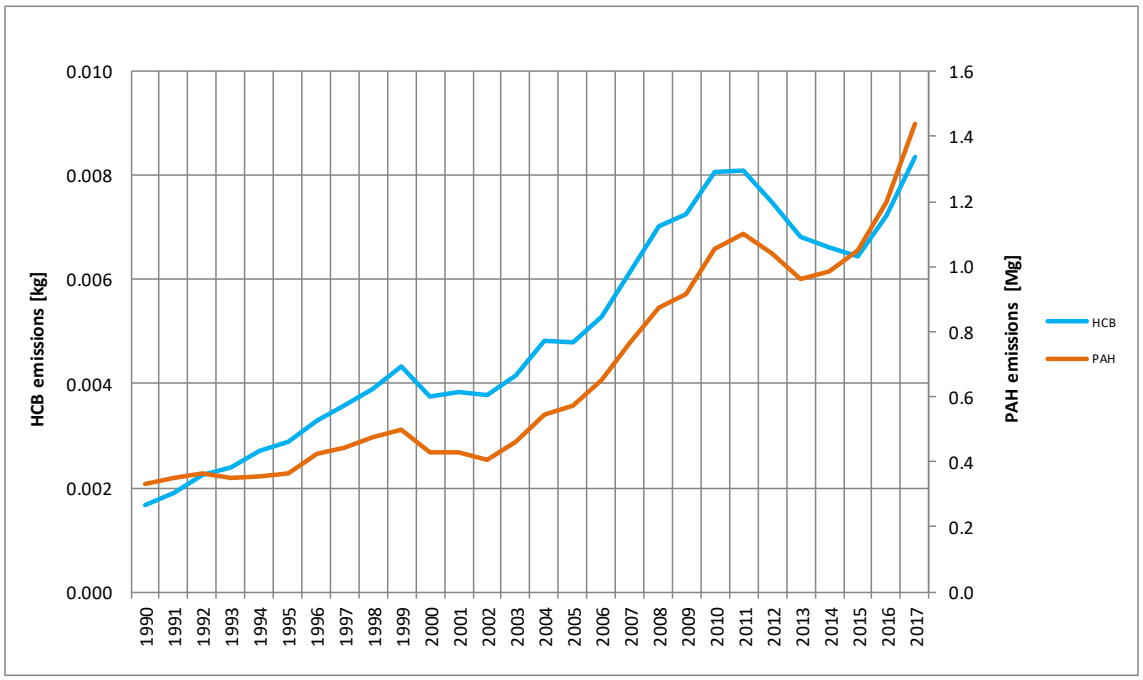

Figure 3.26. HCB and PAH emissions for 1.A.3 category in 1990-2017

3.3.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector *1.A.3* was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector *1.A.3* are given below.

Performed recalculations (period 1990-2017) of data ensured consistency for whole time-series.

Table 3.9. Results of the uncertainty analysis for NFR sector *1.A.3*

NFR subsector		NOx	NMVOC	SO_2	NH_3	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAH
1A3ai(i)	International aviation LTO (civil)	112%	112%	86%	NA	86%	50%	50%	50%						
1A3aii(i)	Domestic aviation LTO (civil)	50%	98%	25%	NA	96%	72%	72%	72%						
1A3bi	Road transport: Passenger cars	70%	49%	19%	83%	70%	70%	70%	70%	70%	70%		70%	70%	70%
1A3bii	Road transport: Light duty vehicles	70%	46%	22%	66%	70%	70%	70%	70%	70%	70%		70%	70%	70%
1A3biii	Road transport: Heavy duty vehicles and buses	70%	59%	20%	66%	70%	70%	70%	70%		70%		70%	70%	70%
1A3biv	Road transport: Mopeds & motorcycles	30%	73%	23%	78%	100%	100%	100%	100%	100%			100%	100%	100%
1A3bv	Road transport: Gasoline evaporation		90%												
1A3bvi	Road transport: Automobile tyre and brake wear	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
1A3bvii	Road transport: Automobile road abrasion	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
1A3c	Railways	50%	100%	30%	50%	100%	100%	100%	100%		50%		100%	100%	100%
1A3dii	National navigation (shipping)	36%	78%	27%		84%	72%	72%	72%	100%	45%	100%	71%	71%	71%
1A3ei	Pipeline transport	50%		70%											

3.3.5 Source-specific QA/QC and verification

Activity data used in the pollutant emission inventory concerning the sector come from yearbooks published by the Statistics Poland (GUS). GUS is responsible for QA/QC of collected and published data.

3.3.6 Source-specific recalculations

- Fuel consumption was corrected based on updated Eurostat database.
- Road transport emission have been estimated and have been updated for the period 1990-2016, based on the country studies [48; 49; 50] and with the use of COPERT 5 software.
- International Aviation emission have been estimated based on emission factors from the 2016 EMEP/EEA Guidebook.
- Pipeline transport emission have been estimated and updated for the period 1994-2016, based on the new activity data.

3.3.7 Source-specific planned improvements

Following recommendations resulting from 2018 NECD Comprehensive Review Poland will:

- check the availability of coal activity data for railways directly from the operators;
- try to collect data on lead content in aviation gasoline;
- try to estimate separate activity data between international inland waterways and national inland waterways (for example by using tkm).

3.4 Other sectors (NFR sector 1.A.4)

3.4.1 Source category description

The category encompasses stationary fuel combustion emission sources (1.A.4.ai, 1.A.4.bi and 1.A.4.ci) as well as mobile off-road machinery and other machinery (1.A.4.cii and 1.A.4.ciii).

Emissions for 1.A.4 *Other Sectors* are calculated based on fuel consumption provided for sub-categories given below:

- Commercial/Institutional (1.A.4.ai)
- Residential (1.A.4.bi)
- Agriculture/Forestry/Fishing (1.A.4.ci)
- Agriculture – mobile sources: off-road vehicles and other machinery (1.A.4.cii)
- Fishing (1.A.4.ciii).

Stationary fuel combustion emission sources (1.A.4ai, 1.A.4.bi and 1.A.4.ci)

The small combustion installations included in this chapter are mainly intended for heating and provision of hot water in residential and commercial/institutional sectors. Secondary activities extend to the use of appliances within residential and commercial sectors for cooking. In the agricultural sector the heat generated by the installations is used also for crops drying and for heating greenhouses.

Mobile fuel combustion emission sources (1.A.4.cii and 1.A.4.ciii)

The type of mobile fuel combustion emission sources includes off-road vehicles and other machinery used in agriculture, forestry and fishing).

Shares of emissions from the 1.A.4 category in the country total for the particular pollutants in 2017 are shown on the Figure 3.27. Subsector 1.A.4.b *Residential* is by far the largest contributor to emissions from this category.

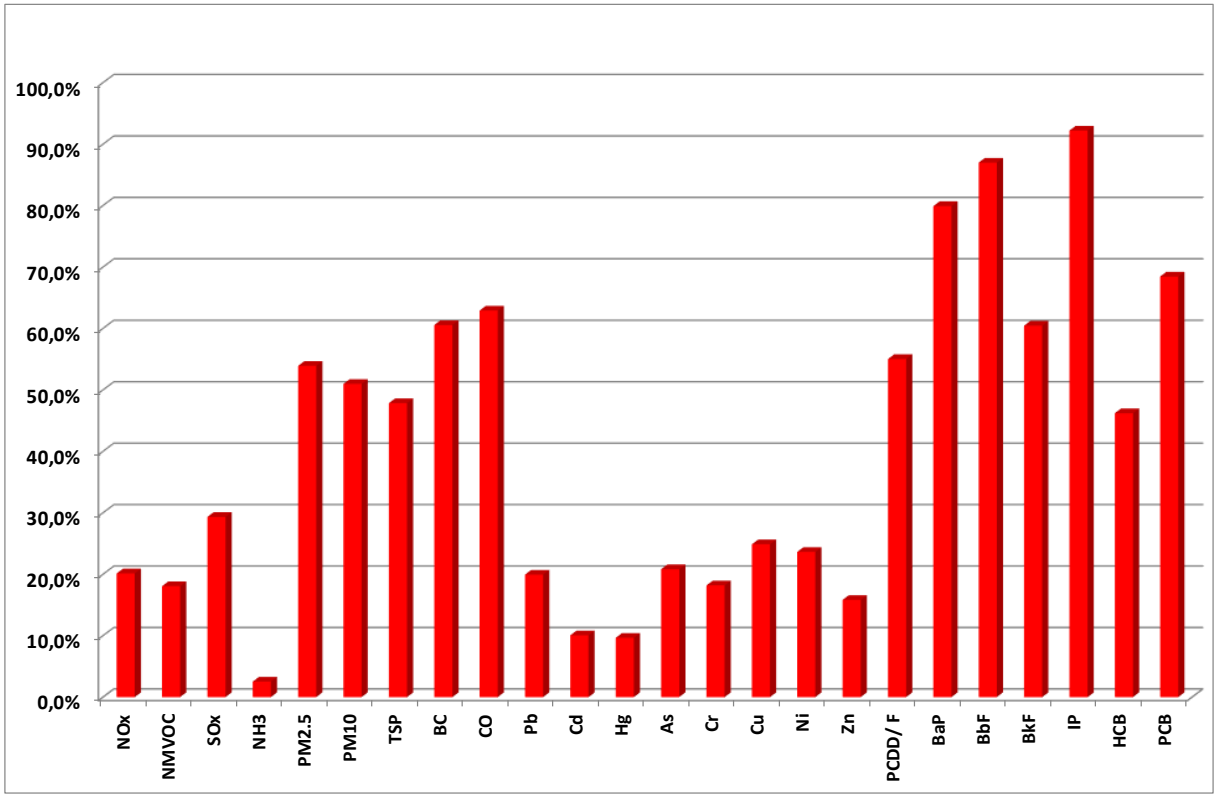

Figure 3.27. Shares of emissions from the 1.A.4 category in the country total

3.4.1.1 Other Sectors – Commercial/Institutional (1.A.4.a i)

The detailed data on fuels use in stationary sources in the sub-category 1.A.4.ai *Other Sectors – Commercial/Institutional* over the 1990-2017 period are presented in table A1.18 in Annex 5.

Applied emission factors are presented in Annex 6.

Recalculations implemented for this category are described in chapter 3.4.6.

3.4.1.2 Other Sectors – Residential (NFR sector 1.A.4.b i)

The detailed data on fuels use in stationary sources in the sub-category 1.A.4.bi *Residential* over the 1990-2017 period are presented in table A1.19 in Annex 5.

Applied emission factors are presented in Annex 6. They also include emission factors which were changed following 2018 Review recommendation.

Recalculations implemented for this category are described in chapter 3.4.6.

3.4.1.3 Other Sectors – Agriculture/Forestry/Fishing – stationary (NFR sector 1.A.4.c i)

The detailed data on fuels use in stationary sources in the sub-category 1.A.4.c.i Agriculture/Forestry/ Fishing over the 1990-2017 period are presented in table A1.20 in Annex 5.

Applied emission factors are presented in Annex 6.

Recalculations implemented for this category are described in chapter 3.4.6.

3.4.1.4 Other Sectors – Agriculture/Forestry/Fishing – mobile sources

Mobile sources included in the national inventory in category 1.A.4 include:

- Machinery and off-road transport in agriculture (sub-category 1.A.4.c.ii);
- Fishing (sub-category 1.A.4.c.iii).

The amounts of fuels used in the above listed sub-categories in the 1990-2017 period are presented in table A1.21 in Annex 5.

Applied emission factors are presented in Annex 6.

Recalculations implemented for this category are described in chapter 3.4.6.

Following 2017 and 2018 Review recommendation:

1. Regarding the decrease of liquid fuel usage comparing 2005 and 2006 in the sub-category 1.A.4.cii Poland has consulted this issue with the Energy Market Agency (ARE) which is responsible for collecting data concerning fuel consumption (and submitting it to GUS).

   The ARE representative stated that:

   - Fuel consumption in this category includes road Diesel and fuel and other gas oil;
   - In the years preceding 2006 a large supply of heating and other gas oil was reported by refineries. In order to balance the supply and demand in the fuel and energy balance, a large part of this fuel was attributed to agriculture, as no justification was found in assigning such a significant amount to stationary sources (quite a common use of light fuel oil instead of diesel in agriculture was assumed).
   - In 2004 Poland had become the EU member and also a beneficiary of EU funds. One of the projects founded by the EU was partial re-financing of Diesel fuel purchase costs incurred by farmers. Beforehand, farmers often used fuel oil instead of Diesel oil due to the fact that it was cheaper and could be used in older machines just as Diesel oil. After the subsidies had been implemented farmers generally started using Diesel.
   - The decrease of fuel consumption between 2005 and 2006 concerned fuel oils, the consumption of Diesel fuel increased, nevertheless total fuel consumption in this category finally decreased.

2. Notation key applied for NH_3 emissions in the sector 1.A.4.ciii has been changed to 'NE'. NH_3 emissions factors for this category are not available in 2016 EMEP/EEA Guidebook.

3.4.2 Methodological issues

Methodology of emission estimation in 1.A.4 subcategory corresponds with methodology described for fuel combustion in stationary sources. Detailed information on fuel consumption and applied emission factors for subsectors included in 1.A.4 subcategory are presented in Annex 5 and 3.

3.4.3 Emission trends for the NFR sector 1.A.4

Volumes and trends of pollutant emissions for 1.A.4 sector are shown below on figures below (Figure 3.28 - Figure 3.33).

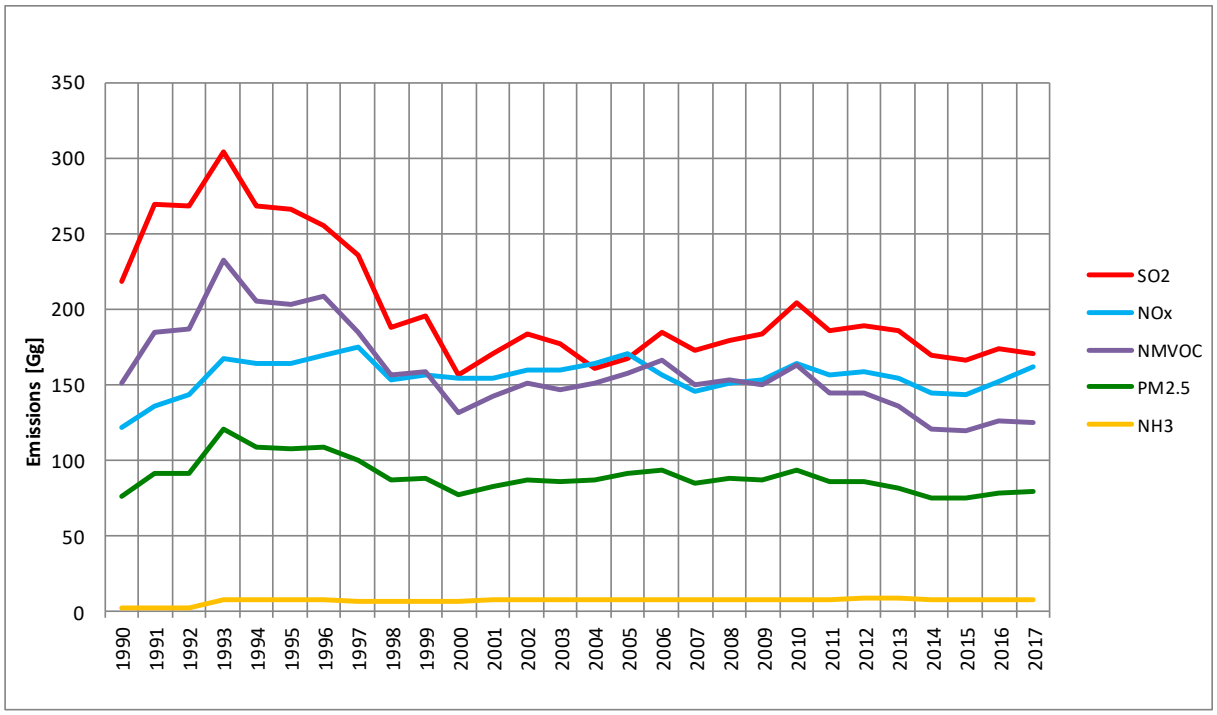

Figure 3.28. SO_2, NOx, PM2.5, NH_3 and NMVOC emissions for 1.A.4 category in 1990-2017

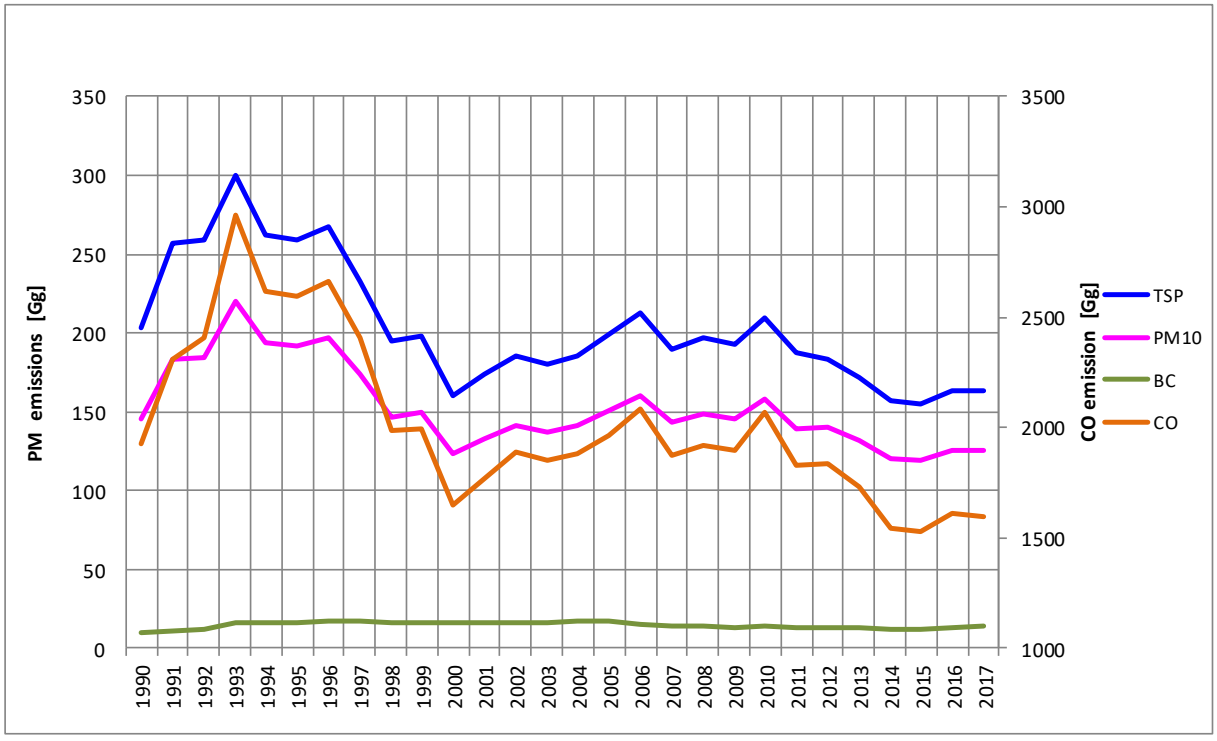

Figure 3.29. CO and particulates emissions for 1.A.4 category in 1990-2017

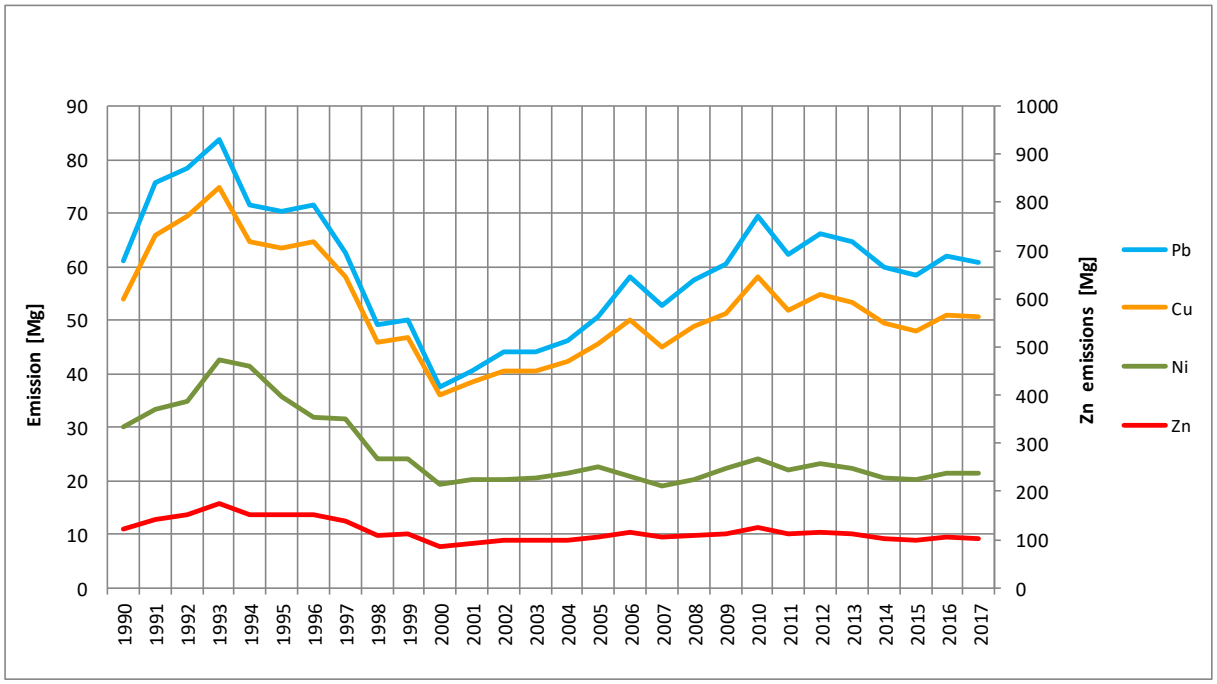

Figure 3.30. Pb, Cu, Zn and Ni emissions for 1.A.4 category in 1990-2017

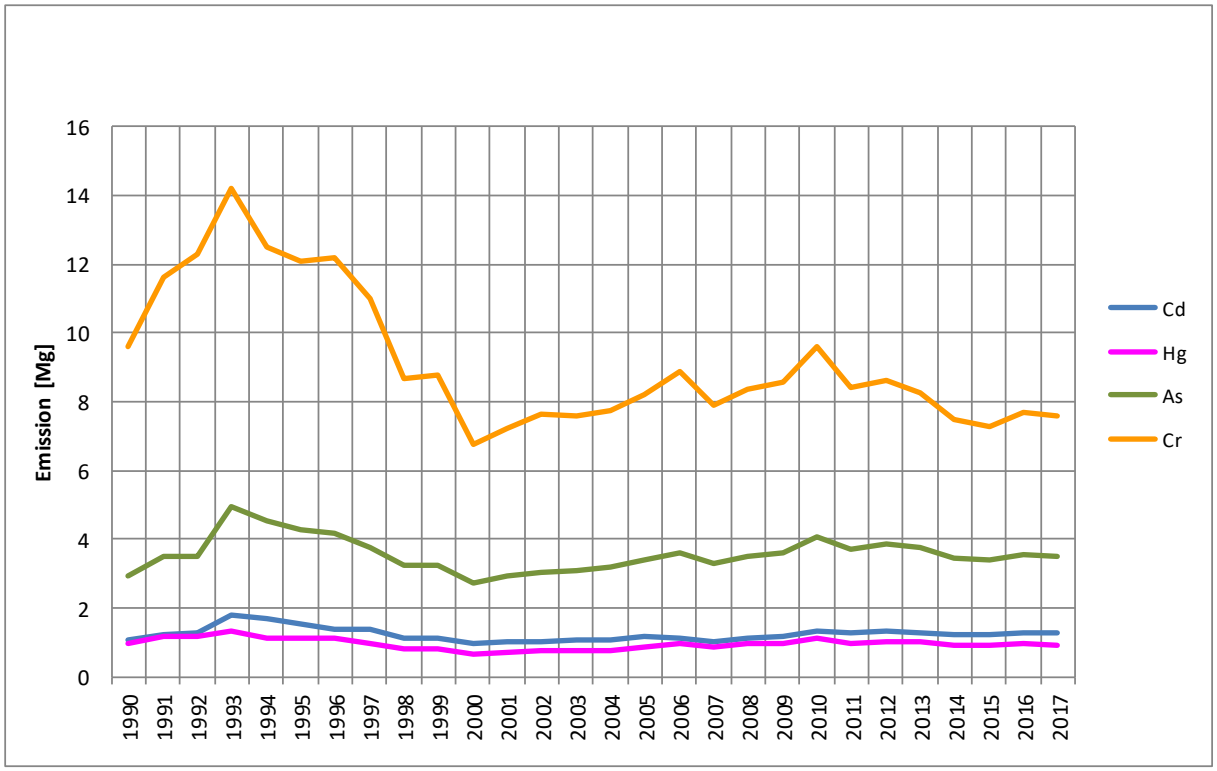

Figure 3.31. Cd, As, Hg and Cr emissions for 1.A.4 category in 1990-2017

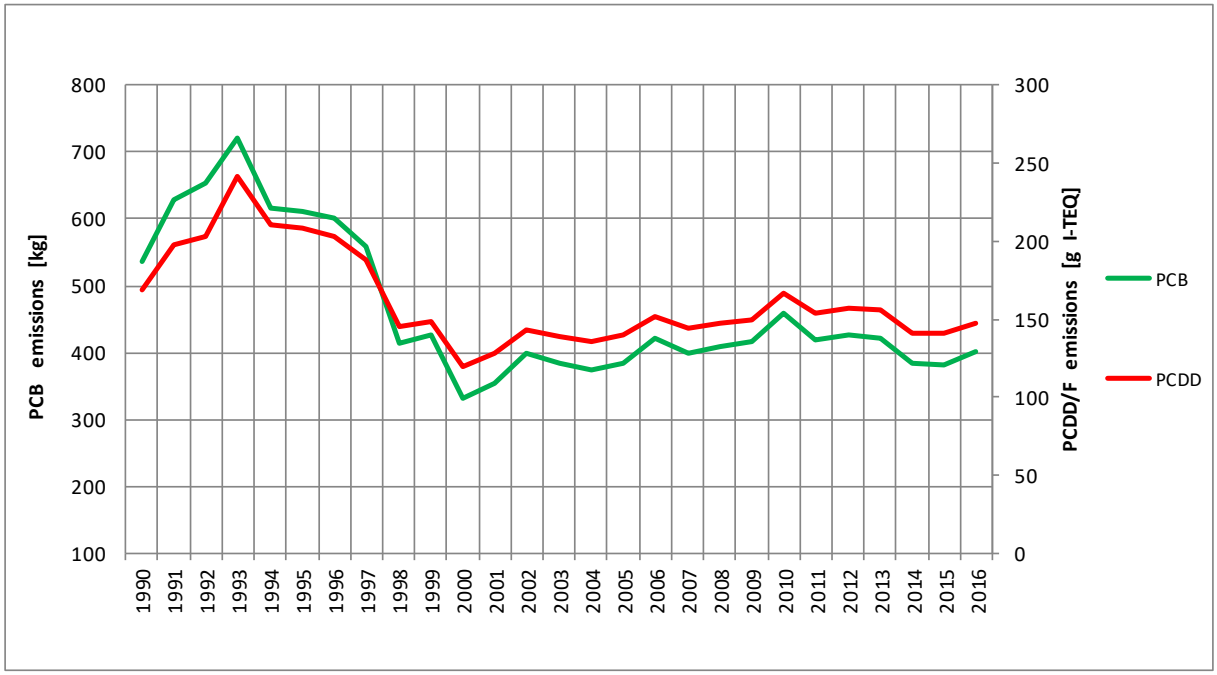

Figure 3.32. PCB and PCDD/F emissions for 1.A.4 category in 1990-2017

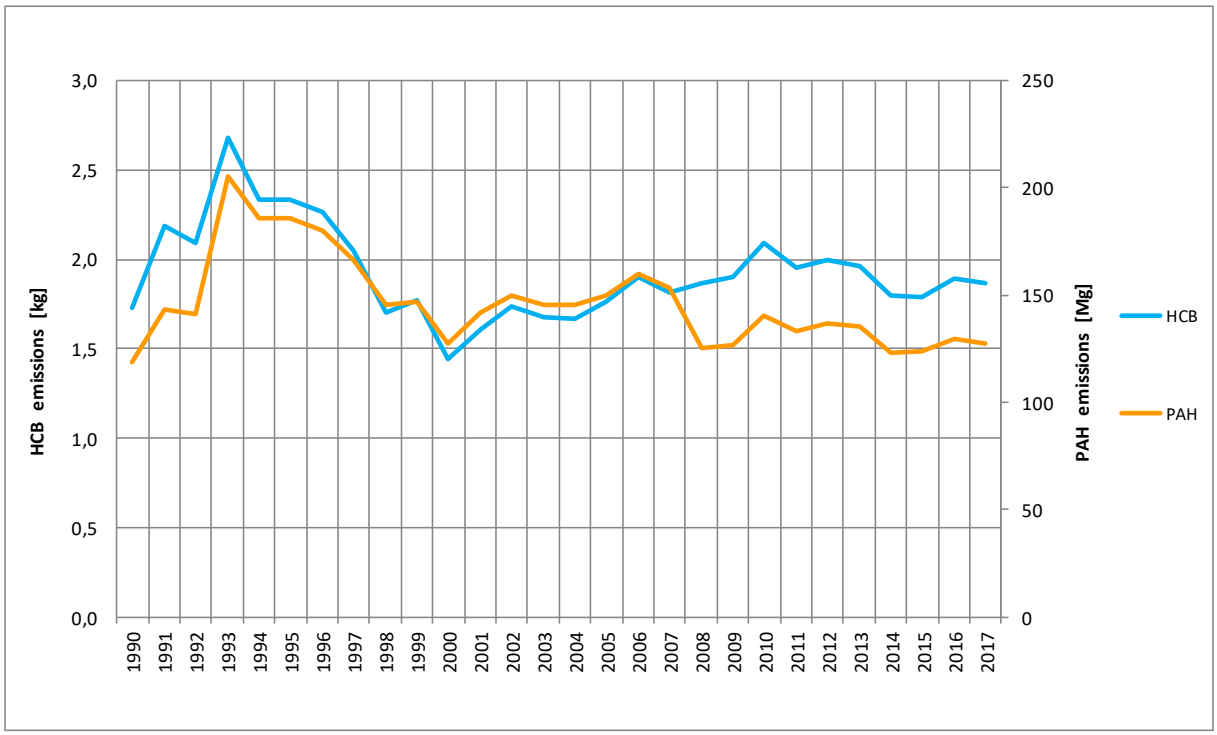

Figure 3.33. HCB and PAH emissions for 1.A.4 category in 1990-2017

3.4.4 Uncertainties and time-series consistency for 1.A.4

Uncertainty analysis for the 2017 for NFR sector *1.A.4* was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector *1.A.4* are given below. Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 3.10.Results of the uncertainty analysis for NFR sector 1.A.4

NFR subsector		NOx	NMVOC	SO_2	NH_3	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAH
1A4ai	Commercial/institutional: Stationary	18%	32%	26%		37%	41%	40%	41%	69%	52%	64%	54%	54%	54%
1A4bi	Residential: Stationary	20%	35%	29%	43%	36%	39%	38%	35%	66%	53%	60%	76%	76%	76%
1A4ci	Agriculture/Forestry/ Fishing: Stationary	23%	34%	26%		35%	41%	40%	35%	59%	55%	63%	93%	93%	93%
1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	43%	86%	28%	46%	90%	91%	91%	91%		46%		91%	91%	91%
1A4ciii	Agriculture/Forestry/ Fishing: National fishing	37%	73%	28%		73%	73%	73%	73%		37%		100%	100%	100%

3.4.5 Source-specific QA/QC and verification

For detailed information please see Section 3.1.5.

3.4.6 Source-specific recalculations

Activity data on fuel consumption for years 1990-2017 were updated due to changes made in EUROSTAT database.

Moreover, emission factors were updated (where appropriate) according to EMEP/EEA Emission Inventory Guidebook 2016:

1. in the category 1.A.4.ai:
   - NOx, CO, PM2.5, PM10 and TSP emission factors for liquid and gaseous fuels;
   - NMVOC, PCDD, benzo(a)pyrene, benzo(b)fluorantene, benzo(k)fluorantene and indeno(1,2,3-cd)pyrene emission factor for gaseous fuels.

2. in the category 1.A.4.bi:

   a) Following 2018 Review recommendation:

   - NOx, NMVOC and PM2.5 emission factors for liquid and gaseous fuels have been changed to those presented in 2016 EMEP/EEA Guidebook; regarding solid fuels, emission factors are country specific therefore they have not been changed;
   - SO_2 emission factors are country specific therefore they have not been changed;
   - NH_3 emission factor for wood and waste wood has been changed according to 2016 EMEP/EEA Guidebook. NH_3 emission factor for hard coal and brown coal has not changed comparing to 2016 EMEP/EEA Guidebook.

b) Other emission factors

- CO, PM10 and TSP emission factors for liquid and gaseous fuels;
- PCDD emission factor for gaseous fuels;
- PCB emission factor for brown coal;
- Benzo(a)pyrene, benzo(b)fluorantene, benzo(k)fluorantene and indeno(1,2,3-cd)pyrene emission factor for gaseous fuels.

3. in the category 1.A.4.ci
   - NOx, CO, PM2.5, PM10 and TSP emission factors for liquid and gaseous fuels;
   - NMVOC, PCDD, benzo(a)pyrene, benzo(b)fluorantene, benzo(k)fluorantene and indeno(1,2,3-cd)pyrene emission factor for gaseous fuels;
   - TSP, PM10 and PM2,5 factors for wood and waste wood.
4. in the categories 1.A.4.cii and 1A4ciii:
   - NOx, NMVOC emission factors for the sector 1.A.4.cii (only for agricultural machinery);
   - SO_2 emission factor for the sector 1.A.4.cii (tractors and agricultural machinery) and 1.A.4.ciii (fishing);
   - Cd, Cu, Ni emission factors for the sector 1.A.4.cii (tractors and agricultural machinery) and 1.A.4.ciii (fishing);
   - Pb, Hg for the sector 1.A.4.ciii (fishing – new emission factors).

3.4.7 Source-specific planned improvements

Fuel use in the categories *1A4aii Commercial/institutional: Mobile* and *1A4bii Residential: Household and gardening (mobile)* are not separated in the National Statistics therefore it is assumed they are included in the category 1A3b (notation key 'IE'). The same approach is used in GHG inventory. The KOBIZE will attempt to undertake the survey to separate categories 1A4aii and 1A4bii from the category 1A3. This regards especially:

- Regarding separating activity data for the category 1.A.4.aii from 1.A.3.b: analysis of the possibility of separating categories is being under elaboration.
- Moreover, the possibility of modelling fuel consumption data for 1.A.4.bii is being investigated.

3.5 Fugitive emissions (NFR sector 1.B)

3.5.1 Source category description

The Fugitive emissions sector consists of the following main subcategories:

- fugitive emission from solid fuels (NFR 1.B.1)
- fugitive emission from oil and natural gas (NFR 1.B.2).

Shares of emissions from the 1.B category in the country total for the particular pollutants in 2017 are shown on the Figure 3.34.

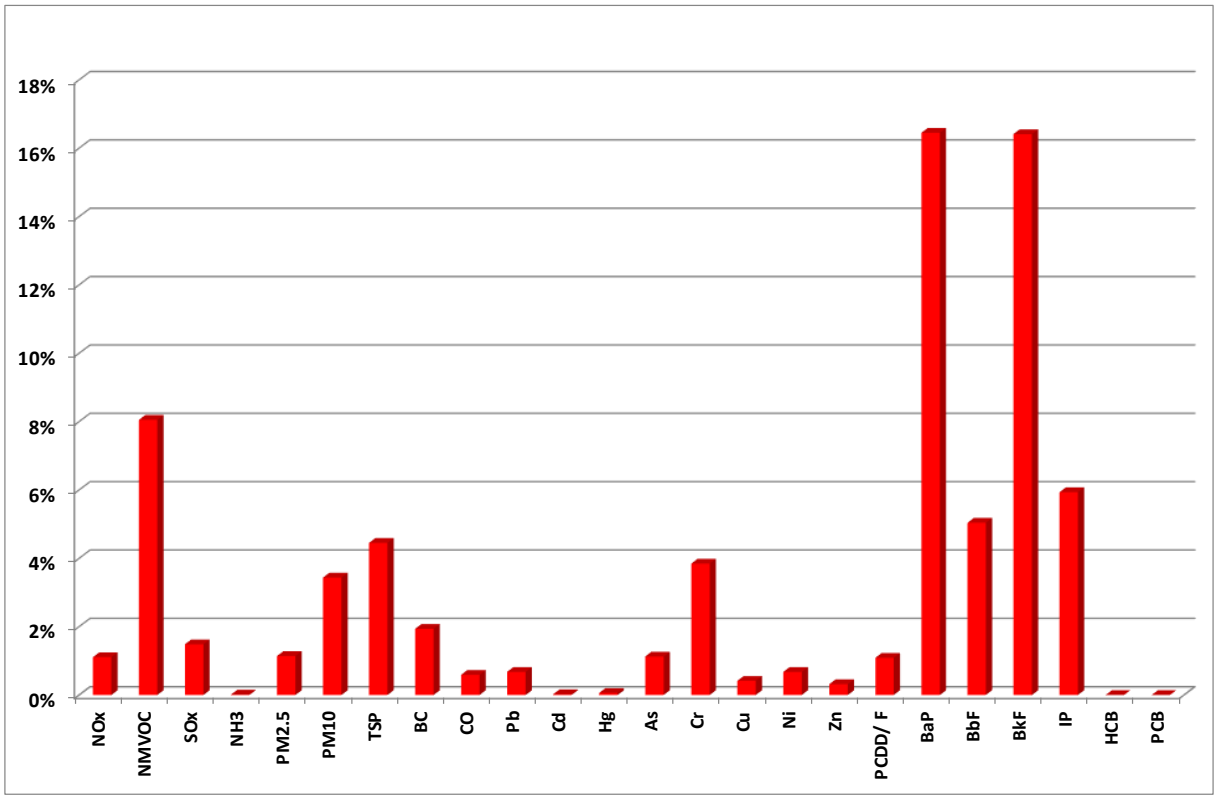

Figure 3.34. Shares of emissions from the 1 B category in the country total

3.5.1.1 Fugitive emission from solid fuels (NFR sector 1.B.1)

Fugitive emission from solid fuels involves emissions from:

- coal mining and handling (NFR 1.B.1.a.)
- solid fuel transformation (NFR 1.B.1.b.).

The large share of emission in 1.B category comes from coal mining and handling. The hard coal and brown coal extraction are presented at the graph bellow. The main reason for the decreasing coal extraction since late 1980s was the declining demand for coal and brown coal in economy.

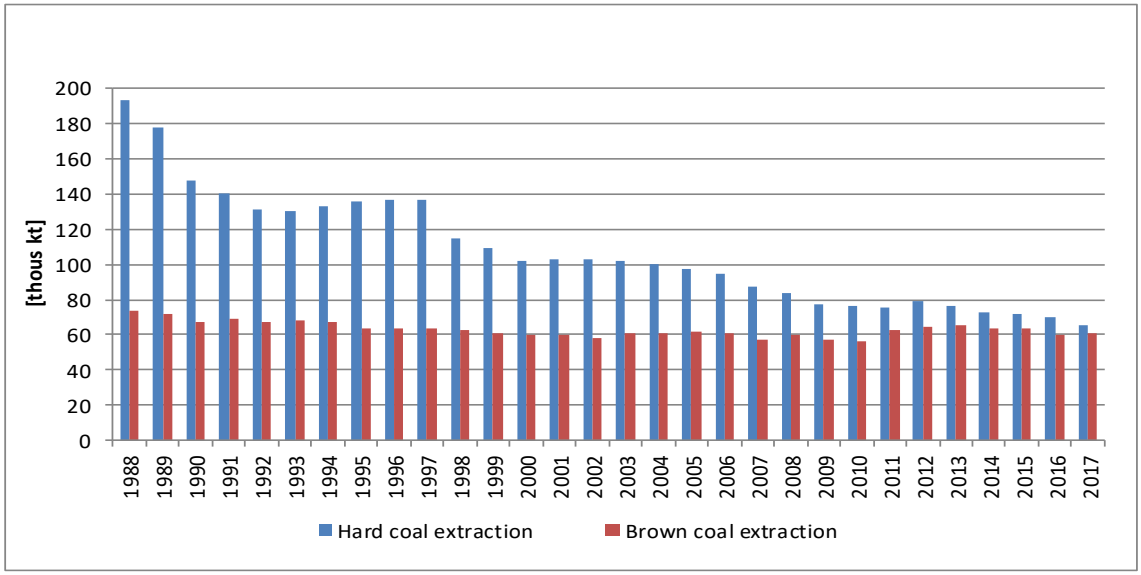

Figure 3.35. Hard coal and brown coal extraction in 1988-2017

Activity data used in the sub-category 1.B.1 for the years 1990-2017 are presented in Annex 5. Applied emission factors are presented in Annex 6.

3.5.1.2 Fugitive emissions from oil and natural gas (NFR sector 1.B.2)

Fugitive emission from oil and gas include fugitive emissions from:

- production, transport and refining of oil;
- production, processing, transmission, distribution and underground storage of gas;
- flaring in gas subsystem.

Fugitive emissions from fuels – oil (NFR sector 1.B.2.a)

Fugitive emission from oil include fugitive emissions from production, refining and transport of oil. Activity data used in the sub-category 1.B.2.a for the years 1990-2017 are presented in Annex 5. Applied emission factors are presented in Annex 6.

Fugitive emissions from fuels – natural gas (NFR sector 1.B.2.b).

Fugitive emission from gas include fugitive emissions from production and transport of gas. The activity data used in the sub-category 1.B.2.b for the years 1990-2017 are presented in Annex 5. Emission factors used in the sub-category 1.B.2.b are presented in Annex 6.

Fugitive emissions from fuels – Venting and Flaring (NFR sector 1.B.2.c)

Fugitive emission from venting and flaring include fugitive emissions from refinery throughput. The activity data used in the sub-category 1.B.2.c for the years 1990-2017 are presented in Annex 5. Emission factors used in the sub-category 1.B.2.c are presented in Annex 6.

3.5.2 Methodological issues

Fugitive emission from solid fuels (NFR sector 1.B.1)

Particulates emissions from coal storage and handling (NFR 1.B.1.a) have been estimated by considering only the hard coal production. Normally, the humidity of the brown coal is approximately 50% and it is excavated as muddy substance. Next step is load the output to the conveyor (maximum 20 km) and transporting it directly to the power plant. Brown coal in Poland is not handled very long, neither transported to the longer distances. Considering humidity, PM2.5 emission from the conveyor is negligible.

As for solid fuel transformation (NRF 1.B.1.b) data provided by plants and collected in the national emission database are collected since 2010, for the years 1990-2009 the notation key 'NE' has been applied.

Fugitive emissions from oil and natural gas (NFR sector 1.B.2

For the category *Fugitive emissions from fuels – oil* (NFR sector 1.B.2.a) emission values for NOx and SO_2 have been sourced from the National Emission Database (NED, for brevity), which have been collected since 2010. Before 2010 proxy data have been used (refinery crude oil throughput). Emission factors for NOx (0.24 kg/Mg crude oil input) and SO_2 (0.62 kg/Mg crude oil input) have been taken from 2016 Guidebook.

To estimate NMVOC emissions from refinery dispatch stations and service stations with the Tier 2 approach more investigation is required to assess technology split on the basis of information from neighbouring countries with similar petroleum product delivery infrastructure.

Fugitive emission estimates of Cd, Hg, Pb and PCDD/Fs from Oil: Refining/Storage (NFR 1.B.2.aiv), using methods and EFs consistent with the 2016 Guidebook, will be added in the next submission.

For the category *Flaring in oil refinery* (NFR 1.B.2.c) pollutant emissions from flaring were estimated based on throughput as activity data.

3.5.3 Emission trends for the NFR sector 1.B

Volumes and trend of pollutant emissions for 1.B sector are shown below on figures below (Figure 3.36 - Figure 3.40).

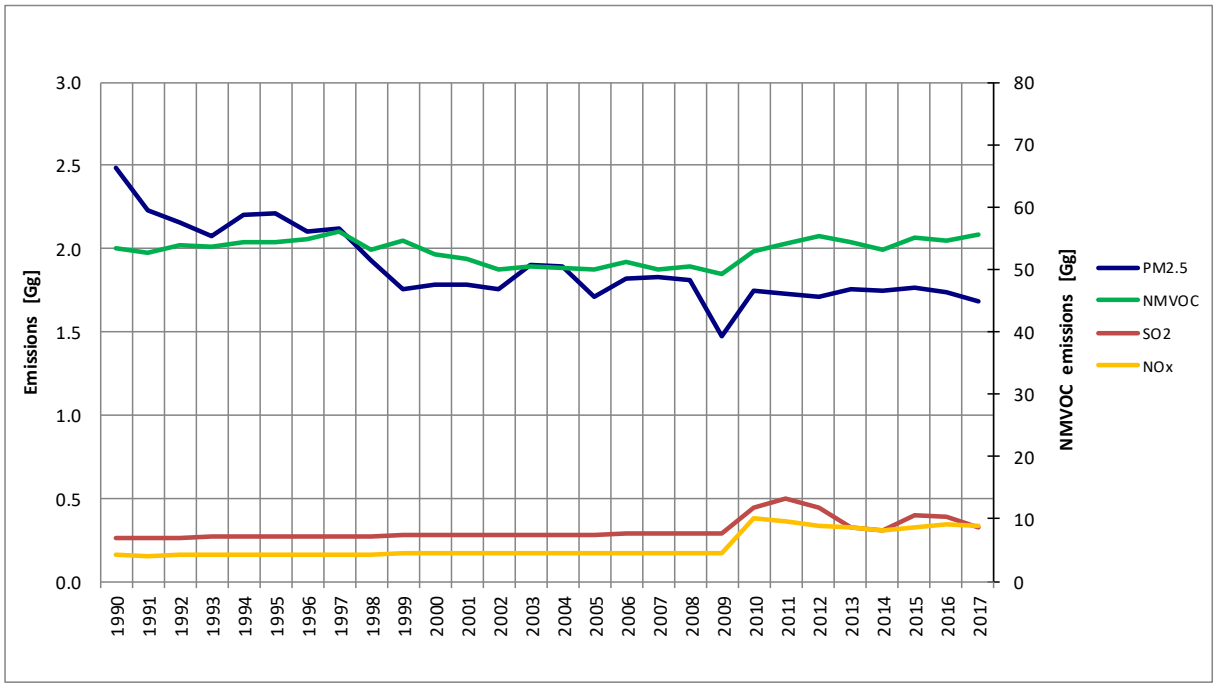

Figure 3.36. NMVOC, SO_2, NOx and PM2.5 emissions for 1.B category in 1990-2017

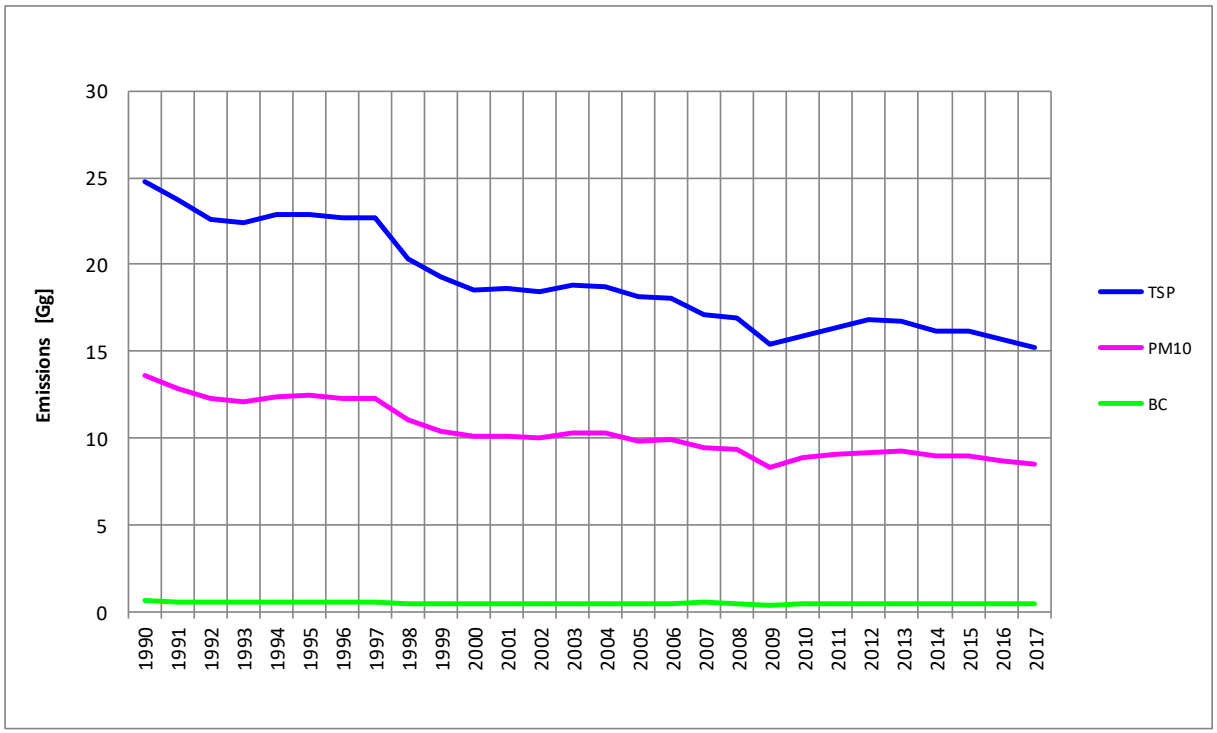

Figure 3.37. Particulates emissions for 1.B category in 1990-2017

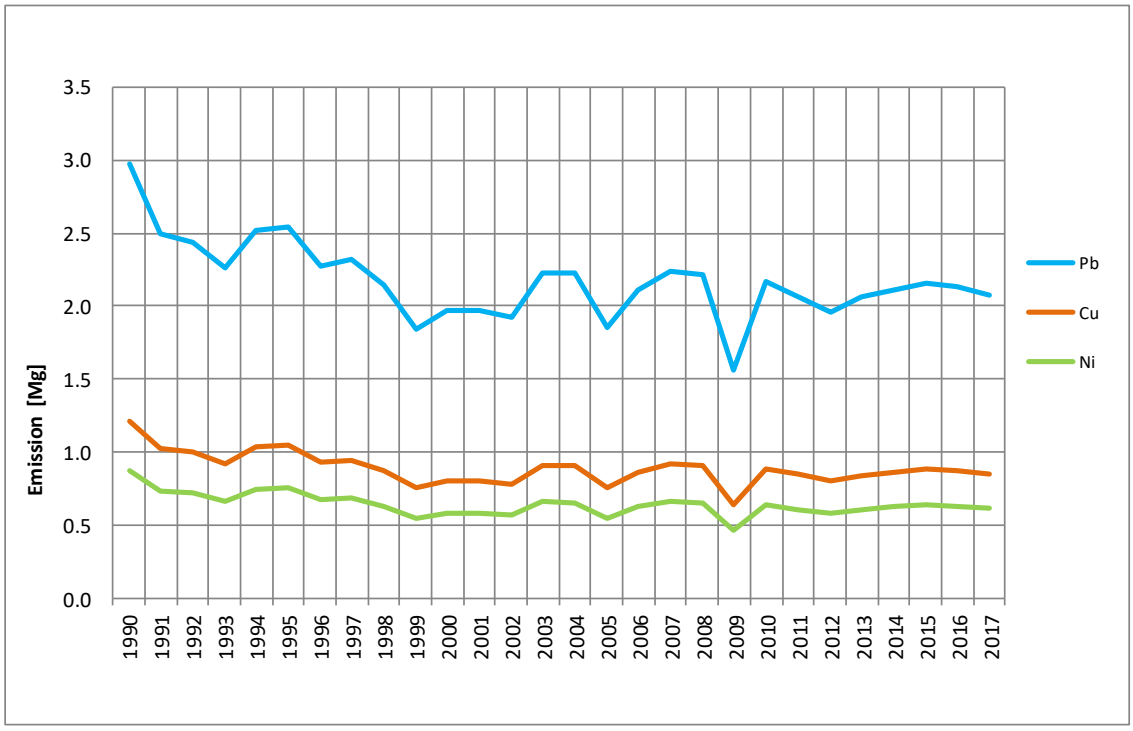

Figure 3.38. Pb, Cu and Ni emissions for 1.B category in 1990-2017

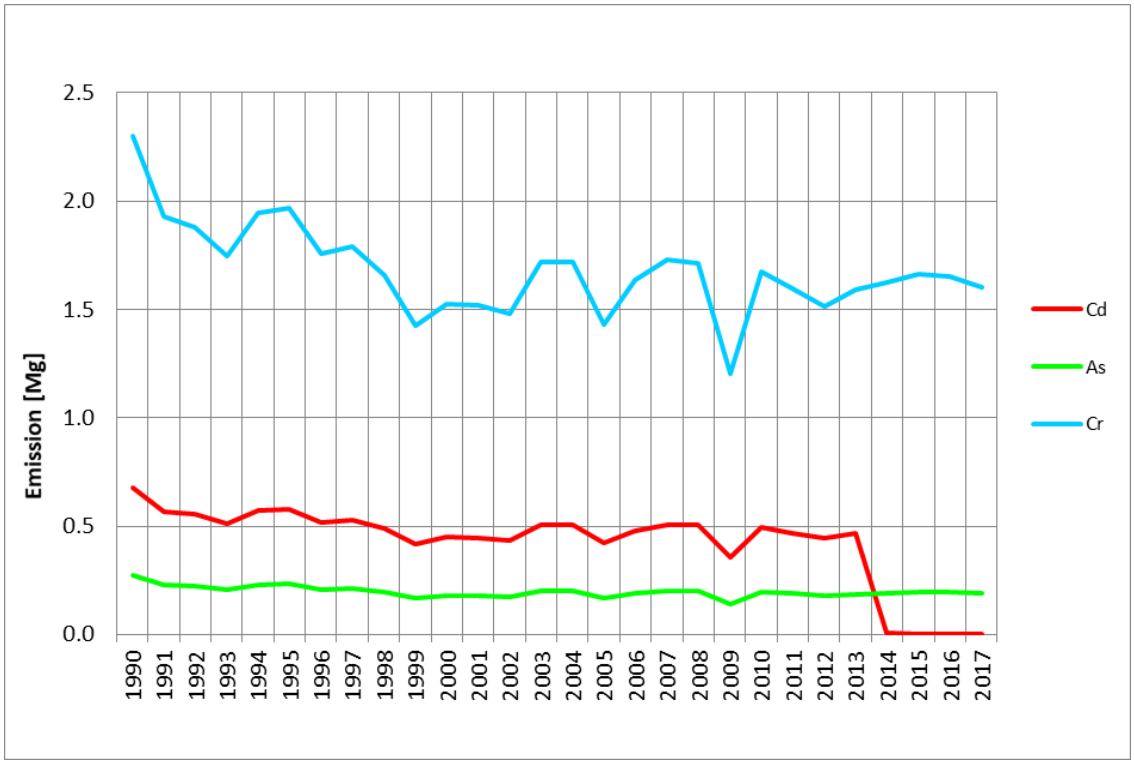

Figure 3.39. Cd, As and Cr emissions for 1.B category in 1990-2017

Decrease of Cd emissions after 2013 was related to the use of data provided by plans and collected in the National Emissions Database.

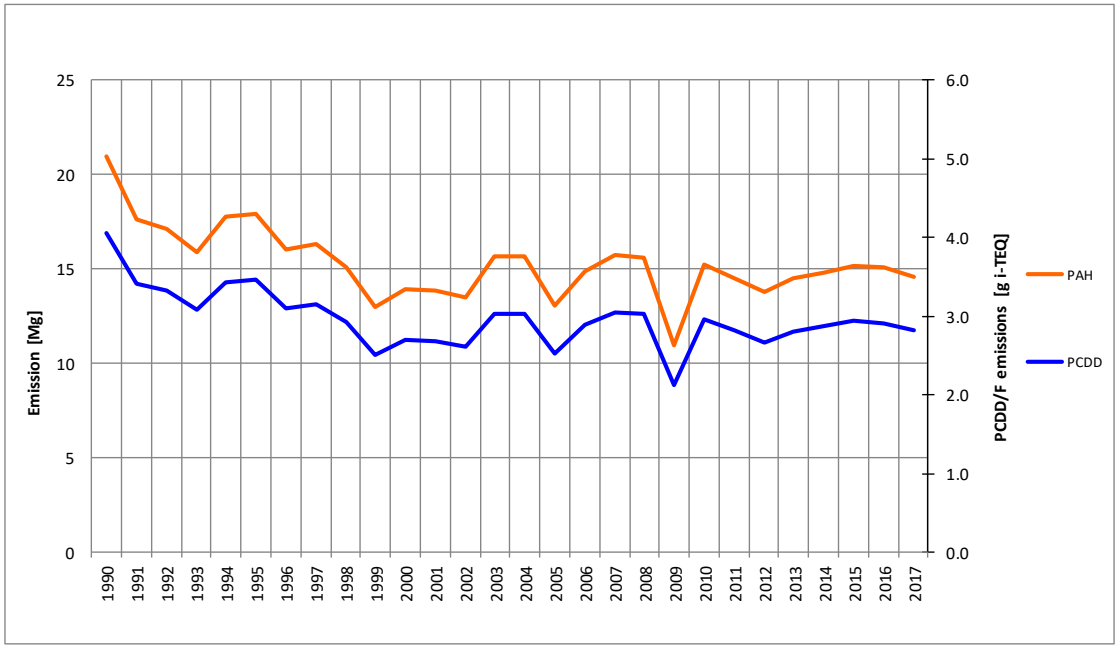

Figure 3.40. PCDD/F and PAH emissions for 1.B category in 1990-2017

3.5.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector *1.B* was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector *1.B* are given below.

Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series are shown in the table below.

Table 3.11. Results of the emission uncertainty analysis for NFR sector 1.B

NFR subsector		NOx	NMVOC	SO_2	NH_3	TSP	PM10	PM2.5	Pb	Cd	PCDD/F	PAH
1B1a	Fugitive emission from solid fuels: Coal mining and handling		50%			27%	27%	27%				
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	30%	50%	70%	50%	50%	50%	50%	70%	70%	100%	100%
1B2ai	Fugitive emissions oil: Exploration, production, transport		50%									
1B2aiv	Fugitive emissions oil: Refining / storage	30%	39%	70%								
1B2av	Distribution of oil products		38%									
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)		32%									

3.5.5 Source-specific QA/QC and verification

For further details please see chapter 3.1.5.

3.5.6 Source-specific recalculations

Following 2018 Review recommendations:

- $PM_{2.5}$ and NMVOC emissions from coal handling and storage in 1.B.1.a have been verified and emission factors were changed to those presented in 2016 EMEP/EEA Guidebook.;
- activity data for coal mining and handling in 1.B.1a category (hard coal and brown coal) have been verified and updated according to Eurostat database;
- NMVOC estimates for coal mining and handling in 1.B.1.a (open cast mining) have been added .;
- Emission estimates in 1.B.2.aiv category (Fugitive Emissions Oil: Refining / Storage) based on crude oil throughput AD have been added before 2010.

3.5.7 Source-specific planned improvements

Following improvements are planned:

- Fugitive emission from coke production (1.B.1.b – solid fuels transformation) will be recalculated with using EF from EMEP/EEA Guidebook in the next submission;
- To estimate NMVOC emissions from refinery dispatch stations and service stations (NFR 1.B.2.av) with the Tier 2 approach more investigation is required to assess technology split on the basis of information from neighbouring countries with similar petroleum product delivery infrastructure.
- Fugitive emission estimates of Cd, Hg, Pb and PCDD/Fs from Oil: Refining/Storage (NFR 1.B.2.aiv), using methods and EFs consistent with the 2016 Guidebook, will be added in the next submission.
- Emissions from flaring in facilities for natural gas and oil extraction could not be estimated as no activity data were available. Poland is considering to resolve this issue via sectoral associations or questionnaires to companies.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (NFR SECTOR 2)

4.1 Source category description

The pollutant emission sources in the *Industrial processes and Product Use* (IPPU) sector involve:

- 2.A. Mineral Products
- 2.B. Chemical Industry
- 2.C. Metal Production
- 2.D-2.G Other solvent and product use
- 2.H Other industry production,
- 2.I Wood processing (TSP),
- 2.L Other production, consumption, storage, transportation or handling of bulk products (PM).

The IPPU sector is considerable source of NMVOC and HMs. The NMVOCs' emissions are driven by use of solvents for various purposes, and the HMs' emissions are caused by processes in metal industries. Shares of emissions from the NFR 2 category in the country total for the particular pollutants in 2017 are shown in the Figure 4.1.

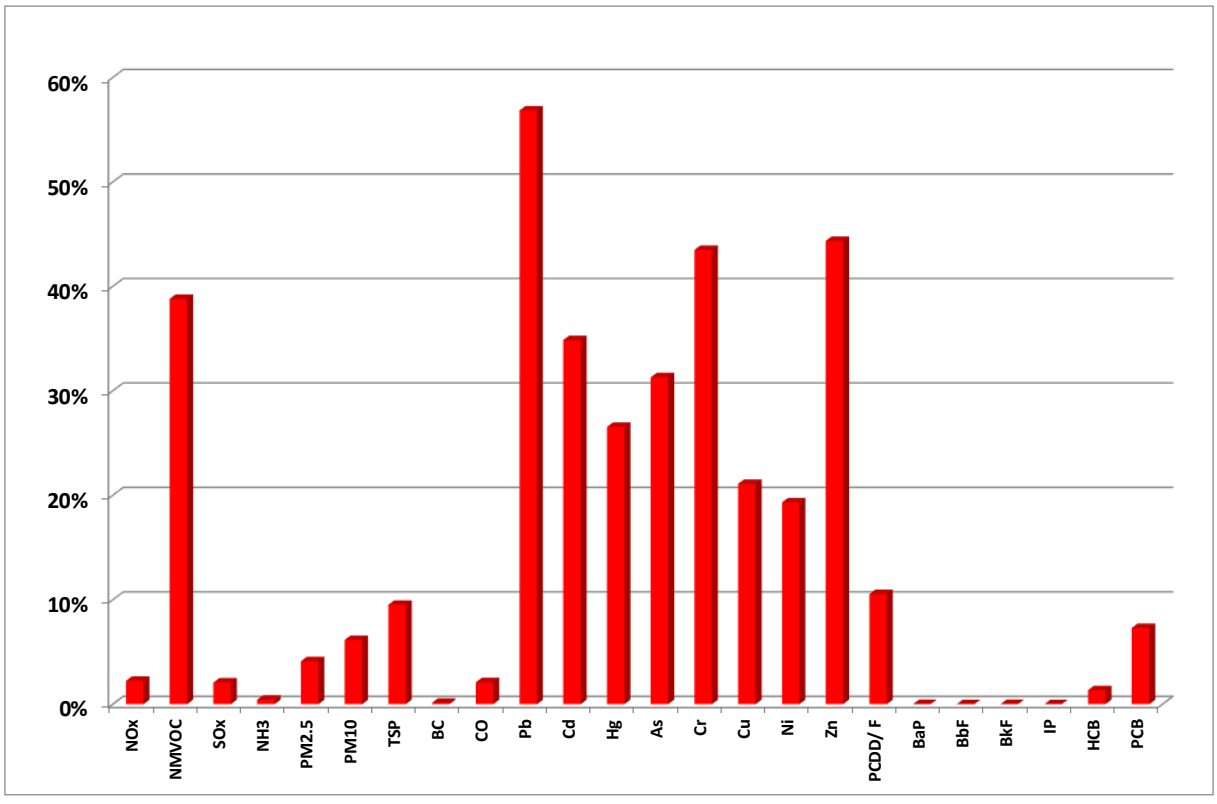

Figure 4.1. Shares of emissions from the NFR 2 category in the country total

4.2 Mineral Products (NFR sector 2.A)

4.2.1 Source category description

The pollutant emission sources related to production processes in mineral industry cover: SO_2, CO, PM, BC, HMs, and PCDD/F. This category corresponds to a part of the category SNAP 0406. Shares of emissions from the NFR 2.A category in the country total for the particular pollutants in 2017 are shown in the Figure 4.2.

Estimation of emissions in 2.A. Mineral products was carried out for sub-categories listed below:

- Cement production (2.A.1),
- Lime (calx) production (2.A.2),
- Gypsum production (2.A.2),
- Production of glass (2.A.3 incl. flat glass, container glass, and glass fiber separately),
- Quarrying of minerals (excl. coal) and ores (copper and zinc-lead), (2.A.5.a),
- Construction and demolition (2.A.5.b).

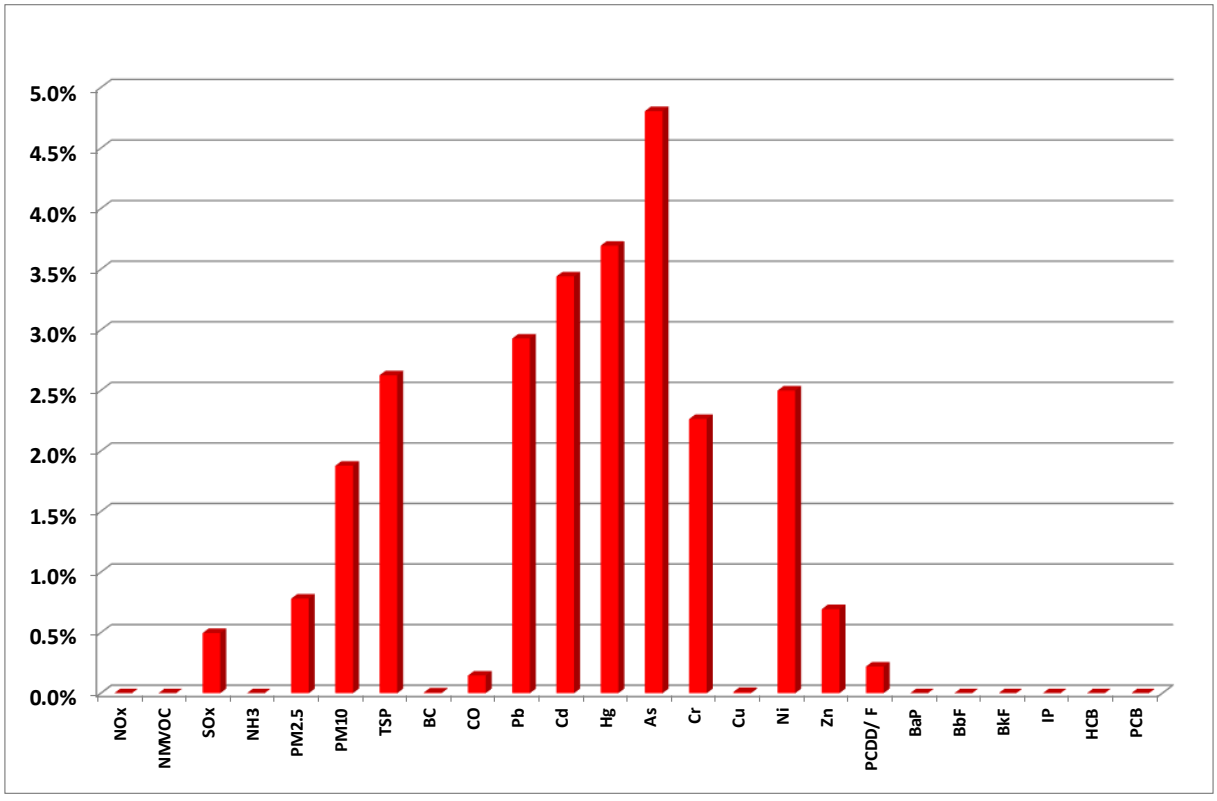

Figure 4.2. Shares of emissions from the NFR 2.A category in the country total

4.2.2 Methodological issues

Activity data for this sector come from GUS statistical yearbooks. Trends of activity data in mineral industry (1990-2017) are presented in the Annex 5. Emission factors used in the sub-category 2.A are presented in the Annex 6.

4.2.3 Emission trends for the NFR sector 2.A

Volumes and trend of pollutant emissions for *Mineral Products* is shown below on Figure 4.3 - Figure 4.5.

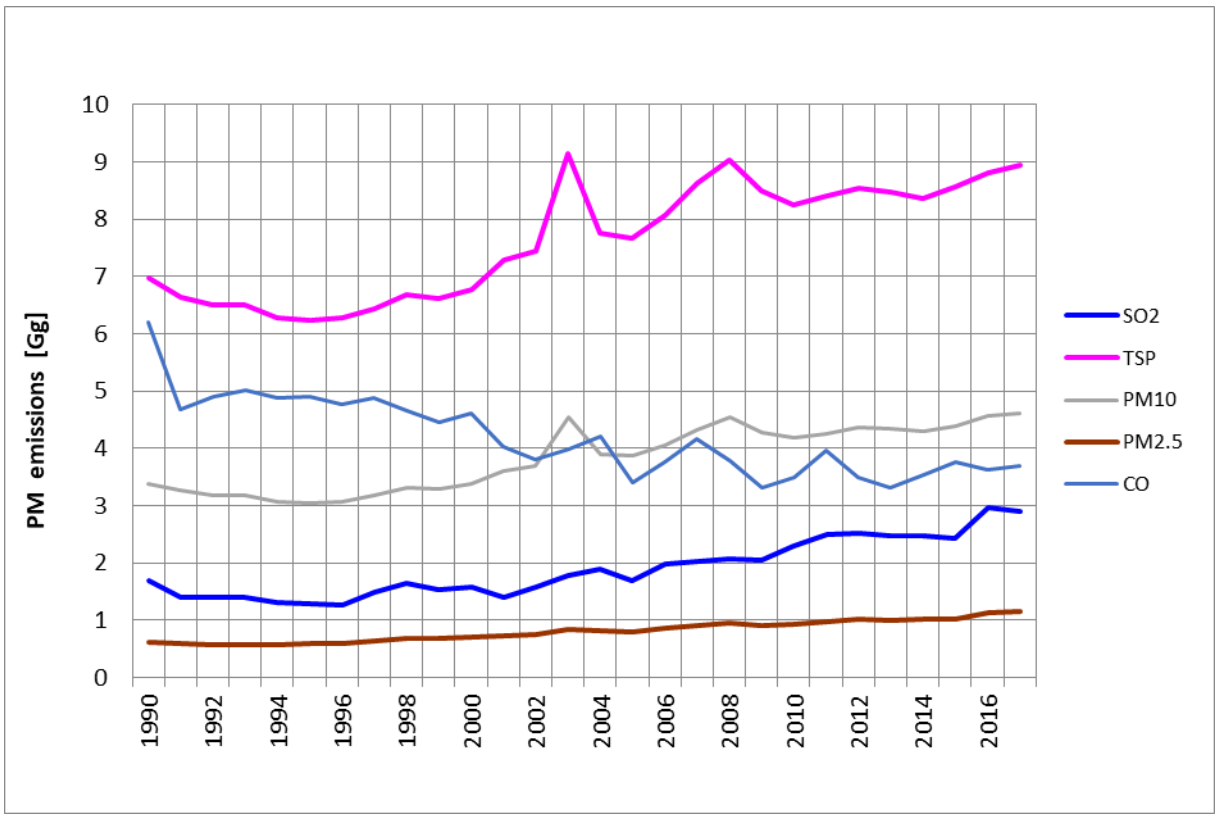

Figure 4.3. SO_2, particulates and CO emissions for 2.A category in 1990-2017

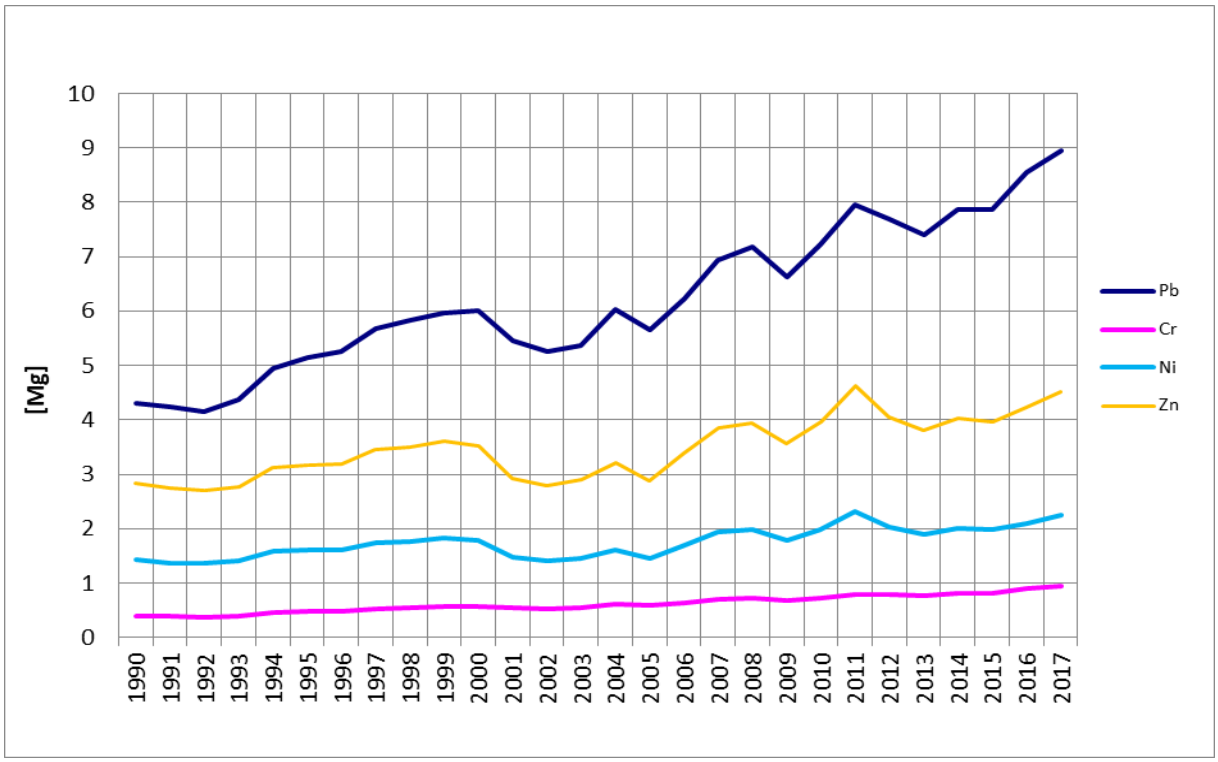

Figure 4.4. Pb, Cr, Ni, and Zn emissions for 2.A category in 1990-2017

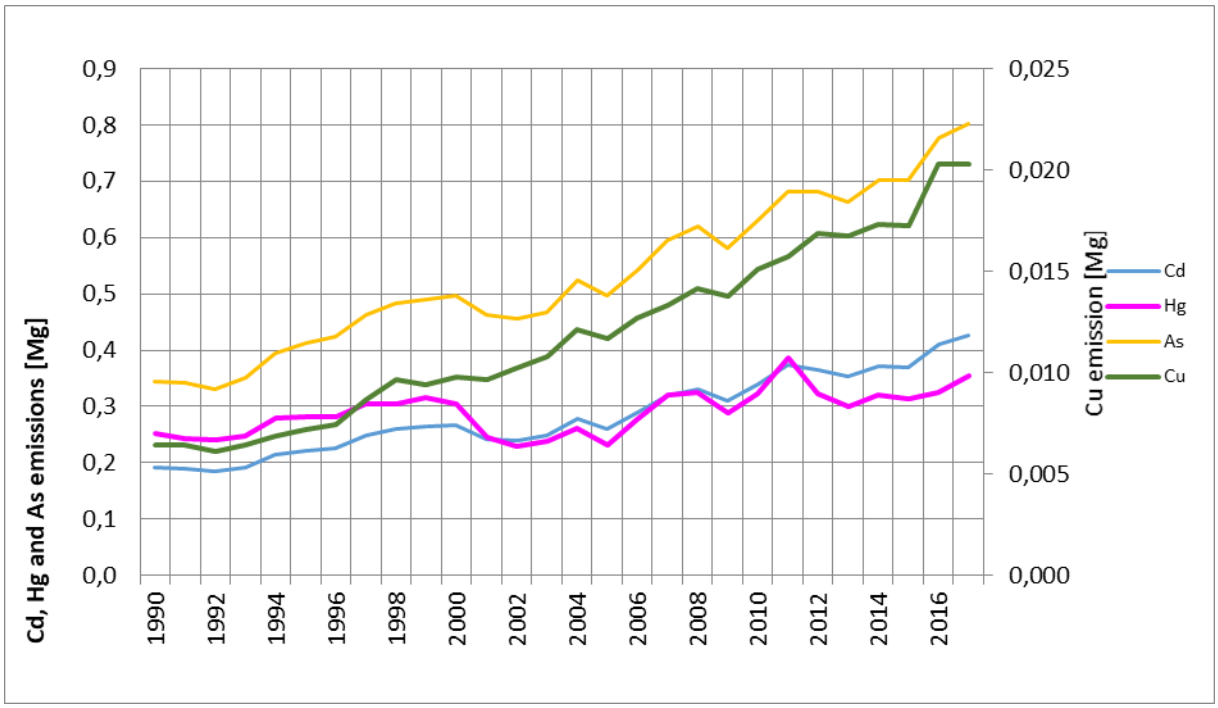

Figure 4.5. Cd, Hg, As, and Cu emissions for 2.A category in 1990-2017

4.2.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector 2.A was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector 2.A are given below.

Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 4.1. Results of the emission uncertainty analysis for NFR 2.A

NFR		SO_2	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F
2A1	Cement production	30%		50%	50%	50%	70%			
2A2	Lime production	40%	50%	50%	50%	50%				
2A3	Glass production		37%	50%	50%	50%	70%	70%	70%	73%
2A5a	Quarrying and mining of minerals other than coal			100%	100%	100%				
2A5b	Construction and demolition			100%	100%	100%				

4.2.5 Source-specific QA/QC and verification

For detailed information please see Section 3.1.5.

