ROMANIA'S INFORMATIVE INVENTORY REPORT 2020

Submission under

UNECE Convention on Long Range Transboundary Air Pollution

Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC

Data sheet:

Romania's Informative Inventory Report 1990-2018

Date: March 13th 2020

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EXECUTIVE SUMMARY

The Romania's Informative Inventory Report (IIR) contains information on the Romania's inventories for the years 1990 to 2018, including descriptions of methods, data sources, key categories analysis and trends analysis.

In this Inventory edition, it was estimated for the first time the emissions for the years 1990 to 1994. New NFR categories were estimated and some recalculations for period 1995-2018 have been carried out, due to updated statistics and correlations with the activity data, according with the Emission Inventory review conducted in 2019.

In this Inventory edition, it was estimated for the first time the emissions for the years 1990 to 1994.

New NFR categories were estimated and recalculations for period 1995-2018 on the following criteria:

- the recommendations from TERT in the NECD Review 2019;
- updated statistics;
- updated emission factors in the 2019 EMEP/EEA Guidebook;
- consistency/correlation with all relevant inventories.

Following the Emission Inventory Review in 2017-2019, large part of recommendations from TERT were assessed and implemented.

The energy sector represents the main source of emissions in Romania for most of pollutants. Thus, SOx, NOx, CO, $PM_{2.5}$, BC, CO, the heavy metals Cd, Hg, Cu, Se and Zn and the HCB account for more than 75% in the national total; NMVOC, As, PCDD/F contribute between 50 to 80% to the national total. This includes fuel combustion in energy industry and in manufacturing industry, transport, small combustion, including off-road mobile machinery and fugitive emissions from fuels.

The estimation was largely based on fuel consumption provided by the EUROSTAT databases and emission factors from the EMEP/ EEA Air Pollutant Emission Inventory Guidebook – 2019, except for public power sector, NFR 1.A.1.a, where estimation included also measured values of TSP, SOx and NOx for LCP installations and for agricuture sector NFR 3B where used EMEP/ EEA Air Pollutant Emission Inventory Guidebook – 2016.

The public power sector was in 2018 a key source for SOx, NOx, PB, Cd, Hg, As, Cr, Ni, Se and HCB. Compared to 1990 emissions, there was a significant decrease of emissions to atmosphere in the public power sector. For main pollutants, decreases are as high as 76% for NOx, 94% for SOx and 91% for PM_{10}. Compared to 2005, the emissions decreased with 64% for NOx, 92% for Sox and 87% for PM_{10}. The decrease is due to implementation of emissions reduction program in LCP installations as well as a general decrease in fuel consumption. Variations of emission values are also determined by the different mixing ratios of

solid/liquid/gaseous fuels along the time series, contributing with different emission factors to the estimate of each pollutant.
The small combustion, including off-road machineries, is the main contributor to the national emissions for particulate matter, BC, part of heavy metals and PCDD/F and PAH, accounting in 2018 for 82% of national total for $PM_{2.5}$, 71% for BC, 70% for CO, 63% for Zn, 64% for PCDD/F and 76% for PAH. The highest emissions comes from residential burning, where biomass (wood) is the main fuel and increased with 500% compared to 1990 and with 11% compared to 2005. This is mostly due to the shift from central to individual heating in small and medium cities and is consistent with the decrease of power plants activity and emissions in the period 1990-2012.

Road transport was for 2018 the key category for NOx (39.89% of National Total), NMVOC (9.17% of National Total), BC (16.25% of National Total) CO (15.42% of National Total), Cu (84.88% of National Total) and Zn (6.98% of National Total). NFR 1.A.3.b.vi and NFR 1.A.3.b.vii first estimate of $PM_{2.5}$, PM_{10} and TSP emissions on Tier 1 for the time series 1990-2004. For the years 2005-2018, emissions were estimated with COPERT 5.

The industrial sector only covers process related emissions arising from industrial processes. Industrial processes and product use sector mainly contributes to the PCBs emissions of the Inventory (70.80% of National Total), Pb emissions (64.93% of National Total), Cr emissions (44.38% Nationl Total), NMVOC emissions (27.71% of National Total), TSP emissions (32.85% of National Total), As (25.12% of National Total) for the year 2018. The emissions for the NFR 2.A.5.b Construction and demolition for the whole 1990-2018 time series have been calculated for the first time. In 2018, 2.D.3.g includes first estimation the emissions for SNAP 060306 (pharmaceutical products manufacturing) and SNAP 060313 (leather tanning) and NFR 2.D.3.i. was improved with first estimation of SNAP 060404 (fat, edible and non-edible oil extraction), SNAP 060405 (application of glues and adhesives) and SNAP 060406 (preservation of wood).

The agricultural sector comprises emissions arising from the agricultural and zootechnical activities, including housing, manure storage and grazing, manure treatment and manure application. The main part of the NH3 emission (89.04%) is related to the agricultural sector. For the year 2018, the distribution of NH3 emissions by agriculture sources was as follows: 41.56% from manure management, 58.43% from manure applied to soils and only 0.0045% from burning fields. For the year 2018, the contribution of NMVOC share from agriculture accounts for 13.66% of the national total. The distribution of NMVOC emissions by agricultural sources was as follows: 73.34% from manure management, 26.62% from manure applied to soils and only 0.0342% from burning fields. Implementation of the national coefficients from *“Romanian Projections for Pollutants Emissions to 2030”* Study, released in 2018 and involved in the calculations of the emission factors for NH3, has led to a change in the amount of NH3, implicitly for NMVOCs and NOx, for the whole time series compared to previous submission. For NFR 3.D.a.1, Inorganic N-fertilizers, were estimated the NH3 emissions with Tier 2 approach for the first time.

The waste sector covers emissions from the solid wastes disposal on land, clinical and industrial wastes incineration, cremation, small scale waste burning and compost manufacturing, wastewater handling and other waste (car fires and house fires). The new source NFR 5.C.1.b.v Cremation, covers the emissions from the activities of crematorium, and for the whole 1990-2018 time series, emissions have been calculated for the first time.

Inclusion/exclusion of the condensable component from PM_{10} and $PM_{2.5}$

NFR	Source/sector name	PM emissions: the condensable component is included	excluded	EF reference and comments
1A1a	Public electricity and heat production	x		2019 EMEP/EEA Guidebook, all table: „The TSP, PM_{10} and $PM_{2.5}$ emission factors represent filterable PM emissions”.
1A4aii	Mobile (off-road) Combustion in Commercial/ Institutional	x		2019 EMEP/EEA Guidebook, Table 3.1 - „ PM factors represent total PM emissions (filterable and condensable fractions)”
1A4bii	Residential: Household and gardening (mobile)	x		2019 EMEP/EEA Guidebook, Table 3.1 - „ PM factors represent total PM emissions (filterable and condensable fractions)”
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	x		2019 EMEP/EEA Guidebook, Table 3.1 - „PM factors represent total PM emissions (filterable and condensable fractions)”
1A2gvii	Stationary combustion in manufacturing industries and construction: Other	x		2019 EMEP/EEA Guidebook, Table 3.1 - „ PM factors represent total PM emissions (filterable and condensable fractions)”
1A2	Stationary combustion in manufacturing industries and construction (all 1A2 industry)			Table 3.2, solid fuels, 2019 EMEP/EEA Guidebook - „ The basis of the TSP, PM_{10} and $PM_{2.5}$ emission factors could not be determined in the reference”.
1A2	Stationary combustion in manufacturing industries and construction (all 1A2 industry)			Table 3.3, gaseous fuels, 2019EMEP/EEA Guidebook - “The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions”;
1A2	Stationary combustion in manufacturing industries and construction (all 1A2 industry)			Table 3.4 liquid fuel, 2019 EMEP/EEA Guidebook - “The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions”;
1A2	Stationary combustion in manufacturing industries and construction (all 1A2 industry)	x		Table 3.5, biomass, 2019 EMEP/EEA Guidebook - „The TSP, PM_{10} and $PM_{2.5}$ emission factors represent filterable PM”.
1A4ai	Commercial/Institutional			Tables 3.7 to 3.19, 2019 EMEP/EEA Guidebook - „The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions”. Table 3.10 - Tier 1

				emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass: “Emission factors have been recalculated to represent total particles (including condensable component) by assuming condensables represent 12% of the total PM mass for $PM_{2.5}$ (average of automatic and medium sized boilers from Denier van der Gon et al., 2015).”
1A4ci	Agriculture/Forestry/Fishing, Stationary			Tables 3.7 to 3.19, 2019 EMEP/EEA Guidebook - „The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions”. Table 3.10 - Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass: “Emission factors have been recalculated to represent total particles (including condensable component) by assuming condensables represent 12% of the total PM mass for $PM_{2.5}$ (average of automatic and medium sized boilers from Denier van der Gon et al., 2015).”
1A5a	Other stationary			Tables 3.7 to 3.19, 2019 EMEP/EEA Guidebook - „The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions”. Table 3.10 - Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass: “Emission factors have been recalculated to represent total particles (including condensable component) by assuming condensables represent 12% of the total PM mass for $PM_{2.5}$ (average of automatic and medium sized boilers from Denier van der Gon et al., 2015).”
1A4bi	Residential			Tables 3.3 to 3.5, coal, gaseous fuels and other liquid fuels, 2019 EMEP/EEA Guidebook - „The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions”.
1A4bi	Residential	x		Tables Tier 2, 3.40, 3.43 and 3.44, wood combustion, 2019 EMEP/EEA Guidebook - “total particles” for TSP, PM_{10}, $PM_{2.5}$ and BC.
1.A.3.b	Road transport	x		2019 EMEP/EEA Guidebook, Table 3.1, “The mass of particles collected on a filter kept below 52 °C during diluted exhaust sampling. This corresponds to total (filterable and condensable) $PM_{2.5}$. Coarse exhaust PM (i.e. > 2.5 µm diameter) is considered to be negligible, hence PM=$PM_{2.5}$”
2C.1	Iron and steel production		x	2019 EMEP/EEA Guidebook, - „These PM factors represent filterable PM emissions only (excluding any condensable fraction)”. These data are confidential.
2.C.2	Ferroalloys production		x	2019 EMEP/EEA Guidebook, - „These PM factors represent filterable PM emissions only (excluding

				any condensable fraction)". These data are confidential.
2.C.3	Aluminum production		x	2019 EMEP/EEA Guidebook, - „These PM factors represent filterable PM emissions only (excluding any condensable fraction)". These data are confidential.
2.C.5	Lead production		x	2019 EMEP/EEA Guidebook, - „These PM factors represent filterable PM emissions only (excluding any condensable fraction)". These data are confidential.
2.C.6	Zinc production		x	2019 EMEP/EEA Guidebook, - „These PM factors represent filterable PM emissions only (excluding any condensable fraction)". These data are confidential.
2.D.3.b	Road Paving with Asphalt		x	2019 EMEP/EEA Guidebook - „The TSP, PM_{10} and $PM_{2.5}$ emission factor represents filterable PM emissions. Note that US EPA (2004) includes condensable PM emission factors and factors for controlled plant". These data are confidential.
3D	Crop production and agricultural soils			2019 EMEP/EEA Guidebook – „The processes which result in particulate emissions are largely low-temperature mechanical activities, and emissions are unlikely to include substantial quantities of condensable particulate material"

Significant recalculations and improvements were developed on the following categories:

- 1A4aii Non-road mobile combustion in Commercial/Institutional: separate the emissions time-series from NFR 1A4bii (implementing the Reviews recommendations RO-1A4aii-2017-0001 and RO-1A4aii-2018-0001);
- 1A4ci Agriculture/Forestry/Fishing, Stationary: Recalculation of the time series with improved activity data;
- 1A4cii Agriculture/Forestry/Fishing: Non-road vehicles and other machinery: recalculation of the time series on Tier2 level;
- NFR 1.A.3.b.vi and NFR 1.A.3.b.vii first estimate of $PM_{2.5}$, PM_{10} and TSP emissions on Tier 1 for the time series 1990-2004;
- NFR 2.A.5.b Construction and demolition – new source;
- NFR 2C3 - emissions from secondary aluminium production were estimated for the 2010-2018 time series;
- NFR 3.B Manure Management – by recalculating to Tier 1 and 2 level for NH_3, NMVOC and NOx;
- NFR 3.D.a.1 Inorganic N-fertilizers - by updating to Tier 2 level assessment for NH_3;
- NFR 3.D.a.2.a Animal manure applied to soils - by recalculating to Tier 1 and 2 level for NH3, as part of Manure Management;
- NFR 3.D.a.3 Urine and dung deposited by grazing animals - by recalculating to Tier 1 and 2 level for NH3, as part of Manure Management.
- NFR 5.C1bv Cremation – new source.

1.1. National Inventory Background

Romania`s Reporting Obligations under the UNECE / CLRTAP Convention and National Framework for Inventory Preparation and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.

Romania is a Party of the Convention on Long Range Transboundary Air Pollution (CLRTAP), ratified by Law 8/1991. The CLRTAP protocols, namely Gothenburg Protocol, POPs Protocol and Heavy Metals Protocol, have been ratified by the Law 271/2003. Romania acceded to the EMEP Protocol by the Law 652/2002. Law 1/2012 and Law 263/2017 accept the adopted POPs, Gothenburg and Heavy Metals Protocols amendments.

The Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC has been transposed into national legislation, by Law no. 293/2018.

The same institutional arrangements are also being used for reporting under the Revised NEC Directive – Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.

1.2. Institutional arrangements

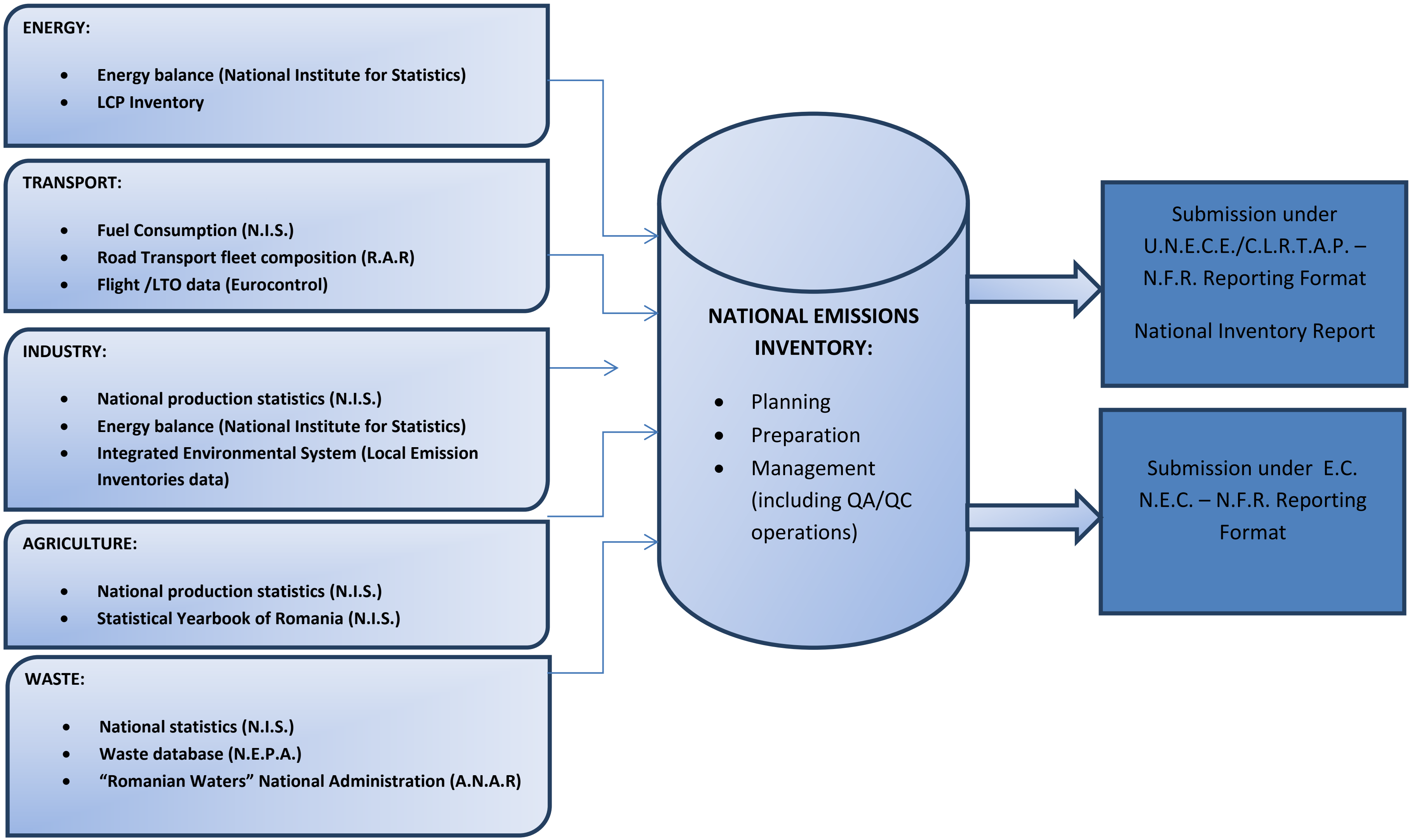
Romania prepares, maintains and reports on a yearly basis the National Emissions Inventory and the whole inventory time series, if required. Emission time series are resubmitted if any recalculation occurred due to the methodology/emission factors changes, new sources identification, updated activity data etc.

The methodology for estimating and reporting emissions is consistent with the "EMEP/ EEA air pollutant emission inventory guidebook – 2019 and 2016(NFR 3B) " and the Ministerial Order no 3.299/2012 for the approval of the methodology for compiling and reporting of air emissions inventories.

The inventory system currently used in Romania is presented in Figure 1.1.1. The National Environmental Protection Agency of Romania (N.E.P.A) is responsible for the national emissions inventory compilation.

In order to collect and compile the inventory data, institutional arrangements are made between N.E.P.A. and other administrative structures such as: National Institute for Statistics (N.I.S.), Romanian Auto Registry (R.A.R.), "Romanian Waters" National Administration (A.N.A.R)

Figure 1.1.1 – National Emissions Inventory Data Sources and Structure



1.3. Inventory preparation process

Inventory compilation starts with the inventory planning process. This includes allocation of human resources, prioritization of actions and improvements. For sectorial/activity improvements, the Key Category Analysis provides a starting point in order to identify the emission sources that are to be given increased importance (emissions estimation based on superior Tier, detailed data collection – activity related data from economic operators/industry etc.).

The next step is inventory preparation. Input data are being collected; emission factors are being selected and all the work is documented. Afterwards, all this data is inserted in a Collect-ER database and emissions are estimated. Output data from Collect-ER is then exported to an excel file and fed to the online Integrated Environmental System application F3 – "National Emissions Inventory", that translates it to Annex I of the CLRTAP reporting format.

The pollutants covered by this methodology guide are: SOx, NOx, NH_3, NMVOC, CO, BC, TSP, PM_{10}, $PM_{2.5}$, Heavy Metals, (Cd, Pb, Hg, As, Cr, Cu, Ni, Se, Zn), POPs (HCB, PCB, dioxins / furans and PAHs).

This step also includes expert allocation for different sectors and for activities required by the QA/QC procedures and data management.

1.4. Methods and data sources

The methodology used for calculation of emissions includes product of activity data (e.g. the production statistics, fuel consumption, waste treated, number of animals, etc.) and corresponding emission factor. Emission factors applied to main pollutants emissions estimates have been updated to 2019 EMEP/EEA Guidebook with except NFR 3B where used EMEP/ EEA Air Pollutant Emission Inventory Guidebook – 2016.

The input data were processed using the Collect-ER software. The Collect-ER software was conducted in accordance with the recommendations TFEIP/EIONET and ETC/ACC European Environment Agency (EEA).

The resulting emissions from road transport sector were directly exported to the reporting formats requested by the UNECE/CRLTAP Secretariat by using COPERT's 5 "export to NFR" option.

A detailed description of the methodology is shown in sector-specific chapters of IIR in chapters from 3 to 6.

Energy	**Energy balance**	**NIS**
	Energy statistics	EUROSTAT
	LCP Inventory	NEPA
	Road Transport fleet composition	RAR
	Flight /LTO data	EUROCONTROL
Industrial processes	National production statistics	NIS
	Integrated Environmental System	NEPA
Agriculture	National production statistics	NIS
	Statistical Yearbook of Romania	NIS
Waste	National statistics	NIS
	Waste database	NEPA
	Romanian Waters	ANAR
	Building and car fires	CTIF , IGSU-MIA

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1.5. Key Category Analysis

This chapter presents results of Romania's pollutant-specific key categories analysis.

The methodology follows the Good Practice Guidance approach to produce pollutant-specific key categories and covers both level and trend assessments. In Approach 1, key categories are identified using a predetermined cumulative emission threshold. Key categories are those which, when summed together in descending order of magnitude, cumulatively add up to 80% of the total level.

As the analysis was made for all different pollutants reported to the UNECE/CLRTAP/EU Commission and as these pollutants differ in their way of formation, most of the identified categories are key categories for one pollutant or more.

The following tables present the key category analysis for:

Table 1.3.1 Key Categories for NOx (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A3biii	Road transport: Heavy duty vehicles and buses	48.361	21.46%	21.46%	1
1A1a	Public electricity and heat production	35.667	15.83%	37.28%	2
1A3bi	Road transport: Passenger cars	29.249	12.98%	50.26%	3
3Da1	Inorganic N-fertilizers (includes also urea application)	18.746	8.32%	58.58%	4
1A4bi	Residential: Stationary	13.419	5.95%	64.53%	5
1A3bii	Road transport: Light duty vehicles	12.205	5.42%	69.95%	6
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	9.868	4.38%	74.33%	7
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	9.270	4.11%	78.44%	8
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	5.660	2.51%	80.95%	9

Table 1.3.2 Key Categories for NMVOC (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	73.1941	30.84%	30.84%	1
2D3a	Domestic solvent use including fungicides	24.8065	10.45%	41.29%	2
1A4aii	Commercial/institutional: Mobile	11.6750	4.92%	46.20%	3
2D3g	Chemical products	11.1927	4.72%	50.92%	4
1A3bi	Road transport: Passenger cars	9.1073	3.84%	54.76%	5
3De	Cultivated crops	8.6342	3.64%	58.39%	6
2H2	Food and beverages industry	6.9890	2.94%	61.34%	7
1A3bv	Road transport: Gasoline evaporation	6.8473	2.88%	64.22%	8
3B1a	Manure management - Dairy cattle	6.4466	2.72%	66.94%	9
1B1a	Fugitive emission from solid fuels: Coal mining and handling	6.3154	2.66%	69.60%	10
2D3f	Dry cleaning	5.8215	2.45%	72.05%	11
2B10a	Chemical industry: Other (please specify in the IIR)	4.7488	2.00%	74.05%	12
2D3d	Coating applications	4.6274	1.95%	76.00%	13
2D3i	Other solvent use (please specify in the IIR)	4.5078	1.90%	77.90%	14
3B4gii	Manure mangement - Broilers	3.8728	1.63%	79.53%	15
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	3.1300	1.32%	80.85%	16

Table 1.3.3 Key Categories for SOx (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	39.3135	47.67%	47.67%	1
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	18.1175	21.97%	69.64%	2
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	8.3576	10.13%	79.77%	3
1B2aiv	Fugitive emissions oil: Refining / storage	7.2299	8.77%	88.54%	4

Table 1.3.4 Key Categories for NH_3 (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
3Da2a	Animal manure applied to soils	42.5943	24.25%	24.25%	1
3Da1	Inorganic N-fertilizers (includes also urea application)	32.9320	18.75%	43.01%	2
3B1a	Manure management - Dairy cattle	18.4295	10.49%	53.50%	3
3B3	Manure management - Swine	17.7659	10.12%	63.62%	4
3Da3	Urine and dung deposited by grazing animals	15.7825	8.99%	72.60%	5
3B4gi	Manure mangement - Laying hens	11.2639	6.41%	79.02%	6
1A4bi	Residential: Stationary	8.7531	4.98%	84.00%	7

Table 1.3.5 Key Categories for $PM_{2.5}$ (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	90.3069	81.55%	81.55%	1

Table 1.3.6 Key Categories for PM_{10} (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	92.7087	63.31%	63.31%	1
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	15.6621	10.70%	74.01%	2
2A2	Lime production	4.0765	2.78%	76.79%	3
2A5a	Quarrying and mining of minerals other than coal	3.4137	2.33%	79.13%	4
2D3b	Road paving with asphalt	3.3449	2.28%	81.41%	5

Table 1.3.7 Key Categories for TSP (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	97.5567	43.79%	43.79%	1
2B10a	Chemical industry: Other (please specify in the IIR)	25.2776	11.35%	55.14%	2
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	15.6621	7.03%	62.17%	3
2D3b	Road paving with asphalt	15.6096	7.01%	69.18%	4
2A2	Lime production	10.4824	4.71%	73.88%	5
3B4gi	Manure mangement - Laying hens	7.2455	3.25%	77.13%	6
2A5a	Quarrying and mining of minerals other than coal	6.9640	3.13%	80.26%	7

Table 1.3.8 Key Categories for BC (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	9.2592	68.63%	68.63%	1
1A3bi	Road transport: Passenger cars	0.9096	6.74%	75.37%	2
1A3biii	Road transport: Heavy duty vehicles and buses	0.7474	5.54%	80.91%	3

Table 1.3.9 Key Categories for CO (2018)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	507.0085	65.08%	65.08%	1
1A3bi	Road transport: Passenger cars	85.3991	10.96%	76.05%	2
1A4aii	Commercial/institutional: Mobile	31.9154	4.10%	80.14%	3

Table 1.3.10 Key Categories for Pb (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
2C1	Iron and steel production	24.5843	61.54%	61.54%	1
1A4bi	Residential: Stationary	3.6022	9.02%	70.55%	2
1A1a	Public electricity and heat production	2.9476	7.38%	77.93%	3
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	2.6947	6.75%	84.68%	4

Table 1.3.11 Key Categories for Cd (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	1.6483	55.60%	55.60%	1
2C1	Iron and steel production	0.4296	14.49%	70.09%	2
1A1a	Public electricity and heat production	0.3532	11.91%	82.00%	3

Table 1.3.12 Key Categories for Hg (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	0.5633	41.66%	41.66%	1
2C1	Iron and steel production	0.2435	18.01%	59.67%	2
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.1747	12.92%	72.59%	3
1A4bi	Residential: Stationary	0.0910	6.73%	79.33%	4
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.0788	5.83%	85.15%	5

Table 1.3.13 Key Categories for As (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	2.7522	66.96%	66.96%	1
2C1	Iron and steel production	0.9569	23.28%	90.24%	2

Table 1.3.14 Key Categories for Cr (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
2C1	Iron and steel production	5.2125	43.55%	43.55%	1
1A4bi	Residential: Stationary	2.9285	24.47%	68.02%	2
1A1a	Public electricity and heat production	1.7618	14.72%	82.75%	3

Table 1.3.15 Key Categories for Cu (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A3bvi	Road transport: Automobile tyre and brake wear	20.0404	84.74%	84.74%	1

Table 1.3.16 Key Categories for Ni (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	3.6777	44.44%	44.44%	1
2C1	Iron and steel production	1.5436	18.65%	63.09%	2
1A5a	Other stationary (including military)	1.1001	13.29%	76.38%	3
1A4ci	Agriculture/Forestry/Fishing: Stationary	0.3739	4.52%	80.90%	4

Table 1.3.17 Key Categories for Se (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	8.328	91.27%	91.27%	1

Table 1.3.18 Key Categories for Zn (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	65.145	60.20%	60.20%	1
2C1	Iron and steel production	13.930	12.87%	73.07%	2
1A3bvi	Road transport: Automobile tyre and brake wear	7.422	6.86%	79.93%	3
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	4.426	4.09%	84.02%	4

Table 1.3.19 Key Categories for PCDD/PCDF (2018)

NFR CODE	CATEGORY	Latest year estimate (g I-TEQ)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	98.6386	64.46%	64.46%	1
2C1	Iron and steel production	33.7801	22.07%	86.53%	2

Table 1.3.20 Key Categories for Total PAHs (2018)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	44.029	75.54%	75.54%	1
2C1	Iron and steel production	6.537	11.21%	86.75%	2

Table 1.3.21 Key Categories for HCB (2018)

NFR CODE	CATEGORY	Latest year estimate (kg)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	1.272	58.47%	58.47%	1
1A4bi	Residential: Stationary	0.634	29.14%	87.61%	2

Table 1.3.22 Key Categories for PCBs (2018)

NFR CODE	CATEGORY	Latest year estimate (kg)	Level assessment (%)	Cumulative total	Rank
2C1	Iron and steel production	13.950	70.80%	70.80%	1
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	3.418	17.35%	88.15%	2

Table 1.3.23 Key Categories by activity/pollutant – Main pollutants (2018)

Category		Main Pollutants (%)								
		NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1A1a	Public electricity and heat production	15.83%		47.67%						
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	2.51%		21.97%						
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4.11%		10.13%						
1A2gvii	Mobile combustion in manufacturing industries and construction (please specify in the IIR)	4.38%								
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		1.32%							
1A3bi	Road transport: Passenger cars	12.98%	3.84%						6.74%	10.96%
1A3bii	Road transport: Light duty vehicles	5.42%								
1A3biii	Road transport: Heavy duty vehicles and buses	21.46%							5.54%	
1A3bv	Road transport: Gasoline evaporation		2.88%							
1A4aii	Commercial/Institutional: Mobile		4.92%							4.10%
1A4bi	Residential: Stationary	5.95%	30.84%		4.98%	81.55%	63.31%	43.79%	68.63%	65.08%
1B1a	Fugitive emission from solid fuels: Coal mining and handling		2.66%							
1B2aiv	Fugitive emissions oil: Refining and storage			8.77%						
2A2	Lime production						2.78%	4.71%		
2A5a	Quarrying and mining of minerals other than coal						2.33%	3.13%		
2B10a	Chemical industry: Other (please specify in the IIR)		2.00%					11.35%		
2D3a	Domestic solvent use including fungicides		10.45%							
2D3b	Road paving with asphalt						2.28%	7.01%		
2D3d	Coating applications		1.95%							
2D3f	Dry cleaning		2.45%							
2D3g	Chemical products		4.72%							
2D3i	Other solvent use (please specify in the IIR)		1.90%							
2H2	Food and beverages industry		2.94%							
3B1a	Manure management - Dairy cattle		2.72%		10.49%					
3B3	Manure management - Swine				10.12%					
3B4gi	Manure management - Laying hens				6.41%			3.25%		
3B4gii	Manure management - Broilers		1.63%							
3Da1	Inorganic N-fertilizers (includes also urea application)	8.32%			18.75%					
3Da2a	Animal manure applied to soils				24.25%					
3Da3	Urine and dung deposited by grazing animals				8.99%					
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products						10.70%	7.03%		
3De	Cultivated crops		3.64%							

Table 1.3.24 Key Categories by activity/ pollutant – Heavy Metals (2018)

Category		Heavy Metals (%)								
		Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**
1A1a	Public electricity and heat production	7.38%	11.91%	41.66%	66.96%	14.72%		44.44%	91.27%	
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	6.75%		12.92%						
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals			5.83%						
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)									4.09%
1A3bvi	Road transport: Automobile tyre and brake wear						84.74%			6.86%
1A4bi	Residential: Stationary	9.02%	55.60%	6.73%		24.47%				60.20%
1A4ci	Agriculture/Forestry/Fishing: Stationary							4.52%		
1A5a	Other stationary (including military)							13.29		
2C1	Iron and steel production	61.54%	14.49%	18.01%	23.28%	43.55%		18.65%		12.87%

Table 1.3.25 Key Categories by activity/pollutant – POPs (2018)

Category		POPs (%)			
		PCDD/F	**Total PAHs**	**HCB**	**PCBs**
1A1a	Public electricity and heat production			58.47%	
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel				17.35%
1A4bi	Residential: Stationary	64.46%	75.54%	29.14%	
2C1	Iron and steel production	22.07%	11.21%		70.80%

1.6. Quality Assurance and Quality Control (QA/QC)

The first draft of the inventory is usually produced first month after the end of the given year depending primarily on the availability of required activity data. During the following several weeks, experts carry out extensive checks, based on trends variation and other activities in order to complete missing data / correct errors in the inventory. Various meetings with data providers are also undertaken, as to clarify important variations in activity data.

Estimated emissions are compared to ones from previous years by sector and activities (time series), and outliers are scrutinized in more detail. After the checking stage is completed, the final inventory is prepared together with the draft version of the accompanying reports.

After this step, the inventory is uploaded on EEA/EIONET database in the requested NFR format and a notification is sent to CLRTAP Secretariat/European Comission and CEIP.

The QA/QC plan aims to improve transparency, consistency, comparability, completeness and confidence of the national emissions inventories. It establishes the procedures to be applied in the process of emission inventorying at all stages from data collection to national emission inventory compilation.

The national air emissions inventory system includes:

- Data collection at:
  - Local level – from economic operators and local public institutions;
  - National level – main statistical data from national public institutions (such as the N.I.S. or the R.A.R.);
- Compilation of the local emission inventories (by the Local Environmental Protection Agencies-L.E.P.A.). Local emission inventories provide source specific data for the National inventory and for the air modeling maps;
- Compilation of the national emission inventory (by N.E.P.A.) according to the latest version of the EMEP/EEA Guidebook and to the UNECE/CLRTAP Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125);

The quality control (QC) procedures refer to:

- Primary Data validation (applied by L.E.P.A). It means the verification routines for validation of activity data provided by the operators through the 'I.E.S-Integrated Environmental System;
- Quality control of emissions inventories (applied at L.E.P.A or N.E.P.A level, for the local or national inventories).

These procedures include the verification methods of the emission inventory compilation such as:

- Checking the quality of data used for compilation of the national inventory (checking if audited, qualitative rating of data);

- Checking the correctness of assumptions, mainly for key categories (emission factors, calculations);
- Checking the proper allocation of NFR;
- Identification of ‘outliers’, verification of plausibility and applying corrections if necessary;
- Checking if data collected bottom-up are comparable with those reported in national statistics;
- Checking if the emission inventory data is consistent and correlated with data reported under different other reporting obligations;
- Checking the plausibility and completeness of the time series;
- Checking the consistency and documentation in case of recalculations;
- Checking the application of improvements or corrections required by reviews or methodology changes;
- Checking the application of archiving procedures.

In addition, quality assurance activities may be conducted by external experts in order to verify and review the quality of emission inventories.
The quality control procedures are being developed by N.E.P.A in cooperation with L.E.P.As.
An internal discussion forum has been set for a better communication between all N.E.P.A and L.E.P.As data providers and contributors to emissions inventory compilation. Discussions are structured on NFR categories/data collection questionnaires and the results of discussions, questions and the adequate solutions are further analyzed, summarized and included in the quality control procedures.
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.
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).
RepDab Report (available at www.ceip.at) is also generated as an additional QA/QC activity.

1.7. General uncertainty evaluation

So far, no analysis has been done on the uncertainty evaluation. A general uncertainty evaluation is one of the planned improvements in the future.

1.8. General Assessment of Completeness

According to reporting guidelines, parties to the Convention are required to inform and explain in a transparent notation keys. Emissions have been estimated by applying emission factors using 2019 EMEP/EEA Guidebook.

Table 1.8. Notation keys used in NFR emission tables – Definition

Notation key	Meaning	Purpose
NO	Not occurring	For activities or processes which do not exist in Romania / for emissions by sources of compounds that do not occur for a particular compound or source category.
NE	Not estimated	Where emission occur, but have not been estimated or reported.
NA	Not applicable	We used for activities which are believed to result in emission which are insignificant to national totals
NR	Not relevant	According to the Emission Reporting Guidelines, NR (not relevant) is introduced to ease the reporting where emissions are not strictly required by the different protocols.
IE	Included elsewhere	For emissions of pollutants which are calculated, but included elsewhere from expected source category in the inventory
C	Confidential	For sources of data of confidential information

1.8.1 Sources reported as “NE“

The Inventory uses NE notation key for categories and pollutants that 2019 EMEP/EEA GB included under the “Not estimated” section of every emission factor table. Emission factors are not available in the methodological guidelines.

Table 1.8.1-1 Explanation to the Notation key NE year 2018

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	PCBs	Reason for not estimation
1A3ai(i)							NE	NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			The values of pollutants due to the aviation activities were taken from the EUROCONTROL values.
1A3aii(i)							NE	NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			The values of pollutants due to the aviation activities were taken from the EUROCONTROL values.
1A3bvi									NE										NE	NE		NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3bvii										NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3c										NE		NE	NE						NE				Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3dii				NE																NE			Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1B1a								NE		NE	NE	NE	NE	NE	NE	NE	NE	NE					Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1B2ai			NE																NE				Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1B2av			NE																NE				Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1B2b			NE																NE				Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1B2c				NE															NE	NE		NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2B1		NE	NE		NE																		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	PCBs	Reason for not estimation
2B2				NE	NE																		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2B7					NE	NE		NE															Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2B10a	NE		NE						NE	NE	NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2C1				NE																			Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2C3		NE		NE						NE	NE	NE	NE	NE	NE	NE	NE	NE			NE		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2C5	NE	NE		NE				NE	NE					NE	NE	NE	NE			NE	NE		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2C6	NE	NE		NE				NE	NE					NE	NE	NE	NE			NE	NE		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3b	NE		NE						NE										NE	NE	NE		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3c	NE									NE	NE	NE							NE	NE	NE		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3e					NE																		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3f					NE																		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3g	NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3h					NE																		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3i	NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2G																	NE				NE	NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	PCBs	Reason for not estimation
2H2					NE	NE	NE	NE															Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2I	NE	NE	NE	NE	NE	NE		NE	NE				NE		NE								Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5A				NE				NE				NE											Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5B1	NE	NE	NE		NE	NE	NE	NE	NE														Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5C1bi				NE										NE	NE		NE	NE				NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5C1bv								NE															Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5C2				NE								NE				NE					NE		Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5D3					NE	NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE					Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5E	NE	NE	NE	NE				NE	NE							NE	NE	NE		NE	NE	NE	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019

1.8.2 Explanation of the notation key “IE“

Table 1.8.2-1 Sources included elsewhere IE year 2018

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	PCBs	Include in NFR code
1A2b	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	1.A.2.a
1A3di(ii)	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE				1A3di(i) memo
1A4bii	IE	IE	IE	IE	IE	IE	IE	IE	IE		IE			IE	IE	IE	IE	IE		IE	IE		1A3b
1A4ciii	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	1A4cii
1A5b	IE	IE	IE	IE	IE	IE	IE	IE	IE		IE			IE	IE	IE	IE	IE		IE	IE		1A5a
2A1	IE	IE	IE	IE					IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	1A2f
2A2	IE	IE	IE	IE					IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	1A2f
2A3	IE		IE						IE														1A2f
2B10b		IE		IE	IE	IE	IE	IE															2B10a
3Da3	IE																						3D2a
3Dc		IE																					3De
5C1biii	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	5C1bi
5C1biv	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	5C1bi
5D1	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	5D3
5D2	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	5D3

2. EXPLANATION OF KEY TRENDS

2.1. Emission trends for Main Pollutants

Table 2.1.1 Total Emission trends (kt) for Main Pollutants, Particulate Matter, CO and BC

Year/Pollutant	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	423.813	273.746	828.402	347.120	75.282	129.795	282.107	5.223	672.855
1991	359.800	229.681	705.225	285.656	62.624	106.290	216.149	4.887	528.548
1992	382.461	233.775	701.250	251.387	60.770	98.809	220.434	6.701	507.893
1993	344.551	213.483	704.190	245.733	63.008	103.261	218.389	6.604	463.690
1994	344.639	223.942	670.750	230.584	65.992	105.273	210.107	7.552	460.481
1995	350.966	231.172	701.637	234.696	71.872	112.631	233.856	8.045	488.218
1996	388.997	284.207	702.525	234.703	109.257	150.640	275.041	12.500	767.135
1997	372.610	297.476	618.210	218.579	129.583	167.424	257.229	14.647	928.327
1998	324.335	274.564	497.558	213.998	116.096	150.965	218.045	13.272	857.271
1999	278.382	240.930	475.608	202.262	106.757	138.151	216.943	11.769	725.702
2000	286.530	264.848	492.627	192.844	104.405	136.431	230.111	11.786	750.298
2001	294.362	254.761	510.898	187.695	85.074	118.568	207.675	9.928	675.322
2002	301.176	260.638	511.967	193.083	88.077	121.069	210.484	10.495	703.835
2003	308.197	270.845	590.319	195.549	104.234	141.680	255.943	11.951	774.124
2004	309.747	279.886	561.095	205.616	117.456	159.505	284.774	13.078	864.535
2005	327.153	315.175	603.622	208.496	120.261	157.498	295.810	14.120	1062.362
2006	324.376	308.663	647.476	208.913	115.419	153.626	269.876	13.742	965.862
2007	306.269	305.313	516.626	207.658	114.382	156.416	292.079	13.831	956.468
2008	301.047	310.527	522.647	204.728	133.332	171.098	314.745	15.596	1007.770
2009	253.527	264.935	442.778	197.916	125.952	161.145	268.375	14.737	905.445
2010	240.086	259.075	353.440	181.128	129.250	165.274	284.515	15.017	896.063
2011	249.568	254.675	323.174	182.125	119.018	156.440	281.852	13.910	827.465

Year/Pollutant	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2012	246.218	253.354	259.274	178.412	122.100	161.797	281.372	14.497	834.242
2013	226.216	245.873	207.606	179.474	114.464	151.512	254.010	13.602	792.472
2014	222.385	241.860	179.807	174.763	114.534	151.753	255.946	13.492	794.540
2015	222.077	237.128	156.688	178.981	110.075	146.820	234.383	13.240	773.168
2016	213.517	235.899	106.882	174.258	110.119	144.047	216.187	13.431	778.146
2017	222.829	239.700	87.078	174.590	111.157	142.880	205.701	13.691	781.837
2018	225.378	237.373	82.473	175.615	110.740	146.427	222.775	13.492	779.021

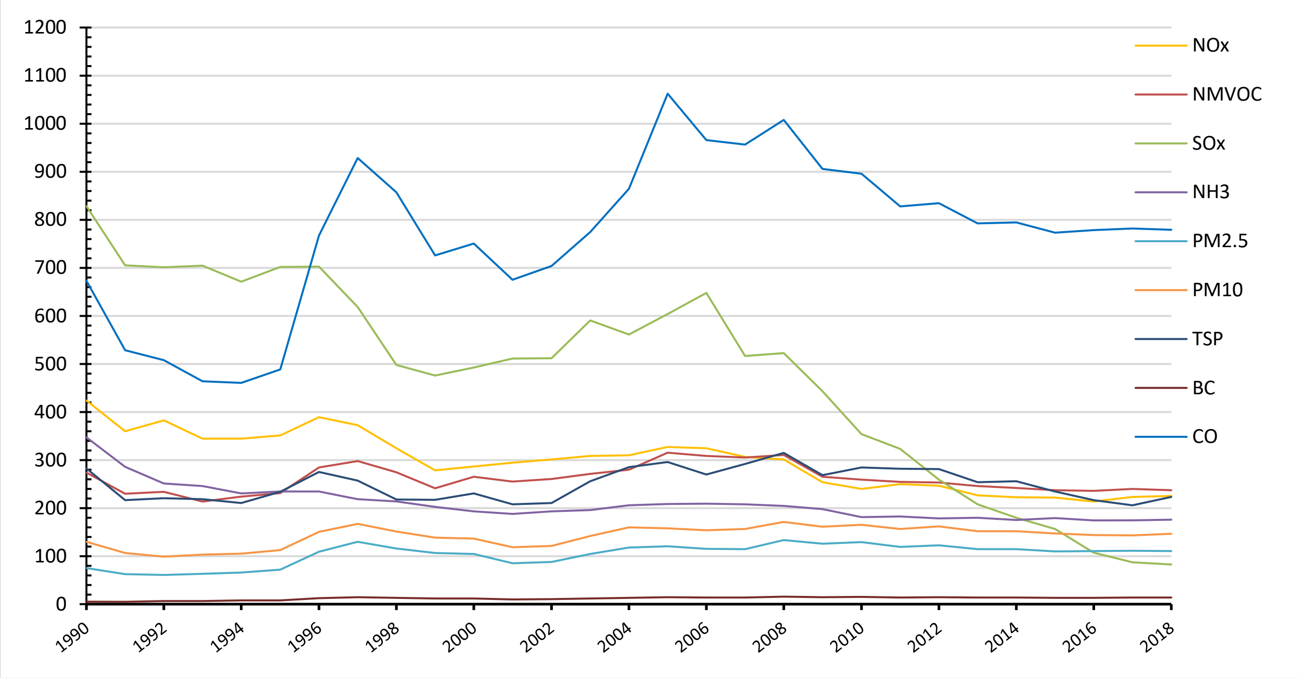


Figure 2.1.1. Total Emission trends (kt) for Main Pollutants, Particulate Matter and CO

The chart shows the total emission trend for main pollutants, particulate matter and CO between 1990-2018.

First of all, the most important variation can be noticed for SOx, starting from 828kt/year in 1990 ending with less than 100kt/year in 2018.

Before 2007, SOx had been fluctuating - between 1996-1999 had been decreasing, in contrast with 2000-2003 when emission had been rising.

Since 2008, SOx emission had decreased dramatically. This was mainly due to the use of low-sulphur fuels and also the regulatory binding on maximal fuel content in transport diesel/gas oil. Also, many LCPs installed desulphurization equipment in order to achieve compliance with the EU legislation.

NOx emissions decreased with 47% in 2018, compared to 1990 and with 31% in 2018, compared to 2005, mainly due to the implementation of emissions reduction program in LCP installations as well as the decrease of the liquid fuel consumption.

NMVOC emission decreased by almost 25% in 2018 compared to 2005, from 315kt in 2005 to 237kt in 2018. In the period 1990-2018, the NMVOC emissions did not have strong variations, recording a maximum of 315kt in 2005.

NH3 emission have gone down slightly from 208kt in 2005 to 175kt in 2018. NH_3 emission had an overall decrease in the given period.

Evolution of $PM_{2.5}$ emission have been fluctuating to a maximum of 133kt in 2008 but since 2008 have been decreasing steadily to 110kt in 2018. Compared to 2005, in 2018 $PM_{2.5}$ emission decreased by almost 8%.

The trend reflects several issues: the economic growth in Romania in the interval 2002-2008, before the world economic crisis that triggered the decrease of industrial production, the decrease of energy production in fossil fuels power plants and the implementation of emission reduction technologies.

2.2. Emission trends for Heavy Metals

Table 2.2.1 Total Emission trends (t) for Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn

Year/Pollutant	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	726.927	4.989	4.030	72.751	25.493	8.711	110.928	19.729	121.781
1991	457.904	4.015	3.126	46.606	19.241	7.231	86.224	16.359	95.474
1992	322.444	3.500	2.413	34.053	15.789	9.161	69.205	16.718	78.472
1993	340.151	3.606	2.299	36.114	16.072	7.761	71.068	16.467	81.910
1994	358.479	3.759	2.381	37.540	17.123	7.559	62.531	15.232	85.964
1995	354.752	3.920	2.631	36.914	19.352	7.829	62.584	15.737	98.240
1996	342.992	4.613	2.460	35.962	19.984	9.198	68.016	16.030	122.622
1997	347.586	4.801	2.197	35.392	22.007	9.183	73.797	13.321	143.062
1998	264.195	4.103	1.885	26.513	20.360	7.832	53.112	10.533	125.117
1999	143.045	3.582	1.574	15.333	15.334	5.955	43.442	10.631	105.213
2000	48.960	3.284	2.351	5.802	16.313	5.769	32.647	11.736	102.733
2001	50.036	2.986	2.381	6.029	14.856	5.508	40.252	11.375	93.595
2002	56.817	2.972	2.430	6.362	17.043	5.899	31.963	11.718	98.426
2003	61.399	3.433	2.929	7.033	18.175	5.936	30.093	13.877	112.240
2004	64.729	3.621	3.045	6.814	18.817	6.298	25.548	13.149	118.644
2005	66.753	3.681	3.052	6.480	18.960	19.221	22.796	12.395	124.742
2006	66.025	3.694	3.193	7.042	18.781	19.597	20.946	14.319	121.552
2007	64.181	3.673	2.963	6.959	18.789	19.931	17.292	14.481	121.211
2008	56.278	3.821	2.844	6.586	16.896	21.229	15.080	14.956	128.261
2009	35.709	3.234	1.946	5.129	11.984	19.690	12.745	12.703	112.838
2010	42.546	3.403	1.979	4.966	12.509	19.324	12.226	11.827	120.305
2011	42.677	3.307	2.356	5.705	12.321	19.642	13.471	14.309	110.918
2012	39.626	3.288	1.750	5.220	11.850	20.735	12.031	13.108	113.058
2013	36.307	2.968	1.351	4.274	11.394	20.016	10.167	9.983	107.217
2014	36.986	2.949	1.361	4.262	11.402	20.168	8.884	10.114	107.168
2015	39.676	2.915	1.410	4.468	12.099	20.448	8.611	10.384	106.766
2016	38.677	2.945	1.334	4.103	11.889	21.629	6.926	9.207	107.984
2017	38.743	2.998	1.342	4.089	11.646	22.769	8.888	9.280	108.819
2018	39.951	2.965	1.352	4.110	11.968	23.648	8.276	9.124	108.212

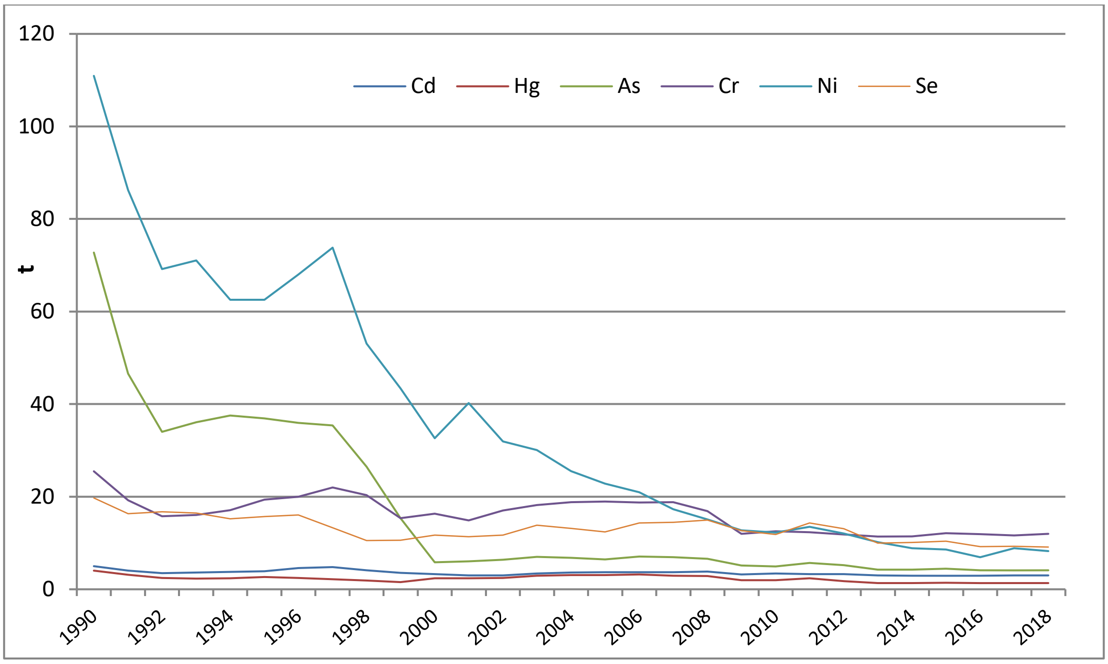


Figure 2.2.1.a Total Emission trends (t) for Cd, Hg, As, Cr, Ni and Se

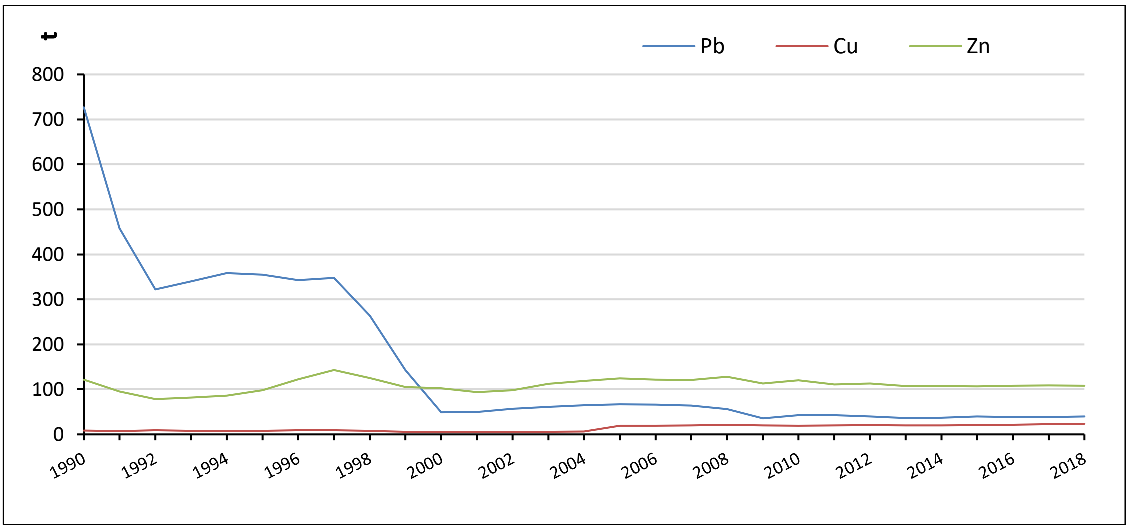


Figure 2.2.1.b Total Emission trends (t) for Pb, Cu and Zn

The graphs describes the total emission trends for heavy metals over the period 1990-2018.

At the beginning of the period analysed, Ni, As and Cr emissions had highly value according to activity data.

Ni, As and Pb emissions started having a dramatic decrease in the first two years of the period continuing with decreased variation till 2000, even if emission showed two peaks in 1997 and 2000. From 2002 Ni continued decreasing but As had got a plateau till the end of the period.

The line graps ilustrated the emision of heavy metals in the last years provide very small changes.

The trends of heavy metals emissions are influenced by the variation in the activity of the Public electricity, NFR 1.A.1.a, Stationary combustion in manufacturing industries and construction (iron and steel, NFR 1.A.2.a), Stationary combustion in manufacturing industries and construction (Non-metallic minerals, NFR 1.A.2.f) and Iron and steel production, NFR 2.C.1.

2.3. Emission trends for POPs

Table 2.3.1 Total Emission trends for PCDD/F (g I-TEQ), total PAHs (t), HCB and PCBs (kg)

Year/Pollutant	PCDD/ PCDF (g I-TEG)	total PAHs (t)	HCB (kg)	PCBs (Kg)
1990	175.387	75.378	2.623	61.645
1991	128.358	53.344	2.349	45.386
1992	107.549	42.720	2.460	34.204
1993	107.570	39.533	2.548	30.852
1994	111.591	38.290	2.533	32.096
1995	143.238	46.412	2.728	38.592
1996	171.573	63.640	2.900	35.852
1997	199.261	76.276	2.717	39.736
1998	178.493	67.733	2.290	37.474
1999	151.799	57.370	2.220	25.800
2000	156.923	57.079	2.352	27.814
2001	140.976	46.976	2.277	29.078
2002	156.605	51.133	2.422	33.834
2003	161.984	58.819	2.759	36.675
2004	176.701	67.240	2.713	38.630
2005	183.910	66.865	2.656	38.461
2006	178.865	63.567	2.933	37.653
2007	173.526	63.399	2.958	35.772
2008	190.122	71.501	3.092	30.171
2009	157.126	62.088	2.708	17.325
2010	172.722	65.189	2.709	20.878
2011	165.236	59.324	3.086	20.091
2012	167.374	60.991	2.978	18.472
2013	150.030	57.981	2.389	17.499
2014	152.713	59.578	2.296	17.996
2015	147.731	59.159	2.325	20.231
2016	147.859	58.680	2.236	19.776
2017	153.279	57.945	2.366	18.589
2018	153.027	58.288	2.176	19.702

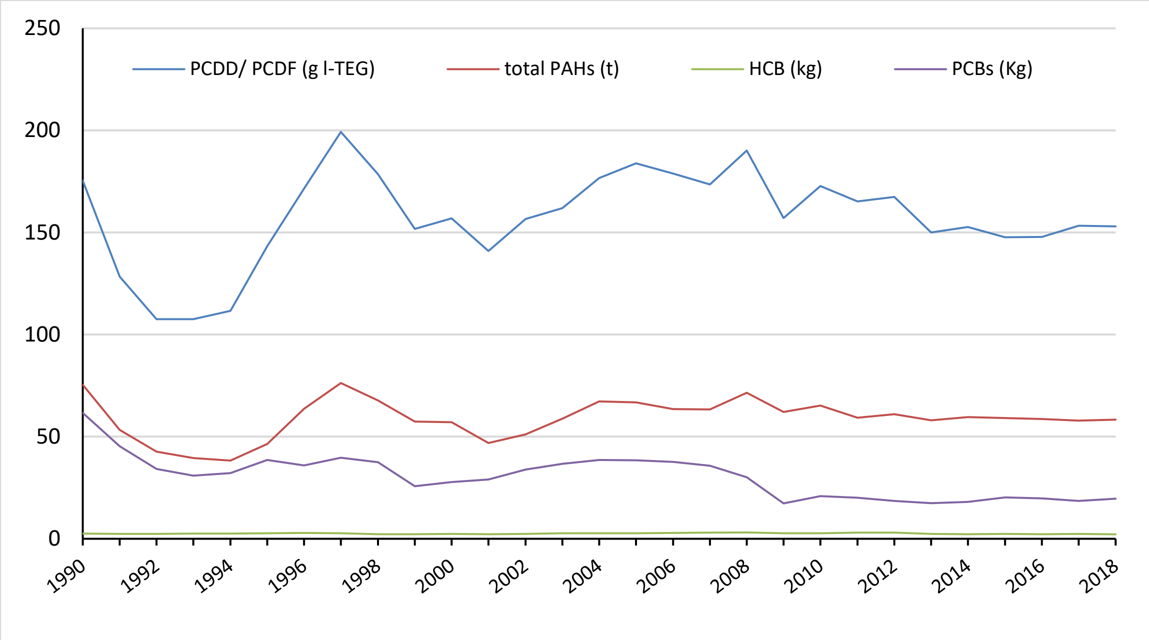


Figure 2.3.1 Total Emission trends for Dioxines (g I-TEQ), total PAHs (t), HCB and PCBs (kg)

The graph provides the total emission trend for POP's between 1990-2018.

The most relevant fluctuation was recorded for PCDD/PCDF emission maintaining to high values. During the first five years all poluatant analysed significantly fell down and PCDD and PAHs rocketed in the following three years continuing a trend of variaton.

Emsission trend for PCDD/PCDF decreased by almost 12.74% in 2018 compared with 1990.

The trends of POP's emissions are influenced by the variation in the activity data of the Public electricity, NFR 1.A.1.a, Stationary combustion in manufacturing industries and construction: Iron and steel, NFR 1.A.2.a, Stationary combustion in manufacturing industries and construction: Non-metallic minerals, NFR 1.A.2.f and waste sector because here was no activity data for the 1990-2004 period for more activities.

All in all, the majority of emision had fluctuated till 2009 and after that they all of them had constantly decreased being in acordance with activity data.

For main polutants 2018 emission in comparation with 2005 had recorded no variation or significat growth.

3. ENERGY (NFR sector 1)

The "ENERGY" sector represents the main source of emissions in Romania. This includes fuel combustion in energy industry (NFR 1.A.1) and in manufacturing industry (NFR 1.A.2), transport (NFR 1.A.3), small combustion (NFR 1.A.4), off-road mobile machinery (1A2gvii, 1A4aii, 1A4bii, 1A4cii) and fugitive emissions from fuels (NFR 1.B.1 and NFR 1.B.2).

3.1 Stationary Fuel Combustion – Sector overview

This chapter considers emissions originating from stationary fuel combustion activities (NFR 1.A.1, NFR 1.A.2, NFR 1.A.4 and 1A5). The related sources of non road mobile machineries NFR 1.A.2.g.ii, 1.A.4.aii, NFR 1.A.4.bii, NFR 1.A.4.cii and NFR 1.A.5.b are also approached by this chapter.

Following the Emission Inventory reviews in 2017 - 2019, all categories were recalculated and extended back to the year 1990, based on the following criteria: answer as much as possible to the specific requests of the reviews, use updated statistics, where possible, use operators measured emissions and corresponding fuel consumption, where available, assure the consistency with all relevant categories from the energy statistics, and update the emission factors to those provided by the 2019 EMEP/EEA Guidebook.

Table 3.1.1 gives a summary of sources of activity data for stationary combustion categories (including the related non-road mobile machineries). The table is relevant for assessing the completion of NFR categories on stationary and non-road mobile machineries.

Table 3.1.1 Reference of activity data for NFR categories 1.A.1, 1.A.2, 1.A.4 and 1.A.5.

