POLAND'S
INFORMATIVE INVENTORY REPORT
2018

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

Warszawa, February 2018

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Executive Summary

Emission estimates in Poland account for sulphur dioxide, nitrogen oxides, ammonia, carbon monoxide, particulate matter (BC, PM2.5, 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), HCB, PCB and PAH.

The Poland's *Informative Inventory Report* (IIR) 2018 contains information on the Poland's inventories for the years 1990 to 2016, including descriptions of methods, data sources, carried out QA/QC activities and a trend analysis. Emission inventories have been reported in the NFR 2014-1 reporting format.

Referring to earlier submissions some methodology changes have been introduced; the major changes include verification of several emission factors following ***2017 Comprehensive Technical Review of National Emission Inventories***. Summary of changes recommended during this review is presented in Appendix 8.
Nevertheless, there is still a scope for inventory improvement; 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 1990-2000,
- further methodology development by applying higher tier of estimation methodology.

Emission volumes in the years 2015 – 2016 for the particular pollutants are presented below.

Pollutant	2015	2016	2016/2015
	Mg		*[%]*
SO_2	701 831,5	581 520,3	82,86
NO_x	704 824,3	726 431,2	103,07
NH_3	267 312,2	267 107,2	99,92
CO	2 370 432,8	2 505 631,3	105,70
NMVOC	590 627,8	608 858,3	103,09
TSP	342 017,6	352 306,1	103,01
PM10	248 654,5	259 165,3	104,23
PM2.5	138 343,5	145 506,9	105,18
BC	19 794,0	21 260,7	107,41
Pb	420,9	418,3	99,38
Cd	12,3	13,1	106,63
Hg	10,6	10,3	97,85
As	30,7	28,3	92,14
Cr	32,7	33,9	103,79
Cu	329,6	316,5	96,04
Ni	81,6	82,4	100,89
Zn	863,2	836,8	96,93
	kg		
PCB	627,3	634,3	101,11
HCB	4,8	4,9	101,89
PAH	139 467,9	146 344,4	104,93
	g I-TEQ		
PCDD/F	290,0	282,3	97.37

Total emissions of most main pollutants have increased as compared to year 2015, especially for carbon oxide - by about 6% however emissions of sulphur dioxide decreased by about 17%. Emissions of heavy metals changed most for As – emissions decreased by about 8% while Cadmium emissions increased by about 6.6%. Among POPs the decrease was observed only for PCDD/F – by about 3% while PAH emissions increased by about 5%.

1. Introduction

The Poland's Informative Inventory Report (IIR) 2018 contains information on the Poland's inventories for the years 1990 to 2016, including descriptions of methods, data sources, carried out QA/QC activities, key categories analysis and a trend analysis.

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

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

By means of this report Poland fulfils its obligation for preparing IIR Report under

- 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).

Structure of the report follows the template for an Informative Inventory Report to LRTAP. The report includes inter alia for each pollutant or group of pollutants:

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

1.1 National Inventory Background

Emission estimates are mainly 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 taken directly from the EMEP/EEA Emission Inventory Guidebook, EMEP/CORINAIR Emission Inventory Guidebook, other international studies and some are nationally developed.

1.2 Institutional arrangements

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. From 2010, following the organizational changes introduced[1], the inventory team was constituted as Emission Inventory and Reporting Unit (EIRU) located in the National Centre for Emissions Management (NCEM; in Polish: KOBiZE), part of the Institute of Environmental Protection-National Research Institute. EIU develops the inventory reports and is also responsible for the final quality control and quality assurance (QA/QC) of the data submitted.
After completing of 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.

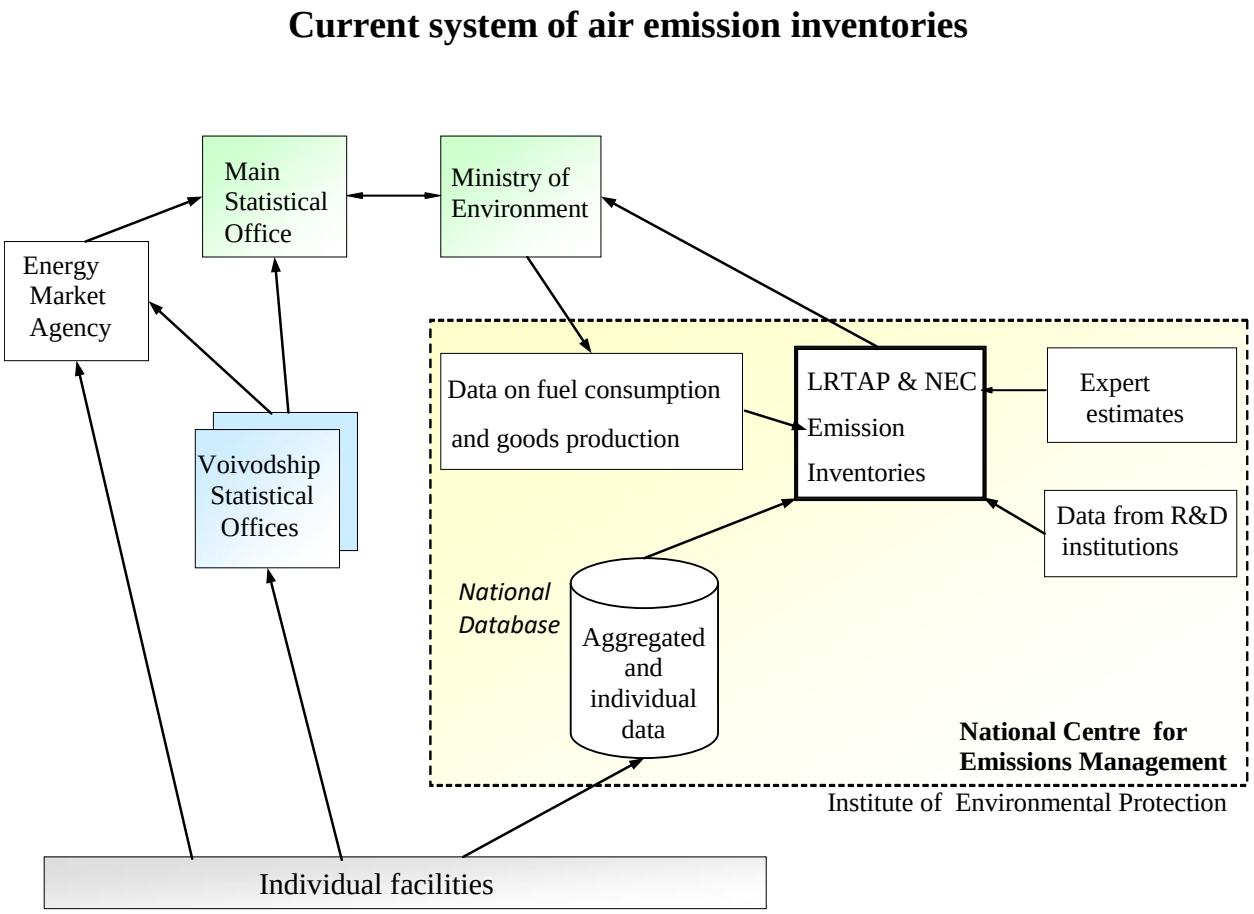

Figure 1.1 Current system of air emission inventories

[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, are mostly taken from numerous official public statistics and Polish data in EUROSTAT database.
The activity data that are not available in public statistics, are worked out 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 are: *Central Statistical Office* (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 mostly taken from EMEP Inventory Guidebooks or reports on domestic research. The sources of particular emission factors are given below in the sectoral chapters.
The inventory team (*Emission Inventory Unit*), as a subunit of the NCEM (KOBiZE), has access to the individual data of entities reporting to the National Database run by KOBiZE. This ensures availability of data for major sources in emissions from 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 keep consistency with reports to UNFCCC Convention activity data (fuels use; goods production) are harmonized with GHG inventories.

Table 1.1 Main sources of information on activities

Emission source category	**Main sources of information - Publications**	**Institution**
Energy	Energy Statistics	GUS
	Statistical Yearbook of Poland	GUS
	Energy Balance for Poland	GUS/Eurostat
Industrial processes	Statistical Yearbook of Industry	GUS
	Statistical Yearbook of Poland	GUS
	Production of industrial goods	GUS
Use of chemical products	Import/export data	GUS
	Statistical Yearbook of Industry	GUS
Agriculture	Statistical Yearbook of Poland	GUS
	Agriculture Yearbook	GUS
Forestry	Forestry Yearbook	GUS
	Environment Yearbook	GUS
Waste	Environment Yearbook	GUS
	Statistical Yearbook of Poland	GUS
	Municipal infrastructure	GUS

1.5 Key Categories

Key categories are sources that together contribute up to 95 % of the level of reported emissions in Poland. In this Report level assessments have been carried out for the following pollutants: NO_x, CO, SO_2, NH_3, NMVOC, TSP, Heavy metals and POPs. The level assessment was performed for 2016 and 1990. The results of the key source category analysis are presented in Appendix 4. 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 produced 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 done. When the official statistics are available the revision of data is made and final inventory is produced.

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 the checking stage is completed, the final inventory files are prepared together with the accompanying reports.

After completing of the inventory it 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 Webdab check procedure and taking into account findings the three stages of the CEIP technical review of submitted data to improve consistency and completeness of the inventories.

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 carried out by the MoE. Since 2010 selected activities and emission volumes are derived from the National Emission Database (NED). For consistency maintenance, the data derived from the NED is verified or consulted with independent sectoral expert.

Data management and archiving

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

Most uncertain values of activity were assigned for burning of agricultural wastes (30 %). Lowest uncertainty values were assigned to 1.A.1 Energy Industries (solid and liquid fuels 2 %, gaseous 1 %). In general Polish energy sector is covered with detailed national statistics, which allows to keep overall uncertainty of inventory at low level.

Application of emission factors derived from expert assessments or obtained using small sample statistics in each case strongly affect magnitude of uncertainty. In this report (see Appendix 6) assessment of uncertainty is presented for: SO_2, NOx, NMVOC, CO, TSP, Pb, Cd, Hg, HCB, PAH and PCDD/F. Tier2 assessment (Monte Carlo simulation) is provided for each two main key categories considering all pollutants separately. 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 determined using Tier1 approach.

At this moment information on uncertainties of activity data and emission factors are collected from sectoral experts and literature. Monte Carlo analysis (Tier2 approach) was developed for public power and energy – the best known sector so far. Some experiences and conclusions from GHG uncertainty analysis were also taken into account. Carrying out presented analysis the highest priority has been given to SO_2, NO_x and NMVOC. Uncertainties of activity data (especially energy data) are of similar level as estimated for GHG inventory.

Uncertainty estimates for main pollutants have been listed under particular NFR categories. All uncertainty estimates are included in the Appendix 6.

1.8 General Assessment of Completeness

General assessment of the completeness presented in this chapter applies to the emission estimates in Poland. The completeness for each pollutant and major sources is discussed briefly below.

Sulphur dioxide emissions

Estimated emissions are considered to be complete for most key sources. The most important source of sulphur dioxide emissions is the stationary combustion of fuels (mainly coal) in the energy sectors which made up app. 100 % of total Poland's SO_2 emissions.
Mobile sources are responsible for about 0,0005% of sulphur dioxide emissions due to the low sulphur content in liquid fuels. Emissions from the sectors: *Extraction and distribution of fossil fuels and Geothermal Energy* (SNAP 05), *Solvent and other product use* (SNAP 06), *Agriculture* (SNAP 10) and *Other sources and sinks* (SNAP 11) are considered to be negligible. The disaggregation of SO_2 emissions in NFR is given below in Table 1.2.

Table 1.2. SO_2 emissions in 2015-2016 according to NFR classification

NFR	SO_2 emissions in 2015 [Gg]	SO_2 emissions in 2016 [Gg]
1A1a	398,698	273,639
1A1b	11,938	11,777
1A1c	0,918	1,017
1A2a	26,191	23,651
1A2b	3,449	2,974
1A2c	31,733	33,129
1A2d	7,890	7,033
1A2e	15,957	16,482
1A2f	22,760	21,070
1A3ai(i)	0,079	0,079
1A3aii(i)	0,011	0,010
1A3bi	0,000	0,000
1A3bii	0,000	0,000
1A3biii	0,000	0,000
1A3biv	0,000	0,000
1A3c	0,008	0,008
1A3dii	0,000	0,000
1A3ei	0,002	0,021
1A4ai	15,698	16,335
1A4bi	127,560	134,353
1A4ci	21,668	22,731
1A4cii	0,158	0,168
1A4ciii	0,002	0,002
1B1b	2,492	2,679
1B2aiv	6,092	5,659
1B2c	2,013	1,986
2B6	0,129	0,151
2B10a	4,329	4,452
2C1	0,239	0,241
2H1	1,747	1,755
5C1a	0,004	0,042
5C1bi	0,004	0,004
5C1biii	0,059	0,069
5C1bv	0,004	0,004
TOTAL	**701,832**	**581,520**

Nitrogen oxides (as NO_2) emissions

Estimated emissions are considered to be complete for key sources. The major sources of emissions are stationary combustion of fuels for energy production in public power plants and road transport. Emissions from the sectors: *Extraction and distribution of fossil fuels and Geothermal Energy* (SNAP 05) and *Other sources and sinks* (SNAP 11) are considered to be negligible. The disaggregation of NO_x emissions in NFR is given below in Table 1.3.

Table 1.3. NO_x emissions in 2015-2016 according to NFR classification

NFR	**NO_x emissions in 2015 [Gg]**	**NO_x emissions in 2016 [Gg]**
1A1a	214,496	192,289
1A1b	3,159	3,116
1A1c	0,864	0,852
1A2a	11,451	10,510
1A2b	1,951	1,751
1A2c	11,075	10,262
1A2d	5,775	5,974
1A2e	6,914	7,389
1A2f	16,991	18,160
1A3ai(i)	1,013	1,013
1A3aii(i)	0,113	0,106
1A3bi	72,539	82,153
1A3bii	26,783	31,003
1A3biii	99,802	117,019
1A3biv	0,903	0,976
1A3c	4,297	4,246
1A3dii	0,201	0,378
1A3ei	0,795	0,842
1A4ai	15,083	16,279
1A4bi	66,200	70,742
1A4ci	8,906	9,609
1A4cii	59,115	62,609
1A4ciii	6,362	6,741
1B1b	4,540	4,822
1B2aiv	2,713	2,829
1B2c	1,412	1,393
2B1	2,718	2,623
2B2	9,106	8,892
2B6	0,004	0,004
2B10a	3,083	3,253
2C1	1,587	1,600
2G	0,000	0,000
2H1	0,873	0,877
3B1a	0,661	0,631
3B1b	0,459	0,471
3B2	0,006	0,007
3B3	0,437	0,407
3B4d	0,002	0,001
3B4e	0,035	0,031
3B4gi	0,079	0,082
3B4gii	0,152	0,185
3B4giv	0,195	0,212
3B4h	0,000	0,000
3Da1	40,144	41,720
3Da2b	0,182	0,174
5C1a	0,055	0,513
5C1bi	0,212	0,240
5C1biii	0,059	0,069
5C1bv	0,010	0,010
5C2	1,311	1,367
TOTAL	**704,824**	**726,431**

Carbon monoxide emissions

Estimated emissions are considered to be complete for key sources. The most important of them (about 61 % of country total) is a combustion of fuels in households. Emissions from the sectors: *Extraction and distribution of fossil fuels and Geothermal Energy* (SNAP 05), *Solvent and other product use* (SNAP 06) and *Other sources and sinks* (SNAP 11) are considered to be negligible. The disaggregation of CO emissions in NFR is given below in Table 1.4.

Table 1.4. CO emissions in 2015-2016 according to NFR classification

NFR	**CO emissions in 2015 [Gg]**	**CO emissions in 2016 [Gg]**
1A1a	49,332	51,475
1A1b	0,136	0,136
1A1c	1,445	1,399
1A2a	158,720	148,809
1A2b	6,697	6,112
1A2c	27,204	32,363
1A2d	6,584	6,628
1A2e	13,568	15,876
1A2f	45,599	48,519
1A3ai(i)	0,087	0,087
1A3aii(i)	0,502	0,381
1A3bi	352,520	380,610
1A3bii	54,310	59,363
1A3biii	25,535	29,945
1A3biv	30,004	32,441
1A3c	2,419	2,390
1A3dii	0,072	0,094
1A3ei	3,222	3,397
1A4ai	49,461	53,346
1A4bi	1 312,937	1 392,665
1A4ci	82,331	89,244
1A4cii	73,515	77,860
1A4ciii	0,872	0,923
1B1b	11,899	10,783
1B2aiv	1,857	1,705
1B2c	0,314	0,309
2A2	3,760	3,618
2A3	0,016	0,019
2B1	0,272	0,262
2B10a	3,044	3,440
2C1	25,518	24,834
2G	0,005	0,006
2H1	4,803	4,826
3F	1,736	0,483
5C1a	0,036	0,336
5C1bi	0,005	0,006
5C1biii	0,118	0,137
5C1bv	0,004	0,004
5C2	19,975	20,798
TOTAL	**2 370,433**	**2 505,631**

Ammonia emissions

Estimated emissions are considered to be complete for key sources. The major source of emissions is *Agriculture* (97 %), of which manure management amounts for 83 %. Emissions from the combustion of fuels in stationary plants, solvents use and off-road transport are not significant. The disaggregation of NH_3 emissions in NFR is given below in Table 1.5.

Table 1.5. NH_3 emissions in 2015-2016 according to NFR classification

NFR	**NH_3 emissions in 2015 [Gg]**	**NH_3 emissions in 2016 [Gg]**
1A2d	0,004	0,004
1A3bi	3,788	4,083
1A3bii	0,113	0,125
1A3biii	0,083	0,097
1A3biv	0,006	0,006
1A3c	0,001	0,001
1A4bi	0,479	0,506
1A4cii	0,013	0,013
1B1b	0,049	0,049
2B1	0,027	0,026
2B7	1,083	1,245
2D3g	0,012	0,014
3B1a	71,210	67,939
3B1b	44,913	46,071
3B2	0,615	0,646
3B3	54,176	50,364
3B4d	0,186	0,101
3B4e	3,419	3,062
3B4gi	14,615	15,078
3B4gii	12,028	14,597
3B4giv	15,423	16,706
3B4h	0,015	0,015
3Da1	42,603	44,276
3Da2b	0,593	0,566
5D1	1,860	1,516
TOTAL	**267,312**	**267,107**

Particulate matter emissions

The main source of TSP emissions in Poland are the combustion processes in the stationary and mobile sources.
Category *Non-industrial combustion plants* (SNAP 02*)* has the highest share in the emission of TSP within the group of stationary sources (SNAP categories 01÷ 05 + 09 + 11).
There has been added particulates emissions from *Farm-level agricultural operations (NFR 3Dc)* as a new emission source in Agriculture (SNAP 10).
Significant part of TSP emissions from production processes (SNAP04) come from bulk transport and storage of coal.
Large part of transport emissions (SNAP 07*)* comes from automobile tire and brake wear.
Estimated emissions are considered to be complete for key sources. Tables 1.6 shows the respective emission estimates in NFR classification.

Table 1.6. Particulate matter emissions in 2015-2016 according to NFR classification

NFR	BC emissions		PM2.5 emissions		PM10 emissions		TSP emissions	
	2015	2016	2015	2016	2015	2016	2015	2016
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
1A1a	0,255	0,271	11,987	12,729	20,715	21,493	29,623	28,300
1A1b	0,037	0,039	0,455	0,463	0,842	0,840	0,842	0,840
1A1c	0,025	0,029	0,280	0,279	0,448	0,479	0,448	0,479
1A2a	0,209	0,197	7,457	6,917	7,457	6,917	7,457	6,917
1A2b	0,157	0,141	1,412	1,249	1,412	1,249	1,412	1,249
1A2c	0,227	0,250	8,121	8,779	8,121	8,779	8,121	8,779
1A2d	0,055	0,051	1,965	1,798	1,965	1,798	1,965	1,798
1A2e	0,113	0,123	4,050	4,307	4,050	4,307	4,050	4,307
1A2f	0,116	0,113	4,153	3,960	4,153	3,960	4,153	3,960
1A3ai(i)	0,002	0,002	0,016	0,016	0,016	0,016	0,016	0,016
1A3aii(i)	0,001	0,000	0,004	0,003	0,004	0,003	0,004	0,003
1A3bi	2,197	2,573	2,902	3,388	2,902	3,388	2,902	3,388
1A3bii	1,099	1,287	1,488	1,741	1,488	1,741	1,488	1,741
1A3biii	1,477	1,733	2,494	2,928	2,494	2,928	2,494	2,928
1A3biv	0,011	0,012	0,064	0,069	0,064	0,069	0,064	0,069
1A3bvi	NA	NA	2,209	2,521	4,116	4,699	5,422	6,187
1A3c	0,251	0,248	0,385	0,381	0,385	0,381	0,385	0,381
1A3dii	0,011	0,015	0,016	0,028	0,016	0,028	0,016	0,028
1A3ei	0,000	0,000	0,006	0,006	0,006	0,006	0,006	0,006
1A4ai	0,331	0,343	4,350	4,581	4,703	4,947	7,216	7,548
1A4bi	4,284	4,539	53,501	56,716	87,999	93,352	116,785	123,933
1A4ci	0,422	0,460	8,144	8,887	17,706	19,107	22,598	24,341
1A4cii	7,085	7,504	8,239	8,726	8,239	8,726	8,239	8,726
1A4ciii	0,135	0,143	0,436	0,462	0,436	0,462	0,436	0,462
1B1a	NE	NE	0,679	0,655	6,791	6,552	13,815	13,328
1B1b	0,480	0,476	0,979	0,971	1,958	1,942	0,654	0,619
1B2aiv	NA	NA	NA	NA	NA	NA	0,393	0,472
2A1	0,050	0,052	1,679	1,736	3,053	3,156	3,526	3,615
2A2	0,001	0,001	0,130	0,127	0,730	0,717	1,794	1,762
2A3	0,001	0,001	0,632	0,751	0,711	0,844	0,790	0,938
2A5a	NA	NA	0,178	0,180	1,778	1,796	3,615	3,652
2A5b	NA	NA	0,120	0,125	1,197	1,253	2,388	2,500
2B6	NA	NA	NA	NA	NA	NA	0,010	0,011
2B7	NA	NA	NA	NA	NA	NA	0,120	0,138
2B10a	NA	NA	1,487	1,482	1,993	1,985	2,998	2,932
2B10b	NA	NA	0,025	0,025	0,202	0,201	0,632	0,628
2C1	0,005	0,005	0,968	0,893	1,235	1,133	2,170	2,002
2C2	NA	NA	NA	NA	NA	NA	0,078	0,078
2C5	NA	NA	0,004	0,003	0,006	0,005	0,006	0,005
2G	0,005	0,006	1,065	1,374	1,065	1,374	1,065	1,374
2H1	0,014	0,014	0,524	0,526	0,699	0,702	0,873	0,877
2L	NA	NA	0,487	0,475	4,868	4,753	12,133	11,843
3B1a	NA	NA	1,002	0,956	1,540	1,469	3,373	3,218
3B1b	NA	NA	0,498	0,511	0,764	0,784	1,653	1,696
3B2	NA	NA	0,005	0,005	0,014	0,014	0,032	0,033
3B3	NA	NA	0,074	0,069	1,658	1,547	11,815	11,041
3B4d	NA	NA	0,002	0,001	0,005	0,003	0,011	0,006
3B4e	NA	NA	0,029	0,026	0,046	0,041	0,099	0,089
3B4gi	NA	NA	0,137	0,141	1,825	1,883	8,670	8,944
3B4gii	NA	NA	0,201	0,244	2,010	2,439	4,020	4,878
3B4giv	NA	NA	0,383	0,415	2,466	2,672	2,466	2,672
3B4h	NA	NA	0,003	0,003	0,006	0,006	0,014	0,014
3Dc	NA	NA	0,959	0,956	24,943	24,848	24,943	24,848
3F	0,176	0,049	0,176	0,049	0,176	0,049	0,176	0,049

NFR	BC emissions		PM2.5 emissions		PM10 emissions		TSP emissions	
	2015	2016	2015	2016	2015	2016	2015	2016
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
5A	NA	NA	0,161	0,140	1,070	0,932	2,262	1,970
5C1a	0,000	0,002	0,005	0,048	0,005	0,048	0,005	0,048
5C1bi	0,011	0,011	0,313	0,325	4,698	4,878	7,830	8,130
5C2	0,548	0,572	1,306	1,361	1,405	1,465	1,446	1,508
TOTAL	**19,794**	**21,261**	**138,344**	**145,507**	**248,655**	**259,165**	**342,018**	**352,306**

NMVOCs emissions

The total emission of non-methane volatile organic compounds from the anthropogenic sources in 2016 was 609 Gg. Estimated emissions are considered to be complete for most sources.
Category SNAP 06 has the highest (about 41%) share in the total emission of NMVOCs. Other significant categories in the national emissions are *Non-industrial combustion plants* with the share of about 19% and *Road transport* with the share of about 10%.

Finally, the natural sources (forests), classified as category SNAP 11, have emitted about 282 Gg of NMVOCs in 2015. Emissions from the natural sources are not included in the country total.

Table 1.7. NMVOC emissions in 2015-2016 according to NFR classification

NFR	NMVOC emissions in 2015 [Gg]	NMVOC emissions in 2016 [Gg]
1A1a	4,332	4,077
1A1b	0,198	0,204
1A1c	0,192	0,197
1A2a	5,366	4,850
1A2b	0,813	0,676
1A2c	4,692	4,657
1A2d	9,301	10,226
1A2e	3,019	3,250
1A2f	13,224	14,014
1A3ai(i)	0,040	0,040
1A3aii(i)	0,009	0,007
1A3bi	37,108	40,105
1A3bii	5,050	5,600
1A3biii	5,188	6,093
1A3biv	3,597	3,886
1A3bv	7,626	7,673
1A3c	0,381	0,377
1A3dii	0,010	0,018
1A4ai	4,249	4,540
1A4bi	98,324	104,256
1A4ci	7,563	8,160
1A4cii	7,079	7,497
1A4ciii	1,384	1,466
1B1a	7,269	7,078
1B1b	0,075	0,075
1B2ai	0,093	0,100
1B2aiv	31,718	30,859
1B2av	12,110	12,738
1B2b	9,110	9,316
1B2c	0,052	0,052

NFR	NMVOC emissions in 2015 [Gg]	NMVOC emissions in 2016 [Gg]
2B10a	8,889	8,043
2C1	3,031	2,744
2D3a	46,125	46,120
2D3b	0,026	0,023
2D3c	3,502	3,648
2D3d	121,750	125,887
2D3e	16,304	15,033
2D3f	5,766	5,765
2D3g	27,509	28,265
2D3h	24,355	24,355
2D3i	7,751	7,528
2G	0,000	0,000
2H1	0,873	0,877
2H2	42,036	42,087
2I	1,003	1,083
3Da1	0,006	0,006
3F	0,013	0,004
5A	0,000	0,000
5C1a	0,301	2,828
5C1bi	1,803	2,042
5C1biii	0,029	0,034
5C1bv	0,000	0,000
5C2	0,383	0,400
5D1	0,000	0,000
TOTAL	**590,628**	**608,858**

Heavy metal emissions

Main share of HM emissions comes from combustion processes. *Combustion in energy and transformation industries* is the biggest source of mercury emissions and for cadmium the biggest source is *Combustion in manufacturing industries.* The highest amounts of arsenic and copper are emitted from copper production. The biggest source of lead, chrome, zinc and nickel emissions is combustion in industry.

Estimated emissions are considered to be complete for key sources. Tables 1.8 and 1.9 below include emissions estimates for Pb, Cd, Hg, As, Cr, Cu, Ni and Zn in 2015 and 2016 according to NFR classification.

Table 1.8. Heavy metals emissions in 2015 according to NFR classification

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1A1a	26,639	0,855	5,338	4,883	5,966	18,132	14,575	103,231
1A1b	1,208	0,861	0,012	0,835	1,069	2,435	22,251	1,807
1A1c	0,489	0,109	0,029	0,055	0,109	0,294	0,304	2,864
1A2a	7,827	1,280	0,121	0,616	1,117	4,185	4,532	32,419
1A2b	196,244	2,353	2,670	18,178	0,149	184,605	0,603	343,681
1A2c	8,524	1,394	0,131	0,671	1,217	4,557	4,935	35,303
1A2d	2,063	0,337	0,032	0,162	0,294	1,103	1,194	8,544
1A2e	4,251	0,695	0,066	0,335	0,607	2,273	2,461	17,607
1A2f	4,359	0,735	0,516	0,343	0,622	2,331	2,524	18,055
1A3aii(i)	NA	NA	NA	NA	NA	0,012	0,020	NA
1A3bi	0,007	0,001	0,045	0,001	0,049	0,034	0,008	0,165

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1A3bii	0,001	0,000	0,011	0,000	0,015	0,010	0,001	0,038
1A3biii	0,002	0,000	0,023	0,000	0,037	0,025	0,001	0,079
1A3biv	0,000	0,000	0,001	0,000	0,001	0,000	0,000	0,003
1A3bvi	5,613	0,026	0,000	0,000	2,079	45,521	0,329	17,522
1A3c	NE	0,004	NA	NE	NA	0,025	0,041	NA
1A3dii	0,000	0,000	0,000	0,000	0,000	0,002	0,003	0,002
1A4ai	6,288	0,132	0,124	0,276	0,682	4,942	1,875	8,839
1A4bi	42,595	0,882	0,601	2,591	5,601	33,094	11,883	77,236
1A4ci	9,292	0,151	0,163	0,468	0,983	7,002	2,772	12,512
1A4cii	NA	0,079	NA	NA	NA	0,475	0,792	NA
1A4ciii	IE	0,005	IE	IE	IE	0,033	0,054	NA
1B1b	2,154	0,003	0,007	0,196	1,665	0,881	0,636	2,154
2A1	3,053	NA	NA	0,183	1,527	NA	1,527	3,053
2A3	9,294	0,139	0,046	0,093	2,323	0,465	1,859	9,294
2B10a	NA	0,226	0,111	NA	NA	NA	NA	NA
2C1	88,262	1,871	0,477	0,775	6,528	16,965	6,463	167,776
2C2	0,019	NA	NA	NA	NA	NA	NA	NA
2C5	0,967	NA	NA	NA	NA	NA	NA	NA
2G	0,000	0,000	0,000	0,000	0,000	0,000	NA	NA
5C1a	1,784	0,153	0,056	0,003	0,015	0,153	0,005	1,070
5C1bv	0,000	0,000	0,000	0,000	0,000	0,000	0,000	NA
TOTAL	**420,933**	**12,295**	**10,579**	**30,664**	**32,655**	**329,553**	**81,649**	**863,254**

Table 1.9. Heavy metals emissions in 2016 according to NFR classification

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1A1a	26,859	0,746	5,297	4,699	5,861	18,057	14,686	101,945
1A1b	1,185	0,854	0,011	0,827	1,066	2,412	22,072	1,718
1A1c	0,607	0,124	0,034	0,066	0,118	0,357	0,355	3,234
1A2a	6,945	1,136	0,107	0,537	1,002	3,693	4,032	28,841
1A2b	176,147	2,093	2,080	15,839	0,124	161,700	0,498	306,656
1A2c	8,814	1,441	0,136	0,682	1,272	4,687	5,117	36,601
1A2d	1,805	0,295	0,028	0,140	0,261	0,960	1,048	7,496
1A2e	4,324	0,707	0,067	0,335	0,624	2,299	2,510	17,955
1A2f	3,976	0,661	0,484	0,308	0,574	2,114	2,308	16,510
1A3aii(i)	NA	NA	NA	NA	NA	0,011	0,018	NA
1A3bi	0,007	0,001	0,051	0,001	0,056	0,038	0,008	0,184
1A3bii	0,001	0,000	0,012	0,000	0,018	0,012	0,001	0,043
1A3biii	0,003	0,000	0,027	0,001	0,044	0,029	0,001	0,092
1A3biv	0,000	0,000	0,001	0,000	0,001	0,000	0,000	0,003
1A3bvi	6,416	0,030	0,000	0,000	2,377	52,034	0,376	19,996
1A3c	NE	0,004	NA	NE	NA	0,024	0,041	NA
1A3dii	0,000	0,000	0,000	0,000	0,000	0,003	0,004	0,002
1A4ai	6,586	0,142	0,130	0,291	0,717	5,141	1,967	9,508
1A4bi	45,277	0,938	0,638	2,746	5,945	35,189	12,638	82,062
1A4ci	10,022	0,166	0,173	0,502	1,051	7,554	3,057	13,575
1A4cii	NA	0,084	NA	NA	NA	0,503	0,839	NA
1A4ciii	IE	0,006	IE	IE	IE	0,035	0,058	NA
1B1b	2,136	0,003	0,007	0,194	1,650	0,874	0,631	2,136

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
2A1	3,156	NA	NA	0,189	1,578	NA	1,578	3,156
2A3	12,133	0,182	0,061	0,121	3,033	0,607	2,427	12,133
2B10a	NA	0,242	0,004	NA	NA	NA	NA	NA
2C1	84,087	1,818	0,475	0,753	6,379	16,728	6,056	162,847
2C2	0,019	NA	NA	NA	NA	NA	NA	NA
2C5	1,035	NA	NA	NA	NA	NA	NA	NA
2G	0,000	0,000	0,000	0,000	0,000	0,000	NA	NA
5C1a	16,778	1,438	0,527	0,024	0,144	1,438	0,048	10,067
5C1bv	0,000	0,000	0,000	0,000	0,000	0,000	0,000	NA
TOTAL	**418,318**	**13,109**	**10,352**	**28,255**	**33,893**	**316,501**	**82,376**	**836,762**

PCDD/F emissions

The main source (about 52 %) of PCDD/F emissions comes from *Combustion processes in Non-industrial combustion plants*. Within this category the dominant source is *Residential: stationary plants*, which covers combustion processes in household boilers and furnaces.

Significant share (about 21%) of total PCDD/F emissions in 2016 is attributed to *Combustion Processes in Industry* (SNAP 03), with the dominant role of metallurgy and lime production. Important source of PCDD/F emissions is the category *Other* which includes fires of: landfills, buildings (public, private and industrial), road vehicles and forests. In this category the dominant source are landfill fires.

Estimated emissions are considered to be complete for all sources. Table 1.10 shows the respective emission estimates in NFR classification.

Table 1.10. PCDD/F emissions in 2015-2016 according to NFR classification

NFR	PCDD/F emissions in 2015 [g i-TEQ]	PCDD/F emissions in 2016 [g i-TEQ]
1A1a	12,828	11,307
1A1b	0,850	0,540
1A1c	0,040	0,037
1A2a	11,266	10,496
1A2b	24,889	23,409
1A2c	1,345	1,584
1A2d	0,326	0,324
1A2e	0,671	0,777
1A2f	1,622	1,695
1A3bi	4,216	4,807
1A3bii	0,929	1,082
1A3biii	0,927	1,087
1A3biv	0,057	0,061
1A3c	0,004	0,003
1A3dii	0,000	0,000
1A4ai	1,660	2,036
1A4bi	136,612	143,963
1A4ci	1,377	1,540
1A4cii	0,068	0,072
1A4ciii	0,002	0,002
1B1b	2,937	2,912
2A2	19,419	18,690

NFR	PCDD/F emissions in 2015 [g i-TEQ]	PCDD/F emissions in 2016 [g i-TEQ]
2A3	0,518	0,617
2C1	12,093	12,201
2G	0,004	0,005
2H2	0,668	0,726
3F	16,257	4,522
5C1a	0,025	0,240
5C1bi	0,008	0,009
5C1biii	0,000	0,000
5C1biv	0,090	0,106
5C1bv	0,316	0,310
5C2	1,994	2,080
5E	35,934	35,076
TOTAL	**289,953**	**282,316**

HCB emissions

The largest (38 %) contribution to the national total of HCB emissions comes from category *Combustion processes in Non-industrial combustion plants* (SNAP 02), especially from coal combustion in households.
Second major (32%) sector *is Combustion in manufacturing industries* (SNAP 03) with large emissions from sinter plants. Estimated emissions are considered to be complete for key sources. Table 1.11 shows the respective emission estimates in NFR classification.

Table 1.11. HCB emissions in 2015-2016 according to NFR classification

NFR	HCB emissions in 2015 [kg]	HCB emissions in 2016 [kg]
1A1a	0,935	0,866
1A1b	0,001	0,000
1A1c	0,001	0,002
1A2a	1,121	1,039
1A2b	0,011	0,010
1A2c	0,088	0,102
1A2d	0,021	0,021
1A2e	0,044	0,050
1A2f	0,282	0,299
1A3bi	0,004	0,005
1A3bii	0,001	0,001
1A3biii	0,001	0,001
1A3biv	0,000	0,000
1A4ai	0,039	0,044
1A4bi	1,641	1,739
1A4ci	0,095	0,105
2C1	0,018	0,016
5C1a	0,008	0,072
5C1bi	0,455	0,473
5C1biii	0,063	0,074
TOTAL	**4,829**	**4,920**

PCB emissions

The dominant source of PCB emissions (72 %) are *Non-industrial combustion plants*, with main share from residential fuels combustion. The other important source is C*ombustion in energy and transformation industries* (20 %). Estimated emissions are considered to be complete for key sources. Table 1.12 shows the respective emission estimates in NFR classification.

Table 1.12. PCB emissions in 2015-2016 according to NFR classification

NFR	**PCB emissions in 2015 [kg]**	**PCB emissions in 2016 [kg]**
1A1a	131,298	125,793
1A1b	0,521	0,334
1A1c	0,068	0,068
1A2a	3,713	3,605
1A2b	1,037	0,986
1A2c	3,517	4,011
1A2d	0,851	0,821
1A2e	1,754	1,967
1A2f	1,878	1,894
1A3bi	0,001	0,001
1A3bii	0,000	0,000
1A3biii	0,000	0,000
1A3biv	0,000	0,000
1A4ai	4,052	5,183
1A4bi	442,483	453,223
1A4ci	2,016	2,140
2C1	33,578	33,585
5C1a	0,010	0,096
5C1bi	0,476	0,494
5C1biii	0,051	0,060
TOTAL	627,306	634,261

PAH emissions

The main source of PAHs emission (88 %) in Poland are *Non-industrial combustion plants* (mostly residential plants). The second major (10%) source of national emissions are *Production processes* with coke production as the dominant sub-sector. Estimated emissions are considered to be complete for key sources. Table 1.13 shows the respective emission estimates in NFR classification.

Table 1.13. PAH emissions in 2015-2016 according to NFR classification

NFR	BaP		BbF		BkF		IP		4-PAH emissions	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1A1a	0,003	0,002	0,154	0,124	0,160	0,132	0,027	0,024	0,343	0,283
1A1b	0,003	0,002	0,002	0,002	0,003	0,002	0,007	0,004	0,015	0,010
1A1c	0,000	0,000	0,003	0,003	0,003	0,003	0,002	0,002	0,008	0,009
1A2a	0,001	0,001	0,052	0,049	0,086	0,082	0,025	0,022	0,165	0,154
1A2b	0,000	0,000	0,007	0,006	0,012	0,010	0,003	0,003	0,022	0,019
1A2c	0,001	0,001	0,057	0,062	0,094	0,104	0,027	0,028	0,180	0,195
1A2d	0,000	0,000	0,014	0,013	0,023	0,021	0,007	0,006	0,043	0,040
1A2e	0,001	0,001	0,028	0,030	0,047	0,051	0,014	0,014	0,090	0,096
1A2f	0,001	0,001	0,029	0,028	0,048	0,047	0,014	0,012	0,092	0,088
1A3bi	0,126	0,145	0,142	0,165	0,109	0,126	0,124	0,144	0,501	0,580
1A3bii	0,036	0,042	0,041	0,048	0,032	0,037	0,035	0,041	0,144	0,168
1A3biii	0,017	0,020	0,105	0,123	0,117	0,137	0,027	0,032	0,266	0,312
1A3biv	0,001	0,001	0,002	0,002	0,001	0,001	0,002	0,002	0,005	0,006
1A3c	0,024	0,024	0,000	0,000	0,000	0,000	0,000	0,000	0,024	0,024
1A3dii	0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,002
1A4ai	0,002	0,002	0,033	0,036	0,033	0,036	0,021	0,021	0,089	0,095
1A4bi	32,381	34,215	38,955	41,141	8,280	8,707	42,045	44,475	121,661	128,538
1A4ci	0,001	0,001	0,060	0,065	0,060	0,065	0,027	0,029	0,149	0,159
1A4cii	0,471	0,498	0,001	0,001	0,001	0,001	0,000	0,000	0,472	0,500
1A4ciii	0,012	0,012	0,000	0,000	0,000	0,000	0,000	0,000	0,012	0,013
1B1b	7,344	7,281	2,448	2,427	2,448	2,427	2,937	2,912	15,177	15,047
2D3i	0,004	0,004	NA	NA	0,002	0,002	0,002	0,002	0,009	0,009
TOTAL	**40,430**	**42,258**	**42,133**	**44,322**	**11,559**	**11,991**	**45,346**	**47,773**	**139,468**	**146,344**

For some air pollutants volumes of emissions have not been placed in the original emission source category but included in other NFR sub-category (usually on a higher level of aggregation). It is caused by the difficulties in appropriate disaggregation of activity data. Such cases have been listed in table 1.14.

Table 1.14 Air pollutant emissions included in other sub-categories (notation key IE)

NFR code	Substance(s)	Included in NFR
1A2gvii	NOx, NMVOC, SO_2, PM (incl. BC), CO, HMs (excl. Cu), POPs (excl. HCB, PCB)	1A3b
1A3bvii	PM (incl. BC)	1A3b
1A3ei	NMVOC, HMs (excl. Ni, Se, Zn), reported only emission from gas turbines in pipeline systems	1A3
1A4aii	NEC, PM (incl. BC), HMs (excl. Se, Zn), PAHs	1A3b
1A4bii	NEC, PM (incl. BC), HMs (excl. Se, Zn), PAHs, PCDD/F	1A3b
1A5a	NEC, PM (incl. BC), HMs (excl. Se, Zn)	1A4ai
1A5b	NEC, PM (incl. BC), HMs (excl. Se, Zn)	1A3b
2C5	NOx	1A2b
2C6	NOx, HMs (excl. Ni, Se, Zn)	1A2b
2C7a	NOx, HMs (excl. Ni, Se, Zn)	1A2b
3B4giii	NOx, NH_3, PM (excl. BC)	3B4giv
3Da2a	NOx, NH_3	3B1-4
3Da3	NOx, NH_3	3B1-4

For some air pollutants volumes of emissions have not been estimated. Usually it is caused by the lack of verified emission factor or there is no appropriate activity data available (table 1.15). There are efforts made to gather needed data for the next inventory submission.

Table 1.15 Not estimated air pollutant emissions (notation key NE)

NFR code	NFR category	Substance(s)	Reason for not estimated
1A3bvii	Road transport: Automobile road abrasion	PM (excl. BC)	The COPERT software does not include emission factors for this category
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Pb, Hg, As, Cr	methodology under verification
1B2c	Venting and flaring	PM (incl. BC)	methodology under verification
All		Se	methodology under verification

2. Explanation of key trends

The description below applies to trends of emissions of several pollutants in the period 1990-2016. Performed recalculations of emission data 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 1990-2016 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 is different from the level reported in the 1990-2015 submission which has been described in the relevant chapters.

Following recommendations resulting from 2017 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 Appendix 8, with the reference to chapters of the IIR report.

SO_2 emissions

Emissions of SO_2 decreased by about 78 % between 1990 and 2016. 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 SNAP 01÷03. It should be noted that during the mentioned period more and more power plants are equipped with desulphurization installations.

In 2016 emissions of sulphur dioxide decreased by about 17% compared to the respective figure for the year 2015. The most significant decreases were in combustion processes in the Power *Plants* and in industries. It has resulted from the adjustment of technical specifications of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

Level of SO_2 emission estimates from road transport (SNAP 07) has considerably decreased due to the introduction of COPERT 5 model and emission trend is much lower from the level reported in the 1990-2015 submission.

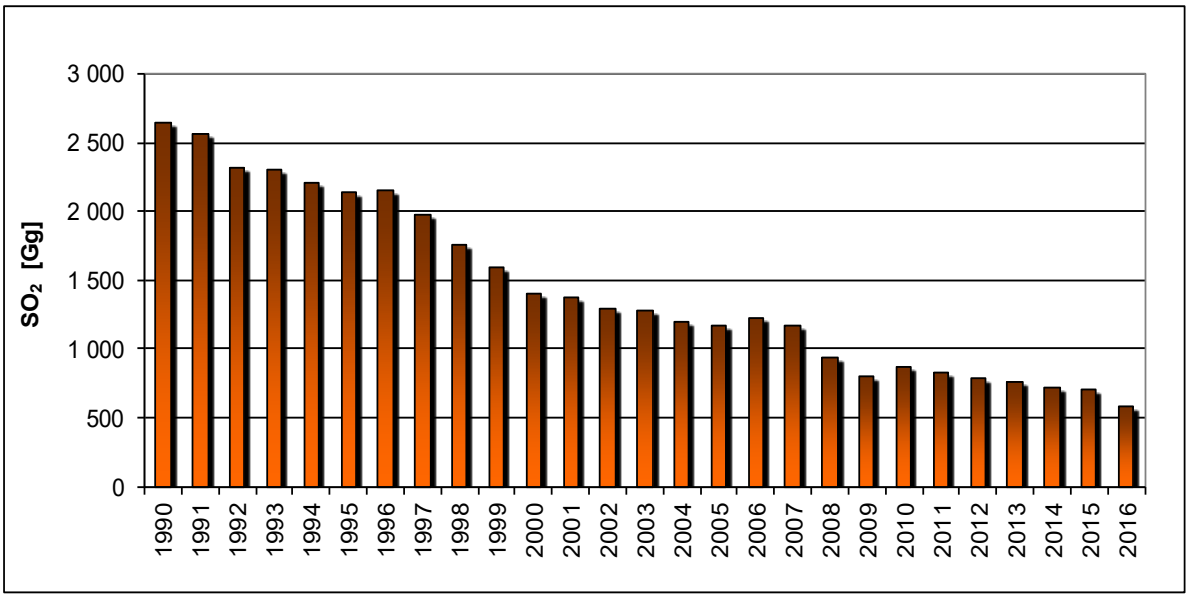

Figure 2.1.a Emissions trend of SO_2

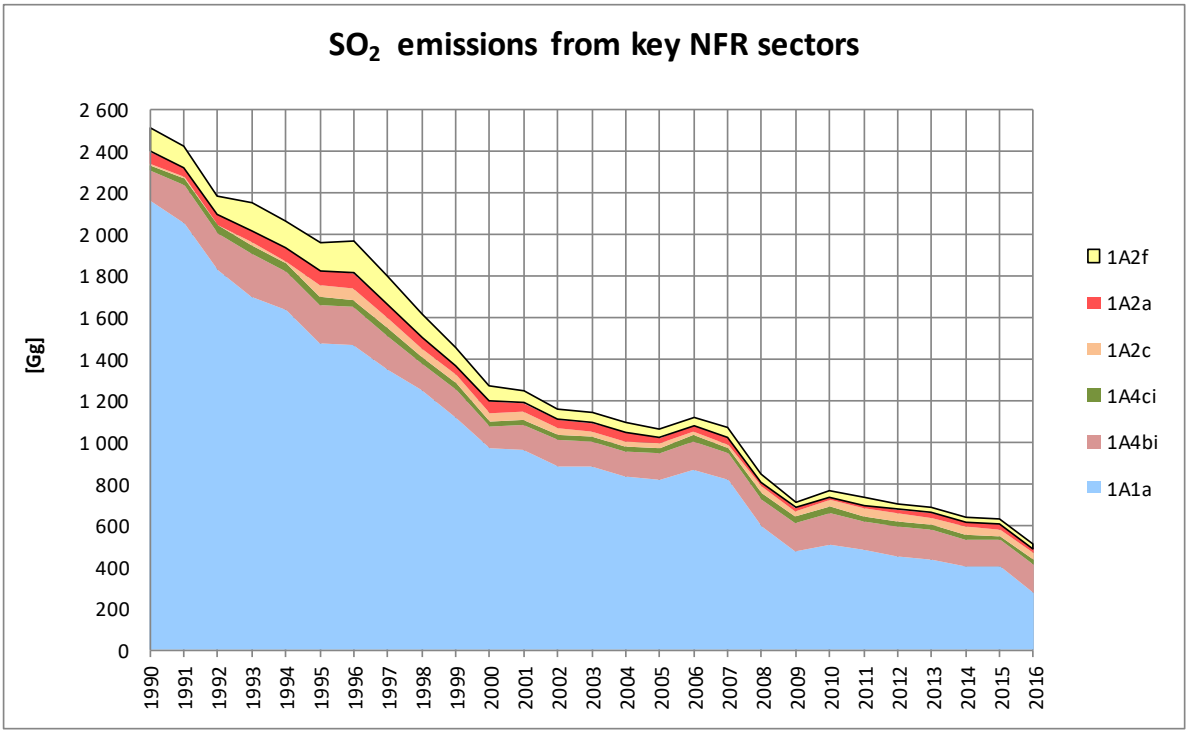

Figure 2.1.b Trend of SO_2 emissions for key NFR sectors

NO_x emissions

Emissions of NO_X decreased by over 30 % between 1990 and 2016. Similarly to sulphur dioxide, most of the reductions were caused by the decline of the heavy industry and lower share of coal 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 2015, in 2016 NO_2 emissions increased by 3.1% which was influenced by:

- higher reported consumption of liquid fuels (about 19% growth for diesel oil and about 6% growth for gasoline)
- higher consumption of coal (by 6%) and wood (by 7%) in the sector *Non-industrial combustion plants* (with the dominant share of households).

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

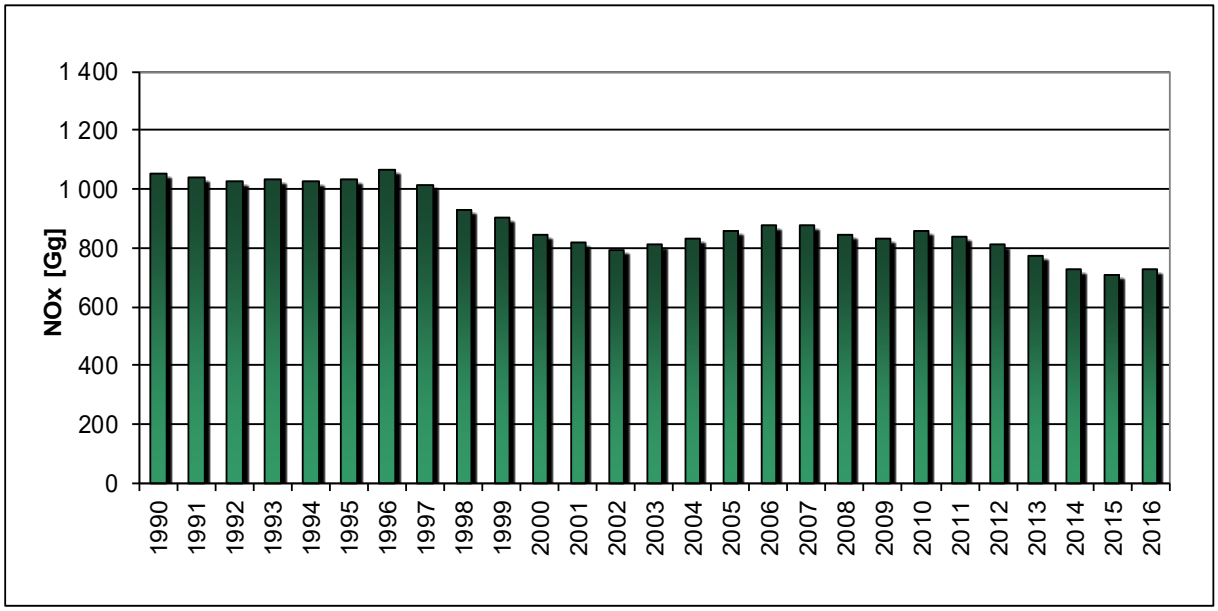

Figure 2.2.a Emissions trend of NO_x

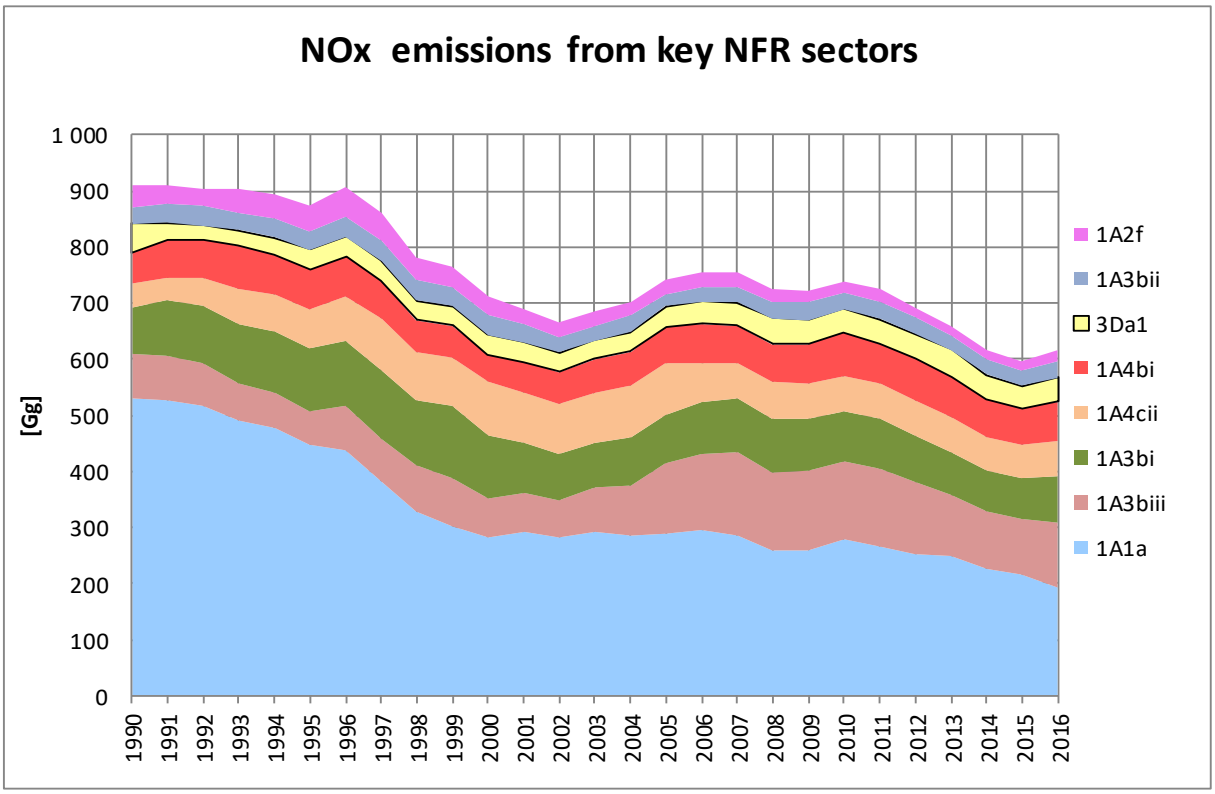

Figure 2.2.b Trend of NO_x emissions for key NFR sectors

CO emissions

From 1990 to 2016 the emissions of CO have decreased by about 30%. Compared to the year 2015, in 2016 emission of CO increased by about 6% which was a result of:

- higher use of coal and wood in households (SNAP 0202)
- higher consumption of liquid fuels in road transport (SNAP 07).

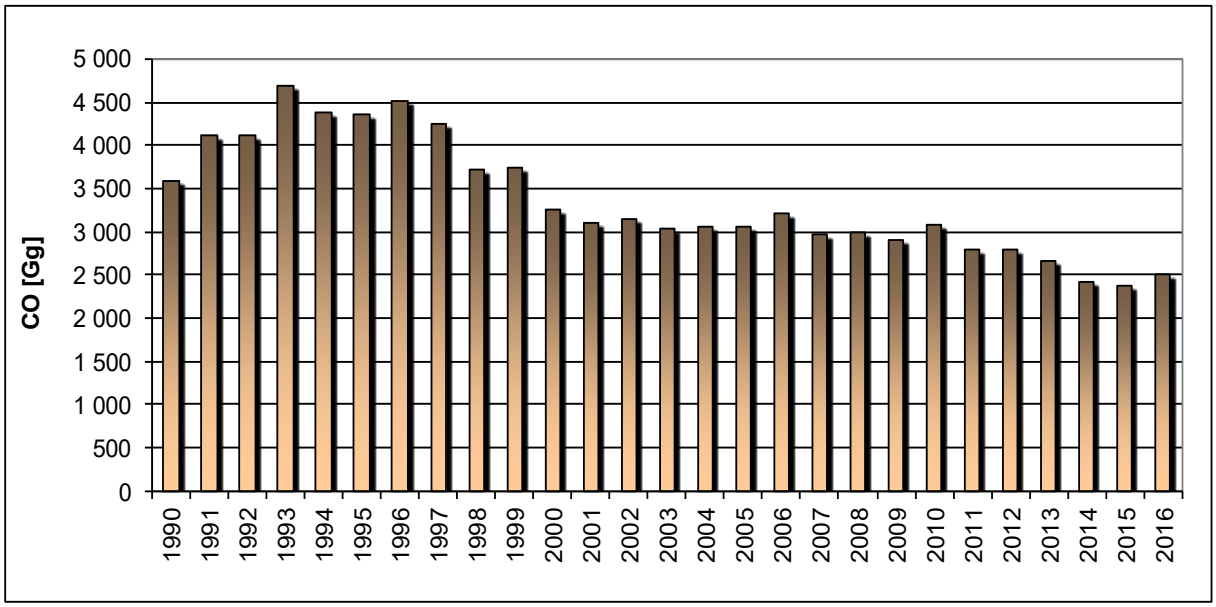

Figure 2.3.a Emissions trend of CO

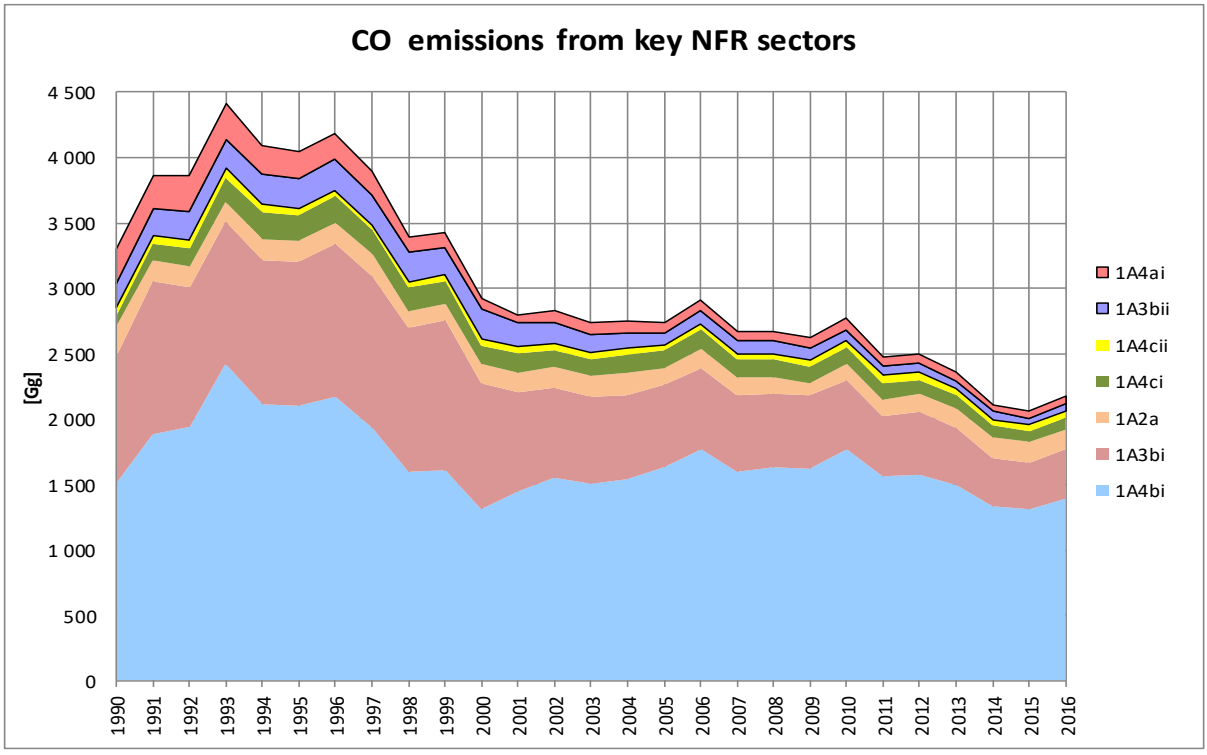

Figure 2.3.b Trend of CO emissions for key NFR sectors

Ammonia emissions

The trend of ammonia emissions is influenced mainly by the agriculture sector, namely by a number of animals and volume of N fertilizers applied. A small decrease by about 0.1% of NH_3 emissions in 2016 compared to 2015 was noted. The main influence on this interannual change had the lower headage of dairy cattle and swine.

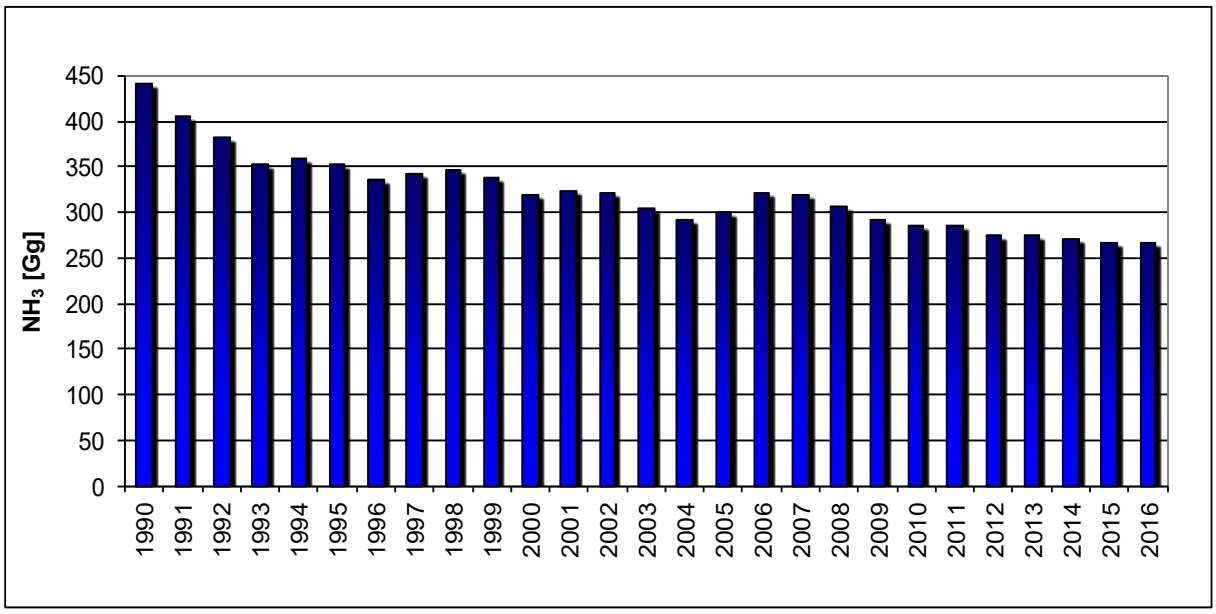

Figure 2.4.a Emissions trend of NH_3

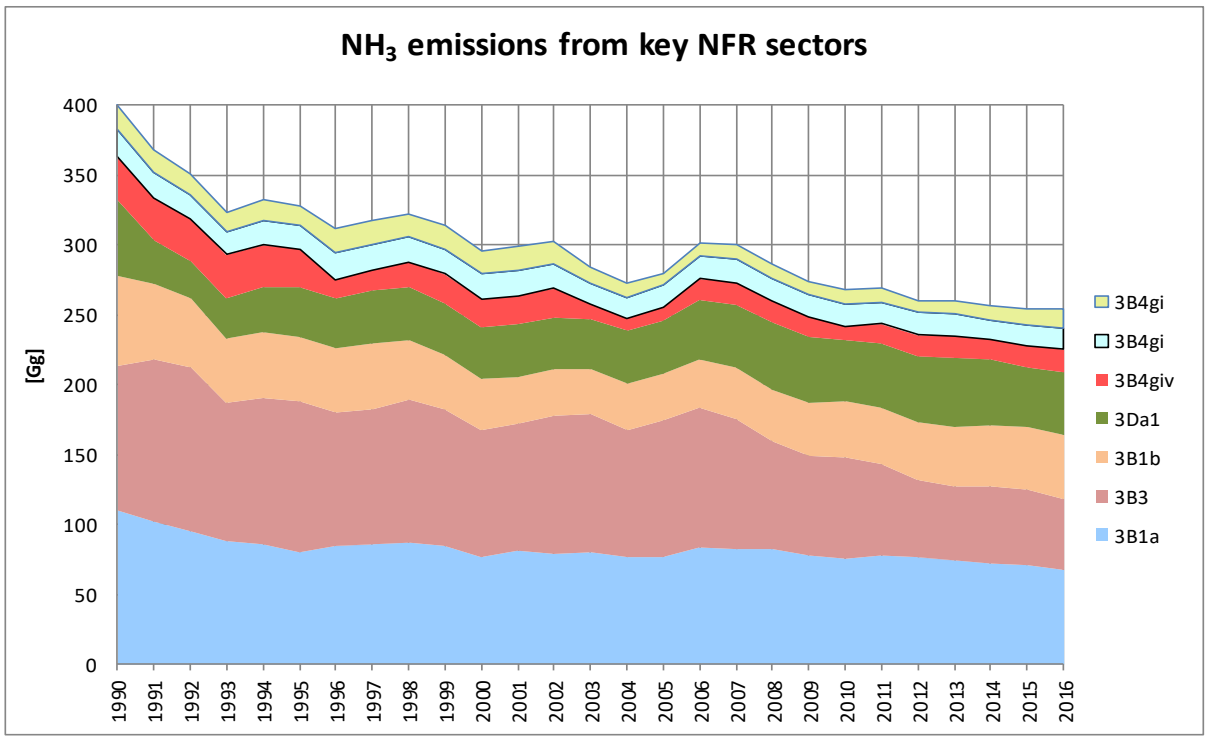

Figure 2.4.b Trend of NH_3 emissions for key NFR sectors

PM emissions

Compared to estimates for the year 2015, emissions of TSP in 2016 slightly increased (by about 3%). The major increase was noted in the category *Non-Industrial Combustion Plants* due to a higher volume of coal used. There was also a growth of emissions in road transport (SNAP 07), 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 adjustment of technical specifications of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

Higher use of coal in households (SNAP 0202) has caused also the growth of emissions of PM10 (by 4%) and PM2.5 (by 5%). Black Carbon emissions in 2016 slightly increased (about 7%) as compared to estimates for the year 2015 due to a higher consumption of liquid fuels in road transport (SNAP 07).

Figure 2.5 shows emission trend of TSP, PM10 and PM2.5 in the years 1990-2016. The volume of emissions in this period remained stable with small increases in 2005-2007, caused by a higher volume of combusted fuels.

As a result of implementation of recommendations of 2017 Comprehensive Technical Review of National Emission Inventories the level of national emission of particulates has increased as compared to the one reported in the previous submission. The major changes included:

- introduction of emission factors from the EMEP/EEA 2016 Emission Inventory Guidebook for *Manure management* (SNAP 1005)
- adding particulates emissions from farm-level agricultural operations (NFR 3Dc) as a new emission source in Agriculture (SNAP 10).

Moreover, as a result of implementation of above recommendations the level of sectoral PM2.5 emissions has changed due to introduction of PM2.5 emission factors from the EMEP/EEA 2016 Emission Inventory Guidebook for:

- production of non-ferrous metals (SNAP 03), which resulted in the higher level of PM2.5 emissions as compared to the one reported in the previous submission for this sector,
- combustion of industrial wastes (SNAP 09), which resulted in the lower level of PM2.5 emissions as compared to the one reported in the previous submission for this sector.

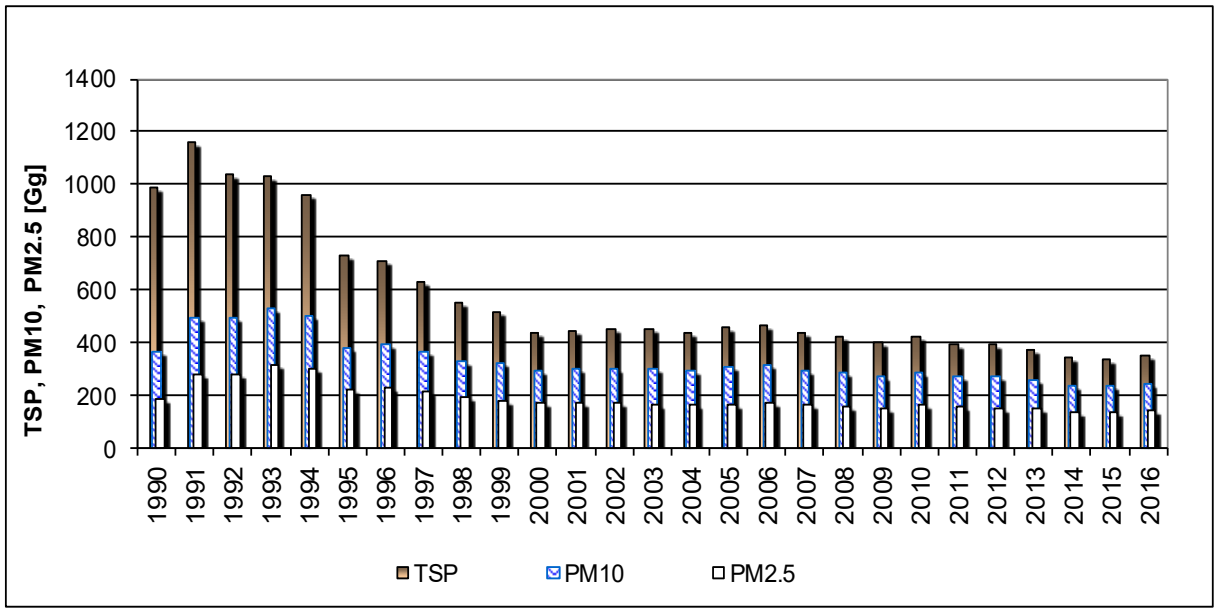

Figure 2.5.a Emissions of particulate matter

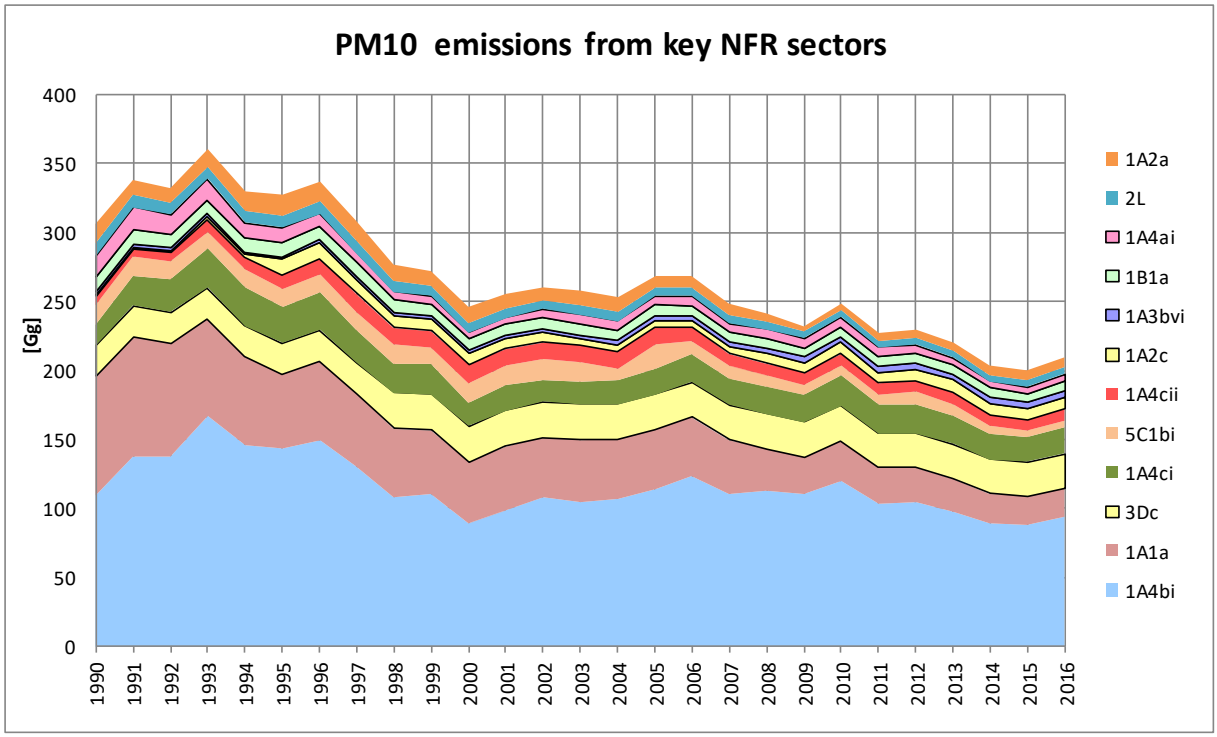

Figure 2.5.b Trend of PM10 emissions for key NFR sectors

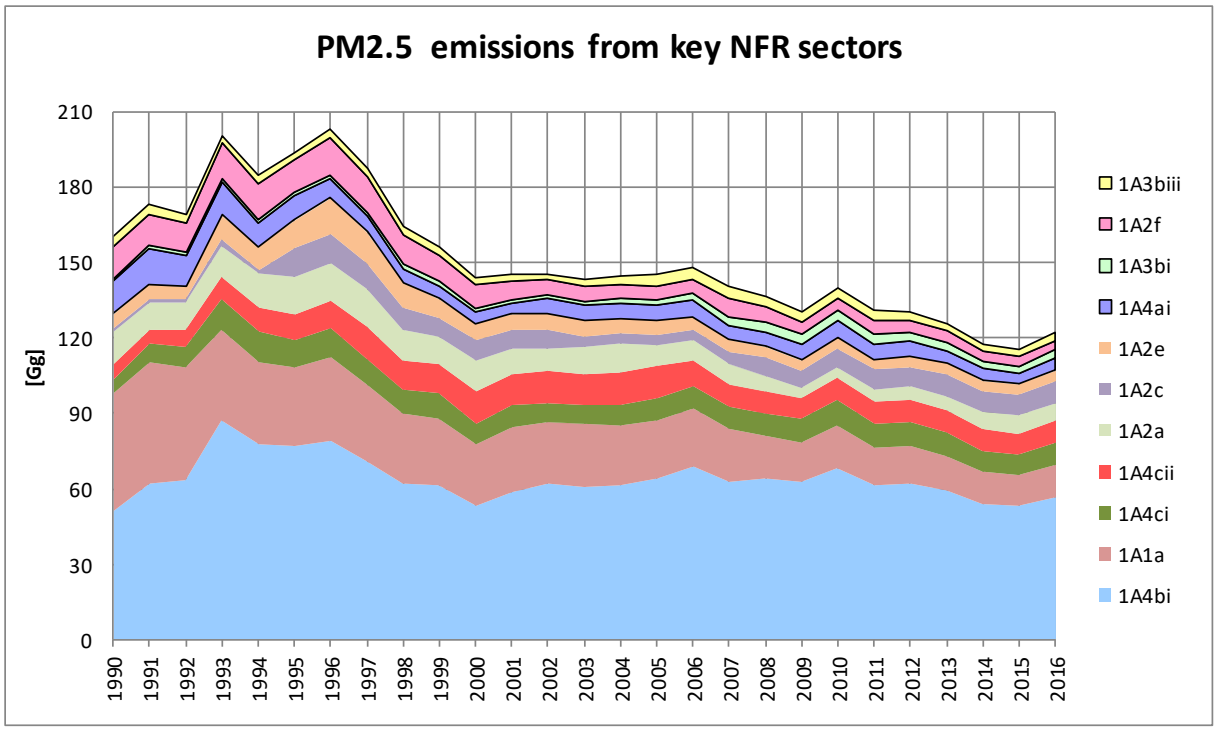

Figure 2.5.c Trend of PM10 emissions for key NFR sectors

Figure 2.5.d shows trend of Black Carbon (BC) emissions in the years 1990-2016.

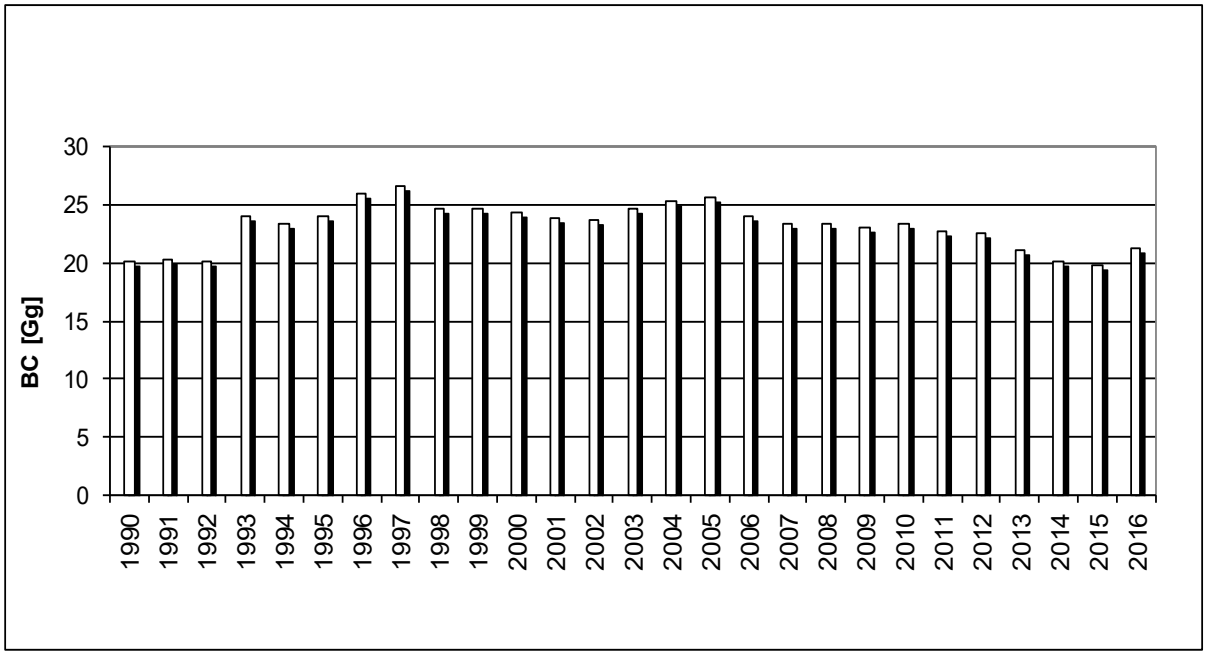

Figure 2.5.d Emissions of Black Carbon

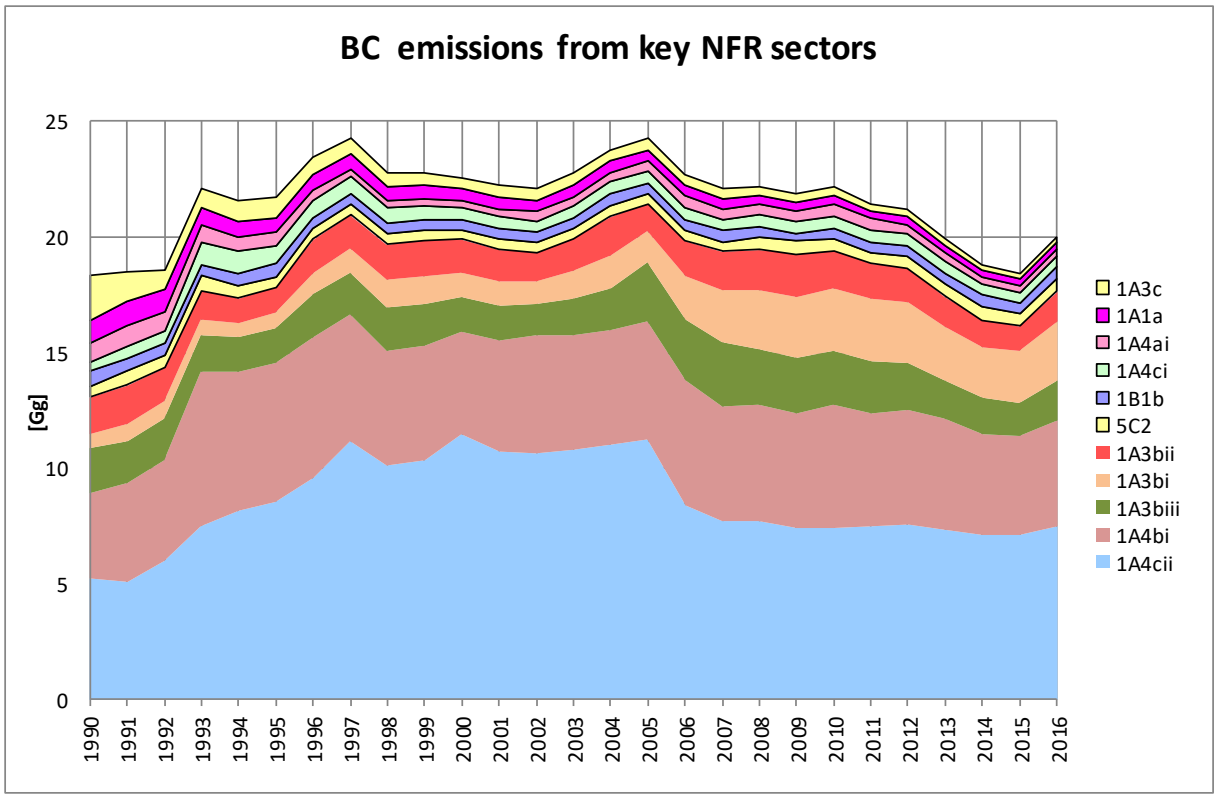

Figure 2.5.e Trend of BC emissions for key NFR sectors

NMVOC emissions

Emissions of NMVOC increased by about 23% between 1990 and 2016. According to calculations, the national total emission of NMVOCs in Poland in 2016 was 608 Gg. The assessed amount is higher by 3.1% compared to the respective figure for the year 2015. The biggest share in the increase of the national total emission was a result of:

- higher use of coal and wood in households (SNAP 0202)
- higher consumption of liquid fuels in road transport (SNAP 07).

The increase of emissions in the sector Waste collection, treatment and disposal activities (SNAP 09) is caused by the higher amount of incinerated municipal wastes.

As a result of implementation of recommendations of 2017 Comprehensive Technical Review of National Emission Inventories the level of national emission of NMVOC has increased as compared to the one reported in the previous submission. The major changes included:

- introduction of emission factors from the EMEP/EEA 2016 Emission Inventory Guidebook for:
  - fuels combustion in the sector Combustion in energy and transformation industries (SNAP 01), which resulted in the nearly seven times lower level of NMVOC emissions as compared to the one reported in the previous submission for this sector,
  - fuels combustion in the sector Combustion in manufacturing industry (SNAP 03), which resulted in the over three times higher level of NMVOC emissions as compared to the one reported in the previous submission for this sector
- supplementing emission sources from the food industry (SNAP 04; products like sugar, meat, fish, fats, food for animals), which resulted in the about 40% higher level of NMVOC emissions as compared to the one reported in the previous submission for this sector
- supplementing emission sources from processes using solvents (SNAP 06; products like tyres, shoes, glues, adhesives, printing inks), which resulted in the about 12% higher level of NMVOC emissions as compared to the one reported in the previous submission for this sector.

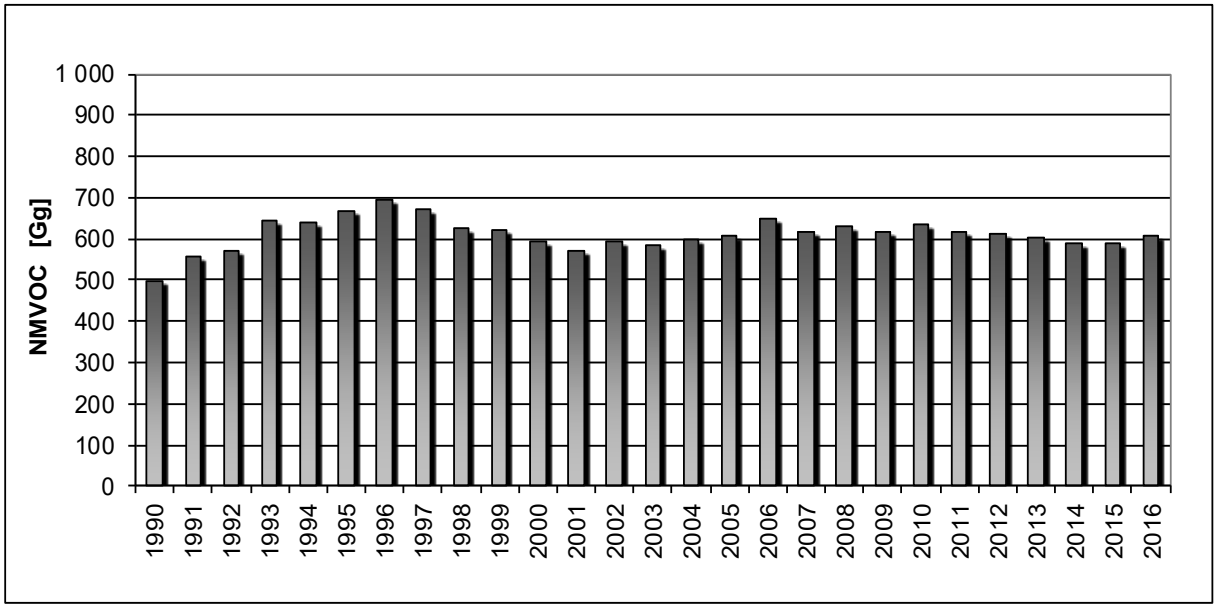

Figure 2.6.a Emissions of NMVOC

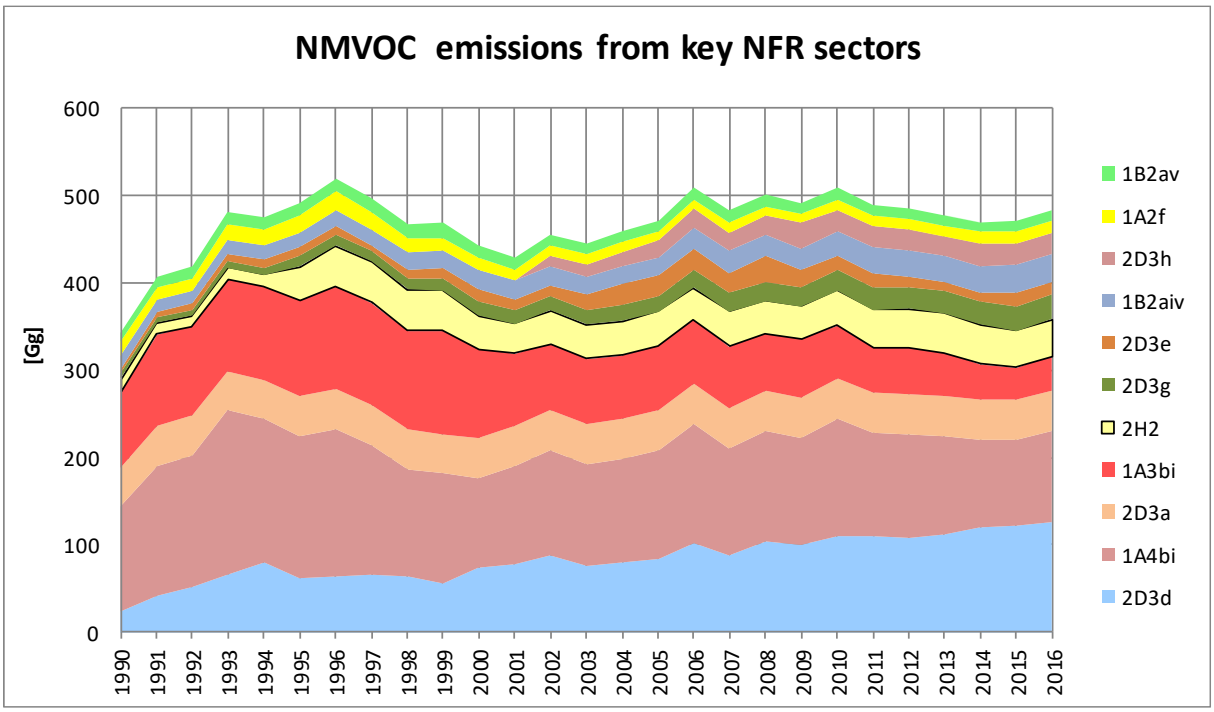

Figure 2.6.b Trend of NMVOC emissions for key NFR sectors

Heavy metals emissions

Figures 2.7 and 2.8 show yearly emissions of heavy metals in the years 1990 - 2016. Visible downward trend in the 1990s has been caused by drop in economic activity.