4.2.6 Source-specific recalculations

There are considerable changes in 2.A.3 *Production of glass* (implemented new emission factors). Regarding this fact emission trends have been recalculated.

4.2.7 Source-specific planned improvements

No further investigation on emissions from this sector is planned.

4.3 Chemical Industry (NFR sector 2.B)

4.3.1 Source category description

Estimation of emissions in 2.B. *Chemical Industry* are carried out in sub-categories listed below:

- Ammonia production (2.B.1),
- Nitric acid production (2.B.2),
- Adipic acid production (2.B.3, production is not occurring since 1995),
- Calcium carbide production (2.B.4, production is not occurring since 2008),
- Titanium dioxide production (2.B.6),
- Soda Ash Production and Use (2.B.7),
- Chemical industry: Other (2.B.10.a):
- Production of: sulfuric acid, NPK fertilisers, carbon black, phosphate fertilizers, ethylene, caprolactam, propylene, polyethylene, polyvinylchloride, polypropylene, polystyrene, formaldehyde, and chlorine production (mercury cell, production is not occurring since 2009),
- Storage, handling and transport of chemical products (2.B 10 b).

The pollutant emission sources related to production processes in mineral industry cover: NO_X, SO_2, NMVOC, NH_3, CO, PM, Cd, Hg. This category corresponds to categories SNAP 0404, SNAP 0405 and SNAP 040617.

Shares of emissions from the NFR 2.B category in the country total for the particular pollutants in 2017 are shown in the figure the Figure 4.6.

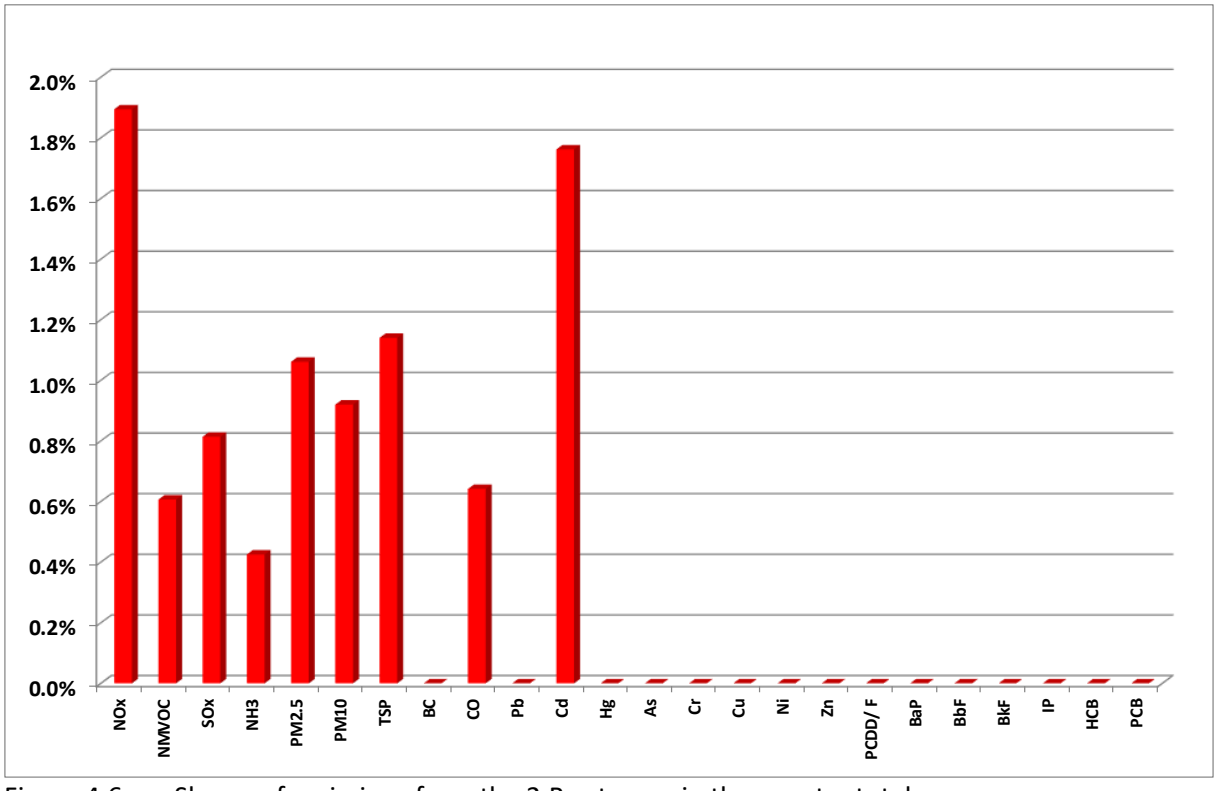

Figure 4.6. Shares of emissions from the 2.B category in the country total

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory:

- SO_2 emission from titanium white (TiO_2) production – according to the information provided from the producer (only in Poland), the TiO_2 is produced using sulphate technology;
- PM emissions from flaring in carbide production – there is no historical information so far, the resolution of the problem strongly depends from availability of historical data sets;
- Poland is currently working on methodology of $PM_{2.5}$ estimation from the high- (HDPE) and low (LDPE) density polyethylene production. Solving of this problem is planned in near future.

4.3.2 Methodological issues

Activity data for this sector come from GUS statistical yearbooks [GUS 2018e]. The activity data used in the sub-category 2.B - Chemical Industry for the years 1990-2016 is presented in the Annex 5.

To estimate emissions domestic and default emission factors are used. Applied emission factors for subcategory 2.B are presented in the Annex 6. Data on mercury emissions from Chlorine production (mercury cell) are taken from producer's report.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory, SO_2 emission factor for the category Titanium dioxide production (NFR 2.B.6; SNAP 040410) has been added from the EMEP/EEA EIG 2016. This change resulted in the small increase of SO_2 emissions from the category 2.B. Applied new emission factor is presented in the Annex 6.

4.3.3 Emission trends for the NFR sector 2.B

Volumes and trend of pollutant emissions for *Chemical Industry* are shown on figures below (Figure 4.7 - Figure 4.9).

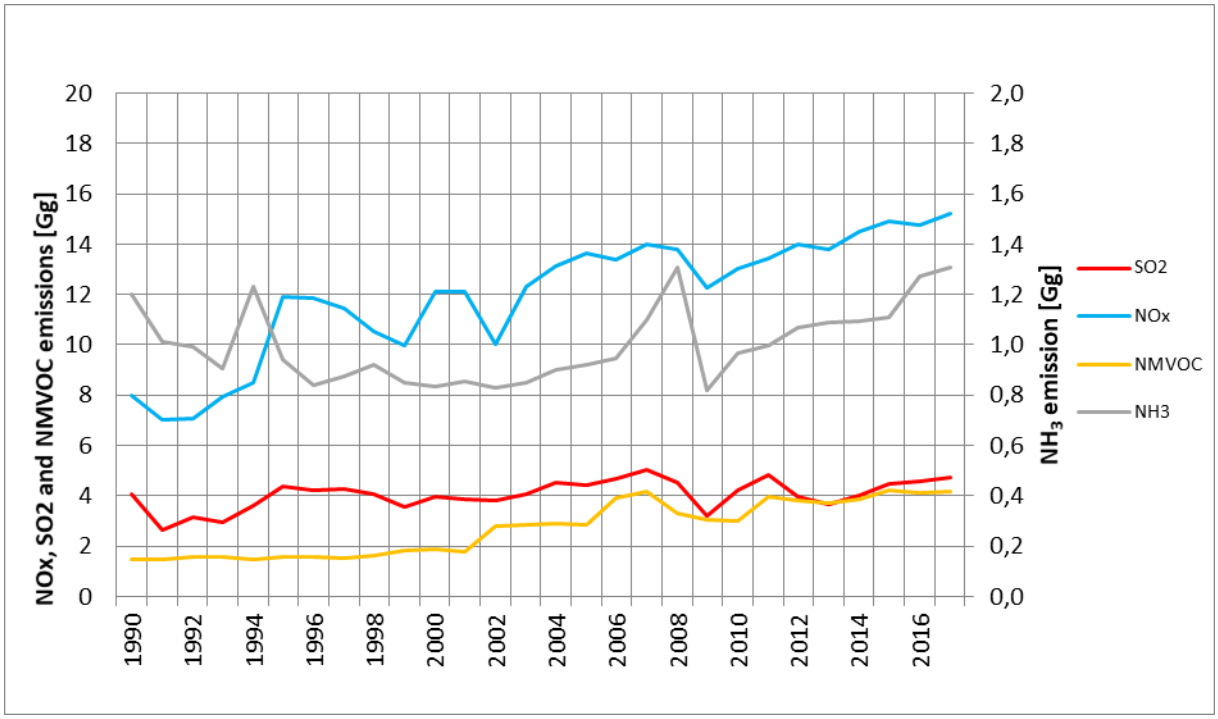

Figure 4.7. SO_2, NO_X, NMVOC, and NH_3 emissions for 2.B category in 1990-2017

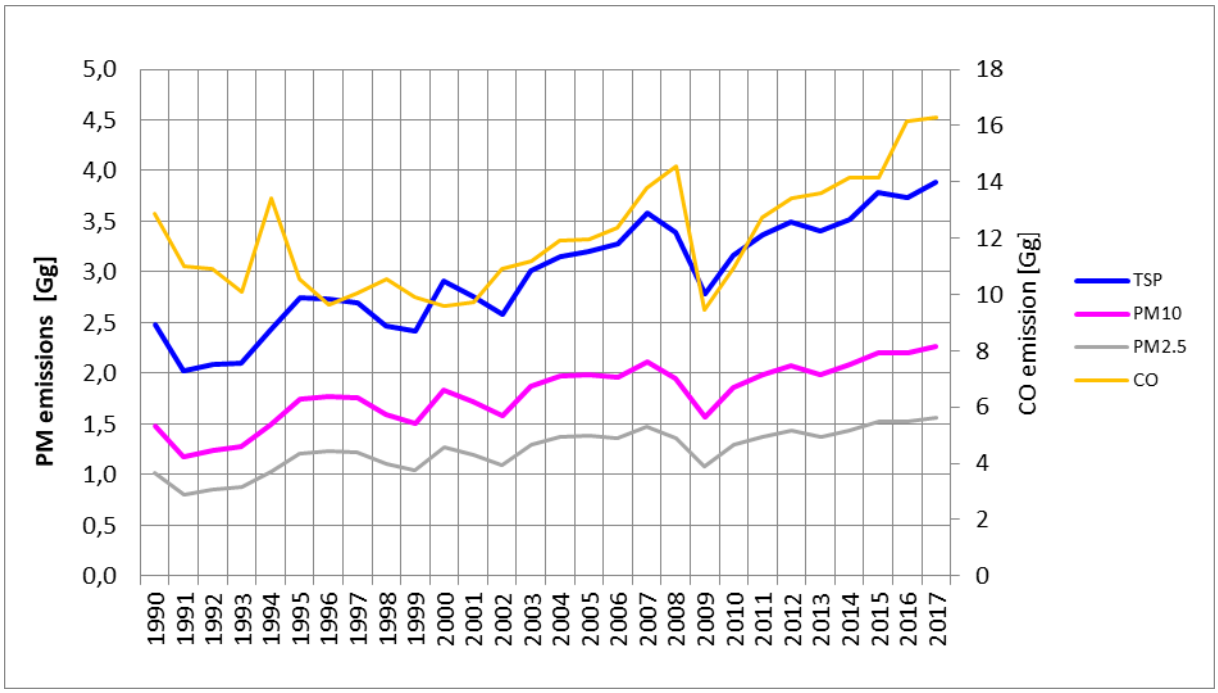

Figure 4.8. Particulates, and CO emissions for 2.B category in 1990-2017

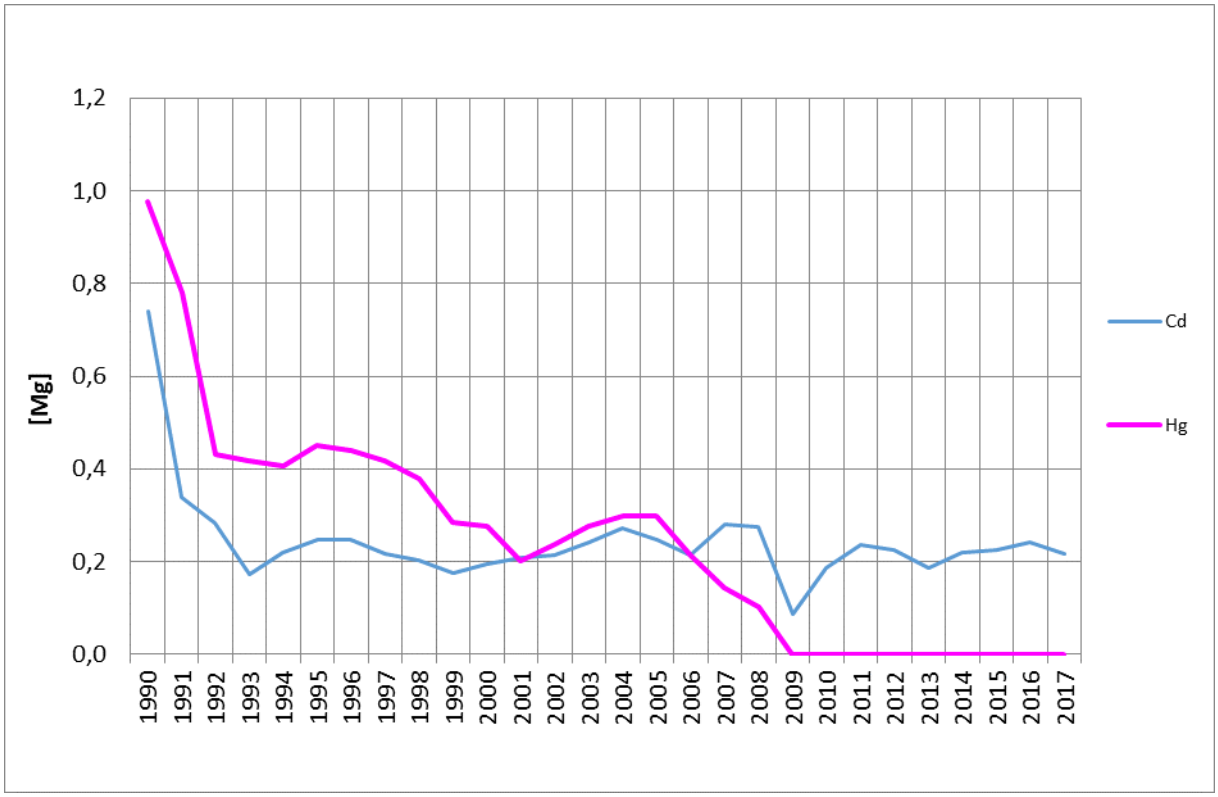

Figure 4.9. Cd and Hg emissions for 2.B category in 1990-2017

4.3.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector 2.B was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector 2.B are given below. Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 4.2. Results of the emission uncertainty analysis for NFR sector 2.B

NFR subsector		NO_x	NMVOC	SO_x	NH_3	CO	TSP	PM10	PM2.5	Cd	Hg
2B1	Ammonia production	30%			50%	50%					
2B2	Nitric acid production	30%									
2B3	Adipic acid production	50%									
2B5	Carbide production						30%				
2B6	Titanium dioxide production	20%		20%			30%				
2B7	Soda ash production				50%	50%	50%				
2B10a	Chemical industry: Other	30%	35%	30%		48%	10%	10%	10%	70%	30%
2B10b	Storage, handling …						30%	30%	30%		

4.3.5 Source-specific QA/QC and verification

For detailed information please see Section 3.1.5.

4.3.6 Source-specific recalculations

Emission trends have been supplemented with adipic acid production (2.B.3) and soda ash production and use (2.B.7).

4.3.7 Source-specific planned improvements

Further investigations on emission factors for flaring in calcium carbide, also on production of high- (HDPE) and low (LDPE) density polyethylene production are planned.

4.4 Metal Production (NFR sector 2.C)

4.4.1 Source category description

Estimation of emissions in 2.C. *Metal Production* are carried out in sub-categories listed below:

- Iron and Steel Production (production in open hearth furnaces is not occurring since 2003, 2.C.1),
- Ferroalloys Production (2.C.2),
- Aluminium Production (primary aluminium production is not occurring since 2009, 2.C.3),
- Lead production, including batteries (2.C.5),
- Zinc production (2.C.6),
- Copper production (2.C.7 a).

The pollutant emission sources related to production processes in metal industry cover all pollutants except for NH_3. This category corresponds to categories SNAP 0402 and SNAP 0403.

Shares of emissions from the NFR 2.C category in the country total for the particular pollutants in 2017 are shown in the Figure 4.10.

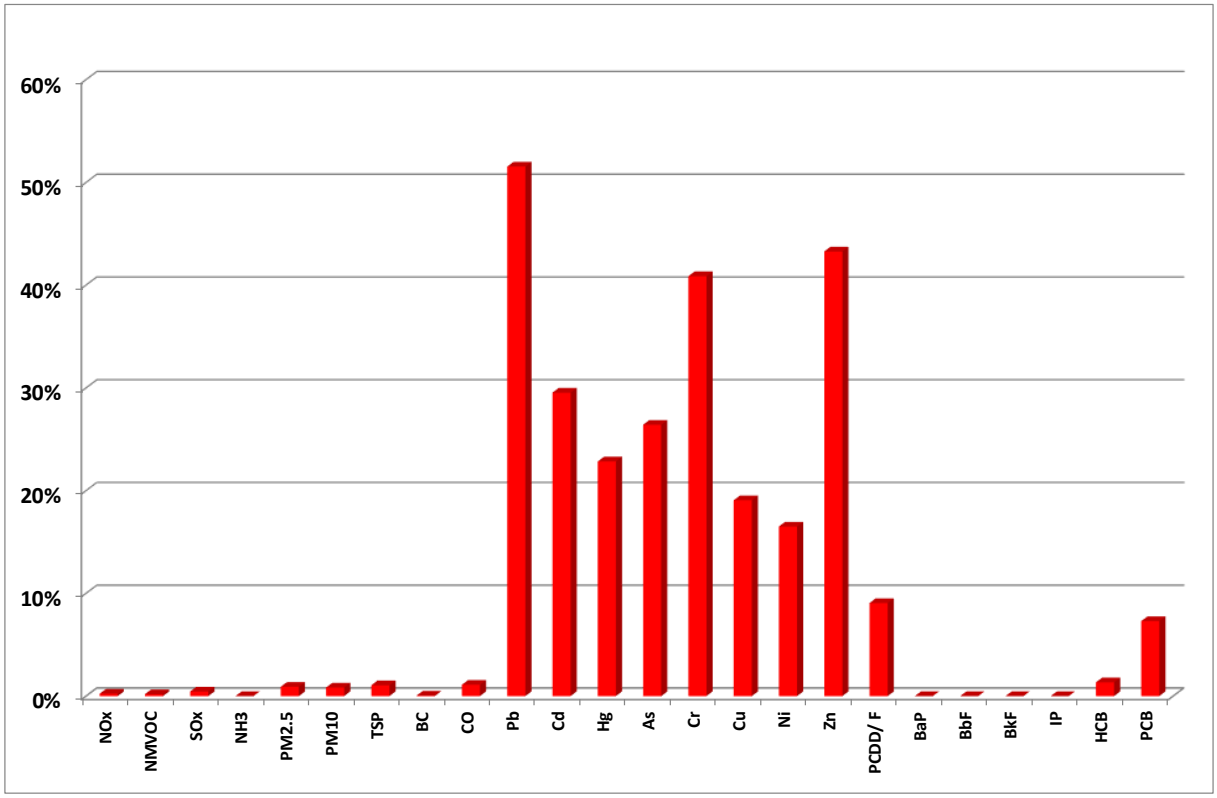

Figure 4.10. Shares of emissions from the 2.C category in the country total

4.4.2 Methodological issues

Activity data for this sector (except for production of copper) comes from the statistical yearbooks [GUS 2018e], and is presented in the Annex 5. Activity data for refined copper production for years: 1990-2016 is obtained from the producer (only in Poland: KGHM Polska Miedź S.A.). Production for 2017 is obtained from official statistics after consultation with the producer to keep the time series consistency.

In comparison to the previous submission, the methodology in cooper production has changed. According to the information received from the producer, there is no possibility to split between primary and secondary copper production. It is caused by applied technologies of copper smelting. In view of information about technologies, the copper scraps are added to both: primary, and secondary smelting process. The HCB emission factor from the copper production is provided by producer (trend of emission factors weighted using the technology of production).

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish emission inventory:

- NMVOC and particulates emission factors for the Iron and Steel Production (NFR 2.C.1) have been applied from the EMEP/EEA EIG 2016. This change resulted in a small decrease of particulates emissions from these activities and small increase of NMVOC emissions from these activities. Applied new emission factors are presented in the Annex 6;

- SO_2 and particulates emission factors for the primary and secondary production of lead, copper and zinc (NFR 2.C) have been applied from the EMEP/EEA EIG 2016. This change resulted in a small increase of SO 2 and particulates emissions from these activities, reported to avoid double-counting under the category 1.A.2.b. Applied new emission factors are presented in the Annex 6.
- SO_2 and particulates emission factors for the Aluminium Production (NFR 2.C.3) have been applied from the EMEP/EEA EIG 2016. This change resulted in a small decrease of particulates emissions and small increase of SO_2 emissions from these activities. Applied new emission factors are presented in the Annex 6.

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory:

- The emission inventory from primary aluminium production (2C3, production since 1990 to 2008) is associated with the Søderberg anodes technology;
- The HCB emission from secondary Aluminium production (2C3) will be included in the next submission;
- The emission of PCB from the secondary lead production will be included in the next submission, after resolving issues connected with activity data (similar issues to copper production, see above).

To estimate emissions domestic and default emission factors are used. Applied emission factors for subcategory 2.C are presented in Annex 6.

4.4.3 Emission trends for the NFR sector 2.C

Volumes and trend of pollutant emissions for *Metal Production* are shown below on figures below (Figure 4.11- Figure 4.16).

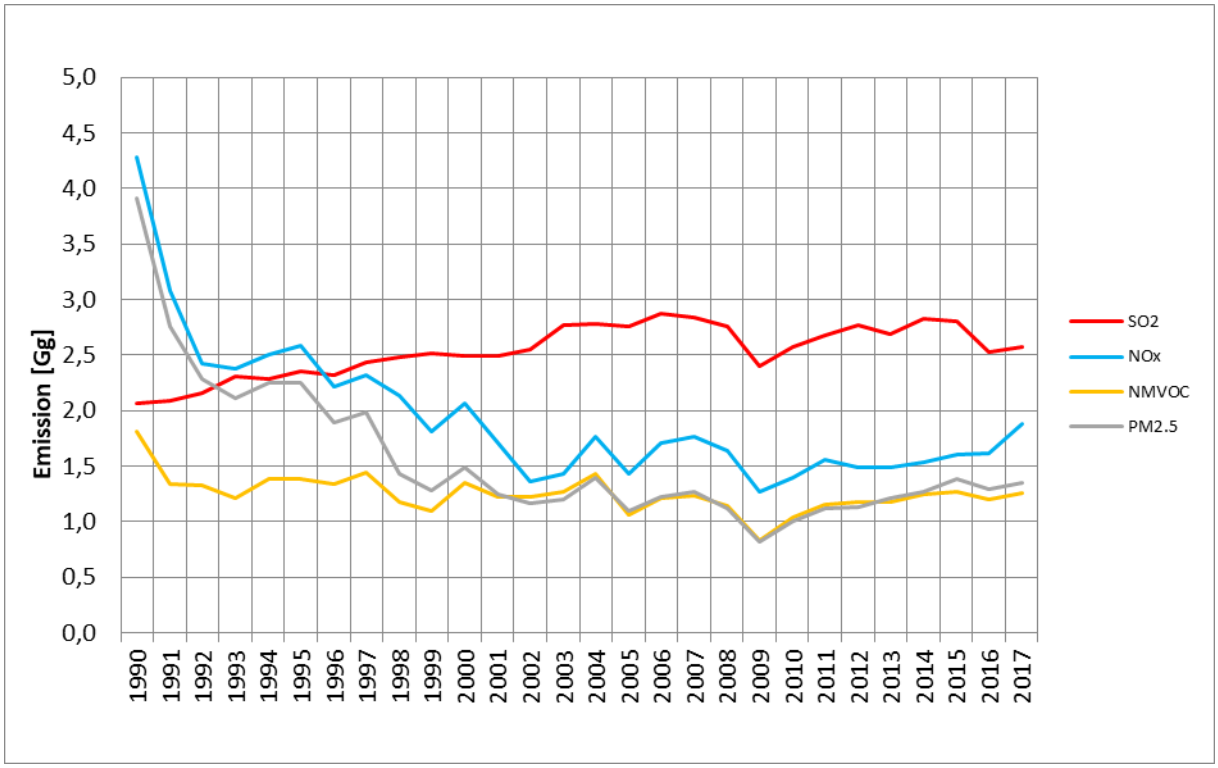

Figure 4.11. Emissions of the NEC pollutants for 2.C category in 1990-2017

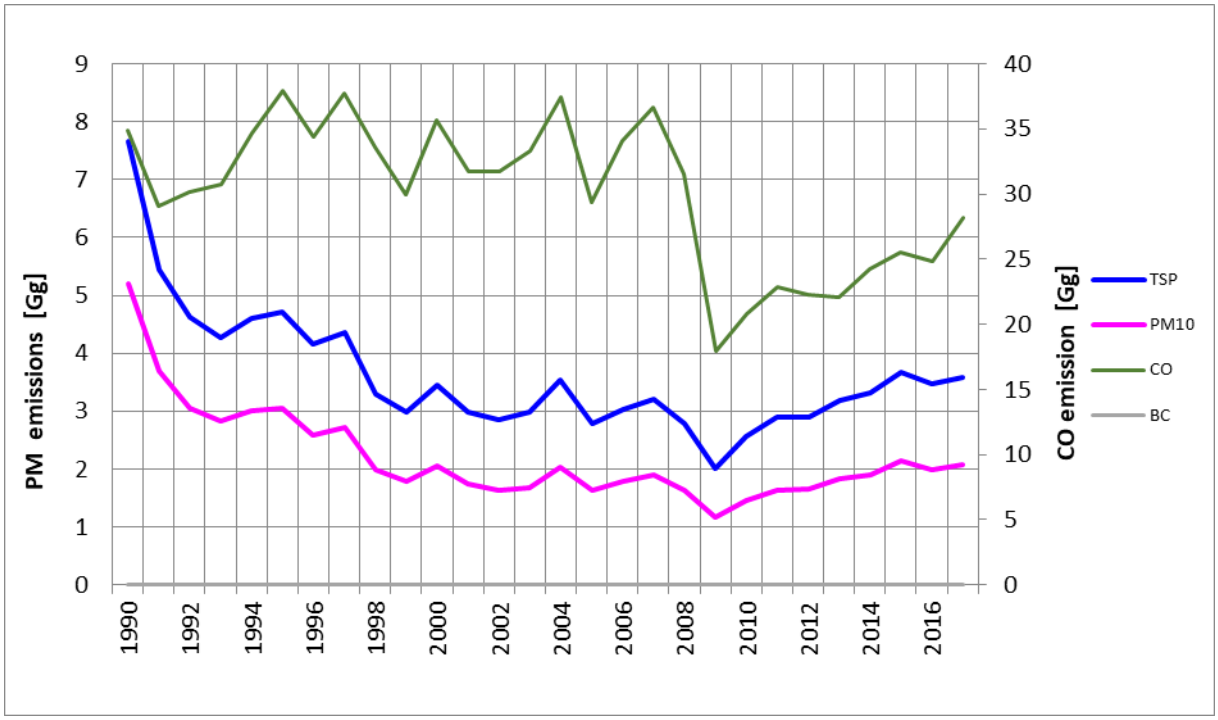

Figure 4.12. Emissions of particulates (TSP, PM_{10}, BC) and CO for 2.C category in 1990-2017

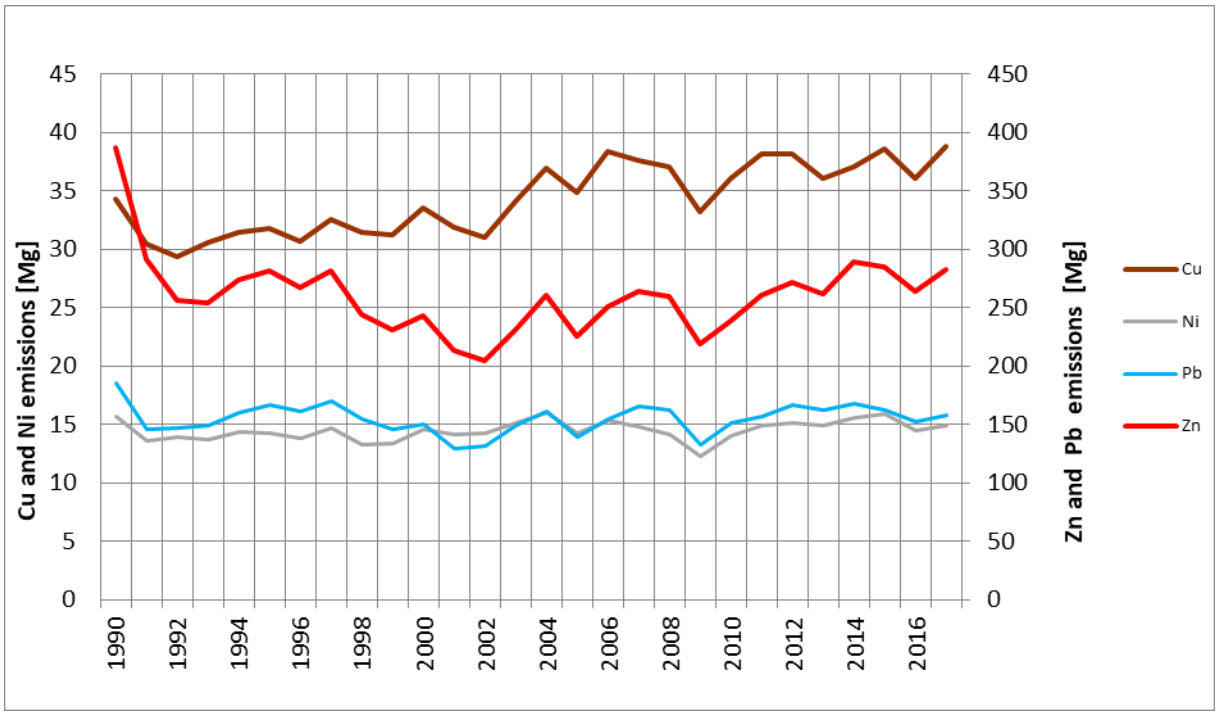

Figure 4.13. Emissions of Cu, Ni, Pb, and Zn for 2.C category in 1990-2017

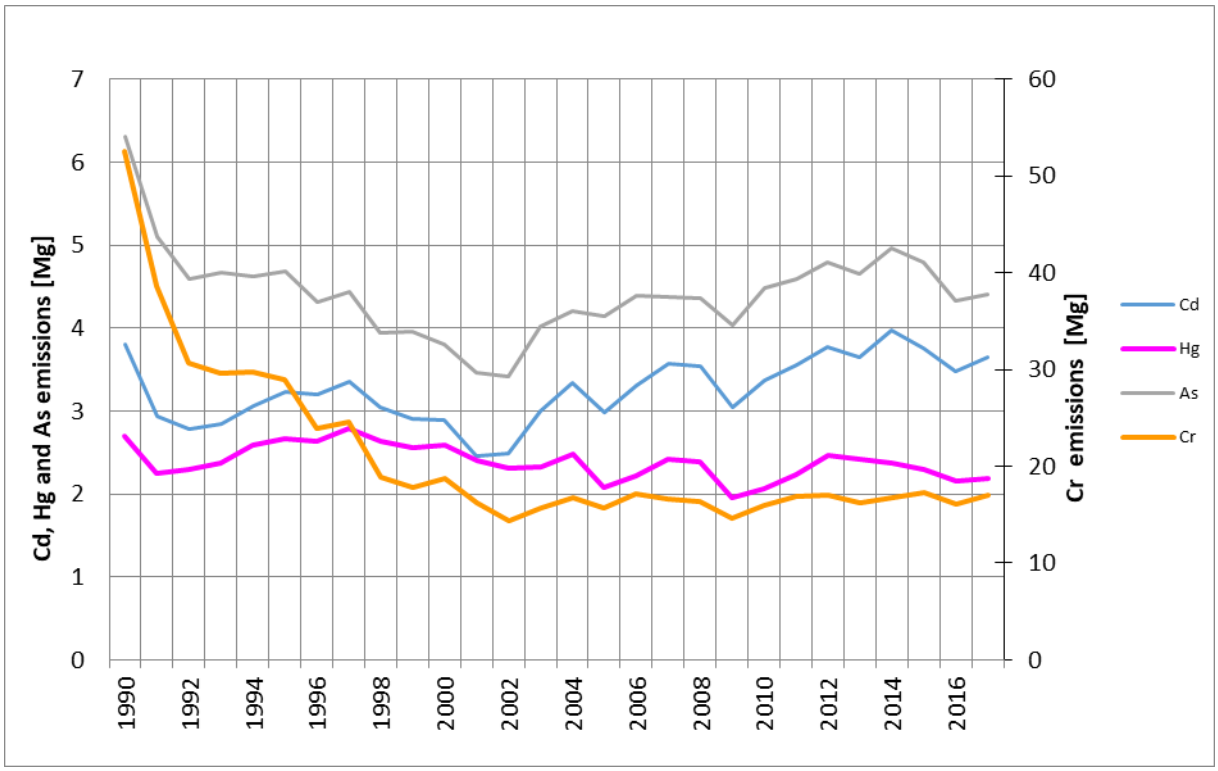

Figure 4.14. Cd, Hg, As and Cr emissions for 2.C category in 1990-2017

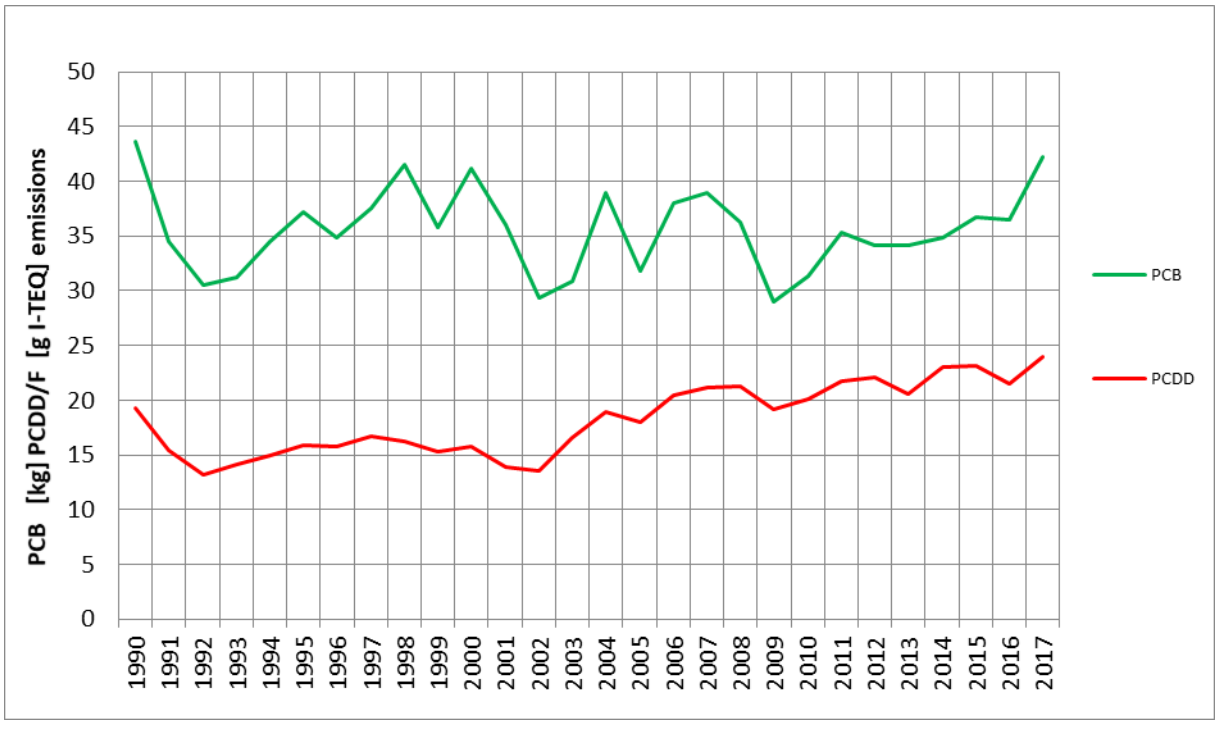

Figure 4.15. PCB and PCDD/F emissions for 2.C category in 1990-2017

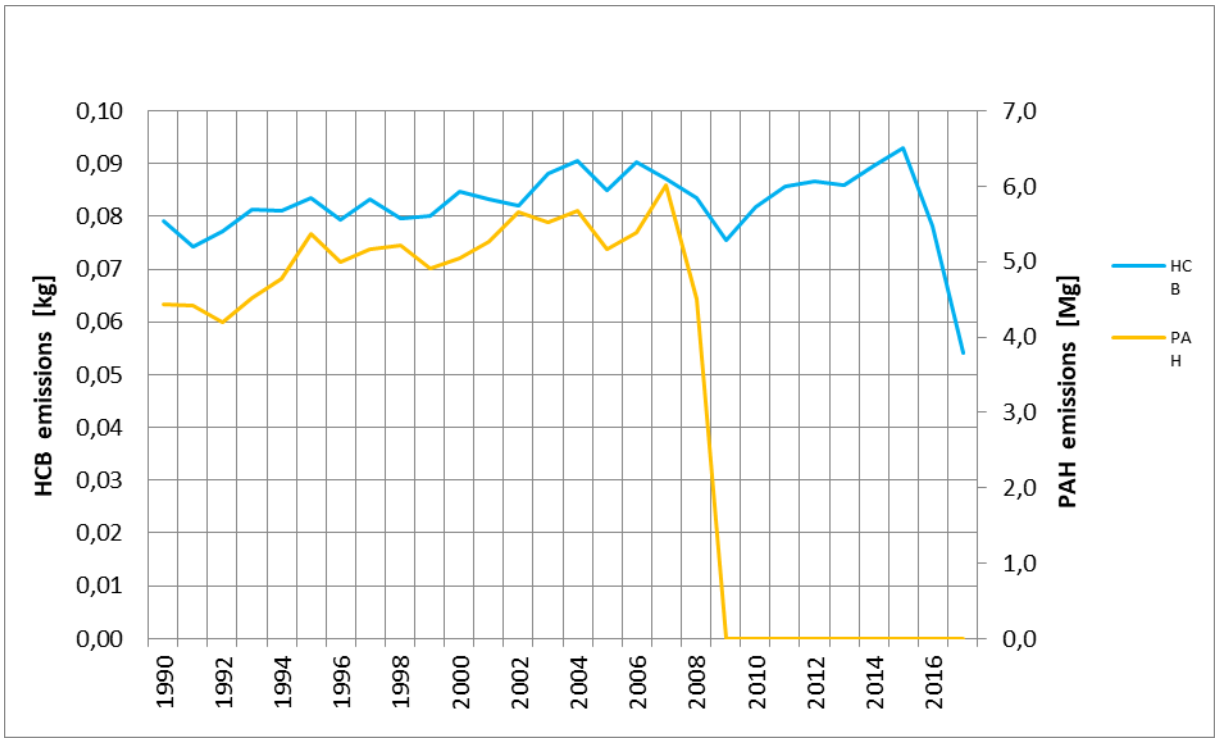

Figure 4.16. HCB and PAH emissions for 2.C category in 1990-2017

4.4.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector 2.C was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector 2.C are given below. Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 4.3. Results of the emission uncertainty analysis for NFR sector 2.C

NFR subsector		NOX	NMVOC	SO2	CO	TSP	PM10	PM2.5
2C1	Iron and steel production	20%	34%	30%	39%	21%	23%	23%
2C2	Ferroalloys production					40%		
2C3	Aluminium production	30%		30%	30%	50%	50%	50%
2C4	Magnesium production							
2C5	Lead production	30%		20%		50%	50%	50%
2C6	Zinc production			20%		50%	50%	50%
2C7a	Copper production			20%		50%	50%	50%
NFR subsector		**BC**	**Pb**	**Cd**	**Hg**	**PCDD/F**	**HCB**	**PAHs**
2C1	Iron and steel production	50%	26%	38%	58%	99%	99%	99%
2C2	Ferroalloys production		70%					
2C3	Aluminium production	70%						
2C4	Magnesium production							
2C5	Lead production		70%	70%	70%	99%	99%	99%
2C6	Zinc production		70%	70%	70%	99%	99%	99%
2C7a	Copper production	70%	70%	70%	70%	99%	99%	99%

4.4.5 Source-specific QA/QC and verification

For detailed information please see Section 3.1.5.

4.4.6 Source-specific recalculations

Heavy metals emissions from processes in production of: lead (2.C.5), zinc, and (2.C.6) copper (2.C.7 a) have been moved from combustion processes (1.A.2.b) to relevant 2.C.* categories.

4.4.7 Source-specific planned improvements

Investigation of the possibility of split between primary and secondary zinc and lead production is planned in the nearest future.

4.5 Solvents Use (NFR sector 2.D)

4.5.1 Source category description

The use of solvents is one of the main sources of NMVOC emissions and includes the following subcategories:

- Domestic solvent use including fungicides (2.D.3.a)
- Road paving with asphalt (2.D.3.b)
- Asphalt roofing (2.D.3.c)
- Coating applications (2.D.3.d)
- Degreasing (2.D.3.e)
- Dry cleaning (2.D.3.f)
- Chemical Products (2.D.3.g)
- Printing (2.D.3.h)
- Other Solvent use (2.D.3.i)

Shares of emissions from the 2 D category in the country total for the particular pollutants in 2017 are shown on the Figure 4.17.

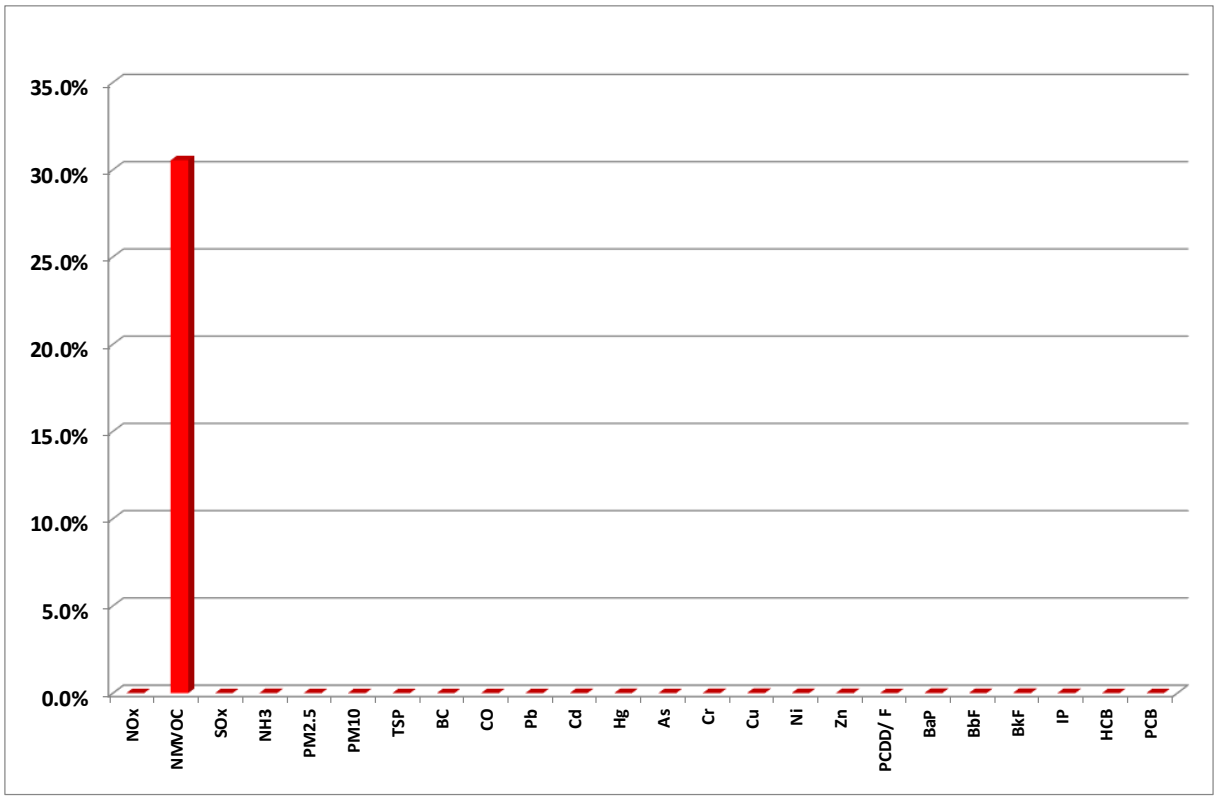

Figure 4.17. Shares of emissions from the 2.D category in the country total

This category corresponds to categories SNAP 06 and SNAP 040610.

Activity data for this sector come from statistical yearbook [GUS 2018e] and import-export balances.

The activity data used in the sub-category 2.D for the years 1990-2017 are presented in Annex 5. Most of NMVOC emission factors have been developed by the Institute for Ecology of Industrial Areas (IETU). Applied emission factors for subcategory 2.D are presented in Annex 6.

4.5.2 Methodological issues

For *Coating applications* methodology of estimates is based on production, import and export of paints. Based on these statistical data the amount of paint has been split into two categories: water based and solvents based. Taking into consideration the latest legislation (Solvent's Directive) Poland assumes that the majority of solvent-based paints has been used for industrial use and water-based paints have been used domestically for decorative use.

For *Degreasing and dry Cleaning* it was assumed that "metals degreasing" include also solvents used for other purposes in industrial processes, which were not included separately in the inventory for NMVOC (eg., electronic industry, textile, leather, etc.). Poland will further investigate possibilities to apply the 2016 EMEP/EEA Guidebook methodology.

4.5.3 Emission trends for the NFR sector 2.D

Volumes and trend of pollutant emissions for *Solvent use* is shown below on Figure 4.18 and Figure 4.19.

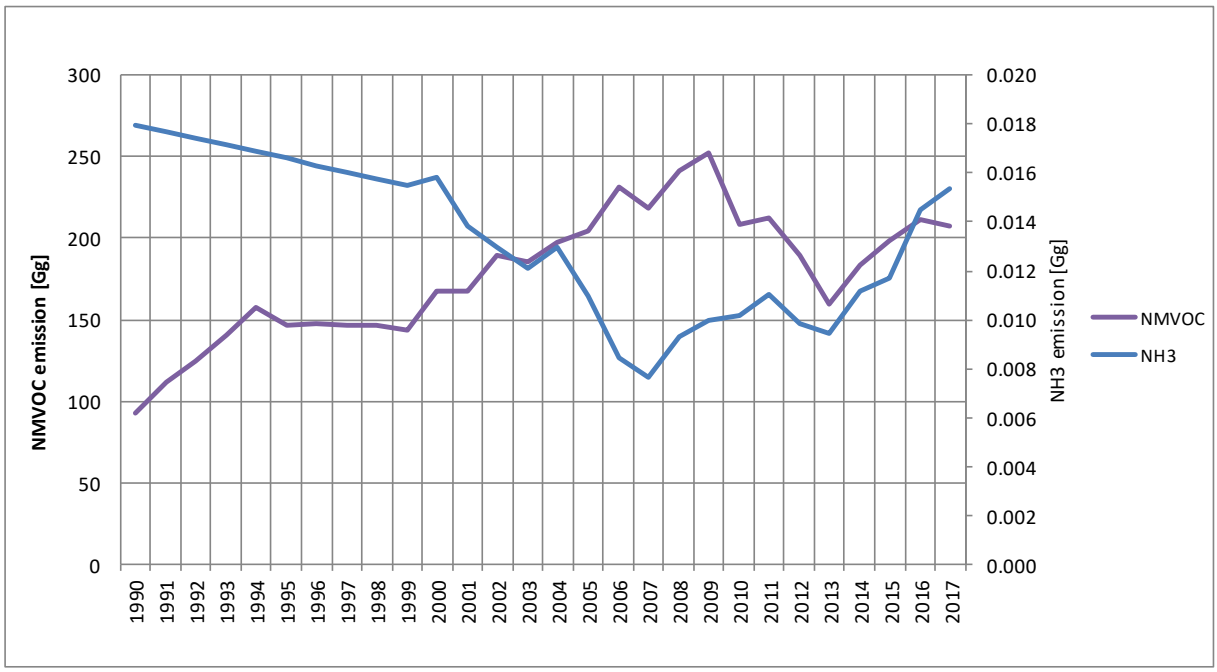

Figure 4.18. NMVOC and NH_3 emissions for NFR 2.D category in 1990-2017

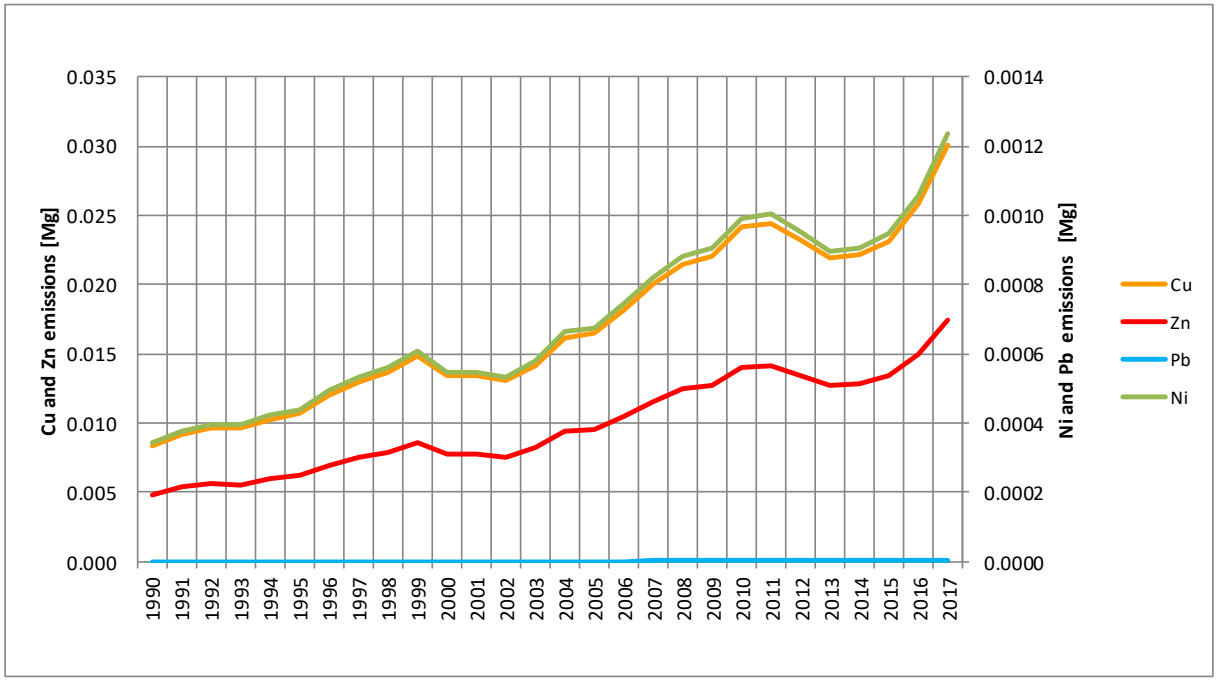

Figure 4.19. Cu, Zn, Pb and Ni emissions for NFR 2.D category in 1990-2017

Pollutant emissions of Cu, Zn, Pb and Ni from lubricant use for the subcategory *Other solvent use* form 2.D.3.i have been calculated by using COPERT 5.2.

4.5.4 Uncertainties and time-series consistency for NFR 2.D

Uncertainty analysis for the 2017 for NFR sector 2.D was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector 2.D are given below.

Performed recalculations (period 1990-2016) of data ensured consistency for the time-series.

Table 4.4. Results of the emission uncertainty analysis for NFR sector 2.D

NFR		NMVOC	NH_3	PAH
2D3a	Domestic solvent use including fungicides	30%		
2D3b	Road paving with asphalt	100%		
2D3c	Asphalt roofing	50%		
2D3d	Coating applications	28%		
2D3e	Degreasing	30%		
2D3f	Dry cleaning	30%		
2D3g	Chemical products	19%	50%	
2D3i	Other solvent use	30%		100%

4.5.5 Source-specific QA/QC and verification

For further details please see chapter 3.1.5.

4.5.6 Source-specific recalculations

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory:

- Hg emission estimates from Domestic Solvent Use Including Fungicides (NFR 2.D.3.a), have been verified and included;
- A schedule of implementation regarding separating part of asphalt production, which is used for the road paving (NFR 2.D.3.b) and information on progress in implementing the improvement has been included in IIR;
- NMVOC emissions for the *Asphalt roofing* (NFR 2.D.3.c) have been recalculated using new methodology approach (assuming average roofing density of 2.5 kg per m^2);
- Description of the applied methodology regarding Coating Applications (NFR 2.D.3.d) has been included in the IIR;
- Schedule of implementation has been included in IIR regarding possibilities to apply the 2016 EMEP/EEA Guidebook methodology for calculation of NMVOC emission (NFR 2D3g);
- Statistical activity data used for tyres and shoes (NFR 2.D.3.g) have been added;
- Information on AD for Printing (NFR 2.D.3.h) has been included in IIR and in NFR Tables;
- AD, methodology description and figures for glues and adhesives (NFR 2.D.3.i) have been included in IIR and relevant Annexes.

4.5.7 Source-specific planned improvements

Development and update of NMVOCs emissions methodology to be continued, especially:

- PAHs emission estimates from asphalt blowing (NFR 2.D.3.g) have not been included due to the fact that emission factors for this process presented in EEA/EMEP Emission Inventory Guidebook (excluding NMVOC) factors are unreferenced in the older Guidebook and should therefore be used with care. According to scientific publications [65, 66] emissions of PAHs from asphalt blowing process are insignificant. Therefore, emissions from asphalt blowing will be included in analysis as soon as reliable emission factors are available.
- For *Degreasing and dry Cleaning* it was assumed that "metals degreasing" include also solvents used for other purposes in industrial processes, which were not included separately in the inventory for NMVOC (eg., electronic industry, textile, leather, etc.). Poland will further investigate possibilities to apply the 2016 EMEP/EEA Guidebook methodology.

4.6 Other products (NFR 2.G, 2.H, 2.I and 2.L)

4.6.1 Source category description

Estimation of emissions in *Other Products* carried out in sub-categories listed below:

- Use of tobacco and fireworks (NFR 2.G),
- Pulp and paper (including chipboards, NFR 2.H.1),
- Food and drink (NFR 2.H.2),
- Wood processing (NFR 2.I),
- Other production, consumption, storage, transportation or handling of bulk products (2.L).

The pollutant emission sources related to production processes in metal industry cover NO_X, SO_2, NMVOC, NH_3, CO, PM, BC, and PCDD/F. This category corresponds to categories SNAP 040601 ÷ SNAP 040608, 040617 (smoke houses; storage and handling) and SNAP 060602 (use of tobacco). Category 2.L consists of the storage and handling of cement, coal and coke. Shares of emissions from the NFR 2.G – 2L categories in the country total for the particular pollutants in 2017 are shown below in the Figure 4.20.

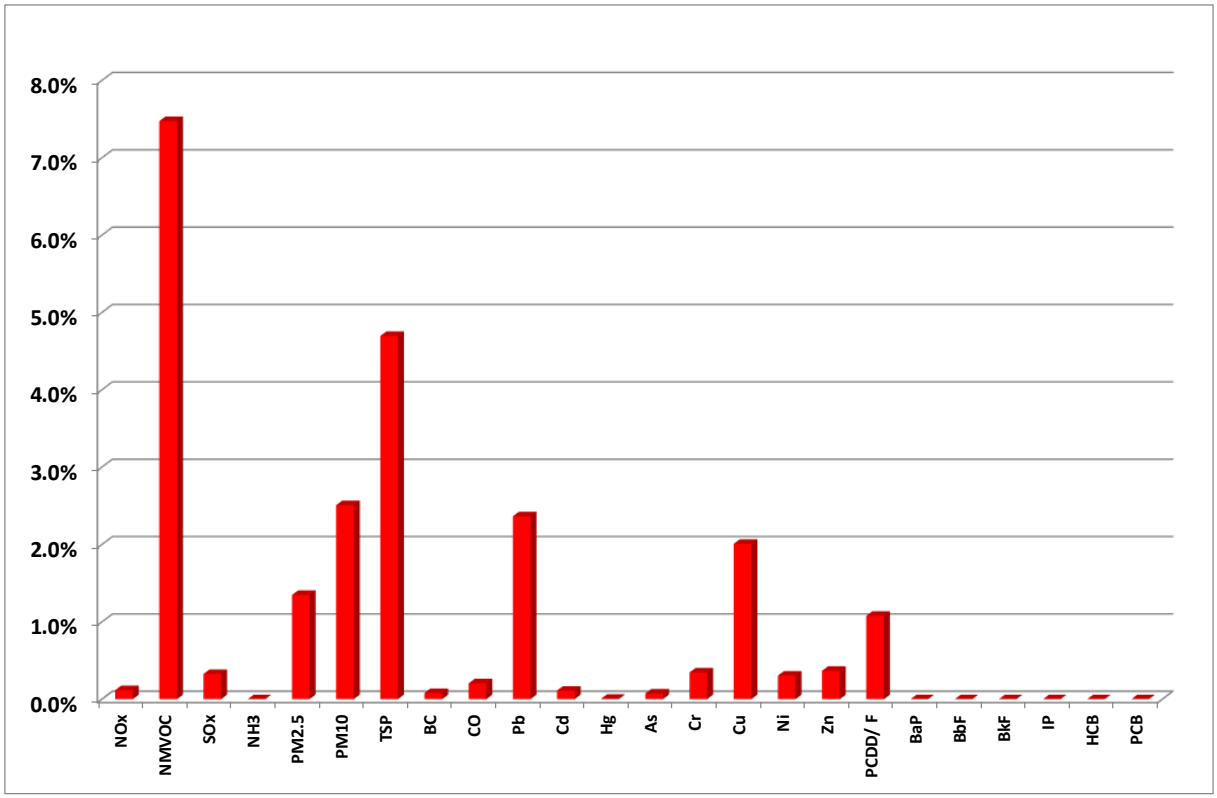

Figure 4.20. Shares of emissions from the 2.G, 2.H, 2.I and 2.L categories in the country total

4.6.2 Methodological issues

Activity data for this sector come from GUS statistical yearbooks [GUS 2018e]. In the Annex 5 is presented the activity data used in the sub-category Other Products for the years 1990-2016. To estimate emissions for subcategories 2.G, 2.H, 2.I and 2.L domestic and default emission factors are used, which are presented in the Annex 6.

4.6.3 Emission trends for the NFR sectors 2.G – 2.L

Volumes and trend of pollutant emissions for *Other Products* are shown below on figures below (Figure 4.21- Figure 4.23).

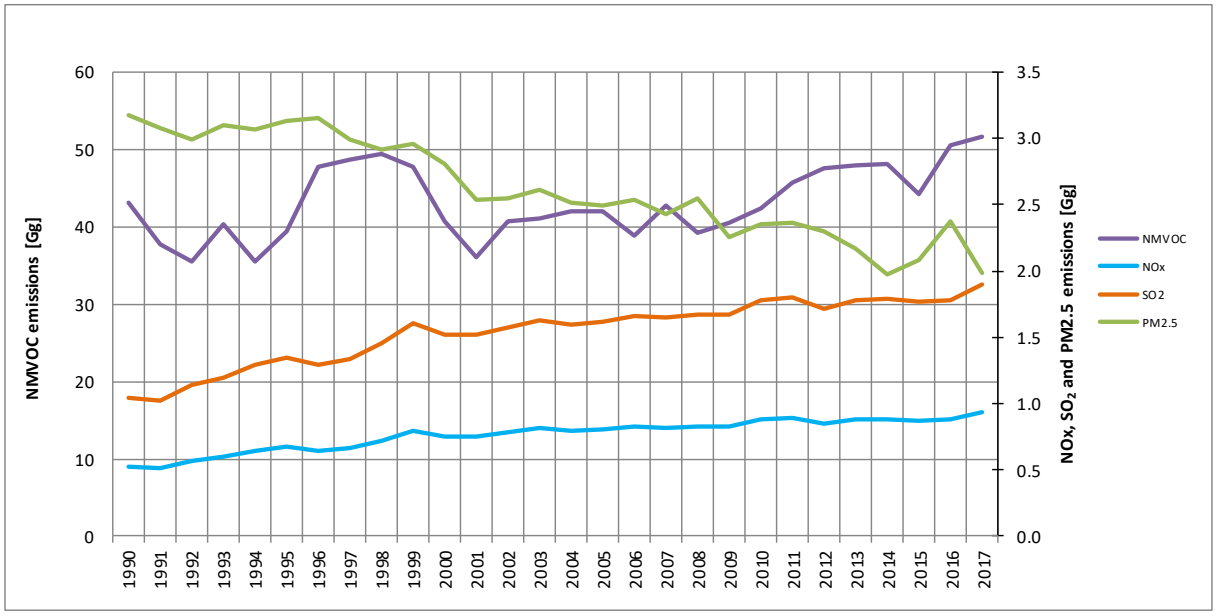

Figure 4.21. The NEC pollutants emissions from the 2.G – 2.L categories in 1990-2017

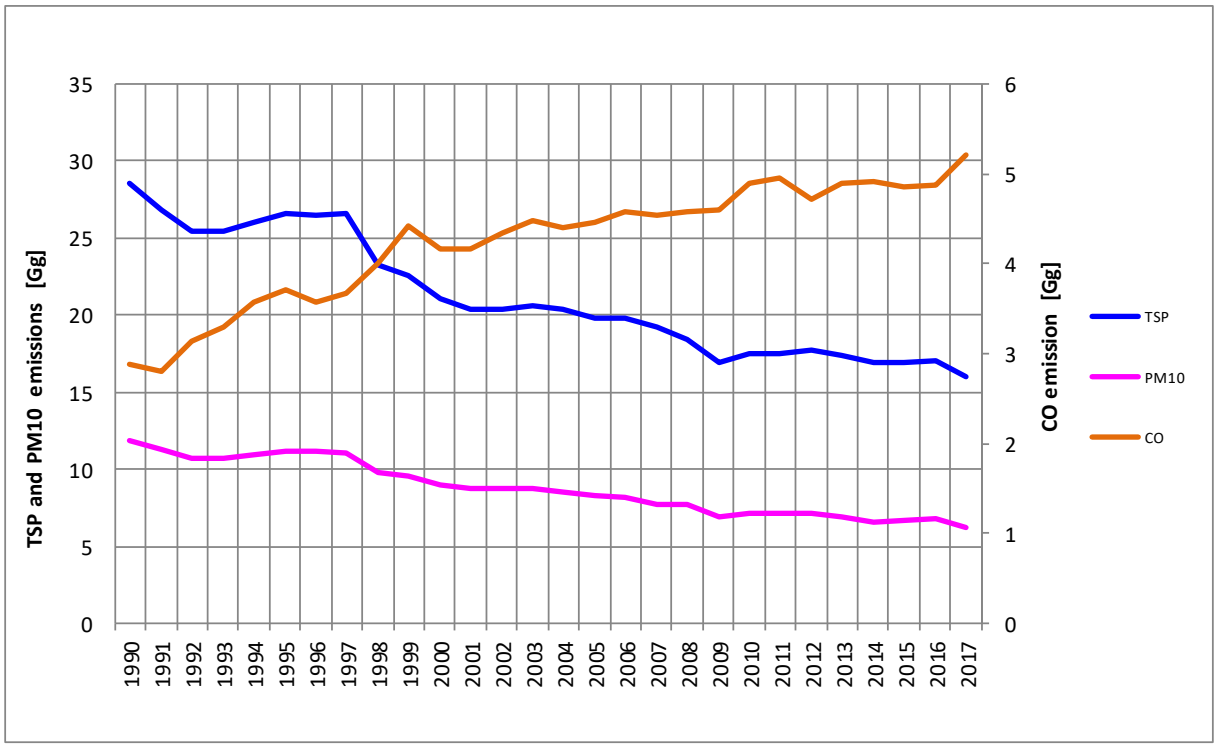

Figure 4.22. Particulates (TSP, PM_{10}) and CO emissions from the 2.G – 2.L categories in 1990-2017

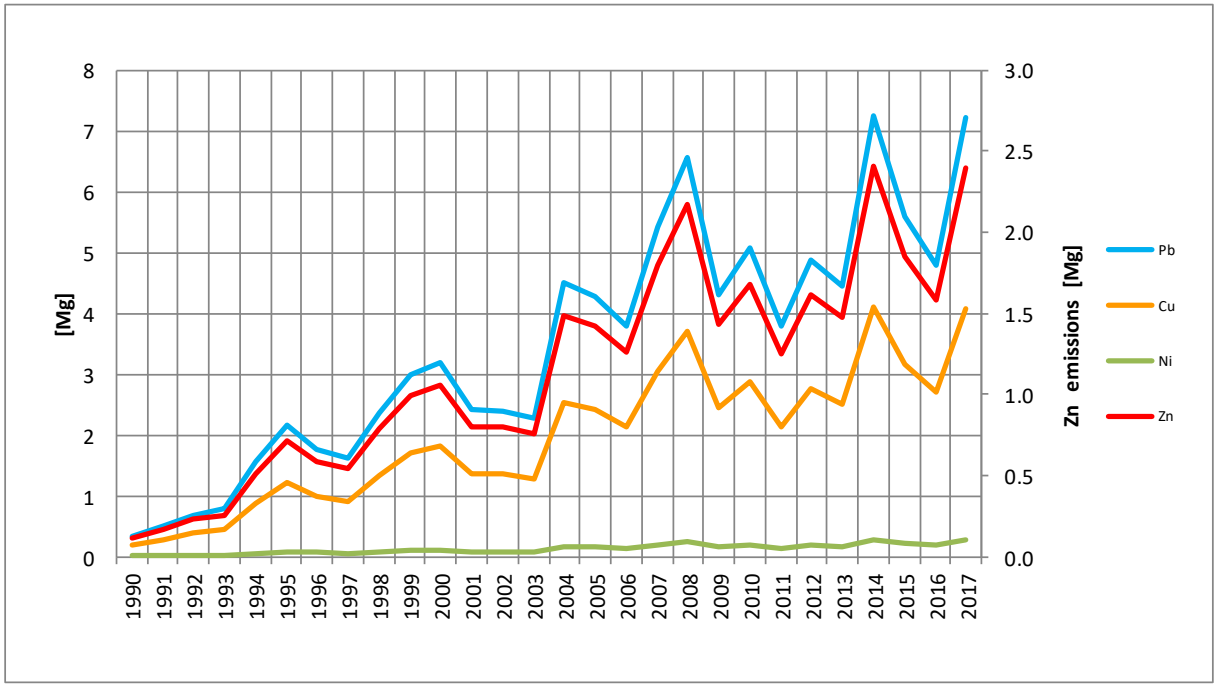

Figure 4.23. Pb, Cu, Ni, and Zn emissions from the 2.G – 2.L categories in 1990-2017

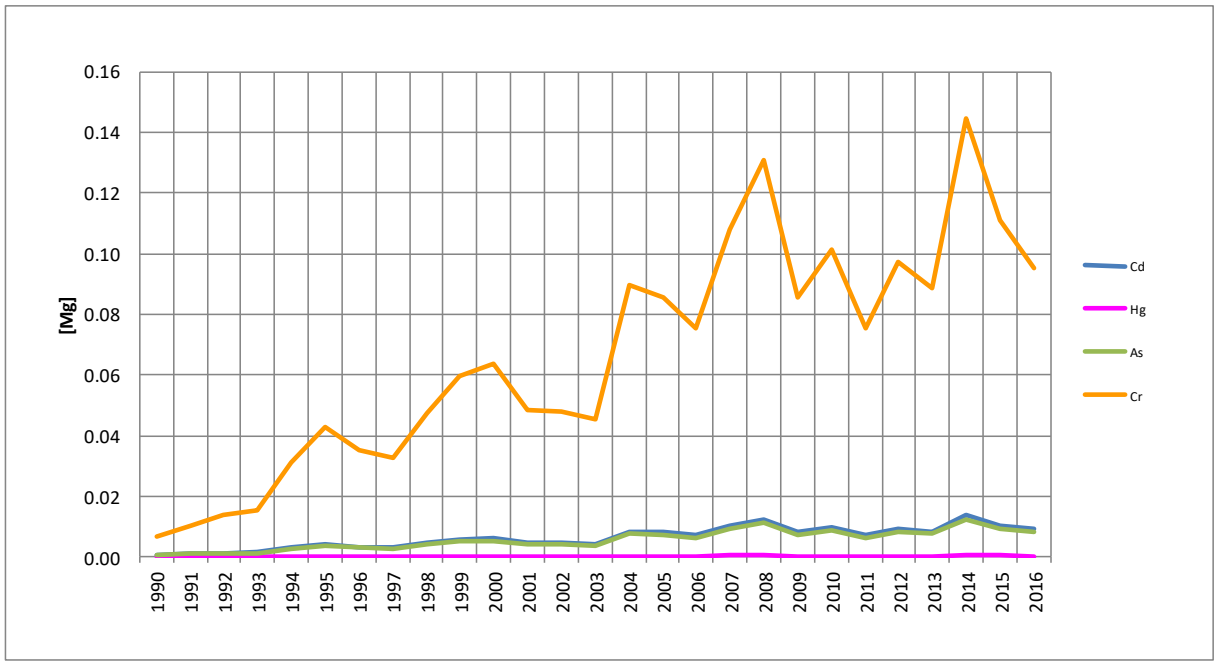

Figure 4.24. Cd, Hg, As, and Cr emissions from the 2.G – 2.L categories in 1990-2017

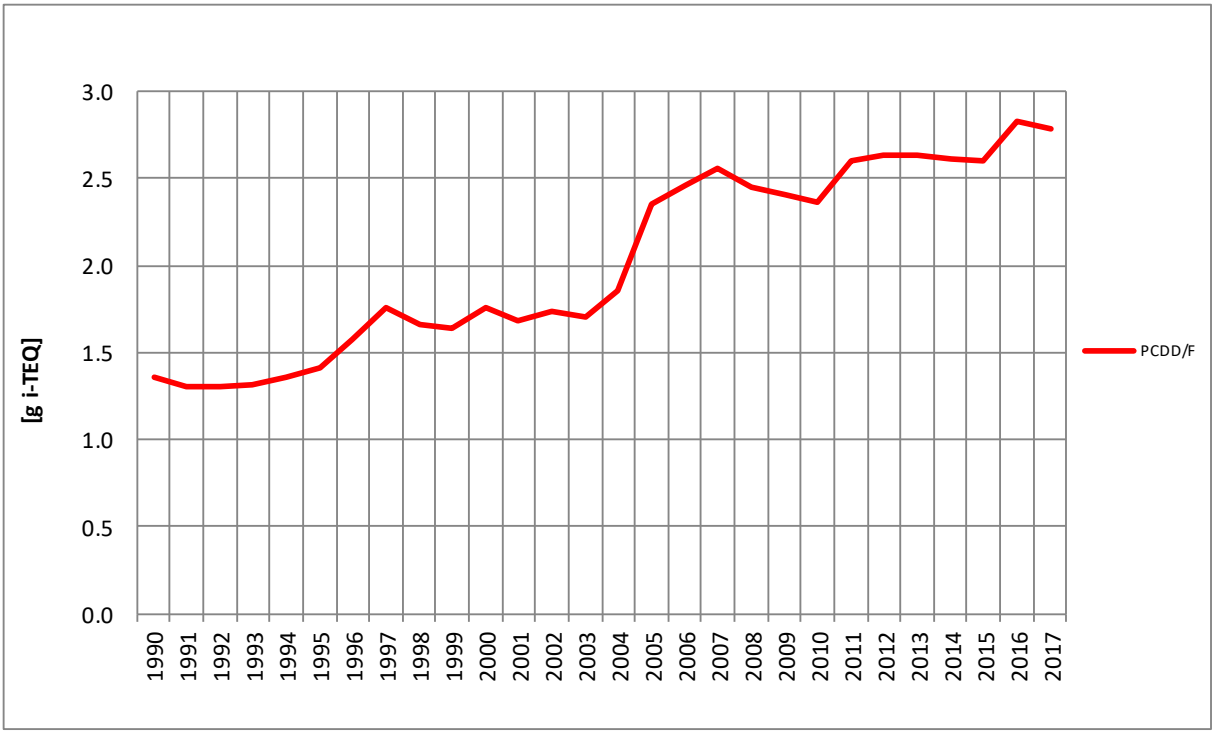

Figure 4.25. PCDD/F emissions from the 2.G – 2.L categories in 1990-2017

4.6.4 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for sector Other Products was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis are given below. Performed recalculations (period 1990-2016) of data ensured consistency for whole time-series.

Table 4.5. Results of the uncertainty analysis for NFR sector 2.G – 2.L

NFR subsector		NOX	NMVOC	SO2	CO	TSP	PM10	PM2.5	BC
2G	Other product use	71%	71%		71%	50%	50%	50%	70%
2H1	Pulp and paper industry	30%	50%	30%	50%	50%	50%	50%	50%
2H2	Food and beverages industry		36%						
2I	Wood processing					50%			
2L	Other …					50%	50%	50%	
NFR subsector		**Pb**	**Cd**	**Hg**	**PCDD/F**	**HCB**	**PAHs**		
2G	Other product use	71%	71%	71%	100%	100%	100%		
2H1	Pulp and paper industry								
2H2	Food and beverages industry								
2I	Wood processing								
2L	Other …								

4.6.5 Source-specific QA/QC and verification

For detailed information please see Section 3.1.5.

4.6.6 Source-specific recalculations

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory:

- In the category Pulp and paper (NFR 2.H.1) SO_2 emission factor has been applied from the EMEP/EEA EIG 2016. This change resulted in a small increase of SO_2 emissions from this category. Applied new emission factor is presented in the Annex 6.
- NMVOC emission factors for the category Food and drink (NFR 2.H.2) have been applied from the EMEP/EEA EIG 2016 for the following products: sugar, meat (cattle, pigs, 101 poultry), frozen sea fish, margarine and fat spreads, food for animals. This change resulted in an increase of NMVOC emissions from this category. Applied new emission factors are presented in the Annex 6.

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory:

- Emissions from tobacco combustion are estimated using a national methodology incorporating the average mass of tobacco in a cigarette and the amount of a cigarettes smoked yearly per inhabitant (from national statistics).
- Emission of NMVOC from production of chipboards is included in the 2H1 sub-sector. In 2I subsector is reported the TSP emission from wood processing (according to EF provided in EIG, 2016).
- However the estimations of emissions from the 2L sector use the same activity data as sectors 2A1 (cement), 1B1a (coal) and 1B1b (coke), PM emissions from the storage and transport of these goods haven't been reallocated under the proposed NFR categories (2A1, 1B1a, and 1B1b). Carrying out this reallocation would affect the spatial mapping of estimated emissions, and would result with considerable change of implied emission factors associated with production of these goods, and will affect the spatial mapping of estimated emissions.
- AD and emission estimates relating to the use of fireworks for the years before 2002 have been included in the report. AD for the years 1990-2001, derived from public statistics, include import and export of fireworks, but do not include the production yet. This should not disturb the quality of data as the production volumes are very small (for the years 2002-2017 production had 0,31% share in the total use of fireworks). The estimates will be completed with the production data in the next IIR.

4.6.7 Source-specific planned improvements

No improvement is planned in categories 2.G – 2.L except from the above mentioned improvement of AD for years 1990-2001 for fireworks (the inclusion of production data), which will take place upon obtaining relevant information from public statistics.

5 AGRICULTURE (NFR SECTOR 3)

5.1 Overview of sector

The pollutant emission sources in agricultural sector involve: manure related to livestock management (NH_3, NO_X, NMVOC, PM10, PM2.5, TSP), agricultural soils (NH_3, NO_X and NMVOC), agricultural operations (PM10, PM2.5, TSP) and agricultural residue burning (CO, NMVOC, TSP, PM10, PM2.5). Emission categories like: rice cultivation and prescribed burning of savannas were skipped as do not occur in Poland.

The agriculture sector is main source of ammonia emissions (93,6%), driven by a number of animals, crop production and volume of mineral N fertilizers applied. Therefore main influence on interannual emissions change has the fluctuations of animal population and amount of nitrogen fertilizers used. Shares of emissions from the NFR 3 category in the country total for the particular pollutants in 2017 are shown in the Figure 5.1.