NFR	**Activity data source**
1.A.1.a Public Electricity and Heat Production	• LCP operators; • Energy statistics*: Main activity producer plants, (Electricity/CHP/Heat only), Own use in electricity, CHP and heat plants, Autoproducers* - 1990-2016, EUROSTAT complete energy balances, annual data (nrg_110a) - 2017-2018, EUROSTAT ENERGY Questionnaires, National Institute of Statistics
1.A.1.b Petroleum refining	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a*) Consumption of the energy branch/Petroleum refineries* • 2017-2018, EUROSTAT ENERGY Questionnaires, National Institute of Statistics
1A1c Manufacture of Solid fuels and Other Energy Industries	• 1990-2015: EUROSTAT complete energy balances, annual data (nrg_110a): *Consumption of the energy branch/ Consumption in Oil and gas extraction, Consumption in Coal Mines, Consumption in Coke Ovens, Consumption in Non-specified (Energy)* • 2016-2018 : EUROSTAT ENERGY Questionnaires, National institute of Statistics
1.A.2.a Iron and Steel	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry/Iron & steel industry;* • 2017-2018 : EUROSTAT ENERGY Questionnaires, National Institute of Statistics
1.A.2.b Non-ferrous Metals	IE – included in NFR 1.A.2.a

NFR	Activity data source
1.A.2.c Chemicals	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry/ Chemical and Petrochemical;* • 2017-2018 : EUROSTAT ENERGY Questionnaires, National Institute of Statistics
1.A.2.d Pulp, Paper and Print	• 1992-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry/ Paper, Pulp and Print;* 1990-1991, included in 1A2gviii; • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.2.e Food Processing, Beverages and Tobacco	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry/ Food and Tobacco;* • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.2.f Non-metallic Minerals	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry/ Non-Metallic Minerals;* • 2017-2018: EUROSTAT ENERGY Questionnaires, National institute of Statistics;
1A2gvii Mobile Combustion in manufacturing industry	• 1992-2016: EUROSTAT complete energy balances, annual data (nrg_110a): Final energy consumption/Industry (all) - gasoline and diesel. 1990-1991: included in NFRs 1A3b; • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.2.gviii Other Stationary Combustion	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry (*all) minus amount considered at the other specific industries; • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.4.a.i Commercial/ Institutional: stationary	• 1992-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Other Sectors /Services;* 1990-1991: included in NFR 1A4bi; • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.4.a.ii Commercial/ institutional: Mobile	• 1992-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Other Sectors / Services,* gasoline and diesel; 1990-1991: included in NFRs 1A3b; • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics
1.A.4.b.i Residential: stationary	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Other Sectors / Residential;* • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.4.b.ii Residential: Household and gardening (mobile)	• Included in NFRs 1A3b. Separataly reported where data were available (gasoline and diesel in the EUROSTAT Energy, *Final energy consumption/Other Sectors/Residential;*
1.A.4.c.i Agriculture/ Forestry/Fishing, Stationary	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Other Sectors / Agriculture / Forestry;* • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	• 1992-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Other Sectors / Agriculture & Forestry ,* Gasoline and Diesel; 1990-1991: included in NFRs 1A3b; • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;
1.A.4.c.iii National fishing	IE – included in 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery;
1.A.5.a Other Stationary (including Military)	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Other Sectors / Non-specified (Other);* • 2017-2018: EUROSTAT ENERGY Questionnaires, National Institute of Statistics ;
1.A.5.b Other, Mobile (including military, land based and recreational boats)	IE – included in 1.A.5a

Fuels in the energy balances were aggregated to categories liquid, solid, gas and biomass according to relevance for Tier 1 application of emission factors, as in the following table:

Table 3.1.2 Aggregation of fuels on fuel types

Tier 1 Fuel type	**Associated fuel types**
Hard coal /solid	Coking coal, other bituminous coal, sub-bituminous coal, coke, manufactured 'patent' fuel
Brown coal / solid	Lignite, oil shale, manufactured 'patent' fuel, peat
Gaseous fuels	Natural gas, natural gas liquids, liquefied petroleum gas, refinery gas, gas works gas, coke oven gas, blast furnace gas
Heavy fuel oil / Liquid fuels	Residual fuel oil, refinery feedstock, petroleum coke, orimulsion, bitumen
Light oil / Liquid fuels	Gas oil, kerosene, naphtha, shale oil
Biomass	Wood, charcoal, vegetable (agricultural) waste

(source: Table 3-1 Tier 1 fuel classifications, 2016 EMEP/EEA Guidebook)

Information on condensable component of PM_{10} and $PM_{2.5}$, as provided by the Guidebook 2019:
For NFR 1A1, all tables of emission factors in Guidebook 2019, used in the estimation of TSP, PM_{10} and $PM_{2.5}$, note that "The TSP, PM_{10} and $PM_{2.5}$ emission factors represent filterable PM emissions".
For non road mobile and machineries (NRMM), NFR 1A2gvii, 1A4aii, 1A4bii and 1A4cii, **Notes** to the Table 3.1 in the NRMM chapter of Guidebook 2019 mentions that "PM factors represent total PM emissions (filterable and condensable fractions)".

For all industry combustion, NFR 1A2:
- Table 3.2, solid fuels, mentions that "The basis of the TSP, PM_{10} and $PM_{2.5}$ emission factors could not be determined in the reference";
- Table 3.3, gaseous fuels and table 3.4, liquid fuel, mentions that "The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions";
- Table 3.5, biomass, mentions that "The TSP, PM_{10} and $PM_{2.5}$ emission factors represent filterable PM".

For 1A4ai, 1A4ci and 1A5a, the Guidebook Tier 1 tables 3.7 to 3.09, used for assessing the emissions from coal, gaseous fuels and liquid fuels, note that "The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions". Table 3.10 - Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass: "Emission factors have been recalculated to represent total particles (including condensable component) by assuming condensables represent 12% of the total PM mass for $PM_{2.5}$ (average of automatic and medium sized boilers from Denier van der Gon et al., 2015)."

For NFR 1A4bi, the Guidebook Tier 1 tables 3.3 to 3.5, used for assessing the emissions from coal, gaseous fuels and other liquid fuels, mention that "The TSP, PM_{10} and $PM_{2.5}$ emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions".

For NFR 1A4bi, wood combustion, tables Tier 2, 3.40, 3.43 and 3.44 mention “total particles” for TSP, PM_{10}, $PM_{2.5}$ and BC.

Details on calculations and trends are given in the following sections.

3.2 NFR 1.A.1.a Public electricity and heat production

Activities in this category cover combustion processes from production of electric power and thermal energy in public power and district heating plants, including the own fuel consumption.

NFR 1.A.1.a is key source for SOx, NOx, PB, Cd, Hg, As, Cr, Ni, Se and HCB.

The shares of emissions from combustion in Public electricity and heat production - NFR 1A1a, in the country total, by pollutant, is shown in the table 3.2.1 and figure 3.2.1:

Table 3.2.1. Share of emissions from 1A1a in the national total

Pollutant	1A1a	National Total	Unit	% 1A1a in national total
NOx	35.66	225.37	kt	15.8
NMVOC	0.71	237.37	kt	0.3
SOx	39.31	82.47	kt	47.7
PM2.5	1.79	110.74	kt	1.62
PM10	2.83	146.42	kt	1.94
TSP	3.71	222.77	kt	1.67
BC	0.04	13.49	kt	0.36
CO	8.19	779.02	kt	1.05
Pb	2.94	39.95	t	7.38
Cd	0.35	2.96	t	11.91
Hg	0.56	1.35	t	41.66
As	2.75	4.11	t	66.96
Cr	1.76	11.96	t	14.72
Cu	0.37	23.64	t	1.58
Ni	3.67	8.27	t	44.44
Se	8.32	9.12	t	91.27
Zn	3.53	108.21	t	3.27
PCDD/ PCDF	2.29	153.02	g I-TEQ	1.50
Total PAH	0.02	58.28	t	0.04
HCB	1.27	2.17	kg	58.47
PCBs	0.026	19.70	kg	0.13

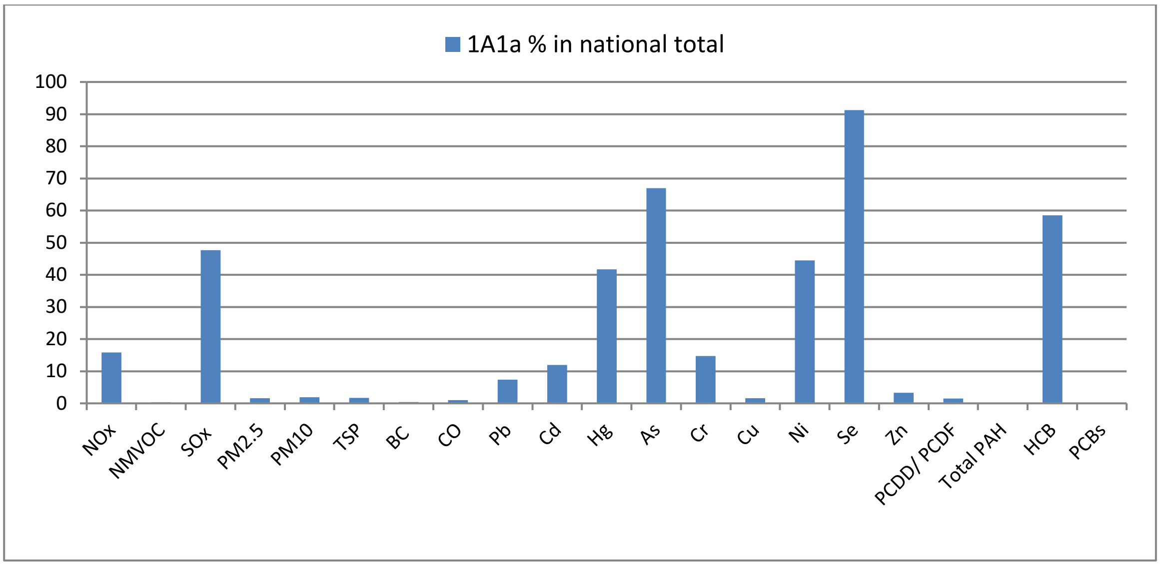


Figure 3.2.1 Share of 1A1a emissions by pollutant in the national total in 2018

The estimation of emissions for the category 1.A.1.a takes into account the fuel consumption in all power and heat plants (including the ones under 50 MW) as well as the fuel consumption for own use in the electricity, CHP and heat plants. A major recalculation of the series was done in 2017, following the Review (review ref: RO-1A1a-2017-0001).

CO, NMVOC, Heavy Metals and POPs:

The emissions were calculated for the entire time series 1990-2018 based on the Guidebook 2019 emission factors (NFR 1.A.1.a, Tier 2 Tables 3.10, 3.11, 3.12 and 3.13) applied on fuel consumption from EUROSTAT energy balances, categories *Main activity producer plants (Electricity/CHP/Heat only)* and *Own use in electricity, CHP and heat plants,* including *Autoproducers*. Note that, based on information from the N.I.S, the autoproducers are not reported in the national statistics separately, but included in the Electricity/CHP/Heat only categories, therefore, the consumption for Autoproducers was allocated to NFR 1.A.1.a, to assure consistency between data sources (Eurostat energy balances and national energy balances).

NOx, SOx and TSP:

Estimation for years 2005-2018 consider the fuel consumption and measured emissions reported by the LCPs operators and the data provided in the Eurostat energy balances. The LCP fuel consumption was compared with Eurostat values, categories *Main activity producer* plants (electricity/CHP/Heat only) and Own use in electricity, CHP and heat plants, including Autoproducers. TSP, NOx and SOx emissions were estimated from the difference between fuel data from energy balances and LCP consumption. These emissions were summed up with the LCPs measured values of TSP, NOx and SOx, to get the values reported on NFR 1.A.1.a.

For the years 1990-2004, NOx and SOx were estimated based on the Eurostat Energy data and the Guidebook emission factors. The TSP emission factors for lignite and heavy fuel oil considered in the estimation are equal to 120 g/GJ for lignite and 40g/GJ for liquid fuel, based on available operators reports for years 2002-2004, averaged and extrapolated back to 1990.

PM_{10}, $PM_{2.5}$ and BC:

PM_{10}, $PM_{2.5}$ and BC were estimated based on TSP measured values. This approach was due to the fact that it was a too high discrepancy between the measured values of TSP and the Guidebook estimation (the measured values higher than estimated ones). Therefore, the following method was used:
1st step: for the years where measured TSP values were available (2005-2018), the emissions of TSP, PM10, PM2.5 and BC were estimated based on Guidebook 2019 emission factors (NFR 1.A.1.a, Tables 3.10, 3.11, 3.12 and 3.13) for the LCP consumptions of solid, liquid, natural gas and biomass fuel. 2nd: the ratios between the estimates PM10/TSP, PM2.5/TSP and BC/TSP were calculated. 3rd: These ratios were used as coefficients to determine the emissions of PM_{10}, $PM_{2.5}$ and BC on the basis of measured TSP.
For the historical years 1990-2004, no measured data were available. For this time series, the average of the measured ratios were used to determine the emissions of PM_{10}, $PM_{2.5}$ and BC from TSP values determined as described in the previous paragraph. The coefficients used for the series 1990-2004 are PM_{10} = 0.693 * TSP; $PM_{2.5}$ = 0.34 * TSP; BC = 0.01 * TSP. This method assures the consistency of the emissions trend.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- Recalculation of SO2, NOx, TSP, PM_{10}, $PM_{2.5}$ and BC emissions for 2016 and 2017, based on final LCP submissions (the previous estimates were provisional);

Table 3.2.1. Emission Trends (kt) for NFR 1.A.1.a. for NOx, SOx, Particulate Matter, Black Carbon and CO

Year/Pollutant (kt)	Nox	SOx	CO	PM2.5	PM10	TSP	BC
1990	146.59	646.90	21.32	16.26	33.15	47.83	0.48
1991	128.62	561.55	19.76	14.09	28.72	41.44	0.41
1992	148.51	589.74	27.75	15.21	31.01	44.75	0.45
1993	149.49	619.81	25.97	15.97	32.56	46.98	0.47
1994	125.65	582.34	18.24	14.62	29.80	43.00	0.43
1995	126.97	599.84	17.75	15.05	30.68	44.28	0.44
1996	130.09	601.00	18.77	15.10	30.78	44.42	0.44
1997	107.99	504.96	14.64	12.64	25.76	37.18	0.37
1998	90.76	400.70	14.24	10.03	20.43	29.49	0.29
1999	86.20	405.94	12.05	10.11	20.61	29.74	0.30
2000	87.41	427.71	11.57	10.64	21.69	31.30	0.31
2001	88.89	442.86	10.85	11.01	22.45	32.39	0.32

Year/Pollutant (kt)	Nox	SOx	CO	PM2.5	PM10	TSP	BC
2002	86.14	438.00	10.67	11.03	22.48	32.45	0.32
2003	98.51	508.79	11.84	12.58	25.64	37.00	0.37
2004	90.02	473.54	10.77	11.80	24.04	34.70	0.35
2005	99.24	518.81	9.67	12.08	21.63	31.00	0.40
2006	105.17	565.52	10.54	11.54	21.47	30.77	0.35
2007	87.69	445.80	10.06	8.37	15.03	21.62	0.29
2008	86.52	453.33	9.31	6.86	14.40	20.83	0.14
2009	65.56	396.06	7.69	5.74	11.53	16.63	0.14
2010	56.47	302.13	7.63	4.87	9.89	14.14	0.10
2011	61.04	275.42	8.48	5.74	11.74	16.80	0.12
2012	56.51	214.31	8.06	4.57	9.15	13.02	0.09
2013	45.42	163.53	7.01	3.80	7.74	11.00	0.07
2014	44.29	138.35	6.90	3.48	6.60	9.17	0.07
2015	42.40	109.62	7.46	2.90	5.07	6.87	0.07
2016	32.43	61.27	7.35	2.44	3.97	5.22	0.06
2017	33.48	45.91	8.14	2.01	3.19	4.18	0.05
2018	35.67	39.31	8.19	1.79	2.84	3.71	0.05

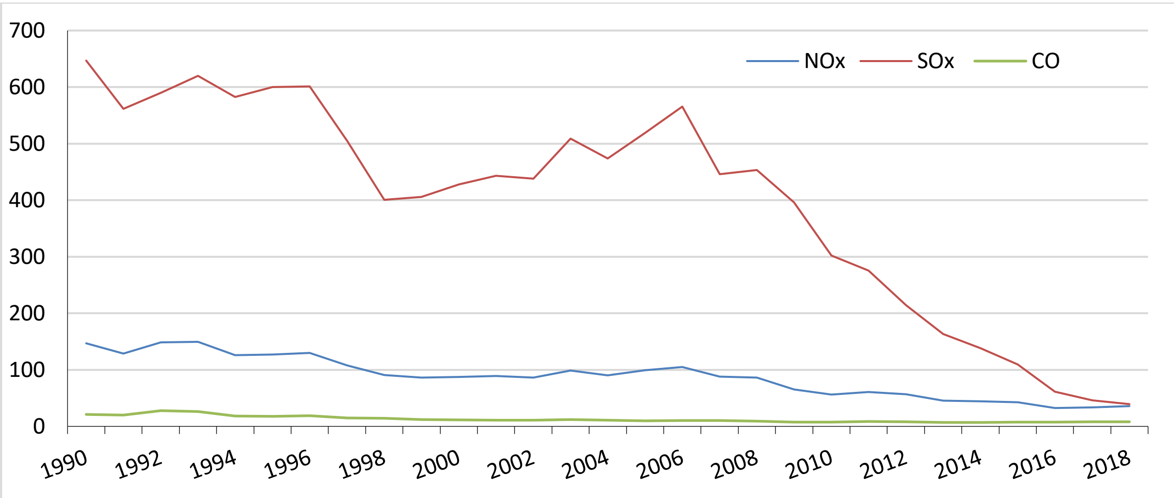


Figure 3.2.1.a Emission Trends (kt) for NFR 1.A.1.a. for NOx, SOx and CO

Compared to 1990 emissions, there was a significant decrease of emissions to atmosphere in the public power sector. For main pollutants, decreases are as high as 76% for NOx, 94% for SOx and 91% for PM_{10}. Compared to 2005, the emissions decreased with 64% for NOx, 92% for Sox and 87% for PM_{10}. The decrease is due to implementation of emissions reduction program in LCP installations as well as a general decrease in fuel consumption. Variations of emission values are also determined by the different mixing ratios of solid/liquid/gaseous fuels along the time series, contributing with different emission factors to the estimate of each pollutant.

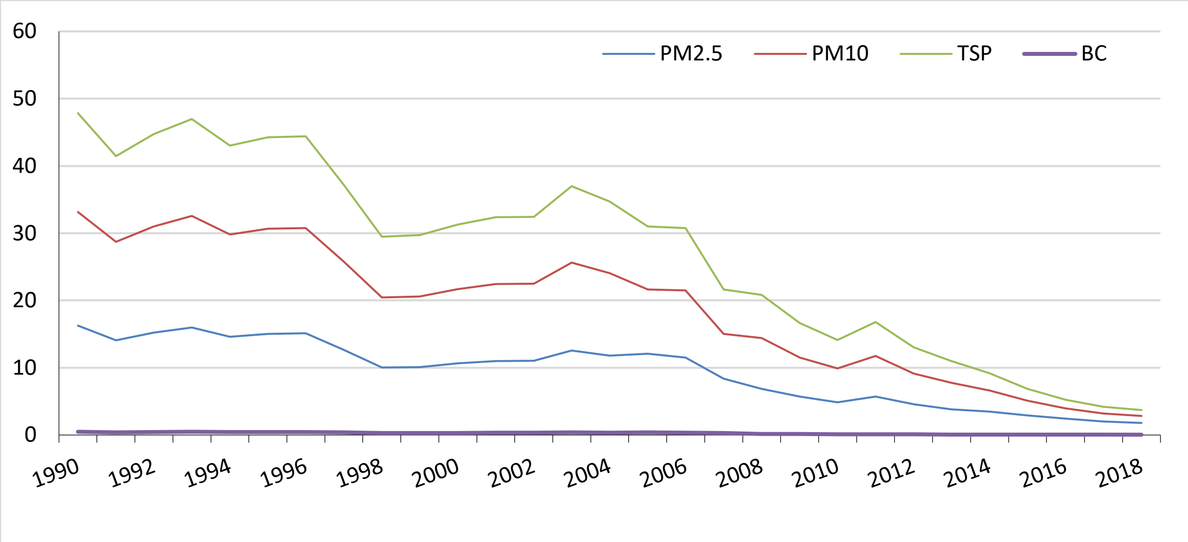


Figure 3.2.1.b. Emission Trends (kt) for NFR 1.A.1.a. for TSP, PM_{10}, $PM_{2.5}$ and BC

Emissions of heavy metals have followed the same decreasing trend; the heaviest reduction took place before 2005.

Table 3.2.2. Emission Trends (t) for NFR 1.A.1.a. for Heavy Metals

Year/Pollutant	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	5.823	0.868	1.022	5.495	3.475	1.699	69.219	14.421	25.614
1991	5.056	0.730	0.910	4.786	3.023	1.302	51.089	12.919	19.247
1992	5.454	0.753	1.004	5.125	3.246	1.325	43.860	14.014	18.193
1993	5.729	0.802	1.038	5.370	3.407	1.467	50.139	14.549	20.436
1994	5.274	0.722	0.972	4.990	3.160	1.101	38.464	14.045	15.388
1995	5.434	0.742	0.999	5.138	3.256	1.127	39.159	14.487	15.712
1996	5.443	0.753	0.995	5.145	3.259	1.199	42.948	14.350	16.965
1997	4.549	0.649	0.817	4.300	2.722	1.113	42.825	11.755	16.287
1998	3.609	0.500	0.667	3.427	2.164	0.776	28.448	9.575	11.078
1999	3.650	0.500	0.674	3.465	2.191	0.737	26.621	9.797	10.435
2000	3.853	0.515	0.719	3.657	2.316	0.689	23.156	10.540	9.425
2001	3.981	0.547	0.729	3.772	2.390	0.811	29.461	10.669	11.519
2002	3.999	0.527	0.741	3.768	2.397	0.720	21.634	10.890	9.420
2003	4.571	0.593	0.865	4.348	2.755	0.671	20.519	12.850	8.765
2004	4.294	0.542	0.818	4.070	2.585	0.565	13.913	12.193	6.773
2005	4.018	0.505	0.772	3.827	2.426	0.469	11.672	11.572	5.604
2006	4.714	0.584	0.903	4.466	2.840	0.552	11.306	13.537	6.184
2007	4.658	0.569	0.906	4.443	2.818	0.421	7.370	13.700	4.413
2008	4.758	0.579	0.925	4.536	2.879	0.410	6.385	14.040	4.143
2009	4.136	0.508	0.798	3.936	2.500	0.400	7.506	12.099	4.297
2010	3.832	0.465	0.741	3.637	2.313	0.364	5.334	11.204	3.658
2011	4.687	0.567	0.902	4.436	2.826	0.459	6.064	13.659	4.510
2012	4.281	0.517	0.823	4.046	2.579	0.431	5.460	12.439	4.207
2013	3.233	0.390	0.622	3.050	1.945	0.340	4.097	9.349	3.296
2014	3.278	0.393	0.621	3.054	1.960	0.415	4.060	9.263	3.926
2015	3.335	0.399	0.632	3.105	1.992	0.426	3.981	9.408	4.002
2016	2.960	0.351	0.562	2.748	1.765	0.384	2.771	8.320	3.478
2017	3.021	0.361	0.575	2.813	1.803	0.391	3.498	8.503	3.654
2018	2.948	0.353	0.563	2.752	1.762	0.373	3.678	8.328	3.537

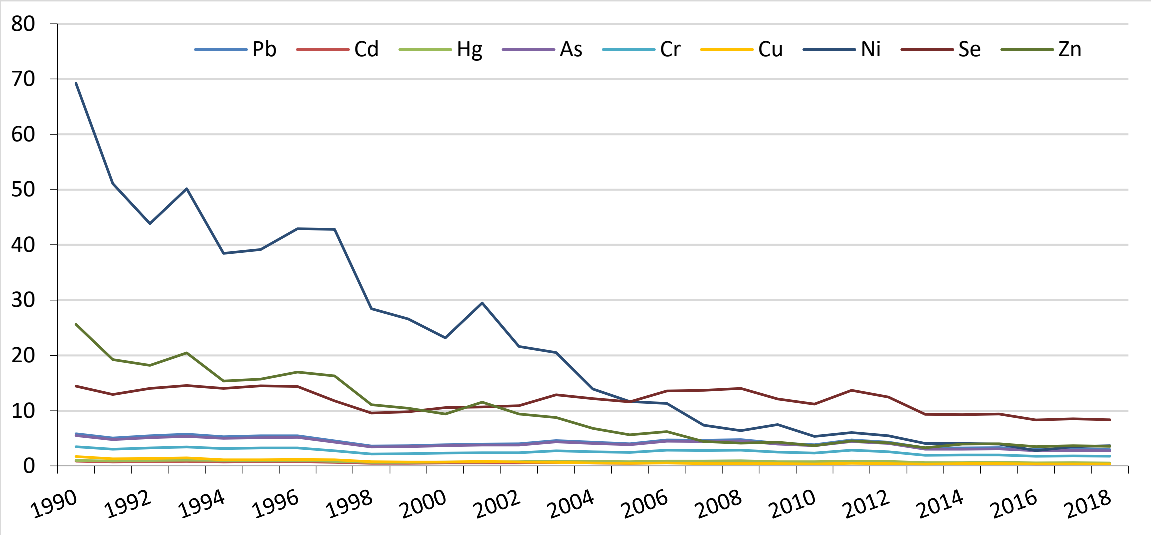


Figure 3.2.2. Emission Trends (t) for NFR 1.A.1.a. for Heavy Metals

Compared to the first year of the estimation, emissions of heavy metals in 2018 decreased between 40% (Se) and 90% (Ni). The highest decrease took place before 2007; in the last years (2014-2018), emissions of heavy metals are steady or slightly increased.

The table and chart below give the fuel consumption values and trend during 1990-2018.

Table 3.2.3 Fuel consumption trends (TJ) by fuel type, for NFR 1.A.1.a.

Year/Fuel type	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
1990	259680	308478	376161	547
1991	189720	278288	369439	772
1992	159992	303748	562945	8132
1993	184200	314526	505400	8259
1994	139063	305585	339389	2699
1995	141408	315309	323274	2877
1996	156419	311576	344917	2700
1997	158235	253902	255451	880
1998	103606	207934	276622	833
1999	96251	213231	222700	593
2000	81981	230389	210910	1100
2001	106668	232146	183694	611
2002	75559	238396	182287	3800
2003	69678	282280	211471	899
2004	44173	268800	192325	2923
2005	35995	255427	174513	1080
2006	32748	299183	182344	3731
2007	17286	303565	180602	1236
2008	13120	311315	161040	1387
2009	19163	267925	126608	1417

Year/Fuel type	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
2010	11321	248362	129687	2642
2011	12017	302833	135098	4364
2012	10662	275770	130300	4663
2013	7945	207248	120611	4281
2014	7671	205244	109766	7991
2015	7210	208475	122413	8477
2016	3368	184433	126235	8610
2017	6100	188432	145830	8067
2018	7004	184515	149633	7170

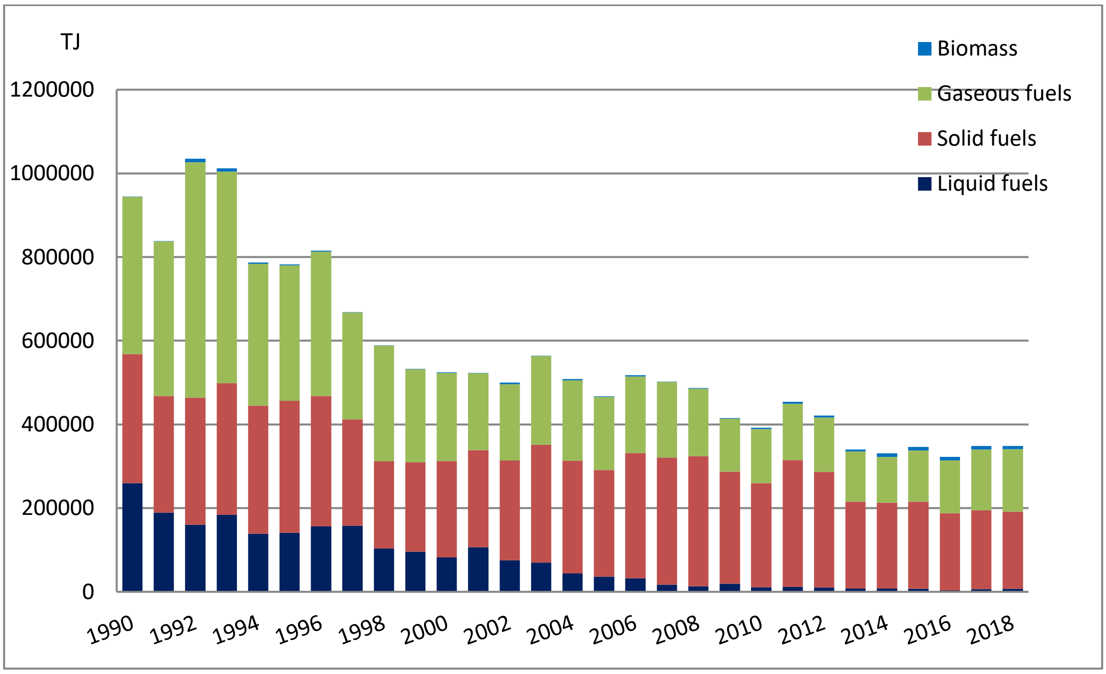


Figure 3.2.3 Fuel consumption [TJ], by fuel type, for NFR 1.A.1.a.

The general decrease in emissions are consistent with the decrease of fuel consumption and technology improvement in power plants. In the last 6 years, the fuel consumption in the energy sector as well as emissions levels were pretty steady.

3.3 NFR 1.A.1.b Petroleum refining

The NFR category 1.A.1.b covers emissions released from combustion processes within refineries. NFR 1.A.1.b is not a key source for any pollutant.

The emissions for years 1990-2018 were calculated by applying Tier 1 emission factors (2019 EMEP/EEA Guidebook 1.A.1.a, Tables 3.3, 3.4, 3.5 and 3.7) to activity data provided by the EUROSTAT energy balances and questionnaires.

Improvements and recalculations: Completion of the reporting for the time series 1990 - 1994

Tables and charts below show the emissions trend and fuel consumption for the category NFR 1.A.1.b., 1990-2018.

Table 3.3.1. Emissions for NFR 1.A.1.b, 1995-2017

Year/Pollutant	NOx (kt)	NMVOC (kt)	SOx (kt)	PM_{10} (kt)	CO (kt)	Ni (t)
1990	7.437	0.198	5.226	0.325	2.763	2.683
1991	5.447	0.138	5.714	0.328	1.844	2.938
1992	3.603	0.096	2.543	0.158	1.338	1.306
1993	3.866	0.101	3.256	0.195	1.385	1.673
1994	5.808	0.144	6.922	0.390	1.887	3.560
1995	5.746	0.142	6.843	0.386	1.867	3.519
1996	6.251	0.145	10.109	0.548	1.778	5.202
1997	5.240	0.126	7.197	0.398	1.612	3.703
1998	6.362	0.158	7.478	0.422	2.077	3.845
1999	5.330	0.139	4.606	0.274	1.898	2.366
2000	5.665	0.151	3.830	0.240	2.119	1.966
2001	4.880	0.127	4.288	0.254	1.731	2.203
2002	5.822	0.161	2.531	0.179	2.312	1.295
2003	4.920	0.135	2.251	0.157	1.943	1.153
2004	4.900	0.132	2.923	0.189	1.870	1.499
2005	5.171	0.139	3.378	0.213	1.946	1.734
2006	4.846	0.126	4.214	0.250	1.724	2.165
2007	4.696	0.126	3.094	0.195	1.765	1.588
2008	4.522	0.125	1.955	0.139	1.797	1.001
2009	3.744	0.102	1.958	0.131	1.455	1.004
2010	4.195	0.109	3.600	0.214	1.496	1.850
2011	3.750	0.096	3.562	0.208	1.305	1.830
2012	3.361	0.088	2.751	0.165	1.212	1.413
2013	3.531	0.091	3.159	0.187	1.247	1.623
2014	2.704	0.078	0.279	0.040	1.159	0.140
2015	2.576	0.074	0.322	0.041	1.099	0.162
2016	2.775	0.080	0.280	0.041	1.190	0.140
2017	2.915	0.084	0.281	0.042	1.252	0.140
2018	2.588	0.076	0.030	0.027	1.132	0.0112

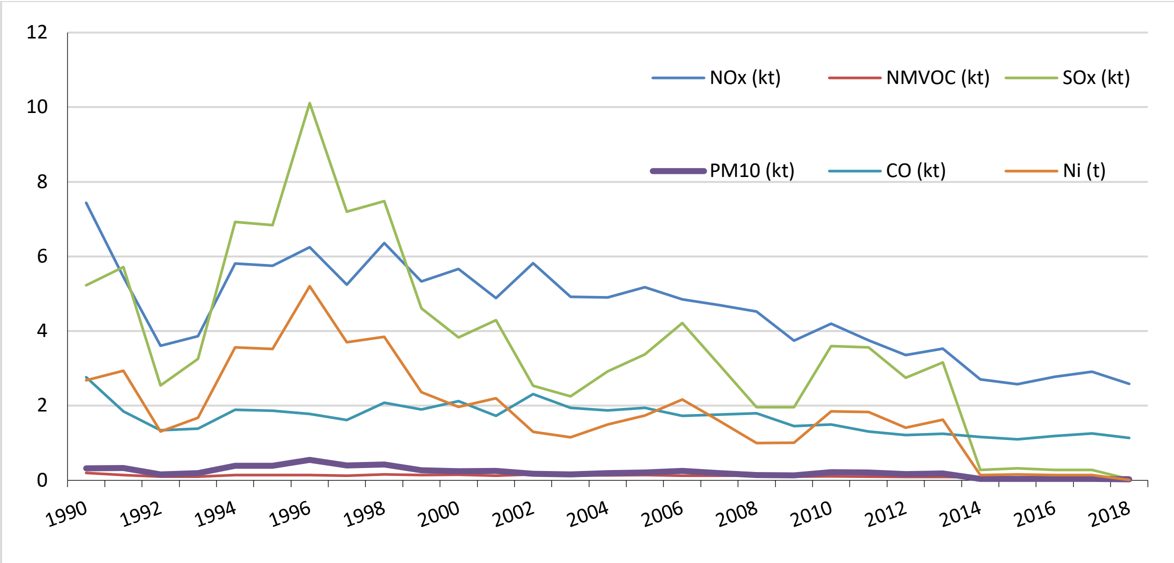


Figure 3.3.1. Emissions for NFR 1.A.1.b, 1990-2018

Emissions trends are consistent with the fuel consumption variation along the time series 1990-2018. The fuel consumption shows a strong variation in first years after 1990 followed by a more steady decrease during the last years. Significant is the decrease of the liquid fuel (from 10250 TJ in 1990 to 43.8 TJ in 2018) which impacts heavily on emission reduction of certain pollutants, such as SOx, NMVOC, PM_{10} or Ni.

Table 3.3.2. Fuel consumption trends (TJ), by fuel type, for NFR 1.A.1.b

Year/Fuel type (TJ)	Liquid fuels	Gaseous fuels	Biomass
1990	10520	66776	0
1991	11520	42818	0
1992	5120	32313	0
1993	6560	32977	0
1994	13960	42984	0
1995	13800	42539	0
1996	20400	37683	0
1997	14520	35707	0
1998	15080	47424	0
1999	9280	45076	0
2000	7709	51355	0
2001	8640	41045	0
2002	5080	57305	0
2003	4520	48065	0
2004	5880	45670	0
2005	6798	47257	0
2006	8489	40909	0
2007	6227	42834	0
2008	3924	44552	0
2009	3936	35788	0
2010	7253	35563	0
2011	7178	30683	0

Year/Fuel type (TJ)	Liquid fuels	Gaseous fuels	Biomass
2012	5542	28924	0
2013	6365	29520	1
2014	547	29513	2
2015	634	27932	2
2016	549.0	30300	1
2017	548.9	31875	1.4
2018	43.8	29010	0.5

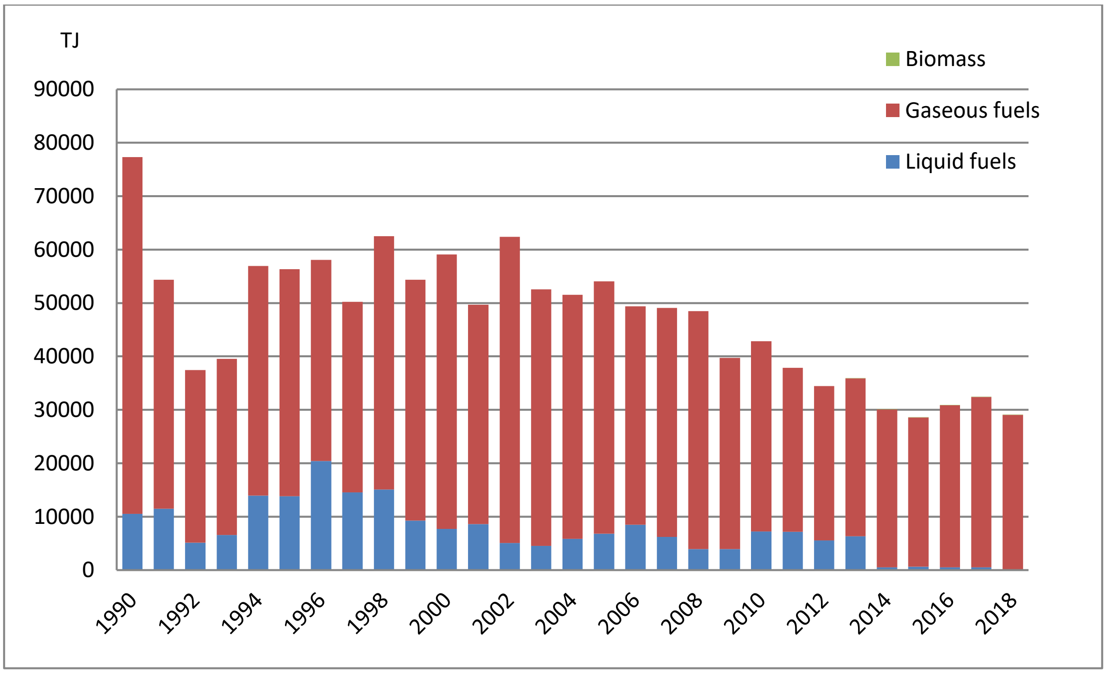


Figure 3.3.2. Fuel consumption [TJ] trends, by fuel type, for NFR 1.A.1.b

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

This category includes emissions from fuel combustion in the following industries: Oil and gas extraction, Coal Mines, Coke Ovens and other non-specified fuel consumption in energy industries. The 1990-2018 emissions were estimated by applying Tier 1 emission factors (2016 EMEP/EEA Guidebook, small combustion) to activity data from EUROSTAT (complete energy balances, annual data - nrg_110a), categories *Consumption of the energy branch/ Consumption in Oil and gas extraction, Consumption in Coal Mines, Consumption in Coke Ovens, Consumption in Non-specified (Energy).* Fuel consumption for 2017 and 2018 was provided by the N.I.S via Eurostat Energy questionnaires. Before 2018 submission, 1A1c category included only coke ovens emissions. Starting 2018 report, NFR category 1A1c was extended to more sources (detailed above), in order to cover all relevant categories reported to EUROSTAT Energy under category *Consumption of the energy branch*. This improvement of the inventory led to an increase of activity data and emissions values for NFR 1A1c, starting with 2018 submission.

NFR 1.A.1.c is not a key source for any pollutant.

Improvements and recalculations:

- First estimation of emissions for the time series 1990-1994;
- Correction of BC values, due to correction of emission factors for liquid fuels;

Tables and charts below show the main emissions and fuel consumption time series for the category NFR 1.A.1.c.

Table 3.4.1. Emissions of NOx, NMVOC, SOx CO and PM for NFR 1.A.1.c.

Year/Pollutant (kt)	NOx	NMVOC	SOx	CO	$PM_{2.5}$	PM_{10}	TSP
1990	0.442	0.029	0.136	0.134	0.026	0.029	0.029
1991	0.579	0.040	0.199	0.200	0.037	0.041	0.041
1992	5.650	0.804	2.628	3.245	0.429	0.471	0.482
1993	6.300	0.873	1.375	2.080	0.280	0.309	0.309
1994	8.563	1.415	2.447	3.736	0.445	0.488	0.495
1995	8.501	1.410	3.548	4.796	0.585	0.640	0.656
1996	6.809	1.266	3.797	4.974	0.586	0.639	0.660
1997	13.773	2.419	4.437	6.711	0.775	0.847	0.864
1998	10.712	1.830	4.280	5.941	0.711	0.778	0.796
1999	7.290	1.022	2.182	2.995	0.399	0.439	0.444
2000	5.708	1.020	1.635	2.614	0.296	0.324	0.329
2001	6.214	1.184	1.685	2.866	0.310	0.338	0.344
2002	8.992	1.429	2.235	3.515	0.431	0.473	0.477
2003	8.853	2.040	9.771	11.739	1.370	1.488	1.558
2004	9.844	1.489	4.443	5.661	0.733	0.802	0.822
2005	9.339	1.301	2.252	3.301	0.443	0.488	0.490
2006	5.929	0.877	1.320	2.068	0.265	0.292	0.292
2007	5.962	0.671	1.523	1.946	0.300	0.332	0.332
2008	6.262	0.758	1.653	2.175	0.319	0.353	0.354
2009	3.401	0.524	0.789	1.250	0.156	0.172	0.173
2010	4.060	0.603	0.892	1.408	0.180	0.198	0.198
2011	3.515	0.525	0.773	1.224	0.155	0.171	0.171
2012	3.211	0.506	0.673	1.127	0.137	0.151	0.151
2013	3.239	0.519	0.622	1.095	0.130	0.143	0.143
2014	3.937	0.596	0.806	1.326	0.166	0.183	0.183
2015	2.565	0.387	0.530	0.866	0.109	0.120	0.120
2016	1.875	0.426	0.222	0.692	0.053	0.057	0.057
2017	3.538	0.470	0.805	1.168	0.162	0.179	0.179
2018	1.341	0.257	0.209	0.470	0.046	0.050	0.050

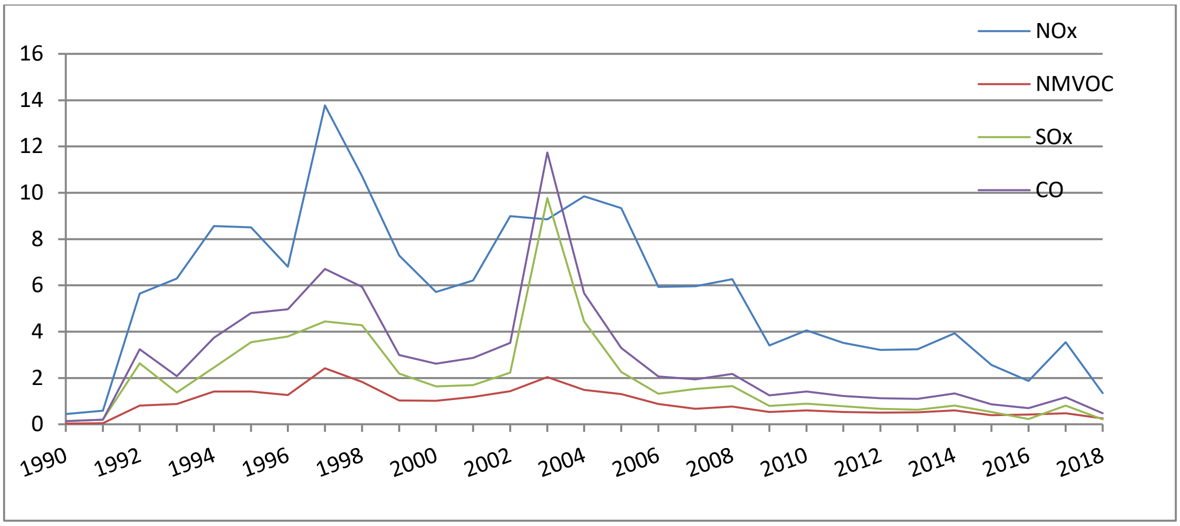


Figure 3.4.1a Emissions (kt) of NOx, NMVOC, SOx and CO for NFR 1.A.1.c.

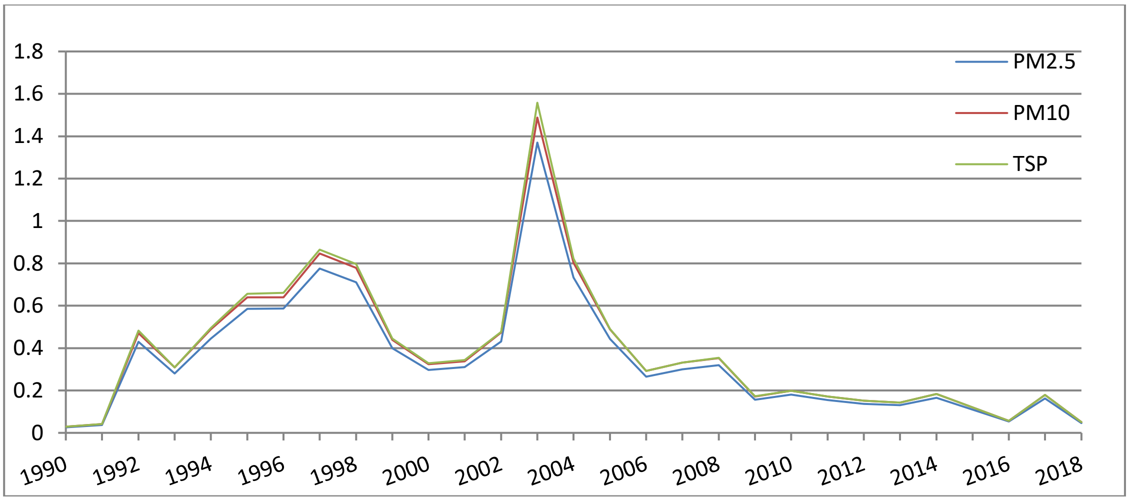


Figure 3.4.1b Emissions (kt) of TSP, PM_{10}, $PM_{2.5}$ for NFR 1.A.1.c.

The emissions peak in 1997 and 2002-2003, corresponding to the variation of coke production in Romania.

Table 3.4.2 Fuel consumption (TJ), by fuel type, for NFR 1.A.1.c

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	1446	0	0	0
1991	1876	27	0	0
1992	13427	1613	17054	0
1993	14450	0	25385	0
1994	17043	972	42966	0
1995	17454	2241	37464	0
1996	12749	3068	32126	0
1997	25873	2328	73690	0
1998	21215	2681	50760	0
1999	16884	687	27087	7
2000	10437	753	32203	14

2001	10447	805	38856	32
2002	18535	552	43545	26
2003	14225	10010	37377	23
2004	22341	2762	34141	16
2005	21460	250	36875	6
2006	12910	106	26484	2
2007	15757	38	15319	2
2008	15904	173	18449	0
2009	7185	123	15953	8
2010	8805	62	18311	1
2011	7584	59	15997	0
2012	6581	52	16048	2
2013	6496	0	16909	1
2014	8365	9	18586	1
2015	5468	9	12031	1
2016	2104	15	16602	1
2017	8394	8	13080	1
2018	2137.8	1.6	9281	0.5

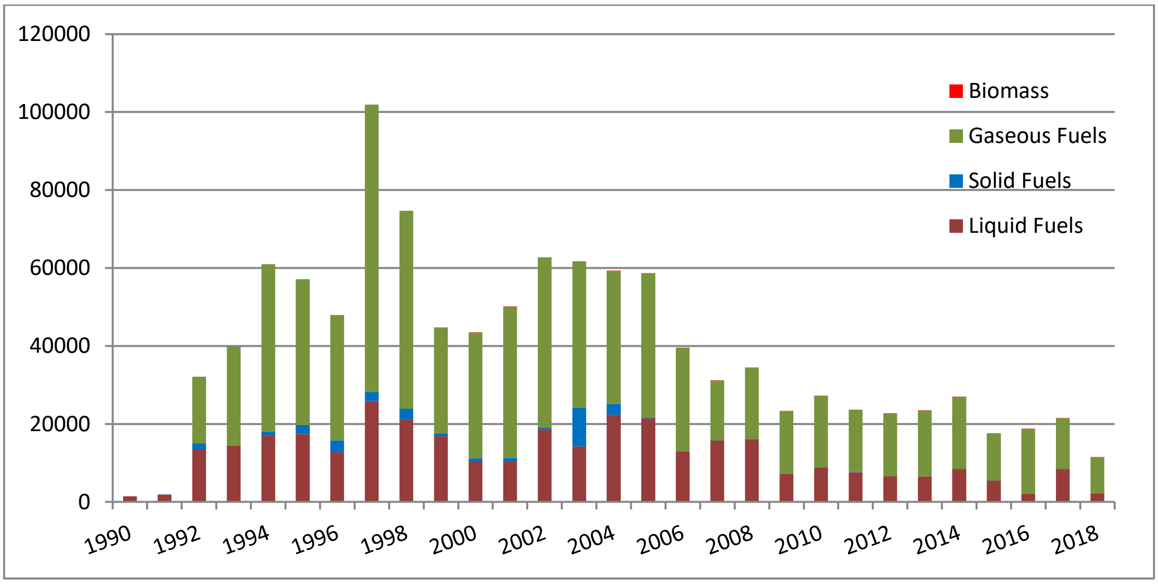


Figure 3.4.2 Fuel consumption [TJ] , by fuel type, for NFR 1.A.1.c, 1990-2018

3.5 NFR 1.A.2 Stationary combustion in manufacturing industries and construction

NFR 1A2 refers to emissions from the stationary combustion in manufacturing industries and construction. The sub-sectors cover the combustion installations from the following sources:

- NFR 1.A.2.a Iron and Steel
- NFR 1.A.2.b Non-Ferrous Metals (included in this submission in 1A2a)
- NFR 1.A.2.c Chemicals
- NFR 1.A.2.d Pulp, Paper and Print
- NFR 1.A.2.e Food Processing, Beverages and Tobacco
- NFR 1.A.2.f Non-metallic minerals
- NFR 1.A.2.gviii Other

The NFR category 1A2gvii - Mobile Combustion in manufacturing industries and construction is also described in this section.

In 2018, key sources from NFR 1A2 sector, combustion in industry, are:

- NFR 1A2a - Iron and steel industry, for SO2 (21.97%), Pb (6.75%) and Hg (12.92%), PCBs (17.35%);
- NFR 1A2f - Non-metallic minerals, for NOx (4.11 %) and Hg (5.83%) ;
- NFR 1A2gvii- Mobile Combustion in manufacturing industries and construction, for NOx (4.38%).

Emissions from stationary fuel combustion in industry, for all subcategories, have been estimated based on fuel consumption data from statistics and default Tier 1 emission factors (2019 EMEP/EEA Guidebook, NFR 1.A.2, Tables 3.2 to 3.5). The statistics relate to EUROSTAT complete energy balances, annual data (nrg_110a), category Final energy consumption/ Industry and, for the last year, Eurostat ENERGY questionnaires provided by the Romanian National Institute of Statistics. Details are given in the *Table 3.1.1 Reference of activity data for NFR categories 1.A.1, 1.A.2, 1.A.4 and 1.A.5.* The emissions from NFR 1A2b - Combustion in non-ferrous metals industry, are included at *NFR 1A2a* - Iron and Steel . The reason is that the fuel consumption for this category is not recorded separately in the available energy statistics.
The shares of emissions from combustion in industry - NFR 1A2, in the country total, by pollutant, is shown in the table 3.5.1 and figure 3.5.1:

Table 3.5.1. Share of emissions from 1A2a in the national total

Pollutant	1A2	National Total	Unit	1A2 in national total %
NOx	32.247	225.378	kt	14.308
NMVOC	12.036	237.373	kt	5.071
SOx	29.104	82.473	kt	35.289
NH3	0.014	175.615	kt	0.008
$PM_{2.5}$	5.827	110.740	kt	5.262
PM_{10}	6.140	146.427	kt	4.193
TSP	6.431	222.775	kt	2.887
BC	1.156	13.492	kt	8.564
CO	48.187	779.021	kt	6.186
Pb	4.485	39.951	t	11.227

Pollutant	1A2	National Total	Unit	1A2 in national total %
Cd	0.190	2.965	t	6.421
Hg	0.324	1.352	t	23.931
As	0.141	4.110	t	3.421
Cr	0.675	11.968	t	5.640
Cu	1.141	23.648	t	4.826
Ni	0.452	8.276	t	5.464
Se	0.073	9.124	t	0.805
Zn	12.208	108.212	t	11.281
PCDD/ PCDF	7.468	153.027	g I-TEQ	4.880
Total PAH	5.229	58.288	t	8.971
HCB	0.070	3.203	kg	3.203
PCBs	5.344	27.124	kg	27.124

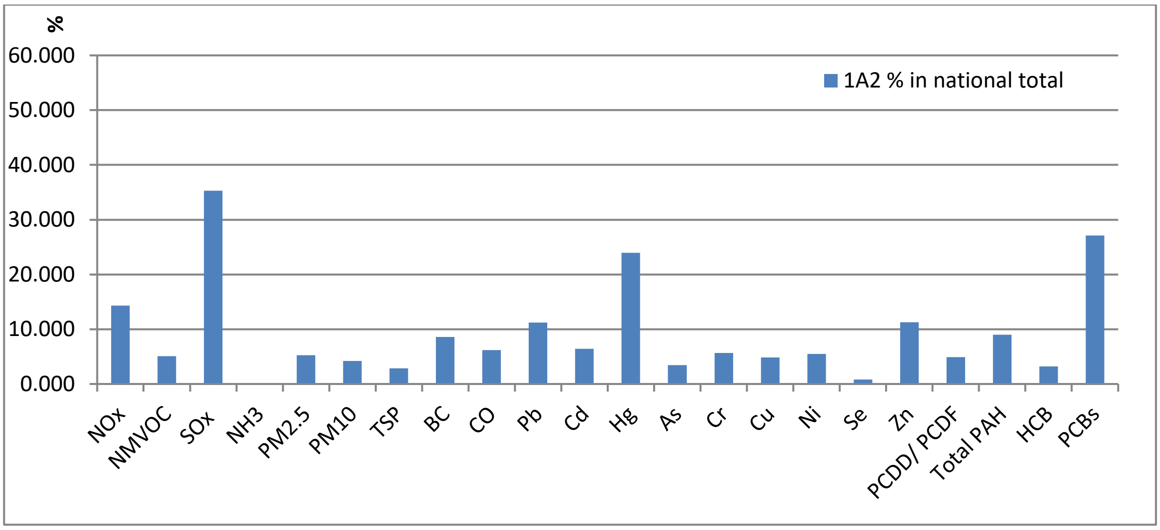


Figure 3.5.1 Share of 1A2 emissions by pollutant in the national total (%) 2018

The following table and chart give details on the shares of fuel consumption by fuel type and subcategory within NFR 1A2 (Fig. 3.5.2), which is relevant for the contribution of the specific industries to sector emissions.

Table 3.5.2. 1A2 Fuel consumption [TJ] by NFR and fuel type, 2018

NFR	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1A2a	22.8	20107.5	29322.5	0.2
1A2c	257.6	2288.0	39580.1	155.8
1A2d	0.0	108.9	2907.7	84.1
1A2e	7.0	289.0	13371.3	1113.1
1A2f	12692.5	8609.6	17047.9	90.6
1A2gvii	13098.7			
1A2gviii	87.5	28.9	23770.8	8595.1

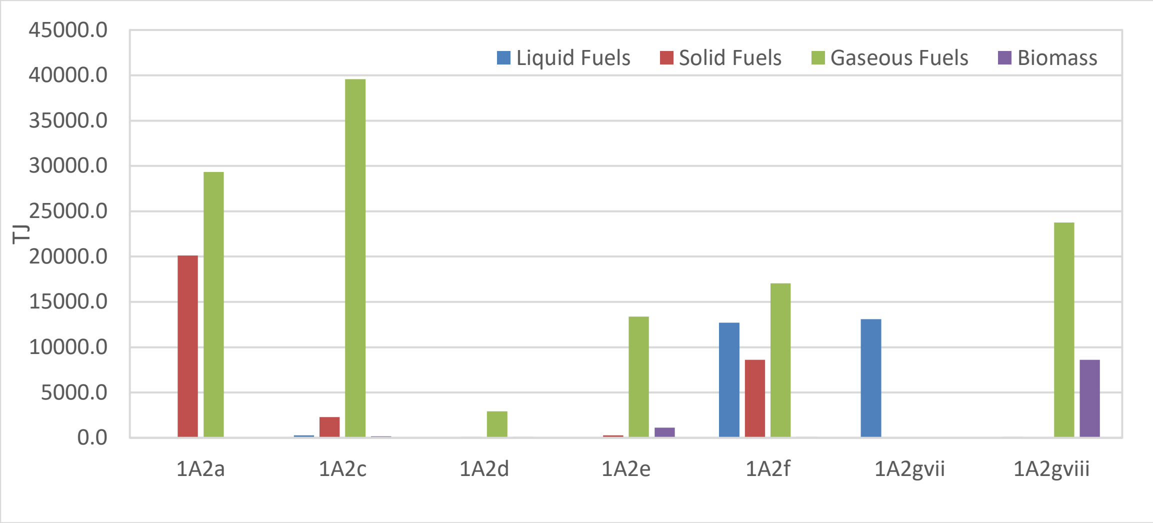


Figure 3.5.2 NFR 1A2 - Fuel consumption [TJ] by fuel type and subcategory, 2018

Time-series trends of emissions and fuel consumption for 1A2 sector and sub-sectors

The trend of fuel consumption in industry (total 1A2), by fuel type, since 1990, is given in the table and chart below:

Table 3.5.3. Trend of fuel consumption, by fuel type, from 1990, for 1A2 sector

Year/Fuel type (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	67735	97919	755418	0
1991	73563	79864	519760	1309
1992	53436	62877	163792	1746
1993	36664	54803	169943	1562
1994	63982	59011	306076	8220
1995	58831	72953	356497	9380
1996	85093	63204	327341	9627
1997	68260	70530	261111	12653
1998	60237	62813	188591	9250
1999	48153	42565	181322	9359
2000	56292	43593	187127	10929
2001	62919	45704	202384	9649
2002	57578	54388	220431	13582
2003	38597	57230	223446	19922
2004	46034	66708	198031	11019
2005	44037	68766	195765	10280
2006	42194	66866	178879	12253
2007	40095	56356	176298	14782
2008	32645	54594	185266	8719
2009	18682	35295	134664	8877
2010	14199	39826	138183	10551
2011	21466	35296	143721	8823
2012	25453	33618	128954	10968

Year/Fuel type (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
2013	21235	30995	121826	11520
2014	23340	29511	124541	10989
2015	27200	34137	114089	10285
2016	26890	33465	105198	12332
2017	27014	28571	120365	12041
2018	26166	31432	126000	10039

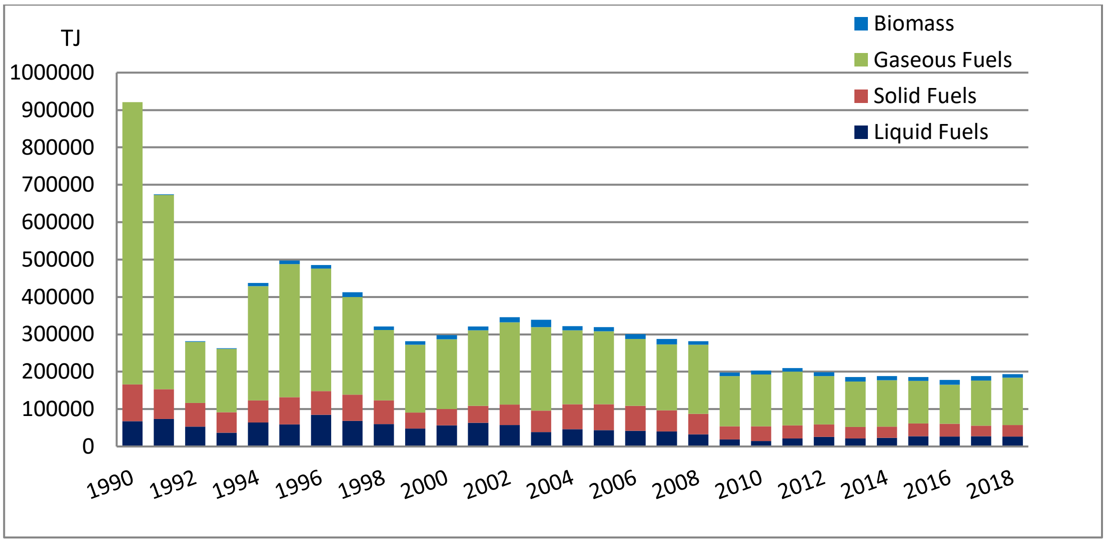


Figure 3.5.3 Fuel consumption (TJ) in industry (NFR 1A2), by fuel type 1990-2018

Total fuel consumption in industry decreased from 1990 to 2018 with about 79% (total energy). The highest decrease was recorded in gaseous fuel consumption, determined mostly by the decrease of production in the iron and steel industry.
The emissions from combustion in industry follow the variation of fuel combustion. The following section gives the emissions by NFR for the relevant pollutants, from 1990 to 2018, in tables and charts. For 1990 and 1991 emissions from NFR 1A2d and NFR 1A2gvii are included in 1A2gviii.