The assessed national emission totals in 2016 for heavy metals are mostly similar to the values calculated for the previous year. The highest increase was noted for Cd – about 6.6%, due to the higher amount of incinerated municipal wastes. The highest decrease was noted for As – about 8%, due to lower primary copper production (SNAP 030306). The decrease of Cu and Zn emissions has also been influenced by this activity change.

Level of most heavy metals (except for As and Hg) emission estimates from road transport (SNAP 07) has considerably decreased due to the introduction of COPERT 5 model and emission trend is now much lower from the level reported in the 1990-2015 submission.

The methodology of HM emission estimates for small emission sources (SNAP 02) 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.

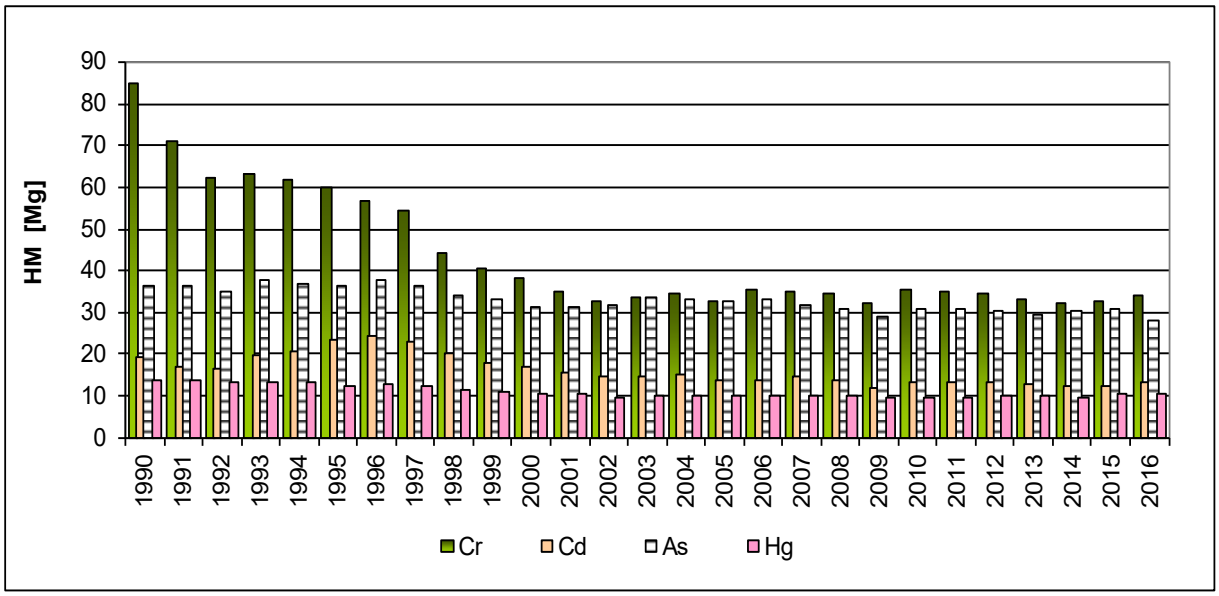

Figure 2.7.a Emissions of chrome, cadmium, arsenic and mercury

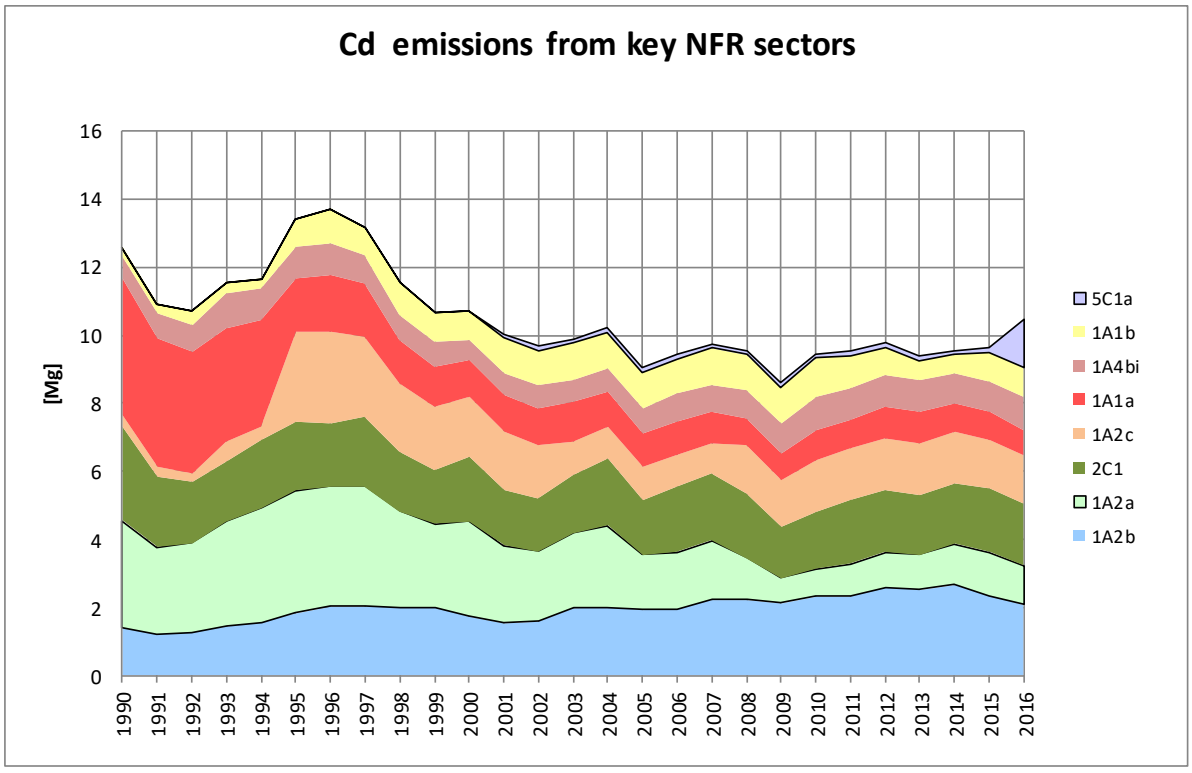

Figure 2.7.b Trend of Cd emissions for key NFR sectors

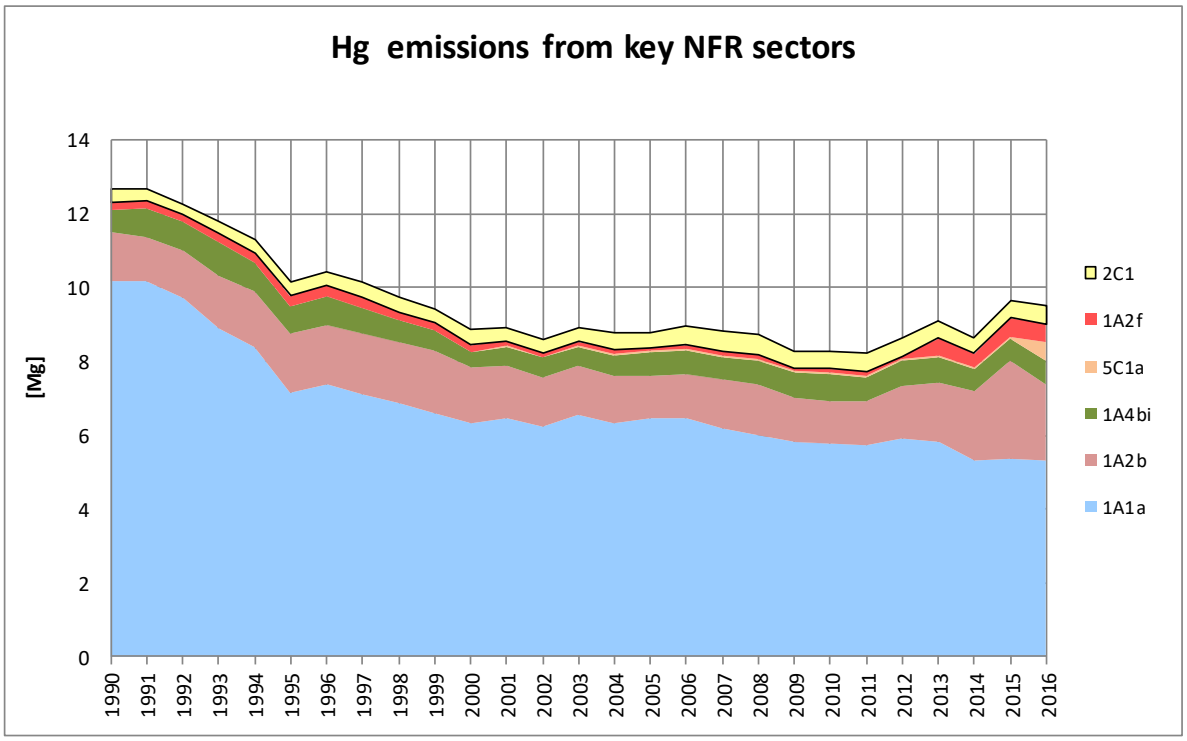

Figure 2.7.c Trend of Hg emissions for key NFR sectors

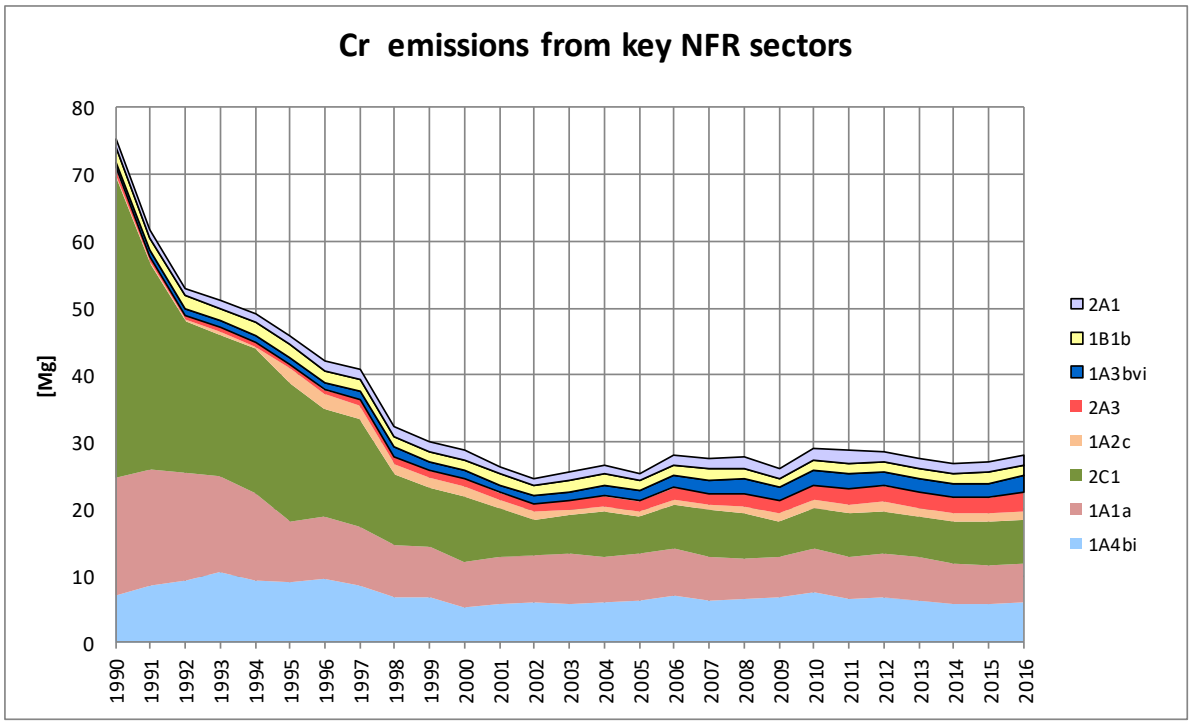

Figure 2.7.d Trend of Cr emissions for key NFR sectors

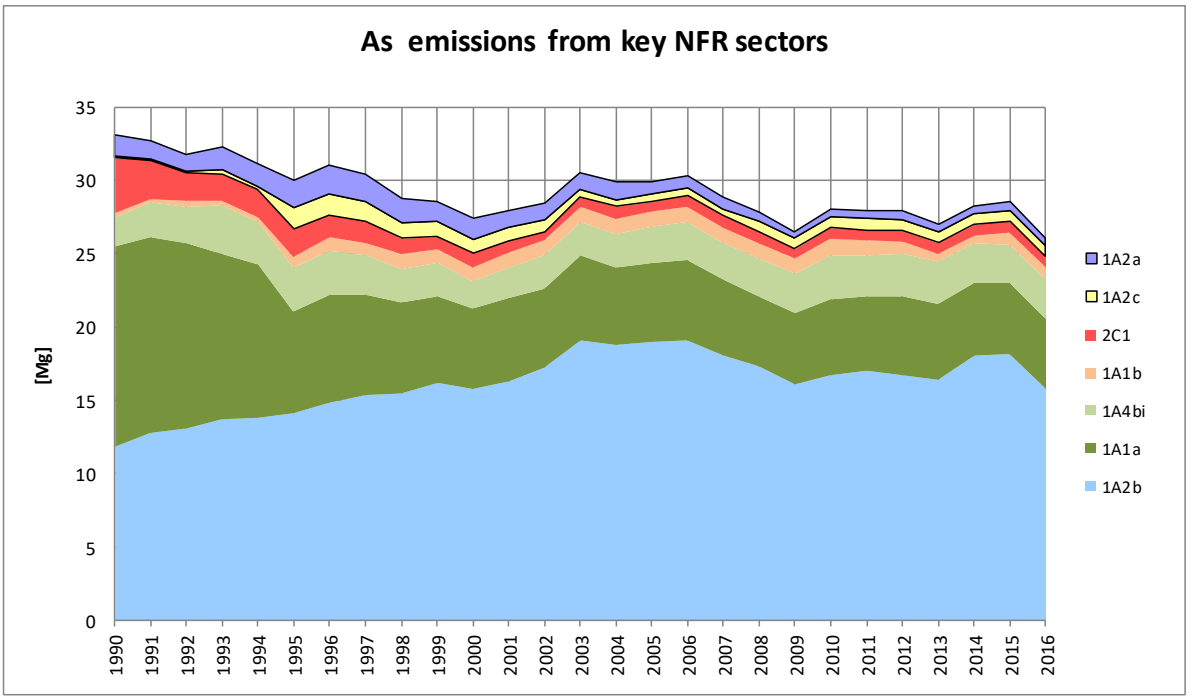

Figure 2.7.e Trend of As emissions for key NFR sectors

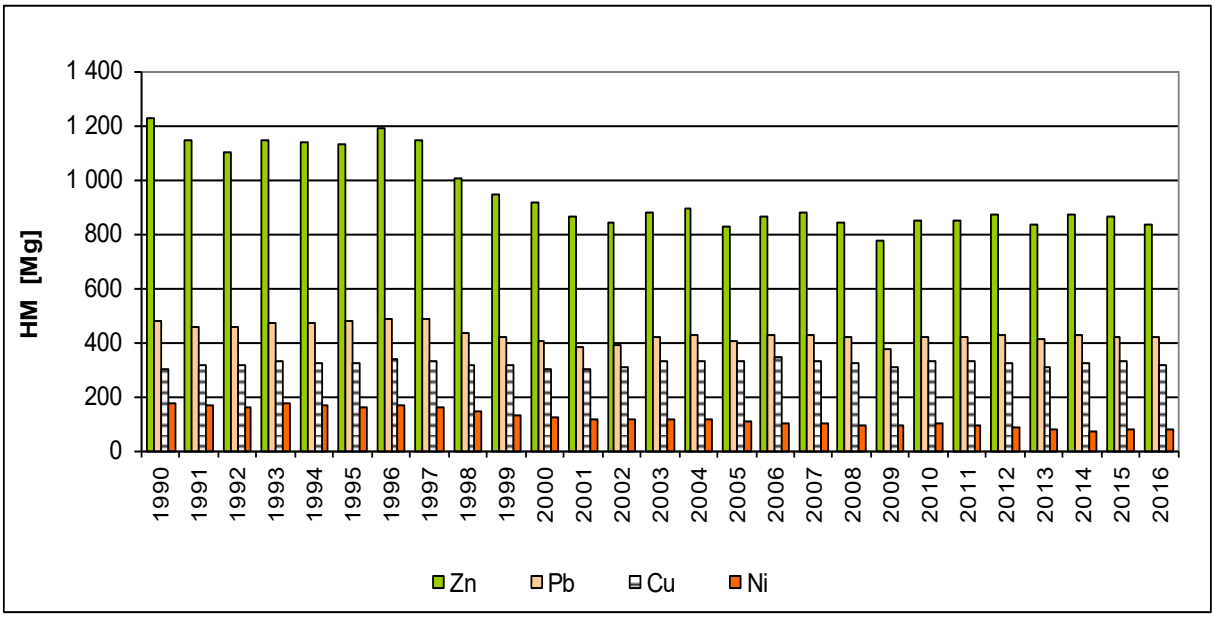

Figure 2.8.a Emissions of zinc, lead, copper and nickel

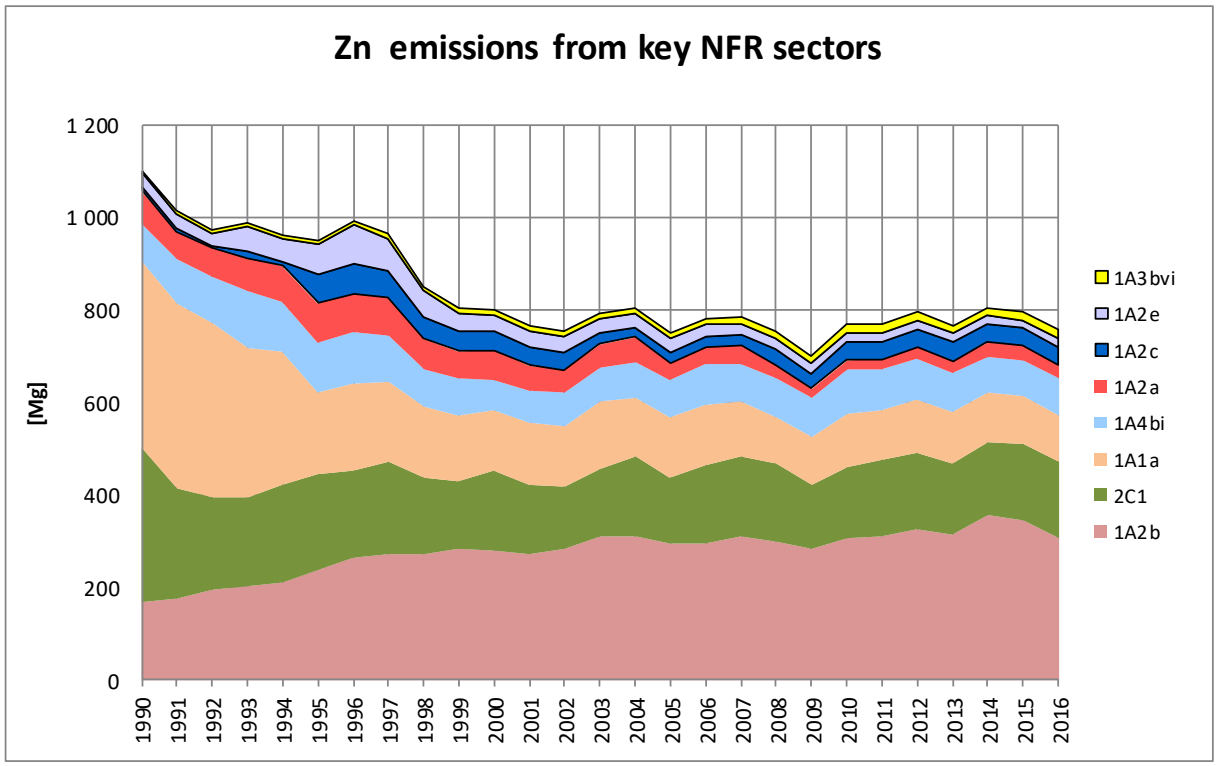

Figure 2.8.b Trend of Zn emissions for key NFR sectors

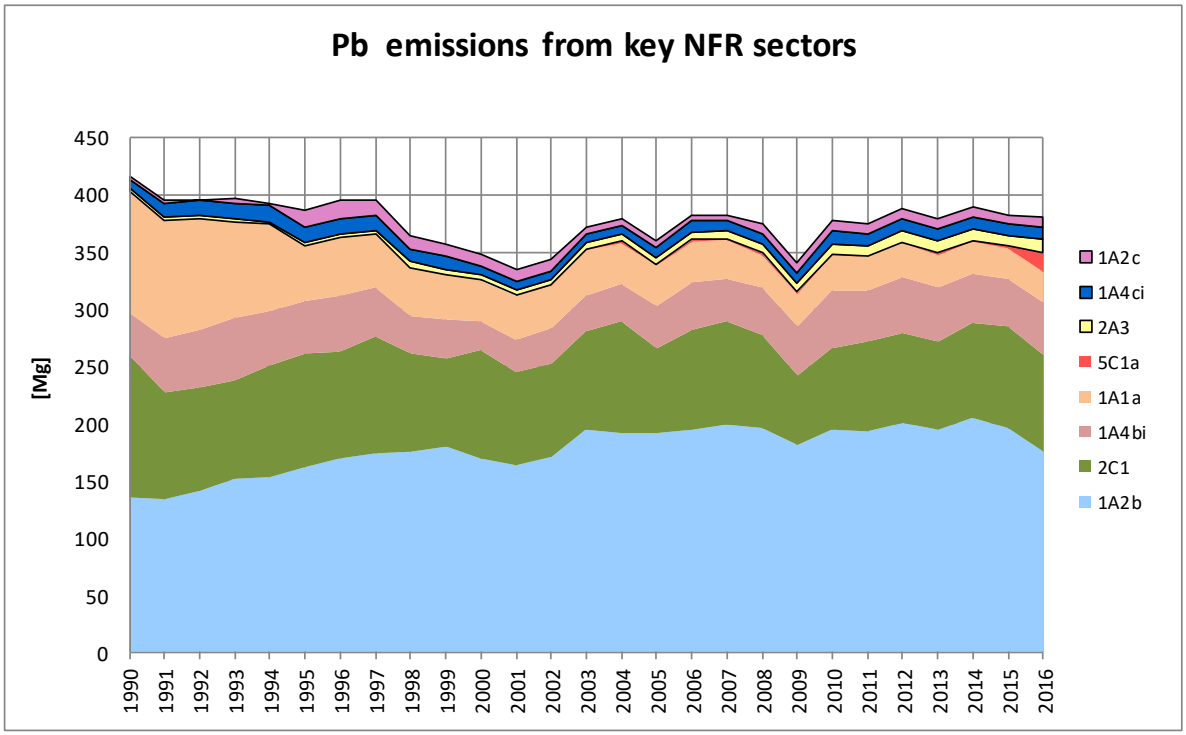

Figure 2.8.c Trend of Pb emissions for key NFR sectors

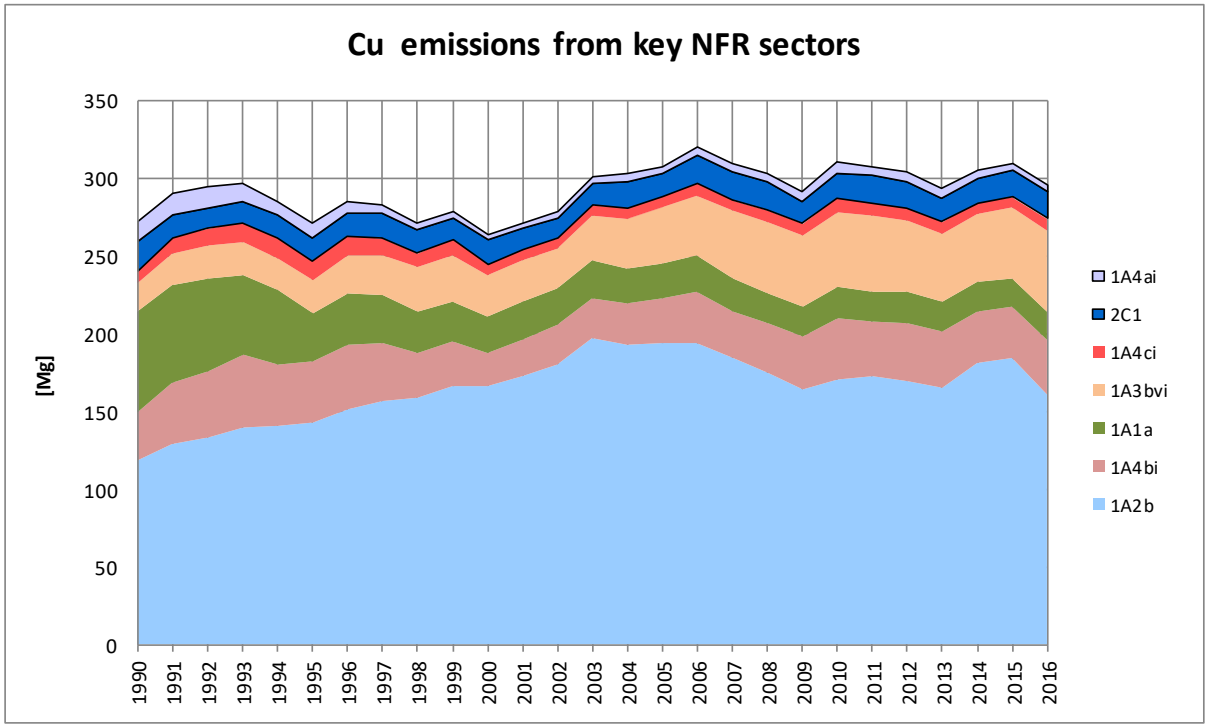

Figure 2.8.d Trend of Cu emissions for key NFR sectors

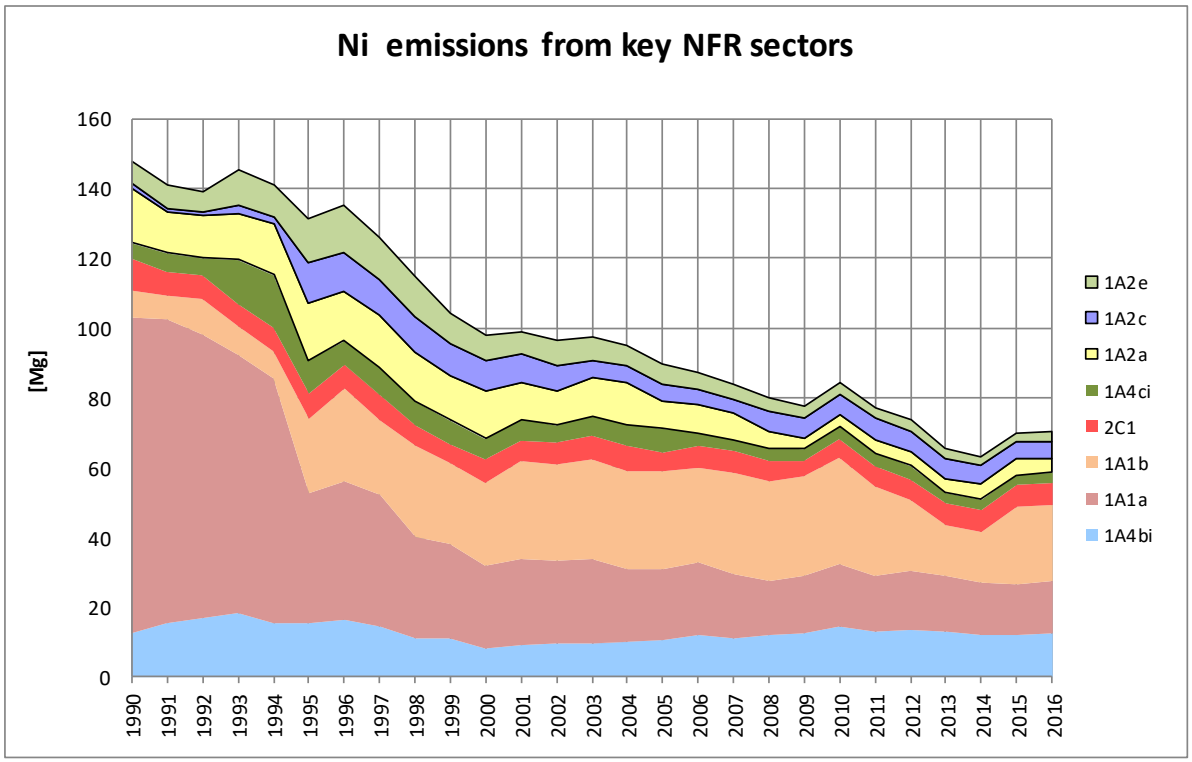

Figure 2.8.e Trend of Ni emissions for key NFR sectors

PCDD/F emissions

Figure 2.9 shows changes of dioxin emissions in the years 1990-2016. The trend of PCDD/F emissions is influenced mainly by the combustion processes in residential and commercial installations and in industry. Compared to the year 2015, in 2016 emissions of PCDD/F decreased by 2.6 %. The main drop of emissions occurred due to the smaller area of on-field burning of stubble and straw (SNAP 1003). There was a parallel increase of PCDD/F emissions, resulting from higher use of hard coal and wood in households (SNAP 0202).

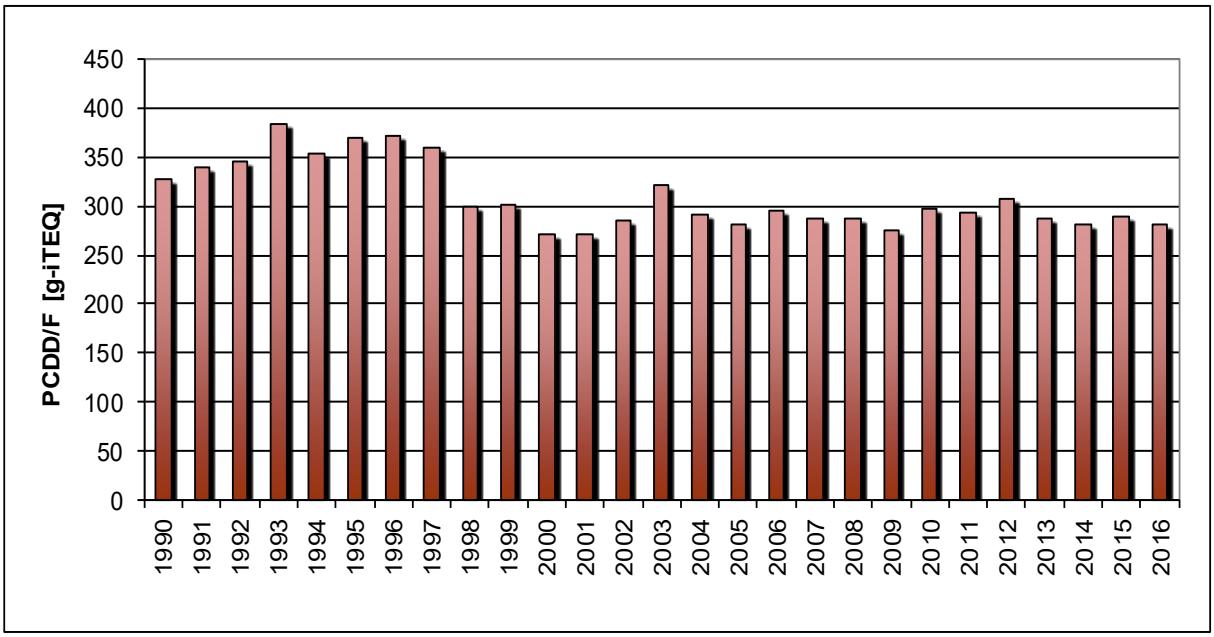

Figure 2.9.a Emissions of dioxins

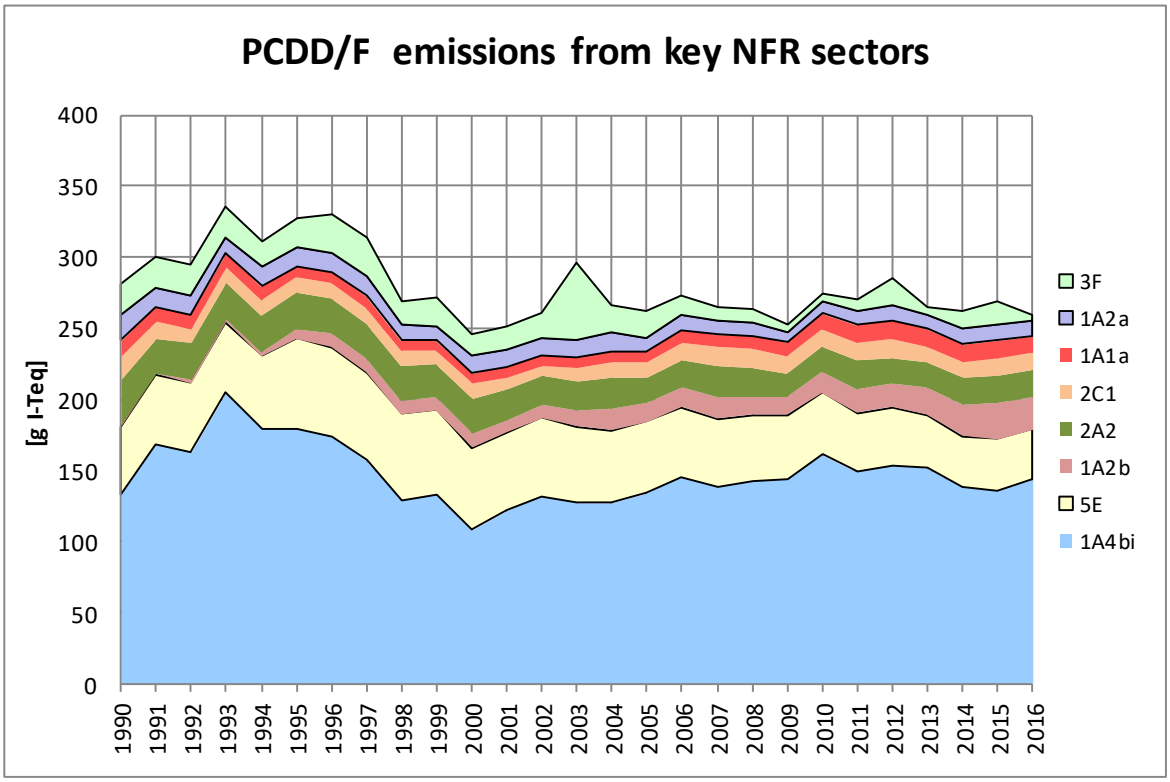

Figure 2.9.b Trend of PCDD/F emissions for key NFR sectors

HCB emissions

Figure 2.10 shows changes of HCB emissions in the years 1990-2016.. Compared to the year 2015, in 2016 emissions of HCB increased by 1.9 %. The main reason for this change was the higher use of hard coal and wood in households (SNAP 0202) and higher volume of incinerated municipal wastes (SNAP 09).

Due to the verification of methodology (change of HCB emission factor for copper production) the level of HCB emissions from the sector Combustion in Industry (SNAP 03) is substantially lower from the level reported in the 1990-2015 submission.
Level of HCB emission estimates from road transport (SNAP 07) has decreased due to the implementation of COPERT 5 model.
The above changes caused that country emission trend is now much lower from the level reported in the 1990-2015 submission.

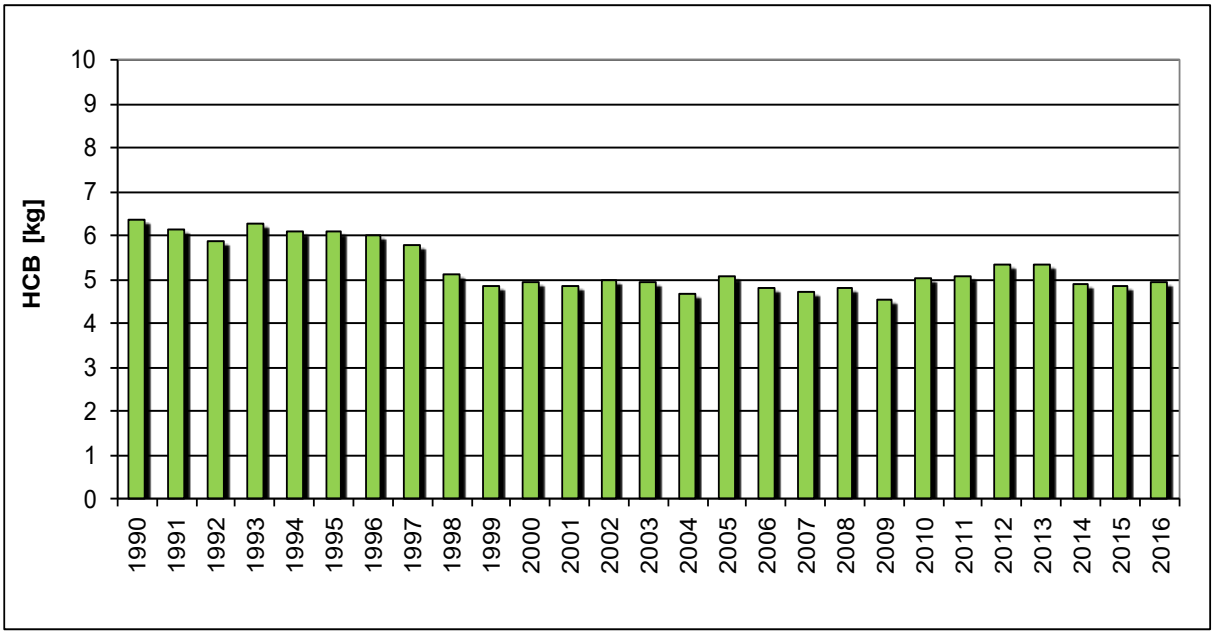

Figure 2.10.a Emissions of HCB

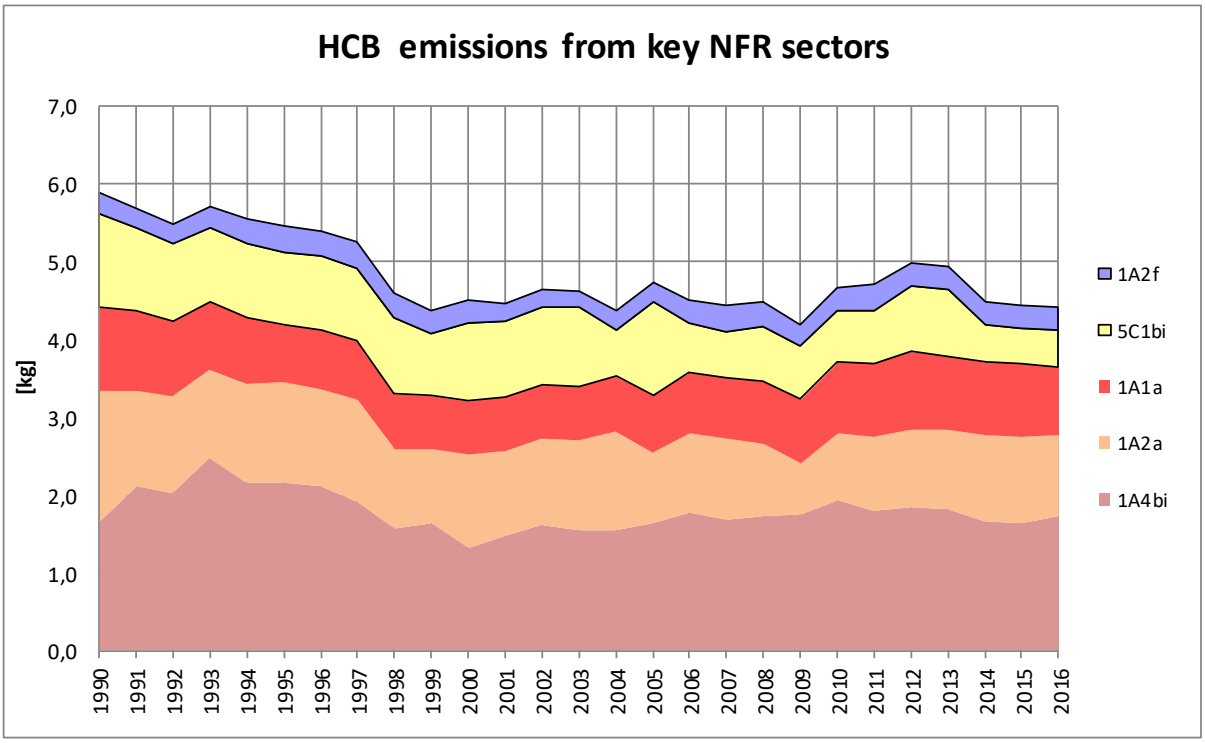

Figure 2.10.b Trend of HCB emissions for key NFR sectors

PCB emissions

Figure 2.11 shows changes of PCB emissions in the years 1990-2016. PCB emissions trend depends mainly on use of fuels in *Non-Industrial Combustion Plants*. Compared to 2015, PCB emissions in 2016 increased by about 1%. The main reason for this change was higher consumption of hard coal in the residential sector (SNAP 0202).

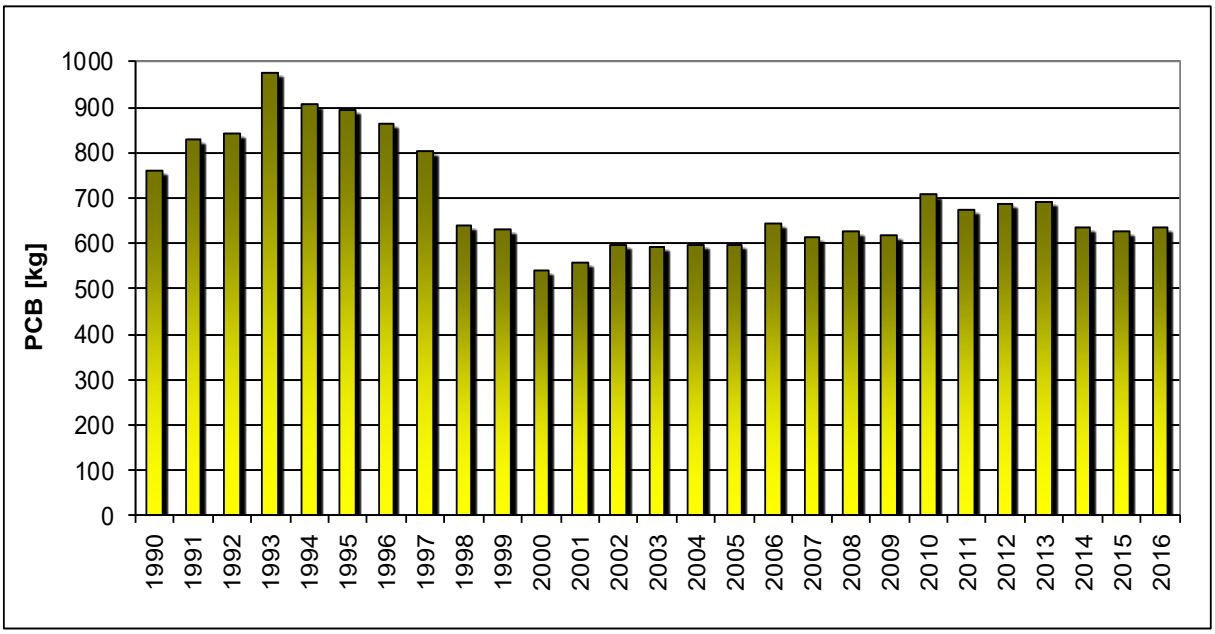

Figure 2.11.a Emissions of PCB

Level of PCB emission estimates from road transport (SNAP 07) has decreased due to the implementation of COPERT 5 model, which caused that country emission trend is now much lower from the level reported in the 1990-2015 submission.

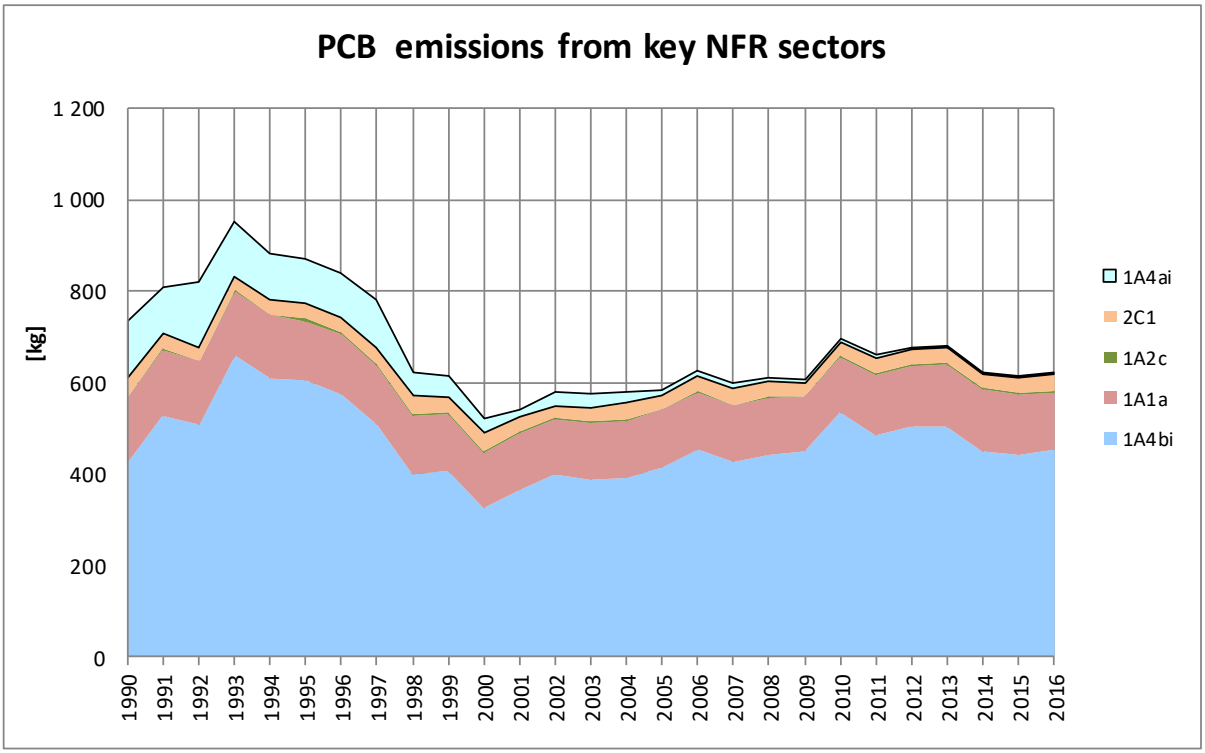

Figure 2.11.b Trend of PCB emissions for key NFR sectors

PAH emissions

Figure 2.12 shows changes of PAH emissions in the years 1990-2016. Changes in volume of PAH emissions are usually a result of changes in the amount of combusted fuels. The 2016 emissions are 4.9 % higher than the estimate for 2015. The reason for this change was the increase in consumption of coal and wood in the residential sector.

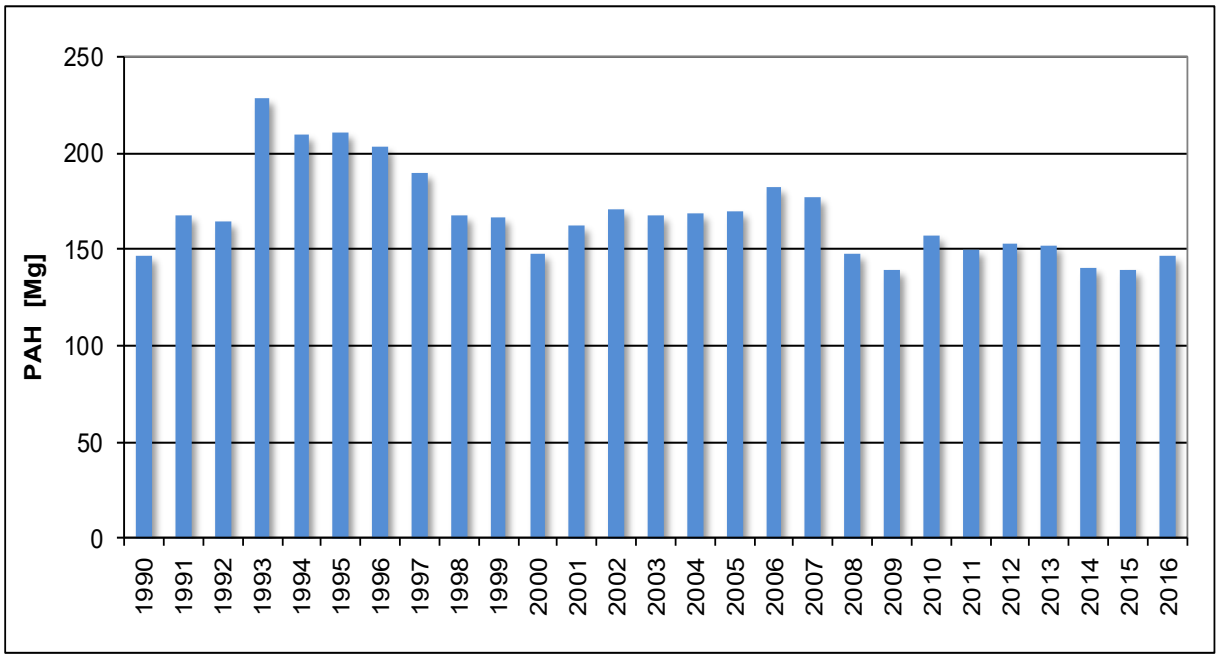

Figure 2.12.a Emissions of PAH

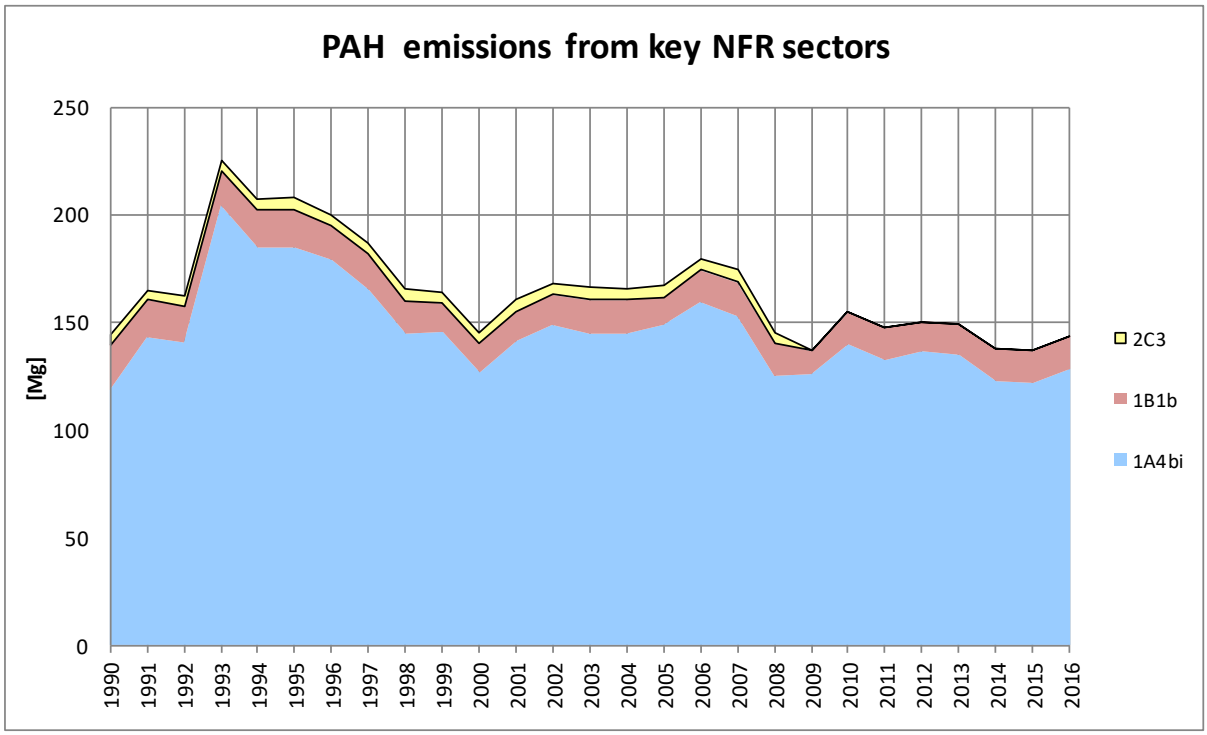

Figure 2.12.b Trend of PAH emissions for key NFR sectors

3. Sectoral Methodologies

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 Central Statistical Office. 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 Appendix 1 and 2.

The estimated values of emissions for main pollutants have been obtained from calculations based on national and international (EMEP, CORINAIR, TNO, etc.) emission factors.
Following EEA recommendations (*2017 Comprehensive Technical Review of National Emission Inventories*) several emission factors have been changed; these changes are described in the relevant chapters below. All emission factors used for 2016 estimates are presented in Appendix 3.

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

Sulphur dioxide emissions

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 aggregation 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.
Following EEA recommendations (*2017 Comprehensive Technical Review of National Emission Inventories*) SO_2 emission factors have been changed for NFR categories 2.B.6, 2.C, 2.C.3 and 2.H.1; these changes are described in the relevant chapters below.

Carbon oxide; Nitrogen oxides

For public power plants NOx emission is an aggregation of individual data. For the category *Open burning of agricultural wastes* (SNAP 0907) 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 were excluded for which residues can be composted or used as forage. So finally there were selected 38 crops containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits which residues could be burned on fields. Activity

[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).

data concerning crop production was taken from [GUS 2017i]. Factors applied for emissions calculation were taken from country study, where experimental and literature data as well as default emission factors were used. In 2017 several emission factors for 1A4 sector have been verified and updated based on a country study.

Following EEA recommendations (*2017 Comprehensive Technical Review of National Emission Inventories*) NO_x emission factor has been changed for NFR category 1.A.2; this change is described in the relevant chapter below.

PM emissions

The estimated values of emissions are a result of calculations based on national activity data and appropriate emission factors. The activity data are obtained mainly from the Central Statistical Office, 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.

The emission factors were partly derived from EMEP/EEA Emission Inventory Guidebook and CEPMEIP, but also some emission factors have been verified and adapted to Polish conditions based on country studies and surveys. The main source for these changes were the results of research done by the Institute for Ecology of Industrial Areas in Katowice in co-operation with the Institute for Chemical Processing of Coal in Zabrze.
In 2014 trend of emission factors for particulates for small emission sources has been verified [29; Kubica K. and Kubica R.].

Following EEA recommendations (*2017 Comprehensive Technical Review of National Emission Inventories*) PM2.5 emission factors have been changed for NFR categories 1.A.2, 2.C, 2.C.1, 2.C.3 and 5.C.1.b.i; these changes are described in the relevant chapters below.

POPs emissions

Estimation of emissions of dioxins/furans – PCDD/F, hexachlorobenzene - HCB, polychlorinated biphenyls - PCBs, and four polyaromatic hydrocarbons PAHs indicators was based on national activity data including fuel statistics as well as on emission factors taken from literature and domestic measurements.

In 2016 trend of emission factors for POPs for small emission sources has been verified [31; Kubica K.].

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.

There has been change of HCB emission factor for copper production, in the sector *Combustion in Industry* (SNAP 03), due to the verification of methodology, described in the chapter 8.2.
Level of HCB and PCB emission estimates from road transport (SNAP 07) has decreased due to the implementation of COPERT 5 model.

NMVOC emissions

Statistical data on production, consumption of fuels and raw materials and land use data, worked out by the Central Statistic Office, 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. Several emission factors for 1A4 sector have been verified and updated based on a country study [30; Kubica K.].

Following EEA recommendations (*2017 Comprehensive Technical Review of National Emission Inventories*) NMVOC emission factors have been changed for NFR categories 1.A.2, 2.C.1, 2.D.3.a, 2.D.3.b, 2.D.3.f, 2.D.3.g, 2.D.3.h and 2.H.2; these changes are described in the relevant chapters below.

HM emissions

The presented HM emission assessments were produced on the basis of the Polish Central Statistical Office (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.

For the HM emission assessments the emission factors used in the report were based on:
- data presented in the "EEA/EMEP Emission Inventory Guidebook" and
- the emission factors specific for processes in Poland.

Following doubts related to mercury EFs for coal combustion in public power plants an appropriate surveys has been undertaken in 2011-2013. EFs finally applied for Hg emissions 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 [34].

The methodology of HM emission estimates for small emission sources (SNAP 02) has been verified, resulting in the new trend of emission factors [51; K. Kubica].

Level of most heavy metals (except for As and Hg) emission estimates from road transport (SNAP 07) has considerably decreased due to the implementation of COPERT 5 model.

All emissions factors for the particular pollutants and emission source categories are presented in the tables in Appendix 3 following NFR classification.

3.1 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 2016 are shown on the figure 3.1.

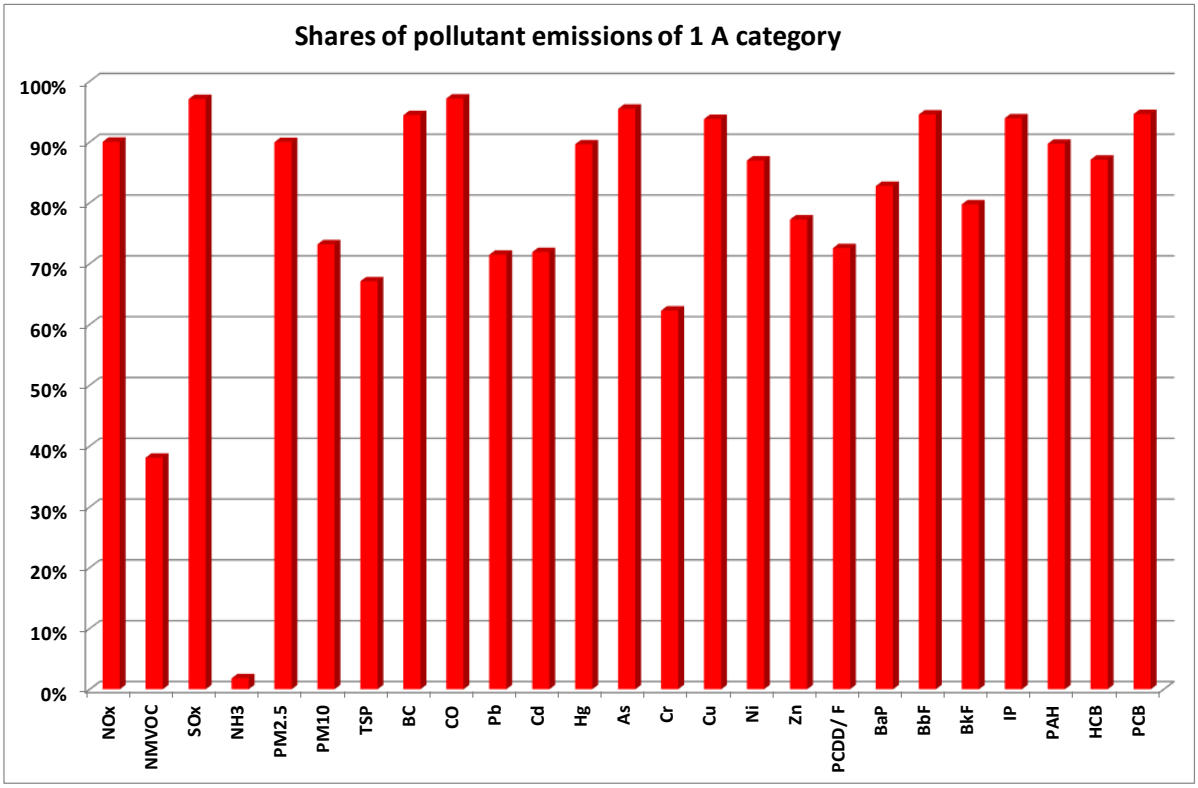

Figure 3.1. Shares of emissions from the 1 A category in the country total

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 2016 is presented in Appendix 5. 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.*

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

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

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

Methodology of emission estimation in 1.A.1 subcategory corresponds with methodology described above for fuel combustion in stationary sources. Detailed information on fuel consumption and applied emission factors for emission source subcategories are presented in Appendix 1 and 3. Shares of emissions from the 1.A.1 category in the country total for the particular pollutants in 2016 are shown on the figure 3.2.

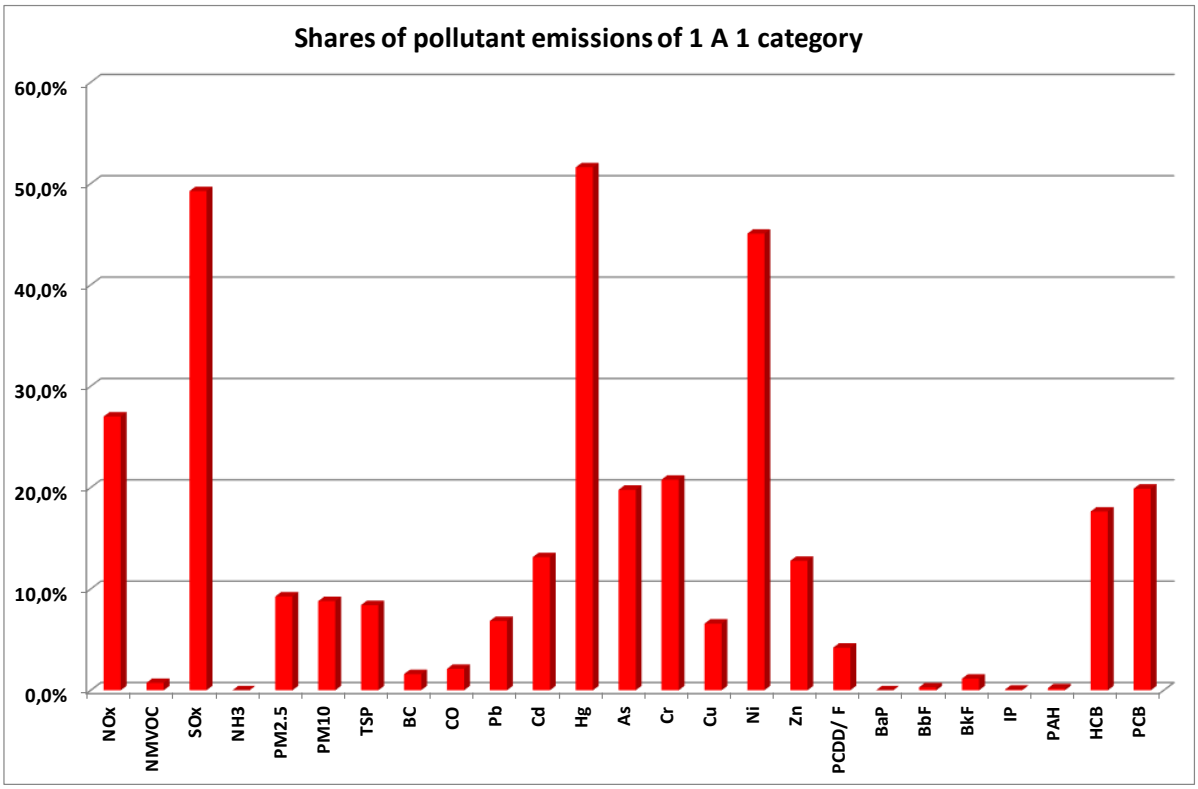

Figure 3.2. Shares of emissions from the 1.A.1 category in the country total

3.3.1. 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.

Tables A1.1 and A1.2 in Appendix 1 present the amounts of fuels used in the sub-category 1.A.1.a - *Public Electricity* and *Industrial Power* for the years 1990-2015.
Table A1.3 in Appendix 1 presents the amounts of fuels used in the sub-category 1.A.1.a - *Heat Production* for the years 1990-2016.
The data in tables A1.1 – A1.3 show that the use of solid fuels is dominant in 1.A.1.a – mainly hard coal.

Applied emission factors for subcategory 1.A.1.a are presented in Appendix 3.
For public power plants, emissions of SO_2 and NOx, as aggregated individual data, were taken from reports to the National Database.

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

This category corresponds to category SNAP 0103. Table A1.4 in Appendix 1 shows fuels consumption data in sub-category 1.A.1.b *Petroleum Refining* for the years 1990-2016.
Applied emission factors for subcategory 1.A.1.a are presented in Appendix 3.
Emissions of SO_2 and NOx, as aggregated individual data, were taken from reports to the National Database.

3.3.3. 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. Tables A1.5 and A1.6 in Appendix 1 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 1990-2016.

Applied emission factors for subcategory 1.A.1.c are presented in Appendix 3. For coking plants amounts of emissions of SO_2 and NOx, as aggregated individual data, were taken from reports to National Database.

Emission trends for the NFR sector 1.A.1

Volumes and trend of pollutant emissions for Public electricity and heat production are shown below on figures 3.3 ÷ 3.8.

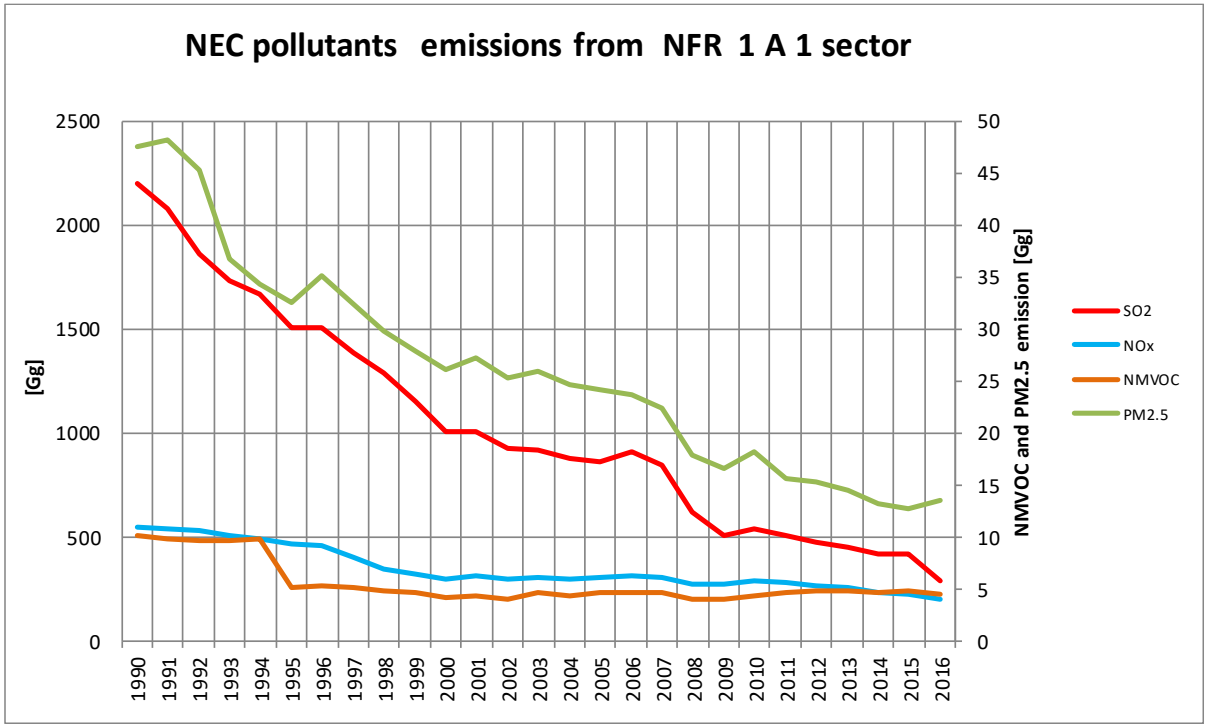

Figure 3.3. SO_2, NOx and NMVOC emissions for 1.A.1 category in 1990-2016

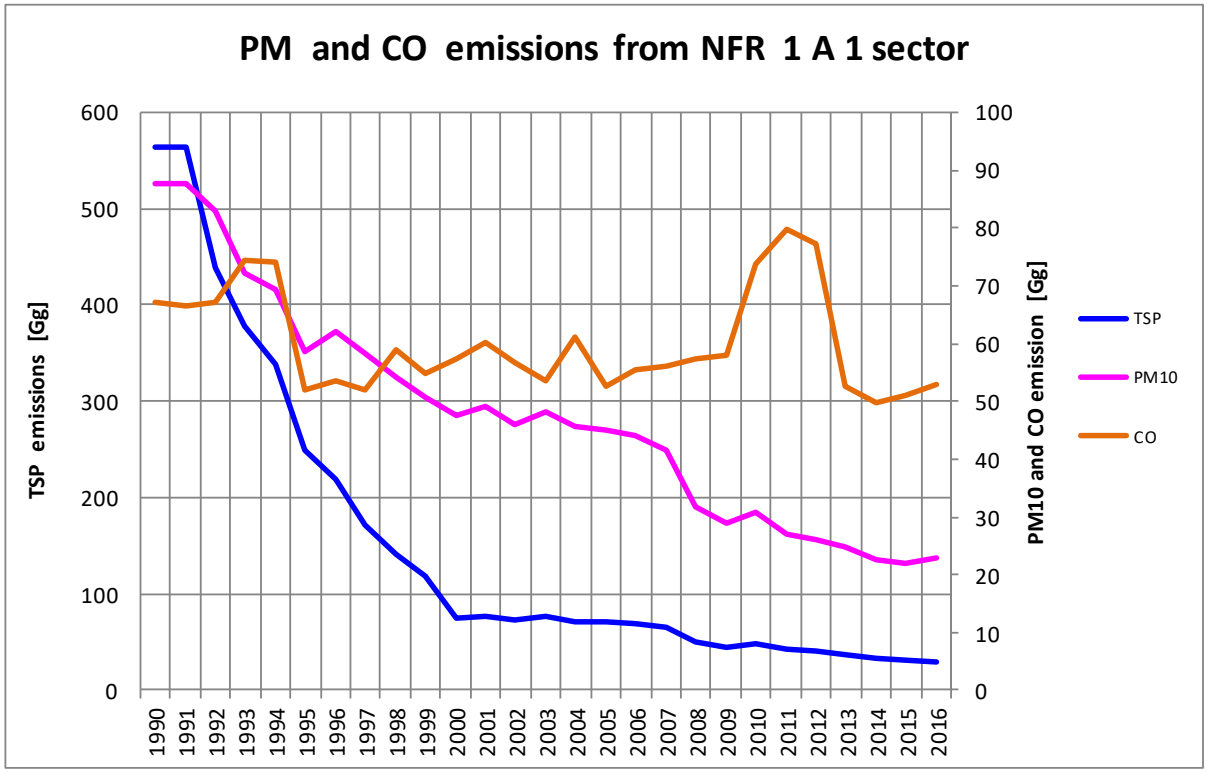

Figure 3.4. Particulates and CO emissions for 1.A.1 category in 1990-2016

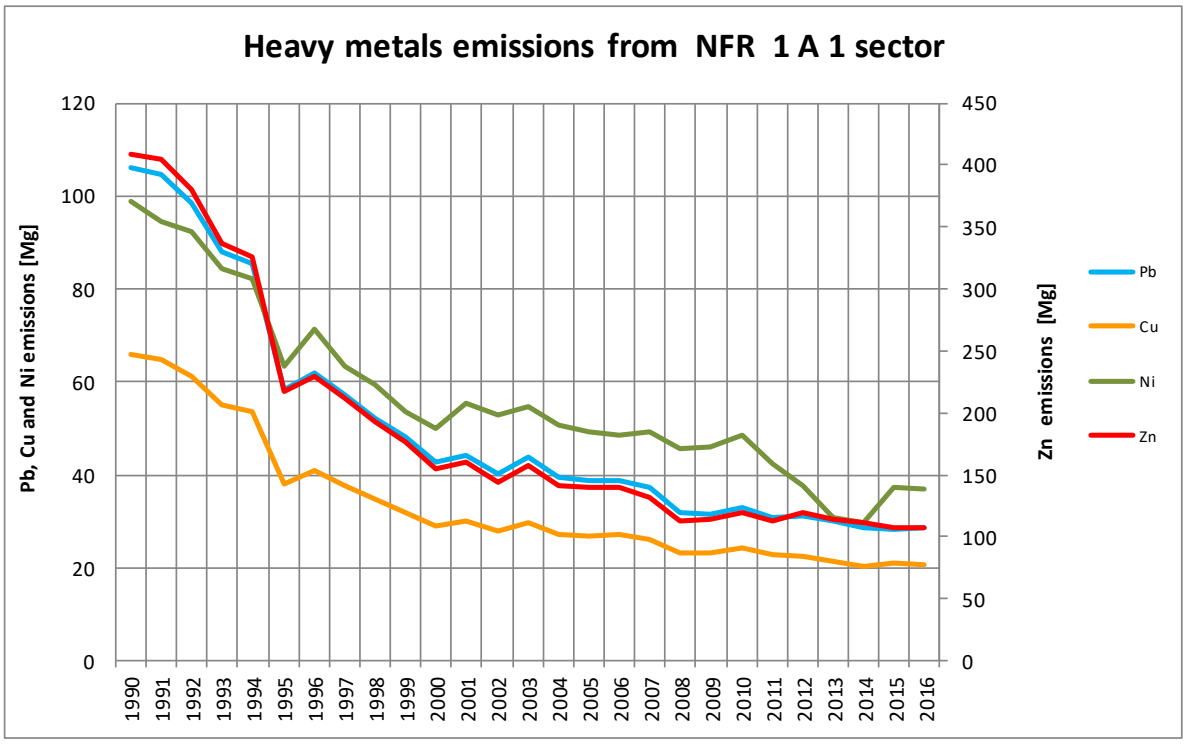

Figure 3.5. Pb, Cu, Ni and Zn emissions for 1.A.1 category in 1990-2016

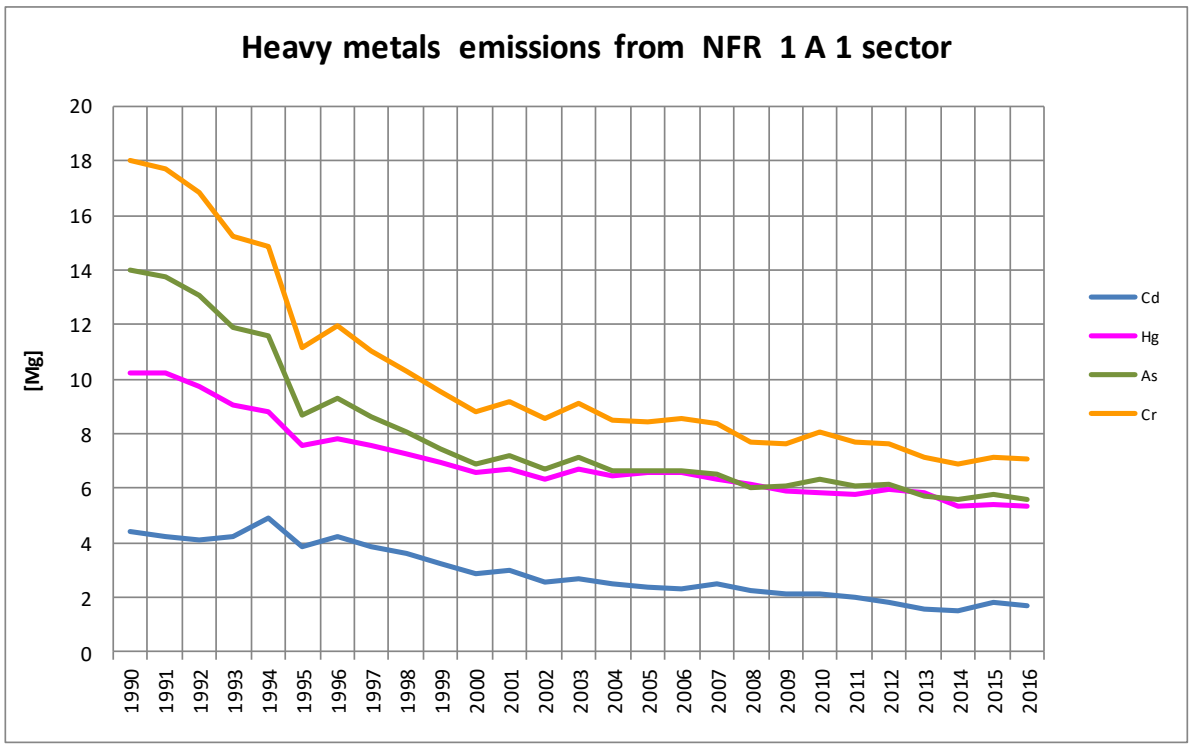

Figure 3.6. Cd, Hg, As and Cr emissions for 1.A.1 category in 1990-2016

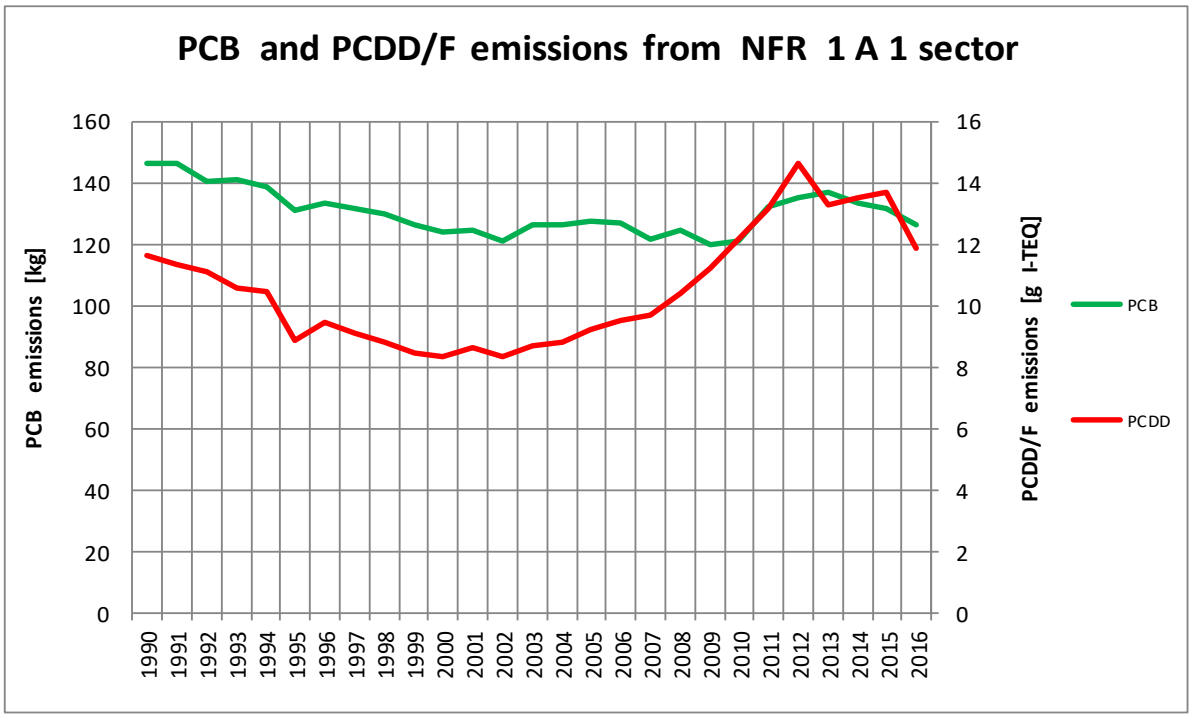

Figure 3.7. PCB and PCDD/F emissions for 1.A.1 category in 1990-2016

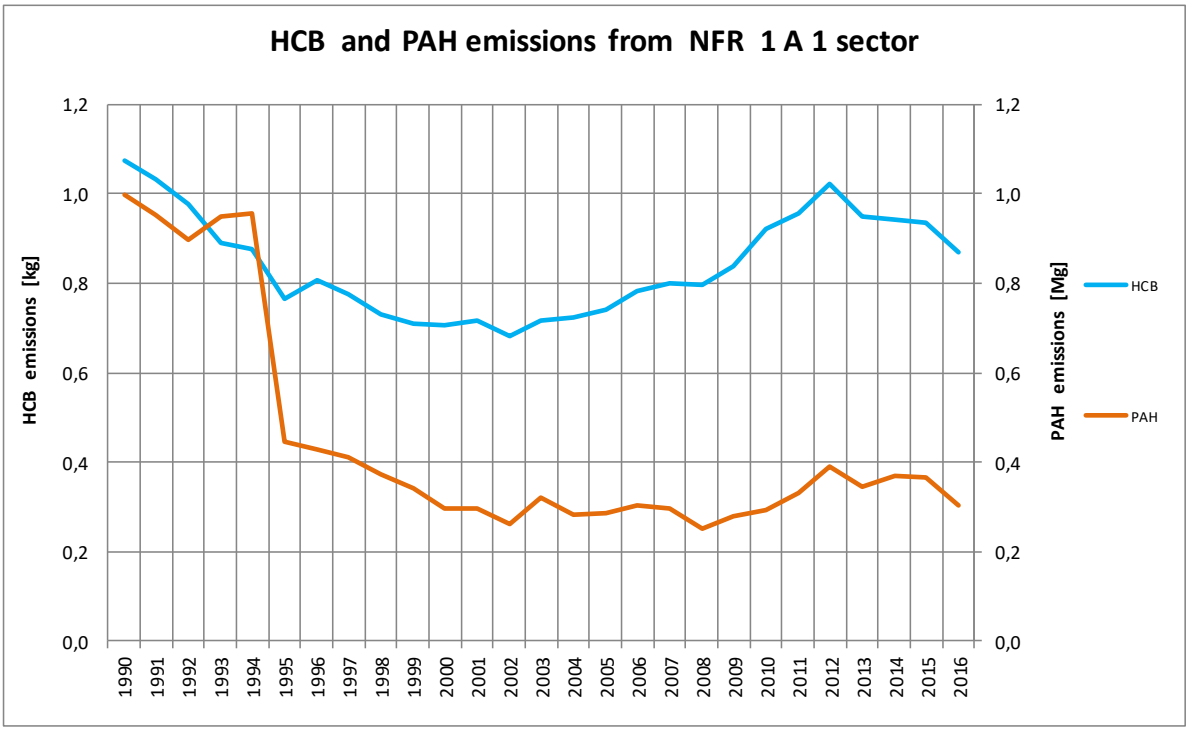

Figure 3.8. HCB and PAH emissions for 1.A.1 category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector *1.A.1* was developed with use of methodology, described in Appendix 6. 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 Appendix 6. Results of the sectoral uncertainty analysis for NFR sector *1.A.1* are given below.
Performed recalculations (period 1990-2015) of data ensured consistency for whole time-series.

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

NFR		NOX	NMVOC	SO2	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAH
1A1a	Public electricity and heat production	22%	21%	12%	40%	27%	28%	33%	38%	25%	58%	52%	64%	62%
1A1b	Petroleum refining	30%	29%	20%	50%	50%	50%	50%	60%	66%	46%	100%	100%	81%
1A1c	Manufacture of solid fuels and other energy industries	30%	30%	20%	50%	50%	50%	50%	53%	43%	45%	76%	71%	68%

Source-specific recalculations

Activity data on fuel consumption for years 1990-2015 were updated due to changes made in EUROSTAT database.

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.

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

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 SNAP03.
Shares of emissions from the 1.A.2 category in the country total for the particular pollutants in 2016 are shown on the figure 3-10.

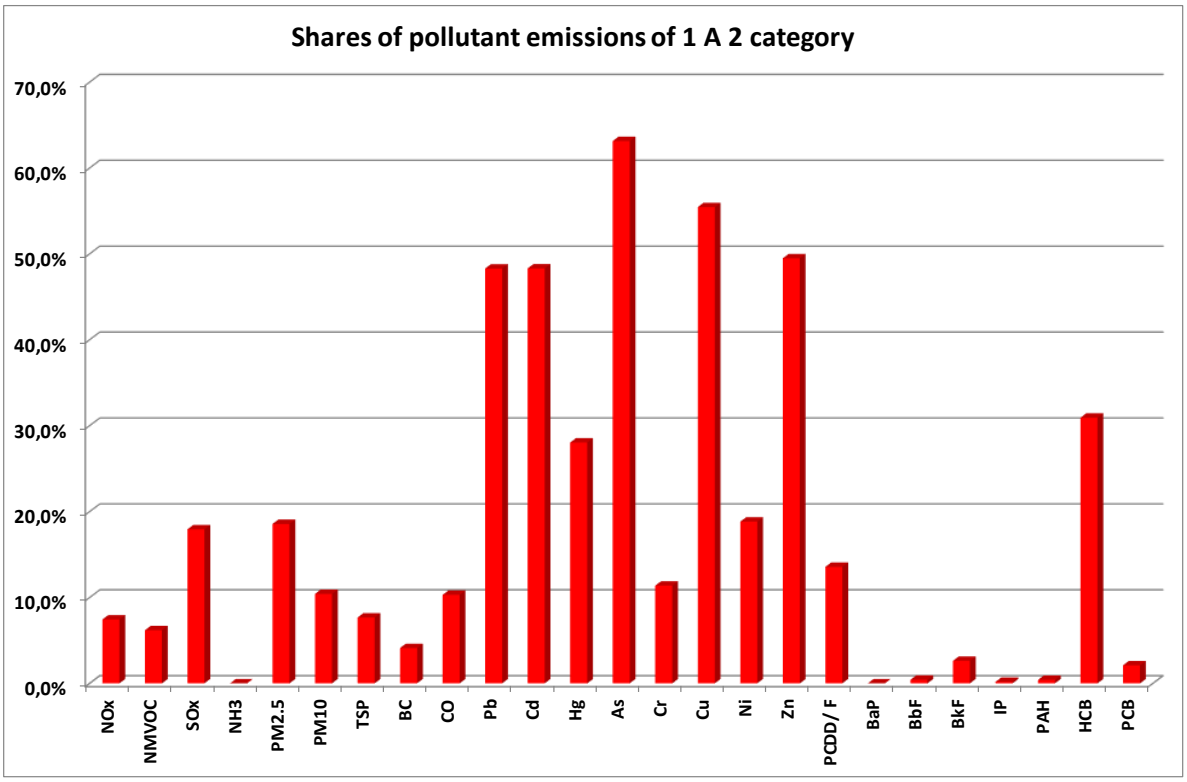

Figure 3-10. Shares of emissions from the 1.A.2 category in the country total

Activity data on fuel use for this sector come from energy statistics. For process emissions activity data come from production statistics [GUS 2017e]. Methodology of emission estimation in 1.A.2 subcategory corresponds with methodology described for fuel combustion in stationary sources.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory, emission factors for NOx, NMVOC and PM2.5 from the category *Stationary combustion in manufacturing industries and construction* (NFR 1A.2; SNAP 0302) have been

updated to those published in EMEP/EEA EIG 2016. This change resulted in the small increase of emissions of the above mentioned pollutants. Applied new emission factors are presented in the tables A3.38, A3.40 and A3.41 in the Appendix 3.