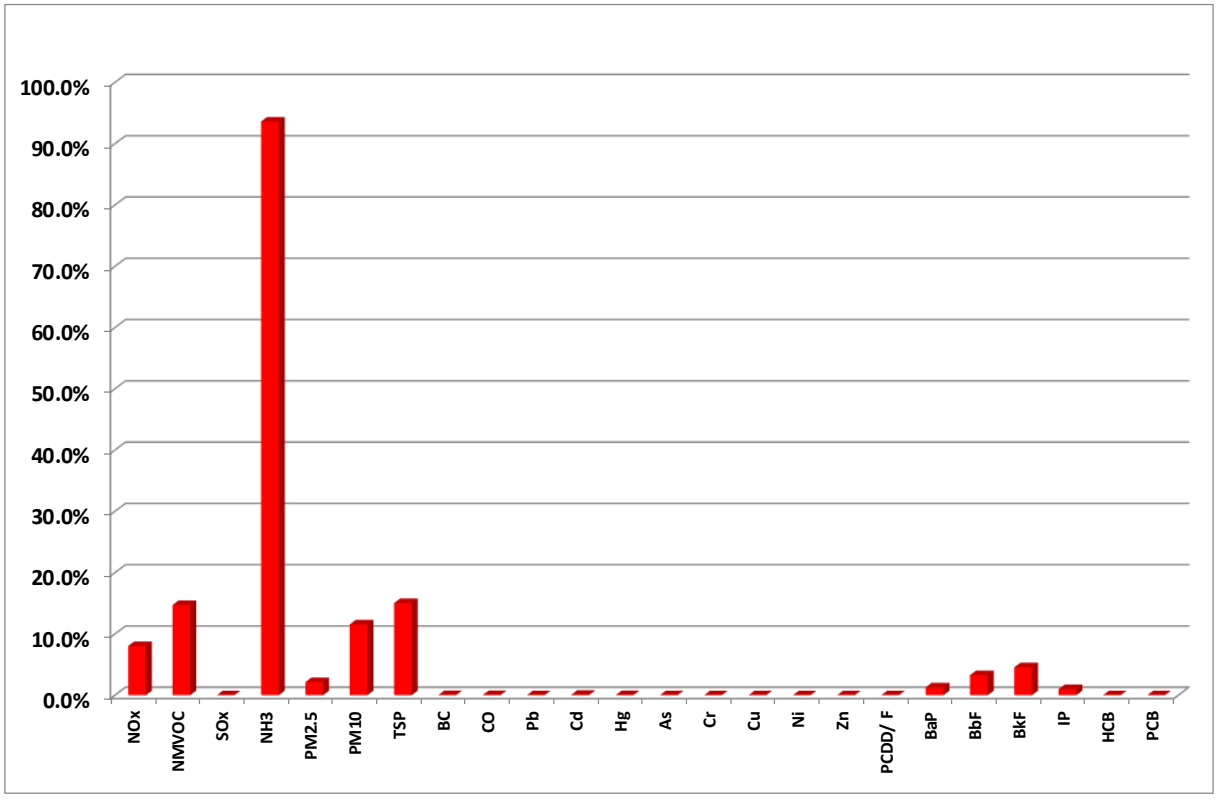

Figure 5.1. Shares of emissions from the NFR 3 category in the country total

5.2 Manure Management (NFR sector 3.B)

The pollutant emission sources in manure related to livestock management cover: NH_3, NO_X, NMVOC and PM10, PM2.5, TSP. Shares of emissions from the NFR 3.B category in the country total for the particular pollutants in 2017 are shown in the Figure 5.2.

The key activity data applied in this category covers livestock population which comes from national statistics and are compiled on the basis of:

- generalized results of sample surveys on cattle, sheep, poultry and pigs, as well as, the animal output in private farms,
- statistical reports in the scope of livestock in state and cooperative farms and companies with public and private property share,
- statistical reports from slaughter houses of farm animals,
- statistical reports from poultry hatcheries,
- information on the livestock of poultry from voivodship experts,
- own estimates.

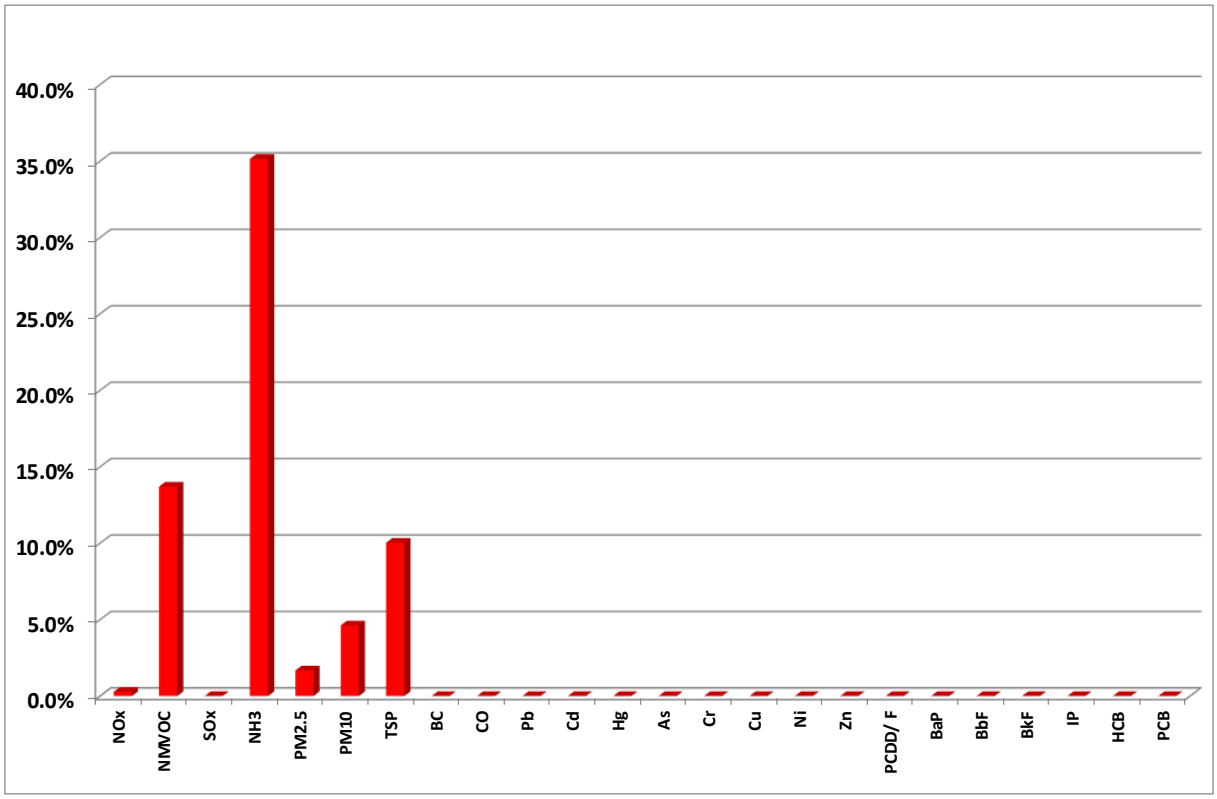

Figure 5.2. Shares of emissions from the 3.B category in the country total

5.2.1 Methodological issues

Activity data for 2017, similarly to those for entire period since 1990, related to livestock population come from national statistics (Statistics Poland) [GUS 2018j]. Generally population of major livestock is available on an annual basis. It should be noted that in Poland the June sample survey is a common date for collecting data by national statistics on all main livestock numbers and covers entire trend since 1990. The exception here is swine population for which data in 1998-2013 were collected also in summer but in July. It should be mentioned that for the last years sample surveys for cattle, sheep and poultry are performed twice a year (June, December) while for swine - three times a year (March, June and December) but the dates for additional sampling are not consistent and use to change since 1990. On the other hand population of horses and goats is collected once a year, in June, only. Additionally, for the first years of the inventoried series, only one annual number of livestock is available (June) for all main animal categories. In conclusion, application of the June survey results is justified and in fact the only one available to ensure time series consistency. Even more - comparison of differences in livestock population in the surveyed months performed for the same year indicated that summer populations are the highest in most of cases of the given year, thus

use of other statistical data could lead to underestimation of the emission. The population data on livestock applied for CLRTAP and GHG inventories correlates also with the numbers available in the FAO database what can be checked for consistency.

For early years of the inventoried period some goats population data is lacking for 1988-1995 and 1997, so data for 1996 was taken for the period 1988−1995 and for 1997 the average value for 1996 and 1998 was calculated. Since 1998 goats population is available on an annual basis. Additionally data on population of rabbits and other fur animals is available only for selected years of the inventoried period. In that case interpolation was made for the years in-between. The last data on fur animals cover the year 2016 so the same value is repeated in 2017. Trends of animal population in 1988−2017 is given in table 5.1.

Table 5.1. Trends of livestock population in 1990-2017

Years	Livestock population [thousands]									
	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Fur animals	Poultry		
								Laying hens	Broilers	Other poultry
1990	4 919	5130	4 159	179	941	19 464	1 490	55 686	132 485	36 694
1991	4 577	4267	3 234	179	939	21 868	1 447	53 427	128 193	34 473
1992	4 257	3964	1 870	179	900	22 086	1 405	49 418	115 636	34 081
1993	3 983	3660	1 268	179	841	18 860	1 363	47 819	112 420	34 467
1994	3 863	3833	870	179	622	19 466	1 321	51 278	116 569	33 549
1995	3 579	3727	713	179	636	20 418	1 278	48 799	110 300	30 885
1996	3 461	3675	552	179	569	17 964	1 236	56 302	136 471	14 707
1997	3 490	3817	491	182	558	18 135	1 218	54 746	130 195	16 300
1998	3 542	3413	453	186	561	19 168	1 200	53 241	127 709	20 413
1999	3 418	3137	392	181	551	18 538	1 182	53 245	125 929	23 333
2000	3 098	2985	362	177	550	17 122	1 164	52 337	122 307	23 692
2001	3 005	2729	343	172	546	17 105	1 146	55 314	128 085	22 810
2002	2 873	2660	345	193	330	18 629	1 128	51 759	123 316	23 708
2003	2 898	2591	338	192	333	18 605	1 122	44 549	88 846	12 926
2004	2 796	2557	318	176	321	16 988	1 116	43 001	76 810	10 478
2005	2 795	2688	316	142	312	18 112	1 110	45 201	67 987	11 585
2006	2 824	2782	301	130	307	18 881	1 104	40 707	70 946	16 938
2007	2 787	2909	332	144	329	18 129	1 098	46 289	77 393	17 548
2008	2 806	2950	324	136	325	15 425	1 093	50 724	78 063	16 708
2009	2 688	3012	286	119	298	14 279	1 087	47 736	66 804	16 697
2010	2 656	3068	258	108	264	14 865	1 081	50 659	80 300	11 502
2011	2 626	3136	251	112	254	13 509	977	47 059	80 482	16 016
2012	2 578	3199	267	90	222	11 581	872	52 455	60 969	17 172
2013	2 531	3329	223	82	207	11 162	768	49 893	73 619	17 179
2014	2 479	3441	201	82	207	11 724	768	41 769	88 092	16 910
2015	2 444	3516	228	82	207	11 640	768	45 629	100 493	17 303
2016	2 332	3607	239	44	185	10 865	768	47 072	121 960	18 742
2017	2 374	3769	261	44	185	11 353	1 389	50 160	127 480	19 897

Ammonia and NO_2 emissions from manure management were estimated based on Tier 2 method (mass flow approach) as published in chapter 3.3.1 in part *3.B Manure Management* of *EMEP/EEA EIG 2016* (equations 5-43) using animal population as given in Table 5.1 and country specific data on the animal waste management systems (AWMS) given in

Table 5.2. [Walczak 2006, 2009, 2011, 2012, 2013]. This data set is consistent with the one used for GHG emission estimation [NIR 2019]. The fractions of manure managed in given AWMS for cattle were assessed on an annual basis for periods 1988-2002 and 2004−2012, data for 2003 was interpolated between 2002 and 2004. The share of pastures and solid storage were assessed for the key years: 1988-1989 and for 2004-2012 and the values in-between were interpolated. As concerns swine manure management systems the share of liquid and solid storage was estimated based on AWMS shares and pigs population for age categories for 1988 [Walczak 2006]. Data for 2004−2012 was taken from [Walczak 2011, 2012, 2013]. Data for years between 1988 and 2004 interpolation was made. Data for 2012 were used for 2013-2017.

For other animals permanent shares of AWMS for entire inventoried period were assumed based on data assessed for 2004−2012: for sheep - 40% on pastures and 60% solid storage, for goats: 44% on pastures and 56% on solid storage and for horses: 22% and 78% respectively. For poultry the following AWMS shares were established: 11% on litter-free systems and 89% on solid storage [Walczak 2011, 2012, 2013].

It should be noted that generally in Poland prevail small farms (56% farms breed livestock, 54% farms have up to 5 ha and only 9% farms have more than 20 ha) where solid systems for animal management are commonly used due to lower investment costs. Liquid systems are applied mostly at big farms, for instance for dairy cattle - having more than 120 animals. Development of such big milk farms in early years of 2000 influenced significant increase of CH_4 emissions from manure management for dairy cattle since 2002.

Table 5.2. Fractions of manure managed in given AWMS for cattle and swine for selected years [%]

Year	Dairy cattle			Other cattle			Swine		
	liquid	solid	pasture	liquid	solid	pasture	liquid	solid	pasture
1990	2.7	76.1	21.2	3.2	79.2	17.6	22.4	77.6	0.0
1995	2.3	80.4	17.2	3.8	80.6	15.6	22.7	77.3	0.0
2000	3.7	83.1	13.2	4.0	82.4	13.6	23.0	77.0	0.0
2005	10.6	79.4	10.0	5.2	82.8	12.0	24.0	76.0	0.0
2010	10.1	79.6	10.3	5.1	82.9	12.1	25.5	74.5	0.0
Since 2012	10.5	79.2	10.3	5.1	82.9	12.0	24.3	75.7	0.0

Data on animals' nitrogen excretion rates (kg N/head/year) is country specific one [IUNG, 2014, 2018]. Country specific Nex values are generally in line with parameters published by EMEP/EEA for most livestock categories (Annex 6). The basis for assessment of Nitrogen excretion rates (Nex) (applied also in calculations of N_2O emissions) constitutes the standard amounts of nitrogen in faeces and urine determined for different groups of livestock animals grounded on standard quantity, sort and digestibility of fodder applied. The Nex parameters for dairy cattle differ in time and are still lower than in Western Europe what is related mostly to lower milk production where mean milk yield exceeded 5500 litters/yr on average already in 2015.

The Nex values for Poland for sheep and goats are among group of countries with lower factor then the default ones. The country specific Nex values were established based on livestock categories raised in Poland as well as country specific conditions and international literature and research. Sheep (as well as goats) in Poland are fed on pastures for around half a year and housed for another half. Sheep and goats are fed mostly on roughage from extensive pastures and meadows. Winter feeding cover hay, straw and root crops. Additional protein fodder is not widely applied among sheep and goats, if applied it is limited to lambs. It should be mentioned here that Nex is established for entire group of sheep of which about 30% are lambs and other immature animals.

The parameters like nitrogen contained in bedding material and NH_3 emission factors related to

specific manure management systems (slurry, liquid, outdoor) were taken from Table 3.7 in part 3.B *Manure Management* of the *EMEP/EEA EIG 2016*. The pasture period for cattle is increasing since 2005 (180 days) reaching 195 days in 2010 and 210 days in 2014-2017.

When using Tier 2 method during calculations of NH_3 emissions from manure management the effect of some abatement measures were taken into account (Table 5.3) following method described in chapter 3.4 in part 3.B *Manure Management* of *EMEP/EEA EIG 2016* which were introduced mostly after joining the EU in 2004. These cover manure cover during storage, partially slated floor use or multiphase feeding. The techniques recognised for 2014 were also used in emission calculations for the next years. The NH_3 emission reduction were elaborated by [Walczak 2016] based on EMEP/EEA guidelines and IIASA analysis.

Table 5.3. NH_3 abatement techniques in manure management applied in 2005-2014

NH_3 abatement techniques	**% of animal population covered in years**			**NH_3 emission reduction coefficient [%]**
	2005	**2010**	**2014**	
Swine partially slated floor	0.0	11.9	15.6	20
Laying hens manure fast removal	0.6	28.0	32.3	32
Laying hens manure ventilation	0.0	12.1	14.3	32
Cattle manure cover	0.5	2.3	2.8	80
Swine manure cover	0.9	12.7	15.3	80
Laying hens manure cover	0.0	1.14	1.34	80
Broilers manure cover	0.2	0.5	0.7	80
Cattle slurry cover	0.0	43.5	44.8	80
Swine slurry cover	0.0	61.8	67.2	80
Dairy cattle protein feeding	0.0	14.2	17.6	15
Laying hens 3-phase feeding	0.0	23.3	27.4	20
Broilers 5-phase feeding	0.0	38.5	42.1	20
Fattening pigs 4-phase feeding	0.0	14.7	18.5	30
Piglets 3-phase feeding	0.0	10.2	14.7	30

Comparison of default NH_3 and NO_X EFs as published in part 3.B *Manure Management* of *EMEP/EEA EIG 2016* in Table 3.1 and CS implied emission factors is given in Annex 6. The CS implied emission factors since 1990 is given in Table 5.4 and Table 5.5.

It should be noticed that EFs for cattle increases in time due to increasing share of slurry systems. In case of dairy cattle EFs raises significantly also due to increasing Nex parameter in time related to improving milkiness. Abatement measures incorporated in calculations are visible the most in case of fattening pigs.

Table 5.4. Country specific NH_3 implied emission factors in manure management [kg NH_3/animal/year]

Source	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Dairy cattle	22.272	22.243	24.683	27.628	28.564	29.778	29.607	29.440	29.115	29.115	32.182	32.182
Other cattle	12.540	12.494	12.366	12.369	12.866	12.851	13.025	12.669	12.765	12.530	12.438	12.767
Fattening pigs	4.716	4.714	4.715	4.715	4.250	4.215	4.180	4.145	4.097	4.097	4.097	4.097
Sows	10.337	10.302	10.309	10.337	10.235	10.218	10.202	10.199	10.195	10.195	10.195	10.195
Sheep	2.416	2.416	2.416	2.416	2.416	2.416	2.416	2.416	2.416	2.416	2.641	2.641
Horses	16.426	16.426	16.426	16.426	16.426	16.426	16.426	16.426	16.426	16.426	16.426	16.426
Goats	2.046	2.046	2.046	2.046	2.046	2.046	2.046	2.046	2.046	2.046	2.046	2.046
Hens	0.324	0.324	0.324	0.338	0.309	0.308	0.308	0.307	0.307	0.307	0.307	0.307

Broilers	0.118	0.118	0.118	0.118	0.109	0.109	0.109	0.108	0.108	0.108	0.108	0.108
Other poultry	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806
Fur bearing animals	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020

Table 5.5. Country specific NO_X implied emission factors in manure management [kg NO_2/animal/year]

Source	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
Dairy cattle	0.215	0.216	0.242	0.252	0.266	0.277	0.275	0.273	0.270	0.270	0.306	0.306
Other cattle	0.128	0.130	0.128	0.126	0.133	0.132	0.134	0.130	0.131	0.128	0.127	0.131
Fattening pigs	0.039	0.040	0.040	0.039	0.035	0.034	0.034	0.034	0.034	0.034	0.034	0.034
Sows	0.082	0.083	0.083	0.082	0.080	0.081	0.081	0.081	0.081	0.081	0.081	0.081
Sheep	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.031	0.031
Horses	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072
Goats	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Hens	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Broilers	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Other poultry	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Fur bearing animals	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003

Following recommendations resulting from *2018 NECD Comprehensive Review of Polish inventory*, NH_3 emissions from manure management are split in division to 3.B (manure excreted) and 3.D (manure applied to soils and manure left on pastures) in this Submission. Also NMVOC emissions from manure management are estimated based on information on livestock silage feeding during the year, covering pasture time (about half of the year) and housing period during winter, collected from the Institute of Agricultural and Food Economics - National Research Institute.

For NMVOC emissions from livestock husbandry Tier 1 method and default EFs from Table 3.4 from EMEP/EEA GB 2016 are used. The shares of silage feeding, used for establishing CS weighted mean NMVOC EFs (Table 5.7), are given in Table 5.6. Data on average shares of silage feeding for specific animals are assumed for entire series since 1990.

Table 5.6. Shares of silage feeding of livestock

Livestock	Share with silage feeding	Share without silage feeding
Dairy cattle	0.575	0.425
Other cattle	0.425	0.575
Sheep & Goats	0.175	0.825
Horses	0.125	0.875

Table 5.7. NMVOC emission factors in livestock breeding [kg NMVOC/animal/year]

Livestock	1990-2017
Dairy cattle	13.734
Other cattle	5.855
Fattening pigs	0.551
Sows	1.704
Sheep	0.188
Horses	4.713

Goats	0.556
Hens	0.165
Broilers	0.108
Other poultry	0.489

Emission factors for TSP, PM10 and PM2.5 for manure management category are those published in *EMEP/EEA EIG 2016*, covering all animals raised. Applied emission factors are shown in Annex 6. EFs for other cattle and other poultry are calculated as weighted mean for different animal subcategories based on their population.

5.3 Agricultural Soils (NFR sector 3.D)

5.3.1 Source category description

The pollutant emissions in agricultural soils involve: NH_3 and NO_X from the application of synthetic nitrogen fertilizers, NH_3 and NO_X from manure applied to soils as well as from sewage sludge applied to soils, NMVOCs from crop cultivation and PM10, PM2.5, TSP from agricultural operations. Shares of emissions from the NFR 3.D category in the country total for the particular pollutants in 2017 are shown on the Figure 5.3.

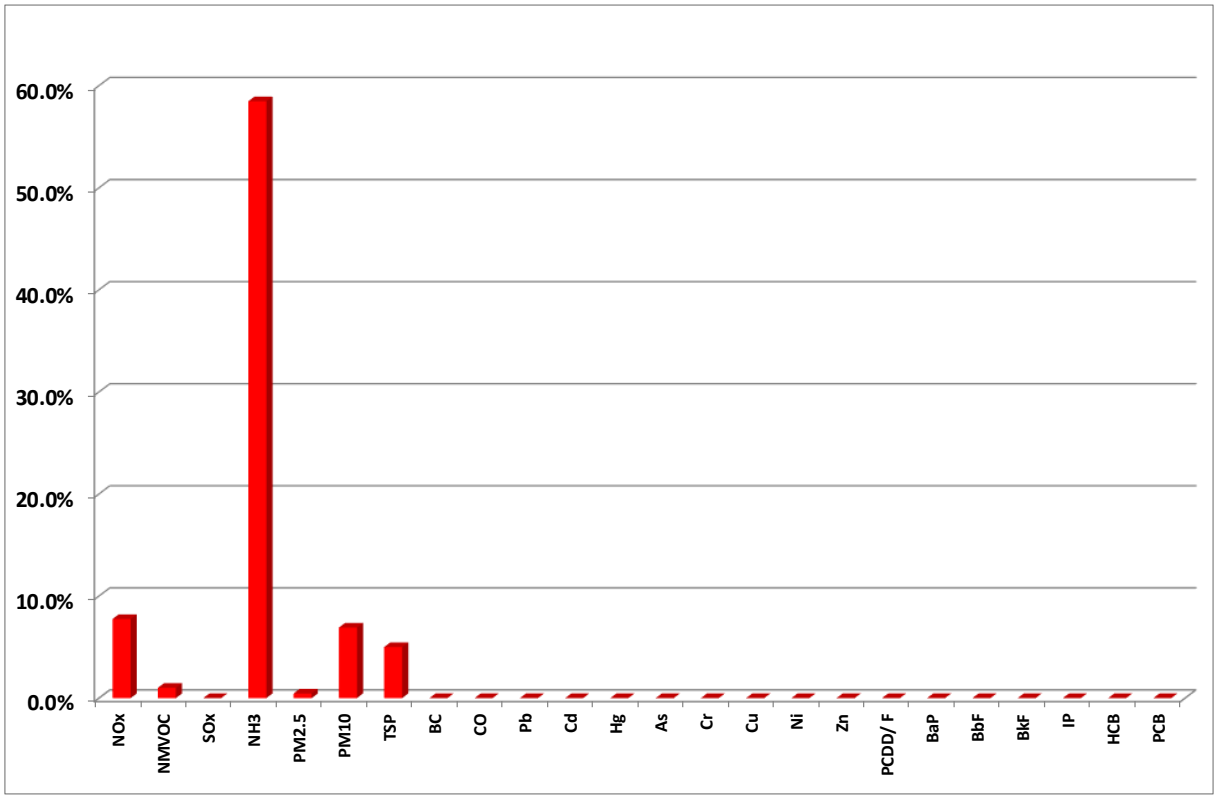

Figure 5.3. Shares of emissions from the 3.D category in the country total

5.3.2 Methodological issues

NH_3 and NOx emissions from synthetic fertilizers were estimated based on the amount of nitrogen synthetic fertilizer applied to agricultural fields come from national statistics (Table 5.8). As the data on fertilizers use does not cover the calendar year but the farming year (covering period since 1 July year x-1 up tp 30 June year x), data for 2017 are those established for farming year 2016/2017 etc.

Data regarding consumption of mineral fertilizers [GUS 2018g] were developed on the basis of reporting and sample surveys, ie. regular surveys on the structure of agricultural holdings (R-SGR) carried out every three years and the June Agricultural Surveys (R-CzBR) conducted between research R- SGR. The data based on information collected in sample surveys include:
– generalized results of the sample survey conducted in individual farms,
– information obtained from the whole population of agricultural farms of legal persons and organizational units without legal personality (approx. 5 thous.).
For farming year 2009/10 the data on fertilizers and tractors were compiled on the basis of the results of the Agricultural Census of 2010. The survey results are presented according to the seat of the farm user.

Table 5.8. Nitrogen fertilizers use in 1990–2017 in Poland [Gg N]

1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
1274	735	619	683	758	836	852	890	891	862	861	895	862	832
2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
895	895	996	1 056	1 142	1095	1028	1091	1095	1179	1098	1004	1043	1151

Ammonia emissions from mineral fertilizers applied to soils have been recalculated following the ERT 2018 recommendation. Update of deriving the country specific NH_3 EF is based on the Tier 2 method and default EFs for specific Nitrogen fertilizers NH_3 published in Table 3.2 of the *3.D Crop production and agricultural soils* of *EMEP/EEA GB 2016,* chapter 3.4, using domestic structure of nitrogen fertilizers application in the year 2000 [Pietrzak 2006]. The EFs for cool climate (as given in Table 10A-4 in Chapter 10 of the 2006 IPCC GLs) are applied as the annual average temperature in Poland span from about 8°C in north-east up to about 11°C in south-west. Additionally soil reaction was updated based on newer reference [Mocek A. (red.): *Gleboznawstwo*. Wyd. I. Warszawa: Wydawnictwo Naukowe PWN, 2015] which says that generally farmland soils in Poland are mostly acid and very acid (~50%), slightly acid and neutral soils are about 42% and alkaline soils (> 7.2 pH) cover about 8% of area. Therefore NH_3 EFs for pH >7 were applied for 8% farmland and for 92% of area – EFs for pH of 7 or below in calculation of weighted mean Emission Factor for NH_3 from inorganic fertilizers.

Table 5.9. Assumptions for calculation of updated EF for NH_3 from mineral fertilizers based on Tier 2 method

Fertilizer type	**Structure of fertilizers use**	**NH_3 EF (EMEP/EEA GB 2016, Chapter 3.D, Table 3-4, cool climate)**	
		normal pH	**high pH**
Ammonium sulphate	0.01	90	165
Urea	0.25	155	164
Ammonium nitrate	0.45	15	32
Calcium ammonium nitrate	0.16	8	17
Nitrogen solutions	0.04	98	95
Ammonium phosphate	0.01	50	91
Other NK and NPK	0.08	8*	17*

* as for CAN

As relates to EFs for specific mixtures of NK and NPK fertilizers (footnote (d) under the Table 3.2), based on information collected from *Grupa Azoty* (Polish association of fertilizers producers), it cannot be confirmed that NK and NP mixtures are MAP/DAP based products. Therefore *Grupa Azoty* recommends to use NH_3 EFs for CAN in case of NPK fertilizers.

Taking into account all above mentioned assumptions (Table 5.9) the weighted mean NH_3 emission factor for Poland amounts to 0.0538 kg NH_3/kg N and is applied for entire series. The works are ongoing to obtain structure of use of specific nitrogen fertilizers for different years of inventoried period. In the underlying Submission, for 1990-2017, the same structure of fertilizers use as of 2000

was used.

For NO_X emissions from inorganic fertilizers the default EF from *EMEP/EEA EIG 2016* was used as of 0.04 t NO_2/t N fertilizer.

Animal manure applied to soils (NFR sector 3Da2a) and left on pastures (3Da3)

Following recommendation ERT 2018 NH_3 emissions resulting from animal manure applied to soils and urine and dung deposited on pastures were moved to category 3.D (previously reported under 3B together with animal manure kept indoor or stored). The method for NH_3 emissions from organic fertilizers is described in previous chapter on NFR sector 3B.

NOx EF as of 0.04 kg/kg manure N applied (Table 3.1 3.D GB 2016) was used for animal manure applied on soils and left on pastures based on Nitrogen amounts reported under UNFCCC in the same source category.

Sewage sludge applied to soils (NFR sector 3Da2b)

The emissions of NH_3 and NO_X from sewage sludge application on agricultural soils was estimated using Tier 1 method and emission factors given in the *EMEP/EEA GB 2016*: 0.13 t NH_3/t N applied (Annex 1 in 3.D GB 2016) and 0.04 t NO_2/t N applied (Annex 2 in 3.D GB 2016).

Activity data on the amount of sewage sludge applied on the fields come from national statistics [GUS 2018c] and regards both - industrial and municipal sewage sludge applied in cultivation of all crops marketed, including crops designed to produce fodder as well as this applied in cultivation of plants intended for compost production. As the consistent reporting of data concerning application of sewage sludge in agriculture in the public statistics starts in 2003, the activities since 1988 were supplemented based on annual mean changes of AD in 2003−2009 where constant increasing trend was noted (NIR 2019). Diminishing trend back to 1988 corresponds to the number of people using sewage treatment plants that ranges from 11 million in 1988 through 19 million in 1998 and almost 28 million in 2015 where this number was more than doubled in 1988-2015. Also the number of municipal sewage treatment plants increased from 558 in 1988 up to 1923 in 1998 and 3268 in 2015. Activity data on sewage sludge used in Agriculture is given in Table 5.10.

Table 5.10.Sewage sludge used as fertilizer on agricultural soils in 1990–2016 in Poland [Gg N]

1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
0.86	1.01	1.15	1.30	1.44	1.59	1.73	1.88	2.02	2.17	2.31	2.46	2.60	2.75
2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
3.26	3.34	3.60	4.28	4.73	4.96	4.39	4.61	4.73	4.38	4.60	4.56	4.35	3.99

Agricultural operations (NFR sector 3Dc)

Emissions of TSP, PM10 and PM2.5 from agricultural operations covering soil cultivation, harvesting and drying were amended for entire series since 1990 using Tier 1 method and default emission factors from the *EMEP/EEA EIG 2016* (Table 3.1 in 3.D Crop production and agricultural soils). Following the guidelines PM emissions are calculated based on area of arable land (Table 5.12), excluding grassland. The attempts will be undertaken to estimate emissions related to agricultural operations based on country specific crops share.

Cultivated crops (NFR sector 3De)

NMVOC emissions from cultivated crops are calculated separately for every inventoried year based on emission factors for wheat, rye, rape and grass (15°C) given in Chapter 3.D in GB 2016, Table 3.3, country specific mean dry matter of crop per ha for mentioned crops and crop distribution in Poland.

Example of calculation of NMVOC EF for 2017 is given in Table 5.11. Such weighted mean NMVOC EFs vary from 0.46 kg NMVOC/ha/yr in 1990, through 0.42 in 2002 up to 0.50 kg NMVOC/ha/yr in 2017. Activity data for this source category constitutes the area of arable land and grassland from national statistics (Table 5.12).

Table 5.11. Estimation of CS NMVOC emission factor for 2017 in Poland

Crop	NMVOC EF [kg/kg dm/ha]	Fraction of the year emitting	NMVOC [kg dm/yr]	Mean dry matter of crop [t dm/ha]	NMVOC [kg/ha/yr]	Crops distribution	Weighted mean EF [kg NMVOC/ha/yr]
Wheat	2.60E-08	0.3	6.82E-05	4.15	0.28	0.34	0.10
Rye	1.41E-07	0.3	3.70E-04	2.63	0.97	0.13	0.12
Rape	2.02E-07	0.3	5.30E-04	2.57	1.36	0.13	0.18
Grass (15°C)	1.03E-08	0.3	4.51E-05	5.42	0.24	0.40	0.10
NMVOC IEF 2017							**0.50**

Table 5.12. Agricultural land area 1990-2017 in Poland [Mha]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Arable land	14.39	14.36	14.34	14.31	14.30	14.29	14.09	14.06	14.11	14.13	13.68	13.67	13.07	12.65
Grassland	4.06	4.04	4.04	4.05	4.06	4.05	4.13	4.14	4.06	4.03	3.87	3.86	3.56	3.27
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Arable land	12.68	12.08	12.36	11.75	11.97	12.00	10.80	11.04	10.87	10.76	10.90	10.89	10.81	10.91
Grassland	3.37	3.39	3.22	3.27	3.18	3.18	3.23	3.29	3.21	3.21	3.12	3.09	3.18	3.17

Emission factors, employed in the agriculture inventory, for the particular pollutants with their source are presented in Annex 6.

5.4 Field Burning of Agricultural Residues (NFR sector 3.F)

5.4.1 Source category description

The pollutant emissions related to on-field burning of stubble include almost all substances reported under CLRTAP. Shares of emissions from the NFR 3.F category in the country total for the particular pollutants in 2017 are mostly insignificant and are shown on the Figure 5.4. This category corresponds to SNAP 1003 category.

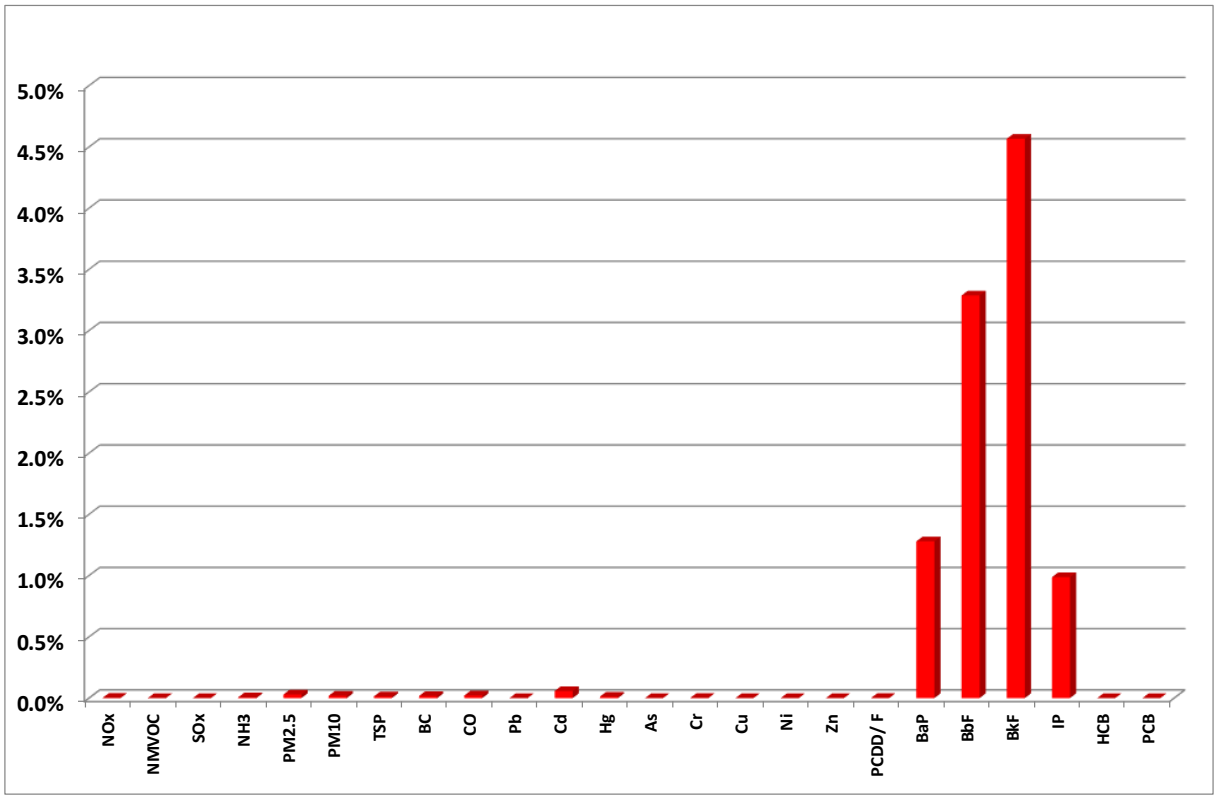

Figure 5.4. Shares of emissions from the 3.F category in the country total

5.4.2 Methodological issues

Estimation of pollutant emissions related to this category is based on the area of agricultural crops, meadows and stubbles fired in a given year. The amount of crop residue burned resulting in emissions is calculated based on equation (2) from chapter 3.2.3. in part *3.F Field burning of agricultural residues* in *EMEP/EEA EIG 2016:*

$$AR_{residue\_burnt} = A * Y * s * d * pb * Cf$$

where:

- **A** (ha) – is the area of land on which crops are grown whose residues are burned,
- **Y** (kg ha-1 fresh weight) is the average yield of those crops (e.g. grain),
- **s** is the ratio between the mass of crop residues and the crop yield,
- **d** is the dry matter content of that yield,
- **pb** is proportion of those residues that are burned (as opposed to being incorporated in the soil, consumed by livestock on the field or removed from the field for use elsewhere) ,
- **Cf** is the combustion factor (proportion of the fuel present at the time of the fire that is actually burned).

Activity data for 2017 come from Statistics Poland's yearbook on environment [GUS 2018c] and for previous years – from analogous publications (Table A2.15 in Annex 5). Parameters like: Y – are taken from agricultural national statistics, while: s, d, pb – come from country case studies and are applied also in GHG emissions inventories. The weighted mean EF calculated for agricultural areas fired is 0.8006 Mg per 1 ha.

The corresponding emission factors for pollutants accompanying on-field burning of stubble are given in Annex 6 and come from the *EMEP/EEA EIG 2016* (Table 3-1).

5.5 Emission trends for the NFR sector 3

Volumes and trend of pollutant emissions for *Agriculture* are shown below on figures below (Figure 5.5 - Figure 5.10).

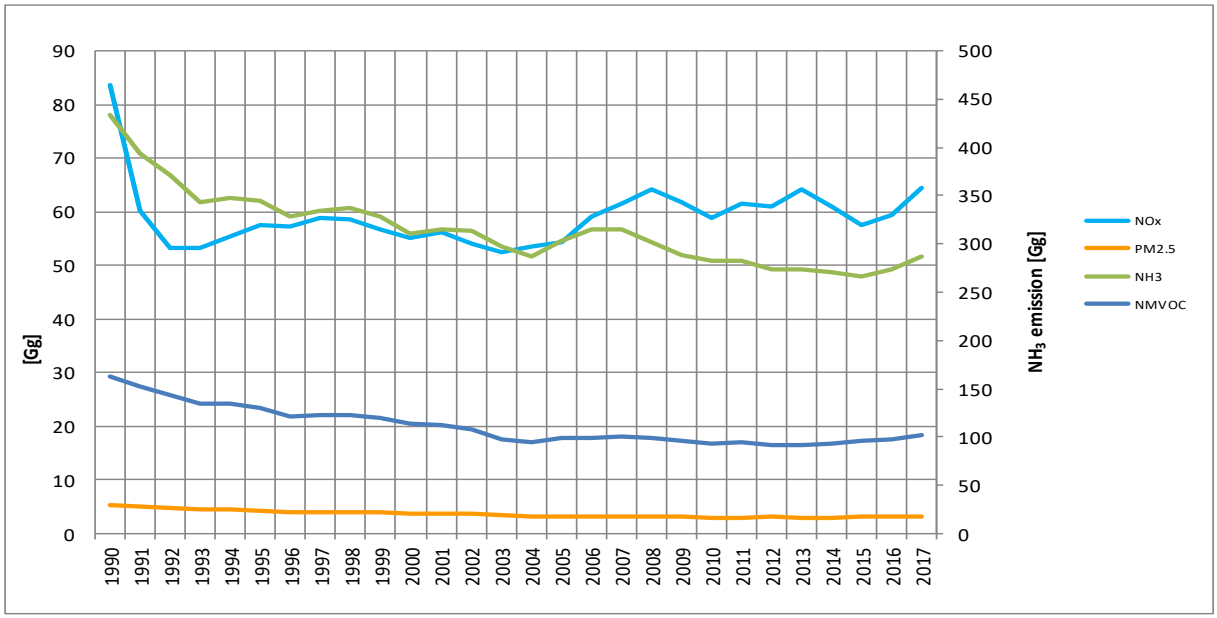

Figure 5.5. NH_3, PM2.5, NMVOC and NOx emissions for NFR 3 category in 1990-2017

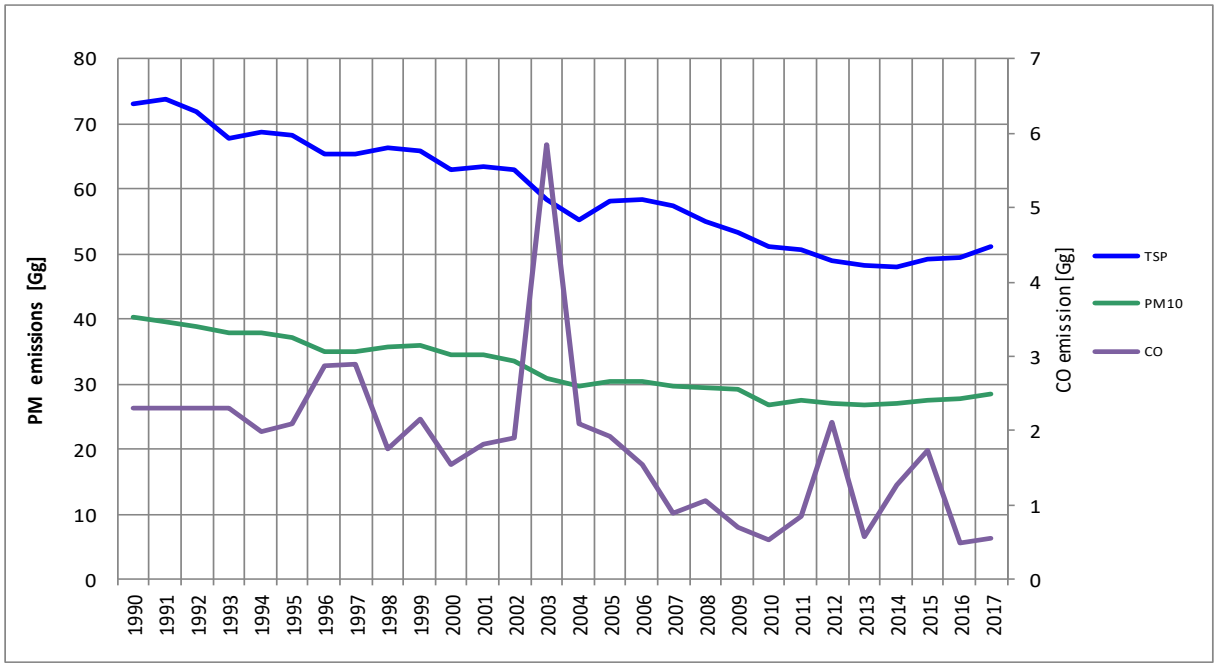

Figure 5.6. Particulates and CO emissions for NFR 3 category in 1990-2017

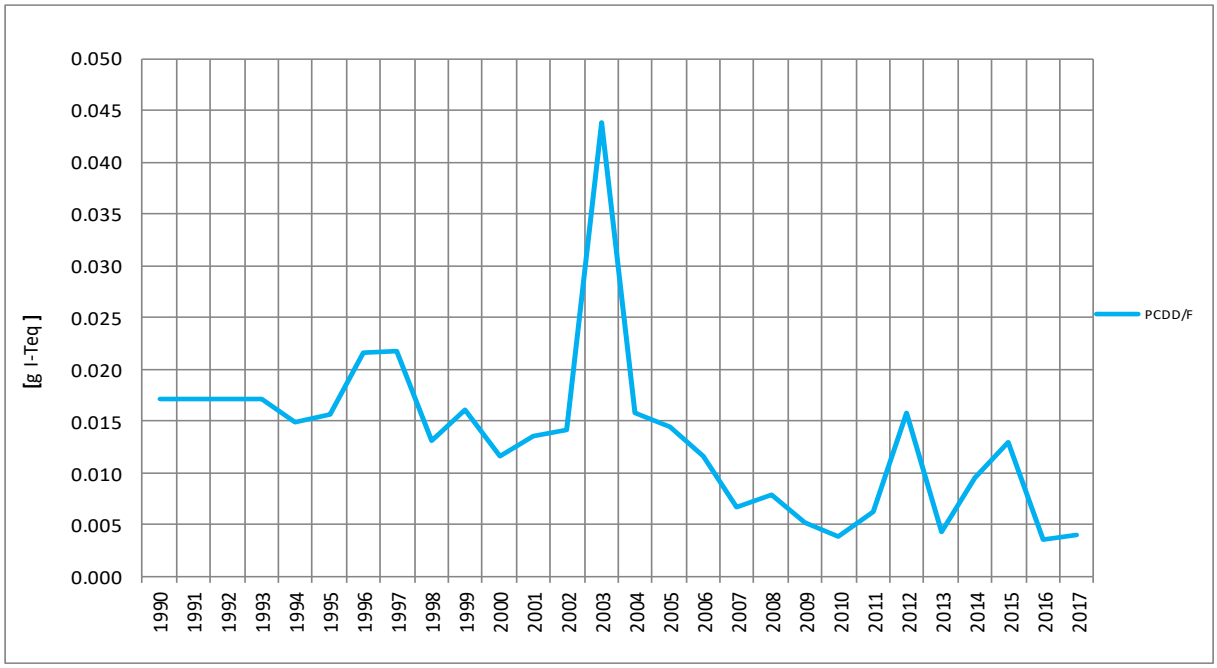

Figure 5.7. PCDD/F emissions for NFR 3 category in 1990-2017

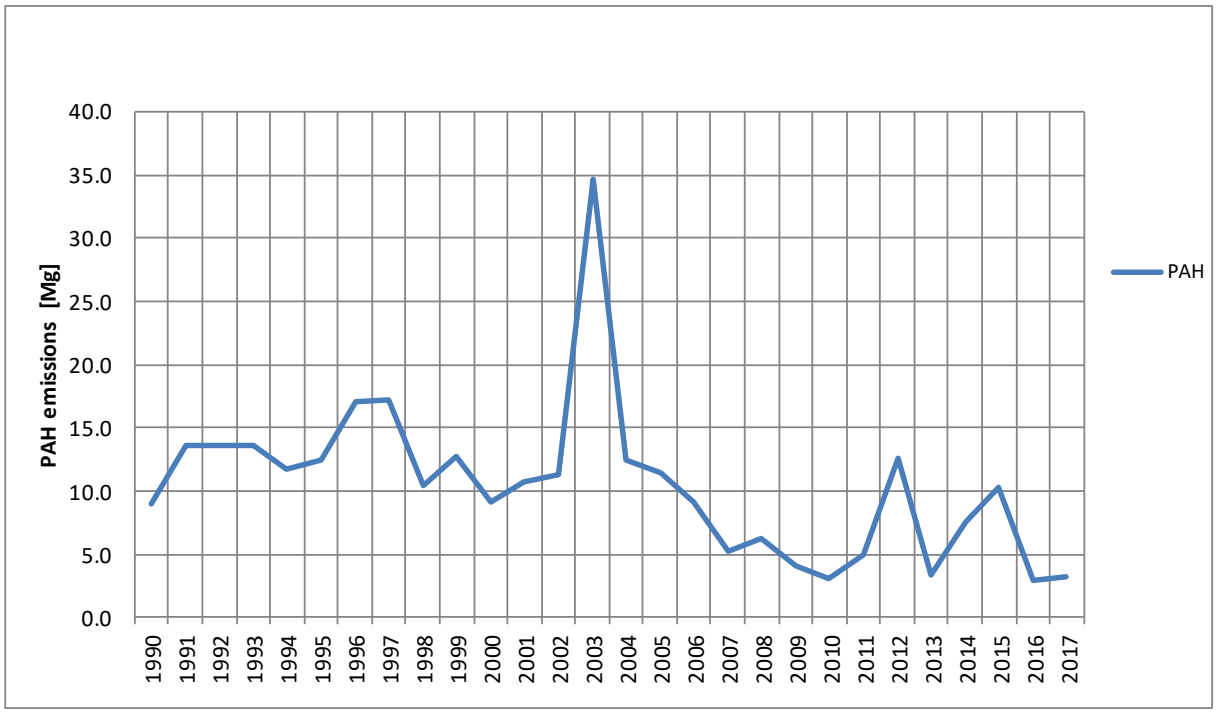

Figure 5.8. PAH emissions for NFR 3 category in 1990-2017

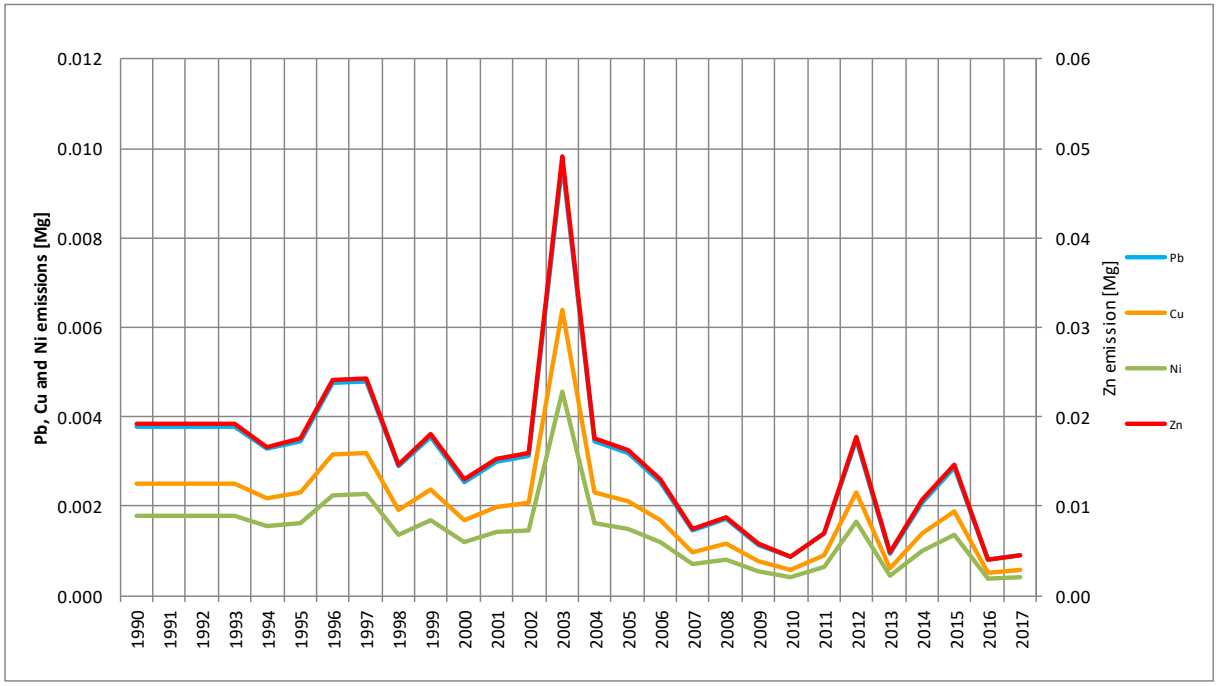

Figure 5.9. Heavy metals emissions for NFR 3 category in 1990-2017

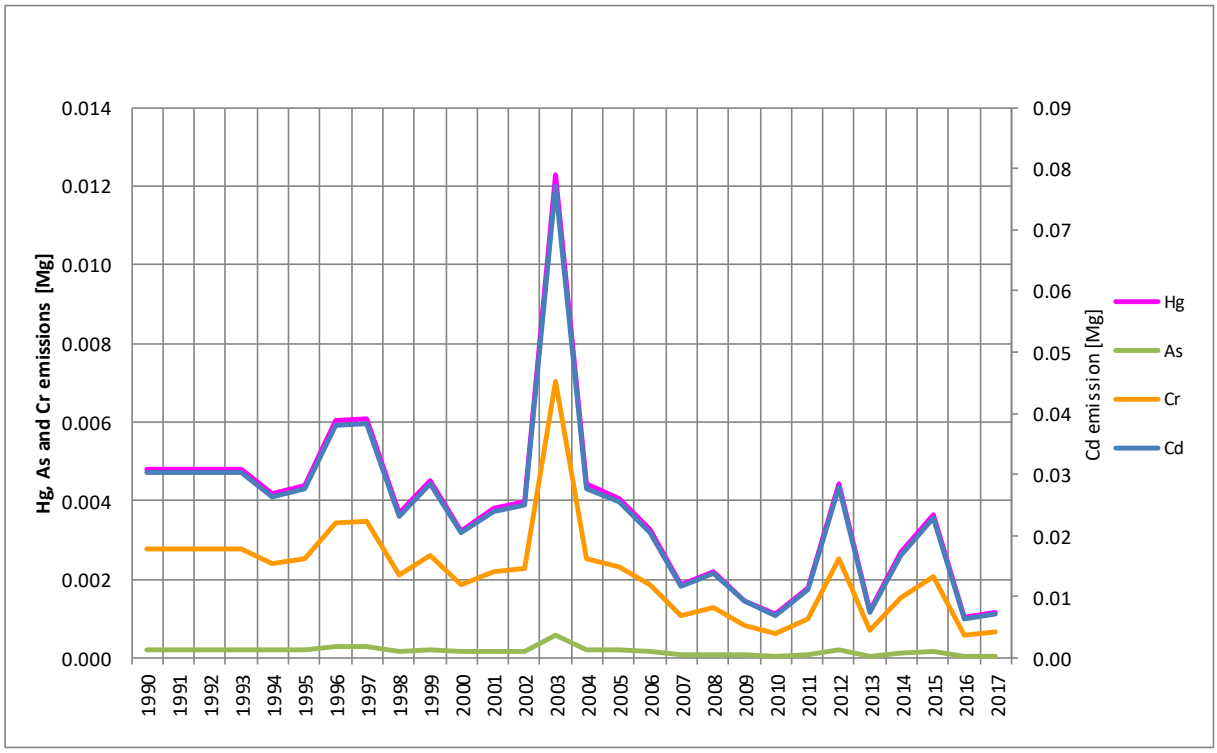

Figure 5.10. Additional heavy metals emissions for NFR 3 category in 1990-2017

Peak of emissions in 2003 is related to significant area of agricultural crops, meadows and stubbles fired in this year.

5.6 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector 3 was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector 3 are given below.

Table 5.13.Results of the uncertainty analysis for NFR sector 3

NFR		NO_X	NMVOC	NH_3	CO	TSP	PM10	PM2.5	PCDD/F
3B1a	Manure management - Dairy cattle			100%		100%	100%	100%	
3B1b	Manure management - Non-dairy cattle			100%		100%	100%	100%	
3B2	Manure management - Sheep			100%		100%	100%	100%	
3B3	Manure management - Swine			86%		95%	91%	88%	
3B4d	Manure management - Goats			100%		100%	100%	100%	
3B4e	Manure management - Horses			100%		100%	100%	100%	
3B4gi	Manure management - Laying hens			100%		100%	100%	100%	
3B4gii	Manure management - Broilers			100%		100%	100%	100%	
3B4giv	Manure management - Other poultry			100%		100%	100%	100%	
3B4h	Manure management - Other animals			100%		150%	150%	150%	
3Da1	Inorganic N-fertilizers (includes also urea application)	30%	150%	100%					
3Da2b	Sewage sludge applied to soils			104%					
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products					150%	150%	150%	
3F	Field burning of agricultural residues		150%		150%	150%	150%	150%	100%

5.7 Source-specific QA/QC and verification

Activity data related to livestock population come from national statistics prepared by the Statistics Poland. Also activity data related to mineral fertilisers use or crop production come from national statistics prepared by the Statistics Poland.

Emphasis was put on data consistency between sub-categories and between sectors using agricultural data. Emission factors and methodology is compared with international literature and other countries methods/EF applied. Calculations were examined with focus on formulas, units and trends consistency. Also consistency with data applied for GHG inventory in Agricultural sector is crosschecked.

5.8 Source-specific recalculations

- NFR 3.B
  - NMVOC emissions from livestock breeding has been amended for entire series since1990.
  - NMVOC emissions from crop cultivation has been estimated based on GB 2016.
  - Correction of Nex for dairy cattle for 2016 related to higher milkiness.
  - Slight correction of NH_3 and NOx IEFs for manure management for all livestock.
- NFR 3.D
  - Recalculation of NH_3 IEF for mineral fertilizers applied on soils based on GB 2016.
  - NOx emissions added from manure applied on soils and left on pastures.

- Activity Data for PM emissions corrected from agricultural operations.

– NFR 3.F

- Emissions of all substances has been recalculated or amended based on EFs from GB 2016.

5.9 Source-specific planned improvements

– NFR 3.B

No improvements are planned.

– NFR 3.D.

Following recommendations resulting from 2018 NECD Comprehensive Review Poland will make an attempt to apply:

– the higher tier method in particulate matter emissions from agricultural operations,

– the higher tier method in NMVOC emissions from silage feeding of livestock.

6 WASTE (NFR SECTOR 5)

6.1 Source category description

Following subcategories from sector 6 have been included in the pollutant inventory:

- 5.A. Solid waste disposal on land
- 5.C. Waste incineration
- 5.C.1.a Municipal waste incineration
- 5.C.1.b Industrial waste incineration (including sludges)
- 5.C.1.b.iii Clinical waste incineration
- 5.C..1.b.v Cremations
- 5.C.2 Open burning of agricultural wastes
- 5.D. Wastewater handling (including latrines)
- 5.E. Other waste handling: Unintentional fires.

Category *Unintentional fires* includes:

- Unintentional house fires
- Unintentional car fires
- Unintentional landfill fires.

Shares of emissions from the major NFR 5 C category in the country total for the particular pollutants in 2017 are shown on the Figure 6.1.

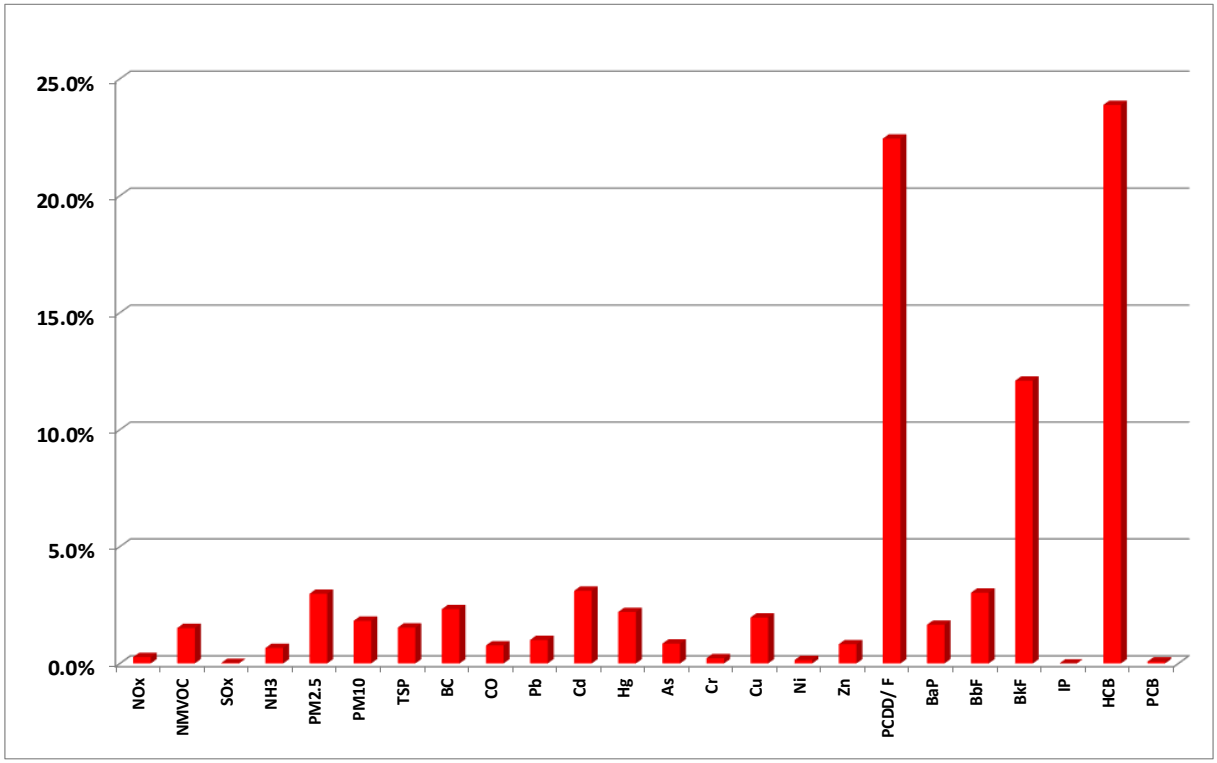

Figure 6.1. Shares of emissions from the NFR 5 category in the country total

6.2 Methodological issues

Activity data, applied for current Polish emission inventory come from various sources. Majority of data is derived from national statistics made publically available by Statistics Poland. Activity data for unintentional fires were derived from fire statistics made by National Headquarters of the State Fire Service and own estimates. Activity data for municipal and clinical waste incineration are derived from statistics collected in Central Waste System database.

All used activity data are presented in Annex 5.

The data on recovered methane (NFR 5A) are plant specific, based on responses to questionnaires of Statistics Poland on energy combustion. Recovered gas is combusted for energy purposes or flared (no data on amounts available). Data on amounts of recovered landfill gas is included in the energy balance under category 'Natural gas'. It is reported to Eurostat by Joint Questionnaire. Emissions from landfill gas burning are therefore included in sector 1.A.

Description of the methodology concerning the selection of EFs for *Clinical waste incineration* (NFR 5.C.1.b.iii) is given below:

- Activity data for incineration of clinical wastes comes from Statistics Poland.
- Share of medical waste incinerators by abatement efficiency has been made by our country expert (dr Grzegorz Wielgosiński). He has estimated that in 2009 27 380 Mg of clinical wastes was burnt in category A waste incinerators and 1 210 Mg was burnt in category B waste incinerators. Due to a lack of new data these shares (95,77% and 4,23% respectively) are used for the whole trend 1990-2017.
- Emission factors for PCDD/F, HCB and PCB, relevant to share of medical waste incinerators by abatement efficiency, come from:
  - expertise Grochowalski A. (2001): Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventory purposes, 2001 (in Polish);
  - project GF/POL/01/004 Enabling activities to facilitate early action on the implementation of the Stockholm Convention on Persistent Organic Pollutants (POPs Convention) in Poland
  - Bailey (2001): Global hexachlorobenzene emission, Chemosphere 43 (2001).

Emission factors for other pollutants come from Emission Inventory Guidebook 2016. All used emission factors are presented in Annex 6.

6.3 Emission trends for the NFR sector 5

Poland is estimating emissions from NFR sector 5.A with application of default methodology described in EMEP/EEA air pollutant emission inventory guidebook – EIG 2016.

Tables with applied emission factors are presented in Annex 6.

Volumes and trend of pollutant emissions for *Waste treatment and disposal* are shown below on figures below (Figure 6.2-Figure 6.6).

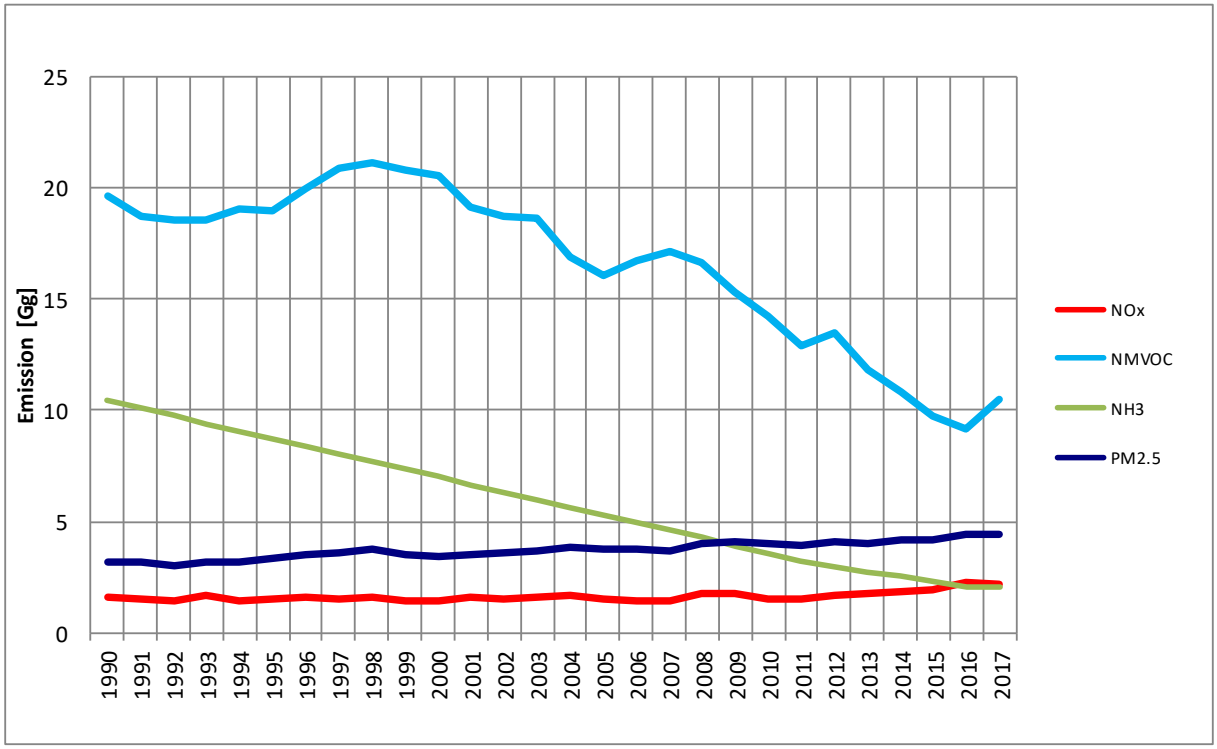

Figure 6.2. NOx, NMVOC, PM2,5 and NH_3 emissions for NFR 5 category in 1990-2017

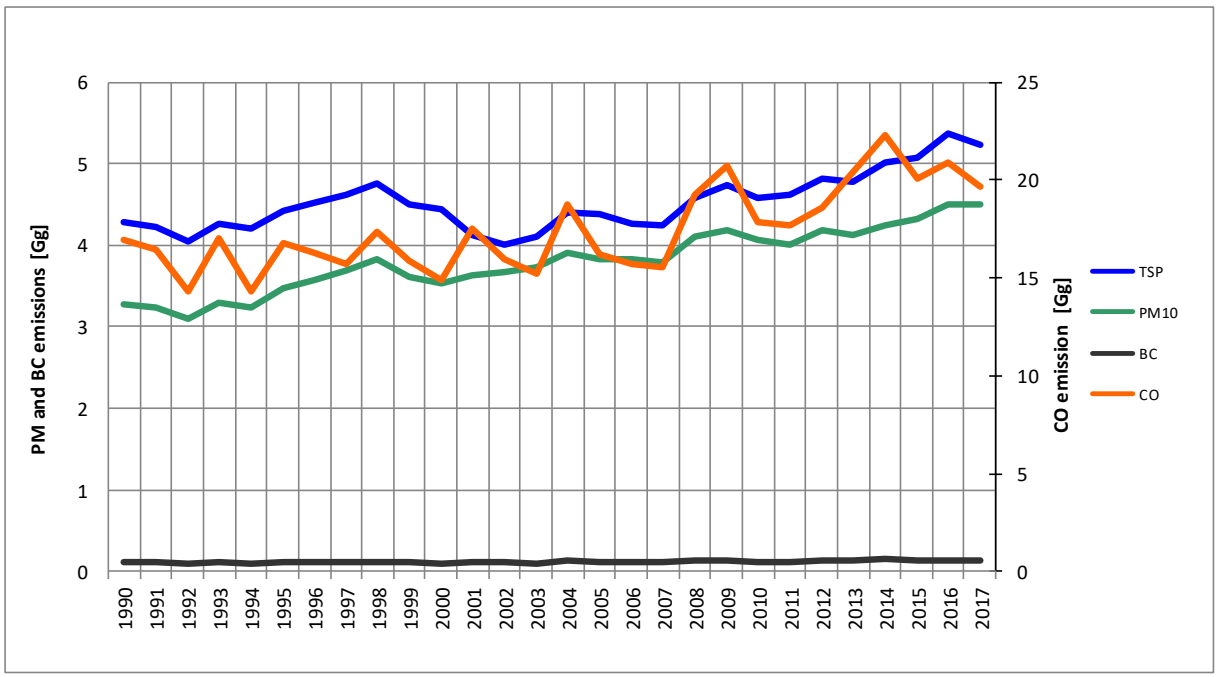

Figure 6.3. CO and PM emissions for NFR 5 category in 1990-2017

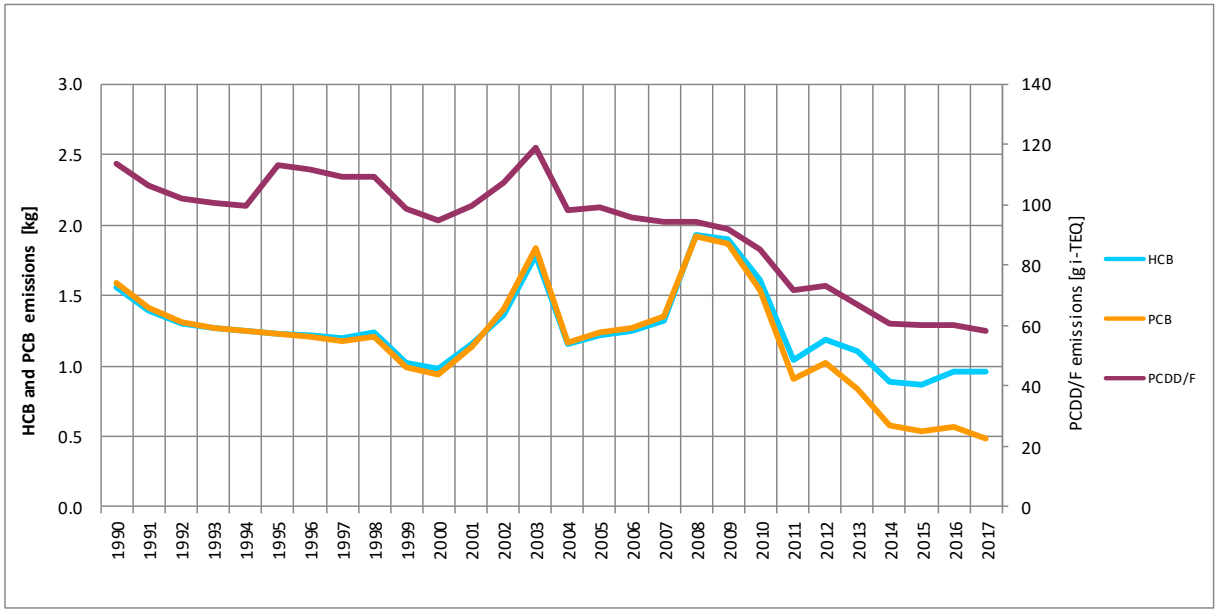

Figure 6.4. HCB, PCB and PCDD/F emissions for NFR 5 category in 1990-2017

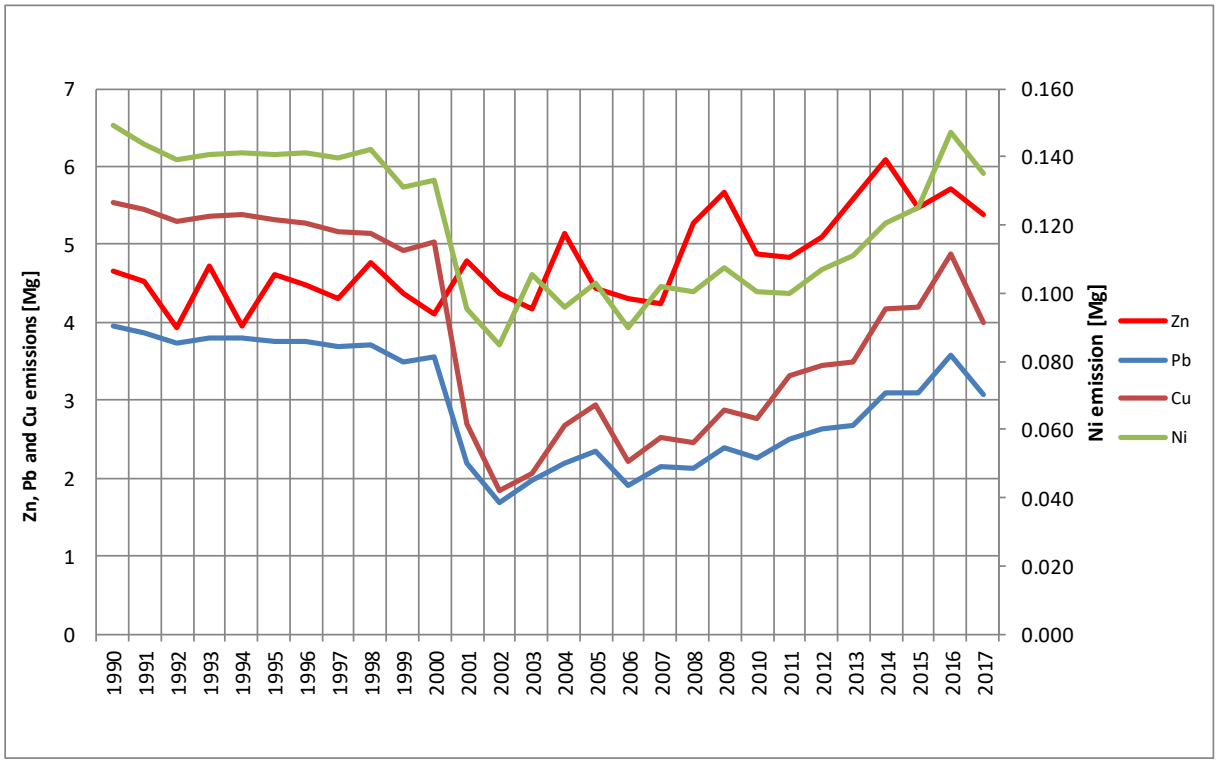

Figure 6.5. Zn, Pb, Cu and Ni emissions for NFR 5 category in 1990-2017

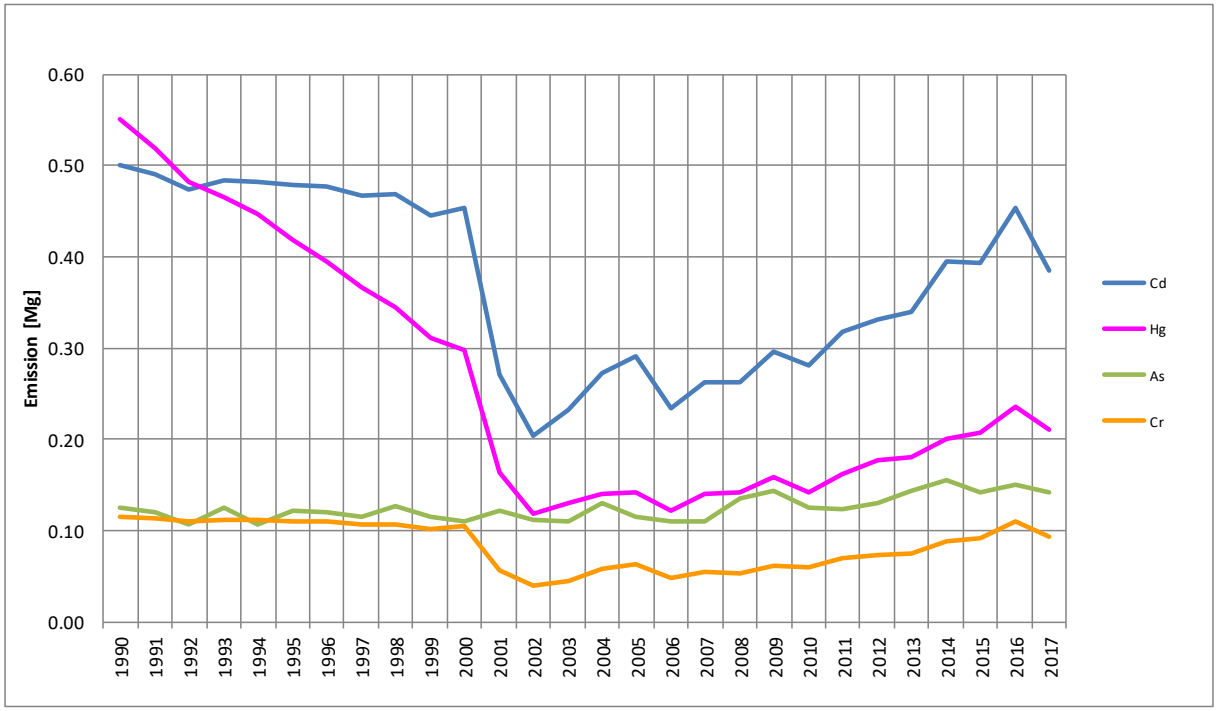

Figure 6.6. Cd, Hg, As and Cr emissions for NFR 5 category in 1990-2017

6.4 Source-specific QA/QC and verification

Activity data related to: solid waste disposal, wastewater handling, latrines and incineration of wastewater sludge comes from national statistics prepared by the Statistics Poland. The rest of data applied for calculations is derived from various sources.

6.5 Uncertainties and time-series consistency

Uncertainty analysis for the 2017 for NFR sector 5 was developed with use of methodology, described in Annex 8. For the most of pollutants there is applied simplified approach described in EMEP/EEA Guidebook (Chapter 5). Results of the sectoral uncertainty analysis for NFR sector 5 are given below.