Table 3.5.4 NOx emissions for 1A2 sector by NFR, 1990-2018 (kt)

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
1990	27.603	25.976	IE	0.223	0.491	IE	50.925
1991	22.793	14.912	IE	0.022	0.127	IE	52.281
1992	15.853	4.305	0.175	1.090	7.762	18.729	7.452
1993	17.396	5.742	0.106	1.238	6.257	8.858	3.884
1994	19.457	13.267	1.175	4.700	6.220	17.106	9.865
1995	20.988	15.192	2.013	5.514	6.976	14.099	9.866
1996	19.855	15.069	2.019	5.384	8.039	27.099	10.120
1997	20.098	11.539	1.611	4.602	6.597	18.939	9.827
1998	19.449	5.822	1.628	1.653	7.021	17.790	7.812
1999	14.651	5.670	1.395	2.313	5.691	10.763	8.747

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
2000	14.396	8.778	1.247	2.148	10.238	13.086	4.839
2001	12.987	12.087	1.314	2.189	11.966	15.590	4.439
2002	13.872	10.431	1.372	1.707	11.481	16.529	4.731
2003	14.280	9.758	1.765	1.685	6.873	12.702	4.337
2004	16.812	7.641	1.058	1.833	10.408	11.103	4.904
2005	18.296	7.653	0.907	2.452	8.466	11.999	3.028
2006	18.826	6.987	0.739	1.657	6.145	12.667	4.046
2007	12.762	6.025	0.852	1.535	5.372	19.274	4.188
2008	11.116	7.024	0.238	1.445	5.900	13.708	5.211
2009	7.081	5.801	0.178	1.338	3.885	7.750	2.426
2010	7.354	5.560	0.347	1.475	2.721	7.166	2.702
2011	6.933	6.082	0.091	1.600	4.795	8.890	2.868
2012	5.542	5.256	0.127	1.787	7.265	9.991	2.596
2013	5.836	4.287	0.136	1.218	6.107	8.793	2.632
2014	5.749	4.131	0.170	1.235	7.410	8.665	2.586
2015	6.600	3.417	0.216	1.177	8.399	10.164	2.367
2016	6.470	2.670	0.239	1.294	8.590	9.771	2.472
2017	5.785	3.289	0.362	1.440	8.695	9.836	2.478
2018	5.660	3.471	0.242	1.144	9.270	9.868	2.591

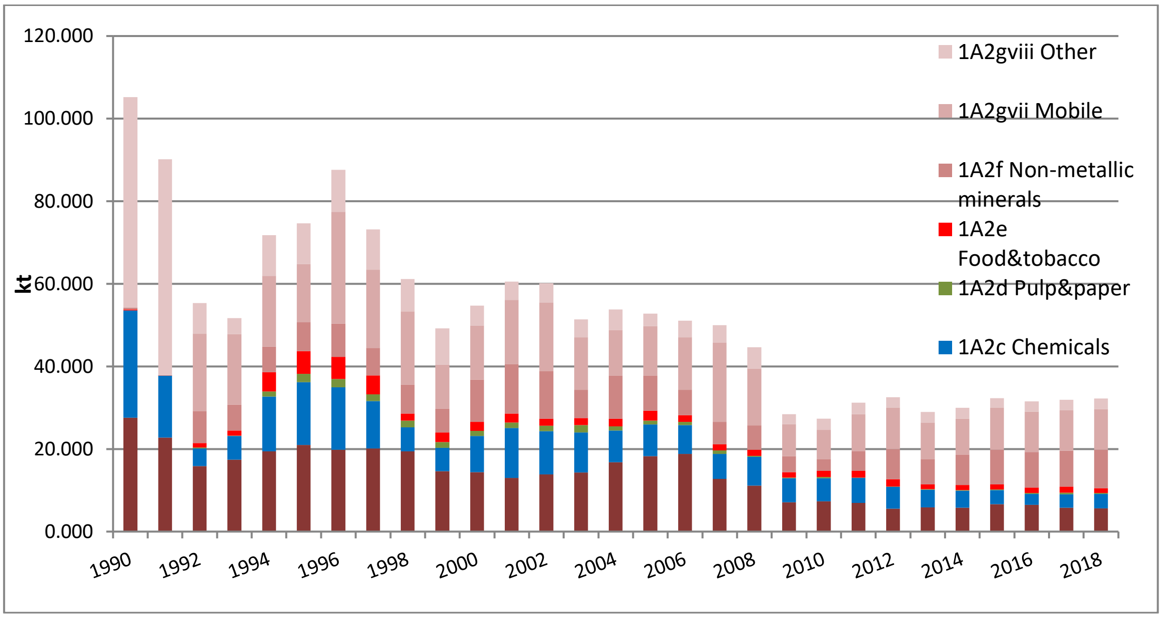


Figure 3.5.4 NOx emissions (kt) for 1A2 sector by NFR, 1990-2018

Table 3.5.5 NMVOC (kt) emissions for 1A2 sector by NFR, 1990-2018

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
1990	11.564	8.318	IE	0.115	0.252	IE	7.960
1991	9.578	4.639	IE	0.012	0.065	IE	6.984

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
1992	6.254	1.411	0.022	0.290	1.119	17.715	1.435
1993	6.170	1.279	0.006	0.310	0.909	6.093	1.175
1994	6.887	2.744	0.059	1.191	0.953	5.316	3.940
1995	7.929	4.103	0.937	1.339	1.007	2.250	3.184
1996	7.143	3.564	0.916	1.274	1.101	14.985	3.224
1997	7.805	2.345	0.942	1.008	1.000	10.473	4.017
1998	6.966	1.510	0.918	0.468	0.891	16.219	2.801
1999	4.733	1.406	0.854	0.628	0.800	8.636	3.157
2000	4.615	2.075	1.186	0.582	1.032	11.046	2.902
2001	4.442	2.675	1.091	0.623	1.254	8.743	2.557
2002	5.026	2.967	1.823	0.453	1.255	22.325	3.262
2003	5.448	3.167	3.029	0.537	0.799	10.934	3.728
2004	6.360	2.388	1.323	0.650	1.089	9.372	2.728
2005	6.626	2.300	1.304	0.817	1.113	13.344	2.190
2006	6.556	1.949	1.283	0.615	0.949	9.124	2.984
2007	5.541	1.944	1.085	0.615	0.945	14.196	3.685
2008	4.949	2.318	0.210	0.505	1.145	8.118	2.938
2009	2.882	1.943	0.161	0.676	1.145	7.198	2.274
2010	3.362	1.921	0.150	0.741	1.118	5.337	2.690
2011	3.141	2.083	0.054	0.687	1.075	3.689	2.282
2012	2.426	1.835	0.074	0.825	1.784	2.885	2.601
2013	2.531	1.540	0.065	0.698	1.744	3.450	2.665
2014	2.484	1.478	0.070	0.766	1.503	3.400	2.771
2015	2.882	1.259	0.091	0.742	1.473	4.064	2.630
2016	2.876	0.951	0.094	0.630	1.617	3.542	3.266
2017	2.497	1.106	0.157	0.794	1.683	3.641	3.027
2018	2.461	1.167	0.102	0.667	1.501	3.009	3.130

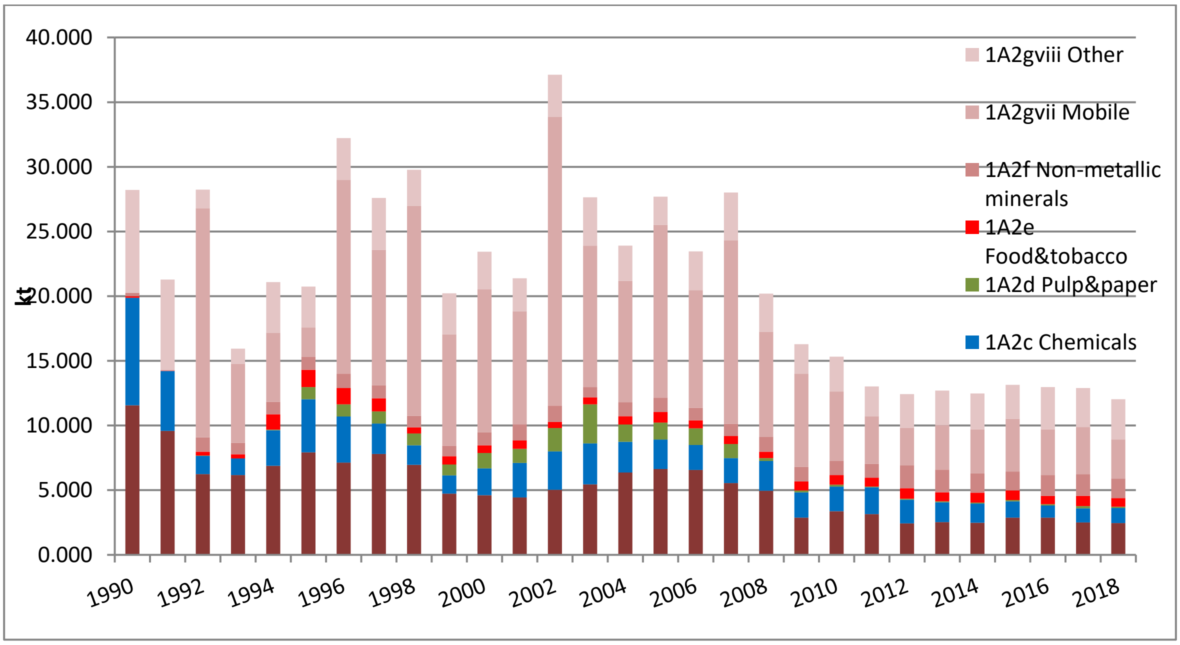


Figure 3.5.5 NMVOC emissions (kt) for 1A2 sector by NFR, 1990-2018

Table 3.5.6 PM2.5 (kt) emissions for 1A2 sector by NFR, 1990-2018

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
1990	9.337	1.014	IE	0.139	0.306	IE	2.336
1991	7.792	0.164	IE	0.014	0.079	IE	2.636
1992	5.962	0.683	0.006	0.144	0.390	1.457	0.504
1993	5.706	0.387	0.004	0.124	0.253	0.653	0.280
1994	6.271	0.332	0.046	0.293	0.228	1.159	1.414
1995	7.089	0.925	0.404	0.362	0.293	0.922	1.204
1996	6.139	0.920	0.388	0.347	0.380	1.940	1.210
1997	7.373	0.617	0.398	0.320	0.248	1.356	1.479
1998	6.392	0.620	0.405	0.139	0.301	1.374	1.060
1999	4.131	0.670	0.372	0.195	0.219	0.813	1.119
2000	4.052	0.912	0.519	0.186	0.423	0.997	1.043
2001	4.031	1.222	0.475	0.123	0.543	1.118	0.878
2002	4.762	1.230	0.807	0.113	0.442	1.391	1.243
2003	5.248	1.085	1.363	0.128	0.292	0.971	1.435
2004	6.250	0.994	0.586	0.178	0.530	0.846	0.966
2005	6.593	0.975	0.566	0.145	0.500	0.965	0.765
2006	6.523	0.860	0.563	0.178	0.393	0.940	1.047
2007	5.327	0.688	0.472	0.152	0.462	1.435	1.450
2008	4.847	0.747	0.072	0.101	0.757	0.990	1.010
2009	2.796	0.722	0.056	0.198	0.724	0.601	0.813
2010	3.354	0.727	0.025	0.248	0.599	0.535	1.014
2011	3.076	0.735	0.014	0.205	0.486	0.617	0.831
2012	2.219	0.724	0.019	0.317	1.231	0.673	0.999
2013	2.267	0.593	0.013	0.276	1.075	0.607	1.018
2014	2.174	0.532	0.011	0.289	0.987	0.598	1.063
2015	2.657	0.515	0.015	0.271	1.013	0.703	1.014
2016	2.761	0.268	0.015	0.217	1.112	0.670	1.324
2017	2.249	0.275	0.034	0.278	1.117	0.676	1.190
2018	2.195	0.305	0.026	0.198	1.210	0.668	1.227

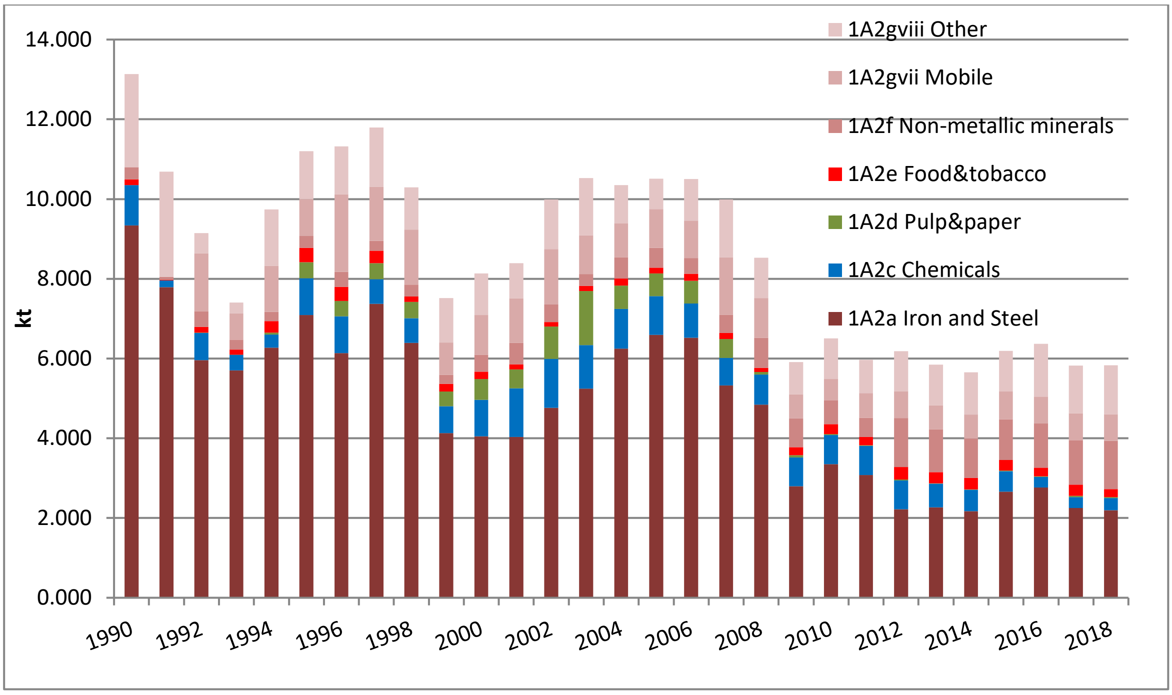


Figure 3.5.6 PM2.5 emissions (kt) for 1A2 sector by NFR, 1990-2018

Table 3.5.7 SOx emissions for 1A2 sector by NFR, 1990-2018

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
1990	76.798	6.499	IE	1.162	2.552	IE	10.752
1991	64.099	0.178	IE	0.117	0.662	IE	10.641
1992	48.676	4.741	0.012	0.838	1.554	1.275	2.132
1993	46.131	1.989	0.009	0.563	0.931	0.585	0.969
1994	50.592	0.585	0.107	1.123	0.754	1.077	2.175
1995	57.525	5.643	0.313	1.361	1.117	0.871	1.936
1996	49.512	5.053	0.173	1.185	1.626	1.759	1.901
1997	60.193	2.421	0.132	0.854	0.866	1.229	1.303
1998	51.874	4.063	0.138	0.301	1.032	1.206	0.976
1999	33.099	4.858	0.129	0.226	0.752	0.720	1.012
2000	32.456	6.430	0.194	0.356	1.365	0.880	0.442
2001	32.556	8.496	0.122	0.231	1.560	1.013	0.354
2002	38.677	9.163	0.126	0.219	1.360	1.179	1.225
2003	42.867	8.230	0.165	0.171	1.040	0.856	0.360
2004	51.030	7.586	0.085	0.225	2.258	0.747	0.525
2005	53.643	7.417	0.065	0.149	1.918	0.833	0.177
2006	52.869	6.432	0.056	0.129	1.737	0.839	0.354
2007	43.961	5.232	0.063	0.104	1.962	1.280	0.283
2008	40.085	5.695	0.007	0.047	3.846	0.894	0.314
2009	22.968	5.585	0.006	0.085	3.560	0.527	0.100
2010	27.788	5.556	0.005	0.466	2.303	0.476	0.125
2011	25.467	5.559	0.002	0.280	0.952	0.567	0.142
2012	18.325	5.577	0.005	0.823	6.147	0.627	0.155
2013	18.706	4.473	0.004	0.878	4.353	0.559	0.129

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
2014	17.934	3.968	0.004	0.741	4.532	0.551	0.132
2015	21.934	3.848	0.012	0.664	4.956	0.647	0.132
2016	22.833	1.832	0.028	0.647	5.477	0.619	0.152
2017	18.50	1.828	0.079	0.646	5.344	0.624	0.129
2018	18.117	2.100	0.101	0.282	8.358	0.006	0.141

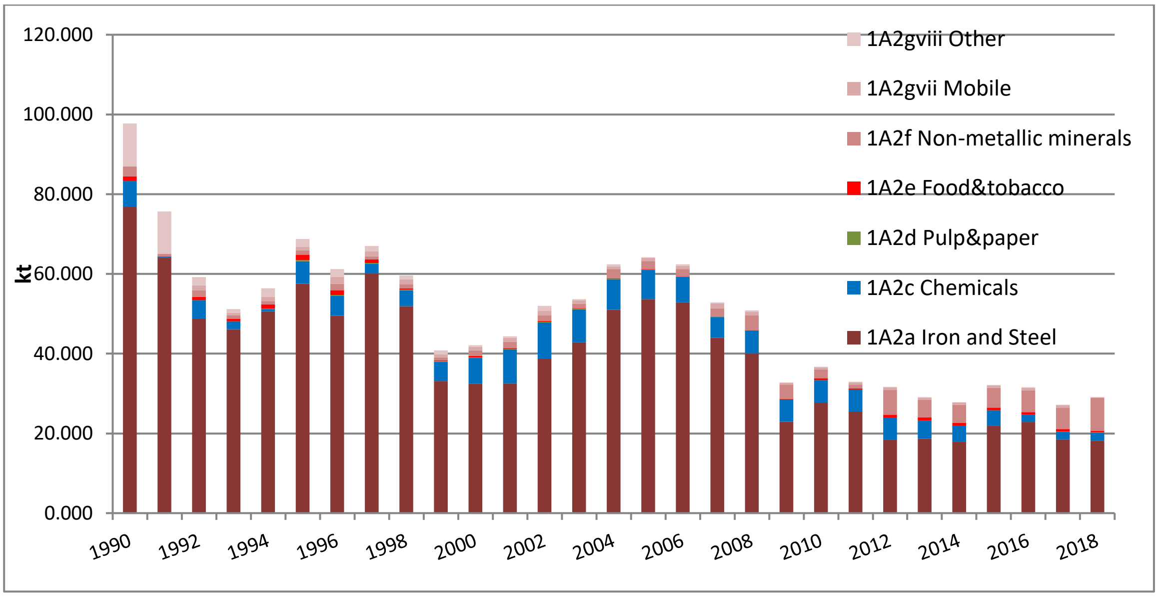


Figure 3.5.7 SOx emissions (kt) for 1A2 sector by NFR, 1990-2018

Table 3.5.8 Pb (t) emissions for 1A2 sector by NFR, 1990-2018

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
1990	11.419	0.938	IE	0.173	0.380	1.159
1991	9.531	0.009	IE	0.017	0.098	1.093
1992	7.215	0.703	0.000	0.122	0.163	0.274
1993	6.812	0.267	0.000	0.081	0.082	0.147
1994	7.471	0.010	0.000	0.155	0.059	0.441
1995	8.517	0.789	0.089	0.186	0.103	8.517
1996	7.318	0.682	0.067	0.160	0.166	7.318
1997	8.917	0.296	0.071	0.113	0.072	8.917
1998	7.661	0.582	0.070	0.047	0.085	7.661
1999	4.867	0.693	0.067	0.038	0.060	4.867
2000	4.771	0.907	0.108	0.056	0.090	4.771
2001	4.799	1.187	0.089	0.035	0.107	4.799
2002	5.715	1.325	0.154	0.032	0.080	5.715
2003	6.345	1.208	0.260	0.031	0.084	6.345
2004	7.550	1.109	0.110	0.046	0.221	7.550
2005	7.924	1.080	0.107	0.030	0.209	7.924
2006	7.799	0.929	0.107	0.034	0.209	7.799
2007	6.534	0.767	0.089	0.031	0.259	6.534
2008	5.961	0.837	0.014	0.015	0.543	5.961

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
2009	3.407	0.822	0.010	0.039	0.538	3.407
2010	4.135	0.822	0.004	0.096	0.374	4.135
2011	3.789	0.822	0.003	0.062	0.140	3.789
2012	2.726	0.826	0.004	0.150	0.907	2.726
2013	2.782	0.666	0.003	0.158	0.666	2.782
2014	2.667	0.591	0.002	0.143	0.647	2.667
2015	3.262	0.574	0.004	0.131	0.688	3.262
2016	3.396	0.275	0.006	0.116	0.772	3.396
2017	2.758	0.272	0.015	0.127	0.756	2.758
2018	2.695	0.311	0.017	0.069	1.157	0.236

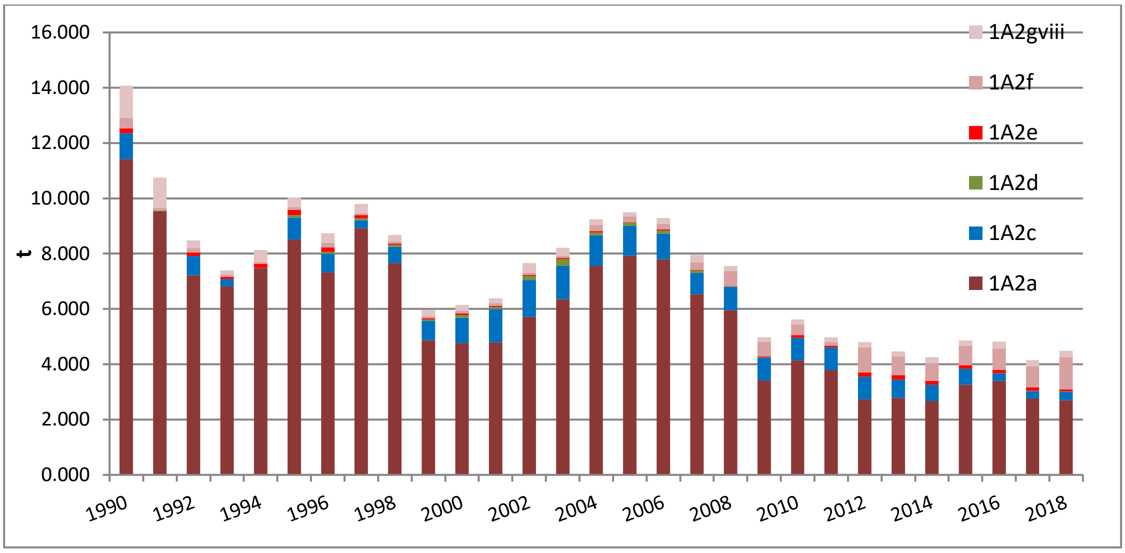


Figure 3.5.8 Pb emissions (t) for 1A2 sector by NFR, 1990-2018

Table 3.5.9 Hg (t) emissions for 1A2 sector by NFR, 1990-2018

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
1990	0.767	0.236	IE	0.010	0.022	0.208
1991	0.638	0.109	IE	0.001	0.006	0.167
1992	0.457	0.059	0.000	0.010	0.027	0.036
1993	0.436	0.037	0.000	0.008	0.021	0.027
1994	0.480	0.058	0.000	0.028	0.021	0.053
1995	0.551	0.125	0.007	0.032	0.023	0.551
1996	0.480	0.104	0.005	0.028	0.027	0.480
1997	0.567	0.056	0.005	0.019	0.022	0.567
1998	0.492	0.056	0.004	0.008	0.019	0.492
1999	0.318	0.061	0.004	0.008	0.018	0.318
2000	0.311	0.085	0.006	0.009	0.020	0.311
2001	0.310	0.109	0.005	0.012	0.022	0.310
2002	0.363	0.125	0.006	0.008	0.024	0.363
2003	0.401	0.126	0.009	0.009	0.017	0.401
2004	0.474	0.103	0.004	0.010	0.027	0.474

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
2005	0.495	0.100	0.005	0.015	0.025	0.495
2006	0.488	0.084	0.004	0.008	0.025	0.488
2007	0.413	0.078	0.004	0.009	0.024	0.413
2008	0.375	0.090	0.002	0.008	0.037	0.375
2009	0.215	0.081	0.001	0.008	0.036	0.215
2010	0.258	0.080	0.003	0.012	0.026	0.258
2011	0.238	0.083	0.001	0.010	0.014	0.238
2012	0.175	0.078	0.001	0.015	0.058	0.175
2013	0.180	0.064	0.001	0.014	0.042	0.180
2014	0.174	0.059	0.001	0.014	0.043	0.174
2015	0.209	0.053	0.002	0.013	0.046	0.209
2016	0.215	0.033	0.002	0.013	0.051	0.215
2017	0.178	0.036	0.003	0.014	0.051	0.178
2018	0.175	0.040	0.002	0.010	0.079	0.018

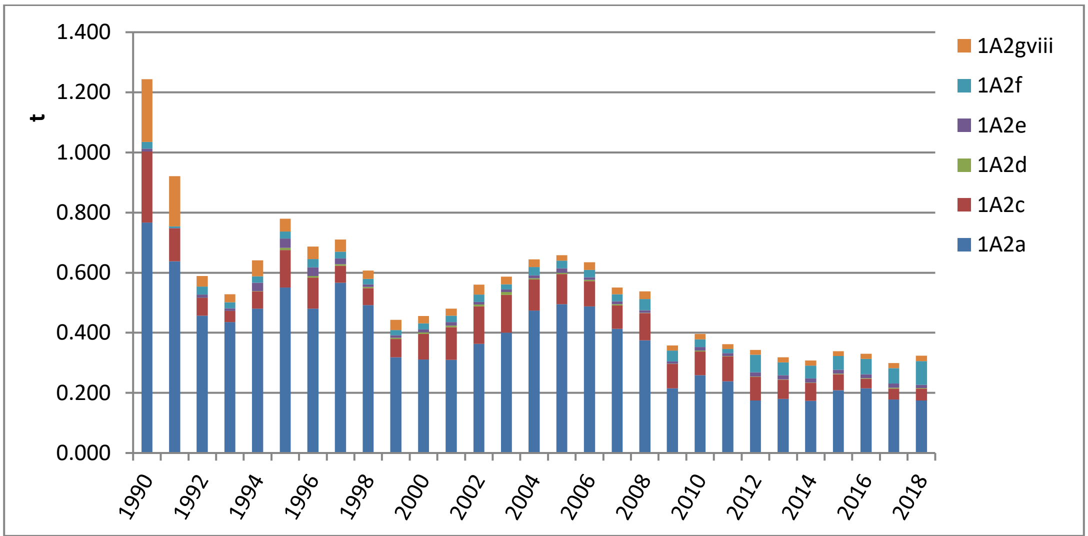


Figure 3.5.9 Hg emissions (t) for 1A2 sector by NFR, 1990-2018

Table 3.5.10 PCBs (kg) emissions for 1A2 sector by NFR, 1990-2018

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
1990	14.484	1.185	IE	0.219	0.482	1.460
1991	12.090	0.008	IE	0.022	0.125	1.332
1992	9.148	0.875	0.000	0.149	0.197	0.321
1993	8.636	0.326	IE	0.094	0.101	0.158
1994	9.470	0.001	IE	0.175	0.072	0.314
1995	0.551	0.125	0.007	0.032	0.023	0.551
1996	0.480	0.104	0.005	0.028	0.027	0.480
1997	0.567	0.056	0.005	0.019	0.022	0.567
1998	0.492	0.056	0.004	0.008	0.019	0.492
1999	0.318	0.061	0.004	0.008	0.018	0.318
2000	0.311	0.085	0.006	0.009	0.020	0.311
2001	0.310	0.109	0.005	0.012	0.022	0.310

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
2002	0.363	0.125	0.006	0.008	0.024	0.363
2003	0.401	0.126	0.009	0.009	0.017	0.401
2004	0.474	0.103	0.004	0.010	0.027	0.474
2005	0.495	0.100	0.005	0.015	0.025	0.495
2006	0.488	0.084	0.004	0.008	0.025	0.488
2007	0.413	0.078	0.004	0.009	0.024	0.413
2008	0.375	0.090	0.002	0.008	0.037	0.375
2009	0.215	0.081	0.001	0.008	0.036	0.215
2010	0.258	0.080	0.003	0.012	0.026	0.258
2011	0.238	0.083	0.001	0.010	0.014	0.238
2012	0.175	0.078	0.001	0.015	0.058	0.175
2013	0.180	0.064	0.001	0.014	0.042	0.180
2014	0.174	0.059	0.001	0.014	0.043	0.174
2015	0.209	0.053	0.002	0.013	0.046	0.209
2016	0.215	0.033	0.002	0.013	0.051	0.215
2017	0.178	0.036	0.003	0.014	0.051	0.178
2018	3.418	0.389	0.019	0.049	1.464	0.005

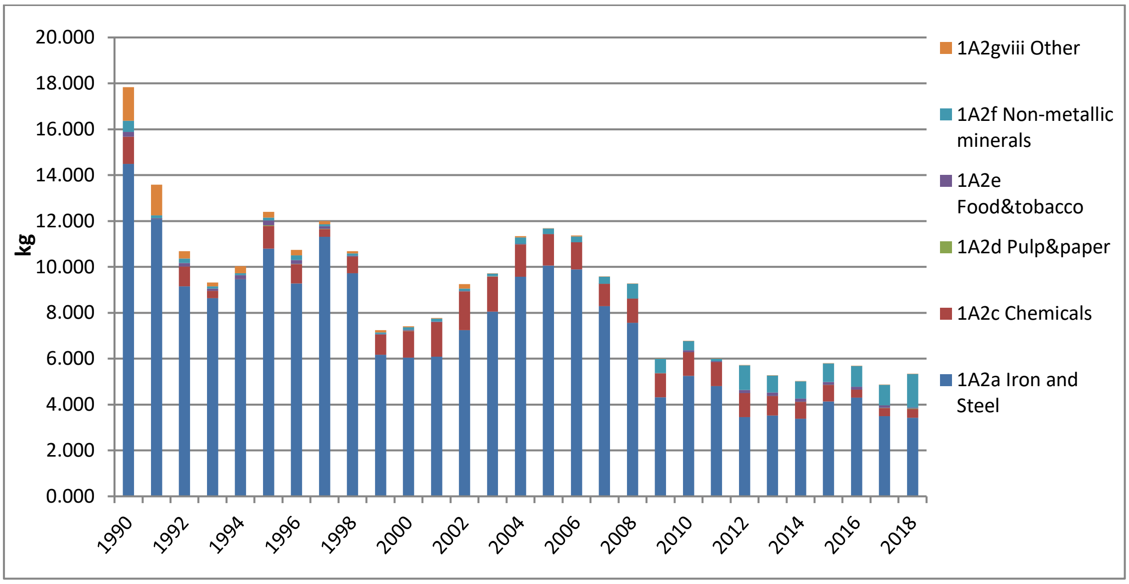


Figure 3.5.10 PCBs emissions (kg) for 1A2 sector by NFR, 1990 -2018

Improvements and recalculations : first estimation of emissions for NFR 1A2c, 1A2d, 1A2e, 1A2f, 1A2gvii and 1A2gviii for time series 1990-1994.
The next subchapters give details on NFR categories which are key sources in 2018.

3.5.1 NFR 1.A.2.a Iron and steel. Stationary combustion.

Emissions from fuel combustion in iron and steel industry have been estimated based on fuel consumption data from the EUROSTAT complete energy balances, annual data (nrg_110a), category *Final energy consumption/Industry/Iron & steel industry* and default Tier 1 emission factors (2019 EMEP/EEA Guidebook, NFR 1.A.2, Tables 3.2-3.5). This category includes also the emissions for NFR 1A2b Non-ferrous metals, because, in EUROSTAT Energy statistics, the specific activity data for Romania are included in fuel consumption for Iron and steel. NFR 1A2a was a key source for emissions of Sox (21.97%), Pb (6.75%), Hg (12.92%) and PCBs(17.35%) in 2018.

The following tables and charts show the trend of emissions and fuel consumption for NFR 1.A.2.a Iron and steel.

Table 3.5.1.1 Emissions of gaseous pollutants, particulate matter, BC, CO (kt), PCDD, PAH and PCBs NFR 1A2a, 1990-2018

Year/Pollutant	NOx (kt)	NMVOC (kt)	SOx (kt)	TSP (kt)	BC (kt)	CO (kt)	PCDD (g)	PAH (t)	PCBs (kg)
1990	27.60	11.56	76.80	10.70	0.59	84.36	17.39	12.49	0.05
1991	22.79	9.58	64.10	8.93	0.50	70.33	14.51	10.43	0.04
1992	15.85	6.25	48.68	6.82	0.43	52.13	10.97	7.98	0.03
1993	17.40	6.17	46.13	6.52	0.44	49.68	10.37	7.61	0.03
1994	19.46	6.89	50.59	7.16	0.49	54.64	11.38	8.35	0.04
1995	20.99	7.93	57.53	0.01	7.09	7.66	12.97	10.80	9.45
1996	19.86	7.14	49.51	0.01	6.14	6.63	11.15	9.27	8.15
1997	20.10	7.81	60.19	0.00	7.37	7.97	13.56	11.31	9.87
1998	19.45	6.97	51.87	0.00	6.39	6.91	11.65	9.72	8.54
1999	14.65	4.73	33.10	0.00	4.13	4.46	7.41	6.17	5.49
2000	14.40	4.62	32.46	0.00	4.05	4.37	7.27	6.05	5.38
2001	12.99	4.44	32.56	0.00	4.03	4.35	7.30	6.09	5.38
2002	13.87	5.03	38.68	0.00	4.76	5.15	8.69	7.25	6.37
2003	14.28	5.45	42.87	0.00	5.25	5.68	9.64	8.05	7.04
2004	16.81	6.36	51.03	0.00	6.25	6.76	11.47	9.58	8.38
2005	18.30	6.63	53.64	0.00	6.59	7.13	12.04	10.05	8.84
2006	18.83	6.56	52.87	0.00	6.52	7.05	11.85	9.89	8.73
2007	12.76	5.54	43.96	0.00	5.33	5.77	9.93	8.29	7.17
2008	11.12	4.95	40.09	0.00	4.85	5.25	9.05	7.56	6.53
2009	7.08	2.88	22.97	0.00	2.80	3.03	5.18	4.32	3.76
2010	7.35	3.36	27.79	0.00	3.35	3.63	6.28	5.25	4.52
2011	6.93	3.14	25.47	0.00	3.08	3.33	5.75	4.81	4.15
2012	5.54	2.43	18.33	0.00	2.22	2.40	4.14	3.46	2.98
2013	5.84	2.53	18.71	0.00	2.27	2.45	4.23	3.53	3.04
2014	5.75	2.48	17.93	0.00	2.17	2.35	4.06	3.38	2.92
2015	6.60	2.88	21.93	0.00	2.66	2.88	4.96	4.14	3.57
2016	6.47	2.88	22.83	0.00	2.76	2.99	5.16	4.31	3.72
2017	5.79	2.50	18.55	0.00	2.25	2.43	4.19	3.50	3.02
2018	5.66	2.46	18.12	2.52	0.14	19.57	4.10	2.95	0.01

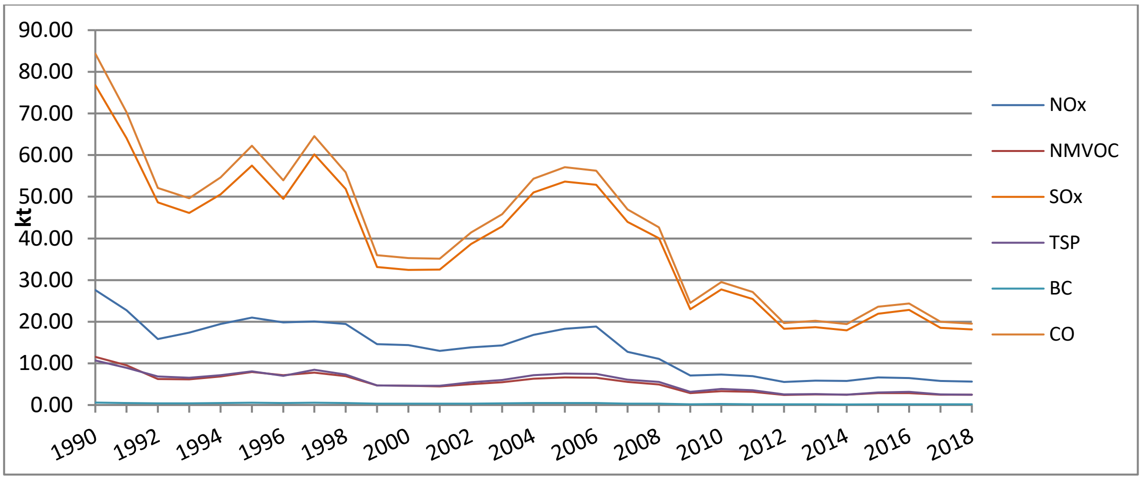


Figure 3.5.1.1 Emissions of NOx, SOx, NMVOC, NH_3, TSP, BC and CO (kt) for NFR 1A2a, 1990-2018

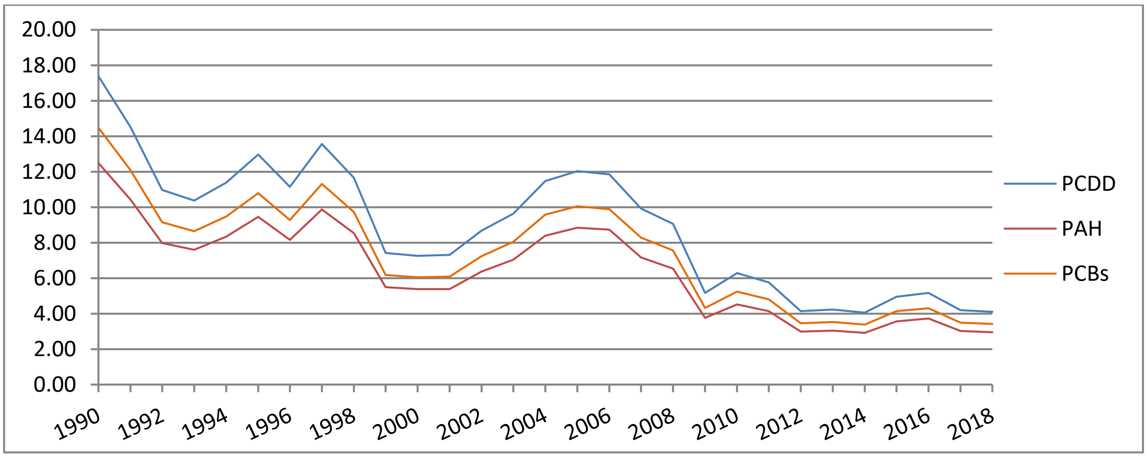


Figure 3.5.1.2 Emissions of PCDD/PCDF (g), PAH (t) and PCBs (kg) for NFR 1A2a, 1990-2018

Emissions of pollutants follow the activity data trend, with peaks in 1990, 1997 and 2005-2006 and then constantly decreasing for the entire time series.

Table 3.5.1.2. Emissions of Heavy Metals (t) for NFR 1.A.2.a.

Year/Pollutant	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	11.419	0.154	0.767	0.358	1.152	1.491	1.110	0.163	17.167
1991	9.531	0.128	0.638	0.299	0.962	1.245	0.926	0.136	14.332
1992	7.215	0.099	0.457	0.221	0.731	0.944	0.701	0.101	10.995
1993	6.812	0.093	0.436	0.210	0.691	0.892	0.662	0.096	10.488
1994	7.471	0.103	0.480	0.230	0.759	0.978	0.726	0.106	11.539
1995	8.517	0.117	0.551	0.263	0.865	1.114	0.827	0.120	13.065
1996	7.318	0.101	0.480	0.227	0.744	0.958	0.711	0.104	11.296
1997	8.917	0.121	0.567	0.274	0.902	1.166	0.866	0.125	13.574
1998	7.661	0.103	0.492	0.236	0.774	1.002	0.744	0.108	11.719
1999	4.867	0.066	0.318	0.151	0.493	0.637	0.473	0.070	7.547
2000	4.771	0.064	0.311	0.148	0.483	0.625	0.463	0.068	7.400
2001	4.799	0.065	0.310	0.148	0.485	0.628	0.466	0.068	7.381
2002	5.715	0.077	0.363	0.175	0.578	0.748	0.555	0.080	8.743
2003	6.345	0.085	0.401	0.194	0.641	0.830	0.616	0.089	9.647
2004	7.550	0.101	0.474	0.231	0.762	0.987	0.733	0.105	11.486

Year/Pollutant	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
2005	7.924	0.107	0.495	0.242	0.801	1.037	0.769	0.110	12.106
2006	7.799	0.105	0.488	0.238	0.788	1.021	0.757	0.109	11.967
2007	6.534	0.088	0.413	0.200	0.659	0.854	0.635	0.091	9.821
2008	5.961	0.080	0.375	0.182	0.601	0.779	0.579	0.083	8.942
2009	3.407	0.046	0.215	0.104	0.344	0.445	0.331	0.047	5.148
2010	4.135	0.056	0.258	0.126	0.417	0.540	0.401	0.057	6.192
2011	3.789	0.051	0.238	0.116	0.382	0.495	0.368	0.052	5.677
2012	2.726	0.037	0.175	0.084	0.275	0.356	0.265	0.038	4.089
2013	2.782	0.037	0.180	0.086	0.281	0.363	0.270	0.039	4.176
2014	2.667	0.036	0.174	0.083	0.269	0.348	0.259	0.038	4.004
2015	3.262	0.044	0.209	0.100	0.329	0.426	0.317	0.046	4.897
2016	3.396	0.046	0.215	0.104	0.343	0.444	0.330	0.047	5.093
2017	2.758	0.037	0.178	0.085	0.278	0.360	0.268	0.039	4.142
2018	2.695	0.036	0.175	0.083	0.272	0.352	0.262	0.038	4.044

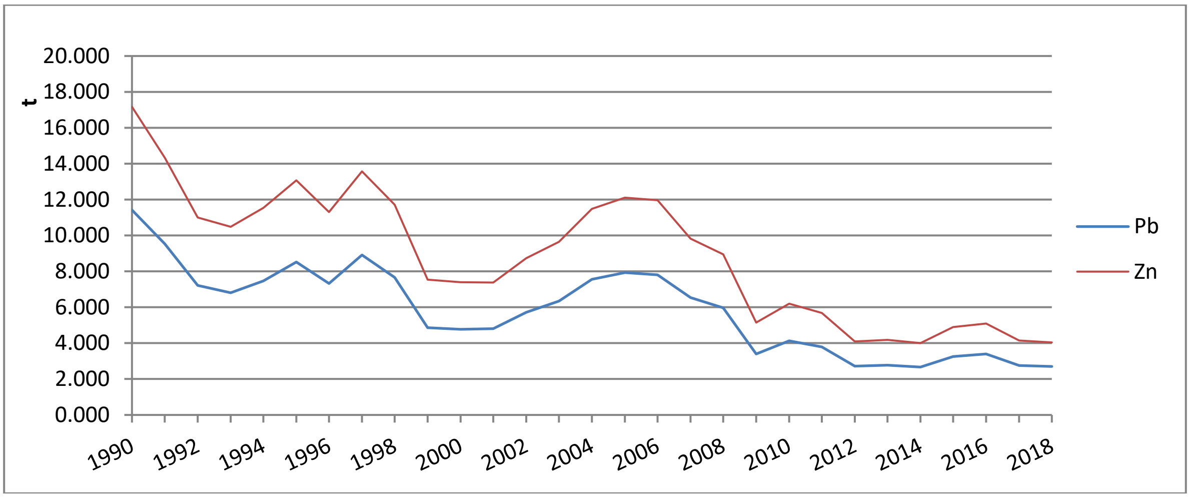


Figure 3.5.1.2.a Emissions of Pb and Zn (t) for NFR 1.A.2.a, 1990-2018

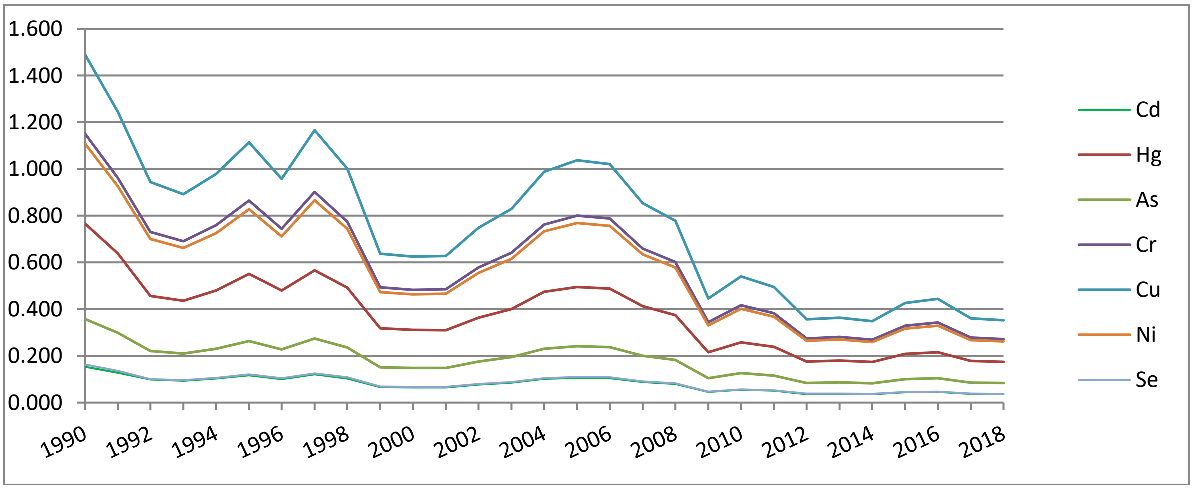


Figure 3.5.1.2.b Emissions of As, Cd, Cr, Cu, Hg, Ni and Se (t) for NFR 1.A.2.a,1990-2018

All heavy metals emissions showed important decreases in 2018 compared to 1990 emissions, around 76 % for Zn and Hg.

The iron and steel industry used mostly gaseous and solid fuels. The fuel consumption decreased from 1990 toward 2000, followed by a slight increase in the interval 2004-2006, a severe decrease to 2009 and a more steady variation afterwards. Total fuel consumption trend in the iron and steel industry is consistent with the production evolution. The amounts are given in the table and figure 3.5.1.3.

Table 3.5.1.3 Fuel consumption (TJ) by fuel type, for NFR 1.A.2.a.

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	0	85202	173824	0
1991	0	71116	141743	10
1992	4403	53810	57750	123
1993	7787	50802	62192	111
1994	8643	55706	72557	184
1995	6520	63507	89689	213
1996	7400	54558	89216	205
1997	5920	66515	74939	88
1998	8040	57163	73445	2
1999	8160	36308	56522	15
2000	8240	35592	54197	6
2001	6320	35807	47979	3
2002	5840	42634	47272	24
2003	4840	47341	48734	6
2004	6240	56335	52222	0
2005	8417	59126	50668	0
2006	9937	58188	49469	9
2007	1006	48755	51498	6
2008	480	44482	42891	0
2009	1554	25420	25481	0
2010	34	30854	27012	0
2011	34	28275	27346	2
2012	69	20338	26867	0
2013	79	20758	29794	1
2014	0	19903	31160	1
2015	172	24339	31094	2
2016	172	25341	27002	1
2017	164	20581	28925	0
2018	23	20108	29323	0

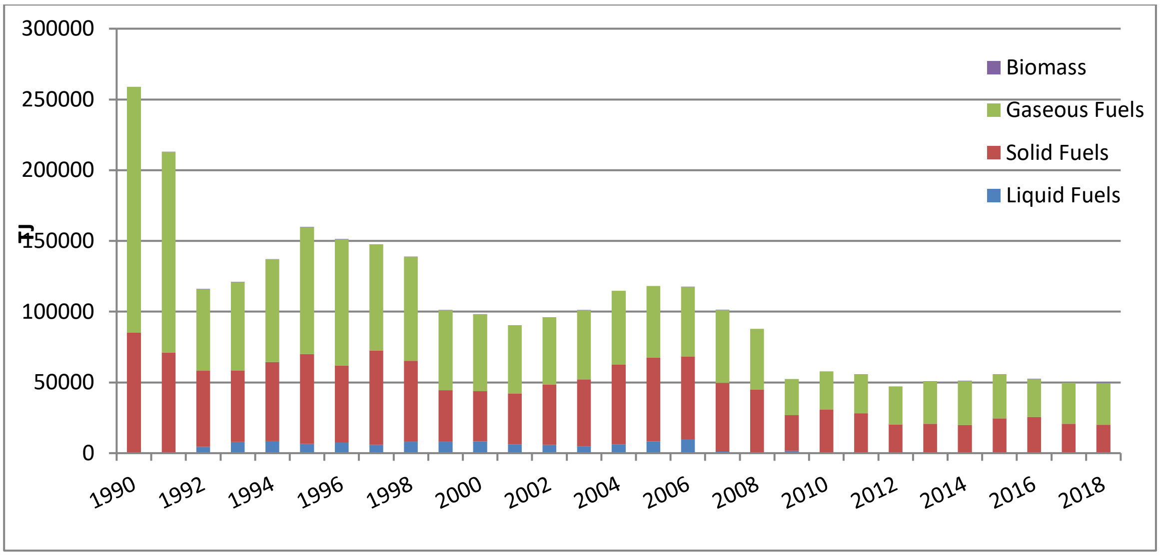


Figure 3.5.1.3 Fuel consumption (TJ), by fuel type, for NFR 1.A.2.a, 1990-2018

3.5.2 NFR 1.A.2.f. Non-metallic minerals. Stationary combustion.

Emissions from fuel combustion in non-metallic minerals industry have been estimated based on fuel consumption data from the EUROSTAT complete energy balances, annual data (nrg_110a), category *Final energy consumption/Industry/ Non-Metallic Minerals* and default Tier 1 emission factors (2019 EMEP/EEA Guidebook, NFR 1.A.2, Tables 3.2-3.5). Stationary combustion in non-metallic minerals industry was a key source for NOx emissions in 2018 (4.11%).

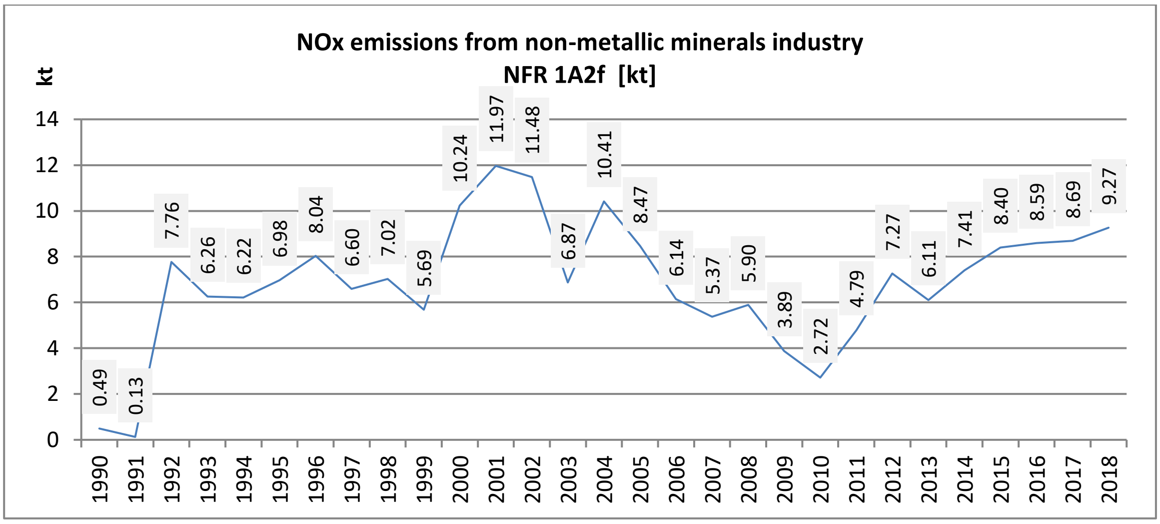


Figure 3.5.2.1 Emission Trend (kt) of NOx for NFR 1.A.2.f Non-metallic minerals – stationary combustion, 1990-2018

The trend in emissions is determined by the type and amount of fuel used in stationary combustion in the sector.

Table 3.5.2.2. Fuel consumption, by fuel type, for 1A2f sector, 1990-2018

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	0	2836	0	0
1991	0	735	0	0
1992	10412	1158	29712	242
1993	7960	597	27918	51
1994	7520	421	30861	61
1995	8960	750	30318	64
1996	10832	1217	30624	58
1997	8040	518	32147	45
1998	10000	605	23994	119
1999	7395	431	24582	39
2000	16283	648	23885	59
2001	19392	697	25114	431
2002	17432	576	32906	39
2003	10200	607	20683	48
2004	16488	1630	22468	50
2005	12712	1444	22277	515
2006	8268	1478	21814	364
2007	7434	1770	15957	783
2008	8528	3806	10244	1193
2009	4678	3685	9477	1611
2010	2636	2389	10446	2000
2011	7074	656	11897	1889
2012	10122	6264	10347	2456
2013	8452	4351	10000	3056
2014	11129	4423	10200	1990
2015	12982	4801	10296	1617
2016	13021	5375	10943	1875
2017	13018	5224	12558	2016
2018	12692	8610	17048	91

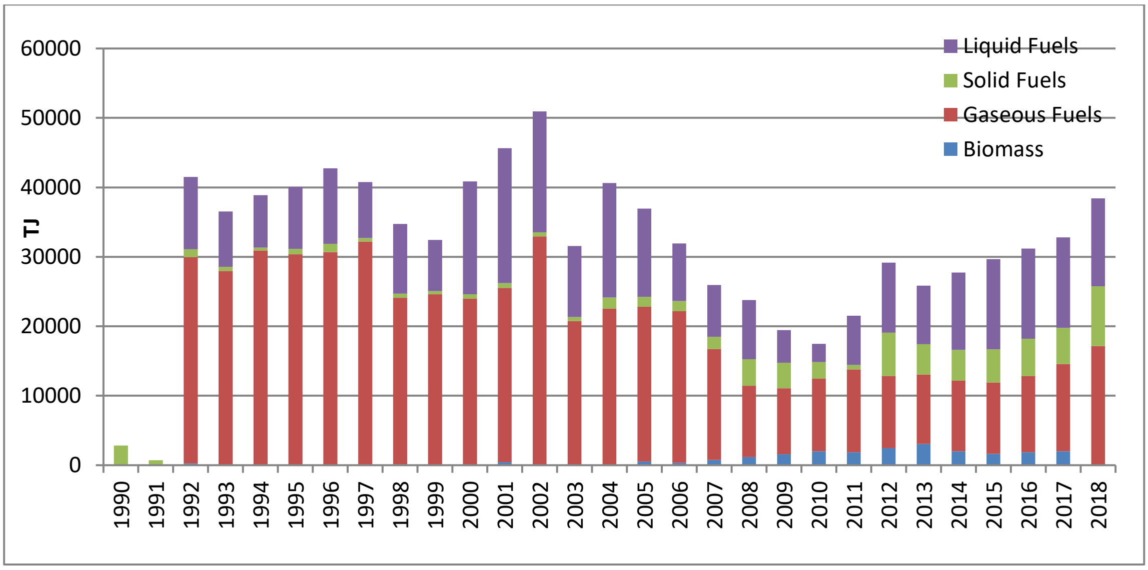


Figure 3.5.2.2 Fuel consumption (TJ), by fuel type, for NFR 1.A.2.f, 1990-2018

The liquid fuels has the highest contribution to NOx emissions, due to higher emission factor and significant consumption. The emission factors used for estimation are:

- liquid fuels: 513 g/GJ (2019 EMEP/EEA Guidebook, 1A2, table 3-4)
- solid fuels: 173 g/GJ (2019 EMEP/EEA Guidebook, 1A2, table 3-2)
- gaseous fuels: 74 g/GJ (2019 EMEP/EEA Guidebook, 1A2, table 3-3)
- biomass: 91 g/GJ (2019 EMEP/EEA Guidebook, 1A2, table 3-5)

3.5.3 NFR 1.A.2.g.viii Stationary combustion in manufacturing industries and construction: Other

This category includes the emissions from stationary combustion in industries not included in the preceding 1A2 categories. Emissions have been estimated by applying Tier 1 emission factors (2016 EMEP/EEA Guidebook, NFR 1.A.2, Tables 3.2-3.5) to fuel consumption data from the EUROSTAT annual energy balances, category Final energy consumption/Industry, for the following industries: Construction, Machinery, Mining and Quarrying, Non-specified (Industry), Textile and Leather, Transport Equipment, Wood and Wood Products. In 2018, NFR1A2gviii was a key source for NMVOC (1.3%). In this NFR, NMVOC comes mainly from biomass combustion, which increased in 2018 with 40% compared to 2005. The main contribution comes from Wood and wood products industry.

Improvements and recalculations:

- First estimation of emissions for 1990-1994;
- The ammonia was recalculated using the newest emission factor (Guidebook 2019, Table 3-5 Tier 1 emission factors for 1.A.2 combustion in industry using biomass);
- Black carbon was recalculated due to an error in the previous submission calculation (error of the unit of measures of the BC emission factor for the biomass). The BC emission for NFR 1A2gviii increased significantly due to recalculation, while the impact on the national emissions is not significant.

The following tables and charts show the trend of emissions and fuel consumption for NFR1.A.2.viii - Stationary combustion in other manufacturing industries and construction.

Table 3.5.3.1. Emissions trend (kt) for NFR 1.A.2.g.viii, Other industries, 1990-2018

Year/Pollutant (kt)	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
1990	50.925	7.960	10.752	2.336	2.413	19.167
1991	52.281	6.984	10.641	2.636	2.710	18.007
1992	7.452	1.435	2.132	0.504	0.523	3.789
1993	3.884	1.175	0.969	0.280	0.291	2.468
1994	9.865	3.940	2.175	1.414	1.452	8.135
1995	9.866	3.184	1.936	1.204	1.235	6.682
1996	10.120	3.224	1.901	1.210	1.240	6.703
1997	9.827	4.017	1.303	1.479	1.511	7.639
1998	7.812	2.801	0.976	1.060	1.082	5.360

Year/Pollutant (kt)	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
1999	8.747	3.157	1.012	1.119	1.142	5.892
2000	4.839	2.902	0.442	1.043	1.065	5.222
2001	4.439	2.557	0.354	0.878	0.896	4.518
2002	4.731	3.262	1.225	1.243	1.276	6.551
2003	4.337	3.728	0.360	1.435	1.465	6.750
2004	4.904	2.728	0.525	0.966	0.987	4.959
2005	3.028	2.190	0.177	0.765	0.780	3.826
2006	4.046	2.984	0.354	1.047	1.069	5.310
2007	4.188	3.685	0.283	1.450	1.480	6.656
2008	5.211	2.938	0.314	1.010	1.030	5.115
2009	2.426	2.274	0.100	0.813	0.830	3.967
2010	2.702	2.690	0.125	1.014	1.035	4.765
2011	2.868	2.282	0.142	0.831	0.848	4.007
2012	2.596	2.601	0.155	0.999	1.020	4.655
2013	2.632	2.665	0.129	1.018	1.039	4.741
2014	2.586	2.771	0.132	1.063	1.086	4.941
2015	2.367	2.630	0.132	1.014	1.036	4.706
2016	2.472	3.266	0.152	1.324	1.352	5.931
2017	2.478	3.027	0.129	1.190	1.215	5.437
2018	2.591	3.130	0.141	1.227	1.253	5.621

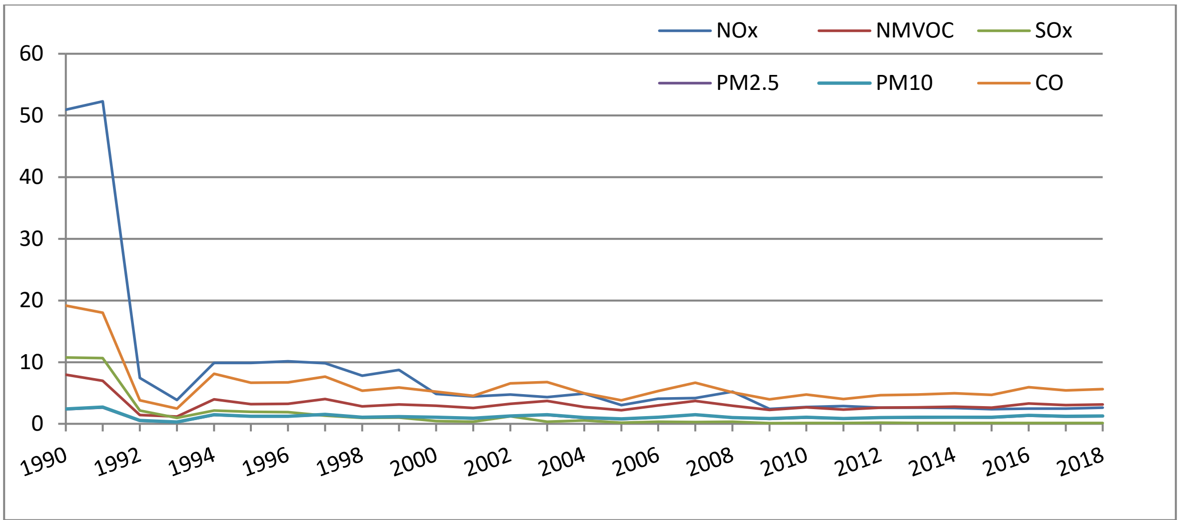


Figure 3.5.3.1 Emission trends (kt) for NFR 1.A.2.g.viii, Other industries, 1990-2018

The sharp decrease of emissions in 1990-1991 is consistent with the decrease of fuel consumption, reported by the national statistics to EUROSTAT Energy database, as consumption in the *Non-specified industry*, mainly as natural gas and fuel oil, as revealed by the table and chart below. The data for 1990-1991, emissions and fuel consumption, include the NFR 1A2d Pulp, Paper and Print.

Table 3.5.3.2 Fuel consumption, by fuel type, for NFR 1.A.2.g.viii, Other industries, 1990-2018

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1990	60763	8590	246860	0
1991	73563	7835	176630	1289

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1992	8508	1889	36410	724
1993	2082	932	34902	790
1994	8395	1845	62026	7131
1995	10908	1477	47314	5641
1996	11247	1419	48492	5672
1997	9738	799	53267	8259
1998	8881	524	35772	5699
1999	9049	543	46803	6021
2000	3086	223	35312	6643
2001	2566	165	34947	5582
2002	2120	1131	37375	7494
2003	1883	159	33284	9671
2004	3243	314	35677	5996
2005	1061	59	27139	5113
2006	1214	217	37234	6927
2007	2170	59	29323	9837
2008	3286	69	39524	6470
2009	93	19	25165	5637
2010	458	11	24666	7033
2011	1056	15	24466	5638
2012	608	40	22293	6897
2013	529	12	23198	7057
2014	329	21	23516	7400
2015	203	33	21816	7068
2016	209	29	20462	9292
2017	86	20	22577	8346
2018	87	29	23771	8595

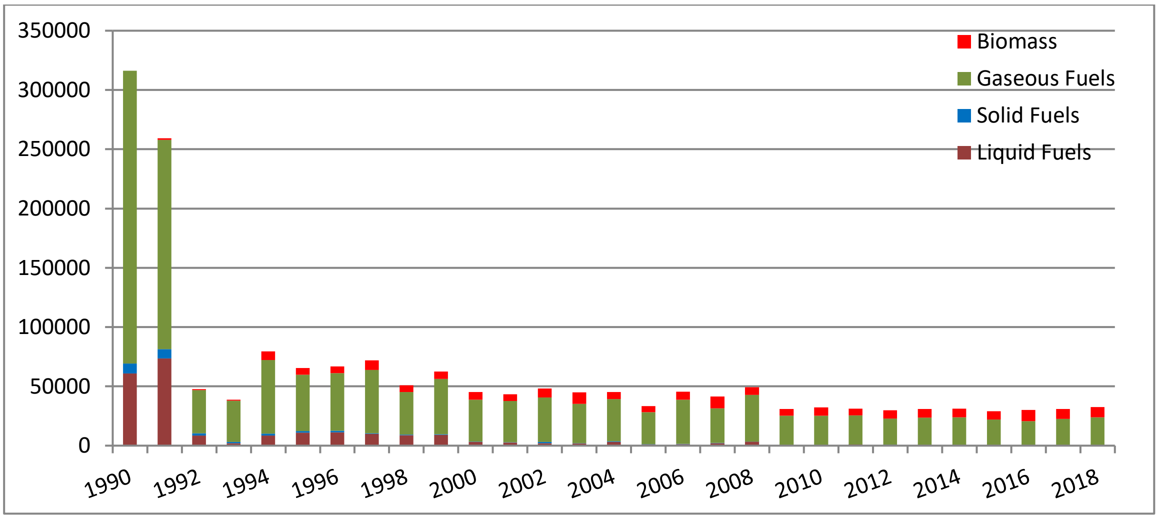


Figure 3.5.3.2 Fuel consumption [TJ] , by fuel type, for NFR 1.A.2.g.viii, Other industries, 1990-2018

3.6 NFR 1.A.2.g.vii Mobile Combustion in manufacturing industries and construction

Category NFR 1A2gvii refers to emissions from combustion of fuels in non-road mobile machinery sources, in manufacturing industries and construction. The activity data are provided by Eurostat statistics, energy balances (nrg_110a) and Eurostat ENERGY questionnaires (for 2017 and 2018). The approach used in the current emission estimation for this NFR is the following: Tier 1 emission factors (*2019 EMEP/EEA Guidebook, Non road mobile machinery, Table 3.1 for gasoline and diesel oi*l) were applied to aggregated values of diesel and gasoline fuels in the category *Final energy consumption/Industry* (all industries). The category 1A2gvii-*Mobile combustion in manufacturing industries and construction* is a key source for NOx (4.4%) in 2018.

Improvements and recalculations

- First estimation of emissions for 1992-1994; For 1990 and 1991, the consumption of gasoline and diesel for industry/off road machineries is not available in the national statistics separately, but included in Road transport; the emissions in 1A2gvii sector are included in the estimations for 1A3 categories.
- The 2019 Review rised a question (PTC) in regard to this NFR (RO-1A2gvii-2019-0001), as a key category assessed based on Tier 1 methodology. So far, there are not sufficient national specific data available, in order to upgrade to Tier2 for this category. More research is needed for this improvement. The following tables and charts show the trend of emissions and fuel consumption for NFR 1A2gvii, Mobile Combustion in manufacturing industries and construction.