Detailed information on fuel consumption and applied emission factors for subcategories listed below are presented in Appendix 1, 2 and 3.

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

This category corresponds to categories SNAP 030301 ÷ 030303.
Detailed data on fuel consumptions in the subcategory 1.A.2.a *Iron and Steel* for the period 1990-2016 was presented in table A1.7 in Appendix 1 and in table A1.13 in Appendix 1.
Applied emission factors for subcategory 1.A.2.a are presented in Appendix 3.

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

This category corresponds to categories SNAP 030204 and SNAP 030304 ÷ 030310.
Detailed data concerning fuel consumption in the sub-category 1.A.2.b *Non-Ferrous Metals* over the 1990-2016 period are presented in table A1.8 in Appendix 1. Activity data for industrial processes in this category are shown in table A1.14 in Appendix 1. Applied emission factors for subcategory 1.A.2.b are presented in Appendix 3.

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

This category is a part of the category SNAP03.
The data on fuels consumptions in 1.A.2.c subcategory for the entire period 1990-2016 was presented in table A1.9 in Appendix 1. Emission factors for subcategory 1.A.2.c are presented in Appendix 3.

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

This category is a part of the category SNAP03.
The detailed data on fuels use in the sub-category 1.A.2.d *Pulp, Paper and Print* over the 1990-2016 period are presented in table A1.10 in Appendix 1. Emission factors for subcategory 1.A.2.d are presented in Appendix 3.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory, emission factors for emissions of NH_3 from the category *1A2d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print* (NFR 1A.2.d; SNAP 0302) have been updated to those published in EMEP/EEA EIG 2016. This change resulted in the small increase of NH_3 emissions. Applied new emission factor is presented in the table A3.60 in the Appendix 3.

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

This category is a part of the category SNAP03.
The detailed data on fuels use in the sub-category 1.A.2.e *Food Processing, Beverages and Tobacco* over the 1990-2016 period are presented in table A1.11 in Appendix 1. Emission factors for subcategory 1.A.2.e are presented in Appendix 3.

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

This category is a part of the category SNAP03.
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 table A1.12 in Appendix 1. Activity data for industrial processes in this category are shown in table A1.15 in Appendix 1. Emission factors for subcategory 1.A.2.f are presented in Appendix 3.

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

This category is generally a part of the category SNAP03, however no stationary emission sources were identified and included in it (NFR sector 1.A.2.g viii).

According to methodology currently applied for inventory preparation, diesel oil consumed for mobile combustion (off-road vehicles and other machinery) in industry and construction sub-sectors is included in particular subsectors of NFR 1.A.2 categories (i.e. in particular branches of industry), where fuel is used. Therefore for NFR sector 1.A.2.g vii notation key IE has been applied.

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 3.11 ÷ 3.16.

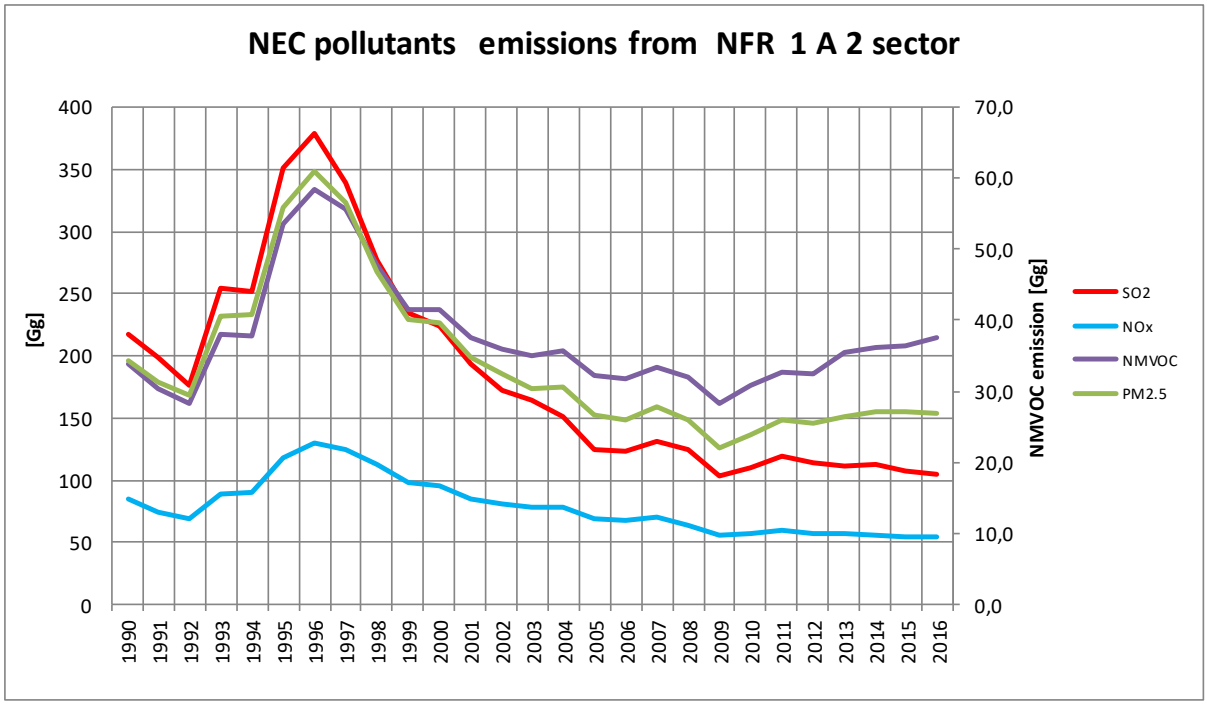

Figure 3.11. SO_2, NOx, PM2.5 and NMVOC emissions for 1.A.2 category in 1990-2016

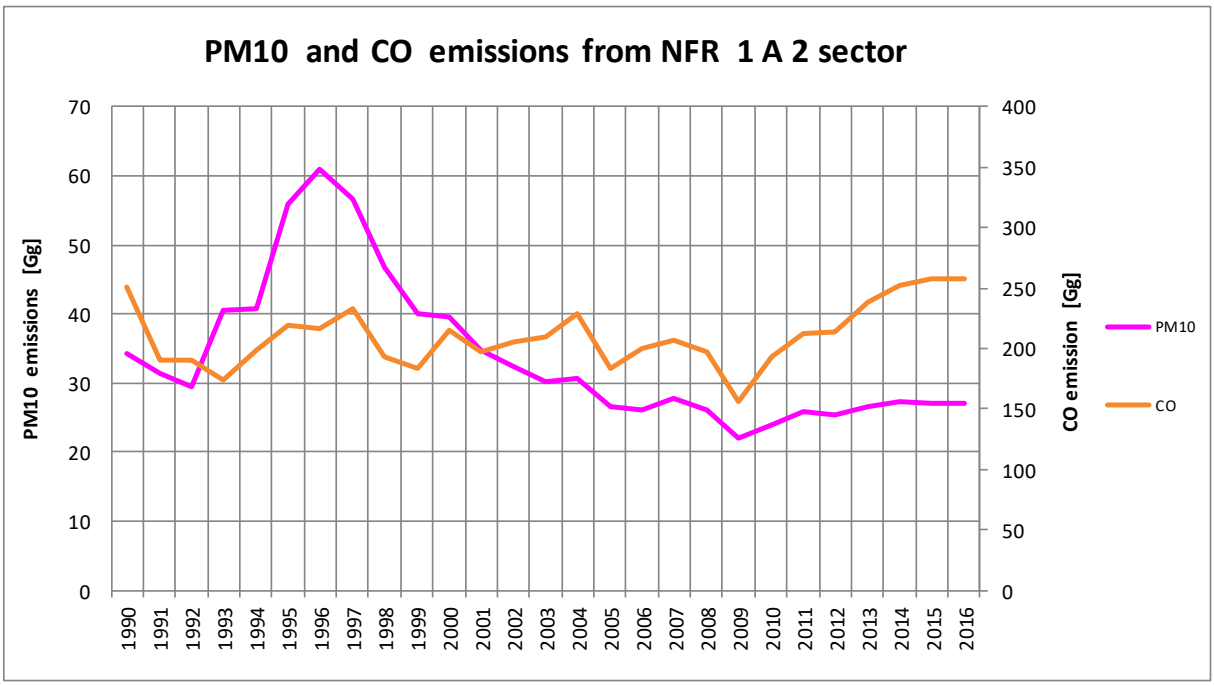

Figure 3.12. Particulates and CO emissions for 1.A.2 category in 1990-2016

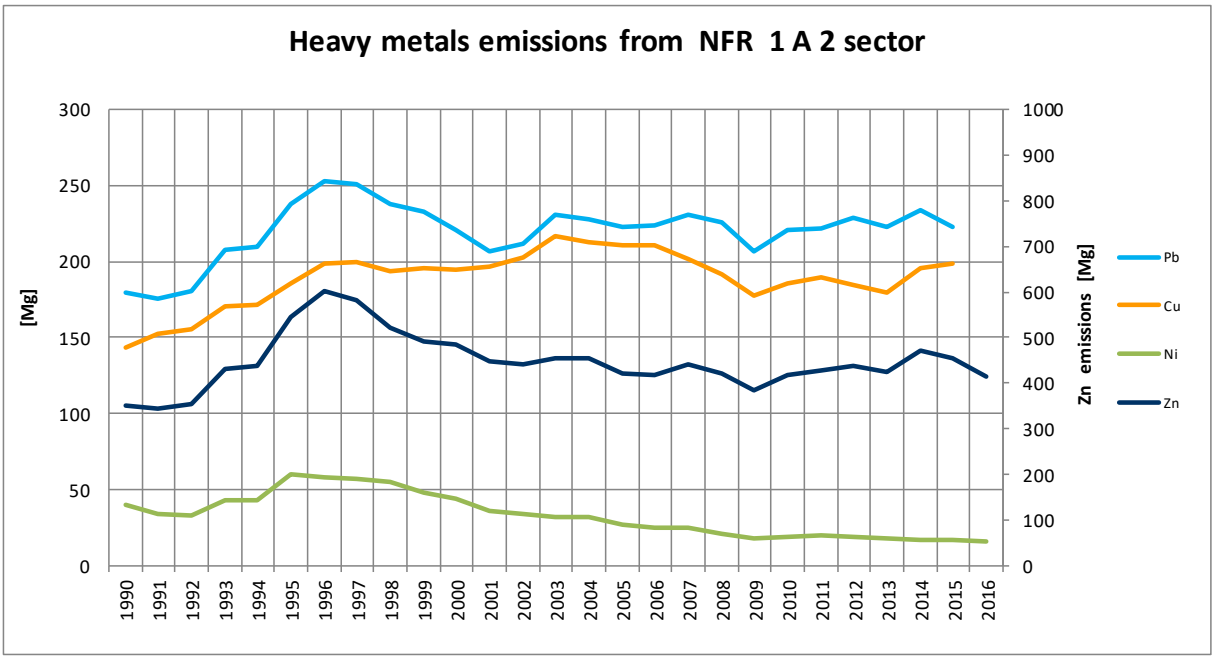

Figure 3.13. Pb, Cu, Ni and Zn emissions for 1.A.2 category in 1990-2016

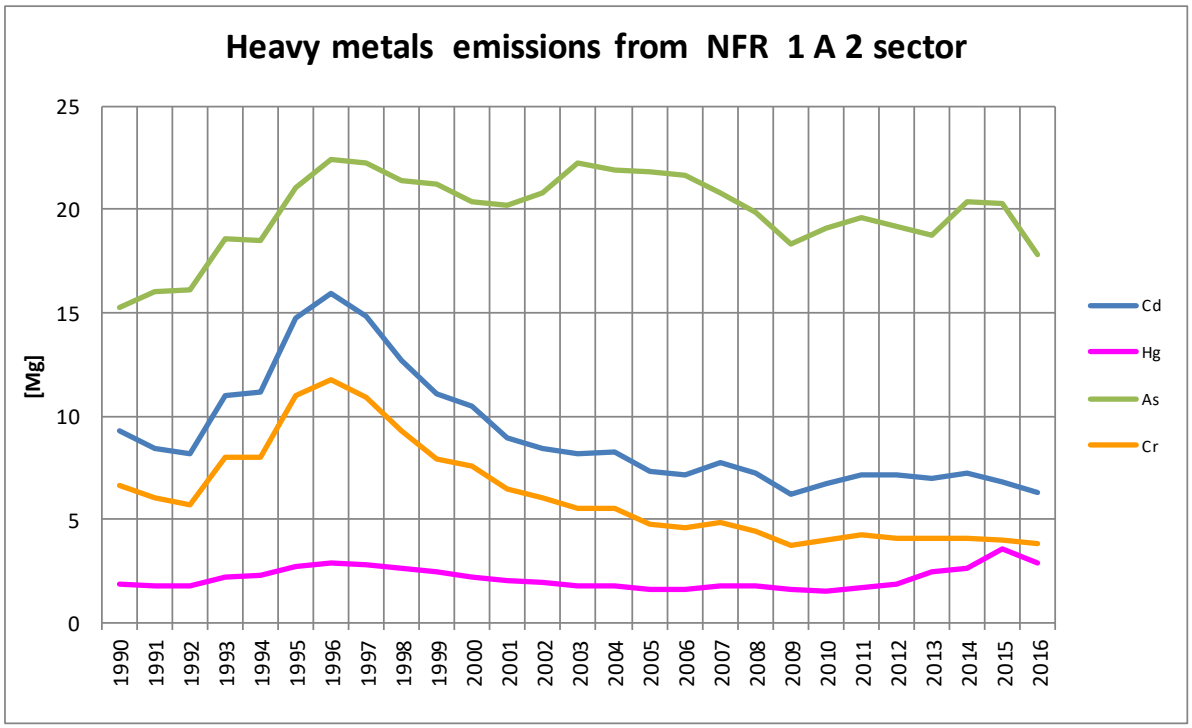

Figure 3-14. Cd, Hg, As and Cr emissions for 1.A.2 category in 1990-2016

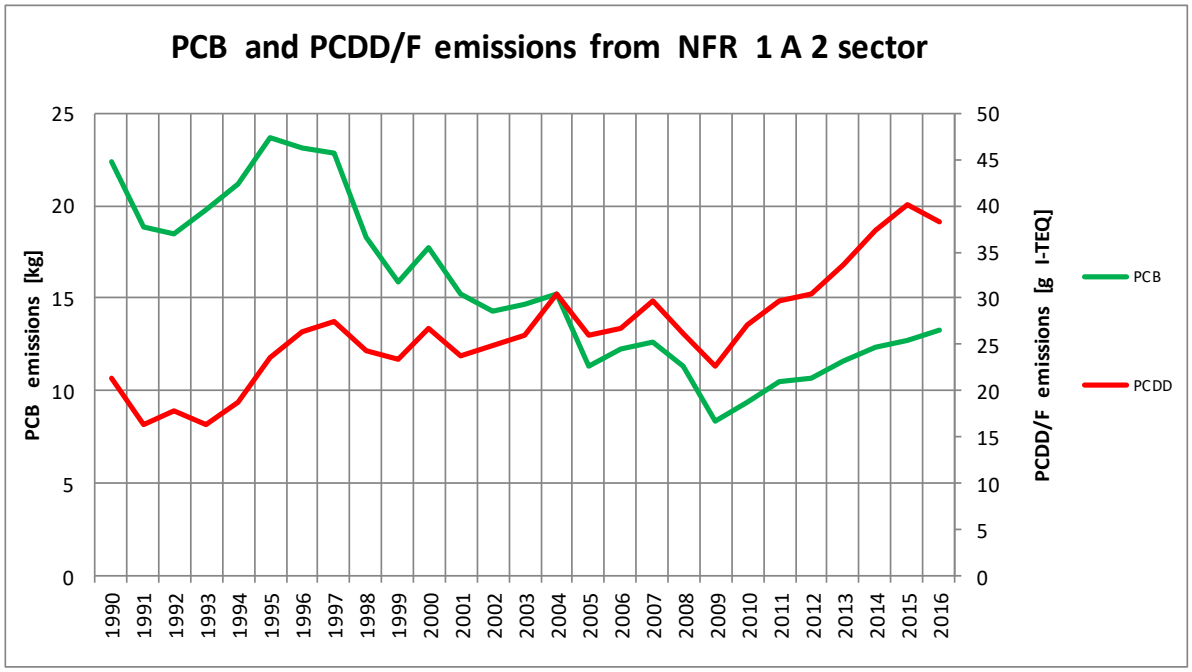

Figure 3-15. PCB and PCDD/F emissions for 1.A.2 category in 1990-2016

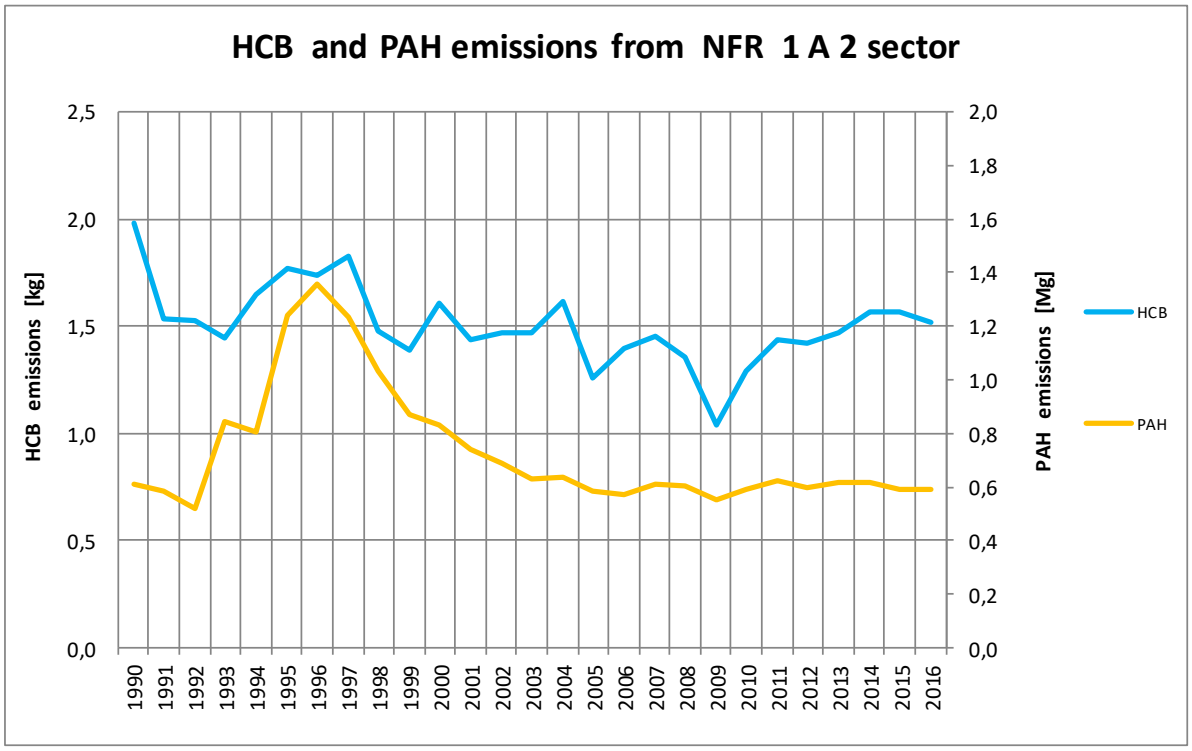

Figure 3-16. HCB and PAH emissions for 1.A.2 category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector *1.A.2* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

Table 3.10. Results of the uncertainty analysis for NFR sector *1.A.2*

NFR		NOX	NMVOC	SO_2	NH_3	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F	HCB	PAH
1A2a	Iron and steel	28%	50%	15%		70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2b	Non-ferrous metals	5%	50%	12%		70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2c	Chemicals	30%	50%	20%		70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2d	Pulp, Paper and Print	30%	50%	20%	14%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2e	Food processing, beverages and tobacco	30%	50%	20%		70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2f	Non-metallic minerals	27%	50%	14%		29%	50%	50%	50%	70%	70%	70%	87%	100%	100%

Source-specific recalculations

Activity data on fuel consumption for years 1990-2015 were updated due to changes made in EUROSTAT database.

3.5. Transport (NFR sector 1.A.3)

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 2016 are shown on the figure 3-17.

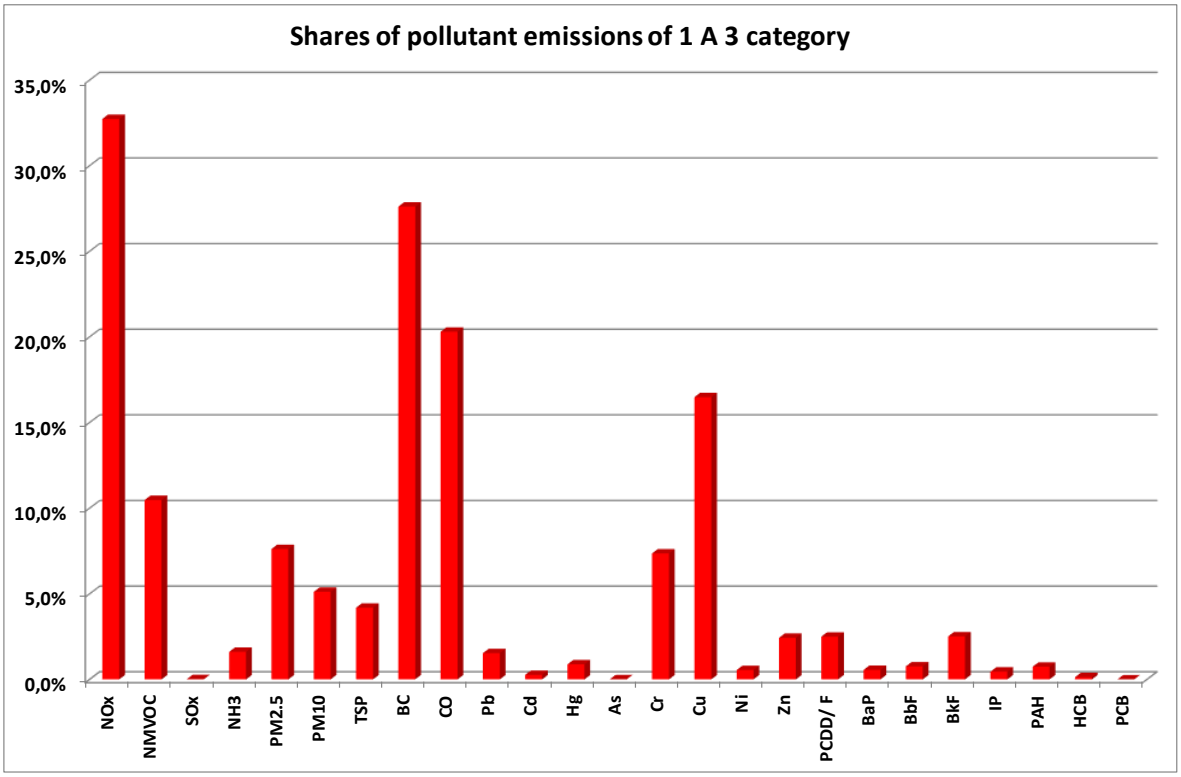

Figure 3-17. Shares of emissions from the 1.A.3 category in the country total

Methodological issues

The methodology used for estimation of pollutant emissions in the national inventory for mobile sources for the entire time series 1990-2016 is factor based – data on fuel used are multiplied by the corresponding emission factors.

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 Appendix 3.

3.5.1. 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 1990-2016 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 table below 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 3.11. Eurocontrol and Eurostat data of jet kerosene used in Poland and the share of domestic and international use.

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eurocontrol													
- domestic	Gg	22.93	25.89	28.18	27.64	25.38	29.48	32.55	46.86	34.84	38.89	34.65	34.57
- international	Gg	302.09	382.61	453.50	513.39	451.76	475.87	477.58	493.48	517.22	548.54	586.05	666.24
Total	Gg	325.02	408.49	481.68	541.04	477.13	505.35	510.13	540.34	552.06	587.43	620.70	700.81
Eurostat	Gg	*311.00*	*415.00*	*432.00*	*519.00*	*470.00*	*495.00*	*485.00*	*537.00*	*524.00*	*590.00*	*646.00*	*685.40*
Share		7.05	6.34	5.85	5.11	5.32	5.83	6.38	8.67	6.31	6.62	5.58	4.93
- domestic	%	92.95	93.66	94.15	94.89	94.68	94.17	93.62	91.33	93.69	93.38	94.42	95.07
- 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
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

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 3.12 presents the amounts of fuels used in the sub-category 1.A.3.a.i - International Aviation for the years 1990-2016. For the LTO cycle it was initially assumed that 10 % of the fuel use is used for that part of flight.

Table 3.12. Jet kerosene consumption in the sub-category 1.A.3.a.i - International Aviation for the years 1990-2016 [Gg]

Year	Jet kerosene	Year	Jet kerosene
1990	202.24	2004	257.74
1991	208.83	2005	289.06
1992	226.70	2006	388.70
1993	225.76	2007	406.72
1994	228.58	2008	492.48
1995	246.45	2009	445.00
1996	289.72	2010	466.12
1997	259.62	2011	454.05
1998	264.33	2012	490.43
1999	236.11	2013	490.93
2000	251.16	2014	550.94
2001	247.39	2015	609.93
2002	242.69	2016	651.59
2003	262.44		

All emission factors applied for International Aviation are shown in the Appendix 3.

3.5.2. 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 1990-2016 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 3.5.1. For the LTO cycle it was initially assumed that 30 % of the fuel use is used for that part of flight. Table 3.13 presents the amounts of fuels used in the sub-category 1.A.3.a ii - Civil Aviation for the years 1990-2016.

Table. 3.13. Amounts of fuels used in the sub-category 1.A.3.a ii - Civil Aviation for the years 1990-2016 [Gg]

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Jet kerosene	12.76	13.17	14.30	14.24	14.42	15.55	18.28	16.38	16.67
Aviation gasoline	8.00	5.00	2.00	4.00	10.00	7.00	4.00	6.00	4.00
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Jet kerosene	14.89	15.84	15.61	15.31	16.56	16.26	21.94	26.30	25.28
Aviation gasoline	3.00	3.00	3.00	4.00	4.00	3.00	3.00	3.00	4.00
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Jet kerosene	26.52	25.00	28.88	30.95	46.57	33.07	39.06	36.07	33.81
Aviation gasoline	3.00	4.00	4.00	5.00	5.00	4.00	5.00	4.00	3.01

All emission factors applied for Civil Aviation are shown in the Appendix 3.

3.5.3. 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 2016 and recalculations of 1990-2015 data were made by model COPERT 5 version 5.1.1. 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 1990-2016 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 1990-2016 period is shown in table 3.14. 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 (399 buses in 2015 and 481 buses in 2016) therefore, it can be assumed that emission in years before 2015 was rather insignificant.

Table 3.14. Amount of fuels consumption in road transport in years 1990-2016 [Gg]

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Gasoline	3 032	3 537	3 751	3 832	4 241	4 299	4 494	4 853	4 948
Diesel oil	2 747	2 722	2 754	2 514	2 364	2 445	3 181	3 246	3 621
LPG	0	0	0	24	71	176	253	336	350
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	5 504	4 960	4 601	4 213	4 024	4 085	3 943	4 045	4 039
Diesel oil	3 778	3 142	3 277	3 143	3 827	4 685	5 357	6 265	7 534
LPG	467	425	586	829	1 070	1 341	1 549	1 700	1 750
	2008	2009	2010	2011	2012	2013	2014	2015	2016
Gasoline	3 991	3 995	3 948	3 734	3 574	3 405	3 366	3 558	3 756
Diesel oil	8 218	8 452	9 303	9 744	9 283	8 532	8 758	9 474	11 266
LPG	1 719	1 653	1 660	1 608	1 606	1 593	1 587	1 543	1 655
CNG/LNG								15.1	13.8

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 Central Statistical Office [GUS 2017d]. The amount of vehicles according to categories and fuel type is shown in the figure below.

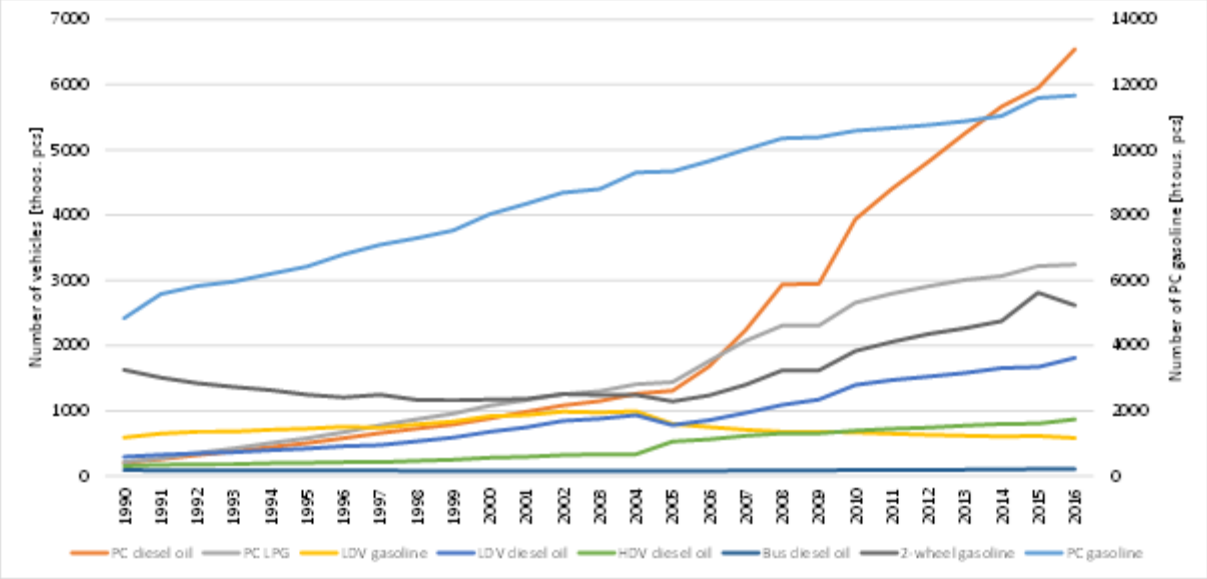

Figure 3.18. Number of vehicles in 1990-2016.

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 [52; Chłopek, 2017]. 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 2016 are presented in figure 3.19. Mileage share and speed per road class are shown in figures 3.20 -3.21. Estimations were made using information from Chlopek [47 – 49].

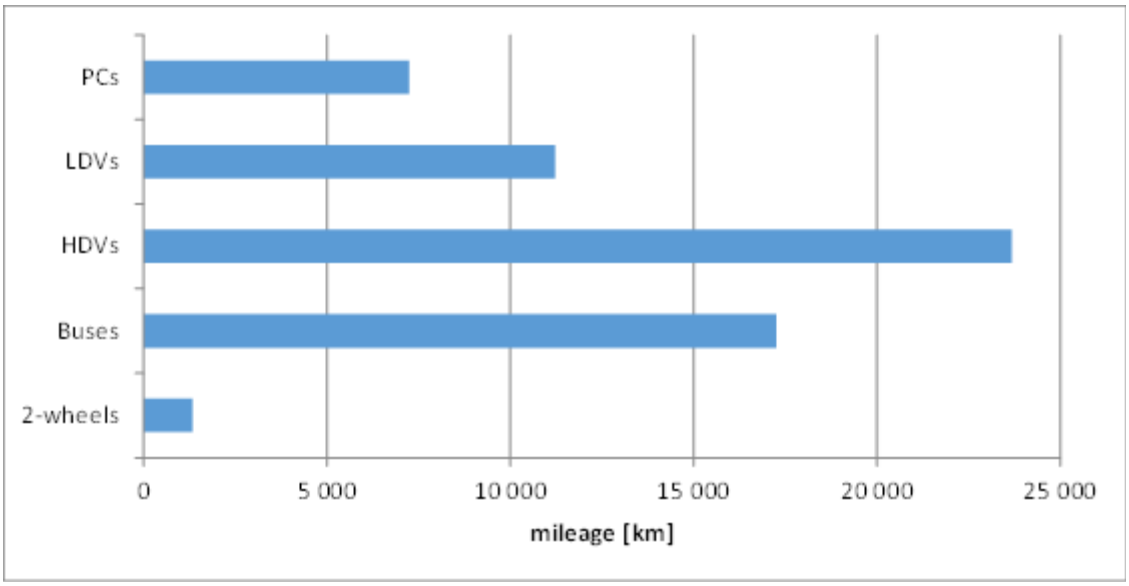

Figure 3.19. Annual mileage driven by vehicles in 2016

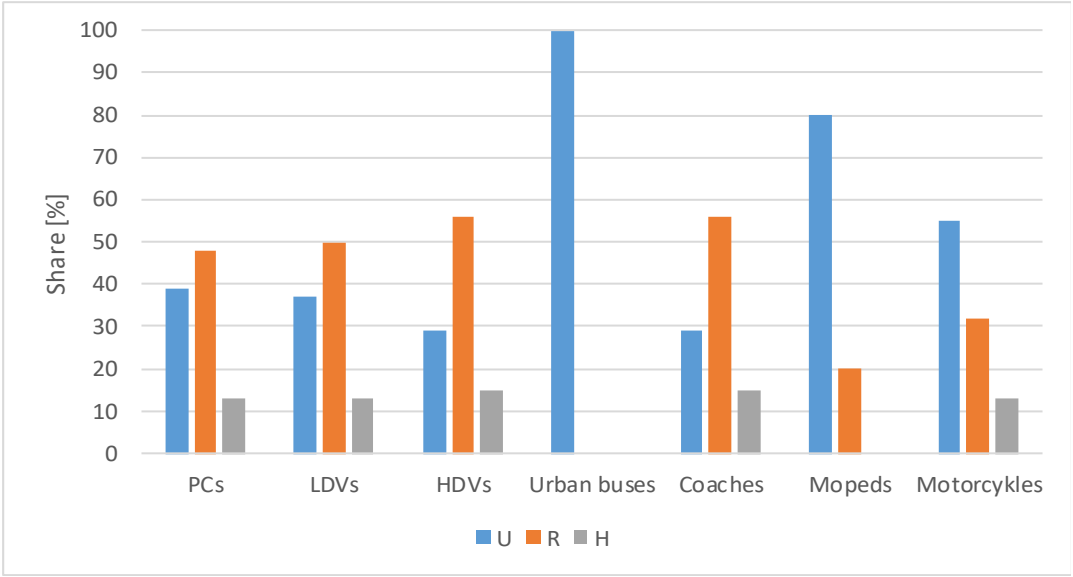

Figure 3.20. Mileage share per road class (urban, rural and highways) in 2016

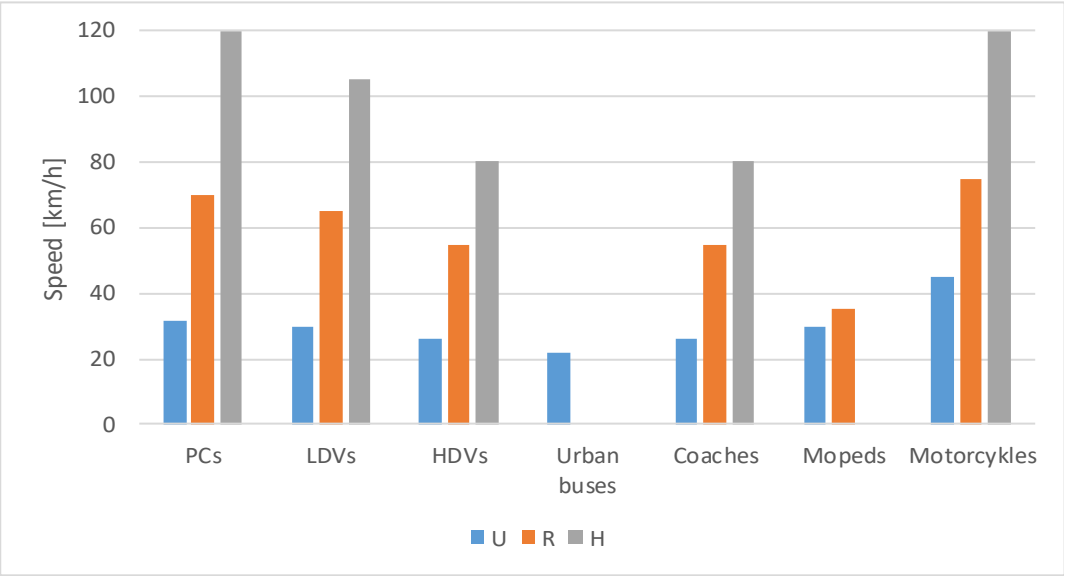

Figure 3.21. The average speed per road class (urban, rural and highways) in 2016

It should be noted that level of emission estimates from road transport (SNAP 07) for several pollutants has considerably decreased due to the implementation of COPERT 5 model and their emission trend is now much lower from the level reported in the 1990-2015 submission.

3.5.4. Railways (NFR sector1.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. Up to year 1998 coal was used by steam locomotives.
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 1990-2016 period are shown in table 3.15.

Table 3.15. Amounts of fuels used in railway transport in the 1990-2016 [Gg]

	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
	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
	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	81.03
Hard coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission factors applied for Railways are shown in the Appendix 3.

3.5.5. 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).

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 1990-2016 period are shown in table 3.16. All emission factors applied for National navigation are shown in the Appendix 3.

Table. 3.16. The amounts of fuels used in navigation in the 1990-2016 [Gg]

	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
	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
	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	1.91
Marine - Diesel oil	0.61	0.38	0.21	0.24	0.23	0.31	0.17	1.59*	4.70*
Marine - fuel oil	1.60	0.94	0.31	0.35	0.26	0.56	0.29	0.00*	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.

3.5.6. 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. Emission data from 2011 were taken from reports to National Database

Emission trends for the NFR sector 1.A.3

Volumes and trend of pollutant emissions for Transport are shown below on figures 3.22 ÷ 3.27. Drop of SO_2 emissions results from new limit of sulfur contents in fuels.

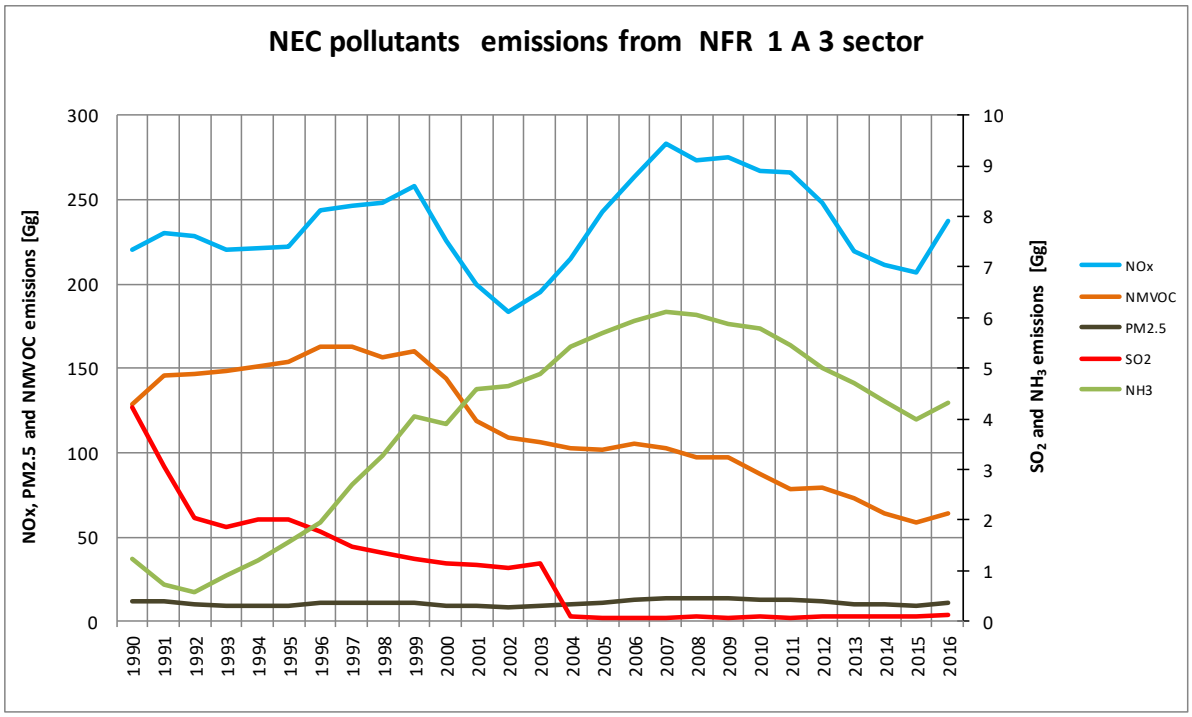

Figure 3.22. SO_2, NOx, NH_3, PM2.5 and NMVOC emissions for 1.A.3 category in 1990-2016

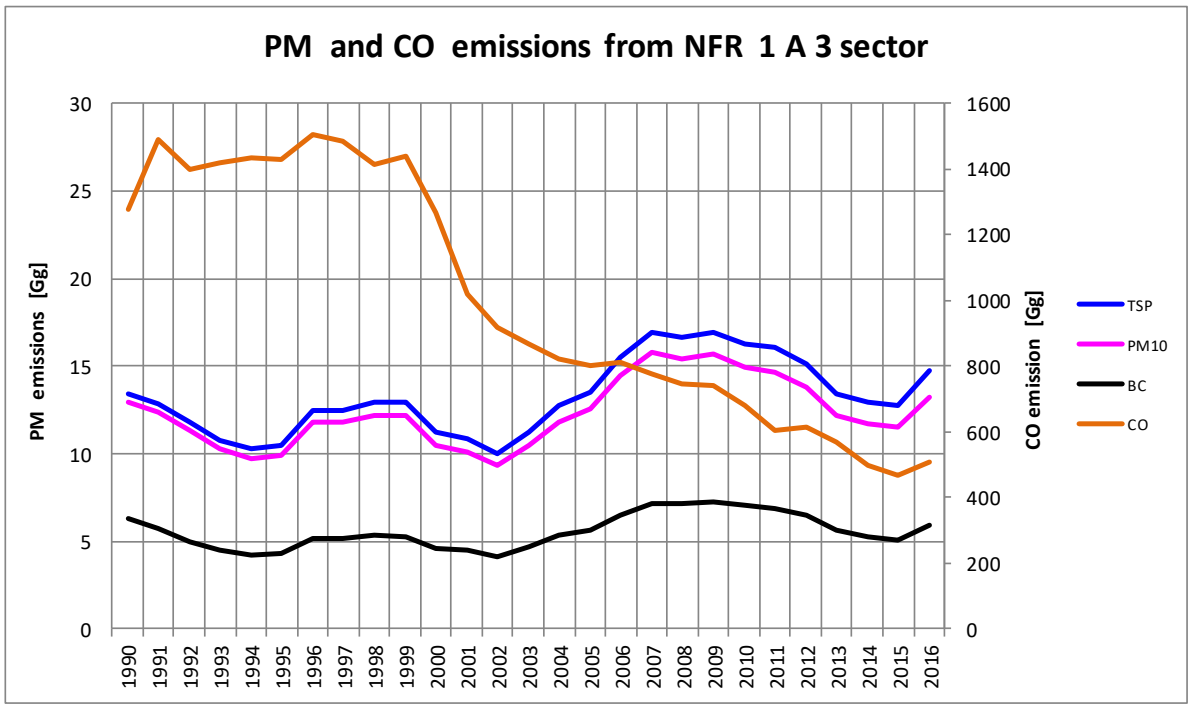

Figure 3.23. Particulates and CO emissions for 1.A.3 category in 1990-2016

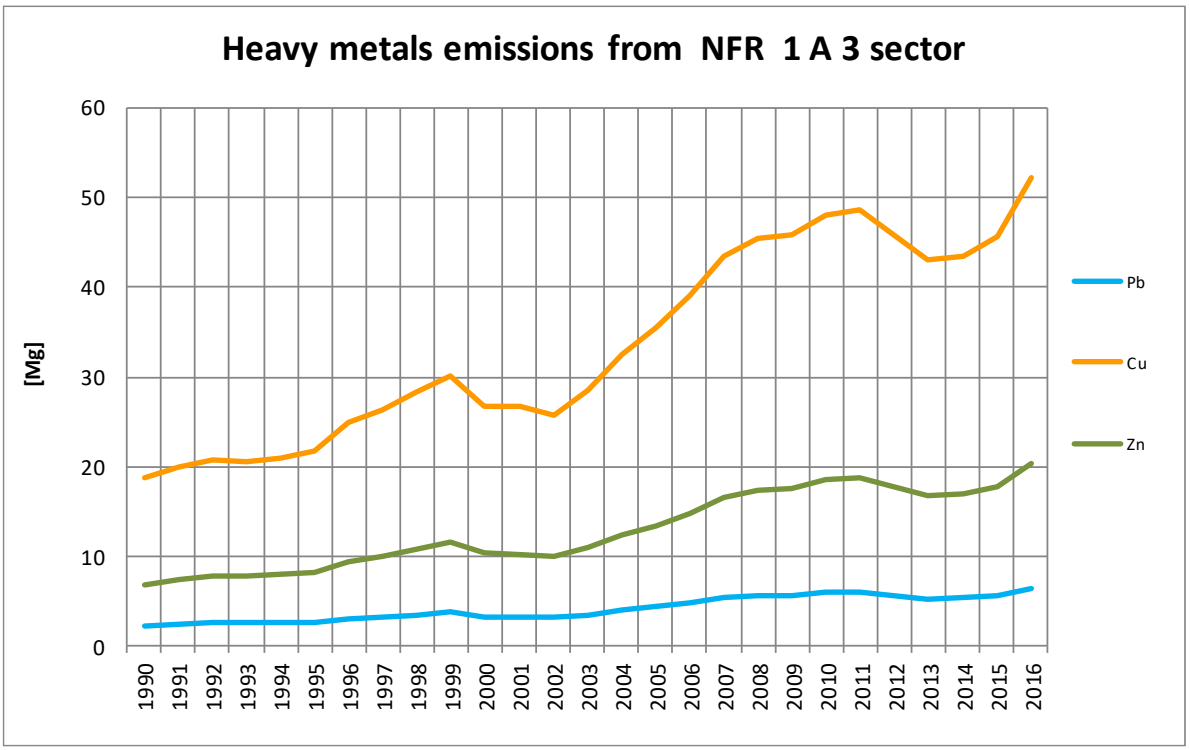

Figure 3.24. Pb, Cu and Zn emissions for 1.A.3 category in 1990-2016

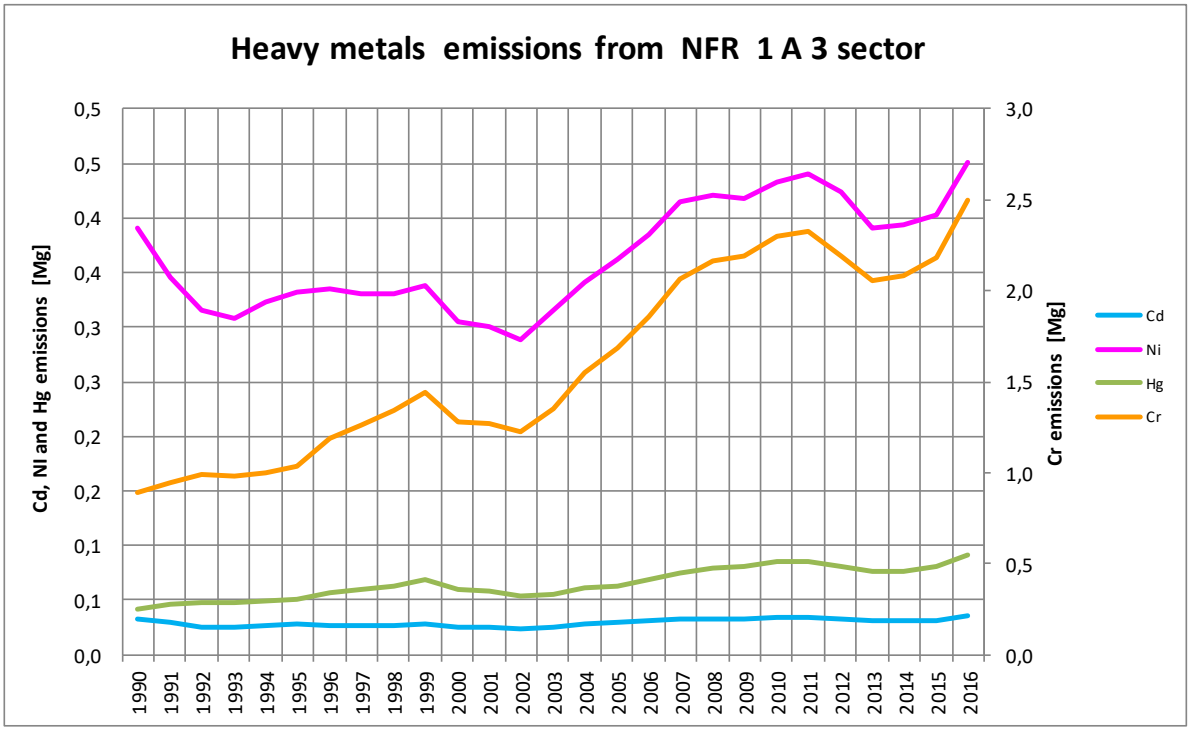

Figure 3.25. Cd, Ni and Cr emissions for 1.A.3 category in 1990-2016

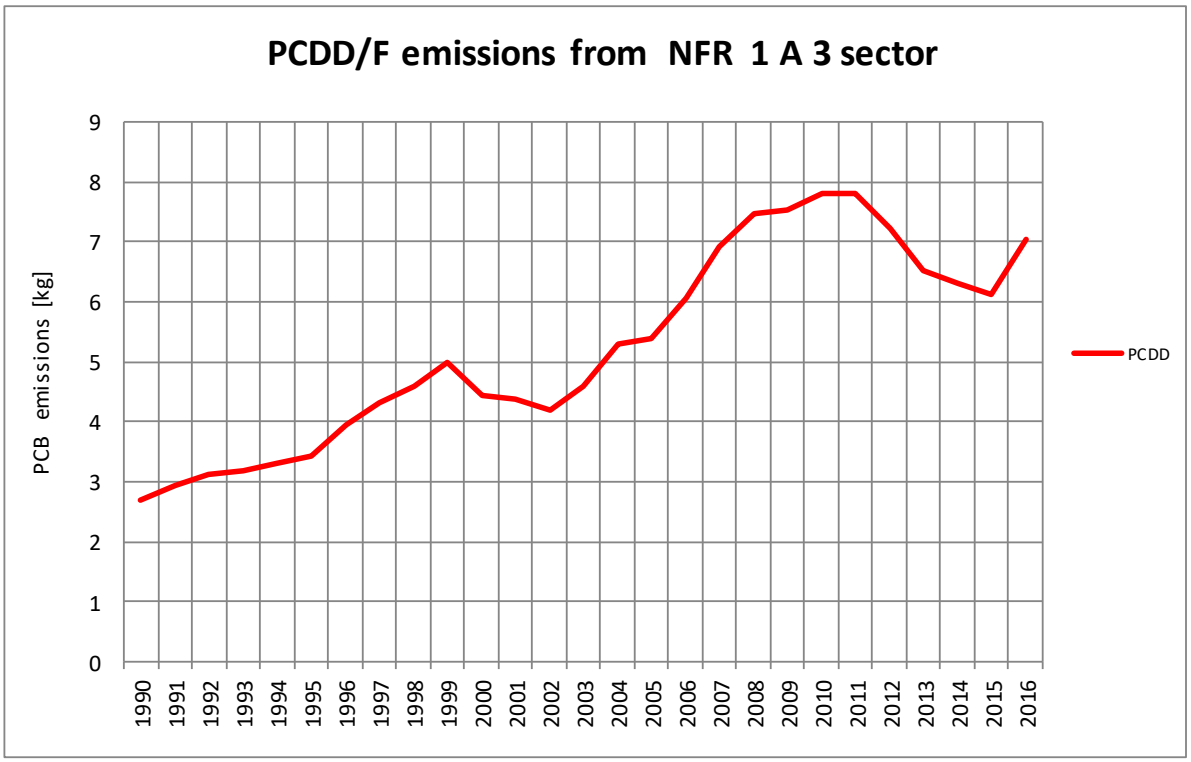

Figure 3.26. PCDD/F emissions for 1.A.3 category in 1990-2016

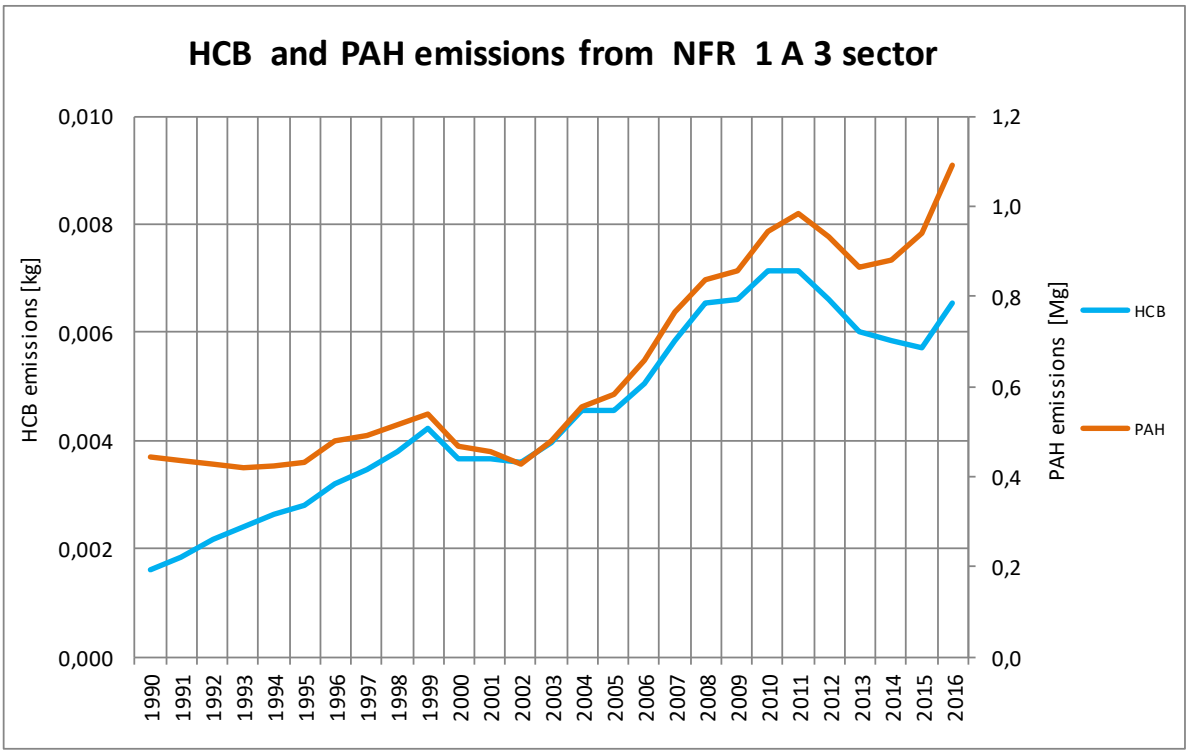

Figure 3.27. HCB and PAH emissions for 1.A.3 category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector *1.A.3* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

Table 3.17. Results of the uncertainty analysis for NFR sector *1.A.3*

NFR		NOx	NM VOC	SO_2	NH_3	CO	TSP	PM 10	PM 2.5	Pb	Cd	Hg	PCDD /F	HCB	PAH
1A3aii(i)	Domestic aviation LTO (civil)	50%	86%	30%		95%	73%	73%	73%						
1A3bi	Road transport: Passenger cars	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A3bii	Road transport: Light duty vehicles	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A3biii	Road transport: Heavy duty vehicles and buses	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A3biv	Road transport: Mopeds & motorcycles	70%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1A3bv	Road transport: Gasoline evaporation		70%												
1A3bvi	Road transport: Automobile tyre and brake wear						100%	100%	100%	70%	70%				
1A3c	Railways	50%	100%	30%	50%	100%	100%	100%	100%		50%		100%		100%
1A3dii	National navigation (shipping)	39%	76%	23%		72%	75%	75%	75%	100%	47%	100%	77%		77%
1A3ei	Pipeline transport	50%		70%											

Source-specific recalculations

Fuel consumption in 1990-2015 was corrected based on updated Eurostat database.
Road transport emission have been estimated and updated for the period 1990-2016, based on the country studies[47; 48; 49] and with the use of COPERT 5 software.

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

Source category description

Emissions in 1.A.4 *Other Sectors* are estimated for each fuel in detailed sub-categories given below:

- *Commercial/Institutional* (1.A.4.a)
- *Residential* (1.A.4.b)
- *Agriculture/Forestry/Fishing* (1.A.4.c)
  - agriculture – stationary sources,
  - agriculture – mobile sources: off-road vehicles and other machinery
  - fishing.

Shares of emissions from the 1.A.4 category in the country total for the particular pollutants in 2016 are shown on the figure 3.28. Subsector 1.A.4.b *Residential* is by far the largest contributor to emissions from this category.

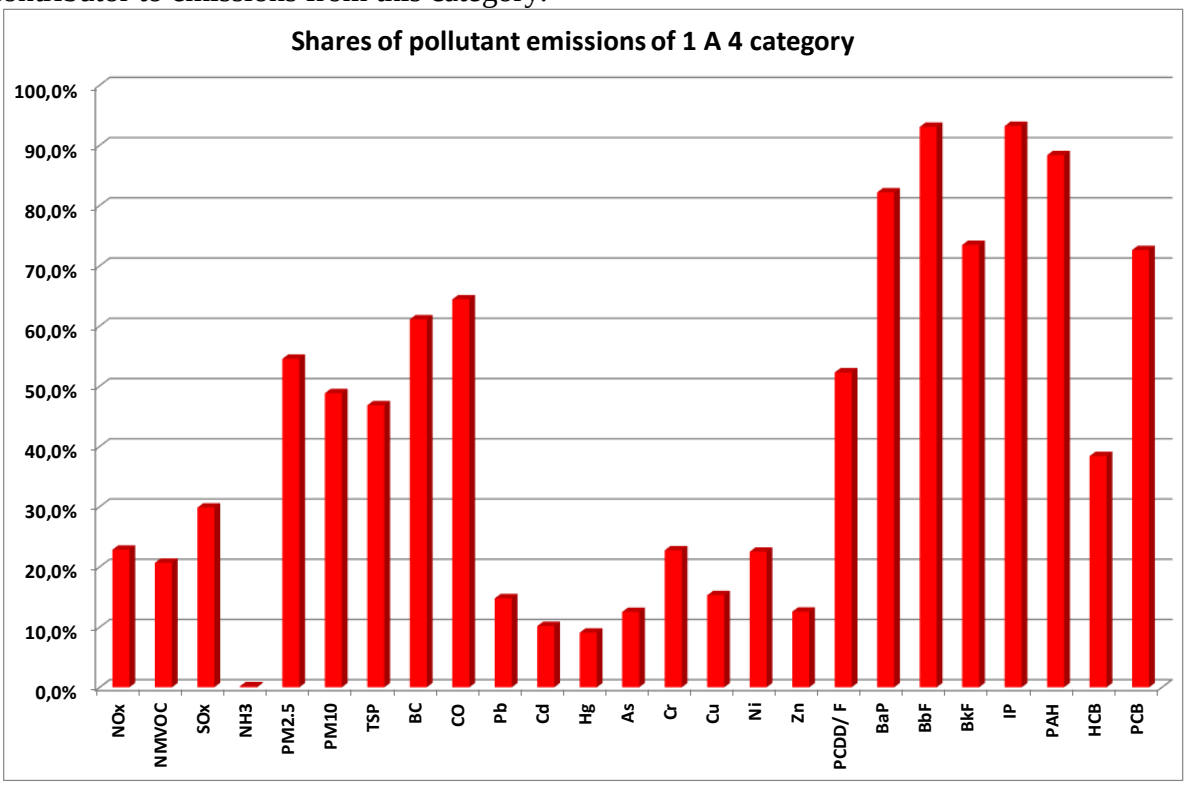

Figure 3.28. Shares of emissions from the 1.A.4 category in the country total

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 Appendix 1 and 3.

In 2017 the methodology of HM emission estimates for small emission sources (SNAP 02) has been verified, resulting in the new trend of emission factors [51; K. Kubica]. New emission factors are presented in the chapter 8.

3.6.1. 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.a i *Other Sectors – Commercial/Institutional* over the 1990-2016 period are presented in table A1.16 in Appendix 1. Applied emission factors are presented in Appendix 3.

3.6.2. 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.b i *Residential* over the 1990-2016 period are presented in table A1.17 in Appendix 1. Applied emission factors are presented in Appendix 3.

3.6.3. 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 1990-2016 period are presented in table A1.18 in Appendix 1. Applied emission factors are presented in Appendix 3.

3.6.4. 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 1990-2016 period are presented in table A1.19 in Appendix 1. Applied emission factors are presented in Appendix 3.

Emission trends for the NFR sector 1.A.4

Volumes and trend of pollutant emissions for 1.A.4 sector are shown below on figures 3.29 ÷ 3.34.

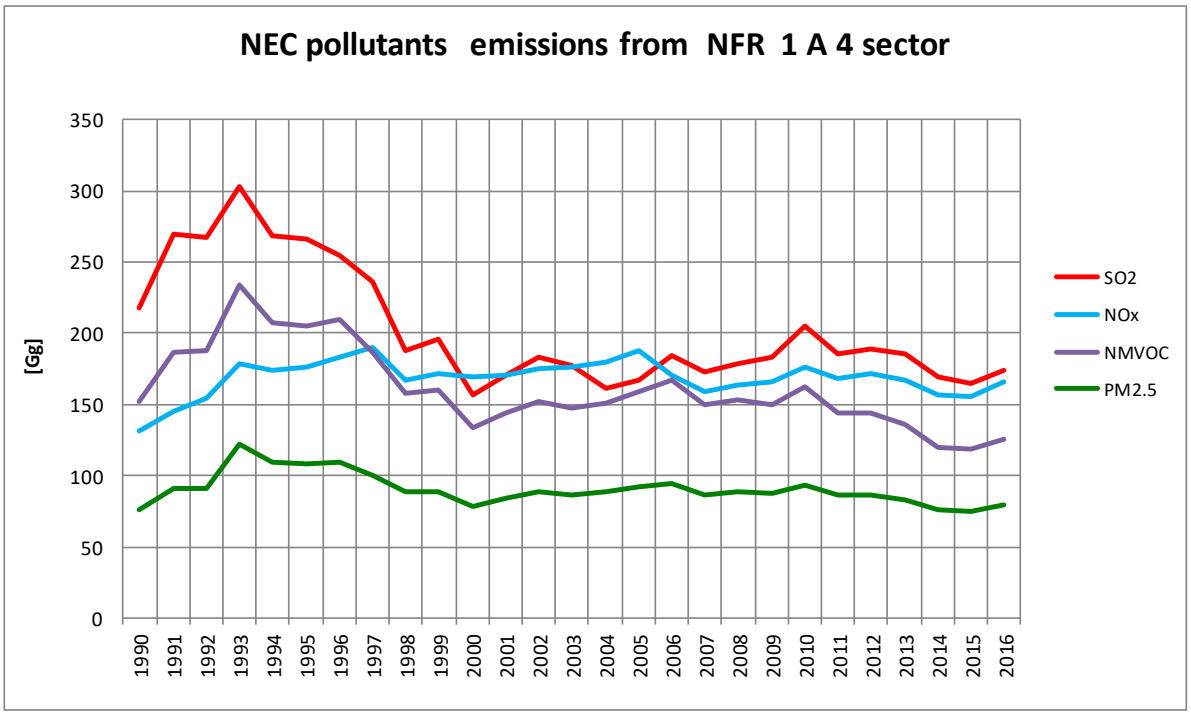

Figure 3-29. SO_2, NOx, PM2.5 and NMVOC emissions for 1.A.4 category in 1990-2016

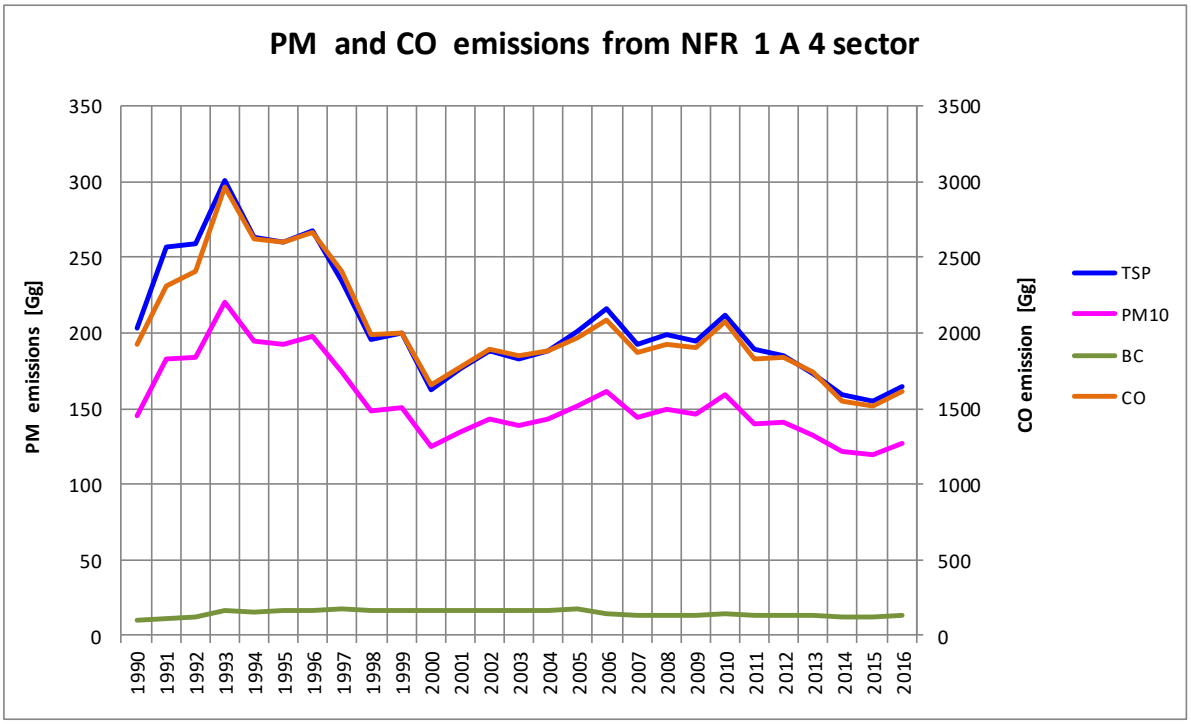

Figure 3-30. CO and particulates emissions for 1.A.4 category in 1990-2016

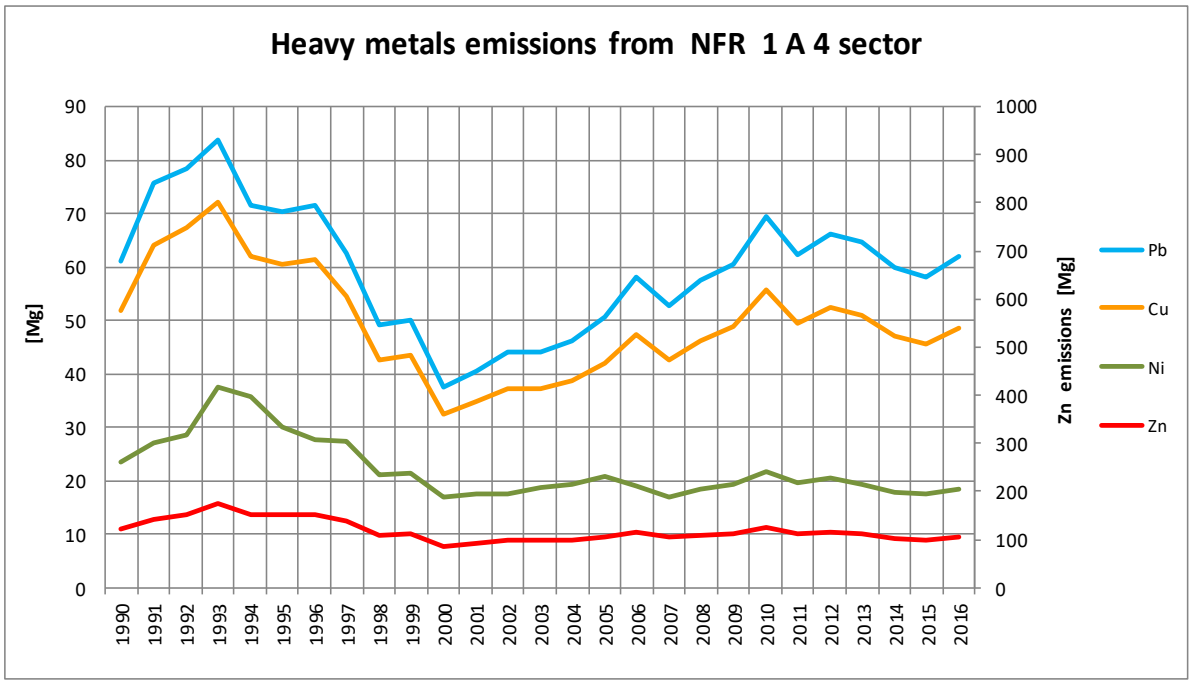

Figure 3-31. Pb, Cu, Zn and Ni emissions for 1.A.4 category in 1990-2016

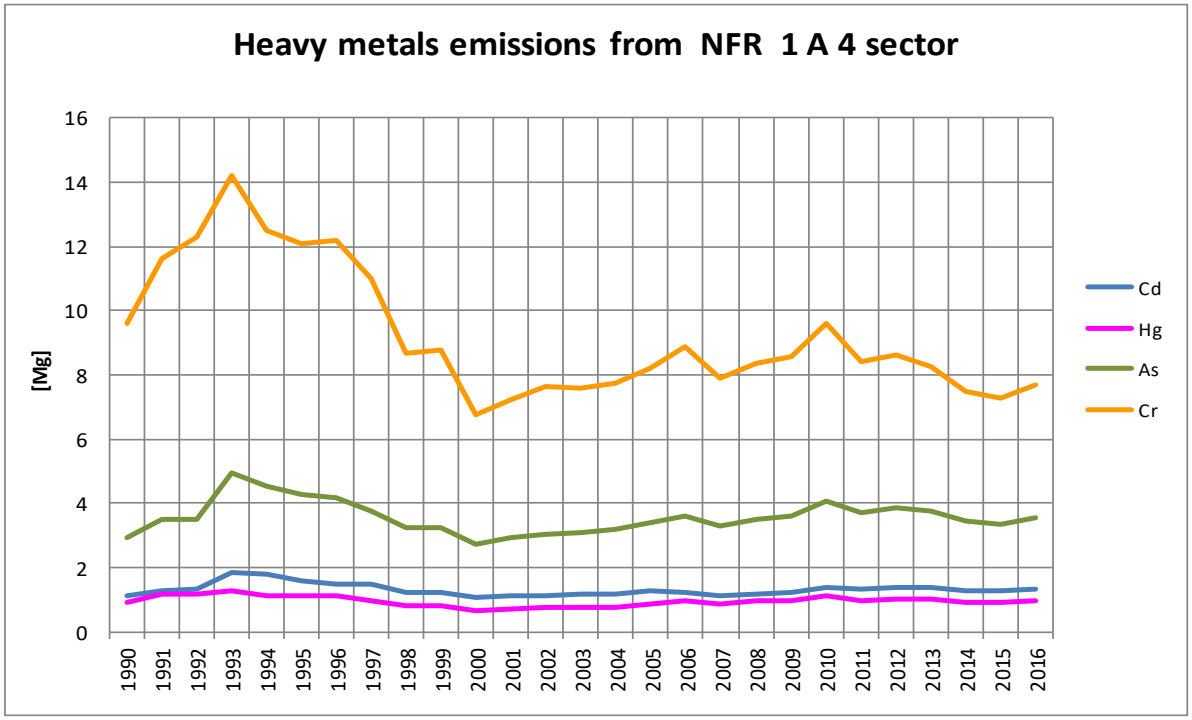

Figure 3-32. Cd, As, Hg and Cr emissions for 1.A.4 category in 1990-2016

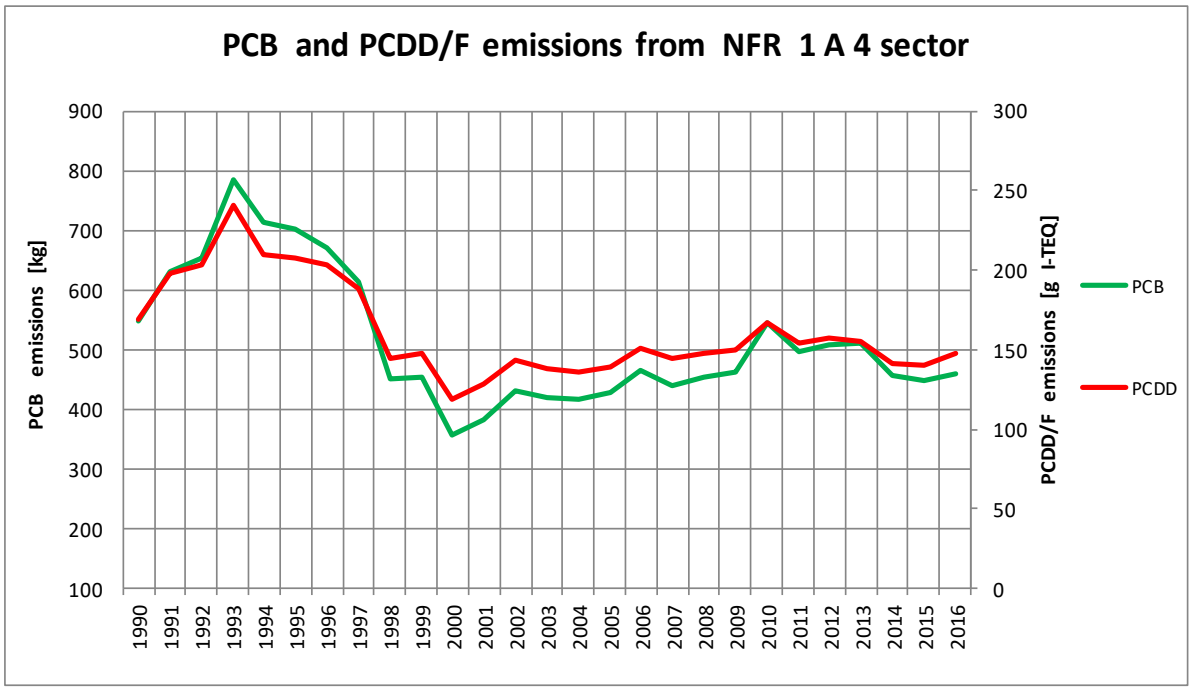

Figure 3-33. PCB and PCDD/F emissions for 1.A.4 category in 1990-2016

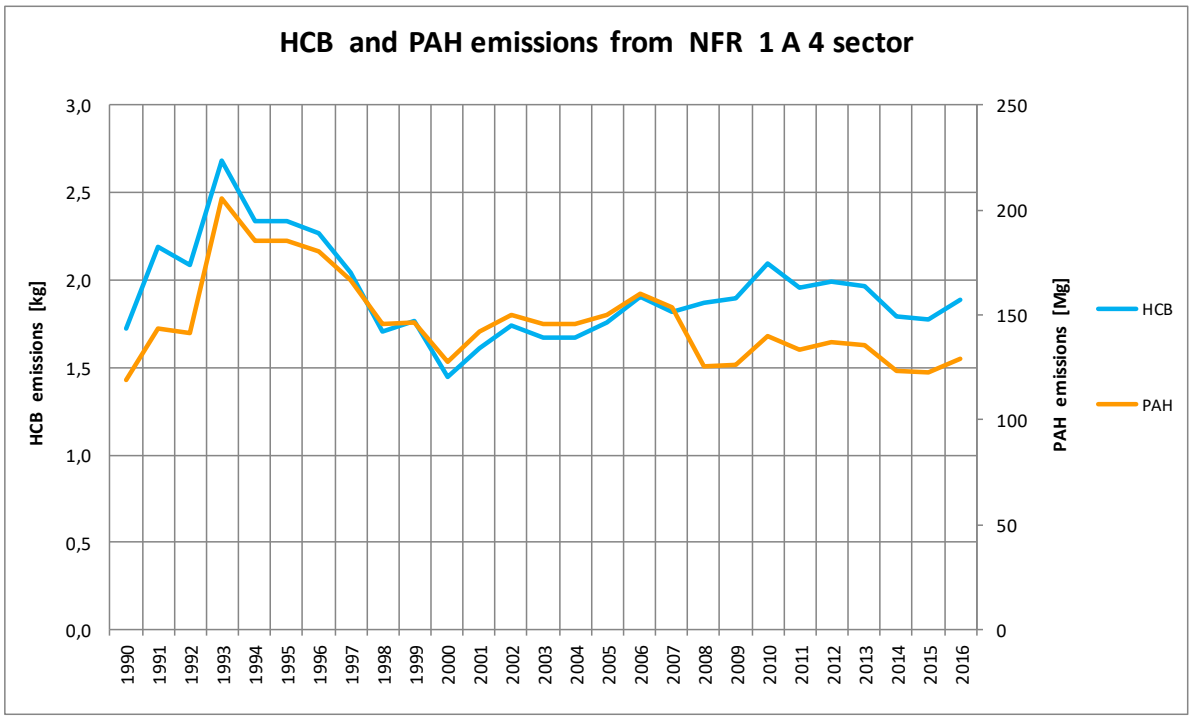

Figure 3-34. HCB and PAH emissions for 1.A.4 category in 1990-2016

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

Uncertainty analysis for the 2016 for NFR sector *1.A.4* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

Table 3.18. Results of the uncertainty analysis for NFR sector *1.A.4*

NFR		NOx	NM VOC	SO_2	NH_3	CO	TSP	PM 10	PM 2.5	Pb	Cd	Hg	PCDD /F	HCB	PAH
1A4ai	Commercial/institutional: Stationary	18%	37%	23%		35%	41%	40%	41%	63%	48%	58%	61%	76%	75%
1A4bi	Residential: Stationary	20%	36%	25%	43%	36%	39%	38%	35%	63%	46%	58%	76%	79%	70%
1A4ci	Agriculture/Forestry /Fishing: Stationary	23%	34%	24%		35%	41%	40%	35%	61%	54%	62%	93%	84%	70%
1A4cii	Agriculture/Forestry /Fishing: Off-road vehicles and other machinery	43%	77%	28%	46%	90%	91%	91%	91%		46%		91%		91%
1A4ciii	Agriculture/Forestry /Fishing: National fishing	37%	73%	25%		73%	73%	73%	73%		37%		100%		100%

Source-specific recalculations

Activity data on fuel consumption for years 1990-2015 were updated due to changes made in EUROSTAT database.
Emission factors for heavy metals have been verified and updated for the period 2000-2015, based on the country study [51].

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.4 category.

3.7. Fugitive emissions (NFR sector 1.B)

Overview of a sector

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 2016 are shown on the figure 3.35.

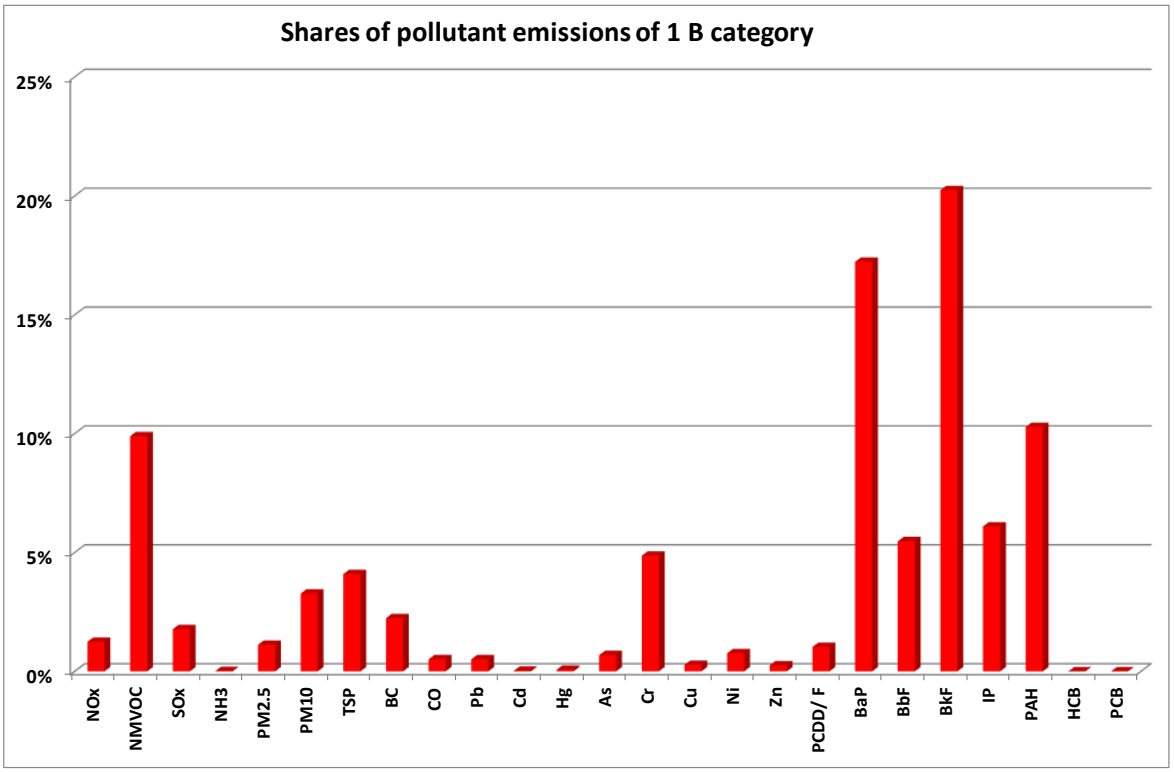

Figure 3.35. Shares of emissions from the 1 B category in the country total

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

Source category description

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.).

Activity data used in the sub-category 1.B.1 for the years 1990-2016 are presented in Table A2.1 in Appendix 2. Applied emission factors are presented in Appendix 3.

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

Source category description

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 1990-2016 are presented in Table A2.2 in Appendix 2. Applied emission factors are presented in Appendix 3.

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. Table A2.3 in Appendix 2 presents the activity data used in the sub-category 1.B.2 b for the years 1990-2016. Emission factors used in the sub-category 1.B.2 b are presented in Appendix 3.

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

Pollutant emissions from flaring in *Flaring in oil refinery* were estimated based on throughput as activity data. Table A2.2 in Appendix 2 presents the activity data used in the sub-category 1.B.2 c for the years 1990-2016. Emission factors used in the sub-category 1.B.c b are presented in Appendix 3.

Source-specific planned improvements

Gathering activity data for flaring in oil and gas extraction.

Emission trends for the NFR sector 1.B

Volumes and trend of pollutant emissions for 1.B sector are shown below on figures 3.36 ÷ 3.40.