Table 6.1. Results of the uncertainty analysis for NFR sector 5

NFR subsector		NO_x	NMVOC	SO_x	NH_3	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAHs
5A	Biological treatment of waste - Solid waste disposal on land		30%				150%	150%	150%						
5C1a	Municipal waste incineration	50%	50%	30%		50%	50%	50%	50%	100%	100%	100%	100%	100%	100%
5C1bi	Industrial waste incineration	37%	37%	22%		37%	37%	37%	37%				99%	99%	99%
5C1biii	Clinical waste incineration	48%	48%	29%		48%							31%	31%	31%
5C1biv	Sewage sludge incineration												76%		
5C1bv	Cremation	71%	51%	32%		51%				71%	71%	71%	100%	100%	100%
5C2	Open burning of waste	50%	50%			50%	50%	50%	50%				94%	94%	94%
5D1	Domestic wastewater handling				30%										
5E	Other waste												100%		

6.6 Source-specific recalculations

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory:

- revised estimates for NMVOC and PM from Solid Waste Disposal on Land (NFR 5A) have been included;
- appropriate AD for the *Industrial waste incineration* (NFR 5.C.1.b.i) and Clinical waste incineration (NFR 5.C.1.b.iii) have been included in the NFR tables;
- description of the methodology, especially concerning the selection of EFs for Clinical waste incineration (NFR 5.C.1.b.iii) has been provided;
- for Clinical Waste Incineration (NFR 5C1biii) new emission estimates of PAHs, Cd, Hg and Pb have been added;
- new emission estimates of SO_2, NO_x, NMVOC, PM2.5, PAHs, HCB, PCDD/F from Sewage Sludge Incineration (NFR 5C1biv) have been added;
- car fires have been included in NFR 5E (instead of 6A);
- revised estimates have been made for Building fires (NFR 5.E). PM2.5 emission factor has been applied from the EMEP/EEA EIG 2016. PM10 and TSP emission factors are equal to PM2.5 emission factor. Repartition per category of buildings has been recommended by TERT team.

6.7 Source-specific planned improvements

Verification of abatement efficiency of medical waste incinerators used in Poland.

7 OTHER AND NATURAL EMISSIONS

The category *Other and Natural emissions* includes emissions that have not been included in the national totals.

7.1 Forest fires (NFR 11.B)

Estimated emissions from forest fires considered as unintentional include NMVOC and PCDD/F.

Activity data were derived from national statistics made publically available by Statistics Poland and are listed in Annex 5. Tables with applied emission factors are presented in Annex 6.

For calculating the emissions of wildfires a country specific Tier2 approach was used. The mass of carbon emitted M(C) was calculated using the following equation

$$M(C)=\mathrm{CF}*A*B*\beta$$

where:

CF = average fraction of carbon in fuel wood;
A = forest area burnt in [m²];
B = mean above-ground biomass of fuel material per unit area in [kg/m²];
β = burning efficiency (fraction burnt) of the above-ground biomass.

The data on forest areas burnt for the period 1990 to 2017 have been taken from national statistics made publically available by Statistics Poland. In accordance with the IPCC 2006 Guidance a burning efficiency of 0.3 was used. The emissions for the pollutants were calculated by multiplying the mass of carbon with the respective emission factors listed in Annex 6.

For the calculation of particulate emissions (TSP, PM_{10} and $PM_{2.5}$) the burnt biomass was multiplied with the respective emission factors from table 3-5 (EMEP/EEA, 2016). Those particulate emission factors have been estimated by averaging the emission factors from the US Environmental Protection Agency (USEPA, 1996) methodology, since no better information is available. Those emission factors are assumed to be the same for all types of forest. Black carbon is currently not measured in Poland and is therefore indicated with "NE".

7.2 Other natural sources (NFR 11.C)

Further explanation is provided in Annex 2.

Estimated emissions from managed broadleaf and managed coniferous forests include NMVOC.

Activity data were derived from national statistics that have been made publically available by Statistics Poland and are listed in Annex 5. Tables with applied emission factors are presented in Annex 6.

8 RECALCULATIONS AND IMPROVEMENTS

In 2019 recalculations of data from 1990 have been provided – therefore completeness and consistency of the extended emission inventory have been maintained. Emission inventory of air pollutants - though generally complete - still needs improvements of some elements.

8.1 Recalculations

Detail sectoral information on performed recalculations are presented in Chapters 3-6 dedicated to source categories. Summary of changes recommended during 2018 NECD Comprehensive Review of Polish Inventory are presented in Annex 7.

Recalculations of data are provided each year for whole period from 1990 compliant to actual methodology. In 2019 the methodology has been updated based on:

- recommendations resulting from 2018 NECD Comprehensive Review of Polish Inventory (Review Report 2018. Second phase of review of national air pollution emission inventory data):
  - emission factors were updated (where appropriate) according to EMEP/EEA Emission Inventory Guidebook 2016;
  - new emission sources not estimated previously were added to the inventory;
- the latest version of the international software COPERT 5 used to determine emissions from road transport;
- methodological changes within NFR categories 1.A.2.b and 2.C encompassing more accurate split of emissions deriving from fuel combustion and process emissions;
- activity data update according to the latest available data.

8.2 Planned improvements

Despite performed recalculations, inventory improvement is still possible; planned programme of improvement is focused on the main following tasks:

- gathering additional activity data to verify the trend 1990-2017,
- further methodology development by applying higher tier of estimation methodology.

Detail sectoral information on planned improvements is included in sectoral Chapters 3-6.

9 PROJECTIONS

In accordance with emission reduction requirements of the Gothenburg Protocol and of the Directive 2016/2284 of the European Parliament and the Council on National Emissions Ceilings (NECD) Poland submitted in 2019 emission projections for the years 2020, 2025 and 2030. These projections encompassed preparation of projections until 2030 in the version “with measures” (WM).

The total projected emissions of NOx, NMVOC, SO_2, NH_3 and PM2.5 are shown in table below together with historic emission for 2005 and 2015.

Table 9.1. Total historic and projected emissions [kt]

Pollutant	2005	2015	2020	2025	2030
NOx	869.5	725.3	668.6	607.2	544.7
NOx*	815.2	667.7	603.3	538.8	474.4
NMVOC	721.1	640.8	610.4	574.2	538.8
NMVOC*	621.4	545.3	510.8	476.5	442.1
SO_2	1171.6	711.5	542.5	439.7	379.2
NH_3	324.3	284.7	306.9	314.8	321.3
PM2.5	160.4	136.0	118.6	102.3	85.9

* Excluding manure management and agricultural soils

It should be noted that since 2020 NOx and NMVOC emissions from manure management (NFR 3B) and agricultural soils (NFR 3D) will not be the part of reduction commitment as it is described in Article 4.3.(d) of the revised NEC Directive (2016/2284).

The analysis of the potential volume of emissions in Poland in 2020-2030 was performed using projected specific activities acquired through the Ministry of the Environment from several ministries (responsible for energy, industrial production and agriculture). This information was previously used in the development of greenhouse gas emission projections for the Third Biennial Report for the Conference of the Parties to the UN Framework Convention on Climate Change (XII 2017) (the so-called BR3). In addition, the available data and publications, analyses of changes resulting from the introduction of legislation and expert estimates were used in constructing the projections.

Voluntary emission projections for the years 2040 and 2050 as well as the option "with additional measures" (WAM) have not been developed due to the lack of necessary national forecast data in the scope necessary for their use.

National activity projections for selected emission sources concerned:

- combustion of fuels for energy production,
- volume of industrial production,
- crop production and animal husbandry,
- demographic forecasts of the Statistics Poland.

The assumptions and expert analyses conducted included:

- projections of emissions from road transport,
- forecast of the amount of incinerated waste,
- forecast of growth in air traffic,
- future expected emission intensity of the housing and communal sector,
- planned forest area.

Volumes of pollutant emissions for 2030 were estimated with the use of the methodology applied in the national emission inventory as submitted in 2019. For most subcategories emissions were estimated using emission factors for 2015. Forecasted emission factors were used for the small combustion sector. Volumes of pollutant emissions for 2020 and 2025 were interpolated using a linear correlation based on estimates for particular categories for 2015 and 2030. Assumptions for emission projections were pollutant-oriented, including impact of the particular sectors (by SNAP).

9.1 Methodology by pollutant

SO_2 emissions

Obtained activity projections for a part of the emission sources included:

- fuel consumption for sectors SNAP 01 ÷ 03,
- production of selected products for the SNAP 04 sector (including sinter plants and cement plants),
- number of deaths (for cremation quantity assessment, SNAP 09).

Following data were assumed for 2030 based on own expert estimates:

- SO_2 emission level associated with the production of electricity and heat, and resulting from the implementation of new emission standards for fuel combustion installations under the IED and MCP directives. This mainly includes sources of emissions from the SNAP 01 sector.
- level of pollutant emissions from road transport (own methodology).

NO_x emissions

Obtained activity projections for a part of the emission sources included:

- fuel consumption for sectors SNAP 01 ÷ 03,
- production of selected products for the SNAP 04 sector (including sinter plants, cement plants and production of nitric acid),
- number of deaths (for cremation quantity assessment, SNAP 09)
- use of fertilizers in agriculture (SNAP 10).

Following data were assumed for 2030 based on own expert estimates:

- NOx emission level associated with the production of electricity and heat, and resulting from the implementation of new emission standards for fuel combustion installations under the IED and MCP directives. This mainly includes sources of emissions from the SNAP 01 sector.
- the emission level from the small combustion sector (SNAP 02) based on the national analysis
- emissions of pollutants from road transport (own methodology),
- projection of air traffic growth by 2% per year, based on data of the Civil Aviation Office
- the value of 1100 cigarettes smoked per capita for calculating the total amount of cigarettes smoked (SNAP 06). This value was obtained from the extrapolation of the trend.

NMVOC emissions

- Obtained activity projections for a part of the emission sources included:

- fuel consumption for sectors SNAP 01 ÷ 03,
- production of selected products for the SNAP 04 sector (including for processing of crude oil),
- fuel extraction for the SNAP sector 05,
- demography forecasts for Poland prepared by GUS for the SNAP sector 06,
- fertilizer consumption (SNAP 10).

Following data were assumed for 2030 based on own expert estimates:

- projections of paint and varnish consumption and share of water based paints,
- the emission level of the small combustion sector (SNAP 02) based on the national analysis ,
- the value of 1100 cigarettes smoked per capita for calculating the total amount of cigarettes smoked (SNAP 06). This value was obtained from the extrapolation of the trend,
- emissions of pollutants from road transport (own methodology),
- projections of air traffic growth by 2% per annum, based on data from the Civil Aviation Office.

NH_3 emissions

Obtained activity projections for a part of the emission sources included:

- fuel consumption for the SNAP 02 sector,
- mineral fertilizers consumption, livestock population and their maintenance systems (SNAP 10) .

The methodology for estimating ammonia emissions in this analysis is the same as implemented in 2019 submission, where:

- in the category of organic fertilizers, the forecasted parameters and national data were included in the calculations along with information on activities affecting the reduction of NH3 emissions obtained from the Ministry of Agriculture and Rural Development for 2014.
- in the category of mineral fertilizers, in the calculation of NH3 emissions, the same share of urea based fertilizers is assumed.

Following data were assumed for 2030 based on own expert estimates:

- emissions of pollutants from road transport (own methodology),
- the range of variability of nitrogen excretion rate - Nex based on prognostic data on cow's milk yield (SNAP 10)
- estimation of the decrease in the number of people using latrines (SNAP 09) based on extrapolation of the trend.

PM2.5 emissions

Obtained activity projections for a part of the emission sources included:

- fuel consumption for sectors SNAP 01 ÷ 03,
- production of selected products for the SNAP 04 sector (including sinter plants and cement plants),
- fuel extraction for the SNAP 05 sector,

- demographic forecasts of the Statistics Poland for the SNAP 06 sector,
- livestock population for the SNAP sector 10.

Following data were assumed for 2030 based on own expert estimates:

- dust emission level associated with the production of electricity and heat, resulting from the implementation of new emission standards for fuel combustion installations under the IED and MCP directives. This includes mainly sources of emissions from the SNAP 01 sector,
- the emission level of the small combustion sector (SNAP 02) based on the national analysis and own estimates concerning transfer to 2040 of the assumptions related to with the rate of replacement of heating devices,
- the value of 1100 cigarettes smoked per capita for calculating the total amount of cigarettes smoked (SNAP 06). This value was obtained from the extrapolation of the trend,
- emissions of pollutants from road transport (own methodology),
- projection of air traffic growth by 2% annually, based on data of the Civil Aviation Office.

The emission projections for 2020, 2025 and 2030, submitted in 2019, constitutes an update of the emission projections prepared in 2017 as no new series of projected data describing activities and technological changes of emission sources until 2030 were available at the time of projection construction.

9.2 Methodology by sector

To maintain consistency, the update of the emission projections was based on the recalculated (in the 2019 emission inventory submission) emission volumes for 2015. The development of emission projections in 2019 for each updated category of emission sources (in the required GNFR classification) is presented below.

Category 1.A.1. Energy industries

The category includes the production of electricity and heat.

NOx, SO_2 and particulate matter emissions were determined on the basis of new KOBiZE analyses.

The NMVOC emissions were determined based on the emission trend for the period 2015-2030 implied from projections prepared in 2017.

Category 1.A.3.b Road transport

While maintaining the previous assumptions for the 2017 projections, an estimate was prepared using the newer COPERT 5 software (formerly COPERT 4). Vehicle structure and mileages in 2030 were assumed according to an expert estimate of Prof. Zdzisław Chłopek, prepared for the needs of forecasts based on the ITS study "Expert forecasts of changes in road transport activity".

Category 3 B

The category includes emissions related to livestock manure (NH_3, NOx) and animal nutrition (NMVOC). The activities related to forecasted livestock were at the same level as in the 2017 projections, obtained from the Ministry of Agriculture and Rural Development. The calculations include only measures affecting the reduction of NH_3 emissions implemented until 2014 (according to data provided by Ministry / IZ-PIB and used in the inventory). The projected growing milk yield of

cows is reflected in the NH_3 emission factor higher than presently.

The emissions of NOx from animal manure and of NMVOC from livestock feeding were estimated based on the basis of the forecast livestock population and the emission factor for 2017 in accordance with the updated methodology in the national inventory. According to the provisions of art. 4 of the NEC Directive NOx and NMVOC emissions from sector 3B will not be included in the reduction target starting from 2020.

According to the updated NH_3 emission inventory, emissions related to manure management are split into 3B and 3D subcategories (in previous forecasts, the entire NH3 emission from manure was in 3.B).

Category 3 D

The category includes emissions from agricultural soils:

- NH_3 and NOx resulting from the use of mineral nitrogen fertilizers and sewage sludge used in agriculture,
- NOx from the use of natural fertilizers in fields and manure left on pastures,
- NMVOC from crops,
- PM2.5 from agricultural operations.

Activities concerning forecasted consumption of mineral fertilizers, livestock population and crop size were applied at the same level as in the 2017 projections, obtained from the Ministry of Agriculture and Rural Development. No additional reduction measures were introduced except those already included in the national inventory of livestock farms up to 2014.

In accordance with the updated NH_3 emission inventory, the ammonia emission from animal faeces applied to fields and left on pastures was transferred to the category 3.D. According to the provisions of art. 4 of the NEC Directive NOx and NMVOC emissions from the 3D sector will not be included in the reduction target starting from 2020.

10 GRIDDED EMISSIONS

According to Table C in Annex I of NEC Directive EU Member States are obliged to report spatially allocated emissions (gridded data) every four years, starting in 2017.

Emission estimates data in the new EMEP grid resolution (0.1° x 0.1° format) were submitted in 2017 based on individual data reported to the National Database and own analyses for area sources.

Following NECD obligations Poland will submit next gridded data in 2021.

11 ABBREVIATIONS

Table 11.1.Abbreviations

Abbreviation	Full name
ARE	Energy Market Agency
CEPMEIP	Coordinated European Programme on Particulate Matter Emission Inventories
COPERT	Computer programme to calculate emissions from road transport
CORINAIR	EMEP/CORINAIR Emission Inventory Guidebook
EIU	Emission Inventory Unit (of KOBiZE)
EMEP/LRTAP	European Monitoring and Evaluation Programme under the Convention on Long-range Transboundary Air Pollution
EPA	U.S. Environmental Protection Agency
EU	European Union
EUROSTAT	EUROSTAT database
GUS	Statistics Poland
HCB	Hexachlorobenzene
HM	Heavy metals
IChPW	Institute for Chemical Processing of Coal
IETU	Institute of Ecology of Industrial Areas in Katowice
IMUZ	Institute for Land Reclamation and Grassland Farming
IOS	Institute of Environmental Protection - National Research Institute
ITS	Motor Transport Institute in Warsaw
KOBiZE	National Centre for Emissions Management
MoE	Ministry of the Environment
NED	National Database of Emissions
NCEM	National Centre for Emissions Management
NFR	Nomenclature for Reporting
NH_3	Ammonia
NMVOC	Non-methane volatile organic compounds
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
OECD	Organization for Economic Cooperation and Development
PAHs	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCDD/F	Dioxins and furans
PM10	particulate matter - particles of 10 µm or less in aerodynamic diameter
PM2.5	particulate matter - particles of 2.5 µm or less in aerodynamic diameter
POP	Persistent organic pollutants
SNAP	Selected nomenclature for air pollution
SO_2	Sulphur dioxide
TSP	Total suspended particulates
UN ECE	United Nations Economic Commission for Europe

Table 11.2.NFR codes

NFR Code	Longname
1A1a	Public electricity and heat production
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
1A2gvii	Mobile Combustion in manufacturing industries and construction
1A2gviii	Stationary combustion in manufacturing industries and construction: Other
1A3ai(i)	International aviation LTO (civil)
1A3aii(i)	Domestic aviation LTO (civil)
1A3bi	Road transport: Passenger cars
1A3bii	Road transport: Light duty vehicles
1A3biii	Road transport: Heavy duty vehicles and buses
1A3biv	Road transport: Mopeds & motorcycles
1A3bv	Road transport: Gasoline evaporation
1A3bvi	Road transport: Automobile tyre and brake wear
1A3bvii	Road transport: Automobile road abrasion
1A3c	Railways
1A3di(ii)	International inland waterways
1A3dii	National navigation (shipping)
1A3ei	Pipeline transport
1A3eii	Other
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)
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 / 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
2A1	Cement production
2A2	Lime production
2A3	Glass production
2A5a	Quarrying and mining of minerals other than coal
2A5b	Construction and demolition
2A5c	Storage, handling and transport of mineral products
2A6	Other mineral products
2B1	Ammonia production
2B2	Nitric acid production
2B3	Adipic acid production
2B5	Carbide production

NFR Code	Longname
2B6	Titanium dioxide production
2B7	Soda ash production
2B10a	Chemical industry: Other
2B10b	Storage, handling and transport of chemical products
2C1	Iron and steel production
2C2	Ferroalloys production
2C3	Aluminium production
2C4	Magnesium production
2C5	Lead production
2C6	Zinc production
2C7a	Copper production
2C7b	Nickel production
2C7c	Other metal production
2C7d	Storage, handling and transport of metal products
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3c	Asphalt roofing
2D3d	Coating applications
2D3e	Degreasing
2D3f	Dry cleaning
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use
2G	Other product use
2H1	Pulp and paper industry
2H2	Food and beverages industry
2H3	Other industrial processes
2I	Wood processing
2J	Production of POPs
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)
2L	Other production, consumption, storage, transportation or handling of bulk products
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
3Da1	Inorganic N-fertilizers (includes also urea application)
3Da2a	Animal manure applied to soils
3Da2b	Sewage sludge applied to soils
3Da2c	Other organic fertilizers 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

NFR Code	Longname
3F	Field burning of agricultural residues
3I	Agriculture other
5A	Biological treatment of waste - Solid waste disposal on land
5B1	Biological treatment of waste - Composting
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities
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 (please specify in the IIR)
5C2	Open burning of waste
5D1	Domestic wastewater handling
5D2	Industrial wastewater handling
5D3	Other wastewater handling
5E	Other waste
6A	Other (included in national total for entire territory)

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ANNEX 1. KEY CATEGORY ANALYSIS

Key source categories are here sources that together contribute up to 95% of the level of reported emissions in Poland. For this report level assessments were carried out for the following pollutants: SO_2, NO_X, NMVOC, NH_3, CO, TSP, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, dioxins and furans (PCDD/F), PCB, HCB and PAH. The level assessment was performed for the year 1990 and 2017. The ten largest key sources from the 2017 level assessment are presented in the table A1.1. Detailed analysis for the particular pollutants is presented in the tables below.

Table A1. 1 The ten largest key categories from the level assessment for 2017

Pollutant	**Key sources in descending order**									
SOx	1A1a	1A4bi	1A2c	1A2a	1A2f	1A4ci	1A2e	1A4ai	1A1b	1A2d
NOx	1A1a	1A3biii	1A3bi	1A4cii	1A4bi	3Da1	1A3bii	1A2f	1A4ai	3Da2a
CO	1A4bi	1A3bi	1A4cii	1A4ci	1A3bii	1A2c	1A2a	1A1a	1A4ai	1A3biii
NH3	3Da2a	3Da1	3B1a	3B3	3B1b	3B4giv	1A4bi	3B4gii	3B4gi	3Da3
PM10	1A4bi	1A1a	3Dc	1A4ai	1A2a	1A4ci	1A2f	1B1a	2L	1A4cii
PM2.5	1A4bi	1A4cii	1A2c	1A2a	1A4ci	1A1a	1A4ai	1A2e	1A2f	1A3bi
NMVOC	1A4bi	2D3d	2H2	2D3a	1A3bi	3B1a	2D3g	2D3h	3B1b	1A3bv
Cd	2C1	1A2c	1A2a	2C6	1A4bi	1A1b	1A2e	1A1a	1A2f	2C5
Hg	1A1a	2C1	2C6	1A4bi	2A1	2C5	1A4ci	1A2c	1A2a	5C1biii
Pb	2C1	1A4bi	2C5	1A1a	2C6	2C7a	1A4ci	1A2c	1A2a	1A3bvi
As	1A1a	1A4bi	2C7a	2C1	1A2c	1A2a	1A1b	2C5	2A3	2C6
Cr	2C7a	2C1	1A4bi	1A1a	1A3bvi	1B1b	1A2c	1A2a	1A4ci	1A1b
Cu	1A3bvi	1A4bi	2C7a	2C1	1A1a	1A4ci	1A2c	1A4ai	1A2a	2G
Ni	1A1b	1A1a	1A4bi	2C7a	2C1	1A2c	1A2a	1A4ciii	1A4ci	1A2e
Zn	2C1	1A1a	2C6	1A4bi	1A2c	1A2a	1A3bvi	1A2e	1A2f	1A4ci
PCDD/F	1A4bi	5E	2C1	1A1a	5C1bi	1A3bi	2C6	2G	5C2	2C7a
HCB	1A4bi	1A1a	5C1biv	5C1bi	1A2c	1A4ci	1A2a	5C1biii	1A2e	1A2f
PCBs	1A4bi	1A1a	2C1	1A2c	1A4ai	1A2a	1A2e	1A4ci	1A2f	2C7a
PAHs	1A4bi	1B1b	5C2	3F	1A3bi	1A4cii	1A3biii	1A3bii	1A2c	1A1a

Sulphur dioxide emissions

Ten source categories have been identified for 2017 as key sources (level assessment) in SO_2 inventory in Poland. The most important of them are Public Electricity and Heat Production and stationary combustion of fuels in residential plants.

Table A1. 2 Level Assessment for sulphur dioxide emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A1a	Public electricity and heat production	2 164.028	81.59	81.59	1A1a	Public electricity and heat production	260.886	44.78	44.78
1A4bi	Residential: Stationary	144.476	5.45	87.04	1A4bi	Residential: Stationary	132.310	22.71	67.48
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	111.992	4.22	91.26	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	35.332	6.06	73.55
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	62.239	2.35	93.61	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	32.479	5.57	79.12
1A4ai	Commercial/institutional: Stationary	43.133	1.63	95.23	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	22.402	3.84	82.97
					1A4ci	Agriculture/Forestry/Fishing: Stationary	22.399	3.84	86.81
					1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	16.869	2.90	89.71
					1A4ai	Commercial/institutional: Stationary	16.162	2.77	92.48
					1A1b	Petroleum refining	11.481	1.97	94.45
					1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	6.387	1.10	95.55

Nitrogen oxides emission

Seventeen source categories have been identified for 2017 as key sources (level assessment) in NO_x inventory in Poland. The most important of them are: stationary combustion of fuels for energy production in public power plants and road transport.

Table A1. 3 Level Assessment for nitrogen oxides emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A1a	Public electricity and heat production	542.089	49.75	49.75	1A1a	Public electricity and heat production	180.085	22.41	22.41
1A3bi	Road transport: Passenger cars	85.465	7.84	57.60	1A3biii	Road transport: Heavy duty vehicles and buses	165.655	20.61	43.02
1A3biii	Road transport: Heavy duty vehicles and buses	80.533	7.39	64.99	1A3bi	Road transport: Passenger cars	100.621	12.52	55.54
3Da1	Inorganic N-fertilizers (includes also urea application)	50.790	4.66	69.65	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	69.137	8.60	64.14
1A4bi	Residential: Stationary	48.877	4.49	74.14	1A4bi	Residential: Stationary	61.624	7.67	71.81
1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	40.583	3.72	77.86	3Da1	Inorganic N-fertilizers (includes also urea application)	45.871	5.71	77.52
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	37.180	3.41	81.28	1A3bii	Road transport: Light duty vehicles	29.948	3.73	81.25
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	32.987	3.03	84.30	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	18.488	2.30	83.55
1A3bii	Road transport: Light duty vehicles	30.181	2.77	87.07	1A4ai	Commercial/institutional: Stationary	14.619	1.82	85.37
3Da2a	Animal manure applied to soils	24.306	2.23	89.30	3Da2a	Animal manure applied to soils	14.458	1.80	87.16
1A3c	Railways	22.808	2.09	91.40	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	12.996	1.62	88.78
1A4ciii	Agriculture/Forestry/ Fishing: National fishing	12.883	1.18	92.58	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	11.069	1.38	90.16
1A4ai	Commercial/institutional: Stationary	12.404	1.14	93.72	1A4ci	Agriculture/Forestry/Fishing: Stationary	9.479	1.18	91.34
1A1c	Manufacture of solid fuels and other energy industries	7.759	0.71	94.43	2B2	Nitric acid production	9.133	1.14	92.47
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	7.753	0.71	95.14	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	7.703	0.96	93.43
					1A4ciii	Agriculture/Forestry/Fishing: National fishing	6.992	0.87	94.30
					1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	6.085	0.76	95.06

Ammonia emissions

Ten source categories have been identified for 2017 as key sources (level assessment) in NH_3 inventory in Poland. The most important of them are: use of fertilizers and manure management of dairy cattle.

Table A1. 4 Level Assessment for ammonia emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
3Da2a	Animal manure applied to soils	174.706	38.94	38.94	3Da2a	Animal manure applied to soils	111.151	36.14	36.14
3Da1	Inorganic N-fertilizers (includes also urea application)	68.526	15.27	54.21	3Da1	Inorganic N-fertilizers (includes also urea application)	61.888	20.12	56.27
3B3	Manure management - Swine	58.522	13.04	67.26	3B1a	Manure management - Dairy cattle	34.442	11.20	67.47
3B1a	Manure management - Dairy cattle	49.381	11.01	78.26	3B3	Manure management - Swine	29.767	9.68	77.15
3B1b	Manure management - Non-dairy cattle	28.996	6.46	84.72	3B1b	Manure management - Non-dairy cattle	21.687	7.05	84.20
3Da3	Urine and dung deposited by grazing animals	16.253	3.62	88.35	3B4giv	Manure management - Other poultry	7.871	2.56	86.76
3B4giv	Manure management - Other poultry	14.515	3.24	91.58	1A4bi	Residential: Stationary	7.762	2.52	89.28
5D1	Domestic wastewater handling	10.444	2.33	93.91	3B4gii	Manure management - Broilers	6.765	2.20	91.48
3B4gi	Manure management - Laying hens	7.685	1.71	95.62	3B4gi	Manure management - Laying hens	6.557	2.13	93.62
					3Da3	Urine and dung deposited by grazing animals	6.257	2.03	95.65

Particulate matter emissions

Twenty nine source categories have been identified for 2017 as key sources (level assessment) in TSP inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants and for energy production in public power plants and agriculture operations.

Table A1. 5 Level Assessment for TSP emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A1a	Public electricity and heat production	478.130	54.09	54.09	1A4bi	Residential: Stationary	121.950	35.81	35.81
1A4bi	Residential: Stationary	153.542	17.37	71.46	1A4ci	Agriculture/Forestry/ Fishing: Stationary	22.873	6.72	42.52
1A4ai	Commercial/institutional: Stationary	24.110	2.73	74.19	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	17.015	5.00	47.52
2L	Other production, consumption, storage, transportation or handling of bulk products	23.788	2.69	76.88	1A1a	Public electricity and heat production	14.974	4.40	51.92

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	22.445	2.54	79.42	1B1a	Fugitive emission from solid fuels: Coal mining and handling	12.882	3.78	55.70
1B1a	Fugitive emission from solid fuels: Coal mining and handling	21.878	2.48	81.89	3B3	Manure management - Swine	11.540	3.39	59.09
3B3	Manure management - Swine	19.647	2.22	84.12	2L	Other production, consumption, storage, transportation or handling of bulk products	11.086	3.26	62.34
1A4ci	Agriculture/Forestry/ Fishing: Stationary	18.842	2.13	86.25	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	10.463	3.07	65.41
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	15.186	1.72	87.97	1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	10.434	3.06	68.48
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	14.804	1.67	89.64	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	9.693	2.85	71.32
3B4gi	Manure management - Laying hens	10.580	1.20	90.84	3B4gi	Manure management - Laying hens	9.530	2.80	74.12
2C1	Iron and steel production	7.283	0.82	91.66	1A3bvi	Road transport: Automobile tyre and brake wear	8.076	2.37	76.49
3B1a	Manure management - Dairy cattle	6.788	0.77	92.43	1A4ai	Commercial/institutional: Stationary	7.228	2.12	78.62
1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	6.124	0.69	93.12	1A3bvii	Road transport: Automobile road abrasion	5.862	1.72	80.34
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	6.111	0.69	93.81	3B4gii	Manure management - Broilers	5.099	1.50	81.83
3B4gii	Manure management - Broilers	5.299	0.60	94.41	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.943	1.45	83.29
3B4giv	Manure management - Other poultry	5.231	0.59	95.00	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4.713	1.38	84.67

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
					1A3bi	Road transport: Passenger cars	4.158	1.22	85.89
					1A3biii	Road transport: Heavy duty vehicles and buses	4.059	1.19	87.08
					2A5a	Quarrying and mining of minerals other than coal	3.547	1.04	88.12
					3B1a	Manure management - Dairy cattle	3.277	0.96	89.09
					5E	Other waste	3.106	0.91	90.00
					2B10a	Chemical industry: Other	3.071	0.90	90.90
					2I	Wood processing	2.994	0.88	91.78
					3B4giv	Manure management - Other poultry	2.836	0.83	92.61
					2A5b	Construction and demolition	2.679	0.79	93.40
					2C1	Iron and steel production	2.304	0.68	94.07
					1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.884	0.55	94.63
					1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1.836	0.54	95.17

Twenty nine source categories have been identified for 2017 as key sources (level assessment) in PM10 inventory in Poland. The most important of them are stationary combustion of fuels in residential plants and agriculture/forestry.

Table A1. 6 Level Assessment for PM10 emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	109.175	34.69	34.69	1A4bi	Residential: Stationary	91.886	37.31	37.31
1A1a	Public electricity and heat production	39.141	12.44	47.12	1A4ci	Agriculture/Forestry/ Fishing: Stationary	17.799	7.23	44.53
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	22.445	7.13	54.25	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	17.015	6.91	51.44
1A4ai	Commercial/institutional: Stationary	15.347	4.88	59.13	1A1a	Public electricity and heat production	12.451	5.06	56.49
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	14.372	4.57	63.69	1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	10.434	4.24	60.73

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4ci	Agriculture/Forestry /Fishing: Stationary	14.097	4.48	68.17	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	9.919	4.03	64.76
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	14.010	4.45	72.62	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	9.190	3.73	68.49
1B1a	Fugitive emission from solid fuels: Coal mining and handling	10.754	3.42	76.04	1B1a	Fugitive emission from solid fuels: Coal mining and handling	6.332	2.57	71.06
2L	Other production, consumption, storage, transportation or handling of bulk products	9.528	3.03	79.07	1A3bvi	Road transport: Automobile tyre and brake wear	6.146	2.50	73.55
1A4cii	Agriculture/Forestry /Fishing: Off-road vehicles and other machinery	6.124	1.95	81.01	1A4ai	Commercial/institutional: Stationary	4.964	2.02	75.57
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	5.783	1.84	82.85	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.686	1.90	77.47
3B4giv	Manure management - Other poultry	5.231	1.66	84.51	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4.468	1.81	79.29
2C1	Iron and steel production	4.985	1.58	86.09	2L	Other production, consumption, storage, transportation or handling of bulk products	4.452	1.81	81.09
1A3biii	Road transport: Heavy duty vehicles and buses	3.928	1.25	87.34	1A3bi	Road transport: Passenger cars	4.158	1.69	82.78
3B1a	Manure management - Dairy cattle	3.099	0.98	88.33	1A3biii	Road transport: Heavy duty vehicles and buses	4.059	1.65	84.43
1A3bii	Road transport: Light duty vehicles	2.943	0.94	89.26	5E	Other waste	3.106	1.26	85.69
3B3	Manure management - Swine	2.780	0.88	90.15	1A3bvii	Road transport: Automobile road abrasion	2.931	1.19	86.88
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	2.703	0.86	91.00	3B4giv	Manure management - Other poultry	2.836	1.15	88.03
3B4gii	Manure management - Broilers	2.650	0.84	91.85	3B4gii	Manure management - Broilers	2.550	1.04	89.07
1A3c	Railways	2.609	0.83	92.68	2B10a	Chemical industry: Other	2.055	0.83	89.90

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
3B4gi	Manure management - Laying hens	2.227	0.71	93.38	3B4gi	Manure management - Laying hens	2.006	0.81	90.72
5E	Other waste	2.063	0.66	94.04	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.884	0.76	91.48
2G	Other product use	1.905	0.61	94.64	1A3bii	Road transport: Light duty vehicles	1.822	0.74	92.22
1A3bvi	Road transport: Automobile tyre and brake wear	1.601	0.51	95.15	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1.741	0.71	92.93
					2A5a	Quarrying and mining of minerals other than coal	1.740	0.71	93.63
					3B3	Manure management - Swine	1.616	0.66	94.29
					3B1a	Manure management - Dairy cattle	1.496	0.61	94.90
					5C2	Open burning of waste	1.378	0.56	95.46

Twenty four source categories have been identified for 2017 as key sources (level assessment) in PM2.5 inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants and off-road vehicles and other machinery in agriculture and forestry.

Table A1. 7 Level Assessment for PM2.5 emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	51.470	31.49	31.49	1A4bi	Residential: Stationary	55.890	37.95	37.95
1A1a	Public electricity and heat production	20.694	12.66	44.16	1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	10.434	7.08	45.03
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	13.316	8.15	52.30	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	9.341	6.34	51.37
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	12.981	7.94	60.25	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	8.655	5.88	57.25
1A4ai	Commercial/institutional: Stationary	12.812	7.84	68.09	1A4ci	Agriculture/Forestry/ Fishing: Stationary	7.908	5.37	62.62
1A4cii	Agriculture/Forestry /Fishing: Off-road vehicles and other machinery	6.124	3.75	71.83	1A1a	Public electricity and heat production	7.098	4.82	67.44

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	5.358	3.28	75.11	1A4ai	Commercial/institutional: Stationary	4.705	3.19	70.63
1A4ci	Agriculture/Forestry /Fishing: Stationary	4.752	2.91	78.02	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.413	3.00	73.63
1A3biii	Road transport: Heavy duty vehicles and buses	3.928	2.40	80.42	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4.208	2.86	76.49
2C1	Iron and steel production	3.791	2.32	82.74	1A3bi	Road transport: Passenger cars	4.158	2.82	79.31
1A3bii	Road transport: Light duty vehicles	2.943	1.80	84.54	1A3biii	Road transport: Heavy duty vehicles and buses	4.059	2.76	82.07
1A3c	Railways	2.609	1.60	86.14	1A3bvi	Road transport: Automobile tyre and brake wear	3.289	2.23	84.30
5E	Other waste	2.063	1.26	87.40	5E	Other waste	3.106	2.11	86.41
3B1a	Manure management - Dairy cattle	2.017	1.23	88.64	1A3bii	Road transport: Light duty vehicles	1.822	1.24	87.65
2G	Other product use	1.905	1.17	89.80	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1.639	1.11	88.76
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	1.450	0.89	90.69	1A3bvii	Road transport: Automobile road abrasion	1.583	1.07	89.83
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.352	0.83	91.52	2B10a	Chemical industry: Other	1.536	1.04	90.88
1A3bi	Road transport: Passenger cars	1.197	0.73	92.25	5C2	Open burning of waste	1.280	0.87	91.75
5C2	Open burning of waste	1.115	0.68	92.93	2G	Other product use	0.977	0.66	92.41
1B1a	Fugitive emission from solid fuels: Coal mining and handling	1.075	0.66	93.59	3B1a	Manure management - Dairy cattle	0.973	0.66	93.07
2B10a	Chemical industry: Other	0.992	0.61	94.20	2C1	Iron and steel production	0.951	0.65	93.72
2L	Other production, consumption, storage, transportation or handling of bulk products	0.953	0.58	94.78	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.942	0.64	94.36

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4ciii	Agriculture/Forestry /Fishing: National fishing	0.882	0.54	95.32	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	0.866	0.59	94.94
					2A3	Glass production	0.708	0.48	95.42

Eleven source categories have been identified for 2017 as key sources (level assessment) in Black Carbon (BC) inventory in Poland. The most important of them are: off-road vehicles and other machinery in agriculture and forestry and stationary combustion of fuels in residential plants.

Table A1. 8 Level Assessment for BC emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4cii	Agriculture/Forestry /Fishing: Off-road vehicles and other machinery	5.267	27.51	27.51	1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	8.973	37.68	37.68
1A4bi	Residential: Stationary	3.641	19.02	46.54	1A4bi	Residential: Stationary	4.468	18.76	56.44
1A3biii	Road transport: Heavy duty vehicles and buses	1.964	10.26	56.80	1A3bi	Road transport: Passenger cars	3.202	13.45	69.89
1A3c	Railways	1.927	10.07	66.87	1A3biii	Road transport: Heavy duty vehicles and buses	2.404	10.09	79.98
1A3bii	Road transport: Light duty vehicles	1.613	8.43	75.29	1A3bii	Road transport: Light duty vehicles	1.295	5.44	85.42
1A4ai	Commercial/instituti onal: Stationary	0.799	4.18	79.47	5C2	Open burning of waste	0.538	2.26	87.68
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.662	3.46	82.93	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.461	1.94	89.61
1A3bi	Road transport: Passenger cars	0.617	3.22	86.15	1A4ci	Agriculture/Forestry/ Fishing: Stationary	0.419	1.76	91.37
1A1a	Public electricity and heat production	0.473	2.47	88.62	1A4ai	Commercial/instituti onal: Stationary	0.412	1.73	93.10
5C2	Open burning of waste	0.468	2.45	91.07	1A3c	Railways	0.325	1.37	94.47
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.337	1.76	92.83	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.263	1.10	95.57
1A4ci	Agriculture/Forestry /Fishing: Stationary	0.336	1.75	94.58					
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.329	1.72	96.30					

NMVOCs emissions

Thirty two source categories have been identified for 2017 as key sources (level assessment) in NMVOC inventory in Poland. The most important of them are stationary combustion of fuels in households and coating applications.

Table A1. 9 Level Assessment for NMVOC emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	120.105	17.00	17.00	1A4bi	Residential: Stationary	102.084	14.78	14.78
1A3bi	Road transport: Passenger cars	88.563	12.54	29.54	2D3d	Coating applications	81.507	11.80	26.58
3B1a	Manure management - Dairy cattle	67.556	9.56	39.11	2H2	Food and beverages industry	48.631	7.04	33.62
2D3a	Domestic solvent use including fungicides	45.688	6.47	45.58	2D3a	Domestic solvent use including fungicides	46.121	6.68	40.30
2H2	Food and beverages industry	41.791	5.92	51.49	1A3bi	Road transport: Passenger cars	45.428	6.58	46.87
3B1b	Manure management - Non-dairy cattle	30.034	4.25	55.74	3B1a	Manure management - Dairy cattle	32.609	4.72	51.59
1B1a	Fugitive emission from solid fuels: Coal mining and handling	28.266	4.00	59.75	2D3g	Chemical products	29.928	4.33	55.93
2D3d	Coating applications	22.800	3.23	62.97	2D3h	Printing	27.481	3.98	59.91
1A3bv	Road transport: Gasoline evaporation	18.226	2.58	65.55	3B1b	Manure management - Non-dairy cattle	22.064	3.19	63.10
5A	Biological treatment of waste - Solid waste disposal on land	17.296	2.45	68.00	1A3bv	Road transport: Gasoline evaporation	20.013	2.90	66.00
1A3bii	Road transport: Light duty vehicles	16.766	2.37	70.38	1B1a	Fugitive emission from solid fuels: Coal mining and handling	18.780	2.72	68.72
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	15.961	2.26	72.64	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	14.993	2.17	70.89
1A4ai	Commercial/institutional: Stationary	15.751	2.23	74.87	1B2av	Distribution of oil products	13.845	2.00	72.89
3B4gii	Manure management - Broilers	14.308	2.03	76.89	3B4gii	Manure management - Broilers	13.768	1.99	74.88
3B3	Manure management - Swine	12.843	1.82	78.71	1B2aiv	Fugitive emissions oil: Refining / storage	12.751	1.85	76.73
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	12.508	1.77	80.48	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	11.157	1.62	78.34

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1B2av	Distribution of oil products	11.539	1.63	82.11	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	9.925	1.44	79.78
1A3biii	Road transport: Heavy duty vehicles and buses	10.251	1.45	83.57	1A3biii	Road transport: Heavy duty vehicles and buses	8.982	1.30	81.08
3B4gi	Manure management - Laying hens	9.188	1.30	84.87	2D3e	Degreasing	8.518	1.23	82.32
1A3biv	Road transport: Mopeds & motorcycles	8.761	1.24	86.11	3B4gi	Manure management - Laying hens	8.276	1.20	83.51
3De	Cultivated crops	8.156	1.15	87.26	1A4ci	Agriculture/Forestry/ Fishing: Stationary	8.121	1.18	84.69
1A4ci	Agriculture/Forestry /Fishing: Stationary	7.991	1.13	88.39	5A	Biological treatment of waste - Solid waste disposal on land	7.800	1.13	85.82
3B4giv	Manure management - Other poultry	7.203	1.02	89.41	2D3i	Other solvent use	7.641	1.11	86.92
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	6.846	0.97	90.38	3B3	Manure management - Swine	7.275	1.05	87.98
1B2aiv	Fugitive emissions oil: Refining / storage	6.613	0.94	91.32	1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	7.107	1.03	89.01
3B4giii	Manure management - Turkeys	6.572	0.93	92.25	3De	Cultivated crops	6.973	1.01	90.02
2D3g	Chemical products	6.447	0.91	93.16	1A3bii	Road transport: Light duty vehicles	6.488	0.94	90.96
2D3f	Dry cleaning	5.711	0.81	93.97	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	6.039	0.87	91.83
3B4e	Manure management - Horses	4.435	0.63	94.60	3B4giii	Manure management - Turkeys	5.979	0.87	92.70
2D3c	Asphalt roofing	4.257	0.60	95.20	1A4ai	Commercial/instituti onal: Stationary	5.947	0.86	93.56
					2D3f	Dry cleaning	5.765	0.83	94.39
					1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	4.851	0.70	95.09

Carbon monoxide emissions

Thirteen source categories have been identified for 2017 as key sources (level assessment) in CO inventory in Poland. The most important of them are stationary combustion of fuels in households and road transportation by passenger cars.

Table A1. 10 Level Assessment for carbon monoxide emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	1 519.946	41.74	41.74	1A4bi	Residential: Stationary	1 365.949	53.71	53.71
1A3bi	Road transport: Passenger cars	1 003.756	27.57	69.31	1A3bi	Road transport: Passenger cars	439.031	17.26	70.97
1A4ai	Commercial/institutional: Stationary	265.342	7.29	76.60	1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	93.100	3.66	74.63
1A3bii	Road transport: Light duty vehicles	185.584	5.10	81.69	1A4ci	Agriculture/Forestry/ Fishing: Stationary	87.698	3.45	78.08
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	112.647	3.09	84.79	1A3bii	Road transport: Light duty vehicles	69.256	2.72	80.80
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	109.812	3.02	87.80	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	67.213	2.64	83.45
1A3biv	Road transport: Mopeds & motorcycles	84.403	2.32	90.12	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	62.271	2.45	85.89
1A4ci	Agriculture/Forestry/Fishing: Stationary	83.826	2.30	92.42	1A1a	Public electricity and heat production	52.919	2.08	87.98
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	54.649	1.50	93.92	1A4ai	Commercial/institutional: Stationary	52.153	2.05	90.03
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	45.327	1.24	95.17	1A3biii	Road transport: Heavy duty vehicles and buses	42.476	1.67	91.70
					1A3biv	Road transport: Mopeds & motorcycles	37.681	1.48	93.18
					1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	31.756	1.25	94.43

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
					1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	30.275	1.19	95.62

Heavy metal emissions

Tables below include emission *Level Assessment* estimates for Cd, Hg, Pb, As, Cr, Cu, Ni and Zn according to NFR classification.

Sixteen source categories have been identified for 2017 as key sources (level assessment) in Cd inventory in Poland. The most important of them are Iron and steel production and combustion in manufacturing industries, especially in chemicals and metals production.

Table A1. 11 Level Assessment for Cd emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	4.003	20.43	20.43	2C1	Iron and steel production	2.045	16.54	16.54
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	3.162	16.14	36.57	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	1.544	12.49	29.03
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	3.082	15.73	52.31	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	1.431	11.57	40.60
2C1	Iron and steel production	2.763	14.10	66.41	2C6	Zinc production	0.945	7.64	48.24
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	1.272	6.49	72.91	1A4bi	Residential: Stationary	0.928	7.50	55.74
2B10a	Chemical industry: Other	0.739	3.77	76.68	1A1b	Petroleum refining	0.734	5.94	61.68
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.676	3.45	80.13	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0.730	5.90	67.58
2C5	Lead production	0.638	3.26	83.39	1A1a	Public electricity and heat production	0.709	5.73	73.32

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A4bi	Residential: Stationary	0.631	3.22	86.61	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.696	5.63	78.94
5C1biii	Clinical waste incineration	0.448	2.29	88.90	2C5	Lead production	0.626	5.06	84.00
2C6	Zinc production	0.373	1.90	90.80	5C1biii	Clinical waste incineration	0.321	2.60	86.60
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.344	1.76	92.56	2A3	Glass production	0.287	2.32	88.92
1A1b	Petroleum refining	0.282	1.44	94.00	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0.271	2.19	91.12
1A4ai	Commercial/institutional: Stationary	0.261	1.33	95.33	2B10a	Chemical industry: Other	0.218	1.76	92.88
					1A4ci	Agriculture/Forestry/ Fishing: Stationary	0.165	1.34	94.22
					1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	0.143	1.16	95.37

Eleven source categories have been identified as key sources (level assessment) for 2017 in Hg inventory in Poland. The most important of them are: combustion in Public Electricity and Heat Production and Iron and steel production.

Table A1. 12 Level Assessment for Hg emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	10.188	62.71	62.71	1A1a	Public electricity and heat production	5.262	54.94	54.94
2C1	Iron and steel production	1.430	8.80	71.52	2C1	Iron and steel production	1.186	12.38	67.33
2C6	Zinc production	1.057	6.51	78.02	2C6	Zinc production	0.802	8.37	75.70
2B10a	Chemical industry: Other	0.978	6.02	84.04	1A4bi	Residential: Stationary	0.629	6.57	82.27
1A4bi	Residential: Stationary	0.622	3.83	87.87	2A1	Cement production	0.345	3.60	85.87
5C1biii	Clinical waste incineration	0.537	3.30	91.17	2C5	Lead production	0.186	1.94	87.81
2A1	Cement production	0.250	1.54	92.71	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.170	1.78	89.59
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.219	1.35	94.06	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.152	1.59	91.17

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.214	1.31	95.38	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.141	1.47	92.64
					5C1biii	Clinical waste incineration	0.135	1.41	94.06
					1A4ai	Commercial/institutional: Stationary	0.124	1.29	95.35

Fifteen source categories have been identified as key sources (level assessment) for 2017 in Pb inventory in Poland. The most important of them are: Iron and steel production and stationary combustion of fuels in households.

Table A1. 13 Level Assessment for Pb emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
2C1	Iron and steel production	99.342	25.32	25.32	2C1	Iron and steel production	92.067	30.14	30.14
1A1a	Public electricity and heat production	48.129	12.27	37.58	1A4bi	Residential: Stationary	44.561	14.59	44.72
1A4bi	Residential: Stationary	46.288	11.80	49.38	2C5	Lead production	38.251	12.52	57.25
2C5	Lead production	37.961	9.67	59.06	1A1a	Public electricity and heat production	26.219	8.58	65.83
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	21.134	5.39	64.44	2C6	Zinc production	15.529	5.08	70.91
2C6	Zinc production	19.506	4.97	69.41	2C7a	Copper production	11.586	3.79	74.70
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	18.645	4.75	74.16	1A4ci	Agriculture/Forestry/Fishing: Stationary	9.880	3.23	77.94
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	15.987	4.07	78.24	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	9.499	3.11	81.05
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	15.540	3.96	82.20	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	8.801	2.88	83.93
1A4ci	Agriculture/Forestry/Fishing: Stationary	13.175	3.36	85.56	1A3bvi	Road transport: Automobile tyre and brake wear	8.446	2.76	86.69
1A4ai	Commercial/institutional: Stationary	10.779	2.75	88.30	2G	Other product use	7.222	2.36	89.06
2C7a	Copper production	9.785	2.49	90.80	1A4ai	Commercial/institutional: Stationary	6.445	2.11	91.17
1A1c	Manufacture of solid fuels and other energy industries	9.071	2.31	93.11	2A3	Glass production	5.492	1.80	92.96

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	4.804	1.22	94.33	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.488	1.47	94.43
5C1biii	Clinical waste incineration	3.324	0.85	95.18	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4.279	1.40	95.83

Thirteen source categories have been identified for 2017 as key sources (level assessment) in As inventory in Poland. The most important of them are: stationary combustion of fuels in Public Electricity and Heat Production and in households.

Table A1. 14 Level Assessment for As emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	13.634	49.64	49.64	1A1a	Public electricity and heat production	4.521	27.05	27.05
2C1	Iron and steel production	3.798	13.83	63.47	1A4bi	Residential: Stationary	2.699	16.15	43.20
1A4bi	Residential: Stationary	1.966	7.16	70.63	2C7a	Copper production	2.439	14.59	57.79
2C7a	Copper production	1.835	6.68	77.31	2C1	Iron and steel production	0.847	5.07	62.86
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	1.362	4.96	82.27	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.765	4.58	67.44
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	1.328	4.84	87.11	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.709	4.24	71.68
2C5	Lead production	0.650	2.37	89.48	1A1b	Petroleum refining	0.704	4.21	75.89
1A4ai	Commercial/institutional: Stationary	0.558	2.03	91.51	2C5	Lead production	0.632	3.78	79.67
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0.548	2.00	93.50	2A3	Glass production	0.596	3.57	83.24
1A4ci	Agriculture/Forestry/ Fishing: Stationary	0.397	1.45	94.95	2C6	Zinc production	0.496	2.97	86.21
1A1b	Petroleum refining	0.278	1.01	95.96	1A4ci	Agriculture/Forestry/ Fishing: Stationary	0.495	2.96	89.17

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
					1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0.361	2.16	91.33
					1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.345	2.06	93.39
					1A4ai	Commercial/institutional: Stationary	0.286	1.71	95.10

Thirteen source categories have been identified for 2017 as key sources (level assessment) in Cr inventory in Poland. The most important of them are: copper production and iron and steel production.

Table A1. 15 Level Assessment for Cr emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
2C1	Iron and steel production	45.267	49.94	49.94	2C7a	Copper production	9.757	23.45	23.45
1A1a	Public electricity and heat production	17.542	19.35	69.29	2C1	Iron and steel production	7.254	17.43	40.88
2C7a	Copper production	7.341	8.10	77.38	1A4bi	Residential: Stationary	5.843	14.04	54.92
1A4bi	Residential: Stationary	6.983	7.70	85.09	1A1a	Public electricity and heat production	5.686	13.66	68.58
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	2.593	2.86	87.95	1A3bvi	Road transport: Automobile tyre and brake wear	3.130	7.52	76.10
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	2.528	2.79	90.74	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.601	3.85	79.95
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	2.298	2.53	93.27	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	1.366	3.28	83.23
1A4ai	Commercial/institutional: Stationary	1.748	1.93	95.20	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	1.266	3.04	86.27
					1A4ci	Agriculture/Forestry/Fishing: Stationary	1.035	2.49	88.76
					1A1b	Petroleum refining	0.905	2.17	90.93
					2A3	Glass production	0.735	1.77	92.70

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
					1A4ai	Commercial/institutional: Stationary	0.689	1.66	94.35
					1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0.645	1.55	95.91

Thirteen source categories have been identified as key sources (level assessment) for 2017 in Cu inventory in Poland. The most important of them are: automobile tyre and brake wear in road transport and stationary combustion in households.

Table A1. 16 Level Assessment for Cu emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	64.640	31.49	31.49	1A3bvi	Road transport: Automobile tyre and brake wear	68.541	33.66	33.66
1A4bi	Residential: Stationary	31.550	15.37	46.85	1A4bi	Residential: Stationary	34.623	17.00	50.66
2C1	Iron and steel production	19.574	9.53	56.39	2C7a	Copper production	19.513	9.58	60.24
1A3bvi	Road transport: Automobile tyre and brake wear	18.822	9.17	65.55	2C1	Iron and steel production	19.302	9.48	69.72
2C7a	Copper production	14.682	7.15	72.71	1A1a	Public electricity and heat production	17.529	8.61	78.33
1A4ai	Commercial/institutional: Stationary	12.904	6.29	78.99	1A4ci	Agriculture/Forestry/Fishing: Stationary	7.452	3.66	81.99
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	9.791	4.77	83.76	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	5.077	2.49	84.48
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	9.545	4.65	88.41	1A4ai	Commercial/institutional: Stationary	5.033	2.47	86.95
1A4ci	Agriculture/Forestry/Fishing: Stationary	7.050	3.43	91.84	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	4.703	2.31	89.26
5C1biii	Clinical waste incineration	5.490	2.67	94.52	2G	Other product use	4.090	2.01	91.27
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	3.940	1.92	96.44	5C1biii	Clinical waste incineration	3.935	1.93	93.20
					1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	3.411	1.67	94.88

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
					1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	2.398	1.18	96.05

Thirteen source categories have been identified for 2017 as key sources (level assessment) in Ni inventory in Poland. The most important of them are: Petroleum refining and Public electricity and heat production.

Table A1. 17 Level Assessment for Ni emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	90.779	48.59	48.59	1A1b	Petroleum refining	18.774	20.77	20.77
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	15.467	8.28	56.87	1A1a	Public electricity and heat production	14.298	15.82	36.59
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	15.078	8.07	64.94	1A4bi	Residential: Stationary	12.436	13.76	50.35
1A4bi	Residential: Stationary	12.302	6.58	71.52	2C7a	Copper production	8.537	9.44	59.79
2C1	Iron and steel production	9.218	4.93	76.45	2C1	Iron and steel production	6.384	7.06	66.85
1A1b	Petroleum refining	7.514	4.02	80.48	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	5.410	5.98	72.84
1A4ciii	Agriculture/Forestry/Fishing: National fishing	7.059	3.78	84.25	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	5.012	5.54	78.38
2C7a	Copper production	6.423	3.44	87.69	1A4ciii	Agriculture/Forestry/Fishing: National fishing	3.831	4.24	82.62
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	6.224	3.33	91.02	1A4ci	Agriculture/Forestry/Fishing: Stationary	3.056	3.38	86.00
1A4ai	Commercial/institutional: Stationary	5.950	3.18	94.21	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	2.556	2.83	88.83

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A4ci	Agriculture/Forestry/Fishing: Stationary	4.675	2.50	96.71	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	2.437	2.70	91.52
					1A4ai	Commercial/institutional: Stationary	1.891	2.09	93.62
					2A1	Cement production	1.725	1.91	95.53

Thirteen source categories have been identified as key sources (level assessment) for 2017 in Zn inventory in Poland. The most important of them are: iron and steel production and stationary combustion of fuels in Public electricity and heat production.

Table A1. 18 Level Assessment for Zn emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	405.094	36.13	36.13	2C1	Iron and steel production	183.816	28.17	28.17
2C1	Iron and steel production	332.029	29.61	65.74	1A1a	Public electricity and heat production	97.752	14.98	43.15
1A4bi	Residential: Stationary	78.863	7.03	72.77	2C6	Zinc production	83.435	12.79	55.94
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	72.347	6.45	79.22	1A4bi	Residential: Stationary	80.843	12.39	68.33
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	70.527	6.29	85.51	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	39.431	6.04	74.37
2C6	Zinc production	42.151	3.76	89.27	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	36.532	5.60	79.97
1A4ai	Commercial/institutional: Stationary	31.392	2.80	92.07	1A3bvi	Road transport: Automobile tyre and brake wear	26.111	4.00	83.98
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	29.111	2.60	94.66	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	18.630	2.86	86.83
1A4ci	Agriculture/Forestry/Fishing: Stationary	10.885	0.97	95.64	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	17.761	2.72	89.55
					1A4ci	Agriculture/Forestry/Fishing: Stationary	13.387	2.05	91.60
					1A4ai	Commercial/institutional: Stationary	8.993	1.38	92.98
					2C7a	Copper production	8.537	1.31	94.29

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
					1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	6.920	1.06	95.35

PCDD/F emissions

Thirteen source categories have been identified for 2017 as key sources (level assessment) in PCDD/F inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants and landfill fires.

Table A1. 19 Level Assessment for PCDD/F emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		g i-TEQ	%	%			g i-TEQ	%	%
1A4bi	Residential: Stationary	133.929	40.09	40.09	1A4bi	Residential: Stationary	142.064	53.78	53.78
5E	Other waste	59.451	17.80	57.88	5E	Other waste	47.302	17.91	71.68
5C1bi	Industrial waste incineration	50.589	15.14	73.03	2C1	Iron and steel production	14.609	5.53	77.21
1A4ai	Commercial/institutional: Stationary	35.165	10.53	83.55	1A1a	Public electricity and heat production	10.283	3.89	81.10
2C1	Iron and steel production	15.501	4.64	88.19	5C1bi	Industrial waste incineration	7.494	2.84	83.94
1A1a	Public electricity and heat production	11.339	3.39	91.59	1A3bi	Road transport: Passenger cars	5.871	2.22	86.16
2G	Other product use	10.082	3.02	94.60	2C6	Zinc production	5.459	2.07	88.23
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	4.055	1.21	95.82	2G	Other product use	5.169	1.96	90.18
					5C2	Open burning of waste	3.055	1.16	91.34
					2C7a	Copper production	3.049	1.15	92.49
					1B1b	Fugitive emission from solid fuels: Solid fuel transformation	2.825	1.07	93.56
					2H2	Food and beverages industry	2.788	1.06	94.62
					1A2c	Stationary combustion in manufacturing industries: Chemicals	1.745	0.66	95.28

HCB emissions

Ten source categories have been identified as key sources (level assessment) for 2017 in HCB inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants and Public electricity and heat production.

Table A1. 20 Level Assessment for HCB emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		kg	%	%			kg	%	%
1A4bi	Residential: Stationary	1.654	36.29	36.29	1A4bi	Residential: Stationary	1.714	42.49	42.49
5C1bi	Industrial waste incineration	1.207	26.49	62.78	1A1a	Public electricity and heat production	0.803	19.91	62.40
1A1a	Public electricity and heat production	1.070	23.49	86.27	5C1biv	Sewage sludge incineration	0.465	11.52	73.92
5C1biii	Clinical waste incineration	0.326	7.15	93.42	5C1bi	Industrial waste incineration	0.408	10.12	84.04
2C7a	Copper production	0.054	1.18	94.59	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.112	2.77	86.81
1A4ai	Commercial/institutional: Stationary	0.050	1.09	95.68	1A4ci	Agriculture/Forestry/ Fishing: Stationary	0.104	2.59	89.40
					1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.088	2.18	91.58
					5C1biii	Clinical waste incineration	0.061	1.50	93.09
					1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0.055	1.36	94.45
					1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.050	1.25	95.70

PCB emissions

Three source categories have been identified for 2017 as key sources (level assessment) in PCB inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants and Public Electricity and Heat Production.

Table A1. 21 Level Assessment for PCB emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		kg	%	%			kg	%	%
1A4bi	Residential: Stationary	409.154	54.59	54.59	1A4bi	Residential: Stationary	390.081	67.45	67.45
1A1a	Public electricity and heat production	146.027	19.48	74.08	1A1a	Public electricity and heat production	126.159	21.81	89.26
1A4ai	Commercial/institutional: Stationary	126.236	16.84	90.92	2C1	Iron and steel production	39.312	6.80	96.06
2C1	Iron and steel production	42.333	5.65	96.57					

PAH emissions

Three source categories have been identified as key sources (level assessment) for 2017 in PAH inventory in Poland. They are: stationary combustion of fuels in residential plants and coke production.

Table A1. 22 Level Assessment for PAH emission sources in 1990 and 2017

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2017 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A4bi	Residential: Stationary	118.322	74.54	74.54	1A4bi	Residential: Stationary	126.620	83.54	83.54
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	20.950	13.20	87.73	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	14.598	9.63	93.17
3F	Field burning of agricultural residues	9.012	5.68	93.41	5C2	Open burning of waste	3.861	2.55	95.71
2C3	Aluminum production	4.430	2.79	96.20					

ANNEX 2. METHODOLOGY OF BIOGENIC NATURAL VOC (BVOC) EMISSION ESTIMATES

All methodologies for calculating biogenic emissions essentially involve multiplying an emissions factor for a type of vegetation by a statistic giving the amount of vegetation in the country or grid square. Two major alternatives for this are (1) to perform these calculations at a general or preferably species specific level (requiring for example separate statistics for Norway spruce, Douglas fir, etc.), or (2) to perform the calculations for different ecosystem types. In this latter method, each ecosystem is assumed to consist of a number of species, and the assigned emission rates attempt to give the average emissions from this category. Our ability to assess the impact of natural emissions on tropospheric oxidant levels is very dependent on the quality and quantity of available measurements. Measurements of natural emissions from vegetation have been improved considerably during the past decade as a result of advances in analytical methods and measurement techniques.

Emission estimation

Emissions identification of individual species is a difficult exercise, requiring consideration of variations in the species emitted at different periods of the year, and differences in species emitted by different plant species among other things. The simplified methodology consists of modifying equation is considering seasonal calculation. The simplified equation applied in calculation is as follows:

$$F = \varepsilon * D * \gamma$$

Where:

D- foliar biomass estimates,

ε - is the average emission potentials (μg $g^{-1}h^{-1}$ at 30°C),

ɣ - represents the integrated value of ɣ over the growing season of the vegetation concerned.

Integrated values, ɣ-iso and ɣ-mts, have been provided in the section 4 of the chapter 11.C of the *EMEP/EEA air pollutant emission inventory guidebook 2016.* With this simplified methodology we could estimate, for example, the isoprene emissions from 1 km^2 of particular tree species (e.g. Q. robur) as simply:

$$Emission = Area * \varepsilon * D * \gamma\text{-}iso$$

Vegetation coverage in terms of the vegetation types discussed in section 8 of the chapter 11.C of the *EMEP/EEA air pollutant emission inventory guidebook 2016* was required, together with foliar biomass estimates (D), and estimates of growing seasons.

Integrated environmental correction factors (ɣ)

Table A2. 1. Country average values of integrated environmental correction factors, ɣ -iso and ɣ -mts for 6- and 12-month growing seasons (unit= hours

Integrated correction factor				
Growing season	[ɣ -mts] = [ɣ -ovoc]		[ɣ -iso]	
	6-month	12-month	6-month	12-month
Poland	736	912	558	669

Foliar biomass densities

For the simpler methodology, seasonal average foliar biomass densities were used. Default values are suggested below and in section 8 of the chapter 11.C of the *EMEP/EEA air pollutant emission inventory guidebook 2016.*

Table A2. 2. Default foliar biomass densities; broadleaf species

Land use type	**Foliar biomass density, D (gm^{-2})**
Deciduous oaks	320
Birch (*Betula*)	320
Poplar, aspen (*Populus*)	320
Default deciduous, broadleaved	300
Evergreen, broadleaved	500

Table A2. 3. Default foliar biomass densities; coniferous species

Land use type	**Foliar biomass density, D (gm^{-2})**
Norway spruce *(Picea abies) < 55˚N latitude*	1600
Scots pine *(Pinus sylvestris) < 60˚N latitude*	700
Other *Pinus ssp*.	700
Abies ssp.	1400
Douglas fir *(Pseutotsuga menziessi)*	1000
Larch *(Larix)*	300
Other coniferous	1000

Standard emission potentials (ε)

Emission potentials (ε) were required separately for isoprene, monoterpenes and OVOC. Furthermore, for monoterpenes, two classes of behaviour were distinguished. For most trees, emissions are temperature-only dependant, controlled by the ɣ-mts environmental factor. Standard emission (ɣ) potentials have been applied separately for isoprene, terpenes, and OVOC, and this division represents the most important level of speciation. However, there are many species represented within the class of terpenes and OVOC covering a wide range of chemical behaviour.

Table A2. 4. Standard emission potentials (µg g-1h-1 at 30°C and PAR=1 000 µmol m-2 s-1) for European trees

Common name	**Latin name**	**Iso. Terpenes**			**O-VOC**
		ε-iso	**ε-mtl**	**ε-mts**	
Fir	*Abies*	0	0	3	1.5
Common alder	*Alnus*	0	0	1.5	1.5
Birch	*Betula*	0	0	0.2	1.5
Hornbeam	*Carpinus*	0	0	0.65	1.5
European beech	*Fagus*	0	0	0.65	1.5
Ash	*Fraxinus*	0	0	0	1.5
European larch	*Larix*	0	0	1.5	1.5
Spruce	*Picea sp.*	1	1.5	1.5	1.5
Scots pine	Scots pine	0	0	1.5	1.5
Poplar	*Populus*	60	0	0	1.5
Cherry	*Prunus*	0	0	0	1.5
Douglas Fir	*Pseudotsuga*	0	0	1.5	1.5
European oak	*Quercus robur*	60	0	0.2	1.5

Activity data and emission factors applied

The inventory incorporates default data on foliar biomass densities that became available in the last years for the main tree species in Poland. Furthermore, default bioclimatic correction factor was introduced to correct the foliar biomass densities of trees for the different plant growth conditions.

It shall be noted that accurate estimates of foliar biomass are important for quantifying BVOC in forest ecosystems, but they are not reported either on regional or national inventories. Therefore the amount and composition of plant species that cover the land surface which are the primary control on the type and magnitude of biogenic volatile organic compound (BVOC) flux were attributed to the available country specific plant species distribution. In this specific case foliar biomass densities values could only be applied when the area of the tree species by single species has been provided. Since the commercial forestry is at least well documented in Poland we were able to obtain relevant information from the in-country forest inventories.

Table A2. 5. Major tree species area distribution in 2016 (as of 31 December 2016)

Inventory year	**2016**
Common name	**[kha]**
Scots pine	5355
Spruce	567
Fir	287
Other	106
Coniferous	6315
Beech	544
Oak	708
Hornbeam	150
Birch	669
Common alder	525
Poplar	78
Other	226
Broadleaved	2900
Total	9215

Data source: *Statistical Yearbook: "Forestry 2017"; Table 5. "Forest area by species structure and age class of tree stands"; CSO 2017.*

Uncertainty estimates

The identification and quantification of OVOC emissions from plants has proven one of the most difficult problems in evaluating total biogenic emissions. OVOC consists of a wide variety of compounds, many of which have been difficult to measure. With the limited screening studies available, it has been assumed to use the recommended emission rate of 1.5 µg g^{-1} h_{-1} is associated with a 10-fold range (0.5–5 µg g^{-1} h^{-1}) in possible emissions as the most appropriate.

Assessment of the uncertainties inherent in calculations of biogenic VOC emissions in Europe is rather difficult. It has been recognised that the minimum level of uncertainty in global biogenic emission estimates is a factor of three (Guenther et al., 1995[1]), but this is likely to represent a lower limit for the accuracy of European emission estimates. Furthermore, this figure relates to estimates of annual emissions. Uncertainties for episodic calculations must obviously be substantially greater.

[1] Guenther A., Hewitt C.N., Erickson D., Fall R., Geron C., Graedel T., Harley P., Klinger L., Lerdau M., McKay W.A., Pierce T., Scholes R., Steinbrecher R., Tallamraju R., Taylor J. and Zimmerman P. , 1995. 'A global model of natural volatile organic compound emissions', Journal of Geophysical Research, 100, No D5, pp. 8873–8892.

Further/planned improvements

The emission factors and knowledge of land-use within each region are certainly the weakest aspects. The emission factors can only be improved with more measurements. Collection of this land-use data is of the greatest priority. Other wooded land is a common category where definitions are more problematic. For a given inventory it is actually most important to specify the correct foliar biomass density to accompany any given area of vegetation.

ANNEX 3. ASSESSMENT OF COMPLETENESS

In 2019 submission there is a larger scope of NFR categories and pollutants marked as 'NE' than reported in 2018. It is due to the recommendations from 2018 Review to change NA key (from the last submission) for NE key or insert NE key if there is no appropriate emission factor in the EEA/EMEP Emission Inventory Guidebook.

In Table A3. 1 there are listed categories for which reliable activity data have not been gathered yet or the estimation methodology is still under verification. All other instances of NE keys in the inventory are due to the lack of appropriate emission factor in the 2016 EEA/EMEP Emission Inventory Guidebook.

Table A3. 1. Not estimated air pollutant emissions (notation key NE)

NFR code	NFR category	Substance(s)	Reason for not estimated
1B2c	Venting and flaring (oil, gas, combined oil and gas)	PM2.5, PM10, TSP,BC	methodology under verification
2A5c	Storage, handling and transport of mineral products	PM2.5, PM10, TSP	no activity available (storage area)
2B10b	Storage, handling and transport of chemical products	NOx, NMVOC, SOx,NH3,BC,CO,Pb,Cd,Hg, As,Cr,Cu,Ni,Zn,PCDD/PCDF, BaP, BbF, BkF, IP,HCB,PCBs	the lack of activity data and EFs
2C5	Lead production	HCB, PCBs	the activity data is under investigation
2C6	Zinc production	PCBs	the activity data is under investigation
2C7c	Other metal production (please specify in the IIR)	all	the activity data is under investigation
2C7d	Storage, handling and transport of metal products	PM2.5, PM10, TSP	no activity available (storage area)
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	Pb,Cd,Hg, As,Cr,Cu,Ni,Zn,HCB	the activity data is under investigation
3Da2c	Other organic fertilisers applied to soils (including compost)	NO_X,NH_3	No activity data is available
All		Se	Methodology under verification

For some air pollutants volumes of emissions have not been positioned in the original emission source category but included in other NFR sub-category (usually on a higher level of aggregation). It is caused by difficulties in appropriate disaggregation of activity data. Such cases have been listed in Table A3. 2.