Table 3.6.1. Emission Trend (kt) of NOx and NMVOC and CO for NFR 1.A.2.g.vii

Year/Pollutant (kt)	NOx	NMVOC	CO
1992	18.73	17.71	49.26
1993	8.86	6.09	17.06
1994	17.11	5.32	15.33
1995	14.10	2.25	6.81
1996	27.10	14.98	42.21
1997	18.94	10.47	29.50
1998	17.79	16.22	45.13
1999	10.76	8.64	24.10
2000	13.09	11.05	30.79
2001	15.59	8.74	24.62
2002	16.53	22.33	61.75
2003	12.70	10.93	30.46
2004	11.10	9.37	26.12
2005	12.00	13.34	37.01
2006	12.67	9.12	25.52
2007	19.27	14.20	39.68
2008	13.71	8.12	22.82
2009	7.75	7.20	20.02

Year/Pollutant (kt)	NOx	NMVOC	CO
2010	7.17	5.34	14.91
2011	8.89	3.69	10.50
2012	9.99	2.89	8.35
2013	8.79	3.45	9.84
2014	8.66	3.40	9.70
2015	10.16	4.06	11.58
2016	9.77	3.54	10.14
2017	9.84	3.64	10.41
2018	9.87	3.01	8.69

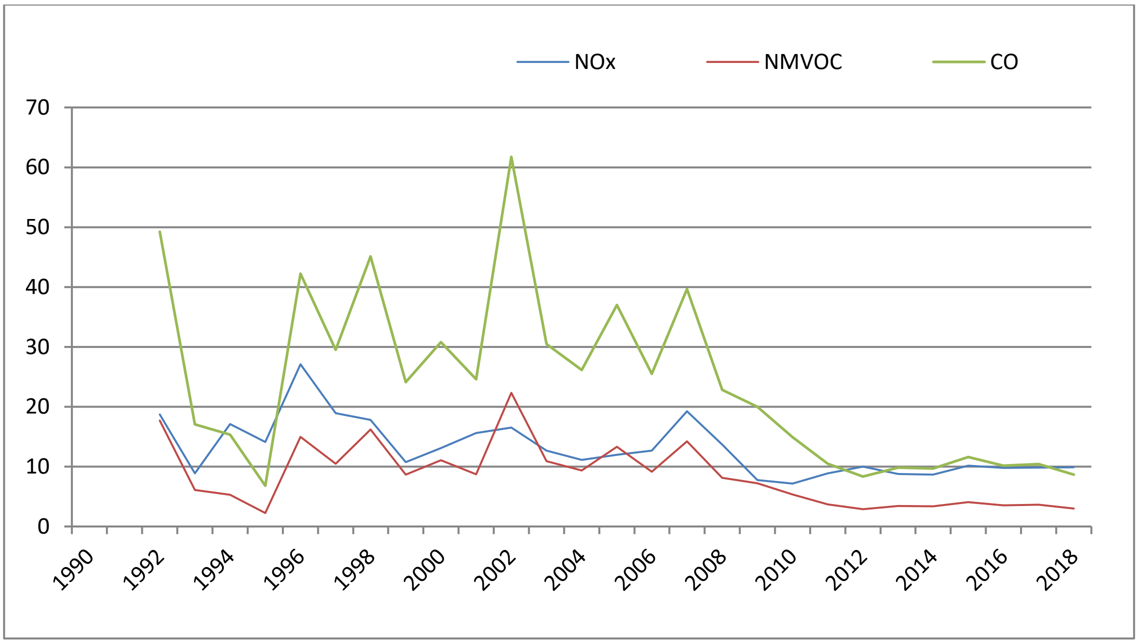


Figure 3.6.1 Emissions of NOx, NMVOC and CO (kt) for NFR 1.A.2.gvii

Emission trends of pollutants follow the fuel consumption variation. Most of the fuel is diesel fuel, gasoline quantities are much lower, in the range 1 to 15%, along the time series.

Table 3.6.2 Fuel consumption (TJ) for NFR 1.A.2.gvii

Year/Fuel (TJ)	Diesel fuel	Gasoline	Total liquid fuel
1992	24151	3009	27160
1993	11455	989	12444
1994	22223	674	22897
1995	18361	135	18496
1996	35091	2335	37426
1997	24539	1617	26156
1998	22953	2739	25692
1999	13899	1438	15337
2000	16902	1841	18743
2001	20206	1347	21553
2002	21195	3952	25147
2003	16388	1842	18230
2004	14331	1572	15903

Year/Fuel (TJ)	Diesel fuel	Gasoline	Total liquid fuel
2005	15443	2308	17751
2006	16386	1481	17867
2007	24925	2316	27241
2008	17760	1267	19027
2009	9996	1220	11216
2010	9266	872	10138
2011	11540	522	12062
2012	12984	350	13334
2013	11415	480	11895
2014	11243	479	11722
2015	13196	567	13763
2016	12688	480	13168
2017	24151	3009	27160
2018	12732	367	13099

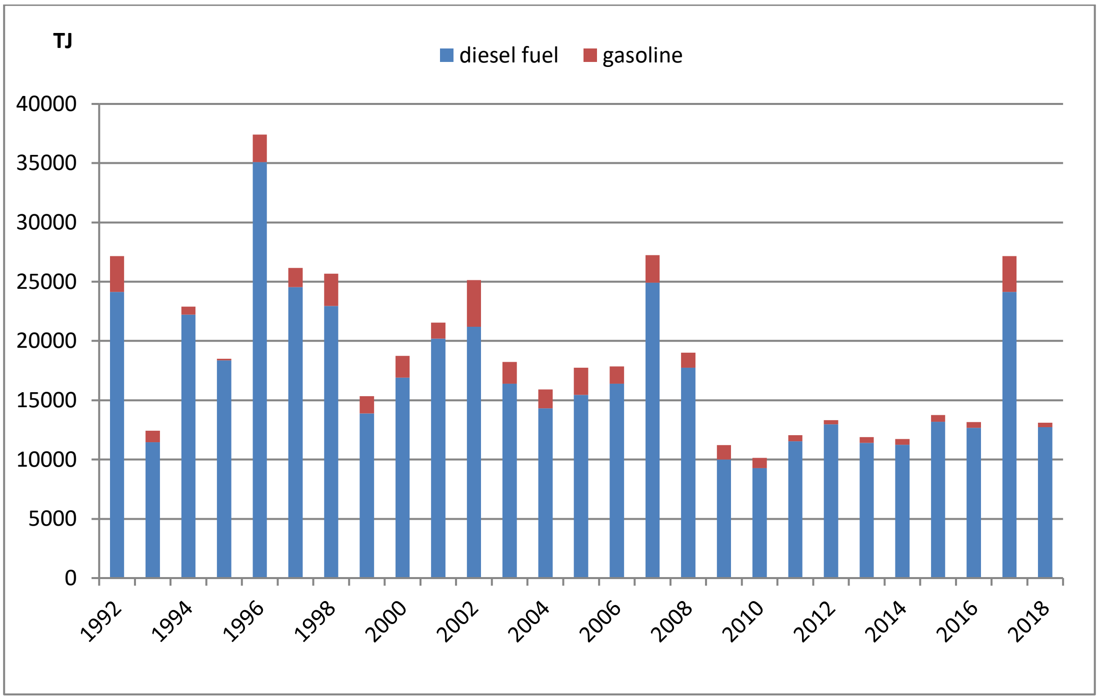


Figure 3.6.2 Fuel consumption (TJ) for NFR 1.A.2.gvii

3.7 NFR1.A.4. Small combustion overview

NFR categories from section 1.A.4 include emissions from fuel combustion in small facilities, in commercial or institutional buildings, for space and water heating in households and fuel combustion in agriculture, forestry and fishing industries. Emissions from mobile sources related to this sector are also included in this section. Small combustion for district heating is reported under NFR 1.A.1, while small combustion in industry is reported under NFR 1.A.2.
A summary of activities covered by NFR 1.A.4 is given bellow.

Table 3.7.1 Source description for 1.A.4 sector

NFR	NFR name	Source description, actual reporting aggregation
1A4ai	Commercial/institutional	Fuel combustion in commercial and institutional buildings (stationary), except combustion of diesel and gasoline, which is allocated to 1A4aii
1A4aii	Mobile Combustion in Commercial/institutional	Diesel and gasoline consumption in commercial/institutional sector
1A4bi	Residential	Fuel combustion in households (such as heating and water warming), except combustion of diesel and gasoline, which is allocated to 1A4bii
1A4bii	Residential: Household and gardening (mobile)	Combustion of diesel and gasoline in residential sector. Not available separately for all years. IE means included in NFR 1A3b.
1A4ci	Agriculture/Forestry/Fishing: Stationary	Stationary fuel combustion in agriculture, forestry and fishing industries (such as farms)
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Combustion of diesel and gasoline in Agriculture/Forestry/Fishing , in off-road vehicles and machineries used in farms and in forestry works. It also includes the National fishing (1A4ciii)
1A5a	Other stationary (including military)	Fuel combustion in small facilities in other sectors than those reported under 1A4
1A5b	Other, Mobile (including military, land based and recreational boats)	Included in 1A5a

The share of emissions from small combustion sources, including the non-road mobile and machineries, in the country total, by pollutant, is shown in the table 3.7.2 and figure 3.7.1:

Table 3.7.2 Share of emissions from small combustion, including non-road, in the national total, by pollutant

Pollutant	1A4	National Total	Unit	% 1A4 in national total
NOx	24.34	225.38	kt	10.8
NMVOC	88.64	237.37	kt	37.3
SOx	4.59	82.47	kt	5.6
NH3	8.92	175.61	kt	5.1
PM2.5	91.68	110.74	kt	82.8
PM10	94.14	146.43	kt	64.3
TSP	99.02	222.77	kt	44.4
BC	9.68	13.49	kt	71.7
CO	548.66	779.02	kt	70.4
Pb	3.92	39.95	t	9.8
Cd	1.71	2.96	t	57.7

Pollutant	1A4	National Total	Unit	% 1A4 in national total
Hg	0.11	1.35	t	8.2
As	0.06	4.11	t	1.4
Cr	3.16	11.97	t	26.4
Cu	0.99	23.65	t	4.2
Ni	1.77	8.28	t	21.4
Se	0.24	9.12	t	2.7
Zn	68.04	108.21	t	62.9
PCDD/ PCDF	99.33	153.03	g I-TEQ	64.9
Total PAH	15.45	17.44	t	88.6
HCB	14.40	17.40	t	82.7
PCBs	5.45	7.16	t	76.1

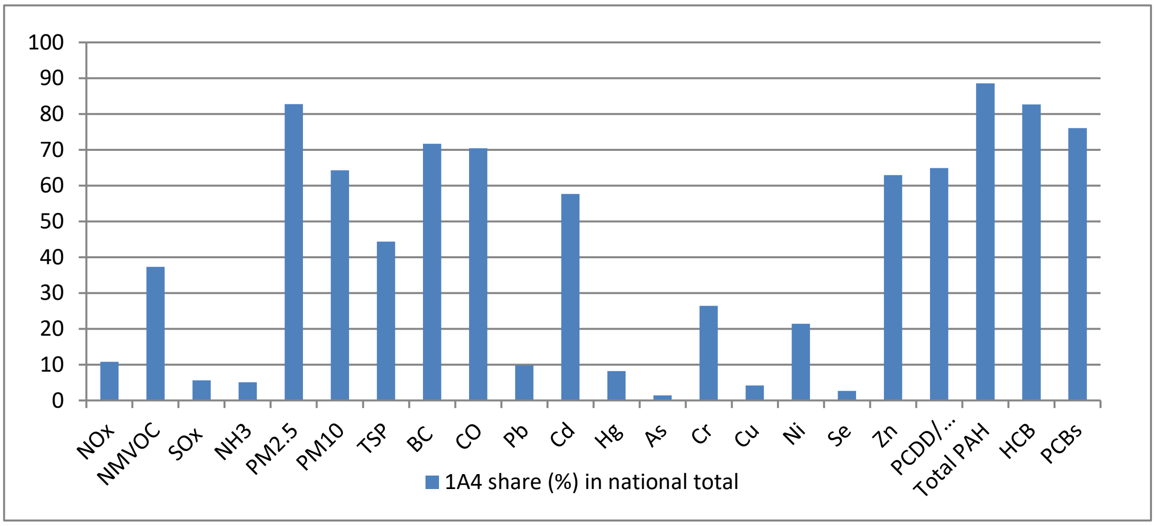


Figure 3.7.1 Share of emissions from 1A4 small combustion, including non-road, in the national total

3.8 NFR 1.A.4.a.i Commercial/Institutional

The 1990-2018 emissions were estimated by applying Tier 1 emission factors (2016 EMEP/EEA Guidebook, NFR 1.A.4 Small combustion, Tables 3.7 – 3.10 Tier 1 emission factors for NFR category 1.A.4.a/c, 1.A.5.a) to activity data from EUROSTAT energy balances, annual data nrg_110a, category *Final energy consumption/Other Sectors/Services.* Data for 2018 fuel consumption were provided by N.I.S., in EUROSTAT ENERGY questionnaires. The diesel and gasoline consumption of this category was not included in 1A4ai, but allocated to 1A4aii - Mobile machineries.

NFR 1.A.4.ai was not a key source for any pollutant in 2018.
Improvements and recalculations:

- First estimation of emissions for 1992-1994; data for 1990 and 1991 are not separately available in the national statistics for consumption in "Services sector" , but included in residential sector, i.e. NFR 1A4bi.
- Update of emission factors to the European Guidebook 2019 (slight increase of emission factors for TSP, PM10, PM2.5 and BC in tables Table 3.10 *Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass*).

The following tables and charts show the trend of emissions and fuel consumption for NFR 1A4ai, stationary combustion in commercial/institutional sector.

Table 3.8.1. Emissions (kt) of gaseous pollutants, PM and BC from NFR 1.A.4.a.i

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM_{10}	BC	CO
1992	1.023	0.318	0.009	0.011	0.0004	0.401
1993	0.711	0.221	0.006	0.007	0.0003	0.279
1994	0.891	0.277	0.008	0.009	0.0004	0.349
1995	1.046	0.325	0.009	0.011	0.0004	0.410
1996	1.131	0.351	0.010	0.012	0.0005	0.443
1997	0.841	0.261	0.008	0.009	0.0004	0.330
1998	1.625	0.454	0.077	0.029	0.0075	0.619
1999	1.238	0.377	0.126	0.030	0.0029	0.585
2000	0.846	0.262	0.141	0.028	0.0022	0.459
2001	1.695	0.538	0.274	0.053	0.0028	0.930
2002	0.364	0.114	0.165	0.026	0.0022	0.299
2003	1.582	0.490	0.130	0.033	0.0024	0.729
2004	2.387	0.728	0.089	0.036	0.0035	0.979
2005	2.706	0.842	0.038	0.030	0.0013	1.074
2006	5.456	1.608	0.264	0.093	0.0154	2.210
2007	3.722	1.153	0.090	0.047	0.0028	1.506
2008	2.597	0.805	0.041	0.030	0.0016	1.030
2009	3.180	0.925	0.112	0.049	0.0098	1.230
2010	3.033	0.928	0.065	0.038	0.0035	1.203
2011	2.709	0.765	0.146	0.051	0.0117	1.060
2012	2.498	0.759	0.059	0.033	0.0036	0.988
2013	2.619	0.785	0.083	0.038	0.0053	1.039
2014	2.594	0.810	0.262	0.067	0.0067	1.257
2015	2.498	0.788	0.243	0.062	0.0051	1.212
2016	2.516	0.800	0.240	0.064	0.0053	1.229
2017	2.932	0.924	0.162	0.056	0.0045	1.303
2018	3.338	2.176	0.207	0.733	0.1908	3.677

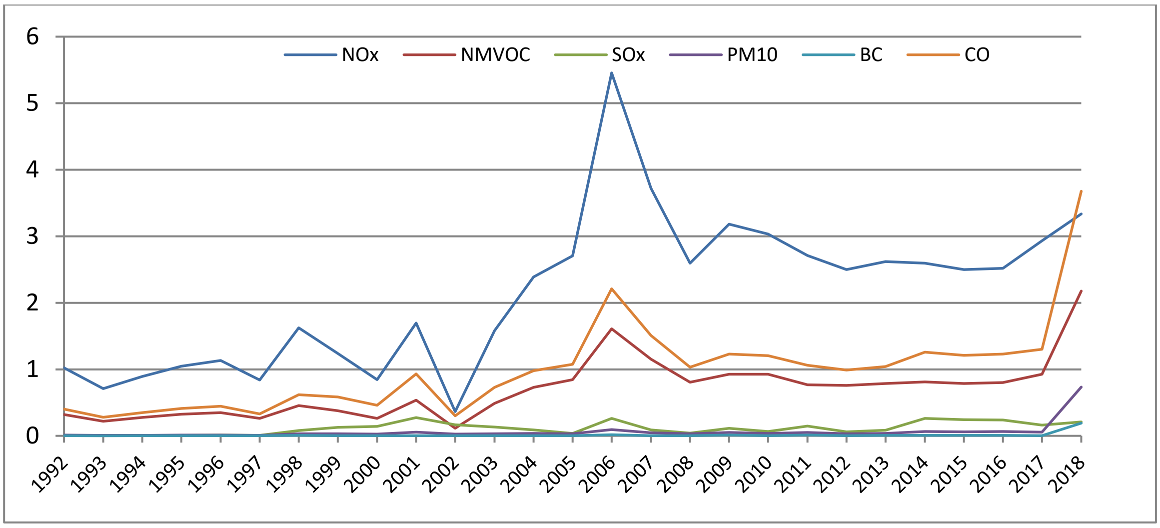


Figure 3.8.1 Emissions (kt) of NOx, NMVOC, SOx, PM_{10}, BC and CO for NFR 1.A.4.a.i

Trend of emissions follows the variation of fuel consumption, which increased from 1995 to 2006, in line with development of services in Romania, then decreased due to economic crises and increased again slowly in the last years.

Table 3.8.2 Fuel consumption trends (TJ) by fuel type, for NFR 1.A.4.a.i

Year/Fuel type	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1992	0	0	13828	0
1993	0	0	9606	0
1994	0	0	12046	0
1995	0	0	14139	0
1996	0	0	15282	0
1997	0	0	11368	0
1998	680	0	19148	0
1999	160	120	15791	0
2000	83	150	10743	0
2001	0	308	22188	0
2002	80	184	4162	0
2003	83	129	20732	0
2004	215	57	31237	0
2005	0	16	36529	0
2006	1228	122	68368	0
2007	80	58	49825	0
2008	40	16	34887	0
2009	840	8	39474	0
2010	204	23	40087	0
2011	1043	31	32228	0
2012	243	17	32710	1
2013	400	27	33668	1
2014	206	261	33540	39
2015	86	253	32774	32
2016	43	254	33176	46
2017	47	157	39017	38
2018	73	152	39293	4191

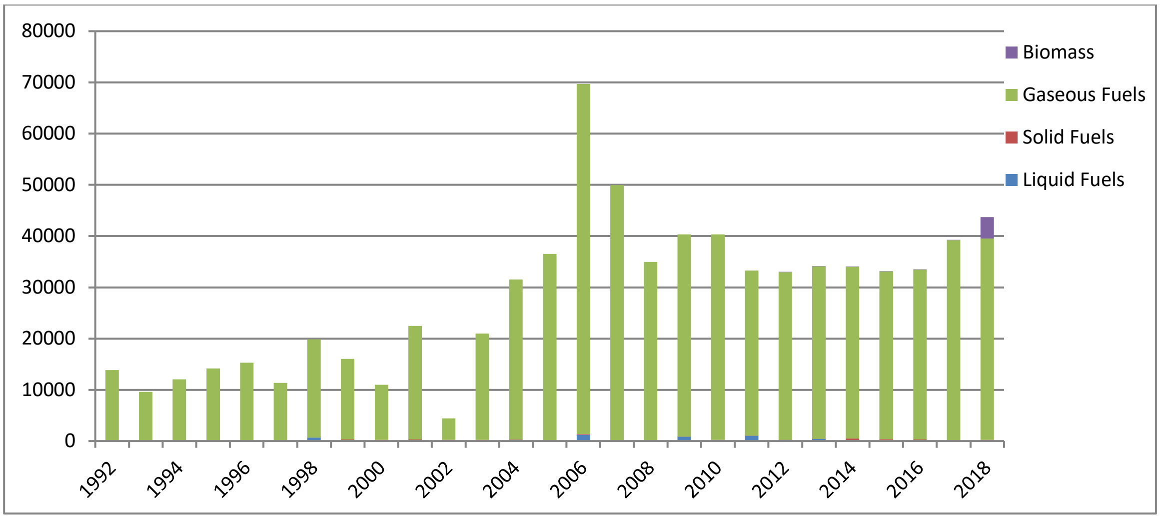


Figure 3.8.2 Fuel consumption (TJ), by fuel type, for NFR 1.A.4.a.i

3.8.1 NFR 1A4aii – Non- road mobile combustion in Commercial/Institutional

This NFR covers the emissions from commercial and institutional mobile machinery, except road transport. The estimation is based on diesel and gasoline fuel consumption, taken from the EUROSTAT energy balances, category Final energy consumption/Other Sectors/Services. Data for 2017 were provided by Eurostat Energy questionnaires. Tier 1 emission factors were used (2016 EMEP/EEA Guidebook, NFR 1.A.4 Non road mobile machinery, Table 3.11.1 - gasoline and diesel oil). SOx is estimated based sulphur content in the fuel. In 2018, NFR 1A4aii was a key source for NMVOC (4.9%) and CO (4.1%). Compared to 2005, NMVOC decreased for this NFR in 2018 with 50%.

Improvements and recalculations:

- First estimation of emissions for 1992-1994. For 1990 and 1991, the consumption of gasoline and diesel for small combustion/non-road machineries is not available in the national statistics separately, but included in Road transport, therefore the non-road emissions in 1A4aii are included in 1A3 categories.
- The Reviews recommendations RO-1A4aii-2017-0001 and RO-1A4aii-2018-0001, regarding reporting the 1A4aii emissions apart from 1A4bii were implemented in the present submission.

The following tables and charts show the trend of emissions and fuel consumption for NFR 1A4aii, Mobile (off-road) Combustion in Commercial/Institutional.

Table 3.8.1.1. Emissions (kt) of NOx, NMVOC and CO from NFR 1.A.4.a.ii

Year/Pollutant (kt)	NOx	NMVOC	CO
1992	0.034	2.815	7.69
1993	0.077	6.330	17.29
1994	0.026	2.110	5.76
1995	0.014	1.170	3.20
1996	0.063	5.160	14.09

Year/Pollutant (kt)	NOx	NMVOC	CO
1997	0.237	19.464	53.16
1998	0.652	12.947	35.39
1999	0.361	2.613	7.15
2000	0.974	9.701	26.54
2001	0.977	18.139	49.58
2002	5.660	8.076	22.32
2003	2.913	12.251	33.59
2004	2.655	12.685	34.77
2005	1.891	22.895	62.61
2006	0.547	15.270	41.72
2007	0.565	22.171	60.57
2008	0.403	11.419	31.20
2009	0.379	4.126	11.29
2010	0.942	4.413	12.10
2011	0.786	10.521	28.77
2012	1.008	5.331	14.61
2013	0.610	7.326	20.03
2014	0.694	6.197	16.96
2015	0.757	5.973	16.35
2016	0.721	8.472	23.17
2017	0.733	8.615	23.56
2018	0.722	11.675	31.92

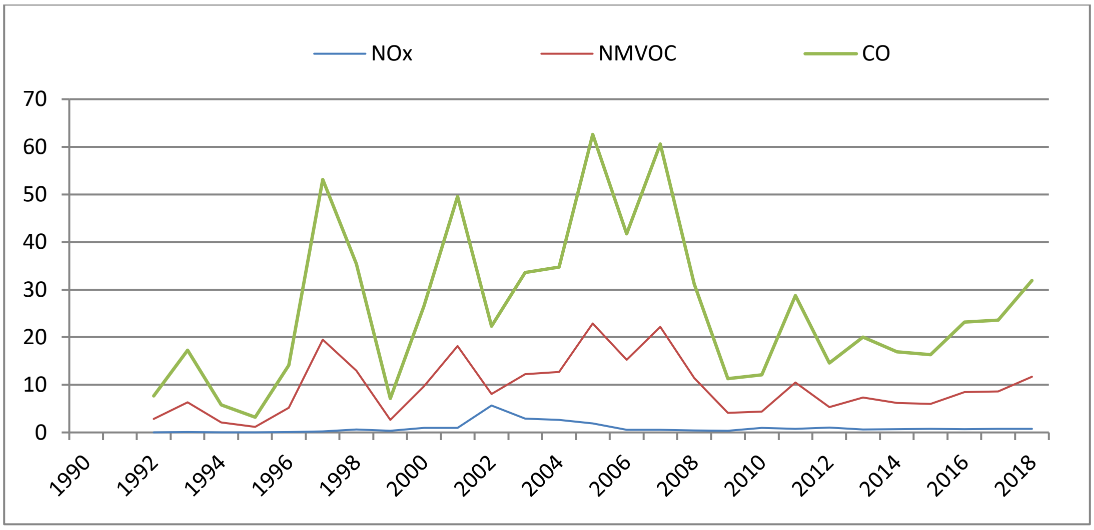


Figure 3.8.1.1 Emissions of NOx, NMVOC and CO (kt) for NFR 1.A.4.a.ii

Emission trends of pollutants follow the variation of the fuel consumption.

Table 3.8.1.2 Fuel consumption (TJ) for NFR 1.A.4.a.ii

Year/Fuel (TJ)	Diesel fuel	Gasoline	Total liquid fuel
1992	0	539	539
1993	0	1212	1212
1994	0	404	404
1995	0	224	224
1996	0	988	988
1997	0	3727	3727

Year/Fuel (TJ)	Diesel fuel	Gasoline	Total liquid fuel
1998	644	2470	3114
1999	429	494	923
2000	1115	1841	2956
2001	987	3457	4444
2002	7250	1437	8687
2003	3604	2290	5894
2004	3260	2380	5640
2005	2102	4352	6454
2006	472	2916	3388
2007	386	4238	4624
2008	343	2182	2525
2009	429	783	1212
2010	1158	827	1985
2011	858	2001	2859
2012	1231	1001	2232
2013	679	1392	2071
2014	806	1175	1981
2015	891	1131	2022
2016	806	1610	2416
2017	801	1590	2391
2018	751	2142	2893

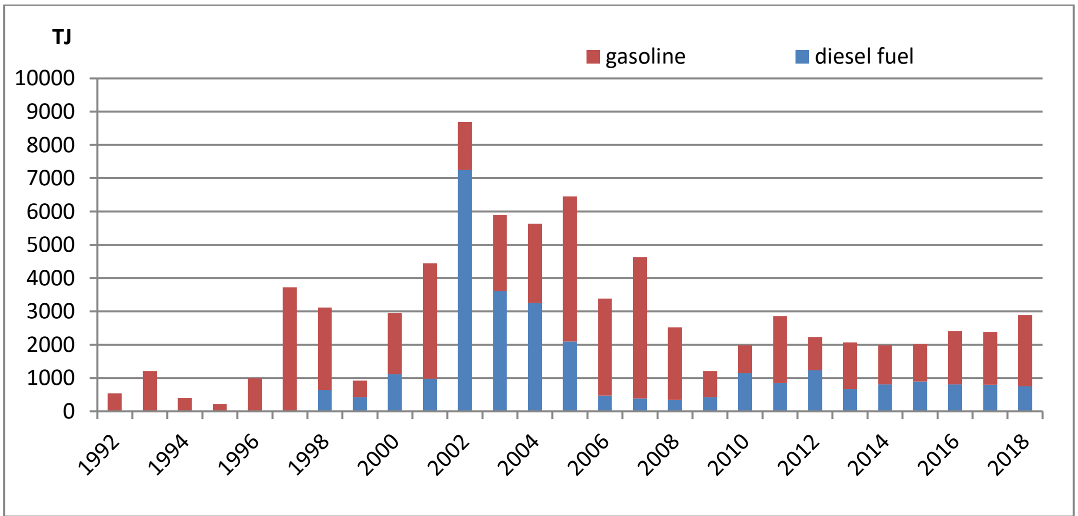
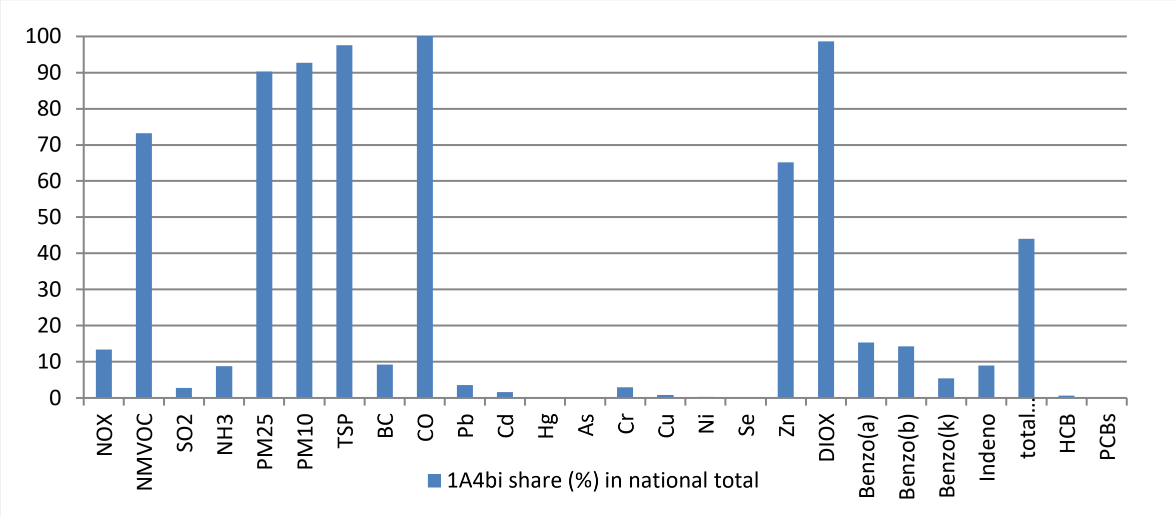


Figure 3.8.1.2 Fuel consumption (TJ) for NFR 1.A.4.a.ii

3.9 NFR 1.A.4.b.i Residential

Residential heating is, as for 2018, key source category for many pollutants, accounting for the following contributions to the national total: $PM_{2.5}$ (81.5%), PAH (75.5%), BC (68.6%), PM_{10} (63.3%), CO (65.1%), Zn (60.2%), Cd (55.6%), PCDD/PCDF (64.4%), TSP (43.8%), NMVOC (30.8%), HCB (29.1%), Cr (43.5%), Pb (9.0%), Hg (6.7), NOx (5.9).



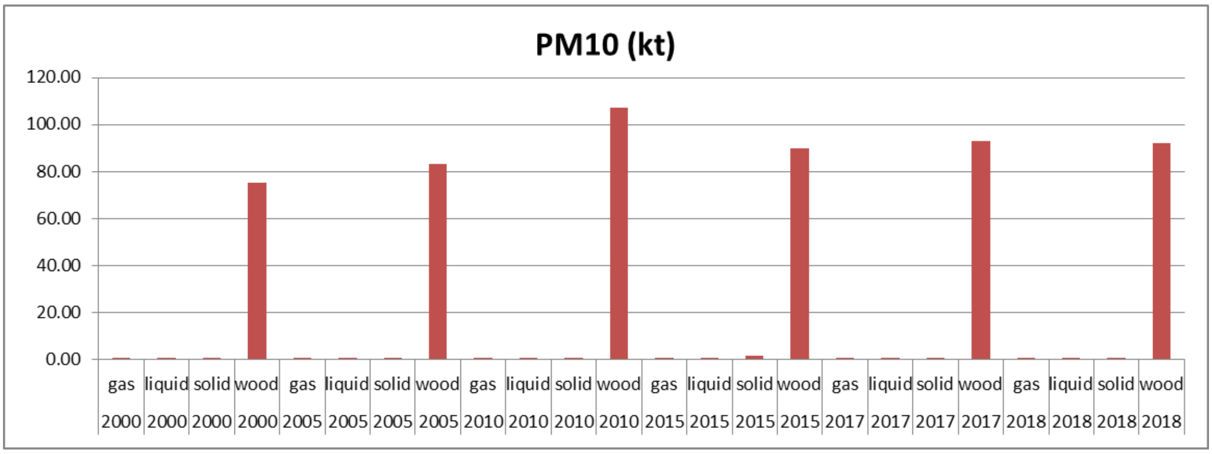
The activity data consist of fuel consumption provided, for the years 1990-2019, by EUROSTAT (energy balances, annual data - nrg_110a, *Final energy consumption/Other Sectors /Residential)* and for 2017-2018 by the N.I.S, in the forms of the EUROSTAT ENERGY questionnaires.

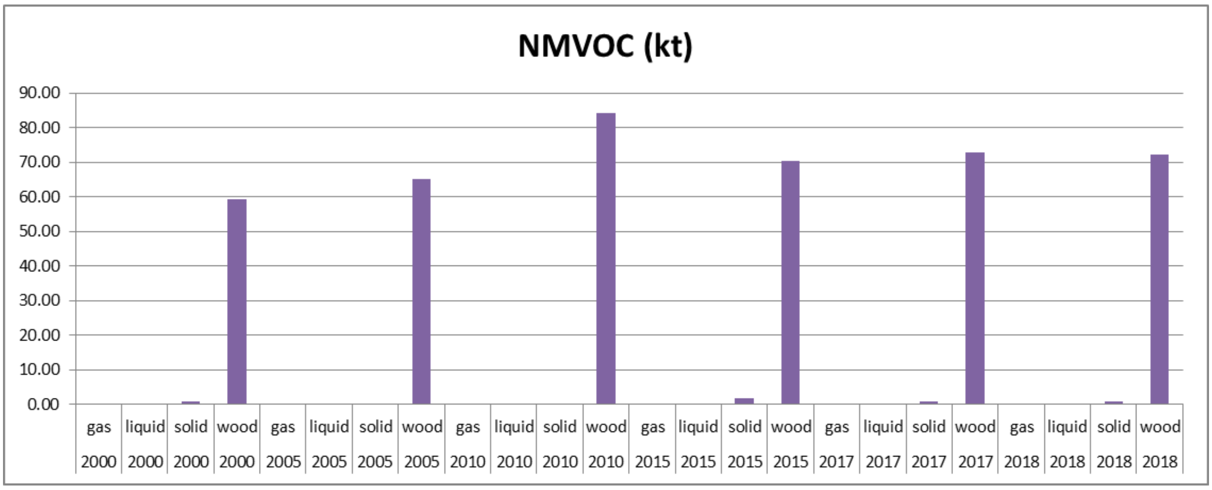
The emission factors are given by the 2019 EMEP/EEA Guidebook.

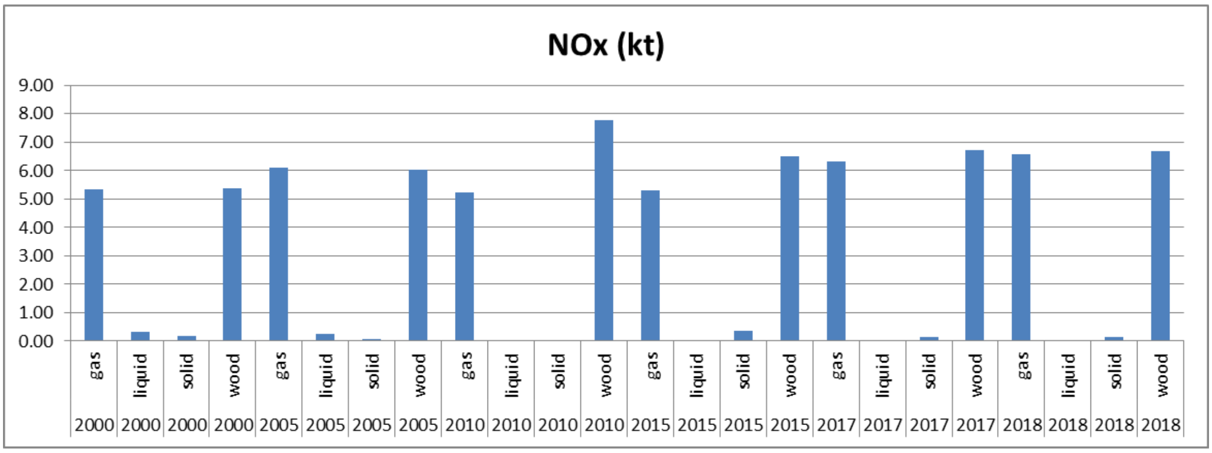
Tier 2 methodology was applied for wood combustion, with following percentages of technologies in 2018: conventional stoves burning wood and similar wood waste 91% (*Small combustion, Table 3.40 Tier 2 emission factors for NFR category 1.A.4.b.i*), conventional boilers < 50 kW burning wood and similar wood waste 7% (*Table 3.43 Tier 2 emission factors for NFR category 1.A.4.b.i*), pellet stoves and boilers burning wood pellets 2% (*Table 3.44 Tier 2 emission factors for NFR category 1.A.4.b.i*). Tier 1 methodology was applied for solid, gaseous and liquid fuels, with emission factors from Small combustion chapter, *Tables 3.3* to *3.5, Tier 1 emission factors for NFR category 1.A.4.b.*

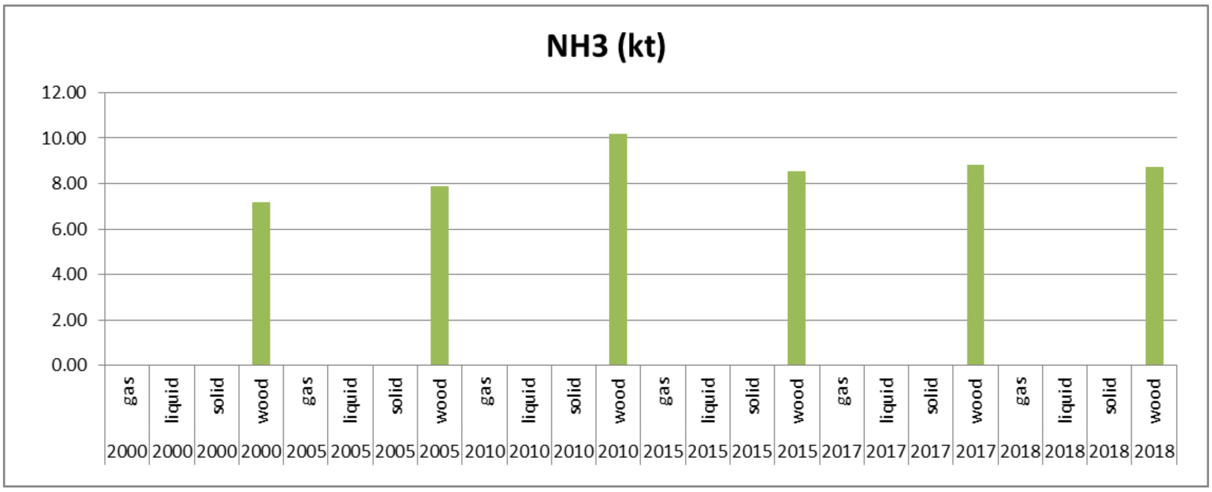
The reason for this approach is illustrated below.

For NFR category 1A4bi, relevant fuels are solid Biomass (wood) and natural gas (see Figure 3.9.1). Biomass is assessed based on Tier2, the other fuels based on Tier 1 emission factors. The contribution to emissions on type of fuels for the main pollutants NOx, NH3, PM2.5, NMVOC is shown in charts below.









It is obvious that biomass gives the most emissions.

Gaseous fuels contributes significantly only to NOx emissions. The pollutants for gaseous fuels were estimated based on emission factors from Guidebook 2019, Small combustion chapter, *Tables 3.4, Tier 1 emission factors for NFR category 1.A.4.b.* The Tier 1 emission factors are average of Tier 2 values in Tables 3.13 and 3.16 for NOx, CO, NMVOC, TSP and PM and, for the other pollutants, are equal in Tier 1 and Tier 2 tables. In particular, for NOx, Tier 1 value is 51 g/GJ, which is average of 60 g/GJ - Tier 2 (stoves) and 42 g/GJ - Tier 2 (small boilers). The difference between Tier 1 and Tier 2 values does not lead to significant differences between Tier 1 and Tier 2 estimates of NOx.

Improvements and recalculations: First estimation of emissions for 1990-1994.

The tables and charts below give the trend of emissions and fuel consumption in residential sector. Gasoline and diesel fuels is not included in 1A4bi consumption, but used for emissions estimation in NFR 1.A.4.b.ii – Household and gardening.

Table 3.9.1 Emission Trends (kt) of Main Pollutants, Particulate Matter, BC and CO for NFR 1.A.4.b.i

Year/Pollutant	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	10.35	30.25	30.00	30.73	31.39	33.65	2.62	249.81
1991	9.64	21.16	17.98	22.11	22.61	24.16	1.95	170.96
1992	6.86	20.12	14.39	21.76	22.27	23.72	1.98	157.73
1993	6.80	23.37	9.41	26.83	27.51	29.13	2.57	172.53
1994	6.15	23.32	3.10	28.15	28.89	30.45	2.81	163.02
1995	6.74	25.97	2.79	31.53	32.36	34.09	3.18	181.92
1996	9.39	55.95	6.32	67.97	69.76	73.50	6.86	391.15
1997	11.89	73.85	5.91	90.27	92.67	97.59	9.16	512.69
1998	11.35	66.17	2.07	81.61	83.79	88.17	8.33	454.84
1999	10.69	62.61	3.04	76.96	79.01	83.17	7.84	431.96
2000	10.95	60.29	2.80	74.21	76.18	80.18	7.59	417.99
2001	8.80	42.59	1.13	52.60	54.00	56.81	5.40	294.39
2002	9.71	43.57	1.75	53.64	55.07	57.95	5.49	302.15
2003	11.19	53.50	1.70	66.00	67.76	71.29	6.77	370.17
2004	12.36	65.20	2.91	80.33	82.47	86.78	8.23	451.84
2005	12.44	65.79	2.15	81.31	83.48	87.83	8.35	455.12
2006	12.12	61.86	1.99	76.48	78.51	82.60	7.85	427.96
2007	11.67	64.48	2.14	79.73	81.86	86.12	8.19	445.86
2008	13.09	82.94	3.64	102.32	105.04	110.54	10.49	574.59
2009	12.82	81.59	2.15	100.91	103.60	109.00	10.36	563.35
2010	13.04	84.65	2.04	104.74	107.53	113.14	10.76	584.20
2011	12.51	75.78	2.22	93.66	96.16	101.17	9.61	523.76
2012	13.22	79.24	2.60	97.87	100.48	105.72	10.04	548.10
2013	12.63	75.01	2.42	92.65	95.12	100.08	9.51	518.81
2014	12.31	76.13	4.13	93.67	96.16	101.22	9.58	528.75
2015	12.22	72.33	4.46	88.87	91.23	96.04	9.08	503.23
2016	12.24	72.42	3.55	89.18	91.55	96.36	9.13	502.61
2017	13.23	73.82	2.76	91.08	93.51	98.40	9.34	511.28
2018	13.42	73.19	2.75	90.31	92.71	97.56	9.26	507.01

The following charts show the variation of the pollutants for which 1A4bi is a key source.

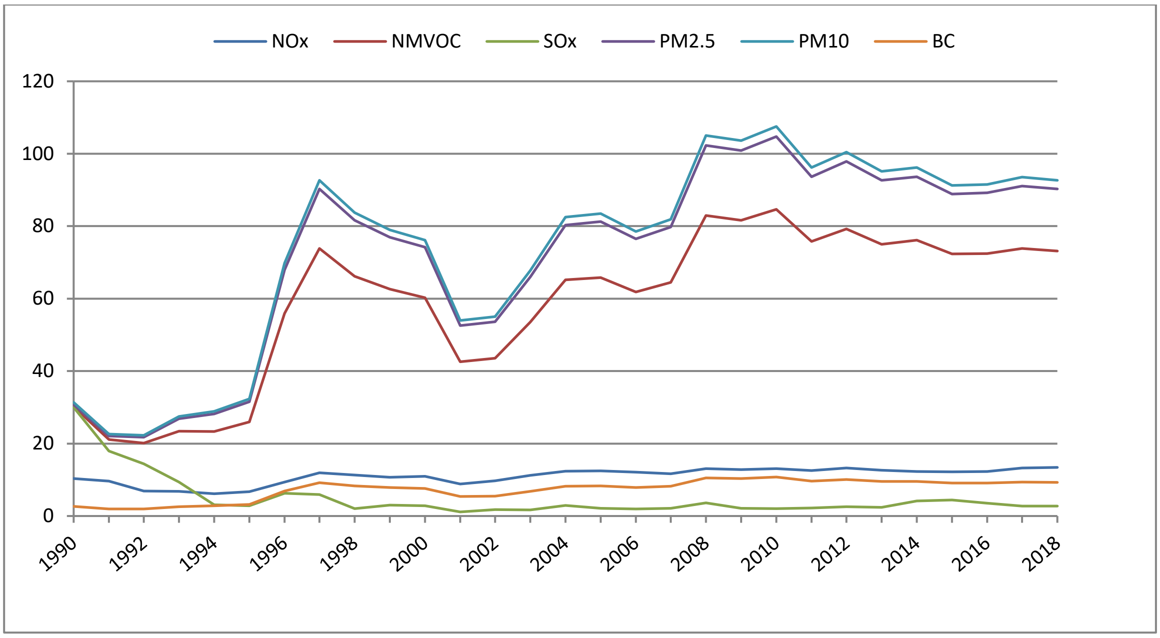


Figure 3.9.1 Emissions (kt) of NOx, NMVOC, SOx, PM10/2.5 for NFR 1.A.4.b.i

Table 3.9.2 Emissions of Pb, Cd, Cr, Zn (t) and HCB (kg) for NFR 1.A.4.b.i

Year/Pollutant	Pb (t)	Cd (t)	Cr (t)	Zn (t)	HCB (kg)
1990	4.904	0.362	0.921	19.537	0.141
1991	3.060	0.282	0.667	14.261	0.109
1992	2.548	0.301	0.664	14.309	0.117
1993	2.119	0.422	0.831	18.191	0.163
1994	1.377	0.484	0.881	19.527	0.186
1995	1.462	0.550	0.995	22.075	0.212
1996	3.202	1.186	2.148	47.652	0.456
1997	3.932	1.591	2.858	63.469	0.612
1998	3.121	1.459	2.589	57.595	0.561
1999	3.092	1.369	2.439	54.236	0.527
2000	3.003	1.338	2.383	52.984	0.515
2001	2.018	0.953	1.689	37.598	0.367
2002	2.136	0.968	1.722	38.291	0.372
2003	2.565	1.195	2.120	47.159	0.460
2004	3.207	1.450	2.580	57.371	0.558
2005	3.163	1.488	2.639	58.697	0.572
2006	2.961	1.400	2.482	55.206	0.538
2007	3.088	1.460	2.588	57.574	0.562
2008	4.126	1.866	3.319	73.820	0.718
2009	3.913	1.849	3.276	72.895	0.711
2010	4.041	1.920	3.400	75.681	0.738
2011	3.663	1.714	3.039	67.632	0.659
2012	3.864	1.789	3.175	70.647	0.688
2013	3.653	1.694	3.006	66.880	0.652
2014	3.906	1.702	3.036	67.504	0.655
2015	3.772	1.611	2.879	63.996	0.620

Year/Pollutant	Pb (t)	Cd (t)	Cr (t)	Zn (t)	HCB (kg)
2016	3.670	1.623	2.891	64.288	0.624
2017	3.635	1.663	2.954	65.709	0.639
2018	3.602	1.648	2.929	65.145	0.634

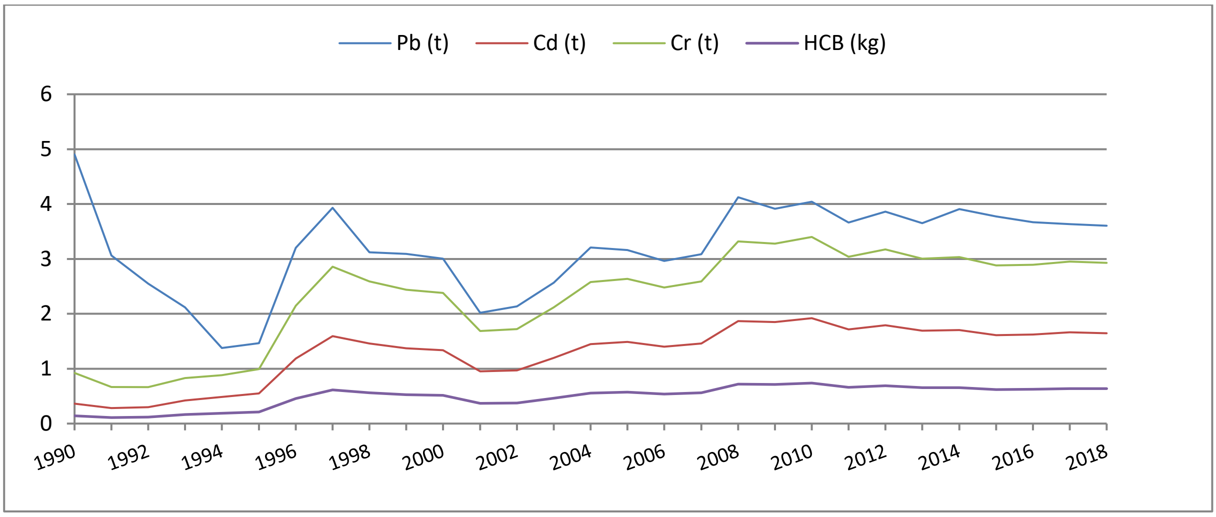


Figure 3.9.2 Emissions of Pb, Cd, Cr and HCB for category NFR 1.A.4.bi

Table 3.9.3 Emissions of PCDD/F (g I-TEQ) and Total PAHs (t) for NFR 1.A.4.b.i

Year/Pollutant	PCDD/F (g I-TEQ)	Total 4 PAHs (t)	PCB (kg)
1990	45.39	34.49	5.563
1991	31.18	22.31	3.314
1992	29.20	19.52	2.577
1993	32.71	18.64	1.667
1994	31.60	15.07	0.501
1995	35.14	16.52	0.431
1996	75.88	35.90	0.995
1997	99.75	45.99	0.847
1998	88.80	39.27	0.127
1999	84.21	37.82	0.339
2000	81.24	36.54	0.306
2001	57.23	25.30	0.055
2002	58.63	26.22	0.172
2003	71.93	31.92	0.118
2004	87.81	39.31	0.267
2005	88.58	39.21	0.103
2006	83.27	36.81	0.078
2007	86.82	38.39	0.082
2008	111.90	50.13	0.343
2009	109.84	48.62	0.107
2010	113.95	50.35	0.080
2011	102.06	45.28	0.145
2012	106.76	47.51	0.206
2013	101.05	44.95	0.188
2014	102.85	46.58	0.504
2015	97.79	44.54	0.578

Year/Pollutant	PCDD/F (g I-TEQ)	Total 4 PAHs (t)	PCB (kg)
2016	97.76	44.09	0.409
2017	99.49	44.42	0.252
2018	98.64	44.03	0.247

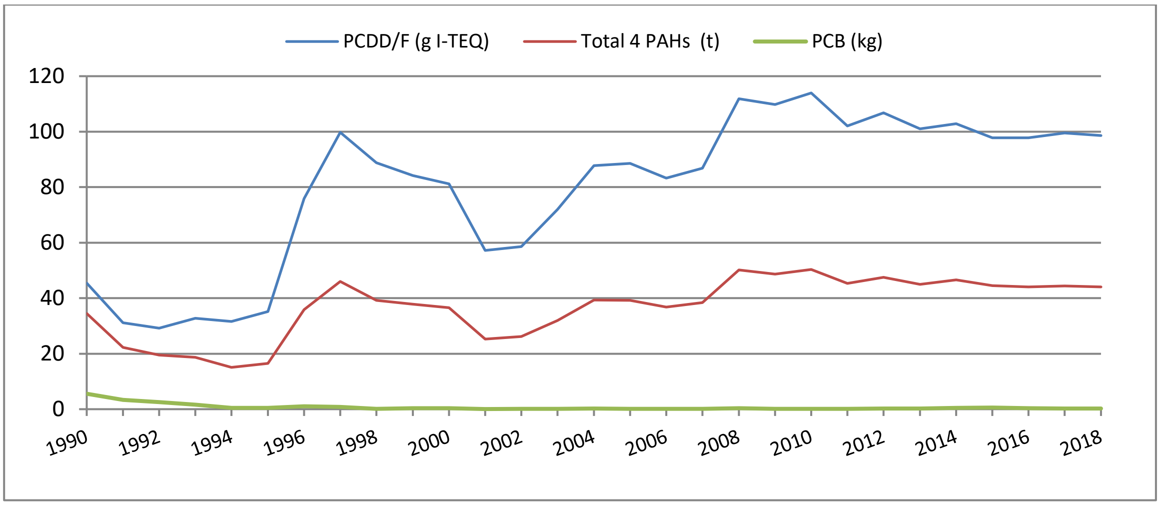


Figure 3.9.3 Emissions of PCDD/F (g I-TEQ) and Total PAHs (t) for NFR 1.A.4.b.i

Most of pollutants increased along the time series, in line with increasing biomass consumption. SOx, PCBs and a few heavy metals decreased in the interval 1990-1998 compared to 1990 because they arise mostly from solid fuel, which decreased in the same interval.

Compared to 2005, the emissions in 2018 increased with 7% for NOx, 27% for SOx, 11% for NMVOC, 10% for NH_3 and 11% for $PM_{2.5}$.

Table 3.9.4 Fuel consumptions (TJ) for Residential heating

Year/Fuel (TJ)	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
1990	3655	32716	104523	24098
1991	2663	19490	124732	19477
1992	7079	15151	73326	21431
1993	3305	9794	77462	31318
1994	516	2933	76715	36877
1995	504	2518	83555	42033
1996	814	5823	78844	90567
1997	1337	4939	97464	121839
1998	2378	706	104793	112184
1999	1272	1958	97410	105087
2000	774	1766	104546	102725
2001	335	296	96169	73306
2002	120	988	111760	74362
2003	889	661	122687	91822
2004	3800	1531	120720	111392
2005	4882	568	119670	114395
2006	5544	420	120046	107639

Year/Fuel (TJ)	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
2007	6833	441	104994	112254
2008	3807	1966	100489	143331
2009	516	580	102737	142124
2010	120	418	102120	147635
2011	200	810	107214	131745
2012	43	1166	114585	137482
2013	0	1061	110921	130169
2014	463	2922	99751	130588
2015	695	3355	103914	123550
2016	352	2361	105937	124547
2017	403	1437	124027	127719
2018	680	1408	128551	126630

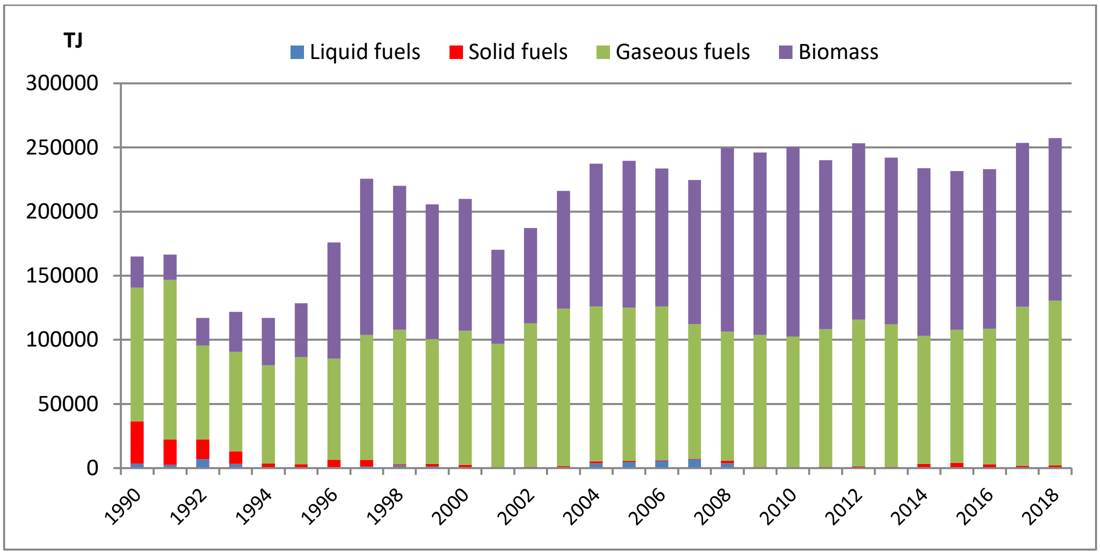


Figure 3.9.4 Fuel consumptions trend (TJ) for Residential heating (NFR 1.A.4.bi)

3.9.1 NFR 1.A.4.b.ii Residential: Household and gardening

NFR 1.A.4.b.ii includes fuel combustion in mobile, non-road sources from residential household and gardening. The estimation is based on diesel and gasoline fuel consumption, provided by EUROSTAT energy balance, category *Final energy consumption/Other Sectors/Residential.* Tier 1 emission factors were used (2016 EMEP/EEA Guidebook, NFR 1.A.4 Non road mobile machinery, Table 3.11.1 - gasoline and diesel oil). SOx is estimated based sulphur content in the fuel.

Following the Review recommendations RO-1A4aii-2017-0001 and RO-1A4aii-2018-0001, a number of 13 years in the time series 1990-2018 have been recalculated, for the years where the diesel and gasoline in the national statistics for population consumption (1A4bii) was available. Where data for are not available separately, the estimation is included in NFRs 1A3b (also for 2018).

The tables and charts below gives the emissions for main pollutants and the fuel consumption time-series.

Table 3.9.1.1 Emissions of main pollutants for NFR 1.A.4bii

Year/Pollutant (kt)	NOx	NMVOC	$PM_{2.5}$	CO
1990	IE	IE	IE	IE
1991	IE	IE	IE	IE
1992	IE	IE	IE	IE
1993	IE	IE	IE	IE
1994	0.38	0.04	0.02	0.127
1995	2.78	0.29	0.15	0.926
1996	IE	IE	IE	IE
1997	4.04	0.41	0.22	1.343
1998	4.07	0.42	0.23	1.355
1999	3.27	0.34	0.18	1.089
2000	4.66	0.48	0.26	1.552
2001	1.53	0.16	0.09	0.510
2002	0.03	0.00	0.00	0.012
2003	1.60	0.16	0.09	0.533
2004	0.14	0.01	0.01	0.046
2005	0.14	0.01	0.01	0.046
2006	0.49	0.05	0.03	0.162
2007	IE	IE	IE	IE
2008	IE	IE	IE	IE
2009	IE	IE	IE	IE
2010	IE	IE	IE	IE
2011	IE	IE	IE	IE
2012	0.17	0.02	0.01	0.057
2013	IE	IE	IE	IE
2014	IE	IE	IE	IE
2015	IE	IE	IE	IE
2016	IE	IE	IE	IE
2017	IE	IE	IE	IE
2018	IE	IE	IE	IE

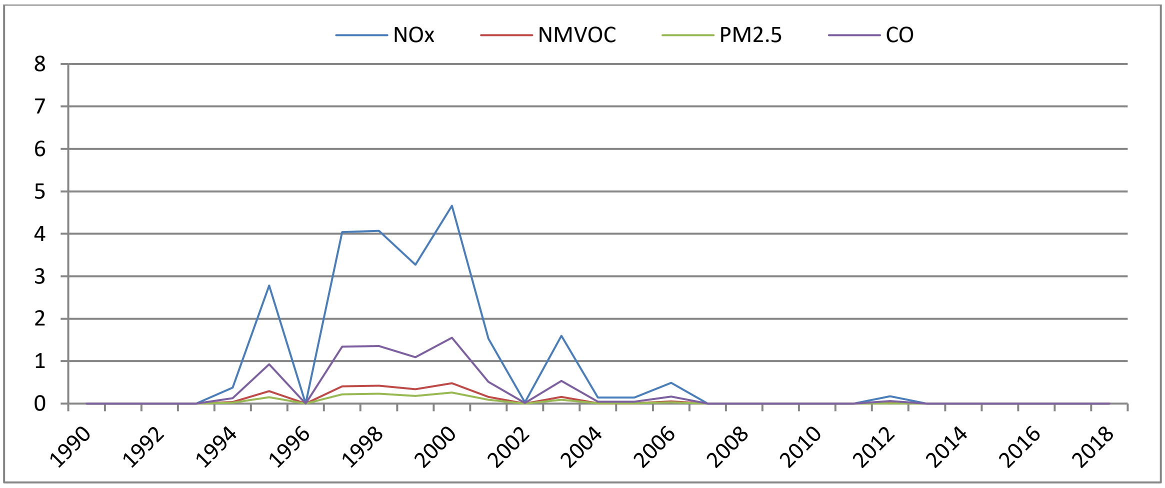


Figure 3.9.1.1 Emissions of main pollutants (kt) from NFR 1A4bii

The fuel consumption for the time-series 1990-2018 for this category is given in the table and chart below.

Table 3.9.1.2 Fuel consumption for NFR 1A4bii

Year/Fuel (TJ)	Diesel Oil
1990	0
1991	0
1992	0
1993	0
1994	472
1995	3432
1996	0
1997	4976
1998	5019
1999	4033
2000	5749
2001	1888
2002	43
2003	1973
2004	172
2005	172
2006	601
2007	0
2008	0
2009	0
2010	0
2011	0
2012	212
2013	0
2014	0
2015	0
2016	0
2017	0
2018	0

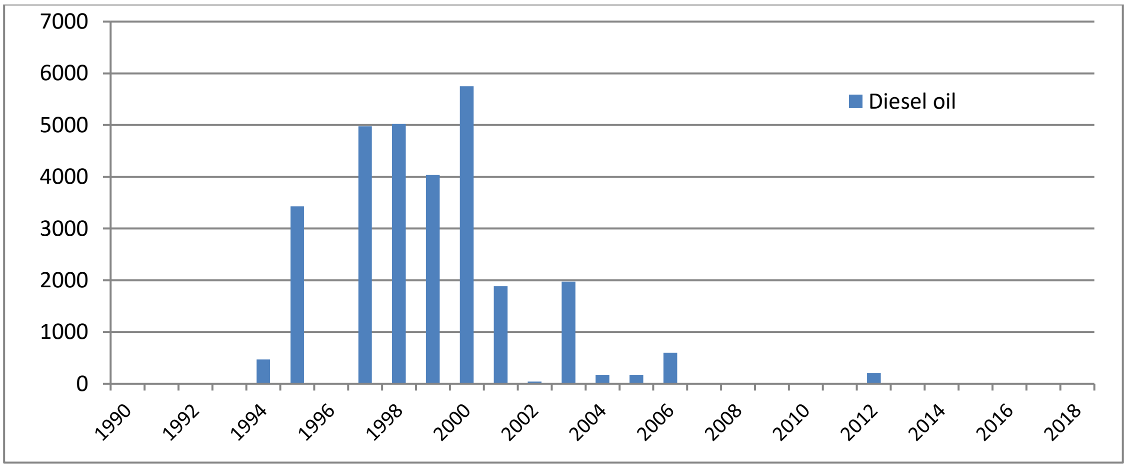


Figure 3.9.1.2 Fuel consumption (TJ) for NFR 1A4bii

3.10 NFR 1.A.4.c.i Agriculture/Forestry/Fishing, Stationary

The emissions for 1990-2018 were estimated by applying Tier 1 emission factors (2019 EMEP/EEA Guidebook, NFR 1.A.4 Small combustion, Tables 3.7 – 3.10 Tier 1 emission factors for NFR category 1.A.4.a/c, 1.A.5.a,) to the fuel consumption from EUROSTAT energy

balances: *Final energy consumption/Other Sectors/Agriculture/Forestry.* From oil category, the fuel oil and 20% of the diesel oil was allocated to this category. The gasoline and 80% of the diesel fuel were used for estimation of emissions for the NFR 1.A.4.c.ii – Non-road vehicles and other machinery.
NFR 1A4ci is not a key source for any pollutant.