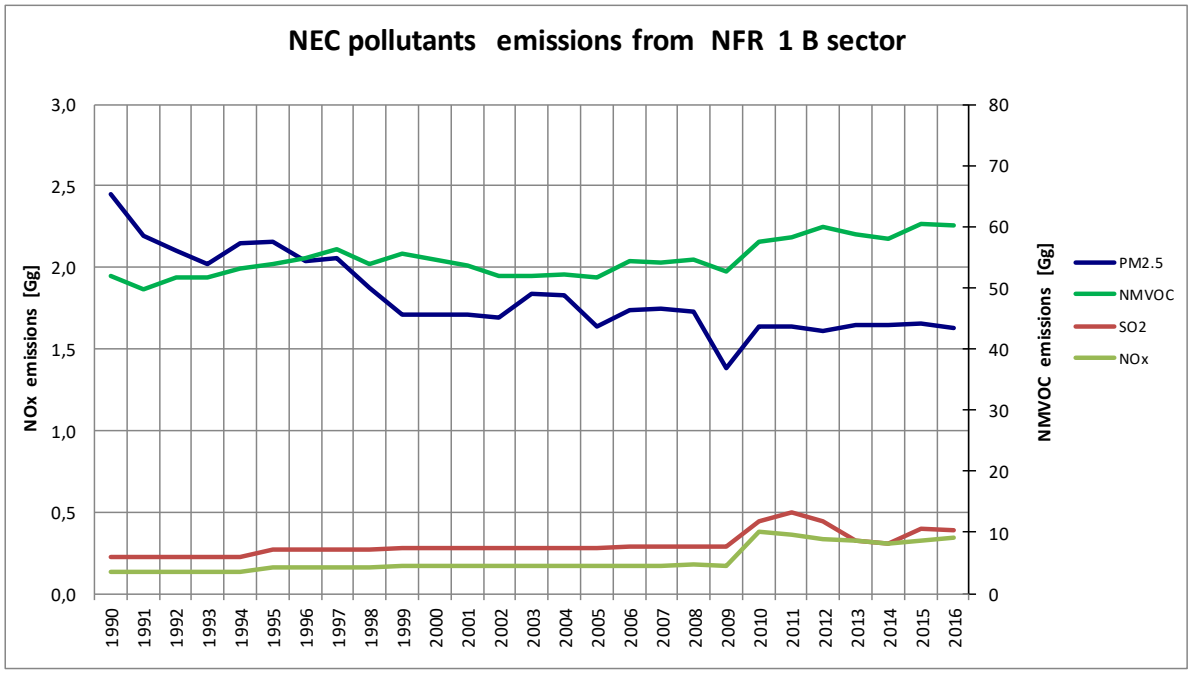

Figure 3-36. NMVOC, SO2, NOx and PM2.5 emissions for 1.B category in 1990-2016

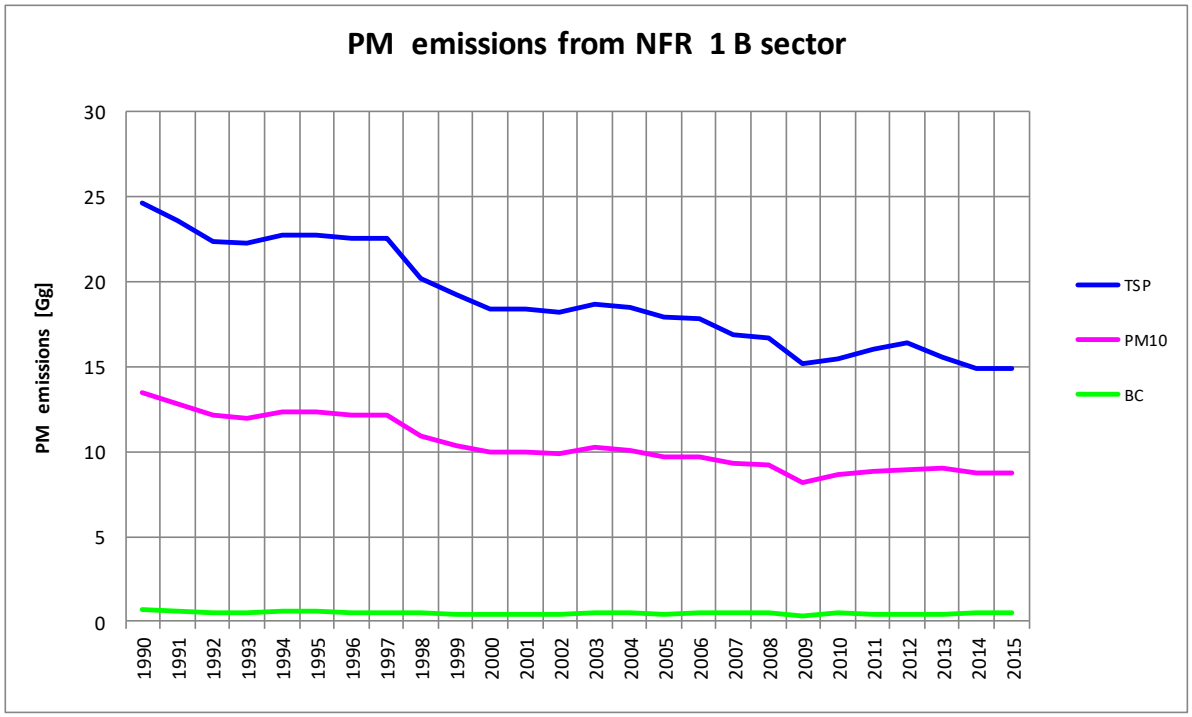

Figure 3-37. Particulates emissions for 1.B category in 1990-2016

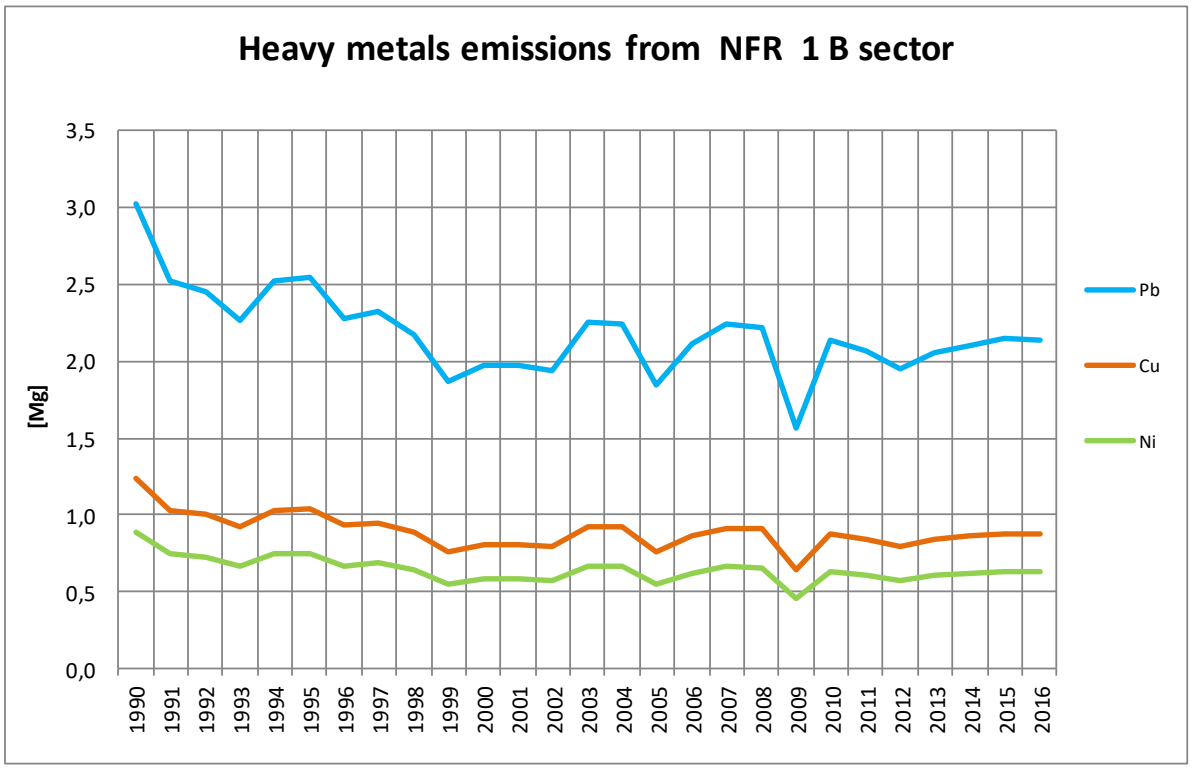

Figure 3-38. Pb, Cu and Ni emissions for 1.B category in 1990-2016

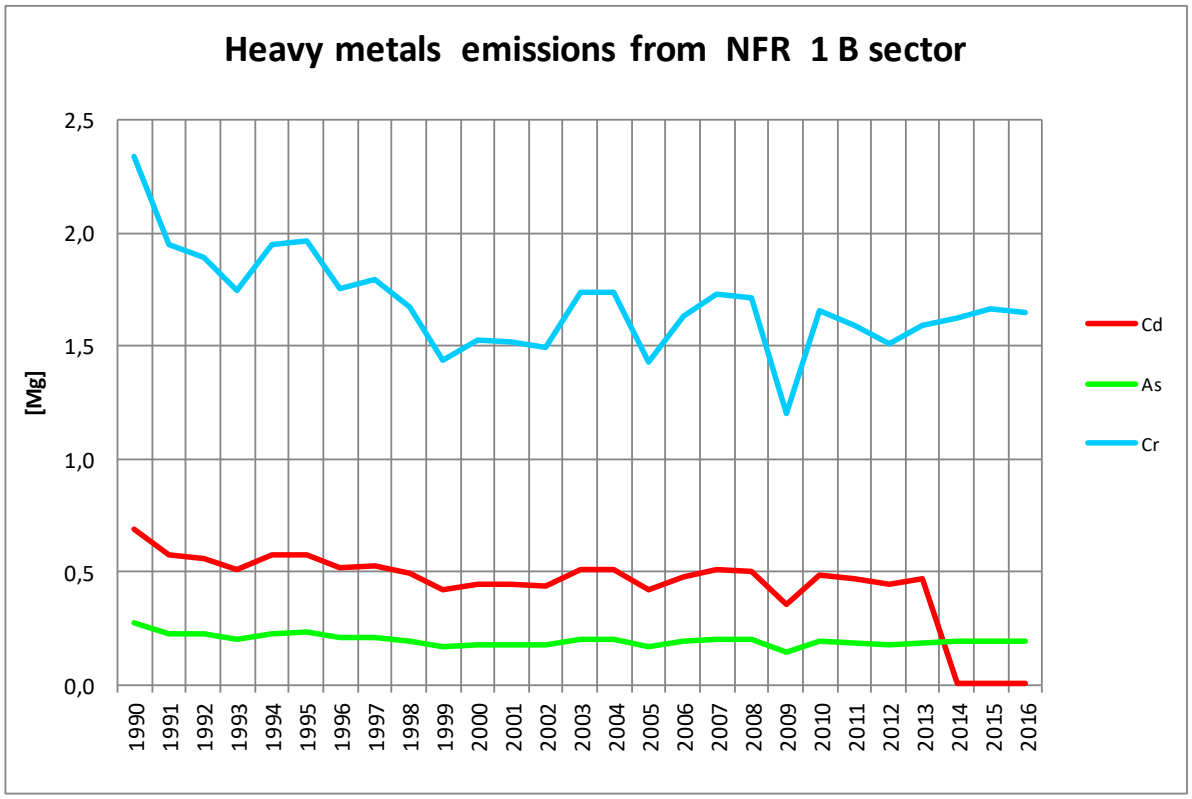

Figure 3-39. Cd, As and Cr emissions for 1.B category in 1990-2016

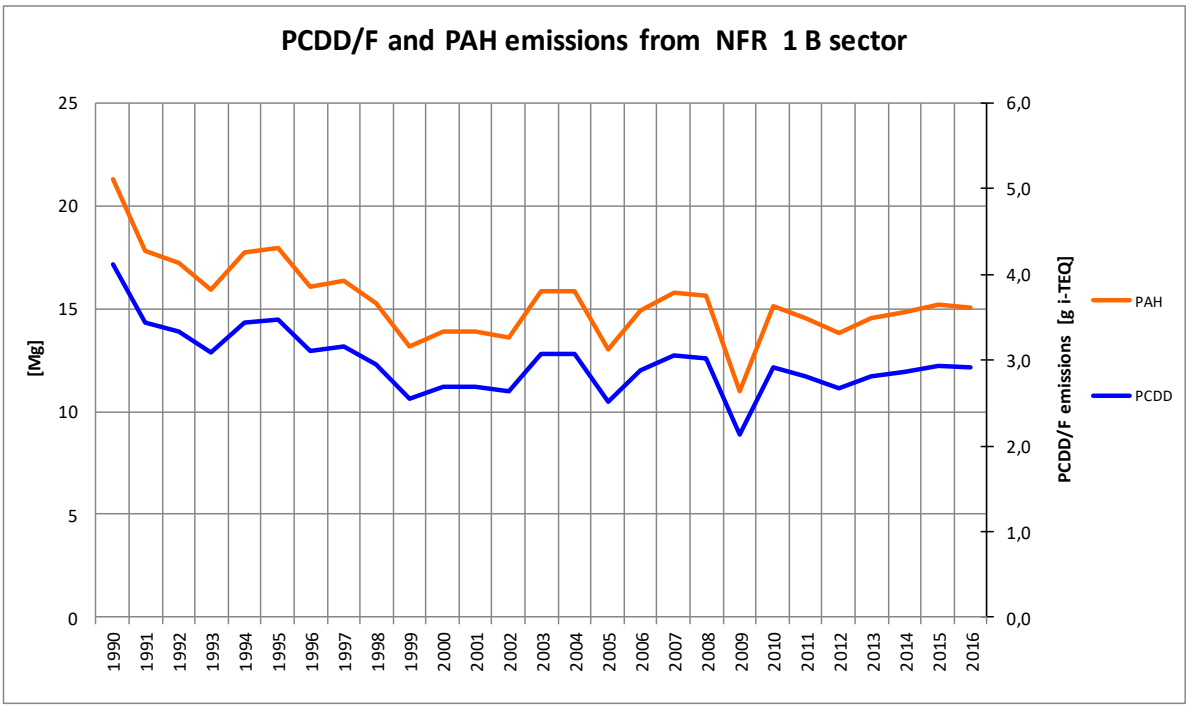

Figure 3-40. PCDD/F and PAH emissions for 1.B category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector *1.B* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

Table 3.19. Results of the emission uncertainty analysis for NFR sector *1.B*

NFR		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%		NA	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		44%									
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)		33%									

4. Industrial processes (NFR sector 2)

Source category description

The following subcategories from sector 2 have been included in the pollutant inventory:

- 2.A. Mineral Products
- 2.B. Chemical Industry
- 2.C. Metal Production
- 2.D. Solvent use
- 2.G. Other product use
- 2.H1. Pulp and paper industry
- 2.H2. Food and beverages industry
- 2.I. Wood processing
- 2.L. Other – bulk products.

Shares of emissions from the NFR 2 category in the country total for the particular pollutants in 2016 are shown on the figure 4.1.

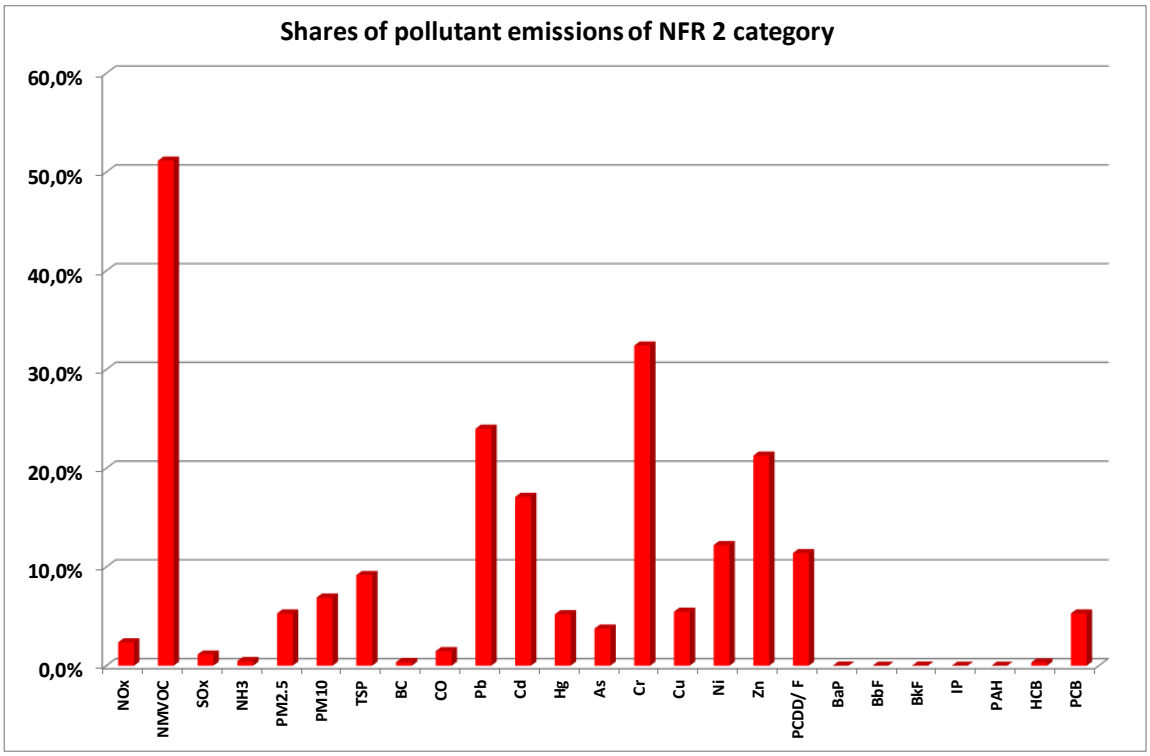

Figure 4.1. Shares of emissions from the NFR 2 category in the country total

4.1. Mineral Products (NFR sector 2.A)

Source category description

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

- *Cement Production* (2.A.1)
- *Lime Production* (2.A.2)
- *Gypsum Production* (2.A.2)
- *Glass production* (2.A.3)

– *Quarrying and mining of minerals other than coal* (2.A.5 a)
– *Construction and demolition* (2.A.5 b).

Shares of emissions from the NFR 2 A category in the country total for the particular pollutants in 2016 are shown on the figure 4.2.

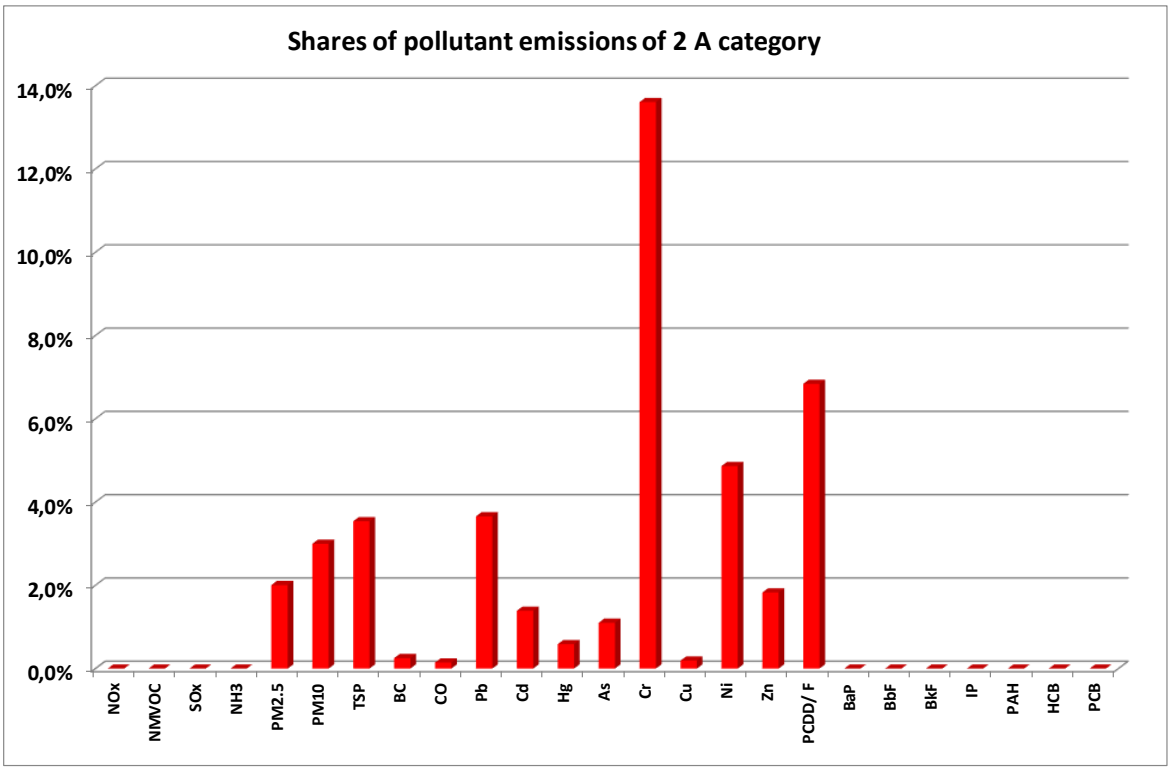

Figure 4.2. Shares of emissions from the NFR 2 A category in the country total

This category corresponds to a part of the category SNAP 0406.
Activity data for this sector come from GUS statistical yearbooks. Table A2.4 in Appendix 2 presents the activity data used in the sub-category 2.A - *Mineral Products* for the years 1990-2016.
To estimate emissions default emission factors are used. Applied emission factors for subcategory 2.A are presented in Appendix 3.

Emission trends for the NFR sector 2.A

Volumes and trend of pollutant emissions for *Mineral Products* is shown below on figures 4.3 and 4.4.

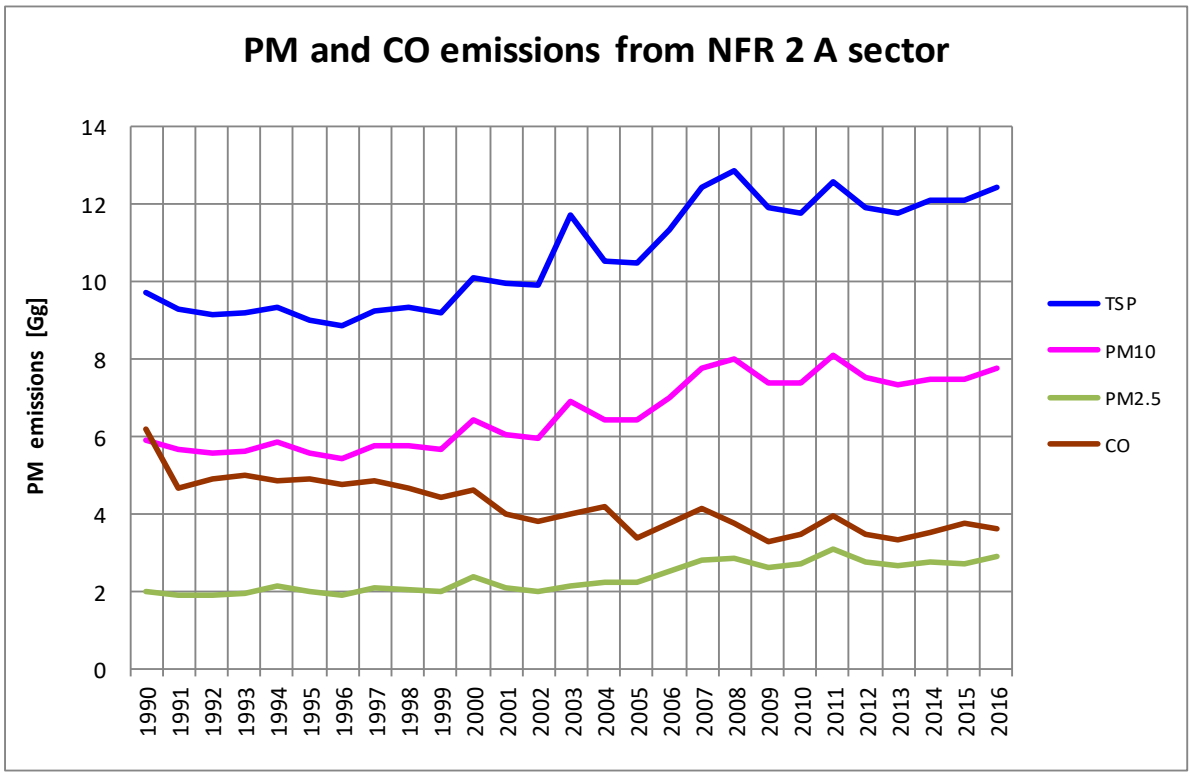

Figure 4.3. Particulates and CO emissions for 2.A category in 1990-2016

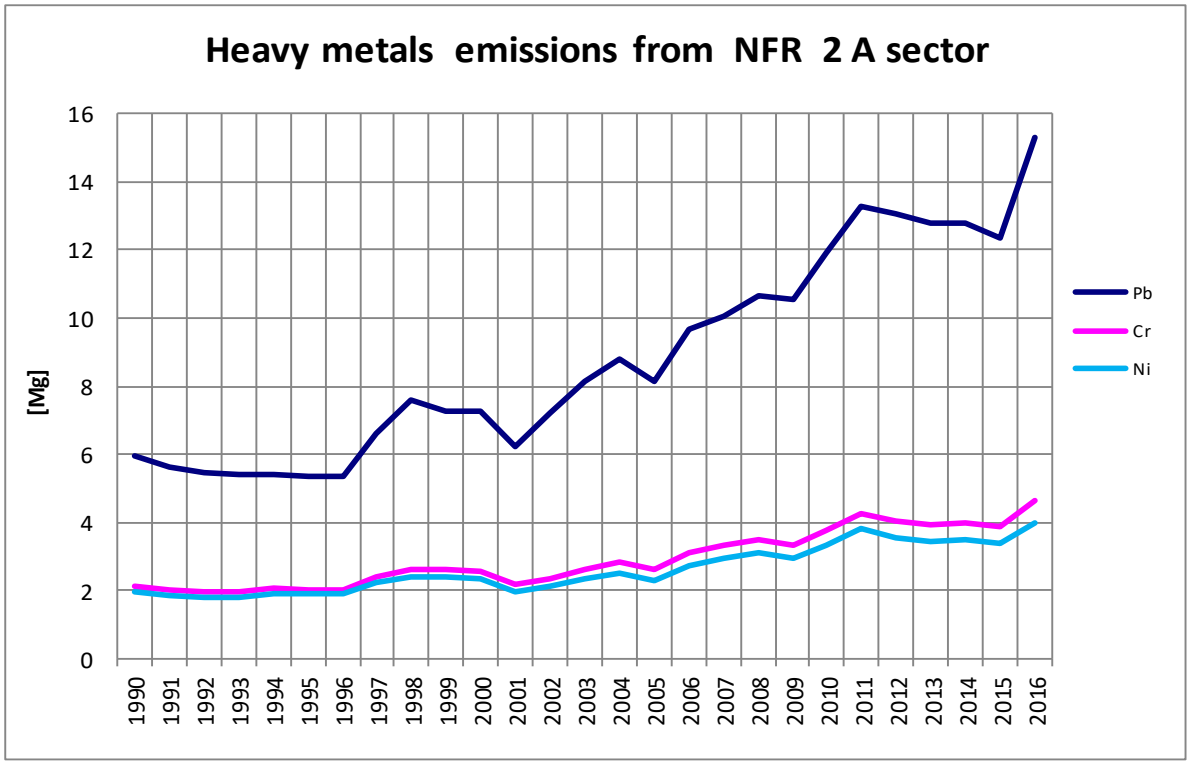

Figure 4.4. Pb, Cr and Ni emissions for 2.A category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector 2.*A* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

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

NFR		CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F
		%	%	%	%	%	%	%	%
2A1	Cement production		1	30	30	70			
2A2	Lime production	50	50	50	50				100
2A3	Glass production	36	50	50	50	70	70	70	72
2A5a	Quarrying and mining of minerals other than coal		47	47	47				
2A5b	Construction and demolition		50	50	50				

4.2. Chemical Industry (NFR sector 2.B)

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)
- *Carbide Production* (2.B.5)
- *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, chlorine production (Mercury cell)
- *Storage, handling and transport of chemical products* (2.B 10 b).

This category corresponds to categories SNAP 0404, SNAP 0405 and SNAP 040617.
Shares of emissions from the 2 B category in the country total for the particular pollutants in 2016 are shown on the figure 4.5.
Activity data for this sector come from GUS statistical yearbooks [GUS 2017e]. Table A2.5 in Appendix 2 presents the activity data used in the sub-category 2.B - *Chemical Industry* for the years 1990-2016.

To estimate emissions domestic and default emission factors are used. Applied emission factors for subcategory 2.B are presented in Appendix 3. 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 table A3.138 in the Appendix 3.

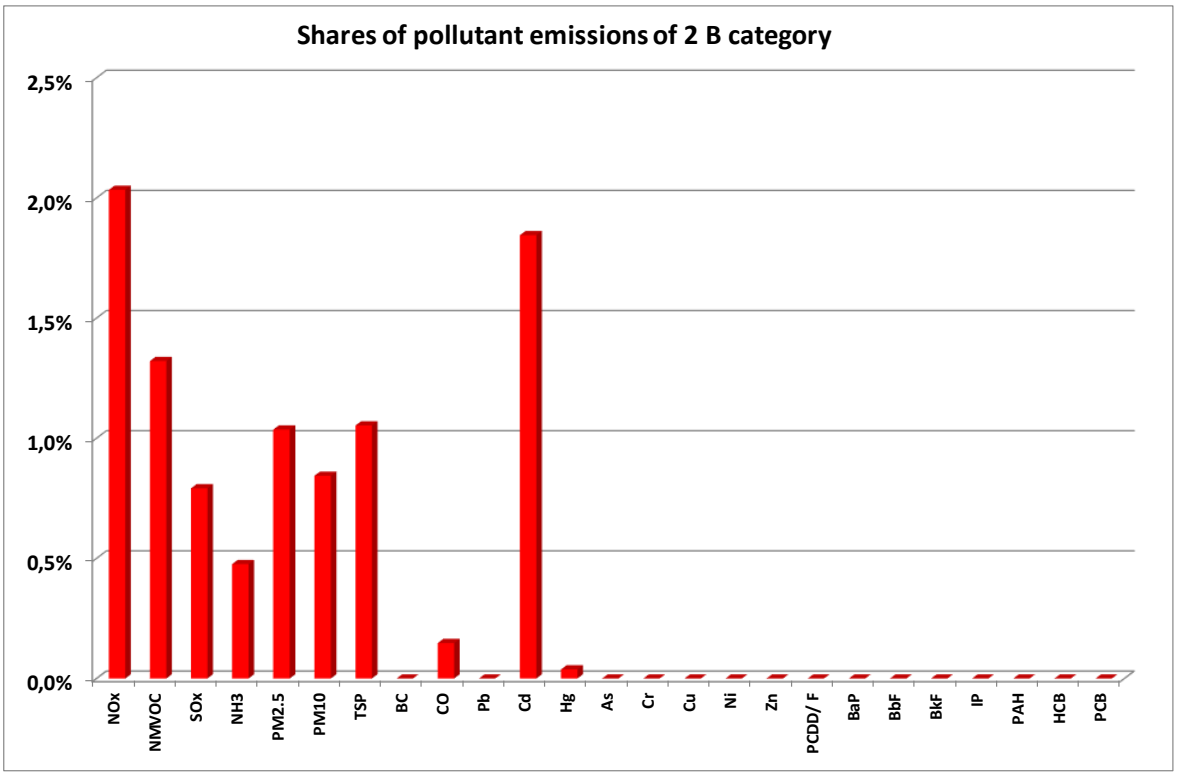

Figure 4.5. Shares of emissions from the 2 B category in the country total

Emission trends for the NFR sector 2.B

Volumes and trend of pollutant emissions for *Chemical Industry* are shown below on figures 4.6 ÷ 4.8.

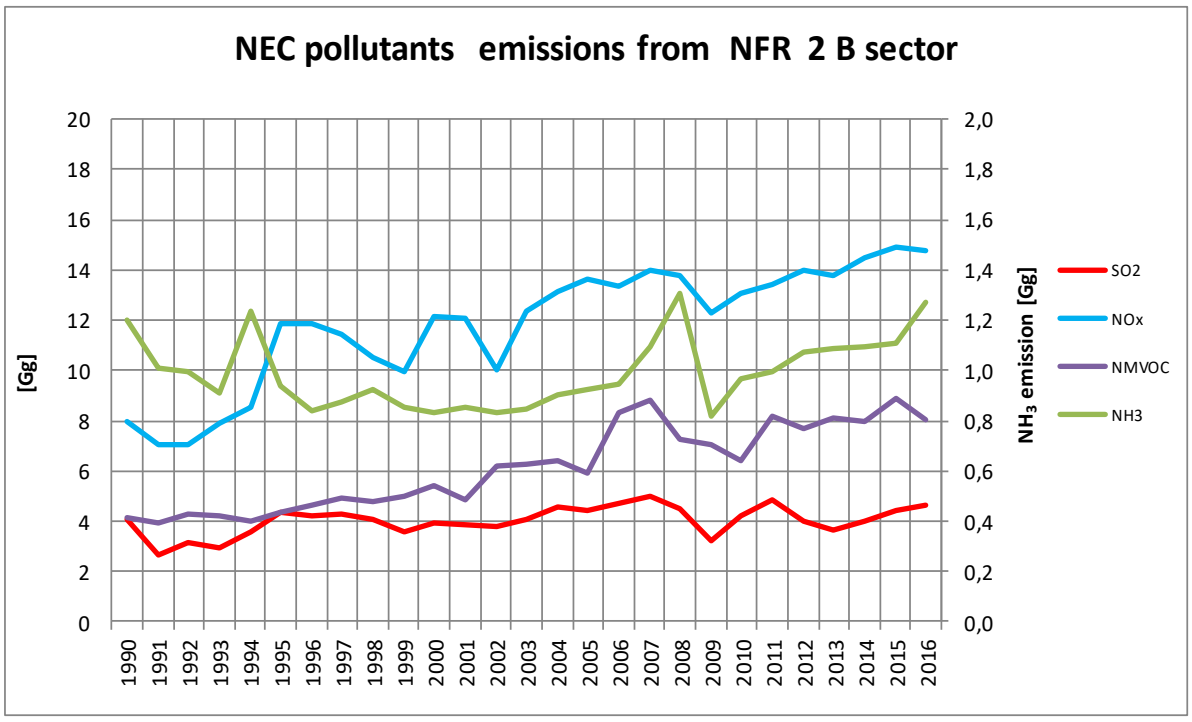

Figure 4.6. SO_2, NOx, NH_3 and NMVOC emissions for 2.B category in 1990-2016

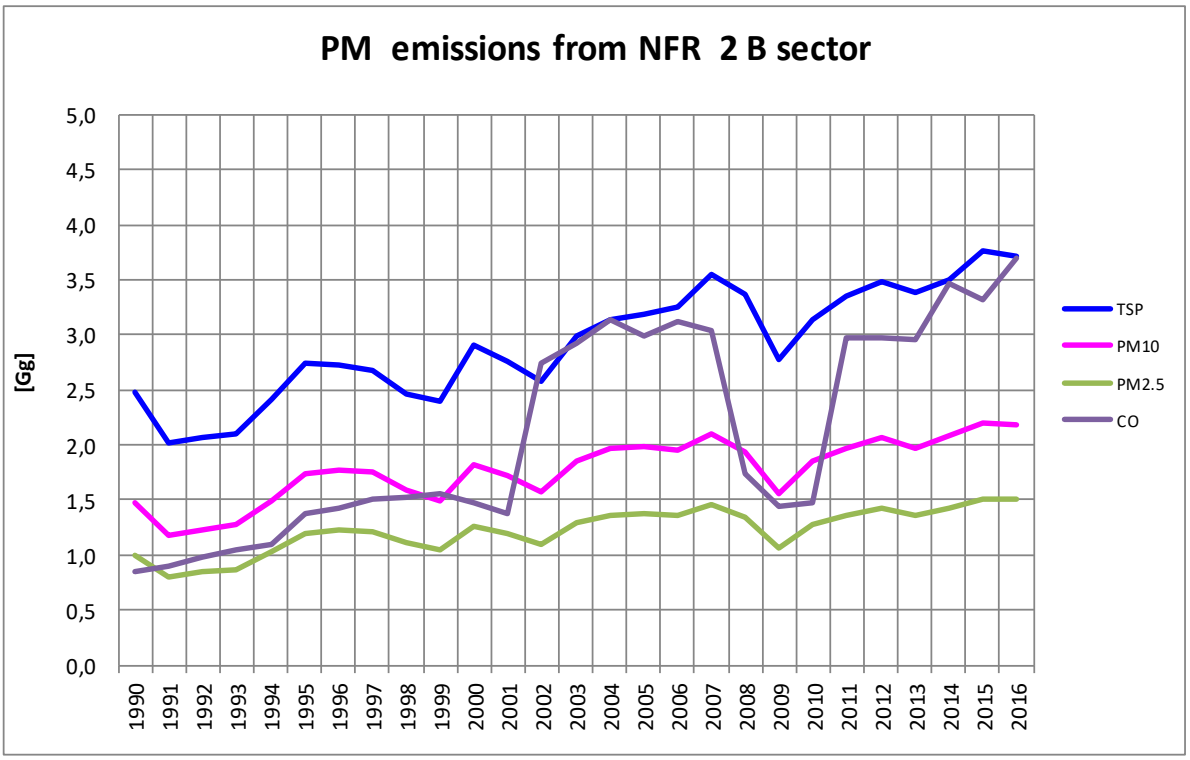

Figure 4.7. Particulates emissions for 2.B category in 1990-2016

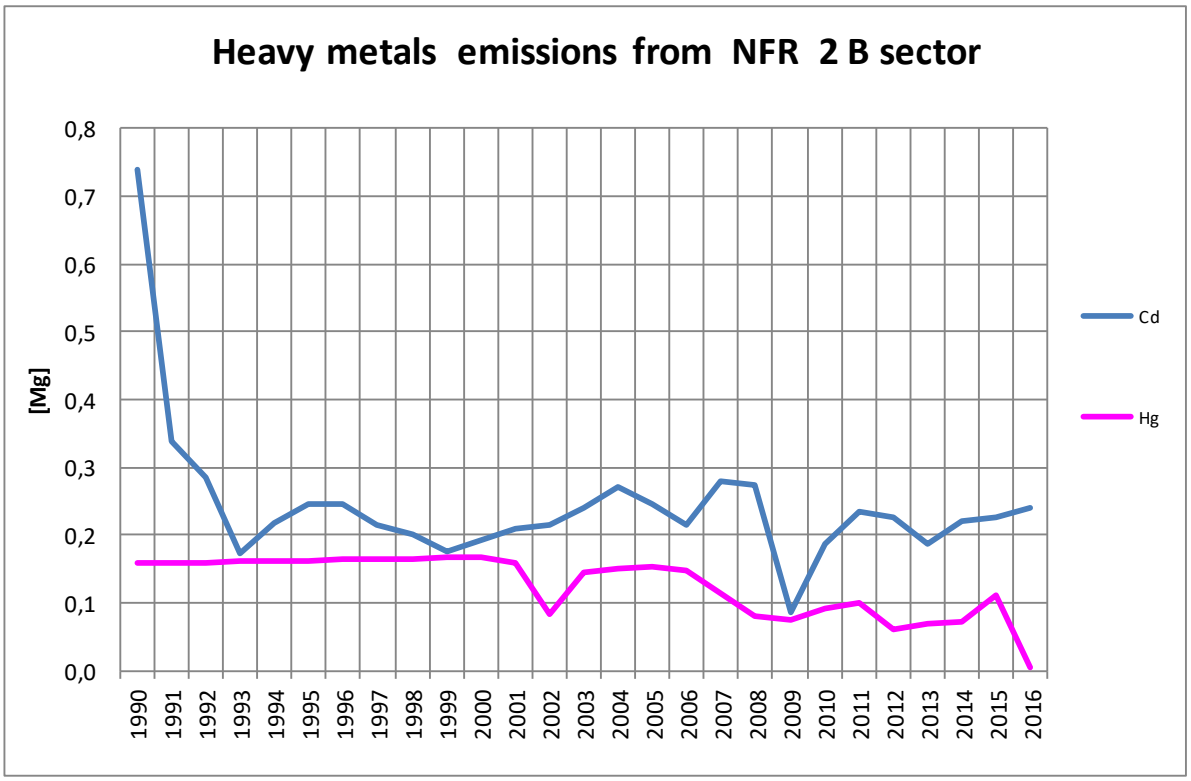

Figure 4.8. Cd and Hg emissions for 2.B category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector 2.*B* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

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

NFR		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									
2B6	Titanium dioxide production	30		30			50				
2B7	Soda ash production				50		50				
2B10a	Chemical industry: Other	24	22	24		48	7	49	50	70	10
2B10b	Storage, handling and transport of chemical products						139	139	139		

4.3. Metal Production (NFR sector 2.C)

Source category description

This category corresponds to categories SNAP 0402 and SNAP 0403. Estimation of emissions in 2.C. *Metal Production* are carried out in sub-categories listed below:

- Iron and Steel Production (2.C.1)
- Ferroalloys Production (2.C.2)
- Aluminium Production (2.C.3)
- Lead production, including batteries (2.C.5)
- Zinc production (2.C.6)
- Copper production (2.C.7 a).

Shares of emissions from the 2 C category in the country total for the particular pollutants in 2016 are shown on the figure 4.9.

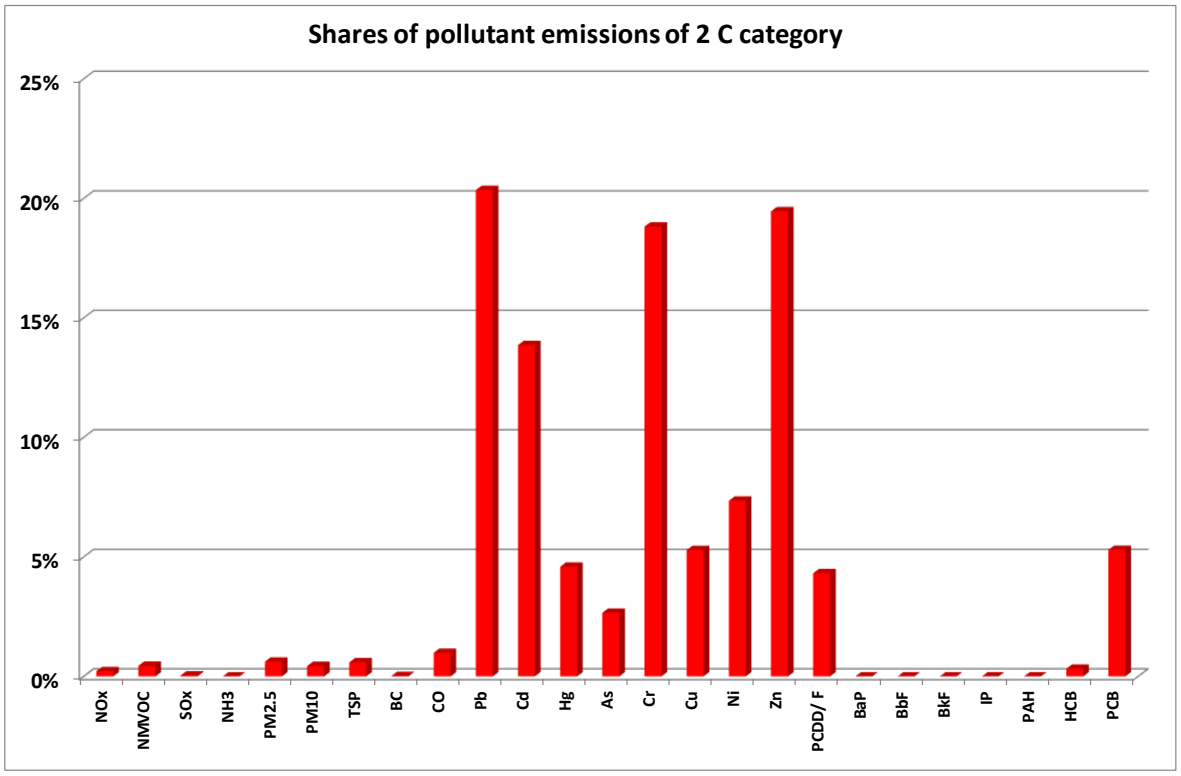

Figure 4.9. Shares of emissions from the 2 C category in the country total

Activity data for this sector come from statistical yearbooks [GUS 2017e].
Table A2.6 in Appendix 2 presents the activity data used in the sub-category 2.C - *Metal Production* for the years 1990-2016.

To estimate emissions domestic and default emission factors are used. Applied emission factors for subcategory 2.C are presented in Appendix 3.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish 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 tables A3.147 and A3.148 in the Appendix 3

- 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 tables A3.53 and A3.147 in the Appendix 3.

- 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 tables A3.144 and A3.147 in the Appendix 3.

Heavy metals emissions from Zinc production (2.C.6) and Copper production (2.C.7 a) are included with combustion processes in 1 A 2 b category.

Emission trends for the NFR sector 2.C

Volumes and trend of pollutant emissions for *Metal Production* are shown below on figures 4.10 ÷ 4.15.

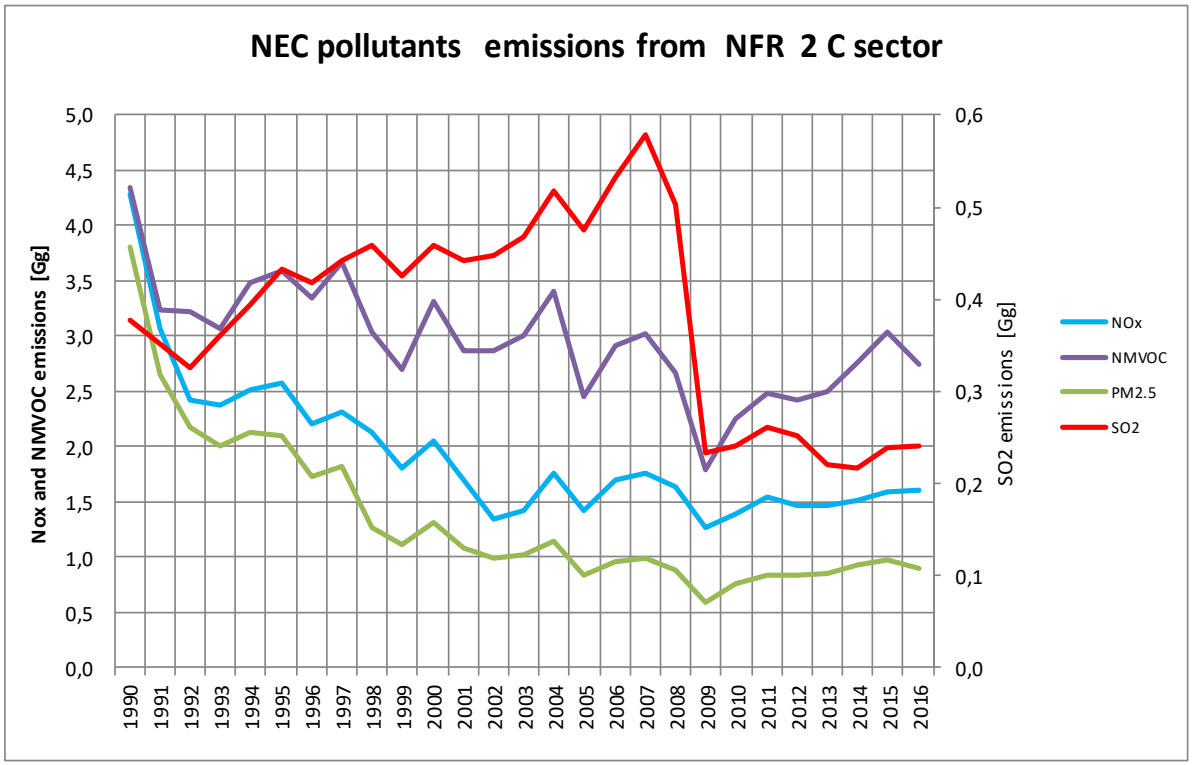

Figure 4.10. SO_2, NOx, PM2.5 and NMVOC emissions for 2.C category in 1990-2016

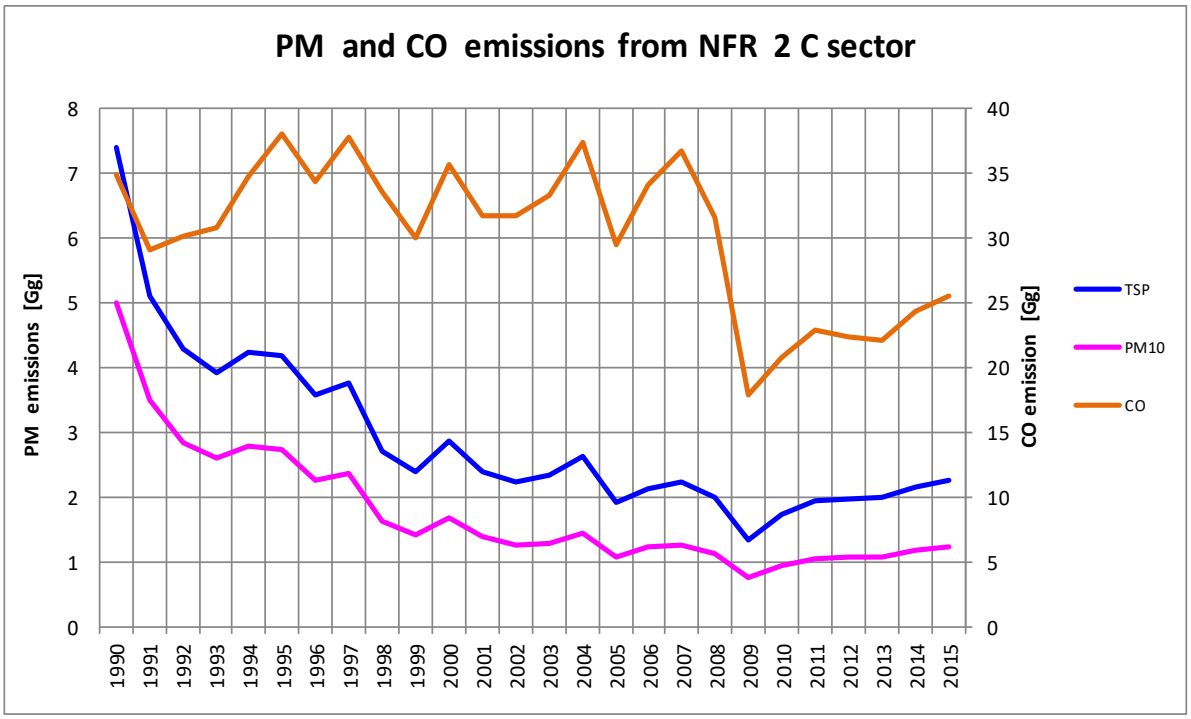

Figure 4.11. CO and particulates emissions for 2.C category in 1990-2016

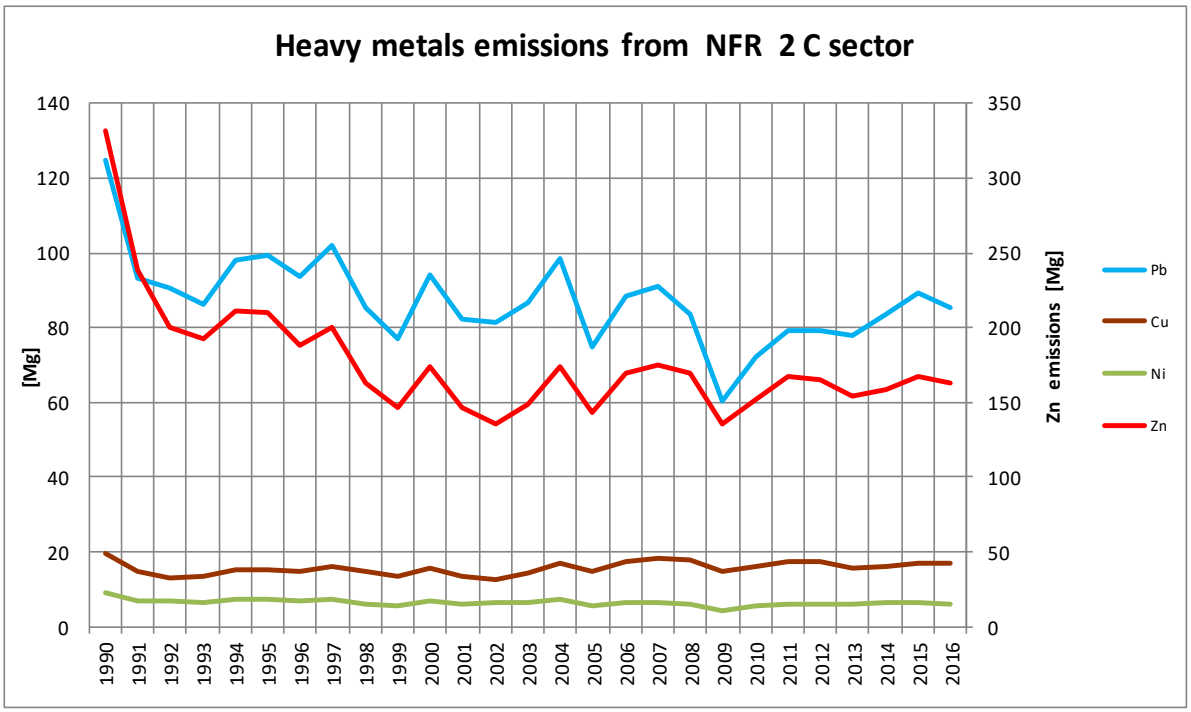

Figure 4.12. Pb, Cu, Ni and Zn emissions for 2.C category in 1990-2016

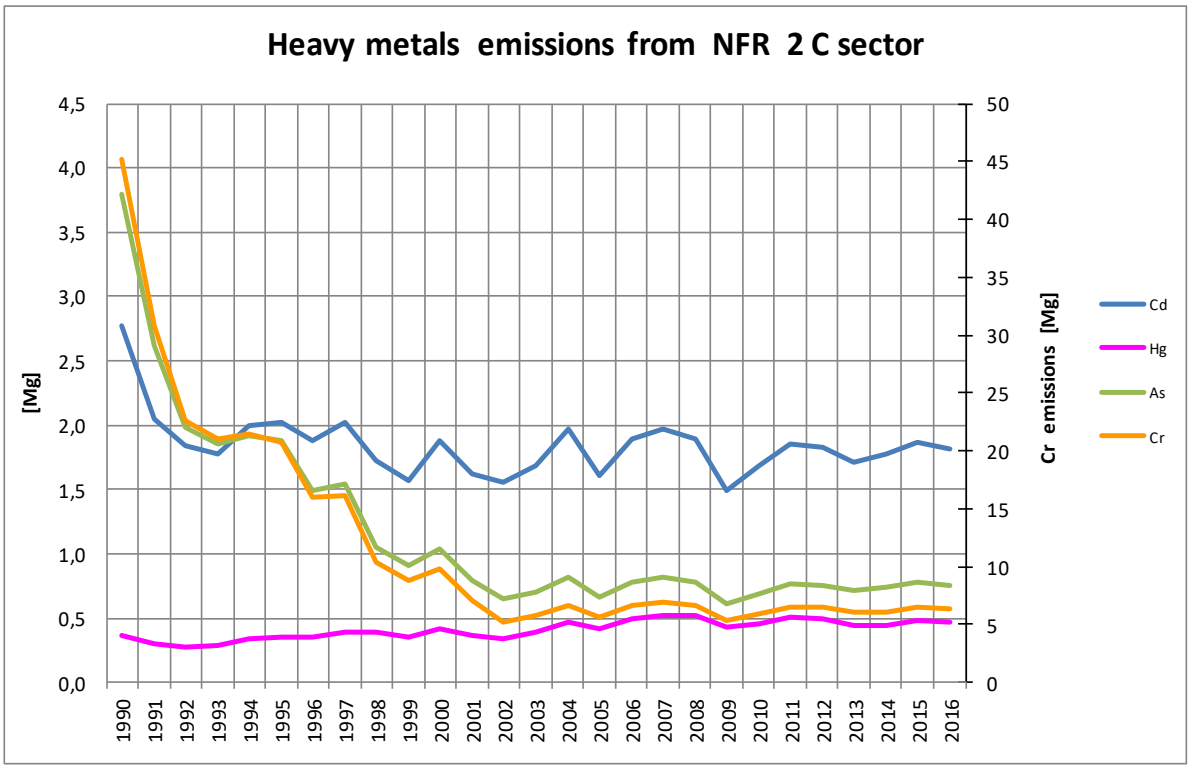

Figure 4.13. Cd, Hg, As and Cr emissions for 2.C category in 1990-2016

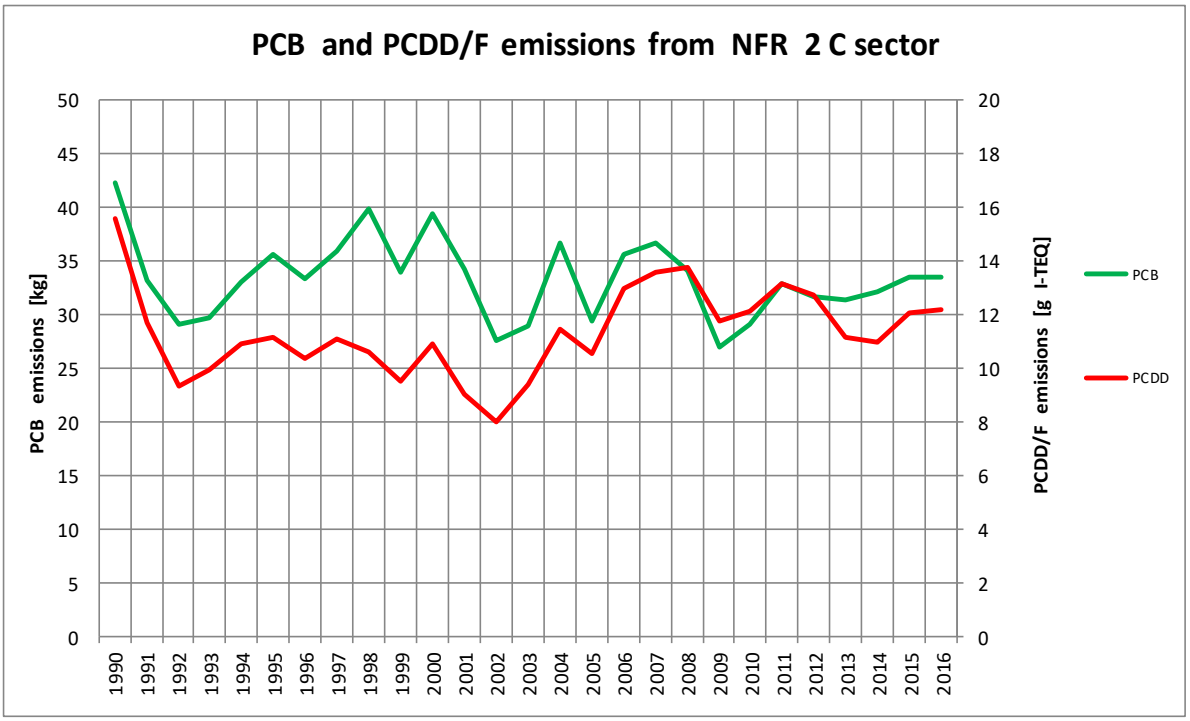

Figure 4.14. PCB and PCDD/F emissions for 2.C category in 1990-2016

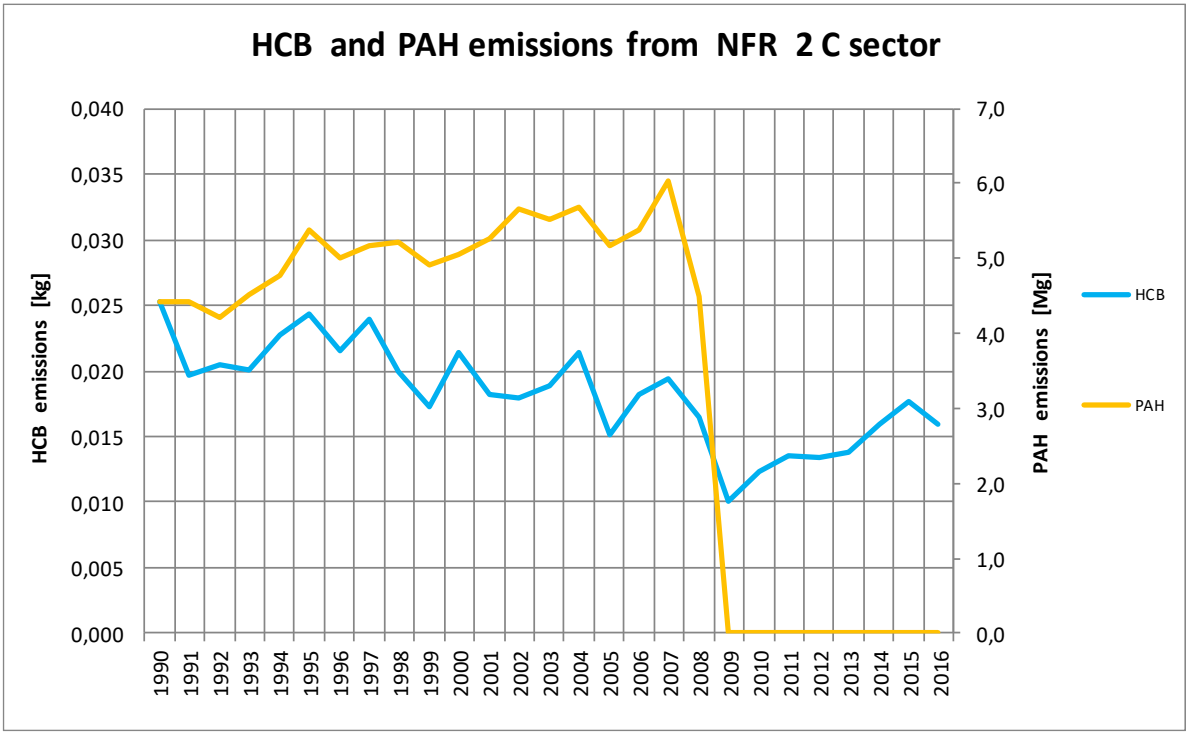

Figure 4.15. HCB and PAH emissions for 2.C category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector 2.*C* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

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

NFR		NO_x	NMVOC	SO_x	CO	TSP	PM 10	PM 2.5	Pb	Cd	Hg	PCDD/F	HCB
		%	%	%	%	%	%	%	%	%	%	%	%
2C1	Iron and steel production	20	21	30	39	8	12	11	27	39	59	99	71
2C2	Ferroalloys production					50			70				
2C3	Aluminum production					50	50	50					
2C5	Lead production					50	50	50	70				

4.4. Solvents Use (NFR sector 2.D)

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 2016 are shown on the figure 4.16.

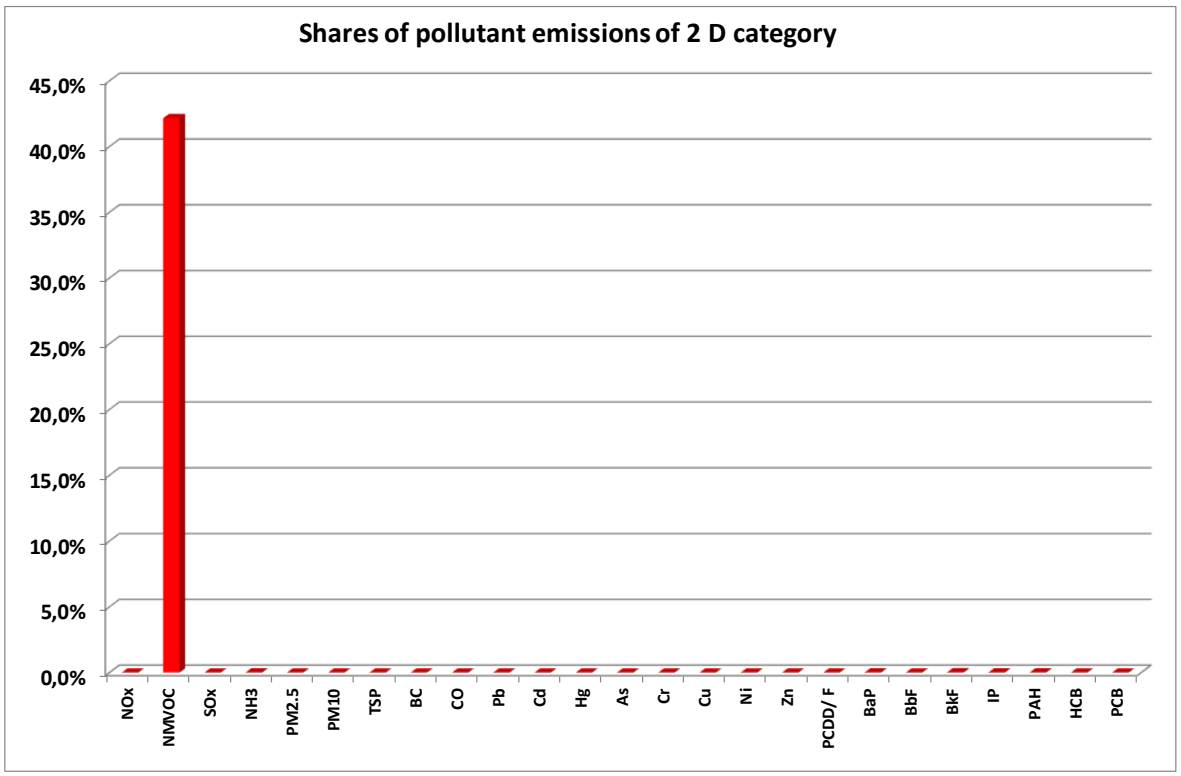

Figure 4.16. Shares of emissions from the 2.D category in the country total

This category corresponds to categories SNAP 06 and SNAP 040610.
Activity data for this sector come from statistical yearbook [GUS 2017e] and import-export balances. Tables A2.7 ÷ A2.12 in Appendix 2 present the activity data used in the sub-category 2.D for the years 1990-2016. 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 Appendix 3.

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

- in the category *Domestic solvent use* (NFR 2.D.3.a) and *Dry cleaning* (NFR 2.D.3.f) the trend of population (as activity data) has been verified and corrected;

- NMVOC emission factor for the *Road paving with asphalt* (NFR 2.D.3.b) has been applied from the EMEP/EEA EIG 2016. This change resulted in a small increase of NMVOC emissions from this activity. Applied new emission factors are presented in the table A3.155 in the Appendix 3.

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.).

The emission inventory for *Chemical products* till 2017 included emissions from the following processes: polyvinylchloride processing, polystyrene foam processing, rubber processing, pharmaceutical products manufacturing and paints manufacturing.
Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory NMVOC emissions from the category *Chemical products* (NFR 2.D.3.g) has been supplemented by the following products: tyres and shoes. Emission factors have been applied from the EMEP/EEA EIG 2016. This change resulted in a small increase of NMVOC emissions from this category. Applied new emission factors are presented in the table A3.158 in the Appendix 3.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory NMVOC emissions from the category *Printing* (NFR 2.D.3.h) has been added for the product *Printing Inks*. Emission factor has been applied from the EMEP/EEA EIG 2016. This change resulted in an increase of NMVOC emissions from this category. Applied new emission factor is presented in the table A3.159 in the Appendix 3.

In the category *Other solvent use* till 2017 included emissions from the following processes: oil extraction (production of fats and oils) and preservation of wood.
Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory NMVOC emissions from the category *Other solvent use* (NFR 2.D.3.i) has been supplemented by the following products: glues and adhesives. Emission factor has been applied from the EMEP/EEA EIG 2016. This change resulted in a small increase of NMVOC emissions from this category. Applied new emission factors are presented in the table A3.160 in the Appendix 3.
For *Preservation of wood* (NFR 2.D.3.i) resulting in PAH emissions there was a temporary expert estimate of 8,5 Gg activity every year.

Source-specific QA/QC and verification

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

Source-specific planned improvements

Development and update of NMVOCs emissions methodology to be continued.

Emission trends for the NFR sector 2.D

Volumes and trend of pollutant emissions for *Solvent use* is shown below on figure 4.17.

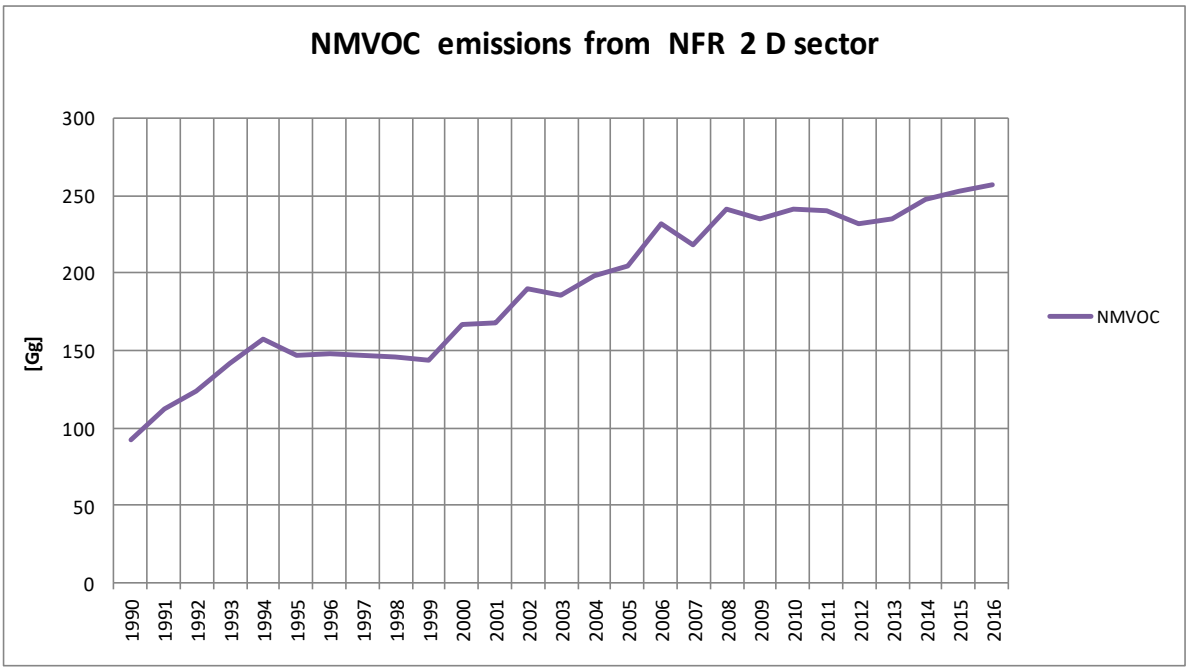

Figure 4.17. NMVOC emissions for NFR 2.D category in 1990-2016

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

Uncertainty analysis for the 2016 for NFR sector 2.D was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole 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	15	50	
2D3i	Other solvent use	28		100

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

Source category description

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

- Use of tobacco (NFR 2.G)
- Pulp and paper (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).

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 2 D category in the country total for the particular pollutants in 2016 are shown on the figure 4.18.

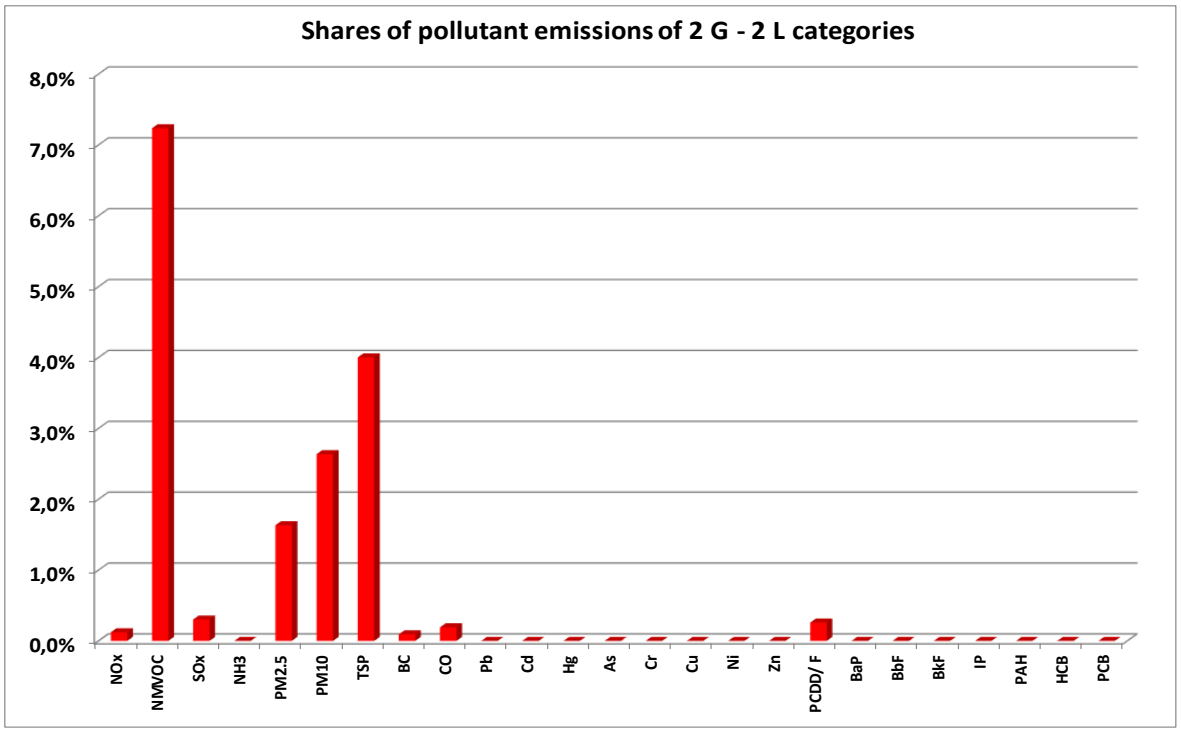

Figure 4.18. Shares of emissions from the 2.G, 2.H, 2.I and 2.L categories in the country total

Activity data for this sector come from GUS statistical yearbooks [GUS 2017e].
Table A2.13 in Appendix 2 presents 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 Appendix 3.

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 table A3.164 in the Appendix 3;
- 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,

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 table A3.166 in the Appendix 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 4.19 ÷ 4.21.

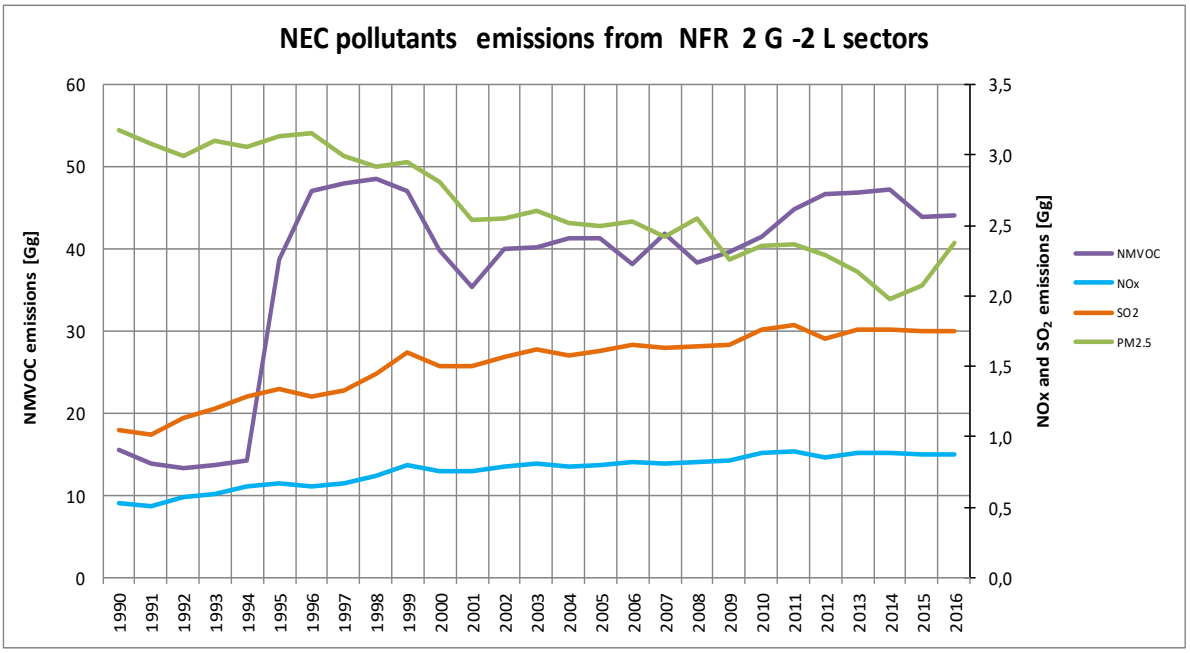

Figure 4.19. NOx, SO_2, PM2.5 and NMVOC emissions for 2.G – 2.L categories in 1990-2016

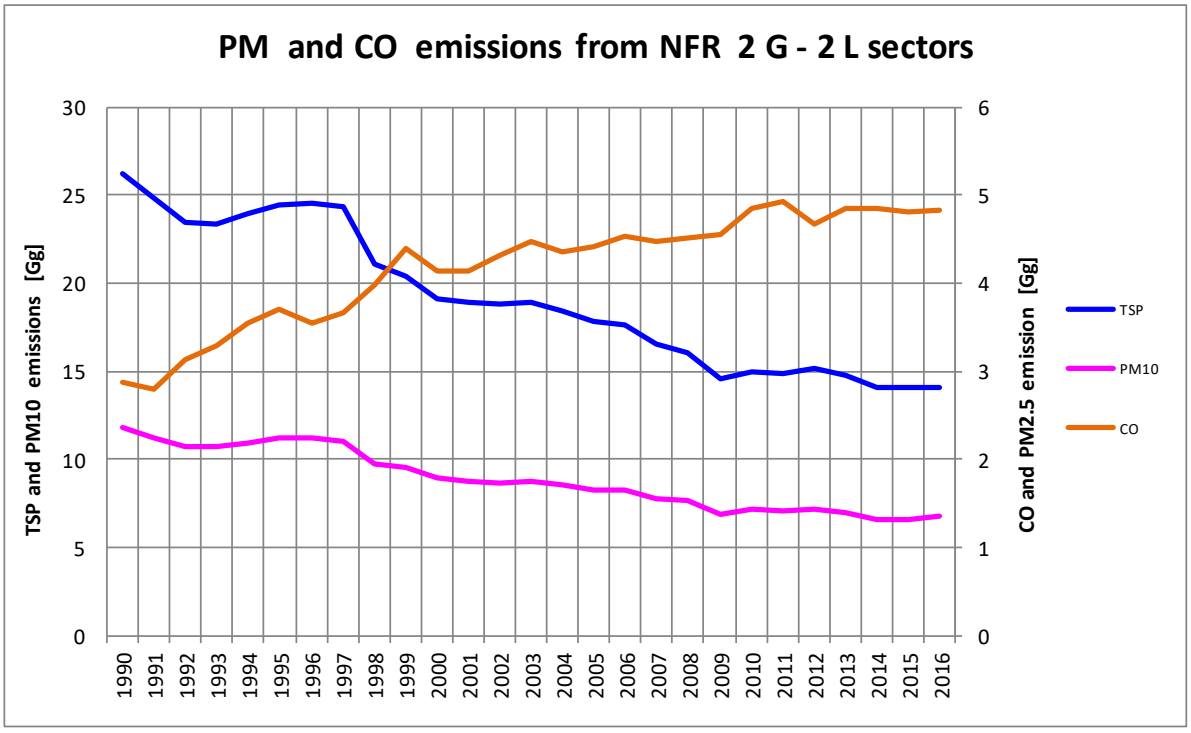

Figure 4.20. Particulates and CO emissions for 2.G – 2.L categories in 1990-2016

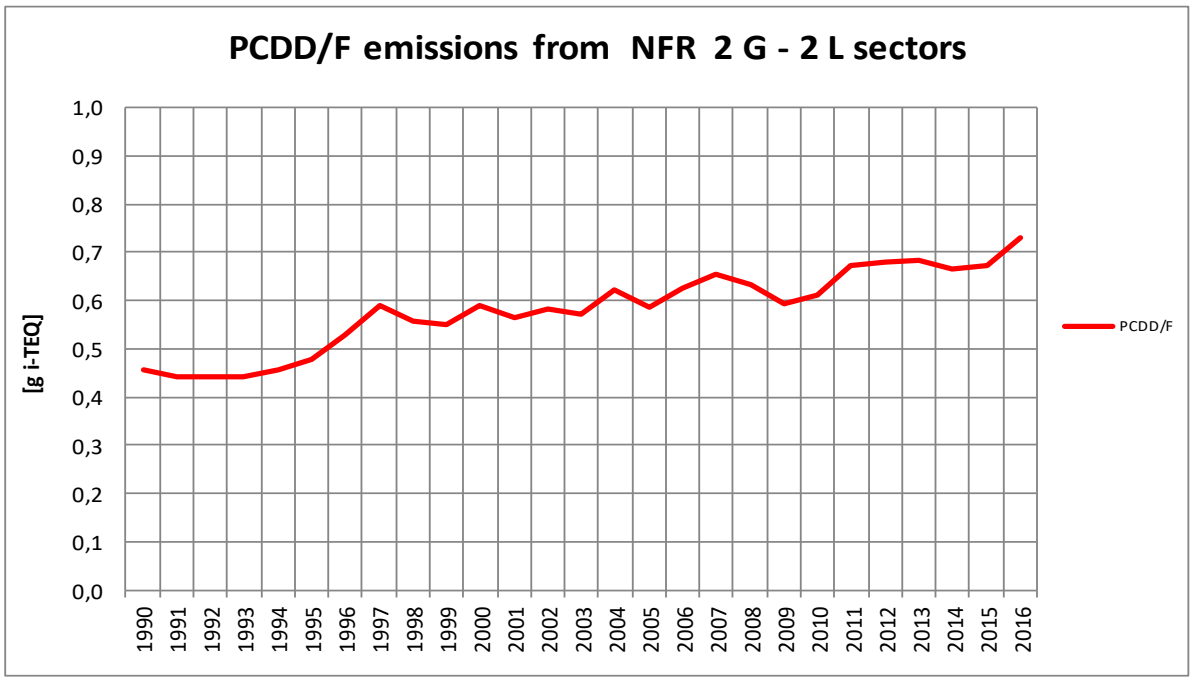

Figure 4.21. PCDD/F emissions for 2.G – 2.L categories in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for sector *Other Products* was developed with use of methodology, described in Appendix 6. 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 1990-2015) of data ensured consistency for whole time-series.

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

NFR		NO_X	NMVOC	SO_2	CO	TSP	PM10	PM2.5	Pb	Cd	Hg	PCDD/F
		%	%	%	%	%	%	%	%	%	%	%
2G	Other product use	71	71		71	50	50	50	71	71	71	100
2H1	Pulp and paper industry	30	50	30	50	50	50	50				
2H2	Food and beverages industry		24									85
2I	Wood processing		50									
2L	Other production, consumption, storage, transportation or handling of bulk products					63	50	63				

5. Agriculture (NFR sector 3)

Overview of sector

The pollutant emission sources in agricultural sector involve: manure related to livestock management (NH_3, NO_X, 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 (98%), driven by a number of animals 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 2016 are shown on the figure 5.1.

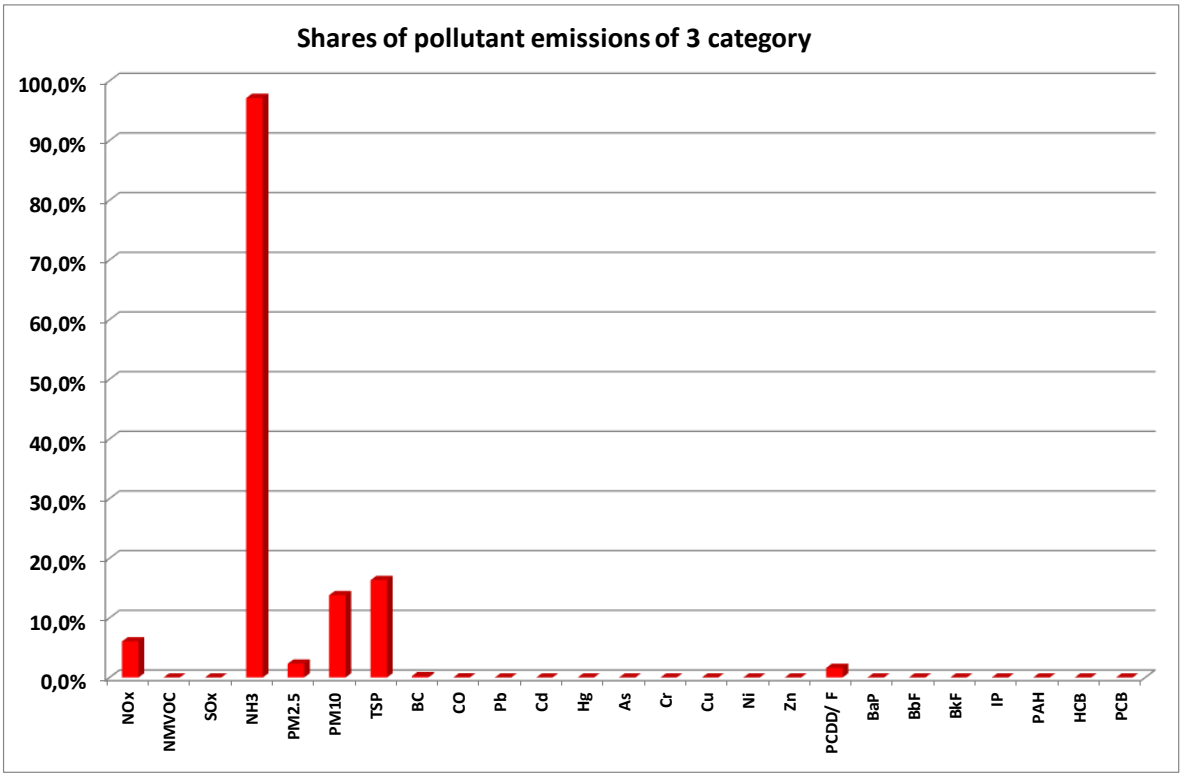

Figure 5.1. Shares of emissions from the NFR 3 category in the country total

5.1. Manure Management (NFR sector 3.B)

The pollutant emission sources in manure related to livestock management cover: NH_3, NO_X PM10, PM2.5 and TSP. Shares of emissions from the NFR 3.B category in the country total for the particular pollutants in 2016 are shown on 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.

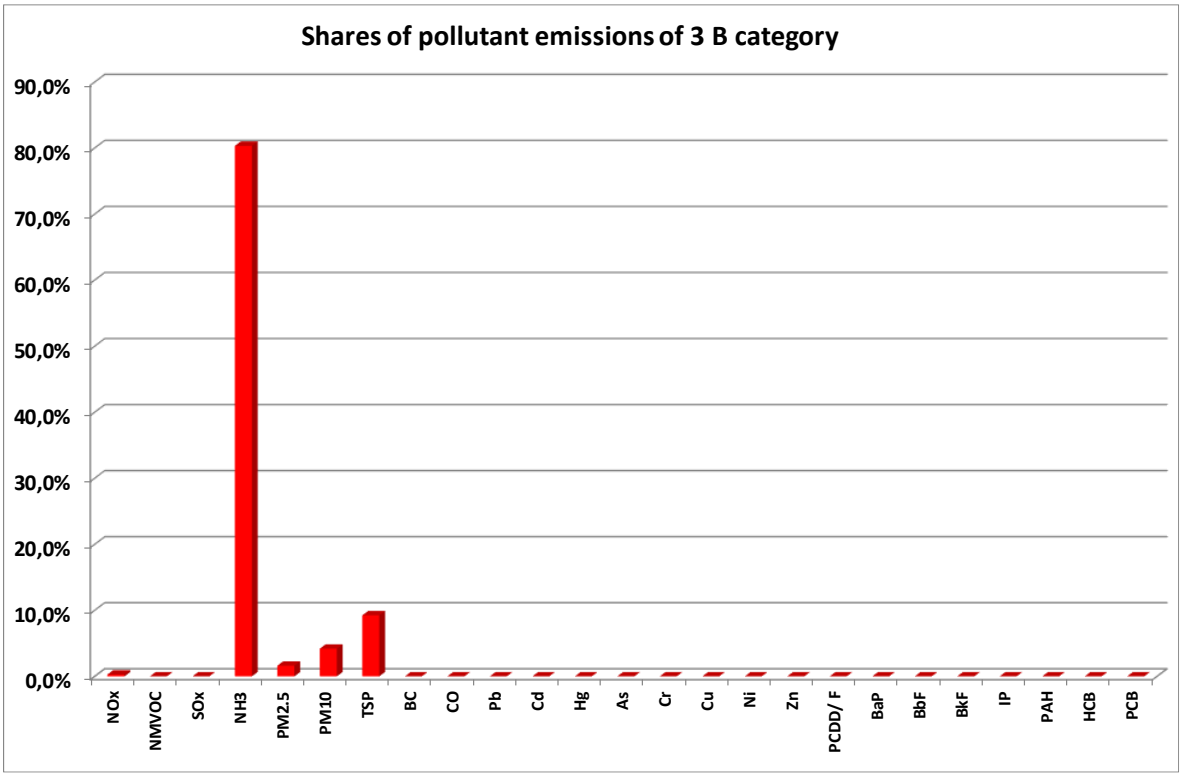

Figure 5.2. Shares of emissions from the 3.B category in the country total

Activity data for 2016, similarly to those for entire period since 1990, related to livestock population come from national statistics (Central Statistical Office) [GUS 2017j]. 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 timeseries 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 2013 so the same value is repeated until 2016. Trends of animal population in 1988−2016 is given in table 5.1.

Table 5.1. Trends of livestock population in 1990-2016

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

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) [Walczak 2006, 2009, 2011, 2012, 2013]. This data are consistent with those used for GHG emission estimation [NIR 2018]. 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 (tab. 5.8). 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 2013-2016. In Poland small farms prevail where solid systems for animal management are commonly used. Liquid systems are applied only at big farms, having more than 120 animals.