Table A3. 2 Air pollutant emissions included in other sub-categories (notation key IE)

NFR code	Substance(s)	Included in NFR
1A2gvii	All	1A3b
1A4aii	All (excl. Se, PCDD/PCDF,HCB,PCBs)	1A3b
1A4bii	All (excl. Se,HCB,PCBs)	1A3b
1A5a	All (excl. Se,PCDD/PCDF, BaP, BbF, BkF, IP,HCB,PCBs)	1A4ai
1A5b	NOx, NH_3 ,PM2.5,PM10, TSP,BC,CO,Pb,Cd,Hg, As,Cr,Cu,Ni,Zn	1A3b
3B4giii	NOx, NH3, PM2.5,PM10, TSP	3B4giv
5C1bii	All (excl. Se)	1A1

Table A3. 3 Air pollutant emissions not occurring (notation key NO)

NFR code	NFR category	Substance(s)
1A3di(ii)	International inland waterways	NO_x,NMVOC,SOx,NH3, PM2.5,,CO,Pb,Cd,Hg,Cu
1B1c	Other fugitive emissions from solid fuels	Pb,Hg, As,Cr,Cu
1B2d	Other fugitive emissions from energy production	NMVOC,Pb,Cd,Hg,As,Cr,Cu,Ni
2B3	Adipic acid production	PM2.5,Pb
2J	Production of POPs	NOX,NMVOC,SOx,NH3,PM2.5,PM10,TSP,BC,CO,HCB,PCBs
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	PCBs
2C7b	Nickel production	All (excl. Se)
3B4a	Manure management - Buffalo	NO_x,NH_3,PM2.5,PM10, TSP
3B4f	Manure management - Mules and asses	NO_x,NH_3,PM2.5,PM10, TSP
3I	Agriculture other (please specify in the IIR)	All (excl. Se, BC)
5C1a	Municipal waste incineration	All (excl. Se)
5C2	Open burning of waste	NH_3,Hg

ANNEX 4. NATIONAL ENERGY BALANCE FOR 2017 IN EUROSTAT FORMAT

Original units	Hard coal	Patent fuels	Coke	Total lignite	Brown coal briquettes	Tar, benzol	Coke-oven gas	Blast-furn. gas	Gasworks gas and Other recovered gases	Total Derived Gas
			1000 t			1000 t	TJ (GCV)			
Primary production	65479,9			61160,7						
Primary production receipt										
Other sources (recovered products)	495,2									
Recycled products										
Imports	12866,1	14,2	209,3	327,8	28,6	2,2				
Stock change	2042,9	-0,5	94,7	-48,5	-0,2	-1,4				
Exports	7099,2	4,0	6494,1	256,2	1,6	361,1				
Bunke										
Direct use										
Gross inland consumption	**73784,9**	**9,7**	**-6190,1**	**61183,7**	**26,8**	**-360,4**				
Transformation input	**57318,8**		**1258,2**	**60526,3**	**0,4**		**23457,6**	**15883,8**	**1693,5**	**41034,8**
Conventional thermal power stations	39620,6			60485,8			22961,3	15883,8	1666,9	40512,0
Public thermal power stations	38431,9			60485,8			13256,4	15883,8	1359,5	30499,7
Autoprod. thermal power stations	1188,7						9704,9		307,3	10012,2
Nuclear power stations										
District heating plants	4812,5		0,4	40,5	0,4		496,2		26,6	522,9
Coke-oven plants	12516,6		92,6							
Blast-furnace plants	366,2		1007,6							
Gas works										
Refineries										
Patent fuel plants	2,8									
BKB/PB plants										
Charcoal production plants										
Coal liquefaction plants										
For blended natural gas										
Gas-To-Liquids (GTL) plants										
Non-specified Transformation Input			157,6							
Transformation output		**2,3**	**9418,1**			**372,0**	**76852,4**	**27164,4**	**3585,0**	**107601,8**
Conventional thermal power stations										
Public thermal power stations										
Autoprod. thermal power stations										
Nuclear power stations										
District heating plants										2537,1
Coke-oven plants			9418,1			372,0	76852,4			76852,4
Blast-furnace plants								27164,4	1047,9	28212,3
Gas works										
Refineries										
Patent fuel plants		2,3								
BKB/PB plants										
Charcoal production plants										
Non-specified Transformation Output									2537,1	
Exchanges and transfers, returns										
Interproduct transfers										
Products transferred										
Returns from petrochem. industry										
Consumption of the energy branch	**142,5**		**0,2**	**8,3**			**44776,2**			**44776,2**
Production and distribution of electricity	0,0		0,0	1,6			1,3			1,3
Pumped storage stations										
District heating plants	0,4		0,1							
Extraction and agglo. of solid fuels	29,8		0,0	6,8						
Coke-oven and gas works plants	78,4						44774,9			44774,9
Oil and Nat. Gat extraction plants										
Oil refineries	33,9									
Nuclear fuel fabrication plants										
Distribution losses										
Available for final consumption	**16323,6**	**12,0**	**1969,6**	**649,0**	**26,4**	**11,6**	**8618,6**	**11280,7**	**1891,5**	**21790,8**
Statistical difference	**-1304,9**		**-8,9**	**86,1**		**11,6**				
Final non-energy consumption	**115,2**		**0,0**							
Chemical industry	7,0									
Other sectors	108,1		0,0							
Final energy consumption	**17513,3**	**12,0**	**1978,5**	**563,0**	**26,4**		**8618,6**	**11280,7**	**1891,5**	**21790,8**
Industry	4803,9	0,3	1794,4	122,9	3,7		8618,6	11280,7	1891,5	21790,8
Iron & steel industry	69,7	0,0	1592,9				5534,1	11280,7	554,4	17369,2
Chemical industry	2136,4		53,4				692,0			692,0
Non-ferrous metal industry	3,6		41,9				95,2		1337,1	1432,3
Glass, pottery & building mat. industry	909,1	0,0	77,2	60,7			2155,4			2155,4
Transport equipment	15,6		0,0	0,0						
Machinery	54,9	0,1	2,3	0,0			4,6			4,6
Mining and Quarryig	17,3		0,8				137,4			137,4
Food, drink & tobacco industry	1008,7		25,9	0,3						
Paper and printing	384,3									
Wood and wood product	77,2									
Construction	24,3	0,0		56,7	3,7					
Textile, leather & clothing industry	14,2	0,0	0,0	4,7						
Not elsewhere specified (Industry)	88,5			0,5						
Transport										
Railways										
Road transport										
International aviation										
Domestic aviation										
Domestic navigation										
Pipeline transport										
Not elsewhere specified (Transport)										
Other sectors	12709,4	11,8	184,2	440,0	22,7				0,0	0,0
Commercial and public services	1029,4		25,2	30,0					0,0	0,0
Residential	10200,0		150,0	310,0						
Agriculture/Forestry	1479,9	11,8	9,0	100,0	22,7					
Fishing	0,1									
Not elsewhere specified (Other)	0,0									

Original units	Natural gas	Crude oil	Feedstock	Total pet. products	Refinery gas	LPG	Motor spirit	Kerosenes, jet fuels	Naphtha	Gas / diesel oil	Residual fuel oil	Other pet. products
	TJ (GCV)			1000 t						1000 t		
Primary production	163372,8	996,0	1,4									
Primary production receipt												
Other sources (recovered products)												
Recycled products				35,3								
Imports	606014,3	24647,8	665,4	9098,2		2488,3	455,2	3,2		5176,8	38,0	300,1
Stock change	-3664,2	-279,9		-324,4		2,1	-35,8	-0,8		-258,6	-17,7	-4,3
Exports	47231,7	219,5		5195,1		448,2	246,5	239,2	480,8	187,2	2471,1	312,2
Bunke				263,8						210,8	52,9	
Direct use												
Gross inland consumption	**718491,2**	**25144,3**	**666,8**	**3350,2**		**2042,2**	**172,9**	**-236,9**	**-480,8**	**4520,1**	**-2503,7**	**-16,5**
Transformation input	**120434,8**	**25139,3**	**1496,6**	**434,2**	**12,7**	**0,2**				**42,4**	**378,9**	
Conventional thermal power stations	83637,6			406,8	12,7					25,5	368,6	
Public thermal power stations	57732,1			128,2						23,8	104,4	
Autoprod. thermal power stations	25905,6			278,6	12,7					1,7	264,2	
Nuclear power stations												
District heating plants	9103,4			27,4		0,2				16,9	10,4	
Coke-oven plants												
Blast-furnace plants												
Gas works												
Refineries	27693,8	25139,3	1496,6									
Patent fuel plants												
BKB/PB plants												
Charcoal production plants												
Coal liquefaction plants												
For blended natural gas												
Gas-To-Liquids (GTL) plants												
Non-specified Transformation Input												
Transformation output				**26693,6**	**541,7**	**545,4**	**3946,0**	**1089,8**	**1935,2**	**11884,3**	**3435,9**	**1322,3**
Conventional thermal power stations												
Public thermal power stations												
Autoprod. thermal power stations												
Nuclear power stations												
District heating plants												
Coke-oven plants												
Blast-furnace plants												
Gas works												
Refineries				26693,6	541,7	545,4	3946,0	1089,8	1935,2	11884,3	3435,9	1322,3
Patent fuel plants												
BKB/PB plants												
Charcoal production plants												
Non-specified Transformation Output												
Exchanges and transfers, returns			**829,8**	**-829,8**	**-77,9**	**-38,1**			**-385,4**	**-52,5**		**-218,2**
Interproduct transfers												
Products transferred			119,5	-119,5		-1,8				-41,5		-18,4
Returns from petrochem. industry			710,3	-710,3	-77,9	-36,3			-385,4	-11,0		-199,8
Consumption of the energy branch	**66489,9**			**755,4**	**235,0**	**6,4**	**0,8**	**0,0**		**31,2**	**449,1**	**27,6**
Production and distribution of electricity	58,6			6,0		0,0	0,6	0,0		4,0	0,4	0,0
Pumped storage stations												
District heating plants	13,8			0,9		0,0	0,1			0,8		
Extraction and agglo. of solid fuels	444,5			22,0		0,0	0,0	0,0		17,5		0,6
Coke-oven and gas works plants	2548,1			0,3			0,0			0,0		
Oil and Nat. Gat extraction plants	14711,8			9,1		0,2	0,1			8,7		0,0
Oil refineries	48713,1			717,0	235,0	6,2	0,0			0,2	448,7	27,0
Nuclear fuel fabrication plants												
Distribution losses	**582,8**											
Available for final consumption	**530983,7**	**5,0**	**0,0**	**28024,4**	**216,1**	**2542,9**	**4118,1**	**852,9**	**1069,0**	**16278,4**	**104,1**	**1060,1**
Statistical difference	**2288,6**	**5,0**	**0,0**	**2,7**		**-80,6**					**9,3**	**73,9**
Final non-energy consumption	**101387,9**			**3882,1**		**100,6**		**0,0**	**1069,0**			**983,8**
Chemical industry	101387,9			2013,8		100,6		0,0	1069,0			833,1
Other sectors				1868,2								150,7
Final energy consumption	**427307,1**	**0,0**		**24139,6**	**216,1**	**2522,9**	**4118,1**	**852,9**		**16278,4**	**94,8**	**2,4**
Industry	171406,1			711,1	216,1	77,9	6,3	0,6		273,9	79,8	2,4
Iron & steel industry	26350,3			5,9		1,0	0,1			3,0		0,0
Chemical industry	14467,1			272,1	216,1	6,5	0,2	0,0		40,6	8,7	
Non-ferrous metal industry	8393,7			16,5		0,6	0,0	0,0		4,3	11,6	
Glass, pottery & building mat. industry	49527,3			90,3		8,0	0,8	0,0		24,0	5,3	0,0
Transport equipment	5032,0			14,9		3,3	0,5	0,4		10,6	0,0	0,1
Machinery	10848,8			30,2		10,1	1,8	0,1		17,2	0,5	0,5
Mining and Quarryig	1779,1			72,4		3,2	0,2	0,0		67,7	0,0	1,3
Food, drink & tobacco industry	33270,0			78,6		26,0	0,4	0,0		34,3	18,0	0,0
Paper and printing	9676,5			42,7		2,3	0,5	0,0		13,3	26,4	0,1
Wood and wood product	2084,1			13,4		3,0	0,1	0,0		7,6	2,8	0,0
Construction	1603,1			45,9		2,7	1,3	0,0		36,3	5,1	0,4
Textile, leather & clothing industry	1918,3			5,8		1,1	0,0			4,3	0,5	
Not elsewhere specified (Industry)	6455,8			22,2		10,1	0,4			10,8	0,9	0,0
Transport	17793,2			20327,6		1831,5	4110,9	851,6		13533,6		
Railways				84,1						84,1		
Road transport	517,9			19383,1		1831,5	4107,5			13444,0		
International aviation				828,2				828,2				
Domestic aviation				26,7			3,3	23,4				
Domestic navigation				4,6						4,6		
Pipeline transport	17275,3			1,0			0,0			1,0		
Not elsewhere specified (Transport)												
Other sectors	238107,8	0,0		3100,9		613,5	0,9	0,7		2470,9	15,0	0,0
Commercial and public services	67562,2	0,0		423,0		71,5	0,0	0,7		350,9	0,0	0,0
Residential	168857,8			550,0		480,0				70,0		
Agriculture/Forestry	1687,8			2127,9		62,0	0,9			2050,0	15,0	
Fishing												
Not elsewhere specified (Other)	0,0											

Original units	White spirit	Lubricants	Bitumen	Petroleum coke	Nuclear heat	Total Renewables	Solar heat	Geothermal heat	Biomass	Wood	MSW	Biogas, biofuels
	1000 t				TJ	TJ						
Primary production						332851,6	2280,5	945,5	311991,5	257952,3	3870,8	50168,4
Primary production receipt												
Other sources (recovered products)		35,3										
Recycled products												
Imports	33,8	239,6	306,4	56,8		31819,6			31819,6	16581,0		15238,6
Stock change	-3,4	-10,3	7,2	-2,7		-110,3			-110,3			-110,3
Exports	49,5	418,1	342,3			39297,7			39297,7	11150,7		28147,0
Bunke												
Direct use												
Gross inland consumption	**-19,0**	**-153,6**	**-28,6**	**54,1**		**325263,1**	**2280,5**	**945,5**	**304403,0**	**263382,6**	**3870,8**	**37149,7**
Transformation input						**66111,8**			**66111,8**	**56413,9**	**1419,8**	**8278,2**
Conventional thermal power stations						63328,6			63328,6	53653,8	1413,7	8261,1
Public thermal power stations						45540,1			45540,1	40289,7	44,6	5205,7
Autoprod. thermal power stations						17788,5			17788,5	13364,1	1369,0	3055,4
Nuclear power stations												
District heating plants						2783,2			2783,2	2760,0	6,1	17,1
Coke-oven plants												
Blast-furnace plants												
Gas works												
Refineries												
Patent fuel plants												
BKB/PB plants												
Charcoal production plants												
Coal liquefaction plants												
For blended natural gas												
Gas-To-Liquids (GTL) plants												
Non-specified Transformation Input												
Transformation output	**88,5**	**452,1**	**1452,3**									
Conventional thermal power stations												
Public thermal power stations												
Autoprod. thermal power stations												
Nuclear power stations												
District heating plants												
Coke-oven plants												
Blast-furnace plants												
Gas works												
Refineries	88,5	452,1	1452,3									
Patent fuel plants												
BKB/PB plants												
Charcoal production plants												
Non-specified Transformation Output												
Exchanges and transfers, returns		**-57,8**				**-17634,1**						
Interproduct transfers												
Products transferred		-57,8				-17634,1						
Returns from petrochem. industry												
Consumption of the energy branch	**0,0**	**5,2**				**48,7**			**48,7**	**14,6**		**34,1**
Production and distribution of electricity	0,0	1,0										
Pumped storage stations												
District heating plants	0,0	0,1				8,5			8,5			8,5
Extraction and agglo. of solid fuels	0,0	3,9				14,6			14,6	14,6		
Coke-oven and gas works plants	0,0	0,2				25,6			25,6			25,6
Oil and Nat. Gat extraction plants		0,1										
Oil refineries												
Nuclear fuel fabrication plants												
Distribution losses												
Available for final consumption	**69,5**	**235,5**	**1423,7**	**54,1**		**241468,5**	**2280,5**	**945,5**	**238242,5**	**206954,1**	**2451,0**	**28837,4**
Statistical difference												
Final non-energy consumption	**69,5**	**235,5**	**1423,7**									
Chemical industry	7,5	3,5										
Other sectors	62,0	231,9	1423,7									
Final energy consumption				**54,1**		**241468,5**	**2280,5**	**945,5**	**238242,5**	**206954,1**	**2451,0**	**28837,4**
Industry				54,1		70983,7			70983,7	67949,9	2410,9	622,9
Iron & steel industry				1,9		0,9			0,9	0,9		
Chemical industry						117,4			117,4	98,8		18,6
Non-ferrous metal industry												
Glass, pottery & building mat. industry				52,2		2617,3			2617,3	176,0	2410,9	30,4
Transport equipment						4,5			4,5	4,5		
Machinery						87,4			87,4	87,4		
Mining and Quarryig						4,9			4,9	4,9		
Food, drink & tobacco industry						1494,1			1494,1	1072,5		421,6
Paper and printing						33880,8			33880,8	33741,9		138,9
Wood and wood product						28019,5			28019,5	28019,5		
Construction						7,5			7,5	7,5		
Textile, leather & clothing industry						7,5			7,5	7,5		
Not elsewhere specified (Industry)						4741,9			4741,9	4728,5		13,4
Transport						25323,5			25323,5			25323,5
Railways												
Road transport						25323,5			25323,5			25323,5
International aviation												
Domestic aviation												
Domestic navigation												
Pipeline transport												
Not elsewhere specified (Transport)												
Other sectors				0,0		145161,3	2280,5	945,5	141935,3	139004,2	40,1	2891,0
Commercial and public services				0,0		11045,2	247,5	233,8	10564,0	8002,8	40,1	2521,1
Residential						112469,7	2033,0	711,7	109725,0	109725,0		
Agriculture/Forestry						21646,3			21646,3	21276,4		369,9
Fishing												
Not elsewhere specified (Other)									0,0			0,0

Original units	Wind energy	Hydro energy	Other fuels	Derived heat	Electrical energy
	GWh		TJ		GWh
Primary production	15074,5	2559,6	36621,1		
Primary production receipt					
Other sources (recovered products)				743,2	
Recycled products					
Imports					13271,0
Stock change					
Exports					10984,0
Bunke					
Direct use					
Gross inland consumption	**15074,5**	**2559,6**	**36621,1**	**743,2**	**2287,0**
Transformation input			**6159,1**	**692,9**	
Conventional thermal power stations			5560,5	692,9	
Public thermal power stations			5,4		
Autoprod. thermal power stations			5555,1	692,9	
Nuclear power stations					
District heating plants			598,6		
Coke-oven plants					
Blast-furnace plants					
Gas works					
Refineries					
Patent fuel plants					
BKB/PB plants					
Charcoal production plants					
Coal liquefaction plants					
For blended natural gas					
Gas-To-Liquids (GTL) plants					
Non-specified Transformation Input					
Transformation output				**299015,7**	**152356,9**
Conventional thermal power stations				196618,5	152356,9
Public thermal power stations				180758,8	140614,2
Autoprod. thermal power stations				15859,7	11742,8
Nuclear power stations					
District heating plants				102397,2	
Coke-oven plants					
Blast-furnace plants					
Gas works					
Refineries					
Patent fuel plants					
BKB/PB plants					
Charcoal production plants					
Non-specified Transformation Output					
Exchanges and transfers, returns	**-15074,5**	**-2559,6**			**17634,1**
Interproduct transfers					
Products transferred	-15074,5	-2559,6			17634,1
Returns from petrochem. industry					
Consumption of the energy branch			**5,9**	**26044,2**	**26474,0**
Production and distribution of electricity			1,0	16276,6	17239,7
Pumped storage stations					260,6
District heating plants				5189,5	1137,8
Extraction and agglo. of solid fuels			2,1	3512,2	5278,6
Coke-oven and gas works plants			2,8	733,4	815,6
Oil and Nat. Gat extraction plants				0,1	162,7
Oil refineries				332,5	1579,0
Nuclear fuel fabrication plants					
Distribution losses				**28195,3**	**9996,0**
Available for final consumption			**30456,1**	**244826,4**	**135808,1**
Statistical difference					**0,0**
Final non-energy consumption					
Chemical industry					
Other sectors					
Final energy consumption			**30456,1**	**244826,4**	**135808,1**
Industry			30020,3	30220,9	54543,2
Iron & steel industry				3905,5	6808,4
Chemical industry			1493,9	5379,0	8733,7
Non-ferrous metal industry				1251,9	2339,7
Glass, pottery & building mat. industry			28126,4	1011,1	5483,4
Transport equipment			0,2	1952,6	2928,2
Machinery			5,5	2651,9	4804,0
Mining and Quarryig			66,4	2788,7	2763,0
Food, drink & tobacco industry			0,0	2968,9	6758,8
Paper and printing			294,7	3296,2	4665,5
Wood and wood product				2963,0	2400,4
Construction			0,2	350,9	903,0
Textile, leather & clothing industry				522,9	606,2
Not elsewhere specified (Industry)			32,8	1178,5	5348,7
Transport					3326,0
Railways					3064,8
Road transport					26,5
International aviation					
Domestic aviation					
Domestic navigation					
Pipeline transport					234,6
Not elsewhere specified (Transport)					
Other sectors			435,9	214605,5	77938,9
Commercial and public services			435,9	49705,5	47038,9
Residential				164000,0	29181,0
Agriculture/Forestry				900,0	1715,9
Fishing					3,1
Not elsewhere specified (Other)					0,0

ANNEX 5. ACTIVITY DATA

Table A5. 1. Fuel consumption [TJ] in 1.A.1.a category - Public power SNAP 0101

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	908 174	879 953	855 928	842 875	859 577	899 258	934 573	921 518	892 435	885 198	907 060	900 562	879 153	917 776
Lignite	550 804	557 422	545 139	548 823	537 834	528 123	531 967	529 899	534 764	520 692	504 805	511 871	494 449	518 326
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	270	268	279	276	257	333	1 733	1 803	2 082	5 949	10 399	14 430	22 928	28 959
Fuel wood and wood waste	6		4	8	11	3	1 162	1 150	1 384	1 259	1 301	1 217	1 134	2 008
Biogas						1	11	28	23	22	27	12	18	18
Industrial wastes	167	1 477	1 173	507	248	468	155	229			511	653	1 210	17
Municipal waste - non-biogenic fraction											4			
Municipal waste – biogenic fraction											4	1		
Other petroleum products											40			
Petroleum coke														
Coke	86	142	114	256	684	627	114	57	57	28	28	28		
Liquid petroleum gas (LPG)									46					
Motor gasoline	45	45	45	90	179	134		45	45	45	45	45	45	
Jet kerosene														
Diesel oil														
Fuel oil	430	472	472	472	772	944	558	516	387	473	600	514	686	558
Light fuel oil	7 040	7 360	6 280	6 400	7 240	6 680	6 840	7 320	7 640	7 400	7 120	7 040	6 680	6 400
Feedstocks														
Refinery gas														
Petroleum coke oven gas	8	6	1		239	2 614	5 571	7 186	8 841	9 255	9 354	9 448	8 508	9 199
Blast furnace gas														
Gas works gas		5							219	82	11	28	21	

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	930 264	917 143	970 093	978 059	915 594	882 870	926 086	911 353	837 871	845 778	781 505	797 519	815 796	808 379
Lignite	514 306	533 690	525 529	502 046	522 436	494 456	478 308	518 202	527 410	539 384	513 194	507 638	484 540	496 534
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	36 403	40 048	36 167	36 907	38 844	39 448	38 062	41 348	42 713	31 498	32 459	42 039	47 074	52 024
Fuel wood and wood waste	3 841	9 643	13 440	17 527	30 448	46 544	55 096	65 643	92 948	73 314	84 159	81 982	59 860	40 290
Biogas	73	33	33	43	17	3							4 391	5 214
Industrial wastes	4						1			1	1		1	1
Municipal waste - non-biogenic fraction											29		19	
Municipal waste – biogenic fraction													2	45
Other petroleum products								30	31					0
Petroleum coke														
Coke														4
Liquid petroleum gas (LPG)														2
Motor gasoline														28
Jet kerosene														
Diesel oil														0
Fuel oil	386	429	472	386	644	779	692	1 517	736	779	736	1 290	817	1 231
Light fuel oil	6 640	6 200	6 000	5 800	6 480	5 600	6 080	6 160	5 280	5 200	4 200	4 360	4 240	4 189
Feedstocks														
Refinery gas														
Petroleum coke oven gas	8 929	7 637	9 424	10 653	10 764	8 439	12 049	11 001	9 904	11 696	11 609	12 306	11 993	11 932
Blast furnace gas					7 595	5 787	8 316	9 166	8 740	8 689	11 257	16 242	14 630	15 884
Gas works gas					3 775	4 249	4 379	4 772	4 809	4 955	4 745	4 331	3 162	1 360

Table A5. 2. Fuel consumption [TJ] in 1.A.1.a category – Industrial power SNAP 0301

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	310 328	293 377	279 161	273 625	247 872	80 485	76 263	74 315	67 850	65 730	57 975	58 314	61 537	79 319
Lignite	1 431	1 260	1 004	1 089	1 095	417	500	296	82	39	19			
Hard coal briquettes (patent fuels)													29	
Brown coal briquettes														
Crude oil														
Natural gas	2 705	2 087	1 639	2 081	2 733	2 537	1 860	1 034	2 070	2 271	2 187	2 709	3 804	4 658
Fuel wood and wood waste	10 408	11 105	13 041	13 323	13 749	924	1 219	1 499	1 789	1 614	1 628	3 058	2 878	2 742
Biogas						117	130	81	169	300	396	532	609	823
Industrial wastes	5 005	7 378	5 887	6 103	6 404	3 246	3 144	2 902	267	267	375	379	301	305
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke		28											57	
Liquid petroleum gas (LPG)														
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	129	129	129	86	129	43		86	43	43	43	43	43	86
Light fuel oil	43 480	39 400	38 560	40 000	40 560	10 200	9 640	10 880	3 000	3 280	2 400	2 000	2 080	1 520
Feedstocks														
Refinery gas	990	742	644	842	1 238	50								
Petroleum coke oven gas	5 296	5 586	7 154	7 715	11 999	9 309	7 515	8 367	3 975	5 908	6 779	6 710	7 160	7 821
Blast furnace gas	19 916	11 170	12 107	10 099	13 023	5 854	2 976	2 902	2 602	3 036	4 143	4 904	4 783	5 715
Gas works gas									3 041	2 425	2 344	2 290	3 088	2 589

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	65 180	68 898	69 064	55 542	30 298	29 451	31 099	31 253	31 230	32 262	33 051	30 939	28 078	26 626
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	4 691	4 915	4 385	2 544	1 750	1 554	2 831	6 612	9 247	11 152	10 528	9 693	14 998	23 315
Fuel wood and wood waste	3 606	5 922	5 357	5 943	5 451	6 390	8 432	11 297	11 060	12 462	11 118	12 181	11 764	13 364
Biogas	469	539	924	1 139	2 004	2 172	2 763	3 312	4 204	4 872	5 718	6 298	2 856	3 010
Industrial wastes	399	533	453	422	192	314	354	344	292	292	377	601	366	477
Municipal waste - non-biogenic fraction					384	368	367	403	371	337	208	727	3 615	5 078
Municipal waste – biogenic fraction													323	1 369
Other petroleum products														
Petroleum coke														
Coke						28								
Liquid petroleum gas (LPG)														
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	43												43	71
Light fuel oil	1 880	1 120	1 040	960	80	320	400	240	160	80	80	80	40	27
Feedstocks														
Refinery gas														
Petroleum coke oven gas	3 310	3 576	4 833	5 366	6 000	4 419	6 159	5 164	5 676	5 776	5 785	8 175	10 414	8 734
Blast furnace gas	7 036	4 484	8 677	6 395	2 609	1 943	1 638	1 835	2 588	3 040	2 680			
Gas works gas	3 640	4 750	4 815	4 404	687	541	647	560	393	292	312	377	326	307

Table A5. 3. Fuel consumption [TJ] in 1.A.1.a category - District heating plants SNAP 0102

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	385 339	403 578	372 244	250 756	214 596	230 966	259 833	227 883	198 459	177 661	155 463	171 164	153 122	149 953
Lignite	3 352	2 820	2 480	848	348	584	610	475	394	347	337	357	310	301
Hard coal briquettes (patent fuels)	2 520	322	117	59	59			59						
Brown coal briquettes	140	60	200											
Crude oil														
Natural gas	18 676	13 989	7 672	824	1 221	2 098	3 636	5 225	6 684	8 062	9 104	11 269	12 306	12 532
Fuel wood and wood waste	4 163	3 279	4 224	460	302	398	278	647	503	528	535	647	805	1 056
Biogas	14	3	24		6	8	7	7	35	49	47	31	6	20
Industrial wastes	93	59	294	50	226	164	95	136	283	308	5	7	14	63
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	12 626	12 939	10 944	8 864	7 524	7 239	6 954	5 301	4 076	2 850	1 995	1 710	1 197	912
Liquid petroleum gas (LPG)								46	184	230	184	184	184	46
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	343	343	300	214	172	214	1 072	1 459	1 416	1 416	1 716	1 802	1 888	1 759
Light fuel oil	14 880	14 560	11 640	9 040	8 040	9 080	11 400	9 160	7 480	6 200	4 400	5 720	4 800	4 240
Feedstocks														
Refinery gas														
Petroleum coke oven gas	1 825	1 966	1 708	429	909	907	889	897	881	914	965	1 066	780	1 025
Blast furnace gas	2 461	1 627	1 271	140	167	51	242	404	458	250	174	72		
Gas works gas	167	129	335	85	37	21	4	2	2	2	35	20		3

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	132 073	127 145	125 991	117 619	115 567	121 962	138 920	112 477	121 134	115 726	105 605	99 447	105 861	109 909
Lignite	290	289	289	273	284	291	311	259	386	301	258	364	370	436
Hard coal briquettes (patent fuels)														
Brown coal briquettes														6
Crude oil														
Natural gas	13 023	12 300	12 474	10 353	10 673	10 733	11 560	10 140	10 087	10 768	9 055	8 728	8 534	8 193
Fuel wood and wood waste	1 470	1 665	1 796	1 697	2 097	1 936	1 878	1 772	1 685	1 995	1 712	1 494	2 433	2 760
Biogas		1	2	4	21	27	15	16	15	15	14	16	16	16
Industrial wastes	56	8	24	18	17		88	114	128	89	93	92	179	145
Municipal waste - non-biogenic fraction											106	132	199	
Municipal waste – biogenic fraction											16	9	6	6
Other petroleum products							60		31					
Petroleum coke														
Coke	598	342	171	142	86	28	57	28	28	28	28			11
Liquid petroleum gas (LPG)														8
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	1 330	1 072	1 030	601	515	476	563	390	390	433	433	387	516	725
Light fuel oil	1 600	1 080	1 040	720	880	800	960	640	920	320	320	280	360	415
Feedstocks														
Refinery gas														
Petroleum coke oven gas	280	314	286	10	8	265	417	478	415	398	397	403	415	447
Blast furnace gas	17	5												
Gas works gas	54	56	61	59	40	38	46	25		60	12	15	22	27

Table A5. 4. Fuel consumption [TJ] in 1.A.1.b category - Petroleum refining SNAP 0103

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	46	90	69	245	68	1 302	1 451	1 349	629	586	208	70	23	
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	1 671	1 539	1 508	1 608	1 591	1 562	1 749	2 529	8 244	10 832	12 110	11 354	10 124	12 770
Fuel wood and wood waste														
Biogas														
Industrial wastes	5 222	272	682	2	259	1 919	350	163		310	219	95	253	176
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products							520	1 080	880	1 720		40	40	40
Petroleum coke														
Coke		28												
Liquid petroleum gas (LPG)								46	92	184	276		46	92
Motor gasoline										90	135			135
Jet kerosene														
Diesel oil														
Fuel oil	43	43		86	86	172	172	214	343	86	1 373	386	858	343
Light fuel oil	11 440	10 560	15 760	12 800	11 960	32 400	40 520	32 200	39 840	35 080	36 160	42 280	42 560	43 520
Feedstocks														
Refinery gas	7 474	7 623	8 514	9 256	10 444	12 028	8 960	10 197	6 286	6 386	9 058	10 444	10 048	10 048
Petroleum coke oven gas									81	51	69	70		
Blast furnace gas														
Gas works gas														

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal						113	114	114	91	113	158	916	819	767
Lignite								50	22	63	23	11		
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	15 535	14 482	14 900	20 816	18 816	17 511	19 363	27 468	30 638	34 779	35 103	25 957	25 802	43 842
Fuel wood and wood waste														
Biogas														
Industrial wastes	221	285	224											2
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products	360	320	440	360	672	986	450	660	1 271	992	960	785	1 074	1 079
Petroleum coke														
Coke														
Liquid petroleum gas (LPG)								92	92	92	138	644	828	285
Motor gasoline														0
Jet kerosene														
Diesel oil		43												
Fuel oil	987	300	729	172	429	216	130	173	130	43	87	43		9
Light fuel oil	43 000	42 560	41 720	44 080	43 560	44 160	46 560	39 280	31 400	22 200	21 640	33 760	33 480	28 476
Feedstocks														
Refinery gas	11 632	10 692	12 969	16 582	17 424	15 246	22 869	21 532	28 215	20 988	15 444	18 909	21 830	11 627
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A5. 5. Fuel consumption [TJ] in 1.A.1.c category - Manufacture of solid fuels SNAP 0104

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	91	68	46	803	2 156	1 302	1 705	280	70	23			47	70
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas			181	269	462	518	398	570	744	540	424	253	65	10
Fuel wood and wood waste														
Biogas														
Industrial wastes					233	184	126	138						
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	448	280	28	86	456	170	398	56						114
Liquid petroleum gas (LPG)	92	92	92	46	46	46	46							
Motor gasoline				45	90	90	45	45						
Jet kerosene														
Diesel oil														
Fuel oil			43	1 158	1 158	858	815	686	343	43	86			
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	43 553	38 485	39 121	34 084	40 237	36 851	34 676	36 572	33 476	29 642	32 403	32 647	31 702	35 822
Blast furnace gas	3 961	1 995	1 430	2 123	2 488	1 954	1 582	1 893	1 695	847	840	149	86	21
Gas works gas	5	47	10	4		6	36	19	165	166	4	4	4	4

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	4 488	2 768	2 456	2 494	1 841	2 183	327	1 919	1 845	1 597	1 884	1 894	2 483	2 321
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas				4	6	8	14	3	3	3	2	2	2	1 154
Fuel wood and wood waste														
Biogas													6	26
Industrial wastes								9				1	2	
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	57	28		28	598			57						
Liquid petroleum gas (LPG)						46								
Motor gasoline														0
Jet kerosene														
Diesel oil														
Fuel oil														1
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	40 686	35 560	40 008	43 584	44 646	32 390	43 511	41 007	38 516	40 094	40 177	42 278	40 522	40 297
Blast furnace gas	30	42	45	37										
Gas works gas	4	3	4	5	6	12	12	9	12	8	1			

Table A5. 6. Fuel consumption [TJ] in 1.A.1.c category - other energy industries SNAP 0105

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	3 734	5 380	3 355	20 145	50 783	51 745	54 961	53 298	50 142	42 347	32 313	29 904	14 897	17 269
Lignite	78	132	73	313	303	336	370	324	286	276	258	298	279	248
Hard coal briquettes (patent fuels)	29													
Brown coal briquettes	20	20		40	20	20	40	40	20	20	20			
Crude oil							80	82	83	83	41		41	128
Natural gas	12 361	12 417	14 455	12 011	16 822	14 102	22 798	20 472	16 967	18 846	19 004	12 567	12 112	9 078
Fuel wood and wood waste										2	3	3	21	1
Biogas														
Industrial wastes				309			31				2			
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products							80	80	40	80	40		40	40
Petroleum coke														
Coke	86	116	142	171	86	87	86	29	29		143			
Liquid petroleum gas (LPG)										46				
Motor gasoline	45	45	45	45	45	45	45							
Jet kerosene														
Diesel oil														
Fuel oil	1 544	1 802	1 888	2 917	1 716	2 059	1 973	1 759	1 587	1 415	1 330	1 287	944	1 029
Light fuel oil					40	40								
Feedstocks														
Refinery gas														
Petroleum coke oven gas				520	252	185	429	428	233	230	228	320	298	260
Blast furnace gas														
Gas works gas		128		116			25							

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	11 508	8 668	7 751	14 894	11 582	6 578	1 734	2 410	614	587	566	893	865	800
Lignite	221	175	204	201	224	209	291	223	246	221	260	102	77	58
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil	126													
Natural gas	10 700	9 942	10 214	9 563	9 129	8 767	10 140	9 663	11 118	11 987	12 761	24 053	17 787	14 779
Fuel wood and wood waste			1	1		87	57	39	52	45	39		26	15
Biogas														
Industrial wastes							1	1	1	1	1	1	2	20
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products	40	80	40	40	32	29	30	30	31	32				25
Petroleum coke														
Coke					58									1
Liquid petroleum gas (LPG)			46	46										9
Motor gasoline														5
Jet kerosene														
Diesel oil														1
Fuel oil	901	1 030	944	987	1 029	1 213	1 256	1 212	1 169	1 516	1 126	1 419	1 204	1 127
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	226	155	116	133	136	126	142	144	135	123	119	106	108	
Blast furnace gas														
Gas works gas														

Table A5. 7. Fuel consumption [TJ] in 1.A.2.a category - Stationary combustion in manufacturing industries : Iron and steel

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	1 138	1 243	1 494	9 159	8 513	25 320	28 922	23 636	21 085	19 074	18 262	14 701	12 424	12 593
Lignite		19						9						
Hard coal briquettes (patent fuels)												29	29	29
Brown coal briquettes														
Crude oil														
Natural gas	52 851	33 974	26 568	25 562	25 487	24 239	25 898	28 278	23 993	21 440	22 024	18 328	15 463	14 827
Fuel wood and wood waste				16	14	5	6	4	6	4	3	6	3	4
Biogas														
Industrial wastes	4 079	6 756	6 497	4 272	3 757	2 941	498							
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	106 132	87 229	89 783	86 616	99 734	95 330	83 317	91 007	69 691	60 019	77 048	64 276	58 231	63 248
Liquid petroleum gas (LPG)								46		46	184	184	230	184
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	172	129	172	343	558	772	901	558	300	343	515	172	129	129
Light fuel oil	11 000	7 800	5 280	4 280	2 960	2 040	960	4 720	1 600	1 800	1 040	640		
Feedstocks														
Refinery gas														
Petroleum coke oven gas	26 038	22 090	22 568	21 604	25 480	27 686	24 404	24 257	24 742	15 875	17 574	16 994	15 122	16 132
Blast furnace gas	36 484	27 903	25 909	25 676	28 350	37 610	34 205	36 120	29 520	24 034	31 874	26 768	23 876	25 282
Gas works gas	2 174	1 462	718	613	67	68	80	58	7	8		277	706	1 195

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	16 840	10 744	9 071	11 747	3 950	4 784	3 592	4 871	8 276	6 177	7 913	8 754	9 001	12 785
Lignite														
Hard coal briquettes (patent fuels)			29						29					0
Brown coal briquettes														
Crude oil														
Natural gas	19 964	20 455	20 998	22 716	20 397	16 595	16 916	17 209	16 905	16 242	16 096	16 701	19 458	23 715
Fuel wood and wood waste	4	2	1	1	1	1				1	1	1	1	1
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														0
Petroleum coke								32	64	96	64	64	64	60
Coke	67 096	44 264	49 539	50 647	42 197	23 169	26 878	32 791	32 927	35 764	40 915	42 959	40 716	44 611
Liquid petroleum gas (LPG)	138				46	46	46	46	92	46	46	46	46	45
Motor gasoline														2
Jet kerosene														
Diesel oil														
Fuel oil	129	86	129	86	86	87	86	87	43	43	87	86	86	130
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	15 302	12 570	12 835	13 885	9 850	5 296	8 378	8 420	8 230	8 518	9 014	5 555	4 360	4 981
Blast furnace gas	26 721	18 896	20 226	28 194	18 347	9 873	12 059	11 258	11 352	10 797	11 863	10 228	10 528	11 281
Gas works gas	1 654	965	1 015	1 313	993	474	187	203	47	28	99	770	607	554

Table A5. 8. Fuel consumption [TJ] in 1.A.2.b category - Stationary combustion in manufacturing industries : Non-Ferrous Metals

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	455	565	850	1 916	1 771	4 172	4 285	3 907	3 331	3 117	3 108	3 790	2 560	2 115
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	4 599	4 633	1 213	1 745	5 321	5 447	5 108	5 424	5 638	5 660	5 814	5 700	5 589	5 868
Fuel wood and wood waste				1	1		149	42	26	10	11	5	1	
Biogas														
Industrial wastes	439	483	514	729	823	2 150	2 411	2 361						
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	6 014	5 216	2 280	2 793	6 412	6 327	6 612	6 584	6 384	5 928	6 070	6 156	6 156	5 928
Liquid petroleum gas (LPG)							46				46	92	46	46
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	43	43	129	86	129	172	214	214	257	172	257	172	172	129
Light fuel oil	760	800	800	760	800	720	680	640	520	560	560	520	400	320
Feedstocks														
Refinery gas														
Petroleum coke oven gas	397	178	186	43										
Blast furnace gas														
Gas works gas	42	6							2 164	2 070	2 268	2 551	2 739	2 539

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	1 092	24	24	570				250	114	113	91	23	68	82
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	6 402	6 464	6 880	6 740	6 537	5 846	6 039	6 670	6 890	6 703	6 950	7 225	7 226	7 554
Fuel wood and wood waste														
Biogas														
Industrial wastes							1						1	
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products	40													
Petroleum coke														
Coke	5 956	5 814	6 042	6 441	6 640	6 270	6 042	6 214	6 384	6 270	6 469	6 840	5 643	5 586
Liquid petroleum gas (LPG)	46	46	46	46	46	46	46	46						27
Motor gasoline														1
Jet kerosene														
Diesel oil														2
Fuel oil	172	172	172	172	172	173	216	173	173	173	173	129	172	183
Light fuel oil	400	400	400	160	160	160	120	120	120	120	80	120	240	463
Feedstocks														
Refinery gas														
Petroleum coke oven gas								39	43	39	51	47	53	86
Blast furnace gas														
Gas works gas	1 763	961	951	949	1 220	1 086	960	967	928	1 066	1 275	1 316	1 202	1 337

Table A5. 9. Fuel consumption [TJ] in 1.A.2.c category - Stationary combustion in manufacturing industries : Chemicals

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	7 216	6 623	4 550	13 125	7 945	70 221	71 191	63 913	54 992	50 522	50 115	48 485	45 458	27 959
Lignite	39	38	27	47	29	428	460	389	429	138				
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	5 289	4 340	4 432	10 075	4 507	6 356	6 191	11 024	9 408	9 041	9 464	8 481	7 199	6 457
Fuel wood and wood waste	118	39	10	3	35	7							1	153
Biogas									1					
Industrial wastes	16 712	18 586	17 039	18 003	22 591	21 546	17 374	14 356	672	582	607	618	567	875
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products							2 600	2 880	3 440	2 520	480	480	280	240
Petroleum coke														
Coke	2 679	1 966	1 852	1 881	1 938	3 477	2 964	1 454	1 539	1 624	1 596	1 710	1 738	1 568
Liquid petroleum gas (LPG)				46										
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	987	858	772	729	729	944	1 072	1 072	1 416	1 330	1 030	4 762	4 247	4 333
Light fuel oil	2 720	1 880	2 760	2 480	3 600	8 160	9 320	9 360	17 560	15 680	13 520	7 360	7 640	7 080
Feedstocks														
Refinery gas	396	3 465	5 445	4 455	198	1 584	6 584	9 652	18 513	19 602	23 314	20 542	20 740	21 830
Petroleum coke oven gas	701	522	440	1 548	276	729	784	140	174	130	50	150	285	634
Blast furnace gas	47	10	6	11	14	23	4	13	4	7	11	8	4	13
Gas works gas	7 216	6 623	4 550	13 125	7 945	70 221	71 191	63 913	54 992	50 522	50 115	48 485	45 458	27 959

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	26 665	27 446	25 398	26 780	43 781	42 011	47 304	47 704	46 768	47 308	46 501	42 588	44 158	45 822
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	7 494	8 061	9 009	8 754	7 950	9 707	11 807	13 887	13 568	14 696	14 500	14 860	12 068	13 020
Fuel wood and wood waste	94	153		121		58	58	53	131	50	103	88	138	99
Biogas											8	6	6	5
Industrial wastes	1 070	570	671	707	509	584	770	732	581	1 092	1 082	936	652	1 494
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products		40	40											
Petroleum coke														
Coke	1 881	1 454	2 964	1 938	1 168	884	826	1 340	3 164	3 021	2 992	3 164	3 506	1 495
Liquid petroleum gas (LPG)						92	138	138	138	184	138	230	276	300
Motor gasoline						90		45	45	45				8
Jet kerosene														
Diesel oil														0
Fuel oil	3 904	3 775	4 076	3 732	3 689	4 590	4 200	3 637	3 334	4 027	2 468	1 806	1 505	1 744
Light fuel oil	7 280	3 880	3 840	3 560	640	1 080	600	720	560	440	400	560	400	348
Feedstocks														
Refinery gas	22 424	18 266	21 334	22 473	19 156	20 889	17 176	12 276	9 702	11 979	10 296	7 722	8 019	10 695
Petroleum coke oven gas	606	608	547	658	654	483	627	616	595	639	645	624	598	623
Blast furnace gas	19	6												
Gas works gas	26 665	27 446	25 398	26 780	43 781	42 011	47 304	47 704	46 768	47 308	46 501	42 588	44 158	45 822

Table A5. 10. Fuel consumption [TJ] in 1.A.2.d category - Stationary combustion in manufacturing industries : Pulp. Paper and Print

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	1 548	1 741	1 379	4 524	3 836	22 318	22 233	23 979	18 936	17 528	15 696	15 564	14 317	14 050
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	101	61	26	61	250	232	455	1 096	563	1 007	1 210	1 445	1 461	2 094
Fuel wood and wood waste	1			1 585	1 610	15 437	16 243	16 472	16 476	15 545	15 938	15 138	16 622	17 950
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	256	285	256	314	285	285	256	142	86		28	28	28	57
Liquid petroleum gas (LPG)	46	46	46	46	46	46	46	92	184	92	138	92	46	46
Motor gasoline														90
Jet kerosene														
Diesel oil														
Fuel oil	43	86	43	43	86	129	601	987	1 115	815	601	472	429	472
Light fuel oil	1 280	1 200	1 320	1 560	1 400	2 360	1 040	1 040	1 320	1 320	1 360	1 480	1 560	1 600
Feedstocks														
Refinery gas														
Petroleum coke oven gas	3	3	2	3	2	2	1							
Blast furnace gas														
Gas works gas	3	14	2				4							

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	13 797	13 430	11 592	9 452	7 850	8 515	10 086	11 301	10 643	11 460	11 291	10 922	9 628	8 862
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	2 657	2 288	2 976	4 087	4 822	4 972	5 134	4 587	5 535	6 271	6 994	7 166	7 991	8 709
Fuel wood and wood waste	18 957	18 611	19 379	18 644	19 729	19 171	19 581	19 402	20 358	27 152	26 987	27 070	30 415	33 742
Biogas						18	49	73	83	91	105	86	111	139
Industrial wastes										37	125	108	190	295
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products		40	40											3
Petroleum coke														
Coke	28	28	28	28	28		28							
Liquid petroleum gas (LPG)	92	46	92	184	46	92	92	92	92	92	92	92	92	107
Motor gasoline														23
Jet kerosene														
Diesel oil														0
Fuel oil	472	343	386	429	300	303	260	216	173	260	173	258	473	574
Light fuel oil	1 680	1 600	1 600	1 720	1 640	1 600	1 640	1 680	1 520	1 520	1 280	1 480	1 320	1 057
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A5. 11. Fuel consumption [TJ] in 1.A.2.e category - Stationary combustion in manufacturing industries : Food Processing. Beverages and Tobacco

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	31 914	35 940	32 724	55 643	53 801	73 024	88 777	78 207	64 659	46 327	43 417	40 020	41 803	39 030
Lignite	58	19	18	369	195	265	380	250	317	237	191	149	192	175
Hard coal briquettes (patent fuels)				205	205	59	29							
Brown coal briquettes												20		
Crude oil														
Natural gas	1 970	1 984	2 339	3 171	7 180	3 839	15 051	12 927	10 694	9 255	10 494	11 363	12 490	15 075
Fuel wood and wood waste	91	94	72	151	56	82	94	75	101	69	49	62	60	323
Biogas									3	20	63	42	37	63
Industrial wastes			31	3	3						1	14		
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products							80	80	40					
Petroleum coke														
Coke	3 334	2 936	2 650	3 249	2 708	2 565	3 192	2 850	2 080	1 710	1 624	1 368	1 539	1 340
Liquid petroleum gas (LPG)	46	46	46	46	92	138	184	184	276	460	690	874	1 426	1 380
Motor gasoline	135	90	135	180	135	180	180	45	90	45	135	45	90	90
Jet kerosene														
Diesel oil														
Fuel oil	1 244	1 030	901	1 201	1 072	901	5 448	5 191	6 821	7 465	7 336	7 250	6 864	6 864
Light fuel oil	1 640	1 480	1 320	3 280	3 920	6 120	2 720	2 400	2 680	2 280	2 520	2 720	2 960	3 040
Feedstocks														
Refinery gas														
Petroleum coke oven gas	111	125	124	102	3	25	4							
Blast furnace gas														
Gas works gas	51	14	1	1			3							

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	36 095	35 894	30 864	31 165	26 778	25 814	25 903	25 614	26 172	24 724	24 428	22 011	22 555	23 921
Lignite	129	92	74											3
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	16 164	17 456	18 623	20 614	20 725	20 950	21 610	22 128	23 704	24 475	25 094	26 008	27 590	29 943
Fuel wood and wood waste	373	214	239	164	365	192	441	534	436	664	747	1 134	1 383	1 072
Biogas	74	68	72	84	94	109	101	145	199	202	350	345	407	422
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														0
Petroleum coke														
Coke	1 226	969	855	912	656	656	627	542	314	370	456	627	656	726
Liquid petroleum gas (LPG)	1 564	1 426	1 196	920	1 012	966	828	782	690	828	966	966	1 104	1 195
Motor gasoline		45	45	45	45	45	45						43	16
Jet kerosene														
Diesel oil														0
Fuel oil	6 178	5 405	4 504	4 076	4 504	3 161	2 901	2 382	2 944	1 992	1 516	1 290	1 419	1 473
Light fuel oil	3 280	3 160	2 920	2 760	2 000	1 440	1 240	1 360	1 360	1 080	1 000	600	760	720
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A5. 12. Fuel consumption [TJ] in 1.A.2.f category - Stationary combustion in manufacturing industries : Non-metallic minerals and other industries

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	111 151	109 154	98 583	157 659	157 182	160 663	192 054	169 693	131 898	109 929	94 011	73 100	60 843	55 377
Lignite	332	714	273	815	391	784	750	574	470	316	267	158	125	55
Hard coal briquettes (patent fuels)	88	29					29				58			
Brown coal briquettes	60	60	40	40	40	40	40	40	40	40	40	20	20	40
Crude oil														
Natural gas	40 219	34 459	36 057	39 908	38 842	40 694	40 860	41 715	44 737	40 271	46 521	50 177	52 506	56 740
Fuel wood and wood waste	6 981	5 973	5 077	5 028	3 414	4 978	6 529	8 199	8 237	8 606	10 111	10 991	12 592	11 999
Biogas						2	1	1	2					
Industrial wastes	90	35	401	548	1 738	2 491	2 819	1 180	2 287	2 011	2 547	2 326	2 586	3 974
Municipal waste - non-biogenic fraction														3
Municipal waste – biogenic fraction														
Other petroleum products							120	1 840	1 720	760	240	40	80	80
Petroleum coke														4 416
Coke	26 733	21 346	22 116	21 118	18 040	15 732	16 758	12 625	12 112	10 885	9 150	7 212	6 327	6 642
Liquid petroleum gas (LPG)	138	92	92	92	230	184	184	506	690	1 104	1 978	1 840	2 714	2 622
Motor gasoline	1 123	1 302	898	943	539	1 032	630	2 336	763	360	315	180	135	225
Jet kerosene														
Diesel oil									86	86	86	86	43	43
Fuel oil	11 369	9 610	8 066	8 494	8 107	9 610	20 335	18 362	15 230	13 171	12 397	11 840	11 925	12 442
Light fuel oil	6 320	4 640	5 960	7 280	8 040	11 120	6 960	7 400	10 440	9 480	7 480	7 400	7 440	7 240
Feedstocks														
Refinery gas														
Petroleum coke oven gas	3 776	2 805	2 075	1 709	538	935	531	363	999	810	417	917	783	863
Blast furnace gas	101	106	79	108	120	53	53	36	10	5	11	3	3	
Gas works gas	4 002	3 595	2 918	2 414	2 153	1 804	1 034	502	330	304				

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	54 236	51 229	49 547	60 388	51 044	37 446	39 393	44 499	34 385	30 096	29 689	28 141	23 967	30 007
Lignite	9	9	18		72	163	313	646	818	779	645	612	793	1 306
Hard coal briquettes (patent fuels)								29						6
Brown coal briquettes	40	40	40	60	120	100	80	200	100	220	40	40	40	55
Crude oil														
Natural gas	60 807	62 279	64 563	66 006	65 961	64 255	67 836	68 368	65 368	66 947	64 268	63 264	68 473	71 324
Fuel wood and wood waste	12 445	12 303	11 763	13 351	14 266	14 289	18 200	20 399	21 261	25 340	26 653	28 560	30 545	33 036
Biogas					1	3				4	44	84	80	44
Industrial wastes	3 479	4 401	8 832	6 898	8 554	9 107	10 524	11 781	12 239	12 861	15 235	15 113	17 286	19 643
Municipal waste - non-biogenic fraction	13	717	1 620	1 777	378	4 419	4 512	5 017	3 913	3 752	4 060	4 011	8 179	8 588
Municipal waste – biogenic fraction			2	6	1	29	123	1 338	1 360	1 391	1 528	1 664	2 094	2 411
Other petroleum products	120	80	120	80	64	29	90	90	93	64	96	68	70	92
Petroleum coke	3 232	7 072	3 584	1 568	1 152	2 752	1 792	64	1 184	448	768	832	1 056	1 670
Coke	5 784	3 220	3 904	5 328	3 363	2 734	2 906	2 907	2 679	2 565	2 650	3 249	2 878	2 249
Liquid petroleum gas (LPG)	2 990	2 208	1 610	1 472	1 564	1 426	1 564	1 564	1 196	1 472	1 748	1 518	1 702	1 909
Motor gasoline	180	180	225	135	90	180	270	135	90	90	176	129	129	222
Jet kerosene														
Diesel oil	43	43	86	86	43	43	43	43		43	43		43	25
Fuel oil	12 397	12 656	12 955	11 797	11 326	11 084	10 653	11 041	8 963	8 010	7 967	7 353	7 783	7 673
Light fuel oil	7 360	7 000	5 520	3 600	3 680	3 240	3 320	3 120	2 360	1 880	1 240	480	440	602
Feedstocks														
Refinery gas														
Petroleum coke oven gas	1 941	1 480	1 527	1 673	1 570	1 266	1 634	1 891	1 697	1 562	1 955	1 844	2 010	2 053
Blast furnace gas	13	13				7	9	12	4	4	2			

Table A5. 13. Jet kerosene consumption in the sub-category 1.A.3.a.i - International Aviation for the years 1990-2017 [Gg]

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Jet kerosene	215	222	241	240	243	262	308	276	281	251	267	263	258	279

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jet kerosene	274	311	415	432	519	470	495	485	537	524	590	646	685	852

Table A5. 14. Amounts of fuels used in the sub-category 1.A.3.a ii - Civil Aviation for the years 1990-2017 [Gg]

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Jet kerosene	12.73	13.15	14.27	14.21	14.39	15.51	18.24	16.34	16.64	14.86	15.81	15.57	15.28	16.52
Aviation gasoline	8.00	5.00	2.00	4.00	10.00	7.00	4.00	6.00	4.00	3.00	3.00	3.00	4.00	4.00

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jet kerosene	16.22	21.91	26.24	25.21	26.48	24.92	28.80	30.84	46.43	33.00	39.05	36.04	33.71	39.76
Aviation gasoline	3.00	3.00	3.00	4.00	3.00	4.00	4.00	5.00	5.00	4.00	5.00	4.00	4.00	3.34

Table A5. 15. Amount of fuels consumption in road transport in years 1990-2017 [TJ]

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Gasoline	136 137	158 811	168 420	172 057	190 421	193 025	201 781	217 900	222 165	247 130	222 704	206 585	189 164	180 678
Diesel oil	117 846	116 774	118 147	107 851	101 416	104 890	136 465	139 253	155 341	162 076	134 792	140 583	134 835	164 178
LPG	0	0	0	1 104	3 266	8 096	11 638	15 456	16 100	21 482	19 550	26 956	38 134	49 220

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Gasoline	183 416	177 041	181 620	181 351	179 196	179 775	177 660	168 030	160 830	153 225	148 020	152 994	161 594	176 617
Diesel oil	200 986	229 815	268 768	323 209	352 552	365 972	402 820	421 915	401 954	369 436	379 221	407 382	484 266	578 072
LPG	61 686	71 254	78 200	80 500	79 074	76 038	76 360	73 968	73 876	73 278	73 830	74 980	79 396	84 275
CNG/LNG	0	0	0	0	0	0	0	0	0	0	0	669	611	466

Table A5. 16. Amounts of fuels used in railway transport in the 1990-2017 [Gg]

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Diesel oil	414.00	316.00	247.00	243.00	275.00	268.00	225.00	202.00	190.00	180.00	165.00	161.00	153.00	161.00
Hard coal	141.00	75.00	15.00	13.00	7.00	6.00	8.00	8.00	6.00	0.00	0.00	0.00	0.00	0.00

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Diesel oil	161.00	158.00	145.00	143.00	125.00	120.00	111.00	115.00	107.00	99.00	89.00	82.00	82.00	106.50
Hard coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A5. 17. The amounts of fuels used in navigation in the 1990-2017 [Gg]

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Inland navigation - Diesel Oil	20.00	16.00	19.00	16.00	7.00	16.00	16.00	15.00	9.00	7.00	6.00	6.00	5.00	7.00
Marine - Diesel oil	5.50	4.34	2.82	1.94	2.32	2.21	1.66	0.65	0.62	0.58	0.57	0.46	0.45	0.73
Marine - fuel oil	22.55	20.67	13.68	8.54	10.69	10.75	9.94	3.21	3.93	3.51	3.41	3.28	3.27	4.46

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Inland navigation - Diesel Oil	6.00	5.00	6.00	5.00	5.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	4.57
Marine - Diesel oil	0.53	0.70	0.73	0.56	0.61	0.38	0.21	0.24	0.23	0.31	0.17	1.59	4.75	2.20
Marine - fuel oil	2.11	1.50	1.99	1.62	1.60	0.94	0.31	0.35	0.26	0.56	0.29	0.00	0.00	0.00

Table A5. 18. Fuel consumption [TJ] in 1.A.4. a i category - Commercial/Institutional: Stationary

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	54 547	62 166	54 214	50 334	34 666	34 267	25 608	18 696	16 200	15 104	13 354	13 460	21 677	21 539
Lignite				17	91	25	26	9	9	9				
Hard coal briquettes (patent fuels)						322								
Brown coal briquettes	420			1 780	1 820	1 940	240	540	120	520	380		20	
Crude oil														
Natural gas	13 787	10 977	11 190	11 548	9 573	13 260	18 771	24 256	32 769	37 696	38 567	49 971	61 001	67 057
Fuel wood and wood waste	4 501	2 945		12 312	11 719	11 560	10 046	9 028	8 437	8 553	8 514	5 736	5 747	5 752
Biogas	379	187	206	62	249	423	579	599	648	663	678	860	683	700
Industrial wastes	504	81	11	352	89		124		3	4	4	91	92	60
Municipal waste - non-biogenic fraction											20		9	11
Municipal waste – biogenic fraction											19		10	14
Other petroleum products										640	880	3 000	360	1 720
Petroleum coke														
Coke	34 712	28 264	40 068	33 402	27 332	25 878	26 220	28 642	13 480	12 226	8 265	3 819	8 122	8 180
Liquid petroleum gas (LPG)					1 334	782	782	1 748	1 564	2 070	2 300	3 266	3 358	5 520
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil							987	4 290	6 220	7 636	13 342	15 015	19 090	16 774
Light fuel oil								80						
Feedstocks														
Refinery gas														
Petroleum coke oven gas	1 224	1 088	877	428	123	53	34	127						
Blast furnace gas														
Gas works gas	312	554	576	91	14	14	14	72	40	5	5	4	3	4

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	22 502	25 405	29 320	25 291	28 763	31 393	34 503	31 119	32 855	30 116	27 068	25 958	27 222	26 450
Lignite							1 475	702	531	515	402	327	280	240
Hard coal briquettes (patent fuels)														
Brown coal briquettes														0
Crude oil														0
Natural gas	69 564	68 410	63 517	65 488	71 250	75 746	83 433	78 278	80 888	76 501	67 429	71 823	80 972	60 806
Fuel wood and wood waste	6 028	6 171	4 580	5 482	5 020	7 104	8 029	7 818	6 833	7 433	6 556	7 043	7 715	8 003
Biogas	1 325	1 602	1 582	1 438	1 795	1 675	1 830	1 963	2 280	2 123	2 118	2 361	2 700	2 502
Industrial wastes	2	22				92	21	11	9	388	79	145	116	119
Municipal waste - non-biogenic fraction					37	31	5	35	28	33	152	50	239	317
Municipal waste – biogenic fraction	13	30	28	29	8								808	40
Other petroleum products	2 000						60							
Petroleum coke														
Coke	5 928	2 679	2 878	2 594	2 080	2 138	2 109	1 824	741	1 083	570	826	912	694
Liquid petroleum gas (LPG)	5 014	4 600	5 244	4 922	4 462	3 772	3 404	3 312	4 048	2 852	2 990	2 990	3 220	3 288
Motor gasoline														
Jet kerosene														
Diesel oil														29
Fuel oil	14 286	13 213	23 252	22 866	22 866	21 910	27 409	25 634	18 402	15 155	14 722	14 577	14 534	15 088
Light fuel oil							80	40						
Feedstocks														
Refinery gas														
Petroleum coke oven gas			1	1	1	2	1	1	1		1			
Blast furnace gas														
Gas works gas	3	3	3	14	18	17	17	18	14	10	2			

Table A5. 19. Fuel consumption [TJ] in 1.A.4. b i category - Residential: Stationary plants

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	272 689	358 521	351 542	372 347	309 920	305 701	326 681	271 980	213 584	223 330	166 012	184 730	209 771	207 214
Lignite	526	42		2 956	4 403	4 279	3 420	2 626	1 772	1 286	1 169	1 373	1 482	1 605
Hard coal briquettes (patent fuels)														
Brown coal briquettes	1 240													
Crude oil														
Natural gas	122 204	133 674	141 212	141 590	151 671	159 559	143 057	150 022	138 268	135 995	127 611	133 737	127 093	127 629
Fuel wood and wood waste	34 335	27 721	33 969	106 000	104 715	105 000	101 000	100 000	100 700	95 000	95 000	104 500	104 500	103 075
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	14 866	12 110	26 732	30 752	27 788	27 502	28 044	32 775	19 950	18 525	11 685	11 970	8 550	8 550
Liquid petroleum gas (LPG)	1 702	1 012	1 840	6 072	8 970	12 834	16 100	18 400	18 400	19 320	20 240	20 700	21 390	25 300
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil							2 145	6 435	8 580	9 781	17 160	21 450	22 952	22 952
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	15 155	13 706	11 334	6 779	3 560	1 723	226							
Blast furnace gas														
Gas works gas	3 088	1 307	739	431	418	258	222	181	164	163	158	151	134	128

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	219 654	249 994	284 628	257 388	276 073	279 808	319 753	275 817	291 964	280 095	257 420	252 837	268 841	265 200
Lignite	1 919	2 006	2 168	1 972	2 565	2 219	4 035	3 593	3 619	4 022	3 214	3 105	2 989	2 480
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	126 376	135 111	138 686	132 622	131 450	134 857	148 427	135 471	141 397	143 187	131 598	132 202	145 148	151 972
Fuel wood and wood waste	103 360	100 700	104 500	102 000	102 500	102 500	112 746	115 000	116 850	116 850	105 450	108 395	111 435	109 725
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	7 125	2 992	3 278	1 425	1 140	5 928	6 526	5 700	5 415	5 700	4 845	4 275	3 990	4 200
Liquid petroleum gas (LPG)	23 920	23 000	23 000	23 920	24 380	25 254	24 840	23 000	23 000	21 620	21 390	21 390	21 620	22 086
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	21 450	19 305	19 305	15 444	11 583	8 010	4 546	4 763	3 767	3 464	3 031	3 182	3 010	3 010
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas	113	95	99	81	71	69	67	59	40	47	36	3		

Table A5. 20. Fuel consumption [TJ] in 1.A.4. c i category - Agriculture/Forestry/Fishing – stationary

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hard coal	36 365	57 356	62 959	62 501	60 542	58 583	62 611	52 483	46 050	49 162	33 231	36 975	30 820	29 693
Lignite	844	1 018	911	814	1 642	1 698	1 299	1 292	1 419	1 097	939	1 236	1 395	1 528
Hard coal briquettes (patent fuels)	645	146	88	59	59									
Brown coal briquettes	40	20	20											
Crude oil														
Natural gas	448	275	55	132	212	243	428	571	868	476	536	777	914	1 197
Fuel wood and wood waste	39	278	583	20 057	18 367	18 500	17 567	17 000	17 100	17 100	17 100	19 043	19 010	19 017
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction										6	12	11		
Municipal waste – biogenic fraction										6	13	10		
Other petroleum products														
Petroleum coke														
Coke	1 568	1 168	684	570	4 018	4 018	4 104	5 130	5 700	5 130	3 420	3 705	2 850	2 850
Liquid petroleum gas (LPG)					460	690	1 150	1 380	1 380	1 610	1 840	2 300	2 760	3 220
Motor gasoline				674	1 122	1 122	1 122	1 212	1 122	1 347	1 392	943	269	314
Jet kerosene														
Diesel oil														
Fuel oil														
Light fuel oil	3 560	2 720	1 440	13 400	16 720	8 720	4 000	6 560	5 680	5 480	5 600	5 240	3 880	5 840
Feedstocks														
Refinery gas														
Petroleum coke oven gas	2	2												
Blast furnace gas														
Gas works gas	1			2					1					

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hard coal	31 728	35 673	42 074	37 748	41 640	41 538	47 291	41 488	43 715	41 611	39 003	36 305	38 962	38 480
Lignite	2 086	2 188	2 489	2 125	2 770	2 485	1 667	1 337	1 327	1 609	1 286	1 144	981	800
Hard coal briquettes (patent fuels)	29				59	29	29	59	205	293	264	146	381	273
Brown coal briquettes			40		40	40			20	520	1 360	700	400	407
Crude oil														
Natural gas	1 182	1 084	1 492	1 840	1 900	1 577	1 486	1 531	1 796	1 501	1 438	1 144	1 305	1 519
Fuel wood and wood waste	19 878	19 047	19 978	19 062	19 024	19 030	21 088	23 931	20 948	20 937	19 310	20 256	21 458	21 276
Biogas					94	97	39	223	252	286	328	385	357	370
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	1 995	1 140	1 425	855	826	855	940	998	285	570	627	256	285	252
Liquid petroleum gas (LPG)	3 220	3 220	2 300	2 300	2 346	2 070	2 300	2 346	2 300	2 300	2 438	2 622	2 760	2 853
Motor gasoline	224	269	314	224	224	225	45	45	45	45	44	43	43	38
Jet kerosene														
Diesel oil														
Fuel oil														
Light fuel oil	5 960	7 200	1 720	1 200	1 360	1 200	920	1 280	1 360	560	480	400	560	600
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A5. 21. Fuel consumption [Gg] in 1.A.4.c category - Agriculture/Forestry/Fishing – mobile

Fuel use	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1.A.4.c ii														
Off-road transport in agriculture - ON	1 060	1 021	1 200	1 514	1 639	1 726	1 926	2 241	2 038	2 088	2 313	2 156	2 150	2 175
Machinery in agriculture - ON	118	113	133	168	182	192	214	249	226	232	257	240	239	242
1.A.4.c iii														
Fishery – ON	80	77	81	66	75	74	60	62	45	45	40	42	41	33
Fishery – OP	140	135	141	115	132	130	105	109	79	79	70	74	72	58

Fuel use	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.A.4.c ii														
Off-road transport in agriculture - ON	2 215	2 266	1 683	1 547	1 548	1 490	1 495	1 507	1 518	1 484	1 433	1 426	1 510	1 806
Machinery in agriculture - ON	246	252	187	172	172	166	166	167	169	165	159	158	168	201
1.A.4.c iii														
Fishery – ON	37	32	30	31	30	44	36	38	38	41	37	40	42	44
Fishery – OP	65	56	53	54	52	78	63	66	67	72	65	69	73	76

Note: ON - diesel oil; OP - fuel oil

Table A5. 22. Activity data used in the category 1.B.1 - Fugitive emission from solid fuels [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Lignite extraction	67 584	69 406	66 852	68 105	66 770	63 547	63 845	63 169	62 820	60 839	59 484	59 552	58 210	60 920
Hard coal extraction	147 493 000	140 027 000	131 313 000	130 047 000	133 127 000	136 190 000	137 048 000	137 129 000	115 145 000	109 322 000	102 219 000	103 280 000	102 723 000	101 659 000
Coke production	13 516	11 356	11 066	10 275	11 455	11 578	10 339	10 535	9 746	8 368	8 972	8 946	8 723	10 112

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Lignite extraction	61 198	61 636	60 844	57 538	59 668	57 108	56 510	62 841	64 280	65 849	63 877	63 128	60 246	61 161
Hard coal extraction	100 517 000	97 110 000	94 407 000	87 406 000	83 661 000	77 478 000	76 172 000	75 668 000	79 234 000	76 466 000	72 540 000	72 176 000	70 385 000	65 479 946
Coke production	10 097	8 404	9 613	10 168	10 075	7 091	9 844	9 377	8 893	9 360	9 568	9 792	9 718	9 418

Table A5. 23. Activity data used in the sub-category 1.B.2 a - Fugitive emission from oil [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Extraction of crude oil	160 000	158 000	200 000	235 000	284 000	292 000	317 000	289 000	360 000	434 000	653 000	767 000	728 000	765 000
Liquid fuel distribution (exept gasoline)														
Marine terminals	13 126 000	11 454 000	12 769 000	13 674 000	12 721 000	12 957 000	14 026 000	14 713 000	15 367 000	16 022 000	18 001 600	17 558 000	17 942 200	17 448 300
Refinery thtoughput	12 846 000	11 726 000	13 146 000	13 366 000	13 448 000	13 443 000	14 597 000	14 884 000	16 023 000	16 719 000	18 274 000	17 962 000	17 785 000	17 457 000
Handling and storage - diesel oil	5 297 000	4 922 000	5 135 000	5 572 000	5 781 000	5 350 000	6 103 000	6 096 000	5 808 000	6 343 000	6 004 000	5 739 000	5 070 000	5 908 000
Petrol distribution														
Refinery dispatch station	2 414 000	2 400 000	3 201 000	3 486 000	3 773 000	3 037 000	3 481 000	3 413 000	3 465 000	4 287 000	4 412 000	4 294 000	4 019 000	4 038 000
Transport and depots	3 773 000	4 100 000	4 750 000	4 350 000	4 746 000	5 454 000	4 836 000	5 085 000	5 020 000	5 743 000	5 174 000	4 746 000	4 314 000	4 212 000
Service stations (including refuelling of cars)	3 773 000	4 100 000	4 750 000	4 350 000	4 746 000	4 777 000	4 615 000	4 966 000	5 020 000	5 743 000	4 999 000	4 629 000	4 203 000	4 212 000

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Extraction of crude oil	886 000	848 000	796 000	721 000	755 000	687 000	687 000	617 000	681 000	962 000	951 000	928 000	1 001 000	996 049
Liquid fuel distribution (exept gasoline)														
Marine terminals	17 316 100	17 912 300	19 813 000	20 885 100	20 786 950	20 097 683	22 688 120	23 792 000	24 633 000	23 347 000	23 713 000	26 492 000	24 573 000	24 648 000
Refinery thtoughput	18 118 000	18 165 000	20 045 000	20 113 000	20 804 000	20 304 000	22 843 000	24 001 000	25 153 000	24 302 000	24 196 000	26 140 000	25 790 000	25 139 294
Handling and storage - diesel oil	6 748 000	7 405 000	8 224 000	9 510 000	10 430 853	10 800 000	12 006 000	12 295 000	12 093 000	11 252 000	11 080 000	12 084 000	13 791 000	16 436 000
Petrol distribution														
Refinery dispatch station	4 081 000	4 203 000	4 255 000	3 969 000	4 081 000	4 271 000	4 221 590	3 921 000	4 027 000	4 040 000	3 849 000	4 183 000	4 205 000	4 188 000
Transport and depots	4 198 000	4 065 000	4 158 000	4 144 000	4 416 000	4 242 000	4 145 000	3 951 000	3 872 000	3 669 000	3 583 000	3 781 000	3 998 000	4 387 000
Service stations (including refuelling of cars)	4 115 000	4 008 000	4 135 000	4 139 000	4 166 000	4 242 000	4 145 000	3 951 000	3 872 000	3 669 000	3 583 000	3 781 000	3 998 000	4 387 000

Table A5. 24. Activity data used in the sub-category 1.B.2.b - Fugitive emission from gas [mln m^3]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Extraction of high - methane natural gas	1 260	1 644	1 509	2 129	1 997	1 642	1 952	1 988	2 101	2 004	2 035	2 088	2 016	2 075
Extraction of nitrogenous natural gas	2 622	2 504	2 519	2 821	2 638	2 831	2 802	2 848	2 751	2 712	2 917	3 090	3 247	3 259
Gas distribution networks	9 534	8 837	8 193	8 561	8 640	9 515	9 999	9 938	9 278	8 990	8 974	9 195	9 024	9 786
High - methane natural gas	2 829	2 716	2 684	2 927	2 719	2 938	2 956	2 982	1 784	1 461	1 445	1 651	1 587	1 499
Nitrogenous natural gas	1 589	1 412	1 203	1 169	1 065	1 177	987	1 074	887	1 016	1 098	1 127	1 091	1 346

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Extraction of high - methane natural gas	2 297	2 232	2 239	2 243	2 116	2 047	2 010	2 025	2 016	1 976	1 969	2 014	1 823	1 687
Extraction of nitrogenous natural gas	3 333	3 510	3 444	3 494	3 335	3 511	3 753	3 896	3 972	3 907	3 795	3 748	3 669	3 721
Gas distribution networks	10 273	10 913	11 023	10 843	11 094	11 366	14 010	13 970	14 819	14 762	14 484	14 608	15 617	16 491
High - methane natural gas	1 343	1 289	1 388	1 503	1 436	1 455	3 771	3 853	3 870	3 942	3 864	3 828	3 753	3 812
Nitrogenous natural gas	987	804	1 098	1 133	1 131	913	1 229	1 164	1 081	1 177	1 196	1 367	1 489	1 394

Table A5. 25. Activity data used in the sub-category 1.B.2.c – Venting and flaring

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Throughput [Mg]						13 443 700	14 603 000	14 884 000	16 191 000	16 784 000	18 080 300	18 113 000	17 878 100	17 459 600
Throughput [m^3]						15 614 053	16 960 511	17 286 876	18 804 878	19 493 612	20 999 187	21 037 166	20 764 344	20 278 281

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Throughput [Mg]	18 068 000	18 191 100	22 842 700	24 001 000	25 152 500	24 997 901	24 885 247	26 142 665	25 790 170	25 139 294	18 068 000	18 191 100	22 842 700	24 001 000
Throughput [m^3]	20 984 901	21 127 875	26 530 430	27 875 726	29 213 124	29 033 567	28 902 726	30 363 141	29 953 740	29 197 786	20 984 901	21 127 875	26 530 430	27 875 726

Table A5. 26. Activity data used in the category NFR 2.A [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Cement production	12 518	12 012	11 908	12 200	13 834	13 914	13 959	15 003	14 970	15 555	15 046	12 074	11 206	11 653
Lime production	3 200	2 413	2 526	2 584	2 516	2 526	2 461	2 516	2 406	2 299	2 376	2 074	1 960	2 053
Gypsum production	192	247	222	290	357	407	450	504	511	459	445	1 035	1 244	1 443
Flat glass production	345	323	308	295	266	254	254	360	458	418	425	383	495	579
Container glass production	577	592	565	624	712	777	811	874	918	928	976	993	970	968
Glass fiber production	0	0	3	4	5	8	6	5	13	2	57	68	72	77
Quarrying and mining of minerals	375 115	379 153	383 191	390 808	396 978	81 439	79 776	72 442	73 347	70 333	102 946	87 310	86 389	95 822
Extraction of mineral ores - copper	24 359	25 702	24 115	27 113	26 136	26 463	27 427	26 165	27 594	28 395	28 503	30 227	29 705	29 992
Extraction of mineral ores - zinc and lead	4 875	4 849	5 017	4 819	4 871	5 040	5 030	4 939	5 052	5 068	4 857	4 666	4 805	4 754
Construction and demolition [m^2]	10 361 398	10 259 250	9 972 675	7 659 814	6 733 080	6 009 651	5 722 173	6 876 770	7 527 480	7 156 767	7 872 700	9 118 237	9 691 798	18 838 485

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cement production	12 837	11 353	13 547	15 774	16 000	14 172	15 812	18 993	15 797	14 598	15 595	15 265	15 782	17 254
Lime production	2 168	1 749	1 936	2 143	1 952	1 704	1 799	2 036	1 799	1 710	1 817	1 942	1 869	1 904
Gypsum production	557	771	1 190	1 422	1 579	1 317	1 347	1 349	1 220	1 264	1 073	1 099	1 119	1 182
Flat glass production	621	587	698	691	748	769	876	947	992	987	968	929	1 213	1 169
Container glass production	1 108	1 083	1 116	1 210	1 270	1 202	1 281	1 305	1 422	1 409	1 506	1 531	1 689	1 733
Glass fiber production	80	79	77	86	83	67	88	91	83	108	111	124	127	147
Quarrying and mining of minerals	99 582	109 421	120 750	138 098	142 791	150 946	160 236	216 499	168 387	156 903	159 845	166 444	158 750	175 608
Extraction of mineral ores - copper	31 880	32 019	32 875	31 809	30 920	31 253	30 805	31 241	31 725	32 215	32 613	33 187	33 620	32 781
Extraction of mineral ores - zinc and lead	4 669	4 445	4 089	4 003	3 891	3 198	2 450	2 345	2 329	2 328	2 297	2 241	2 172	1 870
Construction and demolition [m^2]	11 619 777	12 010 635	11 721 159	14 117 500	17 185 370	15 942 523	14 410 837	14 028 000	15 657 370	15 181 226	14 445 449	14 741 558	15 434 213	16 540 000

Table A5. 27. Activity data used in the category 2.B Chemical Industry [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Ammonia production	2	2	1	2	2	2 248	2 185	2 252	2 048	1 785	2 243	2 104	1 595	2 247
Nitric acid production	1 577	1 438	1 388	1 608	1 701	1 931	1 929	1 808	1 671	1 635	2 007	2 060	1 689	2 030
Adipic acid production	4	3	3	3	1									
Calcium carbide production	297	283	221	180	174	178	145	121	70	53	39	38	28	29
Titanium dioxide	30	27	28	24	34	35	35	32	35	37	35	38	38	42
Soda ash production and use	1 335	1 125	1 103	1 007	1 369	1 019	909	950	1 000	926	902	926	906	917
Sulfuric acid	1 721	1 088	1 244	1 145	1 452	1 861	1 761	1 791	1 707	1 505	1 763	1 690	1 648	1 764
NPK fertilisers	5 423	4 288	4 547	4 707	5 540	6 491	6 625	6 558	5 983	5 634	6 869	6 441	5 924	6 975
Nitrogen fertilisers	3 604	3 333	3 278	3 514	3 814	4 389	4 378	4 271	3 739	3 433	4 401	4 281	3 650	4 642
Phosphate fertilizers	1 232	564	474	289	364	411	411	361	337	294	323	349	357	401
Carbon black	23	17	26	26	26	23	25	25	23	19	13	15	16	18
Chlorine - mercury cell	204	162	90	87	85	94	91	87	79	59	58	42	50	58
Chlorine - diaphragm cell	136	131	130	111	98	109	136	150	161	164	180	159	168	174
Ethylene	501	448	473	477	399	436	493	510	519	494	508	431	523	492
Caprolactam	97	104	105	103	106	126	128	130	131	140	147	149	153	152
Propylene	193	177	190	188	164	176	194	202	189	198	249	228	256	257
Polyethylene	159	150	163	162	142	155	163	160	173	134	147	155	170	161
Polyvinylchloride	203	195	220	212	202	225	254	285	266	259	274	226	249	256
Polypropylene	86	89	86	75	76	76	45	35	38	104	123	123	144	145
Polystyrene	19	21	26	32	34	46	47	49	51	71	94	93	87	82
Polystyrene - EPS	12	13	16	20	21	29	29	30	32	44	56	50	53	60
Polystyrene - GPPS/HIPS	4	5	6	7	7	10	10	11	11	15	17	20	16	10
Formaldehyde	65	70	75	80	85	90	95	100	105	110	101	94	211	221
Storage, handling and transport of nitrogen fert.	3 604	3 333	3 278	3 514	3 814	4 389	4 378	4 271	3 739	3 433	4 401	4 281	3 650	4 642
Storage, handling and transport of potassium fert.	3	3	3	3	3	3	3	3	3	3	3	9	8	3
Storage, handling and transport of phosphate fert.	1 232	564	474	289	364	411	411	361	337	294	323	349	357	401
Storage, handling and transport of phosphates	1 232	564	474	289	364	523	570	596	593	535	323	349	357	391

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Ammonia production	2 452	2 524	2 327	2 418	2 485	2 011	2 059	2 322	2 526	2 482	2 651	2 718	2 623	2 779
Nitric acid production	2 085	2 219	2 201	2 270	2 267	2 139	2 209	2 168	2 323	2 280	2 366	2 396	2 340	2 404
Adipic acid production														
Calcium carbide production	28	25	21	16										
Titanium dioxide	41	41	41	39	40	36	40	38	37	36	36	32	38	40
Soda ash production and use	975	996	1 026	1 192	1 425	890	1 051	1 083	1 162	1 183	1 187	1 203	1 384	1 421
Sulfuric acid	1 811	1 807	1 907	2 010	1 813	1 243	1 686	1 889	1 693	1 462	1 550	1 701	1 637	1 713
NPK fertilisers	7 385	7 464	7 347	7 896	7 290	5 759	6 967	7 389	7 719	7 341	7 744	8 171	8 164	8 385
Nitrogen fertilisers	4 662	4 908	4 850	5 087	4 825	4 472	4 709	4 987	5 455	5 407	5 698	5 858	5 789	6 047
Phosphate fertilizers	453	410	359	466	458	146	310	392	376	311	366	377	403	363
Carbon black	35	29	32	38	33	26	33	42	20	28	35	42	54	53
Chlorine - mercury cell	62	62	44	30	21									
Chlorine - diaphragm cell	157	139	203	175	115	230	212	227	239	268	253	282	269	298
Ethylene	489	447	878	924	798	759	738	813	753	487	472	545	447	482
Caprolactam	149	160	160	158	145	145	159	164	163	160	168	165	164	168
Propylene	246	249	413	409	365	358	337	359	326	352	340	391	336	341
Polyethylene	153	162	374	397	360	340	365	371	338	347	348	395	346	371
Polyvinylchloride	268	217	278	303	251	258	196	283	261	306	275	321	259	289
Polypropylene	143	157	215	271	281	267	243	255	248	257	231	298	264	292
Polystyrene	97	93	101	108	120	127	142	145	143	136	128	133	148	153
Polystyrene - EPS	58	59	70	64	79	83	82	85	86	78	75	83	91	96
Polystyrene - GPPS/HIPS	20	17	13	21	26	32	42	45	46	48	44	42	47	47
Formaldehyde	232	221	233	224	116	96	98	219	221	219	258	243	273	257
Storage, handling and transport of nitrogen fert.	4 662	4 908	4 850	5 087	4 825	4 472	4 709	4 987	5 455	5 407	5 698	5 858	5 789	6 047
Storage, handling and transport of potassium fert.	3	2	2	0	0	2	5	0	0	9	22	85	90	154
Storage, handling and transport of phosphate fert.	453	410	359	466	458	146	310	392	376	311	366	377	403	363
Storage, handling and transport of phosphates	441	410	358	465	457	145	309	391	375	311	366	377	403	363