Improvements and recalculations:

- First estimation of emissions for 1990-1994;
- Recalculation of the time series with updated activity data;
- TSP, PM_{10}, $PM_{2.5}$ and BC were recalculated on the entire time series using the newest emission factors (slight increase of emission factors for TSP, PM_{10}, $PM_{2.5}$ and BC in Table 3.10 *Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass*).

Table 3.10.1 Emission Trends of main pollutants for NFR 1.A.4.c.i

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM10	BC	CO	Pb
1990	2.720	0.859	0.583	0.106	0.007	1.625	0.089
1991	2.565	0.899	0.042	0.098	0.021	1.225	0.013
1992	2.473	0.357	0.822	0.259	0.099	1.167	0.092
1993	2.013	0.330	0.702	0.225	0.082	1.050	0.084
1994	1.387	0.330	0.470	0.212	0.072	0.907	0.065
1995	1.745	0.327	0.530	0.175	0.063	0.893	0.063
1996	1.396	0.273	0.417	0.166	0.060	0.742	0.051
1997	1.699	0.547	0.452	0.309	0.103	1.256	0.073
1998	1.474	0.508	0.439	0.296	0.096	1.201	0.074
1999	0.878	0.274	0.219	0.147	0.049	0.615	0.035
2000	0.719	0.105	0.206	0.068	0.027	0.308	0.022
2001	0.503	0.096	0.144	0.059	0.022	0.258	0.017
2002	0.525	0.118	0.218	0.069	0.021	0.361	0.030
2003	0.436	0.081	0.257	0.056	0.015	0.339	0.035
2004	0.458	0.082	0.169	0.044	0.014	0.253	0.021
2005	0.441	0.102	0.217	0.057	0.016	0.338	0.031
2006	0.540	0.157	0.338	0.098	0.025	0.543	0.052
2007	0.575	0.536	0.289	0.301	0.082	1.216	0.078
2008	0.745	0.306	0.417	0.161	0.040	0.863	0.072
2009	0.919	0.287	0.474	0.150	0.038	0.857	0.074
2010	0.900	0.244	0.442	0.124	0.032	0.749	0.066
2011	0.971	0.206	0.488	0.119	0.033	0.717	0.067
2012	1.042	0.197	0.256	0.094	0.036	0.477	0.029
2013	1.060	0.621	0.495	0.346	0.095	1.504	0.105
2014	0.904	0.208	0.441	0.121	0.034	0.687	0.062
2015	0.993	0.242	0.499	0.140	0.039	0.795	0.072
2016	1.059	0.223	0.559	0.133	0.036	0.807	0.078
2017	1.237	0.293	0.646	0.153	0.039	0.984	0.092
2018	1.446	0.311	0.806	0.175	0.044	1.144	0.113

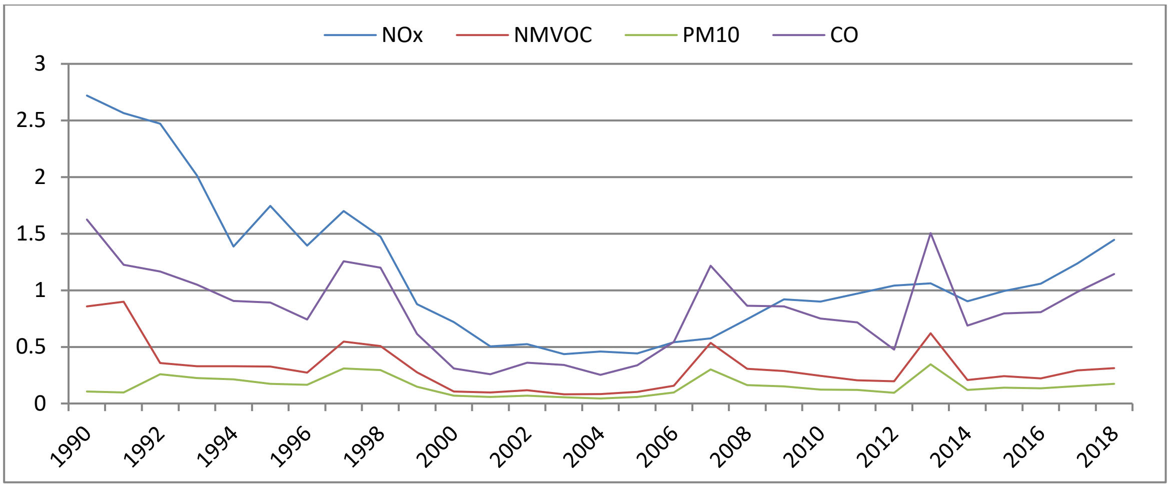


Figure 3.10.1 Emission Trends of main pollutants for NFR 1.A.4.c.i

The fuel consumption for the time-series 1990-2018 for this category is given in the table and chart below.

Table 3.10.2 NFR 1.A.4.c.i: Agriculture/Forestry/Fishing, stationary

Year/Fuel (TJ)	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
1990	123	652	34725	0
1991	160	0	33484	420
1992	7433	139	1718	521
1993	5794	179	2216	492
1994	3958	106	1261	709
1995	4364	133	4741	396
1996	3858	57	2197	468
1997	4433	23	2992	1291
1998	3904	68	2078	1253
1999	2171	8	2122	604
2000	2076	10	938	137
2001	1424	9	680	171
2002	1270	114	1371	170
2003	1070	184	950	72
2004	1072	79	1487	65
2005	944	150	1566	114
2006	1193	264	1436	254
2007	995	211	1245	1564
2008	1202	352	3581	561
2009	1665	369	4155	418
2010	1656	334	4184	285
2011	2159	334	3174	199
2012	2512	18	3376	226
2013	2071	334	3010	1603
2014	2045	290	2761	258
2015	2181	343	3206	315
2016	2365	396	3345	214

Year/Fuel (TJ)	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
2017	2371	496	5439	254
2018	2922	625	5723	218

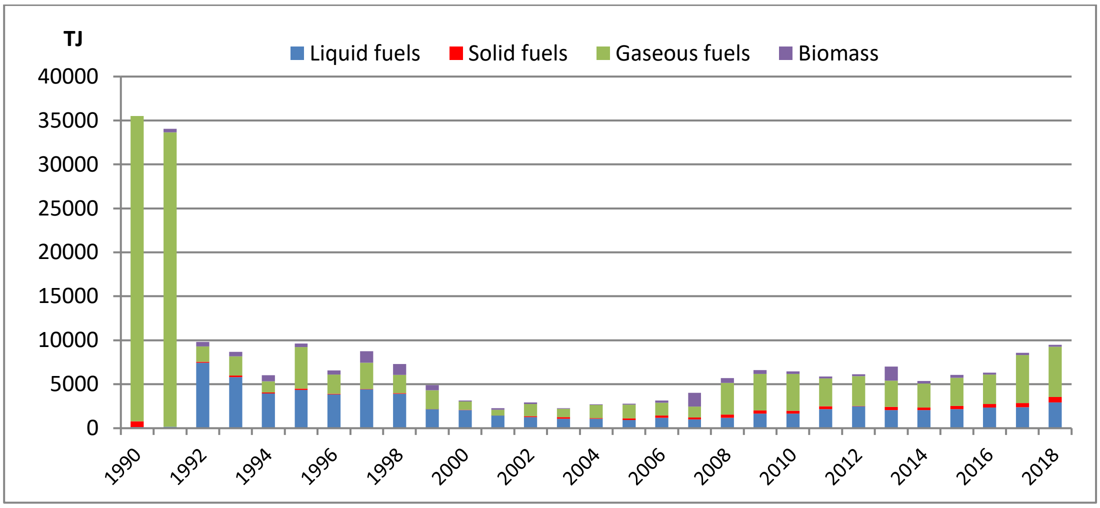


Figure 3.10.2 Fuel consumptions (TJ) for NFR 1.A.4.c.i: Agriculture/Forestry/Fishing, stationary

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

This category includes emissions from fuel combustion in mobile, non-road sources from agricultural/forestry sector. NFR 1A4ciii, National fishing, is also reported at this category, because the fuel consumption for national fishing is not reported separately to EUROSTAT.
Improvements and recalculations:

- First estimation of emissions for 1992-1994;
- Recalculation of the emissions in the interval 1995-1998 (due to reallocation of 20% of diesel consumption to 1A4ci;
- Implementation of the Review recommendation RO-1A4cii-2019-0001 on update to Tier2.

The estimation is based on diesel and gasoline fuel consumptions, given in EUROSTAT Energy balance, category *Final energy consumption/Other Sectors/Agriculture/Forestry/ Fishing*. Data for 2017 and 2018 were provided by N.I.S. in the forms of the Eurostat Energy questionnaires.
NFR 1.A.4.cii was estimated in the previous submissions on Tier 1 level. NFR 1A4cii was a key source for NOx (4% in the national total for 2017) in the 2019 submission, therefore, the Review observation (RO-1A4cii-2019-0001) recommended to recalculate the emissions on Tier2 level. The Review recommendation was implemented in the 2020 submission. For the reference year 2018, the share of NOx from NFR 1A4cii in the national total is 1.2%, which is out of the range of key sources. Compared to 2005, NOx in 2018 decreased with 15%.

The activity data considered in the actual estimation is 80% of the Gas/Diesel oil in the Eurostat *Final energy consumption/Other Sectors/Agriculture/Forestry/Fishing* and 100% Motor Gasoline. 20% of the Gas/Diesel oil is allocated to 1A4ci. The emission factors used for Tier 2 calculation are given in the Table 3-2 - Tier 2 emission factors for non-road machinery, Diesel, 1A4cii Agriculture and Forestry, Guidebook 2019.

There are no available data on fuel consumption split by engine age and technologies, therefore, the method used for splitting the fuel for Tier 2 estimation is the alternative approach provided by the Guidebook 2019 , data derived from Winther (2016) and Winther & Nielsen (2006), given in the Tables 3–3 in the chapter Non-road mobile sources and machinery and Tables 3-5 & 3–6, in the Annex file accompanying the Guidebook chapter. The method applies to 1998-2018 interval, for which all pollutants were recalculated on Tier2 with regard to diesel consumption. For the interval 1992-1997, Tier 1 applies for both diesel and gasoline fuels. The estimation for 1990-1991 is included in NFRs 1A3b. The diesel oil has a contribution over 99.5% to NOx emissions, while gasoline less than 0.5%. Therefore, gasoline emissions are calculated on Tier 1 level, using the emission factors in Table 3.11.1, NFR 1.A.4 Non road mobile machinery, Guidebook 2019.

Table 3.10.1.1 Emission Trends of main pollutants for NFR 1.A.4.cii non-road Agriculture/Forestry/Fishing

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM_{10}	BC	CO
1992	23.76	5.96	1.377	1.37	0.77	17.51
1993	18.42	3.30	1.068	1.04	0.59	9.98
1994	12.59	1.77	0.730	0.71	0.41	5.49
1995	13.90	2.60	0.806	0.79	0.45	7.82
1996	12.43	4.79	0.719	0.75	0.40	13.74
1997	14.27	3.11	0.827	0.82	0.46	9.24
1998	12.56	4.10	0.727	0.74	0.41	11.85
1999	8.90	2.12	0.140	0.49	0.26	6.03
2000	8.77	3.73	0.137	0.50	0.25	10.42
2001	5.98	1.55	0.094	0.31	0.17	4.40
2002	5.16	1.21	0.084	0.26	0.14	3.48
2003	4.54	1.36	0.068	0.22	0.12	3.95
2004	3.85	1.29	0.071	0.19	0.10	3.70
2005	3.19	0.96	0.009	0.15	0.08	2.81
2006	3.77	3.28	0.011	0.21	0.10	9.19
2007	2.89	0.93	0.009	0.13	0.08	2.75
2008	2.53	1.35	0.009	0.12	0.07	3.89
2009	3.98	1.02	0.003	0.17	0.10	3.15
2010	3.78	1.22	0.003	0.17	0.10	3.73
2011	4.47	0.82	0.004	0.18	0.12	2.77
2012	4.93	2.66	0.005	0.22	0.12	7.95
2013	2.51	1.34	0.004	0.11	0.06	4.08
2014	3.29	0.94	0.004	0.12	0.08	3.21
2015	3.10	2.30	0.004	0.14	0.07	6.98
2016	2.88	0.92	0.004	0.11	0.07	3.32

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM_{10}	BC	CO
2017	2.53	0.88	0.004	0.10	0.06	3.24
2018	2.72	1.11	0.005	0.11	0.06	4.10

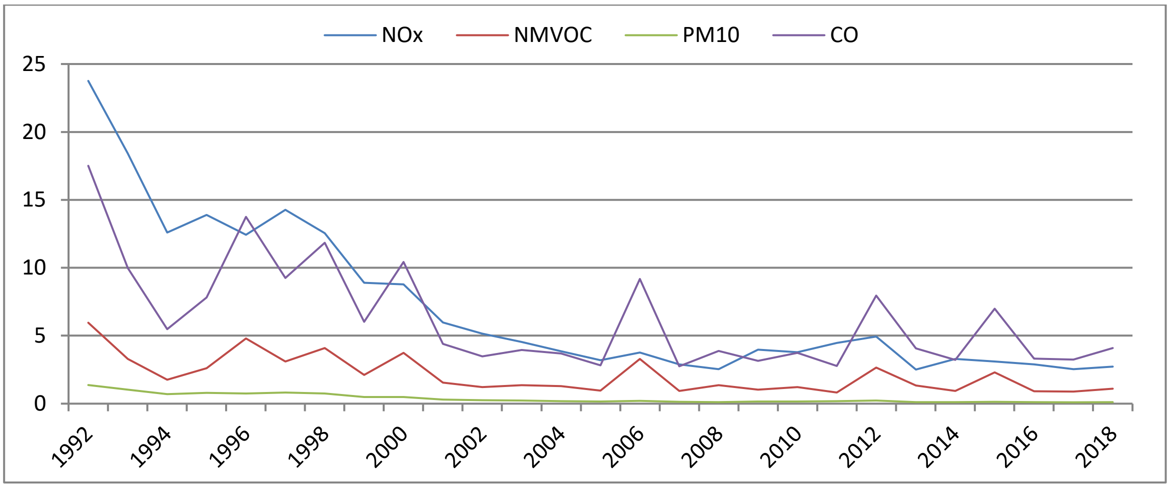


Figure 3.10.1.1 Emissions (kt) of NOx, NMVOC, PM10 and CO for NFR 1.A.4.c.ii, 1992-2018

The emission trends are consistent with the variation of the fuel consumption. Compared to 2005, the emissions in 2018 decreased with The fuel consumption for the time-series 1992-2018 for this category is given in the table and chart below.

Table 3.10.1.2 Emission Trends of main pollutants for NFR 1.A.4.cii non-road Agriculture/Forestry/Fishing

Year/Fuel (TJ)	Gasoline	Diesel fuel	Total liquid fuel
1992	674	36551	37225
1993	269	28357	28626
1994	90	19391	19481
1995	224	21407	21631
1996	674	19090	19764
1997	314	21965	22279
1998	539	19305	19844
1999	224	10639	10863
2000	539	10382	10921
2001	180	7121	7301
2002	135	6349	6484
2003	180	5148	5328
2004	180	5362	5542
2005	131	4719	4850
2006	566	5963	6529
2007	131	4976	5107
2008	218	4719	4937
2009	131	8108	8239
2010	174	8280	8454
2011	87	10596	10683
2012	435	12561	12996
2013	218	10354	10572

Year/Fuel (TJ)	Gasoline	Diesel fuel	Total liquid fuel
2014	131	10227	10358
2015	392	10906	11298
2016	131	11627	11758
2017	127	11648	11775
2018	159	11518	11677

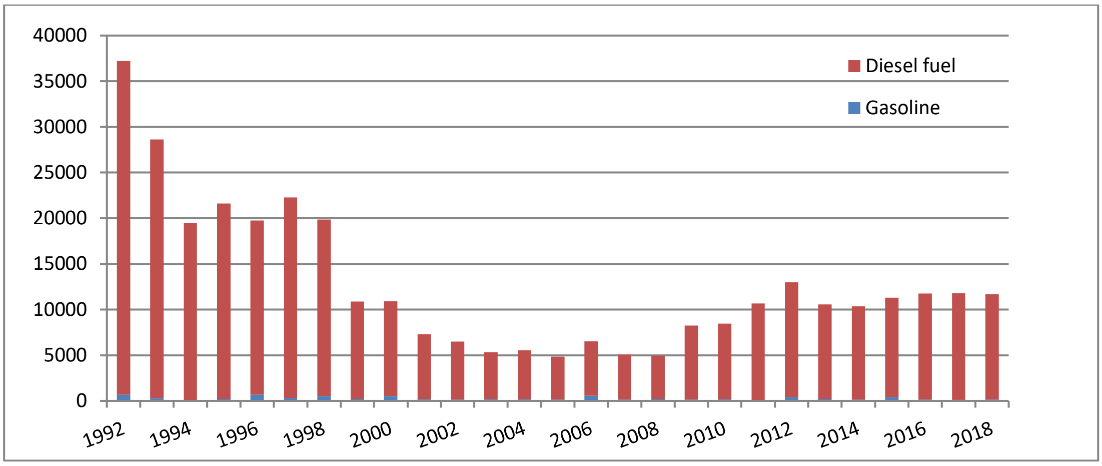


Figure 3.10.1.2 Fuel consumption (TJ) for NFR 1.A.4.c.ii, off road Agriculture/Forestry/Fishing

3.11 NFR 1.A.5 - Other stationary (including military)

The emissions reported at NFR 1A5 - Other stationary (including military) for the years 1990-2018 are based on Eurostat Energy data and Tier 1 emission factors. The data for 1990-2016 were provided by the EUROSTAT annual energy balances (nrg_110) in the category: *Final energy consumption/Other Sectors/Non-specified (Oth*er). Data for 2017-2018 were provided by the National Institute of Statistics in the forms of the Eurostat Energy questionnaires. Tier 1 emission factors were applied (2019 EMEP/EEA Guidebook, NFR 1.A.4 Small combustion, Tables 3.7 – 3.10 *Tier 1 emission factors for NFR category 1.A.4.a/c, 1.A.5.a*). NFR 1A5b Other, Mobile (including military, land based and recreational boats) is also included in NFR 1A5a.

Improvements and recalculations:

- First estimation of emissions for 1990-1994;
- TSP, PM_{10}, $PM_{2.5}$ and BC were recalculated on the entire time series using the newest emission factors (slight increase of emission factors for TSP, PM10, PM2.5 and BC in Table 3.10 *Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using solid biomass*).

The table 3.11.1 and chart 3.11.1 below give the values of the significant pollutants. NFR 1.A.5a is not a key category for any pollutant.

Table 3.11.1 Emissions for NFR 1.A.5, 1990-2018

Year/Pollutant	NOx	NMVOC	SOx	PM_{10}	BC	CO	Ni
1990	2.25	1.09	10.27	1.43	0.09	11.38	0.22
1991	3.71	3.09	8.96	2.42	0.43	13.80	0.69
1992	1.41	0.83	5.02	0.86	0.09	6.09	0.19
1993	1.33	0.64	0.74	0.41	0.12	1.76	0.45
1994	1.88	0.67	0.93	0.45	0.13	1.94	0.68
1995	2.20	0.73	1.76	0.55	0.14	2.79	0.76
1996	1.38	1.04	0.55	0.61	0.18	2.34	0.44
1997	3.74	0.90	1.17	0.61	0.22	2.40	1.45
1998	3.02	0.57	0.99	0.41	0.15	1.68	1.18
1999	0.63	0.69	0.16	0.39	0.11	1.39	0.18
2000	0.92	0.33	0.89	0.26	0.06	1.36	0.31
2001	1.98	1.80	1.05	1.07	0.30	4.18	0.58
2002	1.66	2.00	0.60	1.14	0.32	4.18	0.44
2003	2.11	1.97	0.71	1.13	0.33	4.17	0.63
2004	5.75	1.94	2.40	1.29	0.40	5.31	2.12
2005	5.39	2.68	1.89	1.64	0.50	6.26	1.90
2006	2.76	2.31	0.78	1.33	0.39	4.82	0.87
2007	4.47	2.07	1.27	1.25	0.40	4.64	1.62
2008	3.95	1.90	1.12	1.14	0.36	4.22	1.42
2009	1.58	1.56	0.40	0.88	0.26	3.16	0.47
2010	1.61	1.63	0.41	0.92	0.27	3.31	0.48
2011	2.56	1.03	0.74	0.64	0.21	2.37	0.94
2012	2.56	0.96	0.74	0.60	0.20	2.24	0.95
2013	1.97	0.82	0.56	0.51	0.16	1.88	0.72
2014	1.84	0.71	0.53	0.44	0.14	1.64	0.68
2015	2.22	1.45	0.61	0.85	0.26	3.08	0.75
2016	2.19	1.68	0.58	0.97	0.29	3.50	0.71
2017	2.96	1.48	0.84	0.89	0.28	3.26	1.06
2018	2.69	0.18	0.83	0.18	0.09	0.82	1.10

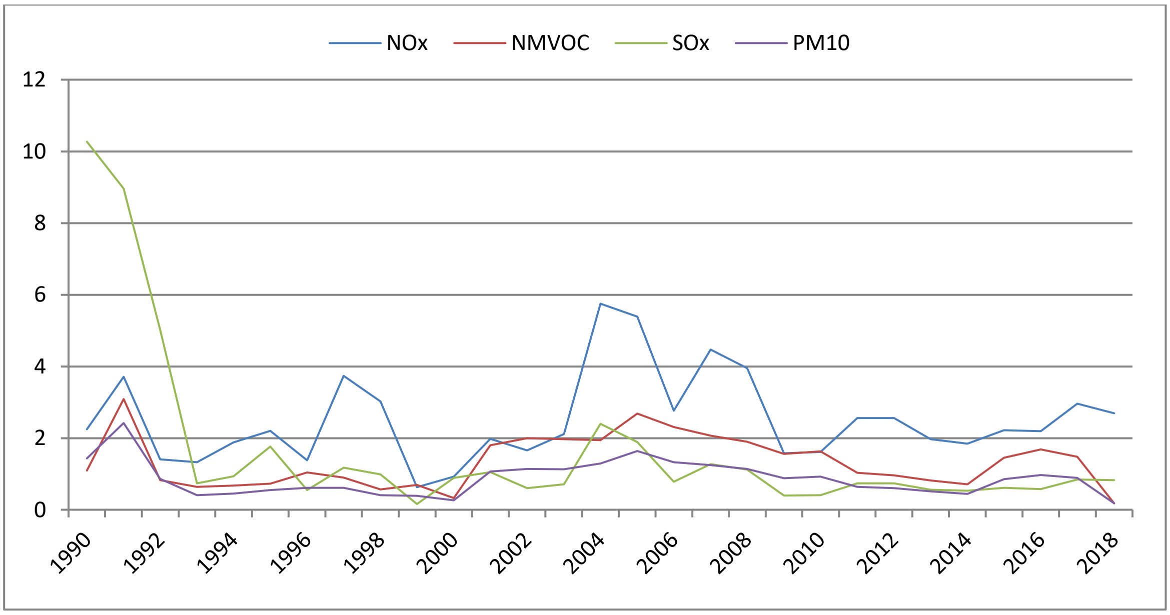


Figure 3.11.1 Emissions for NFR 1A5, 1990-2018

The emissions are consistent with the variation of the fuel consumption in the Energy statistics. The fuel consumption for the time-series 1990-2018 for this category is given in the table and chart below.

Table 3.11.2 Fuel consumption (TJ), 1A5, 1990-2018

Year/Fuel (TJ)	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
1990	458	12180	46	0
1991	4334	10095	0	7013
1992	860	5867	690	924
1993	3544	458	46	1757
1994	5360	487	0	1726
1995	5888	1414	46	1618
1996	3426	229	46	3165
1997	11529	74	0	2208
1998	9438	105	0	1237
1999	1416	0	0	2210
2000	2360	790	0	702
2001	4462	682	0	5486
2002	3389	253	0	6367
2003	4938	214	0	6167
2004	16746	916	0	5084
2005	15053	460	0	7779
2006	6822	71	0	7231
2007	12828	0	0	6039
2008	11240	0	0	5575
2009	3689	0	0	4950
2010	3732	0	0	5192
2011	7508	0	0	2930
2012	7553	0	0	2693
2013	5729	0	0	2366
2014	5432	0	0	1998
2015	5941	0	0	4430
2016	5601	0	0	5226
2017	8376	0	73	4356
2018	8800	0	0	0

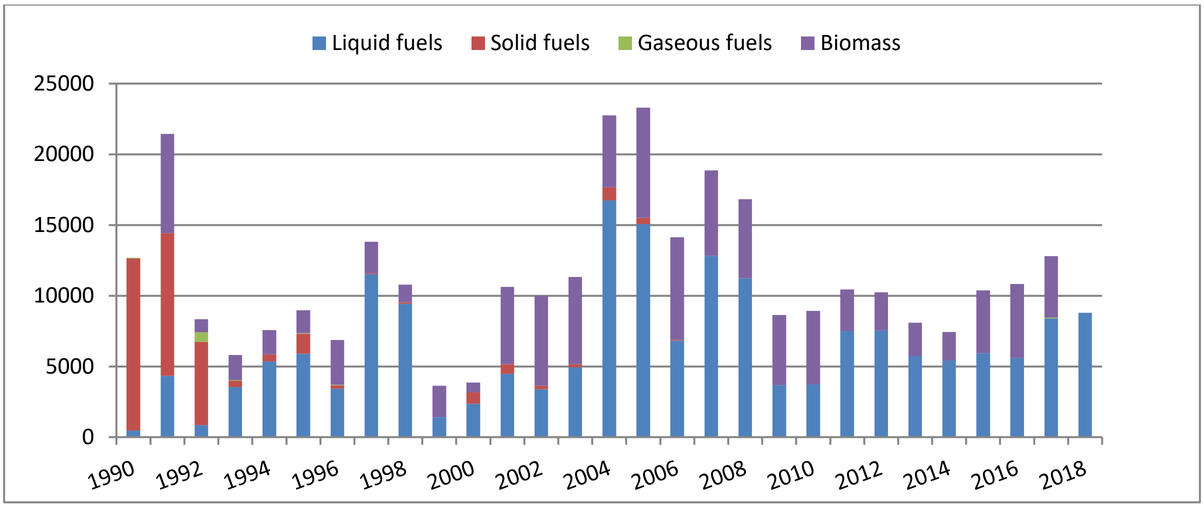


Figure 3.11.2 Fuel consumption (TJ), 1A5, 1990-2018

3.12 NFR 1.A.3.a Aviation transport

The emissions from the civil aviation include both, air pollution from national and international aviation, according with the flight phases: for landing and take-off (LTO) cycles comprise under NFR 1.A.3.ai(i) - International aviation LTO (civil) and NFR 1.A.3.aii(i) - Domestic aviation LTO (civil) and for the Cruise cycle (phase for floating over long distance at high altitude (>3000ft (914.4 m), are reported as a memo items: NFR 1.A.3.ai(ii) - International aviation cruise (civil) and NFR 1.A.3.aii(ii) - Domestic aviation cruise (civil).

This category does not include military aviation activities. The values of pollutants due to the aviation activities for the period 2005-2018 were taken from the EUROCONTROL report.

"For the LTO stages, a Tier 3A calculation is performed with the assumption that the LTO stages are described by an ICAO LTO cycle but with the default ICAO taxi-in and taxi-out times being replaced by more accurate values if available. Average fuel consumption and emission data are assumed for each FEIS type of aircraft.

For the en-route stage, a Tier 3B calculation is performed in which the masses of the jet fuel and avgas burnt and the masses of some of the species of interest emitted are calculated on a flight segment by flight segment basis" [1].

For the period 1990-2004, there is a lack of information as regards to EUROCONTROL values for pollutants arising from aviation activities, the emissions are not estimated and "NE" notation is used.

NFR 1.A.3.ai(i) and 1.A.3.aii(i) are not a key source for any pollutant.

[1] D2.3 - European Aviation Fuel Burn and Emissions System for the EEA.V2, pg. 31-32

Table 3.12.1. Fuel burnt (tonnes), in 2005-2018, Aviation transport

Year/Fuel burnt [t]	NFR 1A3ai(i)	NFR 1A3aii(i)	Memo item 1A3ai(ii)	Memo item 1A3aii(ii)
2005	16850.47	3180.26	107700.24	8109.26
2006	19615.08	3594.43	127245.28	8909.44
2007	25950.37	4694.09	170242.07	10847.79
2008	29441.04	5756.02	206924.12	14088.73
2009	29120.20	6369.11	200587.17	15530.53
2010	31152.48	6411.82	213601.98	15874.32
2011	31612.13	5370.95	213317.27	13238.78
2012	31898.99	4495.79	220257.70	11779.79
2013	31644.76	3908.51	217537.90	9808.26
2014	35738.74	3708.58	233871.35	9080.91
2015	39514.95	3936.81	254183.73	9353.27
2016	45456.24	6618.82	295565.63	14458.85
2017	51813.92	9569.74	337422.45	20047.89
2018	55605.77	9938.80	360482.43	20671.42

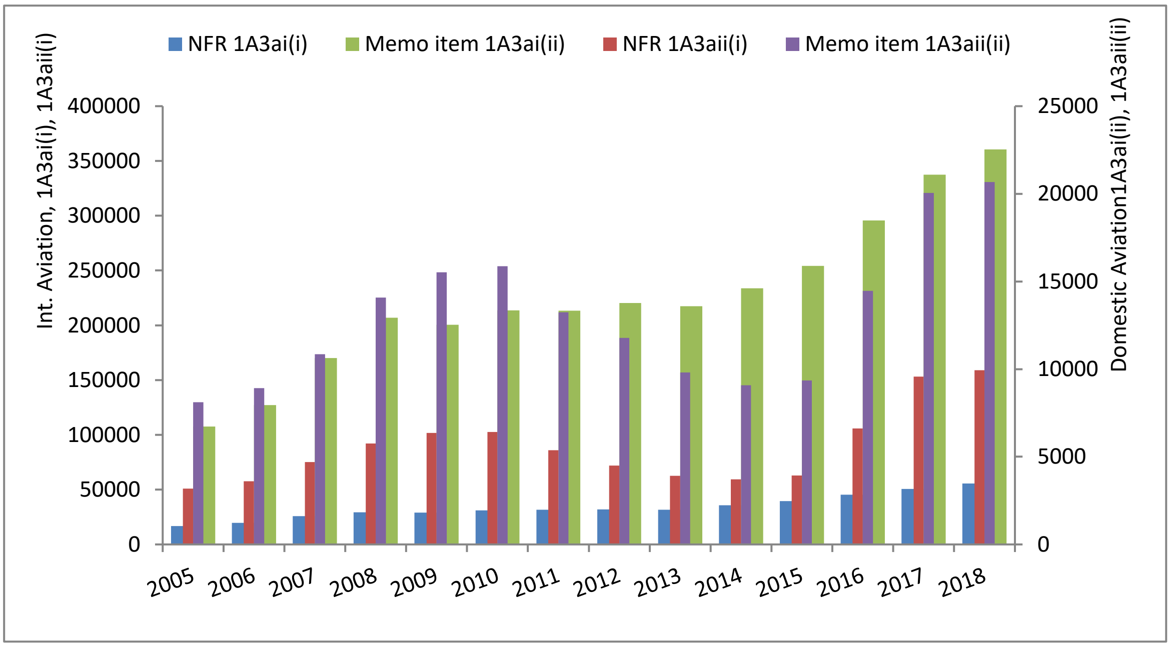


Figure 3.12.1. Fuel burnt (tonnes), in 2005-2018, Aviation transport

Table 3.12.2. Emissions trends (kt), NFR 1.A.3.aii(i) - Domestic aviation LTO (civil), 2005-2018

Year/Pollutant	NOx [kt]	NMVOC [kt]	SOx [kt]	CO [kt]	∑ ($PM_{2.5}$ PM_{10})[kt]
2005	0.030092	0.005340	0.002671	0.046251	0.000281
2006	0.035866	0.007463	0.003019	0.050431	0.000398
2007	0.049189	0.008269	0.003943	0.061659	0.000531
2008	0.063543	0.007962	0.004835	0.074937	0.000845
2009	0.071488	0.008925	0.005350	0.091709	0.000795

Year/Pollutant	NOx [kt]	NMVOC [kt]	SOx [kt]	CO [kt]	Σ ($PM_{2.5}$ PM_{10})[kt]
2010	0.070027	0.009291	0.005386	0.079221	0.000769
2011	0.059273	0.006406	0.004512	0.062534	0.000823
2012	0.050068	0.005502	0.003776	0.058276	0.000634
2013	0.044230	0.004040	0.003280	0.045210	0.000420
2014	0.041591	0.003896	0.003115	0.043091	0.000381
2015	0.044259	0.005314	0.003307	0.047174	0.000447
2016	0.076581	0.006140	0.005560	0.073910	0.000859
2017	0.111725	0.009269	0.008039	0.103946	0.001486
2018	0.117487	0.009029	0.008348	0.105247	0.001644

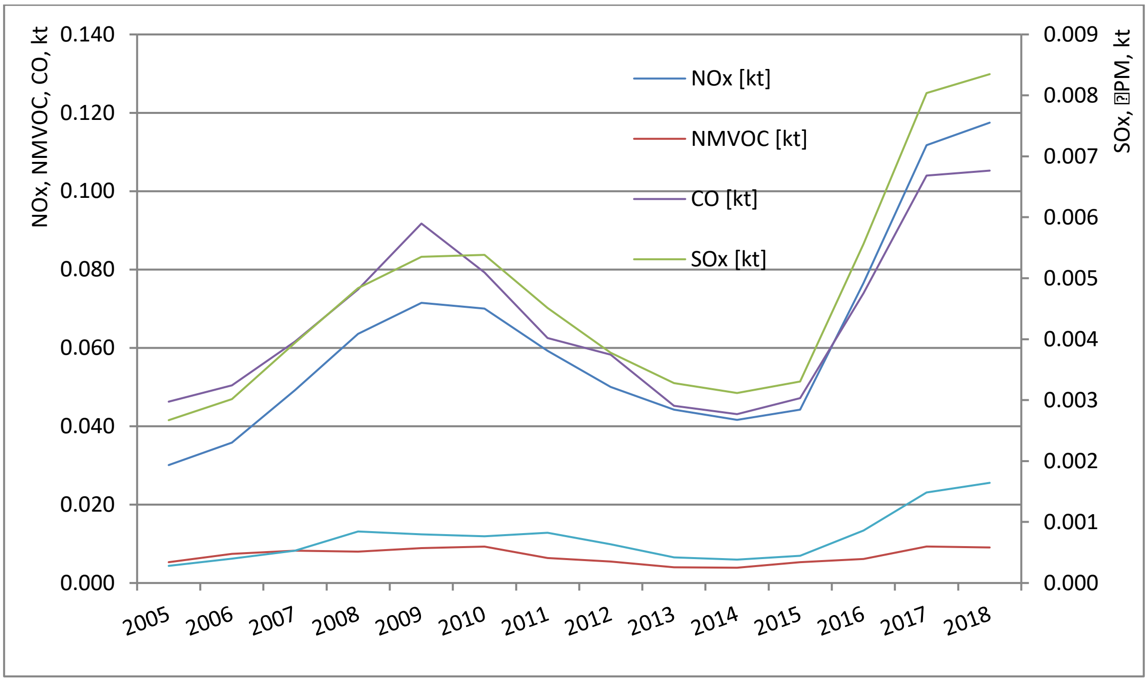


Figure 3.12.2. Emissions trends (kt), NFR 1.A.3.aii(i) - Domestic aviation LTO (civil), 2005-2018

The trend is upward in the period 2005-2009, after which it is declining, until 2014, and upward, from 2015 to now. The emission are directly correlated with the fuel consumption.

Recalculations and improvements:

- There were not recalculations since the previous submission.

3.13 NFR 1.A.3.b Road transport

This sector includes emissions from road transport from Passenger Cars (1.A.3.b.i), Light Duty Vehicles (1.A.3.b.ii), Heavy Duty Vehicles and Busses (1.A.3.b.iii), Mopeds and Motorcycles (1.A.3.b.iv), as well as emissions from Gasoline Evaporation (1.A.3.b.v), Automobile tyre and brake wear (1.A.3.b.vi), and Automobile road abrasion (1.A.3.b.vii).

The road transport sector contributed to the total national emissions in 2018, for NOx with 39.89% of the total, NMVOC with 9.17% of total, BC with 16.25% of the total, CO with 15.42% of the total, Cu with 84.88% of the total and Zn with 6.98% of the total.

Table 3.13.1. Share of emissions (%) from 1A3b in the national total in 2018

Pollutant	1A3bi	1A3bii	1A3biii	1A3biv	1A3bv	1A3bvi	1A3bvii	1A3b
NOx	12.98%	5.42%	21.46%	0.04%	-	-	-	39.89%
NMVOC	3.84%	0.84%	1.29%	0.32%	2.88%	-	-	9.17%
SOx	0.03%	0.01%	0.02%	0.00%	-	-	-	0.07%
NH3	0.51%	0.03%	0.03%	0.00%	-	-	-	0.58%
PM2.5	1.07%	0.63%	1.15%	0.01%	-	0.84%	0.42%	4.13%
PM10	0.81%	0.48%	0.87%	0.01%	-	1.20%	0.59%	3.96%
TSP	0.53%	0.32%	0.57%	0.01%	-	1.03%	0.78%	3.23%
BC	6.74%	3.96%	5.54%	0.02%	-	-	-	16.25%
CO	10.96%	2.29%	1.69%	0.48%	-	-	-	15.42%
Pb	0.01%	0.00%	0.00%	0.00%	-	6.17%	-	6.18%
Cd	0.01%	0.00%	0.00%	0.00%	-	0.38%	-	0.40%
Hg	1.54%	0.37%	0.78%	0.01%	-	0.00%	-	2.70%
As	0.01%	0.00%	0.00%	0.00%	-	0.00%	-	0.02%
Cr	0.19%	0.06%	0.14%	0.00%	-	7.64%	-	8.04%
Cu	0.07%	0.02%	0.05%	0.00%	-	84.74%	-	84.88%
Ni	0.04%	0.00%	0.00%	0.00%	-	1.74%	-	1.79%
Se	0.00%	0.00%	0.00%	0.00%	-	0.20%	-	0.21%
Zn	0.07%	0.02%	0.03%	0.00%	-	6.86%	-	6.98%
PCDD/ PCDF	1.18%	0.35%	0.31%	0.01%	-	-	-	1.85%
Total PAH	0.43%	0.12%	0.24%	0.00%	-	-	-	0.79%
HCB	0.08%	0.02%	0.01%	0.00%	-	-	-	0.12%
PCBs	0.00%	0.00%	0.00%	0.00%	-	-	-	0.00%

Note - Only two decimals are displayed in the table

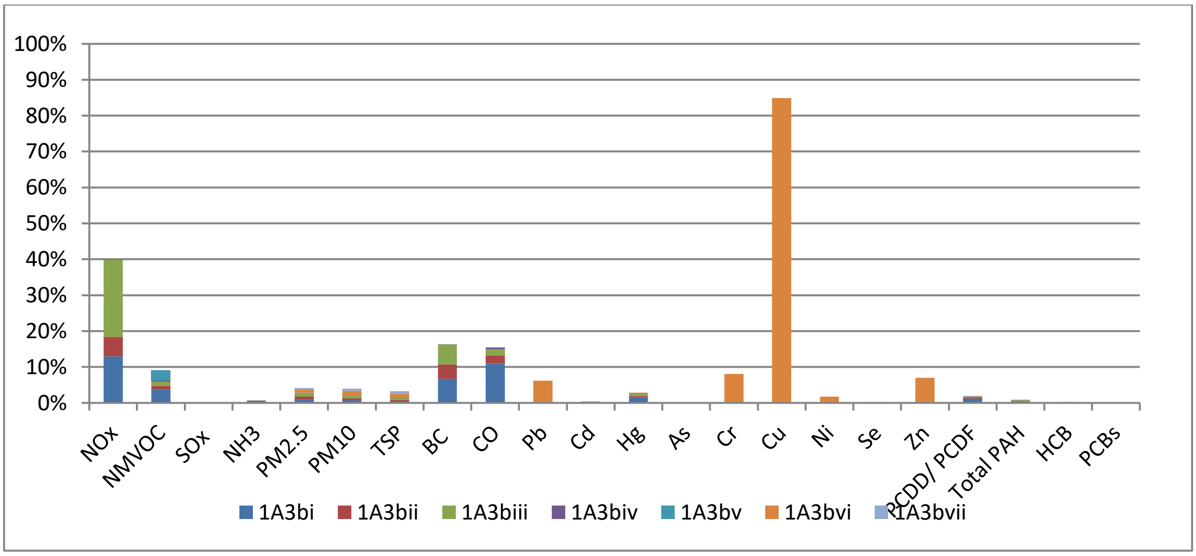


Figure 3.13.1 Share of emissions (%) from 1A3b in the national total in 2018

In 2018, key sources from NFR 1.A.3.b. sector, road transport, are:

- NFR 1.A.3.b.i - Road transport: Passenger cars, for NOx, NMVOC, BC and CO;
- NFR 1.A.3.b.ii - Road transport: Light duty vehicles, for NOx;
- NFR 1.A.3.b.iii - Road transport: Heavy duty vehicles and buses, for NOx and BC;
- NFR 1.A.3.b.v - Road transport: Gasoline evaporation, for NMVOC;
- NFR 1.A.3.b.vi - Road transport: Automobile tyre and brake wear, for Cu and Zn.

Table 3.13.2. Share of 1.A.3.b.- Road transport emissions by key categories pollutant in the national total in 2018 (%)

NFR / Pollutant	NOx	NMVOC	BC	CO	Cu	Zn
1A3bi Road transport: Passenger cars	12.98%	3.84%	6.74%	10.96%	0.07%	0.07%
1A3bii Road transport: Light duty vehicles	5.42%	0.84%	3.96%	2.29%	0.02%	0.02%
1A3biii Road transport: Heavy duty vehicles and buses	21.46%	1.29%	5.54%	1.69%	0.05%	0.03%
1A3biv Road transport: Mopeds & motorcycles	0.04%	0.32%	0.02%	0.48%	0.00%	0.00%
1A3bv Road transport: Gasoline evaporation	NA	2.88%	NA	NA	NA	NE
1A3bvi Road transport: Automobile tyre and brake wear	NA	NA	NA	NE	84.74%	6.86%
1A3bvii Road transport: Automobile road abrasion	NA	NA	NA	NE	NE	NA
TOTAL	**39.89%**	**9.17%**	**16.25%**	**15.42%**	**84.88%**	**6.98%**

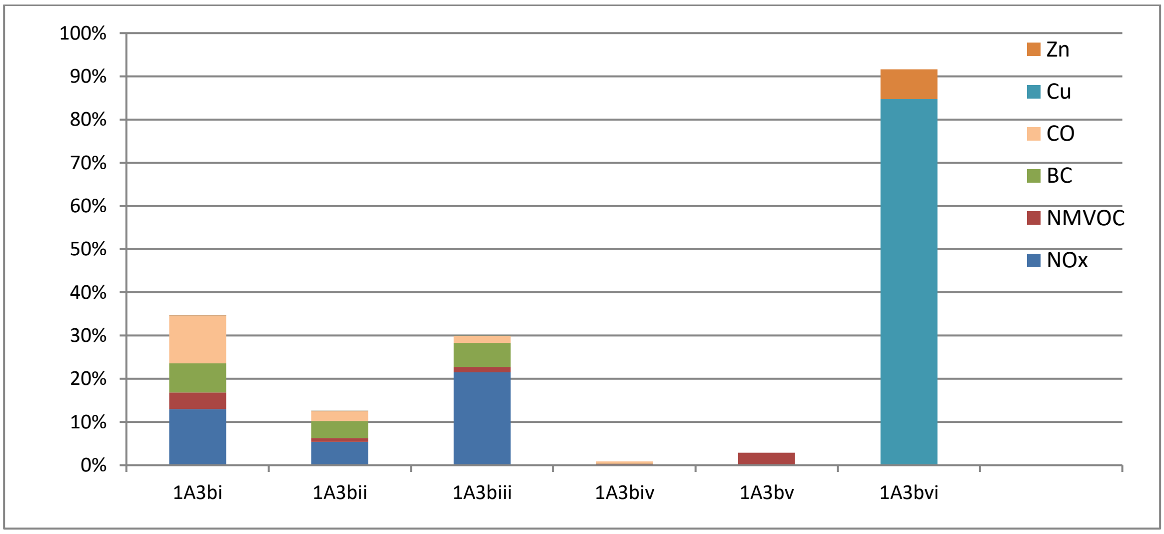


Figure 3.13.2 Share of 1.A.3.b.- Road transport emissions by key categories pollutant in the national total in 2018 (%)

Details on calculations and trends are given in the following section.

For the period 1990-2004:

For this period, Tier 1 methodology was used in the absence of more detailed data necessary to run COPERT.

Emissions from NFR 1.A.3.b.i to NFR 1.A.3.b.iv were estimated based on fuel consumption data from Romania CRF report, for each category of main vehicles (Passenger cars, Light duty vehicles, Heavy duty vehicles and buses, Mopeds & motorcycles) and the default Tier 1 emission factors (2019 EMEP/EEA Guidebook, chapter 1.A.3.b.i-iv, Tables 3.5 to 3.11). The sulfur content of the fuel from table 3-14 was used to estimate SO2 emissions.

Emissions from NFR 1.A.3.b.v were estimated based on the numbers of gasoline fuelled vehicles in each category from Romania CRF report, the national daily temperature range and the default Tier 1 emission factors (2019 EMEP/EEA Guidebook, chapter 1.A.3.b.v, Tables 3.1 to 3.4).

Emissions from NFR 1.A.3.b.vi and 1.A.3.b.vii were estimated based on the numbers of vehicles in each category, the average mileage driven per vehicle in each category from Romania CRF report and the default Tier 1 emission factors (2019 EMEP/EEA Guidebook, chapter 1.A.3.b.vi-vii, Tables 3.1 to 3.2).

For the period 2005-2017:

Emissions were estimated by importing data from COPERT 4 into the latest version of COPERT 5. The emissions were calculated through the input of detailed data on, such as vehicle fleet categorized in sectors, subsectors and technology, vehicle stock and annual mileage, speed and driving shares, average daily trip length, the relative humidity per month, minimum and maximum temperatures per month, consumption and fuel specifications. Default COPERT, sulphur and heavy metals contents have been taken into account for emission estimates. Input data for COPERT have been provided by National Institute for Statistics (for fuel consumption from Energy Balance), Romanian Automobile Registry (for fleet data) and National Institute of Meteorology (maximum and minimum temperatures and relative humidity).

Information on the source sectors including the condensable component of PM_{10} and $PM_{2.5}$ is provided by the 2019 EMEP/EEA Guidebook, chapter 1.A.3.bi-iv: "… at a temperature lower than 52ºC. At this temperature, PM contains a large fraction of condensable species. Hence, PM mass emission factors in this chapter are considered to include both filterable and condensable material."

The fleet evolution and the fuel consumption per fuel type, for Road Transport 1.A.3.b., are shown in the tables and figures below.

Table 3.13.3. Fleet evolution (number of vehicles)

Year	Passenger Cars – Gasoline	Passenger Cars – Diesel	Light duty vehicles - Gasoline	Light duty vehicles - Diesel	Heavy duty vehicles and buses - Gasoline	Heavy duty vehicles and buses - Diesel	Mopeds & motorcycles - Gasoline
1990	1163055	129228	78864	91933	-	375824	311646
1991	1288409	143157	81471	97022	-	392875	315479
1992	1433726	159303	87131	102796	-	409138	322756
1993	1613749	179305	93563	109118	-	430348	326505
1994	1818015	202002	101463	117387	-	456580	325701
1995	1977729	219748	113652	127921	-	474837	327724
1996	2093559	232618	123126	136214	-	489510	254996
1997	2202378	244709	132559	142987	-	501382	250510
1998	2335114	259457	147970	153983	-	517112	245719
1999	2431864	270207	163646	165695	-	534542	242583
2000	2499835	277759	169692	169090	-	533941	239208
2001	2593072	288119	175049	170185	-	528059	237901
2002	2676051	297339	170720	161234	-	477555	238480
2003	2778865	308763	183168	175032	-	517104	235850
2004	2902830	322537	197097	177804	-	495394	234702
2005	2577574	531086	155951	188506	2958	217808	42281
2006	2753270	735042	165721	232966	2988	239358	56848
2007	2865048	878212	159836	262753	993	275852	91591
2008	3109937	1120927	160997	305222	991	293753	126907
2009	3224375	1229908	159311	322429	967	291475	142075
2010	3197552	1321954	151099	331007	968	291210	148001
2011	3174988	1374744	145355	358752	951	295685	157328
2012	3253328	1479473	141386	397814	947	303454	149815
2013	3356558	1605702	137555	436478	934	310619	176288
2014	3460973	1741099	134074	475379	931	322269	184261
2015	3564137	1905592	130674	515391	949	339095	191307
2016	3693451	2119555	127149	561171	949	355718	199645
2017	3875064	2515792	124036	607344	950	371599	209330
2018	3915218	2890563	120345	658713	951	386418	211120

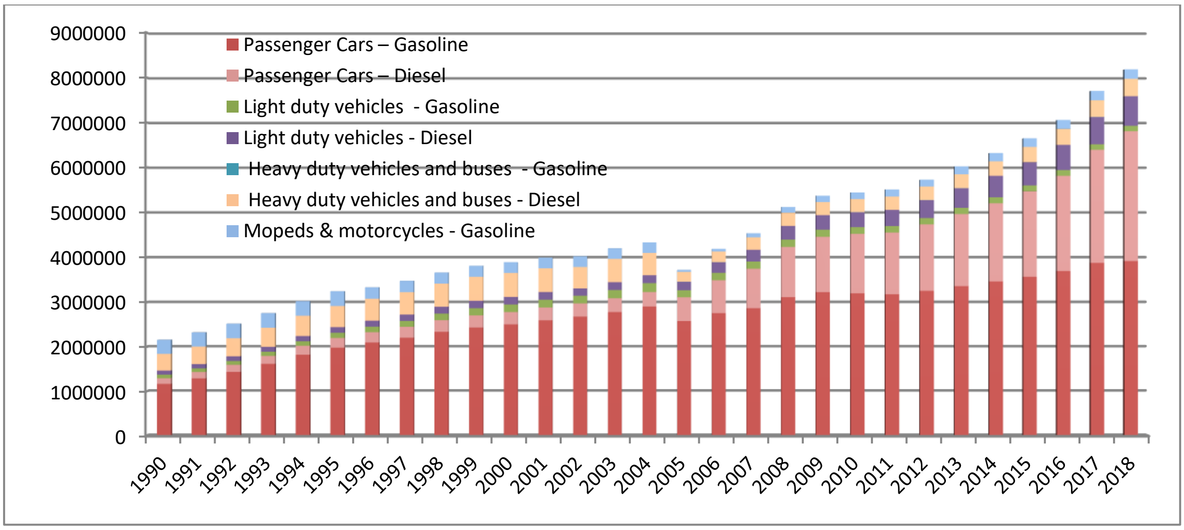


Figure 3.13.3. Fleet evolution (number of vehicles)

Compared to 2005 data, in 2018 the number of vehicles increased by almost 545% for diesel passenger cars, 500% for gasoline mopeds&motorcycles, 350% for diesel light duty vehicles and 178% for diesel heavy vehicles and busses.

Table 3.13.4. Fuel consumption per fuel type (TJ), for Road Transport 1.A.3.b.

Year	Gasoline	Diesel	LPG
1990	90429	49216	-
1991	75712	38842	-
1992	50446	58648	-
1993	44846	50294	-
1994	50811	52796	
1995	43876	50931	-
1996	57299	80785	-
1997	61911	70565	-
1998	61386	68953	-
1999	52152	54578	-
2000	53533	58225	-
2001	68568	75357	-
2002	66873	80403	144
2003	68004	91005	337
2004	70431	91938	3947
2005	66980	91377	3772
2006	62585	103861	2311
2007	63301	102917	770
2008	63201	124496	1540
2009	62686	128957	2118
2010	59130	124196	3129
2011	56345	130502	818
2012	55736	140502	3466
2013	53082	138762	2407
2014	56694	143261	2214
2015	53126	147377	2455
2016	55519	159556	2647
2017	59714	173103	3129
2018	55218	180741	3923

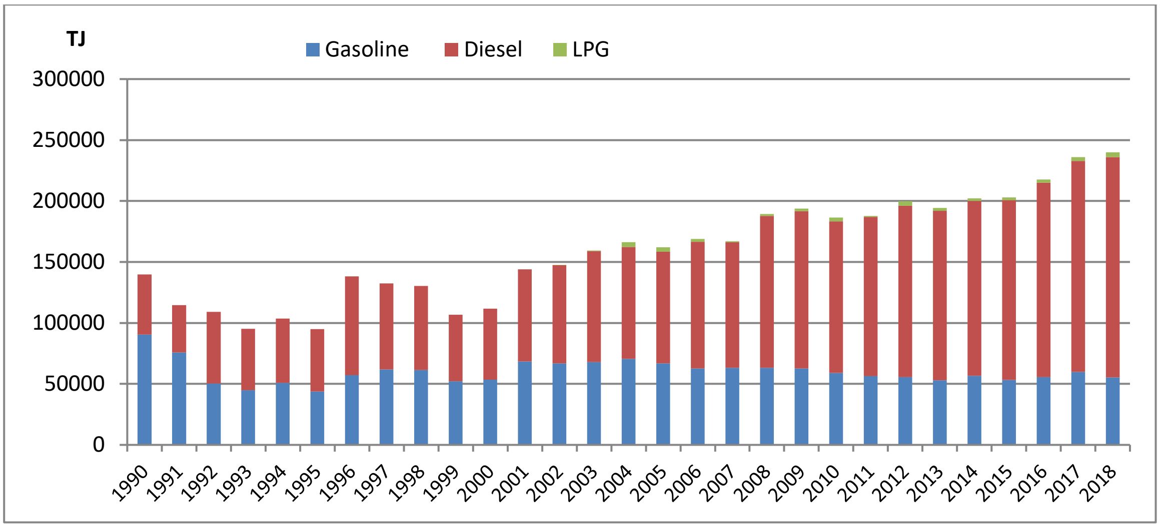


Figure 3.13.3. Fuel consumption (TJ), for Road Transport 1.A.3.b.

NFR 1.A.3.b.i., 1.A.3.b.ii, 1.A.3.b.ii are key source for emissions of NOx in 2018.

Table 3.13.5. NOx (kt) emissions for Road Transport 1.A.3.b. by NFR

Year	1A3bi	1A3bii	1A3biii	1A3biv
1990	18.050	2.615	33.299	0.145
1991	14.868	2.403	26.254	0.147
1992	10.566	2.685	39.047	0.150
1993	9.379	2.486	33.101	0.145
1994	10.528	3.024	34.046	0.151
1995	8.966	2.821	33.538	0.153
1996	12.611	3.812	52.512	0.118
1997	13.049	3.710	46.046	0.117
1998	12.838	3.929	44.674	0.114
1999	10.508	3.639	35.244	0.113
2000	10.840	3.914	37.502	0.111
2001	14.463	4.594	47.927	0.111
2002	14.729	4.824	49.925	0.111
2003	15.042	5.392	56.992	0.110
2004	15.985	4.940	60.683	0.109
2005	34.199	9.141	52.483	0.018
2006	31.343	9.195	54.860	0.022
2007	28.827	7.342	52.880	0.036
2008	27.843	9.441	55.467	0.044
2009	27.507	8.864	54.208	0.048
2010	24.863	8.181	50.604	0.048
2011	23.455	8.496	50.955	0.049
2012	27.107	10.846	48.422	0.045
2013	24.089	9.635	50.907	0.054
2014	25.363	8.811	51.821	0.060
2015	24.546	10.394	48.879	0.058
2016	26.210	11.403	50.260	0.062
2017	28.271	11.936	50.017	0.076
2018	29.249	12.205	48.361	0.090

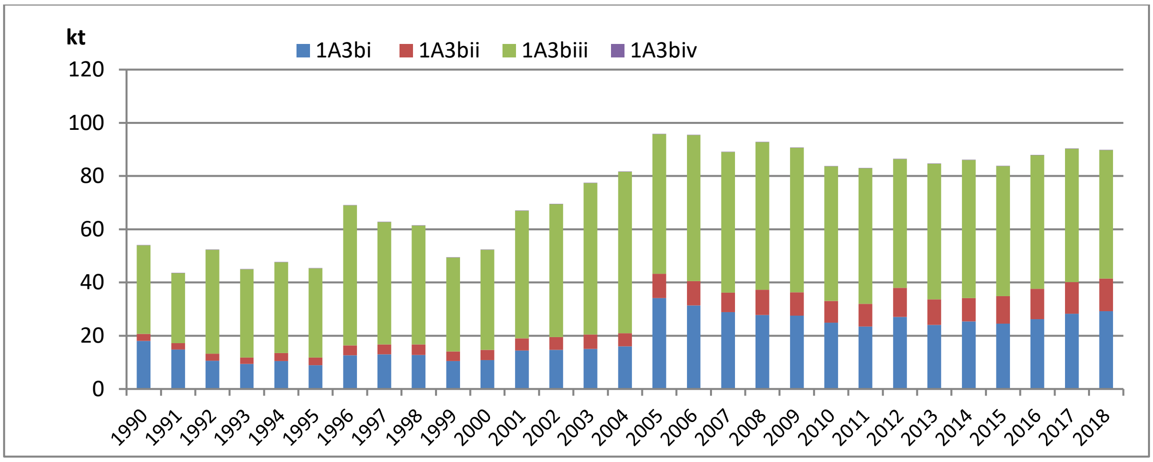


Figure 3.13.5. NOx emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.i. and 1.A.3.b.v are key source for emissions of NMVOC in 2018.

Table 3.13.6. NMVOC (kt) emissions for Road Transport 1.A.3.b. by NFR

Year	1A3bi	1A3bii	1A3biii	1A3biv	1A3bv
1990	19.670	1.661	1.916	2.875	3.919
1991	16.200	1.715	1.511	2.906	4.270
1992	10.584	1.489	2.247	2.973	4.694
1993	9.267	1.494	1.905	2.870	5.207
1994	10.566	1.654	1.959	2.996	5.785
1995	8.856	1.767	1.930	3.021	6.267
1996	11.948	2.021	3.021	2.344	6.505
1997	12.898	2.138	2.649	2.306	6.829
1998	12.634	2.355	2.570	2.262	7.241
1999	10.510	2.279	2.028	2.230	7.562
2000	10.637	2.580	2.158	2.199	7.764
2001	14.073	2.749	2.758	2.187	8.033
2002	13.769	2.752	2.872	2.196	8.237
2003	14.004	2.930	3.279	2.169	8.561
2004	15.591	2.907	3.492	2.157	8.949
2005	29.685	4.316	5.440	0.764	9.817
2006	25.304	3.876	5.504	0.716	9.406
2007	21.844	3.250	5.336	0.585	8.762
2008	19.283	3.137	5.084	0.647	8.329
2009	17.134	2.793	4.696	0.671	8.107
2010	13.849	2.376	4.218	0.645	7.399
2011	12.200	2.236	4.028	0.637	6.871
2012	12.320	2.415	3.620	0.512	6.792
2013	11.068	2.138	3.666	0.510	6.623
2014	10.891	1.998	3.602	0.604	6.578
2015	9.939	2.008	3.295	0.581	6.420
2016	10.102	2.098	3.316	0.602	6.694
2017	9.838	2.089	3.232	0.730	6.751
2018	9.107	1.984	3.070	0.764	6.847

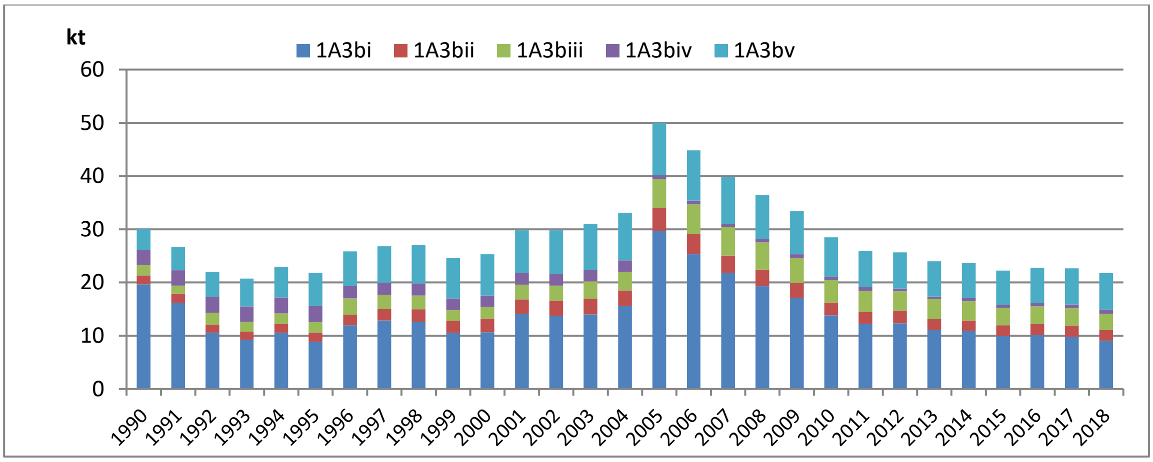


Figure 3.13.6. NMVOC emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.i. and 1.A.3.b.iii are key source for emissions of BC in 2018.