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].

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

	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
2016	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, Kopiński 2014]. Country specific Nex values are generally in line with parameters published by EMEP/EEA for most livestock categories (table A3.178 Appendix 3). 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 4500 litters/yr on average already in 2011.

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 2014-2016.

When using Tier 2 method during calculations of NH_3 emissions from manure management the effect of some abatement measures were taken into account (see 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 2015-2016. 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 [%]
	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 table A3.177 in Appendix 3. The CS implied emission factors since 1990 is given in Tables 5.4-5.5. 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]

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016
Dairy cattle	22.285	22.255	24.697	27.643	28.579	29.794	29.623	29.456	29.131	29.131	29.131
Other cattle	12.547	12.502	12.374	12.377	12.874	12.858	13.033	12.677	12.773	12.773	12.773
Fattening pigs	4.719	4.717	4.717	4.718	4.252	4.217	4.182	4.147	4.099	4.099	4.099
Sows	11.075	11.053	11.057	11.075	10.959	10.948	10.937	10.934	10.930	10.930	10.930
Sheep	2.703	2.703	2.703	2.703	2.703	2.703	2.703	2.703	2.703	2.703	2.703
Horses	16.509	16.509	16.509	16.509	16.509	16.509	16.509	16.509	16.509	16.509	16.509
Goats	2.279	2.279	2.279	2.279	2.279	2.279	2.279	2.279	2.279	2.279	2.279
Hens	0.338	0.338	0.338	0.345	0.323	0.322	0.322	0.321	0.320	0.320	0.320
Broilers	0.131	0.131	0.131	0.131	0.121	0.120	0.120	0.120	0.120	0.120	0.120
Other poultry	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891

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

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016
Dairy cattle	0.215	0.216	0.242	0.252	0.266	0.277	0.275	0.273	0.270	0.270	0.270
Other cattle	0.128	0.130	0.128	0.126	0.133	0.132	0.134	0.130	0.131	0.131	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
Sows	0.082	0.083	0.083	0.082	0.080	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	0.028
Horses	0.168	0.168	0.168	0.168	0.168	0.168	0.168	0.168	0.168	0.168	0.168
Goats	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
Broilers	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

NH_3 and NO_X emissions from manure management are reported altogether with emissions related to manure applied to soils in this Submission. NMVOC emissions from manure management will be amended when detail information on livestock silage feeding is collected.

Following recommendations resulting from *2017 NECD Comprehensive Review* of Polish inventory emission factors for TSP, PM10 and PM2.5 for manure management category have been updated to those published in *EMEP/EEA EIG 2016*, covering all animals raised. Applied emission factors are shown in Appendix 3, table A3.179. EFs for other cattle and other poultry are calculated as weighted mean for different animal subcategories based on their population.

5.2. Agricultural Soils (NFR sector 3.D)

Source category description

The pollutant emissions in agricultural soils involve: NH_3, NO_X and NMVOCs from the application of synthetic nitrogen fertilizers, NH_3, and NO_X from sewage sludge applied to soils, as well as 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 2016 are shown on the figure 5.3.

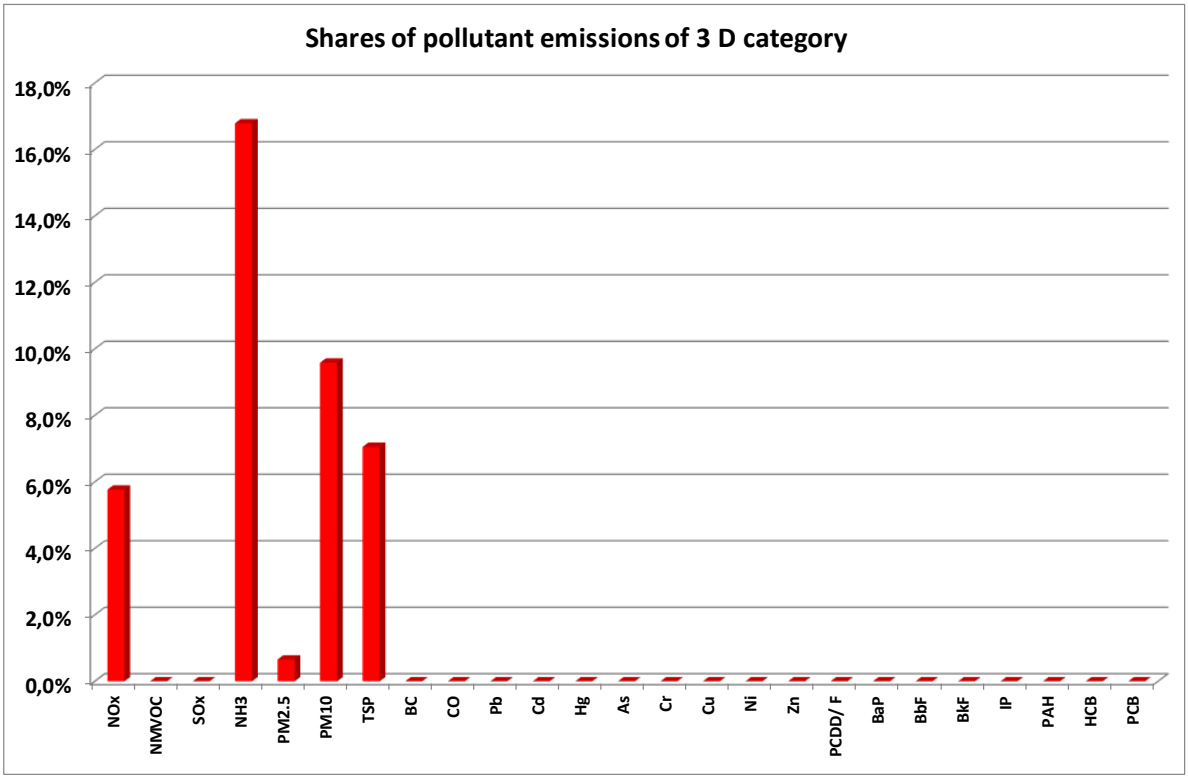

Figure 5.3. Shares of emissions from the 3.D category in the country total

Methodological issues

NH_3, NOx and NMVOC emissions from synthetic fertilizers were estimated based on the amount of nitrogen synthetic fertilizer applied to agricultural fields published in *Statistical*

yearbook [GUS 2017g] (table 5.6). 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 2016 are those established for farming year 2015/2016 etc.

Data regarding consumption of mineral fertilizers is elaborated on the basis of reporting from production and trade units, statistical reports of agricultural farms: state-owned, co-operatives and companies with share of public and private sector, expert's estimates as well as Central Statistical Office estimates. The recommendations following agricultural good practice elaborated by the Ministry of Agriculture and Rural Development contain the rules for rational use of fertilisers, free consultancy system for farmers in this area, while the large-scale farms are obliged to elaborate fertilizing plans.

Table 5.6. Nitrogen fertilizers use in 1990–2016 in Poland [Gg N]

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

Ammonia emissions from mineral fertilizers use for crop cultivation were estimated based on annual nitrogen fertilizers use in Poland and the CS emission factor. Emission factor was established on the basis of method published in chapter 3.3.2 in part *4.D Crop production and agricultural soils* of *EMEP/EEA EIG 2009* using domestic structure of nitrogen fertilizers application in the year 2000 [Pietrzak 2006], the default ammonia EFs with assumption that mean spring temperature t_s = 7.4 ^{o}C (table 5.7). In case of ammonium sulphates and ammonium phosphates multiplayer 10 was applied for 20% of soils for which pH exceeds 7.0 in Poland [Zawadzki 1999]. The weighted mean NH_3 emission factor for Poland amounts to 0.042 kg NH_3/kg N and is plied 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 1990-2016, the same structure of fertilizers use as of 2000 was used (Table 5.7).

Table 5.7. The structure of nitrogen fertilizers consumption in Poland in 2000 and EFs used

Fertilizer type	Structure of fertilizers use:	NH_3 EF (EMEP/EEA EIG 2009 table 3-2)
Ammonium sulphate	0.01	0,0107 + 0,0006 t_s
Urea	0.25	0,1067 + 0,0035 t_s
Ammonium nitrate	0.45	0,0080 + 0,0001 t_s
Calcium ammonium nitrate	0.16	0,0080 + 0,0001 t_s
Nitrogen solutions	0.04	0,0481 + 0,0025 t_s
Ammonium phosphate	0.01	0,0107 + 0,0006 t_s
Other NK and NPK	0.08	0,0080 + 0,0001 t_s

For NO_X emissions the default EF from *EMEP/EEA EIG 2016* was used as of 0.04 t NO_2-N / t N-fertilizer. NMVOC emissions are estimated using Tier 1 method based on *EMEP/EEA EIG 2009* emission factor of 0.005955 kg/Gg fertilizer. Recalculation of NMVOC emissions from cultivated crops based on *EMEP/EEA EIG 2016* applying specific country shares of crops is planned for next Submission.

Following recommendations resulting from *2017 NECD Comprehensive Review* the emissions of NH_3 and NO_X from sewage sludge application on agricultural soils have been supplemented using Tier 1 method and emission factors given in the *EMEP/EEA EIG 2016*. Activity data on the amount of sewage sludge applied on the fields come from national statistics [GUS 2017c] 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 2017). 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 [NIR 2017]. Activity data on sewage sludge used in Agriculture is given in Table 5.8.

Table 5.8. 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	
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	
2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
2.75	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

Following recommendations resulting from *2017 NECD Comprehensive Review* the 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.* The attempts will be undertaken to estimate emissions related to agricultural operations based on country specific crops share.

Emission factors for the particular pollutants with their source are presented in Appendix 3, section III.2 Agricultural soils.

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

Source category description

The pollutant emissions related to on-field burning of stubble include PCDD/F, CO, NMVOC, TSP, PM10 and PM2.5. Shares of emissions from the NFR 3.F category in the country total for the particular pollutants in 2016 are shown on the figure 5.4. This category corresponds to SNAP 1003 category.

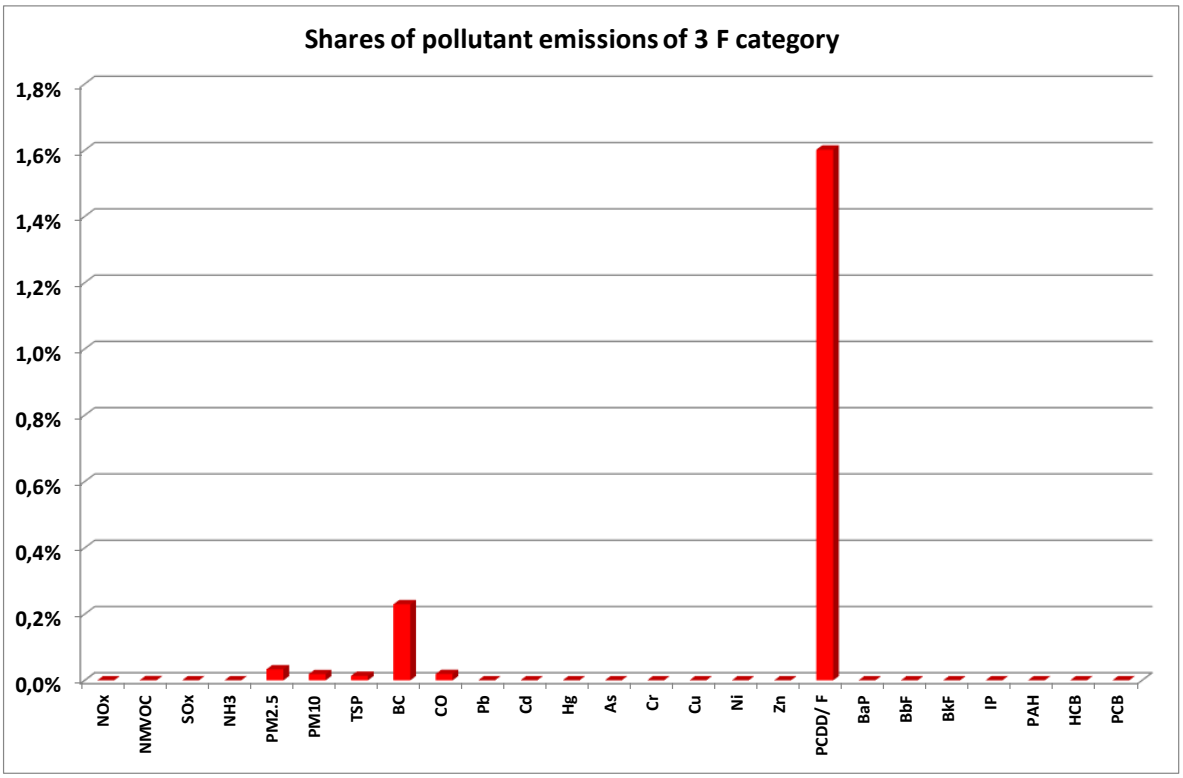

Figure 5.4. Shares of emissions from the 3.F category in the country total

Methodological issues

Estimation of pollutant emissions related to on-field stubble burning is based on the area of agricultural crops, meadows and stubbles burned 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* which amounts on average 0.80 Mg on 1 ha of area.

Activity data for 2016 come from Central Statistical Office's yearbook on environment [GUS 2017c] and for previous years – from analogous publications (table A2.14 in Appendix 2).

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

Source-specific QA/QC and verification

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

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.

Source-specific recalculations

NFR 3.B
Update of TSP, PM10 and PM2.5 emission factors according to the *EMEP/EEA EIG 2016.*
Inclusion of NO_X emissions from manure management using Tier 2 method.

NFR 3.D
Inclusion of NH_3 and NO_X emissions from sewage sludge used as fertilizer on agricultural soils.
Inclusion of TSP, PM10 and PM2.5 emissions from agricultural operations using Tier 1 method.

NFR 3.F
No recalculations were made.

Source-specific planned improvements

NFR 3.B.
Amendment for NMVOC emissions from animal husbandry related to silage feeding.

NFR 3.D.
Application of higher tier method in NMVOC emissions in cultivated crops (N fertilizers use).
Application of higher tier method in particulate matter emissions from agricultural operations.

Emission trends for the NFR sector 3

Volumes and trend of pollutant emissions for *Agriculture* are shown below on figures 5.5 ÷ 5.7.

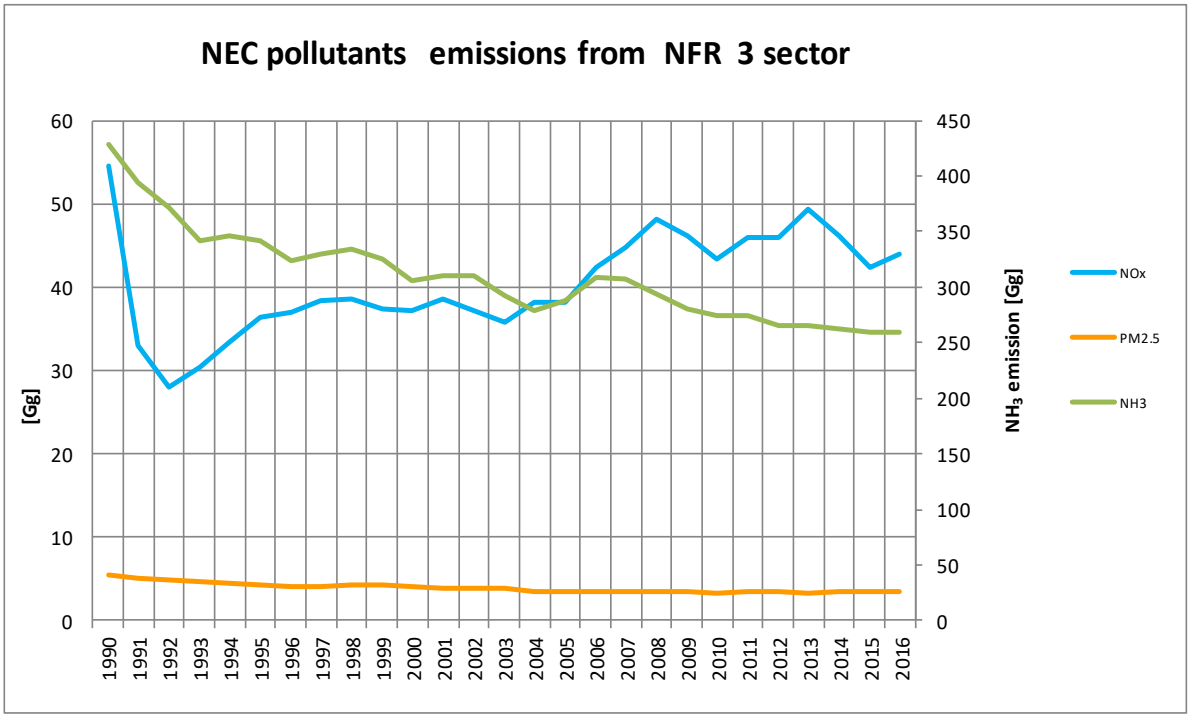

Figure 5.5. NH_3, PM2.5 and NOx emissions for NFR 3 category in 1990-2016

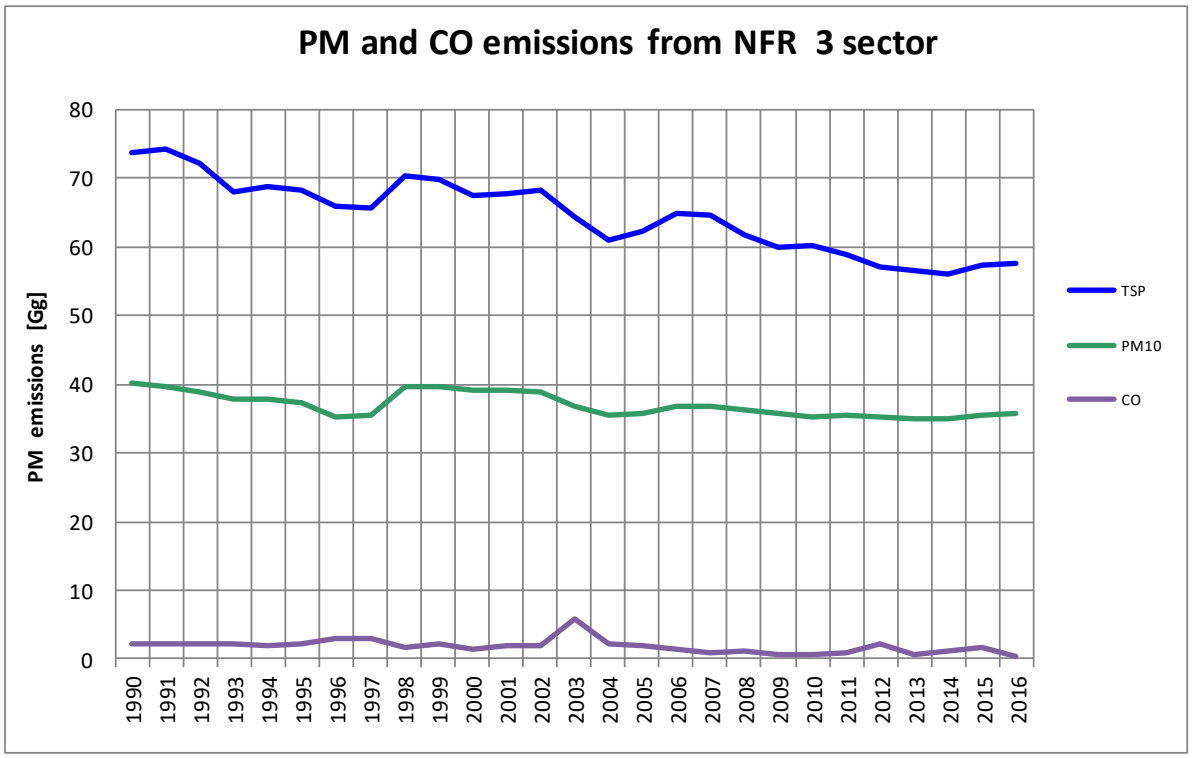

Figure 5.6. Particulates and CO emissions for NFR 3 category in 1990-2016

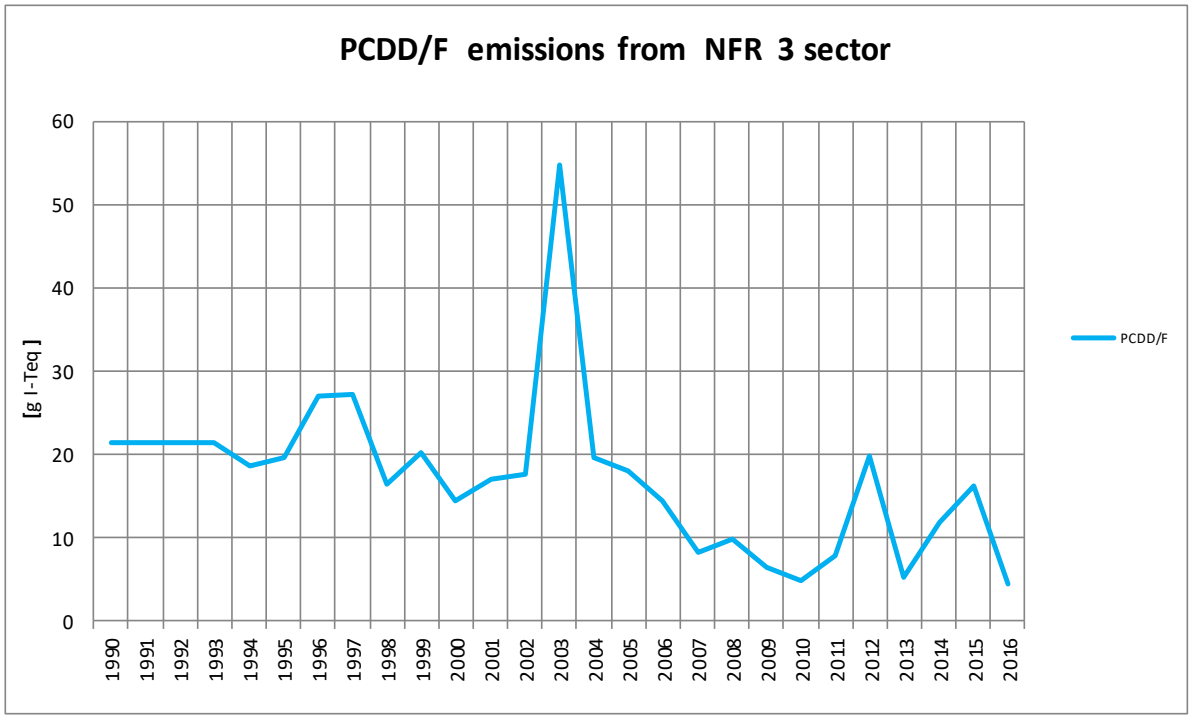

Figure 5.7. PCDD/F emissions for NFR 3 category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector 3 was developed with use of methodology, described in Appendix 6. 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 5.8. Results of the uncertainty analysis for NFR sector 3

NFR		NO_X	NMVOC	NH_3	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			84	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			104	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	100

6. NFR SECTOR 5 - Waste

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 2016 are shown on the figure 6.1.

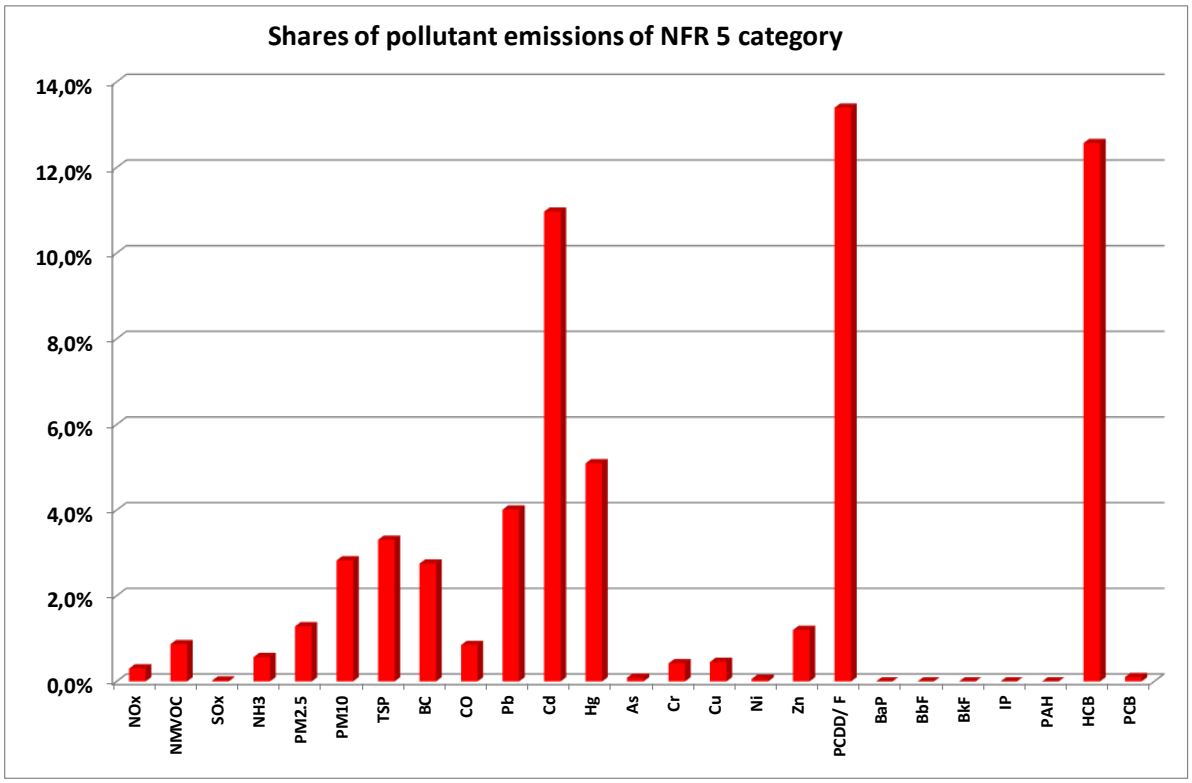

Figure 6.1. Shares of emissions from the NFR 5 category in the country total

Activity data

Activity data, applied for current Polish emission inventory come from various sources. Majority of data is derived from national statistics made by GUS (Central Statistical Office). Activity data for unintentional fires were derived from fire statistics made by National Headquarters of the State Fire Service and own estimates.
All used activity data are presented in Tables A2.15 ÷ A2.22 in Appendix 2.

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory PM2.5 emission factor for the *Industrial waste incineration* (NFR 5.C.1.b.i) has been applied from the EMEP/EEA EIG 2016. This change resulted in a decrease of PM2.5 emissions from this activity. Tables with applied emission factors are presented in Appendix 3.

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 Main Statistical Office of Poland. The rest of data applied for calculations is derived from various sources. Description of them is provided in Appendix 6.

Emission trends for the NFR sector 5

Volumes and trend of pollutant emissions for *Waste treatment and disposal* are shown below on figures 6.2 ÷ 6.5.

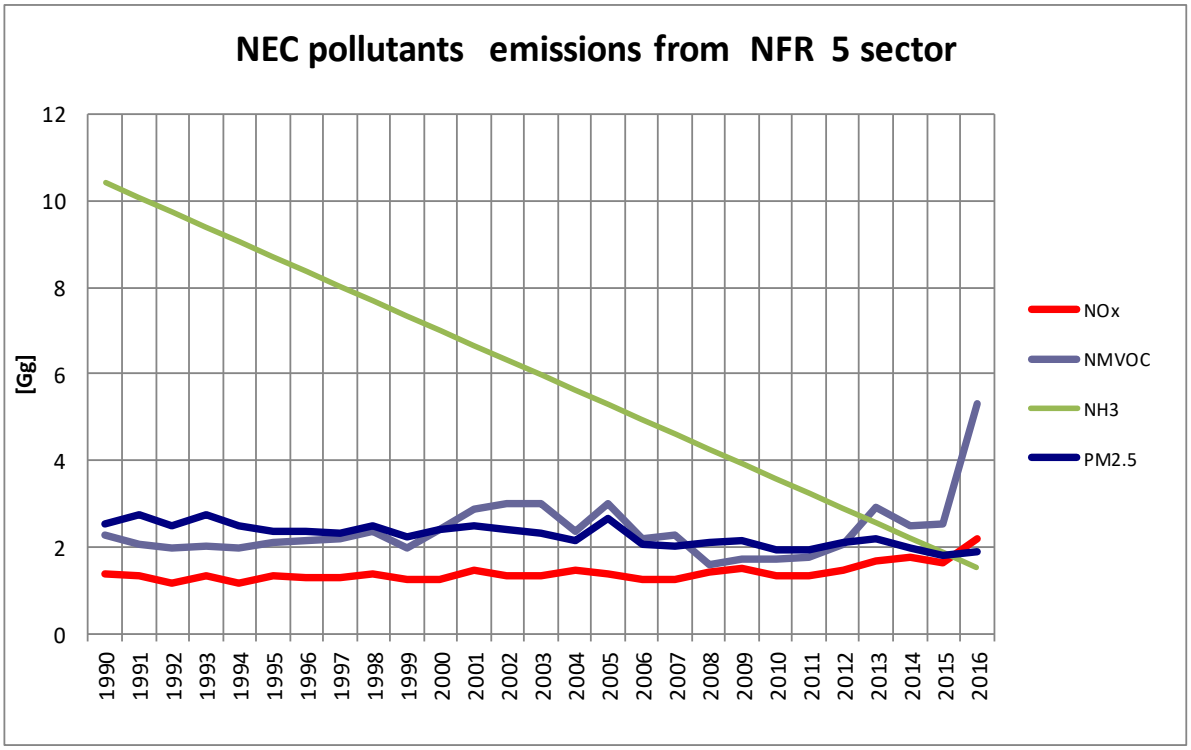

Figure 6.2. NOx, NMVOC and NH_3 emissions for NFR 5 category in 1990-2016

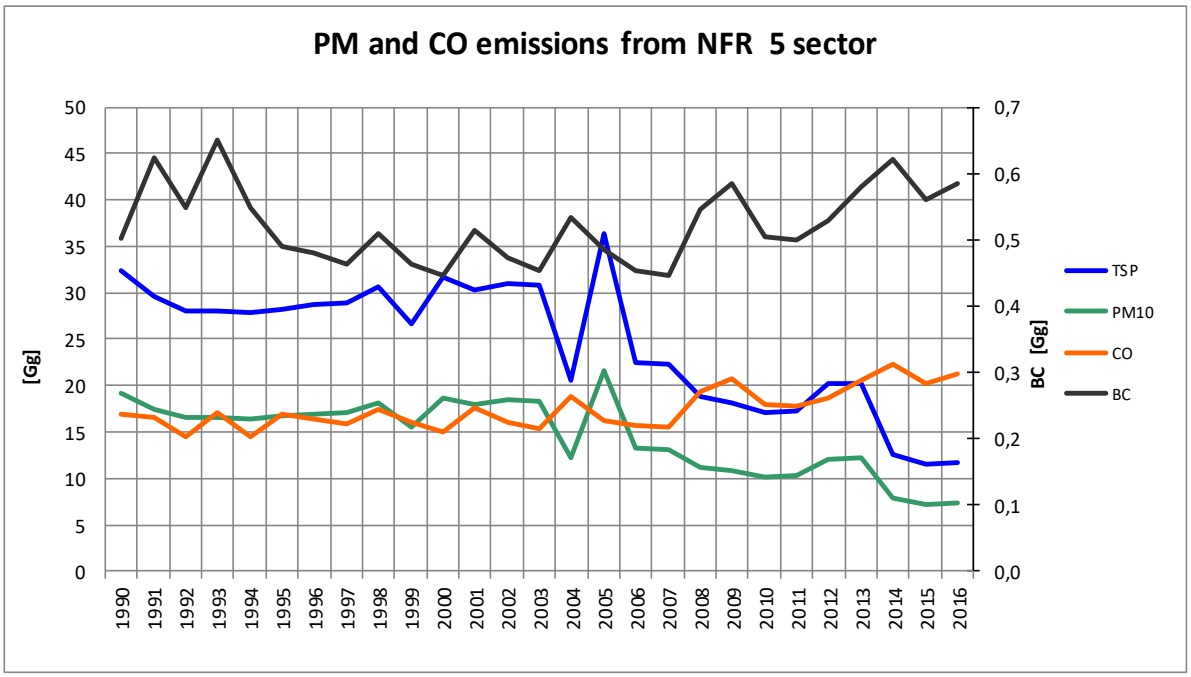

Figure 6.3. CO and PM emissions for NFR 5 category in 1990-2016

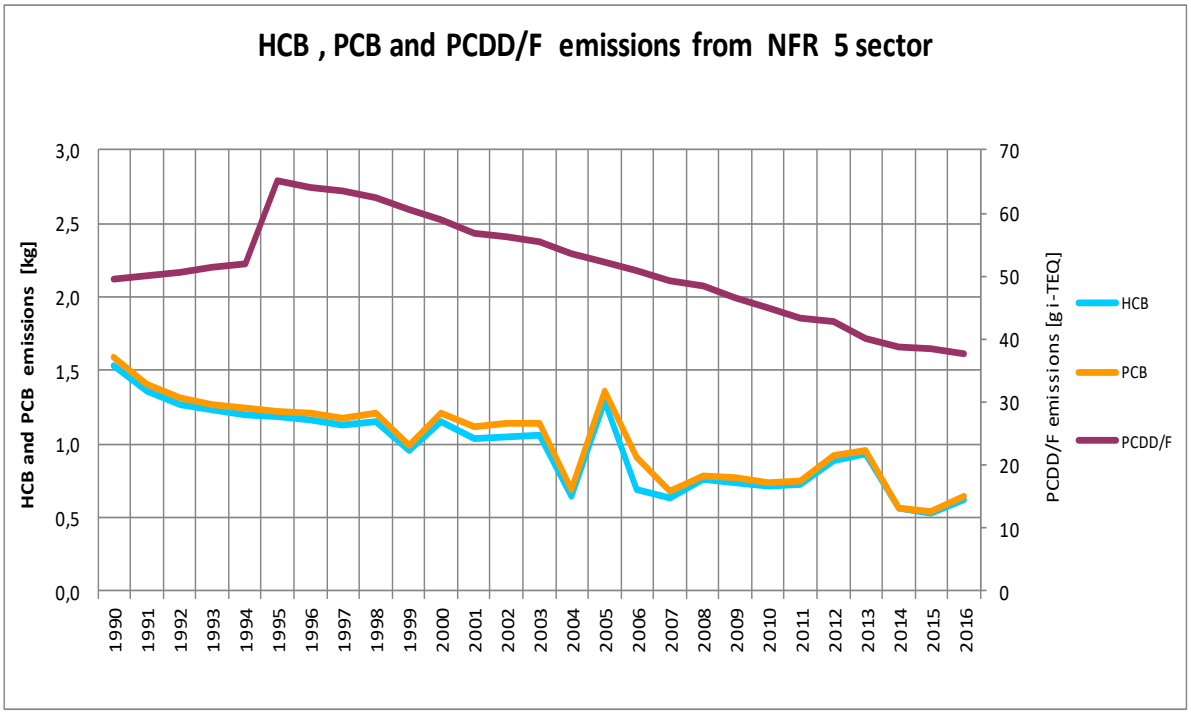

Figure 6.4. PCDD/F emissions for NFR 5 category in 1990-2016

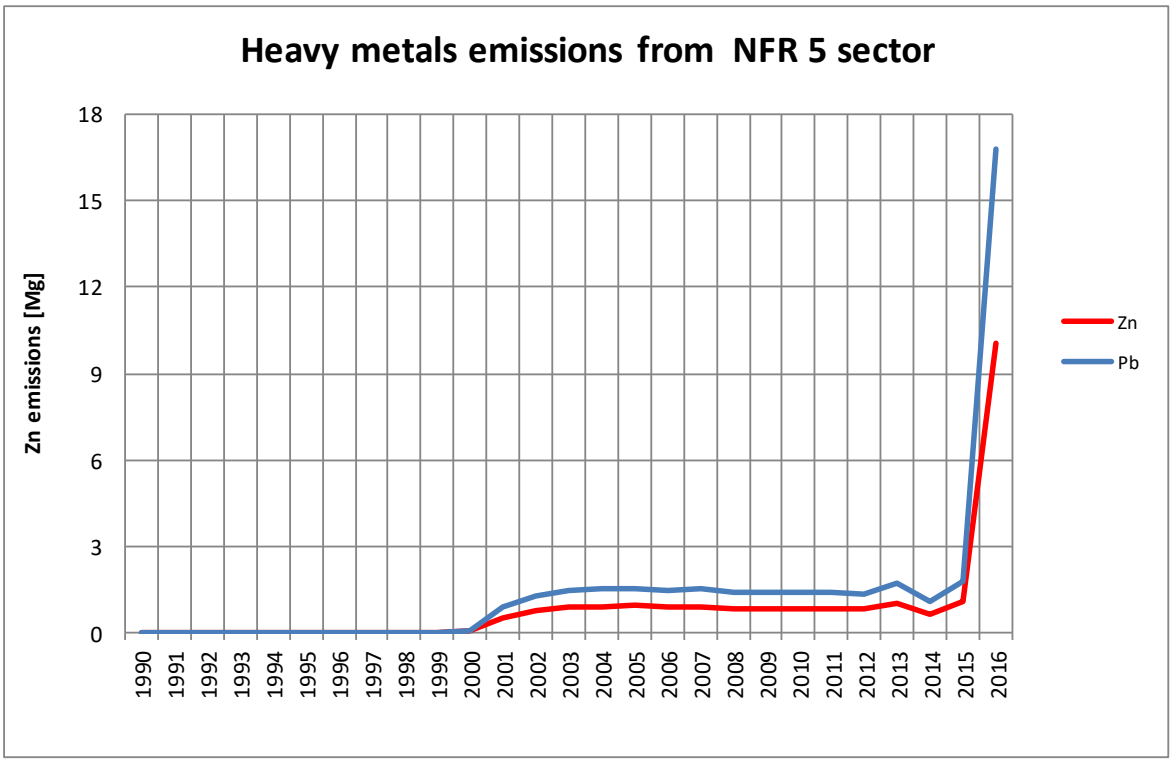

Figure 6.5. Zn and Pb emissions for NFR 5 category in 1990-2016

Uncertainties and time-series consistency

Uncertainty analysis for the 2016 for NFR sector 5 was developed with use of methodology, described in Appendix 6. 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	NO_x	NMVOC	SO_x	NH_3	CO	TSP	PM 10	PM 2.5	Pb	Cd	Hg	PCD D/F	HCB
		%	%	%	%	%	%	%	%	%	%	%	%	%
5A	Biological treatment of waste - Solid waste disposal on land		30				150	150	150					
5C1a	Municipal waste incineration	50	50	30					50					
5C1bi	Industrial waste incineration	37	37	22		37	37	37	37				99	98
5C1biii	Clinical waste incineration	48	48	29		48							31	83
5C1biv	Sewage sludge incineration												76	
5C1bv	Cremation	71	51	32		51				71	71	71	100	
5C2	Open burning of waste	50	50			50	50	50	50				94	
5D1	Domestic wastewater handling				30									
5E	Other waste												100	

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 include NMVOC and PCDD/F.
Activity data were derived from national statistics made by GUS and are listed in Table A2.23 in Appendix 2. Tables with applied emission factors are presented in Appendix 3.

7.2 Other natural sources (NFR 11.C)

Estimated emissions from Non-managed broadleaf and coniferous forests include NMVOC.
Activity data were derived from national statistics made by GUS and are listed in Table A2.24 in Appendix 2. Tables with applied emission factors are presented in Appendix 3.

8. Recalculations and Improvements

In 2017 recalculations of data from 1990 have been performed – therefore completeness and consistency of emission inventory have been improved. Emission inventory of air pollutants - though generally complete - still needs improvements of the elements described below in paragraph 8.2.

8.1 Recalculations

In 2017 update of energy data from 1990 has been performed which changed some inventory data for combustion processes in the trend 1990-2015.
As compared to the previous submissions there has been some methodology changes introduced into the Polish emission inventory of air pollutants.
The major improvements of the inventory are enumerated below:

Sectoral improvements - methodology:

- NFR 1A2b (Stationary combustion in manufacturing industries and construction: Non-ferrous metals)

Regarding HCB emissions from copper production in the Polish inventory – in year 2017 additional analysis of the methodology and applied emission factor was performed, resulting in revision of the employed approach.
As there is no HCB emission factors in the EMEP/EEA Guidebooks or related documents for this source - in previous submission Poland applied emission factor based on literature, where emission factor used for copper production was 39 mg/t secondary copper smelted [53; Bailey R. 2001].
However, in comparison with EFs applied by other EU countries for copper production it became visible, that above mentioned EF could be significantly overestimated. For instance in the Germany's IIR 2017 the emission factor 1 mg HCB / 1 t copper produced has been

reported. Another reason to reconsider applied methodology was that in approach used by Germany emission factor covers entire copper production process (primary and secondary) while previously used by Poland - only secondary copper smelting.
Attempts has been undertaken to obtain national data on HCB emissions from copper production from KGHM Polska Miedź, the main Polish copper producer. The initial information indicated that the level of emissions should not exceed the value applied for the same source in Germany.
In conclusion, until country specific emission factor for copper production is not available, Poland decided to revise applied methodology and EF to follow methodology applied in the IIR of Germany. Revision of the methodology aimed to improve accuracy and transparency of the estimates for that category is under way.

- NFR 1A3b (Road transport)

Road transport emissions have been estimated and updated for the period 1990-2016, based on the country studies [47; 48; 49] and with the use of newer version of software (COPERT 5). The methodology changes have been described in the Chapter 3.5.3.

- NFR 1A4 (Other sectors)

HM emission factors for non-industrial combustion of solid fuels have been verified for 2000-2016 period, based on the country-study [51]

- NFR 1A4ai (Commercial / institutional: Stationary)
- NFR 1A4ci (Agriculture/Forestry/Fishing: Stationary)

Table 8.1 HM emission factors for combustion of solid fuels in NFR 1A4ai and 1A4ci [g/TJ]

Hard coal																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	200,00	200,08	200,22	200,84	201,98	203,50	204,99	207,04	208,92	210,71	212,57	214,29	215,71	217,96	220,17	220,17	220,17
Cd	2,00	2,02	2,04	2,09	2,14	2,19	2,25	2,33	2,42	2,50	2,64	2,78	2,88	3,06	3,24	3,24	3,24
Hg	3,00	3,01	3,03	3,07	3,10	3,14	3,19	3,25	3,32	3,38	3,48	3,58	3,66	3,80	3,93	3,93	3,93
As	8,00	8,01	8,02	8,04	8,07	8,10	8,12	8,16	8,21	8,25	8,32	8,39	8,44	8,53	8,62	8,62	8,62
Cr	20,00	20,02	20,06	20,13	20,22	20,34	20,46	20,63	20,80	20,96	21,18	21,39	21,55	21,83	22,11	22,11	22,11
Cu	180,00	180,04	180,11	180,22	180,34	180,48	180,62	180,82	181,06	181,26	181,61	181,94	182,21	182,66	183,11	183,11	183,11
Ni	60,00	60,08	60,22	60,44	60,68	60,95	61,24	61,64	62,12	62,51	63,22	63,89	64,41	65,31	66,22	66,22	66,22
Se	8,00	8,00	8,01	8,02	8,03	8,05	8,06	8,08	8,11	8,13	8,16	8,19	8,22	8,27	8,31	8,31	8,31
Zn	269,98	269,64	269,01	268,02	266,93	265,71	264,40	262,62	260,44	258,71	255,51	252,51	250,16	246,11	242,01	242,01	242,01

Fuel wood																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	30,00	30,00	30,21	30,89	31,69	33,01	35,38	38,10	40,79	43,60	45,98	48,59	51,11	53,91	56,73	56,73	56,73
Cd	1,30	1,30	1,30	1,29	1,29	1,27	1,25	1,22	1,20	1,17	1,15	1,12	1,10	1,07	1,04	1,04	1,04
Hg	0,70	0,70	0,70	0,70	0,69	0,68	0,67	0,65	0,64	0,62	0,61	0,59	0,58	0,56	0,54	0,54	0,54
As	10,00	10,00	9,97	9,87	9,76	9,57	9,21	8,78	8,37	7,93	7,56	7,17	6,78	6,35	5,91	5,91	5,91
Cr	10,00	10,00	9,97	9,86	9,74	9,53	9,15	8,72	8,29	7,84	7,46	7,05	6,65	6,20	5,75	5,75	5,75
Cu	20,00	20,00	19,94	19,76	19,55	19,20	18,54	17,79	17,05	16,27	15,61	14,90	14,21	13,43	12,65	12,65	12,65
Ni	5,00	5,00	4,99	4,94	4,89	4,80	4,63	4,45	4,26	4,06	3,90	3,72	3,55	3,35	3,16	3,16	3,16
Se	1,90	1,90	1,90	1,89	1,88	1,86	1,84	1,80	1,77	1,74	1,71	1,68	1,65	1,62	1,58	1,58	1,58
Zn	180,00	180,00	179,96	179,87	179,77	179,58	179,16	178,65	178,15	177,63	177,20	176,75	176,31	175,79	175,27	175,27	175,27

Brown coal																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	70,01	70,02	70,16	70,42	70,76	71,10	71,76	71,92	72,28	72,64	72,98	73,30	73,52	73,76	73,98	73,98	73,98
Cd	1,00	1,00	1,00	1,01	1,02	1,03	1,04	1,05	1,06	1,07	1,07	1,08	1,09	1,09	1,10	1,10	1,10
Hg	4,00	4,00	4,02	4,06	4,11	4,17	4,26	4,29	4,34	4,40	4,45	4,50	4,53	4,56	4,60	4,60	4,60
As	14,01	14,01	14,10	14,25	14,46	14,66	15,06	15,15	15,37	15,58	15,79	15,98	16,11	16,26	16,39	16,39	16,39
Cr	29,99	29,99	29,88	29,69	29,43	29,18	28,68	28,56	28,29	28,02	27,77	27,53	27,36	27,18	27,02	27,02	27,02
Cu	12,02	12,04	12,30	12,80	13,44	14,09	15,34	15,65	16,33	17,02	17,66	18,27	18,69	19,14	19,56	19,56	19,56
Ni	7,00	7,01	7,06	7,15	7,27	7,39	7,62	7,67	7,80	7,92	8,04	8,16	8,23	8,32	8,39	8,39	8,39
Se	4,00	4,00	4,02	4,04	4,08	4,11	4,18	4,19	4,23	4,26	4,30	4,33	4,35	4,38	4,40	4,40	4,40
Zn	100,02	100,04	100,32	100,84	101,52	102,20	103,52	103,84	104,56	105,28	105,96	106,60	107,04	107,52	107,96	107,96	107,96

Coke																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00	130,00
Cd	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00
Hg	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
As	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Cr	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00	17,00
Cu	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00	86,00
Ni	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00	76,00
Se	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00
Zn	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00

- NFR 1A4bi (Residential: Stationary)

Table 8.2 HM emission factors for combustion of solid fuels in NFR 1A4bi [g/TJ]

Hard coal																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	124,33	124,60	124,99	127,61	129,06	131,02	132,38	134,14	136,35	139,02	141,34	144,37	147,15	149,94	151,89	151,89	151,89
Cd	1,57	1,57	1,58	1,60	1,61	1,64	1,65	1,69	1,72	1,76	1,79	1,82	1,86	1,89	1,91	1,91	1,91
Hg	2,00	2,00	2,00	1,99	1,99	1,99	1,98	1,98	1,97	1,96	1,96	1,95	1,94	1,93	1,93	1,93	1,93
As	5,60	5,60	5,61	5,68	5,73	5,81	5,86	5,94	6,04	6,15	6,24	6,36	6,46	6,56	6,64	6,64	6,64
Cr	21,41	21,25	21,02	20,75	20,52	20,30	20,00	19,70	19,38	19,04	18,73	18,40	18,09	17,80	17,57	17,57	17,57
Cu	100,00	100,01	100,03	101,99	102,97	104,32	105,26	106,48	108,07	110,04	111,73	114,02	116,11	118,24	119,70	119,70	119,70
Ni	38,00	38,02	38,04	38,31	38,50	38,94	39,13	39,58	40,09	40,61	41,06	41,57	42,04	42,49	42,86	42,86	42,86
Se	8,00	8,00	8,00	7,93	7,90	7,88	7,82	7,77	7,71	7,64	7,58	7,50	7,43	7,35	7,30	7,30	7,30
Zn	235,78	236,37	237,16	236,46	236,12	235,88	234,11	232,43	230,38	228,29	226,54	224,57	222,71	220,89	219,40	219,40	219,40

Fuel wood																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	30,00	30,00	30,00	29,98	29,96	29,93	29,89	29,85	29,84	29,77	29,73	29,69	29,65	29,61	29,51	29,51	29,51
Cd	2,26	2,32	2,36	2,38	2,41	2,43	2,45	2,39	2,47	2,51	2,54	2,62	2,72	2,83	2,94	2,94	2,94
Hg	0,69	0,69	0,69	0,69	0,68	0,68	0,67	0,66	0,66	0,65	0,64	0,63	0,62	0,62	0,61	0,61	0,61
As	9,56	9,53	9,50	9,46	9,37	9,25	9,13	9,01	8,91	8,74	8,46	8,32	8,18	8,03	7,87	7,87	7,87
Cr	10,00	10,00	9,99	9,93	9,78	9,60	9,40	9,10	8,97	8,75	8,14	7,97	7,84	7,69	7,52	7,52	7,52
Cu	20,00	20,00	19,99	19,89	19,67	19,40	19,09	18,64	18,46	18,11	17,23	16,97	16,76	16,52	16,25	16,25	16,25
Ni	5,00	5,00	5,00	4,97	4,91	4,84	4,76	4,65	4,60	4,51	4,27	4,21	4,15	4,09	4,02	4,02	4,02
Se	1,90	1,90	1,90	1,89	1,88	1,87	1,86	1,84	1,83	1,81	1,77	1,75	1,75	1,73	1,72	1,72	1,72
Zn	174,50	174,15	173,85	173,63	173,38	172,98	172,59	172,83	172,30	171,54	171,48	170,64	169,72	168,78	167,53	167,53	167,53

Brown coal																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	70,00	70,00	70,00	70,00	70,38	70,62	70,78	71,00	71,22	71,40	71,58	71,74	71,88	72,02	72,02	72,02	72,02
Cd	1,00	1,00	1,00	1,00	1,01	1,02	1,02	1,03	1,03	1,04	1,04	1,04	1,05	1,05	1,05	1,05	1,05
Hg	4,00	4,00	4,00	4,00	4,06	4,09	4,12	4,15	4,18	4,21	4,24	4,26	4,28	4,30	4,32	4,32	4,32
As	14,00	14,00	14,00	14,00	14,23	14,37	14,47	14,60	14,73	14,84	14,95	15,04	15,13	15,21	15,27	15,27	15,27
Cr	30,00	30,00	30,00	30,00	29,72	29,54	29,42	29,25	29,09	28,95	28,82	28,70	28,59	28,49	28,32	28,32	28,32
Cu	12,00	12,00	12,00	12,00	12,72	13,18	13,48	13,90	14,32	14,66	15,00	15,31	15,57	15,84	16,08	16,08	16,08
Ni	7,00	7,00	7,00	7,00	7,13	7,22	7,27	7,35	7,43	7,49	7,55	7,61	7,66	7,71	7,74	7,74	7,74
Se	4,00	4,00	4,00	4,00	4,04	4,06	4,08	4,10	4,12	4,14	4,16	4,17	4,19	4,20	4,21	4,21	4,21
Zn	100,00	100,00	100,00	100,00	100,76	101,24	101,56	102,00	102,44	102,80	103,16	103,48	103,76	104,04	104,12	104,12	104,12

Coke																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pb	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00	170,00
Cd	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00
Hg	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20
As	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Cr	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00	45,00
Cu	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00	237,00
Ni	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00	110,00
Se	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00	8,00
Zn	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00	450,00

- NFR 5 (Agriculture)

Source-specific recalculations for agricultural sector have been described in the Chapter 5.

- NFR 11c (Other natural emissions)

NMVOC natural emissions from forests have estimated based on new developed methodology, described in Appendix 7.

- NECD Review

Following recommendations resulting from 2017 NECD Comprehensive Review of Polish inventory several emission factors have been applied from the EMEP/EEA EIG 2016 and some emission sources not estimated earlier added to the inventory. These changes are described in more detail in chapters 3-6, concerning sectoral methodologies. Summary of changes recommended during this review is presented in Appendix 8.

8.2 Planned improvements

Even after performed recalculations there is still scope for inventory improvement; planned programme of improvement is focused on the main following tasks:

- verification of NMVOC emissions from the solvents use,
- gathering additional activity data to verify the trend 1990-2000,
- further methodology development by applying higher tier of estimation methodology.

9. Projections

Due to the 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 2017 emission projections for the years 2020 and 2030.

Emission projection, though including several reduction measures, show that compliance with tough reduction limits (as in the table 9.1) will be a challenge.

Table 9.1. Emission levels and emission reduction limits in 2020 and 2030 for Poland

	[Gg]				
	SO_2	**NO_x**	**NMLZO**	**NH_3**	**PM2.5**
2005 emissions (as reported in February 2018)	**1164**	**859**	**606**	**300**	**169**
2016 emissions (as reported in February 2018)	**582**	**726**	**609**	**267**	**146**
Emission reduction to be achieved in **2020**	59%	30%	25%	1%	16%
Emission reduction projections (as reported in 2017)	60%	28%	10%	9%	36%
Emission reduction to be achieved in **2030**	70%	39%	26%	17%	58%
Emission reduction projections (as reported in 2017)	64%	34%	25%	6%	54%

10. Gridded emissions

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.

Abbreviations

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
EPA	U.S. Environmental Protection Agency
EU	European Union
EUROSTAT	EUROSTAT database
GUS	Central Statistical Office (CSO)
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
Pb	Lead
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

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Appendix 1. Activity data - fuels consumption in NFR 1 A

Table A1.1. Fuel consumption [TJ] in 1.A.1.a category - Public power SNAP 0101

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
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
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
Fuel wood and wood waste	6		4	8	11	3	1 162	1 150	1 384	1 259	1 301	1 217	1 134
Biogas						1	11	28	23	22	27	12	18
Industrial wastes	167	1 477	1 173	507	248	468	155	229			511	653	1 210
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
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
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
Blast furnace gas													
Gas works gas		5							219	82	11	28	21

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	917 776	930 264	917 143	926 086	837 871	845 778	781 505	797 519	810 054.07	917 776	930 264	917 143	926 086	837 871
Lignite	518 326	514 306	533 690	478 308	527 410	539 384	513 194	507 638	484 465	518 326	514 306	533 690	478 308	527 410
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	28 959	36 403	40 048	38 062	42 713	31 498	32 459	41 703	47 074.77	28 959	36 403	40 048	38 062	42 713
Fuel wood and wood waste	2 008	3 841	9 643	55 096	92 948	73 314	84 159	81 982	59 860	2 008	3 841	9 643	55 096	92 948
Biogas	18	73	33						4 381	18	73	33		
Industrial wastes	17	4		1		1	1		1	17	4		1	
Municipal waste - non-biogenic fraction							29							
Municipal waste – biogenic fraction									2.2					
Other petroleum products					31									31
Petroleum coke														
Coke									0.5					
Liquid petroleum gas (LPG)									1.8					
Motor gasoline									22					

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Jet kerosene														
Diesel oil														
Fuel oil	558	386	429	692	736	779	736	1 290	821	558	386	429	692	736
Light fuel oil	6 400	6 640	6 200	6 080	5 280	5 200	4 200	4 360	4 274	6 400	6 640	6 200	6 080	5 280
Feedstocks														
Refinery gas														
Petroleum coke oven gas	9 199	8 929	7 637	12 049	9 904	11 696	11 609	12 306	11 992	9 199	8 929	7 637	12 049	9 904
Blast furnace gas				8 316	8 740	8 689	11 257	16 242	14 630				8 316	8 740
Gas works gas				4 379	4 809	4 955	4 745	4 331	3 162				4 379	4 809

Table A1.2. Fuel consumption [TJ] in 1.A.1.a category – Industrial power SNAP 0301

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
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
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
Biogas						117	130	81	169	300	396	532	609
Industrial wastes	5 005	7 378	5 887	6 103	6 404	3 246	3 144	2 902	267	267	375	379	301
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
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
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
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
Gas works gas									3 041	2 425	2 344	2 290	3 088

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	79 319	65 180	68 898	31 099	31 230	32 262	33 051	30 939	27 448.95	79 319	65 180	68 898	31 099	31 230
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	4 658	4 691	4 915	2 831	9 247	11 152	10 528	10 029	14 998.87	4 658	4 691	4 915	2 831	9 247
Fuel wood and wood waste	2 742	3 606	5 922	8 432	11 060	12 462	11 118	12 181	11 764.47	2 742	3 606	5 922	8 432	11 060
Biogas	823	469	539	2 763	4 204	4 872	5 718	6 298	2 855.99	823	469	539	2 763	4 204
Industrial wastes	305	399	533	354	292	292	377	601	366	305	399	533	354	292
Municipal waste - non-biogenic fraction				367	371	337	208	727	3 615				367	371
Municipal waste – biogenic fraction									322.65					
Other petroleum products														
Petroleum coke														
Coke														
Liquid petroleum gas (LPG)									1.4					
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	86	43							53	86	43			

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	1 520	1 880	1 120	400	160	80	80	80	22	1 520	1 880	1 120	400	160
Feedstocks														
Refinery gas														
Petroleum coke oven gas	7 821	3 310	3 576	6 159	5 676	5 776	5 785	8 175	10 414	7 821	3 310	3 576	6 159	5 676
Blast furnace gas	5 715	7 036	4 484	1 638	2 588	3 040	2 680			5 715	7 036	4 484	1 638	2 588
Gas works gas	2 589	3 640	4 750	647	393	292	312	377	326	2 589	3 640	4 750	647	393

Table A1.3. Fuel consumption [TJ] in 1.A.1.a category - District heating plants SNAP 0102

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Lignite	3 352	2 820	2 480	848	348	584	610	475	394	347	337	357	310
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
Fuel wood and wood waste	4 163	3 279	4 224	460	302	398	278	647	503	528	535	647	805
Biogas	14	3	24		6	8	7	7	35	49	47	31	6
Industrial wastes	93	59	294	50	226	164	95	136	283	308	5	7	14
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
Liquid petroleum gas (LPG)								46	184	230	184	184	184
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
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
Feedstocks													
Refinery gas													
Petroleum coke oven gas	1 825	1 966	1 708	429	909	907	889	897	881	914	965	1 066	780
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	

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	149 953	132 073	127 145	138 920	121 134	115 726	105 605	99 447	111 580	149 953	132 073	127 145	138 920	121 134
Lignite	301	290	289	311	386	301	258	364	440	301	290	289	311	386
Hard coal briquettes (patent fuels)														
Brown coal briquettes									1.5					
Crude oil														
Natural gas	12 532	13 023	12 300	11 560	10 087	10 768	9 055	8 728	8 534	12 532	13 023	12 300	11 560	10 087
Fuel wood and wood waste	1 056	1 470	1 665	1 878	1 685	1 995	1 712	1 494	2 433	1 056	1 470	1 665	1 878	1 685
Biogas	20		1	15	15	15	14	16		20		1	15	15
Industrial wastes	63	56	8	88	128	89	93	92	178	63	56	8	88	128
Municipal waste - non-biogenic fraction							106	132						
Municipal waste – biogenic fraction							16	9	5.5					
Other petroleum products				60	31								60	31
Petroleum coke														
Coke	912	598	342	57	28	28	28		1.2	912	598	342	57	28
Liquid petroleum gas (LPG)	46								4.6	46				
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	1 759	1 330	1 072	563	390	433	433	387	502	1 759	1 330	1 072	563	390

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	4 240	1 600	1 080	960	920	320	320	280	383	4 240	1 600	1 080	960	920
Feedstocks														
Refinery gas														
Petroleum coke oven gas	1 025	280	314	417	415	398	397	403	415	1 025	280	314	417	415
Blast furnace gas		17	5								17	5		
Gas works gas	3	54	56	46		60	12	15	22	3	54	56	46	

Table A1.4. Fuel consumption [TJ] in 1.A.1.b category - Petroleum refining SNAP 0103

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Fuel wood and wood waste													
Biogas													
Industrial wastes	5 222	272	682	2	259	1 919	350	163		310	219	95	253
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products							520	1 080	880	1 720		40	40
Petroleum coke													
Coke		28											
Liquid petroleum gas (LPG)								46	92	184	276		46
Motor gasoline										90	135		
Jet kerosene													
Diesel oil													
Fuel oil	43	43		86	86	172	172	214	343	86	1 373	386	858
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
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
Petroleum coke oven gas									81	51	69	70	
Blast furnace gas													
Gas works gas													

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal				114	91	113	158	916	802				114	91
Lignite					22	63	23	11						22
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	12 770	15 535	14 482	19 363	30 638	34 779	35 103	25 957	25 802	12 770	15 535	14 482	19 363	30 638
Fuel wood and wood waste														
Biogas														
Industrial wastes	176	221	285						2	176	221	285		
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products	40	360	320	450	1 271	992	960	785	1 223	40	360	320	450	1 271
Petroleum coke														
Coke														
Liquid petroleum gas (LPG)	92				92	92	138	644	843	92				92
Motor gasoline	135								9.5	135				
Jet kerosene														
Diesel oil			43									43		
Fuel oil	343	987	300	130	130	43	87	172	12	343	987	300	130	130

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	43 520	43 000	42 560	46 560	31 400	22 200	21 640	33 760	33 486	43 520	43 000	42 560	46 560	31 400
Feedstocks														
Refinery gas	10 048	11 632	10 692	22 869	28 215	20 988	15 444	18 909	21 819	10 048	11 632	10 692	22 869	28 215
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A1.5. Fuel consumption [TJ] in 1.A.1.c category - Manufacture of solid fuels SNAP 0104

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hard coal	91	68	46	803	2 156	1 302	1 705	280	70	23			47
Lignite													
Hard coal briquettes (patent fuels)													
Brown coal briquettes													
Crude oil													
Natural gas			181	269	462	518	398	570	744	540	424	253	65
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					
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
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
Gas works gas	5	47	10	4		6	36	19	165	166	4	4	4

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	70	4 488	2 768	327	1 845	1 597	1 884	1 894	2 484	70	4 488	2 768	327	1 845
Lignite									4					
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	10			14	3	3	2	2	2	10			14	3
Fuel wood and wood waste														
Biogas									16					
Industrial wastes								1						
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	114	57	28							114	57	28		
Liquid petroleum gas (LPG)														
Motor gasoline									13					
Jet kerosene														
Diesel oil														
Fuel oil									1.7					

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	35 822	40 686	35 560	43 511	38 516	40 094	40 177	42 278	40 522	35 822	40 686	35 560	43 511	38 516
Blast furnace gas	21	30	42							21	30	42		
Gas works gas	4	4	3	12	12	8	1			4	4	3	12	12

Table A1.6. Fuel consumption [TJ] in 1.A.1.c category - other energy industries SNAP 0105

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hard coal	3 734	5 380	3 355	20 145	50 782	51 744	54 960	53 298	50 142	42 346	32 313	29 904	14 897
Lignite	78	132	73	313	303	336	370	324	286	276	258	298	279
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
Natural gas	12 360	12 416	14 456	12 010	16 822	14 102	22 798	20 471	16 966	18 847	19 004	12 567	12 113
Fuel wood and wood waste											3	3	21
Biogas													
Industrial wastes				309			31				2		
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products							80	80	40	80	40		40
Petroleum coke													
Coke	86	114	142	171	86	86	86	28	28		142		
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
Light fuel oil					40	40							
Feedstocks													
Refinery gas													
Petroleum coke oven gas				520	252	184	429	428	233	230	228	320	298
Blast furnace gas													
Gas works gas		128		116			25						

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	17 269	11 508	8 668	1 734	614	587	566	893	1 007	17 269	11 508	8 668	1 734	614
Lignite	248	220	175	291	246	221	260	102	59	248	220	175	291	246
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil	128	126								128	126			
Natural gas	9 078	10 699	9 942	10 139	11 119	11 987	12 760	24 054	17 788	9 078	10 699	9 942	10 139	11 119
Fuel wood and wood waste	1			57	52	45	39		26	1			57	52
Biogas														
Industrial wastes				1	1	1	1	1					1	1
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction									2					
Other petroleum products	40	40	80	30	31	32			20	40	40	80	30	31
Petroleum coke														
Coke									1					
Liquid petroleum gas (LPG)									1					
Motor gasoline									4					
Jet kerosene														
Diesel oil									1					
Fuel oil	1 029	901	1 030	1 256	1 169	1 516	1 126	1 419	1 176	1 029	901	1 030	1 256	1 169

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	260	226	155	142	135	123	119	106	108	260	226	155	142	135
Blast furnace gas														
Gas works gas														

Table A1.7. Fuel consumption [PJ] in 1.A.2.a category - Stationary combustion in manufacturing industries : Iron and steel

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Lignite		0.019						0.009					
Hard coal briquettes (patent fuels)												0.029	0.029
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
Fuel wood and wood waste	0	0	0	0.016	0.014	0.005	0.006	0.004	0.006	0.004	0.003	0.006	0.003
Biogas													
Industrial wastes	4.079	6.756	6.497	4.272	3.757	2.941	0.498						
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products													
Petroleum coke													
Coke	9.076	19.909	22.910	28.028	34.566	28.031	25.180	29.632	24.400	21.724	22.144	17.650	20.776
Liquid petroleum gas (LPG)								0.046	0	0.046	0.184	0.184	0.230
Motor gasoline													
Jet kerosene													
Diesel oil													
Fuel oil	0.172	0.129	0.172	0.343	0.558	0.772	0.901	0.558	0.300	0.343	0.515	0.172	0.129
Light fuel oil	11	7.800	5.280	4.280	2.960	2.040	0.960	4.720	1.600	1.800	1.040	0.640	
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
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
Gas works gas	2.174	1.462	0.718	0.613	0.067	0.068	0.080	0.058	0.007	0.008		0.277	0.706

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	12.593	16.840	10.744	9.071	11.747	3.950	4.784	2.635	2.545	2.299	1.972	2.448	0.756	0.688
Lignite														
Hard coal briquettes (patent fuels)	0.029			0.029						0.029				
Brown coal briquettes														
Crude oil														
Natural gas	14.827	19.964	20.455	20.998	22.716	20.397	16.595	16.916	17.209	16.905	16.242	16.096	16.701	19.459
Fuel wood and wood waste	0.004	0.004	0.002	0.001	0.001	0.001	0.001				0.001	0.001	0.001	0.001
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke	0	0	0	0	0	0	0	0	0.032	0.064	0.032	0.064	0.064	0.053
Coke	22.147	22.831	15.847	12.684	4.874	5.613	2.679	3.050	8.062	9.636	10.601	9.687	11.260	8.531
Liquid petroleum gas (LPG)	0.184	0.138				0.046	0.046	0.046	0.046	0.092	0.046	0.046	0.046	0.051
Motor gasoline														0.002
Jet kerosene														
Diesel oil														
Fuel oil	0.129	0.129	0.086	0.129	0.086	0.086	0.087	0.087	0.087	0.043	0.043	0.087	0.086	0.115

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas	16.132	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
Blast furnace gas	25.282	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
Gas works gas	1.195	1.654	0.965	1.015	1.313	0.993	0.474	0.187	0.203	0.047	0.028	0.099	0.770	0.607

Table A1.8. Fuel consumption [PJ] in 1.A.2.b category - Stationary combustion in manufacturing industries : Non-Ferrous Metals

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hard coal	0.455	0.565	0.850	1.916	1.771	4.172	4.285	3.907	3.331	3.117	3.108	3.790	2.560
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
Fuel wood and wood waste				0.001	0.001		0.149	0.042	0.026	0.010	0.011	0.005	0.001
Biogas													
Industrial wastes	0.439	0.483	0.514	0.729	0.823	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
Liquid petroleum gas (LPG)							0.046				0.046	0.092	0.046
Motor gasoline													
Jet kerosene													
Diesel oil													
Fuel oil	0.043	0.043	0.129	0.086	0.129	0.172	0.214	0.214	0.257	0.172	0.257	0.172	0.172
Light fuel oil	0.760	0.800	0.800	0.760	0.800	0.720	0.680	0.640	0.520	0.560	0.560	0.520	0.400
Feedstocks													
Refinery gas													
Petroleum coke oven gas	0.397	0.178	0.186	0.043									
Blast furnace gas													
Gas works gas	0.042	0.006							2.164	2.070	2.268	2.551	2.739

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	2.115	1.092	0.024	0.024	0.570				0.250	0.114	0.113	0.091	0.023	0.061
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	5.868	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
Fuel wood and wood waste														
Biogas														
Industrial wastes								0.001						
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products		0.040												
Petroleum coke														
Coke	5.928	5.956	5.814	6.042	6.441	6.640	6.270	6.042	6.214	6.384	6.270	6.469	6.840	5.236
Liquid petroleum gas (LPG)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046					0.023
Motor gasoline														
Jet kerosene														
Diesel oil														0.002
Fuel oil	0.129	0.172	0.172	0.172	0.172	0.172	0.173	0.216	0.173	0.173	0.173	0.173	0.129	0.163

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	0.320	0.400	0.400	0.400	0.160	0.160	0.160	0.120	0.120	0.120	0.120	0.080	0.120	0.241
Feedstocks														
Refinery gas														
Petroleum coke oven gas									0.039	0.043	0.039	0.051	0.047	0.053
Blast furnace gas														
Gas works gas	2.539	1.763	0.961	0.951	0.949	1.220	1.086	0.960	0.967	0.928	1.066	1.275	1.316	1.202

Table A1.9. Fuel consumption [PJ] in 1.A.2.c category - Stationary combustion in manufacturing industries : Chemicals

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Lignite	0.039	0.038	0.027	0.047	0.029	0.428	0.460	0.389	0.429	0.138			
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
Fuel wood and wood waste	0.118	0.039	0.010	0.003	0.035	0.007							0.001
Biogas									0.001				
Industrial wastes	16.712	18.586	17.039	18.003	22.591	21.546	17.374	14.356	0.672	0.582	0.607	0.618	0.567
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products							2.600	2.880	3.440	2.520	0.480	0.480	0.280
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
Liquid petroleum gas (LPG)				0.046									
Motor gasoline													
Jet kerosene													
Diesel oil													
Fuel oil	0.987	0.858	0.772	0.729	0.729	0.944	1.072	1.072	1.416	1.330	1.030	4.762	4.247
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
Feedstocks													
Refinery gas	0.396	3.465	5.445	4.455	0.198	1.584	6.584	9.652	18.513	19.602	23.314	20.542	20.740
Petroleum coke oven gas	0.701	0.522	0.440	1.548	0.276	0.729	0.784	0.140	0.174	0.130	0.050	0.150	0.285
Blast furnace gas	0.047	0.010	0.006	0.011	0.014	0.023	0.004	0.013	0.004	0.007	0.011	0.008	0.004
Gas works gas	0.214	0.192	0.133	0.126	0.110	0.070	0.052						

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	27.959	26.665	27.446	25.398	26.780	43.781	42.011	47.304	47.704	46.768	47.308	46.501	42.588	41.332
Lignite														
Hard coal briquettes (patent fuels)														0.001
Brown coal briquettes														
Crude oil														
Natural gas	6.457	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
Fuel wood and wood waste	0.153	0.094	0.153		0.121		0.058	0.058	0.053	0.131	0.050	0.103	0.088	0.138
Biogas												0.008	0.006	0.006
Industrial wastes												1.082	0.936	0.652
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products	0.240		0.040	0.040										
Petroleum coke														
Coke	1.568	1.881	1.454	2.964	1.938	1.168	0.884	0.826	1.340	3.164	3.021	2.992	3.164	3.457
Liquid petroleum gas (LPG)							0.092	0.138	0.138	0.138	0.184	0.138	0.230	5.020
Motor gasoline							0.090		0.045	0.045	0.045			0.009
Jet kerosene														
Diesel oil														
Fuel oil	4.333	3.904	3.775	4.076	3.732	3.689	4.590	4.200	3.637	3.334	4.027	2.468	2.279	1.482

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	7.080	7.280	3.880	3.840	3.560	0.640	1.080	0.600	0.720	0.560	0.440	0.400	0.560	0.409
Feedstocks														
Refinery gas	21.830	22.424	18.266	21.334	22.473	19.156	20.889	17.176	12.276	9.702	11.979	10.296	7.425	8.015
Petroleum coke oven gas	0.634	0.606	0.608	0.547	0.658	0.654	0.483	0.627	0.616	0.595	0.639	0.645	0.624	0.598
Blast furnace gas	0.013	0.019	0.006											
Gas works gas														

Table A1.10. Fuel consumption [PJ] in 1.A.2.d category - Stationary combustion in manufacturing industries : Pulp. Paper and Print

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Lignite													
Hard coal briquettes (patent fuels)													
Brown coal briquettes													
Crude oil													
Natural gas	0.101	0.061	0.026	0.061	0.250	0.232	0.455	1.096	0.563	1.007	1.210	1.445	1.461
Fuel wood and wood waste	0.001			1.585	1.610	15.437	16.243	16.472	16.476	15.545	15.938	15.138	16.622
Biogas													
Industrial wastes													
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products													
Petroleum coke													
Coke	0.256	0.285	0.256	0.314	0.285	0.285	0.256	0.142	0.086		0.028	0.028	0.028
Liquid petroleum gas (LPG)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.092	0.184	0.092	0.138	0.092	0.046
Motor gasoline													
Jet kerosene													
Diesel oil													
Fuel oil	0.043	0.086	0.043	0.043	0.086	0.129	0.601	0.987	1.115	0.815	0.601	0.472	0.429
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
Feedstocks													
Refinery gas													
Petroleum coke oven gas	0.003	0.003	0.002	0.003	0.002	0.002	0.001						
Blast furnace gas													
Gas works gas	0.003	0.014	0.002				0.004						

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	14.050	13.797	13.430	11.592	9.452	7.850	8.515	10.086	11.301	10.643	11.460	11.291	10.922	9.790
Lignite														
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	2.094	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
Fuel wood and wood waste	17.950	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
Biogas							0.018	0.049	0.073	0.083	0.091	0.105	0.086	0.111
Industrial wastes											0.037	0.125	0.108	0.190
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products			0.040	0.040										
Petroleum coke														
Coke	0.057	0.028	0.028	0.028	0.028	0.028		0.028						
Liquid petroleum gas (LPG)	0.046	0.092	0.046	0.092	0.184	0.046	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.109
Motor gasoline	0.090													0.015
Jet kerosene														
Diesel oil														
Fuel oil	0.472	0.472	0.343	0.386	0.429	0.300	0.303	0.260	0.216	0.173	0.260	0.173	0.258	0.473

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	1.600	1.680	1.600	1.600	1.720	1.640	1.600	1.640	1.680	1.520	1.520	1.280	1.480	1.323
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A1.11. Fuel consumption [PJ] in 1.A.2.e category - Stationary combustion in manufacturing industries : Food Processing. Beverages and Tobacco

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hard coal	31.914	35.940	32.724	55.643	53.801	73.024	88.777	78.207	64.659	46.327	43.417	31.914	35.940
Lignite	0.058	0.019	0.018	0.369	0.195	0.265	0.380	0.250	0.317	0.237	0.191	0.058	0.019
Hard coal briquettes (patent fuels)				0.205	0.205	0.059	0.029						
Brown coal briquettes													
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	1.970	1.984
Fuel wood and wood waste	0.091	0.094	0.072	0.151	0.056	0.082	0.094	0.075	0.101	0.069	0.049	0.091	0.094
Biogas									0.003	0.020	0.063		
Industrial wastes			0.031	0.003	0.003						0.001		
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products							0.080	0.080	0.040				
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	3.334	2.936
Liquid petroleum gas (LPG)	0.046	0.046	0.046	0.046	0.092	0.138	0.184	0.184	0.276	0.460	0.690	0.046	0.046
Motor gasoline	0.135	0.090	0.135	0.180	0.135	0.180	0.180	0.045	0.090	0.045	0.135	0.135	0.090
Jet kerosene													
Diesel oil													
Fuel oil	1.244	1.030	0.901	1.201	1.072	0.901	5.448	5.191	6.821	7.465	7.336	1.244	1.030
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	1.640	1.480
Feedstocks													
Refinery gas													
Petroleum coke oven gas	0.111	0.125	0.124	0.102	0.003	0.025	0.004					0.111	0.125
Blast furnace gas													
Gas works gas	0.051	0.014	0.001	0.001			0.003					0.051	0.014

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	40.020	41.803	39.030	36.095	35.894	30.864	31.165	26.778	25.814	25.903	25.614	26.172	24.724	24.428
Lignite	0.149	0.192	0.175	0.129	0.092	0.074								
Hard coal briquettes (patent fuels)														
Brown coal briquettes	0.020													
Crude oil														
Natural gas	11.363	12.490	15.075	16.164	17.456	18.623	20.614	20.725	20.950	21.610	22.128	23.704	24.475	25.094
Fuel wood and wood waste	0.062	0.060	0.323	0.373	0.214	0.239	0.164	0.365	0.192	0.441	0.534	0.436	0.664	0.747
Biogas	0.042	0.037	0.063	0.074	0.068	0.072	0.084	0.094	0.109	0.101	0.145	0.199	0.202	0.350
Industrial wastes	0.014													
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	1.368	1.539	1.340	1.226	0.969	0.855	0.912	0.656	0.656	0.627	0.542	0.314	0.370	0.456
Liquid petroleum gas (LPG)	0.874	1.426	1.380	1.564	1.426	1.196	0.920	1.012	0.966	0.828	0.782	0.690	0.828	0.966
Motor gasoline	0.045	0.090	0.090	0	0.045	0.045	0.045	0.045	0.045	0.045				
Jet kerosene														
Diesel oil														
Fuel oil	7.250	6.864	6.864	6.178	5.405	4.504	4.076	4.504	3.161	2.901	2.382	2.944	1.992	1.516
Light fuel oil	2.720	2.960	3.040	3.280	3.160	2.920	2.760	2	1.440	1.240	1.360	1.360	1.080	1

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A1.12. Fuel consumption [PJ] in 1.A.2.f category - Stationary combustion in manufacturing industries : Non-metallic minerals and other industries

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hard coal	72.637	72.514	68.894	76.924	83.926	79.647	86.930	81.562	66.639	59.965	53.349	41.103	33.981
Lignite	0.156	0.150	0.091	0.161	0.117	0.163	0.150	0.185	0.153	0.069	0.057	0.009	0.019
Hard coal briquettes (patent fuels)											0.029		
Brown coal briquettes	0.020	0.020						0.040	0.040	0.040	0.040	0.020	0.020
Crude oil													
Natural gas	24.574	22.704	22.246	21.986	21.506	25.518	26.650	25.655	27.097	23.917	27.976	31.858	33.233
Fuel wood and wood waste	1.155	0.455	0.042	0.033	0.004	0.010	0.010	0.005	0.006	0.002	0.006	0.275	0.292
Biogas													
Industrial wastes	0.068	0.023	0.267	0.250	0.145	0.197	0.144	0.047	0.207	0.529	0.472	0.524	0.508
Municipal waste - non-biogenic fraction													
Municipal waste – biogenic fraction													
Other petroleum products								1.400	1.200	0.400			
Petroleum coke													
Coke	13.936	11.314	11.115	10.716	11.400	10.118	11.144	8.664	10.089	8.008	6.868	4.874	4.418
Liquid petroleum gas (LPG)					0.092	0.138	0.046	0.092	0.230	0.322	0.506	0.736	1.610
Motor gasoline								0.135					
Jet kerosene													
Diesel oil													
Fuel oil	0.944	0.815	0.772	0.772	0.944	1.330	1.802	2.788	2.016	1.716	1.630	1.973	2.145
Light fuel oil	4.160	2.800	3.560	3.960	4.320	6.080	3.760	4.120	6.680	5.920	3.880	4.320	4.600
Feedstocks													
Refinery gas													
Petroleum coke oven gas	2.101	1.821	1.341	1.234	0.482	0.886	0.509	0.353	0.988	0.804	0.413	0.897	0.767
Blast furnace gas	0.101	0.106	0.079	0.108	0.120	0.053	0.053	0.036	0.010	0.005	0.011	0.003	0.003
Gas works gas	3.270	3.136	2.706	2.392	2.090	1.788	1.033	0.501	0.330	0.304			

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	30.332	32.309	31.182	31.523	43.846	36.975	26.468	28.045	34.403	26.766	22.808	23.013	20.539	21.780
Lignite						0.063	0	0.224	0.283	0.549	0.347	0.487	0.545	0.526
Hard coal briquettes (patent fuels)														0.009
Brown coal briquettes	0.040	0.040	0.040	0.040	0.040	0.040					0.180			
Crude oil														
Natural gas	35.584	38.225	38.955	41.274	42.465	39.696	41.394	42.872	44.492	42.349	40.911	40.873	40.514	43.984
Fuel wood and wood waste	0.102	0.261	0.110	0.139	0.116	0.223	0.285	0.299	0.348	0.407	0.498	0.724	0.623	0.511
Biogas											0.004	0.044	0.040	0.038
Industrial wastes	1.471	1.818	2.701	5.043	5.961	7.400	7.715	10.454	11.729	12.170	12.763	15.171	15.068	17.249
Municipal waste - non-biogenic fraction	0.003	0.013	0.717	1.620	1.776	0.378	4.419	4.512	5.017	3.913	3.752	4.060	4.011	8.179
Municipal waste – biogenic fraction					0.001	0.001	0.029	0.123	1.338	1.360	1.391	1.528	1.664	2.094
Other petroleum products														
Petroleum coke	4.416	3.232	7.072	3.584	1.568	1.152	2.752	1.792	0.064	0.064	0.160	0.032	0	0.933
Coke	4.874	4.674	2.594	3.050	4.503	2.679	2.280	2.536	2.679	2.508	2.366	2.508	3.164	2.754
Liquid petroleum gas (LPG)	1.380	1.656	0.874	0.368	0.322	0.368	0.460	0.414	0.368	0.230	0.322	0.414	0.368	0.321
Motor gasoline							0.045						0.043	0.040
Jet kerosene														
Diesel oil														
Fuel oil	2.274	2.788	2.188	1.888	1.845	2.188	1.992	1.992	2.338	1.862	1.472	1.299	1.290	1.411

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	4.520	4.480	4.080	2.880	2.120	2.400	1.960	1.840	1.640	1.400	1.320	0.680	0.280	0.212
Feedstocks														
Refinery gas														
Petroleum coke oven gas	0.746	1.505	1.370	1.465	1.614	1.523	1.233	1.614	1.866	1.687	1.552	1.951	1.841	2.006
Blast furnace gas							0.001							
Gas works gas														

Table A1.13. Activity data for 1.A.2.a category [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sinter and pelletizing plants	11 779 441	8 612 668	8 621 683	7 628 228	8 787 422	8 646 567	8 318 575	8 980 785	6 882 149	6 475 927	8 078 720	7 352 758	7 616 887
Pig iron	8 423400	7 391 200	6 359 000	6 161 600	6 931 900	7 420 000	6 600 000	7 343 000	6 179 000	5 233 000	6 491 867	5 440 047	5 296 410
Casting of iron	887 800	603 200	549 600	583 200	629 800	1 137 438	1 073 413	1 054 730	904 220	882 894	982 735	984 608	876 968
Casting of steel	178 600	100 400	69 000	68 500	72 500	175 901	193 919	178 378	140 090	123 874	124 775	122 748	109 009
Primary lead production	64 812	50 776	53 693	62 305	61 248	66 421	66 000	64 700	64 300	64 000	45 412	28 823	34 000
Primary zinc production	132 131	126 067	134 594	149 107	157 618	166 421	165 000	173 000	178 000	178 000	161 835	160 147	145 725
Primary copper production	346 083	378 479	387 010	404 170	405 093	406 708	425 000	441 000	447 000	470 000	462 838	485 869	510 725

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sinter and pelletizing plants	7 732 206	8 590 558	6 168 357	5 837 251	6 672 473	6 854 233.70	7 389 437.90	7 429 860.70	6 850 463.40	7 732 206	8 590 558	6 168 357	5 837 251	6 672 473
Pig iron	5 631 830	6 400 007	4 476 622	3 637 995	3 943 968	4 013 877	4 637 478	5 620 849	4 673 680	5 631 830	6 400 007	4 476 622	3 637 995	3 943 968
Casting of iron	865 238	893 865	914 745	769 232	1 022 158	1 035 451	1 037 492	1 068 112	1 038 530	865 238	893 865	914 745	769 231.56	1 022 158.03
Casting of steel	111 511	117 354	133 187	148 132	113 187	115 604	120 879	109 670	110 989	111 511	117 354	133 187	148 132	113 187
Primary lead production	55 563	56 827	62 455	91 174	95 801	91 611	86 285	68 790	65 731	55 563	56 827	62 455	91 174	95 801
Primary zinc production	131 938	131 332	113 822	97 942	133 566	134 148	123 060	114 767	107 145	131 938	131 332	113 822	97 942	133 566
Primary copper production	559 960	547 228	555 681	469 656	466 715	458 789	503 111	514 774	446 902	559 960	547 228	555 681	469 656	466 715

Table A1.14. Activity data for 1.A.2.b category [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Plaster furnaces	191 700	246 600	222 100	290 000	357 000	407 000	450 000	504 000	511 000	459 000	444 700	1 034 500	1 243 600
Secondary lead production	10 836	10 836	14 825	10 474	11 854	14 235	22 375	30 710	39 259	17 416	32 261	32 261	66 500
Secondary zinc production	3 034	3 034	2 963	3 160	2 924	8 235	15 512	15 878	14 000	16 034	8 140	8 140	12 700
Secondary copper production: BOF	17 304	18 924	19 351	20 209	20 255	20 335	21 250	22 050	22 350	23 500	19 628	27 931	29 355
Secondary copper production: excl. BOF's	6 147	4 527	34 322	29 132	36 475	61 947	93 002	92 202	91 902	90 752	126 593	95 247	93 823
Secondary aluminium production	22 520	22 520	31 102	17 948	34 092	91 629	116 925	116 925	116 925	116 925	116 925	116 925	119 134

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Plaster furnaces	1 442 800	557 000	771 000	1 346 800	1 220 300	1 263 700	1 072 700	1 099 100	1 118 500	1 442 800	557 000	771 000	1 346 800	1 220 300
Secondary lead production	66 979	39 414	39 414	45 644	56 048	57 894	88 555	77 756	63 108	66 979	39 414	39 414	45 644	56 048
Secondary zinc production	26 649	31 095	31 095	36 010	44 218	45 675	69 864	61 094	49 585	26 649	31 095	31 095	36 010	44 218
Secondary copper production: BOF	24 098	33 317	28 254	78 420	82 297	78 009	72 585	67 624	60 369	24 098	33 317	28 254	78 420	82 297
Secondary copper production: excl. BOF's	99 080	89 861	71 880	90 815	83 473	67 231	85 706	87 003	92 783	99 080	89 861	71 880	90 815	83 473
Secondary aluminium production	122 682	251 587	246 700	238 787	302 388	416 492	390 210	526 546	507 615	122 682	251 587	246 700	238 787	302 388