Table A5. 28. Activity data used in the category 2.C Metal Production [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Blast furnace charging	8 657	6 502	6 462	6 293	7 081	7 420	6 600	7 343	6 179	5 233	6 492	5 440	5 296	5 632
Blast furnaces - smelting	8 657	6 502	6 462	6 293	7 081	7 420	6 600	7 343	6 179	5 233	6 492	5 440	5 296	5 632
Open hearth furnaces	3 965	2 638	1 820	1 660	1 631	1 545	1 063	1 034	496	378	376	178	7	
Basic oxygen furnaces (BOFs)	7 210	5 746	6 248	6 162	7 034	7 685	6 757	7 531	6 223	5 453	6 800	5 823	5 799	6 070
Electric arc furnaces (EAFs)	2 447	2 048	1 797	2 115	2 447	2 582	2 648	2 906	3 117	2 825	3 290	2 809	2 561	3 037
Hot rolling mills	9 836	8 036	7 550	7 632	8 595	9 542	9 064	9 834	11 710	9 849	11 478	10 161	8 011	8 088
Cold rolling mills	1 201	796	793	857	964	1 116	1 383	1 450	1 279	1 188	1 356	1 168	1 363	1 433
Sinter	11 779	8 613	8 622	7 628	8 787	8 647	8 319	8 981	6 882	6 476	8 079	7 353	7 617	7 732
Ferrosilicon	89	60	36	43	54	70	72	77	75	63	56	49	42	93
Primary aluminium	46	46	44	47	50	56	52	54	54	51	52	55	59	57
Secondary aluminium	23	23	31	18	34	92	117	117	117	117	117	117	119	123
Batteries	39	34	32	33	35	39	36	40	41	45	50	53	74	84
Primary lead	65	51	54	62	61	66	66	65	64	64	45	29	34	56
Secondary lead	11	11	15	10	12	14	22	31	39	17	32	32	67	67
Primary zinc	132	126	135	149	158	166	165	173	178	178	162	160	146	132
Secondary zinc	3	3	3	3	3	8	16	16	14	16	8	8	13	27
Copper (refined)	459	487	509	539	515	515	500	522	526	563	558	574	572	619

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Blast furnace charging	6 400	4 477	5 543	5 804	4 934	2 984	3 638	3 975	3 941	4 012	4 637	5 621	4 674	5 199
Blast furnaces - smelting	6 400	4 477	5 543	5 804	4 934	2 984	3 638	3 975	3 941	4 012	4 637	5 359	5 145	5 728
Open hearth furnaces														
Basic oxygen furnaces (BOFs)	6 858	4 893	5 766	6 188	5 225	3 236	3 995	4 424	4 333	4 520	5 182	5 359	5 145	5 728
Electric arc furnaces (EAFs)	3 721	3 443	4 225	4 433	4 502	3 893	4 001	4 353	4 209	3 679	3 617	3 977	4 016	4 812
Hot rolling mills	10 369	7 877	9 465	9 640	8 589	6 455	7 182	8 261	7 949	8 382	8 733	8 913	8 881	10 284
Cold rolling mills	1 612	1 159	1 326	1 398	1 323	1 107	1 540	1 666	1 261	1 623	1 706	1 783	1 975	2 168
Sinter	8 591	6 168	6 908	6 954	6 306	4 363	5 837	6 513	6 672	6 854	7 389	7 430	6 850	6 992
Ferrosilicon	84	65	13	59	56	10	53	73	78	74	63	78	78	66
Primary aluminium	59	54	56	63	47									
Secondary aluminium	252	247	250	294	214	199	239	295	302	416	390	527	508	508
Batteries	92	110	125	124	122	118	148	151	178	179	177	193	207	212
Primary lead	57	62	67	80	86	79	91	84	96	92	86	69	66	62
Secondary lead	39	39	39	41	40	41	46	50	56	58	89	78	63	63
Primary zinc	131	114	110	127	129	110	98	109	134	134	123	115	107	100
Secondary zinc	31	31	30	32	31	32	36	40	44	46	70	61	50	50
Copper (refined)	627	634	654	610	599	574	626	645	656	639	664	675	603	610

Table A5. 29. Activity data used in the category NFR 2.D.3.a Domestic solvent use [thous. inhab]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Domestic solvent use including fungicides	38 073	38 144	38 203	38 239	38 265	38 284	38 294	38 290	38 277	38 263	38 254	38 242	38 219	38 191

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Domestic solvent use including fungicides	38 174	38 157	38 125	38 116	38 136	38 167	38 530	38 538	38 533	38 496	38 479	38 437	38 433	38 434

Table A5. 30. Activity data used in the category NFR 2.D.3.b and 2.D.3.c [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Road paving with asphalt	721 900	548 000	578 200	527 100	652 000	615 000	695 000	710 000	714 000	828 000	1 041 600	782 000	924 200	1 001 500
Asphalt roofing [thous. m^2]	85 144	100 580	103 197	108 392	128 323	114 000	102 000	109 000	93 400	98 000	92 957	73 845	76 621	80 155

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Road paving with asphalt	1 097 200	1 311 500	1 605 500	1 721 000	1 578 200	2 234 200	1 855 000	2 000 900	1 700 900	1 374 800	1 326 800	1 628 100	1 452 000	1 545 616
Asphalt roofing [thous. m^2]	90 636	89 339	92 508	98 379	88 734	84 601	91 688	91 372	87 197	74 529	75 596	70 031	72 963	79 043

Table A5. 31. Activity data used in the category NFR 2.D.3.d [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Decorative coating application	10 000	20 000	30 000	38 000	51 000	66 180	86 948	105 500	158 041	181 361	*176 183*	*198 034*	*228 430*	254 430
Industrial coating application	45 000	80 000	100 000	128 000	155 000	120 400	123 249	126 000	116 394	101 569	*138 300*	*145 141*	*160 563*	136 656

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Decorative coating application	262 267	360 749	315 124	379 183	380 611	354 658	373 483	372 637	355 148	339 813	358 309	382 596	374 273	378 693
Industrial coating application	142 095	143 986	186 496	153 978	186 473	214 193	135 011	142 196	109 407	54 794	90 190	112 236	136 696	140 292

Table A5. 32. Activity data used in the category NFR 2.D.3.e and 2.D.3.f

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Degreasing [Mg]	4 000	5 500	7 000	8 500	9 500	11 348	9 790	7 191	9 746	12 128	*14 564*	*11 710*	*12 566*	18 388
Dry cleaning [thous. inhab.]	38 073	38 144	38 203	38 239	38 265	38 284	38 294	38 290	38 277	38 263	38 254	38 242	38 219	38 191

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Degreasing [Mg]	24 236	22 580	24 236	23 227	29 613	20 519	16 963	16 343	11 903	10 310	10 441	16 304	15 028	8 518
Dry cleaning [thous. inhab.]	38 174	38 157	38 125	38 116	38 136	38 167	38 530	38 538	38 533	38 496	38 479	38 437	38 433	38 434

Table A5. 33. Activity data used in the category NFR 2D.3.g Chemical products [Mg]

Industrial process	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Polyvinylchloride processing	203 405	211 684	219 963	212 143	202 273	225 267	254 000	285 000	266 000	259 000	*273 930*	225 608	248 541	255 762
Polystyrene foam processing	19 096	22 423	25 750	31 509	33 822	46 243	46 500	48 900	51 200	70 600	*94 335*	92 540	87 228	82 369
Rubber processing	203 989	161 488	171 362	184 317	210 085	249 000	266 000	271 000	288 000	290 000	*353 773*	383 251	399 487	449 821
Pharmaceutical products manufacturing [thous. inhab.]	38 073	38 144	38 203	38 239	38 265	38 284	38 294	38 290	38 277	38 263	38 254	38 242	38 219	38 191
Paints manufacturing	310 000	320 000	330 000	350 000	377 000	453 167	539 208	247 000	367 391	334 266	*280 231*	*295 981*	*330 989*	361 884
Leather tanning	26 400	26 000	25 600	25 200	24 800	24 400	24 000	23 600	23 200	22 800	23 314	20 343	19 118	17 760
Leather shoes production (thous. pairs)						24 600	26 990	27 700	24 400	22 600	19 617	18 658	19 176	18 115
Tyres production						152 000	160 000	162 000	185 000	176 000	202 101	220 908	236 444	260 013

Industrial process	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Polyvinylchloride processing	268 454	216 775	277 798	302 716	251 380	258 086	195 836	282 952	261 339	306 129	275 159	320 964	258 888	288 547
Polystyrene foam processing	87 228	92 667	101 179	107 815	119 973	127 281	142 051	145 099	143 160	135 731	128 352	132 908	148 249	152 500
Rubber processing	519 118	556 990	625 632	679 590	714 446	621 829	790 196	897 851	857 201	915 888	975 473	1 030 971	1 162 909	1 146 167
Pharmaceutical products manufacturing [thous. Inhab.]	38 174	38 157	38 125	38 116	38 136	38 167	38 530	38 538	38 533	38 496	38 479	38 437	38 433	38 434
Paints manufacturing	375 160	429 262	388 989	485 847	456 322	418 262	449 559	458 440	458 423	456 940	509 664	529 715	543 992	547 482
Leather tanning	19 038	16 148	12 382	11 253	13 652	14 721	14 952	16 197	14 438	13 898	16 416	17 249	21 272	22 589
Leather shoes production (thous. Pairs)	16 825	14 904	14 642	15 154	13 377	11 433	11 784	12 049	11 489	11 860	14 907	12 430	14 164	14 847
Tyres production	308 428	319 264	345 361	382 141	352 007	318 080	415 087	460 231	425 953	458 847	478 465	506 142	517 233	541 391

Table A5. 34. Activity data used in the category NFR 2.D.3.h Printing [kg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Printing inks													25 323	27 186

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Printing inks	30 594	36 432	44 671	41 933	42 054	57 486	49 540	47 032	47 855	45 093	53 751	48 710	52 251	54 961

Table A5. 35. Activity data used in the category NFR 2.D.3.i Other solvent use [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fat. edible and non edible oil extraction	260 363	221 645	200 383	227 069	227 452	298 538	303 700	317 375	319 674	367 700	464 800	461 700	432 500	396 100
Glues													76 188	64 417
Adhesives													25 323	27 186

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Fat. edible and non edible oil extraction	395 300	427 400	452 100	502 600	567 100	565 800	488 700	509 523	470 154	519 058	543 425	522 987	506 023	487 544
Glues	37 729	80 667	93 690	91 945	113 031	113 788	122 714	121 520	125 996	122 612	132 459	150 791	171 270	172 808
Adhesives	30 594	36 432	44 671	41 933	42 054	57 486	49 540	47 032	47 855	45 093	53 751	48 710	52 251	54 961

Table A5. 36. Activity data used in the category NFR 2.G – 2.L Other Products Use [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Tobacco combustion [Mg]	70 572	69 502	66 855	70 666	67 205	68 573	69 925	63 301	64 353	65 067	62 503	52 324	52 361	53 773
Fireworks [Mg]	442	663	883	998	1 989	2 745	2 245	2 076	3 024	3 832	4 088	3 091	3 067	2 908
Chipboard [m^3]	923 600	1 136 600	1 201 000	1 329 000	2 014 200	1 538 000	1 747 000	2 072 000	2 452 000	2 599 000	3 031 000	2 937 000	3 111 500	3 748 000
Paper pulp (kraft process)	523	509	567	597	644	671	644	664	722	798	751	753	783	811
Paper pulp (sulphite process)	86	86	90	93	100	96	88	78	75	85	243	0	0	0
Bread	3 129	2 775	2 634	2 707	2 750	2 750	2 915	3 194	3 449	3 674	1 620	1 653	1 547	1 556
Wine [hl]	2 113 921	2 970 381	2 285 079	2 468 887	2 498 055	2 470 000	3 480 000	4 280 000	4 500 000	4 490 000	3 855 586	3 315 476	3 549 022	3 558 239
Beer [hl]	11 294 200	13 633 300	14 138 800	12 584 900	14 098 600	15 200 000	16 700 000	19 300 000	21 000 000	23 400 000	25 231 000	25 162 900	26 874 900	28 621 700
Spirits [hl 100%]	151 005	143 331	135 656	149 518	156 621	153 947	665 041	665 041	665 041	665 041	665 041	574 023	607 484	795 615
Sugar	1 971	1 636	1 468	1 982	1 383	1 595	2 220	2 145	2 102	1 821	2 009	1 543	2 030	1 906
Slaughter products - cattle and calves	446	338	221	181	181	137	161	203	214	180	156	133	135	172
Slaughter products - pigs	963	844	823	718	654	728	727	720	785	824	704	701	835	1 033
Slaughter products - poultry	201	197	199	187	247	276	342	418	478	539	619	715	823	965
Slaughter products - fish	23	30	35	31	49	43	43	50	51	55	67	81	74	54
Margarine and fat spreads, excluding liquid margarine	179	194	234	276	320	374	368	395	363	367	384	380	371	351
Prepared feeds for farm animals	4 968	4 372	4 164	2 941	3 121	4 453	4 453	4 453	4 453	4 453	4 453	4 598	4 741	5 596
Prepared pet foods	92	82	90	137	139	141	141	141	141	141	141	184	162	181
Smoke houses (excl. afterburning)	188	181	181	182	187	196	218	244	230	227	244	233	240	237
Smoke houses (incl. afterburning)	375	361	361	363	375	391	435	488	459	453	487	465	480	473
Sawn wood	2 397	2 027	2 029	2 076	2 055	2 086	1 952	2 255	2 190	2 091	2 035	1 563	1 584	1 686
Storage, handling and transport of bulk prod. - cement	12 518	12 012	11 908	12 200	13 834	13 914	13 959	15 003	14 970	15 555	15 046	12 074	11 206	11 653
Storage, handling and transport of bulk prod. - coal	147 674	140 270	131 531	130 479	133 933	137 000	138 000	138 000	116 000	112 000	103 331	103 992	103 705	103 016
Storage, handling and transport of bulk prod. - coke	13 739	11 468	11 128	10 282	11 456	11 579	10 340	10 536	9 847	8 476	8 972	8 954	8 788	10 232

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Tobacco combustion	51 328	51 493	52 725	50 294	55 790	46 728	48 694	48 808	46 616	41 849	35 435	39 487	50 928	36 186
Fireworks	5733	5469	4840	6902	8375	5497	6477	4822	6227	5661	9250	7122	6107	9212
Chipboard [m^3]	4 101 200	3 939 600	4 485 900	5 330 400	5 081 400	4 703 800	4 684 100	4 917 500	4 879 400	4 785 800	4 809 500	5 014 100	5 417 400	5 617 000
Paper pulp (kraft process)	791	802	825	814	820	826	881	894	848	881	881	873	877	936
Paper pulp (sulphite process)	0	249	345	352	331	319	299	307	304	306	301	286	303	301
Bread	1 532	1 549	1 552	1 523	1 684	1 663	1 675	1 601	1 675	1 689	1 570	1 588	1 591	1 549
Wine [hl]	3 236 412	2 764 698	2 679 669	2 456 338	2 230 163	1 881 311	1 816 152	1 666 663	1 483 883	1 531 133	1 526 271	1 402 824	1 255 548	1 204 782
Beer [hl]	31 850 600	31 572 200	33 953 300	36 895 500	37 107 500	36 235 800	36 800 400	38 066 600	39 605 100	40 001 200	40 075 300	40 890 000	41 369 200	40 382 000
Spirits [hl 100%]	868 605	790 175	833 375	927 524	1 081 306	1 043 402	1 070 126	1 035 802	1 032 199	1 156 615	881 248	960 727	977 017	950 054
Sugar	1 999	2 033	1 574	1 857	1 397	1 515	1 579	1 943	1 996	1 952	2 070	1 670	2 170	2 215
Slaughter products - cattle and calves	163	186	222	229	194	191	219	234	231	214	204	215	204	224
Slaughter products - pigs	1 017	1 031	1 186	1 221	1 020	909	929	913	1 103	1 186	1 216	1 222	1 282	1 321
Slaughter products - poultry	1 035	1 237	1 305	1 354	1 413	1 425	1 586	1 706	1 931	2 042	2 199	2 383	2 797	3 038
Slaughter products - fish	66	78	50	49	45	45	44	44	79	101	86	78	71	66
Margarine and fat spreads, excluding liquid margarine	355	348	345	345	341	363	391	402	426	432	421	348	359	335
Prepared feeds for farm animals	5 464	5 278	6 337	6 993	7 070	7 287	7 906	7 738	8 413	8 574	8 869	9 308	10 093	10 993
Prepared pet foods	208	225	254	265	269	320	354	362	393	403	447	496	588	644
Smoke houses (excl. afterburning)	258	326	342	354	339	333	328	361	365	366	362	361	392	387
Smoke houses (incl. afterburning)	516	653	684	708	678	667	656	722	730	732	725	722	784	774
Sawn wood	1 899	2 016	2 164	2 650	2 318	2 310	2 532	2 653	2 549	2 592	2 835	2 901	2 947	2 994
Storage, handling and transport of bulk prod. - cement	12 837	1 312	1 606	1 721	1 578	2 234	15 812	18 993	15 919	14 831	15 815	15 265	15 782	17 254
Storage, handling and transport of bulk prod. - coal	100 087	97 903	95 221	88 313	84 345	78 065	76 728	76 448	79 813	77 056	73 271	72 686	70 784	65 967
Storage, handling and transport of bulk prod. - coke	10 214	8 404	9 613	10 168	10 075	7 091	9 738	9 377	8 891	9 360	9 568	9 792	9 708	9 256

Table A5. 37. Activity data used in the category NFR 3.F On-field burning of stubble

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fires of agricultural crops, meadows, stubbles [ha]	42 991	42 991	42 991	42 991	37 208	39 275	53 919	54 369	32 795	40 380	28 943	34 038	35 435	109 624

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Fires of agricultural crops, meadows, stubbles [ha]	39 331	36 149	28 998	16 652	19 696	13 031	9 855	15 691	39 639	10 640	23 817	32 513	9 043	10 140

Table A5. 38. Activity data used in the category NFR 5.A Biological treatment of waste - Solid waste disposal on land [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
MSW landfilled	11 087	10 627	10 610	10 552	10 900	10 784	11 402	11 964	11 988	12 035	11 888	10 638	10 162	9 609
ISW landfilled	38 948	35 097	31 531	29 819	31 322	28 615	30 658	44 044	35 807	27 740	22 347	20 507	17 052	16 065
Landfilled Solid Waste	50 035	45 724	42 141	40 370	42 222	39 398	42 060	56 008	47 795	39 775	34 235	31 144	27 214	25 674

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MSW landfilled	9 194	8 623	8 987	9 098	8 693	7 859	7 369	6 967	7 158	5 979	5 437	4 808	4 255	5 000
ISW landfilled	17 133	16 713	18 818	19 467	20 290	21 369	20 694	26 601	26 998	33 262	22 236	22 026	22 069	16 910
Landfilled Solid Waste	26 327	25 336	27 805	28 565	28 983	29 228	28 063	33 568	34 156	39 241	27 673	26 834	26 324	21 910

Table A5. 39. Activity data used in the category NFR 5.C.1.a Municipal waste incineration [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Municipal waste incineration	0	0	0	0	0	0	0	0	0	0	2.90	26.00	36.00	41.60

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Municipal waste incineration	43.00	44.38	41.27	43.80	40.82	40.30	40.90	39.72	43.09	85.33	67.17	283.47	472.23	557.27

Table A5. 40. Activity data used in the category NFR 5.C.1.b Industrial waste incineration [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
ISW incinerated (no APCs)	7.9	6.6	5.8	5.3	4.9	4.6	4.2	3.8	3.6	2.6	2.1	2.8	3.5	4.7
ISW incinerated (minimal APCs)	54.3	48.0	45.1	44.2	43.9	44.1	44.4	43.9	46.5	38.0	36.7	47.9	60.5	79.7
ISW incinerated (good APCs)	131.6	117.8	112.3	111.4	112.2	114.3	116.5	116.9	125.4	104.0	101.8	132.9	167.8	219.9
ISW incinerated (very good APCs)	57.1	51.4	49.3	49.1	49.7	50.9	52.1	52.5	56.6	47.1	46.3	60.5	76.4	100.6

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ISW incinerated (no APCs)	2.9	3.1	2.6	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ISW incinerated (minimal APCs)	49.8	52.9	55.5	59.7	93.2	90.3	74.0	42.5	48.1	38.6	25.5	23.6	24.5	21.1
ISW incinerated (good APCs)	138.0	146.6	111.3	133.3	9.5	11.1	9.1	5.2	5.9	4.7	3.1	2.9	3.0	2.6
ISW incinerated (very good APCs)	62.8	66.8	109.6	128.4	211.1	198.7	162.8	93.5	106.0	84.9	56.0	51.9	53.8	46.5

Table A5. 41. Activity data used in the category NFR 5.C.1. b.iii Clinical waste incineration [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Incineration of clinical wastes (compliance with EU Directive)	45.25	45.07	44.26	45.43	46.21	45.98	46.25	45.82	46.00	44.69	46.26	24.69	16.88	19.22
Incineration of clinical wastes (minimal APCs)	10.77	10.05	9.21	8.80	8.30	7.63	7.05	6.39	5.82	5.09	4.70	2.21	1.32	1.28
Incineration of clinical wastes (no APCs)														

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Incineration of clinical wastes (compliance with EU Directive)	25.40	28.19	21.18	24.25	23.47	27.38	26.55	31.94	33.12	33.43	40.01	40.23	46.90	38.46
Incineration of clinical wastes (minimal APCs)	1.40	1.25	0.94	1.07	1.04	1.21	1.17	1.41	1.46	1.48	1.77	1.78	2.07	1.70
Incineration of clinical wastes (no APCs)														

Table A5. 42. Activity data used in the category NFR 5.C.1. b.iv Sewage sludge incineration [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Sludge incineration (good APCs)	4.95	5.28	5.61	6.27	6.60	7.92	9.24	11.22	13.66	10.54	1.36	1.86	1.26	1.88
Sludge incineration (very good APCs)	10.05	10.72	11.39	12.73	13.40	16.08	18.76	22.78	27.73	21.40	32.74	44.71	30.24	45.12

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sludge incineration (good APCs)	1.60	1.49	1.57	1.35	1.78	2.01	2.66	3.41	4.04	5.95	6.58	6.61	7.79	9.29
Sludge incineration (very good APCs)	38.30	35.86	37.75	32.33	42.76	48.35	63.74	81.81	97.07	142.82	157.84	158.76	186.89	222.99

Table A5. 43. Activity data used in the category NFR 5.C.1.b.v Cremations [thous.]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Cremations	0.2	0.4	0.6	0.8	1.0	2.0	2.5	3.0	3.4	4.7	6.0	7.7	9.4	11.5

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cremations	14.6	16.3	19.5	22.4	25.4	27.9	20.7	24.4	30.8	31.0	30.1	31.6	31.0	32.2

Table A5. 44. Activity data used in the category NFR 5.C.2 Open burning of agricultural wastes [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Open burning of agricultural wastes	266 114	257 732	224 832	269 275	224 973	262 737	255 997	246 043	272 249	248 690	234 152	273 641	249 054	237 886

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Open burning of agricultural wastes	292 687	252 293	245 444	241 430	300 324	322 809	278 419	275 720	290 128	318 474	347 214	312 048	325 489	305 490

Table A5. 45. Activity data used in the category NFR 5.D Wastewater handling

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Municipal Waste water treatment [mln m^3]	2 772	26 21	2 466	2 308	2 374	2 319	2 303	2 329	2 378	2 288	2 200	2 160	2 074	1 965
Latrines [mln inhabitants]	6.53	6.31	6.10	5.88	5.67	5.45	5.24	5.03	4.81	4.60	4.38	4.17	3.95	3.74

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Municipal Waste water treatment [mln m^3]	1 943	1 929	1 960	2 000	2 077	2 062	2 134	2 098	2 055	2 039	2 011	2 015	2 061	2 091
Latrines [mln inhabitants]	3.52	3.31	3.09	2.88	2.66	2.45	2.24	2.02	1.87	1.72	1.57	1.42	1.27	1.28

Table A5. 46. Activity data used in the category NFR 5.E Unintentional fires

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Landfill fires - surface	353	353	353	353	354	480	465	450	435	420	405	389	375	360
Landfill fires - deep	40	40	40	40	39	53	51	49	48	46	44	43	41	39
Automobile fires	3 500	4 000	4 600	5 091	5 237	5 277	5 540	6 135	6 701	7 243	7 100	6 851	7 212	6 916
Houses and industry plants fires	25 349	25 349	25 349	25 349	27 178	27 873	29 561	31 401	31 794	30 287	30 294	29 180	31 068	32 416

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Landfill fires - surface	344	329	315	299	284	269	254	239	224	208	194	179	163	148
Landfill fires - deep	38	36	34	33	31	29	28	26	24	23	21	19	18	16
Automobile fires	6 700	7 307	7 835	7 463	7 552	8 131	8 667	8 436	8 126	7 815	8 201	8 395	8 996	9 408
Houses and industry plants fires	31 561	33 001	33 373	32 891	33 644	33 432	34 318	33 635	35 045	32 853	32 793	35 548	36 943	38 061

Table A5. 47. Activity data used in the category NFR 11.B Forest fires [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Forest fires	240 308	86 491	1 455 721	257 293	273 555	160 383	431 651	199 629	122 430	244 768	208 449	100 658	153 653	630 322

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Forest fires	112 698	171 255	174 090	103 560	89 390	130 550	66 504	87 687	226 627	46 575	90 297	181 647	55 012	38 641

Table A5. 48. Activity data used in the category NFR 11.C Non-managed forests [thous. ha]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Non-managed broadleaf forests	1 766	1 776	1 779	1 791	1 798	1 816	1 829	1 861	1 893	1 908	1 948	1 981	2 019	2 050
Non-managed coniferous forests	6 739	6 743	6 751	6 736	6 738	6 735	6 757	6 755	6 771	6 772	6 761	6 740	6 754	6 784

Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Non-managed broadleaf forests	2 079	2 104	2 112	2 122	2 641	2 648	2 665	2 673	2 753	2 786	2 836	2 876	2 891	2 914
Non-managed coniferous forests	6 829	6 849	6 849	6 896	6 404	6 421	6 432	6 449	6 394	6 378	6 342	6 314	6 286	6 307

ANNEX 6. EMISSION FACTORS

I. NFR SECTOR 1 - ENERGY

Emission factors with their source used for estimation of 2016 emissions of the particular pollutants are presented in the tables below according to NFR categories. These factors are used when the information on emission volume is not available directly.

I.1 Public electricity and heat production (NFR sector 1.A.1.a)

Table A6. 1. SO_2 emission factors applied for NFR 1.A.1.a

Emission source	EF	EF unit
Heating plants		
Hard coal	0.0174	Mg/Mg
Coke	0.016	Mg/Mg
Fuel oils	0.006	Mg/Mg

Note: emission factors applied are country specific, based on sulphur content;

Table A6. 2. NO_x emission factors applied for NFR 1.A.1.a

Emission source	EF	EF unit	EF reference
Heating plants			
Hard coal	0.209	Mg/TJ	EMEP/EEA EIG 2016
Brown coal	0.247	Mg/TJ	EMEP/EEA EIG 2016
Diesel oil	0.065	Mg/TJ	EMEP/EEA EIG 2016
Fuel oil	0.142	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.089	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 3. CO emission factors applied for NFR 1.A.1.a

Emission source	EF	EF unit	EF reference
Heating plants			
Hard coal	0.0087	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.0151	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.039	Mg/TJ	EMEP/EEA EIG 2016
Industrial power			
Hard coal and lignite	0.0087	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.039	Mg/TJ	EMEP/EEA EIG 2016
Fuel wood and wood waste	0.09	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.0087	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.0151	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.039	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 4. PM emission factors applied for NFR 1.A.1.a

Emission source	EF			EF unit	EF reference	BC*** % of PM2.5
	TSP	PM10	PM2.5			
Public power						
Hard coal	0.0091	0.006	0.003	Mg/TJ	PL (ARE) *	2.2
Brown coal	0.0092	0.006	0.003	Mg/TJ	PL (ARE) *	1.0
Fuel oils	0.0354	0.0252	0.0193	Mg/TJ	EMEP/EEA EIG 2016	5.6
Natural gas	0.00089	0.00089	0.00089	Mg/TJ	EMEP/EEA EIG 2016	2.5
Industrial gases	0.00089	0.00089	0.00089	Mg/TJ	EMEP/EEA EIG 2016	2.5
Heating plants						
Hard coal and coke	0. 0279	0.0182	0.0096	Mg/TJ	**	2.2
Fuel oils	0.0354	0.0252	0.0193	Mg/TJ	EMEP/EEA EIG 2016	5.6
Natural gas	0.00089	0.00089	0.00089	Mg/TJ	EMEP/EEA EIG 2016	2.2
Industrial gases	0.00089	0.00089	0.00089	Mg/TJ	EMEP/EEA EIG 2016	2.5
Industrial power						
Hard coal	0.0114	0.0077	0.0034	Mg/TJ	EMEP/EEA EIG 2016	2.2
Brown coal	0.0117	0.0079	0.0032	Mg/TJ	EMEP/EEA EIG 2016	1.0
Wood and wood waste	0.172	0.155	0.133	Mg/TJ	EMEP/EEA EIG 2016	3.3
Fuel oils	0.0354	0.0252	0.0193	Mg/TJ	EMEP/EEA EIG 2016	5.6
Industrial gases	0.00089	0.00089	0.00089	Mg/TJ	EMEP/EEA EIG 2016	2.5

* PL(ARE) emission factors come from ARE surveys
** emission factors from national publications [62, 63, 64];
*** emission factors from EMEP/EEA EIG 2016

Table A6. 5. NMVOC emission factors applied for NFR 1.A.1.a

Emission source	EF	EF unit	EF reference
Public power			
Hard coal, brown coal, coal briquettes	0.001	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.001	Mg/TJ	EMEP/EEA EIG 2016
Gasoline	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.0023	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0.00731	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Biogas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Heating plants			
Hard coal, hard coal briquettes	0.001	Mg/TJ	EMEP/EEA EIG 2016
Brown coal, brown coal briquettes, coke	0.0014	Mg/TJ	EMEP/EEA EIG 2016
Gasoline	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.0023	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0,00731	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Biogas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.0026	Mg/TJ	EMEP/EEA EIG 2016

Emission source	EF	EF unit	EF reference
Industrial power			
Hard coal, brown coal	0.001	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0.00731	Mg/TJ	EMEP/EEA EIG 2016
Biogas	0.0025	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.0026	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Diesel oil	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Fuel oil	0.0023	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.0026	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 6. Main Heavy Metals emission factors applied for NFR 1.A.1.a

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Public power					
Hard coal	0.00024	-	0.00896	kg/TJ	PL (IETU)
Brown coal	0.00023	-	0.00384	kg/TJ	PL (IETU)
Coke	0.001	-	0.0086	kg/TJ	PL (IETU)
Wood and wood waste	0.0018	-	0.021	kg/TJ	PL (IETU)
Fuel oil	0.0024	-	0.003	kg/TJ	PL (IETU)
Natural gas	0.0005	-	0.0002	kg/TJ	PL (IETU)
Industrial gases	0.0005	-	0.0002	kg/TJ	PL (IETU)
Heating plants					
Hard coal	0.00137	0.0064	0.1024	kg/TJ	PL (IETU)
Brown coal	0.00013	0.004	0.00384	kg/TJ	PL (IETU)
Hard coal briquettes	0.01638	0.0064	0.1024	kg/TJ	PL (IETU)
Brown coal briquettes	0.00013	0.004	0.00384	kg/TJ	PL (IETU)
Coke	0.001	0.0017	0.0086	kg/TJ	PL (IETU)
Wood and wood waste	0.0018	0.0015	0.021	kg/TJ	PL (IETU)
Fuel oil	0.024	-	0.03	kg/TJ	PL (IETU)
Natural gas	0.0005	0.0001	0.0002	kg/TJ	PL (IETU)
Industrial gases	0.0005	0.0001	0.0002	kg/TJ	PL (IETU)
Industrial power					
Hard coal	0.0052	0.008	0.17	kg/TJ	PL (IETU)
Brown coal	0.0004	0.005	0.022	kg/TJ	PL (IETU)
Hard coal briquettes	0.0052	0.008	-	kg/TJ	PL (IETU)
Brown coal briquettes	0.0040	0.005	-	kg/TJ	PL (IETU)
Coke	0.023	0.0006	0.13	kg/TJ	PL (IETU)
Wood and wood waste	0.0018	0.0007	0.025	kg/TJ	PL (IETU)
Fuel oil	0.024	-	0.03	kg/TJ	PL (IETU)
Natural gas	0.0005	0.0002	0.0002	kg/TJ	PL (IETU)

Note: * Hg EFs applied have been based on a country study, conducted in 2011-2013 by Polish Energy Group PGE, data from Polish emissions database and own analyses. Note: PL (IETU) emission factors from IETU surveys

Table A6. 7. Additional Heavy Metals emission factors applied for NFR 1.A.1.a

Emission source	EF *					EF unit	EF reference
	As	Cr	Cu	Ni	Zn		
Public power							
Hard coal	0.00134	0.0025	0.00704	0.00576	0.01792	kg/TJ	PL (IETU)
Brown coal	0.00282	0.00192	0.00384	0.0009	0.01664	kg/TJ	PL (IETU)
Hard coal briquettes	0.0013	0.0025	0.007	0.00576	0.01792	kg/TJ	PL (IETU)
Brown coal briquettes	0.0028	0.00192	0.00384	0.0009	0.01664	kg/TJ	PL (IETU)
Coke	0.0084	0.0053	0.0078	0.0057	0.019	kg/TJ	PL (IETU)
Wood and wood waste	0.0095	0.009	0.021	0.014	0.181	kg/TJ	PL (IETU)
Fuel oil	0.0024	0.0029	0.0068	0.0654	0.0024	kg/TJ	PL (IETU)
Natural gas	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)
Industrial gases	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)
Heating plants							
Hard coal	0.01024	0.01408	0.0576	0.0512	0.416	kg/TJ	PL (IETU)
Brown coal	0.00282	0.00192	0.00384	0.0009	0.01664	kg/TJ	PL (IETU)
Hard coal briquettes	0.01024	0.01408	0.0576	0.0512	0.416	kg/TJ	PL (IETU)
Brown coal briquettes	0.00282	0.00192	0.00384	0.0009	0.01664	kg/TJ	PL (IETU)
Coke	0.0084	0.0053	0.0078	0.0057	0.019	kg/TJ	PL (IETU)
Wood and wood waste	0.0095	0.009	0.021	0.014	0.181	kg/TJ	PL (IETU)
Fuel oil	0.024	0.029	0.068	0.654	0.024	kg/TJ	PL (IETU)
Natural gas	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)
Industrial gases	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)
Industrial power							
Hard coal	0.017	0.022	0.095	0.085	0.69	kg/TJ	PL (IETU)
Brown coal	0.018	0.011	0.024	0.005	0.11	kg/TJ	PL (IETU)
Coke	0.002	0.017	0.086	0.076	0.53	kg/TJ	PL (IETU)
Wood and wood waste	0.0014	0.0065	0.0046	0.002	0.114	kg/TJ	PL (IETU)
Fuel oil	0.024	0.029	0.068	0.654	0.024	kg/TJ	PL (IETU)
Natural gas	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)

Note: * all Additional Heavy Metals emission factors are country specific – PL (IETU) surveys

Table A6. 8. PCDD/F emission factors applied for NFR 1.A.1.a

Activity	EF	EF unit	EF reference
Hard coal	0.06	mg TEQ/Gg	Grochowalski A., 2002
Lignite	0.06	mg TEQ/Gg	EF for hard coal was applied
Hard coal briquettes (patent fuels)	0.06	mg TEQ/Gg	EF for hard coal was applied
Brown coal briquettes	0.06	mg TEQ/Gg	EF for hard coal was applied
Fuel wood and wood waste	1	mg TEQ/Gg	Berdowski et al., 1995
Fuel oil	1	mg TEQ/Gg	NILU, 1999
Natural gas	0.5	ng TEQ/GJ	EMEP/EEA Guidebook (2016)
Industrial gases	0.5	ng TEQ/GJ	EMEP/EEA Guidebook (2016)

Table A6. 9. Emission factors of PCBs applied for NFR 1.A.1.a

Activity	EF	EF unit	EF reference
Hard coal	0.31	g/Gg	EF applied in Bulgaria
Lignite - Public power	1.8	g/Gg	Parma at al., 1995
Brown coal briquettes	1.8	g/Gg	EF for lignite was applied
Fuel wood and wood waste	0.9	g/Gg	Parma at al., 1995
Fuel oils	0.6	g/Gg	Parma at al., 1995

Table A6. 10. HCB emission factors applied for NFR 1.A.1.a

Activity	EF	EF unit	EF reference
Hard coal	0.013	g/Gg	Bailey, 2001
Fuel wood and wood waste	0.06	g/Gg	Bailey, 2001

Table A6. 11. Benzo(a)pyrene emission factors applied for NFR 1.A.1.a

Activity	EF	EF unit	EF reference
Hard coal	0.00352	g/Gg	Berdowski et al., 1995
Lignite	0.00352	g/Gg	Berdowski et al., 1995
Natural gas	0.56	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.56	µg/GJ	EMEP/EEA EIG 2016
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al., 1995
Fuel oils	4.68	g/Gg	Berdowski et al., 1995

Table A6. 12. Benzo(b)fluoranthene emission factors applied for NFR 1.A.1.a

Activity	EF	EF unit	EF reference
Hard coal	0.00732	g/Gg	Berdowski et al., 1995
Lignite	0.00732	g/Gg	Berdowski et al., 1995
Natural gas	0.84	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.84	µg/GJ	EMEP/EEA EIG 2016
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Fuel oils	3.98	g/Gg	Berdowski et al., 1995

Table A6. 13. Benzo(k)fluoranthene emission factors applied for NFR 1.A.1.a

Activity	EF	EF unit	EF Reference
Hard coal	0.00732	g/Gg	Berdowski et al., 1995
Lignite	0.00732	g/Gg	Berdowski et al., 1995
Natural gas	0.84	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.84	µg/GJ	EMEP/EEA EIG 2016
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Fuel oil	3.98	g/Gg	Berdowski et al., 1995

Table A6. 14. Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.1.a

Activity	EF	EF unit	EF Reference
Hard coal	0.00703	g/Gg	Berdowski et al., 1995
Lignite	0.00703	g/Gg	Berdowski et al., 1995
Natural gas	0.84	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.84	µg/GJ	EMEP/EEA EIG 2016
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al., 1995
Fuel oils	7.57	g/Gg	Berdowski et al., 1995

I.2 Petroleum refining (NFR sector 1.A.1.b)

For *Petroleum refining plants* aggregate emission data of SO_2 and NO_x were included from the National Database. CO emissions have been estimated based on confidential data and volume of production.

Table A6. 15. PM emission factors applied for NFR 1.A.1.b

Emission source	EF			EF unit	BC % of PM2.5	EF reference
	TSP	PM10	PM2.5			
Petroleum refining plants						
Hard coal	0.0114	0.0077	0.0034	Mg/TJ	2.2	EMEP/EEA EIG 2016
Coke	0.0114	0.0077	0.0034	Mg/TJ	2.2	EMEP/EEA EIG 2016
Diesel oil	0.0065	0.0032	0.0008	Mg/TJ	33.5	EMEP/EEA EIG 2016
Fuel oils	0.0354	0.0252	0.0193	Mg/TJ	5.6	EMEP/EEA EIG 2016
Natural gas	0.00089	0.00089	0.00089	Mg/TJ	2.2	EMEP/EEA EIG 2016
Industrial gases	0.00089	0.00089	0.00089	Mg/TJ	18.4	EMEP/EEA EIG 2016

Table A6. 16. NMVOC emission factors applied for NFR 1.A.1.b

Emission source	EF	EF unit	EF Reference
Petroleum refining plants			
Hard coal, brown coal and briquettes	0.001	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.001	Mg/TJ	EMEP/EEA EIG 2016
Gasoline	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Fuel oil	0.0023	Mg/TJ	EMEP/EEA EIG 2016
Other products from crude oil	0.0023	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0.00731	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Biogas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.0026	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 17. Main Heavy Metals emission factors applied for NFR 1.A.1.b

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Petroleum refining plants					
Hard coal	0.027	0.008	0.17	kg/TJ	PL (IETU)
Brown coal	0.0007	0.005	0.022	kg/TJ	PL (IETU)
Coke	0.023	0.0006	0.13	kg/TJ	PL (IETU)
Fuel oil	0.024	-	0.03	kg/TJ	PL (IETU)
Natural gas	0.0005	0.0001	0.0002	kg/TJ	PL (IETU)
Industrial gases	0.00071	0.00009	0.0018	kg/TJ	PL (IETU)

Note: PL (IETU) emission factors from IETU surveys

Table A6. 18. Additional Heavy Metals emission factors applied for NFR 1.A.1.b

Emission source	EF					EF unit	EF reference
	As	Cr	Cu	Ni	Zn		
Petroleum refining plants							
Hard coal	0.017	0.022	0.095	0.085	0.69	kg/TJ	PL (IETU)
Brown coal	0.018	0.011	0.024	0.005	0.11	kg/TJ	PL (IETU)
Coke	0.002	0.017	0.086	0.076	0.53	kg/TJ	PL (IETU)
Fuel oil	0.024	0.029	0.068	0.654	0.024	kg/TJ	PL (IETU)
Natural gas	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)
Industrial gases	0.00034	0.0027	0.0022	0.0036	-	kg/TJ	PL (IETU)

Note: all additional Heavy Metals emission factors are country specific – PL (IETU) surveys

Table A6. 19. PCDD/F emission factors applied for NFR 1.A.1.b

Activity	EF	EF unit	EF Reference
Hard coal	0.06	mg TEQ/Gg	Grochowalski A., 2002
Lignite	0.06	mg TEQ/Gg	EF for hard coal was applied
Fuel wood and wood waste	1	mg TEQ/Gg	Berdowski et al., 1995
Fuel oil	1	mg TEQ/Gg	NILU, 1999
Natural gas	0.5	ng TEQ/GJ	EMEP/EEA EIG 2016
Industrial gases	0.5	ng TEQ/GJ	EMEP/EEA EIG 2016

Table A6. 20. Emission factors of PCBs applied for NFR 1.A.1.b

Activity	EF	EF unit	EF Reference
Hard coal	0.31	g/Gg	EF applied in Bulgaria
Fuel wood and wood waste	0.9	g/Gg	Parma at al., 1995
Fuel oils	0.6	g/Gg	Parma at al., 1995

Table A6. 21. HCB emission factors applied for NFR 1.A.1.b

Activity	EF	EF unit	EF Reference
Hard coal	0.013	g/Gg	Bailey R., 2001

Table A6. 22. Benzo(a)pyrene emission factors applied for NFR 1.A.1.b

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al., 1995
Hard coal	0.586	g/Gg	Berdowski et al., 1995
Lignite	0.586	g/Gg	Berdowski et al., 1995
Fuel oils	3.43	g/Gg	Berdowski et al., 1995
Industrial gases	0.67	µg/GJ	EMEP/EEA Guidebook 2009

Note: Applied emission factors come from Berdowski et al., 1995 [55]

Table A6. 23. Benzo(b)fluoranthene emission factors applied for NFR 1.A.1.b

Activity	EF	EF unit	EF Reference
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	Berdowski et al., 1995
Fuel oils	1.81	g/Gg	Berdowski et al., 1995

Table A6. 24. Benzo(k)fluoranthene emission factors applied for NFR 1.A.1.b

Activity	EF	EF unit	EF Reference
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	Berdowski et al., 1995
Fuel oil	2.83	g/Gg	Berdowski et al., 1995

Table A6. 25. Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.1.b

Activity	EF	EF unit	EF Reference
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al., 1995
Hard coal	17.6	g/Gg	Berdowski et al., 1995
Lignite	17.6	g/Gg	Berdowski et al., 1995
Diesel oil	6.84	g/Gg	EF for fuel oil was applied
Fuel oil	6.84	g/Gg	Berdowski et al., 1995

I.3 Manufacture of solid fuels and other energy industries (NFR sector 1.A.1.c)

For category NFR 1.A.1.c aggregate emission data of SO_2 and NO_x were included from the National Database. CO emissions have been estimated based on confidential data and volume of production.

Table A6. 26. PM emission factors applied for NFR 1.A.1.c

Emission source	EF			EF unit	BC % of PM2.5	EF reference
	TSP	PM10	PM2.5			
Hard coal	0.082	0.079	0.055	Mg/TJ	2.2	EMEP/EEA EIG 2016
Fuel oils	0.0354	0.0252	0.0193	Mg/TJ	5.6	EMEP/EEA EIG 2016
Diesel oil	0.0065	0.0032	0.0008	Mg/TJ	33.5	EMEP/EEA EIG 2016
Natural gas	0.00089	0.00089	0.00089	Mg/TJ	2.2	EMEP/EEA EIG 2016
Industrial gases	0.00089	0.00089	0.00089	Mg/TJ	2.2	EMEP/EEA EIG 2016
Coal mining, oil / gas extraction, pipeline compressors						
Brown coal	0.082	0.079	0.055	Mg/TJ	1.0	EMEP/EEA EIG 2016
Coke	0.082	0.079	0.055	Mg/TJ	2.2	EMEP/EEA EIG 2016

Table A6. 27. NMVOC emission factors applied for NFR 1.A.1.c

Emission source	EF	EF unit	EF Reference
Hard coal	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Coal briquettes	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Biogas	0.0026	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.0026	Mg/TJ	EMEP/EEA EIG 2016

Emission source	EF	EF unit	EF Reference
Coal mining, oil/gas extraction			
Brown coal	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Gasoline	0.0008	Mg/TJ	EMEP/EEA EIG 2016
Fuel oil	0.0023	Mg/TJ	EMEP/EEA EIG 2016

Note: PL (IETU) emission factors come from IETU surveys

Table A6. 28. Main Heavy Metals emission factors applied for NFR 1.A.1.c

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Hard coal	0.027	0.008	0.17	kg/TJ	PL (IETU)
Brown coal	0.0007	0.005	0.022	kg/TJ	PL (IETU)
Coke	0.023	0.001	0.13	kg/TJ	PL (IETU)
Fuel oil	0.024	-	0.03	kg/TJ	PL (IETU)
Natural gas	0.0005	0.0001	0.0002	kg/TJ	PL (IETU)
Industrial gases	0.0005	0.0001	0.0002	kg/TJ	PL (IETU)

Note: PL (IETU) emission factors from IETU surveys

Table A6. 29. Additional Heavy Metals emission factors applied for NFR 1.A.1.c

Emission source	EF					EF unit	EF reference
	As	Cr	Cu	Ni	Zn		
Hard coal	0.017	0.022	0.095	0.085	0.69	kg/TJ	PL (IETU)
Brown coal	0.018	0.011	0.024	0.005	0.11	kg/TJ	PL (IETU)
Coke	0.002	0.017	0.086	0.076	0.53	kg/TJ	PL (IETU)
Fuel oil	0.024	0.029	0.068	0.654	0.024	kg/TJ	PL (IETU)
Natural gas	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)
Industrial gases	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)

Note: all Additional Heavy Metals emission factors are country specific – PL (IETU) surveys

Table A6. 30. PCDD/F emission factors applied for NFR 1.A.1.c

Activity	EF	EF unit	EF Reference
Hard coal	0.06	mg TEQ/Gg	Grochowalski A., *2002*
Lignite	0.06	mg TEQ/Gg	EF for hard coal was applied
Fuel wood and wood waste	1	mg TEQ/Gg	Berdowski et al., 1995
Fuel oil	1	mg TEQ/Gg	NILU, 1999
Natural gas	0.5	ng TEQ/GJ	EMEP/EEA EIG 2016
Industrial gases	0.5	ng TEQ/GJ	EMEP/EEA EIG 2016

Table A6. 31. Emission factors of PCBs applied for NFR 1.A.1.c

Activity	EF	EF unit	EF Reference
Hard coal	0.31	g/Gg	EF applied in Bulgaria
Lignite (public power)	1.8	g/Gg	Parma at al., 1995
Fuel wood and wood waste	0.9	g/Gg	Parma at al., 1995
Fuel oils	0.6	g/Gg	Parma at al., 1995

Table A6. 32. HCB emission factors applied for NFR 1.A.1.c

Activity	EF	EF unit	EF Reference
Hard coal	0.013	g/Gg	Bailey R., 2001
Fuel wood and wood waste	0.06	g/Gg	Bailey R., 2001

Table A6. 33. Benzo(a)pyrene emission factors applied for NFR 1.A.1.c

Activity	EF	EF unit	EF Reference
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al., 1995
Hard coal	0.586	g/Gg	
Lignite	0.586	g/Gg	
Fuel oils	3.43	g/Gg	

Table A6. 34. Benzo(b)fluoranthene emission factors applied for NFR 1.A.1.c

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	Berdowski et al., 1995
Fuel oils	1.81	g/Gg	Berdowski et al., 1995

Table A6. 35. Benzo(k)fluoranthene emission factors applied for NFR 1.A.1.c

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	Berdowski et al., 1995
Fuel oils	1.81	g/Gg	Berdowski et al., 1995

Table A6. 36. Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.1.c

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al., 1995
Hard coal	17.6	g/Gg	Berdowski et al., 1995
Lignite	17.6	g/Gg	Berdowski et al., 1995
Diesel oil	6.84	g/Gg	EF for fuel oil was applied
Fuel oil	6.84	g/Gg	Berdowski et al., 1995

I.4 Stationary combustion in manufacturing industries (NFR sector 1.A.2)

Most of the emission factors for stationary combustion in manufacturing industries are similar for the particular industries - they are shown below under the section I.4 *Stationary Combustion in Manufacturing Industries*.

Table A6. 37. SO_2 emission factors applied for NFR 1.A.2

Emission source	EF	EF unit
Hard coal	0.016	Mg/Mg
Brown coal	0.006	Mg/Mg
Coke	0.016	Mg/Mg

Note: emission factors applied for combustion of fuels are country specific, based on sulphur content

Table A6. 38. NO_x emission factors applied for NFR 1.A.2

Emission source	EF	EF unit	EF reference
Hard coal	0.173	Mg/TJ	EMEP/EEA EIG 2016
Brown coal	0.173	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.173	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0.091	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.513	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.074	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.074	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 39. CO emission factors applied for NFR 1.A.2

Emission source	EF	EF unit	EF reference
Hard coal	0.931	Mg/TJ	EMEP/EEA EIG 2016
Brown coal	0.931	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.931	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0.57	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.066	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.029	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.029	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 40. PM emission factors applied for NFR 1.A.2

Emission source	EF			EF unit	BC % of PM2.5	EF reference
	TSP	PM10	PM2.5			
Hard coal, brown coal and coke	0.124	0.117	0.108	Mg/TJ	2.2	EMEP/EEA EIG 2016
Natural gas	0.00078	0.00078	0.00078	Mg/TJ	2.5	EMEP/EEA EIG 2016
Wood and wood waste	0.150	0.143	0.140	Mg/TJ	3.3	EMEP/EEA EIG 2016
Fuel oils	0.02	0.02	0.02	Mg/TJ	5.6	EMEP/EEA EIG 2016
Industrial gases	0.00078	0.00078	0.00078	Mg/TJ	2.5	EMEP/EEA EIG 2016

Table A6. 41. NMVOC emission factors applied for NFR 1.A.2

Emission source	EF	EF unit	EF reference
Hard coal, brown coal and coal briquettes	0.0888	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0230	Mg/TJ	EMEP/EEA EIG 2016
Wood and wood waste	0.3000	Mg/TJ	EMEP/EEA EIG 2016
Biogas	0.0230	Mg/TJ	EMEP/EEA EIG 2016
Other petroleum products	0.0250	Mg/TJ	EMEP/EEA EIG 2016
Coke	0.0888	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.0230	Mg/TJ	EMEP/EEA EIG 2016
Gasoline and oils	0.0250	Mg/TJ	EMEP/EEA EIG 2016
Industrial gases	0.0230	Mg/TJ	EMEP/EEA EIG 2016

Table A6. 42. Main Heavy Metals emission factors applied for NFR 1.A.2

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Coke	0.023	0.001	0.13	kg/TJ	PL (IETU)
Wood and wood waste	0.0018	0.0007	0.025	kg/TJ	PL (IETU)
Fuel oil	0.024		0.03	kg/TJ	PL (IETU)
Natural gas	0.0005	0.0002	0.0002	kg/TJ	PL (IETU)
Hard coal	0.027	*	0.17	kg/TJ	PL (IETU)
Brown coal	0.0007	*	0.022	kg/TJ	PL (IETU)
Hard coal briquettes	0.027	0.008	0.17	kg/TJ	PL (IETU)
Brown coal briquettes	0.0007	0.005	0.022	kg/TJ	PL (IETU)

Note: Main Heavy Metals emission factors are country specific – PL (IETU) surveys;
* Emissions reported to National Database

Table A6. 43. Additional Heavy Metals emission factors applied for NFR 1.A.2

Emission source	EF					EF unit	EF reference
	As	Cr	Cu	Ni	Zn		
0302 Process furnaces without contact							
Hard coal	0.017	0.022	0.095	0.085	0.69	kg/TJ	PL (IETU)
Brown coal	0.018	0.011	0.086	0.005	0.11	kg/TJ	PL (IETU)
Coke	0.002	0.017	0.068	0.076	0.53	kg/TJ	PL (IETU)
Fuel oil	0.024	0.029	0.024	0.654	0.024	kg/TJ	PL (IETU)
0303 Processes with contact							
Hard coal	0.017	0.022	0.095	0.085	0.69	kg/TJ	PL (IETU)
Brown coal	0.018	0.011	0.086	0.005	0.11	kg/TJ	PL (IETU)
Hard coal briquettes	0.017	0.022	0.095	0.085	0.69	kg/TJ	PL (IETU)
Brown coal briquettes	0.018	0.011	0.086	0.005	0.11	kg/TJ	PL (IETU)
Coke	0.002	0.017	0.068	0.076	0.53	kg/TJ	PL (IETU)
Wood and wood waste	0.0014	0.0065	0.0046	0.002	0.114	kg/TJ	PL (IETU)
Fuel oil	0.024	0.029	0.024	0.654	0.024	kg/TJ	PL (IETU)
Natural gas	0.00009	0.0007	0.0004	0.001	0.014	kg/TJ	PL (IETU)

Note: Additional Heavy Metals emission factors are country specific – PL (IETU) surveys

Table A6. 44. PCDD/F emission factors applied for NFR 1.A.2

Activity	EF	EF unit	EF reference
Hard coal	0.06	mg TEQ/ Gg	Grochowalski A., *2002*
Lignite	0.06	mg TEQ/ Gg	EF for hard coal was applied
Fuel wood and wood waste	1	mg TEQ/ Gg	Berdowski et al., 1995
Fuel oil	1	mg TEQ/ Gg	NILU, 1999
Natural gas	0.52	ng TEQ/ GJ	EMEP/EEA EIG 2016
Industrial gases	0.52	ng TEQ/ GJ	EMEP/EEA EIG 2016

Table A6. 45. Emission factors of PCBs applied for NFR 1.A.2

Activity	EF	EF unit	EF reference
Hard coal	0.31	g/Gg	EF applied in Bulgaria
Lignite	1.8	g/Gg	Parma at al., 1995
Fuel wood and wood waste	0.9	g/Gg	Parma at al., 1995
Coke	3.6	g/Gg	NILU, 1999
Diesel oil	0.6	g/Gg	EF for fuel oil was applied
Fuel oil	0.6	g/Gg	Parma at al., 1995

Table A6. 46. HCB emission factors applied for NFR 1.A.2

Activity	EF	EF unit	EF reference
Hard coal	0.013	g/Gg	Bailey R., 2001
Fuel wood and wood waste	0.06	g/Gg	Bailey R., 2001

Table A6. 47. Benzo(a)pyrene emission factors applied for NFR 1.A.2

Activity	EF	EF unit	EF reference
Hard coal	0.586	g/Gg	Berdowski et al., 1995
Lignite	0.586	g/Gg	Berdowski et al., 1995
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al., 1995
Fuel oil	3.43	g/Gg	Berdowski et al., 1995
Natural gas	0.6	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.6	µg/GJ	EMEP/EEA EIG 2016

Table A6. 48. Benzo(b)fluoranthene emission factors applied for NFR 1.A.2

Activity	EF	EF unit	EF reference
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	Berdowski et al., 1995
Fuel wood and wood waste	19	g/Gg	Berdowski et al., 1995
Fuel oils	1.81	g/Gg	Berdowski et al., 1995
Natural gas	0.72	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.72	µg/GJ	EMEP/EEA EIG 2016

Table A6. 49. Benzo(k)fluoranthene emission factors applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	
Fuel wood and wood waste	19	g/Gg	
Fuel oils	1.81	g/Gg	
Natural gas	1.1	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	1.1	µg/GJ	EMEP/EEA EIG 2016

Table A6. 50. Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	17.6	g/Gg	Berdowski et al., 1995
Lignite	17.6	g/Gg	Berdowski et al., 1995
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al., 1995
Fuel oil	6.84	g/Gg	Berdowski et al., 1995
Natural gas	1.08	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	1.08	µg/GJ	EMEP/EEA EIG 2016

I.5 Transport (NFR sector 1.A.3)

I.5.1 Civil and International Aviation (NFR sector 1.A.3.a)

Table A6. 51. SO_2 emission factors applied for 1.A.3.a

SO_2 emission source	EF	EF unit	EF reference
Aviation (LTO & Cruise)	1.0	kg/Mg	EMEP/EEA EIG 2009

Table A6. 52. NO_x emission factors applied for 1.A.3.a

NO_x emission source	EF	EF unit	EF reference
Aviation (LTO & Cruise)			
Jet fuel - Civil Aviation	10.3	kg/Mg	EMEP/EEA EIG 2009
Jet fuel - International Aviation	12.8	kg/Mg	EMEP/EEA EIG 2009
Aviation gasoline - Civil Aviation	4.0	kg/Mg	EMEP/EEA EIG 2016

* emission factors come from ITS surveys

Table A6. 53. CO emission factors applied for 1.A.3.a

CO emission source	EF	EF unit	EF Reference
Aviation (LTO & Cruise)			
Jet fuel - Civil Aviation	2.0	kg/Mg	EMEP/EEA EIG 2016
Jet fuel - International Aviation	1.1	kg/Mg	EMEP/EEA EIG 2016
Aviation gasoline - Civil Aviation	1200.0	kg/Mg	EMEP/EEA EIG 2016

Table A6. 54. PM emission factors applied for 1.A.3.a

PM Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
Aviation (LTO & Cruise)					
Jet fuel - Civil Aviation	0.2	0.2	0.2	Mg/Gg	EMEP/EEA EIG 2009
Jet fuel - International Aviation	0.2	0.2	0.2	Mg/Gg	EMEP/EEA EIG 2009
Aviation gasoline - Civil Aviation	4	4	4	Mg/Gg	EMEP/EEA EIG 2009

Table A6. 55. NMVOC emission factors applied for 1.A.3.a

Emission source	EF	EF unit	EF reference
Aviation (LTO & Cruise)			
Jet fuel - Civil Aviation	0.1	kg/Mg	EMEP/EEA EIG 2009
Jet fuel - International Aviation	0.5	kg/Mg	EMEP/EEA EIG 2009
Aviation gasoline - Civil Aviation	19.0	kg/Mg	EMEP/EEA EIG 2016

I.5.2 Road Transportation (NFR sector 1.A.3.b)

Emission has been estimated with the use of COPERT 5 emission factors.

I.5.3 Railways (NFR sector 1.A.3.c)

Table A6. 56. SO_2, NO_x, CO and NMVOC emission factors applied for 1.A.3.c

SO_2 emission source	EF	EF unit	EF reference
Diesel locomotives			
SO_2 emissions	0.1	kg/Mg	PL (ITS)
NO_x emissions	52.4	kg/Mg	EMEP/EEA EIG 2016
CO emissions	10.7	kg/Mg	EMEP/EEA EIG 2016
NMVOC emissions	4.65	kg/Mg	EMEP/EEA EIG 2016

Table A6. 57. NH_3 emission factors applied for 1.A.3.c

Emission source	EF	EF unit	EF reference
Diesel locomotives	0.007	kg/Mg diesel	EMEP/EEA EIG 2016

Table A6. 58. PM emission factors applied for 1.A.3.c

PM Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
Diesel locomotives	4.7000	4.7000	4.7000	kg/Mg	PL (ITS)

Table A6. 59. Main Heavy Metals emission factors applied for 1.A.3.c

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Diesel oil	0.01			kg/Gg	INT. PUBL.

Table A6. 60. Additional Heavy Metals emission factors applied for 1.A.3.c

Emission source	EF					EF unit	EF reference
	As	Cr	Cu	Ni	Zn		
Diesel oil			0.3	0.07*	1.0*	kg/Gg	EMEP/EEA EIG, 2016

Table A6. 61. PCDD/F emission factors applied for 1.A.3.c

Activity	EF	EF unit	EF reference
Diesel oil	0.043	mg TEQ/Gg	LUA-NRW, 1997

Table A6. 62. Benzo(a)pyrene emission factors applied for 1.A.3.c

Activity	EF	EF unit	EF reference
Benzo(a)pyrene			
Diesel oil	0.03	g/Mg	EMEP/EEA EIG, 2016
Benzo(k)fluoranthene			
Diesel oil	0.4158	g/Gg	Berdowski et al., 1995
Indeno(1.2.3-cd)pyrene			
Diesel oil	0.2970	g/Gg	Berdowski et al., 1995

I.5.4 Navigation (NFR sector 1.A.3.d)

Table A6. 63. SO_2 emission factors applied for 1.A.3.d

Emission source	EF	EF unit	EF reference
1.A.3.d.ii - National navigation			
Inland waterways - Diesel oil	0.044	kg/Mg	PL (ITS)
Maritime activities			
National sea traffic, diesel oil	0.044	kg/Mg	PL (ITS)
National sea traffic, fuel oil	0.02	Mg/Mg	PL (ITS)

Table A6. 64. NO_x emission factors applied for 1.A.3.d

Emission source	EF	EF unit	EF reference
1.A.3.d.ii - National navigation			
Inland waterways - Diesel oil	54	kg/Mg	PL (ITS)
Maritime activities			
National sea traffic, diesel oil and fuel oil	58.4	kg/Mg	PL (ITS)

Table A6. 65. CO emission factors applied for 1.A.3.d

Emission source	EF	EF unit	EF reference
1.A.3.d.ii - National navigation			
Inland waterways - Diesel oil	7.4	kg/Mg	EMEP/EEA EIG 2016
Maritime activities			
National sea traffic, diesel oil and fuel oil	8	kg/Mg	PL (ITS)

Note: PL (ITS) emission factors come from ITS surveys.

Table A6. 66. PM emission factors applied for 1.A.3.d

PM Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
1.A.3.d.ii - National navigation					
Inland waterways - Diesel oil	4.7000	4.7000	4.7000	kg/Mg	PL (ITS)
Maritime activities					
National sea traffic, diesel oil and fuel oil	1.5	1.5	1.4	kg/Mg	EMEP/EEA EIG 2016

Note: PL (ITS) emission factors come from ITS surveys

Table A6. 67. NMVOC emission factors applied for 1.A.3.d

Emission source	EF	EF unit	EF reference
1.A.3.d.ii - National navigation			
Inland waterways - Diesel oil	2.7	Mg/Gg	EMEP/EEA EIG 2016
Maritime activities			
National sea traffic, diesel oil and fuel oil	2.7	Mg/Gg	EMEP/EEA EIG 2016

Note: PL (ITS) emission factors come from ITS surveys

Table A6. 68. Main Heavy Metals emission factors applied for 1.A.3.d

Emission source	EF			EF unit	EF reference
1.A.3.d.ii - National navigation	**Cd**	**Hg**	**Pb**		
Diesel oil	0.02	0.02	0.18	g/Mg	INT. PUBL.

Note: EFs were taken from international publications

Table A6. 69. Additional Heavy Metals emission factors applied for 1.A.3.d

Emission source	EF					EF unit
1.A.3.d.ii - National navigation	**As**	**Cr**	**Cu**	**Ni**	**Zn**	
Diesel oil	0.68	0.72	0.3	0.5		g/Mg

Note: EFs were taken from international publications

Table A6. 70. POPs emission factors applied for 1.A.3.d

Activity	EF	Unit	EF reference
Benzo(a)pyrene			
Diesel oil	0.297	kg/Gg	Berdowski et al., 1995
Benzo(k)fluoranthene			
Diesel oil	0.4158	g/Gg	Berdowski et al., 1995
Indeno(1.2.3-cd)pyrene			
Diesel oil	0.2970	g/Gg	Berdowski et al., 1995

I.5.5 Other transportation (NFR sector 1.A.3.e)

Table A6. 71. SO_2 emission factors applied for 1.A.3.e

Emission source	EF	EF unit	EF reference
Pipeline Transport	0.67	kg/Mg	EMEP/EEA EIG 2016

Table A6. 72. NO_x emission factors applied for 1.A.3.e

Emission source	EF	EF unit	EF reference
Pipeline Transport	74	kg/Mg	EMEP/EEA EIG 2009

Table A6. 73. CO emission factors applied for 1.A.3.a

Emission source	EF	EF unit	EF Reference
Pipeline Transport	29	kg/Mg	EMEP/EEA EIG 2016

Table A6. 74. PM emission factors applied for 1.A.3.e

Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
Pipeline Transport	0.78	0.78	0.78	Mg/Gg	EMEP/EEA EIG 2016

Table A6. 75. NMVOC emission factors applied for 1.A.3.e

Emission source	EF	EF unit	EF reference
Pipeline Transport	23	kg/Mg	EMEP/EEA EIG 2009

I.6 Other sectors – stationary sources (NFR sector 1.A.4)

I.6.1 Commercial/Institutional (NFR sector 1.A.4.ai), Residential (NFR sector 1.A.4.bi), Agriculture/Forestry/Fishing (NFR sector 1.A.4.ci)

Table A6. 76. SO_2 emission factors applied for NFR 1.A.4

Emission source	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	0.012	Mg/Mg	Kubica K., 2016
Hard coal briquettes	0.012	Mg/Mg	Kubica K., 2016
Brown coal	0.012	Mg/Mg	Kubica K., 2016
Brown coal briquettes	0.012	Mg/Mg	Kubica K., 2016
Wood and waste wood	0.002	Mg/Mg	Kubica K., 2016
Coke	0.011	Mg/Mg	Kubica K., 2016
Fuel oils	0.006	Mg/Mg	Kubica K., 2016
1.A.4.b.i Residential plants			
Hard coal	0.011	Mg/Mg	Kubica K., 2016
Brown coal	0.011	Mg/Mg	Kubica K., 2016
Wood and waste wood	0.002	Mg/Mg	Kubica K., 2016
Coke	0.011	Mg/Mg	Kubica K., 2016
Fuel oils	0.006	Mg/Mg	Kubica K., 2016
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.012	Mg/Mg	Kubica K., 2016
Hard coal briquettes	0.012	Mg/Mg	Kubica K., 2016
Brown coal	0.012	Mg/Mg	Kubica K., 2016
Brown coal briquettes	0.012	Mg/Mg	Kubica K., 2016
Wood and waste wood	0.002	Mg/Mg	Kubica K., 2016
Coke	0.011	Mg/Mg	Kubica K., 2016
Fuel oils	0.006	Mg/Mg	Kubica K., 2016

Note: applied emission factors come from K. Kubica 2016 [30]

Table A6. 77. NOx emission factors applied for NFR 1.A.4

Emission source	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	0.178	Mg/TJ	Kubica K., 2016
Hard coal briquettes	0.178	Mg/TJ	
Brown coal	0.113	Mg/TJ	
Brown coal briquettes	0.113	Mg/TJ	
Coke	0.064	Mg/TJ	
Wood and wood waste	0.090	Mg/TJ	
Fuel oils	0.306	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.074	Mg/TJ	
Industrial gases	0.074	Mg/TJ	
1.A.4.b.i Residential plants			
Hard coal	0.165	Mg/TJ	Kubica K., 2016
Brown coal	0.104	Mg/TJ	
Wood and wood waste	0.076	Mg/TJ	
Coke	0.006	Mg/TJ	
Fuel oils	0.051	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.051	Mg/TJ	
LPG	0.051	Mg/TJ	
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.178	Mg/TJ	Kubica K., 2016
Hard coal briquettes	0.178	Mg/TJ	
Brown coal	0.113	Mg/TJ	
Brown coal briquettes	0.113	Mg/TJ	
Wood and wood waste	0.090	Mg/TJ	
Coke	0.064	Mg/TJ	
Fuel oils	0.306	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.074	Mg/TJ	
LPG	0.074	Mg/TJ	

Note: applied emission factors come from K. Kubica, 2016 [30] and EMEP/EEA Emission Inventory Guidebook, 2016 [1]

Table A6. 78. CO emission factors applied for NFR 1.A.4

Emission source	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	1.329	Mg/TJ	Kubica K., 2016
Brown coal	2.669	Mg/TJ	
Coke	2.871	Mg/TJ	
Wood and wood waste	1.576	Mg/TJ	
Fuel oils	0.093	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.029	Mg/TJ	
Industrial gases	0.029	Mg/TJ	
1.A.4.b.i Residential plants			
Hard coal	3.390	Mg/TJ	Kubica K., 2016
Brown coal	3.997	Mg/TJ	
Coke	3.675	Mg/TJ	
Wood and wood waste	3.983	Mg/TJ	
Fuel oils	0.057	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.026	Mg/TJ	

Emission source	EF	EF unit	EF reference
LPG	0.026	Mg/TJ	
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	1.329	Mg/TJ	Kubica K., 2016
Brown coal	2.669	Mg/TJ	
Coke	2.871	Mg/TJ	
Wood and wood waste	1.576	Mg/TJ	
Fuel oils	0.093	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.029	Mg/TJ	
LPG	0.029	Mg/TJ	

Note: applied emission factors come from K. Kubica, 2016 [30] and EMEP/EEA Emission Inventory Guidebook, 2016 [1]

Table A6. 79. NH3 emission factors applied for NFR 1.A.4

Emission source	EF	EF unit	EF reference
1.A.4.b.i Residential plants			
Hard coal	0.3	kg/TJ	EMEP/EEA EIG 2016
Hard coal briquettes	0.3	kg/TJ	
Brown coal	0.3	kg/TJ	
Brown coal briquettes	0.3	kg/TJ	
Coke	0.3	kg/TJ	
Biomass (wood)	70.0	kg/TJ	

Note: applied emission factors come from EMEP/EEA Emission Inventory Guidebook, 2016 [1]

Table A6. 80. PM emission factors applied for NFR 1.A.4

Emission source	EF				EF unit	EF reference
	TSP	PM10	PM2.5	BC***		
1.A.4.a.i Commercial and institutional plants						
Hard coal	0.226	0.143	0.137	6.4	Mg/TJ	Kubica K. and R., 2014
Brown coal	0.126	0.079	0.064	6.4	Mg/TJ	
Coke	0.074	0.033	0.020	6.4	Mg/TJ	
Wood and wood waste	0.102	0.095	0.092	3.3	Mg/TJ	
Fuel oils	0.021***	0.021	0.018	56.0	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.00078	0.00078	0.00078	4.0	Mg/TJ	
Industrial gases	0.00078	0.00078	0.00078	4.0	Mg/TJ	
1.A.4.b.i Residential plants						
Hard coal	0.344	0.244	0.115	6.4	Mg/TJ	Kubica K. and R., 2014
Brown coal	0.357	0.284	0.100	6.4	Mg/TJ	
Coke	0.091	0.038	0.020	6.4	Mg/TJ	
Wood and wood waste	0.267	0.237	0.226	10.0	Mg/TJ	
Fuel oils	0.0019	0.0019	0.0019	8.50	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0012	0.0012	0.0012	5.40	Mg/TJ	
LPG	0.0012	0.0012	0.0012	5.40	Mg/TJ	
1.A.4.c.i Agriculture/Forestry/Fishing						
Hard coal	0.500	0.375	0.125	6.4	Mg/TJ	PL *
Brown coal	0.500	0.375	0.125	6.4	Mg/TJ	
Coke	0.100	0.040	0.020	6.4	Mg/TJ	Kubica K. and R., 2014
Wood and wood waste	0.150	0.143	0.140	3.3	Mg/TJ	EMEP/EEA EIG 2016
Fuel oils	0.021**	0.021	0.018	56.0	Mg/TJ	
Natural gas	0.00078	0.00078	0.00078	4.0	Mg/TJ	
LPG	0.00078	0.00078	0.00078	4.0	Mg/TJ	

Note: applied emission factors come from K. Kubica and R. Kubica, 2014 [29] and EMEP/EEA Emission Inventory Guidebook, 2016 [1]. Moreover, country specific factors come from PL* - IChPW & IETU surveys; ** in EIG 2016 emission factor for TSP is 0.020 Mg/TJ and for PM10 is 0.021 Mg/TJ. Due to the fact that amount of emitted TSP cannot be lesser than amount of PM10, both factors were estimated as 0.021 Mg/GJ. ***BC emission factors are apllied from EMEP/EEA Emission Inventory Guidebook 16

Table A6. 81. NMVOC emission factors applied for NFR 1.A.4

Emission source	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	0.116	Mg/TJ	Kubica K., 2016
Brown coal	0.234	Mg/TJ	
Hard coal briquettes	0.020	Mg/TJ	PL (IETU)*
Brown coal briquettes	0.020	Mg/TJ	
Coke	0.047	Mg/TJ	Kubica K., 2016
Wood and wood waste	0.150	Mg/TJ	
Diesel / fuel oil	0.003	Mg/TJ	PL (IETU)*
Natural gas	0.023	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.023	Mg/TJ	
Industrial gases	0.023	Mg/TJ	
Biogas	0.023	Mg/TJ	

Emission source	EF	EF unit	EF reference
1.A.4.b.i Residential plants			
Hard coal	0.236	Mg/TJ	Kubica K., 2016
Brown coal	0.354	Mg/TJ	
Hard coal briquettes	0.020	Mg/TJ	PL (IETU)*
Brown coal briquettes	0.020	Mg/TJ	
Coke	0.075	Mg/TJ	Kubica K., 2016
Wood and wood waste	0.345	Mg/TJ	
Diesel oil	0.00069	Mg/TJ	EMEP/EEA EIG 2016
Natural gas	0.0019	Mg/TJ	
LPG	0.0019	Mg/TJ	
Industrial gases	0.0019	Mg/TJ	
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.116	Mg/TJ	Kubica K., 2016
Brown coal	0.234	Mg/TJ	
Hard coal briquettes	0.020	Mg/TJ	PL (IETU)*
Brown coal briquettes	0.020	Mg/TJ	
Coke	0.047	Mg/TJ	Kubica K., 2016
Wood and wood waste	0.150	Mg/TJ	
Diesel oil	0.003	Mg/TJ	PL (IETU)*
Natural gas	0.023	Mg/TJ	EMEP/EEA EIG 2016
LPG	0.023	Mg/TJ	
Industrial gases	0.023	Mg/TJ	
Biogas	0.023	Mg/TJ	

Note: applied emission factors come from K. Kubica, 2016 [30] and EMEP/EEA Emission Inventory Guidebook, 2016 [1]. Moreover, country specific factors come from PL (IETU)* - IETU surveys

Table A6. 82. Main Heavy Metals emission factors applied for NFR 1.A.4

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
1.A.4.a.i Commercial and institutional plants					
Hard coal	0.0032	0.0039	0.220	kg/TJ	K. Kubica 2017
Brown coal	0.0011	0.0046	0.074	kg/TJ	
Hard coal briquettes	0.0032	0.0039	0.220	kg/TJ	
Brown coal briquettes	0.0011	0.0046	0.074	kg/TJ	
Coke	0.0040	0.0006	0.130	kg/TJ	
Wood and wood waste	0.0010	0.0005	0.057	kg/TJ	
Natural gas	0.00052	0.00023	0.00098	kg/TJ	PL (IETU)
1.A.4.b.i Residential plants					
Hard coal	0.0019	0.0019	0.152	kg/TJ	Kubica K., 2017
Brown coal	0.0011	0.0043	0.072	kg/TJ	
Hard coal briquettes	0.0019	0.0019	0.152	kg/TJ	
Brown coal briquettes	0.0011	0.0043	0.072	kg/TJ	
Coke	0.0040	0.0012	0.170	kg/TJ	
Wood and wood waste	0.0029	0.0006	0.0295	kg/TJ	
Fuel oil	0.024	-	0.03	kg/TJ	Hławiczka S., 2001 (IETU)

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Natural gas	0.00052	0.00023	0.00098	kg/TJ	PL (IETU)
1.A.4.c.i Agriculture/Forestry/Fishing					
Hard coal	0.0032	0.0039	0.220	kg/TJ	Kubica K., 2017
Brown coal	0.0011	0.0046	0.074	kg/TJ	
Hard coal briquettes	0.0032	0.0039	0.220	kg/TJ	
Brown coal briquettes	0.0011	0.0046	0.074	kg/TJ	
Coke	0.0040	0.0006	0.130	kg/TJ	
Wood and wood waste	0.0010	0.0005	0.057	kg/TJ	
Fuel oil	0.024	-	0.030	kg/TJ	Hławiczka S., 2001 (IETU)
Natural gas	0.00052	0.00023	0.000011	kg/TJ	PL (IETU)

Note: applied emission factors come from Hławiczka S., 2001 (IETU) [18], K. Kubica, 2017 [52] and EMEP/EEA Emission Inventory Guidebook 2009/2013 [1] and PL (IETU)* - IETU surveys

Table A6. 83. Additional Heavy Metals emission factors applied for NFR 1.A.4

Emission source	EF					EF unit	EF reference
	As	Cr	Cu	Ni	Zn		
1.A.4.a.i Commercial and institutional plants							
Hard coal	0.0086	0.022	0.183	0.066	0.242	kg/TJ	Kubica K., 2017
Brown coal	0.016	0.027	0.020	0.008	0.108	kg/TJ	
Hard coal briquettes	0.0086	0.022	0.183	0.066	0.242	kg/TJ	
Brown coal briquettes	0.016	0.027	0.020	0.008	0.108	kg/TJ	
Coke	0.002	0.017	0.086	0.076	0.450	kg/TJ	
Wood and wood waste	0.0059	0.0058	0.013	0.003	0,175	kg/TJ	
Natural gas	0.000094	0.00066	0.0004	0.00098	0.014	kg/TJ	PL (IETU)
1.A.4.b.i Residential plants							
Hard coal	0.007	0.018	0.120	0.043	0.219	kg/TJ	Kubica K., 2017
Brown coal	0.015	0.028	0.016	0.008	0.104	kg/TJ	
Hard coal briquettes	0.007	0.018	0.120	0.043	0.219	kg/TJ	
Brown coal briquettes	0.015	0.028	0.016	0.008	0.104	kg/TJ	
Coke	0.005	0.045	0.237	0.110	0.450	kg/TJ	
Wood and wood waste	0.0079	0.0075	0.016	0.004	0.168	kg/TJ	
Fuel oil	0.024	0.029	0.068	0.654	0.024	kg/TJ	Hławiczka S., 2001
Natural gas	0.000094	0.00066	0.0004	0.00098	0.014	kg/TJ	PL (IETU)
1.A.4.c.i Agriculture/Forestry/Fishing							
Hard coal	0.0086	0.022	0.183	0.066	0.242	kg/TJ	Kubica K., 2017
Brown coal	0.016	0.027	0.020	0.008	0.108	kg/TJ	
Hard coal briquettes	0.0086	0.022	0.183	0.066	0.242	kg/TJ	
Brown coal briquettes	0.016	0.027	0.020	0.008	0.108	kg/TJ	
Coke	0.002	0.017	0.086	0.076	0.450	kg/TJ	
Wood and wood waste	0.0059	0.0058	0.013	0.003	0.175	kg/TJ	
Fuel oil	0.024	0.029	0.068	0.654	0.024	kg/TJ	Hławiczka S., 2001
Natural gas	0.000094	0.00066	0.0004	0.00098	0.014	kg/TJ	PL (IETU)

Note: applied emission factors from K. Kubica, 2017 [52], Hławiczka S., 2001 [18] and EMEP/EEA Emission Inventory Guidebook 2009 [1] and PL (IETU)* - IETU surveys

Table A6. 84. PCDD/F emission factors applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	0.06	mg TEQ/ Gg	Grochowalski A., 2002
Brown coal	0.06	mg TEQ/ Gg	EF for hard coal was applied
Fuel wood and wood waste	1	mg TEQ/ Gg	Berdowski et al., 1995
Coke	1	mg TEQ/ Gg	Berdowski et al., 1995
Fuel oil	1	mg TEQ/ Gg	NILU, 1999
Natural gas	0.52	ng TEQ/ GJ	EMEP/EEA EIG 2016
Industrial gases	0.52	ng TEQ/ GJ	
1.A.4.b.i Residential plants			
Hard coal	10	mg TEQ/ Gg	Berdowski et al., 1995
Brown coal	10	mg TEQ/ Gg	
Fuel wood and wood waste	5	mg TEQ/ Gg	
Fuel oil	1	mg TEQ/ Gg	NILU, 1999
Coke	0.61	mg TEQ/ Gg	LUA-NRW, 1997
Natural gas	1.5	ng TEQ/ GJ	EMEP/EEA EIG 2016
Industrial gases	1.5	ng TEQ/ GJ	
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.06	mg TEQ/ Gg	Grochowalski A., 2002
Brown coal	0.06	mg TEQ/ Gg	EF for hard coal was applied
Fuel wood and wood waste	1	mg TEQ/ Gg	Berdowski et al.,1995
Fuel oil	1	mg TEQ/ Gg	NILU, 1999
Natural gas	0.52	ng TEQ/ GJ	EMEP/EEA EIG 2016
Industrial gases	0.52	ng TEQ/ GJ	

Note: Applied emission factors come from: Grochowalski A., 2002 [16], EMEP/EEA Emission Inventory Guidebook, 2016 [1], Berdowski et al., 1995 [55], NILU, 1999 [56] and LUA-NRW, 1997 [57]

Table A6. 85. Emission factors of PCB applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	0.413	g/Gg	EF applied in Bulgaria
Brown coal	1.8	g/Gg	Parma at al., 1995
Fuel wood and wood waste	0.9	g/Gg	
Coke	3.6	g/Gg	NILU, 1999
Fuel oils	0.6	g/Gg	Parma at al., 1995
1.A.4.b.i Residential plants			
Hard coal	31.6	g/Gg	Parma at al., 1995
Brown coal	1.38*	g/Gg	EMEP/EEA EIG 2016
Fuel wood and wood waste	9	g/Gg	EF applied in Czech Republic
Coke	9.7	g/Gg	
Fuel oil	3.6	g/Gg	NILU, 1999
Diesel oil	0.6	g/Gg	Parma at al., 1995
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.413	g/Gg	EF applied in Bulgaria
Brown coal	1.8	g/Gg	Parma at al., 1995
Fuel wood and wood waste	0.9	g/Gg	
Coke	3.6	g/Gg	NILU, 1999
Fuel oils	0.6	g/Gg	Parma at al., 1995

Note: Applied emission factors come from: Parma at al., 1995 [58], NILU, 1999 [56]

* emission factor was calculated based on emission factor included in EMEP/EEA EIG 2016 – 170 g/GJ assuming that average calorific value of brown coal is 8,14 MJ/kg

Table A6. 86. HCB emission factors applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	0.013	g/Gg	Bailey R., 2001
Fuel wood and wood waste	0.06	g/Gg	
1.A.4.b.i Residential plants			
Hard coal	0.125	g/Gg	EF applied in Czech Republic www.recetox.muni.cz
Fuel wood and wood waste	0.06	g/Gg	Bailey R., 2001
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.013	g/Gg	Bailey R., 2001
Fuel wood and wood waste	0.06	g/Gg	

Note: Applied emission factors come from: Bailey R., 2001 [54], EMEP/EEA Emission Inventory Guidebook, 2016 [1].