Table 3.13.7. BC (kt) emissions for Road Transport 1.A.3.b. by NFR

Year	1A3bi	1A3bii	1A3biii	1A3biv
1990	0.056	0.069	0.497	0.005
1991	0.046	0.053	0.392	0.005
1992	0.073	0.083	0.583	0.005
1993	0.071	0.070	0.494	0.005
1994	0.072	0.094	0.508	0.006
1995	0.068	0.076	0.501	0.006
1996	0.118	0.123	0.784	0.004
1997	0.098	0.110	0.687	0.004
1998	0.099	0.111	0.667	0.004
1999	0.074	0.097	0.526	0.004
2000	0.085	0.098	0.560	0.004
2001	0.119	0.130	0.716	0.004
2002	0.145	0.144	0.745	0.004
2003	0.150	0.169	0.851	0.004
2004	0.114	0.143	0.906	0.004
2005	0.557	0.402	1.073	0.002
2006	0.620	0.426	1.091	0.002
2007	0.572	0.302	1.042	0.002
2008	0.675	0.469	1.034	0.002
2009	0.703	0.418	0.982	0.002
2010	0.669	0.384	0.899	0.002
2011	0.672	0.404	0.882	0.002
2012	0.849	0.533	0.817	0.002
2013	0.717	0.458	0.843	0.001
2014	0.753	0.342	0.844	0.002
2015	0.727	0.486	0.783	0.002
2016	0.781	0.525	0.795	0.002
2017	0.881	0.544	0.782	0.002
2018	0.910	0.534	0.747	0.002

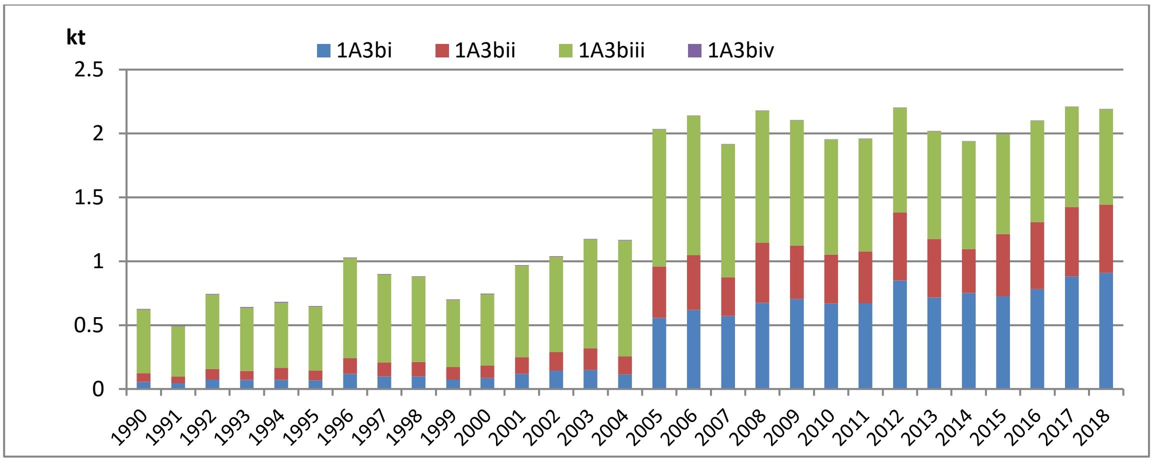


Figure 3.13.7. BC emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.i. is key source for emissions of CO in 2018.

Table 3.13.8. CO (kt) emissions for Road Transport 1.A.3.b. by NFR

Year	1A3bi	1A3bii	1A3biii	1A3biv
1990	165.574	16.631	7.564	10.891
1991	136.367	17.362	5.964	11.005
1992	88.917	14.687	8.869	11.262
1993	77.823	14.864	7.519	10.870
1994	88.772	16.291	7.733	11.350
1995	74.374	17.667	7.618	11.442
1996	100.235	19.829	11.928	8.880
1997	108.322	21.178	10.459	8.735
1998	106.089	23.425	10.148	8.568
1999	88.288	22.785	8.006	8.448
2000	89.315	25.919	8.519	8.330
2001	118.139	27.341	10.887	8.283
2002	115.374	27.227	11.340	8.317
2003	117.208	28.834	12.946	8.216
2004	128.327	28.862	13.784	8.172
2005	271.702	46.373	15.048	2.324
2006	230.419	40.665	15.798	2.283
2007	195.291	34.862	15.317	2.294
2008	169.583	32.502	15.595	2.548
2009	152.682	28.683	14.951	2.704
2010	125.332	23.951	13.829	2.661
2011	110.008	21.998	13.789	2.648
2012	110.907	22.949	13.077	1.964
2013	100.950	20.338	13.747	2.502
2014	100.564	19.319	14.015	2.916
2015	92.507	18.730	13.251	2.820
2016	94.234	19.384	13.660	2.967
2017	91.998	19.092	13.607	3.534
2018	85.399	17.809	13.179	3.758

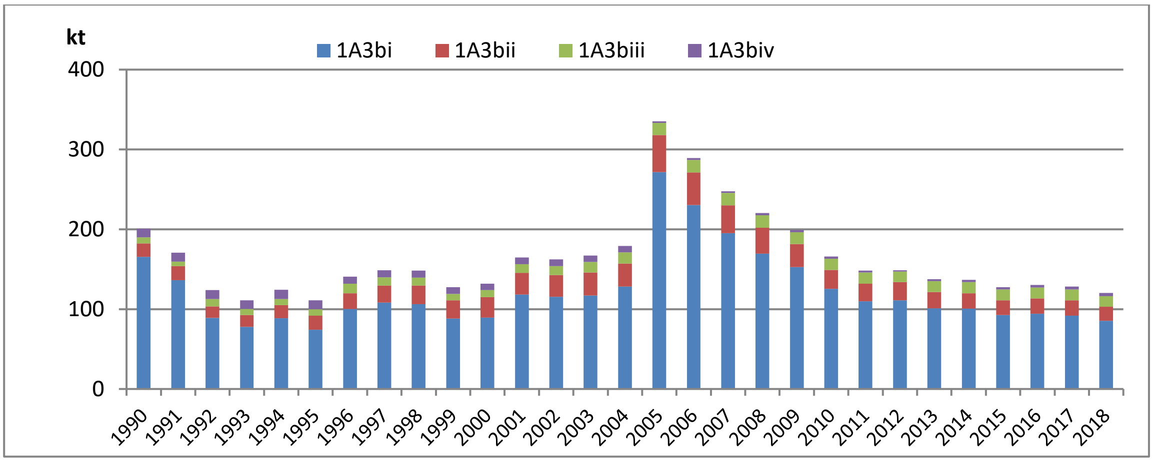


Figure 3.13.8. CO emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.vi. is key source for emissions of Cu and Zn in 2018. These emissions are estimate for the 2005-2018 period. For the other NFRs of road transport, these emissions are not significant.

Table 3.13.9. Cu and Zn (t) emissions for NFR 1.A.3.b.vi Road transport: Automobile tyre and brake wear

Year	Cu (t)	Zn (t)
2005	13.217	4.566
2006	14.040	4.860
2007	14.543	5.014
2008	16.151	5.630
2009	16.301	5.727
2010	15.606	5.512
2011	15.842	5.609
2012	17.021	6.182
2013	16.524	5.948
2014	16.781	6.107
2015	16.793	6.166
2016	18.253	6.722
2017	19.296	7.137
2018	20.040	7.422

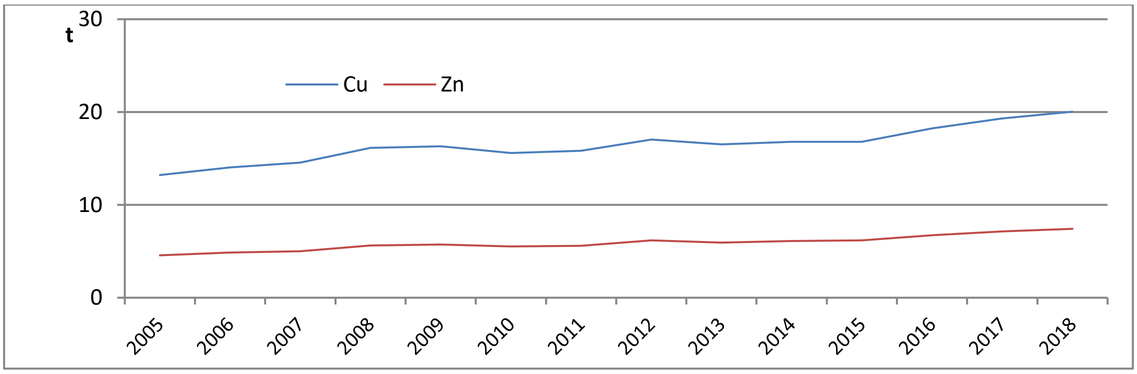


Figure 3.13.9. Cu and Zn (t) emissions for NFR 1.A.3.b.vi Road transport: Automobile tyre and brake wear

Recalculations and improvements:

- First estimate of emissions on Tier 1 for the time series 1990-1994 for Road Transport 1.A.3.b.
- First estimate of $PM_{2.5}$, PM_{10} and TSP emissions on Tier 1 for the time series 1990-2004 for NFR 1.A.3.b.vi and NFR 1.A.3.b.vii (recommendation RO-1A3bvii-2017-0001 was implemented). The trend of emissions is shown in the table below.

Table 3.13.10. $PM_{2.5}$, PM_{10} and TSP (kt) emissions for NFR 1.A.3.b.vi and 1.A.3.b.vii.

	1A3bvi			1A3bvii		
Year	**$PM_{2.5}$**	**PM_{10}**	**TSP**	**$PM_{2.5}$**	**PM_{10}**	**TSP**
1990	0.374	0.697	0.918	0.214	0.394	0.788
1991	0.306	0.570	0.751	0.174	0.321	0.642
1992	0.305	0.569	0.750	0.178	0.329	0.658
1993	0.266	0.496	0.654	0.155	0.285	0.571
1994	0.289	0.538	0.709	0.167	0.307	0.614
1995	0.265	0.495	0.652	0.154	0.284	0.568
1996	0.392	0.730	0.962	0.229	0.422	0.845
1997	0.372	0.693	0.913	0.216	0.398	0.796
1998	0.365	0.681	0.897	0.211	0.390	0.779
1999	0.298	0.556	0.733	0.172	0.316	0.632
2000	0.314	0.584	0.770	0.180	0.332	0.664
2001	0.403	0.751	0.991	0.232	0.428	0.856
2002	0.414	0.772	1.018	0.239	0.440	0.880
2003	0.451	0.840	1.108	0.261	0.481	0.961
2004	0.459	0.856	1.128	0.268	0.493	0.986
2005	0.571	1.095	1.407	0.272	0.504	1.009
2006	0.608	1.165	1.498	0.290	0.537	1.073
2007	0.627	1.203	1.545	0.306	0.567	1.134
2008	0.705	1.348	1.736	0.342	0.633	1.267
2009	0.717	1.369	1.766	0.351	0.649	1.299
2010	0.691	1.316	1.700	0.339	0.627	1.254
2011	0.703	1.339	1.730	0.346	0.641	1.281
2012	0.776	1.468	1.909	0.379	0.703	1.405
2013	0.746	1.415	1.836	0.372	0.688	1.377
2014	0.767	1.450	1.886	0.392	0.726	1.451
2015	0.775	1.461	1.905	0.395	0.731	1.461
2016	0.845	1.592	2.077	0.429	0.794	1.589
2017	0.897	1.689	2.205	0.454	0.841	1.681
2018	0.933	1.756	2.293	0.468	0.867	1.733

- Recalculation of NMVOC emissions for the time series 1995-2004 for NFR 1.A.3.bv, updating the national daily temperature range from three intervals to four intervals and correcting the errors since the last submission. Emissions changes due to recalculations are shown in the following table:

Table 3.13.11. Differences for NMVOC emissions (kt) between 2020 and 2019 submissions, for NFR 1.A.3.bv

Year	NMVOC submission 2019	NMVOC submission 2020	Difference between 2020 and 2019
1995	2.107	6.267	4.160
1996	2.204	6.505	4.301
1997	2.315	6.829	4.514
1998	2.454	7.241	4.787
1999	2.559	7.562	5.002
2000	2.629	7.764	5.135
2001	2.723	8.033	5.311
2002	2.800	8.237	5.438
2003	2.908	8.561	5.653
2004	3.039	8.949	5.911

- Recalculation of SO_2 emissions for the time series 1995-2004 for NFR 1.A.3.bi to NFR 1.A.3.biv, using the default sulfur content of the fuel from table 3-14, 2019 EMEP/EEA Guidebook. The trend of SO_2 emissions is shown in the table below.

Table 3.13.12. SO_2 (kt) emissions for Road Transport 1.A.3.b. by NFR

Year	1A3bi	1A3bii	1A3biii	1A3biv
1990	0.7065	0.1004	0.7983	0.0072
1991	0.5820	0.0869	0.6294	0.0073
1992	0.4338	0.1093	0.9361	0.0075
1993	0.3879	0.0979	0.7935	0.0075
1994	0.4318	0.1237	0.8162	0.0075
1995	0.3709	0.1090	0.8040	0.0076
1996	0.5327	0.1578	1.2589	0.0059
1997	0.5396	0.1487	1.1039	0.0058
1998	0.5320	0.1549	1.0710	0.0057
1999	0.4318	0.1406	0.8449	0.0056
2000	0.3506	0.1127	0.6743	0.0044
2001	0.4695	0.1381	0.8617	0.0043
2002	0.4850	0.1478	0.8977	0.0043
2003	0.4941	0.1681	1.0247	0.0043
2004	0.4741	0.1495	1.0911	0.0043
2005	0.3312	0.1281	0.4522	0.0006
2006	0.3660	0.1446	0.4850	0.0007
2007	0.0901	0.0219	0.0715	0.0003
2008	0.0992	0.0295	0.0785	0.0004
2009	0.1028	0.0285	0.0778	0.0004
2010	0.0199	0.0053	0.0148	0.0001
2011	0.0198	0.0055	0.0151	0.0001
2012	0.0233	0.0071	0.0147	0.0001
2013	0.0214	0.0063	0.0158	0.0001
2014	0.0230	0.0059	0.0166	0.0001
2015	0.0228	0.0068	0.0165	0.0001
2016	0.0251	0.0075	0.018	0.0001
2017	0.0275	0.0079	0.018	0.0001
2018	0.0289	0.0081	0.018	0.0001

SO_2 emissions have decreased due to increasing stringent fuel quality standards regulating the maximum allowable sulfur content of fuels used in road transport.

- For the time series 1995-1999 for NFR 1.A.3.bi to NFR 1.A.3.biv, the correction of Pb emissions (emissions were reported in kt, in the last submission).
- For NFR 1.A.3.bi, correction of activity data and emissions for 1995 (it was reported the same values as for 2000 year).

Implementation of Review recommendations:

- The TERT recommendation RO-1A3bvii-2017-0001, for pollutants $PM_{2.5}$, PM_{10} and TSP, was implemented.

3.14 NFR 1.A.3.c Railways

This sector covers emissions from rail transport regarding the movement of goods or persons by rail. The emissions arise from combusting the fuel in an internal combustion engine. The emissions for electric locomotives are not estimated here, these are accounted in chapter 1.A.1 Energy industries.

The emissions from railway activities were estimated using the default Tier 1 emission factors from 2019 EMEP/EEA Guidebook, chapter 1.A.3.c, Table 3-1 and the diesel consumption for railways from Energy Balance provided by the N.I.S.

Table 3.14.1.Fuel consumption (t) for NFR 1.A.3.c – Railway

Year	Diesel (t)
1990	133958
1991	116218
1992	315000
1993	309000
1994	276000
1995	279000
1996	286000
1997	285000
1998	246000
1999	201000
2000	287000
2001	143000
2002	192000
2003	170000
2004	195000
2005	72000
2006	71000
2007	180000
2008	168000
2009	126000
2010	143000

Year	Diesel (t)
2011	193000
2012	182000
2013	161000
2014	107000
2015	111000
2016	108000
2017	113870
2018	92581

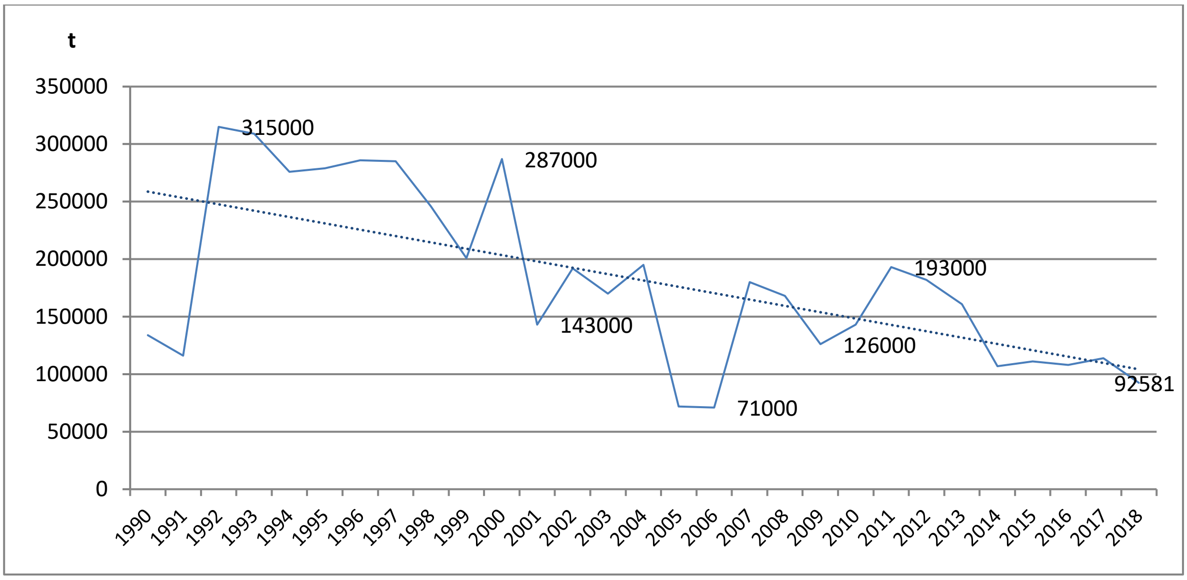


Figure 3.14.1. Fuel consumption (t) for NFR 1.A.3.c – Railway

Diesel consumption for rail transport in the period 1990-2009 shows high fluctuations (max. 315000t in 1992, min. 71000t in 2006), and in the period 2011-2018 having a decreasing tendency (from 193000t in 2011 to 92581t in 2018, a decrease of 52%).

NFR 1.A.3.c is not a key source for any pollutant.

The emissions trend of the main pollutants, $PM_{2.5}$ and CO from rail transport is shown in the following table and figures.

Table 3.14.2. Emissions trend (kt) of Main Pollutants, $PM_{2.5}$ and CO for NFR 1.A.3.c – Railway

Year/Pollutant	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	CO
1990	7.0194	0.6229	0.2679	0.0009	0.1835	1.4333
1991	6.0898	0.5404	0.2324	0.0008	0.1592	1.2435
1992	16.5060	1.4648	0.6300	0.0022	0.4316	3.3705
1993	16.1916	1.4369	0.6180	0.0022	0.4233	3.3063
1994	14.4624	1.2834	0.5520	0.0019	0.3781	2.9532
1995	14.6196	1.2974	0.5580	0.0020	0.3822	2.9853
1996	14.9864	1.3299	0.5720	0.0020	0.3918	3.0602
1997	14.9340	1.3253	0.5700	0.0020	0.3905	3.0495
1998	12.8904	1.1439	0.4920	0.0017	0.3370	2.6322
1999	10.5324	0.9347	0.1407	0.0014	0.2754	2.1507

Year/Pollutant	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	CO
2000	15.0388	1.3346	0.2009	0.0020	0.3932	3.0709
2001	7.4932	0.6650	0.1001	0.0010	0.1959	1.5301
2002	10.0608	0.8928	0.1344	0.0013	0.2630	2.0544
2003	8.9080	0.7905	0.1190	0.0012	0.2329	1.8190
2004	10.2180	0.9068	0.1365	0.0014	0.2672	2.0865
2005	3.7728	0.3348	0.0072	0.0005	0.0986	0.7704
2006	3.7204	0.3302	0.0071	0.0005	0.0973	0.7597
2007	9.4320	0.8370	0.0180	0.0013	0.2466	1.9260
2008	8.8032	0.7812	0.0168	0.0012	0.2302	1.7976
2009	6.6024	0.5859	0.0126	0.0009	0.1726	1.3482
2010	7.4932	0.6650	0.0029	0.0010	0.1959	1.5301
2011	10.1132	0.8975	0.0039	0.0014	0.2644	2.0651
2012	9.5368	0.8463	0.0036	0.0013	0.2493	1.9474
2013	8.4364	0.7487	0.0032	0.0011	0.2206	1.7227
2014	5.6068	0.4976	0.0021	0.0007	0.1466	1.1449
2015	5.8164	0.5162	0.0022	0.0008	0.1521	1.1877
2016	5.6592	0.5022	0.0022	0.0008	0.1480	1.1556
2017	5.9668	0.5295	0.0023	0.0008	0.1560	1.2184
2018	4.8512	0.4305	0.0019	0.0006	0.1268	0.9906

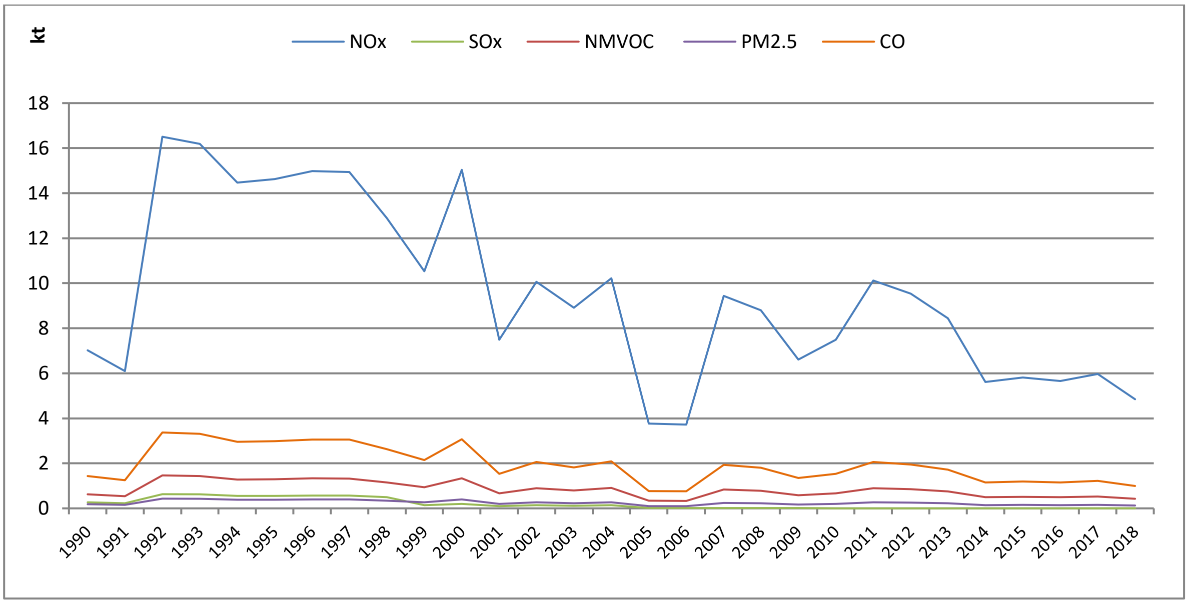


Figure 3.14.2. Emissions trend (kt) of NOx, NMVOC, SOx, $PM_{2.5}$
and CO for NFR 1.A.3.c – Railway

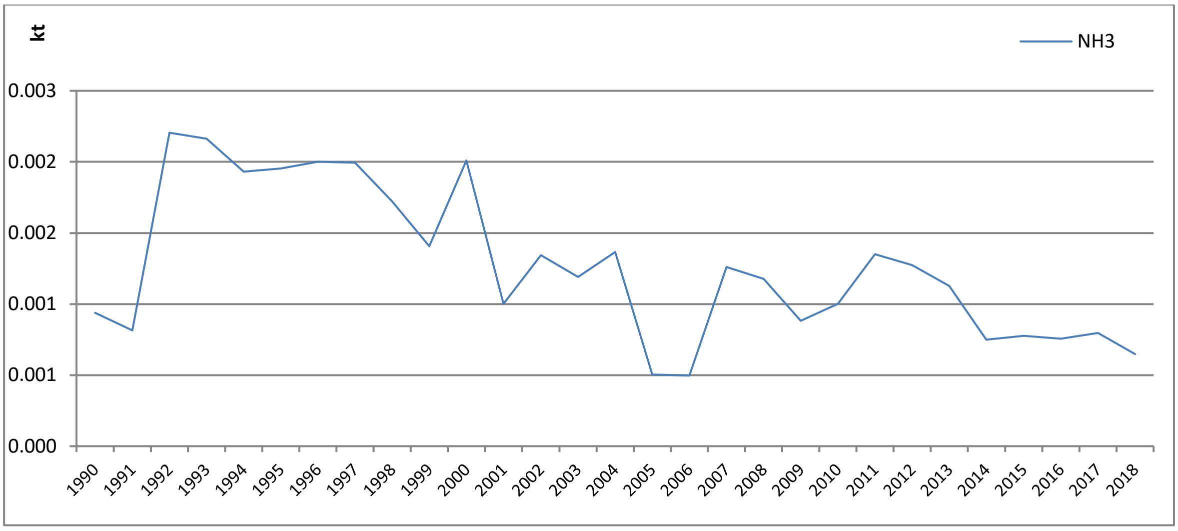


Figure 3.14.3. Emissions trend (kt) of NH_3 for NFR 1.A.3.c – Railway

Emissions trend of pollutants are consistent with the fuel consumption variation.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.
- Recalculation for the time series 1999-2011, using national sulfur content of the diesel fuel provided by Ministry for Transport, Infrastructure and Communications, resulting in lower SOx emissions in the range from -0.13 kt to -0.38 kt.

3.15 NFR 1.A.3.d. Navigation

In this section the emissions from the following NFR are estimated:

- 1.A.3.di(ii) - International inland waterways (is included in NFR 1A3di(i));
- 1.A.3.dii - National navigation (shipping);
- Memo item 1.A.3.di(i) - International maritime navigation.

NFR 1.A.3.dii contributed to the total national emissions in 2018, for NOx with 1.39% of the total, NMVOC with 0.05% of the total, SOx with 0.1% of the total and CO with 0.04% of the total. NFR 1.A.3.dii is not a key source for any pollutant.

Emissions from navigation activities were estimated using the default Tier 1 emission factors from 2019 EMEP/EEA Guidebook, chapter 1.A.3.d, Table 3-1 and Table 3-2 and fuel consumption (fuel oil and marine diesel oil) from Energy Balance provided by the N.I.S. Before this submission, 1.A.3.dii category included only marine diesel oil emissions. This improvement of the inventory led to an increase of activity data and emissions values for NFR 1.A.3.dii, for the period 1990-2006.

The following table and chart give details on the shares of fuel consumption by fuel type and the emissions trends for NFR 1.A.3.dii - National navigation (shipping):

Table 3.15.1. Fuel consumption (t) for NFR 1.A.3.dii - National navigation (shipping)

Year	Fuel oil (t)	Marine diesel oil (t)
1990	327000	-
1991	399000	-
1992	230000	124000
1993	69000	65000
1994	78000	52000
1995	54000	50000
1996	92000	59000
1997	239000	106000
1998	163000	59000
1999	161000	60000
2000	61000	53000
2001	91000	13000
2002	75000	30000
2003	57000	13000
2004	22000	20000
2005	1000	40000
2006	1000	39000
2007	-	82000
2008	-	70000
2009	-	54000
2010	-	58000
2011	-	51000
2012	-	42000
2013	-	41000
2014	-	37000
2015	-	43000
2016	-	40000
2017	-	39853
2018	-	39812

Table 3.15.2. Emissions trend (kt) of Main Pollutants, $PM_{2.5}$ and CO for NFR 1.A.3.dii - National navigation

Year/ Pollutant	NOx	NMVOC	SOx	$PM_{2.5}$	CO
1990	25.93110	0.88290	17.65800	1.8312	2.41980
1991	31.64070	1.07730	21.54600	2.2344	2.95260
1992	27.97300	0.96820	13.66000	1.4616	2.61960
1993	10.57420	0.36830	4.37600	0.4774	0.99160
1994	10.26740	0.35620	4.73200	0.5096	0.96200
1995	8.20720	0.28580	3.41600	0.3724	0.76960
1996	11.92710	0.41360	5.55800	0.5978	1.11740
1997	27.27370	0.94210	13.96600	1.4868	2.55300
1998	17.55740	0.60530	9.39200	0.9954	1.64280
1999	17.47730	0.60270	9.29400	0.9856	1.63540
2000	8.99780	0.31310	3.82400	0.4158	0.84360
2001	8.23680	0.28210	5.04400	0.5278	0.76960
2002	8.30250	0.28650	4.17000	0.4620	0.77700
2003	5.54060	0.19030	3.13000	0.3374	0.51800
2004	3.31460	0.11540	1.26800	0.1512	0.31080

Year/ Pollutant	NOx	NMVOC	SOx	$PM_{2.5}$	CO
2005	3.21930	0.11470	0.21400	0.0616	0.30340
2006	3.14080	0.11190	0.21000	0.0602	0.29600
2007	6.43700	0.22960	0.32800	0.1148	0.60680
2008	5.49500	0.19600	0.28000	0.0980	0.51800
2009	4.23900	0.15120	0.21600	0.0756	0.39960
2010	4.55300	0.16240	0.11600	0.0812	0.42920
2011	4.00350	0.14280	0.10200	0.0714	0.37740
2012	3.29700	0.11760	0.08400	0.0588	0.31080
2013	3.21850	0.11480	0.08200	0.0574	0.30340
2014	2.90450	0.10360	0.07400	0.0518	0.27380
2015	3.37550	0.12040	0.08600	0.0602	0.31820
2016	3.14000	0.11200	0.08000	0.0560	0.29600
2017	3.12846	0.11159	0.07971	0.0558	0.29491
2018	3.12524	0.11147	0.07962	0.0557	0.29461

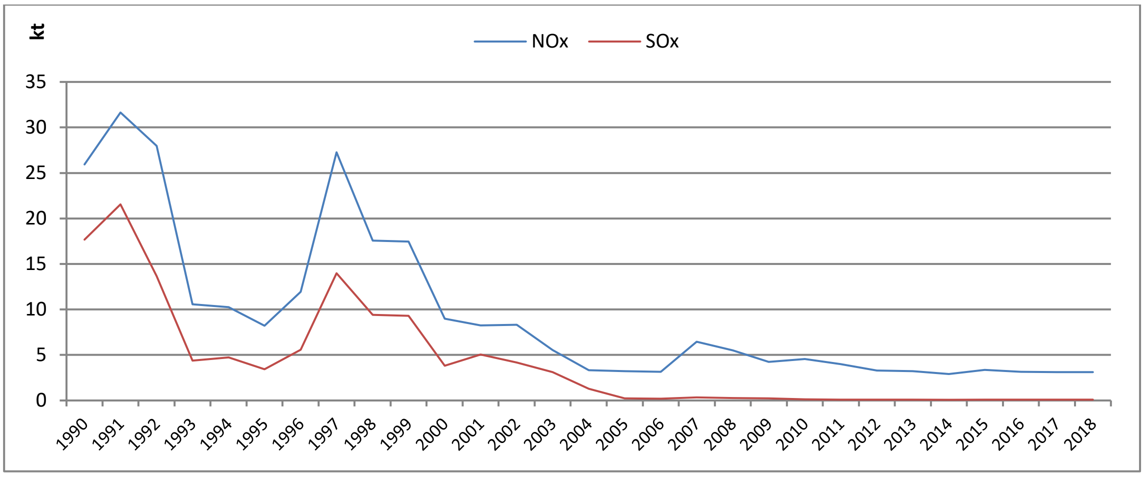


Figure 3.15.1. Emissions trend (kt) of NOx and SOx for NFR 1.A.3.dii - National navigation

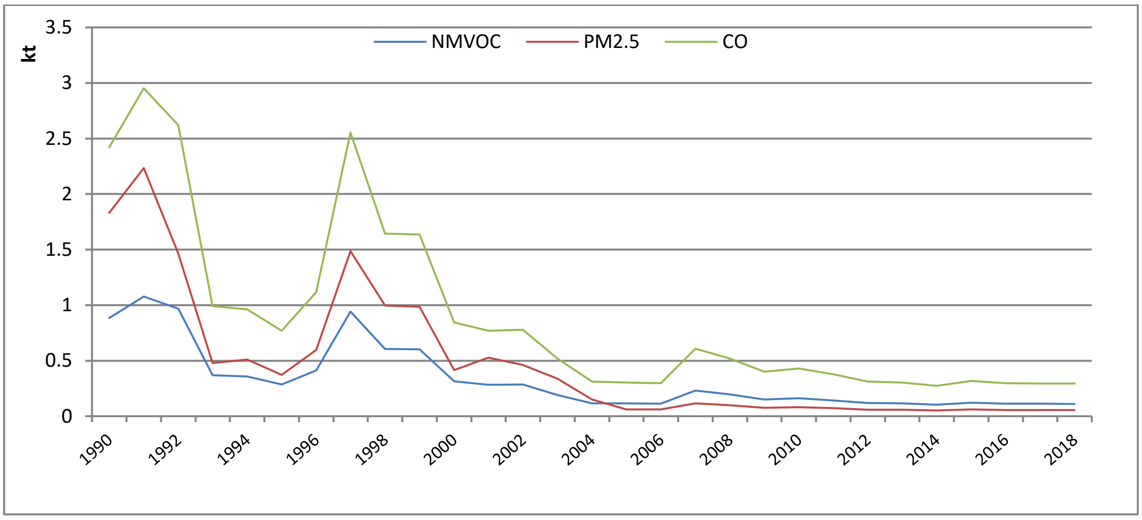


Figure 3.15.2. Emissions trend (kt) of NMVOC, $PM_{2.5}$ and CO for NFR 1.A.3.dii - National navigation

The emissions from NFR 1.A.3.di(ii) - International inland waterways are marked with IE notation and are included in the memo item NFR 1A3di(i) - International maritime navigation.

The calculation was made using the default Tier 1 emission factors from 2019 EMEP/EEA Guidebook, chapter 1.A.3.d, Table 3-1 and Table 3-2 and bunker fuel oil and marine diesel oil from Energy Balance provided by N.I.S. Only from 2007 there are data.

Before this submission, 1.A.3.di(ii) category included only marine diesel oil emissions. For this submission bunker fuel oil was added to activity data and the incorrectly applied emission factors were corrected. This improvement of the inventory led to an increase of activity data and emissions values for NFR 1.A.3.di(ii), for the period 2007-2010.

Table 3.15.3. International maritime bunkers (t) for memo item, NFR 1.A.3.di(i), 2007-2018

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Fuel oil (t)	14000	52000	9000	4000								
Marine diesel oil (t)	20000	18000	6000	11000	9000	14000	41000	79000	44000	31000	27527	17853

Recalculations and improvements:
NFR 1 A3dii- National navigation (shipping)

- First estimate of emissions for the time series 1990-1994.
- Change of activity data and emissions for time series 1995-2006, as detailed above.
- Error correction for SOx and BC emissions, time series 2007-2017.

Memo item 1.A.3.di(i) - International maritime navigation

- Change of activity data and emissions for the time series 2007-2017, as detailed above.

3.16 NFR 1.B.1.a Coal mining and handling

Activity data provided by the N.I.S. and from the Romania’s Greenhouse Gas Inventory – N.I.R., improving the consistency between data for NFR and CRF. Default 2019 EMEP/EEA Guidebook emission factors (Tier 2) were used. To apply the Tier 2 methodology the activity data and the emission factors needed to be stratified according to the different techniques that may occur in the country. The approach followed to apply a Tier 2 methodology was to stratify the coal mining/storage/handling in the country to model the different product and process types occurring in the national coal mining industry into the inventory by :

- defining the production using each of the separate product and/or process types (together called ‘technologies’ in the formulae below) separately, and
- applying technology specific emission factors for each process type.

As a result, it splited NFR 1.B.1.a into two SNAPs:

- Open cast mining with default 2019 EMEP/EEA Guidebook emission factors (Tier 2, Table 3-2);

- Underground mining with default 2019 EMEP/EEA Guidebook emission factors (Tier 2, Table 3-3).

In 2018 NFR 1.B.1.a was a key source of NMVOC with 2.66% from the national total.
Recalculations and improvements: First estimate of NMVOC,TSP, $PM_{2.5}$ and PM_{10} emissions for the time series 1990-1994 .

Table 3.16.1 Emissions Trend (kt) for NFR 1.B.1.a for NMVOC

Year	NMVOC (kt)
1990	34.266
1991	29.218
1992	33.546
1993	27.550
1994	28.380
1995	28.216
1996	29.092
1997	25.130
1998	19.610
1999	16.784
2000	28.033
2001	29.509
2002	27.248
2003	25.717
2004	23.570
2005	21.414
2006	18.971
2007	12.336
2008	11.316
2009	9.889
2010	8.437
2011	9.482
2012	8.914
2013	6.428
2014	5.559
2015	5.486
2016	4.596
2017	7.270
2018	6.315

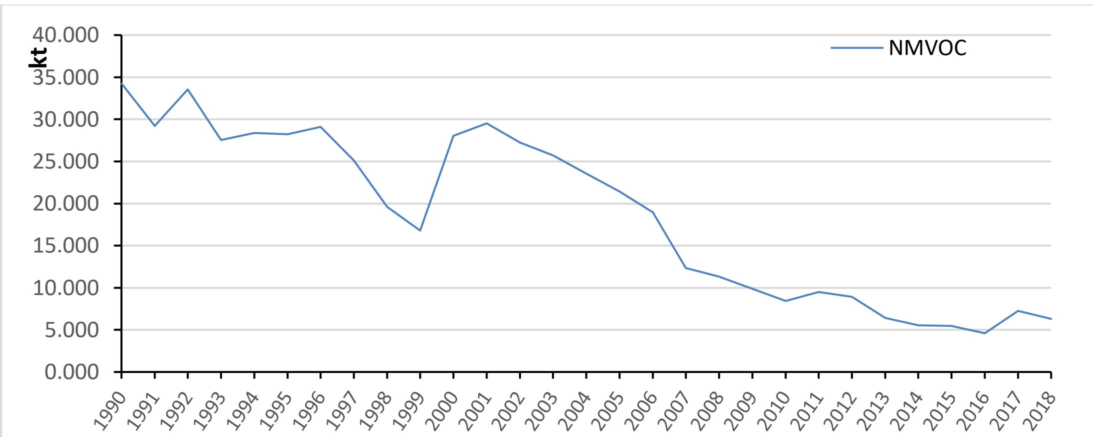


Figure 3.16.1 Emissions Trend (kt) for NFR 1.B.1.a

It is to be noticed that NMVOC emissions decreased from 1990 to 1999 and increase in 2000-2001; decreased from 2001 until 2018 due to decline coal production. In 2018 there was coal production in surface and underground mines, but it was lower than in 2017, which led to lower NMVOC emissions in 2018 compare to 2017.

3.17 NFR 1.B.1.b Fugitive emissions from solid fuels: solid fuel transformation

Activity data is represented by coke production, taken from N.I.S. Default 2019 EMEP/EEA Guidebook emission factors were used. Coke production has been decreasing from 3384000t in 1995 down to 0 t in 2010 and has been 0 t for the time period 2010 -2018.

Table 3.17.1. Activity data trends (t product) for NFR 1.B.1.b coke production

Year	AD (t coke production)
1990	3965000
1991	2581000
1992	2903000
1993	2601000
1994	2884000
1995	3384000
1996	3153000
1997	3316000
1998	3132000
1999	1716000
2000	1613000
2001	1413000
2002	1866000
2003	1638000
2004	1675000
2005	1891000
2006	1790000
2007	1647000
2008	1138000
2009	341000

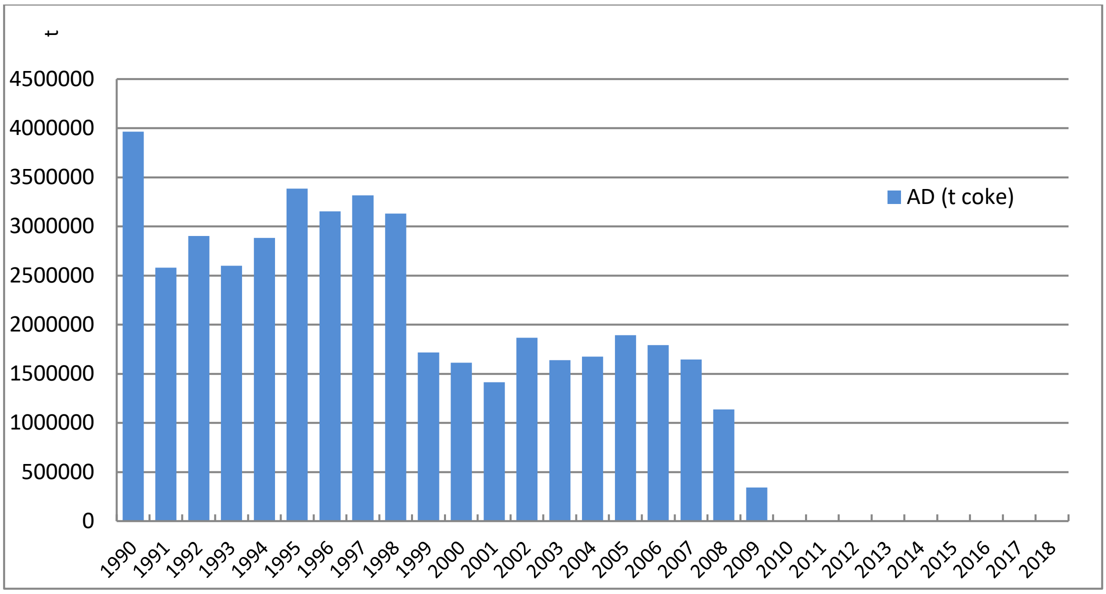


Figure 3.17.1. Activity data trends (t product) for NFR 1.B.1.b coke production

The pollutants emissions trend had the same variation as the activity data, it decreased to zero in the years without production.

Recalculations and improvements: First estimate emissions for the time series 1990-1994.
Implementation of Reviews recommendations: RO-1B1b-2019-0001 - the emissions of Pb, Cd, Hg, benzo(a), benzo(b), benzo(k), indeno in the time series 2002-2004 were corrected.

3.18 NFR 1.B.2.a.i Oil

Activity data were oil produced and imports from the Energy Balance provided by N.I.S. and have been recalculated for entire time series 2000-2016 for improving the consistency between data for NFR and CRF. Activity data fluctuates,increasing and decreasing during the 1990-2018 time series. Default 2019 EMEP/EEA Guidebook emission factors (Table 3-1, Tier 1) were used.
The emissions of NMVOC are calculated based on Tier 1 methodology for process emissions from oil exploration, production and transport, applying the general equation:

$E_{pollutant} = AR_{production} \times EF_{pollutant}$, where:

- Epollutant - is the emission of a pollutant (kg) ;
- ARproduction - is the annual production of oil and imports (in Mg) ;
- EFpollutant - is the emission factor of the relevant pollutant (in kg pollutant / Mg oil produced and imports).

Pollutant emissions trend for NMVOC varies according to the activity data variation.

Table 3.18.1 Emissions Trend (kt) for NFR 1.B.2.a.i for NMVOC 1990-2018

Year	NMVOC (kt)
1990	4.797
1991	3.038

Year	NMVOC (kt)
1992	2.637
1993	2.859
1994	2.972
1995	3.075
1996	2.756
1997	2.552
1998	2.457
1999	2.087
2000	2.160
2001	2.311
2002	2.434
2003	2.174
2004	2.555
2005	2.781
2006	2.691
2007	2.615
2008	2.592
2009	2.256
2010	1.998
2011	1.905
2012	1.798
2013	1.868
2014	2.138
2015	2.100
2016	2.231
2017	2.259
2018	2.347

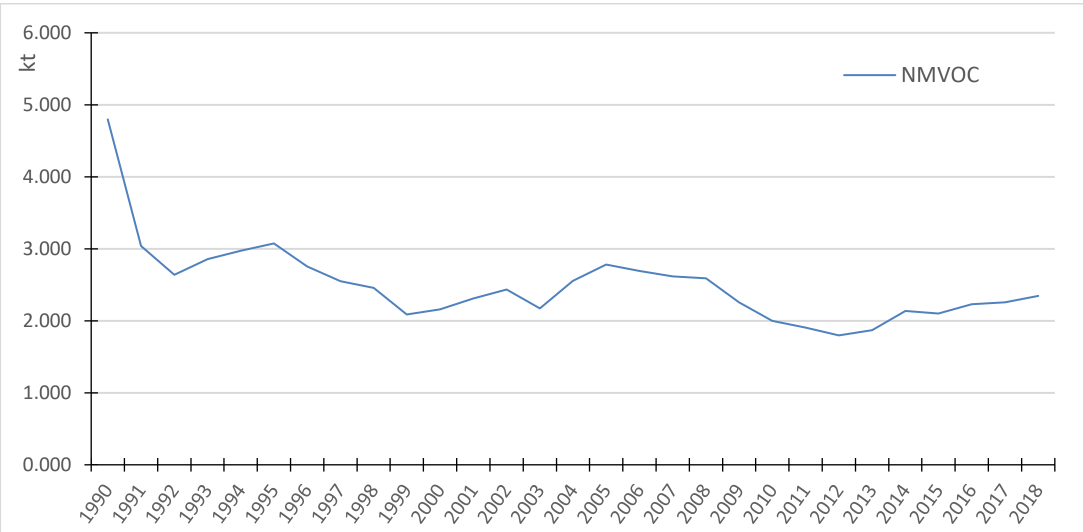


Figure 3.18.1 Emissions Trend (kt) for NFR 1.B.2.a.i for NMVOC

Recalculations and improvements: first estimate emissions for the time series 1990-1994.

3.19 NFR 1.B.2.a.iv Refining, storage

For NFR 1.B.2.a.iv, activity data is represented by refinery oil inputs from the Energy Balance provided by N.I.S., together with default 2019 EMEP/EEA Guidebook emission factors (Table 3-1,Tier 1).

The emissions were calculated based on Tier 1 methodology for process emissions from oil refining and storage, applying the general equation:

Epollutant = ARproduction× EFpollutant where:

- Epollutant - is the emission of a pollutant (kg) ;
- ARproduction - is the annual refinery oil inputs in the transformation (in Mg) ;
- EFpollutant - is the emission factor of the relevant pollutant (in kg pollutant / Mg oil inputs in the transformation).

Tabel 3.19.1 Activity data trends (t product) for NFR 1.B.2.a.iv 1990-2018

Year	AD (t)
1990	23824000
1991	15167000
1992	12797000
1993	15201000
1994	15201000
1995	15201000
1996	13431000
1997	12522000
1998	12071000
1999	10075000
2000	10546000
2001	11509000
2002	12061000
2003	10851000
2004	12340000
2005	13796000
2006	13453000
2007	13432000
2008	12846000
2009	11181000
2010	10022000
2011	9590000
2012	8823000
2013	9397000
2014	10318000
2015	10382000
2016	11304694
2017	11441404
2018	11661176

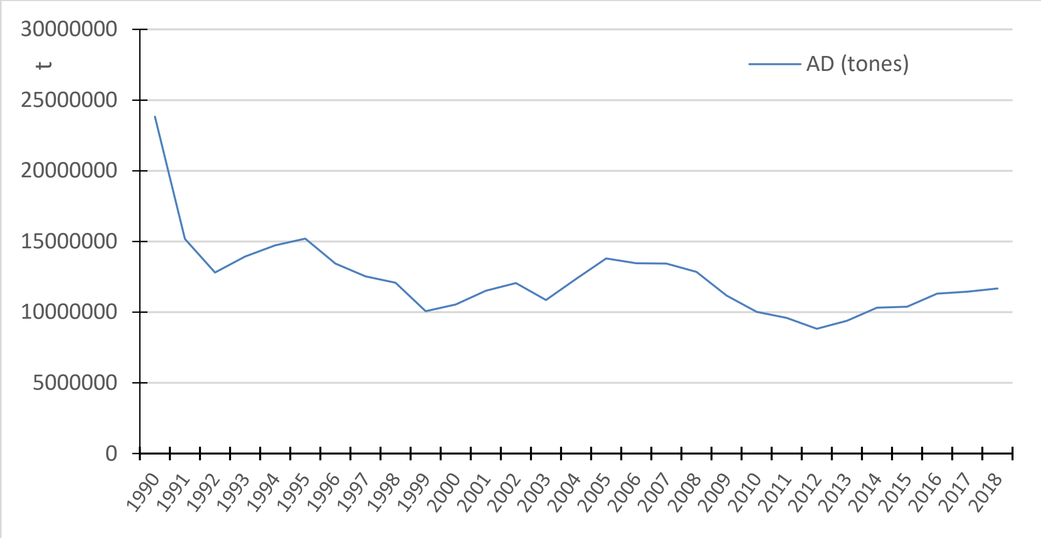


Figure 3.19.1 Activity data trends (t product) for NFR 1.B.2.a.iv

Tabel 3.19.2 Emissions Trend (kt) for NFR 1.B.2.a.iv for SO_x NO_x and NMVOC 1990-2018

Year	SO_x	NO_x	NMVOC
1990	14.771	5.718	4.765
1991	9.404	3.640	3.033
1992	7.934	3.071	2.559
1993	8.636	3.343	2.786
1994	9.123	3.532	2.943
1995	9.425	3.648	3.040
1996	8.327	3.223	2.686
1997	7.764	3.005	2.504
1998	7.484	2.897	2.414
1999	6.247	2.418	2.015
2000	6.539	2.531	2.109
2001	7.136	2.762	2.302
2002	7.478	2.895	2.412
2003	6.728	2.604	2.170
2004	7.651	2.962	2.468
2005	8.554	3.311	2.759
2006	8.341	3.229	2.691
2007	8.328	3.224	2.686
2008	7.965	3.083	2.569
2009	6.932	2.683	2.236
2010	6.214	2.405	2.004
2011	5.946	2.302	1.918
2012	5.470	2.118	1.765
2013	5.826	2.255	1.879
2014	6.397	2.476	2.064
2015	6.437	2.492	2.076
2016	7.009	2.713	2.261
2017	7.094	2.746	2.288
2018	7.230	2.799	2.332

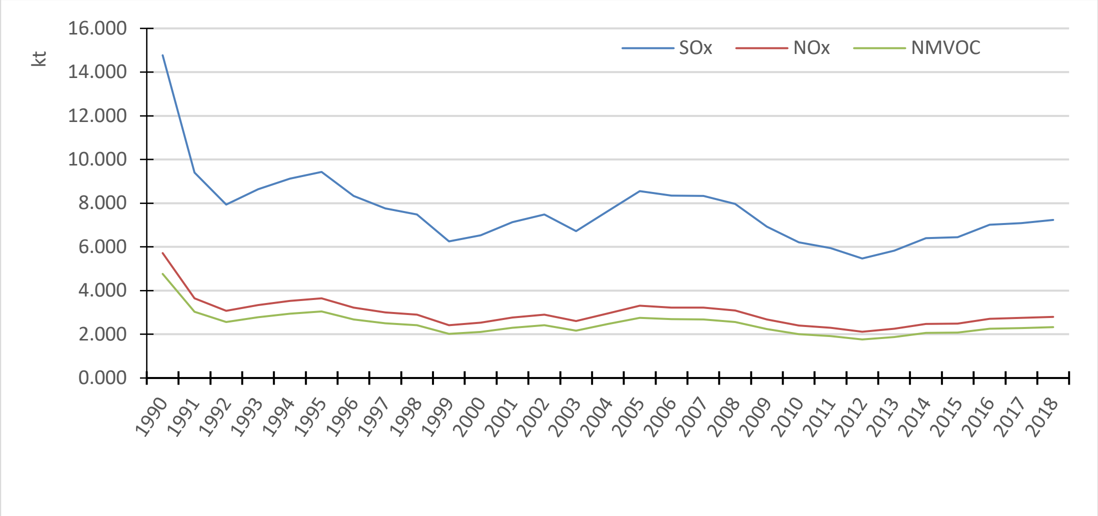


Figure 3.19.2 Emissions Trend (kt) for NFR 1.B.2.a.iv for SO_x , NO_x and NMVOC

Pollutant emissions trends for SOx , NOx and NMVOC vary according to the activity data variation.

Recalculations and improvements:First estimate emissions for the time series 1990-1994.

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

For NFR 1.B.2.a.v, statistical activity data consisted of gasoline refinery gross outputs and imports minus exports.

AD = (Refinery gross outputs + Imports) – Exports (Mg)

The activity data provided by the N.I.S. and by the Romania's Greenhouse Gas Inventory, improved the consistency between data for NFR and CRF.

In the 2019 EMEP/EEA Guidebook : "considerable reduction of hydrocarbon emissions from gasoline distribution network is achieved by modifying truck, barge or rail car tanks loading practices, installing vapour recovery units (VRU). These emission controls have been mandated under the terms of Directive 94/63/EU (EU,1994).

Stage I controls refer to a variety of techniques reducing NMVOC emissions at marketing terminals (Stage IA) and when gasoline is delivered to service stations (Stage IB).Stage II applies to vapour balancing systems between automobile fuel tanks during refuelling and the service station tank supplying the gasoline (Directive 2009/126/EC)".

Directive 94/63/EC has been transposed into Romanian legislation by Government Decision 568/2001 and Directive 2009/126/EC has been transposed by Government Decision 958/2012.

Tier 2 emission factor is calculated taking into account Stage I and II control. The abatement efficiencies related to this control options provided in the 2019 EMEP/EEA Guidebook are taken into account.

For the calculation of the Tier 2 emission factor, two country-specific characteristics are needed: the average annual temperature of Romania that is taken from the Statistical Yearbook and the maximal RVP (Reid Vapor Pressure) which is determined by Government Decision 689/2004 (Appendix 3).

Below, you find the calculation of the Romanian country specific Tier 2 emission factor, incorporating abatement efficiencies as it is suggested in the 2016 EMEP/EEA Guidebook.

$$TVP = RVP \times 10^{AT+B},$$

where:
A = 0.000007047 x RVP + 0.0132, B = 0.0002311 x RVP – 0.5236,
T – average annual temperature of Romania (^{0}C) = 9.5 ^{0}C (Statistical Yearbook of Romania);
RVP – is Reid Vapor Pressure (kPa) = 60 (determined by Government Decision 689/2004, Appendix 3).
A = 0.000007047 x 60 + 0.0132 = 0.01362282
B = 0.0002311 x 60 – 0.5236 = - 0.509734
AT + B = - 0.380317
$10^{AT+B} = 10^{-0.380317} = 0.416572$
TVP = 24.994 kPa = 25 kPa

Calculation of Tier 2 emission factor

Category	Emission source	EF NMVOC default (g/m^3throughput/kPa TVP)	Abatement efficiency (%)	TVP- true vapor pressure (kPa)	EF NMVOC (g/m^3) (EF abated x TVP)
Service stations	Storage tank filling without Stage I (table 3-8)	24	95 (stage I)	25.0	30.0
	Storage tank breathing (table 3-9)	3		25.0	75.0
	Automobile refueling with no emission controls in operation (table 3-10)	37	85 (stage II)	25.0	138.75
	Automobile refueling: drips and minor spillage (table 3-11)	2		25.0	50.0
				SUM	293.75

Using “the assumed liquid gasoline density is 730 kg/m^3” from chapter 3.3.2.3 of 2019 EMEP/EEA Guidebook, the 293.75 g/m^3 NMVOC results 0.4023 kg NMVOC/t gasoline (293.75 x 10^{-3} kg NMVOC / 730 x10^{-3} t gasoline).

Tabel 3.20.1. Emissions Trend (kt) for NFR 1.B.2.a.v for NMVOC 1990 -2018

Year	NMVOC (kt)
1990	0.8406
1991	0.6841
1992	0.8084

Year	NMVOC (kt)
1993	0.4008
1994	0.4269
1995	0.6559
1996	0.5372
1997	0.7328
1998	0.7251
1999	0.5867
2000	0.6108
2001	0.7002
2002	0.6507
2003	0.6615
2004	0.6205
2005	0.6370
2006	0.5718
2007	0.6728
2008	0.5727
2009	0.6829
2010	0.6437
2011	0.5286
2012	0.5290
2013	0.5230
2014	0.5427
2015	0.5242
2016	0.5666
2017	0.5890
2018	0.5314

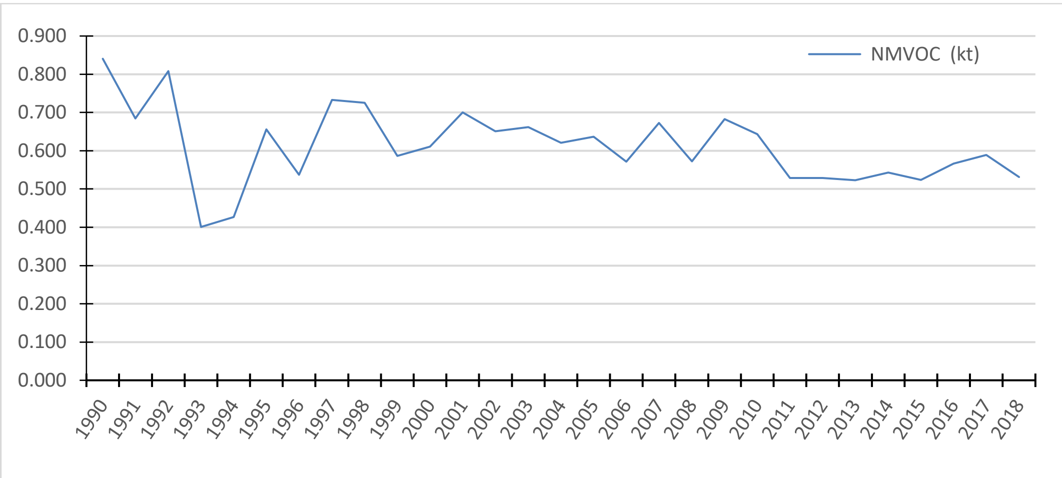


Figure 3.20.1. Emissions Trend (kt) for NFR 1.B.2.a.v for NMVOC

It can be observed that emissions of NMVOC follow the activity data trend of NFR 1.B.2.a.v - Distribution of oil products.

Recalculations and improvements: First estimate emissions for the time series 1990-1994

3.21 NFR 1.B.2.b Natural gas

This source includes emissions from the exploration, production and transport for natural gas. The emission factor for NMVOC is Tier 1 default emission factor for natural gas from 2019 EMEP/EEA Guidebook (Table 3-2). Activity data is represented by the extracted natural gas and imports and it is taken from the Energy Balance provided by N.I.S. and by the Romania's Greenhouse Gas Inventory, improved the consistency between data for NFR and CRF.

Tabel 3.21.1. Emissions Trend (kt) for NFR 1.B.2.b. for NMVOC 1990-2018

Year	NMVOC (kt)
1990	3.567
1991	2.943
1992	2.623
1993	2.523
1994	2.315
1995	2.400
1996	2.427
1997	1.997
1998	1.869
1999	1.718
2000	1.711
2001	1.644
2002	1.681
2003	1.890
2004	1.792
2005	1.722
2006	1.779
2007	1.622
2008	1.567
2009	1.317
2010	1.313
2011	1.399
2012	1.381
2013	1.231
2014	1.164
2015	1.129
2016	1.128
2017	1.177
2018	1.180

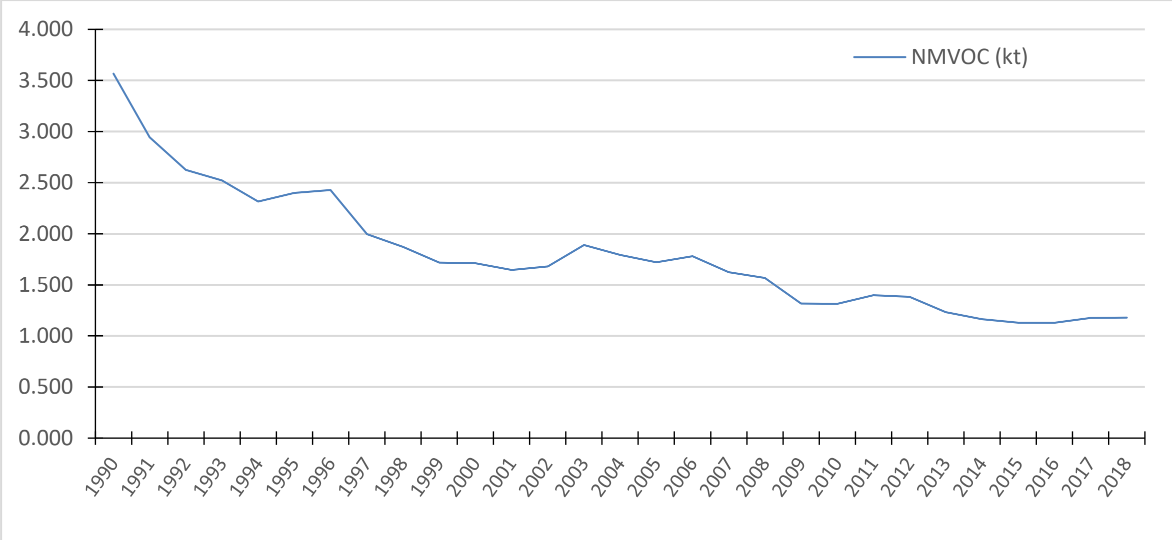


Figure 3.21.1. Emissions Trend (kt) for NFR 1.B.2.b. for NMVOC

It is observed that the emissions trend of NMVOC is decreasing for the 1990-2018 time period.

Recalculations and improvements: First estimate emissions for the time series 1990-1994.

3.22 NFR 1.B.2.c Venting and flaring

This NFR "treats emissions from venting and flaring in the extraction and refining of oil and gas".
For NFR 1.B.2.c, for the time series 2012-2018, activity data is represented by refinery gases flared (m3).
The following activities with corresponding SNAP codes are included:

- Flaring in oil refinery (SNAP 090203);
- Flaring in gas and oil extraction (SNAP 090206).

The emissions are calculated based on Tier 2 methodology from 2019 EMEP/EEA Guidebook for SNAP 090203 in which it is specified "the factors are identical to the emission factors for flaring in oil refineries as given in Tier 1 (Table 3-3)".

The emissions are calculated based on Tier 1 methodology from 2019 EMEP/EEA Guidebook for SNAP 090206 (Table 3-1), applying the general equation:

$$Epollutant = ARproduction \times EFpollutant,$$

where:

- Epollutant - is the emission of a pollutant (kg) ;
- EFpollutant - is the emission factor of the relevant pollutant (in kg pollutant / Mg gas burned/ throughput).
- ARproduction - is the volume of gas burned (m^3).

For the time series 1990-2011, as activity data we still used the category “losses” of natural gas from the Energy Balance provided by N.I.S, together with default 2019 EMEP/EEA Guidebook emission factors (Table 3-1, Tier 1) for a preliminary estimate of pollutant emissions, due to the lack of activity data from economic operators.