Table A1.15. Activity data for 1.A.2.f category [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Clinker	10 309 000	10 235 000	10 469 000	9 730 000	12 558 000	12 602 000	11 756 000	12 739 000	11 974 000	11 678 000	11 558 500	9 335 100	8 811 600
Asphalt mixing	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
Bricks and tiles	3 948 800	3 363 200	3 465 600	3 580 800	3 587 200	2 848 000	2 713 600	3 136 000	2 832 000	2 432 000	2 591 680	2 133 440	1 707 200
Ceramics	219 467	192 011	183 000	191 056	199 181	172 225	210 646	282 860	418 500	483 700	694 428	687 894	903 709

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Clinker	8 647 400	9 620 600	9 468 400	11 767 800	11 807 300	10 855 300	11 865 500	11 278 400	12 075 300	8 647 400	9 620 600	9 468 400	11 767 800	11 807 300
Asphalt mixing	1 001 500	1 097 200	1 311 500	1 855 000	1 700 900	1 374 800	1 326 800	1 628 100	1 452 000	1 001 500	1 097 200	1 311 500	1 855 000	1 700 900
Bricks and tiles	1 553 920	1 640 960	1 428 800	760 640	591 680	419 840	449 280	332 480	361 600	1 553 920	1 640 960	1 428 800	760 640	591 680
Ceramics	1 096 774	1 307 626	1 347 381	1 521 039	1 556 120	1 636 740	1 589 511	1 724 140	1 698 117	1 096 774	1 307 626	1 347 381	1 521 039	1 556 120

Table A1.16. Fuel consumption [TJ] in 1.A.4. a i category - Commercial/Institutional: Stationary SNAP 0201

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
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
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
Biogas	379	187	206	62	249	423	579	599	648	663	678	860	683
Industrial wastes	504	81	11	352	89		124		3	4	4	91	92
Municipal waste - non-biogenic fraction											20		9
Municipal waste – biogenic fraction											19		10
Other petroleum products										640	880	3 000	360
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
Liquid petroleum gas (LPG)					1 334	782	782	1 748	1 564	2 070	2 300	3 266	3 358
Motor gasoline													
Jet kerosene													
Diesel oil													
Fuel oil							987	4 290	6 220	7 636	13 342	15 015	19 090
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

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	21 539	22 502	25 405	34 503	32 855	30 116	27 068	25 958	26 811	21 539	22 502	25 405	34 503	32 855
Lignite				1 475	531	515	402	327	273				1 475	531
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	67 057	69 564	68 410	83 433	80 888	76 501	67 429	71 823	80 972	67 057	69 564	68 410	83 433	80 888
Fuel wood and wood waste	5 752	6 028	6 171	8 029	6 833	7 433	6 556	6 530	7 716	5 752	6 028	6 171	8 029	6 833
Biogas	700	1 325	1 602	1 830	2 280	2 123	2 118	2 361	2 701	700	1 325	1 602	1 830	2 280
Industrial wastes	60	2	22	21	9	388	79	145	116	60	2	22	21	9
Municipal waste - non-biogenic fraction	11			5	28	33	152	50	239	11			5	28
Municipal waste – biogenic fraction	14	13	30						808	14	13	30		
Other petroleum products	1 720	2 000		60						1 720	2 000		60	
Petroleum coke									0.01					
Coke	8 180	5 928	2 679	2 109	741	1 083	570	826	1 120	8 180	5 928	2 679	2 109	741
Liquid petroleum gas (LPG)	5 520	5 014	4 600	3 404	4 048	2 852	3 726	2 990	3 596	5 520	5 014	4 600	3 404	4 048
Motor gasoline														
Jet kerosene														
Diesel oil									1.7					
Fuel oil	16 774	14 286	13 213	27 409	18 402	15 155	14 722	14 448	14 502	16 774	14 286	13 213	27 409	18 402

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil				80									80	
Feedstocks														
Refinery gas														
Petroleum coke oven gas				1	1		1		0.01				1	1
Blast furnace gas														
Gas works gas	4	3	3	17	14	10	2			4	3	3	17	14

Table A1.17. Fuel consumption [TJ] in 1.A.4. b i category - Residential: Stationary plants SNAP0202

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Lignite	526	42		2 956	4 403	4 279	3 420	2 626	1 772	1 286	1 169	1 373	1 482
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
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
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
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
Motor gasoline													
Jet kerosene													
Diesel oil													
Fuel oil							2 145	6 435	8 580	9 781	17 160	21 450	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

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	207 214	219 654	249 994	319 753	291 964	280 095	257 420	252 837	269 100	207 214	219 654	249 994	319 753	291 964
Lignite	1 605	1 919	2 006	4 035	3 619	4 022	3 214	3 105	2 930	1 605	1 919	2 006	4 035	3 619
Hard coal briquettes (patent fuels)														
Brown coal briquettes														
Crude oil														
Natural gas	127 629	126 376	135 111	148 427	141 397	143 187	131 598	132 202	145 148	127 629	126 376	135 111	148 427	141 397
Fuel wood and wood waste	103 075	103 360	100 700	112 746	116 850	116 850	105 450	105 450	111 435	103 075	103 360	100 700	112 746	116 850
Biogas														
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	8 550	7 125	2 992	6 526	5 415	5 700	4 845	4 275	4 480	8 550	7 125	2 992	6 526	5 415
Liquid petroleum gas (LPG)	25 300	23 920	23 000	24 840	23 000	21 620	22 540	21 390	22 546	25 300	23 920	23 000	24 840	23 000
Motor gasoline														
Jet kerosene														
Diesel oil														
Fuel oil	22 952	21 450	19 305	4 546	3 767	3 464	3 031	3 010	3 010	22 952	21 450	19 305	4 546	3 767

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil														
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas	128	113	95	67	40	47	36	3		128	113	95	67	40

Table A1.18. Fuel consumption [TJ] in 1.A.4. c i category - Agriculture/Forestry/Fishing – stationary SNAP0203

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
Lignite	844	1 018	911	814	1 642	1 698	1 299	1 292	1 419	1 097	939	1 236	1 395
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
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
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
Liquid petroleum gas (LPG)					460	690	1 150	1 380	1 380	1 610	1 840	2 300	2 760
Motor gasoline				674	1 122	1 122	1 122	1 212	1 122	1 347	1 392	943	269
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
Feedstocks													
Refinery gas													
Petroleum coke oven gas	2	2											
Blast furnace gas													
Gas works gas	1			2					1				

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hard coal	29 693	31 728	35 673	47 291	43 715	41 611	39 003	36 305	39 000	29 693	31 728	35 673	47 291	43 715
Lignite	1 528	2 086	2 188	1 667	1 327	1 609	1 286	1 144	977	1 528	2 086	2 188	1 667	1 327
Hard coal briquettes (patent fuels)		29		29	205	293	264	146	292		29		29	205
Brown coal briquettes					20	520	1 360	700	392					20
Crude oil														
Natural gas	1 197	1 182	1 084	1 486	1 796	1 501	1 438	1 144	1 305	1 197	1 182	1 084	1 486	1 796
Fuel wood and wood waste	19 017	19 878	19 047	21 088	20 948	20 937	19 310	19 116	21 458	19 017	19 878	19 047	21 088	20 948
Biogas				39	252	286	328	385	357				39	252
Industrial wastes														
Municipal waste - non-biogenic fraction														
Municipal waste – biogenic fraction														
Other petroleum products														
Petroleum coke														
Coke	2 850	1 995	1 140	940	285	570	627	256	280	2 850	1 995	1 140	940	285
Liquid petroleum gas (LPG)	3 220	3 220	3 220	2 300	2 300	2 300	2 760	2 622	2 761	3 220	3 220	3 220	2 300	2 300
Motor gasoline	314	224	269	45	45	45	44	43	50	314	224	269	45	45
Jet kerosene														
Diesel oil														
Fuel oil														

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light fuel oil	5 840	5 960	7 200	920	1 360	560	480	400	539.78	5 840	5 960	7 200	920	1 360
Feedstocks														
Refinery gas														
Petroleum coke oven gas														
Blast furnace gas														
Gas works gas														

Table A1.19. Fuel consumption [Gg] in 1.A.4.c category - Agriculture/Forestry/Fishing – mobile

Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1.A.4.c ii													
Off-road transport in agriculture - ON	80	77	81	66	75	74	60	62	45	45	40	42	41
Machinery in agriculture - ON	140	135	141	116	132	130	105	109	79	79	70	74	72
1.A.4.c iii													
Fishery – ON	80	77	81	66	75	74	60	62	45	45	40	42	41
Fishery – OP	140	135	141	116	132	130	105	109	79	79	70	74	72

Fuels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1.A.4.c ii														
Off-road transport in agriculture - ON	2 175	2 215	2 266	1 495	1 518	1 484	1 433	1 426	1 510	2 175	2 215	2 266	1 495	1 518
Machinery in agriculture - ON	242	246	252	166	169	165	159	158	168	242	246	252	16	169
1.A.4.c iii														
Fishery – ON	33	37	32	36	38	41	37	40	42	33	37	32	36	38
Fishery – OP	58	66	56	63	67	72	65	69	73	58	65	56	63	67

Note: ON - diesel oil. OP - fuel oil

Appendix 2. Activity data for categories NFR 1 B - 11

Table A2.1. 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
Lignite extraction	675 846	69 359	66 852	68 105	66 770	63 500	63 800	63 200	62 800	60 800	59 484	59 557	58 210
Hard coal extraction	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
Coke production	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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lignite extraction	60 919	61 198	61 636	56 510	64 280	65 849	63 877	63 128	60 246	60 919	61 198	61 636	56 510	64 280
Hard coal extraction	103 016	100 087	97 903	76 728	79 813	77 056	73 271	72 686	70 784	103 016	100 087	97 903	76 728	79 812
Coke production	10 232	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

Table A2.2. 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
Extraction of crude oil	160 000	158 000	200 000	235 000	284 000	292 000	317 000	289 000	357 000	425 000	652 696	767 004	727 973
Liquid fuel distribution (except gasoline)													
Marine terminals	13 126 000	11 454 000	12 769 000	13674000	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
Refineries throughput	12 866 600	11 733 700	12 583 900	13 372 800	13 447 800	13 443 700	14 603 000	14 884 000	16 191 000	16 784 000	18 080 300	18 113 000	17 878 100
Handling and storage - diesel oil	5 297 000	4 922 000	5 135 000	5572000	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
Petrol distribution													
Refinery dispatch station	2 414 000	2 400 000	3 201 000	3486000	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
Transport and depots	3 773 000	4 100 000	4 750 000	4350000	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
Service stations (including refuelling of cars)	3 773 000	4 100 000	4 750 000	4350000	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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Extraction of crude oil	764 806	886 188	847 844	688 487	677 664	960 672	984 216	927 737	1 001 000	764 806	886 188	847 844	688 487	677 664
Liquid fuel distribution (except gasoline)														
Marine terminals	17 448 300	17 316 100	17 912 300	22 688 120	24 633 000	23 347 000	23 713 000	26 492 000	24 573 000	17 448 300	17 316 100	17 912 300	22 688 120	24 633 000
Refineries throughput	17 459 600	18 068 000	18 191 100	20 049 900	20 024 209	21 036 097	20 303 600	22 842 700	24 001 000	25 152 500	24 997 901	24 885 247	26 142 665	25 790 170
Handling and storage - diesel oil	5 908 000	6 748 000	7 405 000	12 006 000	12 093 000	11 252 000	11 080 000	12 084 000	13 791 000	5 908 000	6 748 000	7 405 000	12 006 000	12 093 000
Petrol distribution														
Refinery dispatch station	4 038 000	4 081 000	4 203 000	4 221 590	4 027 000	4 040 000	3 849 000	4 183 000	4 205 000	4 038 000	4 081 000	4 203 000	4 221 590	4 027 000
Transport and depots	4 212 000	4 198 000	4 065 000	4 145 000	3 872 000	3 669 000	3 583 000	3 781 000	3 998 000	4 212 000	4 198 000	4 065 000	4 145 000	3 872 000
Service stations (including refuelling of cars)	4 212 000	4 115 000	4 008 000	4 145 000	3 872 000	3 669 000	3 583 000	3 781 000	3 998 000	4 212 000	4 115 000	4 008 000	4 145 000	3 872 000

Table A2.3. 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
Extraction of high - methane natural gas	1 260	1 644	1 509	2 129	1 997	1 641,60	1 952	1 988	2 101	2 003,97	2 035	2 088	2 016
Extraction of nitrogenous natural gas	2 622	2 504	2 519	2 821	2 638	2 830,57	2 802	2 848	2 751	2 712,06	2 917	3 090	3 247
Gas distribution networks													
High - methane natural gas	*9 534*	*8 837*	*8 193*	*8 561*	*8 640*	*9 515*	*9 999*	9 938,05	9 278	8 990	*8 974*	*9 195*	*9 024*
Nitrogenous natural gas	*2 829*	*2 716*	*2 684*	*2 927*	*2 719*	*2 938*	*2 956*	2 982,02	1 784	1 460,99	*1 445*	*1 651*	*1 587*
Coke oven gas	*5 784*	*5 056*	*4 881*	*4 435*	*4 911*	*4 873*	*4 229*	4 501	3 426	2 694	*2 910*	*2 956*	*2 804*

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Extraction of high - methane natural gas	2 075	2 297	2 232	2 010	2 016	1 976	1 969	2 014	1 823	2 075	2 297	2 232	2 010	2 016
Extraction of nitrogenous natural gas	3 259	3 333	3 510	3 753	3 972	3 907	3 795	3 748	3 669	3 259	3 333	3 510	3 753	3 972
Gas distribution networks														
High - methane natural gas	*9 786*	*10 273*	*10 913*	14 010	14 819	14 762	14 484	14 608	15 617	*9 786*	*10 273*	*10 913*	14 010	14 819
Nitrogenous natural gas	*1 499*	*1 343*	*1 289*	3 771	3 870	3 942	3 864	3 828	3 753	*1 499*	*1 343*	*1 289*	3 771	3 870
Coke oven gas	*3 277*	*3 260*	*2 757*	1 284	1 178	1 256	1 316	1 098	1 018	*3 277*	*3 260*	*2 757*	1 284	1 178

Table A2.4. Activity data used in the category NFR 2.A (SNAP0406) [Gg]

Industrial process	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cement production	12 518	12 012	11 908	12 200	13 834	13 914	13 959	15 003	14 970	15 555	15 046	12074	11 206
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
Gypsum production	*192*	*247*	*222*	*290*	*357*	*407*	*450*	*504*	*511*	*459*	*445*	*10 355*	*1 244*
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
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
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
Construction and demolition [thous. m^2]	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361

Industrial process	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cement production	11 653	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
Lime production	2 053	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
Gypsum production	*1 443*	*557*	*771*	*1 190*	*1 422*	*1 579*	*1 317*	*1 347*	*1 349*	*1 220*	*1 264*	*1073*	*1 099*	*1 119*
Quarrying and mining of minerals	95 822	99 582	109 421	120 749	138 097	142 791	150 947	160 437	216 615	168 197	157 054	159 807	166 388	158 183
Extraction of mineral ores - copper	29 992	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
Extraction of mineral ores - zinc and lead	4 754	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
Construction and demolition [thous. m^2]	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361	10 361

Table A2.5. Activity data used in the category 2.B *Chemical Industry* [Mg]

Industrial process	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sulfuric acid	1 721 100	1 088 400	1 244 300	1 144 800	1 451 900	1 861 000	1 761 000	1 791 000	1 707 000	1 505 000	1 763 000	1 690 000	1 648 000
Nitric acid production	1 577 200	1 438 200	1 388 300	1 607 600	1 700 500	1 930 500	1 929 000	1 808 000	1 671 000	1 635 000	2 007 363	2 060 012	1 688 879
Ammonia production	1 532	1 561	1 481	1 631	1 945	2 248 317	2 185 188	2 251 616	2 047 948	1 784 726	2 243 108	2 103 805	1 594 797
Carbide production	297 400	283 000	220 800	180 400	173 700	178 000	145 000	120 600	69 600	53 200	39 368	38 351	27 796
Soda ash production and use	*1 334 888*	*1 124 761*	*1 103 430*	*1 007 100*	*1 369 166*	1 019 000	909 000	950 000	1 000 000	926 000	*902 418*	*925 744*	*906 000*
NPK fertilisers	5 423 000	4 287 900	4 547 300	4 707 100	5 539 700	6 491 000	6 625 000	6 558 000	5 983 000	5 634 000	6 868 720	6 441 333	5 923 667
NPK fertilisers - nitrogenous	3 603 800	3 332 600	3 278 200	3 513 500	3 813 900	4 389 000	4 378 000	4 271 000	3 739 000	3 433 000	4 401 118	4 280 696	3 650 044
Carbon black	22 652	17 141	25 877	26 433	25 537	23 256	24 800	25 000	22 600	18 700	13 016	14 713	15 820
Titanium dioxide	30 064	27 107	27 972	24 460	33 515	34 879	34 616	32 419	34 758	37 191	35 235	38 099	37 807
Phosphate fertilizers	1 231 600	563 700	474 100	289 200	364 400	523 000	570 000	596 000	593 000	535 000	323 484	348 949	357 380
Ethylene	500 967	448 219	472 768	476 602	398 537	436 000	493 000	510 000	519 000	494 000	508 341	431 330	522 686
Caprolactam	97 288	103 652	104 681	103 169	106 274	126 276	127 769	130 294	131 310	139 588	146 900	148 600	152 900
Propylene	192 757	176 862	189 641	187 526	163 518	176 000	194 000	202 000	189 000	198 000	249 142	227 902	256 348
Polyethylene	158 527	149 865	163 088	162 178	141 898	155 031	163 000	160 000	173 000	134 000	146 982	155 353	170 005
Polyvinylchloride	203 405	194 808	219 963	212 143	202 273	225 267	254 000	285 000	266 000	259 000	273 930	225 608	248 541
Polypropylene	86 195	88 585	85 666	75 191	75 781	76 445	45 400	35 300	38 200	104 000	122 924	122 915	144 363
Polystyrene	19 096	20 826	25 750	31 509	33 822	46 243	46 500	48 900	51 200	70 600	94 335	92 540	87 228
Polystyrene - EPS	11 840	12 913	15 966	19 537	20 971	28 673	28 832	30 320	31 746	43 775	56 182	50 153	53 296
Polystyrene - GPPS/HIPS	4 128	4 502	5 567	6 812	7 312	9 997	10 053	10 571	11 069	15 263	16 945	19 986	16 079
Formaldehyde	65 000	70 000	75 000	80 000	85 000	90 000	95 000	100 000	105 000	110 000	101 396	94 157	211 081

Industrial process	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sulfuric acid	1 764 000	1 811 000	1 807 000	1 907 000	2 010 000	1 813 000	1 243 000	1 686 000	1 889 000	1 693 000	1 462 000	1 550 000	1 701 000	1 637 000
Nitric acid production	2 030 445	2 084 560	2 219 374	2 200 804	2 269 876	2 267 371	2 139 417	2 209 363	2 168 123	2 322 586	2 279 669	2 365 877	2 396 255	2 340 058
Ammonia production	2 246 505	2 451 557	2 523 790	2 326 621	2 417 543	2 485 148	2 010 891	2 059 437	2 321 849	2 526 174	2 482 151	2 651 068	2 717 823	2 623 085
Carbide production	29 281	27 516	24 740	21 072	16 141									
Soda ash production and use	*917 100*	*975 435*	*996 245*	*1 026 309*	*1 191 665*	*1 424 841*	*889 857*	*1 050 952*	*1 083 222*	*1 161 736*	*1 183 310*	*1 186 661*	*1 203 273*	*1 383 684*
NPK fertilisers	6 974 761	7 384 802	7 463 901	7 347 359	7 896 433	7 290 428	5 759 166	6 966 582	7 389 434	7 719 324	7 340 802	7 744 006	8 171 052	8 164 149
NPK fertilisers - nitrogenous	4 641 510	4 662 097	4 908 027	4 850 113	5 087 104	4 824 952	4 472 445	4 708 955	4 986 790	5 454 509	5 406 997	5 697 547	5 858 052	5 788 574
Carbon black	17 700	34 956	28 510	31 971	38 163	33 349	25 806	32 560	42 148	20 065	27 947	35 431	42 115	53 557
Titanium dioxide	42 300	41 008	41 201	41 003	39 400	40 379	36 363	39 773	38 020	36 788	35 785	36 207	32 415	37 966
Phosphate fertilizers	390 790	441 194	409 863	358 366	465 095	456 990	144 787	309 348	391 128	374 829	310 753	365 851	376 533	403 032
Ethylene	492 482	489 356	446 633	878 300	924 102	798 038	758 595	737 808	813 052	753 229	487 088	471 831	545 115	446 820
Caprolactam	152 373	149 490	159 733	159 708	157 602	144 852	144 974	159 307	164 000	162 995	159 916	167 601	164 695	164 426
Propylene	257 480	245 764	248 656	412 603	408 522	365 336	358 192	337 070	358 842	325 518	351 615	340 441	390 578	335 587
Polyethylene	160 528	153 387	161 566	373 598	397 210	359 762	340 474	364 603	371 009	337 641	347 110	348 168	395 322	346 867
Polyvinylchloride	255 762	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
Polypropylene	145 397	143 405	157 490	215 383	270 777	280 678	267 001	243 444	255 134	248 245	256 608	230 621	298 305	264 049
Polystyrene	82 369	97 488	92 667	101 179	107 815	119 973	127 281	142 051	145 099	143 160	135 731	128 352	132 908	148 249
Polystyrene - EPS	60 150	57 638	59 319	70 446	63 948	78 625	82 593	82 324	85 201	86 238	77 655	75 058	82 802	90 804
Polystyrene - GPPS/HIPS	10 230	20 086	16 729	13 036	21 308	25 561	32 058	42 030	44 836	45 855	47 634	44 435	42 037	47 272
Formaldehyde	221 125	232 450	221 012	232 690	224 060	115 701	96 289	97 837	218 535	221 096	218 535	258 424	243 155	273 295

Table A2.6. Activity data used in the category 2.C *Metal Production* [Mg]

Industrial process	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Pig iron tapping	8 656 711	6 501 541	6 462 033	6 292 896	7 081 233	7 420 000	6 600 000	7 343 000	6 179 000	5 233 000	6 491 867	5 440 047	5 296 410
Open hearth furnace steel plant	3 964 700	2 637 700	1 820 400	1 660 300	1 631 000	1 544 653	1 063 029	1 034 482	495 860	378 389	375 750	177 615	7 271
Basic oxygen furnace steel plant	7 210 000	5 745 500	6 247 700	6 162 000	7 033 500	7 685 488	6 757 479	7 531 274	6 222 532	5 452 751	6 799 681	5 822 518	5 799 042
Electric furnace steel plant	2 446 900	2 047 500	1 797 400	2 114 500	2 446 600	2 581 861	2 648 398	2 906 324	3 116 918	2 825 084	3 289 965	2 809 078	2 561 171
Hot rolling mills	9 835 600	8 036 400	7 549 800	7 631 600	8 594 800	9 542 360	9 064 041	9 834 131	11 710 103	9 849 381	11 477 797	10 161 226	8 010 784
Cold rolling mills	1 200 531	795 588	793 272	857 132	964 433	1 115 993	1 383 377	1 449 947	1 279 267	1 187 535	1 355 819	1 167 569	1 363 179
Sinter and pelletizing plant	11 779 441	8 612 668	8 621 683	7 628 228	8 787 422	8 646 567	8 318 575	8 980 785	6 882 149	6 475 927	8 078 720	7 352 758	7 616 887
Aluminium production	45 974	45 793	43 628	46 942	49 509	55 728	51 900	53 600	54 200	51 000	52 335	54 606	58 777
Ferroalloys production	88 600	60 100	36 100	43 100	54 200	70 400	71 800	77 300	75 000	62 500	55 969	48 608	41 759
Batteries manufacturing	38 692	34 079	32 055	32 603	34 817	39 200	36 200	39 900	40 600	45 200	50 269	53 280	74 179
Secondary lead production	10 836	10 836	14 825	10 474	11 854	14 235	22 375	30 710	39 259	17 416	32 261	32 261	66 500

Industrial process	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pig iron tapping	5 631 830	6 400 007	4 476 622	5 543 350	5 804 418	4 933 781	2 983 500	3 638 000	3 974 922	3 941 428	4 011 968	4 637 478	5 358 991	5 145 076
Open hearth furnace steel plant	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basic oxygen furnace steel plant	6 069 988	6 857 583	4 892 671	5 766 385	6 187 910	5 225 075	3 235 666	3 994 650	4 423 604	4 333 168	4 520 358	5 182 371	5 358 991	5 145 076
Electric furnace steel plant	3 037 396	3 720 889	3 443 227	4 225 253	4 432 806	4 502 250	3 892 816	4 001 427	4 352 854	4 209 346	3 678 994	3 617 102	3 977 479	4 015 584
Hot rolling mills	8 087 541	10 368 737	7 877 168	9 464 920	9 640 042	8 588 582	6 455 376	7 182 091	8 261 158	7 948 503	8 382 473	8 732 852	8 913 453	8 880 729
Cold rolling mills	1 433 451	1 612 251	1 158 969	1 326 434	1 397 755	1 322 845	1 107 456	1 539 529	1 666 144	1 261 491	1 622 662	1 705 887	1 782 930	1 974 825
Sinter and pelletizing plant	7 732 206	8 590 558	6 168 357	6 907 824	6 953 950	6 306 368	4 362 554	5 837 251	6 512 751	6 672 473	6 854 234	7 389 438	7 429 861	6 850 463
Aluminium production	57 237	58 931	53 582	55 939	62 508	46 730	0	0	0	0	0	0	0	0
Ferroalloys production	92 700	83 552	65 118	13 034	58 538	56 031	9 673	53 206	72 668	78 115	73 589	62 878	77 754	77 682
Batteries manufacturing	84 027	92 461	110 072	124 771	124 340	122 403	117 652	147 829	151 001	178 462	179 459	177 185	193 315	206 927
Secondary lead production	66 979	39 414	39 414	38 658	40 600	39 609	40 783	45 644	50 435	56 048	57 894	88 555	77 756	63 108

Table A2.7. 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
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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Domestic solvent use including fungicides	38 191	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

Table A2.8. 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
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
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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Road paving with asphalt	1 001 500	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
Asphalt roofing [thous. m^2]	80 155	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

Table A2.9. 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
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*
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*

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Decorative coating application	254 430	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
Industrial coating application	136 656	142 095	143 986	186 496	153 978	186 473	179 294	199 082	198 716	194 132	204 967	218 711	220 544	229 318

Table A2.10. 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
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*
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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Degreasing [Mg]	18 388	24 236	22 580	24 236	23 227	29 613	20 519	16 963	16 343	11 903	10 310	10 441	16 304	15 033
Dry cleaning [thous. inhab.]	38 191	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

Table A2.11. 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
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
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
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
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
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*
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

Industrial process	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Polyvinylchloride processing	255 762	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
Polystyrene foam processing	82 369	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
Rubber processing	449 821	519 118	556 990	625 632	679 590	714 446	621 829	790 196	897 851	857 201	915 888	975 473	1 027 984	1 058 943
Pharmaceutical products manufacturing [thous. inhab.]	38 191	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
Paints manufacturing	*361 884*	*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
Leather tanning	17 760	19 038	16 148	12 382	11 253	13 652	14 721	14 952	16 197	14 438	13 898	16 416	17 249	21 140

Table A2.12. 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
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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fat. edible and non edible oil extraction	396 100	395 300	427 400	452 100	502 600	567 100	565 800	488 700	509 523	470 154	519 058	543 425	522 987	507 077

Table A2.13. Activity data used in the category NFR 2.G – 2.L *Other Products Use* [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Tobacco combustion	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
Tobacco combustion [mln pcs]	100 817	99 289	95 508	100 951	96 007	97 961	99 893	90 430	91 933	92 953	89 290	74 748	74 802
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
Paper pulp (kraft process)	522 600	508 800	566 600	597 100	644 400	671 200	644 000	664 000	722 000	798 000	750 900	753 100	783 400
Bread	3 129 100	2 775 000	2 633 600	2 707 300	2 750 300	2 750 000	2 915 000	3 194 000	3 449 000	3 674 000	1 619 800	1 653 300	1 547 000
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
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
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
Smoke houses - no flue gas burn out	187 607	180 595	180 707	181 667	187 333	195 633	217 717	243 817	229 733	226 517	243 705	232 514	239 935
Smoke houses - flue gas burn out	375 215	361 191	361 413	363 333	374 667	391 267	435 433	487 633	459 467	453 033	487 410	465 028	479 869
Storage and handling – cement [Gg]	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
Storage and handling – coal [Gg]	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
Storage and handling – coke [Gg]	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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tobacco combustion [Mg]	53 773	51 328	51 493	52 725	50 294	55 790	46 728	48 694	48 808	46 616	41 849	35 420	39 444	50 874
Tobacco combustion [mln pcs]	76 819	73 326	73 561	75 322	71 849	79 701	66 754	69 562	69 725	66 594	59 784	50 599	56 349	72 677
Chipboard [m^3]	3 748 000	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
Paper pulp (kraft process)	810 800	790 600	802 300	824 600	813 800	819 900	826 300	881 000	894 300	847 600	881 300	880 700	873 334	877 400
Bread	1 556 400	1 532 000	1 548 700	1 551 500	1 523 000	1 683 800	1 663 000	1 674 900	1 600 900	1 675 000	1 689 200	1 569 500	1 587 800	1 589 400
Wine [hl]	3 558 239	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
Beer [hl]	28 621 700	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
Spirits [hl 100%]	795 615	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
Smoke houses - no flue gas burn out	236 609	257 802	242 475	258 388	271 152	261 014	244 759	252 850	277 671	281 814	283 294	276 274	278 450	302 353
Smoke houses - flue gas burn out	473 217	515 604	484 951	516 775	542 304	522 027	489 519	505 700	555 343	563 629	566 587	552 549	556 899	604 707
Storage and handling – cement [Gg]	11 653	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
Storage and handling – coal [Gg]	103 016	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
Storage and handling – coke [Gg]	10 232	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

Table A2.14. 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
On-field burning of stubble [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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
On-field burning of stubble [ha]	109 624	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

Table A2.15. Activity data used in the category NFR 5.A *Municipal solid waste disposal* [Gg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Municipal solid waste disposal on land	13 213	12 912	12 470	12 384	12 412	12 081	12 773	13 129	13 299	13 463	12 954	11 458	11 031

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Municipal solid waste disposal on land	10 419	9 783	11 912	11 717	11 610	11 079	10 051	9 631	9 459	9 830	7 941	5 549	4 885	4 255

Table A2.16. Activity data used in the category NFR 5.C.1.a *Municipal waste incineration* [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Municipal waste incineration	0	0	0	0	0	0	0	0	0	0	2 900	26 000	36 000

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Municipal waste incineration	41 600	43 000	44 381	41 274	43 800	40 815	40 300	40 899	39 427	38 530	50 074	31 611	50 959	479 361

Table A2.17. Activity data used in the category NFR 5.C.1.b *Industrial waste incineration* [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Incineration of industrial wastes (no APCs)	7 894	6 593	5 833	5 349	4 946	4 590	4 227	3 790	3 589	2 582	2 830	2 727	2 844
Incineration of industrial wastes (minimal APCs)	54 270	47 960	45 093	44 184	43 910	44 126	44 369	43 908	46 490	38 034	48 466	46 699	48 706
Incineration of industrial wastes (good APCs)	131 597	117 831	112 253	111 458	112 251	114 325	116 515	116 877	125 450	104 052	134 426	129 526	135 093
Incineration of industrial wastes (very good APCs)	57 151	51 426	49 231	49 118	49 703	50 860	52 076	52 478	56 583	47 142	61 178	58 948	61 482

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Incineration of industrial wastes (no APCs)	2 852	1 674	3 408	16 700	1 000									
Incineration of industrial wastes (minimal APCs)	48 853	28 670	58 359	16 500	29 200	36 770	35 950	34 326	34 726	43 260	45 052	25 457	23 561	24 464
Incineration of industrial wastes (good APCs)	135 502	79 520	161 867	63 650	65 200	3 748	4 400	4 201	4 250	5 295	5 514	3 116	2 884	2 994
Incineration of industrial wastes (very good APCs)	61 668	36 190	73 667	62 700	62 800	83 300	79 120	75 545	76 426	95 208	99 151	56 027	51 855	53 842

Table A2.18. Activity data used in the category NFR 5.C.1. b.iii *Clinical waste incineration* [Mg]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Incineration of clinical wastes (compliance with EU Directive)	45 247	45 067	44 259	45 427	46 211	45 982	46 253	45 819	46 000	44 689	46 256	24 686	16 884
Incineration of clinical wastes (minimal APCs)	10 774	10 049	9 215	8 803	8 304	7 630	7 054	6 386	5 821	5 094	4 705	2 214	1 316
Incineration of clinical wastes (no APCs)													

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Incineration of clinical wastes (compliance with EU Directive)	19 222	25 398	28 189	21 176	24 248	23 473	27 380	26 553	31 944	32 716	33 410	39 964	40 235	46 902
Incineration of clinical wastes (minimal APCs)	1 278	1 402	1 246	936	1 072	1 037	1 210	1 173	1 412	1 446	1 476	1 766	1 778	2 073
Incineration of clinical wastes (no APCs)			1 296	0	0	208								

Table A2.19. 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
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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cremations	11.5	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

Table A2.20. 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
Open burning of agricultural wastes	265 101	256 813	224 188	268 498	224 327	262 023	255 262	245 307	271 502	248 016	233 571	272 988	248 525

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Open burning of agricultural wastes	237 425	292 120	251 755	244 967	240 810	299 749	322 211	277 838	275 107	289 518	317 866	346 607	311 600	324 925

Table A2.21. 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
Municipal Waste water treatment [mln m^3]	1 391	1 363	1 330	1 282	1 276	1 258	1 245	1 274	1 311	1 293	1 243	1 227	1 191
Latrines [mln inhabitants]	6.5	6.3	6.1	5.9	5.7	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.0

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Municipal Waste water treatment [mln m^3]	1 159	1 152	1 140	1 155	1 174	1 169	1 181	1 242	1 203	1 221	1 244	1 237	1 254	1 289
Latrines [mln inhabitants]	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.2	2.0	1.8	1.6	1.4	1.2	0.9

Table A2.22. 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
car fires	3 500	4 000	4 600	5 091	5 237	5277	5540	6135	6701	7243	7 100	6 851	7 212
house fires [Gg]	22	24	25	26	28	28	30	32	33	32	32	30	33
landfill fires - surface	353	353	353	353	353	471	457	443	429	415	400	386	371
landfill fires - deep	40	40	40	40	40	53	51	50	48	46	45	43	42

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
car fires	6 916	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
house fires [Gg]	35	33	34	35	34	35	35	35	35	37	33	34	37	37
landfill fires - surface	358	344	329	315	300	286	273	258	244	229	215	201	187	171
landfill fires - deep	40	38	37	35	34	32	30	29	27	26	24	22	21	21

Table A2.23. 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
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

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Forest fires	630 322	112 698	171 255	174 090	103 560	89 390	130 550	66 504	87 687	226 627	46 575	90 470	181 647	55 012

Table A2.24. 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
Non-managed broadleaf forests	1 806	1 815	1 818	1 831	1 798	1 816	1 829	1 861	1 893	1 908	1 948	1 981	2 019
Non-managed coniferous forests	6 888	6 891	6 900	6 884	6 738	6 735	6 757	6 755	6 771	6 772	6 761	6 740	6 754

Activity	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Non-managed broadleaf forests	2 050	2 079	2 104	2 112	2 122	2 641	2 648	2 665	2 673	2 753	2 786	2 836	2 881	2 903
Non-managed coniferous forests	6 784	6 829	6 849	6 849	6 896	6 404	6 421	6 432	6 449	6 394	6 378	6 342	6 324	6 312

Appendix 3. 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 1.A.1.a)

Table A3.1 SO_2 emission factors applied for NFR 1.A.1.a

SO_2 emission source	Emission factor	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 A3.2 NO_x emission factors applied for NFR 1.A.1.a

NOx emission source	Emission factor	EF unit	EF reference
Heating plants			
Hard coal	0.209	Mg/TJ	EIG 2016
Brown coal	0.247	Mg/TJ	EIG 2016
Diesel oil	0.065	Mg/TJ	EIG 2016
Fuel oil	0.142	Mg/TJ	EIG 2016
Natural gas	0.089	Mg/TJ	EIG 2016

Table A3.3 CO emission factors applied for NFR 1.A.1.a

CO emission source	Emission factor	EF unit
Heating plants		
Hard coal	0.0325	Mg/TJ
Fuel oils	0.015	Mg/TJ
Natural gas	0.019	Mg/TJ
Industrial power		
Hard coal and lignite	0.0058	Mg/TJ
Natural gas	0.02	Mg/TJ
Fuel wood and wood waste	1.5	Mg/TJ
Coke	0.0058	Mg/TJ
Fuel oils	0.0156	Mg/TJ
Industrial gases	0.02	Mg/TJ

Note: emission factors applied for SNAP 0102 come from Corinair;

Table A3.4 PM emission factors applied for NFR 1.A.1.a

PM emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Public power					
Hard coal	0.0091	0.006	0.003	Mg/TJ	PL(ARE) *
Brown coal	0.0092	0.006	0.003	Mg/TJ	PL(ARE) *
Fuel oils	0.0400	0.0200	0.0100	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
Industrial gases	0.0050	0.0050	0.0050	Mg/TJ	CEPMEIP
Heating plants					
Hard coal and coke	0.14	0.093	0.07	Mg/TJ	CEPMEIP**
Fuel oils	0.0400	0.0200	0.0100	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
Industrial gases	0.0050	0.0050	0.0050	Mg/TJ	CEPMEIP
Industrial power					
Hard coal	0.1400	0.0700	0.0170	Mg/TJ	CEPMEIP
Brown coal	0.1600	0.0800	0.0200	Mg/TJ	CEPMEIP
Coke	0.1400	0.0700	0.0170	Mg/TJ	CEPMEIP
Wood and wood waste	0.1600	0.0800	0.0200	Mg/TJ	CEPMEIP
Fuel oils	0.0400	0.0200	0.0100	Mg/TJ	CEPMEIP
Industrial gases	0.0050	0.0050	0.0050	Mg/TJ	CEPMEIP

* PL(ARE) emission factors come from ARE surveys

** emission factors for TSP come from CEPMEIP;

EFs for PM10 and PM2.5 are calculated as a share of PM_{10} and $PM_{2.5}$ fractions in TSP

Table A3.5 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	EIG 2016
Coke	0.01	Mg/TJ	PL (IETU)
Crude oil	0.003	Mg/TJ	CORINAIR
Intermediate from crude oil	0.003	Mg/TJ	PL (IETU)
Gasoline	0.003	Mg/TJ	PL (IETU)
Other petroleum products	0.003	Mg/TJ	PL (IETU)
Wood and wood waste	0.0073	Mg/TJ	EIG 2016
Natural gas	0.0026	Mg/TJ	EIG 2016
LPG	0.0035	Mg/TJ	PL (IETU)
Biogas	0.0026	Mg/TJ	EIG 2016
Industrial gases	0.0026	Mg/TJ	EIG 2016
Heating plants			
Hard coal, hard coal briquettes	0.001	Mg/TJ	EIG 2016
Brown coal, brown coal briquettes, coke	0.0014	Mg/TJ	EIG 2016
Crude oil	0.003	Mg/TJ	CORINAIR
Intermediate from crude oil	0.003	Mg/TJ	PL (IETU)
Gasoline	0.003	Mg/TJ	PL (IETU)
Fuel oils	0.0023	Mg/TJ	EIG 2016
Other petroleum products	0.003	Mg/TJ	PL (IETU)
Wood and wood waste	0,0073	Mg/TJ	EIG 2016
Natural gas	0.0026	Mg/TJ	EIG 2016
LPG	0.0035	Mg/TJ	PL (IETU)
Biogas	0.0026	Mg/TJ	EIG 2016
Industrial gases	0.0026	Mg/TJ	EIG 2016
Industrial power			
Hard coal, brown coal	0.02	Mg/TJ	CORINAIR
Natural gas	0.001	Mg/TJ	CORINAIR
Wood and wood waste	0.1	Mg/TJ	CORINAIR
Biogas	0.0025	Mg/TJ	CORINAIR
Coke	0.01	Mg/TJ	CORINAIR
LPG	0.0035	Mg/TJ	CORINAIR
Diesel oil and fuel oil	0.003	Mg/TJ	PL(IETU)
Industrial gases	0.0025	Mg/TJ	CORINAIR

Note: PL (IETU) emission factors come from IETU surveys

Table A3.6 Main Heavy Metals emission factors applied for NFR 1.A.1.a

Emission source	Emission factors			Unit	EF Reference
	Cd	Hg	Pb		
Public power					
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			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)

* 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 A3.7 Additional Heavy Metals emission factors applied for NFR 1.A.1.a

Emission source	Unit	Emission factors *				
		As	Cr	Cu	Ni	Zn
Public power						
Hard coal	kg/TJ	0.00134	0.0025	0.00704	0.00576	0.01792
Brown coal	kg/TJ	0.00282	0.00192	0.00384	0.0009	0.01664
Hard coal briquettes	kg/TJ	0.0013	0.0025	0.007	0.00576	0.01792
Brown coal briquettes	kg/TJ	0.0028	0.00192	0.00384	0.0009	0.01664
Coke	kg/TJ	0.0084	0.0053	0.0078	0.0057	0.019
Wood and wood waste	kg/TJ	0.0095	0.009	0.021	0.014	0.181
Fuel oil	kg/TJ	0.0024	0.0029	0.0068	0.0654	0.0024
Natural gas	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014
Industrial gases	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014
Heating plants						
Hard coal	kg/TJ	0.01024	0.01408	0.0576	0.0512	0.416
Brown coal	kg/TJ	0.00282	0.00192	0.00384	0.0009	0.01664
Hard coal briquettes	kg/TJ	0.01024	0.01408	0.0576	0.0512	0.416
Brown coal briquettes	kg/TJ	0.00282	0.00192	0.00384	0.0009	0.01664
Coke	kg/TJ	0.0084	0.0053	0.0078	0.0057	0.019
Wood and wood waste	kg/TJ	0.0095	0.009	0.021	0.014	0.181
Fuel oil	kg/TJ	0.024	0.029	0.068	0.654	0.024
Natural gas	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014
Industrial gases	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014
Industrial power						
Hard coal	kg/TJ	0.017	0.022	0.095	0.085	0.69
Brown coal	kg/TJ	0.018	0.011	0.024	0.005	0.11
Coke	kg/TJ	0.002	0.017	0.086	0.076	0.53
Wood and wood waste	kg/TJ	0.0014	0.0065	0.0046	0.002	0.114
Fuel oil	kg/TJ	0.024	0.029	0.068	0.654	0.024
Natural gas	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014

* all Additional Heavy Metals emission factors applied for SNAP 01 are country specific – PL (IETU) surveys

Table A3.8 PCDD/F emission factors applied for NFR 1.A.1.a

Activity	EF	Unit	EF Reference
Hard coal	0.06	mg TEQ/Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*
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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	1	mg TEQ/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Natural gas	0.0005	ng TEQ/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.0005	ng TEQ/GJ	EMEP/EEA Guidebook (2009)

Table A3.9 Emission factors of PCBs applied for NFR 1.A.1.a

Activity	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): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
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): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Fuel oils	0.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)

Table A3.10 HCB emission factors applied for NFR 1.A.1.a

Activity	EF	Unit	EF Reference
Hard coal	0.013	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182
Fuel wood and wood waste	0.06	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182

Table A3.11 Benzo(a)pyrene emission factors applied for NFR 1.A.1.a

Activity	EF	Unit	EF Reference
Hard coal	0.00352	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	0.00352	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.6	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.6	µg/GJ	EMEP/EEA Guidebook (2009)
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	4.68	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.12 Benzo(b)fluoranthene emission factors applied for NFR 1.A.1.a

Activity	EF	Unit	EF Reference
Hard coal	0.00732	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	0.00732	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Fuel wood and wood waste	19	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	3.98	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.13 Benzo(k)fluoranthene emission factors applied for NFR 1.A.1.a

Activity	EF	Unit	EF Reference
Hard coal	0.00732	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	0.00732	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Fuel wood and wood waste	19	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	3.98	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.14 Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.1.a

Activity	EF	Unit	EF Reference
Hard coal	0.00703	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	0.00703	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	7.57	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

I.2. Petroleum refining (NFR 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 A3.15 PM emission factors applied for NFR 1.A.1.b

Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Petroleum refining plants					
Hard coal	0.1400	0.0700	0.0170	Mg/TJ	CEPMEIP
Coke	0.1400	0.0700	0.0170	Mg/TJ	CEPMEIP
Fuel oils	0.0400	0.0200	0.0100	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
Industrial gases	0.0050	0.0050	0.0050	Mg/TJ	CEPMEIP

Table A3.16 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	0.02	Mg/TJ	PL (IETU)
Coke	0.01	Mg/TJ	PL (IETU)
Crude oil	0.003	Mg/TJ	CORINAIR
Intermediate from crude oil	0.003	Mg/TJ	PL (IETU)
Gasoline	0.003	Mg/TJ	PL (IETU)
Fuel oil	0.003	Mg/TJ	PL (IETU)
Other products from crude oil	0.003	Mg/TJ	PL (IETU)
Wood and wood waste	0.1	Mg/TJ	PL (IETU)
Natural gas	0.001	Mg/TJ	CORINAIR
LPG	0.0035	Mg/TJ	PL (IETU)
Biogas	0.0025	Mg/TJ	PL (IETU)
Industrial gases	0.0025	Mg/TJ	CORINAIR

Note: PL (IETU) emission factors come from IETU surveys

Table A3.17 Main Heavy Metals emission factors applied for NFR 1.A.1.b

	Emission factors			Unit	EF Reference
Emission source	**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 A3.18 Additional Heavy Metals emission factors applied for NFR 1.A.1.b

Emission source	Unit	Emission factors				
		As	**Cr**	**Cu**	**Ni**	**Zn**
Petroleum refining plants						
Hard coal	kg/TJ	0.017	0.022	0.095	0.085	0.69
Brown coal	kg/TJ	0.018	0.011	0.024	0.005	0.11
Coke	kg/TJ	0.002	0.017	0.086	0.076	0.53
Fuel oil	kg/TJ	0.024	0.029	0.068	0.654	0.024
Natural gas	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014
Industrial gases	kg/TJ	0.00034	0.0027	0.0022	0.0036	

Note: all Additional Heavy Metals emission factors applied for SNAP 01 are country specific – PL (IETU) surveys

Table A3.19 PCDD/F emission factors applied for NFR 1.A.1.b

Activity	EF	Unit	EF Reference
Hard coal	0.06	mg TEQ/Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*
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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	1	mg TEQ/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Natural gas	0.0005	ng TEQ/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.0005	ng TEQ/GJ	EMEP/EEA Guidebook (2009)

Table A3.20 Emission factors of PCBs applied for NFR 1.A.1.b

Activity	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): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Fuel oils	0.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)

Table A3.21 HCB emission factors applied for NFR 1.A.1.b

Activity	EF	Unit	EF Reference
Hard coal	0.013	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182

Table A3.22 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	0.586	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	0.586	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	3.43	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Industrial gases	0.67	µg/GJ	EMEP/EEA Guidebook (2009)

Table A3.23 Benzo(b)fluoranthene emission factors applied for NFR 1.A.1.b

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	19	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	1.81	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.24 Benzo(k)fluoranthene emission factors applied for NFR 1.A.1.b

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	19	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	2.83	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.25 Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.1.b

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Diesel oil	6.84	g/Gg	EF for fuel oil was applied
Fuel oil	6.84	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

I.3. Manufacture of solid fuels and other energy industries (NFR 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 A3.26 PM emission factors applied for NFR 1.A.1.c

Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Hard coal	0.1400	0.0700	0.0170	Mg/TJ	CEPMEIP
Fuel oils	0.0400	0.0200	0.0100	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
Industrial gases	0.0050	0.0050	0.0050	Mg/TJ	CEPMEIP
Coal mining, oil / gas extraction, pipeline compressors					
Brown coal	0.1600	0.0800	0.0200	Mg/TJ	CEPMEIP
Coke	0.1400	0.0700	0.0170	Mg/TJ	CEPMEIP
Crude oil		0.0200	0.0100	Mg/TJ	CEPMEIP

Table A3.27 NMVOC emission factors applied for NFR 1.A.1.c

Emission source	EF	EF unit	EF Reference
Hard coal	0.02	Mg/TJ	CORINAIR
Coal briquettes	0.02	Mg/TJ	PL (IETU)
Coke	0.01	Mg/TJ	CORINAIR
Crude oil	0.003	Mg/TJ	CORINAIR
Intermediate from crude oil	0.003	Mg/TJ	PL (IETU)
Natural gas	0.001	Mg/TJ	CORINAIR
LPG	0.0035	Mg/TJ	PL (IETU)
Biogas	0.0025	Mg/TJ	PL (IETU)
Industrial gases	0.0025	Mg/TJ	CORINAIR
Coal mining, oil/gas extraction			
Brown coal	0.02	Mg/TJ	CORINAIR
Gasoline	0.003	Mg/TJ	PL (IETU)
Fuel oil	0.003	Mg/TJ	PL (IETU)
Other products from crude oil	0.003	Mg/TJ	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A3.28 Main Heavy Metals emission factors applied for NFR 1.A.1.c

Emission source	Emission factors			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 A3.29 Additional Heavy Metals emission factors applied for NFR 1.A.1.c

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
Hard coal	kg/TJ	0.017	0.022	0.095	0.085	0.69
Brown coal	kg/TJ	0.018	0.011	0.024	0.005	0.11
Coke	kg/TJ	0.002	0.017	0.086	0.076	0.53
Fuel oil	kg/TJ	0.024	0.029	0.068	0.654	0.024
Natural gas	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014
Industrial gases	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014

Note: all Additional Heavy Metals emission factors applied for SNAP 01 are country specific – PL (IETU) surveys

Table A3.30 PCDD/F emission factors applied for NFR 1.A.1.c

Activity	EF	Unit	EF Reference
Hard coal	0.06	mg TEQ/Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*
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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	1	mg TEQ/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Natural gas	0.0005	ng TEQ/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.0005	ng TEQ/GJ	EMEP/EEA Guidebook (2009)

Table A3.31 Emission factors of PCBs applied for NFR 1.A.1.c

Activity	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): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Fuel wood and wood waste	0.9	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Fuel oils	0.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)

Table A3.32 HCB emission factors applied for NFR 1.A.1.c

Activity	EF	Unit	EF Reference
Hard coal	0.013	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182
Fuel wood and wood waste	0.06	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182

Table A3.33 Benzo(a)pyrene emission factors applied for NFR 1.A.1.c

Activity	EF	Unit	EF Reference
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	0.586	g/Gg	
Lignite	0.586	g/Gg	
Fuel oils	3.43	g/Gg	

Table A3.34 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	1.81	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.35 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	1.81	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.36 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Hard coal	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Diesel oil	6.84	g/Gg	EF for fuel oil was applied
Fuel oil	6.84	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

I.4. Stationary combustion in manufacturing industries (NFR 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.4.1 *Stationary Combustion in Manufacturing Industries.*

Process emission factors specific for stationary combustion in the particular industries are shown under appropriate sections NFR 1.A.2.a - NFR 1.A.2.f.

I.4.1 Stationary combustion in manufacturing industries (NFR 1.A.2)

Table A3.37 SO_2 emission factors applied for NFR 1.A.2

SO_2 emission source	Emission factor	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 sulfur content

Table A3.38 NO_x emission factors applied for NFR 1.A.2

NOx emission source	Emission factor	EF unit	EF reference
Hard coal	0.173	Mg/TJ	EIG 2009
Brown coal	0.173	Mg/TJ	EIG 2009
Coke	0.173	Mg/TJ	EIG 2009
Wood and wood waste	0.091	Mg/TJ	EIG 2016
Fuel oils	0.513	Mg/TJ	EIG 2016
Natural gas	0.074	Mg/TJ	EIG 2016
Industrial gases	0.074	Mg/TJ	EIG 2016

Table A3.39 CO emission factors applied for NFR 1.A.2

CO emission source	Emission factor	EF unit
Hard coal	0.0058	Mg/TJ
Brown coal	0.0058	Mg/TJ
Coke	0.0058	Mg/TJ
Wood and wood waste	1.5	Mg/TJ
Fuel oils	0.0156	Mg/TJ
Natural gas	0.02	Mg/TJ
Industrial gases	0.02	Mg/TJ

Note: emission factors applied for combustion of fuels come from Corinair;

Table A3.40 PM emission factors applied for NFR 1.A.2

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Hard coal, brown coal and coke	0.1000	0.0600	0.108	Mg/TJ	EIG 2016
Natural gas	0.0002	0.0002	0.001	Mg/TJ	EIG 2016
Wood and wood waste	0.1000	0.0600	0.140	Mg/TJ	EIG 2016
Fuel oils	0.0500	0.0400	0.020	Mg/TJ	EIG 2016
Industrial gases	0.0050	0.0050	0.001	Mg/TJ	EIG 2016

Table A3.41 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	EIG 2016
Crude oil	0.0250	Mg/TJ	EIG 2016
Natural gas	0.0230	Mg/TJ	EIG 2016
Wood and wood waste	0.3000	Mg/TJ	EIG 2016
Biogas	0.0025	Mg/TJ	EIG 2016
Other petroleum products	0.0888	Mg/TJ	EIG 2016
Coke	0.0888	Mg/TJ	EIG 2016
LPG	0.0230	Mg/TJ	EIG 2016
Gasoline and oils	0.0250	Mg/TJ	EIG 2016
Industrial gases	0.0230	Mg/TJ	EIG 2016

Table A3.42 Main Heavy Metals emission factors applied for NFR 1.A.2

Emission source	Emission factors			Unit
	Cd	Hg	Pb	
Coke	0.023	0.001	0.13	kg/TJ
Wood and wood waste	0.0018	0.0007	0.025	kg/TJ
Fuel oil	0.024		0.03	kg/TJ
Natural gas	0.0005	0.0002	0.0002	kg/TJ
Hard coal	0.027	*	0.17	kg/TJ
Brown coal	0.0007	*	0.022	kg/TJ
Hard coal briquettes	0.027	0.008	0.17	kg/TJ
Brown coal briquettes	0.0007	0.005	0.022	kg/TJ

Note: most of Main Heavy Metals emission factors for combustion of fuels applied for SNAP 03 are country specific – PL (IETU) surveys; * Emissions reported to National Database

Table A3.43 Additional Heavy Metals emission factors applied for NFR 1.A.2

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
0302 Process furnaces without contact						
Hard coal	kg/TJ	0.017	0.022	0.095	0.085	0.69
Brown coal	kg/TJ	0.018	0.011	0.086	0.005	0.11
Coke	kg/TJ	0.002	0.017	0.068	0.076	0.53
Fuel oil	kg/TJ	0.024	0.029	0.024	0.654	0.024
0303 Processes with contact						
Hard coal	kg/TJ	0.017	0.022	0.095	0.085	0.69
Brown coal	kg/TJ	0.018	0.011	0.086	0.005	0.11
Hard coal briquettes	kg/TJ	0.017	0.022	0.095	0.085	0.69
Brown coal briquettes	kg/TJ	0.018	0.011	0.086	0.005	0.11
Coke	kg/TJ	0.002	0.017	0.068	0.076	0.53
Wood and wood waste	kg/TJ	0.0014	0.0065	0.0046	0.002	0.114
Fuel oil	kg/TJ	0.024	0.029	0.024	0.654	0.024
Natural gas	kg/TJ	0.00009	0.0007	0.0004	0.001	0.014

Note: Additional Heavy Metals emission factors applied for fuels combustion in SNAP 03 are country specific – PL (IETU) surveys

Table A3.44 PCDD/F emission factors applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	0.06	mg TEQ/ Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*
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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	1	mg TEQ/ Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Natural gas	0.002	ng TEQ/ GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.002	ng TEQ/ GJ	EMEP/EEA Guidebook (2009)

Table A3.45 Emission factors of PCBs applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	0.31	g/Gg	EF applied in Bulgaria
Lignite	1.8	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Fuel wood and wood waste	0.9	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Coke	3.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Diesel oil	0.6	g/Gg	EF for fuel oil was applied
Fuel oil	0.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)

Table A3.46 HCB emission factors applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	0.013	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182
Fuel wood and wood waste	0.06	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182

Table A3.47 Benzo(a)pyrene emission factors applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	0.586	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	0.586	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	0.095	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	3.43	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.6	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.6	µg/GJ	EMEP/EEA Guidebook (2009)

Table A3.48 Benzo(b)fluoranthene emission factors applied for NFR 1.A.2

Activity	EF	Unit	EF Reference
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	19	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	1.81	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.8	µg/GJ	EMEP/EEA Guidebook (2009)

Table A3.49 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	
Fuel wood and wood waste	19	g/Gg	
Fuel oils	1.81	g/Gg	
Natural gas	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.8	µg/GJ	EMEP/EEA Guidebook (2009)

Table A3.50 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	6.84	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.8	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.8	µg/GJ	EMEP/EEA Guidebook (2009)

I.4.2 Stationary combustion in manufacturing industries : Iron and steel (NFR 1.A.2.a)

Table A3.51 SO_2, NO_x and CO emission factors applied for NFR 1.A.2.a

Emission source	Emission factor	EF unit
SO_2 emissions		
030301 Sinter and pelletizing plants (agglomeration)	0.463	kg/Mg
NO_x emissions		
030301 Sinter and pelletizing plants (agglomeration)	0.558	kg/Mg
030303 Gray iron foundries	0.285	kg/Mg
CO emissions		
030301 Sinter and pelletizing plants (agglomeration)	18	kg/Mg

Note: for process emissions emission factors were taken from EMEP/EEA (2009) Guidebook

Table A3.52 POPs emission factors applied for NFR 1.A.2.a

Activity	EF	Unit	EF Reference
PCDD-F emissions			
Sinter and pelletizing plants	1.35	mg TEQ/Gg	*Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland;* Danish Environmental Protection Agency and Ministry of the Environment, 2005
PCB emissions			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, 2002*
Sinter and pelletizing plants	0.065	g/Gg	
HCB emissions			
Sinter and pelletizing plants	0.14	g/Gg	

I.4.3 Stationary Combustion in Manufacturing Industries: Non-ferrous Metals (NFR 1.A.2.b)

Table A3.53 SO_2 emission factors applied for NFR 1.A.2.b

SO_2 emission source	Emission factor	EF unit	EF Reference
030304 Primary lead production	2.050	kg/Mg	EIG 2016
030305 Primary zinc production	1.350	kg/Mg	EIG 2016
030306 Primary copper production	3.000	kg/Mg	EIG 2016
030307 Secondary lead production	2.050	kg/Mg	EIG 2016
030308 Secondary zinc production	1.350	kg/Mg	EIG 2016
030309 Secondary copper production - converters	3.000	kg/Mg	EIG 2016
030309 Secondary copper production - other furnaces	1.225	kg/Mg	EIG 2009
030310 Secondary aluminium production	0.603	kg/Mg	EIG 2009

Table A3.54 NOx and CO emission factors applied for NFR 1.A.2.b

NO2 emission source	Emission factor	EF unit
NOx emissions		
030307 Secondary lead production	0.186	kg/Mg
030310 Secondary aluminium production	0.449	kg/Mg
CO emissions		
030309 Secondary copper production	4.690	kg/Mg

Note: for process emissions emission factors were taken from EMEP/EEA (2009) Guidebook

Table A3.55 PM emission factors applied for NFR 1.A.2.b

PM Emission source	Emission factor			EF unit
	TSP	PM10	PM2.5	
030310 Secondary aluminium production	2	1.4	0.55	kg/Mg

Note: for process emissions emission factors were taken from EMEP/EEA (2009) Guidebook

Table A3.56 Main Heavy Metals emission factors applied for NFR 1.A.2.b

	Emission factors			Unit
Emission source	Cd	Hg	Pb	
030304 Primary lead production	9.8	3	560	kg/Gg
030305 Primary zinc production	2.5	8	113	kg/Gg
030306 Primary copper production	0.42	0.1	230	kg/Gg
030307 Secondary lead production	0.3		40	kg/Gg
030308 Secondary zinc production	14	0.02	85	kg/Gg
030309 Secondary copper production	2		110	kg/Gg

Note: for process emissions EFs for Pb (metal production) are country specific – PL (IETU) surveys while for other emission sources EFs were taken from international publications.

Table A3.57 Additional Heavy Metals emission factors applied for NFR 1.A.2.b

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
030304 Primary lead production	kg/Gg	10		7.5		100
030305 Primary zinc production	kg/Gg					294
030306 Primary copper production	kg/Gg	32		334		300
030307 Secondary lead production	kg/Gg	0.2				6
030308 Secondary zinc production	kg/Gg	10				1089
030309 Secondary copper production	kg/Gg	2		75		500

Note: Additional Heavy Metals emission factors applied for process emissions EFs for Cr, Ni are country specific – PL (IETU) surveys while other EFs were taken from international publications

Table A3.58 PCDD/F emission factors applied for NFR 1.A.2.b

SNAP	Activity	EF	Unit	EF Reference
030307	Secondary lead production	8	mg TEQ/Gg	UNEP Chemicals (2005): Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases, 2005
030308	Secondary zinc production (basic APCs)	100	mg TEQ/Gg	UNEP Chemicals (2005): Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases, 2005
030309	Secondary copper production in converter furnaces	0.01	mg TEQ/Gg	UNEP Chemicals (2005): Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases, 2005
030309	Secondary copper production in other furnaces (exc. converters)	50	mg TEQ/Gg	UNEP Chemicals (2005): Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases, 2005
030310	Secondary aluminium production (including scrap processing; minimal treatment of inputs, simple dust removal)	150	mg TEQ/Gg	UNEP Chemicals (2005): Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases, 2005
030310	Secondary aluminium production (including scrap processing, well-controlled fabric filter, lime injection)	4	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

Table A3.59 Emission factors of PCB and HCB applied for NFR 1.A.2.b

SNAP	Activity	EF	Unit	EF Reference
	PCB emissions			
030309	Secondary copper production	2.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING*
030310	Secondary aluminium production	2.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING*
	HCB emissions			
030309	Secondary copper production	1	g/Gg	DE IIR Report

I.4.4 Stationary Combustion in Manufacturing Industries: Paper and Pulp NFR 1.A.2.d

Table A3.60 NH_3 emission factors applied for NFR 1.A.2.d

SO_2 emission source	Emission factor	EF unit	EF Reference
Paper and Pulp: wood combustion	0.037	Mg/TJ	EIG 2016

I.4.5 Stationary Combustion in Manufacturing Industries: Other NFR 1.A.2.f

Table A3.61 SO_2 emission factors applied for NFR 1.A.2.f

SO_2 emission source	Emission factor	EF unit
030311 Clinker	0.374	kg/Mg
030312 Lime	0.316 *	kg/Mg
030313 Asphalt concrete plants	0.0177	kg/Mg
030314 Glass - flat	1.962	kg/Mg
030319 Bricks and tiles	0.04 *	kg/Mg
030320 Fine ceramic materials	0.247	kg/Mg

Note: for process emissions emission factors were taken from EMEP/EEA (2009) Guidebook
(* EMEP/EEA 2016 Guidebook)

Table A3.62 NO_x emission factors applied for NFR 1.A.2.f

NO2 emission source	Emission factor	EF unit
030311 Clinker	1.55	kg/Mg
030312 Lime	2.236	kg/Mg
030313 Asphalt concrete plants	0.0356	kg/Mg
030314 Glass - flat	2.931	kg/Mg
030316 Glass wool (exc. binding)	1.625	kg/Mg
030319 Bricks and tiles	0.142	kg/Mg
030320 Fine ceramic materials	0.85	kg/Mg

Note: for process emissions emission factors were taken from EMEP/EEA (2009) Guidebook

Table A3.63 CO emission factors applied for NFR 1.A.2.f

CO emission source	Emission factor	EF unit
030311 Clinker	2	kg/Mg
030312 Lime	1.936	kg/Mg
030313 Asphalt concrete plants	0.2	kg/Mg
030314 Glass - flat	0.0061	kg/Mg
030315 Glass - container	0.0061	kg/Mg
030319 Bricks and tiles	0.415	kg/Mg
030320 Fine ceramic materials	0.456	kg/Mg

* for process emissions EFs were taken from EMEP/EEA Guidebook (2009)

Table A3.64 PM emission factors applied for NFR 1.A.2.f

PM Emission source	Emission factors			EF unit
	TSP	PM10	PM2.5	
030314Flat glass	0.3	0.27	0.24	kg/Mg
030315Container glass	0.3	0.27	0.24	kg/Mg
030315Glass wool (exc. binding)	0.1	0.09	0.08	kg/Mg

* for process emissions EFs were taken from EMEP/EEA Guidebook (2009)

Main Heavy Metals emission factors applied for NFR 1.A.2.f

	Emission factors			Unit
Emission source	Cd	Hg	Pb	
030311 Clinker	0.008*	0.02 *	0.2	kg/Gg

Note: EF for Pb is country specific – PL (IETU) surveys

* Emission factor based on submission from producers, country specific.

Table A3.65 Additional Heavy Metals emission factors applied for NFR 1.A.2.f

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
030311 Clinker	kg/Gg	0.012	0.1		0.1	0.2

Note: Additional Heavy Metals emission factors applied for process emissions EFs for Cr, Ni and Zn (cement production) are country specific – PL (IETU) surveys while for other emission sources EFs were taken from international publications

Table A3.66 PCDD/F emission factors applied for NFR 1.A.2.f

SNAP	Emission source	EF	Unit	EF Reference
030311	Cement	0.07	mg TEQ/Gg of cement clinker production	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*
030313	Asphalt mixing (no APCs)	0.07	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
030313	Asphalt mixing (scrubbers, fabric filters)	0.007	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
030319	Bricks and tiles (no or minimal APCs)	0.2	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
030319	Bricks and tiles (good APCs)	0.02	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
030320	Ceramics (no or minimal APCs)	0.2	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
030320	Ceramics (good APCs)	0.02	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

Table A3.67 Emission factors of PCB and HCB applied for NFR 1.A.2.f

SNAP	Emission source	EF	Unit	EF Reference
PCB emissions				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, 2002*
030311	Clinker	0.007	g/Gg	
HCB emissions				
030311	Cement	0.021	g/Gg of cement clinker	

I.5. Transport (NFR sector 1.A.3)

I.5.1. Civil and International Aviation (1.A.3.a)

Table A3.68 SO_2 emission factors applied for 1.A.3.a

SO_2 emission source	Emission factor	EF unit	EF Reference
Aviation (LTO & Cruise)	1.0	kg/Mg	EIG (2009)

Table A3.69 NO_x emission factors applied for 1.A.3.a

NO_x emission source	Emission factor	EF unit	EF Reference
Aviation (LTO & Cruise)			
jet fuel - Civil Aviation	10.3	kg/Mg	EIG (2009)
jet fuel - International Aviation	12.8	kg/Mg	EIG (2009)
aviation gasoline - Civil Aviation	4.0	kg/Mg	EIG (2016)

* emission factors come from ITS surveys

Table A3.70 CO emission factors applied for 1.A.3.a

CO emission source	Emission factor	EF unit	EF Reference
Aviation (LTO & Cruise)			
jet fuel - Civil Aviation	2.0	kg/Mg	EIG (2009)
jet fuel - International Aviation	1.1	kg/Mg	EIG (2009)
aviation gasoline - Civil Aviation	1200.0	kg/Mg	EIG (2009)

Table A3.71 PM emission factors applied for 1.A.3.a

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Aviation (LTO & Cruise)					
jet fuel - Civil Aviation	0.2	0.2	0.2	Mg/Gg	EIG (2009)
jet fuel - International Aviation	0.2	0.2	0.2	Mg/Gg	EIG (2009)
aviation gasoline - Civil Aviation	4	4	4	Mg/Gg	EIG (2009)

Table A3.72 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	EIG (2009)
jet fuel - International Aviation	0.5	kg/Mg	EIG (2009)
aviation gasoline - Civil Aviation	19.0	kg/Mg	EIG (2009)

I.5.2. Road Transportation (1.A.3.b)

Emission has been estimated with the use of COPERT 5 emission factors.

I.5.3. Railways (1.A.3.c)

Table A3.73 SO_2, NO_x, CO and NMVOC emission factors applied for 1.A.3.c

SO2 emission source	Emission factor	EF unit	EF Reference
Diesel locomotives			
SO_2 emissions	0.1	kg/Mg	PL (ITS)
NO_x emissions	52.4	kg/Mg	EIG (2016)
CO emissions	29.5	kg/Mg	PL (ITS)
NMVOC emissions	4.65	kg/Mg	EIG (2016)

Note: PL (ITS) emission factor based on sulphur content comes from ITS surveys

Table A3.74 NH_3 emission factors applied for 1.A.3.c

Emission source	EF	unit	EF reference
Diesel locomotives	0.007	kg/Mg diesel	EIG (2009)

Table A3.75 PM emission factors applied for 1.A.3.c

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Diesel locomotives	4.7000	4.7000	4.7000	kg/Mg	PL(ITS)

Note: PL (ITS) emission factor based on sulphur content comes from ITS surveys

Table A3.76 Main Heavy Metals emission factors applied for 1.A.3.c

Emission source	Emission factors			Unit
	Cd	Hg	Pb	
Diesel oil	0.05			kg/Gg

Note: EFs were taken from international publications

Table A3.77 Additional Heavy Metals emission factors applied for 1.A.3.c

Emission source	Emission factors					Unit
	As	Cr	Cu	Ni	Zn	
Diesel oil			0.3	0.5		kg/Gg

Note: EFs were taken from international publications

Table A3.78 PCDD/F emission factors applied for 1.A.3.c

Activity	EF	Unit	EF Reference
Diesel oil	0.043	mg TEQ/Gg	LUA-NRW (1997): *Identification of Relevant Industrial Sources of Dioxins and Furans in Europe – The European Dioxin Inventory", Essen 1997*

Table A3.79 Benzo(a)pyrene emission factors applied for 1.A.3.c

Activity	EF	Unit	EF Reference
Benzo(a)pyrene emissions			
Diesel oil	0.297	kg/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Benzo(k)fluoranthene emissions			
Diesel oil	0.41580	g/Gg	
Indeno(1.2.3-cd)pyrene emissions			
Diesel oil	0.2970	g/Gg	

I.5.4. Navigation (1.A.3.d)

Table A3.80 SO_2 emission factors applied for 1.A.3.d

SO2 emission source	Emission factor	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)

Note: PL (ITS) emission factors based on sulphur content come from ITS surveys

Table A3.81 NO_x emission factors applied for 1.A.3.d

NO_x emission source	Emission factor	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)

Note: PL (ITS) emission factors come from ITS surveys

Table A3.82 CO emission factors applied for 1.A.3.d

CO emission source	Emission factor	EF unit	EF Reference
1.A.3.d.ii - National navigation			
Inland waterways - Diesel oil	29.5	kg/Mg	PL (ITS)
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 A3.83 PM emission factors applied for 1.A.3.d

PM Emission source	Emission factor			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	4.0000	4.0000	4.0000	kg/Mg	PL(ITS)

Note: PL (ITS) emission factors come from ITS surveys

Table A3.84 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	EIG (2016)
Maritime activities			
National sea traffic, diesel oil and fuel oil	2.7	Mg/Gg	EIG (2016)

Note: PL (ITS) emission factors come from ITS surveys

Table A3.85 Main Heavy Metals emission factors applied for 1.A.3.d

Emission source	Emission factors			Unit
1.A.3.d.ii - National navigation	Cd	Hg	Pb	
Diesel oil	0.05			kg/Gg

Note: EFs were taken from international publications

Table A3.86 Additional Heavy Metals emission factors applied for 1.A.3.d

Emission source	Emission factors					Unit
1.A.3.d.ii - National navigation	As	Cr	Cu	Ni	Zn	
Diesel oil			0.3	0.5		kg/Gg

Note: EFs were taken from international publications

Table A3.87 POPs emission factors applied for 1.A.3.d

Activity	EF	Unit	EF Reference
Benzo(a)pyrene emissions			
Diesel oil	0.297	kg/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Benzo(k)fluoranthene emissions			
Diesel oil	0.41580	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Indeno(1.2.3-cd)pyrene emissions			
Diesel oil	0.2970	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

I.6. Other sectors – stationary sources (NFR 1.A.4)

Table A3.88 SO_2 emission factors applied for NFR 1.A.4

SO2 emission source	Emission factor	EF unit
1.A.4.a.i Commercial and institutional plants		
Hard coal	0.012	Mg/Mg
Coke	0.011	Mg/Mg
Fuel oils	0.006	Mg/Mg
1.A.4.b.i Residential plants		
Hard coal	0.011	Mg/Mg
Brown coal	0.011	Mg/Mg
Coke	0.011	Mg/Mg
Fuel oils	0.006	Mg/Mg
1.A.4.c.i Agriculture/Forestry/Fishing		
Hard coal	0.012	Mg/Mg
Coke	0.011	Mg/Mg
Fuel oils	0.006	Mg/Mg

Note: emission factors applied are country specific, based on sulphur content; for solid fuels [30]

Table A3.89 NO_x emission factors applied for NFR 1.A.4

NO_x emission source	Emission factor	EF unit
1.A.4.a.i Commercial and institutional plants		
Hard coal	0.17802	Mg/TJ
Brown coal	0.11268	Mg/TJ
Coke	0.064	Mg/TJ
Wood and wood waste	0.090	Mg/TJ
Fuel oils	0.18	Mg/TJ
Natural gas	0.1	Mg/TJ
Industrial gases	0.1	Mg/TJ
1.A.4.b.i Residential plants		
Hard coal	0.16477	Mg/TJ
Wood and wood waste	0.076435	Mg/TJ
Fuel oils	0.18	Mg/TJ
Natural gas	0.1	Mg/TJ
LPG	0.1	Mg/TJ
1.A.4.c.i Agriculture/Forestry/Fishing		
Hard coal	0,178	Mg/TJ
Wood and wood waste	0,090	Mg/TJ
Fuel oils	0.17	Mg/TJ
Natural gas	0.1	Mg/TJ
LPG	0.1	Mg/TJ

Note: emission factors applied for solid fuels come from country study [30]; other from Corinair

Table A3.90 CO emission factors applied for NFR 1.A.4

CO emission source	Emission factor	EF unit
1.A.4.a.i Commercial and institutional plants		
Hard coal	1.32869	Mg/TJ
Brown coal	2.6686	Mg/TJ
Coke	2.8709	Mg/TJ
Wood and wood waste	1.5759	Mg/TJ
Fuel oils	0.015	Mg/TJ
Natural gas	0.02	Mg/TJ
Industrial gases	0.02	Mg/TJ
1.A.4.b.i Residential plants		
Hard coal	3.3902	Mg/TJ
Wood and wood waste	3.98264	Mg/TJ
Fuel oils	0.015	Mg/TJ
Natural gas	0.05	Mg/TJ
LPG	0.05	Mg/TJ
1.A.4.c.i Agriculture/Forestry/Fishing		
Hard coal	1.32869	Mg/TJ
Wood and wood waste	1.5759	Mg/TJ
Fuel oils	0.05	Mg/TJ
Natural gas	0.02	Mg/TJ
LPG	0.05	Mg/TJ

Note: emission factors applied for solid fuels come from [K.Kubica 2016; 30]; other from Corinair

Table A3.91 NH_3 emission factors applied for NFR 1.A.4

Emission source	EF	EF unit	EF reference
1.A.4.b.i Residential plants			
Hard coal, brown coal, coke	0.3	kg/TJ	EIG 2009
Biomass (wood)	3.8	kg/TJ	

Table A3.92 PM emission factors applied for NFR 1.A.4

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
1.A.4.a.i Commercial and institutional plants					
Hard coal	0.22569	0.14347	0.13685	Mg/TJ	[Kub, 2014]*
Brown coal	0.12612	0.07938	0.06375	Mg/TJ	[Kub, 2014]*
Coke	0.07392	0.03348	0.02	Mg/TJ	[Kub, 2014]*
Wood and wood waste	0.1015	0.09525	0.0921	Mg/TJ	[Kub, 2014]*
Fuel oils	0.040	0.0200	0.0100	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
Industrial gases	0.0050	0.0050	0.0050	Mg/TJ	CEPMEIP
1.A.4.b.i Residential plants					
Hard coal	0.34361	0.24422	0.11516	Mg/TJ	[Kub, 2014]*
Brown coal	0.35668	0.28417	0.10039	Mg/TJ	[Kub, 2014]*
Coke	0.0912	0.0378	0.0200	Mg/TJ	[Kub, 2014]*
Wood and wood waste	0.26742	0.23733	0.22604	Mg/TJ	[Kub, 2014]*
Fuel oils	0.0600	0.0500	0.0400	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
LPG	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
1.A.4.c.i Agriculture/Forestry/Fishing					
Hard coal	0.5000	0.3750	0.1250	Mg/TJ	PL **
Brown coal	0.5000	0.3750	0.1250	Mg/TJ	PL **
Coke	0.1000	0.0400	0.0200	Mg/TJ	PL (IETU)
Wood and wood waste	0.2000	0.1900	0.1800	Mg/TJ	CEPMEIP
Fuel oils	0.0600	0.0500	0.0400	Mg/TJ	CEPMEIP
Natural gas	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP
LPG	0.0002	0.0002	0.0002	Mg/TJ	CEPMEIP

Note: [Kub, 2014]*, emission factors derived from Kubica K., Kubica R., 2014; PL**, emission factors are country specific from IChPW & IETU surveys; PL (IETU) emission factors are country specific from IETU surveys

Table A3.93 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	0.1164	Mg/TJ	Kubica K. 2016
Brown coal	0.2340	Mg/TJ	Kubica K. 2016
Coal briquettes	0.02	Mg/TJ	PL (IETU)
Coke	0.01	Mg/TJ	CORINAIR
Wood and wood waste	0,1502	Mg/TJ	Kubica K. 2016
Diesel / fuel oil	0.003	Mg/TJ	PL (IETU)
Other petroleum products	0.003	Mg/TJ	PL (IETU)
Natural gas	0.001	Mg/TJ	CORINAIR
LPG	0.0035	Mg/TJ	CORINAIR
Industrial gases	0.0025	Mg/TJ	CORINAIR
Biogas	0.0025	Mg/TJ	CORINAIR
1.A.4.b.i Residential plants			
Hard coal	0.2364	Mg/TJ	Kubica K. 2016
Brown coal	0.3536	Mg/TJ	Kubica K. 2016
Coke	0.0750	Mg/TJ	Kubica K. 2016
Wood and wood waste	0.3451	Mg/TJ	Kubica K. 2016
Diesel oil	0.003	Mg/TJ	PL (IETU)
Natural gas	0.005	Mg/TJ	CORINAIR
LPG	0.0035	Mg/TJ	CORINAIR
Industrial gases	0.0025	Mg/TJ	CORINAIR
1.A.4.c.i Agriculture/Forestry/Fishing			
Hard coal	0.1164	Mg/TJ	Kubica K. 2016
Brown coal	0.2340	Mg/TJ	Kubica K. 2016
Wood and wood waste	0.1502	Mg/TJ	Kubica K. 2016
Natural gas	0.005	Mg/TJ	CORINAIR
LPG	0.0035	Mg/TJ	CORINAIR

Note: emission factors are mostly country specific: for solid fuels come from [30]; PL (IETU) from IETU surveys

Table A3.94 Main Heavy Metals emission factors applied for NFR 1.A.4

Emission source	Emission factors			Unit	EF Reference
	Cd	Hg	Pb		
1.A.4.a.i Commercial and institutional plants					
Hard coal and hard coal briquettes	0.002	0.004	0.220	kg/TJ	K. Kubica 2017
Brown coal and brown coal briquettes	0.001	0.0046	0.074	kg/TJ	K. Kubica 2017
Coke	0.004*	0.0006	0.13*	kg/TJ	K. Kubica 2017
Natural gas	0.00052*	0.00023*	0.00098	kg/TJ	K. Kubica 2017
1.A.4.b.i Residential plants					
Hard coal and hard coal briquettes	0.002	0.002	0.152	kg/TJ	K. Kubica 2017
Brown coal and brown coal briquettes	0.001	0.004	0.072	kg/TJ	K. Kubica 2017
Coke	0.004	0.001	0.170	kg/TJ	K. Kubica 2017
Wood and wood waste	0.003	0.0006	0.0295	kg/TJ	K. Kubica 2017
Fuel oil	0.024*		0.03	kg/TJ	PL (IETU)
Natural gas	0.00052	0.00023	0.001	kg/TJ	PL (IETU)
1.A.4.c.i Agriculture/Forestry/Fishing					
Hard coal	0.003	0.004	0.220	kg/TJ	K. Kubica 2017
Brown coal	0.001	0.0046	0.074	kg/TJ	K. Kubica 2017
Hard coal briquettes	0.003	0.004	0.220	kg/TJ	K. Kubica 2017
Brown coal briquettes	0.001	0.0046	0.074	kg/TJ	K. Kubica 2017
Coke	0.004	0.001*	0.13	kg/TJ	K. Kubica 2017
Wood and wood waste	0.0010	0.0005	0.0567	kg/TJ	K. Kubica 2017
Fuel oil	0.024		0.03	kg/TJ	PL (IETU)
Natural gas	0.00052	0.00023	0.000011	kg/TJ	PL (IETU)

Note: * Own estimation based on Cadmium content in fuel; PL (IETU) emission factors come from IETU surveys

Table A3.95 Additional Heavy Metals emission factors applied for NFR 1.A.4

Emission source	Emission factors					Unit
	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
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
Natural gas	0.000094*	0.00066*	0.0004*	0.00098*	0.014*	kg/TJ
1.A.4.b.i Residential plants						
Hard coal	0.007	0.018	0.120	0.043	0.219	kg/TJ
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	0.008	0.016	0.004	0.168	kg/TJ
Fuel oil	0.024*	0.029*	0.068*	0.654*	0.024*	kg/TJ
Natural gas	0.000094*	0.00066*	0.0004*	0.00098*	0.014*	kg/TJ
1.A.4.c.i Agriculture/Forestry/Fishing						
Hard coal	0.0086	0.022	0.183	0.066	0.242	kg/TJ
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	0.0127	0.0032	0.1753	kg/TJ
Fuel oil	0.024*	0.029*	0.068*	0.654*	0.024*	kg/TJ
Natural gas	0.000094*	0.00066*	0.0004*	0.00098*	0.014*	kg/TJ

Note:* For liquid and gaseous fuels emission factors applied are country specific – PL (IETU) surveys, For solid fuels emission factors applied are country specific – PL [Kubica, 2017]

Table A3.96 PCDD/F emission factors applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Hard coal	0.06	mg TEQ/ Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*
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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oil	1	mg TEQ/ Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Natural gas	2	ng TEQ/ Gg	EMEP/EEA Guidebook (2009)
Industrial gases	2	ng TEQ/ Gg	EMEP/EEA Guidebook (2009)
1.A.4.b.i Residential plants			
Coal	10	mg TEQ/ Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	5	mg TEQ/ Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Coke	0.61	mg TEQ/ Gg	LUA-NRW (1997): *Identification of Relevant Industrial Sources of Dioxins and Furans in Europe – The European Dioxin Inventory", Essen 1997*
Natural gas	0.0005	ng TEQ/ Gg	EMEP/EEA Guidebook (2009)
Industrial gases	0.0005	ng TEQ/ Gg	EMEP/EEA Guidebook (2009)
1.A.4.c.i Agriculture/Forestry/Fishing			
Natural gas	0.002	ng TEQ/ Gg	EMEP/EEA Guidebook (2009)
Industrial gases	0.002	ng TEQ/ Gg	EMEP/EEA Guidebook (2009)

Table A3.97 Emission factors of PCB applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Hard coal	0.413	g/Gg	EF applied in Bulgaria
Lignite	1.8	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Fuel wood and wood waste	0.9	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Coke	3.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Fuel oils	0.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
1.A.4.b.i Residential plants			
Hard coal	31.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Lignite	183.2	g/Gg	EMEP/CORINAIR (1994) *EMEP/CORINAIR atmospheric emission inventory guidebook.*
Fuel wood and wood waste	9	g/Gg	EF applied in Czech Republic
Coke	9.7	g/Gg	EF applied in Czech Republic
Fuel oil	3.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Diesel oil	0.6	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)

Table A3.98 HCB emission factors applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Hard coal	0.013	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182
Fuel wood and wood waste	0.06	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001), 167-182
1.A.4.b.i Residential plants			
Hard coal	0.125	g/Gg	EF applied in Czech Republic www.recetox.muni.cz

Table A3.99 Benzo(a)pyrene emission factors applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Fuel oils	3.43	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.562	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.562	µg/GJ	EMEP/EEA Guidebook (2009)
Hard coal and briquettes	1500	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite and briquettes	845	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Wood and wood waste	2480	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
1.A.4.a.i Commercial and institutional plants			
Hard coal and briquettes	0.586	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite and briquettes	0.586	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Wood and wood waste	0.095	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.100 Benzo(b)fluoranthene emission factors applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	19	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	1.81	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.843	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.843	µg/GJ	EMEP/EEA Guidebook (2009)
1.A.4.b.i Residential plants			
Hard coal	1600	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	1150	g/Gg	
Fuel wood and wood waste	3260	g/Gg	

Table A3.101 Benzo(k)fluoranthene emission factors applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Hard coal	23.4	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 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): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Natural gas	0.843	µg/GJ	EMEP/EEA Guidebook (2009)
Industrial gases	0.843	µg/GJ	EMEP/EEA Guidebook (2009)
1.A.4.b.i Residential plants			
Hard coal	50	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	525	g/Gg	
Fuel wood and wood waste	1080	g/Gg	

Table A3.102 Indeno(1.2.3-cd)pyrene emission factors applied for NFR 1.A.4

Activity	EF	Unit	EF Reference
Hard coal	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	17.6	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	0.17	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel oils	6.84	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
1.A.4.b.i Residential plants			
Hard coal	3000	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Lignite	1110	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Fuel wood and wood waste	1760	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

I.7. Agriculture/Forestry/Fishing – mobile sources (1.A.4.c.ii & 1.A.4.c.iii)

Table A3.103 SO_2 emission factors applied for mobile sources

SO2 emission source	Emission factor	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Tractors	0.1	kg/Mg	PL (ITS)
Machinery	0.1	kg/Mg	PL (ITS)
1.A.4.c.iii National fishing			
diesel oil	0.044	kg/Mg	PL (ITS)
fuel oil	0.006	Mg/Mg	PL (ITS)

Note: PL (ITS) emission factors based on sulphur content come from ITS surveys

Table A3.104 NO_x emission factors applied for mobile sources

NO_x emission source	Emission factor	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Tractors	34.457	kg/Mg	EIG 2016
Machinery	63	kg/Mg	PL (ITS)
1.A.4.c.iii National fishing			
diesel oil and fuel oil	58.4	kg/Mg	PL (ITS)

Note: PL (ITS) emission factors based on sulphur content come from ITS surveys

Table A3.105 CO emission factors applied for mobile sources

CO emission source	Emission factor	EF unit	EF Reference
1.A.4.c.ii Off-road vehicles and other machinery			
Tractors	46	kg/Mg	PL (ITS)
Machinery	50	kg/Mg	PL (ITS)
1.A.4.c.iii National fishing			
Diesel oil and fuel oil	8	kg/Mg	PL (ITS)