Table A6. 87. Benzo(a)pyrene emission factors applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal and briquettes	0.586	g/Gg	Berdowski et al., 1995
Brown coal and briquettes	0.586	g/Gg	
Wood and wood waste	0.095	g/Gg	
Fuel oils	3.43	g/Gg	
Natural gas	0.72	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.72	µg/GJ	
1.A.4.b.i Residential plants			
Hard coal and briquettes	1500	g/Gg	Berdowski et al., 1995
Brown coal and briquettes	845	g/Gg	
Wood and wood waste	2480	g/Gg	
Fuel oils	3.43	g/Gg	
Natural gas	0.56	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.56	µg/GJ	
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal and briquettes	0.586	g/Gg	Berdowski et al., 995
Brown coal and briquettes	0.586	g/Gg	
Wood and wood waste	0.095	g/Gg	
Fuel oils	3.43	g/Gg	
Natural gas	0.72	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.72	µg/GJ	

Note: Applied emission factors come from: EMEP/EEA Emission Inventory Guidebook, 2016 [1] and Berdowski et al., 1995 [55]

Table A6. 88. Benzo(b)fluoranthene emission factors applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Brown coal	23.4	g/Gg	
Fuel wood and wood waste	19	g/Gg	
Fuel oils	1.81	g/Gg	
Natural gas	2.9	µg/GJ	EMEP/EEA EIG 2016

Activity	EF	EF unit	EF reference
Industrial gases	2.9	µg/GJ	
1.A.4.b.i Residential plants			
Hard coal	1600	g/Gg	Berdowski et al., 1995
Brown coal	1150	g/Gg	
Fuel wood and wood waste	3260	g/Gg	
Fuel oils	1.81	g/Gg	
Natural gas	0.84	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	0.84	µg/GJ	
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Brown coal	23.4	g/Gg	
Fuel wood and wood waste	19	g/Gg	
Fuel oils	1.81	g/Gg	
Natural gas	2.9	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	2.9	µg/GJ	

Note: Applied emission factors come from: EMEP/EEA Emission Inventory Guidebook, 2016 [1] and Berdowski et al., 1995 [55]

Table A6. 89. Benzo(k)fluoranthene emission factors applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Brown coal	23.4	g/Gg	
Fuel wood and wood waste	19	g/Gg	
Diesel oil	1.81	g/Gg	EF for fuel oil was applied
Fuel oils	1.81	g/Gg	Berdowski et al., 1995
Natural gas	1.1	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	1.1	µg/GJ	
1.A.4.b.i Residential plants			
Hard coal	50	g/Gg	Berdowski et al., 1995
Brown coal	525	g/Gg	
Fuel wood and wood waste	1080	g/Gg	
Fuel oils	2.83*	g/Gg	EMEP/EIA EIG 2016
Natural gas	0.84	µg/GJ	EMEP/EEA EIG 2016
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	23.4	g/Gg	Berdowski et al., 1995
Lignite	23.4	g/Gg	
Fuel wood and wood waste	19	g/Gg	
Diesel oil	1.81	g/Gg	EF for fuel oil was applied
Fuel oils	1.81	g/Gg	Berdowski et al., 1995
Natural gas	1.1	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	1.1	µg/GJ	

Note: Applied emission factors come from: EMEP/EEA Emission Inventory Guidebook, 2016 [1], Berdowski et al., 1995 [55]

* emission factor was calculated based on emission factor included in EMEP/EEA EIG 2016 (Tier 2) – 70 g/GJ assuming that average calorific value of fuel oils is 40.4 MJ/kg

Table A6. 90. Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.4

Activity	EF	EF unit	EF reference
1.A.4.a.i Commercial and institutional plants			
Hard coal	17.6	g/Gg	Berdowski et al., 1995
Brown coal	17.6	g/Gg	
Fuel wood and wood waste	0.17	g/Gg	
Fuel oils	6.84	g/Gg	
Natural gas	1.08	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	1.08	µg/GJ	
1.A.4.b.i Residential plants			
Hard coal	3000	g/Gg	Berdowski et al., 1995
Brown coal	1110	g/Gg	
Fuel wood and wood waste	1760	g/Gg	
Fuel oils	6.84	g/Gg	
1.A.4.c.i Agriculture/Forestry/Fishing			
Natural gas	0.84	µg/GJ	EMEP/EEA EIG 2016
Hard coal	17.6	g/Gg	Berdowski et al., 1995
Brown coal	17.6	g/Gg	
Fuel wood and wood waste	0.17	g/Gg	
Fuel oils	6.84	g/Gg	
Natural gas	1.080	µg/GJ	EMEP/EEA EIG 2016
Industrial gases	1.08	µg/GJ	

Note: Applied emission factors come from: EMEP/EEA Emission Inventory Guidebook, 2016 [1] and Berdowski et al., 1995 [55]

I.6.2 Agriculture/Forestry/Fishing – mobile sources (NFR sector 1.A.4.c.ii & 1.A.4.c.iii)

Table A6. 91. SO_2 emission factors applied for mobile sources

Emission source	EF	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.02*	kg/Mg	EMEP/EEA EIG 2016
1.A.4.c.iii National fishing			
Diesel oil	0.02*	kg/Mg	EMEP/EEA EIG 2016
Fuel oil	0.04**	kg/Mg	

Note: emission factors were calculated based on guidelines included in EMEP/EEA Emission Inventory Guidebook 2016 [1] assuming that all sulphur in the fuel is transformed completely into SO_2, then EF = 2 x S, where S is the maximal allowed sulphur content in fuel

* emission factor was calculated based on sulphur content in Diesel fuel (in Polish regulations – currently 10 mg/kg)

* emission factor was calculated based on sulphur content in fuel oil used in national fishing (in Polish regulations – currently 20 mg/kg)

Table A6. 92. NOx emission factors applied for mobile sources

Emission source	EF	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	34.457	kg/Mg	EMEP/EEA EIG 2016
1.A.4.c.iii National fishing			
Diesel oil and fuel oil	58.4	kg/Mg	PL (ITS)

Note: emission factors come from ITS surveys and EMEP/EEA Emission inventory Guidebook 2016 [1]

Table A6. 93. CO emission factors applied for mobile sources

Emission source	EF	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors)	46	kg/Mg	PL (ITS)
Diesel oil (machinery)	50	kg/Mg	
1.A.4.c.iii National fishing			
Diesel oil and fuel oil	8	kg/Mg	PL (ITS)

Note: applied emission factors come from ITS surveys

Table A6. 94. NH_3 emission factors applied for mobile sources

Emission source	EF	EF unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.008	kg/Mg diesel	EMEP/EEA EIG 2016

None: applied emission factors come from: EMEP/EEA Emission Inventory Guidebook, 2016 [1]

Table A6. 95. PM emission factors applied for mobile sources

PM Emission source	EF			BC % of PM2.5	EF unit	EF reference
	TSP	PM10	PM2.5			
1.A.4.c.ii Off-road vehicles and other machinery						
Diesel oil (tractors and machinery)	5.2	5.2	5.2	86.0*	kg/Mg	PL (ITS)
1.A.4.c.iii National fishing						
Diesel oil and fuel oil	4.0	4.0	4.0	31.0**	kg/Mg	PL (ITS)

Note: applied emission factors come from ITS surveys, BC emission factors come from *own publications [61] **EMEP/EEA Emission Inventory Guidebook 2016

Table A6. 96. NMVOC emission factors applied for mobile sources

Emission source	EF	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	3.542	kg/Mg	EMEP/EEA EIG 2016
1.A.4.c.iii National fishing			
Diesel oil and fuel oil	12.7	kg/Mg	PL (ITS)

Note: applied emission factors come from ITS surveys

Table A6. 97. Main Heavy Metals emission factors applied for mobile sources

Emission source	EF			EF unit
	Cd	Hg	Pb	
1.A.4.c.ii Off-road vehicles and other machinery				
Diesel oil (tractors and machinery)	0.01	-	-	kg/Gg
1.A.4.c.iii National fishing				
Diesel oil and fuel oil	0.02	0.02	0.18	kg/Gg

Note: applied emission factors come from EMEP/EEA Emission Inventory Guidebook, 2016 [1]

Table A6. 98. Additional Heavy Metals emission factors applied for mobile sources

Emission source	EF					EF unit
	As	Cr	Cu	Ni	Zn	
1.A.4.c.ii Off-road vehicles and other machinery						
Diesel oil (tractors and machinery)	-	-	1.7	0,07	-	kg/Gg
1.A.4.c.iii National fishing						
Diesel oil and fuel oil	-	-	1.25	32.0	-	kg/Gg

None: applied emission factors come from: EMEP/EEA Emission Inventory Guidebook, 2016 [1]

Table A6. 99. PCDD/F emission factors applied for mobile sources

Activity	EF	EF unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.043	mg TEQ/Gg	LUA-NRW, 1997
1.A.4.c.iii National fishing			
Diesel oil and fuel oil	0.043	mg TEQ/Gg	LUA-NRW, 1997

Note: Applied emission factors come from LUA-NRW, 1997 [57]

Table A6. 100. Benzo(a)pyrene emission factors applied for mobile sources

Activity	EF	EF unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.297	kg/Gg	Berdowski et al., 1995
1.A.4.c.iii National fishing			
Diesel oil	0.297	mg TEQ/Gg	LUA-NRW, 1997

Note: Applied emission factors come from Berdowski et al., 1995 [55], LUA-NRW, 1997 [57]

Table A6. 101. Benzo(b)fluorantene emission factors applied for mobile sources

Activity	EF	EF unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.416	kg/Gg	Berdowski et al., 1995
1.A.4.c.iii National fishing			
Diesel oil	0.416	kg/Gg	Berdowski et al., 1995

Note: Applied emission factors come from Berdowski et al., 1995 [55]

Table A6. 102. Benzo(k)fuorantene emission factors applied for SNAP 08

Activity	EF	EF unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.416	kg/Gg	Berdowski et al., 1995
1.A.4.c.iii National fishing			
Diesel oil	0.416	kg/Gg	Berdowski et al., 1995

Note: Applied emission factors come from Berdowski et al., 1995 [55]

Table A6. 103. Indeno(1.2.3-cd)pyrene emission factors applied for SNAP 08

Activity	EF	EF unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery			
Diesel oil (tractors and machinery)	0.297	kg/Gg	Berdowski et al., 1995
1.A.4.c.iii National fishing			
Diesel oil	0.297	kg/Gg	Berdowski et al., 1995

Note: Applied emission factors come from Berdowski et al., 1995 [55]

I.7 Fugitive emission (NFR sector 1.B)

I.7.1 Fugitive emission from solid fuels (NFR sector 1.B.1)

– *coal mining and handling (NFR 1.B.1.a.)*

Table A6. 104. NMVOC emission factors applied for NFR 1.B.1.a

Emission source	EF	EF unit	EF reference
Underground mining – hard coal	0.1	kg/Mg prod	PL (IETU)
Open coast mining	0.2	kg/Mg	PL (IETU)

Note: emission factor comes from IETU surveys

Table A6. 105. PM emission factors applied for NFR 1.B.1.a

Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2,5		
Extraction of brown coal	0.10172	0.05	-	kg/Mg	CEPMEIP
Extraction of hard coal	0.10172	0.05	-	kg/Mg	CEPMEIP
Emission source	**EF**			**EF unit**	**EF reference**
	TSP	**PM10**	**PM 2.5**		
Extraction of brown coal	-	-	0.005	kg/Mg	EMEP/EEA EIG 2016
Extraction of hard coal	-	-	0.005	kg/Mg	EMEP/EEA EIG 2016

– *solid fuel transformation (NFR 1.B.1.b.)*

Table A6. 106. NH3 emission factors applied for NFR 1.B.1.b

Emission source	EF	EF unit	EF reference
Coke oven plants	5	g/Mg coke	EMEP/EEA EIG 2009

Table A6. 107. PM emission factors applied for NFR 1.B.1.b

PM Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
Coke oven plants	0.2	0.2	0.1	kg/Mg	CEPMEIP

Table A6. 108. NMVOC emission factors applied for NFR 1.B.1.b

Emission source	EF	EF unit	EF reference
Coke oven plants	0.000008	Mg/Mg	EMEP/EEA EIG 2016

Table A6. 109. Main Heavy Metals emission factors applied for NFR 1.B.1.b

Emission source	EF			EF unit	EF reference
	Cd	Hg	Pb		
Coke oven plants	0.05	0.03	0.22	kg/Gg	PL (IETU)

Note: EF for Main Heavy Metals emission from Coke oven plants is country specific and come from IETU surveys

Table A6. 110. Additional Heavy Metals emission factors applied for NFR 1.B.1.b

Emission source	EF					Unit	EF reference
	As	Cr	Cu	Ni	Zn		
Coke oven plants	0.02	0.17	0.09	0.065	0.22	kg/Gg	International publications

Note: Additional Heavy Metals emission factors applied in SNAP 04 for process emissions were taken from international publications

Table A6. 111. POPs emission factors applied for NFR 1.B.1.b

Activity	EF	Unit	EF reference
Coke production (APCs/flue gas burn out)			
PCDD/F	0.3	mg TEQ/Gg	UNEP Toolkit, 2013
Benzo(a)pyrene	0.75	kg/Gg	Berdowski et al., 1995
Benzo(b)fluoranthene	0.25	kg/Gg	
Benzo(k)fluoranthene	0.25	kg/Gg	
Indeno(1.2.3-cd)pyrene	0.30	kg/Gg	

I.7.2 Fugitive emissions from oil and natural gas (NFR sector 1.B.2)

- *production, transport and refining of oil*

Table A6. 112. NMVOC emission factors applied for NFR 1.B.2.a

Emission source	EF	EF unit	EF reference
040101 Petroleum products processing	0.0002	Mg/Gg	EMEP/EEA EIG 2016
0504 Liquid fuel distribution (except gasoline distribution)			
050401 Marine terminals	0.3	kg/Mg	CORINAIR
050402 Fuel oil distribution	0.02	kg/Mg	CORINAIR
0505 Gasoline distribution			
050501 Refinery dispatch station	0.31	kg/Mg	CORINAIR
050502 Transport and depots	0.00006	kg/Mg	EMEP/EEA EIG 2016
050503 Service stations (including refuelling of cars)	2.8	kg/Mg	CORINAIR

Note: PL (IETU) emission factor comes from IETU surveys

- *production, processing, transmission, distribution of gas*

Table A6. 113. NMVOC emission factors applied for NFR 1.B.2.b

Emission source	EF	EF unit	EF reference
0503 Extraction of gaseous fuels			
high - methane natural gas	0.068	Mg/hm^3	PL (IETU)
nitrogenous natural gas	0.063	Mg/hm^3	PL (IETU)
0506 Gas distribution networks			
natural gas (high - methane)	0.338	Mg/hm^3	PL (IETU)
natural gas (nitrogenous)	0.784	Mg/hm^3	PL (IETU)
coke oven gas	0.727	Mg/hm^3	PL (IETU)

Note: PL (IETU) emission factor comes from IETU surveys

Table A6. 114. NMVOC emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF reference
Venting and flaring	2	g/m^3	EMEP/EEA EIG 2016

Table A6. 115. SOx emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF reference
Venting and flaring	77	g/m^3	EMEP/EEA EIG 2016

Table A6. 116. NOx emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF reference
Venting and flaring	54	g/m^3	EMEP/EEA EIG 2016

Table A6. 117. CO emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF reference
Venting and flaring	12	g/m^3	EMEP/EEA EIG 2016

II. NFR SECTOR 2 – INDUSTRIAL PROCESSES AND PRODUCT USE

II.1 Mineral Products (NFR sector 2.A)

Table A6. 118. Emission factors applied for 2.A - SO_2

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A2	Calx	Mg/Gg	0.32	0.32	EMEP/EEA EIG 2016*
2A3	Flat glass	Mg/Gg	1.96	1.96	EMEP/EEA EIG 2016

*) EMEP/EEA EIG 2016 – EMEP/EEA Air Pollutant Emissions Inventory Guidebook 2016

Table A6. 119. Emission factors applied for 2.A - CO

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A2	Calx	Mg/Gg	1.94	1.94	EMEP/EEA EIG 2016
2A3	Flat glass	Mg/Gg	0.01	0.01	EMEP/EEA EIG 2016
2A3	Container glass	Mg/Gg	0.01	0.01	EMEP/EEA EIG 2016

Table A6. 120. Emission factors applied for 2.A - TSP

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	Mg/Gg	0.00026	0.00026	EMEP/EEA EIG 2016
2A2	Calx	Mg/Gg	0.59	0.59	EMEP/EEA EIG 2009
2A2	Gypsum	Mg/Gg	0.59	0.59	EMEP/EEA EIG 2009
2A3	Flat glass	Mg/Gg	0.3	0.3	EMEP/EEA EIG 2016
2A3	Container glass	Mg/Gg	0.3	0.3	EMEP/EEA EIG 2016
2A3	Glass fiber	Mg/Gg	0.1	0.1	EMEP/EEA EIG 2016
2A5a	Quarrying of minerals (other than coal)	Mg/Gg	0.00007	0.00007	EMEP/EEA EIG 2009
2A5a	Quarrying of copper ore	Mg/Gg	0.102	0.102	EMEP/EEA EIG 2016
2A5a	Quarrying of zinc-lead ores	Mg/Gg	0.102	0.102	EMEP/EEA EIG 2016
2A5b	Construction	Mg/m^2	0.000162	0.000162	EMEP/EEA EIG 2009

Table A6. 121. Emission factors applied for 2.A – PM10

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	Mg/Gg	0.000234	0.000234	EMEP/EEA EIG 2016
2A2	Calx	Mg/Gg	0.24	0.24	EMEP/EEA EIG 2009
2A2	Gypsum	Mg/Gg	0.24	0.24	EMEP/EEA EIG 2009
2A3	Flat glass	Mg/Gg	0.27	0.27	EMEP/EEA EMEP/EEA EIG 2016
2A3	Container glass	Mg/Gg	0.27	0.27	EMEP/EEA EMEP/EEA EIG 2016
2A3	Glass fiber	Mg/Gg	0.09	0.09	EMEP/EEA EIG 2016
2A5a	Quarrying of minerals (other than coal)	Mg/Gg	0.00004	0.00004	EMEP/EEA EIG 2009
2A5a	Quarrying of copper ore	Mg/Gg	0.05	0.05	EMEP/EEA EIG 2016
2A5a	Quarrying of zinc-lead ores	Mg/Gg	0.05	0.05	EMEP/EEA EIG 2016
2A5b	Construction	Mg/m^2	0.000081	0.000081	EMEP/EEA EIG 2009

Table A6. 122. Emission factors applied for 2.A – PM2.5

NFR Code	Emission source	EF Unit	EF 1990	EF 2017	EF reference
2A1	Cement	Mg/Gg	0.00013	0.00013	EMEP/EEA EIG 2016
2A2	Calx	Mg/Gg	0.05	0.05	EMEP/EEA EIG 2009
2A2	Gypsum	Mg/Gg	0.03	0.03	EMEP/EEA EIG 2009
2A3	Flat glass	Mg/Gg	0.24	0.24	EMEP/EEA EIG 2016
2A3	Container glass	Mg/Gg	0.24	0.24	EMEP/EEA EIG 2016
2A3	Glass fiber	Mg/Gg	0.08	0.08	EMEP/EEA EIG 2016
2A5a	Quarrying of minerals (other than coal)	Mg/Gg	0.000004	0.000004	EMEP/EEA EIG 2009
2A5a	Quarrying of copper ore	Mg/Gg	0.005	0.005	EMEP/EEA EIG 2016
2A5a	Quarrying of zinc-lead ores	Mg/Gg	0.005	0.005	EMEP/EEA EIG 2016
2A5b	Construction	Mg/m^2	0.00000812	0.00000812	EMEP/EEA EIG 2009

Table A6. 123. Emission factors applied for 2.A – BC

NFR Code	Emission source	EF unit*	EF 1990	EF 2017	EF reference
2A1	Cement	fr. $PM_{2.5}$	0.03	0.03	EMEP/EEA EIG 2016
2A2	Calx	fr. $PM_{2.5}$	0.0046	0.0046	EMEP/EEA EIG 2009
2A2	Gypsum	fr. $PM_{2.5}$	0.0046	0.0046	EMEP/EEA EIG 2009
2A3	Flat glass	fr. $PM_{2.5}$	0.00062	0.00062	EMEP/EEA EIG 2016
2A3	Container glass	fr. $PM_{2.5}$	0.00062	0.00062	EMEP/EEA EIG 2016
2A3	Glass fiber	fr. $PM_{2.5}$	0.02	0.02	EMEP/EEA EIG 2016

*) EFs are given in absolute forms – e.g. 0.062% PM2.5 = 0.00062 of PM2.5 emission.

Table A6. 124. Emission factors applied for 2.A – Pb

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.20	0.20	PL (IETU)*
2A3	Flat glass	kg/Gg	0.40	0.40	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	2.90	2.90	EMEP/EEA EIG 2016

*) Country specific EF (IETU – Institute of Ecology of Industrial Areas)

Table A6. 125. Emission factors applied for 2.A – Cd

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.008	0.008	PL (PCA)*
2A3	Flat glass	kg/Gg	0.07	0.07	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.12	0.12	EMEP/EEA EIG 2016

*) EF obtained from producers (Polish Cement Association)

Table A6. 126. Emission factors applied for 2.A – Hg

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.02	0.02	PL (PCA)*
2A3	Flat glass	kg/Gg	0.003	0.003	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.003	0.003	EMEP/EEA EIG 2016

Table A6. 127. Emission factors applied for 2.A – As

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.01	0.01	Int. pub.*
2A3	Flat glass	kg/Gg	0.08	0.08	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.29	0.29	EMEP/EEA EIG 2016

*) EF obtained from international publications.

Table A6. 128. Emission factors applied for 2.A – Cr

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.01	0.01	PL (IETU)
2A3	Flat glass	kg/Gg	0.08	0.08	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.37	0.37	EMEP/EEA EIG 2016

Table A6. 129. Emission factors applied for 2.A – Cu

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A3	Flat glass	kg/Gg	0.007	0.007	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.007	0.007	EMEP/EEA EIG 2016

Table A6. 130. Emission factors applied for 2.A – Ni

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.10	0.10	PL (IETU)
2A3	Flat glass	kg/Gg	0.10	0.10	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.24	0.24	EMEP/EEA EIG 2016

Table A6. 131. Emission factors applied for 2.A – Zn

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A1	Cement	kg/Gg	0.20	0.20	PL (IETU)
2A3	Flat glass	kg/Gg	0.37	0.37	EMEP/EEA EIG 2016
2A3	Container glass	kg/Gg	0.37	0.37	EMEP/EEA EIG 2016

Table A6. 132. Emission factors applied for 2.A – PCDD/F

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2A3	Flat glass	mg I-TEQ/Gg	0.20	0.20	UNEP Toolkit, 2013*
2A3	Container glass	mg I-TEQ/Gg	0.20	0.20	UNEP Toolkit, 2013

*) See: http://toolkit.pops.int/.

II.2 Chemical Industry (NFR sector 2.B)

Table A6. 133. Emission factors applied for 2.B – NOX

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B1	Ammonia	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016
2B2	Nitric acid	Mg/Gg	3.80	3.80	PL*
2B3	Adipic acid	Mg/Gg	8.00	-**	EMEP/EEA EIG 2016
2B6	Titanium white (TiO_2)	Mg/Gg	0.108	0.108	EMEP/EEA EIG 2016
2B10a	NPK fertilizers	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2009
2B10a	Carbon black	Mg/Gg	15.00	15.00	EMEP/EEA EIG 2016

*) Emission factor derived from initial country studies (the methodology is still developing – the emission factor could be changed).
**) Production is not occurring since 1996.

Table A6. 134. Emission factors applied for 2.B – SO2

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B6	Titanium white (TiO_2)	Mg/Gg	3.97	3.97	EMEP/EEA EIG 2016
2B10a	Sulfuric acid	Mg/Gg	2.00	2.00	PL*
2B10a	Carbon black	Mg/Gg	22.00	22.00	EMEP/EEA EIG 2016

*) Emission factor derived from initial country studies (the methodology is still developing – the emission factor could be changed).

Table A6. 135. Emission factors applied for 2.B – NMVOC

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B10a	Carbon black	Mg/Gg	0.70	0.70	EMEP/EEA EIG 2016
2B10a	Ethylene	Mg/Gg	0.60	0.60	EMEP/EEA EIG 2016
2B10a	Propylene	Mg/Gg	0.005	0.005	CORINAIR
2B10a	Polyetylene	Mg/Gg	2.40	2.40	EMEP/EEA EIG 2016
2B10a	Polyvinylchloride (PVC)	Mg/Gg	0.008	0.008	PL (IETU)
2B10a	Polypropylene	Mg/Gg	4.00	4.00	EMEP/EEA EIG 2016
2B10a	Polystyrene	Mg/Gg	0.00126	0.00126	PL (IETU)
2B10a	Formaldehyde	Mg/Gg	7.00	7.00	EMEP/EEA EIG 2016

Table A6. 136. Emission factors applied for 2.B – NH3

NFR Code	Emission source	EF Unit	EF 1990	EF 2017	EF reference
2B1	Ammonia	Mg/Gg	0.01	0.01	EMEP/EEA EIG 2009
2B7	Soda ash	Mg/Gg	0.90	0.90	EMEP/EEA EIG 2016

Table A6. 137. Emission factors applied for 2.B – CO

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B1	Ammonia	Mg/Gg	0.10	0.10	EMEP/EEA EIG 2016
2B3	Adipic acid	Mg/Gg	0.40	-*	EMEP/EEA EIG 2016
2B10a	Carbon black	Mg/Gg	3.00	3.00	EMEP/EEA EIG 2016
2B10a	Formaldehyde	Mg/Gg	12.00	12.00	EMEP/EEA EIG 2016

*) Production is not occurring since 1996.

Table A6. 138. Emission factors applied for 2.B – TSP

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B5	Calcium carbide	Mg/Gg	0.10	-*	EMEP/EEA EIG 2016
2B6	Titanium white (TiO2)	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2016
2B7	Soda ash	Mg/Gg	0.10	0.10	EMEP/EEA EIG 2016
2B10a	NPK fertilizers	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2009
2B10a	Carbon black	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2016
2B10a	Polyethylene	Mg/Gg	0.064	0.064	EMEP/EEA EIG 2016, average from LDPE and HDPE
2B10a	Polyvinylchloride (PVC)	Mg/Gg	0.263	0.263	EMEP/EEA EIG 2016
2B10a	Polypropylene	Mg/Gg	1.50	1.50	EMEP/EEA EIG 2016
2B10a	Polystyrene EPS	Mg/Gg	0.03	0.03	EMEP/EEA EIG 2016
2B10a	Polystyrene GPPS/HIPS	Mg/Gg	0.004	0.004	EMEP/EEA EIG 2016
2B10b	Storage, handling and transport of nitrogen fert.	Mg/Gg	0.10	0.10	CEPMEIP
2B10b	Storage, handling and transport of potassium fert.	Mg/Gg	0.10	0.10	CEPMEIP
2B10b	Storage, handling and transport of phosphate fert.	Mg/Gg	0.10	0.10	CEPMEIP

*) Production is not occurring since 2008.

Table A6. 139. mission factors applied for 2.B – PM10

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B10a	NPK fertilizers	Mg/Gg	0.24	0.24	EMEP/EEA EIG 2009
2B10a	Carbon black	Mg/Gg	0.27	0.27	EMEP/EEA EIG 2016
2B10a	Polyvinylchloride (PVC)	Mg/Gg	0.10	0.10	EMEP/EEA EIG 2016

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B10b	Storage, handling and transport of nitrogen fert.	Mg/Gg	0.032	0.03	CEPMEIP
2B10b	Storage, handling and transport of potassium fert.	Mg/Gg	0.032	0.03	CEPMEIP
2B10b	Storage, handling and transport of phosphate fert.	Mg/Gg	0.032	0.03	CEPMEIP

Table A6. 140. Emission factors applied for 2.B – PM2.5

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B10a	NPK fertilizers	Mg/Gg	0.18	0.18	EMEP/EEA EIG 2009
2B10a	Carbon black	Mg/Gg	0.24	0.24	EMEP/EEA EIG 2016
2B10a	Polyvinylchloride (PVC)	Mg/Gg	0.05	0.05	EMEP/EEA EIG 2016
2B10b	Storage, handling and transport of nitrogen fert.	Mg/Gg	0.004	0.004	CEPMEIP
2B10b	Storage, handling and transport of potassium fert.	Mg/Gg	0.004	0.004	CEPMEIP
2B10b	Storage, handling and transport of phosphate fert.	Mg/Gg	0.004	0.004	CEPMEIP

Table A6. 141. Emission factors applied for 2.B – Cd

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B10a	Phosphate fertilizers	kg/Gg	0.60	0.60	S. Hławiczka and J. Fudała (2003)*

*) S. Hławiczka and J. Fudała. Distribution of Cd, Pb and Hg emissions among sectors of economy in Poland and the emission assessment for the years 1990-2000. In: L. Pawłowski, M.R. Dudzińska (eds.), Environmental Engineering Studies: Polish Research on the Way to the EU, Kluwer Academic/Plenum Publishers 2003.

Table A6. 142. Emission factors applied for 2.B – Hg

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2B10a	Chlorine - mercury cell	kg/Gg	4.80	-*	EMEP/EEA EIG 2016

*) Production is not occurring since 2009.

II.3 Metal production (NFR sector 2.C)

Table A6. 143. Emission factors applied for 2.C – NO_X

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Open hearth furnaces	Mg/Gg	0.70	-*	Int. pub.**
2C1	Basic oxygen furnaces (BOFs)	Mg/Gg	0.01	0.01	Int. pub.
2C1	Electric arc furnaces (EAFs)	Mg/Gg	0.13	0.13	Int. pub.
2C1	Rolling mills - hot	Mg/Gg	0.10	0.10	Int. pub.
2C1	Rolling mills - cold	Mg/Gg	0.07	0.07	Int. pub.
2C3	Aluminium	Mg/Gg	1.00	-***	EMEP/EEA EIG 2016
2C5	Secondary lead	Mg/Gg	0.19	0.19	EMEP/EEA EIG 2016

*) Production is not occurring since 2005.
**) EFs obtained from international publications.
***) Production is not occurring since 2009.

Table A6. 144. Emission factors applied for 2.C – SO_2

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Electric arc furnaces (EAFs)	Mg/Gg	0.06	0.06	EMEP/EEA EIG 2009
2C3	Aluminium	Mg/Gg	4.50	-*	EMEP/EEA EIG 2016
2C5	Primary lead	Mg/Gg	2.05	2.05	EMEP/EEA EIG 2016
2C5	Secondary lead	Mg/Gg	2.05	2.05	EMEP/EEA EIG 2016
2C6	Primary zinc	Mg/Gg	1.35	1.35	EMEP/EEA EIG 2016
2C6	Secondary zinc	Mg/Gg	1.35	1.35	EMEP/EEA EIG 2016
2C7a	Copper (refined)	Mg/Gg	3.00	3.00	EMEP/EEA EIG 2016

*) Production is not occurring since 2009.

Table A6. 145. Emission factors applied for 2.C – NMVOC

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	Mg/Gg	0.000237	0.000237	PL (IETU)
2C1	Open hearth furnaces	Mg/Gg	0.000015	-*	PL (IETU)
2C1	Basic oxygen furnaces (BOFs)	Mg/Gg	0.000038	0.000038	PL (IETU)
2C1	Electric arc furnaces (EAFs)	Mg/Gg	0.046	0.046	EMEP/EEA EIG 2016
2C1	Rolling mills - hot	Mg/Gg	0.007	0.007	EMEP/EEA EIG 2016
2C1	Rolling mills - cold	Mg/Gg	0.000126	0.000126	PL (IETU)
2C1	Sinter	Mg/Gg	0.138	0.138	EMEP/EEA EIG 2016

*) Production is not occurring since 2005.

Table A6. 146. Emission factors applied for 2.C – CO

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Basic oxygen furnaces (BOFs)	Mg/Gg	3.50	3.50	EMEP/EEA EIG 2009
2C1	Electric arc furnaces (EAFs)	Mg/Gg	1.70	1.70	EMEP/EEA EIG 2009
2C3	Aluminium (primary)	Mg/Gg	120.00	-*	EMEP/EEA EIG 2016

*) Production is not occurring since 2009.

Table A6. 147. Emission factors applied for 2.C – TSP

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	Mg/Gg	0.05	0.05	EMEP/EEA EIG 2016
2C1	Open hearth furnaces	Mg/Gg	1.00	-*	EMEP/EEA EIG 2016
2C1	Basic oxygen furnaces (BOFs)	Mg/Gg	0.035	0.035	EMEP/EEA EIG 2016
2C1	Electric arc furnaces (EAFs)	Mg/Gg	0.03	0.03	EMEP/EEA EIG 2016
2C1	Rolling mills - hot	Mg/Gg	0.009	0.009	EMEP/EEA EIG 2016
2C1	Rolling mills - cold	Mg/Gg	0.096	0.096	EMEP/EEA EIG 2016
2C1	Sinter	Mg/Gg	0.20	0.20	EMEP/EEA EIG 2016
2C2	Ferrosilicon	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016
2C3	Aluminium (primary)	Mg/Gg	1.80	-**	EMEP/EEA EIG 2016
2C3	Aluminium (secondary)	Mg/Gg	2.00	2.00	EMEP/EEA EIG 2016
2C5	Primary lead	Mg/Gg	0.006	0.006	EMEP/EEA EIG 2016
2C5	Secondary lead	Mg/Gg	0.073	0.073	PL (domestic studies)
2C6	Primary zinc	Mg/Gg	0.015	0.015	EMEP/EEA EIG 2016
2C6	Secondary zinc	Mg/Gg	0.015	0.015	EMEP/EEA EIG 2016
2C7a	Copper (refined)	Mg/Gg	0.32	0.32	EMEP/EEA EIG 2016

*) Production is not occurring since 2005.
**) Production is not occurring since 2009.

Table A6. 148. Emission factors applied for 2.C – PM10

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Sinter	Mg/Gg	0.10	0.10	EMEP/EEA EIG 2016
2C3	Aluminium (primary)	Mg/Gg	1.50	-*	EMEP/EEA EIG 2016
2C3	Aluminium (secondary)	Mg/Gg	1.40	1.40	EMEP/EEA EIG 2016
2C5	Primary lead	Mg/Gg	0.005	0.005	EMEP/EEA EIG 2016
2C5	Secondary lead	Mg/Gg	0.005	0.005	EMEP/EEA EIG 2016
2C6	Primary zinc	Mg/Gg	0.013	0.013	EMEP/EEA EIG 2016
2C6	Secondary zinc	Mg/Gg	0.013	0.013	EMEP/EEA EIG 2016
2C7a	Copper (refined)	Mg/Gg	0.25	0.25	EMEP/EEA EIG 2016

*) Production is not occurring since 2009.

Table A6. 149. Emission factors applied for 2.C – PM2.5

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	Mg/Gg	0.025	0.025	EMEP/EEA EIG 2016
2C1	Open hearth furnaces	Mg/Gg	0.60	-*	EMEP/EEA EIG 2016
2C1	Basic oxygen furnaces (BOFs)	Mg/Gg	0.028	0.028	EMEP/EEA EIG 2016
2C1	Electric arc furnaces (EAFs)	Mg/Gg	0.021	0.021	EMEP/EEA EIG 2016
2C1	Sinter	Mg/Gg	0.08	0.08	EMEP/EEA EIG 2016
2C3	Aluminium (primary)	Mg/Gg	0.40	-**	EMEP/EEA EIG 2016
2C3	Aluminium (secondary)	Mg/Gg	0.55	0.55	EMEP/EEA EIG 2016
2C5	Primary lead	Mg/Gg	0.0025	0.0025	EMEP/EEA EIG 2016
2C5	Secondary lead	Mg/Gg	0.0025	0.0025	EMEP/EEA EIG 2016
2C6	Primary zinc	Mg/Gg	0.01	0.01	EMEP/EEA EIG 2016
2C6	Secondary zinc	Mg/Gg	0.012	0.012	EMEP/EEA EIG 2016
2C7a	Copper (refined)	Mg/Gg	0.19	0.19	EMEP/EEA EIG 2016

*) Production is not occurring since 2005.
**) Production is not occurring since 2009.

Table A6. 150. Emission factors applied for 2.C – BC

NFR Code	Emission source	EF unit*	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	fr. $PM_{2.5}$	0.024	0.024	EMEP/EEA EIG 2016
2C1	Open hearth furnaces	fr. $PM_{2.5}$	0.024	-**	EMEP/EEA EIG 2016
2C1	Basic oxygen furnaces (BOFs)	fr. $PM_{2.5}$	0.0036	0.0036	EMEP/EEA EIG 2016
2C1	Electric arc furnaces (EAFs)	fr. $PM_{2.5}$	0.0036	0.0036	EMEP/EEA EIG 2016
2C1	Sinter	fr. $PM_{2.5}$	0.0017	0.0017	EMEP/EEA EIG 2016
2C3	Aluminium (primary)	fr. PM2.5	0.02	-***	EMEP/EEA EIG 2016
2C3	Aluminium (secondary)	fr. PM2.5	0.02	0.02	EMEP/EEA EIG 2016
2C7a	Copper (refined)	fr. PM2.5	0.001	0.001	EMEP/EEA EIG 2016

*) EFs are given in absolute forms – e.g. 0.062% PM2.5 = 0.00062 of PM2.5 emission.
**) Production is not occurring since 2005.

Table A6. 151. Emission factors applied for 2.C – Pb

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	kg/Gg	0.29	0.29	S. Hławiczka and J. Fudała (2003)*
2C1	Blast furnaces - smelting	kg/Gg	4.50	4.50	S. Hławiczka and J. Fudała (2003)
2C1	Open hearth furnaces	kg/Gg	1.40	-**	S. Hławiczka and J. Fudała (2003)
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.10	0.10	S. Hławiczka and J. Fudała (2003)
2C1	Electric arc furnaces (EAFs)	kg/Gg	5.50	5.50	S. Hławiczka and J. Fudała (2003)
2C1	Sinter	kg/Gg	5.40	5.40	S. Hławiczka and J. Fudała (2003)

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C2	Ferrosilicon	kg/Gg	0.24	0.24	S. Hławiczka and J. Fudała (2003)
2C5	Batteries	kg/Gg	5.00	5.00	S. Hławiczka and J. Fudała (2003)
2C5	Primary lead	kg/Gg	560.00	560.00	S. Hławiczka and J. Fudała (2003)
2C5	Secondary lead	kg/Gg	40.00	40.00	S. Hławiczka and J. Fudała (2003)
2C6	Primary zinc	kg/Gg	113.00	113.00	S. Hławiczka and J. Fudała (2003)
2C6	Secondary zinc	kg/Gg	85.00	85.00	S. Hławiczka and J. Fudała (2003)
2C7a	Copper (refined)	kg/Gg	19.00	19.00	EMEP/EEA EIG 2016

*) S. Hławiczka and J. Fudała. Distribution of Cd, Pb and Hg emissions among secotrs of economy in Poland and the emission assessment for the years 1990-2000. In: L. Pawłowski, M.R. Dudzińska (eds.), Environmental Engineering Studies: Polish Research on the Way to the EU, Kluwer Academic/Plenum Publishers 2003.
**) Production is not occurring since 2005.

Table A6. 152. Emission factors applied for 2.C – Cd

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Open hearth furnaces	kg/Gg	0.20	-*	S. Hławiczka and J. Fudała (2003)**
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.025	0.025	S. Hławiczka and J. Fudała (2003)
2C1	Electric arc furnaces (EAFs)	kg/Gg	0.25	0.25	S. Hławiczka and J. Fudała (2003)
2C1	Sinter	kg/Gg	0.10	0.10	S. Hławiczka and J. Fudała (2003)
2C3	Aluminium (primary)	kg/Gg	0.10	-***	S. Hławiczka and J. Fudała (2003)
2C5	Primary lead	kg/Gg	9.80	9.80	S. Hławiczka and J. Fudała (2003)
2C5	Secondary lead	kg/Gg	0.30	0.30	S. Hławiczka and J. Fudała (2003)
2C6	Primary zinc	kg/Gg	2.50	2.50	S. Hławiczka and J. Fudała (2003)
2C6	Secondary zinc	kg/Gg	14.00	14.00	S. Hławiczka and J. Fudała (2003)
2C7a	Copper (refined)	kg/Gg	0.06	0.06	PL (IChPW)****

*) Production is not occurring since 2005.
**) S. Hławiczka and J. Fudała. Distribution of Cd, Pb and Hg emissions among secotrs of economy in Poland and the emission assessment for the years 1990-2000. In: L. Pawłowski, M.R. Dudzińska (eds.), Environmental Engineering Studies: Polish Research on the Way to the EU, Kluwer Academic/Plenum Publishers 2003.
***) Production is not occurring since 2009.
****) EF obtained from the Institute for Chemical Processing of Coal.

Table A6. 153. Emission factors applied for 2.C – Hg

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnaces - smelting	kg/Gg	0.0000001	0.0000001	EMEP/EEA EIG 2016
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.001	0.001	Int. publ.*
2C1	Electric arc furnaces (EAFs)	kg/Gg	0.10	0.10	Int. publ.
2C1	Sinter	kg/Gg	0.10	0.10	Int. publ.
2C5	Primary lead	kg/Gg	3.00	3.00	S. Hławiczka and J. Fudała (2003)**
2C6	Primary zinc	kg/Gg	8.00	8.00	EMEP/EEA EIG 2016
2C6	Secondary zinc	kg/Gg	0.02	0.02	S. Hławiczka and J. Fudała (2003)
2C7a	Copper (refined)	kg/Gg	0.02	0.02	EMEP/EEA EIG 2016

*) EFs are taken from international publications.
**) S. Hławiczka and J. Fudała. Distribution of Cd, Pb and Hg emissions among sectors of economy in Poland and the emission assessment for the years 1990-2000. In: L. Pawłowski, M.R. Dudzińska (eds.), Environmental Engineering Studies: Polish Research on the Way to the EU, Kluwer Academic/Plenum Publishers 2003.

Table A6. 154. Emission factors applied for 2.C – As

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Open hearth furnaces	kg/Gg	0.75	0.75	Int. publ.*
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.015	0.015	Int. publ.
2C1	Electric arc furnaces (EAFs)	kg/Gg	0.10	0.10	Int. publ.
2C1	Sinter	kg/Gg	0.04	0.04	Int. publ.
2C5	Primary lead	kg/Gg	10.00	10.00	Int. publ.
2C5	Secondary lead	kg/Gg	0.20	0.20	Int. publ.
2C6	Secondary zinc	kg/Gg	10.00	10.00	Int. publ.
2C7a	Copper (refined)	kg/Gg	4.00	4.00	EMEP/EEA EIG 2016

*) EFs are taken from international publications.

Table A6. 155. Emission factors applied for 2.C – Cr

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Open hearth furnaces	kg/Gg	9.80	9.80	Int. publ.*
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.06	0.06	Int. publ.
2C1	Electric arc furnaces (EAFs)	kg/Gg	1.00	1.00	Int. publ.
2C1	Sinter	kg/Gg	0.30	0.30	Int. publ.
2C7a	Copper (refined)	kg/Gg	16.00	16.00	EMEP/EEA EIG 2016

*) EFs are taken from international publications.

Table A6. 156. Emission factors applied for 2.C – Cu

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnaces - smelting	kg/Gg	0.00	0.00	Int. publ.*
2C1	Open hearth furnaces	kg/Gg	1.18	-**	Int. publ.
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.03	0.03	Int. publ.
2C1	Electric arc furnaces (EAFs)	kg/Gg	3.10	3.10	Int. publ.
2C1	Sinter	kg/Gg	0.60	0.60	Int. publ.
2C7a	Copper (refined)	kg/Gg	32.00	32.00	EMEP/EEA EIG 2016

*) EFs are taken from international publications.
**) Production is not occurring since 2005.

Table A6. 157. Emission factors applied for 2.C – Ni

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.05	0.05	Int. publ.*
2C1	Electric arc furnaces (EAFs)	kg/Gg	0.25	0.25	Int. publ.
2C1	Sinter	kg/Gg	0.70	0.70	Int. publ.
2C3	Aluminium (primary)	kg/Gg	0.10	-**	Int. publ.
2C7a	Copper (refined)	kg/Gg	14.00	14.00	EMEP/EEA EIG 2016

*) EFs are taken from international publications.
**) Production is not occurring since 2009.

Table A6. 158. Emission factors applied for 2.C – Zn

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	kg/Gg	0.58	0.58	Int. publ.*
2C1	Blast furnaces - smelting	kg/Gg	0.021	0.021	Int. publ.
2C1	Open hearth furnaces	kg/Gg	40.15	40.15	Int. publ.
2C1	Basic oxygen furnaces (BOFs)	kg/Gg	0.60	0.60	Int. publ.

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Electric arc furnaces (EAFs)	kg/Gg	23.90	23.90	Int. publ.
2C1	Sinter	kg/Gg	8.90	8.90	Int. publ.
2C3	Aluminium (primary)	kg/Gg	0.15	-**	Int. publ.
2C5	Primary lead	kg/Gg	100.00	100.00	Int. publ.
2C5	Secondary lead	kg/Gg	6.00	6.00	Int. publ.
2C6	Primary zinc	kg/Gg	294.00	294.00	Int. publ.
2C6	Secondary zinc	kg/Gg	1,089.00	1,089.00	Int. publ.
2C7a	Copper (refined)	kg/Gg	14.00	14.00	EMEP/EEA EIG 2016

*) EFs are taken from international publications.
**) Production is not occurring since 2009.

Table A6. 159. Emission factors applied for 2.C – PCDD/F

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnaces - smelting	mg I-TEQ/Gg	0.01	0.01	UNEP Toolkit, 2013
2C1	Open hearth furnaces	mg I-TEQ/Gg	2.00	-*	DK EPA, PL (2005)**
2C1	Basic oxygen furnaces (BOFs)	mg I-TEQ/Gg	0.02	0.02	DK EPA, PL (2005)
2C1	Electric arc furnaces (EAFs)	mg I-TEQ/Gg	3.00	3.00	EMEP/EEA EIG 2016
2C3	Aluminium (primary)	mg I-TEQ/Gg	2.00	-***	DK EPA, PL (2005)
2C5	Primary lead	mg I-TEQ/Gg	5.00	5.00	EMEP/EEA EIG 2016
2C5	Secondary lead	mg I-TEQ/Gg	8.00	8.00	EMEP/EEA EIG 2016
2C6	Primary zinc	mg I-TEQ/Gg	5.00	5.00	EMEP/EEA EIG 2016
2C6	Secondary zinc	mg I-TEQ/Gg	100.00	100.00	UNEP Toolkit, 2013
2C7a	Copper (refined)	mg I-TEQ/Gg	5.00	5.00	EMEP/EEA EIG 2016

*) Production is not occurring since 2005.
**) Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland; Danish Environmental Protection Agency and Ministry of the Environment, 2005. See: http://www.dioksyny.pl/wp-content/uploads/Opportunities-for-reduction-of-dioxin-emissions-2005.pdf [accessed: 2019-01-24].
***) Production is not occurring since 2009.

Table A6. 160. Emission factors applied for 2.C – PCB

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	g/Gg	0.0064	0.0064	DK EPA, PL (2005)*
2C1	Open hearth furnaces	g/Gg	2.60	-**	NILU (1999)***
2C1	Basic oxygen furnaces (BOFs)	g/Gg	0.00	0.00	DK EPA, PL (2005)
2C1	Electric arc furnaces (EAFs)	g/Gg	2.60	2.60	NILU (1999)
2C1	Rolling mills - hot	g/Gg	2.60	2.60	NILU (1999)
2C3	Aluminium (secondary)	g/Gg	2.60	2.60	NILU (1999)
2C7a	Copper (refined)	g/Gg	2.60	2.60	NILU (1999)

*) Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland; Danish Environmental Protection Agency and Ministry of the Environment, 2005. See: http://www.dioksyny.pl/wp-content/uploads/Opportunities-for-reduction-of-dioxin-emissions-2005.pdf [accessed: 2019-01-24].
**) Production is not occurring since 2005.
***) NILU (1999). Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic), 1999.

Table A6. 161. Emission factors applied for 2.C – HCB

NFR Code	Emission source	EF Unit	EF 1990	EF 2017	EF reference
2C1	Blast furnace charging	g/Gg	0.00	0.00	DK EPA, PL (2005)*
2C1	Basic oxygen furnaces (BOFs)	g/Gg	0.00	0.00	DK EPA, PL (2005)
2C7a	Copper (refined)	g/Gg	0.12	0.06	PL (KGHM)**

*) Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland; Danish Environmental Protection Agency and Ministry of the Environment, 2005. See: http://www.dioksyny.pl/wp-content/uploads/Opportunities-for-reduction-of-dioxin-emissions-2005.pdf [accessed: 2019-01-24].
**) Trend of EF (weighted using changes in production technologies) obtained from producer (KGHM, Polska Miedź S.A.).

Table A6. 162. Emission factors applied for 2.C – PAHs

NFR Code	Emission source	EF Unit	EF 1990	EF 2017	EF reference
BaP - Benzo[a]pyrene					
2C3	Aluminium (primary)	kg/Gg	11.00	-*	Berdowski et al. (1995)**
BbF - Benzo[b]fluoranthene					
2C3	Aluminium (primary)	kg/Gg	40.18	-*	Berdowski et al. (1995)
BkF - Benzo[k]fluoranthene					
2C3	Aluminium (primary)	kg/Gg	40.18	-*	Berdowski et al. (1995)
IP - Indeno[1,2,3-cd]pyrene					
2C3	Aluminium (primary)	kg/Gg	5.00	-*	Berdowski et al. (1995)

*) Production is not occurring since 2009.
**) Berdowski et al. (1995): Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants, 1995.

II.4 Solvent use (NFR sector 2.D)

Table A6. 163. NMVOC emission factors applied for NFR 2.D.3.a

Emission source	EF	EF unit	EF reference
Fat, edible and nonedible oil extraction	0.014	kg/Mg	PL (IETU)
Domestic solvent use (other than paint application)	1.2	kg/capita	EMEP/EEA EIG 2016
Covering with asphalt materials	16	g/Mg	EMEP/EEA EIG 2016

Note: PL (IETU) emission factors come from IETU surveys

Table A6. 164. Hg emission factors applied for 2.D.3.a

Emission source	EF	EF unit	EF reference
Domestic solvent use (other than paint application)	5.6	mg/capita	EMEP/EEA EIG 2016

Table A6. 165. NMVOC emission factors applied for 2.D.3.b.

Emission source	EF	EF unit	EF reference
Road paving with asphalt	16	g/Mg	EMEP/EEA EIG 2016

Table A6. 166. NMVOC emission factors applied for NFR 2.D.3.d

Emission source	EF	EF unit	EF reference
Paint application			
Waterborne paints	0.03	Mg/Mg paints	PL (IETU)
Conventional solvent paint	0.5	Mg/Mg paints	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A6. 167. NMVOC emission factors applied for NFR 2.D.3.e - f

Emission source	EF	EF unit	EF reference
Degreasing, dry cleaning and electronics			
Metal degreasing	1	Mg/Mg solvent	PL (IETU)
Dry cleaning	0.15	Mg/1000 people	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A6. 168. NMVOC emission factors applied for NFR 2.D.3.g

Emission source	EF	EF unit	EF reference
Polyvinylchloride processing	0.0078	Mg/Mg	PL (IETU)
Polystyrene foam processing	0.0600	Mg/Mg	EMEP/EEA EIG 2016
Rubber processing	0.008	Mg/Mg	EMEP/EEA EIG 2016
Pharmaceutical products manufacturing	0.014	Mg/1000 people	PL (IETU)
Paints manufacturing	0.005	Mg/Mg	PL (IETU)
Tyres	10	kg/Mg	EMEP/EEA EIG 2016
Asphalt blowing	27.2	kg/Mg	EMEP/EEA EIG 2016
Shoes	0.045	g/pair of shoes	EMEP/EEA EIG 2016

Note: PL (IETU) emission factors come from IETU surveys

Table A6. 169. NMVOC emission factors applied for NFR 2.D.3.h

Emission source	EF	EF unit	EF reference
Printing inks	500	g/kg ink	EMEP/EEA EIG 2016

Table A6. 170. NMVOC emission factors applied for NFR 2.D.3.i

Emission source	EF	EF unit	EF reference
Glues	2	kg/Mg	EMEP/EEA EIG 2016
Adhesives	2	kg/Mg	EMEP/EEA EIG 2016

Table A6. 171. NH_3 emission factors applied for NFR 2.D.3.g

Emission source	EF	EF unit	EF reference
Chemical products manufacturing or processing - Leather tanning	0.68	Mg/Gg	EMEP/EEA EIG 2016

Table A6. 172. PAH emission factors applied for NFR 2.D.3.i

Activity	EF	Unit	EF reference
Wood preservation			
Benzo(a)pyrene	0.5	kg/Gg	Berdowski et al., 1995
Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1.2.3-cd)pyrene	0.250	kg/Gg	

II.5 Other solvent and product use (NFR sector 2.G)

Emission factors applied for NFR 2.G

Source and emissions	EF	EF unit	EF reference
Tobacco combustion			
NO_X	0.0034652	Mg/Gg	Aasestad, 2007 (Report for Norway)
NMVOC	0.0048374	Mg/Gg	Aasestad, 2007 (Report for Norway)
CO	0.1215475	Mg/Gg	Aasestad, 2007 (Report for Norway)
TSP	27	Mg/Gg	EMEP/EEA EIG 2016
PM10	27	Mg/Gg	EMEP/EEA EIG 2016
PM2.5	27	Mg/Gg	EMEP/EEA EIG 2016
BC	0.45	% of PM2.5 emission	EMEP/EEA EIG 2016
Pb	0.00005	g/Mg	Aasestad, 2007
Cd	0.0001	g/Mg	Aasestad, 2007
Hg	0.0001	g/Mg	Aasestad, 2007
As	0.000159	g/Mg	Aasestad, 2007
Cr	0.000354	g/Mg	Aasestad, 2007
Cu	0.000152	g/Mg	Aasestad, 2007
PCDD/F	0.1	µg I-TEQ/Mg tobacco	EMEP/EEA EIG 2016
Fireworks			
NO_X	260	g/Mg	EMEP/EEA EIG 2016
SO_2	3020	g/Mg	EMEP/EEA EIG 2016
CO	7150	g/Mg	EMEP/EEA EIG 2016
TSP	109.83	g/Mg	EMEP/EEA EIG 2016
PM10	99.92	g/Mg	EMEP/EEA EIG 2016
PM2.5	51.94	g/Mg	EMEP/EEA EIG 2016
Ni	30	g/Mg	EMEP/EEA EIG 2016
Pb	784	g/Mg	EMEP/EEA EIG 2016
Cd	1.48	g/Mg	EMEP/EEA EIG 2016
Hg	0.057	g/Mg	EMEP/EEA EIG 2016
As	1.33	g/Mg	EMEP/EEA EIG 2016
Cr	15.6	g/Mg	EMEP/EEA EIG 2016
Cu	444	g/Mg	EMEP/EEA EIG 2016
Zn	260	g/Mg	EMEP/EEA EIG 2016

II.6 Other industry production (NFR sector 2.H)

Table A6. 173. Emission factors applied for 2.H – NO_X

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016

Table A6. 174. Emission factors applied for 2.H – SO_2

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	Mg/Gg	2.00	2.00	EMEP/EEA EIG 2016

Table A6. 175. Emission factors applied for 2.H – NMVOC

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Chipboards	Mg/m^3	0.0002	0.0002	PL (IETU)
2H1	Paper pulp (Kraft process)	Mg/Gg	2.00	2.00	EMEP/EEA EIG 2016
2H2	Bread	Mg/Gg	4.50	4.50	EMEP/EEA EIG 2016
2H2	Wine	Mg/hl	0.000034	0.000034	EMEP/EEA EIG 2016
2H2	Beer	Mg/hl	0.00002	0.00002	EMEP/EEA EIG 2016
2H2	Spirits	Mg/hl	0,0024	0,0024	EMEP/EEA EIG 2016
2H2	Sugar	Mg/Gg	10,00	10,00	EMEP/EEA EIG 2016
2H2	Slaughter products - cattle and calves	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2016
2H2	Slaughter products - pigs	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2016
2H2	Slaughter products - poultry	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2016
2H2	Slaughter products - fish	Mg/Gg	0.30	0.30	EMEP/EEA EIG 2016
2H2	Margarine and fat spreads, excluding liquid margarine	Mg/Gg	10.00	10.00	EMEP/EEA EIG 2016
2H2	Prepared feeds for farm animals	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016
2H2	Prepared pet foods	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016

Table A6. 176. Emission factors applied for 2.H – CO

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	Mg/Gg	5.50	5.50	EMEP/EEA EIG 2016

Table A6. 177. Emission factors applied for 2.H – TSP

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016

Table A6. 178. Emission factors applied for 2.H – PM10

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	Mg/Gg	0.80	0.80	EMEP/EEA EIG 2016

Table A6. 179. Emission factors applied for 2.H – PM2.5

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	Mg/Gg	0.60	0.60	EMEP/EEA EIG 2016

Table A6. 180. Emission factors applied for 2.H – BC

NFR Code	Emission source	EF unit*	EF 1990	EF 2017	EF reference
2H1	Paper pulp (Kraft process)	fr. PM2.5	0.026	0.026	EMEP/EEA EIG 2016

*) EFs are given in absolute forms – e.g. 0.062% $PM_{2.5}$ = 0.00062 of $PM_{2.5}$ emission.

Table A6. 181. Emission factors applied for 2.H – PCDD/F

NFR Code	Emission source	EF unit*	EF 1990	EF 2017	EF reference
2H2	Smoke houses (excl. afterburning)	mg I-TEQ/Gg	6.00	6.00	UNEP Toolkit, 2013
2H2	Smoke houses (incl. afterburning)	mg I-TEQ/Gg	0.60	0.60	UNEP Toolkit, 2013

II.7 Wood processing and Other production, consumption, storage, transportation or handling of bulk products (NFR sector 2.I, 2.L)

Table A6. 182. Emission factors applied for 2.I – 2.L – TSP

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2I	Sawn wood	Mg/Gg	1.00	1.00	EMEP/EEA EIG 2016
2L	Storage, handling and transport of bulk prod. - cement	Mg/Gg	0.01	0.01	CEPMEIP
2L	Storage, handling and transport of bulk prod. - coal	Mg/Gg	0.15	0.15	CEPMEIP
2L	Storage, handling and transport of bulk prod. - coke	Mg/Gg	0.11	0.11	CEPMEIP

Table A6. 183. Emission factors applied for 2.D – 2.L – PM10

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2L	Storage, handling and transport of bulk prod. - cement	Mg/Gg	0.005	0.005	CEPMEIP
2L	Storage, handling and transport of bulk prod. - coal	Mg/Gg	0.06	0.06	CEPMEIP
2L	Storage, handling and transport of bulk prod. - coke	Mg/Gg	0.044	0.044	CEPMEIP

Table A6. 184. Emission factors applied for 2.D – 2.L – PM2.5

NFR Code	Emission source	EF unit	EF 1990	EF 2017	EF reference
2L	Storage, handling and transport of bulk prod. - cement	Mg/Gg	0.0005	0.0005	CEPMEIP
2L	Storage, handling and transport of bulk prod. - coal	Mg/Gg	0.006	0.006	CEPMEIP
2L	Storage, handling and transport of bulk prod. - coke	Mg/Gg	0.0044	0.0044	CEPMEIP

III. NFR SECTOR 3 - AGRICULTURE

III.1 Manure Management (NFR sector 3.B)

Table A6. 185. NH_3 and NO_2 emission factors applied for NFR 3.B

Livestock slurry	NH_3 EF [kg NH_3/animal/yr]		NO_2 EF [kg NH_3/animal/yr]	
	EMEP/EEA EIG 2016	CS (IEF)	EMEP/EEA 2016	CS (IEF)
Dairy cattle slurry	39.3	22.3 (1990) – 32.2 (2017)	0.011	0.215 (1990) – 0.306 (2017)
Dairy cattle solid	28.7		0.236	
Other cattle slurry	13.4	12.5 (1990) – 12.8 (2017)	0.003	0.128 (1990) – 0.131 (2017)
Other cattle solid	9.2		0.144	
Fattening pigs slurry	6.7	4.7 (1990) – 4.1 (2017)	0.002	0.039 (1990) – 0.034 (2017)
Fattening pigs solid	6.5		0.069	
Sows slurry	15.8	10.3 (1990) – 10.2 (2017)	0.006	0.082 (1990) – 0.081 (2017)
Sows solid	18.2		0.204	
Sheep solid	1.4	2.6	0.002	0.031
Goats solid	1.4	2.0	0.008	0.023
Horses solid	14.8	16.4	0.201	0.072
Laying hens solid/slurry	0.48	0.3	0.005 / 0.0002	0.0017
Broilers litter	0.22	0.1	0.002	0.0015
Other poultry litter	0.35 - 0.95	0.9	0.002 - 0.008	0.0113
Fur animals	0.02	-	0.0003	-

Table A6. 186. Nitrogen excreted (Nex) in manure by livestock categories (NFR 3.B)

Livestock	Nex [kg/head/year]	
	CS	EMEP/EEA EIG 2016
Dairy cattle:		
1988–1995	65.0	
1996–2000	70.0	
2001–2005	75.0	105
2006–2010	80.0	
2011–2015	83.0	
Since 2016	90.0	
Non-dairy cattle:		
calves up to 1 year	19.0	
Young cattle 1–2 years	46.0	41
Heifers above 2 years	53.0	
Bulls above 2 years	65.0	
Swine:		
Piglets (< 20 kg)	2.6	
Piglets (20-50 kg)	9.0	12.1
Fattening pigs (> 50 kg)	15.0	34.5 (including piglets to 25 kg)
Sows	20.0	
Butcher hogs	18.0	
Sheep	9.5	15.5
Goats	8.0	15.5
Horses	55.0	47.5
Poultry:		
Laying hens	0.8	0.77
Broilers	0.2	0.36
Turkeys	1.6	1.64
Ducks	1.0	1.26
Geese	1.6	0.55

Table A6. 187. PM emission factors applied for NFR 3.B

PM Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
3.B Manure management					
3.B.1.a Dairy cows	1.380	0.630	0.410	kg/animal	EMEP/EEA EIG 2016
3.B.1.b Other cattle	0.470	0.217	0.142	kg/animal	EMEP/EEA EIG 2016
3.B.2 Sheep	0.140	0.060	0.020	kg/animal	EMEP/EEA EIG 2016
3.B.3 Fattening pigs	1.050	0.140	0.006	kg/animal	EMEP/EEA EIG 2016
3.B.3 Sows	0.620	0.170	0.010	kg/animal	EMEP/EEA EIG 2016
3.B.4.d Goats	0.140	0.060	0.020	kg/animal	EMEP/EEA EIG 2016
3.B.4.e Horses	0.480	0.220	0.140	kg/animal	EMEP/EEA EIG 2016
3.B.4.g.i Laying hens	0.190	0.040	0.003	kg/animal	EMEP/EEA EIG 2016
3.B.4.g.ii Broilers	0.040	0.020	0.002	kg/animal	EMEP/EEA EIG 2016
3.B.4.g.iv Other poultry	0.143	0.143	0.022	kg/animal	EMEP/EEA EIG 2016
3.B.4.h Fur animals	0.018	0.008	0.004	kg/animal	EMEP/EEA EIG 2016

III.2 Agricultural Soils (NFR sector 3.D)

Table A6. 188. NH_3 emission factors applied for NFR 3.D

NFR	Activity	EF	EF unit	EF reference
3.D.a.1	Inorganic N-fertilisers	0.0538	kg NH_3/kg N	Country Specific based on EMEP/EEA EIG 2016
3.D.a.2.b	Sewage sludge applied to soils	0.130	kg NH_3/kg N	EMEP/EEA EIG 2016

Table A6. 189. NOx, NMVOC and PM emission factors applied for NFR 3.D

Emission source	EF	EF unit	EF reference
3.D.a.2.a Animal manure applied to soils and 3.D.a.3 Animal manure left on pastures			
NO_2 emission	0.040	kg NO_2 / kg manure N applied	EMEP/EEA EIG 2016
3.D.a.2.b. Sewage sludge applied to soils			
NO_2 emission	0.040	kg NO_2 / kg N	EMEP/EEA EIG 2016
3.D.c Agricultural operations			
TSP	1.56	kg/ha	EMEP/EEA EIG 2016
PM10	1.56	kg/ha	EMEP/EEA EIG 2016
PM2.5	0.06	kg/ha	EMEP/EEA EIG 2016
3.D.e Cultivated crops			
NMVOC emission	0.50	kg/ha crop area	Country Specific based on EMEP/EEA EIG 2016

III.3 Field Burning of Agricultural Residues (NFR sector 3.F)

Table A6. 190. PM emission factors applied for NFR 3.F

PM Emission source	EF			EF unit	EF reference
	TSP	PM10	PM2.5		
3. Agriculture					
3.F On-field burning of stubble	0.0058	0.0057	0.0054	Mg/Mg DM	EMEP/EEA EIG 2016

Table A6. 191. Other pollutants, including metals. emission factors applied for NFR 3.F

Emission source	EF	EF unit	EF reference
3. Agriculture			
3.F On-field burning of stubble			
BC	500	mg/kg DM	EMEP/EEA EIG 2016
NMVOC	0.0005	kg/kg DM	EMEP/EEA EIG 2016
CO	0.0667	kg/kg DM	EMEP/EEA EIG 2016
NOx	0.0023	kg/kg DM	EMEP/EEA EIG 2016
SOx	0.0005	kg/kg DM	EMEP/EEA EIG 2016
NH_3	0.0024	kg/kg DM	EMEP/EEA EIG 2016
Cr	0.08	mg/kg DM	EMEP/EEA EIG 2016
Cu	0.073	mg/kg DM	EMEP/EEA EIG 2016
Zn	0.56	mg/kg DM	EMEP/EEA EIG 2016
As	0.0064	mg/kg DM	EMEP/EEA EIG 2016
Se	0.02	mg/kg DM	EMEP/EEA EIG 2016
Pb	0.11	mg/kg DM	EMEP/EEA EIG 2016
Cd	0.88	mg/kg DM	EMEP/EEA EIG 2016
Hg	0.14	mg/kg DM	EMEP/EEA EIG 2016
Ni	0.052	mg/kg DM	EMEP/EEA EIG 2016

Table A6. 192. PCDD/F and PAHs emission factors applied for NFR 3.F

SNAP	Activity	EF	EF unit	EF reference
3. Agriculture - 3.F On-field burning of stubble				
PCDD/F		0.500	µg TEQ/t	EMEP/EEA EIG 2016
Benzo(b)fluoranthene		189.1	mg/kg DM	EMEP/EEA EIG 2016
Benzo(k)fluoranthene		80.7	mg/kg DM	EMEP/EEA EIG 2016
Benzo(a)pyrene		67.7	mg/kg DM	EMEP/EEA EIG 2016
Indeno(1,2,3-cd)pyrene		57.9	mg/kg DM	EMEP/EEA EIG 2016

IV. NFR SECTOR 5 – WASTE

IV.1 Solid waste disposal on land (NFR sector 5.A)

Table A6. 193. Emission factors applied for NFR 5 A

Pollutant	EF	EF unit	EF reference
NMVOC	1.56	kg/Mg	EMEP/EEA EIG 2016
TSP	0.463	g/Mg	EMEP/EEA EIG 2016
PM10	0.219	g/Mg	EMEP/EEA EIG 2016
PM2.5	0.033	g/Mg	EMEP/EEA EIG 2016

IV.2 Waste incineration (NFR sector 5.C)

IV.2.1 Municipal waste incineration (NFR sector 5.C.1.a)

Table A6. 194. Emission factors applied for NFR 5.C.1.a

Pollutant	EF	EF unit	EF reference
NO_x	1.071	kg/t	EMEP/EEA EIG 2016
NMVOC	5.9	g/t	EMEP/EEA EIG 2016
SO_2	0.087	kg/t	EMEP/EEA EIG 2016
NH_3	3	g/t	EMEP/EEA EIG 2016
TSP	3	g/t	EMEP/EEA EIG 2016
PM10	3	g/t	EMEP/EEA EIG 2016
PM2.5	3	g/t	EMEP/EEA EIG 2016
BC	3.5	% of PM2.5	EMEP/EEA EIG 2016
CO	41	g/t	EMEP/EEA EIG 2016
Pb	58	mg/t	EMEP/EEA EIG 2016
Cd	4.6	mg/t	EMEP/EEA EIG 2016
Hg	18.8	mg/t	EMEP/EEA EIG 2016
As	6.2	mg/t	EMEP/EEA EIG 2016
Cr	16.4	mg/t	EMEP/EEA EIG 2016
Cu	13.7	mg/t	EMEP/EEA EIG 2016
Ni	21.6	mg/t	EMEP/EEA EIG 2016
Zn	24.5	mg/t	EMEP/EEA EIG 2016
PCDD/F	52.5	ng/t	EMEP/EEA EIG 2016
HCB	45.2	µg/t	EMEP/EEA EIG 2016
PCB	3.4	ng/t	EMEP/EEA EIG 2016

Pollutant	EF	EF unit	EF reference
Benzo(a)pyrene	8.4	µg/t	EMEP/EEA EIG 2016
Benzo(b)fluoranthene	17.9	µg/t	EMEP/EEA EIG 2016
Benzo(k)fluoranthene	9.5	µg/t	EMEP/EEA EIG 2016
Indeno(1,2,3-cd)pyrene	11.6	µg/t	EMEP/EEA EIG 2016

IV.2.2 Industrial waste incineration (including sludges) (NFR sector 5.C.1.bi)

Table A6. 195. Emission factors applied for NFR 5.C.1.b.i

Pollutant	EF	EF unit	EF reference
NO_x	0.87	kg/t	EMEP/EEA EIG 2016
NMVOC	0.0074	t/t	EMEP/EEA EIG 2016
SO_2	0.047	kg/t	EMEP/EEA EIG 2016
TSP	0.01	kg/t	EMEP/EEA EIG 2016
PM10	0.007	kg/t	EMEP/EEA EIG 2016
PM2.5	0.004	kg/t	EMEP/EEA EIG 2016
BC	3.5	% of PM2.5	EMEP/EEA EIG 2016
CO	0.07	kg/t	EMEP/EEA EIG 2016
Pb	1.30	g/t	EMEP/EEA EIG 2016
Cd	0.10	g/t	EMEP/EEA EIG 2016
Hg	0.06	g/t	EMEP/EEA EIG 2016
As	0.02	g/t	EMEP/EEA EIG 2016
Ni	0.14	g/t	EMEP/EEA EIG 2016
PAH	0.02	g/t	EMEP/EEA EIG 2016

Table A6. 196. PCDD/F emission factors applied for NFR 5.C.1.b.i

Activity	EF	EF unit	EF reference
Industrial waste incineration (no APCs)	3500	mg TEQ/kt	UNEP Toolkit, 2013
Industrial waste incineration (minimal APCs)	350	mg TEQ/kt	
Industrial waste incineration (good APCs)	30	mg TEQ/kt	
Industrial waste incineration (very good APCs)	0.5	mg TEQ/kt	

Table A6. 197. Emission factors of PCBs applied for NFR 5.C.1.b.i

Activity	EF	EF unit	EF reference
Industrial waste incineration (no APCs)	30.4	g/kt	Parma at al., 1995
Industrial waste incineration (minimal APCs)	19.3	g/kt	Parma at al., 1995
Industrial waste incineration (good and very good APCs)	0.38	g/kt	GF/POL/01/004, 2002

Note: Applied emission factors come from: Parma at al., 1995 [58], GF/POL/01/004 [59]

Table A6. 198. HCB emission factors applied for NFR 5.C.1.b.i

Activity	EF	EF unit	EF reference
Industrial waste incineration (no or minimal APCs)	19	g/kt	Bailey R., 2001
Industrial waste incineration (good and very good APCs)	0.139	g/kt	GF/POL/01/004, 2002

IV.2.3 Clinical waste incineration (NFR sector 5.C.1.b.iii)

Table A6. 199. Emission factors applied for NFR 5.C.1.b.iii

Pollutant	EF	EF unit	EF reference
NO_x (installations that comply with EU Directive)	1.8	kg/t	EMEP/EEA EIG 2016
NO_x (lower APCs efficiencies)	2.3	kg/t	EMEP/EEA EIG 2016
NMVOC	0.0007	t/t	EMEP/EEA EIG 2016
SO_2 (installations that comply with EU Directive)	1.1	kg/t	EMEP/EEA EIG 2016
SO_2 (lower APCs efficiencies)	0.54	kg/t	EMEP/EEA EIG 2016
CO	0.19	kg/t	EMEP/EEA EIG 2016
TSP	17	kg/t	EMEP/EEA EIG 2016
BC	2.3	% of PM2.5	EMEP/EEA EIG 2016
Pb	62	g/t	EMEP/EEA EIG 2016
Cd	8	g/t	EMEP/EEA EIG 2016
Hg (installations that comply with EU Directive)	1.62	g/t	EMEP/EEA EIG 2016
Hg (minimal and no APCs)	43	g/t	EMEP/EEA EIG 2016
As	0.2	g/t	EMEP/EEA EIG 2016
Cr	2	g/t	EMEP/EEA EIG 2016
Cu	98	g/t	EMEP/EEA EIG 2016
Ni	2	g/t	EMEP/EEA EIG 2016
Total 4 PAHs	0.04	mg/t	EMEP/EEA EIG 2016

Table A6. 200. PCDD/F emission factors applied for NFR 5.C.1.b.iii

Activity	EF	EF unit	EF reference
Clinical waste incineration (installations that comply with EU Directive)	1.38	mg TEQ/kt	Grochowalski A., 2002
Clinical waste incineration (minimal APCs)	68	mg TEQ/kt	GF/POL/01/004, 2002
Clinical waste incineration (no APCs)	453.3	mg TEQ/kt	Grochowalski A., 2002

Note: Applied emission factors come from: Grochowalski A., 2002 [16], GF/POL/01/004 [59]

Table A6. 201. Emission factors of PCBs applied for NFR 5.C.1.b.iii

Activity	EF	EF unit	EF reference
Clinical waste incineration (installations that comply with EU Directive)	0.39	g/kt	GF/POL/01/004, 2002
Clinical waste incineration (no or minimal APCs)	20	g/kt	*EMEP/CORINAIR atmospheric emission inventory guidebook.*

Note: Applied emission factors come from: GF/POL/01/004 [59]

Table A6. 202. HCB emission factors applied for NFR 5.C.1.b.iii

Activity	EF	EF unit	EF reference
Clinical waste incineration (installations that comply with EU Directive)	0.295	g/kt	GF/POL/01/004, 2002
Clinical waste incineration (no or minimal APCs)	29	g/kt	Bailey, 2001

Note: Applied emission factors come from: GF/POL/01/004 [59], Bailey R., 2001 [54]

IV.2.4 Sewage sludge incineration (NFR sector 5.C.1.b.iv)

Table A6. 203. Emission factors applied for NFR 5.C.1.b.iv

Pollutant	EF	EF unit	EF reference
PCDD/F	350	ug TEQ/kt	EMEP/EEA EIG 2016
NO_x	0.87	kg/t	EMEP/EEA EIG 2016
CO	0.07	kg/t	EMEP/EEA EIG 2016
NMVOC	7.4	kg/t	EMEP/EEA EIG 2016
SO_2	0.047	kg/t	EMEP/EEA EIG 2016
TSP	0.01	kg/t	EMEP/EEA EIG 2016
PM10	0.007	kg/t	EMEP/EEA EIG 2016
PM2.5	0.004	kg/t	EMEP/EEA EIG 2016
BC	3.5	% of PM2.5	EMEP/EEA EIG 2016
Pb	1.3	g/t	EMEP/EEA EIG 2016
Cd	0.1	g/t	EMEP/EEA EIG 2016
Hg	0.056	g/t	EMEP/EEA EIG 2016
As	0.016	g/t	EMEP/EEA EIG 2016
Ni	0.14	g/t	EMEP/EEA EIG 2016
TOTAL 4 PAHs	0.02	g/t	EMEP/EEA EIG 2016
HCB	0.002	g/t	EMEP/EEA EIG 2016

IV.2.5 Cremations (NFR sector 5.C.1.b.v)

Table A6. 204. Emission factors applied for NFR 5.C.1.b.v

Emission source	EF	EF unit	EF reference
NO_x	0.825	kg/body	EMEP/EEA EIG 2016
NMVOC	0.013	kg/body	EMEP/EEA EIG 2016
SO_2	0.113	kg/body	EMEP/EEA EIG 2016
CO	0.14	kg/body	EMEP/EEA EIG 2016
TSP	38.56	g/body	EMEP/EEA EIG 2016
PM10	34.7	g/body	EMEP/EEA EIG 2016
PM2.5	34.7	g/body	EMEP/EEA EIG 2016
Pb	30.03	mg/body	EMEP/EEA EIG 2016
Cd	5.03	mg/body	EMEP/EEA EIG 2016
Hg	1.49	g/body	EMEP/EEA EIG 2016
As	13.61	mg/body	EMEP/EEA EIG 2016
Cr	13.56	mg/body	EMEP/EEA EIG 2016
Cu	12.43	mg/body	EMEP/EEA EIG 2016
Ni	17.33	mg/body	EMEP/EEA EIG 2016
Zn	160.12	mg/body	EMEP/EEA EIG 2016
PCDD/F	0.027	µg/body	EMEP/EEA EIG 2016
PCB	0.41	mg/body	EMEP/EEA EIG 2016
HCB	0.15	mg/body	EMEP/EEA EIG 2016
Benzo(a)pyrene	13.2	µg/body	EMEP/EEA EIG 2016
Benzo(b)fluoranthene	7.21	µg/body	EMEP/EEA EIG 2016
Benzo(k)fluoranthene	6.44	µg/body	EMEP/EEA EIG 2016
Indeno(1,2,3-cd)pyrene	6.99	µg/body	EMEP/EEA EIG 2016

IV.2.6 Open burning of agricultural wastes (NFR SECTOR 5.C.2)

Table A6. 205. NO_x emission factors applied for NFR 5.C.2

Emission source	EF	EF unit
Open burning of agricultural wastes	0.004	Mg/Mg

Note: emission factors applied for Open burning of agricultural wastes is country specific

Table A6. 206. CO emission factors applied for NFR 5.C.2

Emission source	EF	EF unit
Open burning of agricultural wastes	0.064	Mg/Mg

Note: emission factors applied for Open burning of agricultural wastes is country specific

Table A6. 207. PM emission factors applied for NFR 5.C.2

PM Emission source	Emission factor				EF unit	EF reference
	TSP	PM10	PM2.5	BC		
Open burning of agricultural wastes	0.00464	0.00451	0.00419	0.00176	Mg/Mg	EMEP/EEA EIG 2016

Table A6. 208. NMVOC, SOx and metals emission factors applied for NFR 5.C.2

Emission source	EF	EF unit	EF reference
NMVOC	0.00123	Mg/Mg	EMEP/EEA EIG 2016
SOx	0.00011	Mg/Mg	EMEP/EEA EIG 2016
Cr	0.00001	g/Mg	EMEP/EEA EIG 2016
Cu	0.0002	Mg/Mg	EMEP/EEA EIG 2016
Zn	0.01753	Mg/Mg	EMEP/EEA EIG 2016
As	0.00041	Mg/Mg	EMEP/EEA EIG 2016
Se	0.00007	Mg/Mg	EMEP/EEA EIG 2016
Pb	0.00049	Mg/Mg	EMEP/EEA EIG 2016
Cd	0.0001	Mg/Mg	EMEP/EEA EIG 2016

Table A6. 209. PCDD/F and PAHs emission factors applied for NFR 5.C.2

Activity	EF	EF unit	EF reference
PCDD/F	0.01	g TEQ/Gg	EMEP/EEA EIG 2016
Benzo(b)fluoranthene	0.00463	Mg/Gg	EMEP/EEA EIG 2016
Benzo(k)fluoranthene	0.00568	Mg/Gg	EMEP/EEA EIG 2016
Benzo(a)pyrene	0.00233	Mg/Gg	EMEP/EEA EIG 2016

IV.3 Wastewater handling (NFR sector 5.D)

Table A6. 210. Emission factors applied for NFR 5.D

Pollutant	EF	EF unit	EF reference
NH_3	1.6	kg/person	EMEP/EEA EIG 2016
NNVOC	15	mg/m^3	EMEP/EEA EIG 2016

IV.4 Other waste (NFR sector 5.E)

Table A6. 211. Emission factors applied for NFR 5.E

Pollutant	EF	EF unit	EF reference
PCDD/F (Landfill fires - surface)	0.07	g TEQ/fire	Costner P., International POPs Elimination Network 2006
PCDD/F (Landfill fires - deep)	0.35	g TEQ/fire	
PCDD/F (Automobile fires)	0.048	mg/fire	EMEP/EEA EIG 2016
PCDD/F (Detached house fire)	1.44	mg/fire	EMEP/EEA EIG 2016
PCDD/F (Undetached house fire)	0.62	mg/fire	EMEP/EEA EIG 2016
PCDD/F (Apartment building fire)	0.44	mg/fire	EMEP/EEA EIG 2016
PCDD/F (Industrial building fire)	0.27	mg/fire	EMEP/EEA EIG 2016
TSP (Automobile fires)	2.3	kg/fire	EMEP/EEA EIG 2016
PM 10 (Automobile fires)	2.3	kg/fire	EMEP/EEA EIG 2016
PM 2.5 (Automobile fires)	2.3	kg/fire	EMEP/EEA EIG 2016
TSP (Detached house fires)	143.82	kg/fire	EMEP/EEA EIG 2016
TSP (Undetached house fires)	61.62	kg/fire	EMEP/EEA EIG 2016
TSP (Apartment building fires)	43.78	kg/fire	EMEP/EEA EIG 2016
TSP (Industrial building fires)	27.23	kg/fire	EMEP/EEA EIG 2016
PM 10 (Detached house fires)	143.82	kg/fire	EMEP/EEA EIG 2016
PM 10 (Undetached house fires)	61.62	kg/fire	EMEP/EEA EIG 2016
PM 10 (Apartment building fires)	43.78	kg/fire	EMEP/EEA EIG 2016
PM 10 (Industrial building fires)	27.23	kg/fire	EMEP/EEA EIG 2016
PM 2.5 (Detached house fires)	143.82	kg/fire	EMEP/EEA EIG 2016
PM 2.5 (Undetached house fires)	61.62	kg/fire	EMEP/EEA EIG 2016
PM 2.5 (Apartment building fires)	43.78	kg/fire	EMEP/EEA EIG 2016
PM 2.5 (Industrial building fires)	27.23	kg/fire	EMEP/EEA EIG 2016

Note: Applied emission factors come from: Costner P, International POPs Elimination Network 2006 [60]

V. MEMO ITEMS

V.1 Aviation (NFR sector 1.A.3.ai)

It was assumed that emission factors for cruise traffic per fuel use are the same as used for LTO cycle.