Tabel 3.22.1. Emissions Trend (kt) for NFR 1.B.2.c. for SO_X and NOx 1990-2018

Year	SO_X (kt)	NOx (kt)
1990	0.263	0.002
1991	1.028	0.010
1992	0.840	0.008
1993	1.092	0.010
1994	1.393	0.013
1995	0.793	0.007
1996	0.710	0.007
1997	0.196	0.002
1998	0.446	0.004
1999	0.571	0.005
2000	0.452	0.004
2001	0.561	0.005
2002	0.616	0.006
2003	0.877	0.008
2004	0.642	0.006
2005	0.856	0.008
2006	1.324	0.012
2007	0.646	0.006
2008	0.668	0.006
2009	0.472	0.004
2010	0.509	0.005
2011	0.490	0.005
2012	*0.063*	*0.061*
2013	*0.797*	*1.112*
2014	*0.055*	*0.060*
2015	*0.795*	*1.117*
2016	*0.579*	*0.813*
2017	*0.418*	*0.575*
2018	*0.413*	*0.571*

NOx and SOx emissions presented in above table with italic font are calculated for the time series 2012-2018 with activity data from economic operators.

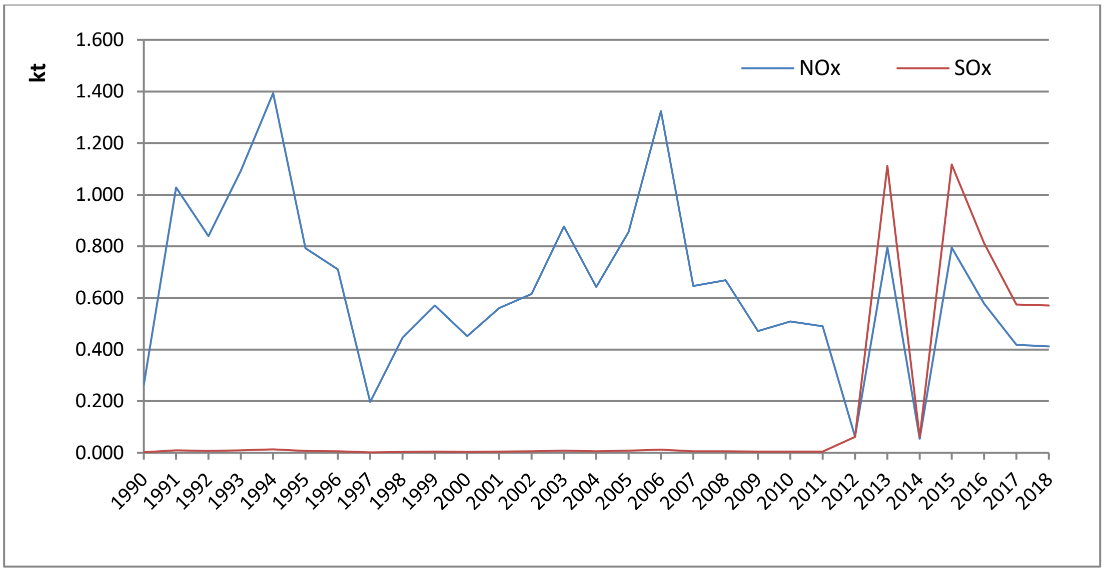


Figure 3.22.1. Emissions Trend (kt) for NFR 1.B.2.c for ,SO_X and NOx

The chart show the variation of the pollutants for 1.B.2.c

Recalculations and improvements: we reviewed and corrected the calculations for NFR 1B2c for activity data and pollutant emissions for 2012-2017, because unfortunately there was a mistake in calculating them, which was not noticed by us.

First estimate emissions for the time series 1990-1994.

4. INDUSTRIAL PROCESSES AND PRODUCT USE (NFR sector 2)

The industrial processes and product use sector is a key category of NMVOC, PM_{10}, TSP, Pb, Cd, Hg, As, Cr, Ni, Zn, PCDD/F, PAHs and PCBs.

Table 4.1. The key category for Industrial Processes and product use

Pollutant	NFR code	Category	Level assessment (%)
NMVOC	2D3a	Domestic solvent use including fungicides	10.45%
NMVOC	2D3g	Chemical products	4.72%
NMVOC	2H2	Food and beverages industry	2.94%
NMVOC	2D3f	Dry cleaning	2.45%
NMVOC	2B10a	Chemical industry: Other (please specify in the IIR)	2.00%
NMVOC	2D3d	Coating applications	1.95%
NMVOC	2D3i	Other solvent use (please specify in the IIR)	1.90%
PM10	2A2	Lime production	2.78%
PM10	2A5a	Quarrying and mining of minerals other than coal	2.33%
PM10	2D3b	Road paving with asphalt	2.28%
TSP	2B10a	Chemical industry: Other (please specify in the IIR)	11.35%
TSP	2D3b	Road paving with asphalt	7.01%
TSP	2A2	Lime production	4.71%
TSP	2A5a	Quarrying and mining of minerals other than coal	3.13%
Pb	2C1	Iron and steel production	61.54%
Cd	2C1	Iron and steel production	14.49%
Hg	2C1	Iron and steel production	18.01%
As	2C1	Iron and steel production	23.28%
Cr	2C1	Iron and steel production	43.55%
Ni	2C1	Iron and steel production	18.65%

Pollutant	NFR code	Category	Level assessment (%)
Zn	2C1	Iron and steel production	12.87%
PCDD/F	2C1	Iron and steel production	22.07%
PAHs	2C1	Iron and steel production	11.21%
PCBs	2C1	Iron and steel production	70.80%

Industrial processes and product use sector mainly contributes to the PCBs emissions of the Inventory (70.80% of the total national), Pb emissions (64.93% of the total national), Cr emissions (44.38% of the total national), NMVOC emissions (27.71% of the total national), TSP emissions (32.85% of the total national), As (25.12% of the total national) and with a relatively low contribution to the emissions of the rest of pollutants reported.

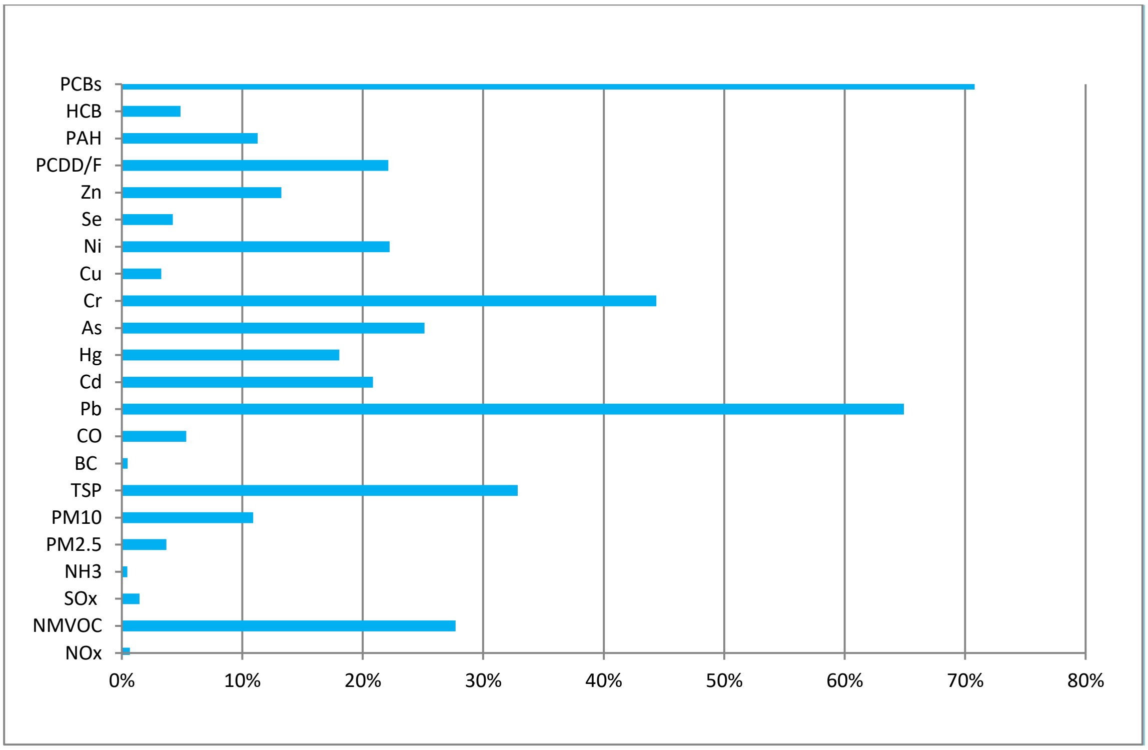


Figure 4.1. Emissions of pollutants (%) for IPPU sector in 2018

This sector only covers process related emissions arising from industrial processes. Emissions due to fuel combustion in manufacturing industries have been allocated to NFR 1.A.2 Fuel Combustion in Manufacturing Industries and Construction.

Information on which source sectors include the condensable component of PM10 and PM2.5, as provided by the Guidebook 2019:

For NFR 2C.1, 2.C.2, 2.C.3, 2.C.5 and 2.C.6, all tables of emission factors used in the actual estimation of particulate matter note that: “These PM factors represent filterable PM emissions only (excluding any condensable fraction).”

For NFR 2.D.3.b, is specified in a note below the table with emissions factors used: ”The TSP, PM10 and PM2.5 emission factor represents filterable PM emissions. Note that US EPA (2004) includes condensable PM emission factors and factors for controlled plant”.

4.1 NFR 2.A.1 Cement production

This activity covers emissions from cement manufacture process. The present chapter only considers emissions of particulate matter from cement plants. According to the 2019 EMEP/EEA Guidebook emissions from the kiln are a combination of combustion and process emissions but the emissions of the main pollutants — NOx, sulphur oxides (SOx), CO, non-methane volatile organic compounds (NMVOC) and NH3 — as well as heavy metals and persistent organic pollutants (POPs) are assumed to originate mainly from the combustion of the fuel. These emissions are therefore treated under NFR 1.A.2, which addresses combustion in cement production.

The methodology for estimating emissions from cement production applies the general equation:

$$Epollutant = ARproduction \times Efpollutant \quad , \quad \text{where:}$$

- $E_{pollutant}$ is the emission of the specified pollutant
- $AR_{production}$ is the activity rate for the cement production
- $EF_{pollutant}$ is the emission factor for this pollutant.

The emission factors used to calculate the emissions from cement production are from 2019 EMEP/EEA Guidebook, chapter 2.A.1 Cement production, Table 3.1.

The activity data used for emission calculations is the annual national total clinker production from the “PRODROM” statistics, provided by the N.I.S..

Table 4.1.1. Activity data trends (kt product) for NFR 2.A.1. Cement production

Year	kt product
1990	8379
1991	6037
1992	5488
1993	5349
1994	5232
1995	5938
1996	6038
1997	5669
1998	5497
1999	4971
2000	5006
2001	5218
2002	4984
2003	4996
2004	5661
2005	6007
2006	6916
2007	7670
2008	7780
2009	5841

Year	kt product
2010	5202
2011	5751
2012	5874
2013	5062
2014	5467
2015	6203
2016	5933
2017	6190
2018	6587

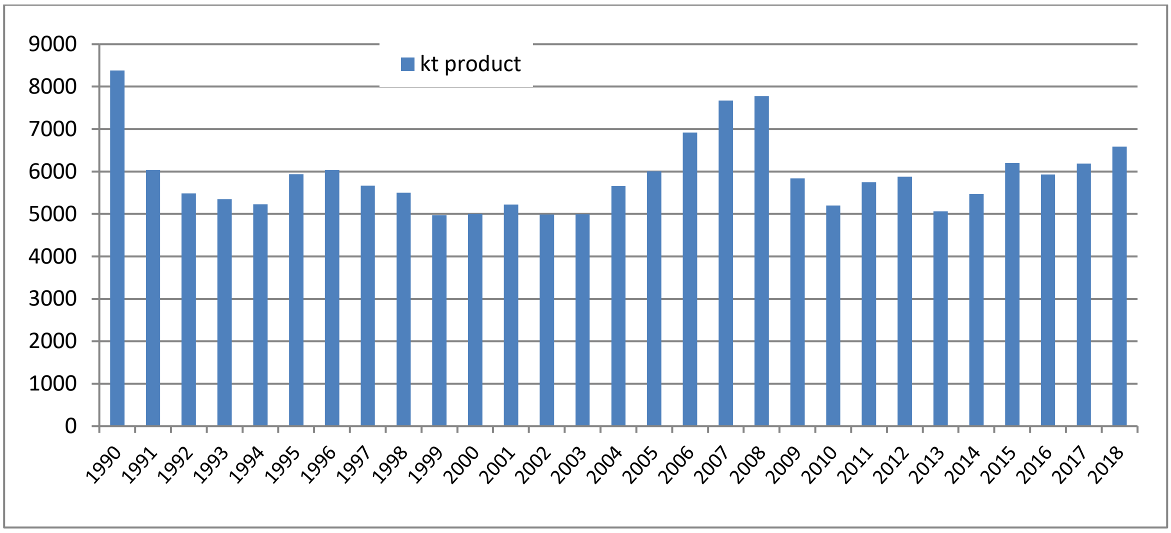


Figure 4.1.1. Activity data trend (kt product) for NFR 2.A.1. Cement production

The emissions trends for particles from the cement production are shown in the following table and figure.

Table 4.1.2. Emission Trends (kt) for NFR 2.A.1 Cement Production

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
1990	1.089	1.961	2.179
1991	0.785	1.413	1.570
1992	0.713	1.284	1.427
1993	0.695	1.252	1.391
1994	0.680	1.224	1.360
1995	0.772	1.389	1.544
1996	0.785	1.413	1.570
1997	0.737	1.327	1.474
1998	0.715	1.286	1.429
1999	0.646	1.163	1.292
2000	0.651	1.171	1.302
2001	0.678	1.221	1.357
2002	0.648	1.166	1.296
2003	0.649	1.169	1.299
2004	0.736	1.325	1.472
2005	0.781	1.406	1.562
2006	0.899	1.618	1.798
2007	0.997	1.795	1.994

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
2008	1.011	1.821	2.023
2009	0.759	1.367	1.519
2010	0.676	1.217	1.352
2011	0.748	1.346	1.495
2012	0.764	1.374	1.527
2013	0.658	1.184	1.316
2014	0.711	1.279	1.421
2015	0.806	1.452	1.613
2016	0.771	1.388	1.543
2017	0.805	1.448	1.609
2018	0.856	1.541	1.713

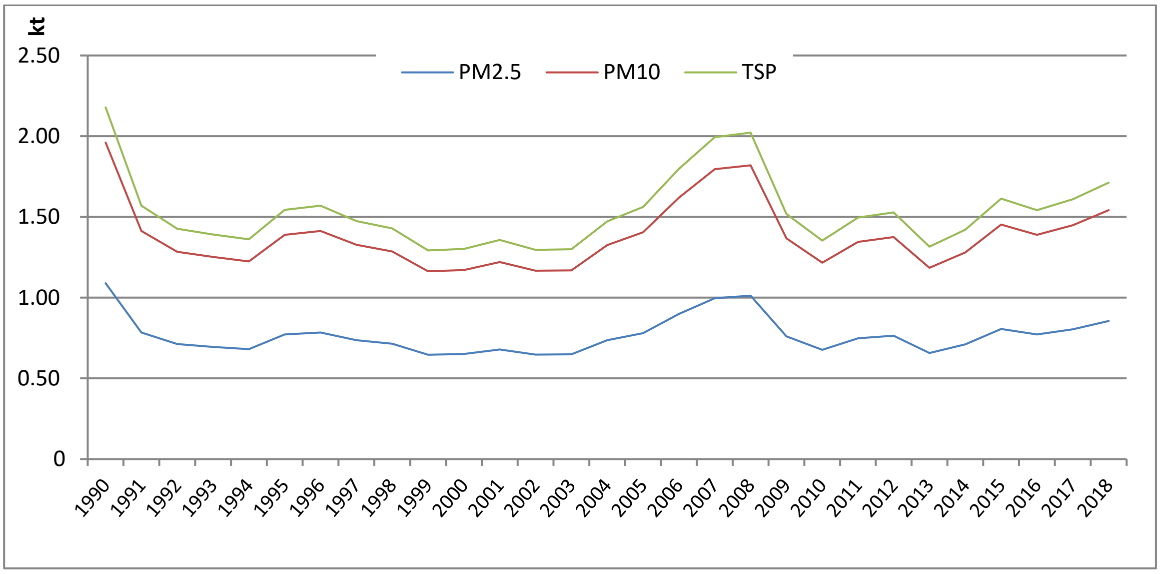


Figure 4.1.2. Emission Trends (kt) for NFR 2.A.1 Cement Production

The particulate matter emissions from this activity followed the activity data trend: for the 2000-2004 time period emissions recorded lower values, increasing from 2005 to 2008 when it recorded a peak and decreasing afterwards until 2010. For the 2010-2016 time period emissions recorded variations related to clinker production activity.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.2 NFR 2.A.2 Lime production

The production of lime causes emissions from both processes and combustion. Emissions from combustion activities are treated under NFR 1.A.2. This chapter covers only emissions for particulate fractions.

NFR 2.A.2 is key source category for PM_{10} and TSP pollutants.

The emissions are calculated based on Tier 1 methodology for this process applying the general equation:

$E_{pollutant} = AR_{production} \times Ef_{pollutant}$, where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate for the lime production
- EFpollutant is the emission factor for this pollutant.

The emission factors used to calculate the emissions from lime production are from 2019 EMEP/EEA Guidebook, chapter NFR 2.A.2 Lime production, Table 3.1.

Lime production is taken from the Statistical Yearbook provided by the N.I.S. and from the Romania's Greenhouse Gas Inventory – N.I.R., improving the consistency between data for NFR and CRF. These data are structured by type of lime: calcium quicklime and dolomitic lime. For the period 2000-2008 calcium quicklime production is taken from the Statistical Yearbook provided by the N.I.S applying a correction factor value. For the period 2009-2018 calcium quicklime production is taken from the economic operators. For dolomitic lime produced, the N.I.S. activity data are used for the 2000-2018 period.

Table 4.2.1. Activity data trend (kt product) for NFR 2.A.2. Lime production

Year	kt product
1990	2025
1991	1551
1992	1295
1993	1162
1994	1087
1995	1179
1996	1164
1997	1124
1998	1396
1999	1250
2000	1260
2001	1439
2002	1358
2003	1357
2004	1468
2005	1278
2006	1430
2007	1748
2008	1505
2009	1073
2010	1171
2011	1161
2012	1001
2013	964
2014	1233
2015	1050
2016	1062
2017	1125
2018	1165

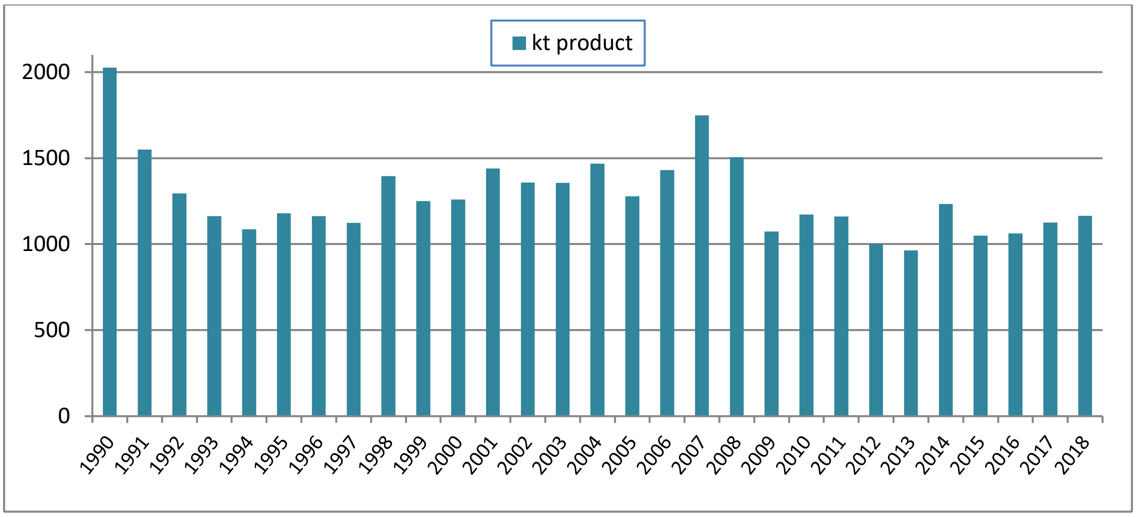


Figure 4.2.1. Activity data Trend (kt) for NFR 2.A.2. Lime production

The emission trends for particles from lime production are shown in the following table and figure.

Table 4.2.2. Emission Trends (kt) for NFR 2.A.2. Lime production

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
1990	1.418	7.088	18.225
1991	1.085	5.427	13.955
1992	0.906	4.532	11.654
1993	0.814	4.068	10.461
1994	0.761	3.804	9.782
1995	0.825	4.127	10.612
1996	0.814	4.072	10.472
1997	0.787	3.935	10.118
1998	0.977	4.885	12.561
1999	0.875	4.375	11.251
2000	1.031	5.157	13.260
2001	1.168	5.841	15.019
2002	1.123	5.614	14.435
2003	1.124	5.619	14.448
2004	1.205	6.026	15.496
2005	1.056	5.279	13.575
2006	1.175	5.877	15.112
2007	1.407	7.037	18.096
2008	1.249	6.243	16.054
2009	0.833	4.167	10.716
2010	0.937	4.686	12.051
2011	0.929	4.645	11.943
2012	0.814	4.071	10.467
2013	0.790	3.949	10.155
2014	0.863	4.314	11.094
2015	0.739	3.697	9.506
2016	0.743	3.717	9.557
2017	0.787	3.937	10.124
2018	0.815	4.076	10.482

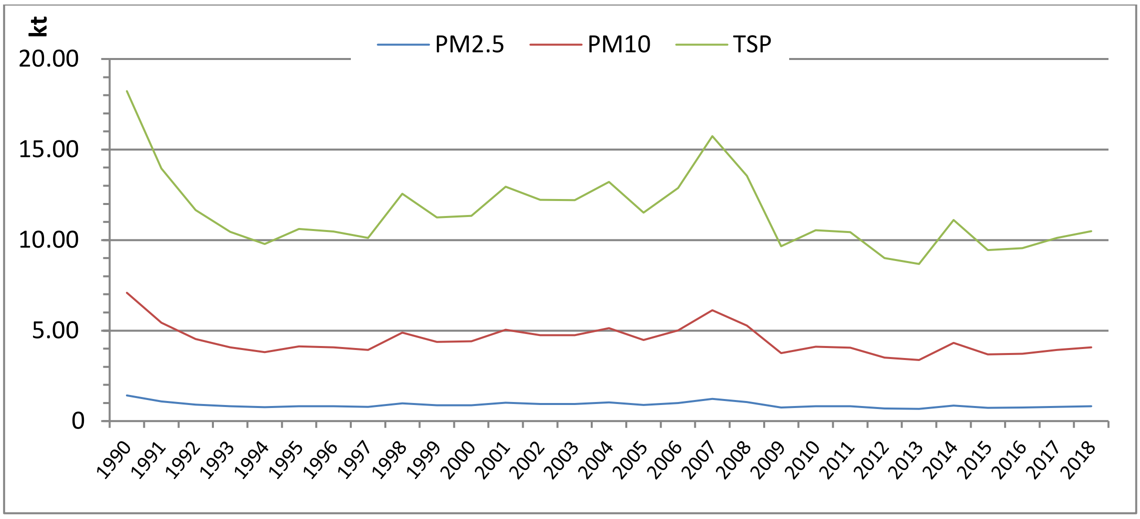


Figure 4.2.2. Emission Trends (kt) for NFR 2.A.2. Lime production

The emissions of $PM_{2.5}$, PM_{10} and TSP follow the activity data trends for lime production which varied substantially from year to year due to high variation of industry outputs.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.
- There were not recalculations since the previous submission.

4.3 NFR 2.A.3 Glass production

This activity covers emissions released during the production of the particular types of glass:

- Flat glass (SNAP 030314);
- Container glass (SNAP 030315);
- Glass wool (SNAP 0303156).

Emissions from combustion activities within the glass industry are treated under NFR 1.A.2.

NFR 2.A.3 is not a key source for any pollutant.

The emissions have calculated based on Tier 2 methodology for this process applying the general equation:

$$E_{pollutant} = \sum_{technologies} AR_{production,\ technology} \times EF_{technology,\ pollutant}$$

where:

- ARproduction, technology = the production rate within the source category, using this specific technology
- EFtechnology, pollutant = the emission factor for this technology and this pollutant

This equation is applied at the national level using annual national flat glass, container glass and glass wool production.

The emission factors used to calculate the emissions from glass production are from 2019 EMEP/EEA Guidebook, chapter 2.A.3 Glass production, Table 3.2, Table 3.3 and Table 3.5.

The glass production is taken from the Statistical Yearbook provided by the National Institute of Statistics (N.I.S.) and from the Romania's Greenhouse Gas Inventory – N.I.R., improving the consistency between data for NFR and CRF. The data and information on glass production was collected from economic operators. The glass quantity from the data collected from the economic operators is higher compared to the one provided by the N.I.S. due to the fact that data collected from the operators are the melted glass quantity and data from the N.I.S. represents the glass quantity sold. Since there are confidential data in some categories, only aggregated activity data are reported in the following table. There is no production of glass wool in 2016-2017.

Table 4.3.1. Activity data trend (kt product) for NFR 2.A.3. Glass production

Year	kt product
1990	925.88
1991	753.97
1992	621.27
1993	497.62
1994	545.88
1995	612.23
1996	651.43
1997	542.86
1998	482.54
1999	286.51
2000	389.05
2001	404.13
2002	404.13
2003	538.15
2004	385.63
2005	301.85
2006	284.04
2007	461.81
2008	451.04
2009	358.02
2010	400.31
2011	386.43
2012	377.08
2013	373.58
2014	363.76
2015	394.66

Year	kt product
2016	411.33
2017	401.93
2018	394.28

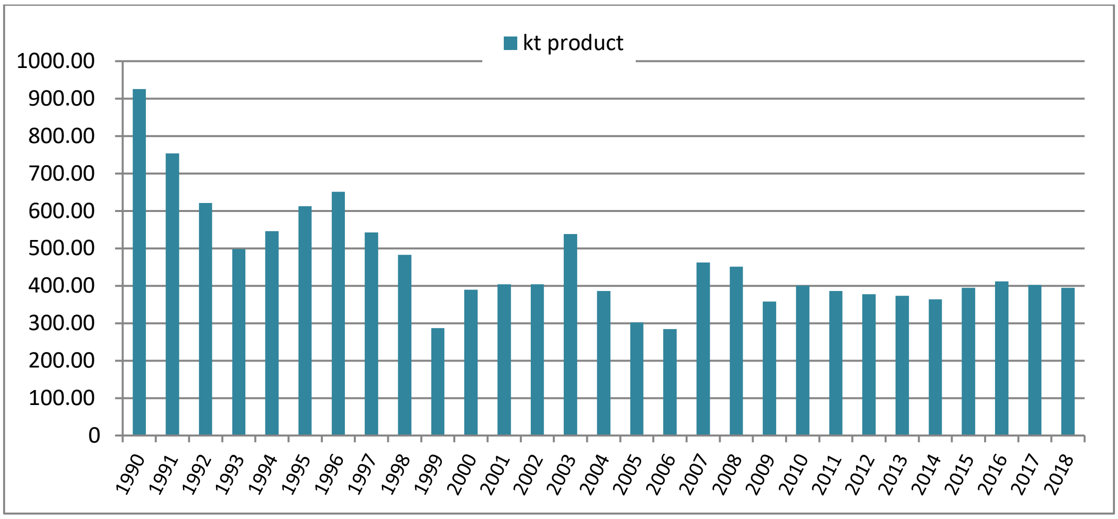


Figure 4.3.1. Activity data Trend (kt) for NFR 2.A.3. Glass production

The emission trends for the glass production are shown in the following table and figure.

Table 4.3.2. Emission Trends (t) for NFR 2.A.3 Glass production

Year/Pollutant	Pb	Cd	As	Ni	Se
1990	1.249	0.080	0.147	0.488	0.615
1991	1.017	0.065	0.119	0.397	0.501
1992	0.838	0.053	0.098	0.327	0.413
1993	0.671	0.043	0.079	0.262	0.331
1994	0.736	0.047	0.086	0.288	0.363
1995	0.826	0.053	0.097	0.323	0.407
1996	0.879	0.056	0.103	0.343	0.433
1997	0.732	0.047	0.086	0.286	0.361
1998	0.651	0.042	0.076	0.254	0.321
1999	0.387	0.025	0.045	0.151	0.190
2000	0.525	0.033	0.062	0.205	0.258
2001	0.545	0.035	0.064	0.213	0.269
2002	0.545	0.035	0.064	0.213	0.269
2003	0.981	0.052	0.107	0.241	0.494
2004	0.592	0.035	0.067	0.193	0.295
2005	0.503	0.028	0.056	0.141	0.252
2006	0.476	0.026	0.053	0.131	0.239
2007	0.523	0.038	0.065	0.262	0.253
2008	0.500	0.036	0.062	0.255	0.241
2009	0.434	0.030	0.053	0.200	0.211
2010	0.460	0.033	0.057	0.228	0.223
2011	0.454	0.032	0.056	0.219	0.220
2012	0.437	0.031	0.054	0.214	0.212
2013	0.417	0.030	0.052	0.216	0.201

Year/Pollutant	Pb	Cd	As	Ni	Se
2014	0.419	0.030	0.052	0.206	0.203
2015	0.534	0.034	0.063	0.207	0.263
2016	0.586	0.037	0.068	0.220	0.289
2017	0.592	0.036	0.068	0.211	0.293
2018	0.621	0.036	0.070	0.192	0.310

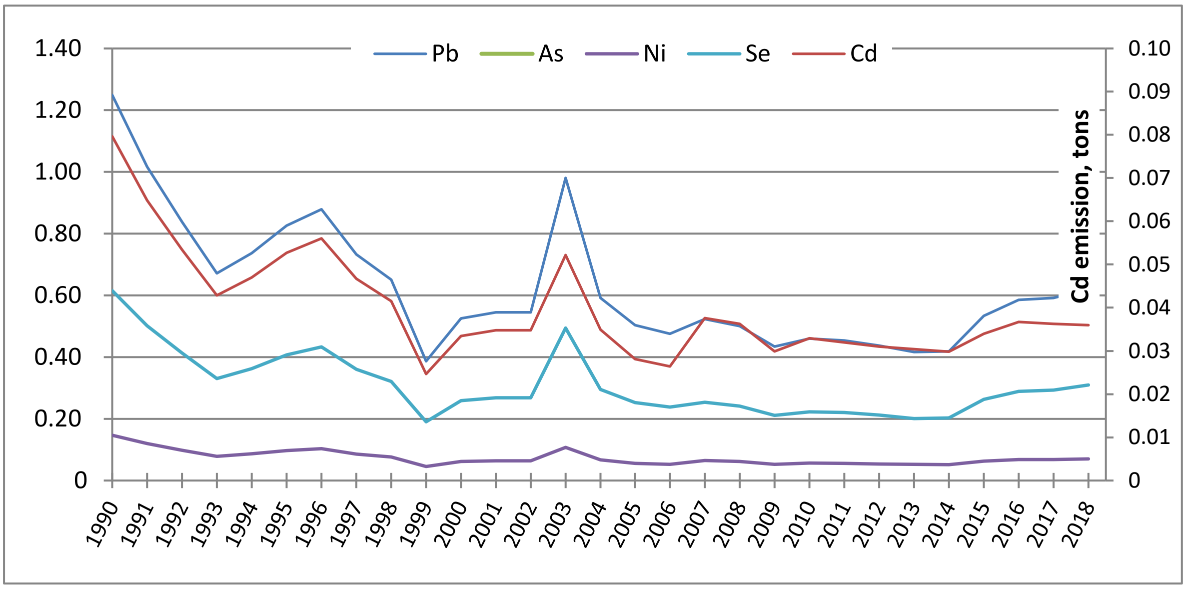


Figure 4.3.2. Emission Trends (t) for NFR 2.A.3. Glass production

The emissions of Pb, Cd, As, Ni and Se varied for all 1995-2018 period in consensus with the variation of glass production as activity data, with peaks in 1996 and 2003. Flat glass production was much higher than that of container glass in 2007 and 2008, resulting in higher emissions of Ni than Se.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994 with Tier 2 methodology;
- There were not recalculations since the previous submission.

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

The emissions of particulates are relevant for quarrying and mining of minerals other than coal. These emissions are generally fugitive in nature and it is difficult to quantify.

The methodology for estimating emissions of particulate matter is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 3.2 - Tier 1 default approach, by multiplying the annual amount of minerals with emission factors from the Table 3.1.

NFR 2.A.5.a is key source category for TSP pollutant with a share of 3.13% of the national total.

The activity data are provided by the N.I.S. and consist of production data for each product type: metalliferous ores of various kinds, stones, marble, granit, sandstone, limestone, clays, other minerals, other chemical and fertiliser minerals, etc. The annual quantity of extracted minerals is provided by the N.I.S., starting with 1993. From 1990-2003, the activity data for the metalliferous ores are provided by the N.I.S., and the quantity of minerals, other than the metalliferous, was estimated based on the production indices by industry, mining and quarrying.

The production of metalliferous ores has decreased heavily after 2000, and the other productions had variable increases. Since there are confidential data in some categories, only aggregated activity data are reported in the following table.

Table 4.4.1. Activity data trend (kt) for NFR 2.A. 5.a Quarrying and mining of minerals other than coal

Year	Material quarried (kt)
1990	25448.15
1991	18620.62
1992	16069.24
1993	14107.11
1994	19997.79
1995	19745.21
1996	19674.72
1997	18188.54
1998	19859.53
1999	12171.58
2000	10743.95
2001	20488.47
2002	25294.18
2003	35296.49
2004	40419.96
2005	42586.00
2006	47544.97
2007	61606.59
2008	65103.74
2009	50510.80
2010	48843.36
2011	57046.19
2012	57290.47
2013	57207.87
2014	59999.06
2015	73464.75

Year	Material quarried (kt)
2016	75636.95
2017	64266.14
2018	68275.00

The emission trends for NFR 2.A. 5.a are shown in the following table and figure.

Table 4.4.2. Emission Trends (kt) for NFR 2.A. 5.a Quarrying and mining of minerals other than coal

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
1990	0.127	1.272	2.596
1991	0.093	0.931	1.899
1992	0.080	0.803	1.639
1993	0.071	0.705	1.439
1994	0.100	1.000	2.040
1995	0.099	0.987	2.014
1996	0.098	0.984	2.007
1997	0.091	0.909	1.855
1998	0.099	0.993	2.026
1999	0.061	0.609	1.242
2000	0.054	0.537	1.096
2001	0.102	1.024	2.090
2002	0.126	1.265	2.580
2003	0.176	1.765	3.600
2004	0.202	2.021	4.123
2005	0.213	2.129	4.344
2006	0.238	2.377	4.850
2007	0.308	3.080	6.284
2008	0.326	3.255	6.641
2009	0.253	2.526	5.152
2010	0.244	2.442	4.982
2011	0.285	2.852	5.819
2012	0.286	2.865	5.844
2013	0.286	2.860	5.835
2014	0.300	3.000	6.120
2015	0.367	3.673	7.493
2016	0.378	3.782	7.715
2017	0.321	3.213	6.555
2018	0.341	3.414	6.964

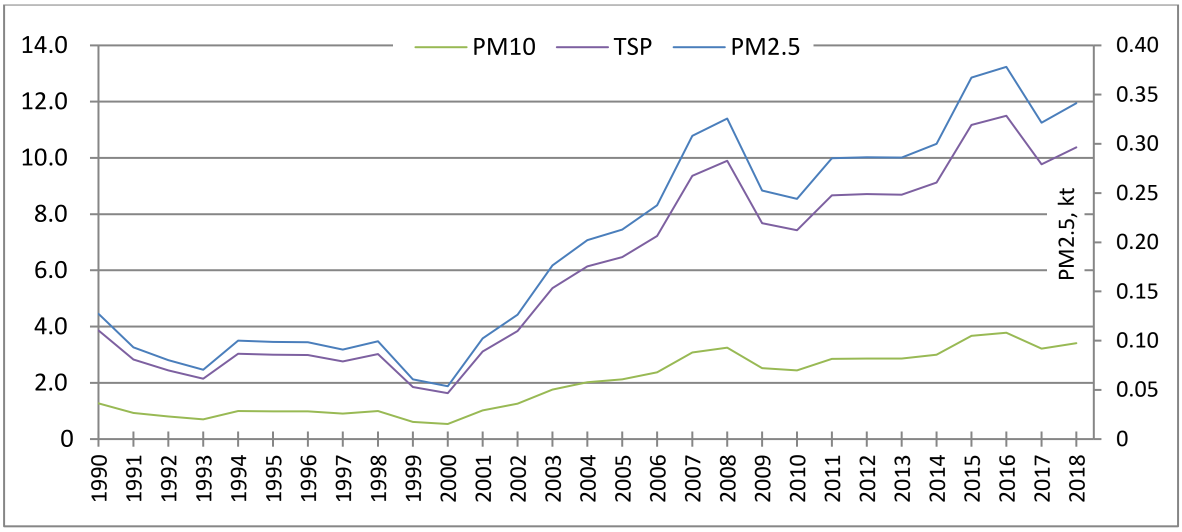


Figure 4.4.1. Emission Trends (kt) for NFR 2.A. 5.a Quarrying and mining of minerals other than coal

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.
- There were not recalculations since the previous submission.

4.5 NFR 2.A.5.b Construction and demolition

Emissions of particulate matter are relevant for construction and are estimated using the default method given in the 2019 EMEP/EEA Guidebook, Chapter 2.A.5.b Construction and demolition.

The following equation is used:

- $EM = EF \cdot Aaffected \cdot d \cdot (1 - CE) \cdot (24/PE) \cdot (s/9\%)$

Where:

- EM = emission (kg)
- EF = the emission factor for pollutant emission (kg/[m² · year])
- A affected = area affected by construction activity (m²)
- d = duration of construction (year)
- CE = efficiency of emission control measures (-)
- PE = Thornthwaite precipitation-evaporation index (-)
- s = soil silt content (%)

The methodology for estimating emissions considers four main types of construction:

- Residential housing, single- or two family
- Residential housing, apartments
- Non-residential housing
- Road construction.

The activity data are required for each type of construction, but these activity data do not exist for Romania, so the activity data are estimate based on other statistics such as the total constructed utility floor area and the annually reported length of the road network, available from N.I.S.

Regarding residential housing, the national statistics cover the total constructed utility floor area for both houses and apartments and this is divided according to the percentage of houses and apartments, available from N.I.S.

In case of non-residential housing, the total constructed utility floor area is available from 2002, for the years 1990-2001 the same value was used as for year 2002.

The affected area is estimated using 0,8 m^2 footprint are per m^2 utility floor area, as it is suggested in the 2019 EMEP/EEA Guidebook.

The affected area for road construction is estimated from the total length of new road constructed (only new mains roads i.e highways), which is available from national statistical using default width of exposed area from the guidebook.

The emission factors used are from the Table 3.1 to Table 3.4. The duration of construction (d) and the efficiency of emission control measures (CE) were used as presented in the guidebook. For the thornthwaite precipitation-evaporation index (PE) the value of 120 is used and for soil silt content (s) 20% is used, as assumed for Germany.

Table 4.5.1. Area affected by construction activity (m^2) for NFR 2.A.5.b Construction and demolition

Year	Houses	Apartments	Non-residential housing	New roads
1990	1385503	2154539	1818487	0
1991	888996	1172977	1818487	0
1992	1259425	1095961	1818487	0
1993	1401366	886048	1818487	0
1994	1733890	1060748	1818487	0
1995	1763071	920922	1818487	0
1996	1662783	685040	1818487	0
1997	1789518	772254	1818487	0
1998	1860948	849686	1818487	0
1999	1882017	878743	1818487	0
2000	1842515	879575	1818487	0
2001	1988243	905585	1818487	0
2002	1990509	1043874	1818487	0
2003	2010389	1204296	2217350	0
2004	2057337	1437693	2447980	4140000
2005	2406446	1455091	3000996	0
2006	2963636	1732733	4267430	0
2007	3678925	2220658	5920100	1908000
2008	5088056	2811712	5456956	0
2009	4715579	2596564	3524523	1440000
2010	4187520	2035482	2779669	396000
2011	3986767	1810989	3513478	648000
2012	3787197	1758362	2833776	7200000
2013	3635093	1814922	2647615	3384000

Year	Houses	Apartments	Non-residential housing	New roads
2014	3377849	1872626	3215746	1404000
2015	3392603	1892046	2262618	2304000
2016	3707240	2112103	2004063	0
2017	3711782	2149530	2555798	576000
2018	3924517	2337276	2881797	2160000

NFR 2.A.5.b is not a key source for any pollutant

The emission trends for NFR 2.A.5.b are shown in the following table and figure.

Table 4.5.2. Emission Trends (kt) for NFR 2.A.5.b Construction and demolition

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
1990	0.058	0.577	1.914
1991	0.047	0.470	1.555
1992	0.047	0.469	1.553
1993	0.045	0.451	1.493
1994	0.047	0.475	1.572
1995	0.046	0.461	1.527
1996	0.044	0.436	1.442
1997	0.045	0.447	1.480
1998	0.046	0.456	1.510
1999	0.046	0.459	1.521
2000	0.046	0.459	1.519
2001	0.046	0.464	1.537
2002	0.048	0.478	1.583
2003	0.057	0.568	1.881
2004	0.275	2.751	9.186
2005	0.075	0.745	2.467
2006	0.102	1.017	3.366
2007	0.236	2.360	7.845
2008	0.138	1.385	4.587
2009	0.174	1.736	5.779
2010	0.100	0.999	3.318
2011	0.124	1.237	4.108
2012	0.445	4.451	14.875
2013	0.247	2.469	8.241
2014	0.156	1.563	5.202
2015	0.185	1.849	6.169
2016	0.065	0.652	2.163
2017	0.105	1.052	3.497
2018	0.194	1.944	6.482

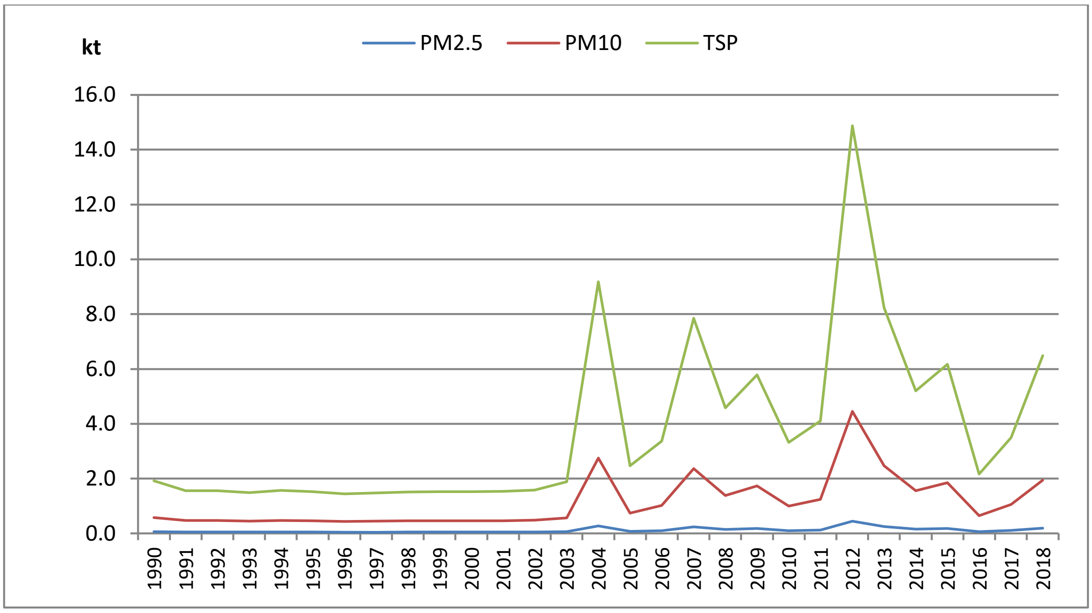


Figure 4.5.1. Emission Trends (kt) for NFR 2.A.5.b Construction and demolition

The particulate matter emissions followed the activity data trend with peaks in the years when new roads were built.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-2018.

Implementation of Review recommendations:

- The TERT recommendation RO-2A5b-2019-0001, to estimate emissions from this source was implemented.

4.6 NFR 2.B.1 Ammonia production

This activity covers emissions from ammonia manufacture process.

NFR 2.B.1 is not a key source for any pollutant.

The methodology for estimating emissions of NOx, NH_3 and CO is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 2.B Chemical industry, by multiplying the annual amount of ammonia production with default emission factors.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from ammonia productions is not included.

The activity data used for emission calculations is the annual national total ammonia production from the Statistical Yearbook provided by the N.I.S. Since 2015 the ammonia production data are confidential.

Table 4.6.1. Activity data trend (kt) for NFR 2.B.1. Ammonia production

Year	kt production
1990	2178.00
1991	1375.00
1992	1733.00
1993	1620.00
1994	1443.00
1995	1809.00
1996	1841.00
1997	951.00
1998	467.53
1999	833.93
2000	1254.70
2001	1154.73
2002	1137.46
2003	1444.66
2004	1422.14
2005	1611.00
2006	1580.00
2007	1371.00
2008	1275.00
2009	1139.00
2010	1392.00
2011	1588.00
2012	1543.00
2013	1127.00
2014	1193.00

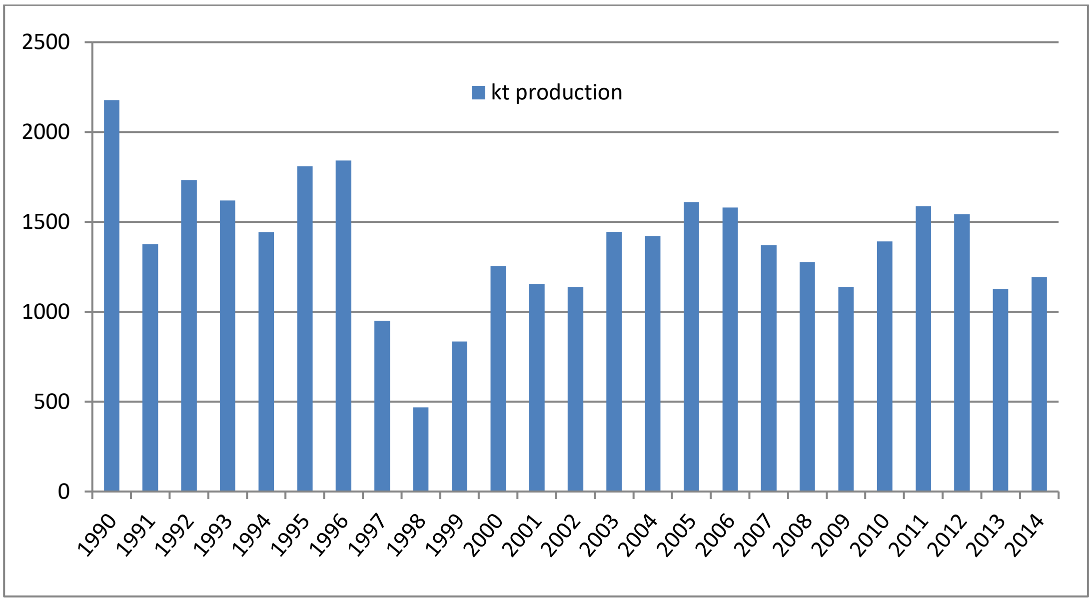


Figure 4.6.1. Activity data trend (t) for NFR 2.B.1. Ammonia production

The emission trends are shown below in the following table and figures.

Table 4.6.2 Total Emission Trends (kt) for NFR 2.B.1. Ammonia production

Year/Pollutant	NOx	NH_3	CO
1990	2.178	0.022	0.218
1991	1.375	0.014	0.138
1992	1.733	0.017	0.173
1993	1.620	0.016	0.162
1994	1.443	0.014	0.144
1995	1.809	0.018	0.181
1996	1.841	0.018	0.184
1997	0.951	0.010	0.095
1998	0.468	0.005	0.047
1999	0.834	0.008	0.083
2000	1.255	0.013	0.125
2001	1.155	0.012	0.115
2002	1.137	0.011	0.114
2003	1.445	0.014	0.144
2004	1.422	0.014	0.142
2005	1.611	0.016	0.161
2006	1.580	0.016	0.158
2007	1.371	0.014	0.137
2008	1.275	0.013	0.128
2009	1.139	0.011	0.114
2010	1.392	0.014	0.139
2011	1.588	0.016	0.159
2012	1.543	0.015	0.154
2013	1.127	0.011	0.113
2014	1.193	0.012	0.119
2015	0.607	0.006	0.061
2016	0.537	0.005	0.054
2017	0.628	0.006	0.063
2018	0.656	0.007	0.066

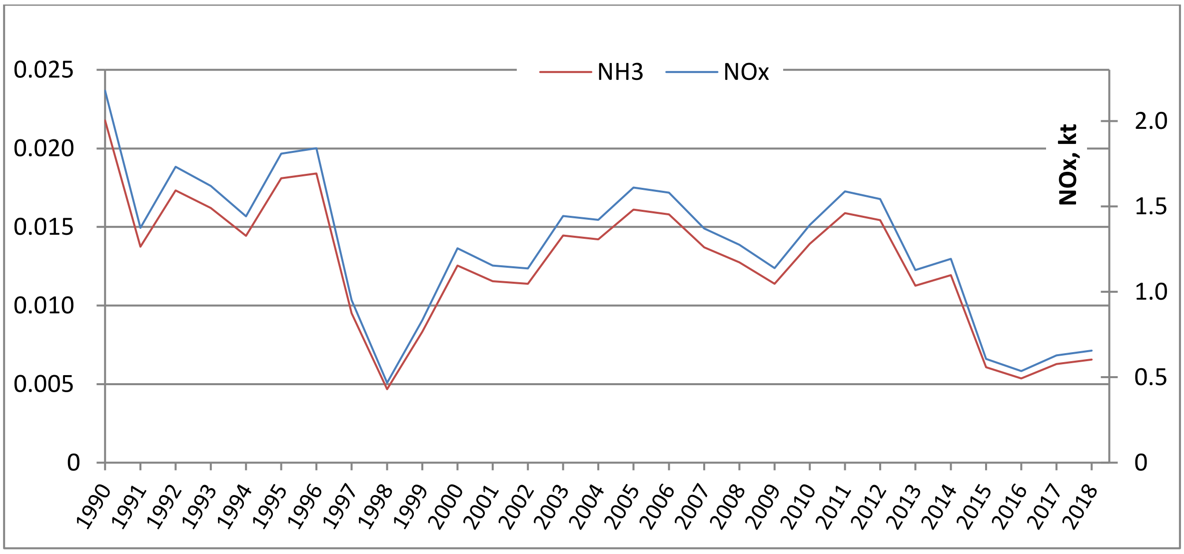


Figure 4.6.2a Total Emission Trends (kt) for NOx and NH_3 for NFR 2.B.1. Ammonia production

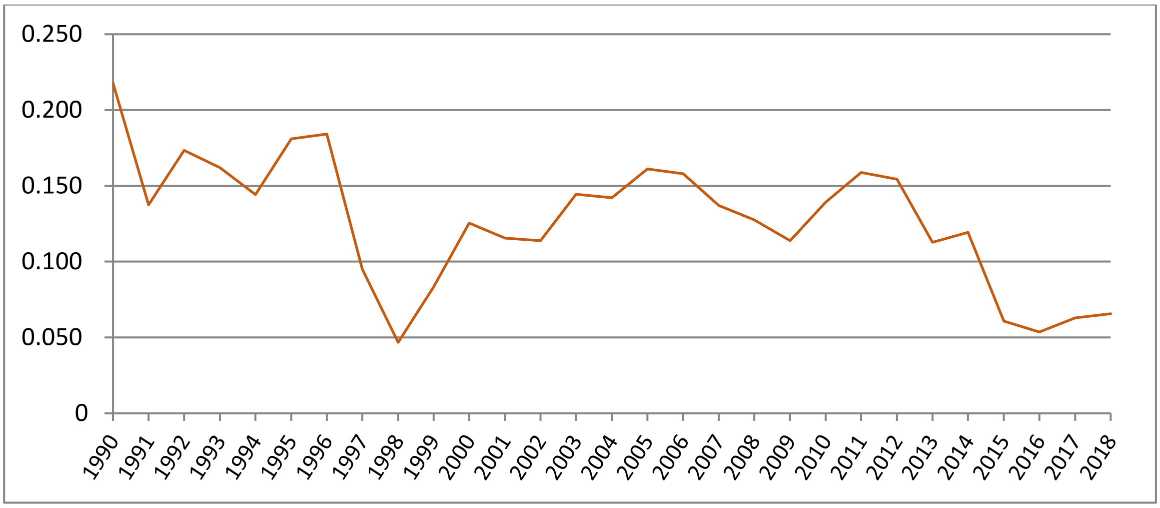


Figure 4.6.2b Total Emission Trends (kt) for CO for NFR 2.B.1. Ammonia production

The emissions of NOx, NH_3 and CO follow the activity data trends for ammonia production which varies substantially from year to year due to high variation of industry outputs.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.7 NFR 2.B.2 Nitric acid production

This activity covers emissions from nitric acid manufacture process. At industrial scale, nitric acid is produced by synthesis, from ammonia, atmospheric air and water.

The methodology for estimating emissions of NOx is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 2.B Chemical industry, using Tier 2 or Tier 3 approach. Approach Tier 2 was used for nitric acid production facilities that do not have continuous emission monitoring systems. Approach Tier 3 was used for nitric acid production facilities that have Continuous Emissions Monitoring Systems.

Emissions of nitrogen oxide were estimated by multiplying annual nitric acid production (tons 100% HNO_3 by each plant) by a default emission factor.

The nitric acid production is from the Romania's Greenhouse Gas Inventory – N.I.R., improving the consistency between data for NFR and CRF. Activity data and emissions are collected directly from nitric acid production plants for each facility and each year to use a higher Tier methodology. In Romania, in 1990 there were seven chemical plants with ten nitric acid production plants. In 2014 there were five chemical plants with six nitric acid production plants (medium and high pressure) and one old plant, without non-catalytic reduction (SNCR), erected before 1975. In 2017 there were only two chemical plants, where four nitric acid production facilities are in operation.

The nitric acid production submitted by operators were compared to the production acquired from the N.I.S. and it was discovered that the production registered by the N.I.S is constantly lower. This can be explained through the fact that certain operators do not report the production values, as they are confidential.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from nitric acid production is not included.

NFR 2.B.2 is not a key source for NOx pollutant.

The NOx emissions trends are shown below in the following table and figure.

Table 4.7.1. Emission trends (kt) for NFR 2.B.2. Nitric acid production

Year/Pollutant	NOx
1990	9.708
1991	5.667
1992	8.027
1993	7.826
1994	6.680
1995	7.726
1996	7.945
1997	4.923
1998	3.858
1999	4.141
2000	5.643
2001	5.101
2002	5.353
2003	3.470
2004	2.248
2005	2.923
2006	2.304
2007	2.492
2008	2.176
2009	2.157
2010	3.695
2011	3.280
2012	1.925
2013	0.809
2014	0.827
2015	0.488
2016	0.401
2017	0.307
2018	0.365

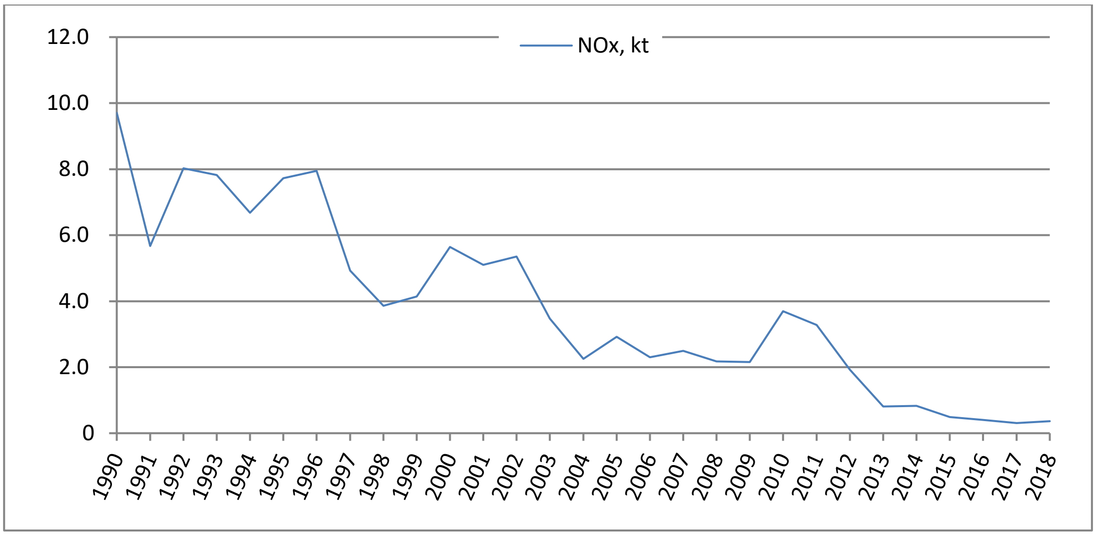


Figure 4.7.1. Emission trends (kt) for NOx for NFR 2.B.2. Nitric acid production

The emissions of NOx follow the activity data trends for nitric acid production which varied substantially from year to year due to high variation of industry outputs. In recent years, most nitric acid production facilities have been fitted with emission reduction and monitoring systems, leading to the drop of emissions.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.8 NFR 2.B.3 Adipic acid production

This activity covers emissions from adipic acid manufacture process.

The methodology for estimating emissions of NOx and CO is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 2.B Chemical industry, by multiplying the annual amount of adipic acid production with Tier 2 emission factors from the Table 3.16.

The activity data used for emission calculations is the annual national total adipic acid production from the "PRODROM" statistics, provided by the N.I.S. There is no adipic acid production since the year 2002.

NFR 2.B.3 is not key category for any pollutant.

NOx and CO emissions followed the activity data with peaks in the years 1998 and 2000.

Table 4.8.1. Activity data trend (kt adipic acid) for NFR 2.B.3 Adipic acid production

Year	kt production
1990	6.17
1991	5.25
1992	3.73

Year	kt production
1993	5.88
1994	5.78
1995	6.37
1996	6.42
1997	8.97
1998	9.31
1999	7.46
2000	9.26
2001	5.32

Table 4.8.2. Emission trends (kt) for NFR 2.B.3 Adipic acid production

Year	NOx	CO
1990	0.04935	0.00247
1991	0.04202	0.00210
1992	0.02983	0.00149
1993	0.04703	0.00235
1994	0.04621	0.00231
1995	0.05095	0.00255
1996	0.05136	0.00257
1997	0.07173	0.00359
1998	0.07450	0.00372
1999	0.05969	0.00298
2000	0.07406	0.00370
2001	0.04258	0.00213

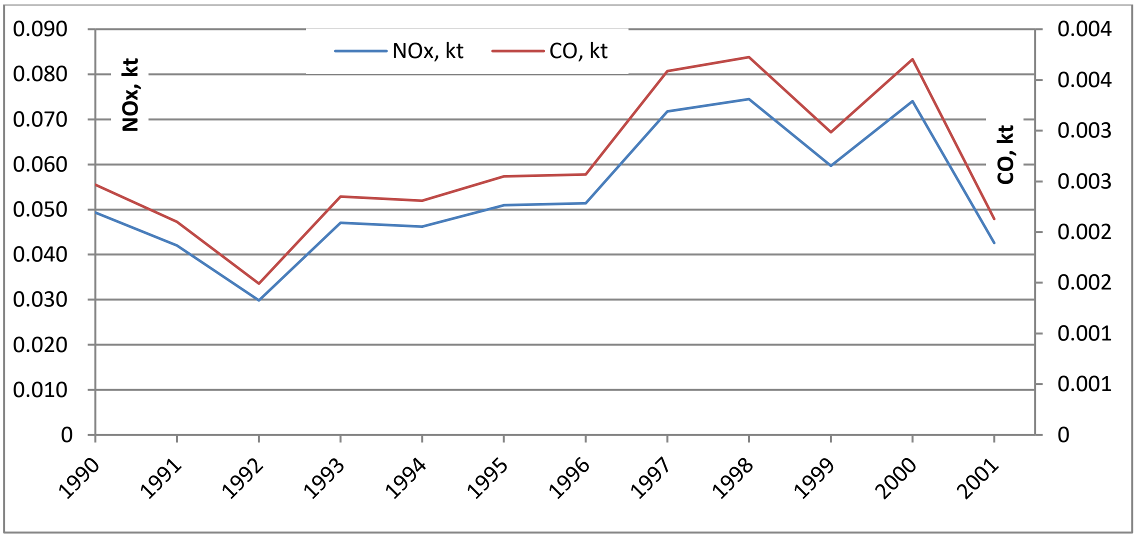


Figure 4.8.1. Emission trends (kt) for NFR 2.B.3 Adipic acid production

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.9 NFR 2.B.5 Carbide production

This activity covers emissions from carbide manufacture process.

The methodology for estimating emissions of TSP is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 2.B Chemical industry, by multiplying the annual amount of carbide production with Tier 1 emission factors from the Table 3.5.

The activity data used for emission calculations is the annual national total calcium carbide production from the Statistical Yearbook provided by the N.I.S. There is no calcium carbide production since the year 2007.

NFR 2.B.5 is not a key source for TSP pollutant.

Table 4.9.1. Activity data trend (kt Carbide) for NFR 2.B.5 Carbide production

Year	kt production
1990	129
1991	94
1992	87
1993	82
1994	67
1995	90
1996	106
1997	91
1998	73
1999	54
2000	55
2001	53
2002	53
2003	45
2004	63
2005	34
2006	20

The emission trends are shown below in the following figure.

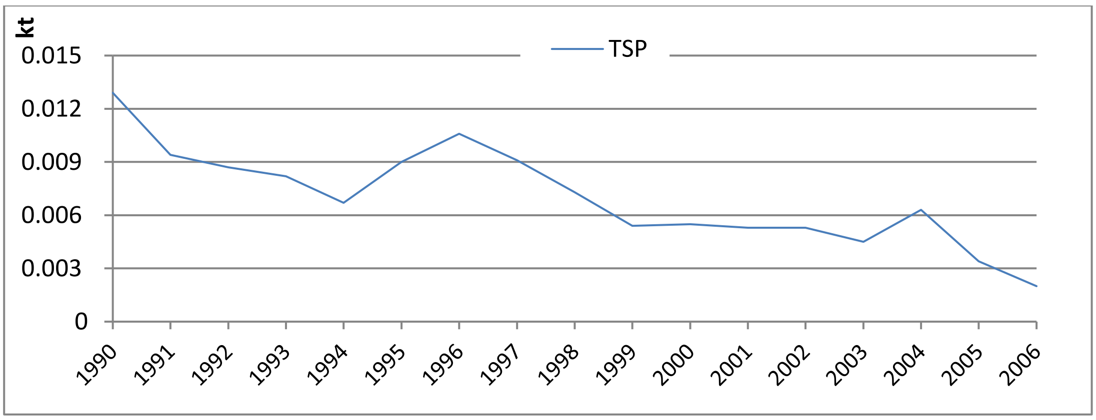


Figure 4.9.1. Total Emission trends (kt) for TSP for NFR 2.B.5 Carbide production

TSP emissions followed the activity data trend for carbide production, with a peak in 1996.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.10 NFR 2.B.7 Soda ash production

This activity covers emissions from soda ash manufacture process.