Note: PL (ITS) emission factors based on sulphur content come from ITS surveys

Table A3.106 NH_3 emission factors applied for mobile sources

Emission source	EF	unit	EF reference
1.A.4.c.ii Off-road vehicles and other machinery	0.008	kg/Mg diesel	*EMEP/EEA emission inventory guidebook 2009*

Table A3.107 PM emission factors applied for mobile sources

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
1.A.4.c.ii Off-road vehicles and other machinery					
Tractors	5.2000	5.2000	5.2000	kg/Mg	PL(ITS)
Machinery	5.2000	5.2000	5.2000	kg/Mg	PL(ITS)
1.A.4.c.iii National fishing					
Diesel oil	4.0000	4.0000	4.0000	kg/Mg	PL(ITS)

Note: PL (ITS) emission factors based on sulphur content come from ITS surveys

Table A3.108 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			
Tractors	3.542	kg/Mg	EIG 2016
Machinery	12.8	kg/Mg	PL (ITS)
1.A.4.c.iii National fishing			
Diesel oil	12.7	kg/Mg	PL (ITS)

Note: PL (ITS) emission factors based on sulphur content come from ITS surveys

Table A3.109 Main Heavy Metals emission factors applied for mobile sources

Emission source	Emission factors			Unit
	Cd	Hg	Pb	
Agriculture/Forestry/Fishing				
Unleaded gasoline			4.3	kg/Gg
Diesel oil	0.05			kg/Gg

Note: EFs were taken from international publications

Table A3.110 Additional Heavy Metals emission factors applied for mobile sources

Emission source	Emission factors					Unit
	As	Cr	Cu	Ni	Zn	
Agriculture/Forestry/Fishing						
Unleaded gasoline		0.5	0.3	0.5		kg/Gg
Diesel oil			0.3	0.5		kg/Gg

Note: EFs were taken from international publications

Table A3.111 PCDD/F emission factors applied for mobile sources

Activity	EF	Unit	EF Reference
Diesel oil	0.043	mg TEQ/Gg	LUA-NRW (1997): *Identification of Relevant Industrial Sources of Dioxins and Furans in Europe – The European Dioxin Inventory", Essen 1997*

Table A3.112 Benzo(a)pyrene emission factors applied for mobile sources

Activity	EF	Unit	EF Reference
Diesel oil	0.297	kg/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995

Table A3.113 Indeno(1.2.3-cd)pyrene emission factors applied for SNAP 08

Activity	EF	Unit	EF Reference
Motor gasoline	0.0107	g/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Diesel oil	0.2970	g/Gg	

I.8. Fugitive emission (NFR sector 1 B)

I.8.1 Fugitive emission from solid fuels (NFR sector 1.B.1)

– *coal mining and handling (NFR 1.B.1.a.)*

Table A3.114 NMVOC emission factors applied for NFR 1.B.1.a

Emission source	EF	EF unit
Underground mining – hard coal	0.1	kg/Mg prod

Note: emission factor comes from IETU surveys

Table A3.115 PM emission factors applied for NFR 1.B.1.a

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Extraction of brown coal	0.10172	0.05	0.005	kg/Mg	CEPMEIP
Extraction of hard coal	0.10172	0.05	0.005	kg/Mg	CEPMEIP

– *solid fuel transformation (NFR 1.B.1.b.).*

Table A3.116 NH_3 emission factors applied for NFR 1.B.1.b

Emission source	EF	unit	EF reference
Coke oven plants	5	g/Mg coke	EMEP/EEA (2009): *EMEP/EEA emission inventory guidebook 2009*

Table A3.117 PM emission factors applied for NFR 1.B.1.b

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Coke oven plants	0.2	0.2	0.1	kg/Mg	CEPMEIP

Table A3.118 NMVOC emission factors applied for NFR 1.B.1.b

Emission source	EF	EF unit	EF reference
Coke oven plants	0.000008	Mg/Mg	EIG 2016

Table A3.119 Main Heavy Metals emission factors applied for NFR 1.B.1.b

	Emission factors			Unit
Emission source	Cd	Hg	Pb	
Coke oven plants	0.05	0.03	0.22	kg/Gg

Note: EF for Main Heavy Metals emission from *Coke oven plants* is country specific – PL (IETU)

Table A3.120 Additional Heavy Metals emission factors applied for NFR 1.B.1.b

	Unit	Emission factors				
Emission source		**As**	**Cr**	**Cu**	**Ni**	**Zn**
Coke oven plants	kg/Gg	0.02	0.17	0.09	0.065	0.22

Note: Additional Heavy Metals emission factors applied in SNAP 04 for process emissions were taken from international publications

Table A3.121 POPs emission factors applied for NFR 1.B.1.b

Activity	EF	Unit	EF Reference
Coke production (APCs/flue gas burn out)			
PCDD/F emissions	0.3	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Benzo(a)pyrene emissions	0.75	kg/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Benzo(b)fluoranthene emissions	0.25	kg/Gg	
Benzo(k)fluoranthene emissions	0.25	kg/Gg	
Indeno(1.2.3-cd)pyrene emissions	0.30	kg/Gg	

I.8.2 Fugitive emissions from oil and natural gas (NFR sector 1.B.2)

- *production, transport and refining of oil*

Table A3.122 NMVOC emission factors applied for NFR 1.B.2.a

Emission source	EF	EF unit	EF Reference
040101 Petroleum products processing	0.0009	Mg/Gg	PL (IETU)
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	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 A3.123 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 A3.124 NMVOC emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF Reference
Venting and flaring	2	g/m^3	EIG 2016

Table A3.125 SOx emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF Reference
Venting and flaring	77	g/m^3	EIG 2016

Table A3.126 NOx emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF Reference
Venting and flaring	54	g/m^3	EIG 2016

Table A3.127 CO emission factors applied for NFR 1.B.2.c

Emission source	EF	EF unit	EF Reference
Venting and flaring	12	g/m^3	EIG 2016

II. NFR SECTOR 2 – Industrial processes and solvents use

II.1. Mineral Products (NFR sector 2.A)

Table A3.128 CO emission factors applied for NFR 2.A.2 and 2.A.3

Emission source	Emission factor	EF unit
030312 Lime	1.936	kg/Mg
030313 Flat glass; 030315 Container glass	0.0061	kg/Mg

Table A3.129 PM emission factors applied for NFR 2.A

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
040612 Cement (decarbonizing)	0.22	0.2	0.11	kg/Mg	EIG 2009
040614 Calx	0.59	0.24	0.05	kg/Mg	EIG 2009
040614 Gypsum (calcined)	0.59	0.24	0.03	kg/Mg	EIG 2009
040616 Quarrying of minerals (exc. coal)	0.00007	0.00004	0.000004	kg/Mg	EIG 2009
040617 Extraction of zinc-lead ores	0.10172	0.05	0.005	kg/Mg	CEPMEIP
040617 Extraction of copper ores	0.10172	0.05	0.005	kg/Mg	CEPMEIP
040624 Construction and demolition	0.162	0.0812	0.00812	kg/m²	EIG 2009

Table A3.130 Main Heavy Metals emission factors applied for NFR 2.A.3

Emission source	Emission factors			Unit
	Cd	Hg	Pb	
030314 Flat glass	0.15	0.05	10	kg/Gg

Table A3.131 Additional Heavy Metals emission factors applied for NFR 2.A.3

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
030314 Flat glass	kg/Gg	0.1	2.5	0.5	2	10

Table A3.132 PCDD/F emission factors applied for NFR 2.A.2 and 2.A.3

SNAP	Emission source	EF	Unit	EF Reference
030312	Lime (no or minimal APCs)	10	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
030312	Lime (good APCs)	0.07	mg TEQ/Gg	
030314	Flat glass (no or minimal APCs)	0.2	mg TEQ/Gg	
030315	Container glass (no or minimal APCs)	0.2	mg TEQ/Gg	

II.2. Chemical Industry (NFR sector 2.B)

Table A3.133 SO_2 emission factors applied for NFR 2.B.10.a

SO_2 emission source	Emission factor	EF unit
040401 Sulfuric acid	2	kg/Mg
040409 Carbon black	22	kg/Mg

Note: emission factor applied for sulfuric acid production is country specific; for other process emissions EF was taken from EMEP/EEA (2009) Guidebook

Table A3.134 NO_x emission factors applied for NFR 2.B

NO_x emission source	Emission factor	EF unit
040402 Nitric acid production*	3.8	kg/Mg
040403 Ammonia	1	kg/Mg
040407 NPK fertilisers	0.3	kg/Mg
040409 Carbon black	15	kg/Mg
040410 Titanium dioxide	0.108	kg/Mg

Note: emission factors were taken from EMEP/EEA Guidebook (2009)
* emission factor derived from initial country studies (the methodology is still developing – the emission factor could be changed)

Table A3.135 NH_3 emission factors applied for NFR 2.B

Emission source	EF	unit	EF reference
040403 Ammonia	0.01	Mg/Gg NH3	EIG 2009
040619 Soda ash production and use	0.9	Mg/Gg prod. Na_2CO_3	EIG 2009

Table A3.136 CO emission factors applied for NFR 2.B.1

CO emission source	Emission factor	EF unit
040403 Ammonia	0.1	kg/Mg

Note: emission factors were taken from EMEP/EEA Guidebook (2009)

Table A3.137 CO emission factors applied for NFR 2.B.10.a

CO emission source	Emission factor	EF unit
040409 Carbon black	3	kg/Mg
040517 Formaldehyde	12	kg/Mg

Note: emission factors were taken from EMEP/EEA Guidebook (2009)

Table A3.138 SO_2 emission factors applied for NFR 2.B.6

NO_x emission source	Emission factor	EF unit
040410 Titanium dioxide	3.5	kg/Mg

Table A3.139 PM emission factors applied for NFR 2.B.6

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
040410 Titanium dioxide	0.3			kg/Mg	EIG 2009
040412 Calcium carbide production	0.1			kg/Mg	EIG 2009

Table A3.140 PM emission factors applied for NFR 2.B.7

Emission source	EF	unit	EF reference
040619 Soda ash production and use	0.1	kg/Mg	EIG 2009

Table A3.141 PM emission factors applied for NFR 2.B.10.a-b

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
040407 NPK Fertilisers	0.3	0.24	0.18	kg/Mg	EIG 2009
040412 Calcium carbide production	0.1			kg/Mg	EIG 2009
040508 Polyvinylchloride	0.263	0.1	0.05	kg/Mg	EIG 2009
040509 Polypropylene	1.5			kg/Mg	EIG 2009
040511 Polystyrene (EPS)	0.03			kg/Mg	EIG 2009
040511 Polystyrene (GPPS, HIPS)	0.004			kg/Mg	EIG 2009
040617 Storage and transport of fertilisers	0.1	0.032	0.004	kg/Mg	CEPMEIP

Table A3.142 NMVOC emission factors applied for NFR 2.B

Emission source	EF	EF unit	EF Reference
040409 Carbon black	0,0007	Mg/Mg	EIG 2016
040501 Ethylene	0,0006	Mg/Mg	EIG 2016
040502 Propylene	0.005	Mg/Mg	CORINAIR
040506 Polyethylene low density	0,0024	Mg/Mg	EIG 2016
040508 Polyvinylchloride	0.008	Mg/Mg	PL (IETU)
040509 Polypropylene	0,004	Mg/Mg	EIG 2016
040511 Polystyrene	0.00126	Mg/Mg	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A3.143 Main Heavy Metals emission factors applied for NFR 2.B.10.a

	Emission factors			Unit
Emission source	**Cd**	**Hg**	**Pb**	
040414 Phosphate fertilizers	0.6			kg/Gg

Note: emission factors were taken from international publications

II.3. Metal Production (NFR sector 2.C)

Table A3.144 SO_2 emission factors applied for NFR 2.C

SO_2 emission source	**Emission factor**	**EF unit**	**EF Reference**
040207 Electric furnace steel plant	0.06	kg/Mg	EIG 2009
040301 Aluminium production (electrolysis)	5	kg/Mg	EIG 2016

Table A3.145 NO_x emission factors applied for NFR 2.C

NO_x emission source	**Emission factor**	**EF unit**
040205 Open hearth furnace steel plant	0.7	kg/Mg
040206 Basic oxygen furnace steel plant	0.01	kg/Mg
040207 Electric furnace steel plant	0.13	kg/Mg
040208 Rolling mills - hot	0.1	kg/Mg
040208 Rolling mills - cold	0.07	kg/Mg
040301 Primary aluminium production (electrolysis)	1	kg/Mg

Note: emission factors were taken from international publications

Table A3.146 CO emission factors applied for NFR 2.C

CO emission source	**Emission factor**	**EF unit**
040206 Basic oxygen furnace steel plant	3.5	kg/Mg
040207 Electric furnace steel plant	1.7	kg/Mg
040301 Primary aluminium production (electrolysis)	120	kg/Mg

Note: emission factor was taken from EMEP/EEA (2009) Guidebook

Table A3.147 PM emission factors applied for NFR 2.C

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
040202 Blast furnace charging	0.05	0.04	0.025	kg/Mg	EIG 2009
040206 Basic oxygen furnace steel plant	0.3	0.032	0.028	kg/Mg	EIG 2009
040207 Electric furnace steel plant	0.3	0.024	0.021	kg/Mg	EIG 2009
040208 Rolling mills - hot	0.009			kg/Mg	EIG 2009
040208 Rolling mills - cold	0.096			kg/Mg	EIG 2009
040209 Sinter and pelletizing plants	0.2	0.1	0.08	kg/Mg	EIG 2009
040301 Aluminium production	0.6	0.5	0.4	kg/Mg	EIG 2016
040302 Ferrosilicon	1			kg/Mg	EIG 2009
040309 Primary lead production	0.073	0.073	0.052	kg/Mg	PL*
030304 Primary lead production			2.5	g/Mg	EIG 2016
030305 Primary zinc production			12.0	g/Mg	EIG 2016
030306 Primary copper production			190.0	g/Mg	EIG 2016
030307 Secondary lead production			2.5	g/Mg	EIG 2016
030308 Secondary zinc production			12.0	g/Mg	EIG 2016
030309 Secondary copper production			190.0	g/Mg	EIG 2016

Note: PL* emission factors for Primary lead production is country specific from domestic studies

Table A3.148 NMVOC emission factors applied for NFR 2.C

Emission source	EF	EF unit	EF Reference
040202 Blast furnace charging	0.000237	Mg/Mg	PL (IETU)
040206 Basic oxygen furnace steel plant	0.000038	Mg/Mg	PL (IETU)
040207 Electric furnace steel plant	0.000046	Mg/Mg	EIG 2016
040208 Rolling mills - hot	0.000007	Mg/Mg	EIG 2016
040208 Rolling mills - cold	0.000126	Mg/Mg	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A3.149 Main Heavy Metals emission factors applied for NFR 2.C

Emission source	Emission factors			Unit
	Cd	Hg	Pb	
040202 Blast furnace charging		0.0000001	0.287	kg/Gg
040203 Pig iron tapping			4.5	kg/Gg
040205 Open hearth furnace steel plant	0.2		1.4	kg/Gg
040206 Basic oxygen furnace steel plant	0.025	0.001	0.1	kg/Gg
040207 Electric furnace steel plant	0.25	0.10	5.5	kg/Gg
040209 Sinter and pelletizing plants (excluding 030301)	0.1	0.01	5.4	kg/Gg
040301 Aluminium production	0.1			kg/Gg
040302 Ferro alloys			0.24	kg/Gg
040309 Other (production of batteries)			5	kg/Gg

Note: EF for Pb emissions from *production of batteries* is country specific – PL (IETU) surveys while for other emission sources EFs were taken from international publications

Table A3.150 Additional Heavy Metals emission factors applied for NFR 2.C

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
040202 Blast furnace charging	kg/Gg					0.58
040203 Pig iron tapping	kg/Gg			0.003		0.021
040205 Open hearth furnace steel plant	kg/Gg	0.75	9.8	1.18		40.15
040206 Basic oxygen furnace steel plant	kg/Gg	0.015	0.06	0.03	0.05	0.6
040207 Electric furnace steel plant	kg/Gg	0.1	1	3.1	0.25	23.9
040209 Sinter and pelletizing plants (excluding 030301)	kg/Gg	0.04	0.3	0.6	0.7	8.9
040301 Aluminium production	kg/Gg				0.1	0.15

Note: Additional Heavy Metals emission factors applied for process emissions were taken from international publications

Table A3.151 PCDD/F emission factors applied for NFR 2.C

Activity	EF	Unit	EF Reference
Pig iron tapping	0.01	mg TEQ/Gg	*Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland;* Danish Environmental Protection Agency and Ministry of the Environment, 2005
Basic oxygen furnace steel plants	0.02	mg TEQ/Gg	*Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland;* Danish Environmental Protection Agency and Ministry of the Environment, 2005
Electric furnace steel plants	3	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Aluminium production (electrolysis)	2	mg TEQ/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999

Table A3.152 Emission factors of PCBs applied for NFR 2.C

Activity	EF	Unit	EF Reference
Pig iron tapping	0.0064	g/Gg	*Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland;* Danish Environmental Protection Agency and Polish Ministry of the Environment, 2005
Open heart furnace steel plants	2.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING-Baltic)*, 1999
Basic oxygen furnace steel plants	0.0048	g/Gg	*Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland;* Danish Environmental Protection Agency and Polish Ministry of the Environment, 2005
Electric furnace steel plants	2.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING*
Rolling mills	2.6	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING*

Table A3.153 HCB emission factors applied for NFR 2.C

Activity	EF	Unit	EF Reference
Pig iron tapping	0.00146	g/Gg	Opportunities for reduction of dioxin emissions from the metallurgical sector in Poland; Danish Environmental Protection Agency and Ministry of the Environment. Institute of Environmental Protection, 2005
Basic oxygen furnace steel plants	0.00176	g/Gg	

Table A3.154 PAH emission factors applied for NFR 2.C

Activity	EF	Unit	EF Reference
Aluminium production			
Benzo(a)pyrene emissions	11.000	kg/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Benzo(b)fluoranthene emissions	40.180	kg/Gg	
Benzo(k)fluoranthene emissions	40.180	kg/Gg	
Indeno(1.2.3-cd)pyrene emissions	5.000	kg/Gg	

II.4. Solvent use (NFR sector 2.D)

Table A3.155 NMVOC emission factors applied for NFR 2.D.3

Emission source	EF	EF unit	EF Reference
Fat, edible and non edible oil extraction	0.014	kg/Mg	PL (IETU)
Domestic solvent use (other than paint application)	1.2	Mg/thousand people	PL (IETU)
Covering with asphalt materials	16	g/Mg	EIG 2016

Note: PL (IETU) emission factors come from IETU surveys

Table A3.156 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 A3.157 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/thousand people	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A3.158 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	EIG 2016

Emission source	EF	EF unit	EF Reference
Rubber processing	0.008	Mg/Mg	EIG 2016
Pharmaceutical products manufacturing	0.014	Mg/thousand people	PL (IETU)
Paints manufacturing	0.005	Mg/Mg	PL (IETU)
Tyres	10	kg/Mg	EIG 2016
Asphalt	27.2	kg/Mg	EIG 2016
Shoes	0.045	kg/Mg	EIG 2016

Note: PL (IETU) emission factors come from IETU surveys

Table A3.159 NMVOC emission factors applied for NFR 2.D.3.h

Emission source	EF	EF unit	EF Reference
Printing inks	500	g/kg ink	EIG 2016

Table A3.160 NMVOC emission factors applied for NFR 2.D.3.i

Emission source	EF	EF unit	EF Reference
Glues	2	kg/Mg	EIG 2016
Adhesives	2	kg/Mg	EIG 2016

Table A3.161 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	EIG 2009

Table A3.162 PAH emission factors applied for NFR 2.D.3.i

Activity	EF	Unit	EF Reference
Wood preservation			
Benzo(a)pyrene emissions	0.5	kg/Gg	Berdowski et al. (1995): *Technical paper to the OSPARCOM-HELCOM-UNECE emission heavy metals and persistent organic pollutants*, 1995
Benzo(b)fluoranthene emissions Benzo(k)fluoranthene emissions Indeno(1.2.3-cd)pyrene emissions	0.250	kg/Gg	

II.5. Other product use (NFR sector 2.G)

Table A3.163 Emission factors applied for NFR 2.G

Source and emissions	EF	Unit	EF reference
Tobacco combustion			
NO_X emissions	0.0034652	Mg/Gg	Aasestad, 2007 (Report for Norway)
NMVOC emissions	0.0048374	Mg/Gg	Aasestad, 2007 (Report for Norway)
CO emissions	0.1215475	Mg/Gg	Aasestad, 2007 (Report for Norway)
TSP emissions	27	Mg/Gg	EIG 2013 table 3-14
PM10 emissions	27	Mg/Gg	EIG 2013 table 3-14
PM2.5 emissions	27	Mg/Gg	EIG 2013 table 3-14
Pb emissions	0.00005	g/Mg	Aasestad, 2007
Cd emissions	0.0001	g/Mg	Aasestad, 2007

Source and emissions	EF	Unit	EF reference
Hg emissions	0.0001	g/Mg	Aasestad, 2007
As emissions	0.000159	g/Mg	Aasestad, 2007
Cr emissions	0.000354	g/Mg	Aasestad, 2007
Cu emissions	0.000152	g/Mg	Aasestad, 2007
PCDD/F emissions	0.1	pg TEQ/ cigarette	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

II.5. Other Production (NFR sectors 2.H and 2.I)

Table A3.164 Emission factors applied for NFR 2.H.1

Source and emissions	Emission factor	EF unit
Pulp and paper		
NOx emissions	1	kg/Mg
CO emissions	5.5	kg/Mg
TSP emissions	1	kg/Mg
PM10 emissions	0.8	kg/Mg
PM2.5 emissions	0.6	kg/Mg
SO_2 emissions	2	Mg/Gg

Note: emission factor was taken from EMEP/EEA Guidebook (2009)

Table A3.165 NMVOC emission factors applied for NFR 2.I and 2.H.1

Emission source	EF	EF unit	EF Reference
040601 Chipboard	0.0002	Mg/m3	PL (IETU)
040602 Paper pulp	0.001	Mg/Mg	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Table A3.166 NMVOC emission factors applied for NFR 2.H.2

Emission source	EF	EF unit	EF Reference
040605 Bread	0.0045	Mg/Mg	CORINAIR
040606 Wine	0.000034	Mg/hl	CORINAIR
040607 Beer	0.00002	Mg/hl	CORINAIR
040608 Spirits	0.0024	Mg/hl 100%	CORINAIR
Sugar production	10	Mg/Gg	EIG 2016
Slaughter products (cattle and calves)	0.3	Mg/Gg	EIG 2016
Slaughter products (Pigs)	0.3	Mg/Gg	EIG 2016
Slaughter products (Poultry meat)	0.3	Mg/Gg	EIG 2016
Slaughter products (Frozen sea fish)	0.3	Mg/Gg	EIG 2016
Fats (Margarine and fat spreads, excluding liquid margarine)	10	Mg/Gg	EIG 2016
Prepared pet foods (Prepared feeds for farm animals)	1	Mg/Gg	EIG 2016
Prepared pet foods (Prepared pet foods)	1	Mg/Gg	EIG 2016

Note: PL (IETU) emission factors come from IETU surveys

Table A3.167 PCDD/F emission factors applied for NFR 2.H.2

Activity	EF	Unit	EF Reference
Other (smoke houses - clean fuel, no flue gas burn out)	6	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Other (smoke houses - clean fuel, flue gas burn out)	0.6	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

II.6. Other production, consumption, storage, transportation or handling of bulk products (NFR sector 2.L)

Table A3.168 PM emission factors applied for NFR 2.L

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
040617 Storage and transport of cement	0.01	0.005	0.0005	kg/Mg	CEPMEIP
040617 Storage and transport of coal	0.15	0.06	0.006	kg/Mg	CEPMEIP
040617 Storage and transport of coke	0.11	0.044	0.0044	kg/Mg	CEPMEIP

III. NFR SECTOR 3 - AGRICULTURE

III.1 Manure Management (NFR sector 3.B)

Table A3.169 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 2016	CS (IEF)	EMEP/EEA 2016	CS (IEF)
Dairy cattle slurry	39.3	22.3 (1990) – 29.1 (2016)	0.011	0.2151 (1990) – 0.2704 (2016)
Dairy cattle solid	28.7		0.236	
Other cattle slurry	13.4	12.5 (1990) – 12.8 (2016)	0.003	0.1285 (1990) – 0.1305 (2016)
Other cattle solid	9.2		0.144	
Fattening pigs slurry	6.7	4.7 (1990) – 4.1 (2016)	0.002	0.0393 (1990) – 0.0337 (2016)
Fattening pigs solid	6.5		0.069	
Sows slurry	15.8	11.1 (1990) – 10.9 (2016)	0.006	0.0818 (1990) – 0.0815 (2016)
Sows solid	18.2		0.204	
Sheep solid	1.4	2.7	0.002	0.0278
Goats solid	1.4	2.3	0.008	0.0226
Horses solid	14.8	16.5	0.201	0.1681
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 A3.170 Nitrogen excreted (Nex) in manure by livestock categories (NFR 3.B)

Livestock	Nex [kg/head/year]	
	CS	EMEP/EEA 2016
Dairy cattle:		
1988−1995	65.0	105
1996−2000	70.0	
2001–2005	75.0	
2006–2010	80.0	
Since 2011	83.0	
Non-dairy cattle:		
calves up to 1 year	19.0	41
Young cattle 1−2 years	46.0	
Heifers above 2 years	53.0	
Bulls above 2 years	65.0	
Swine:		
piglets (< 20 kg)	2.6	12.1 34.5 (including piglets to 25 kg)
piglets (20-50 kg)	9.0	
fattening pigs (> 50 kg)	15.0	
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 A3.171 PM emission factors applied for NFR 3.B

PM Emission source	Emission factor			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 A3.172 NH_3 emission factors applied for NFR 3.D

NFR	Activity	EF	unit	EF reference
3.D.a.1	Inorganic N-fertilisers	0.042	kg NH3/kg N	EMEP/EEA EIG 2009
3.D.a.2.b	Sewage sludge applied to soils	0.130	kg NH3/kg N	EMEP/EEA EIG 2016

Table A3.173 NO_x, NMVOC and PM emission factors applied for NFR 3.D

Emission source	EF	EF unit	EF Reference
3.D.a.i Cultures with fertilizers			
NO_2 emission	0.040	t NO_2-N / t N-fertilizer	EMEP/EEA EIG 2016
NMVOC emission	0.005955	kg/Gg fertilizer	EMEP/EEA EIG 2009
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

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

Table A3.174 PM emission factors applied for NFR 3.F

PM Emission source	Emission factor			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 A3.175 NMVOC and CO emission factors applied for NFR 3.F

Emission source	EF	EF unit	EF Reference
3. Agriculture			
3.F On-field burning of stubble			
NMVOC	0.0005	kg/kg DM	EMEP/EEA EIG 2016
CO	0.0667	kg/kg DM	EMEP/EEA EIG 2016

Table A3.176 PCDD/F emission factors applied for NFR 3.F

SNAP	Activity	EF	Unit	EF Reference
3. Agriculture				
3.F On-field burning of stubble		0.500	μg TEQ/t	EMEP/EEA EIG 2016

IV. NFR SECTOR 5 – WASTE

IV.1. Solid waste disposal on land (NFR SECTOR 5 A)

Table A3.177 NMVOC emission factors applied for NFR 5 A

Emission source	EF	EF unit
Municipal solid waste disposal on land	1.56	kg/Mg

Note: emission factor applied was taken from EMEP/EEA (2009) Guidebook

IV.2. Wastewater handling (NFR SECTOR 5D)

Table A3.178 NH_3 emission factors applied for NFR 5.D.1

Emission source	EF	unit	EF reference
Latrines	1.6	[kg/person/year]	EMEP/EEA EIG 2009

Table A3.179 NMVOC emission factors applied for 5.D

Emission source	EF	EF unit
Municipal Waste water treatment	15.0	mg/m^3

Note: emission factor applied was taken from EMEP/EEA (2009) Guidebook

IV.3. Waste incineration (NFR SECTOR 5 C)

IV.3.1 Clinical waste incineration (NFR SECTOR 5.C.1.b.iii)

Table A3.180 SO_2 emission factors applied for NFR 5.C.1.b.iii

SO2 emission source	Emission factor	EF unit
Clinical waste incineration	1.4	kg/Mg

Note: emission factor applied was taken from EMEP/EEA (2009) Guidebook

Table A3.181 NO_x emission factors applied for NFR 5.C.1.b.iii

NO_x emission source	Emission factor	EF unit
Clinical waste incineration	1.4	kg/Mg

Note: emission factor applied was taken from EMEP/EEA (2009) Guidebook

Table A3.182 NMVOC emission factors applied for NFR 5.C.1.b.iii

Emission source	EF	EF unit
Clinical waste incineration	0.0007	Mg/Mg

Note: emission factor applied was taken from EMEP/EEA (2016) Guidebook

Table A3.183 PCDD/F emission factors applied for NFR 5.C.1.b.iii

Activity	EF	Unit	EF Reference
Clinical waste incineration (installations that comply with EU Directive)	1.38	mg TEQ/Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*
Clinical waste incineration (minimal APCs)	68	mg TEQ/Gg	GF/POL/01/004 *Enabling activities to facilitate early action on the impementation of the Stockholm Convention on Persistent Organic Pollutants (POPs Convention) in Poland*
Clinical waste incineration (no APCs)	453.3	mg TEQ/Gg	Grochowalski A. (2001): *Estimation and analysis of emission factors for PCDD/F and PAHs from selected sources for emission inventor purposes, 2001 (in Polish)*

Table A3.184 Emission factors of PCBs applied for NFR 5.C.1.b.iii

Activity	EF	Unit	EF Reference
Clinical waste incineration (installations that comply with EU Directive)	0.39	g/Gg	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, 2002*
Clinical waste incineration (no or minimal APCs)	20	g/Gg	*EMEP/CORINAIR atmospheric emission inventory guidebook.*

Table A3.185 HCB emission factors applied for NFR 5.C.1.b.iii

Activity	EF	Unit	EF Reference
Clinical waste incineration (installations that comply with EU Directive)	0.295	g/Gg	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, 2002*
Clinical waste incineration (no or minimal APCs)	29	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001),

IV.3.2 Industrial waste incineration (including sludges) (NFR SECTOR 5.C.1.b)

Table A3.186 SO_2 emission factors applied for NFR 5.C.1.b.i

SO2 emission source	Emission factor	EF unit
Industrial waste incineration	0.047	kg/Mg

Note: emission factor applied was taken from EMEP/EEA (2009) Guidebook

Table A3.187 NO_x emission factors applied for NFR 5.C.1.b.i and 5.C.1.b.iv

NO_x emission source	Emission factor	EF unit
Industrial waste incineration	0.87	kg/Mg
Sludge incineration	0.87	kg/Mg

Note: emission factors applied were taken from EMEP/EEA (2009) Guidebook

Table A3.188 PM emission factors applied for NFR 5.C.1.b.i

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Industrial waste incineration	0.1000	0.0600	0.0040	Mg/Mg	CEPMEIP

Table A3.189 NMVOC emission factors applied for NFR 5.C.1.b.i and 5.C.1.b.iv

Emission source	EF	EF unit
Industrial waste incineration	0.0074	Mg/Mg
Sludge incineration	0.0074	Mg/Mg

Note: emission factors applied were taken from Corinair

Table A3.190 PCDD/F emission factors applied for NFR 5.C.1.b.i and 5.C.1.b.iv

Activity	EF	Unit	EF Reference
Industrial waste incineration (no APCs)	3500	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Industrial waste incineration (minimal APCs)	350	mg TEQ/Gg	
Industrial waste incineration (good APCs)	30	mg TEQ/Gg	
Industrial waste incineration (very good APCs)	0.5	mg TEQ/Gg	
Sewage sludge incineration (with APCs)	4	mg TEQ/Gg	

Table A3.191 Emission factors of PCBs applied for NFR 5.C.1.b.i

Activity	EF	Unit	EF Reference
Industrial waste incineration (no APCs)	30.4	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Industrial waste incineration (minimal APCs)	19.3	g/Gg	Parma at al. (1995): *Atmospheric emission inventory guidelines for persistent organic pollutants (POPs*)
Industrial waste incineration (good and very good APCs)	0.38	g/Gg	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, 2002*

Table A3.192 HCB emission factors applied for NFR 5.C.1.b.i

Activity	EF	Unit	EF Reference
Industrial waste incineration (no or minimal APCs)	19	g/Gg	Bailey (2001): *Global hexachlorobenzene emission*, Ch*emosphere* 43 (2001),
Industrial waste incineration (good and very good APCs)	0.139	g/Gg	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, 2002*

IV.3.3 Municipal waste incineration (NFR SECTOR 5.C.1.a)

Table A3.193 SO_2 emission factors applied for NFR 5.C.1.a

SO2 emission source	Emission factor	EF unit
Municipal waste incineration	0.087	kg/Mg

Note: emission factor applied was taken from EMEP/EEA (2016) Guidebook

Table A3.194 NO_x emission factors applied for NFR 5.C.1.a

NO_x emission source	Emission factor	EF unit
Municipal waste incineration	1.071	kg/Mg

Note: emission factor applied was taken from EMEP/EEA (2016) Guidebook

Table A3.195 PM emission factors applied for NFR 5.C.1.a

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Municipal waste incineration	0.0001	0.0001	0.0001	Mg/Mg	CEPMEIP

Table A3.196 NMVOC emission factors applied for NFR 5.C.1.a

Emission source	EF	EF unit	EF Reference
Municipal waste incineration	0.0059	Mg/Mg	CORINAIR

Table A3.197 Main Heavy Metals emission factors applied for NFR 5.C.1.a

	Emission factors			Unit
	Cd	Hg	Pb	
Municipal wastes incineration	3	1.1	35	kg/Gg

Note: emission factors applied were taken from EMEP/EEA (2009) Guidebook

Table A3.198 Additional Heavy Metals emission factors applied for NFR 5.C.1.a

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
Municipal wastes incineration	kg/Gg	0.05	0.3	3	0.1	21

Note: Additional Heavy Metals emission factors applied were taken from international publications

Table A3.199 PCDD/F emission factors applied for NFR 5.C.1.a

Activity	EF	Unit	EF Reference
Municipal waste incineration (modern APCs)	0.5	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

Table A3.200 Emission factors of PCBs applied for NFR 5.C.1.a

Activity	EF	Unit	EF Reference
Municipal waste incineration	0.2	g/Gg	NILU (1999): *Environmental Cycling of Selected Persistent Organic Pollutants (POPs) in the Baltic Region (POPCYCLING*

Table A3.201 HCB emission factors applied for NFR 5.C.1.a

Activity	EF	Unit	EF Reference
Municipal waste incineration	0.15	g/Gg	EF applied in Hungary

IV.3.4 Cremations (NFR SECTOR 5.C.1.b.v)

Table A3.202 SO_2 emission factors applied for NFR 5.C.1.b.v

SO_2 emission source	Emission factor	EF unit
Cremations	0.113	kg/body

Note: emission factor applied was taken from EMEP/EEA (2016) Guidebook

Table A3.203 NO_x emission factors applied for NFR 5.C.1.b.v

NO_x emission source	Emission factor	EF unit
Cremations	0.04	kg/body

Note: emission factor applied was taken from EMEP/EEA (2016) Guidebook

Table A3.204 CO emission factors applied for NFR 5.C.1.b.v

CO emission source	Emission factor	EF unit
Cremations	0.14	kg/body

Note: emission factor applied was taken from EMEP/EEA (2009) Guidebook

Table A3.205 NMVOC emission factors applied for NFR 5.C.1.b.v

Emission source	EF	EF unit
Cremations	0.013	Mg/1000 body

Note: emission factors applied were taken from Corinair

Table A3.206 Main Heavy Metals emission factors applied for NFR 5.C.1.b.v

	Emission factors			Unit
Emission source	Cd	Hg	Pb	
Cremations	0.00311	0.934	0.0186	g/1000 body

Note: emission factors applied were taken from EMEP/EEA (2009) Guidebook

Table A3.207 Additional Heavy Metals emission factors applied for NFR 5.C.1.b.v

Emission source	Unit	Emission factors				
		As	Cr	Cu	Ni	Zn
Cremations	g/1000 body	0.011	0.00311	0.00771	0.0107	

Note: emission factors applied were taken from EMEP/EEA (2009) Guidebook

Table A3.208 PCDD/F emission factors applied for NFR 5.C.1.b.v

Activity	EF	Unit	EF Reference
Cremations	10	µg TEQ / cremation	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

IV.3.5 Open burning of agricultural wastes (NFR SECTOR 5.C.2)

Table A3.209 NO_x emission factors applied for NFR 5.C.2

NO_x emission source	Emission factor	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 A3.210 CO emission factors applied for NFR 5.C.2

CO emission source	Emission factor	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 A3.211 PM emission factors applied for NFR 5.C.2

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Open burning of agricultural wastes	0.00464	0.00451	0.00419	Mg/Mg	EIG 2016

Table A3.212 NMVOC emission factors applied for NFR 5.C.2

Emission source	EF	EF unit	EF Reference
Open burning of agricultural wastes	0.00123	Mg/Mg	EMEP/EEA EIG 2016

Table A3.213 PCDD/F emission factors applied for NFR 5.C.2

Activity	EF	Unit	EF Reference
Open burning of agricultural wastes (excluding SNAP 1003)	0.5	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Open burning of agricultural wastes (poor combustion conditions)	30	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

Table A3.214 PCDD/F emission factors applied for NFR 5.E

Activity	EF	Unit	EF Reference
Forest and other vegetation fires	5	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Landfill fires - surface)	0.07	g TEQ/ fire	Update of Dioxin Emission Factors for Forest Fires, Grassland and Moor Fires, Open Burning of Agricultural Residues, Open Burning of Domestic Waste, Landfills and Dump Fires. Pat Costner International POPs Elimination Network, 2006. http://www.ipen.org/ipenweb/work/dioxin.html
Landfill fires- deep	0.35	g TEQ/ fire	
Automobile fires	94	µg TEQ / fire of vehicle	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005
Houses and industry plants fires	400	mg TEQ/Gg	UNEP Chemicals (2005): *Standardized Toolkit for Identification and Quantification of dioxin and Furan Releases*, 2005

Table A3.215 PM emission factors applied for NFR 5. E

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Car fires	0.0023	0.0023	0.0023	g/amount of fires	Aasestad, 2007

Table A3.216 Black Carbon emission factors applied

NFR	BC Emission source	% PM2.5
1A1a	Hard coal	2.20
1A1a	Brown coal	1.00
1A1a	Natural gas	2.50
1A1a	Fuel wood and wood waste	3.30
1A1a	Coke	2.20
1A1a	Diesel oil	33.50
1A1a	Fuel oil	5.60
1A1a	Refinery gas	2.50
1A1a	Coke-oven gas	2.50
1A1a	Town gas	2.50
1A1b	Hard coal	2.20
1A1b	Natural gas	2.20
1A1b	Diesel oil	33.50
1A1b	Fuel oil	5.60
1A1b	Refinery gas	18.40
1A1b	Town gas	2.20
1A1c	Hard coal	2.20
1A1c	Hard coal (coke-oven plants)	48.00
1A1c	Brown coal	1.00
1A1c	Natural gas	2.20
1A1c	Coke	2.20
1A1c	Diesel oil	33.50
1A1c	Coke-oven gas	2.20
1A2	Hard coal	2.20
1A2	Brown coal	1.00
1A2	Natural gas	2.50
1A2	Fuel wood and wood waste	3.30
1A2	Coke	2.20
1A2	Diesel oil	33.50
1A2	Fuel oil	5.60
1A2	Refinery gas	2.50
1A2	Coke-oven gas	2.50
1A2	Blast-furnace gas	2.50
1A2	Town gas	2.50
1A3a	Aviation	15.00
1A3c	Railways	65.00
1A3dii	Inland waterways	100.00
1A3dii	Maritime activities	31.00
1A4ai	Hard coal	6.40
1A4ai	Brown coal	6.40
1A4ai	Natural gas	4.00
1A4ai	Fuel wood and wood waste	3.30
1A4ai	Coke	6.40
1A4ai	Diesel oil	56.00
1A4ai	Blast-furnace gas	4.00
1A4ai	Town gas	4.00
1A4bi	Hard coal	6.40
1A4bi	Brown coal	6.40
1A4bi	Natural gas	5.40
1A4bi	Fuel wood and wood waste	10.00
1A4bi	Coke	6.40
1A4bi	LPG	5.40
1A4bi	Diesel oil	8.50
1A4ci	Hard coal	6.40
1A4ci	Brown coal	6.40
1A4ci	Natural gas	4.00
1A4ci	Fuel wood and wood waste	3.30
1A4ci	Coke	6.40
1A4ci	LPG	4.00
1A4ci	Fuel oil	56.00
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles	86.00
1A4cii	Agriculture/Forestry/Fishing: other machinery	86.00
1A4ciii	National fishing	31.00
1A4ciii	National fishing	31.00
1B1b	Coke oven (door leakage and extinction)	49.00
2A1	Cement	3.00
2A2	Lime	0.46
2A2	Plaster	0.46
2A3	Glass production	0.06
2A3	Container glass production	0.06
2A3	Glass wool	2.00
2C1	Blast furnace charging	2.40
2C1	Basic oxygen furnace steel plant	0.36
2C1	Electric furnace steel plant	0.36
2C1	Sinter and pelletizing plant	0.17
2C3	Aluminum production	2.3
2G	Use of tobacco	0.45
2H1	Paper pulp (Kraft process)	2.60
3F	On-field burning of stubble, straw,...	100.00
5C1a	Municipal waste incineration	3.50
5C1bi	Industrial waste incineration	3.50
5C1bi	Industrial waste incineration	3.50
5C1bi	Industrial waste incineration	3.50
5C2	Open Burning of Waste	42.00
5.E	Unintentional car fires	100.00
11.B	Forest fires	9.00

V. Memo Items.

V.1 Aviation

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 11 B)

Table A3.217 PM emission factors applied for NFR 11 B

PM Emission source	Emission factor			EF unit	EF reference
	TSP	PM10	PM2.5		
Forests fires	0.0047	0.0033	0.00282	Mg/Mg	CEPMEIP

Table A3.218 NMVOC emission factors applied for NFR 11 B

Emission source	EF	EF unit	EF Reference
Forest fires	0.013	Mg/ha	PL (IETU)

Note: PL (IETU) emission factors come from IETU surveys

Appendix 4: 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 2016. The ten largest key sources from the 2016 level assessment are presented in the table A1.1. Detailed analysis for the particular pollutants is presented in the tables below.

Table A4.1 The ten largest key sources from the level assessment for 2016

Pollutant	Key sources in descending order									
SOx	1A1a	1A4bi	1A2c	1A2a	1A4ci	1A2f	1A2e	1A4ai	1A1b	1A2d
NOx	1A1a	1A3biii	1A3bi	1A4bi	1A4cii	3Da1	1A3bii	1A2f	1A4ai	1A2a
CO	1A4bi	1A3bi	1A2a	1A4ci	1A4cii	1A3bii	1A4ai	1A1a	1A2f	1A3biv
NH3	3B1a	3B3	3B1b	3Da1	3B4giv	3B4gi	3B4gii	1A3bi	3B4e	5D1
PM10	1A4bi	3Dc	1A1a	1A4ci	1A2c	1A4cii	1A2a	1B1a	1A4ai	5C1bi
PM2.5	1A4bi	1A1a	1A4ci	1A2c	1A4cii	1A2a	1A4ai	1A2e	1A2f	1A3bi
NMVOC	2D3d	1A4bi	2D3a	2H2	1A3bi	1B2aiv	2D3g	2D3h	2D3e	1A2f
Cd	1A2b	2C1	1A2c	5C1a	1A2a	1A4bi	1A1b	1A1a	1A2e	1A2f
Hg	1A1a	1A2b	1A4bi	5C1a	1A2f	2C1	1A4ci	1A2c	1A4ai	1A2a
Pb	1A2b	2C1	1A4bi	1A1a	5C1a	2A3	1A4ci	1A2c	1A2a	1A4ai
As	1A2b	1A1a	1A4bi	1A1b	2C1	1A2c	1A2a	1A4ci	1A2e	1A2f
Cr	2C1	1A4bi	1A1a	2A3	1A3bvi	1B1b	2A1	1A2c	1A1b	1A4ci
Cu	1A2b	1A3bvi	1A4bi	1A1a	2C1	1A4ci	1A4ai	1A2c	1A2a	1A1b
Ni	1A1b	1A1a	1A4bi	2C1	1A2c	1A2a	1A4ci	1A2e	2A3	1A2f
Zn	1A2b	2C1	1A1a	1A4bi	1A2c	1A2a	1A3bvi	1A2e	1A2f	1A4ci
PCDD/F	1A4bi	5E	1A2b	2A2	2C1	1A1a	1A2a	1A3bi	3F	1B1b
HCB	1A4bi	1A2a	1A1a	5C1bi	1A2f	1A4ci	1A2c	5C1biii	5C1a	1A2e
PCBs	1A4bi	1A1a	2C1	1A4ai	1A2c	1A2a	1A4ci	1A2e	1A2f	1A2b
PAHs	1A4bi	1B1b	1A3bi	1A4cii	1A3biii	1A1a	1A2c	1A3bii	1A4ci	1A2a

Sulphur dioxide emissions

Nine source categories have been identified for 2016 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 A4.2 Level Assessment for sulphur dioxide emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A1a	Public electricity and heat production	2164.028	81.69	81.69	1A1a	Public electricity and heat production	273.639	47.06	47.06
1A4bi	Residential: Stationary	144.476	5.45	87.15	1A4bi	Residential: Stationary	134.353	23.10	70.16
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	111.992	4.23	91.37	1A2c	Stationary combustion in manufacturing industries: Chemicals	33.129	5.70	75.86
1A2a	Stationary combustion in manufacturing industries: Iron and steel	62.239	2.35	93.72	1A2a	Stationary combustion in manufacturing industries: Iron and steel	23.651	4.07	79.92
1A4ai	Commercial/institutional: Stationary	43.133	1.63	95.35	1A4ci	Agriculture/Forestry/Fishing: Stationary	22.731	3.91	83.83
					1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	21.070	3.62	87.46
					1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	16.482	2.83	90.29
					1A4ai	Commercial/institutional: Stationary	16.335	2.81	93.10
					1A1b	Petroleum refining	11.777	2.03	95.12

Nitrogen oxides emission

Sixteen source categories have been identified for 2016 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 households and road transport.

Table A4.3 Level Assessment for nitrogen oxides emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A1a	Public electricity and heat production	529.158	50.30	50.30	1A1a	Public electricity and heat production	192.289	26.47	26.47
1A3bi	Road transport: Passenger cars	83.073	7.90	58.20	1A3biii	Road transport: Heavy duty vehicles and buses	117.019	16.11	42.58
1A3biii	Road transport: Heavy duty vehicles and buses	79.933	7.60	65.80	1A3bi	Road transport: Passenger cars	82.153	11.31	53.89
1A4bi	Residential: Stationary	54.949	5.22	71.02	1A4bi	Residential: Stationary	70.742	9.74	63.63
3Da1	Inorganic N-fertilizers (includes also urea application)	50.960	4.84	75.86	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	62.609	8.62	72.25
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	43.945	4.18	80.04	3Da1	Inorganic N-fertilizers (includes also urea application)	41.720	5.74	77.99
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	37.180	3.53	83.58	1A3bii	Road transport: Light duty vehicles	31.003	4.27	82.26
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	32.987	3.14	86.71	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	18.160	2.50	84.76
1A3bii	Road transport: Light duty vehicles	29.529	2.81	89.52	1A4ai	Commercial/institutional: Stationary	16.279	2.24	87.00
1A3c	Railways	22.808	2.17	91.69	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	10.510	1.45	88.44
1A4ciii	Agriculture/Forestry/Fishing: National fishing	12.883	1.22	92.91	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	10.262	1.41	89.86
1A4ai	Commercial/institutional: Stationary	12.760	1.21	94.12	1A4ci	Agriculture/Forestry/Fishing: Stationary	9.609	1.32	91.18
1A1c	Manufacture of solid fuels and other energy industries	7.759	0.74	94.86	2B2	Nitric acid production	8.892	1.22	92.40
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	7.753	0.74	95.60	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	7.389	1.02	93.42
					1A4ciii	Agriculture/Forestry/Fishing: National fishing	6.741	0.93	94.35
					1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	5.974	0.82	95.17

Ammonia emissions

Seven source categories have been identified for 2016 as key sources (level assessment) in NH_3 inventory in Poland. The most important of them are: manure management of dairy cattle and swine and use of fertilizers.

Table A4.4 Level Assessment for ammonia emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
3B1a	Manure management - Dairy cattle	109.619	24.86	24.86	3B1a	Manure management - Dairy cattle	67.939	25.44	25.44
3B3	Manure management - Swine	103.518	23.47	48.33	3B3	Manure management - Swine	50.364	18.86	44.29
3B1b	Manure management - Non-dairy cattle	64.369	14.60	62.93	3B1b	Manure management - Non-dairy cattle	46.071	17.25	61.54
3Da1	Inorganic N-fertilizers (includes also urea application)	54.082	12.26	75.19	3Da1	Inorganic N-fertilizers (includes also urea application)	44.276	16.58	78.11
3B4giv	Manure management - Other poultry	32.708	7.42	82.61	3B4giv	Manure management - Other poultry	16.706	6.25	84.37
3B4gi	Manure management - Laying hens	18.831	4.27	86.88	3B4gi	Manure management - Laying hens	15.078	5.64	90.01
3B4gii	Manure management - Broilers	17.317	3.93	90.81	3B4gii	Manure management - Broilers	14.597	5.46	95.48
3B4e	Manure management - Horses	15.535	3.52	94.33					
3B2	Manure management - Sheep	11.243	2.55	96.88					

Particulate matter emissions

Twenty seven source categories have been identified for 2016 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 A4.5 Level Assessment for TSP emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A1a	Public electricity and heat production	562.243	56.71	56.71	1A4bi	Residential: Stationary	123.933	35.18	35.18
1A4bi	Residential: Stationary	153.418	15.48	72.19	1A1a	Public electricity and heat production	28.300	8.03	43.21
5C1bi	Industrial waste incineration	25.091	2.53	74.72	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	24.848	7.05	50.26
1A4ai	Commercial/institutional: Stationary	24.109	2.43	77.15	1A4ci	Agriculture/Forestry/Fishing: Stationary	24.341	6.91	57.17
2L	Other production, consumption, storage, transportation or handling of bulk products	23.788	2.40	79.55	1B1a	Fugitive emission from solid fuels: Coal mining and handling	13.328	3.78	60.96
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	22.374	2.26	81.81	2L	Other production, consumption, storage, transportation or handling of bulk products	11.843	3.36	64.32
1B1a	Fugitive emission from solid fuels: Coal mining and handling	21.896	2.21	84.02	3B3	Manure management - Swine	11.041	3.13	67.45
3B3	Manure management - Swine	19.647	1.98	86.00	3B4gi	Manure management - Laying hens	8.944	2.54	69.99
1A4ci	Agriculture/Forestry/Fishing: Stationary	18.983	1.91	87.91	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	8.779	2.49	72.48
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	13.316	1.34	89.26	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	8.726	2.48	74.96
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	12.981	1.31	90.57	5C1bi	Industrial waste incineration	8.130	2.31	77.27
3B4gi	Manure management - Laying hens	10.580	1.07	91.63	1A4ai	Commercial/institutional: Stationary	7.548	2.14	79.41
2C1	Iron and steel production	7.283	0.73	92.37	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	6.917	1.96	81.37
3B1a	Manure management - Dairy cattle	6.788	0.68	93.05	1A3bvi	Road transport: Automobile tyre and brake wear	6.187	1.76	83.13
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	6.124	0.62	93.67	3B4gii	Manure management - Broilers	4.878	1.38	84.51

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
5A	Biological treatment of waste - Solid waste disposal on land	6.117	0.62	94.29	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.307	1.22	85.74
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	5.358	0.54	94.83	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	3.960	1.12	86.86
3B4gii	Manure management - Broilers	5.299	0.53	95.36	2A5a	Quarrying and mining of minerals other than coal	3.652	1.04	87.90
					2A1	Cement production	3.615	1.03	88.92
					1A3bi	Road transport: Passenger cars	3.388	0.96	89.88
					3B1a	Manure management - Dairy cattle	3.218	0.91	90.80
					2B10a	Chemical industry: Other	2.932	0.83	91.63
					1A3biii	Road transport: Heavy duty vehicles and buses	2.928	0.83	92.46
					3B4giv	Manure management - Other poultry	2.672	0.76	93.22
					2A5b	Construction and demolition	2.500	0.71	93.93
					2C1	Iron and steel production	2.002	0.57	94.50
					5A	Biological treatment of waste - Solid waste disposal on land	1.970	0.56	95.06

Twenty seven source categories have been identified for 2016 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 operations.

Table A4.6 Level Assessment for PM10 emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	109.052	28.88	28.88	1A4bi	Residential: Stationary	93.352	36.02	36.02
1A1a	Public electricity and heat production	86.898	23.01	51.89	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	24.848	9.59	45.61
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	22.374	5.92	57.81	1A1a	Public electricity and heat production	21.493	8.29	53.90
1A4ai	Commercial/institutional: Stationary	15.345	4.06	61.88	1A4ci	Agriculture/Forestry/Fishing: Stationary	19.107	7.37	61.27
5C1bi	Industrial waste incineration	15.055	3.99	65.86	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	8.779	3.39	64.66
1A4ci	Agriculture/Forestry/Fishing: Stationary	14.202	3.76	69.63	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	8.726	3.37	68.03
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	13.316	3.53	73.15	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	6.917	2.67	70.70
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	12.981	3.44	76.59	1B1a	Fugitive emission from solid fuels: Coal mining and handling	6.552	2.53	73.22
1B1a	Fugitive emission from solid fuels: Coal mining and handling	10.763	2.85	79.44	1A4ai	Commercial/institutional: Stationary	4.947	1.91	75.13
2L	Other production, consumption, storage, transportation or handling of bulk products	9.528	2.52	81.96	5C1bi	Industrial waste incineration	4.878	1.88	77.02
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	6.124	1.62	83.58	2L	Other production, consumption, storage, transportation or handling of bulk products	4.753	1.83	78.85
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	5.358	1.42	85.00	1A3bvi	Road transport: Automobile tyre and brake wear	4.699	1.81	80.66
3B4giv	Manure management - Other poultry	5.231	1.39	86.39	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.307	1.66	82.32

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
2C1	Iron and steel production	4.985	1.32	87.71	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	3.960	1.53	83.85
1A3biii	Road transport: Heavy duty vehicles and buses	3.899	1.03	88.74	1A3bi	Road transport: Passenger cars	3.388	1.31	85.16
3B1a	Manure management - Dairy cattle	3.099	0.82	89.56	2A1	Cement production	3.156	1.22	86.38
1A3bii	Road transport: Light duty vehicles	2.921	0.77	90.33	1A3biii	Road transport: Heavy duty vehicles and buses	2.928	1.13	87.51
5A	Biological treatment of waste - Solid waste disposal on land	2.894	0.77	91.10	3B4giv	Manure management - Other poultry	2.672	1.03	88.54
3B3	Manure management - Swine	2.780	0.74	91.84	3B4gii	Manure management - Broilers	2.439	0.94	89.48
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	2.748	0.73	92.56	2B10a	Chemical industry: Other	1.985	0.77	90.25
3B4gii	Manure management - Broilers	2.650	0.70	93.27	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.942	0.75	91.00
1A3c	Railways	2.609	0.69	93.96	3B4gi	Manure management - Laying hens	1.883	0.73	91.72
2A1	Cement production	2.504	0.66	94.62	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1.798	0.69	92.42
3B4gi	Manure management - Laying hens	2.227	0.59	95.21	2A5a	Quarrying and mining of minerals other than coal	1.796	0.69	93.11
					1A3bii	Road transport: Light duty vehicles	1.741	0.67	93.78
					3B3	Manure management - Swine	1.547	0.60	94.38
					3B1a	Manure management - Dairy cattle	1.469	0.57	94.94
					5C2	Open burning of waste	1.465	0.57	95.51

Twenty three source categories have been identified for 2016 as key sources (level assessment) in PM2.5 inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants, agriculture and Public Electricity and Heat Production.

Table A4.7 Level Assessment for PM2.5 emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	51.346	26.97	26.97	1A4bi	Residential: Stationary	56.716	38.98	38.98
1A1a	Public electricity and heat production	46.980	24.68	51.65	1A1a	Public electricity and heat production	12.729	8.75	47.73
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	13.316	7.00	58.65	1A4ci	Agriculture/Forestry/Fishing: Stationary	8.887	6.11	53.83
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	12.981	6.82	65.47	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	8.779	6.03	59.87
1A4ai	Commercial/institutional: Stationary	12.808	6.73	72.20	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	8.726	6.00	65.86
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	6.124	3.22	75.41	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	6.917	4.75	70.62
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	5.358	2.81	78.23	1A4ai	Commercial/institutional: Stationary	4.581	3.15	73.77
1A4ci	Agriculture/Forestry/Fishing: Stationary	4.832	2.54	80.77	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	4.307	2.96	76.73
1A3biii	Road transport: Heavy duty vehicles and buses	3.899	2.05	82.82	1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	3.960	2.72	79.45
2C1	Iron and steel production	3.791	1.99	84.81	1A3bi	Road transport: Passenger cars	3.388	2.33	81.78
1A3bii	Road transport: Light duty vehicles	2.921	1.53	86.34	1A3biii	Road transport: Heavy duty vehicles and buses	2.928	2.01	83.79
1A3c	Railways	2.609	1.37	87.71	1A3bvi	Road transport: Automobile tyre and brake wear	2.521	1.73	85.52

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
3B1a	Manure management - Dairy cattle	2.017	1.06	88.77	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1.798	1.24	86.76
2G	Other product use	1.905	1.00	89.77	1A3bii	Road transport: Light duty vehicles	1.741	1.20	87.95
1A2c	Stationary combustion in manufacturing industries: Chemicals	1.450	0.76	90.53	2A1	Cement production	1.736	1.19	89.15
2A1	Cement production	1.377	0.72	91.26	2B10a	Chemical industry: Other	1.482	1.02	90.17
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.374	0.72	91.98	2G	Other product use	1.374	0.94	91.11
1A3bi	Road transport: Passenger cars	1.186	0.62	92.60	5C2	Open burning of waste	1.361	0.94	92.04
5C2	Open burning of waste	1.111	0.58	93.19	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	1.249	0.86	92.90
1B1a	Fugitive emission from solid fuels: Coal mining and handling	1.076	0.57	93.75	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.971	0.67	93.57
5C1bi	Industrial waste incineration	1.004	0.53	94.28	3B1a	Manure management - Dairy cattle	0.956	0.66	94.23
2B10a	Chemical industry: Other	0.986	0.52	94.80	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	0.956	0.66	94.88
2L	Other production, consumption, storage, transportation or handling of bulk products	0.953	0.50	95.30	2C1	Iron and steel production	0.893	0.61	95.50

Twelve source categories have been identified for 2016 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 A4.8 Level Assessment for BC emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	5.267	26.11	26.11	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	7.504	35.30	35.30
1A4bi	Residential: Stationary	3.635	18.02	44.13	1A4bi	Residential: Stationary	4.539	21.35	56.64
1A3biii	Road transport: Heavy duty vehicles and buses	1.949	9.66	53.80	1A3bi	Road transport: Passenger cars	2.573	12.10	68.75
1A3c	Railways	1.927	9.56	63.35	1A3biii	Road transport: Heavy duty vehicles and buses	1.733	8.15	76.90
1A3bii	Road transport: Light duty vehicles	1.601	7.94	71.29	1A3bii	Road transport: Light duty vehicles	1.287	6.05	82.95
1A1a	Public electricity and heat production	1.020	5.06	76.35	5C2	Open burning of waste	0.572	2.69	85.64
1A4ai	Commercial/institutional: Stationary	0.799	3.96	80.31	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.476	2.24	87.88
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.673	3.34	83.65	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.460	2.16	90.04
1A3bi	Road transport: Passenger cars	0.612	3.03	86.68	1A4ai	Commercial/institutional: Stationary	0.343	1.61	91.65
5C2	Open burning of waste	0.467	2.31	88.99	1A1a	Public electricity and heat production	0.271	1.28	92.93
1A4ci	Agriculture/Forestry/Fishing: Stationary	0.380	1.88	90.88	1A2c	Stationary combustion in manufacturing industries: Chemicals	0.250	1.18	94.11
1A2a	Stationary combustion in manufacturing industries: Iron and steel	0.337	1.67	92.55	1A3c	Railways	0.248	1.16	95.27
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	0.329	1.63	94.18					
1A4ciii	Agriculture/Forestry/Fishing: National fishing	0.274	1.36	95.53					

NMVOCs emissions

Twenty five source categories have been identified for 2016 as key sources (level assessment) in NMVOC inventory in Poland. The most important of them are: coating applications, stationary combustion of fuels in households and domestic solvent use.

Table A4.9 Level Assessment for NMVOC emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	120.498	24.34	24.34	2D3d	Coating applications	125.887	20.68	20.68
1A3bi	Road transport: Passenger cars	86.048	17.38	41.72	1A4bi	Residential: Stationary	104.256	17.12	37.80
2D3a	Domestic solvent use including fungicides	45.688	9.23	50.95	2D3a	Domestic solvent use including fungicides	46.120	7.57	45.37
2D3d	Coating applications	22.800	4.61	55.56	2H2	Food and beverages industry	42.087	6.91	52.29
1A3bii	Road transport: Light duty vehicles	16.312	3.30	58.85	1A3bi	Road transport: Passenger cars	40.105	6.59	58.87
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	15.961	3.22	62.08	1B2aiv	Fugitive emissions oil: Refining / storage	30.859	5.07	63.94
1B2aiv	Fugitive emissions oil: Refining / storage	15.624	3.16	65.23	2D3g	Chemical products	28.265	4.64	68.58
1A4ai	Commercial/institutional: Stationary	15.409	3.11	68.34	2D3h	Printing	24.355	4.00	72.58
1B1a	Fugitive emission from solid fuels: Coal mining and handling	14.767	2.98	71.33	2D3e	Degreasing	15.033	2.47	75.05
2H2	Food and beverages industry	14.741	2.98	74.30	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	14.014	2.30	77.35
1A2a	Stationary combustion in manufacturing industries: Iron and steel	12.508	2.53	76.83	1B2av	Distribution of oil products	12.738	2.09	79.45
1B2av	Distribution of oil products	11.539	2.33	79.16	1A2d	Stationary combustion in manufacturing industries: Pulp, Paper and Print	10.226	1.68	81.13
1A3biii	Road transport: Heavy duty vehicles and buses	10.175	2.06	81.22	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	9.316	1.53	82.66
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	9.896	2.00	83.22	1A4ci	Agriculture/Forestry/Fishing: Stationary	8.160	1.34	84.00
1A1a	Public electricity and heat production	9.817	1.98	85.20	2B10a	Chemical industry: Other	8.043	1.32	85.32
1A3biv	Road transport: Mopeds & motorcycles	8.510	1.72	86.92	1A3bv	Road transport: Gasoline evaporation	7.673	1.26	86.58
1A4ci	Agriculture/Forestry/Fishing: Stationary	7.983	1.61	88.53	2D3i	Other solvent use	7.528	1.24	87.81
2D3g	Chemical products	6.447	1.30	89.83	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	7.497	1.23	89.05
2D3f	Dry cleaning	5.711	1.15	90.99	1B1a	Fugitive emission from solid fuels: Coal mining and handling	7.078	1.16	90.21
1A3bv	Road transport: Gasoline evaporation	5.339	1.08	92.07	1A3biii	Road transport: Heavy duty vehicles and buses	6.093	1.00	91.21
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	5.262	1.06	93.13	2D3f	Dry cleaning	5.765	0.95	92.16
2C1	Iron and steel production	4.343	0.88	94.01	1A3bii	Road transport: Light duty vehicles	5.600	0.92	93.08
2D3c	Asphalt roofing	4.257	0.86	94.87	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	4.850	0.80	93.87
2B10a	Chemical industry: Other	4.112	0.83	95.70	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	4.657	0.76	94.64
					1A4ai	Commercial/institutional: Stationary	4.540	0.75	95.38

Carbon monoxide emissions

Twelve source categories have been identified for 2016 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 A4.10 Level Assessment for carbon monoxide emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Gg	%	%			Gg	%	%
1A4bi	Residential: Stationary	1522.919	42.45	42.45	1A4bi	Residential: Stationary	1392.665	55.58	55.58
1A3bi	Road transport: Passenger cars	975.141	27.18	69.63	1A3bi	Road transport: Passenger cars	380.610	15.19	70.77
1A4ai	Commercial/institutional : Stationary	265.204	7.39	77.02	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	148.809	5.94	76.71
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	218.449	6.09	83.11	1A4ci	Agriculture/Forestry/Fishing: Stationary	89.244	3.56	80.27
1A3bii	Road transport: Light duty vehicles	180.478	5.03	88.14	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	77.860	3.11	83.38
1A4ci	Agriculture/Forestry/Fishing: Stationary	83.668	2.33	90.47	1A3bii	Road transport: Light duty vehicles	59.363	2.37	85.75
1A3biv	Road transport: Mopeds & motorcycles	81.992	2.29	92.76	1A4ai	Commercial/institutional : Stationary	53.346	2.13	87.88
1A1a	Public electricity and heat production	54.718	1.53	94.28	1A1a	Public electricity and heat production	51.475	2.05	89.93
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	54.649	1.52	95.81	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	48.519	1.94	91.87
					1A3biv	Road transport: Mopeds & motorcycles	32.441	1.29	93.16
					1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	32.363	1.29	94.46
					1A3biii	Road transport: Heavy duty vehicles and buses	29.945	1.20	95.65

Heavy metal emissions

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

Thirteen source categories have been identified for 2016 as key sources (level assessment) in Cd inventory in Poland. The most important of them are combustion in manufacturing industries, especially in metals and chemicals production.

Table A4.11 Level Assessment for Cd emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	4.003	20.78	20.78	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	2.093	15.97	15.97
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	3.162	16.42	37.20	2C1	Iron and steel production	1.818	13.86	29.83
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	3.082	16.00	53.20	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	1.441	10.99	40.82
2C1	Iron and steel production	2.763	14.35	67.55	5C1a	Municipal waste incineration	1.438	10.97	51.79
1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	1.397	7.25	74.80	1A2a	Stationary combustion in manufacturing industries: Iron and steel	1.136	8.66	60.46
1A2e	Stationary combustion in manufacturing industries:	1.272	6.61	81.41	1A4bi	Residential: Stationary	0.938	7.16	67.61

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
	Food processing, beverages and tobacco								
2B10a	Chemical industry: Other	0.739	3.84	85.24	1A1b	Petroleum refining	0.854	6.51	74.12
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0.687	3.57	88.81	1A1a	Public electricity and heat production	0.746	5.69	79.81
1A4bi	Residential: Stationary	0.631	3.28	92.09	1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	0.707	5.39	85.21
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.344	1.79	93.87	1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	0.661	5.04	90.24
1A1b	Petroleum refining	0.282	1.46	95.34	1A2d	Stationary combustion in manufacturing industries: Pulp, Paper and Print	0.295	2.25	92.50
					2B10a	Chemical industry: Other	0.242	1.84	94.34
					2A3	Glass production	0.182	1.39	95.73

Seven source categories have been identified as key sources (level assessment) for 2016 in Hg inventory in Poland. The most important of them are: Public Electricity and Heat Production, and combustion in non-ferrous metals production.

Table A4.12 Level Assessment for Hg emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	10.188	73.60	73.60	1A1a	Public electricity and heat production	5.379	50.86	50.86
1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	1.300	9.39	82.99	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	2.756	26.06	76.92
1A4bi	Residential: Stationary	0.622	4.49	87.48	1A4bi	Residential: Stationary	0.598	5.65	82.57
2C1	Iron and steel production	0.370	2.67	90.15	2C1	Iron and steel production	0.477	4.51	87.09
2A1	Cement production	0.250	1.81	91.96	1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	0.455	4.30	91.38
1A2a	Stationary combustion in manufacturing industries: Iron and steel	0.219	1.58	93.54	1A4ai	Commercial/institutional: Stationary	0.223	2.11	93.50
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	0.214	1.54	95.09	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.163	1.54	95.04

Eleven source categories have been identified as key sources (level assessment) for 2016 in Pb inventory in Poland. The most important of them are: combustion in non-ferrous metals production, and iron and steel production.

Table A4.13 Level Assessment for Pb emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	161.798	33.95	33.95	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	176.147	42.11	42.11
2C1	Iron and steel production	99.342	20.84	54.79	2C1	Iron and steel production	84.087	20.10	62.21
1A1a	Public electricity and heat production	48.129	10.10	64.88	1A4bi	Residential: Stationary	45.277	10.82	73.03
1A4bi	Residential: Stationary	46.288	9.71	74.60	1A1a	Public electricity and heat production	26.859	6.42	79.45
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	21.134	4.43	79.03	5C1a	Municipal waste incineration	16.778	4.01	83.46
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	18.645	3.91	82.94	2A3	Glass production	12.133	2.90	86.37
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	15.987	3.35	86.30	1A4ci	Agriculture/Forestry/Fishing: Stationary	10.022	2.40	88.76
1A2c	Stationary combustion in manufacturing industries: Chemicals	15.540	3.26	89.56	1A2c	Stationary combustion in manufacturing industries: Chemicals	8.814	2.11	90.87

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A4ci	Agriculture/Forestry/Fishing: Stationary	13.175	2.76	92.32	1A2a	Stationary combustion in manufacturing industries: Iron and steel	6.945	1.66	92.53
1A4ai	Commercial/institutional: Stationary	10.779	2.26	94.58	1A4ai	Commercial/institutional: Stationary	6.586	1.57	94.10
1A1c	Manufacture of solid fuels and other energy industries	9.070	1.90	96.48	1A3bvi	Road transport: Automobile tyre and brake wear	6.416	1.53	95.64

Nine source categories have been identified for 2016 as key sources (level assessment) in As inventory in Poland. The most important of them are: combustion in non-ferrous metals production and in Public Electricity and Heat Production.

Table A4.14 Level Assessment for As emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	13.634	37.39	37.39	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	15.839	56.06	56.06
1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	11.886	32.59	69.98	1A1a	Public electricity and heat production	4.699	16.63	72.69
2C1	Iron and steel production	3.798	10.41	80.40	1A4bi	Residential: Stationary	2.746	9.72	82.41
1A4bi	Residential: Stationary	1.966	5.39	85.79	1A1b	Petroleum refining	0.827	2.93	85.33
1A2a	Stationary combustion in manufacturing industries: Iron and steel	1.362	3.74	89.52	2C1	Iron and steel production	0.753	2.66	88.00
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	1.328	3.64	93.17	1A2c	Stationary combustion in manufacturing industries: Chemicals	0.682	2.41	90.41
1A4ai	Commercial/institutional : Stationary	0.558	1.53	94.70	1A2a	Stationary combustion in manufacturing industries: Iron and steel	0.537	1.90	92.31
1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	0.548	1.50	96.20	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.502	1.78	94.09
					1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	0.335	1.18	95.27

Thirteen source categories have been identified for 2016 as key sources (level assessment) in Cr inventory in Poland. The most important of them are: iron and steel production, stationary combustion of fuels in residential plants and Public electricity and heat production.

Table A4.15 Level Assessment for Cr emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
2C1	Iron and steel production	45.267	53.30	53.30	2C1	Iron and steel production	6.379	18.82	18.82
1A1a	Public electricity and heat production	17.542	20.66	73.96	1A4bi	Residential: Stationary	5.945	17.54	36.36
1A4bi	Residential: Stationary	6.983	8.22	82.18	1A1a	Public electricity and heat production	5.861	17.29	53.65
1A2a	Stationary combustion in manufacturing industries: Iron and steel	2.593	3.05	85.24	2A3	Glass production	3.033	8.95	62.60
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	2.528	2.98	88.21	1A3bvi	Road transport: Automobile tyre and brake wear	2.377	7.01	69.62
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	2.336	2.75	90.96	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	1.650	4.87	74.48
1A4ai	Commercial/institutional: Stationary	1.748	2.06	93.02	2A1	Cement production	1.578	4.66	79.14
2A1	Cement production	1.252	1.47	94.50	1A2c	Stationary combustion in manufacturing industries: Chemicals	1.272	3.75	82.89
1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	1.043	1.23	95.72	1A1b	Petroleum refining	1.066	3.14	86.04

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
					1A4ci	Agriculture/Forestry/Fishing: Stationary	1.051	3.10	89.14
					1A2a	Stationary combustion in manufacturing industries: Iron and steel	1.002	2.96	92.09
					1A4ai	Commercial/institutional: Stationary	0.717	2.12	94.21
					1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	0.624	1.84	96.05

Eight source categories have been identified as key sources (level assessment) for 2016 in Cu inventory in Poland. The most important of them are: stationary combustion in non-ferrous metals production and automobile tyre and brake wear in road transport.

Table A4.16 Level Assessment for Cu emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	118.436	39.42	39.42	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	161.700	51.09	51.09
1A1a	Public electricity and heat production	64.640	21.51	60.93	1A3bvi	Road transport: Automobile tyre and brake wear	52.034	16.44	67.53
1A4bi	Residential: Stationary	31.550	10.50	71.44	1A4bi	Residential: Stationary	35.189	11.12	78.65
2C1	Iron and steel production	19.574	6.51	77.95	1A1a	Public electricity and heat production	18.057	5.71	84.35
1A3bvi	Road transport: Automobile tyre and brake wear	18.502	6.16	84.11	2C1	Iron and steel production	16.728	5.29	89.64
1A4ai	Commercial/institutional: Stationary	12.904	4.30	88.40	1A4ci	Agriculture/Forestry/Fishing: Stationary	7.554	2.39	92.03
1A2a	Stationary combustion in manufacturing industries: Iron and steel	9.791	3.26	91.66	1A4ai	Commercial/institutional: Stationary	5.141	1.62	93.65
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	9.545	3.18	94.84	1A2c	Stationary combustion in manufacturing industries: Chemicals	4.687	1.48	95.13
1A4ci	Agriculture/Forestry/Fishing: Stationary	7.050	2.35	97.19					

Twelve source categories have been identified for 2016 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 A4.17 Level Assessment for Ni emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	90.779	52.02	52.02	1A1b	Petroleum refining	22.072	26.79	26.79
1A2a	Stationary combustion in manufacturing industries: Iron and steel	15.467	8.86	60.88	1A1a	Public electricity and heat production	14.686	17.83	44.62
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	15.078	8.64	69.52	1A4bi	Residential: Stationary	12.638	15.34	59.96
1A4bi	Residential: Stationary	12.302	7.05	76.57	2C1	Iron and steel production	6.056	7.35	67.32
2C1	Iron and steel production	9.218	5.28	81.86	1A2c	Stationary combustion in manufacturing industries: Chemicals	5.117	6.21	73.53
1A1b	Petroleum refining	7.514	4.31	86.16	1A2a	Stationary combustion in manufacturing industries: Iron and steel	4.032	4.89	78.42
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	6.224	3.57	89.73	1A4ci	Agriculture/Forestry/Fishing: Stationary	3.057	3.71	82.13
1A4ai	Commercial/institutional: Stationary	5.950	3.41	93.14	1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	2.510	3.05	85.18
1A4ci	Agriculture/Forestry/Fishing: Stationary	4.675	2.68	95.82	2A3	Glass production	2.427	2.95	88.13
					1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	2.308	2.80	90.93

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
					1A4ai	Commercial/institutional: Stationary	1.967	2.39	93.32
					2A1	Cement production	1.578	1.92	95.23

Ten source categories have been identified as key sources (level assessment) for 2016 in Zn inventory in Poland. The most important of them are: stationary combustion of fuels in non-ferrous metals production and iron and steel production.

Table A4.18 Level Assessment for Zn emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A1a	Public electricity and heat production	405.094	32.98	32.98	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	306.656	36.65	36.65
2C1	Iron and steel production	332.029	27.04	60.02	2C1	Iron and steel production	162.847	19.46	56.11
1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	168.674	13.73	73.75	1A1a	Public electricity and heat production	101.945	12.18	68.29
1A4bi	Residential: Stationary	78.863	6.42	80.18	1A4bi	Residential: Stationary	82.062	9.81	78.10
1A2a	Stationary combustion in manufacturing industries: Iron and steel	72.347	5.89	86.07	1A2c	Stationary combustion in manufacturing industries: Chemicals	36.601	4.37	82.47
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	70.526	5.74	91.81	1A2a	Stationary combustion in manufacturing industries: Iron and steel	28.841	3.45	85.92
1A4ai	Commercial/institutional: Stationary	31.392	2.56	94.37	1A3bvi	Road transport: Automobile tyre and brake wear	19.996	2.39	88.31
1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	29.111	2.37	96.74	1A2e	Stationary combustion in manufacturing industries: Food processing, beverages and tobacco	17.955	2.15	90.46
					1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	16.510	1.97	92.43
					1A4ci	Agriculture/Forestry/Fishing : Stationary	13.575	1.62	94.05
					2A3	Glass production	12.133	1.45	95.50

PCDD/F emissions

Eleven source categories have been identified for 2016 as key sources (level assessment) in PCDD/F inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants, landfill fires and stationary combustion in manufacturing of non-ferrous metals.

Table A4.19 Level Assessment for PCDD/F emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		g i-TEQ	%	%			g i-TEQ	%	%
1A4bi	Residential: Stationary	133.723	40.77	40.77	1A4bi	Residential: Stationary	143.963	50.99	50.99
5E	Other waste	47.639	14.52	55.29	5E	Other waste	35.076	12.42	63.42
1A4ai	Commercial/institutional: Stationary	35.158	10.72	66.01	1A2b	Stationary combustion in manufacturing industries: Non-ferrous metals	23.409	8.29	71.71
2A2	Lime production	32.000	9.76	75.77	2A2	Lime production	18.690	6.62	78.33
3F	Field burning of agricultural residues	21.496	6.55	82.32	2C1	Iron and steel production	12.201	4.32	82.65
1A2a	Stationary combustion in manufacturing industries: Iron and steel	17.782	5.42	87.74	1A1a	Public electricity and heat production	11.307	4.01	86.66
2C1	Iron and steel production	15.501	4.73	92.47	1A2a	Stationary combustion in manufacturing industries: Iron and steel	10.496	3.72	90.37
1A1a	Public electricity and heat production	11.313	3.45	95.92	1A3bi	Road transport: Passenger cars	4.807	1.70	92.08
					3F	Field burning of agricultural residues	4.522	1.60	93.68
					1B1b	Fugitive emission from solid fuels: Solid fuel transformation	2.912	1.03	94.71
					5C2	Open burning of waste	2.080	0.74	95.45

HCB emissions

Eight source categories have been identified as key sources (level assessment) for 2016 in HCB inventory in Poland. The most important of them are: stationary combustion of fuels in residential plants and stationary combustion in manufacturing of iron and steel.

Table A4.20 Level Assessment for HCB emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		kg	%	%			kg	%	%
1A2a	Stationary combustion in manufacturing industries: Iron and steel	1.694	26.73	26.73	1A4bi	Residential: Stationary	1.739	35.35	35.35
1A4bi	Residential: Stationary	1.654	26.09	52.82	1A2a	Stationary combustion in manufacturing industries: Iron and steel	1.039	21.12	56.48
5C1bi	Industrial waste incineration	1.207	19.04	71.86	1A1a	Public electricity and heat production	0.866	17.60	74.08
1A1a	Public electricity and heat production	1.070	16.88	88.74	5C1bi	Industrial waste incineration	0.473	9.61	83.68
5C1biii	Clinical waste incineration	0.326	5.14	93.88	1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	0.299	6.09	89.77
1A2f	Stationary combustion in manufacturing industries: Non-metallic minerals	0.261	4.11	97.99	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.105	2.14	91.91
					1A2c	Stationary combustion in manufacturing industries: Chemicals	0.102	2.07	93.98
					5C1biii	Clinical waste incineration	0.074	1.50	95.48

PCB emissions

Three source categories have been identified for 2016 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 A4.21 Level Assessment for PCB emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		kg	%	%			kg	%	%
1A4bi	Residential: Stationary	420.609	55.30	55.30	1A4bi	Residential: Stationary	453.223	71.46	71.46
1A1a	Public electricity and heat production	146.027	19.20	74.50	1A1a	Public electricity and heat production	125.793	19.83	91.29
1A4ai	Commercial/institutional: Stationary	126.236	16.60	91.10	2C1	Iron and steel production	33.585	5.30	96.59
2C1	Iron and steel production	42.333	5.57	96.67					

PAH emissions

Two source categories have been identified as key sources (level assessment) for 2016 in PAH inventory in Poland. They are: stationary combustion of fuels in residential plants and coke production.