V.2 Forests fires (NFR sector 11 B)

Table A6. 212. Emission factors applied for NFR 11 B

Emission source	EF	EF unit	EF Reference
NOx	0.0006	Mg/Mg dry mass	IPCC 2006
NMVOC	0.013	Mg/ha	PL (IETU)
CO	0.112	Mg/Mg dry mass	IPCC 2006
TSP	0.0047	Mg/Mg	CEPMEIP
PM10	0.0033	Mg/Mg	CEPMEIP
PM2.5	0.00282	Mg/Mg	CEPMEIP
BC	0.09	% of PM2.5	EEA/EMEP EIG 2016
PCDD	5	mg TEQ / Gg	UNEP Toolkit, 2005

Note: PL (IETU) emission factors come from IETU surveys

V.3 Other natural emissions (NFR sector 11 C)

Table A6. 213. NMVOC emission factors applied for NFR 11 C (average annual emission factor for 2017)

Emission source	EF	EF unit	EF Reference
Managed broadleaf forests	33	kg/ha	IOŚ-PIB
Managed coniferous forests	25	kg/ha	IOŚ-PIB

ANNEX 7. 2018 TECHNICAL REVIEW OF NATIONAL EMISSION INVENTORIES

Following recommendations resulting from 2018 NECD Comprehensive Review of Polish inventory several emission factors has been applied from the EMEP/EEA EIG 2016 and some emission sources not estimated earlier have been added to the inventory.

Changes recommended during this review are presented below in the format of tables from the report "Draft Review Report 2018. Second phase of review of national air pollution emission inventory data pursuant to the Directive on the Reduction of National Emissions of Certain Atmospheric Pollutants (Directive (EU) 2016/2284 or 'NECD'). Poland". These changes are described in more detail in IIR 2019 chapters, concerning sectoral methodologies and recalculations. The column IIR chapter lists reference to the relevant chapter of the IIR report.

Table A6.1 Implementation of recommendations from the NECD Review 2017, considering revised estimates (RE), technical corrections (TC)

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
1.	PL-**1A1**-2018-0001	1A1 Energy production, **NMVOC, $PM_{2.5}$,** 2000-2015	The TERT recommends that Poland reviews and corrects, where required, the application of all EFs to NMVOC and $PM_{2.5}$ in 1A1a, corrects the documentation of EFs in the Annex to the IIR and reports transparently on the methods, EFs and any recalculations in the next submission.	PM & NMVOC EFs from 2016 GB have been applied.	3.1.6
2.	PL-1A1-2018-0002	1A1 Energy production, **SO_2, NO_X, NMVOC, $PM_{2.5}$,** 2000-2015	The TERT re-iterates the recommendation [PL-2017-1A1-0003] from the 2017 NECD Review that Poland checks the activity data of NFRs 1A1, 1A2 and 1A4 for all years and includes the correct activity data in the NFR tables for in the next submission.	Correct AD have been included in NFR tables and IIR.	3. 1.6 and Annex 5
3.	PL-1A2-2018-0001	1A2 Stationary Combustion in Manufacturing Industries and Construction, **SO_2, NO_X, NMVOC, $PM_{2.5}$,** 2000-2015	The TERT recommends that Poland adds new estimates of emissions of all pollutants from the combustion of waste with energy recovery across all source sectors in 1A2 across the time series, using the 2016 EMEP/EEA Guidebook methods in the waste chapter, applying the best available assumptions for waste calorific values in order to apply the EFs on a mass basis to the AD on an energy basis, and reports on the AD, EFs, method, assumptions and all recalculations in the next submission in order to improve inventory completeness.	Poland is still investigating of calorific values of combusted wastes.	3.2.7
4.	PL-1A2a-2018-0001	1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel, **SO_2, NO_X**, 2000-2015	The TERT recommends that Poland improves the documentation of the method in the IIR, including the information provided to the TERT during the review, and further the TERT recommends that Poland revises the EF for grey iron foundries in the next submission as stated in the review week, providing all documentation of methods, AD, EFs and recalculations within the next submission to improve inventory accuracy and completeness.	To avoid double counting and keep the statistical consistency the emission of air pollutants from grey iron foundries is included in fuel combustion sector 1A2a.	3.2.6

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
5.	PL-1A2d-2018-0001	1A2d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print, **NH_3,** 2000-2015	The TERT recommends that Poland include the revised estimate in its next submission.	AD for biomass and revised NH_3 estimate have been included.	3. 2.6
6.	PL-1A2gvii-2018-0002	1A2gvii Mobile Combustion in Manufacturing Industries and Construction: Other, **NH_3,** 1990-2015	The TERT recommends applying the emission factors available from the 2016 EMEP Guidebook for off-road machinery used in 1A2gvii to assure the completeness of the inventory and encourages Poland to improve fuel consumption calculation. In the meantime, as the named emissions are included in category 1A3b, the notation key should be changed to 'IE'.	the 'NA' notation keys have been changed to 'IE'. Poland will check, whether mobile fuel consumption data for 1.A.2.gvii could be modelled.	3. 2.7
7.	PL-1A2gvii-2018-0001	1A2gvii Mobile Combustion in Manufacturing Industries and Construction: Other, **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 1990-2015	her fuel consumption data for NFR sector 1A2gvii could be modelled based on other statistical data. The TERT recommends Poland to check whether fuel consumption data could be modelled based on other statistical data such (e.g. number of vehicles and machinery in use, development of the construction sector, etc.) in order to improve both the inventory's transparency and comparability, or at least to plan the improvement.	Poland will check, whether mobile fuel consumption data for 1A2gvii could be modelled on other statistical data.	3. 2.7
8.	PL-1A3ai(i)-2018-0001	1A3ai(i) International Aviation LTO (Civil), **SO_2, NO_X, NH_3, NMVOC**, 1990-2015	The TERT recommends that Poland checks and updates the references provided for all default emission factors derived from the 2016 guidebook, and finally updates the emission factors to the 2016 EMEP/EEA Guidebook values, if necessary.	EFs from 2016 GB have been applied .	3.3.1.1
9.	PL-1A3aii(i)-2018-0001	1A3aii(i) Domestic Aviation LTO (Civil), **NH_3,** 1990-2015	The TERT recommends Poland to change the notation key to 'NE' in its next submission and to provide the relevant explanatory information in the respective chapters of the IIR.	the 'NA' notation keys have been changed to 'NE'.	3.3.1.2
10.	PL-1A3aii(i)-2018-0002	1A3aii(i) Domestic Aviation LTO (Civil), **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 2012	The TERT recommends that Poland correct activity data in its next submission.	Correct AD have been included in NFR tables and IIR.	3.3.1.2
11.	PL-1A3aii(i)-2018-0003	1A3aii(i) Domestic Aviation LTO (Civil), **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 2012-2015	The TERT recommends that Poland includes the revised AD in its next submission and more generally check data before reporting.	Correct AD have been included in NFR tables and IIR.	3.3.1.2
12.	PL-1A3b-2018-0002	1A3b Road Transport, **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 1990-2015	The TERT recommends that Poland improves emission calculations from lubricants to be able to report in different NFR categories (1A3b and 2G/2D).	emissions from lubricants has been added (COPERT 5).	3.3.1.3
13.	PL-1A3bv-2018-0001	1A3bv Road Transport: Gasoline Evaporation, **NMVOC**, 2005-2015	The TERT recommends that Poland include the activity data in its next submission in order to improve transparency and comparability.	AD on gasoline used in the COPERT model have been included in IIR.	3.3.1.3

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
14.	PL-1A3bvi-2018-0001	1A3bvi Road Transport: Automobile Tyre and Brake Wear, **$PM_{2.5}$**, 1990-2015	The TERT recommends that Poland includes the PM emissions for 1A3bvii in its next submission, by using the emission factor available in the 2016 guidebook 1A3bvi-vii chapter.	PM emissions from road abrasion has been added.	3.3.1.3
15.	PL-1A3c-2018-0001	1A3c Railways, **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 2000-2015	The TERT recommends that Poland change the notation key in its next submission.	the 'NA' notation keys have been changed to 'NE'. Poland will check the availability of coal AD for railways directly from the operators.	3.3.1.4
16.	PL-1A3di(i)-2018-0001	1A3di(i) International Maritime Navigation - Memo Item, **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 1990-2015	The TERT recommends that Poland include the emissions in its next submission by using the 2016 guidebook emission factors.	emission estimates using the 2016 guidebook EFs have been added.	3.3.1.5
17.	PL-1A3ei-2018-0001	1A3ei Pipeline Transport, **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 2011	The TERT recommends that Poland recalculates the whole time series emissions in its next submission based on available activity data and 2016 EMEP/EEA Guidebook emission factors.	Missing emission estimates for pipelines have been added.	3.3.1.6
18.	PL-1A4aii-2018-0001	1A4aii Commercial/Institutional: Mobile, **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 1990-2015	The TERT recommends that Poland realises the new research to separate activity data from 1A3b (and so emissions) and explain clearly in the IIR on the progress in its next submission.	Poland will undertake new research under energy statistics.	3.4.7
19.	PL-1A4bi-2018-0002	1A4bi Residential: Stationary, **SO_2, NO_X, NMVOC, $PM_{2.5}$**, 2000-2015	The TERT re-iterates the recommendation from the previous review, to update the methods and EFs to be consistent with the 2016 EMEP/EEA Guidebook, and to document the methods, AD, EFs and all recalculations within the next submission.	EFs from 2016 GB for liquid and gas fuels have been added.	3.4.6
20.	PL-1A4bii-2018-0001	1A4bii Residential: Household and Gardening (Mobile), **SO_2, NH_3, NMVOC, $PM_{2.5}$**, 1990-2015	The TERT recommends that Poland check, whether fuel consumption data could be modelled for mobile household machinery such as lawn mowers in its next submission.	Poland will check, whether mobile fuel consumption data for household machinery could be modelled .	3.4.7
21.	PL-1A4cii-2018-0001	1A4cii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery**, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 2005-2006	The TERT recommends that Poland continue to check this issue and document it in the IIR in its next submission.	Poland consulted the statistical office and verified AD for 2005-2006.	3.4.1.4

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
22.	PL-1A4ciii-2018-0001	1A4ciii Agriculture/Forestry/Fishing: National Fishing, **NH_3,** 1990-2015	The TERT recommends Poland to change the notation key to 'NE' in its next submission and to provide the relevant explanatory information in the respective chapters of the IIR.	The 'NA' notation keys have been changed to 'NE'.	3.4.1.4
23.	PL-1A5b-2018-0001	1A5b Other, Mobile (Including Military, Land Based and Recreational Boats), **SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$**, 1990-2015	The TERT recommends that Poland provide additional information on the allocation of 1A5b activity data and emissions, and justify this allocation in its next submission.	Poland will make efforts to find more information concerning AD data for 1.A.5b.	3
24.	PL-1B1a-2018-0001	1B1a Fugitive Emission from Solid Fuels: Coal Mining and Handling, **$PM_{2.5}$,** 1990-2015	The TERT recommends that Poland include the revised estimate in its next submission, and report the $PM_{2.5}$ emissions from coal handling and storage in 1B1a, from coke handling in 1B1c and from cement in 2A5a and include a methodology description.	$PM_{2.5}$ and NMVOC emissions from 1.B.1.a have been verified and emission factors were changed to those presented in 2016 EMEP/EEA Guidebook. Regarding 2A5a category, it consists the PM emissions from quarrying of minerals (excl. coal) and ores.	3.5.6
25.	PL-1B1a-2018-0003	1B1a Fugitive Emission from Solid Fuels: Coal Mining and Handling, **NMVOC, $PM_{2.5}$**, 1990-2015	The TERT re-iterates the recommendation, for Poland to report emissions based on gross coal production AD, including documentation of the method, AD, EFs and recalculations, in the next submission.	Gross production AD have been used to estimate emissions.	3.5.6
26.	PL-1B1a-2018-0002	1B1a Fugitive Emission from Solid Fuels: Coal Mining and Handling, **NMVOC**, 1990-2015	The TERT recommends that Poland estimates and reports NMVOC emissions from open cast mining in the next submission.	NMVOC estimates have been added for open cast mining.	3.5.6
27.	PL-1B2aiv-2018-0002	1B2aiv Fugitive Emissions Oil: Refining / Storage**, SO_2, NO_X**, 1990-1999	The TERT re-iterates the recommendation from the previous review, noting that techniques for gap-filling may be appropriate such as the use of proxy data (e.g. refinery crude oil throughput), to include new estimates in the next submission and to improve the description of the source method to improve transparency.	Emission estimates based on crude oil throughput AD have been added before 2010.	3.5.6
28.	PL-1B2av-2018-0001	1B2av Distribution of Oil Products, **NMVOC**, 1990-2015	The TERT re-iterates the recommendation to re-estimate emissions from refinery dispatch and service stations using a Tier 2 approach, through progressing research into the technology split in Poland or through applying the best available assumptions on the technology split, for example based on information from neighboring countries with similar petroleum product delivery infrastructure.	Poland will check and use available information from neighboring countries.	3.5.7

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
29.	PL-2B10a-2018-0001	2B10a Chemical Industry: Other, **$PM_{2.5}$**, 2005-2015	The TERT recommends that Poland investigates which sort of polypropylene or how much of each sort is produced and provides an estimate for at least TSP emissions and possibly also for $PM_{2.5}$ emissions derived from these in its next submission. If not completed in the 2019 submission, the TERT recommends that Poland includes a schedule for implementation in its next IIR, to track progress on the implementation of this recommendation.	Poland will further investigate which sort of polypropylene or how much of each sort is produced.	4.3.1
30.	PL-2B5-2018-0001	2B5 Carbide Production, **$PM_{2.5}$**, 2005-2015	The TERT recommended that Poland includes the revised estimates in its next submission for both carbide production (2B5) and carbon black production (2B10a) and also includes information on the method, activity data and emissions factors in the IIR. The TERT also recommended Poland to investigate if emissions from flaring in carbide production occurred in the past and if so, recommends to include these emissions under NFR 2B10a. Poland specified that emissions from flaring in facilities for natural gas and oil extraction could not be estimated as no activity data were available, and that Poland is considering to resolve this issue via sectoral associations or questionnaires to companies. The TERT also recommends that Poland includes a schedule for implementation regarding emissions from flaring in its next IIR.	PM estimates for 2B5 and 2B10a have been added. Poland will further investigate if emissions from flaring in carbide production occurred in the past.	4.3.1
31.	PL-2B6-2018-0001	2B6 Titanium Dioxide Production, **SO_2, NO_X**, 2005-2015	The TERT recommends that Poland address inconsistencies for the SO_X EF reported, and mistakes for the references provided for NO_X emissions in its next submission.	Inconsistencies for the SO_X EF reported, and mistakes for the references have been corrected.	4.3.1
32.	PL-2C-2018-0001	2C Metal Industry, **SO_2, $PM_{2.5}$**, 2005-2015	The TERT recommends that Poland provide more clarifications on the method used to calculate SO_X and PM emissions from lead, zinc and copper production in the IIR, in particular the split between process and combustion emissions, and the difficulties to do so, in its next submission.	Description in IIR has been added. Poland applied EFs from EIG, 2016.	4.4.2
33.	PL-2C3-2018-0002	2C3 Aluminium Production, **SO_2, NO_X, $PM_{2.5}$**, 2005-2008	Poland confirmed that Søderberg anodes (instead of pre-baked anodes) were used for primary aluminium production (production until 2008), and stated that the time series will be fixed in the next submission. The TERT recommends that Poland correct the notation keys and SO_X and $PM_{2.5}$ estimate, and provide description of anodes used in its next submission.	SO_X and PM2.5 estimates and relevant notation keys have been corrected. Poland supplemented emission inventory with the secondary aluminum production.	4.4.2
34.	PL-2D3b-2018-0001	2D3b Road Paving with Asphalt, **NMVOC,** 1990-2015	Poland confirmed that part of asphalt production, which is used for the road paving is still not known. The TERT recommends that Poland includes a schedule for implementation, and inform on progress in implementing the improvement in its next submission.	Schedule for implementation and information on progress in implementing the improvement has been included in IIR.	4.5.6
35.	PL-2D3d-2018-0001	2D3d Coating Applications, **NMVOC**, 1990-2015	During the 2018 NECD Review, Poland reiterated the description of the methodology used. The TERT recommends that Poland includes this description in its next IIR.	Description of the applied methodology has been included in the IIR .	4.5.6

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
36.	PL-2D3e-2018-0001	2D3e Degreasing, **NMVOC**, 1990-2015	The TERT recommends that Poland investigates possibilities to apply the 2016 EMEP/EEA Guidebook methodology for calculation of NMVOC emission, and documents the method used in the IIR. Poland answered that they face difficulties regarding double-counting. In case of non-implementation, the TERT recommends that Poland includes a schedule for implementation in its next IIR.	Poland will further investigate possibilities to apply the 2016 EMEP/EEA Guidebook methodology. Schedule for implementation has been included in IIR.	4.5.7
37.	PL-2D3g-2018-0002	2D3g Chemical Products, **NMVOC**, 1990-2015	Poland explained that emissions from asphalt blowing were mixed up with 2D3b category. The TERT recommends that Poland implement this recommendation in its next submission. TERT also recommends to add statistical activity data used for tyres and shoes in the next submission.	Emission estimates from asphalt blowing have not been included. Statistical AD used for tyres and shoes have been added.	4.5.7 4.5.6
38.	PL-2D3h-2018-0001	2D3h Printing, **NMVOC**, 1990-2015	The TERT recommends that Poland include information on AD in its next IIR, and AD figures in its next NFR Tables.	Information on AD has been included in IIR and in NFR Tables.	4.5.6
39.	PL-2D3i-2018-0001	2D3i Other Solvent Use, **NMVOC**, 1990-2015	The TERT recommends that Poland add EUROSTAT activity data used for glues and adhesives, methodology description and figures for the use of glues and adhesives in its next IIR.	AD, methodology description and figures for glues and adhesives have been included in IIR.	4.5.6
40.	PL-2G-2018-0002	2G Other Product Use, **SO_2, NO_X, NMVOC, $PM_{2.5}$**, 1990-2015	The TERT reiterates recommendation PL-2G-2017-0002 from the 2017 NECD Review, regarding the correction of AD for 2G-Use of Tobacco and the improvement of the description of the country-specific methodology, including activity data and EFs, in the IIR of the next submission.	Description of national methodology including activity data and EFs has been included in the IIR.	4.6.6
41.	PL-2G-2018-0001	2G Other Product Use, **SO_2, NO_X, $PM_{2.5}$**, 1990-2015	The TERT disagreed the estimates of pollutants for the use of fireworks because no AD is reported before 2002. The TERT recommends that Poland provide AD before 2002, or provide an explanation for the figures, then include the estimates in its next submission, and add information related to the AD in its next IIR.	AD and emission estimates before 2002 have been added. Explanation re. methodology has been included.	4.6.6 and 4.6.7
42.	PL-2I-2018-0001	2I Wood Processing, **NMVOC**, 2000-2015	The TERT recommended that Poland reallocates NMVOC emissions from chipboard production to NFR 2H1 according to the 2016 EMEP/EEA Guidebook methodology in the next submission. The TERT also encouraged Poland to include the revised TSP estimate in category 2I in its next submission.	NMVOC emissions have been reallocated to NFR 2.H.1. TSP estimate has been included in NFR 2.I.	4.6.1
43.	PL-2L-2018-0001	2L Other Production, Consumption, Storage, Transportation or Handling of Bulk Products, **$PM_{2.5}$**, 2000-2015	The TERT recommends that Poland reallocates particle emissions from the storage and transport of cement, coal and coke under the correct NFR categories: 2A1 (cement), 1B1a (coal) and 1B1b (coke) in its next submission.	PM emissions from the storage and transport have not been reallocated. Further explanation is presented in section 4.6.6.	4.6.6.
44.	PL-3B-2018-0001	3B Manure Management, NMVOC, 2005, 2010, 2015	TERT recommends Poland to provide first estimates of NMVOC emission for NFR 3B based on Tier 1 approach for animal categories that do not constitute key sources, and use a Tier 2 approach for animal categories, which are key sources.	NMVOC emissions have been estimated for all livestock categories based on Tier 1 approach.	5.2.1

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
45.	PL-3D-2018-0002	3D Crop Production and Agricultural Soils, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005, 2010, 2015	The TERT recommends Poland to carry out an overall check of all notation keys to ensure the correct use.	Use of notation keys has been improved in Annex I.	Annex I
46.	PL-3D-2018-0001	3D Crop Production and Agricultural Soils, NO_X, 2005, 2010, 2015	The TERT noted that NO_X emissions from NRFs 3Da2a Animal Manure Applied to Soils and 3Da3 Urine and Dung Deposited by Grazing Animals have not been estimated . The TERT recommends Poland to implement the improvement in the next submission and to include all relevant information in the IIR.	NO_X emissions from animal manure applied on soils and left on pastures have been estimated under NFR categories 3Da2a and 3.D.a3 .	5.3.2
46.	PL-3Da1-2018-0002	3Da1 Inorganic N-fertilizers (includes also urea application), NH_3, 2005, 2020, 2015	For NFR 3Da1 Inorganic N-fertilizers the TERT noted that the NH_3 emission was based on EF in 2009 EMEP/EEA Guidebook. In response to a question raised during the review, Poland provided a revised estimate for 1990-2016 and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Poland and attached to the annex of the review report. However, the TERT wants to draw Poland's attention to the footnotes below Table 3-2 EFs for NH_3 emissions from fertilizers when collating data on fertilizer products. Footnote (d) is important because it indicates that if the fertilizer do not include MAP and DAP based products, the NH_3 EF for NK and NP mixtures should instead use the NH_3 EF for CAN or AN. The TERT recommends that Poland includes the revised estimate in its next submission.	NH3 emissions have been estimated based on EFs from GB 2016 taking into account footnote (d) below Table 3-2 (EFs for NH_3 emissions from fertilizers).	5.3.2
47.	PL-3Da1-2018-0001 PL-3De-2018-0001	3Da1 Inorganic N-fertilizers (includes also urea application), NMVOC, 2005, 2010, 2015 3De Cultivated Crops, NMVOC, 2005, 2010, 2015	The TERT recommends Poland to include the revised NMVOC estimate for 3De based on the Tier 2 approach in next submission.	NMVOC emissions have been estimated based on Tier 2 approach.	5.3.2
48.	PL-3Da2a-2018-0002 PL-3Da2a-2018-0001	3Da2a Animal Manure Applied to Soils, NH_3, 2005, 2010, 2015 3Da2a Animal Manure Applied to Soils, NH_3, 2005, 2010, 2015	For category NFR 3Da2a Animal manure applied to soils regarding NH_3 emission 2005-2016 notation key 'IE' is used, even though a Tier 1 methodology is given in the 2016 EMEP/EEA Guidebook (Table 3-2 of Chapter 3B), enabling splitting the NH_3 emissions in 3B, 3Da2a and 3Da3. In response to a question raised during the review, Poland stated that this splitting of the NH_3 emission in 3B and 3D is planned to be provided in the 2019 submission. The TERT recommends that Poland allocate the NH_3 emissions in the correct NFR categories in the next submission.	NH3 emissions from manure management have been splitted between 3B and 3.D.a.2a.	5.3.2
49.	PL-3F-2018-0001	3F Field Burning of Agricultural Residues, NO_X, NH_3, PAHs, Cd, Hg, Pb, 2005, 2010, 2015	The TERT recommends that Poland improve completeness by including emissions of NH_3, NO_X, PAHs, Cd, Hg and Pb from NFR 3F in the next submission	All pollutants related to field burning of agricultural residues have been estimated.	5.4.2

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
50.	PL-5A-2018-0001	5A Biological Treatment of Waste - Solid Waste Disposal on Land, **SO_2, NO_X, NMVOC**, 2005, 2010, 2015	The TERT noted that the recommendation (PL-5A-2017-0001) raised during the 2017 review concerning the transparency of the IIR was not implemented in the 2018 submission. In response to a question raised during the review, Poland provided some information. The TERT recommends Poland to provide an explanation in the IIR about the allocation of emissions from landfill gas recovery in the next submission.	Explanation about the allocation of emissions from landfill gas recovery has been added in the IIR.	6.2
51.	PL-5C1bi-2018-0001	5C1bi Industrial Waste Incineration, **$PM_{2.5}$**, 2005, 2010, 2015	The TERT recommends that Poland includes the appropriate AD for 5C1bi - Industrial Waste Incineration in the NFR tables in the next submission.	Appropriate AD have been included in the NFR tables.	6.4
52.	PL-5C1biii-2018-0002	5C1biii Clinical Waste Incineration, **SO_2, NO_X**, 2005, 2010, 2015	The TERT recommends that Poland includes NO_X and SO_2 emissions in its inventory and provide a transparent description of the methodology for 5C1biii- Clinical Waste Incineration in the IIR, especially concerning the selection of EFs. TERT noted that the Activity Data (AD) reported in the NFR tables are 10 times higher than in the calculation files and Poland confirmed that the correct data are in the calculation file. TERT recommends that Poland provides the correct data in the NFR tables in the next submission.	Transparent description of the methodology, especially concerning the selection of EFs has been provided in the IIR. Correct AD have been provided in the NFR tables.	6.3
53.	PL-5C2-2018-0002	5C2 Open Burning of Waste, **NO_X**, 2005, 2010, 2015	Poland indicated that the NFR 5C2 allocation for open Burning of Waste and pollutants NO_X, NMVOC, $PM_{2.5}$ will be changed in the next submission. The TERT recommends that Poland includes these emissions in its next submission.	Emission estimates have been moved to NFR 3.F .	6.4
54.	PL-5E-2018-0001	5E Other Waste, **$PM_{2.5}$**, 2005, 2010, 2015	Poland provided revised estimates PL-5E_2018-0001 building fires 8 V.xlsx concerning building fires and PL-5E_2018-0001 building and car fires 28 VI.xlsx concerning car fires) that the TERT agreed with. The TERT recommends that Poland includes these revised estimates in its next submission.	Revised estimates have been made and car fires included in NFR 5.E (instead of 6.A).	6.4

Table A6.2 Additional recommendations made during the NECD Review 2018 for NOX, NMVOC, SOX, NH_3, PM2.5 considering revised estimates (RE), technical corrections (TC)

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
1.	PL-5A-2018-0002	5A Biological Treatment of Waste - Solid Waste Disposal on Land, **NMVOC, $PM_{2.5}$**, 1990-2016	$PM_{2.5}$ emissions were over-estimated NMVOC were under-estimated. In response to a question raised during the review Poland provided a revised estimate (RE_PL-5A-2018-0002.xlsx) that the TERT agreed with. The TERT recommends that Poland include this revised estimate in it next submission.	Revised estimates for NMVOC and PM have been included	6.4

Table A6.3 Recommendations from the NECD Review 2018 concerning the first phase of the in-depth review of national emission inventories of POPs and heavy metal

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
1.	PL-**1A3b**-2018-0004	1A3b Road Transport, **PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F,** 1990-2016	For 1A3bi-iv/liquid fuel/HM & POPs/All years, the TERT noted that, with reference to the NFR tables and IIR pages 65-68, there is a lack of transparency regarding the trends of Activity data (AD) and implied emission factors (IEF). The TERT recommends that Poland includes the new activity data and new emissions in its next submission.	The new activity data and new emission estimates have been included	3.3.1.3
2.	PL-**1A2gviii**-2018-0001	1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other, **Cd, Hg, Pb, PCDD/F**, 1990, 2005, 2016	Poland explained that there was an error in the NFR tables and that there are no AD specific to source category 1A2gviii. The TERT recommends that Poland corrects the reporting mistakes in the NFR tables and reviews the completeness of AD and emissions reported across 1A2 in comparison to the national energy balance, and documents the findings in the next submission in order to verify that there are no AD and emissions to be reported in 1A2gviii.	Erroneous AD for category 1A2gviii have been removed from NFR tables	3. 2.6
3.	PL-**1A3aii(i)**-2018-0004	1A3aii(i) Domestic Aviation LTO (civil), **Pb**, 2000-2016	It should be noted however that the share of aviation gasoline in the gasoline market in Poland is less than 0.1% and aviation gasoline with low lead content prevails. The TERT recommends that Poland collect lead content in aviation gasoline in order to improve the completeness in its next submission.	Poland will try to collect data on lead content in aviation gasoline	3.3.7
4.	PL-**1A3di(ii)**-2018-0001	1A3di(ii) International Inland Waterways, **PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F**, 1990-2016	Poland explained that the fuel use in domestic navigation (inland and maritime) does not allocate separately activity data for international inland waterways. The TERT recommends that Poland works on estimating separate activity data between international inland waterways and national inland waterways (for example by using tkm for each type of transport). Until this improvement can be made, 'IE' notation key should be used in the NFR table and associated explanation should be written in the IIR.	Notation key IE has been applied for this category. Poland will try to estimate separate activity data between international inland waterways and national inland waterways.	3.3.1.5 and 3.3.7
5.	PL-**1B2aiv**-2018-0001	1B2aiv Fugitive Emissions Oil: Refining / Storage, **Cd, Hg, PCDD/F**, 1990, 2005, 2016	The TERT noted that reporting of emissions from 1B2aiv Fugitive Emissions Oil: Refining / Storage for all priority metals (Cd, Hg, Pb) and POPs (PCDD/Fs) across the full time series is 'NA'. The TERT recommends that Poland adds new emission estimates of Cd, Hg, Pb and PCDD/Fs for 1B2aiv using methods and EFs consistent with the 2016 EMEP/EEA Guidebook, and to document the methods, AD, EFs and all recalculations within the next submission.	Fugitive emission estimates of Cd, Hg, Pb and PCDD/Fs from Oil: Refining/Storage (NFR 1.B.2.aiv), using methods and EFs consistent with the 2016 Guidebook, will be added in the next submission.	3.5.7

No.	Observations by NFR	Pollutant(s), Year(s)	Short recommendation	Action undertaken	IIR chapter
6.	PL-**2C3**-2018-0001	2C3 Aluminium Production, **HCB**, 1990, 2005, 2016	Poland answered that due to the very high (5 g/Mg) and old EF, initial HCB estimate from 2C3 is thousands of times higher than the previous country total and stated that the HCB estimate needs further investigation. The TERT recommends that Poland further investigates HCB emissions methodology (EF) for secondary aluminium production. If a country-specific EF cannot be derived, the TERT recommends that Poland implements the default EF from the 2016 EMEP/EEA Guidebook in the next submission.	New emission estimates of HCB have been added.	4.4.2
7.	PL-**2D3g**-2018-0001	2D3g Chemical Products**, PAHs**, 1990, 2005, 2016	Regarding the data provided by Poland, the AD used is "road paving with asphalt", whereas the 2016 EMEP/EEA Guidebook says that "Air-blown asphalts are used in the production of asphalt roofing products, in the installation of built-up roofs and for the repair of leaky roofs. Air blowing of asphalt may be conducted at oil refineries, asphalt processing plants and asphalt roofing plants." So the AD used seems to be wrong. The asphalt used for asphalt roofing should be used. This AD in m^2 has to be converted in mass to be used with the EF provided by the 2016 EMEP/EEA Guidebook. The TERT recommends that Poland investigates the AD for asphalt blowing, and then estimate PAH emissions in the next submission.	Emission estimates from asphalt blowing have not been included.	4.5.7
8.	PL-**2C5**-2018-0001	2C5 Lead Production, **PCBs,** 1990, 2005, 2016	For 2C5 Lead Production the TERT noted that no PCBs emissions were estimated while there is a 2016 EMEP/EEA Guidebook methodology and EF provided. In response to a question raised during the review, Poland provided estimates of PCBs emissions for 2C5. The TERT recommends that Poland includes the PCBs emissions in its next submission.	New PCB emission estimates have not been added.	4.4.2
9.	PL-**2D3a**-2018-0001	2D3a Domestic Solvent Use Including Fungicides, **Hg**, 1990, 2005, 2016	TERT noted that that there may be an under-estimate of emissions for mercury from fluorescent tubes. In response to a question raised during the review, Poland provided Hg estimates. The TERT found an error in the unit reported for Hg emissions in the file provided by Poland. Emissions calculated are reported in tons, and not in kg. Tons is the unit to be reported in the NFR Tables for heavy metals. The TERT recommends that Poland include the Hg emissions in its next submission.	Hg emission estimates have been verified and included.	4. 5.6
10.	PL-**5C1biii**-2018-0001	5C1biii Clinical Waste Incineration, **PAHs, Cd, Hg, Pb**, 1990, 2005, 2016	For 5C1biii-Clinical Waste Incineration, the TERT noted that, in the NFR tables, 'NA' is reported for Pb, Cd, Hg and PAHs although there are EFs proposed in the 2016 EMEP/EEA Guidebook. The TERT recommends that Poland includes the heavy metals and PAHs from 5C1biii in its next submission. Special attention must be paid to Hg for which this category will be a key category (corresponding to 20% of national Hg emissions in 2016) and is supposed to be estimated using at least a Tier 2 methodology (taking into account the efficiency of abatement technologies).	Hg emission estimates have been verified. New emission estimates have been added.	6.4
11.	PL-**5C1biv**-2018-0001	5C1biv Sewage Sludge Incineration, **SO_2, NO_X, NMVOC, $PM_{2.5}$, PAHs, HCB, PCDD/F**, 1990, 2005, 2016	For 5C1biv- Sewage Sludge Incineration, the TERT noted that, except for PCDDF, Poland do not estimate emissions although NO_X and NMVOC EFs are presented in the IIR and default EFs are proposed in the 2016 EMEP/EEA Guidebook. The TERT recommends that Poland includes emissions in its inventory for all the pollutants for which a default value is proposed in the 2016 EMEP/EEA Guidebook.	New emission estimates have been added.	6.4

ANNEX 8. UNCERTAINTY ANALYSIS OF EMISSIONS OF SELECTED AIR POLLUTANTS

Do not put your faith in what statistics say until you have carefully considered what they do not say.

– William W. Watt

I. SUMMARY

This annex to the Poland's IIR report summarizes and updates uncertainty estimates of air pollutant emissions covered by the NEC Directive (2016/2284/EU). The data on emissions, as well as activities of emission sources are derived mainly from the official statistics (Statistics Poland and EUROSTAT). Another additional and auxiliary information used for purposes of national air emission inventory compilation is derived from various data sets provided by: National Emission Database (NCEM), Motor Transport Institute, Energy Market Agency, Institute of Ecology of Industrial Areas, National Headquarters of the State Fire Service and other.

The aim of this report is fulfilling obligation on providing uncertainty analysis, elaborated accordingly with the Chapter 5 of the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EEA, 2016), as a collection guidance on compiling of national air pollutant emission inventory.

All statistical calculations have been prepared using the open source platform and statistical language R (https://www.r-project.org/).

II. UNCERTAINTY IN TOTAL EMISSION INVENTORY

The emission trends of air pollutants for 1990-2017 are given in the figure below.

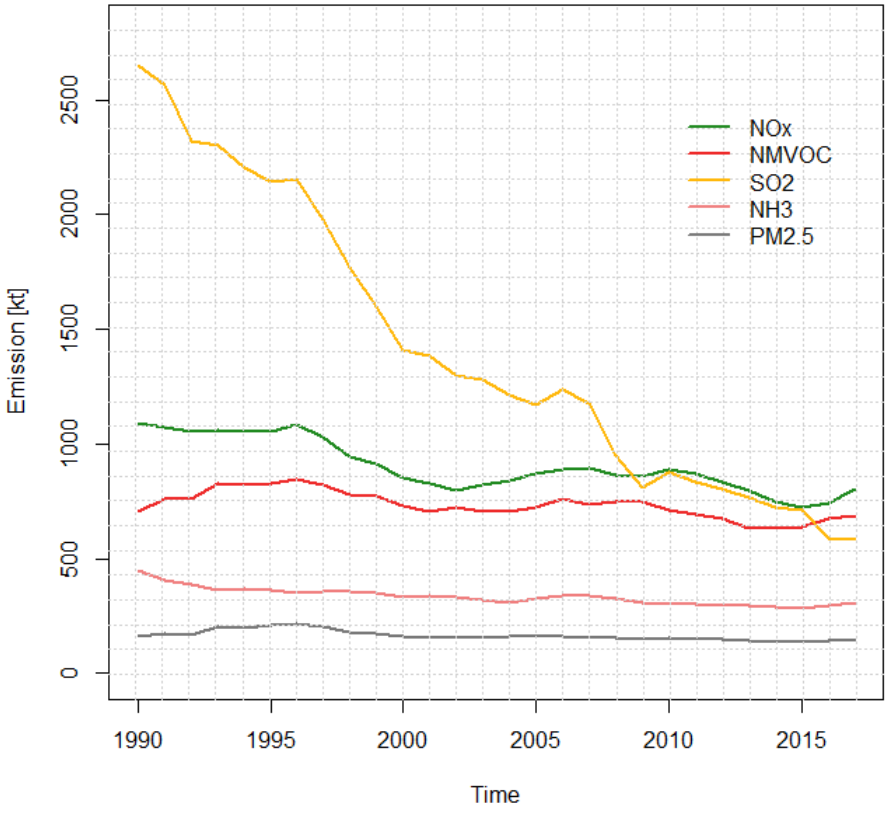

Figure A8.1. Emission trends for the NECD pollutants 1990-2017 [kt]

Considering the emission trend as consistent structure, the uncertainty in total emission inventory is estimated using the normal (Gaussian) distribution, as below:

$$f(x) = \frac{1}{2\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma}},$$

where: $f(x)$ is the Gaussian probability density function (PDF), x is the time series of particular air pollutant's emission $\{x_{1990}, x_{1991}, \ldots, x_{2017}\}$; μ, and σ are: mean and standard deviation respectively.

Using the approximation that the probability of occurrence in the neighborhood of the 2σ:

$$Pr\{\mu - 2\sigma \leqslant x \leqslant \mu + 2\sigma\} \approx 95\%,$$

the total uncertainties of considered pollutants' emissions are presented below:

Figure A8. 1. The total uncertainties of the NEC pollutants' emissions

Pollutant	Uncertainty into the trend [%]	95% Confidence Interval [kt]
NO_X	25.34	[674.01; 1,131.48]
NMVOC	16.17	[615.03; 852.29]
SO_2	91.33	[122.29; 2,699.23]
NH_3	22.78	[258.53; 411.1]
$PM_{2.5}$	27.00	[119.7; 208.24]

In comparison to the results presented by the Germany[2], the majority of considered pollutants (NO_X, NMVOC, and NH_3) have the comparable uncertainties. The occurrence of the outlying value (91.33% for SO_2) is caused by the intensive development of the desulfurization systems installed in Polish energy sector. More information about the developments in Polish energy sector is given in Zasina and Zawadzki (2017)[3]. According to the given information, the uncertainty of the SO_2 emission inventory is calculated also for enumerated trends:

- 1995-2017 (run of the first desulfurization installation) – U = 79.83%; 95%CI = [240.72; 2146.71] kt;
- 2000-2017 (increasing of desulphurization in hard coal combustion) – U = 56.27%; [432.82; 1546.65] kt.

The next considerable driving forces of the results of SO_2 emission inventory are the sulfur content in fuels, especially liquid – according to the legislation which have entered into force[4,5], also planned changes in requirements for coals used in individually heated households.

III. MONTE CARLO SIMULATION FOR TOTAL EMISSIONS

Using the previous result, the distributions of air pollutants' emissions are generated using the Monte Carlo simulation. All distributions are assumed to be normal (Gaussian) with the mean (μ) and the standard deviation (σ) obtained from the particular time series. Each simulation sample consists of 10,000 iterations. The results are presented in the figures below.

2 https://iir-de.wikidot.com/general-uncertainty-evaluation [accessed: 2019-01-22].

3 D. Zasina and J. Zawadzki (2017). Mercury Air Emission from Coal-Fired Public Power Sector: Uncertainty and Its Monthly Distribution. Case Study from Poland. *Environmental Modeling & Assessment* **22**(6) pp 577-589. DOI 10.1007/s10666-017-9573-3.

4 A. Kamiński (2015). National and worldwide environmental requirements in terms of the quality of automotive fuels. *Studia Ecologiae et Bioethicae* **13**(1), pp 147-158. [in Polish, with English abstract].

5 D. Skutecka (2013). Legal regulation for system of monitoring and control of fuels quality, selected issues related to the entrepreneur's control. *Studia Iuridica Toruniensia* vol. XIII, pp 197-220. DOI 10.12775/SIT.2013.023. [in Polish, with English abstract].

NO_X

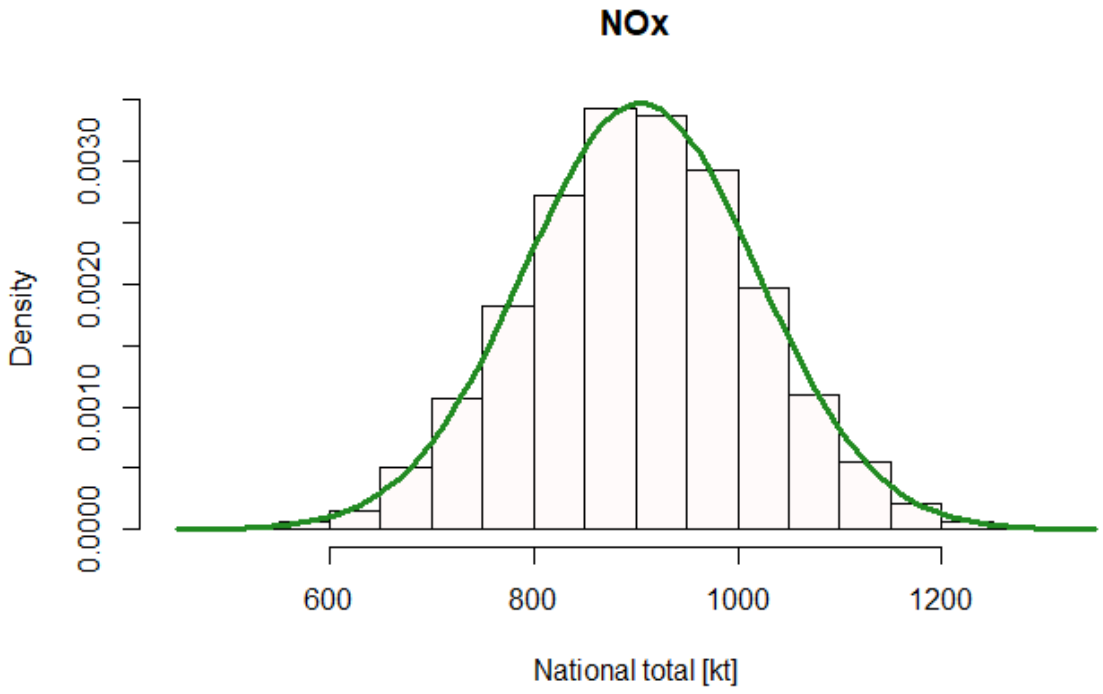

Figure A8.2. Monte Carlo simulation of the national total NOx emission [kt]

NMVOC

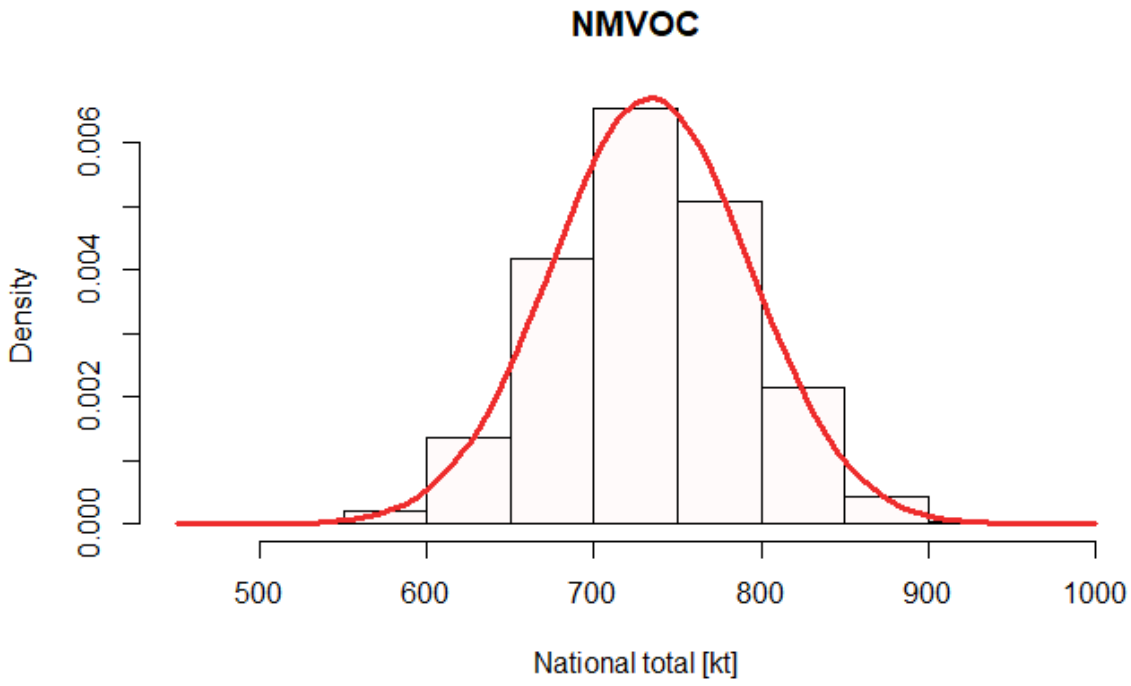

Figure A8.3. Monte Carlo simulation of the national total NMVOC emission [kt]

SO_2

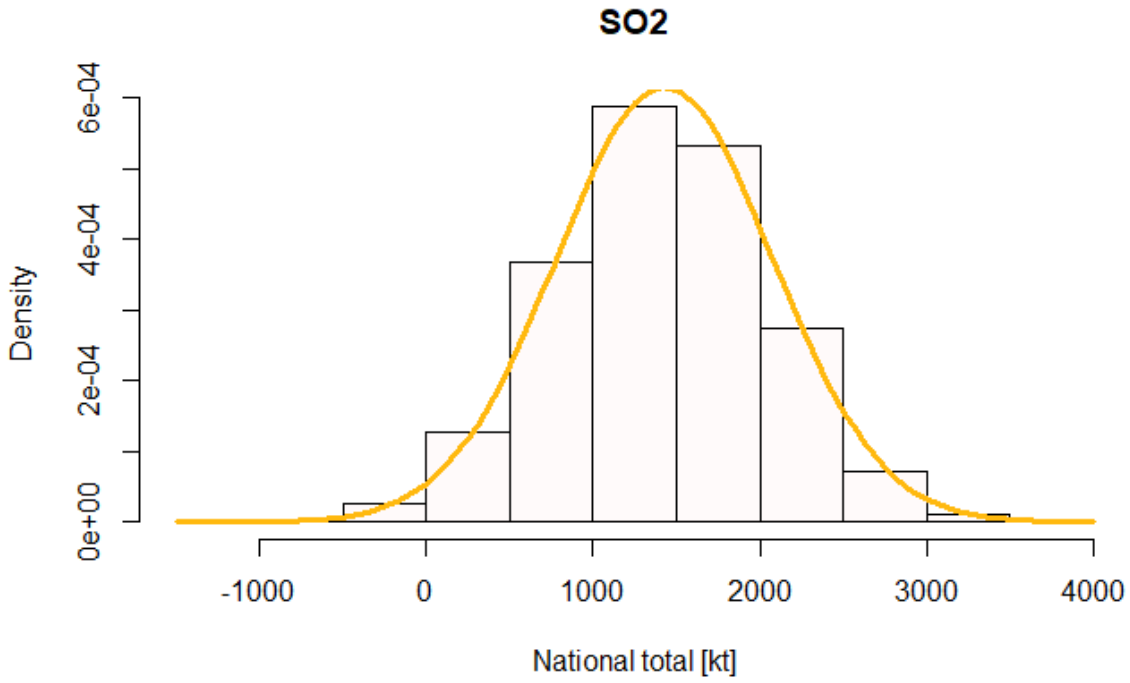

Figure A8.4. Monte Carlo simulation of the national total SO_2 emission [kt]

NH_3

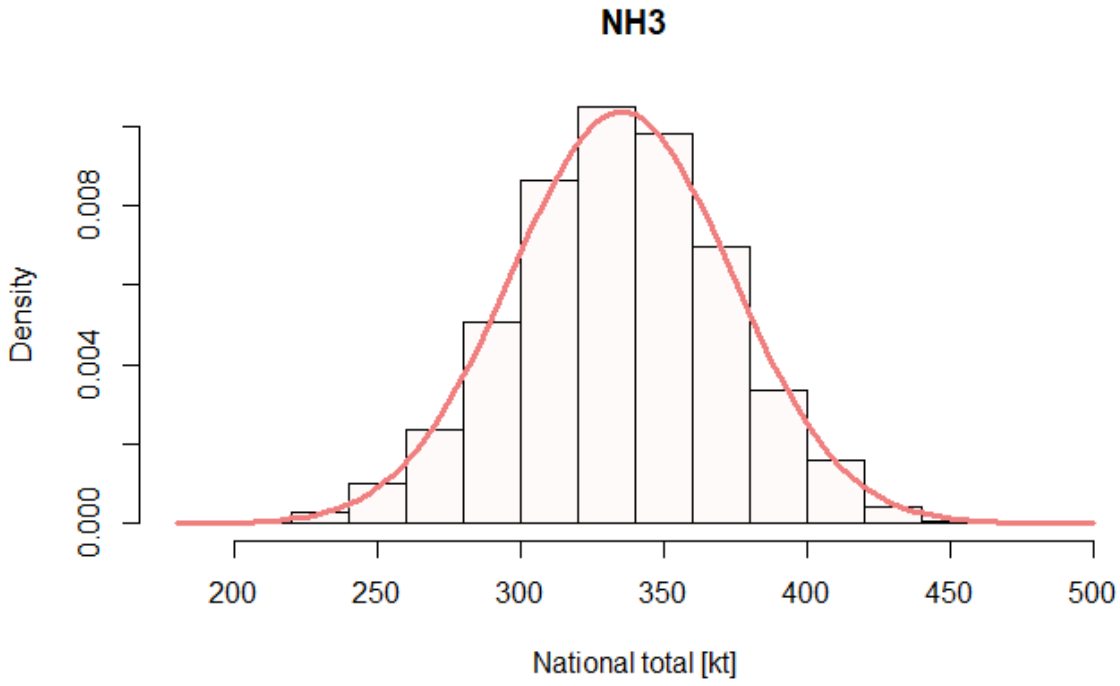

Figure A6.5. Monte Carlo simulation of the national total NH_3 emission [kt]

PM2.5

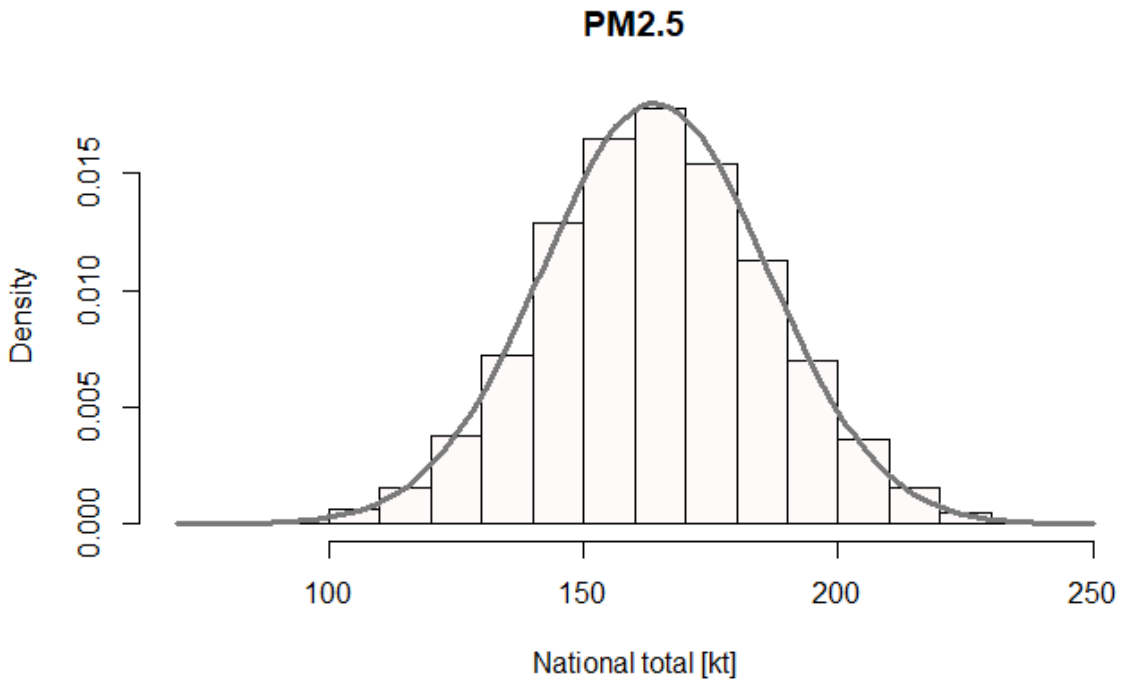

Figure A6.6. Monte Carlo simulation of the national total $PM_{2.5}$ emission [kt]

IV. UNCERTAINTY INTRODUCED INTO THE TREND AND SENSITIVITY ANALYSIS

Uncertainty introduced into the trend is assumed using the relative RMSE[6] of emission forecasts elaborated using the ARIMA[7] approach, formula (A8.1) presented below:

$$RelRMSE = \frac{RMSE}{\widehat{RMSE}}, \quad \text{(A8.1)}$$

where: $RMSE$ – ARIMA emission forecast for 2018-2030 using trend 1990-2017; $\widehat{RMSE}$ – ARIMA emission forecast for 2017-2030 using trend 1990-2016.

The formula for RMSE (A6.2) is given below:

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_t - \widehat{y_{t|N}})}; \quad \text{(A6.2)}$$

where: y_t – actual values in the test set; $\widehat{y_{t|N}}$ – forecasts produced using only the data in the training set[8].

In the figures A6.7 – A6.11 the 80% confidence intervals (80%CI) are marked with dark blue. The light blue is associated with 95%CI.

6 C. Chen, J. Twycross, and J.M. Garibaldi (2017). A new accuracy measure based on bounded relative error for time series forecasting. *PLoS One* **12**(3): e0174202. DOI: 10.1371/journal.pone.0174202.

7 See: 'Introduction to ARIMA: nonseasonal models' by Robert Nau, https://people.duke.edu/~rnau/411arim.htm, and *auto.arima* function from package *forecast* https://CRAN.R-project.org/package=forecast [both accessed 2019-01-23].

8 See: 'Measuring forecast accuracy' by R.J. Hyndman (2014) https://pdfs.semanticscholar.org/af71/3d815a7caba8dff7248ecea05a5956b2a487.pdf [accessed 2019-01-23].

NO_X

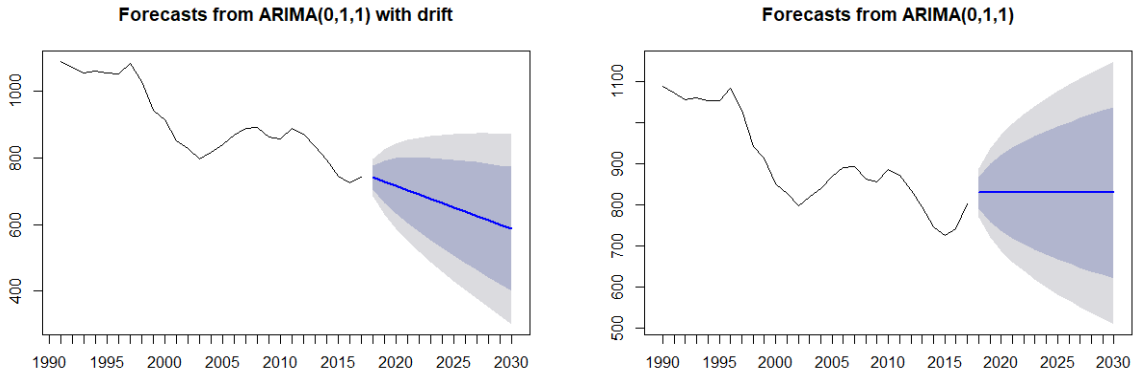

Figure A6.7. ARIMA forecast for the NO_X emission time series. Left: using 1990-2016 data. Right: using 1990-2017 data. RelRMSE = 1.0928

NMVOC

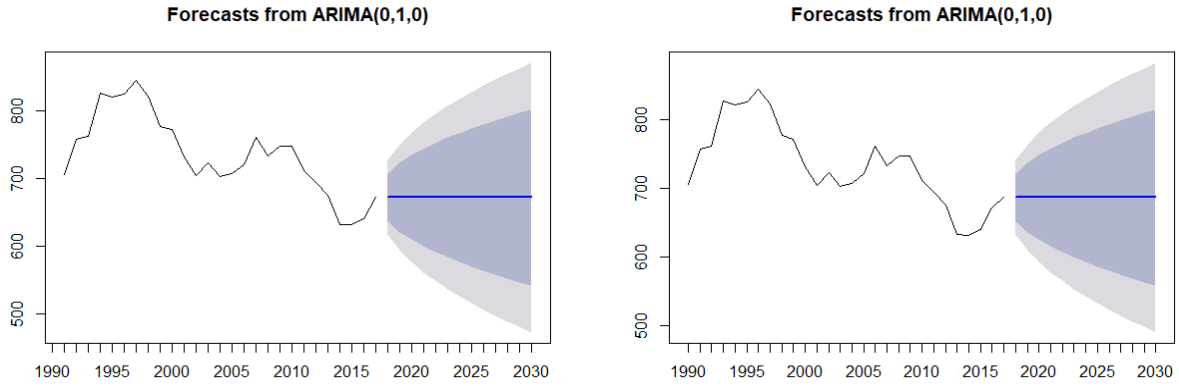

Figure A6.8. ARIMA forecast for the NMVOC emission time series. Left: using 1990-2016 data. Right: using 1990-2017 data. RelRMSE = 0.9871

SO_2

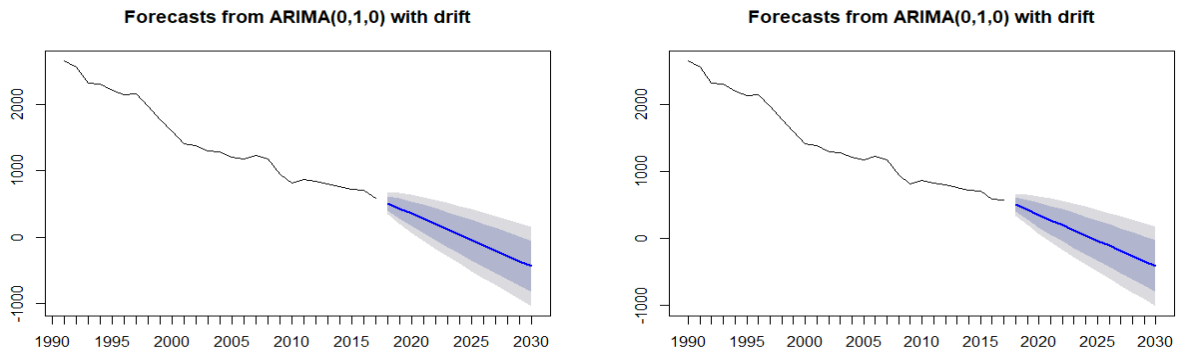

Figure A6.9. ARIMA forecast for the SO_2 emission time series. Left: using 1990-2016 data. Right: using 1990-2017 data. RelRMSE = 0.9955

NH_3

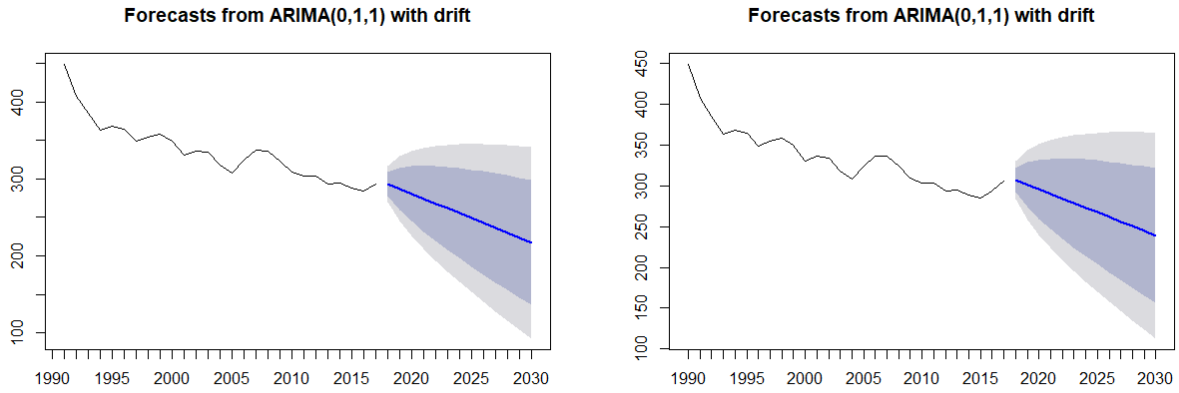

Figure A6.10. ARIMA forecast for the NH_3 emission time series. Left: using 1990-2016 data. Right: using 1990-2017 data. RelRMSE = 1.004

PM2.5

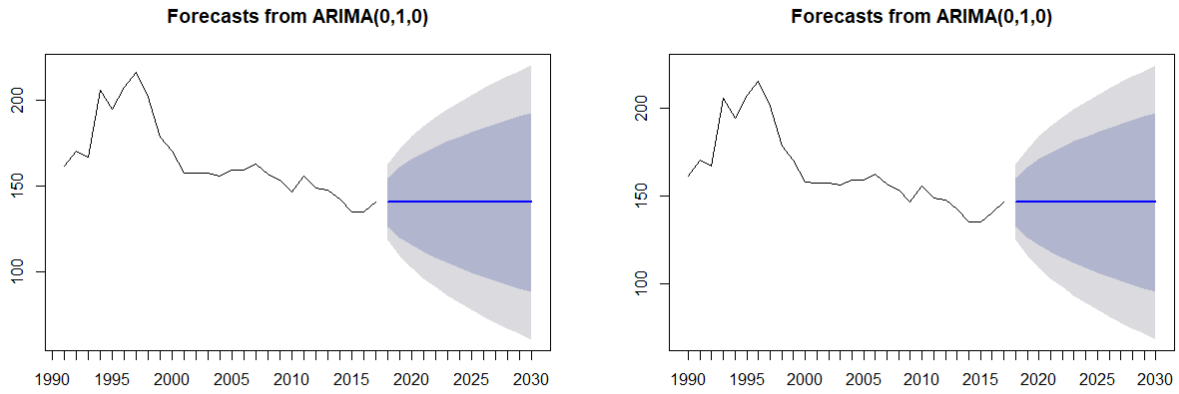

Figure A6.11. ARIMA forecast for the $PM_{2.5}$ emission time series. Left: using 1990-2016 data. Right: using 1990-2017 data. RelRMSE = 0.9870

V. REMARKS

According to the obtained results for only two pollutants (SO_2, and NH_3) it can be observed decreasing forecast, for the rest of pollutants, the forecast trend is stable, even if the trend 1990-2016 is recognized as decreasing (NO_X).

The forecast for the SO_2 emission achieves values below 0 which is not possible. Is probable that the SO_2 emission will be decreasing, and will achieve particular positive value. Afterwards, the emission trend will stabilize.

In case of NO_X emission the stability of the forecast trend is associated with the considerable share of road transport in the national total. In case of NMVOC's emissions this stability is associated with a number of sources recognized as the key categories (presented in tab. A6.2).

Tabela A6.2. Key categories for 2017 (according to results of RepDab report generated 2019-01-30)

Cmp	Key categories (Sorted from high to low from left to right)																		Tot (%)
SO_x	1A1a (44.8%)	**1A4bi (22.7%)**	1A2c (6.1%)	1A2a (5.6%)	1A2f (3.8%)														**83.0**
NO_x	1A1a (22.4%)	1A3biii (20.6%)	1A3bi (12.5%)	1A4cii (8.6%)	1A4bi (7.7%)	3Da1 (5.7%)	1A3bii (3.7%)												**81.2**
NH_3	3Da2a (36.1%)	3Da1 (20.1%)	3B1a (11.2%)	3B3 (9.7%)	3B1b (7.1%)														**84.2**
NM VOC	**1A4bi (14.8%)**	2D3d (11.8%)	2H2 (7.0%)	2D3a (6.7%)	1A3bi (6.6%)	3B1a (4.7%)	2D3g (4.3%)	2D3h (4.0%)	3B1b (3.2%)	1A3bv (2.9%)	1B1a (2.7%)	1A2f (2.2%)	1B2av (2.0%)	3B4gii (2.0%)	1B2aiv (1.8%)	1A2d (1.6%)	1B2b (1.4%)	1A3biii (1.3%)	**81.1**
CO	**1A4bi (53.7%)**	1A3bi (17.3%)	1A4cii (3.7%)	1A4ci (3.4%)	1A3bii (2.7%)														**80.8**
TSP	**1A4bi (35.8%)**	1A4ci (6.7%)	3Dc (5.0%)	1A1a (4.4%)	1B1a (3.8%)	3B3 (3.4%)	2L (3.3%)	1A2c (3.1%)	1A4cii (3.1%)	1A2a (2.8%)	3B4gi (2.8%)	1A3bvi (2.4%)	1A4ai (2.1%)	1A3bvii (1.7%)					**80.3**
PM_{10}	**1A4bi (37.3%)**	1A4ci (7.2%)	3Dc (6.9%)	1A1a (5.1%)	1A4cii (4.2%)	1A2c (4.0%)	1A2a (3.7%)	1B1a (2.6%)	1A3bvi (2.5%)	1A4ai (2.0%)	1A2e (1.9%)	1A2f (1.8%)	2L (1.8%)						**81.1**
$PM_{2.5}$	**1A4bi (37.9%)**	1A4cii (7.1%)	1A2c (6.3%)	1A2a (5.9%)	1A4ci (5.4%)	1A1a (4.8%)	1A4ai (3.2%)	1A2e (3.0%)	1A2f (2.9%)	1A3bi (2.8%)	1A3biii (2.8%)								**82.1**
Pb	2C1 (30.1%)	**1A4bi (14.6%)**	2C5 (12.5%)	1A1a (8.6%)	2C6 (5.1%)	2C7a (3.8%)	1A4ci (3.2%)	1A2c (3.1%)											**81.0**
Hg	1A1a (54.9%)	2C1 (12.4%)	2C6 (8.4%)	1A4bi (6.6%)															**82.3**
Cd	2C1 (16.5%)	1A2c (12.5%)	1A2a (11.6%)	2C6 (7.6%)	1A4bi (7.5%)	1A1b (5.9%)	1A2e (5.9%)	1A1a (5.7%)	1A2f (5.6%)	2C5 (5.1%)									**84.0**
DIOX	**1A4bi (53.8%)**	5E (17.9%)	2C1 (5.5%)	1A1a (3.9%)															**81.1**
PAH	**1A4bi (83.5%)**																		**83.5**
HCB	**1A4bi (42.5%)**	1A1a (19.9%)	5C1biv (11.5%)	5C1bi (10.1%)															**84.0**

Cmp – component, Tot – cumulated percent of national total.

According to the data about key categories for 2017, the significant air pollutants' emissions are released into the air by the households sector (NFR 1A4bi, marked with red color in tab. A6.2). That means, the sector of households is perspective regarding carrying out analysis of actual structure of the sector, future planned mitigation strategies, and also emission reductions. Taking into account available country specific information, the sector can be better recognized in view of the estimated values and uncertainties.