Table A4.22 Level Assessment for PAH emission sources in 1990 and 2016

NFR code	NFR Source Category	1990 Estimate	Level Assessment	Cumulative Total of Emission	NFR code	NFR Source Category	2016 Estimate	Level Assessment	Cumulative Total of Emission
		Mg	%	%			Mg	%	%
1A4bi	Residential: Stationary	118.322	80.62	80.62	1A4bi	Residential: Stationary	128.538	87.83	87.83
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	21.295	14.51	95.13	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	15.047	10.28	98.11

Appendix 5. National energy balance for 2016 in EUROSTAT format

POLAND 2016

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	70386			60246						
Primary production receipt										
Other sources (recovered products)	398									
Recycled products										
Imports	8300	14	123	284	27	2				
Stock change	4732		45	67		1				
Exports	9097	3	6970	212	5	386				
Bunke										
Direct use										
Gross inland consumption	**74719**	**11**	**-6803**	**60385**	**22**	**-383**				
Transformation input	**56923**		**1174**	**59846**	**0**	**0**	**25356**	**14630**	**3511**	**43496**
Conventional thermal power stations	38957			59805			24894	14630	3488	43013
Public thermal power stations	37733			59805			13324	14630	3162	31116
Autoprod. thermal power stations	1224						11571		326	11897
Nuclear power stations										
District heating plants	4869		0	41	0		461		22	483
Coke-oven plants	12812		83			0				
Blast-furnace plants	283		899							
Gas works										
Refineries										
Patent fuel plants	2									
BKB/PB plants										
Charcoal production plants										
Coal liquefaction plants										
For blended natural gas										
Gas-To-Liquids (GTL) plants										
Non-specified Transformation Input			192							
Transformation output		**2**	**9718**			**491**	**78303**	**25158**	**5320**	**108782**
Conventional thermal power stations										
Public thermal power stations										
Autoprod. thermal power stations										
Nuclear power stations										
District heating plants										
Coke-oven plants			9718			491	78303			78303
Blast-furnace plants								25158	1143	26301
Gas works										
Refineries										
Patent fuel plants		2								
BKB/PB plants										
Charcoal production plants										
Non-specified Transformation Output									4177	4177
Exchanges and transfers, returns										
Interproduct transfers										
Products transferred										
Returns from petrochem. industry										
Consumption of the energy branch	**160**		**0**	**7**			**45146**			**45146**
Production and distribution of electricity	0		0	0			1			1
Pumped storage stations										
District heating plants	2		0							
Extraction and agglo. of solid fuels	38		0	7			120			120
Coke-oven and gas works plants	84			0			45024			45024
Oil and Nat. Gat extraction plants										
Oil refineries	36									
Nuclear fuel fabrication plants										
Distribution losses										
Available for final consumption	**17636**	**13**	**1741**	**532**	**22**	**108**	**7802**	**10528**	**1810**	**20139**
Statistical difference	**77**		**-313**	**0**	**-3**	**0**				
Final non-energy consumption	**154**			**10**		**108**				
Chemical industry	8					**108**				
Other sectors	146			10						
Final energy consumption	**17405**	**13**	**2054**	**522**	**25**		**7802**	**10528**	**1810**	**20139**
Industry	4507	0	1852	72	2		7802	10528	1810	20139
Iron & steel industry	28	0	1599				4845	10528	607	15981
Chemical industry	1942	0	123				664			664
Non-ferrous metal industry	3		6				59		1202	1261
Glass, pottery & building mat. industry	836	0	96	43			2229			2229
Transport equipment	19		0							
Machinery	59		4				5			5
Mining and Quarrying	16		1							
Food, drink & tobacco industry	990		23							
Paper and printing	423									
Wood and wood product	66			0						
Construction	19			23	2					
Textile, leather & clothing industry	15		0	5						
Not elsewhere specified (Industry)	90	0		0						
Transport										
Railways										
Road transport										
International aviation										
Domestic aviation										
Domestic navigation										
Pipeline transport										
Not elsewhere specified (Transport)										
Other sectors	12898	13	202	450	22		0		0	0
Commercial and public services	1048		32	30			0		0	0
Residential	10350		160	315						
Agriculture/Forestry	1500	13	10	105	22					
Fishing	0									
Not elsewhere specified (Other)	0									

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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	165272	1001	11									
Primary production receipt												
Other sources (recovered products)				39								
Recycled products												
Imports	566852	24573	188	7279		2196	345	23		3741	46	391
Stock change	-18084	426		-144		-12	-19	21		-125	-2	0
Exports	33294	224		7126		259	533	512	536	1087	2514	473
Bunke				182						129	53	
Direct use												
Gross inland consumption	**680745**	**25777**	**199**	**-134**		**1924**	**-207**	**-469**	**-536**	**2400**	**-2522**	**-81**
Transformation input	**106293**	**25790**	**1085**	**468**	**23**	**0**				**28**	**417**	
Conventional thermal power stations	68953			447	23	0				16	407	
Public thermal power stations	52288			121						15	106	
Autoprod. thermal power stations	16665			325	23	0				1	301	
Nuclear power stations												
District heating plants	9482			21		0				12	10	
Coke-oven plants												
Blast-furnace plants												
Gas works												
Refineries	27858	25790	1085									
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				**27025**	**663**	**601**	**3973**	**1156**	**1810**	**11556**	**3609**	**1448**
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				27025	663	601	3973	1156	1810	11556	3609	1448
Patent fuel plants												
BKB/PB plants												
Charcoal production plants												
Non-specified Transformation Output												
Exchanges and transfers, returns			**886**	**-886**	**-60**	**-49**			**-343**	**-138**		**-238**
Interproduct transfers												
Products transferred			198	-198		-11				-129		
Returns from petrochem. industry			688	-688	-60	-38			-343	-9		-238
Consumption of the energy branch	**48452**			**1044**	**418**	**18**	**1**	**0**		**32**	**538**	**31**
Production and distribution of electricity	2			5		0	0			4	0	0
Pumped storage stations												
District heating plants	15			1		0	0			1	1	0
Extraction and agglo. of solid fuels	522			22		0	0	0		17		0
Coke-oven and gas works plants	3356			1			0			0		
Oil and Nat. Gat extraction plants	15888			11		0	0			10		0
Oil refineries	28668			1004	418	18	0			0	537	31
Nuclear fuel fabrication plants												
Distribution losses	**1233**											
Available for final consumption	**524768**	**-13**	**0**	**24493**	**162**	**2457**	**3765**	**686**	**931**	**13758**	**133**	**1097**
Statistical difference	**-2481**	**-13**	**0**	**42**				**0**			**39**	**0**
Final non-energy consumption	**98080**			**2560**								**1095**
Chemical industry	98080			949								940
Other sectors				1611								155
Final energy consumption	**429168**	**0**		**21891**	**162**	**2457**	**3765**	**686**	**931**	**13758**	**94**	**2**
Industry	158673			1671	162	174	5	1	931	281	81	2
Iron & steel industry	21621			6		1	0			3		0
Chemical industry	13409			1247	162	109	0		931	34	10	
Non-ferrous metal industry	8029			10		0	0	0		4	6	
Glass, pottery & building mat. industry	48871			75		7	1	0		33	5	
Transport equipment	4652			37		3	1	1		30		0
Machinery	9975			30		9	1	0		18	1	1
Mining and Quarryig	1534			66		2	0			63		1
Food, drink & tobacco industry	30655			76		24	1	0		32	18	0
Paper and printing	8879			47		2	0			11	33	0
Wood and wood product	1725			14		3	0	0		10	1	
Construction	1426			36		2	1	0		29	4	0
Textile, leather & clothing industry	1889			6		1	0			4	0	
Not elsewhere specified (Industry)	6011			21		10	0			10	1	0
Transport	17800			17450		1655	3759	685		11350		
Railways				81				0		81		
Road transport	679			16677		1655	3756			11266		
International aviation				665				665				
Domestic aviation				23			3	20				
Domestic navigation				2						2		
Pipeline transport	17122			1		0	0			1		
Not elsewhere specified (Transport)												
Other sectors	252694	0		2770	0	628	1	0		2127	14	
Commercial and public services	89969	0		415	0	78	0	0		337	0	
Residential	161276			560		490				70		
Agriculture/Forestry	1450			1795		60	1			1720	14	
Fishing	0			0		0						
Not elsewhere specified (Other)	0			0		0						

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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						339180	2189	930	321333	268577	3233	49524
Primary production receipt												
Other sources (recovered products)		39										
Recycled products												
Imports	33	237	228	39		34185			34185	24305		9879
Stock change	-2	1	-4	-1		-335			-335			-335
Exports	97	637	479			45288			45288	15709		29579
Bunkε												
Direct use												
Gross inland consumption	**-65**	**-361**	**-255**	**38**		**327742**	**2189**	**930**	**309896**	**277173**	**3233**	**29490**
Transformation input						**81693**			**81693**	**74057**	**330**	**7306**
Conventional thermal power stations						79239			79239	71624	325	7290
Public thermal power stations						64237			64237	59860	2	4375
Autoprod. thermal power stations						15003			15003	11764	323	2915
Nuclear power stations												
District heating plants						2454			2454	2433	6	16
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	**130**	**652**	**1427**									
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	130	652	1427									
Patent fuel plants												
BKB/PB plants												
Charcoal production plants												
Non-specified Transformation Output												
Exchanges and transfers, returns		**-58**				**-14727**						
Interproduct transfers												
Products transferred		-58				-14727						
Returns from petrochem. industry												
Consumption of the energy branch	**0**	**5**	**0**			**47**			**47**	**26**		**22**
Production and distribution of electricity	0	1	0			6			6			6
Pumped storage stations												
District heating plants	0	0										
Extraction and agglo. of solid fuels	0	4				26			26	26		
Coke-oven and gas works plants		0				16			16			16
Oil and Nat. Gat extraction plants		0										
Oil refineries			0									
Nuclear fuel fabrication plants												
Distribution losses												
Available for final consumption	**64**	**228**	**1172**	**38**		**231274**	**2189**	**930**	**228155**	**203091**	**2902**	**22162**
Statistical difference			**0**	**4**								
Final non-energy consumption	**64**	**228**	**1172**									
Chemical industry	8	0										
Other sectors	56	228	1172									
Final energy consumption				**34**		**231274**	**2189**	**930**	**228155**	**203091**	**2902**	**22162**
Industry				34		65180			65180	62482	2094	604
Iron & steel industry				2		1			1	1		
Chemical industry						144			144	138		6
Non-ferrous metal industry				0								
Glass, pottery & building mat. industry				29		2642			2642	511	2094	38
Transport equipment				3		15			15	15		
Machinery						105			105	105		
Mining and Quarryig						12			12	12		
Food, drink & tobacco industry						1790			1790	1383		407
Paper and printing						30526			30526	30415		111
Wood and wood product						24821			24821	24779		42
Construction						10			10	10		
Textile, leather & clothing industry						5			5	5		
Not elsewhere specified (Industry)						5108			5108	5108		
Transport						18485			18485			18485
Railways												
Road transport						18485			18485			18485
International aviation												
Domestic aviation												
Domestic navigation												
Pipeline transport												
Not elsewhere specified (Transport)												
Other sectors				0		147610	2189	930	144491	140609	808	3074
Commercial and public services				0		11712	246	225	11241	7716	808	2717
Residential						114083	1943	705	111435	111435		
Agriculture/Forestry						21815			21815	21458		357
Fishing												
Not elsewhere specified (Other)												

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Original units	Wind energy	Hydro energy	Other fuels	Derived heat	Electrical energy	Biogas	Biofuels
	GWh		TJ		GWh		
Primary production	12588	2139	31046			10929,481	38594,147
Primary production receipt							
Other sources (recovered products)				549			
Recycled products							
Imports					14017		9879,486
Stock change							-334,553
Exports					12018		29578,721
Bunke							
Direct use							
Gross inland consumption	**12588**	**2139**	**31046**	**549**	**1999**	**10929,481**	**18560,359**
Transformation input			**4378**	**534**		**7246,290**	**59,446**
Conventional thermal power stations			4000	534		7230,540	59,446
Public thermal power stations			19			4374,550	
Autoprod. thermal power stations			3981	534		2855,990	59,446
Nuclear power stations							
District heating plants			378			15,750	
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				**292247**	**151425**		
Conventional thermal power stations				188975	151425		
Public thermal power stations				176667	140971		
Autoprod. thermal power stations				12308	10454		
Nuclear power stations							
District heating plants				103272			
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	**-12588**	**-2139**			**14727**		
Interproduct transfers							
Products transferred	-12588	-2139			14727		
Returns from petrochem. industry							
Consumption of the energy branch			**5**	**27111**	**25818**	**21,738**	
Production and distribution of electricity			1	16600	16156	5,971	
Pumped storage stations					261		
District heating plants				5809	1035		
Extraction and agglo. of solid fuels			2	3587	5607		
Coke-oven and gas works plants			2	785	845	15,767	
Oil and Nat. Gat extraction plants				14	201		
Oil refineries				317	1713		
Nuclear fuel fabrication plants							
Distribution losses				**27800**	**9495**		
Available for final consumption			**26663**	**237351**	**132838**	**3661,453**	**18500,913**
Statistical difference				**0**	**0**		
Final non-energy consumption							
Chemical industry							
Other sectors							
Final energy consumption			**26663**	**237351**	**132838**	**3661,449**	**18484,834**
Industry			26308	28668	51209	603,623	
Iron & steel industry				3520	6149		
Chemical industry			652	4302	8303	6,360	
Non-ferrous metal industry			1	1455	2145		
Glass, pottery & building mat. industry			25428	1071	5164	37,526	
Transport equipment				1885	2712		
Machinery			3	2504	4581		
Mining and Quarryig			0	2848	2704		
Food, drink & tobacco industry				2651	6517	406,659	
Paper and printing			190	2957	4266	110,902	
Wood and wood product				3330	2421	42,176	
Construction			0	347	860		
Textile, leather & clothing industry			0	640	609		
Not elsewhere specified (Industry)			34	1159	4779		
Transport					3287		18484,834
Railways					2958		
Road transport					25		18484,834
International aviation							
Domestic aviation							
Domestic navigation							
Pipeline transport					304		
Not elsewhere specified (Transport)							
Other sectors			355	208683	78342	3057,826	
Commercial and public services			355	44783	47800	2700,529	
Residential				163000	28909		
Agriculture/Forestry				900	1630	357,297	
Fishing					3		
Not elsewhere specified (Other)					0		

Appendix 6 to Poland's Informative Inventory Report 2018

Uncertainty analysis of emissions of selected air pollutants

Contents

List of Tables

Abbreviations

APC(s)	Air Pollution Control Device(s)
CHP(s)	Combined Heat and Power
CSO	Central Statistical Office of Poland
CWS	Central Waste System, database of Polish Ministry of Environment
EEA	European Environmental Agency
EF(s)	Emission Factor(s)
EMEP	European Monitoring and Evaluation Programme
EUROCONTROL	European Organization for the Safety of Air Navigation
EUROSTAT	Eurostat database
GHG(s)	Greenhouse gas(es) (inventory)
IEIA	Institute of Ecology of Industrial Areas
IEP-NRI	Institute of Environmental Protection - - National Research Institute
MTI	Motor Transport Institute
NCEM	The National Centre for Emissions Management (at the IEP-NRI)
NEC	2001/81/EC Directive on National Emission Ceilings
NED	National Emission Database of the IEP-NRI
PCAFA	Polish Cemetery and Funeral Association
PDF(s)	probability density function(s)
SFS	National Headquarters of the State Fire Service
UN ECE	United Nations Economic Commission for Europe

> Statistics are used much like a drunk uses a lamppost: for support, not illumination.
> —Vin Scully

Streszczenie

Niniejszy raport przedstawia wyniki pracy nad analizą niepewności oszacowania emisji wybranych zanieczyszczeń do powietrza, zrealizowanej na potrzeby Konwencji Europejskiej Komisji Gospodarczej Organizacji Narodów Zjednoczonych o Transgranicznym Zanieczyszczaniu Powietrza na Dalekie Odległości, ratyfikowanej przez Polskę w 1985r.

Celem niniejszego raportu jest wypełnienie zobowiązania o przedstawieniu wyników analizy niepewności dla krajowej inwentaryzacji emisji zanieczyszczeń do powietrza, tym samym powinien być on traktowany jako załącznik do tzw. „raportu metodycznego[1]". Raport zawiera odwołania do Załącznika VI poprzedniego zgłoszenia[2].

Obliczenia statystyczne wykonano przy pomocy otwartoźródłowego języka statystycznego `R` (R Core Team, 2016).

Summary

This report summarizes and updates uncertainty estimates of selected air pollutant emissions in Poland. The data on semissions, as well as activities of emission sources are derived from official statistics (Central Statistical Office of Poland and EUROSTAT) primarily. Another suplimentary and auxiliary information used for purposes of national air emission inventory compilation is derived from various data sets provided by: National Emission Database (NCEM, 2015b), 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 guidances on compiling of national air pollutant emission inventory.

All statistical calculations have been prepared using the open source platform and statistical language `R` (R Core Team, 2016).

[1] Raport IIR: `http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/`, bieżące zgłoszenie (lata: 1990–2016) będzie dostępne na stronie internetowej konwencji.

[2] W dalszej części cyt. jako: (App. VI, NCEM, 2015a).

1 Key category analysis

Key categories in 1990 and 2015 are included in Tables 1.1 and 1.2 below. Main differences between emission inventories for 1990 and 2016 are found in NFR 1A1a (power plants and CHPs) primarily:

- no flue gas desulphurisation (1990)[3];
- for 1990 emission of main pollutants (SO_2, NO_X, TSP and CO) derived directly from national statistics[4], in 2015 data obtained from NCEM (2015b).

For selected categories, such as 1A1c as well as 1B1b emissions in 2014 is estimated also from the national data (NCEM, 2015b). For the rest of categories applied methodology has not changed significantly.

Table 1.1: Key categories in 1990

SOx	1A1a (81.7%)												81.7
NOx	1A1a (50.3%)	1A3bi (7.9%)	1A3biii (7.6%)	1A4bi (5.2%)	3Da1 (4.8%)	1A4cii (4.2%)							80.0
NH3	3B1a (24.9%)	3B3 (23.5%)	3B1b (14.6%)	3Da1 (12.3%)	3B4giv (7.4%)								82.6
NMVOC	1A4bi (24.3%)	1A3bi (17.4%)	2D3a (9.2%)	2D3d (4.6%)	1A3bii (3.3%)	1A2f (3.2%)	1B2aiv (3.2%)	1A4ai (3.1%)	1B1a (3.0%)	2H2 (3.0%)	1A2a (2.5%)	1B2av (2.3%)	1A3biii (2.1%)	81.2
CO	1A4bi (42.4%)	1A3bi (27.2%)	1A4ai (7.4%)	1A2a (6.1%)										83.1
TSP	1A1a (56.7%)	1A4bi (15.5%)	5C1bi (2.5%)	1A4ai (2.4%)	2L (2.4%)	3Dc (2.3%)								81.8
PM_{10}	1A4bi (28.9%)	1A1a (23.0%)	3Dc (5.9%)	1A4ai (4.1%)	5C1bi (4.0%)	1A4ci (3.8%)	1A2a (3.5%)	1A2f (3.4%)	1B1a (2.9%)	2L (2.5%)				82.0
$PM_{2.5}$	1A4bi (27.0%)	1A1a (24.7%)	1A2a (7.0%)	1A2f (6.8%)	1A4ai (6.7%)	1A4cii (3.2%)	1A2e (2.8%)	1A4ci (2.5%)						80.8
Pb	1A2b (33.9%)	2C1 (20.8%)	1A1a (10.1%)	1A4bi (9.7%)	1A2a (4.4%)	1A2f (3.9%)								82.9
Hg	1A1a (73.6%)	1A2b (9.4%)												83.0
Cd	1A1a (20.8%)	1A2a (16.4%)	1A2f (16.0%)	2C1 (14.3%)	1A2b (7.3%)	1A2e (6.6%)								81.4
DIOX	1A4bi (40.8%)	5E (14.5%)	1A4ai (10.7%)	2A2 (9.8%)	3F (6.6%)									82.3
PAH	1A4bi (80.6%)													80.6
HCB	1A2a (26.7%)	1A4bi (26.1%)	5C1bi (19.0%)	1A1a (16.9%)										88.7

Basing on uncertainty analysis elaborated for the purpose of previous submission[5] we would not expect any significant change in Tier 1 uncertainties submitted for the previous year. Any changes neither methodological, nor the input data could be then treated as uncertainty influent.
Additionally we determined uncertainties using Tier 2 methodology[6] for each two the most significant categories (presented in Table 1.2).

[3] The first installation applied in 1994.
[4] Due to lacks in data derived also from 1991.
[5] Submission in 2015 for the trend 1995-2013.
[6] Monte Carlo analysis.

Table 1.2: Key categories in 2015

SOx	1A1a (47.1%)	1A4bi (23.1%)	1A2c (5.7%)	1A2a (4.1%)	1A4ci (3.9%)								83.8
NOx	1A1a (26.5%)	1A3biii (16.1%)	1A3bi (11.3%)	1A4bi (9.7%)	1A4cii (8.6%)	3Da1 (5.7%)	1A3bii (4.3%)						82.3
NH3	3B1a (25.4%)	3B3 (18.9%)	3B1b (17.2%)	3Da1 (16.6%)	3B4giv (6.3%)								84.4
NMVOC	2D3d (20.7%)	1A4bi (17.1%)	2D3a (7.6%)	2H2 (6.9%)	1A3bi (6.6%)	1B2aiv (5.1%)	2D3g (4.6%)	2D3h (4.0%)	2D3e (2.5%)	1A2f (2.3%)	1B2av (2.1%)	1A2d (1.7%)	81.1
CO	1A4bi (55.6%)	1A3bi (15.2%)	1A2a (5.9%)	1A4ci (3.6%)									80.3
TSP	1A4bi (35.2%)	1A1a (8.0%)	3Dc (7.1%)	1A4ci (6.9%)	1B1a (3.8%)	2L (3.4%)	3B3 (3.1%)	3B4gi (2.5%)	1A2c (2.5%)	1A4cii (2.5%)	5C1bi (2.3%)	1A4ai (2.1%)	1A2a (2.0%)	81.4
PM_{10}	1A4bi (36.0%)	3Dc (9.6%)	1A1a (8.3%)	1A4ci (7.4%)	1A2c (3.4%)	1A4cii (3.4%)	1A2a (2.7%)	1B1a (2.5%)	1A4ai (1.9%)	5C1bi (1.9%)	2L (1.8%)	1A3bvi (1.8%)		80.7
$PM_{2.5}$	1A4bi (39.0%)	1A1a (8.7%)	1A4ci (6.1%)	1A2c (6.0%)	1A4cii (6.0%)	1A2a (4.8%)	1A4ai (3.1%)	1A2e (3.0%)	1A2f (2.7%)	1A3bi (2.3%)				81.8
Pb	1A2b (42.1%)	2C1 (20.1%)	1A4bi (10.8%)	1A1a (6.4%)	5C1a (4.0%)									83.5
Hg	1A1a (51.2%)	1A2b (20.1%)	1A4bi (6.2%)	5C1a (5.1%)										82.5
Cd	1A2b (16.0%)	2C1 (13.9%)	1A2c (11.0%)	5C1a (11.0%)	1A2a (8.7%)	1A4bi (7.2%)	1A1b (6.5%)	1A1a (5.7%)	1A2e (5.4%)					85.2
DIOX	1A4bi (51.0%)	5E (12.4%)	1A2b (8.3%)	2A2 (6.6%)	2C1 (4.3%)									82.7
PAH	1A4bi (87.8%)													87.8
HCB	1A4bi (35.4%)	1A2a (21.1%)	1A1a (17.6%)	5C1bi (9.6%)										83.7

2 Introduction to uncertainty analysis

2.1 General typology of uncertainties

Emissions of air pollutants are always flawed with uncertainties. The subject of uncertainty in general is referred to epistemic (or fundamental) uncertainty, defined by Zheng and Frey (2004) and connected with lack of knowledge. According to further works: Frey (2007a,b) can be distinguished at least several types of particular uncertainties connected with emission factors such as depend on:

- design, maintenance and operational practices of the installation (emission source);
- feedstocks and variability of their occurrence (eg. coal beds geographical differentiation);
- ambient conditions seasonality and/or periodicity.

Van Asselt et al. (2001) proposed more intuitional system of uncertainty classification using split into two main classes: *uncertainty due to variability* and *uncertainty due to limitted knowledge*.

2.2 Emission estimation

Emission of selected pollutant X is usually considered as a product of 2 variables:

$$E_X^S = A^S \times F_X^S \tag{2.1}$$

Where: E_X^S, emission (calculated in unit proper for reporting); A^S, activity rate of emission source S (production of goods or amount of fuel, or energy used); F_X^S, emission factor of pollutant X for source S.

Total emission of pollutant X could be presented as sum of emissions from categories (e.g. for NFR or SNAP) or particular sources:

$$E_X^{total} = \sum_{cat} E_X^{cat} = \sum_{cat} \sum_{S} E_X^S \tag{2.2}$$

Polish emission inventory applies only the main methodologies: *Tier 1* (basic) and *Tier 2* (extended). Differences between these methodologies are described in EEA (2016); Vreuls (2004). Due to lacks in data and another kind of discrepancies in number of cases the uncertainty analysis is carried out using semi-qualitative approach by expert judgement or *relative simple spreadsheet method* defined by Vreuls (2004).

2.3 Statistical expression of uncertainty

2.3.1 Tier 1

The total uncertainty of air pollutant's emission also known as the uncertainty propagation (van Aardenne, 2002; EEA, 2016) could be presented symbolically, as below, for sum (Rule A, Equation 2.3) and for product (Rule B, Equation 2.4) (EEA, 2016, Chapter 5).

$$\mathcal{U}(E_n) = \frac{\sqrt{(\mathcal{U}(E_1) \times x_1)^2 + \cdots + (\mathcal{U}(E_n) \times x_n)^2}}{\sum_{i=1}^{n} x_i} \tag{2.3}$$

$$\mathcal{U}(E) = \sqrt{\mathcal{U}(A)^2 + \mathcal{U}(F)^2} \tag{2.4}$$

For purposes of this analysis, the A and B rules were applied to list of activities ordered in SNAP97 classification. Selection of old classification (SNAP97) was caused by unability of implied emission factor determining. The uncertainty analysis proceeded according with scheme presented below.

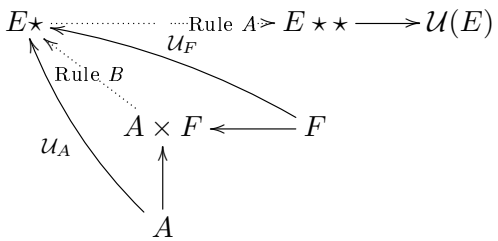

Figure 2.1: Scheme of analysis

where: $E\star$, emission (SNAP classified); $E\star\star$, emission (NFR-14 classified); F, emission factor; A, Activity rate.

2.3.2 Tier 2

The shapes and widths of estimated uncertainties are described by PDFs (Monni and Syri, 2003). Assuming statistical distributions (PDFs) for both parameters: emission factor and activity data the new random variable is created (see Equation 2.1). The new random variable, representing emission of air pollutant from particular emission source(s) has assigned PDF.

The idea of using Monte Carlo analysis is to simulate 95% confidence interval (partial or total) for determined PDF. For the number of cases is tendence for assuming normal distribution as a product of two independent normal distributions[7] which is not correct *sensu stricto*.

3 Uncertainty assessment and calculations

3.1 Uncertainties of activity data

This part presents description of data sources, applied for compiling national emission inventory. Majority of statistical data on activities of emission sources has been derived from official and national statistics (EUROSTAT & CSO).

3.1.1 NFR 1A1 + 1A2 + 1A4

Activity rates for categories:

- 1A1a, 1A1b, 1A1c
- 1A2 (splitted between: 1A2a, 1A2b, 1A2c, 1A2d, 1A2e and 1A2f)
- 1A4ai, 1A4bi, 1A4ci

were derived from EUROSTAT and are consistent with data used for GHGs inventory. Uncertainty rates for particular fuels are presented in table below.

Table 3.1: Activity data sources, NFR Sectors 1A1, 1A2 & 1A4

Fuel	**Unc. rate** [%]	**Fuel**	**Unc. rate** [%]	**Fuel**	**Unc. rate** [%]
Hard coal*	2	Other petr.	2	Diesel oil	5
Brown coal*	2	Petr. coke	2	Fuel oil	5
Crude oil	2	Coke	2	Feedstocks	5
Natural gas	2	LPG	2	Refinery gas	5
Fuel wood	2	Motor gasoline	5	Petr. coke oven gas	5
Biogas	2	Jet kerosene	5	Blast furnace gas	5
Wastes**	2	Jet fuels	5	Gas works gas	5

* Including briquettes; ** Wastes: industrial, municipal (biogenic and non-biogenic).

[7] We assume that random variables representing activity data and emission factor are statistically independent.

3.1.2 Activities of emission sources in other NFR categories

1A2a-b Stationary combustion (...): Iron and steel, non-ferrous metals

Table 3.2: Activity data sources, NFR 1A2a-b

NFR	Source	Unc. rate [%]	Data source
1A2a	Sinter and pelletizing plants	2	GHG
1A2a	Casting of steel	2	GHG
1A2a	Gray iron foundries	2	GHG
1A2b	Primary prod. of metals (lead, zinc, copper)	2	CSO
1A2b	Secondary prod. of metals (lead*, zinc*, copper**)	5	see below
1A2b	Secondary aluminium prod.	5	CSO

* Own estimation based on data derived from CSO.

** Technologies: BOFs, electrolysis, other (excl. BOFs and electrolysis). CSO.

1A2f Stationary combustion (...): Non-metallic minerals

Table 3.3: Activity data sources, NFR 1A2f

NFR	Source	Unc. rate [%]	Data source
1A2f	Clinker	2	CSO
1A2f	Asphalt (batching process)	2	CSO
1A2f	Bricks and tiles	5	CSO*
1A2f	030320 Sanitary ceramic and tiles	5	CSO*

* Own estimation based on data derived from CSO.

1A3 Transport

Table 3.4: Activity data sources, NFR 1A3

NFR	Source	Unc. rate [%]	Data source
1A3aii(i)	Domestic aviation LTO (civil)	5	EUROSTAT
1A3bi-iv	Road transport	2	EUROSTAT/MTI
1A3bv	Gasoline evaporation	5	EUROSTAT
1A3bvi-vii	Automobile tyre and brake wear, road abrasion	5	MTI
1A3c	Railways (diesel)	5	CSO
1A3dii	National navigation (shipping)	5	CSO
1A4cii	Off-road vehicles and other machinery	5	CSO
1A4ciii	National fishing	5	CSO

The road transport emissions are currently modelled using the COPERT 5 software. The total emission's uncertainty including: structure of the fuels used, age of the fleet, and

necessary data transformations is estimated as 70%. For POP's the emissions' uncertainties are estimated as 100%.

1B Extraction and distribution of fossil fuels

Table 3.5: Activity data sources, NFR 1B

NFR	Source	Unc. rate [%]	Data source
1B1a	Mining (open cast/underground)	2	CSO
1B1b	Solid fuel trans. – Coke oven furnaces	2	CSO
1B2ai	Fugitive emissions oil: Exploration, production, transport	2	CSO
1B2aiv	Fugitive emissions oil: Refining / storage	2	CSO
1B2av	Distribution of oil products	2	CSO
1B2b	Fugitive emissions from natural gas	2	CSO

2 Industrial processes

Table 3.6: Activity data sources, NFR 2A

NFR	Source	Unc. rate [%]	Data source
2A1	Cement production	2	CSO
2A2	Lime, calx and gypsum prod.	2	CSO
2A3	Glass (flat, container) prod.	5	CSO/NED
2A5a	Quarrying and mining of minerals other than coal	5	CSO
2A5a	Quarrying of ores	2	CSO
2A5b	Construction and demolition	5	CSO

Table 3.7: Activity data sources, NFR 2B

NFR	Source	Unc. rate [%]	Data source
2B1	Ammonia prod.	2	CSO
2B2	Nitric acid prod.	2	CSO
2B6	Titanium dioxide prod.	5	CSO
2B7	Soda ash prod.	5	CSO
2B10a	Carbon black prod.	5	CSO
2B10a	Formaldehyde prod.	5	CSO
2B10a	Other activities	2	CSO
2B10b	Storage, handling and transport of chem. products (fertilizers)	2	CSO

Table 3.8: Activity data sources, NFR 2C

NFR	Source	Unc. rate [%]	Data source
2C1	Melting (BFs, BOFs, electric arc furnaces)	2	CSO/GHG
2C1	Rolling mills (hot/cold)	5	CSO
2C1	Sinter and pelletizing plants	2	GHG
2C2	Ferroalloys	2	GHG
2C3	Aluminium prod.	5	CSO
2C5	Production of batteries	2	CSO
2C5	Secondary lead prod.	5	see 1A2a-b

Table 3.9: Activity data sources, NFR 2D

NFR	Source	Unc. rate [%]	Data source
2D3a	Domestic solvent use (excl. paint application)	2	CSO
2D3b	040611 Road paving with asphalt	2	CSO
2D3c	040610 Roof covering with asphalt mat.	5	CSO
2D3d	060103,08 Paint application (construction/industrial)	5	CSO*
2D3e	060201 Metal degreasing	5	CSO
2D3f	060202 Dry cleaning	2	CSO
2D3g	060302 PVC processing	2	CSO
2D3g	060304 Polystyrene processing	2	CSO
2D3g	060305 Rubber processing	5	CSO
2D3g	060306 Pharmaceutical products	2	CSO
2D3g	060307 Paints production	5	CSO*
2D3g	060313 Leather tanning	2	CSO
2D3i	060404 Edible and non-edible oil extraction	2	CSO

* Own estimation based on data from CSO.

Table 3.10: Activity data sources, NFR 2G-L

NFR	Source	Unc. rate [%]	Data source
2G	Cigarette smoking [Mg]	10	Own estimation
2G	Cigarette smoking [mln cig.]	2	CSO
2H1	Paper pulp (Kraft process)	2	CSO
2H2	Bread	2	CSO
2H2	Wine	2	CSO
2H2	Beer	2	CSO
2H2	Spirits	5	CSO*
2H2	Smoke houses	5	CSO*
2I	Chipboard prod.	2	CSO
2L	Storage and transport of bulk prod. (cement, coal, coke)	2	CSO

* Own estimation based on data from CSO.

3 Agriculture activities

Table 3.11: Activity data sources, NFR 3

NFR	Source	Unc. rate [%]	Data source
3B1a	Dairy cows	5	CSO
3B1b	Other cattle	5	CSO
3B2	Sheep	5	CSO
3B3	Swine	5	CSO
3B4d	Goats	5	CSO
3B4e	Horses	5	CSO
3B4gi	Laying hens	5	CSO
3B4gii	Broilers	5	CSO
3B4giv	Other poultry (incl. turkeys)	5	CSO
3Da1	Inorganic N-fertilizers (incl. urea appl.)	5	CSO
3F	Field burning of agricultural residuals	10	Own estimation

5 Waste treatment and disposal activities

Table 3.12: Activity data sources, NFR 5

NFR	Source	Unc. rate [%]	Data source
5C1a	Incineration of domestic or municipal wastes	5	CWS
5C1bi	Incineration of industrial wastes	0,05	CWS
5C1biii	Incineration of clinical wastes*	5	CWS
5C1biv	Incineration of sludges from waste water treatment**	5	CWS
5C1bv	Cremations	10	Own estimation/PCAFA
5C2	Open burning of agricultural wastes	5	Own estimation
5D1	Latrines	5	CSO

* Splitted into categories: incinerators compliant with EU Directive, incinerators with minimal APCs, incinerators without APCs installed. ** Splitted into categories: incinerators with good APCs installed, incinerators with very good APCs installed.

Other activities of emission sources

Chapter on uncertainties in the EMEP/EEA Guidebook EEA (2016) doesn't provide uncertainty range for data covered by the national (official) statistics, however in majority of cases it was assumed uncertainty range of 2% due to methodology and guidance applied for GHGs.

Table 3.13: Other activities of emission sources

NFR	**Source**	**Unc. rate** [%]	**Data source**
6A	Fires (landfills, cars, houses, factories)	10	SFS
11B	Forests/Forest fires	5	CSO

3.2 Uncertainties of emission factors

Accordingly to the guidelines (EEA, 2016) and work by Frey (2007a) ranges of emission factor uncertainties (for pollutants: NO_X, NMVOC, SO_2, NH_3, CO, PM, Pb, Cd, Hg and PCDD/F) were assumed basing on table below:

Table 3.14: Emission factor uncertainty rates: summary

Rating	Description*	Typical range of error
A	Excellent	10 to 30%
B	Above average	20 to 60%
C	Average	50 to 200%
D	Below average	100 to 300%
E	Poor	Order of magnitude (approx. $\gg$250%)

* Description by Frey (2007a). Definition of the rating is presented in EEA (2016).

3.3 Uncertainties of emissions

Estimated uncertainties for the selected air pollutants are given in Tab. 3.15.

Table 3.15: Tier 1 uncertainties

NFR	NO_X	NMVOC	SO_2	NH_3	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg	PCDD/F	HCB	PAHs
1A1a	22%	21%	12%	NA	40%	27%	28%	33%	38%	25%	58%	52%	64%	62%
1A1b	30%	29%	20%	NA	50%	50%	50%	50%	60%	66%	46%	100%	100%	81%
1A1c	30%	30%	20%	NA	50%	50%	50%	50%	53%	43%	45%	76%	71%	68%
1A2a	28%	50%	15%	NA	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2b	5%	50%	12%	NA	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2c	30%	50%	20%	NA	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2d	30%	50%	20%	14%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2e	30%	50%	20%	NA	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A2f	27%	50%	14%	NA	29%	50%	50%	50%	70%	70%	70%	87%	100%	100%
1A2gvii	IE	IE	IE	NA	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1A2gviii	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3ai(i)	112%	112%	86%	NA	86%	50%	50%	50%	NA	NA	NA	NA	NA	NA
1A3aii(i)	50%	86%	30%	NA	95%	73%	73%	73%	NA	NA	NA	NA	NA	NA
1A3bi	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A3bii	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A3biii	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	100%	100%
1A3biv	70%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1A3bv	NA	70%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bvi	NA	NA	NA	NA	NA	100%	100%	100%	70%	70%	NA	NA	NA	NA
1A3bvii	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 3.15: Tier 1 uncertainties

NFR	NO_X	NMVOC	SO_2	NH_3	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg	PCDD/F	HCB	PAHs
1A3c	50%	100%	30%	50%	100%	100%	100%	100%	IE	50%	NA	100%	NA	100%
1A3di(ii)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3dii	39%	76%	23%	NA	72%	75%	75%	75%	100%	47%	100%	77%	NA	77%
1A3ei	50%	IE	70%	NA	NA	NA	NA	NA	IE	IE	IE	NA	NA	NA
1A3eii	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A4ai	18%	37%	23%	NA	35%	41%	40%	41%	63%	48%	58%	61%	76%	75%
1A4aii	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1A4bi	20%	36%	25%	43%	36%	39%	38%	35%	63%	46%	58%	76%	79%	70%
1A4bii	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1A4ci	23%	34%	24%	NA	35%	41%	40%	35%	61%	54%	62%	93%	84%	70%
1A4cii	43%	77%	28%	46%	90%	91%	91%	91%	NA	46%	NA	91%	NA	91%
1A4ciii	37%	73%	25%	NA	73%	73%	73%	73%	IE	37%	IE	100%	NA	100%
1A5a	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1A5b	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1B1a	NA	50%	NA	NA	NA	27%	27%	27%	NA	NA	NA	NA	NA	NA
1B1b	30%	50%	70%	50%	NA	50%	50%	50%	70%	70%	NA	100%	NA	100%
1B1c	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NA	NA	NA
1B2ai	NA	50%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1B2aiv	30%	39%	70%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1B2av	NA	44%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1B2b	NA	33%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1B2c	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1B2d	NA	NO	NA	NA	NA	NA	NA	NA	NO	NO	NO	NA	NA	NA

Table 3.15: Tier 1 uncertainties

NFR	NO_X	NMVOC	SO_2	NH_3	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg	PCDD/F	HCB	PAHs
2A1	NA	NA	NA	NA	NA	1%	30%	30%	70%	NA	NA	NA	NA	NA
2A2	NA	NA	NA	NA	50%	50%	50%	50%	NA	NA	NA	100%	NA	NA
2A3	NA	NA	NA	NA	36%	50%	50%	50%	70%	70%	70%	72%	NA	NA
2A5a	NA	NA	NA	NA	NA	47%	47%	47%	NA	NA	NA	NA	NA	NA
2A5b	NA	NA	NA	NA	NA	50%	50%	50%	NA	NA	NA	NA	NA	NA
2A5c	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2A6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2B1	30%	NA	NA	50%	50%	NA	NA	NA	NA	NA	NA	NA	NA	NA
2B2	30%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2B3	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2B5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2B6	30%	NA	30%	NA	NA	50%	NA	NA	NA	NA	NA	NA	NA	NA
2B7	NA	NA	NA	50%	NA	50%	NA	NA	NA	NA	NA	NA	NA	NA
2B10a	24%	22%	24%	NA	48%	7%	49%	50%	NA	70%	10%	NA	NA	NA
2B10b	NA	NA	NA	NA	NA	139%	139%	139%	NA	NA	NA	NA	NA	NA
2C1	20%	21%	30%	NA	39%	8%	12%	11%	27%	39%	59%	99%	71%	NA
2C2	NA	NA	NA	NA	NA	50%	NA	NA	70%	NA	NA	NA	NA	NA
2C3	NA	NA	IE	NA	NA	50%	50%	50%	NA	NA	NA	NA	NA	NA
2C4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2C5	IE	NA	NA	NA	NA	50%	50%	50%	70%	NA	NA	NA	NA	NA
2C6	IE	NA	NA	NA	NA	NA	NA	NA	IE	IE	IE	NA	NA	NA
2C7a	IE	NA	NA	NA	NA	NA	NA	NA	IE	IE	IE	NA	NA	NA
2C7b	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NA	NA	NA

Table 3.15: Tier 1 uncertainties

NFR	NO_X	NMVOC	SO_2	NH_3	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg	PCDD/F	HCB	PAHs
2C7c	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2C7d	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3a	NA	30%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3b	NA	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3c	NA	50%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3d	NA	28%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3e	NA	30%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3f	NA	30%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3g	NA	15%	NA	50%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3h	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3i	NA	28%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100%
2G	71%	71%	NA	NA	71%	50%	50%	50%	71%	71%	71%	100%	NA	NA
2H1	30%	50%	30%	NA	50%	50%	50%	50%	NA	NA	NA	NA	NA	NA
2H2	NA	24%	NA	NA	NA	NA	NA	NA	NA	NA	NA	85%	NA	NA
2H3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2I	NA	50%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2L	NA	NA	NA	NA	NA	63%	50%	63%	NA	NA	NA	NA	NA	NA
3B1a	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B1b	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B2	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B3	NA	NA	NA	84%	NA	95%	91%	88%	NA	NA	NA	NA	NA	NA

Table 3.15: Tier 1 uncertainties

NFR	NO_X	NMVOC	SO_2	NH_3	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg	PCDD/F	HCB	PAHs
3B4a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3B4d	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B4e	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B4f	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3B4gi	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B4gii	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B4giii	NA	NA	NA	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3B4giv	NA	NA	NA	100%	NA	100%	100%	100%	NA	NA	NA	NA	NA	NA
3B4h	NA	NA	NA	104%	NA	150%	150%	150%	NA	NA	NA	NA	NA	NA
3Da1	30%	150%	NA	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da2a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da2b	NA	NA	NA	104%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da2c	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Db	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Dc	NA	NA	NA	NA	NA	150%	150%	150%	NA	NA	NA	NA	NA	NA
3Dd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3De	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Df	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3F	NA	150%	NA	NA	150%	150%	150%	150%	NA	NA	NA	100%	NA	NA
3I	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5A	NA	30%	NA	NA	NA	150%	150%	150%	NA	NA	NA	NA	NA	NA

Table 3.15: Tier 1 uncertainties

NFR	NO_X	NMVOC	SO_2	NH_3	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg	PCDD/F	HCB	PAHs
5B1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5B2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5C1a	50%	50%	30%	NA	NA	NA	NA	50%	NA	NA	NA	NA	NA	NA
5C1bi	37%	37%	22%	NA	37%	37%	37%	37%	NA	NA	NA	99%	98%	NA
5C1bii	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5C1biii	48%	48%	29%	NA	48%	NA	NA	NA	NA	NA	NA	31%	83%	NA
5C1biv	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	76%	NA	NA
5C1bv	71%	51%	32%	NA	51%	NA	NA	NA	71%	71%	71%	100%	NA	NA
5C1bvi	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5C2	50%	50%	NA	NA	50%	50%	50%	50%	NA	NA	NA	94%	NA	NA
5D1	NA	NA	NA	30%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5D2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5D3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5E	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100%	NA	NA
6A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

3.4 Tier 1 sensitivity analysis

Table 3.16: NO_X

	1990	2016			
NFR	C	D	G	H	J
1A1a	529.158 1	192.289 1	0.219 0	0.058 0	0.182 8
1A1b	6.680 5	3.116 2	0.300 0	0.001 3	0.003 0
1A1c	7.758 9	0.851 6	0.300 0	0.000 4	0.000 8
1A2a	32.987 4	10.510 5	0.279 9	0.004 0	0.010 0
1A2b	1.903 9	1.751 3	0.052 7	0.000 1	0.001 7
1A2c	4.122 9	10.261 9	0.300 0	0.004 2	0.009 8
1A2d	0.998 8	5.974 2	0.300 0	0.002 5	0.005 7
1A2e	7.753 5	7.388 7	0.300 0	0.003 1	0.007 0
1A2f	37.180 3	18.160 5	0.267 8	0.006 7	0.017 3
1A3ai(i)	0.335 9	1.012 7	1.118 0	0.001 6	0.001 0
1A3aii(i)	0.016 3	0.105 7	0.496 8	0.000 1	0.000 1
1A3bi	83.073 3	82.152 6	0.700 0	0.079 2	0.078 1
1A3bii	29.528 9	31.002 8	0.700 0	0.029 9	0.029 5
1A3biii	79.933 3	117.019 4	0.700 0	0.112 8	0.111 2
1A3biv	1.627 9	0.975 9	0.700 0	0.000 9	0.000 9
1A3c	22.807 5	4.245 8	0.502 5	0.002 9	0.004 0
1A3dii	2.718 5	0.377 7	0.390 2	0.000 2	0.000 4
1A3ei	NE	0.841 9	0.500 0	0.000 6	0.000 8
1A4ai	12.760 3	16.279 4	0.180 8	0.004 1	0.015 5
1A4bi	54.948 7	70.741 7	0.201 8	0.019 7	0.067 2
1A4ci	6.652 1	9.609 0	0.225 8	0.003 0	0.009 1
1A4cii	43.944 6	62.609 2	0.426 2	0.036 7	0.059 5
1A4ciii	12.883 0	6.741 4	0.368 3	0.003 4	0.006 4
1B1b	NE	4.822 3	0.300 0	0.002 0	0.004 6
1B2aiv	3.490 9	2.829 2	0.300 0	0.001 2	0.002 7
2B1	0.001 5	2.623 1	0.300 7	0.001 1	0.002 5
2B2	5.993 4	8.892 2	0.300 7	0.003 7	0.008 5
2B6	0.003 2	0.004 1	0.304 1	0.000 0	0.000 0
2B10a	1.966 7	3.252 6	0.238 5	0.001 1	0.003 1
2C1	4.233 1	1.599 8	0.197 3	0.000 4	0.001 5
2G	0.000 2	0.000 2	0.707 1	0.000 0	0.000 0
2H1	0.522 6	0.877 4	0.300 7	0.000 4	0.000 8
3Da1	50.960 0	41.720 0	0.300 0	0.017 2	0.039 7
5C1a	NO	0.513 4	0.502 5	0.000 4	0.000 5
5C1bi	0.231 3	0.240 0	0.366 0	0.000 1	0.000 2
5C1biii	0.078 4	0.068 6	0.481 7	0.000 0	0.000 1
5C1bv	0.000 1	0.009 6	0.707 1	0.000 0	0.000 0
5C2	1.060 4	1.367 1	0.502 5	0.000 9	0.001 3
Total:	1 051.972 8	726.431 2		0.403 7	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.17: NMVOC

	1990	2016			
NFR	C	D	G	H	J
1A1a	9.816 7	4.076 9	0.213 5	0.001 4	0.008 2
1A1b	0.055 7	0.203 5	0.292 2	0.000 1	0.000 4
1A1c	0.220 6	0.196 6	0.296 4	0.000 1	0.000 4
1A2a	12.508 5	4.850 0	0.500 0	0.004 0	0.009 8
1A2b	0.710 4	0.676 2	0.500 0	0.000 6	0.001 4
1A2c	1.163 1	4.657 4	0.500 0	0.003 8	0.009 4
1A2d	0.197 1	10.225 8	0.500 0	0.008 4	0.020 7
1A2e	3.288 0	3.249 9	0.500 0	0.002 7	0.006 6
1A2f	15.960 8	14.014 1	0.500 0	0.011 5	0.028 3
1A3ai(i)	0.013 1	0.039 6	1.118 0	0.000 1	0.000 1
1A3aii(i)	0.015 3	0.006 7	0.863 7	0.000 0	0.000 0
1A3bi	86.048 0	40.104 8	0.700 0	0.046 1	0.081 0
1A3bii	16.312 4	5.599 6	0.700 0	0.006 4	0.011 3
1A3biii	10.174 7	6.093 0	0.700 0	0.007 0	0.012 3
1A3biv	8.510 2	3.886 3	1.000 2	0.006 4	0.007 9
1A3bv	5.339 0	7.672 6	0.700 0	0.008 8	0.015 5
1A3c	1.925 1	0.376 8	1.001 2	0.000 6	0.000 8
1A3dii	0.131 8	0.018 0	0.764 4	0.000 0	0.000 0
1A4ai	15.408 8	4.540 1	0.367 2	0.002 7	0.009 2
1A4bi	120.497 7	104.256 4	0.356 8	0.061 1	0.210 6
1A4ci	7.982 7	8.159 9	0.341 8	0.004 6	0.016 5
1A4cii	5.262 1	7.497 1	0.769 8	0.009 5	0.015 1
1A4ciii	2.801 6	1.466 0	0.733 8	0.001 8	0.003 0
1B1a	14.767 4	7.078 4	0.500 4	0.005 8	0.014 3
1B1b	0.105 8	0.074 7	0.500 4	0.000 1	0.000 2
1B2ai	0.016 0	0.100 1	0.500 4	0.000 1	0.000 2
1B2aiv	15.623 7	30.858 9	0.394 9	0.020 0	0.062 3
1B2av	11.539 1	12.737 8	0.442 8	0.009 3	0.025 7
1B2b	9.896 3	9.316 1	0.327 3	0.005 0	0.018 8
2B10a	4.111 8	8.043 2	0.221 8	0.002 9	0.016 2
2C1	4.343 3	2.744 2	0.213 1	0.001 0	0.005 5
2D3a	45.687 6	46.119 6	0.300 7	0.022 8	0.093 2
2D3b	0.011 6	0.023 2	1.000 0	0.000 0	0.000 0
2D3c	4.257 2	3.648 2	0.502 5	0.003 0	0.007 4
2D3d	22.800 0	125.887 0	0.278 3	0.057 5	0.254 3
2D3e	4.000 0	15.033 0	0.304 1	0.007 5	0.030 4
2D3f	5.711 0	5.764 9	0.300 7	0.002 8	0.011 6
2D3g	6.447 3	28.264 6	0.146 7	0.006 8	0.057 1
2D3i	3.645 1	7.528 3	0.283 8	0.003 5	0.015 2
2G	0.000 3	0.000 2	0.707 1	0.000 0	0.000 0
2H1	0.522 6	0.877 4	0.500 4	0.000 7	0.001 8
2H2	14.741 1	42.086 8	0.243 4	0.016 8	0.085 0
2I	0.184 7	1.083 5	0.500 4	0.000 9	0.002 2
3Da1	0.007 6	0.006 2	1.500 8	0.000 0	0.000 0
3F	0.017 2	0.003 6	1.503 3	0.000 0	0.000 0
5A	0.000 0	0.000 0	0.300 7	0.000 0	0.000 0
5C1a	NO	2.828 2	0.502 5	0.002 3	0.005 7
5C1bi	1.909 3	2.041 7	0.366 0	0.001 2	0.004 1
5C1biii	0.039 2	0.034 3	0.481 7	0.000 0	0.000 1
5C1bv	0.000 0	0.000 4	0.509 9	0.000 0	0.000 0
5C2	0.326 1	0.399 7	0.502 5	0.000 3	0.000 8
Total:	495.054 6	608.858 3		0.358 3	

C, kt; D, kt; G, Combined uncertainty; H = (G · D)/ $\sum$ D; J = D/ $\sum$ C.

Table 3.18: SO_2

	1990	2016			
NFR	C	D	G	H	J
1A1a	2 164.027 8	273.639 3	0.122 8	0.057 8	0.103 3
1A1b	15.941 0	11.776 9	0.200 0	0.004 1	0.004 4
1A1c	18.092 5	1.017 3	0.200 0	0.000 3	0.000 4
1A2a	62.239 0	23.650 9	0.151 3	0.006 2	0.008 9
1A2b	3.882 0	2.974 3	0.119 3	0.000 6	0.001 1
1A2c	8.192 1	33.129 3	0.200 0	0.011 4	0.012 5
1A2d	1.654 4	7.032 7	0.200 0	0.002 4	0.002 7
1A2e	29.386 6	16.481 5	0.200 0	0.005 7	0.006 2
1A2f	111.991 9	21.070 0	0.140 8	0.005 1	0.008 0
1A3ai(i)	0.026 2	0.079 1	0.860 2	0.000 1	0.000 0
1A3aii(i)	0.002 1	0.010 4	0.295 5	0.000 0	0.000 0
1A3bi	0.000 1	0.000 2	0.700 0	0.000 0	0.000 0
1A3bii	0.000 0	0.000 0	0.700 0	0.000 0	0.000 0
1A3biii	0.000 0	0.000 1	0.700 0	0.000 0	0.000 0
1A3biv	0.000 0	0.000 0	1.000 0	0.000 0	0.000 0
1A3c	3.597 9	0.008 1	0.304 1	0.000 0	0.000 0
1A3dii	0.604 1	0.000 3	0.233 4	0.000 0	0.000 0
1A3ei	NE	0.020 9	0.700 0	0.000 0	0.000 0
1A4ai	43.133 1	16.335 2	0.234 6	0.006 6	0.006 2
1A4bi	144.476 0	134.353 0	0.254 9	0.058 9	0.050 7
1A4ci	21.772 2	22.730 9	0.238 7	0.009 3	0.008 6
1A4cii	7.066 7	0.167 8	0.275 4	0.000 1	0.000 1
1A4ciii	1.323 6	0.002 3	0.252 4	0.000 0	0.000 0
1B1b	NE	2.679 0	0.700 0	0.003 2	0.001 0
1B2aiv	6.054 4	5.658 6	0.700 0	0.006 8	0.002 1
2B6	0.119 4	0.150 7	0.304 1	0.000 1	0.000 1
2B10a	3.940 5	4.452 3	0.235 3	0.001 8	0.001 7
2C1	0.146 8	0.240 9	0.300 7	0.000 1	0.000 1
2H1	1.045 2	1.754 8	0.300 0	0.000 9	0.000 7
5C1a	NO	0.041 7	0.304 1		
5C1bi	0.011 8	0.003 8	0.221 5	0.000 0	0.000 0
5C1biii	0.078 4	0.068 6	0.291 6	0.000 0	0.000 0
5C1bv	0.000 0	0.003 5	0.316 2	0.000 0	0.000 0
Total:	2 649.035 8	581.520 3		0.181 6	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.19: NH_3

	1990	2016			
NFR	C	D	G	H	J
1A2d	0.004 4	0.003 8	0.141 4	0.000 0	0.000 0
1A3bi	0.077 9	4.083 4	0.700 0	0.010 7	0.009 3
1A3bii	0.019 7	0.124 8	0.700 0	0.000 3	0.000 3
1A3biii	0.024 6	0.096 9	0.700 0	0.000 3	0.000 2
1A3biv	0.008 8	0.006 3	1.000 2	0.000 0	0.000 0
1A3c	1.116 8	0.000 6	0.502 5	0.000 0	0.000 0
1A4bi	0.216 9	0.506 4	0.426 0	0.000 8	0.001 1
1A4cii	0.009 4	0.013 4	0.455 0	0.000 0	0.000 0
1B1b	0.068 7	0.048 5	0.500 4	0.000 1	0.000 1
2B1	0.000 0	0.026 2	0.500 4	0.000 0	0.000 1
2B7	1.201 4	1.245 3	0.502 5	0.002 3	0.002 8
2D3g	0.018 0	0.014 4	0.500 4	0.000 0	0.000 0
3B1a	109.618 5	67.939 3	1.001 2	0.254 7	0.154 1
3B1b	64.368 5	46.070 6	1.001 2	0.172 7	0.104 5
3B2	11.242 8	0.646 4	1.001 2	0.002 4	0.001 5
3B3	103.517 6	50.364 3	0.836 6	0.157 7	0.114 2
3B4d	0.408 6	0.100 7	1.001 2	0.000 4	0.000 2
3B4e	15.535 3	3.062 4	1.001 2	0.011 5	0.006 9
3B4gi	18.830 8	15.077 6	1.001 2	0.056 5	0.034 2
3B4gii	17.317 1	14.596 9	1.001 2	0.054 7	0.033 1
3B4giv	32.708 4	16.706 0	1.001 2	0.062 6	0.037 9
3B4h	0.029 8	0.015 4	1.044 0	0.000 1	0.000 0
3Da1	54.081 6	44.275 6	1.001 2	0.166 0	0.100 4
3Da2b	0.112 4	0.565 6	1.044 0	0.002 2	0.001 3
5D1	10.444 5	1.516 4	0.304 1	0.001 7	0.003 4
Total:	440.982 5	267.107 2		0.957 9	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.20: CO

	1990	2016			
NFR	C	D	G	H	J
1A1a	54.718 2	51.475 2	0.402 4	0.008 3	0.014 3
1A1b	0.771 4	0.136 3	0.500 0	0.000 0	0.000 0
1A1c	11.689 9	1.399 1	0.500 0	0.000 3	0.000 4
1A2a	218.449 0	148.809 0	0.700 0	0.041 6	0.041 5
1A2b	0.502 8	6.112 1	0.700 0	0.001 7	0.001 7
1A2c	0.698 9	32.362 7	0.700 0	0.009 0	0.009 0
1A2d	0.130 9	6.628 2	0.700 0	0.001 9	0.001 8
1A2e	2.582 9	15.876 1	0.700 0	0.004 4	0.004 4
1A2f	28.758 7	48.518 7	0.290 0	0.005 6	0.013 5
1A3ai(i)	0.028 9	0.087 0	0.860 2	0.000 0	0.000 0
1A3aii(i)	0.962 6	0.381 5	0.949 5	0.000 1	0.000 1
1A3bi	975.141 2	380.610 3	0.700 0	0.106 3	0.106 1
1A3bii	180.477 5	59.363 2	0.700 0	0.016 6	0.016 5
1A3biii	25.022 6	29.944 6	0.700 0	0.008 4	0.008 3
1A3biv	81.992 3	32.440 8	1.000 2	0.012 9	0.009 0
1A3c	12.527 4	2.390 3	1.001 2	0.001 0	0.000 7
1A3dii	0.814 5	0.094 0	0.721 9	0.000 0	0.000 0
1A4ai	265.204 1	53.345 5	0.354 8	0.007 6	0.014 9
1A4bi	1 522.919 4	1 392.665 4	0.364 6	0.202 7	0.388 2
1A4ci	83.668 5	89.243 8	0.347 3	0.012 4	0.024 9
1A4cii	54.649 1	77.860 3	0.899 8	0.028 0	0.021 7
1A4ciii	1.764 8	0.923 5	0.733 8	0.000 3	0.000 3
2A2	6.195 2	3.618 4	0.500 4	0.000 7	0.001 0
2A3	0.006 5	0.018 8	0.363 3	0.000 0	0.000 0
2B1	0.000 2	0.262 3	0.500 4	0.000 1	0.000 1
2B10a	0.848 0	3.440 2	0.479 6	0.000 7	0.001 0
2C1	29.394 7	24.834 3	0.388 0	0.003 8	0.006 9
2G	0.008 6	0.006 2	0.707 1	0.000 0	0.000 0
2H1	2.874 3	4.825 7	0.500 4	0.001 0	0.001 3
3F	2.295 7	0.482 9	1.503 3	0.000 3	0.000 1
5C1bi	0.017 6	0.005 7	0.366 0	0.000 0	0.000 0
5C1biii	0.156 9	0.137 1	0.481 7	0.000 0	0.000 0
5C1bv	0.000 0	0.004 3	0.509 9	0.000 0	0.000 0
5C2	16.817 6	20.797 8	0.502 5	0.004 2	0.005 8
Total:	3 587.607 5	2 505.631 3		0.479 7	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.21: TSP

	1990	2016			
NFR	C	D	G	H	J
1A1a	562.243 1	28.300 0	0.272 9	0.021 9	0.028 5
1A1b	0.503 5	0.840 3	0.500 0	0.001 2	0.000 8
1A1c	0.861 8	0.479 4	0.500 0	0.000 7	0.000 5
1A2a	13.315 6	6.917 4	0.700 0	0.013 7	0.007 0
1A2b	0.899 2	1.249 0	0.700 0	0.002 5	0.001 3
1A2c	1.449 7	8.778 8	0.700 0	0.017 4	0.008 9
1A2d	0.271 6	1.798 0	0.700 0	0.003 6	0.001 8
1A2e	5.358 0	4.306 6	0.700 0	0.008 6	0.004 3
1A2f	12.980 5	3.960 0	0.500 0	0.005 6	0.004 0
1A3ai(i)	0.335 9	0.015 8	0.500 0	0.000 0	0.000 0
1A3aii(i)	0.016 3	0.003 2	0.730 7	0.000 0	0.000 0
1A3bi	1.186 2	3.388 1	0.700 0	0.006 7	0.003 4
1A3bii	2.920 8	1.741 4	0.700 0	0.003 5	0.001 8
1A3biii	3.899 0	2.928 1	0.700 0	0.005 8	0.003 0
1A3biv	0.185 2	0.068 6	1.000 2	0.000 2	0.000 1
1A3bvi	2.035 4	6.187 0	1.000 0	0.017 6	0.006 2
1A3c	2.608 5	0.380 8	1.001 2	0.001 1	0.000 4
1A3dii	0.206 2	0.027 8	0.751 0	0.000 1	0.000 0
1A4ai	24.108 7	7.547 6	0.406 4	0.008 7	0.007 6
1A4bi	153.418 2	123.933 0	0.392 3	0.138 0	0.125 0
1A4ci	18.982 8	24.341 0	0.410 6	0.028 4	0.024 6
1A4cii	6.124 5	8.725 7	0.906 7	0.022 5	0.008 8
1A4ciii	0.882 4	0.461 7	0.733 8	0.001 0	0.000 5
1B1a	21.896 0	13.328 4	0.270 3	0.010 2	0.013 4
1B1b	2.747 7	0.619 3	0.500 4	0.000 9	0.000 6
2A1	2.754 0	3.614 9	0.011 8	0.000 1	0.003 6
2A2	2.001 1	1.762 5	0.500 0	0.002 5	0.001 8
2A3	0.317 4	0.938 2	0.500 0	0.001 3	0.000 9
2A5a	2.999 9	3.651 8	0.469 2	0.004 9	0.003 7
2A5b	1.678 5	2.500 3	0.500 0	0.003 5	0.002 5
2B6	0.009 0	0.011 4	0.500 0	0.000 0	0.000 0
2B7	0.133 5	0.138 4	0.500 0	0.000 2	0.000 1
2B10a	1.816 9	2.932 4	0.068 6	0.000 6	0.003 0
2B10b	0.483 8	0.628 1	1.385 9	0.002 5	0.000 6
2C1	7.283 0	2.002 0	0.082 3	0.000 5	0.002 0
2C2	0.088 6	0.077 7	0.500 0	0.000 1	0.000 1
2C3	0.027 6	NO	0.500 0		
2C5	0.000 8	0.004 6	0.500 0	0.000 0	0.000 0
2G	1.905 4	1.373 6	0.500 0	0.001 9	0.001 4
2H1	0.522 6	0.877 4	0.500 0	0.001 2	0.000 9
2L	23.787 6	11.843 3	0.630 8	0.021 2	0.011 9
3B1a	6.788 2	3.218 4	1.000 0	0.009 1	0.003 2
3B1b	2.412 2	1.696 0	1.000 0	0.004 8	0.001 7
3B2	0.582 3	0.033 5	1.000 0	0.000 1	0.000 0
3B3	19.647 3	11.041 5	0.953 3	0.029 9	0.011 1
3B4d	0.025 1	0.006 2	1.000 0	0.000 0	0.000 0
3B4e	0.451 7	0.089 0	1.000 0	0.000 3	0.000 1
3B4gi	10.580 3	8.943 8	1.000 0	0.025 4	0.009 0
3B4gii	5.299 4	4.878 4	1.000 0	0.013 8	0.004 9
3B4giv	5.230 6	2.671 6	1.000 0	0.007 6	0.002 7
3B4h	0.026 8	0.013 8	1.500 0	0.000 1	0.000 0
3Dc	22.374 2	24.847 7	1.500 0	0.105 8	0.025 1
3F	0.232 2	0.048 8	1.503 3	0.000 2	0.000 0
5A	6.117 4	1.970 1	1.500 0	0.008 4	0.002 0
5C1bi	25.091 2	8.130 0	0.366 0	0.008 4	0.008 2
5C2	1.230 1	1.507 6	0.502 5	0.002 2	0.001 5
Total:	3 587.607 5	2 505.631 4		1.130 9	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.22: PM_{10}

	1990	2016			
NFR	C	D	G	H	J
1A1a	86.897 6	21.493 2	0.281 2	0.023 3	0.056 9
1A1b	0.270 6	0.840 3	0.500 0	0.001 6	0.002 2
1A1c	0.551 0	0.479 4	0.500 0	0.000 9	0.001 3
1A2a	13.315 6	6.917 4	0.700 0	0.018 7	0.018 3
1A2b	0.899 2	1.249 0	0.700 0	0.003 4	0.003 3
1A2c	1.449 7	8.778 8	0.700 0	0.023 7	0.023 2
1A2d	0.271 6	1.798 0	0.700 0	0.004 9	0.004 8
1A2e	5.358 0	4.306 6	0.700 0	0.011 6	0.011 4
1A2f	12.980 5	3.960 0	0.500 0	0.007 6	0.010 5
1A3ai(i)	0.335 9	0.015 8	0.500 0	0.000 0	0.000 0
1A3aii(i)	0.016 3	0.003 2	0.730 7	0.000 0	0.000 0
1A3bi	1.186 2	3.388 1	0.700 0	0.009 2	0.009 0
1A3bii	2.920 8	1.741 4	0.700 0	0.004 7	0.004 6
1A3biii	3.899 0	2.928 1	0.700 0	0.007 9	0.007 8
1A3biv	0.185 2	0.068 6	1.000 2	0.000 3	0.000 2
1A3bvi	1.572 4	4.699 1	1.000 0	0.018 1	0.012 4
1A3c	2.608 5	0.380 8	1.001 2	0.001 5	0.001 0
1A3dii	0.206 2	0.027 8	0.751 0	0.000 1	0.000 1
1A4ai	15.345 4	4.946 9	0.397 3	0.007 6	0.013 1
1A4bi	109.051 5	93.352 3	0.379 8	0.136 8	0.247 2
1A4ci	14.201 6	19.107 2	0.397 7	0.029 3	0.050 6
1A4cii	6.124 5	8.725 7	0.906 7	0.030 5	0.023 1
1A4ciii	0.882 4	0.461 7	0.733 8	0.001 3	0.001 2
1B1a	10.762 9	6.551 5	0.270 3	0.006 8	0.017 3
1B1b	2.747 7	1.941 5	0.500 4	0.003 7	0.005 1
2A1	2.503 6	3.156 5	0.300 0	0.003 7	0.008 4
2A2	0.814 0	0.716 9	0.500 0	0.001 4	0.001 9
2A3	0.285 7	0.844 4	0.500 0	0.001 6	0.002 2
2A5a	1.476 7	1.795 9	0.469 0	0.003 2	0.004 8
2A5b	0.841 3	1.253 3	0.500 0	0.002 4	0.003 3
2B10a	1.321 9	1.985 3	0.493 5	0.003 8	0.005 3
2B10b	0.154 8	0.201 0	1.385 9	0.001 1	0.000 5
2C1	4.985 4	1.133 0	0.118 0	0.000 5	0.003 0
2C3	0.023 0	NO	0.500 0		
2C5	0.000 8	0.004 6	0.500 0	0.000 0	0.000 0
2G	1.905 4	1.373 6	0.500 0	0.002 7	0.003 6
2H1	0.418 1	0.701 9	0.500 0	0.001 4	0.001 9
2L	9.527 5	4.753 1	0.500 0	0.009 2	0.012 6
3B1a	3.099 0	1.469 3	1.000 0	0.005 7	0.003 9
3B1b	1.114 7	0.783 8	1.000 0	0.003 0	0.002 1
3B2	0.249 5	0.014 3	1.000 0	0.000 1	0.000 0
3B3	2.780 1	1.546 8	0.911 0	0.005 4	0.004 1
3B4d	0.010 8	0.002 7	1.000 0	0.000 0	0.000 0
3B4e	0.207 0	0.040 8	1.000 0	0.000 2	0.000 1
3B4gi	2.227 4	1.882 9	1.000 0	0.007 3	0.005 0
3B4gii	2.649 7	2.439 2	1.000 0	0.009 4	0.006 5
3B4giv	5.230 6	2.671 6	1.000 0	0.010 3	0.007 1
3B4h	0.011 9	0.006 1	1.500 0	0.000 0	0.000 0
3Dc	22.374 2	24.847 7	1.500 0	0.143 8	0.065 8
3F	0.232 2	0.048 8	1.503 3	0.000 3	0.000 1
5A	2.893 5	0.931 8	1.500 0	0.005 4	0.002 5
5C1bi	15.054 7	4.878 0	0.366 0	0.006 9	0.012 9
5C2	1.195 6	1.465 4	0.502 5	0.002 8	0.003 9
Total:	377.629 7	259.165 3		0.585 1	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.23: $PM_{2.5}$

	1990	2016			
NFR	C	D	G	H	J
1A1a	46.979 7	12.729 2	0.327 7	0.028 7	0.066 9
1A1b	0.153 3	0.462 9	0.500 0	0.001 6	0.002 4
1A1c	0.323 6	0.279 0	0.500 0	0.001 0	0.001 5
1A2a	13.315 6	6.917 4	0.700 0	0.033 3	0.036 3
1A2b	0.899 2	1.249 0	0.700 0	0.006 0	0.006 6
1A2c	1.449 7	8.778 8	0.700 0	0.042 2	0.046 1
1A2d	0.271 6	1.798 0	0.700 0	0.008 6	0.009 4
1A2e	5.358 0	4.306 6	0.700 0	0.020 7	0.022 6
1A2f	12.980 5	3.960 0	0.500 0	0.013 6	0.020 8
1A3ai(i)	0.335 9	0.015 8	0.500 0	0.000 1	0.000 1
1A3aii(i)	0.016 3	0.003 2	0.730 7	0.000 0	0.000 0
1A3bi	1.186 2	3.388 1	0.700 0	0.016 3	0.017 8
1A3bii	2.920 8	1.741 4	0.700 0	0.008 4	0.009 1
1A3biii	3.899 0	2.928 1	0.700 0	0.014 1	0.015 4
1A3biv	0.185 2	0.068 6	1.000 2	0.000 5	0.000 4
1A3bvi	0.827 1	2.520 6	1.000 0	0.017 3	0.013 2
1A3c	2.608 5	0.380 8	1.001 2	0.002 6	0.002 0
1A3dii	0.206 2	0.027 8	0.751 0	0.000 1	0.000 1
1A4ai	12.807 8	4.580 7	0.408 6	0.012 9	0.024 1
1A4bi	51.345 9	56.716 0	0.352 4	0.137 3	0.297 9
1A4ci	4.832 0	8.887 5	0.350 3	0.021 4	0.046 7
1A4cii	6.124 5	8.725 7	0.906 7	0.054 4	0.045 8
1A4ciii	0.882 4	0.461 7	0.733 8	0.002 3	0.002 4
1B1a	1.076 3	0.655 2	0.270 3	0.001 2	0.003 4
1B1b	1.373 9	0.970 8	0.500 4	0.003 3	0.005 1
2A1	1.377 0	1.736 1	0.300 0	0.003 6	0.009 1
2A2	0.165 8	0.127 0	0.500 0	0.000 4	0.000 7
2A3	0.253 9	0.750 6	0.500 0	0.002 6	0.003 9
2A5a	0.147 7	0.179 6	0.469 0	0.000 6	0.000 9
2A5b	0.084 1	0.125 3	0.500 0	0.000 4	0.000 7
2B10a	0.986 3	1.482 5	0.495 7	0.005 0	0.007 8
2B10b	0.019 4	0.025 1	1.385 9	0.000 2	0.000 1
2C1	3.790 9	0.893 3	0.114 1	0.000 7	0.004 7
2C3	0.018 4	NO	0.500 0		
2C5	0.000 6	0.003 3	0.500 0	0.000 0	0.000 0
2G	1.905 4	1.373 6	0.500 0	0.004 7	0.007 2
2H1	0.313 6	0.526 4	0.500 0	0.001 8	0.002 8
2L	0.952 8	0.475 3	0.628 7	0.002 1	0.002 5
3B1a	2.016 8	0.956 2	1.000 0	0.006 6	0.005 0
3B1b	0.726 8	0.511 0	1.000 0	0.003 5	0.002 7
3B2	0.083 2	0.004 8	1.000 0	0.000 0	0.000 0
3B3	0.124 1	0.068 6	0.884 4	0.000 4	0.000 4
3B4d	0.003 6	0.000 9	1.000 0	0.000 0	0.000 0
3B4e	0.131 7	0.026 0	1.000 0	0.000 2	0.000 1
3B4gi	0.167 1	0.141 2	1.000 0	0.001 0	0.000 7
3B4gii	0.265 0	0.243 9	1.000 0	0.001 7	0.001 3
3B4giv	0.812 0	0.414 7	1.000 0	0.002 9	0.002 2
3B4h	0.006 0	0.003 1	1.500 0	0.000 0	0.000 0
3Dc	0.860 5	0.955 7	1.500 0	0.009 9	0.005 0
3F	0.232 2	0.048 8	1.503 3	0.000 5	0.000 3
5A	0.436 0	0.140 4	1.500 0	0.001 4	0.000 7
5C1a	NO	0.047 9	0.502 5	0.000 2	0.000 3
5C1bi	1.003 6	0.325 2	0.366 0	0.000 8	0.001 7
5C2	1.110 8	1.361 4	0.502 5	0.004 7	0.007 2
Total:	190.354 3	145.506 9		0.503 9	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Considering BC (black carbon) emissions and their straighforward relations between the $PM_{2.5}$ fraction (estimation of BC using rescaled emission factors), the uncertainty of $PM_{2.5}$ refers also to BC.

Table 3.24: Pb

	1990	2016			
NFR	C	D	G	H	J
1A1a	48.129 4	26.859 0	0.377 9	0.024 3	0.056 4
1A1b	1.215 3	1.185 3	0.600 7	0.001 7	0.002 5
1A1c	9.070 4	0.606 6	0.526 1	0.000 8	0.001 3
1A2a	21.133 9	6.945 4	0.700 0	0.011 6	0.014 6
1A2b	161.798 2	176.147 0	0.700 0	0.294 8	0.369 6
1A2c	15.539 9	8.814 3	0.700 0	0.014 7	0.018 5
1A2d	4.803 6	1.805 3	0.700 0	0.003 0	0.003 8
1A2e	15.986 9	4.324 0	0.700 0	0.007 2	0.009 1
1A2f	18.645 1	3.976 0	0.700 0	0.006 7	0.008 3
1A3bi	0.005 6	0.007 4	0.700 0	0.000 0	0.000 0
1A3bii	0.001 5	0.001 4	0.700 0	0.000 0	0.000 0
1A3biii	0.000 8	0.002 6	0.700 0	0.000 0	0.000 0
1A3biv	0.000 2	0.000 2	1.000 2	0.000 0	0.000 0
1A3bvi	2.647 4	6.415 7	0.700 0	0.010 7	0.013 5
1A3dii	0.000 0	0.000 0	1.001 2	0.000 0	0.000 0
1A4ai	10.779 4	6.585 8	0.627 9	0.009 9	0.013 8
1A4bi	46.287 8	45.276 9	0.634 3	0.068 7	0.095 0
1A4ci	13.174 7	10.022 2	0.606 0	0.014 5	0.021 0
1B1b	2.547 4	2.135 7	0.700 3	0.003 6	0.004 5
2A1	2.782 8	3.156 5	0.700 3	0.005 3	0.006 6
2A3	2.540 0	12.133 1	0.701 8	0.020 4	0.025 5
2C1	99.342 3	84.086 9	0.266 7	0.053 6	0.176 4
2C2	0.016 9	0.018 6	0.700 3	0.000 0	0.000 0
2C5	0.196 0	1.034 6	0.700 3	0.001 7	0.002 2
2G	0.000 0	0.000 0	0.707 1	0.000 0	0.000 0
5C1bv	0.000 0	0.000 0	0.707 1	0.000 0	0.000 0
Total:	476.645 7	418.318 1		0.553 2	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.25: Cd

	1990	2016			
NFR	C	D	G	H	J
1A1a	4.002 7	0.745 7	0.252 7	0.014 4	0.038 7
1A1b	0.281 9	0.853 7	0.661 1	0.043 1	0.044 3
1A1c	0.145 5	0.123 5	0.429 1	0.004 0	0.006 4
1A2a	3.161 7	1.135 6	0.700 0	0.060 6	0.059 0
1A2b	1.396 9	2.093 0	0.700 0	0.111 8	0.108 7
1A2c	0.344 2	1.441 1	0.700 0	0.077 0	0.074 8
1A2d	0.064 5	0.295 2	0.700 0	0.015 8	0.015 3
1A2e	1.272 2	0.707 0	0.700 0	0.037 8	0.036 7
1A2f	3.082 1	0.660 6	0.700 0	0.035 3	0.034 3
1A3bi	0.000 5	0.000 9	0.700 0	0.000 0	0.000 0
1A3bii	0.000 1	0.000 2	0.700 0	0.000 0	0.000 0
1A3biii	0.000 1	0.000 3	0.700 0	0.000 0	0.000 0
1A3biv	0.000 0	0.000 0	1.000 2	0.000 0	0.000 0
1A3bvi	0.010 3	0.029 8	0.700 0	0.001 6	0.001 5
1A3c	0.020 7	0.004 1	0.502 5	0.000 2	0.000 2
1A3dii	0.001 6	0.000 3	0.470 8	0.000 0	0.000 0
1A4ai	0.261 4	0.141 9	0.477 3	0.005 2	0.007 4
1A4bi	0.630 9	0.938 1	0.458 8	0.032 8	0.048 7
1A4ci	0.166 9	0.166 1	0.544 4	0.006 9	0.008 6
1A4cii	0.058 9	0.083 9	0.455 0	0.002 9	0.004 4
1A4ciii	0.011 0	0.005 8	0.368 3	0.000 2	0.000 3
1B1b	0.686 9	0.003 3	0.700 3	0.000 2	0.000 2
2A3	0.051 8	0.182 0	0.701 8	0.009 7	0.009 4
2B10a	0.739 0	0.241 9	0.700 3	0.012 9	0.012 6
2C1	2.762 9	1.817 6	0.389 9	0.054 1	0.094 4
2G	0.000 0	0.000 0	0.707 1	0.000 0	0.000 0
5C1bv	0.000 0	0.000 0	0.707 1	0.000 0	0.000 0
Total:	19.259 7	13.109 4		0.526 3	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.26: Hg

	1990	2015			
NFR	C	D	G	H	J
1A1a	10.188 1	5.297 0	0.581 2	0.297 4	0.382 7
1A1b	0.001 2	0.011 0	0.459 4	0.000 5	0.000 8
1A1c	0.037 3	0.034 1	0.449 9	0.001 5	0.002 5
1A2a	0.219 0	0.107 5	0.700 0	0.007 3	0.007 8
1A2b	1.299 6	2.080 5	0.700 0	0.140 7	0.150 3
1A2c	0.023 8	0.136 4	0.700 0	0.009 2	0.009 9
1A2d	0.004 5	0.027 9	0.700 0	0.001 9	0.002 0
1A2e	0.088 1	0.066 9	0.700 0	0.004 5	0.004 8
1A2f	0.213 5	0.483 8	0.700 0	0.032 7	0.035 0
1A3bi	0.021 6	0.050 7	0.700 0	0.003 4	0.003 7
1A3bii	0.007 8	0.012 5	0.700 0	0.000 8	0.000 9
1A3biii	0.010 5	0.027 2	0.700 0	0.001 8	0.002 0
1A3biv	0.001 3	0.000 9	1.000 2	0.000 1	0.000 1
1A3dii	0.000 6	0.000 1	1.001 2	0.000 0	0.000 0
1A4ai	0.192 5	0.130 2	0.576 0	0.007 2	0.009 4
1A4bi	0.622 1	0.638 2	0.575 4	0.035 5	0.046 1
1A4ci	0.115 7	0.173 0	0.623 1	0.010 4	0.012 5
2A3	0.017 3	0.060 7	0.701 8	0.004 1	0.004 4
2B10a	0.158 0	0.003 9	0.100 0	0.000 0	0.000 3
2C1	0.369 7	0.475 2	0.591 8	0.027 2	0.034 3
2G	0.000 0	0.000 0	0.707 1	0.000 0	0.000 0
5C1bv	0.000 0	0.000 0	0.707 1	0.000 0	0.000 0
Total:	13.842 5	10.351 8		0.586 3	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.27: PCDD/F

	1990	2016			
NFR	C	D	G	H	J
1A1a	11.313 4	11.306 8	0.520 9	0.020 9	0.034 5
1A1b	0.287 1	0.539 6	0.996 7	0.001 9	0.001 6
1A1c	0.046 6	0.036 9	0.759 1	0.000 1	0.000 1
1A2a	17.782 3	10.496 2	1.000 0	0.037 2	0.032 0
1A2b	1.327 3	23.408 8	1.000 0	0.082 9	0.071 4
1A2c	0.076 4	1.584 0	1.000 0	0.005 6	0.004 8
1A2d	0.014 3	0.324 4	1.000 0	0.001 1	0.001 0
1A2e	0.282 5	0.777 0	1.000 0	0.002 8	0.002 4
1A2f	1.819 9	1.694 9	0.868 9	0.005 2	0.005 2
1A3bi	1.403 5	4.806 7	1.000 0	0.017 0	0.014 7
1A3bii	0.612 3	1.082 2	1.000 0	0.003 8	0.003 3
1A3biii	0.516 8	1.086 7	1.000 0	0.003 8	0.003 3
1A3biv	0.132 8	0.061 5	1.000 0	0.000 2	0.000 2
1A3c	0.017 8	0.003 5	1.000 0	0.000 0	0.000 0
1A3dii	0.001 1	0.000 3	0.767 6	0.000 0	0.000 0
1A4ai	35.157 7	2.036 1	0.606 1	0.004 4	0.006 2
1A4bi	133.723 5	143.962 7	0.764 3	0.389 7	0.438 9
1A4ci	0.194 7	1.540 3	0.930 8	0.005 1	0.004 7
1A4cii	0.005 1	0.072 2	0.905 5	0.000 2	0.000 2
1A4ciii	0.003 4	0.001 8	1.000 0	0.000 0	0.000 0
1B1b	4.121 6	2.912 3	1.000 0	0.010 3	0.008 9
2A2	32.000 0	18.690 0	1.000 0	0.066 2	0.057 0
2A3	0.211 6	0.617 0	0.723 0	0.001 6	0.001 9
2C1	15.500 9	12.201 1	0.987 4	0.042 7	0.037 2
2G	0.007 1	0.005 1	1.000 0	0.000 0	0.000 0
2H2	0.450 3	0.725 6	0.849 8	0.002 2	0.002 2
3F	21.495 5	4.521 5	1.000 0	0.016 0	0.013 8
5C1bi	0.050 6	0.008 7	0.986 6	0.000 0	0.000 0
5C1biii	0.000 8	0.000 2	0.314 7	0.000 0	0.000 0
5C1biv	0.023 8	0.105 9	0.764 7	0.000 3	0.000 3
5C1bv	0.002 0	0.310 4	1.000 0	0.001 1	0.000 9
5C2	1.696 6	2.079 5	0.939 6	0.006 9	0.006 3
5E	47.639 0	35.076 2	1.000 0	0.124 2	0.106 9
Total:	328.010 4	282.315 7		0.853 6	

C, kt; D, kt; G, Combined uncertainty; H = (G · D)/ $\sum$ D; J = D/ $\sum$ C.

Table 3.28: HCB

	1990	2016			
NFR	C	D	G	H	J
1A1a	1.070 3	0.866 0	0.637 4	0.112 2	0.136 6
1A1b	0.000 0	0.000 5	1.000 2	0.000 1	0.000 1
1A1c	0.002 2	0.001 7	0.711 5	0.000 2	0.000 3
1A2a	1.694 4	1.039 3	1.000 0	0.211 2	0.163 9
1A2b	0.003 1	0.010 5	1.000 0	0.002 1	0.001 7
1A2c	0.004 9	0.101 8	1.000 0	0.020 7	0.016 1
1A2d	0.000 9	0.020 8	1.000 0	0.004 2	0.003 3
1A2e	0.018 2	0.049 9	1.000 0	0.010 1	0.007 9
1A2f	0.260 7	0.299 5	1.000 0	0.060 9	0.047 2
1A3bi	0.001 2	0.004 7	1.000 0	0.001 0	0.000 7
1A3bii	0.000 2	0.001 0	1.000 0	0.000 2	0.000 2
1A3biii	0.000 1	0.000 8	1.000 0	0.000 2	0.000 1
1A3biv	0.000 1	0.000 1	1.000 0	0.000 0	0.000 0
1A4ai	0.049 6	0.044 5	0.758 5	0.006 9	0.007 0
1A4bi	1.654 0	1.739 5	0.786 8	0.278 2	0.274 4
1A4ci	0.021 2	0.105 3	0.835 8	0.017 9	0.016 6
2C1	0.025 3	0.015 9	0.714 1	0.002 3	0.002 5
5C1bi	1.207 3	0.472 7	0.983 4	0.094 5	0.074 6
5C1biii	0.325 8	0.073 9	0.834 1	0.012 5	0.011 7
Total:	6.339 6	4.920 2		0.835 4	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

Table 3.29: PAHs

	1990	2016			
NFR	C	D	G	H	J
1A1a	0.982 9	0.282 7	0.618 8	0.001 2	0.001 9
1A1b	0.004 1	0.010 3	0.808 0	0.000 1	0.000 1
1A1c	0.011 9	0.008 8	0.680 9	0.000 0	0.000 1
1A2a	0.237 7	0.153 5	1.000 0	0.001 0	0.001 0
1A2b	0.014 5	0.018 9	1.000 0	0.000 1	0.000 1
1A2c	0.025 9	0.194 8	1.000 0	0.001 3	0.001 3
1A2d	0.004 8	0.039 9	1.000 0	0.000 3	0.000 3
1A2e	0.095 7	0.095 6	1.000 0	0.000 7	0.000 7
1A2f	0.231 8	0.087 9	1.000 0	0.000 6	0.000 6
1A3bi	0.126 2	0.580 1	1.000 0	0.004 0	0.004 0
1A3bii	0.063 2	0.168 2	1.000 0	0.001 1	0.001 1
1A3biii	0.113 5	0.311 7	1.000 0	0.002 1	0.002 1
1A3biv	0.011 3	0.005 6	1.000 0	0.000 0	0.000 0
1A3c	0.123 4	0.024 2	1.000 0	0.000 2	0.000 2
1A3dii	0.007 6	0.002 0	0.767 6	0.000 0	0.000 0
1A4ai	0.169 2	0.094 7	0.749 2	0.000 5	0.000 6
1A4bi	118.322 2	128.538 3	0.701 0	0.615 7	0.875 8
1A4ci	0.113 0	0.159 2	0.703 6	0.000 8	0.001 1
1A4cii	0.351 1	0.500 3	0.905 5	0.003 1	0.003 4
1A4ciii	0.023 9	0.012 5	1.000 0	0.000 1	0.000 1
1B1b	21.295 0	15.046 7	1.000 0	0.102 8	0.102 5
2D3i	0.008 5	0.008 5	1.000 0	0.000 1	0.000 1
Total:	146.767 8	146.344 4		0.735 8	

C, kt; D, kt; G, Combined uncertainty; $H = (G \cdot D)/\sum D$; $J = D/\sum C$.

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Appendix 7. 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 ($\mu g\ g^{-1}h^{-1}$ 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:

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

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 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 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 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 4. Standard emission potentials (μg $g^{-1}h^{-1}$ 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 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 $\mu g\ g^{-1}\ h_{-1}$ is associated with a 10-fold range (0.5–5 $\mu g\ g^{-1}\ h^{-1}$) 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.

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. Relevant activities has been undertaken.

[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.

Appendix 8. 2017 Technical Review of National Emission Inventories

Following recommendations resulting from 2017 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.

Summary of changes recommended during this review is presented below in the format of Table 2 from the report "*2017 Comprehensive Technical Review of National Emission Inventories pursuant to the Directive on the Reduction of National Emissions of Certain Atmospheric Pollutants (Directive (EU) 2016/2284). Poland*". These changes are described in more detail in chapters 3-6, concerning sectoral methodologies. The column *IIR chapter* lists reference to the relevant chapter of the IIR report.

It should be noted that all estimates mentioned in the table have been implemented in the emission inventory submitted in 2018.

Table 2: National totals as reported and national totals including revised estimates (RE) and technical corrections (TC)

Description	**Reference**	**Pollutant estimates (kt) ***			**IIR chapter**
		2005	**2010**	**2015**	
NO_x					
National total	Annex I, row 141	848.393	851.584	713.804	
Difference between original estimate and revised estimate					
1A2 Stationary combustion in manufacturing industries and construction	PL-1A2-2017-0001	14.762	8.846	3.294	3.4
National total (row 141) including revised estimates and technical corrections	*Calculated using data above*	863.156	860.430	717.098	
SO_x					
National total for compliance	Annex I, row 144	1,163.597	866.009	690.260	
Difference between original estimate and revised estimate provided by Poland and accepted by the TERT					
2H1 Pulp and paper industry	PL-2H1-2017-0001	1.605	1.762	1.747	4.5
2B6 Titanium dioxide production	PL-2B6-2017-0001	0.164	0.158	0.129	4.2
2C Metal Industry	PL-2C-2017-0001	2.372	2.378	2.560	4.3
2C3 Aluminium production	PL-2C3-2017-0001	0.268	-	-	4.3
National total (row 141) including revised estimates and technical corrections	*Calculated using data above*	1,168.005	870.307	694.695	
NMVOC					
National total for compliance	Annex I, row 144	543.275	570.912	530.619	
Difference between original estimate and revised estimate provided by Poland and accepted by the TERT					
2D3h Printing	PL-2D3h-2017-0001	18.216	24.770	24.355	4.4
2H2 Food and beverages industry	PL-2H2-2017-0001	30.066	28.794	31.720	4.5
1A2 Stationary combustion in manufacturing industries and construction	PL-1A2-2017-0001	25.568	23.762	27.639	3.4
2C1 Iron and steel production	PL-2C1-2017-0001	0.851	0.806	1.025	4.3
2D3a Domestic solvent use including fungicides	PL-2D3a-2017-0001	-	0.396	-0.050	4.4

Description	Reference	Pollutant estimates (kt) *			IIR chapter
		2005	2010	2015	
2D3b Road paving with asphalt	PL-2D3b-2017-0001	0.021	0.030	0.026	4.4
2D3f Dry cleaning	PL-2D3f-2017-0001	-	0.049	-0.006	4.4
2D3g Chemical products	PL-2D3g-2017-0001	0.040	0.054	0.050	
National total (row 141) including revised estimates and technical corrections	*Calculated using data above*	618.037	649.571	615.377	
NH_3					
National total for compliance	Annex I, row 144	299.066	284.042	267.101	
Difference between original estimate and revised estimate provided by Poland and accepted by the TERT					
1A2d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	PL-1A2d-2017-0001	2.080	2.460	2.965	3.4.4
National total (row 141) including revised estimates and technical corrections	*Calculated using data above*	301.146	286.502	270.066	
$PM_{2.5}$					
National total for compliance	Annex I, row 144	159.093	148.712	124.563	
Difference between original estimate and revised estimate provided by Poland and accepted by the TERT					
1A2 Stationary combustion in manufacturing industries and construction	PL-1A2-2017-0001	16.970	15.507	17.946	3.4
2C Metal Industry	PL-2C-2017-0001	0.125	0.121	0.126	4.3
2C1 Iron and steel production	PL-2C1-2017-0001	-0.958	-0.924	-1.074	4.3
2C3 Aluminium production	PL-2C3-2017-0001	-0.054	-	-	4.3
Difference between original estimate and technical correction deemed necessary by the TERT					
5C1bi Industrial waste incineration	PL-5C1bi-2017-0001	-10.404	-3.992	-4.427	6
National total (row 141) including revised estimates and technical corrections	*Calculated using data above*	164.772	159.425	137.134	

* as reported in 2017 submission