NFR 2.B.7 is not a key source for any pollutant.

The methodology for estimating emissions of NH_3, TSP and CO is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 2.B Chemical industry, by multiplying the annual amount of soda ash production with default emission factors.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions for soda ash production is not included.

The activity data used for emission calculations is the annual national total soda ash production from the Statistical Yearbook provided by the National Institute of Statistics These data are confidential since the year 2007.

The emission trends are shown below in the following table and figure.

Table 4.10.1. Emission trends (kt) for NFR 2.B.7 Soda Ash production

Year/Pollutant	NH_3	TSP	CO
1990	0.5688	0.0632	5.6880
1991	0.4239	0.0471	4.2390
1992	0.4068	0.0452	4.0680
1993	0.3339	0.0371	3.3390
1994	0.4041	0.0449	4.0410
1995	0.4536	0.0504	4.5360
1996	0.4824	0.0536	4.8240
1997	0.4923	0.0547	4.9230
1998	0.4155	0.0462	4.1548
1999	0.3733	0.0415	3.7329
2000	0.3519	0.0391	3.5195
2001	0.4029	0.0448	4.0292
2002	0.4089	0.0454	4.0886
2003	0.3653	0.0406	3.6534
2004	0.3584	0.0398	3.5836
2005	0.3114	0.0346	3.1140
2006	0.4077	0.0453	4.0770
2007	0.4068	0.0452	4.0680
2008	0.4446	0.0494	4.4460
2009	0.3681	0.0409	3.6810
2010	0.3393	0.0377	3.3930

Year/Pollutant	NH_3	TSP	CO
2011	0.3753	0.0417	3.7530
2012	0.3852	0.0428	3.8520
2013	0.3825	0.0425	3.8250
2014	0.3771	0.0419	3.7710
2015	0.4545	0.0505	4.5450
2016	0.4644	0.0516	4.6440
2017	0.4860	0.0540	4.8600
2018	0.4824	0.0536	4.8240

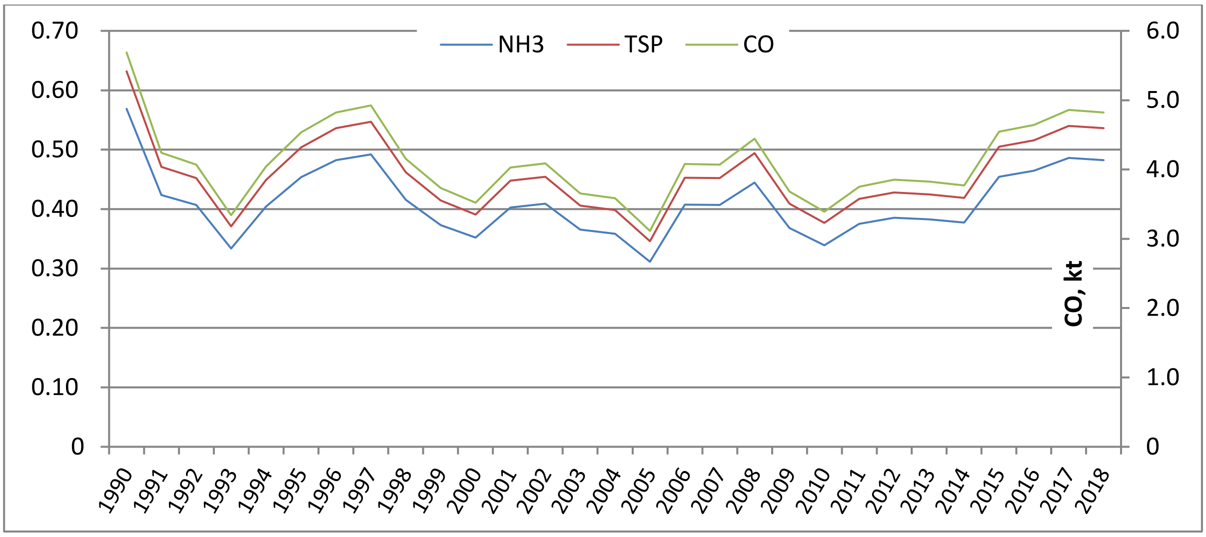


Figure 4.10.1. Emission trends (kt) for NFR 2.B.7 Soda Ash production

The emissions of NH3 and TSP follow the activity data trends for soda ash production which varied substantially from year to year due to high variation of industry outputs.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.11 NFR 2.B.10.a Other chemical industry

This source includes a large collection of different chemical production processes, listed below with corresponding SNAP codes:

- 040407 NPK fertilisers;
- 040408 Urea (not available between 1990-1993);
- 040409 Carbon black (production stopping in year 2003);
- 040413 Chlorine (production using mercury cell technology stopping in year 2014);
- 040501 Ethylene (production stopping in year 2009);
- 040502 Propylene;
- 040506 Polyethylene Low Density (production starting in year 2001);

- 040507 Polyethylene High Density (production starting in year 2001);
- 040508 Polyvinylchloride
- 040509 Polypropylene (production starting in year 2003);
- 040511 Polystyrene (production starting in year 2001);
- 040514 Styrene-butadiene rubber (SBR) (production stopping in year 2014);
- 040516 Ethylene oxide (produced between 2003-2007).

NFR 2.B.10.a is key source category for NMVOC and TSP pollutants.

The methodology for estimating emissions from chemical production applies the general equation:

$$\mathrm{Epollutant} = \sum_{\mathrm{technologies}} \mathrm{ARproduction, technology} \times \mathrm{EFtechnology, pollutant}$$

where:

- ARproduction, technology = the production rate within the source category, using this specific technology
- EFtechnology, pollutant = the emission factor for this technology and this pollutant

The activity data used for the emission calculations are the total productions of each product. These data are provided by N.I.S., with the exception of chlorine production provided by economic operators. These data are confidential.

Following the Emission Inventory reviews in 2018 and 2019, Hg emissions from chlorine production were estimated (RO-2B10a-2018-0001). Chlorine production was taken from economic operators and Hg emissions were estimated for the 1990-2013. Mercury emissions mainly come from the manufacture of chlorine using mercury cell technology. Chlorine production using this process stopped during 2013. Starting with 2014 in Romania, chlorine is produced only by membrane cell electrolysis. No emission factors are available for this in the 2019 EMEP/EEA Guidebook and the notation key NO it use for Hg emissions.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from other chemical industry production is not included.

The emission trends of NMVOC, $PM_{2.5}$, PM_{10}, TSP and Hg are shown below in the following table. The other pollutants as NOx, SOx, NH_3 and CO are estimated only for the period when the chemicals that generated these pollutants were produced.

Table 4.11.1. Emission Trends for NFR 2.B.10.a Other chemical industry

Year/Pollutant	NMVOC (kt)	$PM_{2.5}$ (kt)	PM_{10} (kt)	TSP (kt)	Hg (t)
1990	14.772	0.015	0.031	87.258	0.652
1991	9.191	0.011	0.013	54.514	0.478
1992	11.519	0.007	0.016	69.932	0.177

Year/Pollutant	NMVOC (kt)	$PM_{2.5}$ (kt)	PM_{10} (kt)	TSP (kt)	Hg (t)
1993	10.841	0.007	0.017	65.883	0.168
1994	9.624	0.065	0.098	58.291	0.199
1995	12.004	0.054	0.083	72.572	0.214
1996	12.100	0.072	0.106	73.348	0.145
1997	7.151	0.074	0.111	42.656	NO
1998	3.917	0.096	0.138	22.723	NO
1999	6.381	0.054	0.084	38.273	NO
2000	8.740	0.059	0.090	52.819	0.682
2001	8.039	0.072	0.108	47.137	0.679
2002	7.893	0.074	0.114	46.147	0.611
2003	11.494	0.097	0.147	67.696	0.868
2004	10.606	0.199	0.287	61.608	0.968
2005	14.301	0.264	0.374	84.721	0.967
2006	10.009	0.147	0.217	57.540	1.007
2007	10.304	0.185	0.271	58.670	0.861
2008	15.334	0.201	0.288	89.886	0.786
2009	8.423	0.084	0.115	48.476	0.388
2010	10.143	0.028	0.040	59.678	0.361
2011	11.045	0.090	0.123	64.697	0.600
2012	8.769	0.141	0.189	50.825	0.124
2013	6.580	0.105	0.141	37.400	0.001
2014	6.919	0.056	0.076	39.485	NO
2015	4.265	0.058	0.079	23.177	NO
2016	3.604	0.022	0.031	18.674	NO
2017	4.056	0.054	0.075	21.528	NO
2018	4.749	0.060	0.082	25.278	NO

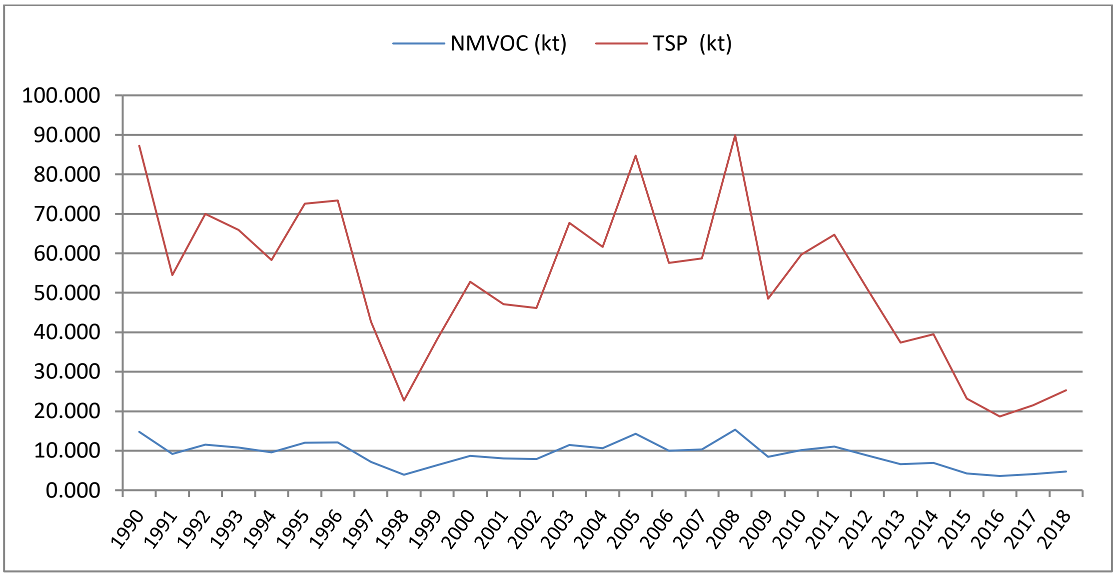


Figure 4.11.1 Emission Trends (kt) of NMVOC, TSP for NFR 2.B.10.a Other chemical industry

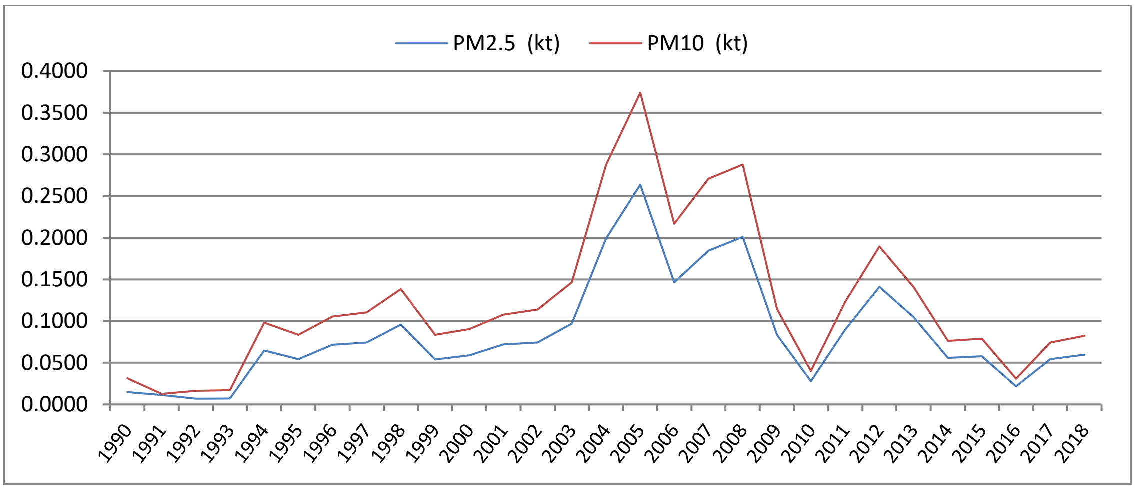


Figure 4.11.2 Emission Trends (kt) of PM2.5 and PM10 for NFR 2.B.10.a Other chemical industry

The emissions of NMVOC, $PM_{2.5}$, PM_{10} and TSP from those activities follow the activity data trends of other chemical industries which varied substantially from year to year due to high variation of industry outputs.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- The recalculation was made for the period 1995-2004, for the NH_3, $PM_{2.5}$, PM_{10}, TSP and BC emissions, due to change of activity data (urea production taken into account).

Implementation of Review recommendations:

- The TERT recommendation (RO-2B10a-2018-0001), regarding Hg emissions from chlorine production was implemented.

4.12 NFR 2.C.1 Iron and steel production

This source category covers the following activities with corresponding SNAP codes:

- 040202 Blast furnace charging;
- 040205 Open hearth furnace steel plant;
- 040206 Basic oxygen furnace steel plant;
- 040207 Electric furnace steel plant;
- 040208 Rolling mills;
- 040209 Sinter and pelletizing plants.

In this sector are reported only the process emissions in iron and steel production. The emissions from combustion activities within the iron and steel industry are reported under NFR 1.A.2.a.

This sector is a key category for emissions of Pb, Cd, Hg, As, Cr, Ni, Zn, PCDD/F, PAHs and PCBs. The other estimated pollutants are NOx, NMVOC, SOx, $PM_{2.5}$, $PM_{10,}$ TSP, BC, CO, Cu, Se and HCB.

The methodology for estimating emissions from iron and steel production applies the general equation:

$$\text{Epollutant} = \sum_{\text{technologies}} \text{ARproduction, technology x EFtechnology, pollutant}$$

where:

- ARproduction, technology = the production rate within the source category, using this specific technology
- EFtechnology, pollutant = the emission factor for this technology and this pollutant

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from iron and steel production is not included.

The activity data used for emission calculations are represented by the total production of each product from the Statistical Yearbook provided by the National Institute of Statistics. These data are confidential since the 2007.

For this submission, the steel produced in the open hearth furnace plant was taken into account for period 1990-1999. The manufacture of steel by this technology stopped in 2000. This improvement of the inventory led to an increase of activity data and emissions values for NFR 2.C.1., for this period.

The emission trends for the key pollutants are shown below in the following table and figures.

Table 4.12.1. Emission Trends for NFR 2.C.1. Iron and steel production

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Ni (t)	Zn (t)	PCDD/F (g I-TEQ)	PAHs (t)	PCBs (kg)
1990	696.218	2.560	0.605	65.798	17.377	24.388	47.818	89.011	20.031	35.878
1991	434.054	1.716	0.453	40.558	12.202	15.467	33.804	65.690	14.444	26.542
1992	301.439	1.255	0.351	27.952	8.802	10.913	25.039	50.001	10.224	19.476
1993	321.650	1.294	0.349	29.977	9.199	11.518	25.642	50.322	10.390	19.688
1994	340.045	1.353	0.365	31.708	10.101	12.098	27.334	53.280	11.250	21.240
1995	333.604	1.375	0.403	30.815	11.881	11.853	30.296	59.858	13.247	25.070
1996	321.158	1.291	0.369	29.778	11.232	11.327	28.313	55.286	12.559	23.475
1997	325.161	1.317	0.393	30.008	12.845	11.375	30.791	60.179	14.018	26.341
1998	245.003	1.072	0.366	22.158	12.532	8.579	28.420	56.899	13.775	26.083
1999	127.691	0.661	0.262	11.105	8.319	4.645	19.039	39.914	9.181	17.988
2000	33.328	0.495	0.295	1.482	8.128	1.726	18.702	43.434	9.688	19.765
2001	35.258	0.518	0.310	1.579	8.665	1.802	19.771	45.801	10.228	20.890
2002	39.804	0.521	0.325	1.916	10.554	1.768	22.188	49.991	12.112	24.169
2003	41.086	0.557	0.343	1.937	10.655	1.908	22.951	52.132	12.559	24.997
2004	43.617	0.618	0.375	2.001	10.994	2.135	24.421	56.049	13.152	26.348

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Ni (t)	Zn (t)	PCDD/F (g I-TEQ)	PAHs (t)	PCBs (kg)
2005	44.623	0.681	0.403	1.943	10.650	2.391	25.088	58.672	13.024	26.510
2006	44.342	0.697	0.408	1.889	10.340	2.460	24.969	58.842	12.699	26.094
2007	44.352	0.699	0.409	1.885	10.318	2.469	24.978	58.909	12.650	26.047
2008	35.420	0.583	0.337	1.453	7.940	2.075	19.996	47.713	9.753	20.445
2009	19.422	0.328	0.188	0.781	4.260	1.170	10.980	26.371	5.263	11.124
2010	25.506	0.495	0.272	0.889	4.811	1.808	14.555	36.374	6.265	13.943
2011	25.873	0.528	0.286	0.848	4.572	1.940	14.812	37.585	6.075	13.853
2012	23.240	0.470	0.255	0.771	4.161	1.724	13.298	33.638	5.526	12.515
2013	21.416	0.373	0.212	0.836	4.552	1.341	12.127	29.401	5.503	11.962
2014	22.151	0.397	0.223	0.840	4.571	1.434	12.569	30.716	5.671	12.347
2015	23.996	0.402	0.231	0.970	5.293	1.436	13.560	32.517	6.472	13.713
2016	23.619	0.396	0.227	0.954	5.205	1.414	13.346	32.017	6.405	13.531
2017	23.805	0.436	0.244	0.884	4.802	1.579	13.531	33.254	6.163	13.335
2018	24.584	0.430	0.243	0.957	5.213	1.544	13.930	33.780	6.537	13.950

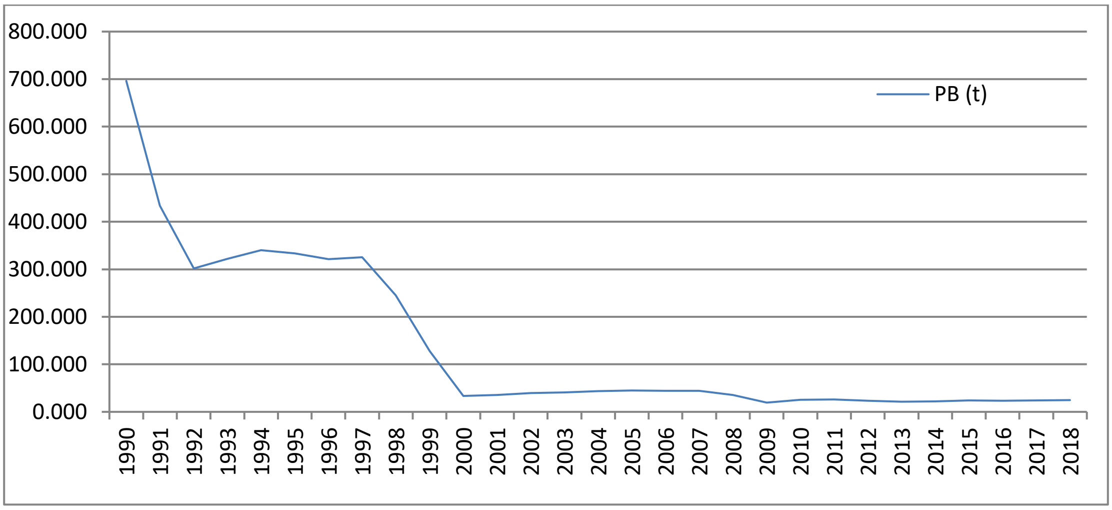


Figure 4.12.1.a Emission Trends of Pb (t) for NFR 2.C.1. Iron and steel production

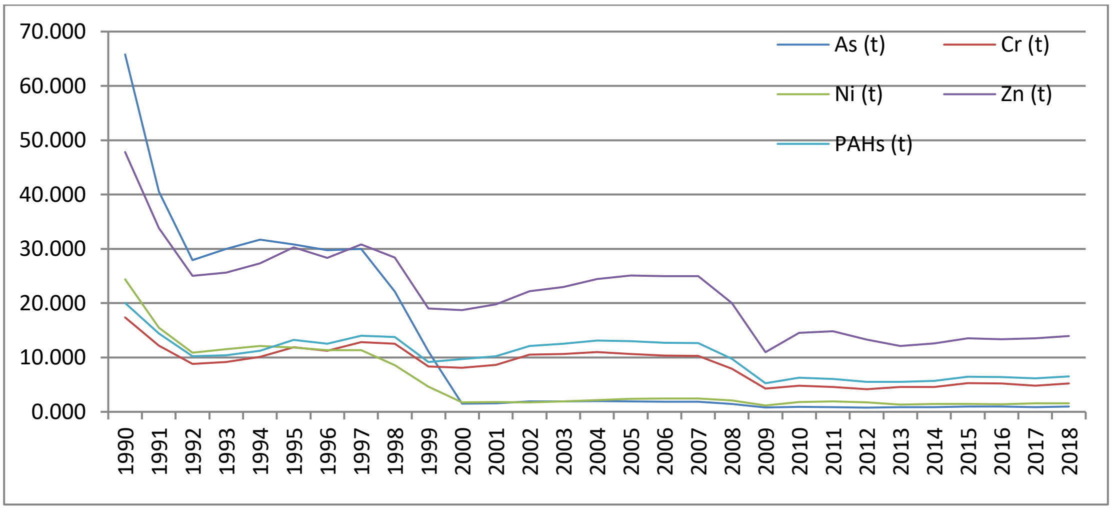


Figure 4.12.1.b Emission Trends of As, Cr, Ni, Zn and PAHs (t) for NFR 2.C.1. Iron and steel production

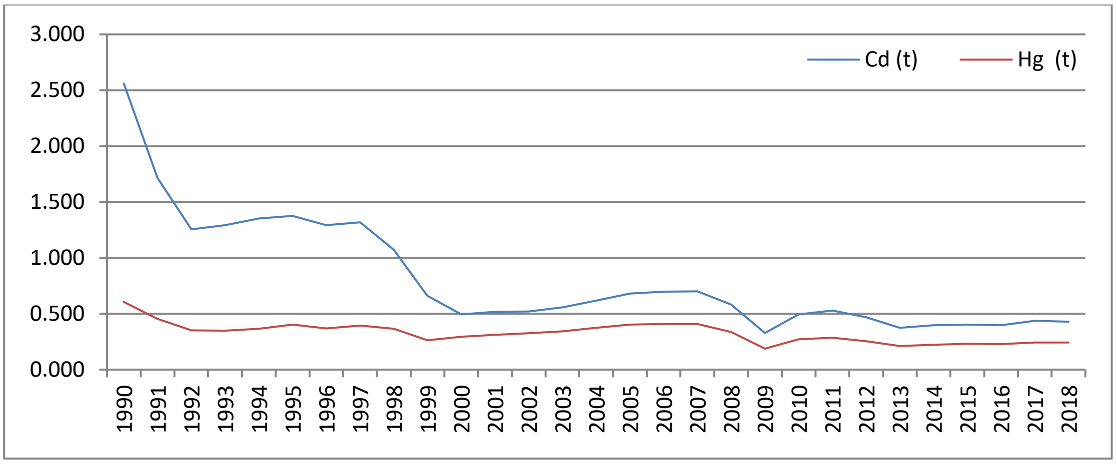


Figure 4.12.1.c Emission Trends of Cd, Hg (t) for NFR 2.C.1. Iron and steel production

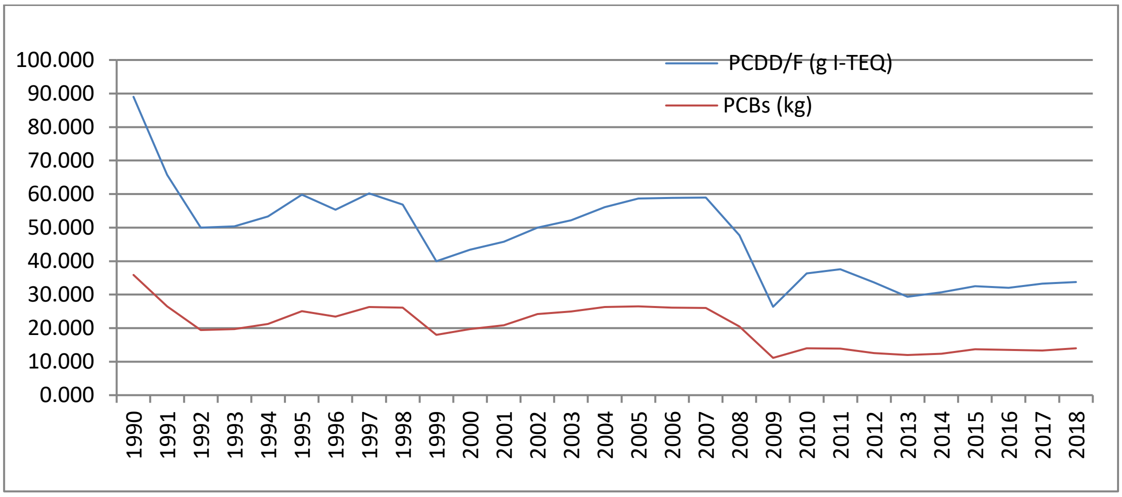


Figure 4.12.1.d Emission Trends of PCDD/F (g I-TEQ) and PCBs (kg) for NFR 2.C.1. Iron and steel production

The emissions from iron and steel production follow the activity data trends which varied substantially from year to year due to high variation of industry outputs. There has been a sudden decrease in emissions for year 2009, according to the decrease in activity data.
The high emissions of Pb, As and Ni from 1990-1999 are the result of the steel produced in the open hearth furnace steel plant. The manufacture of steel by this technology stopped in 2000.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- Change of activity data (new sources taken into account) and emissions for time series 1995-1999, as detailed in the text above. The change in emissions due to recalculation for the key pollutants is presented in the following table:

Table 4.12.2. Differences in emissions between 2020 and 2019 submissions for NFR 2.C.1. Iron and steel production

Year	Pb (t)	Cd (t)	As (t)	Cr (t)	Ni (t)	Zn (t)	PCDD/F (g I-TEQ)	PAHs (t)
Submission 2019								
1995	43.204	0.601	1.775	9.654	2.173	22.455	59.793	13.237
1996	40.058	0.542	1.668	9.077	1.957	20.723	55.223	12.549
1997	44.661	0.569	1.958	10.694	2.025	23.217	60.116	14.009
1998	43.471	0.534	2.005	10.987	1.862	22.979	56.854	13.768
1999	30.464	0.402	1.382	7.574	1.404	16.414	39.892	9.178
Submission 2020								
1995	333.604	1.375	30.815	11.881	11.853	30.296	59.858	13.247
1996	321.158	1.291	29.778	11.232	11.327	28.313	55.286	12.559
1997	325.161	1.317	30.008	12.845	11.375	30.791	60.179	14.018
1998	245.003	1.072	22.158	12.532	8.579	28.420	56.899	13.775
1999	127.691	0.661	11.105	8.319	4.645	19.039	39.914	9.181
Differences between 2020 and 2019								
1995	290.400	0.774	29.040	2.226	9.680	7.841	0.065	0.010
1996	281.100	0.750	28.110	2.155	9.370	7.590	0.063	0.009
1997	280.500	0.748	28.050	2.151	9.350	7.574	0.063	0.009
1998	201.532	0.537	20.153	1.545	6.718	5.441	0.045	0.007
1999	97.227	0.259	9.723	0.745	3.241	2.625	0.022	0.003

4.13 NFR 2.C.2 Ferroalloys production

This chapter only covers the process emissions of particulate matter from ferroalloys production. The combustion-related emissions are addressed in chapter 1.A.2.b.

The methodology for estimating emissions of particulate matter is based on the use of the 2019 EMEP/EEA Guidebook, Chapter 2.C.2 Ferroalloys production, by multiplying the annual amount of ferroalloys production with default emission factors.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from ferroalloys production is not included.

The activity data are represented by the total production of ferroalloys, from the "PRODROM" statistics, provided by the National Institute of Statistics. These data are confidential. There is no ferroalloys production since year 2013.

Emissions from the production of ferroalloys are not significant. The emission trends are shown below in the following table and figure.

Table 4.13.1. Total Emission Trends for $PM_{2.5}$, PM_{10} and TSP (kt) for NFR 2.C.2 Ferroalloys production

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
1990	0.0852	0.1207	0.1420

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
1991	0.0654	0.0927	0.1090
1992	0.0518	0.0734	0.0864
1993	0.0395	0.0560	0.0659
1994	0.0593	0.0840	0.0988
1995	0.0720	0.1019	0.1199
1996	0.0793	0.1124	0.1322
1997	0.0508	0.0719	0.0846
1998	0.0385	0.0546	0.0642
1999	0.0003	0.0005	0.0006
2000	0.0436	0.0617	0.0726
2001	0.0469	0.0664	0.0781
2002	0.0508	0.0720	0.0847
2003	0.0853	0.1208	0.1421
2004	0.1170	0.1657	0.1949
2005	0.0717	0.1016	0.1196
2006	0.0338	0.0480	0.0564
2007	0.0161	0.0228	0.0269
2008	0.0085	0.0120	0.0142
2009	0.0092	0.0131	0.0154
2010	0.0195	0.0277	0.0325
2011	0.0141	0.0200	0.0236
2012	0.0082	0.0116	0.0137

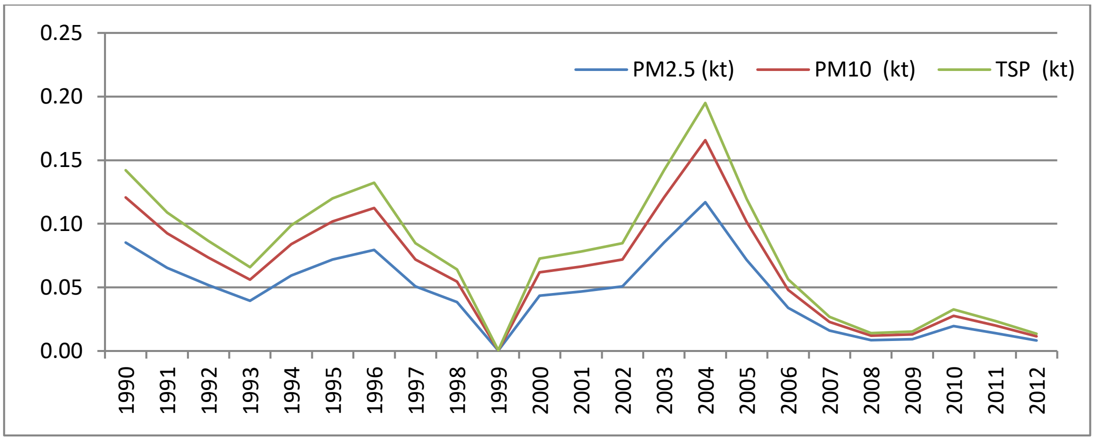


Figure 4.13.1. Total Emission Trends for NFR 2.C.2 Ferroalloys production for $PM_{2.5}$, PM_{10}, TSP (kt)

The emissions from ferroalloys production follow the activity data trends which varied substantially from year to year due to high variation of industry outputs. There has been a sudden decrease in emissions for year 1999 and a peak in year 2004, according to activity data.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- There were not recalculations since the previous submission.

4.14 NFR 2.C.3 Aluminum production

The methodology for estimating emissions from aluminum production applies the general equation:

$$\text{Epollutant} = \sum_{\text{technologies}} \text{ARproduction, technology x EFtechnology, pollutant}$$

where:

- ARproduction,technology = the production rate within the source category, using this specific technology;
- EFtechnology,pollutant = the emission factor for this technology and this pollutant.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from aluminum production is not included.

For this category, emissions are derived from primary (SNAP 040301) and secondary aluminium production (SNAP 030310).

Primary aluminium is produced by the electrolysis process using the pre-baked anodes technology. Emissions are estimated based on activity data provided by N.I.S., using emission factors from the 2019 EMEP/EEA Guidebook.

Following the TERT recommendation (RO-2C3-2018-0001), in this submission, emissions from secondary aluminium production were estimated. Secondary aluminium has been produced since 2010, in Romania. HCB emissions result from the use of hexachloroethane in secondary aluminum production. The use of hexachloroethane for degassing purposes in secondary aluminum refining operations was banned in 2009, so emissions thereafter are considered zero. Emissions are estimated based on activity data and process information provided by the operator.

All these data are confidential.

The emission trends are shown below in the following table.

Table 4.14.1. Emission Trends for CO (kt) for NFR 2.C.3. Aluminum production

Year/Pollutant	CO (kt)
1990	20.128
1991	18.476
1992	12.863
1993	13.408
1994	14.184
1995	16.872

Year/Pollutant	CO (kt)
1996	16.828
1997	19.644
1998	20.965
1999	20.889
2000	20.793
2001	21.578
2002	22.391
2003	23.766
2004	25.831
2005	28.620
2006	32.023
2007	31.509
2008	37.494
2009	24.172
2010	24.902
2011	26.880
2012	24.304
2013	23.703
2014	23.495
2015	24.762
2016	24.909
2017	24.811
2018	25.335

The emissions of CO follow the activity data trends for aluminium production which varied substantially from year to year with a peak in 2008.

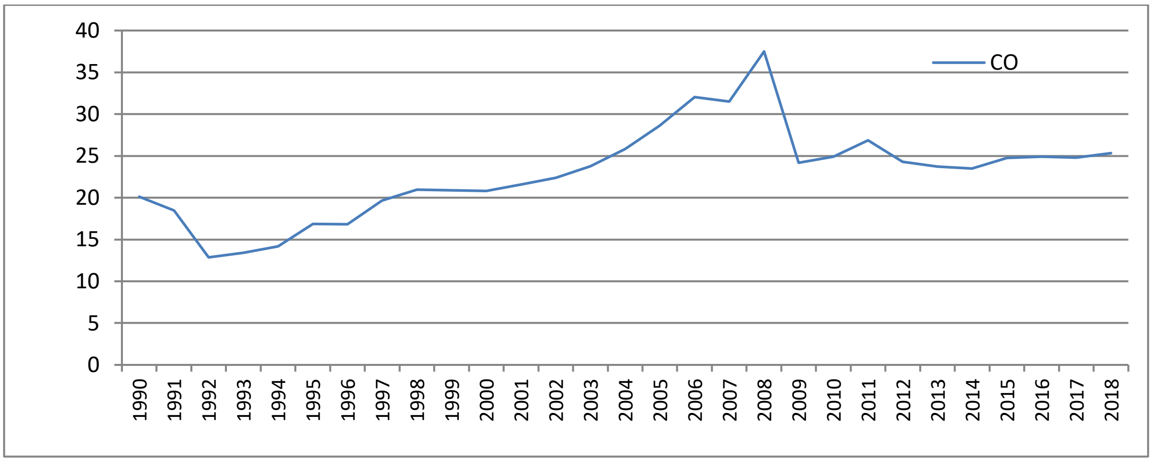


Figure 4.14.1. Emission Trends for CO (kt) for NFR 2.C.3. Aluminum production

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- For the 2010-2017 time series, the recalculation of emissions due to the change of activity data (secondary aluminum production taken into account).

Implementation of Review recommendations:

- RO-2C3-2018-0001, regarding HCB and PCDD/F emissions from secondary aluminium production, was implemented.

4.15 NFR 2.C.5. Lead production

For this sub-category, emissions are derived from primary and secondary lead production.

The most important process emissions are sulphur oxides (SOx), nitrogen oxides (NOx), heavy metals (particularly lead), dust and PCDD.

The methodology for estimating emissions from lead production applies the general equation:

$$\text{Epollutant} = \sum_{\text{technologies}} \text{ARproduction, technology x EFtechnology, pollutant}$$

where:

- ARproduction,technology = the production rate within the source category, using this specific technology;
- EFtechnology,pollutant = the emission factor for this technology and this pollutant.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from lead production is not included.

The activity data used for emission calculations are represented by primary and secondary lead productions from the "PRODROM" statistics, provided by the N.I.S.. These data are confidential.

The emission trends are shown below in the following table and figure.

Table 4.15.1 Total Emission Trends for NFR 2.C.5 Lead production

Year/Pollutant	Pb (t)	Zn (t)
1990	0.053	0.0078
1991	0.041	0.0060
1992	0.037	0.0054
1993	0.049	0.0072
1994	0.068	0.0094
1995	0.079	0.0111
1996	0.063	0.0086
1997	0.058	0.0079
1998	0.067	0.0092
1999	0.060	0.0083
2000	0.106	0.0153
2001	0.098	0.0137
2002	0.101	0.0140
2003	0.115	0.0169
2004	0.101	0.0147
2005	0.120	0.0167

Year/Pollutant	Pb (t)	Zn (t)
2006	0.093	0.0126
2007	0.118	0.0163
2008	0.117	0.0161
2009	0.020	0.0024
2010	0.025	0.0028
2011	0.016	0.0020
2012	0.002	0.0002
2013	0.004	0.0007
2014	0.005	0.0008
2015	0.005	0.0008
2016	0.016	0.0008
2017	0.019	0.0009
2018	0.016	0.0007

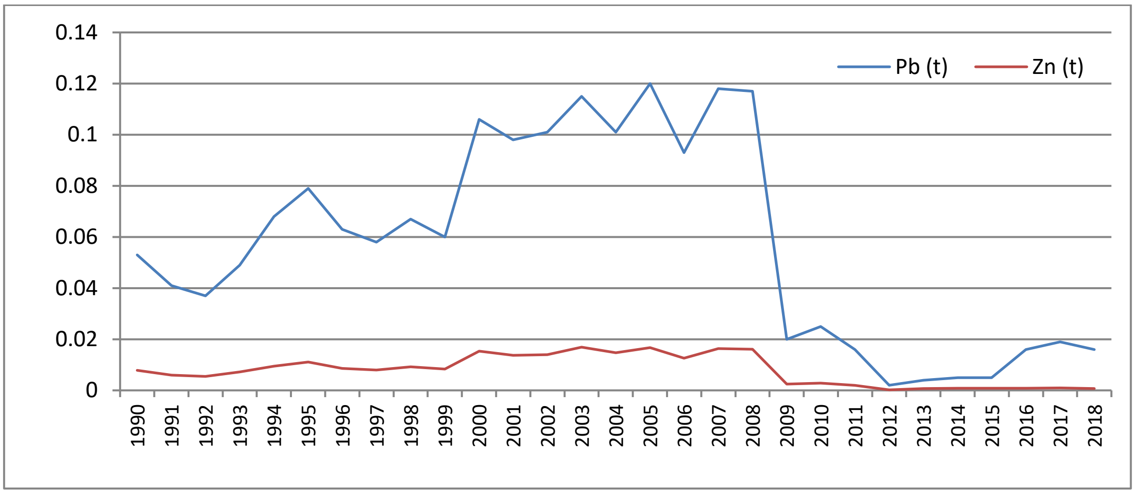


Figure 4.15.1 Total Emission Trends for NFR 2.C.5 Lead production

The emissions of Pb and Zn from those activities follow the activity data trends, which varied substantially from year to year due to high variation of industry outputs and with considerable decrease after 2008.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

4.16 NFR 2.C.6 Zinc production

The main emissions to air from zinc production are sulphur oxides (SO_x), metals and their compounds and dust.

The methodology for estimating emissions from zinc production applies the general equation:

Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant;
- ARproduction is the activity rate for the zinc production;
- EFpollutant is the emission factor for this pollutant.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from zinc production is not included.

The activity data used for emission calculations is the annual national total zinc production, from the “PRODROM” statistics, provided by the N.I.S. These data are confidential.

The emission trends are shown below in the following table and figure.

Table 4.16.1 Total Emission Trends (t) for NFR 2.C.6 Zinc production

Year/Pollutant	Pb (t)	Zn (t)
1990	0.00220	0.0550
1991	0.00180	0.0450
1992	0.00240	0.0600
1993	0.00280	0.0700
1994	0.00380	0.0950
1995	0.00560	0.1400
1996	0.00560	0.1400
1997	0.00600	0.1500
1998	0.00580	0.1450
1999	0.00580	0.1450
2000	0.01040	0.2600
2001	0.00957	0.2393
2002	0.00761	0.1901
2003	0.01020	0.2550
2004	0.01055	0.2637
2005	0.01136	0.2840
2006	0.00874	0.2185
2007	0.01169	0.2922
2008	0.01240	0.3099
2009	0.00008	0.0019
2010	0.00005	0.0011
2011	0.00005	0.0013
2012	0.00007	0.0016
2013	0.00004	0.0011
2014	0.00002	0.0004
2015	0.00004	0.0010
2016	0.00006	0.0016
2017	0.00017	0.0042
2018	0.00012	0.0029

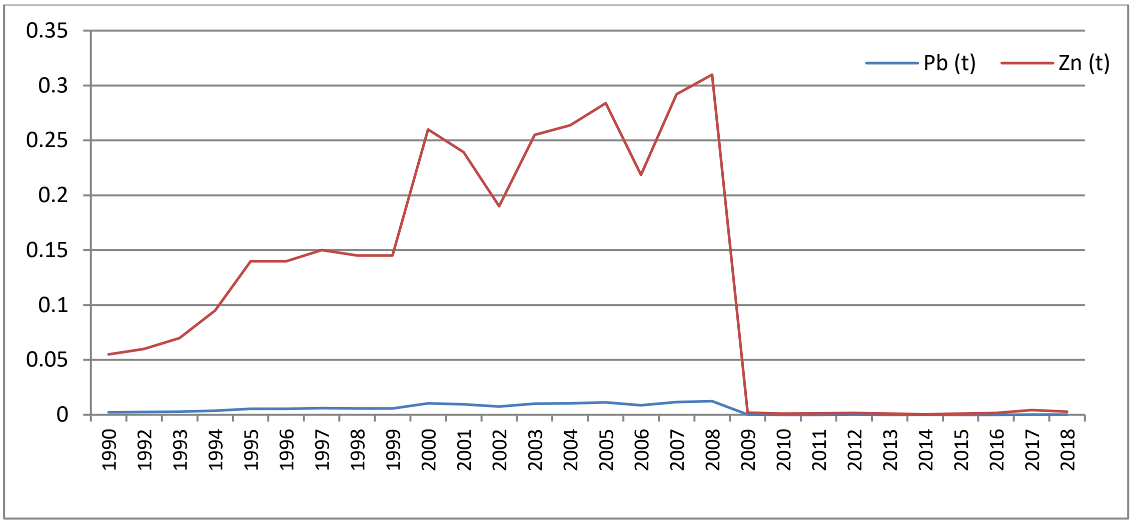


Figure 4.16.1 Total Emission Trends (t) for NFR 2.C.6 Zinc production

The 2016 emissions of Pb and Zn from zinc production decreased by more than 99% compared to the emissions in the year 2000, after reaching a peak level in 2008. This decrease is due to a high and sudden decrease in activity data starting with year 2009.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

4.17 NFR 2.C.7.a Copper production

The main emissions to air from copper production are particulate matter (PM), sulphur oxides (SO_x), volatile organic compounds (NMVOC) and trace elements.

The activity data is represented by total copper production, from the "PRODROM" statistics, provided by the N.I.S.

Due to the different confidentiality policy along the time series, the presentation of emission factors used to estimate emissions from copper production is not included.

There is no copper production since 2009.

Table 4.17.1 Emission Trends (t) for NFR 2.C.7a Copper production

Year/Pollutant	Pb (t)	Cu (t)	Cd (t)
1990	1.007	1.696	0.583
1991	1.026	1.728	0.594
1992	1.045	1.76	0.605
1993	0.969	1.632	0.561
1994	0.969	1.632	0.561
1995	0.855	1.44	0.495
1996	1.178	1.984	0.682
1997	0.912	1.536	0.528

Year/Pollutant	Pb (t)	Cu (t)	Cd (t)
1998	0.755	1.271	0.437
1999	0.855	1.44	0.495
2000	0.603	1.015	0.349
2001	0.506	0.852	0.293
2002	0.386	0.65	0.224
2003	0.403	0.679	0.233
2004	0.467	0.787	0.270
2005	0.394	0.664	0.228
2006	0.41	0.691	0.237
2007	0.347	0.585	0.201
2008	0.253	0.426	0.147

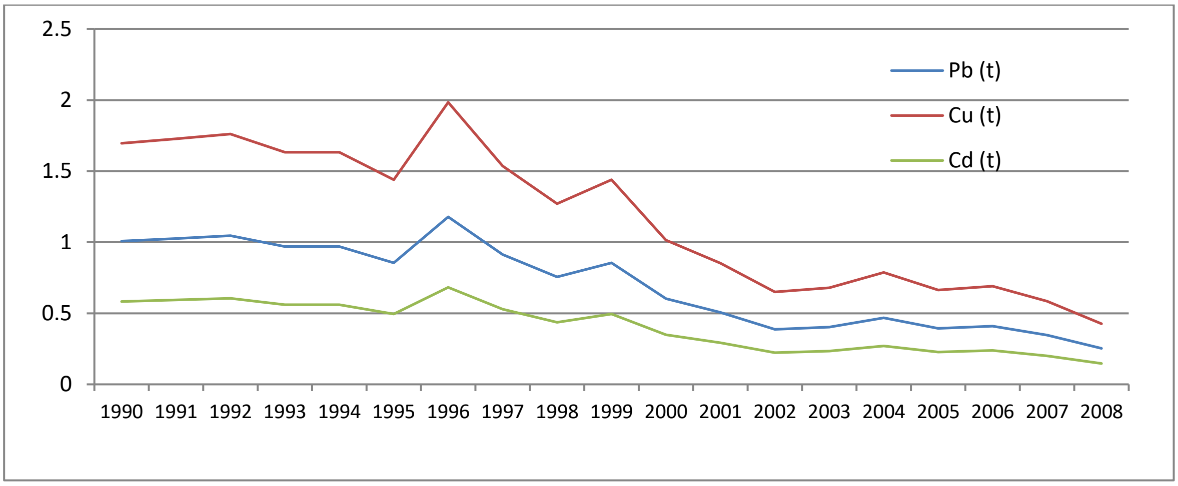


Figure 4.17.1 Total Emission Trends (t) for NFR 2.C.7a Copper production

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

4.18 NFR 2.D.3.a Domestic solvent use including fungicides

According to the 2019 EMEP/EEA Guidebook,"*NMVOCs are used in a large number of products sold for use by the public"* . The main categories in the domestic use of solvents are:

- Cosmetics and toiletries: products for the maintenance or improvement of personal appearance, health or hygiene;
- Household products : products used to maintain or improve of households durables;
- Construction/DIY : products used for improving the appearance or the structure of buildings;
- Car care products: products used for improving the appearance of vehicles,to maintain vehicles or winter products such as antifreeze;

- Pesticides: such as garden fungicides,herbicides and insecticides,and household insecticide sprays may be considered as consumer products.

The difficult issue in this sector is to collect activity data, because it needs data on consumption activity for a wide range of products that are currently not available directly in statistics.

For NFR 2.D.3.a activity data is still represented by the total population of Romania for time series 1990-2017 and is provided by N.I.S.. For this time series used the default emission factor of 2019 EMEP/EEA Guidebook: 1.2 kg/capita due to the lack of consumption activity data.

Table 4.18.1. Activity data trends (caput) for NFR 2.D.3.a Domestic solvent use including fungicides

Year/Activity data	caput
1990	23192274
1991	23143860
1992	23118745
1993	23093262
1994	23009075
1995	23009075
1996	22938405
1997	22885802
1998	22852905
1999	22825288
2000	22809546
2001	22779441
2002	21627509
2003	21521142
2004	21382354
2005	21257016
2006	21130503
2007	20635460
2008	20440290
2009	20294683
2010	20199059
2011	20095996
2012	20020074
2013	19953089
2014	19875542
2015	19760585
2016	19644350
2017	19530631

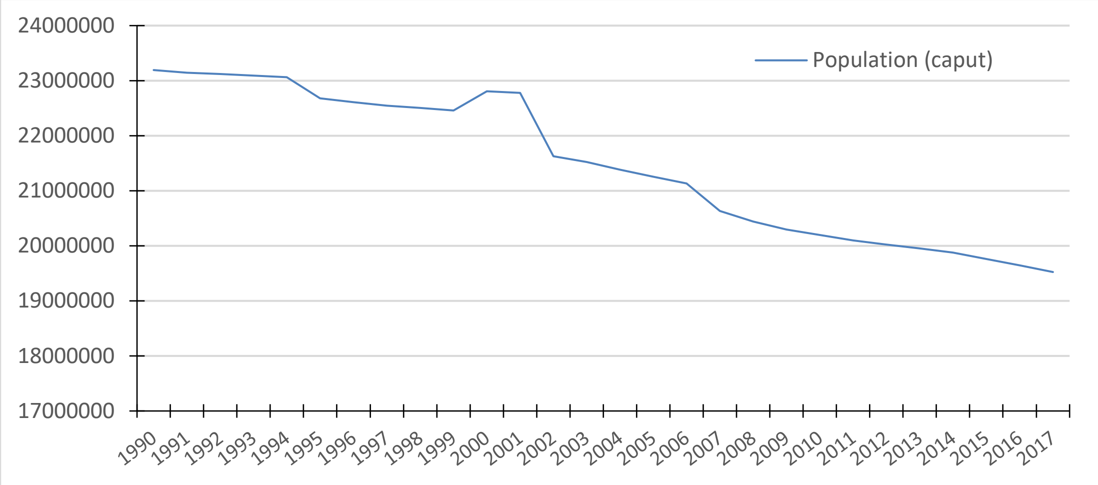


Figure 4.18.1. Activity data trends (caput) for NFR 2.D.3.a Domestic solvent use including fungicides

The emission trends are shown below in the following table and figure.

Table 4.18.2. Emission trends (kt) for NFR 2.D.3.a Domestic solvent use including fungicides

Year	NMVOC (kt)
1990	27.8307
1991	27.7726
1992	27.7424
1993	27.7119
1994	27.6749
1995	27.6109
1996	27.5261
1997	27.4630
1998	27.0034
1999	27.3903
2000	27.3715
2001	27.3353
2002	25.9530
2003	25.8254
2004	25.6588
2005	25.5084
2006	25.3566
2007	24.7626
2008	24.5283
2009	24.3536
2010	24.2389
2011	24.1152
2012	24.0241
2013	23.9437
2014	23.8507
2015	23.7127
2016	23.5732
2017	23.4368

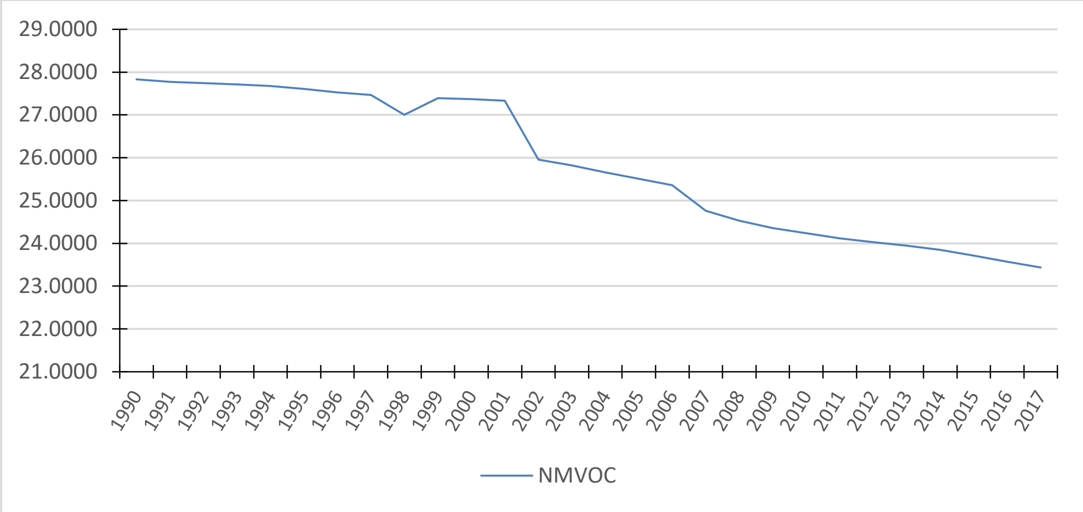


Figure 4.18.2. Emission trends (kt) for NFR 2.D.3.a Domestic solvent use including fungicides

The NMVOC emissions follow the activity data trends for domestic solvent use including fungicides, which varied substantially from year to year due to variations in statistical population data.

Recalculations and improvements: first estimate emissions for the time series 1990-1994 with Tier 1 emission factor from 2019 EMEP/EEA Guidebook which is 1.2 kg/capita.

Implementation of 2019 Review recommendations : RO-2D3a-2017-0001 -for the year 2018 with activity data from the N.I.S., consumption data were calculated for different types of products.

Consumption data were calculated in according to the equation:

AD = (Production + Imports) – Exports (kt).

Were applied Tier2 emission factor, Table 3.4 from 2019 EMEP/EEA Guidebook for the following product types:

- Cosmetics and toiletries (all);
- Household products (all);
- Car care products (all);
- Do it yourself (DIY)/buildings;
- Pesticides.

In 2018 NFR 2D3a was key categories for NMVOC with 10.45% from national total.

Depending on the availability of the consumption data we will report in stages, using Tier 2 methodology for NFR 2D3a in the next two years.

4.19 NFR 2.D.3.b Road Paving with Asphalt

This section covers emissions from asphalt paving operations, as well as subsequent releases from the paved surfaces. This was a key category in 2018, with a share of 7.01% from the national emissions of TSP and 2.28% from the national emissions of PM_{10}.

The main emissions to air from this sector are particulate matter (TSP, PM_{10}, $PM_{2.5}$), volatile organic compounds (NMVOC) and black carbon (BC).

The methodology for estimating emissions from road paving with asphalt applies the general equation:

Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate for the road paving with asphalt
- EFpollutant is the emission factor for this pollutant.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from road paving with asphalt is not included.

The activity data used for emission calculations is the annual national total bitumen production, from the "PRODROM" statistics, provided by the N.I.S. These data are confidential.

The emission trends are shown below in the following table and figure.

Table 4.19.1. Total Emission Trends (kt) for NFR 2.D.3.b Road paving with asphalt

Year/Pollutant	TSP (kt)	PM 10(kt)
1990	5.796	1.2420
1991	5.306	1.1370
1992	5.138	1.1010
1993	4.466	0.9570
1994	4.754	1.0187
1995	4.854	1.0402
1996	4.904	1.0508
1997	4.268	0.9146
1998	2.693	0.5770
1999	2.402	0.5147
2000	3.125	0.6696
2001	2.176	0.4663
2002	2.182	0.4677
2003	2.664	0.5708
2004	13.330	2.8564
2005	9.470	2.0292
2006	13.292	2.8482
2007	33.513	7.1815
2008	7.461	1.5987
2009	19.376	4.1520
2010	23.028	4.9345

Year/Pollutant	TSP (kt)	PM 10(kt)
2011	22.049	4.7247
2012	25.251	5.4110
2013	28.249	6.0533
2014	29.286	6.2755
2015	29.345	6.2883
2016	20.707	4.4373
2017	5.628	1.2061
2018	15.610	3.3449

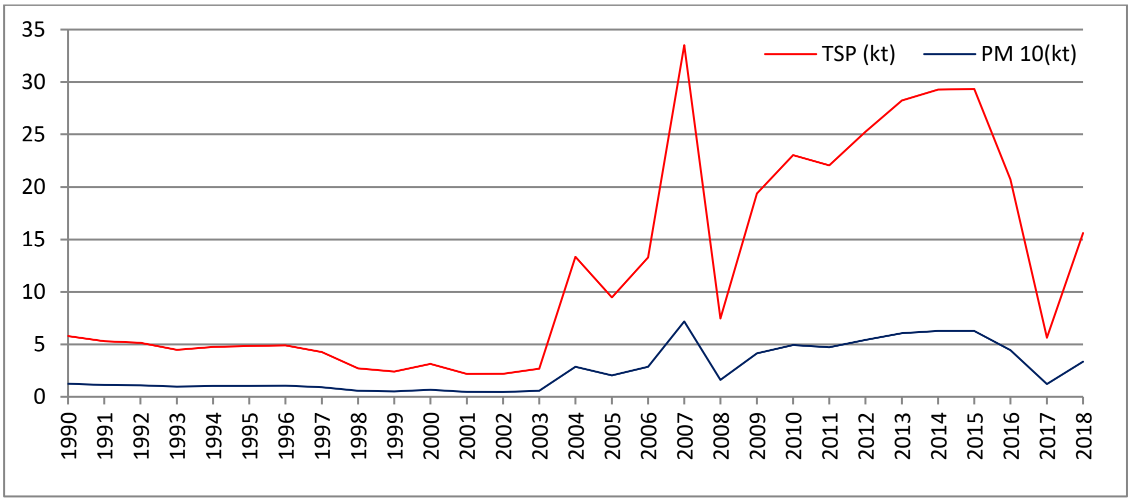


Figure 4.19.1. Total Emission Trends (kt) for NFR 2.D.3.b Road paving with asphalt

The emissions PM_{10} and TSP follow the activity data trend, with an important increase from 2005 to 2007, when it recorded a peak, a sudden decrease from 2007 to 2008, as in 2017.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

4.20 NFR 2.D.3.c Asphalt Roofing

This activity covers emissions from the asphalt roofing industry.

The main emissions to air from this sector are particulate matter (TSP, PM_{10}, $PM_{2.5}$), volatile organic compounds (NMVOC), carbon monoxide (CO) and black carbon (BC).

The methodology for estimating emissions from asphalt roofing industry applies the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

where:

- Epollutant is the emission of the specified pollutant;
- ARproduction is the activity rate for the the asphalt roofing;
- EFpollutant is the emission factor for this pollutant.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from asphalt roofing is not included.

The activity data used for emission calculations is the annual national total production of the asphalt roofing industry, from the "PRODROM" statistics provided by the N.I.S. These data are confidential between 2010-2018.

Table 4.20.1. Activity Data Trend (t asphalt) for NFR 2.D.3.c Asphalt Roofing

Year	t asphalt
1990	97500.0
1991	58500.0
1992	39000.0
1993	37500.0
1994	30000.0
1995	33000.0
1996	36000.0
1997	31500.0
1998	30838.5
1999	27360.0
2000	23317.5
2001	24000.0
2002	24000.0
2003	21000.0
2004	12000.0
2005	12144.0
2006	C
2007	C
2008	1434.0
2009	1000.0

The emission trends are shown below in the following table and figure.

Table 4.20.2. Total Emission Trends (kt) for NFR 2.D.3.c Asphalt Roofing

Year/Pollutant	NMVOC (kt)	TSP (kt)
1990	0.012675	0.156000
1991	0.007605	0.093600
1992	0.005070	0.062400
1993	0.004875	0.060000
1994	0.003900	0.048000
1995	0.004290	0.052800
1996	0.004680	0.057600
1997	0.004095	0.050400

Year/Pollutant	NMVOC (kt)	TSP (kt)
1998	0.004009	0.049342
1999	0.003557	0.043776
2000	0.003031	0.037308
2001	0.003120	0.038400
2002	0.003120	0.038400
2003	0.002730	0.033600
2004	0.001560	0.019200
2005	0.001579	0.019430
2006	0.001143	0.014064
2007	0.000295	0.003630
2008	0.000186	0.002294
2009	0.000130	0.001600
2010	0.000029	0.000355
2011	0.000021	0.000262
2012	0.000023	0.000288
2013	0.000017	0.000206
2014	0.000016	0.000192
2015	0.000012	0.000151
2016	0.000008	0.000094
2017	0.000007	0.000086
2018	0.000004	0.000053

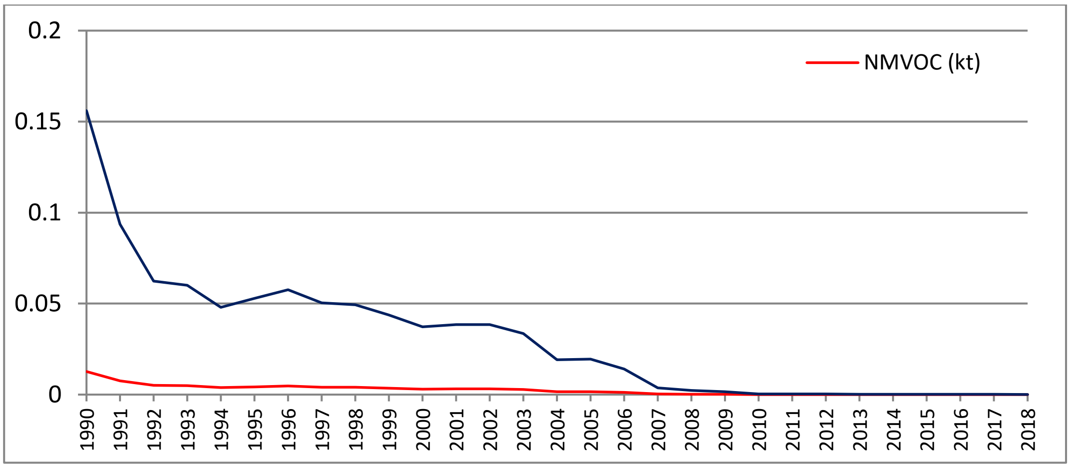


Figure 4.20.2. Total Emission Trends (kt) for NFR 2.D.3.c Asphalt Roofing

After 2009 there was a significant decrease in the asphalt roofing industry, and all emissions followed this trend.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

4.21 NFR 2.D.3.d Coating applications

This source category refers to " the use of paints the industrial and domestic sectors. The term paint is taken to include all materials applied as a continuous layer to a surface with the exception of glues and adhesives which are covered by NFR source category 3.D.3 Other product use".

The methodology for estimating emissions applies the general equation:

$$\text{Epollutant} = \sum_{\text{technologies}} \text{ARuse, technology x EFtechnology, pollutant}$$

where:

- ARuse,technology = the use of paint within the source category, using this specific technology;
- EFtechnology,pollutant = the emission factor for this technology and this pollutant.

For time series 1990-2007 was calculated NMVOC emissions from industrial coating application: manufacture of automobiles (SNAP activity 060101) and other industrial coating applications (SNAP activity 060108), because we do not have activity data for the other activities.

The activity data are represented by numbers of automobiles and other vehicle type (splited by buses, trucks, other transport vehicle) provided by the N.I.S. It used Tier 2 default emission factor for NMVOC (Table 3-6 and Table 3-12 from 2019 EMEP/EEA Guidebook).

The emission trends are shown below in the following table and figure.

Table 4.21.1. Emission trends (kt) for NFR 2.D.3.d Coating applications

Year/Pollutant	NMVOC
1990	1.058
1991	0.911
1992	0.744
1993	1.545
1994	1.400
1995	1.200
1996	1.480
1997	1.457
1998	1.490
1999	1.214
2000	0.897
2001	0.914
2002	0.918
2003	1.145
2004	1.429
2005	1.964
2006	1.957
2007	2.090

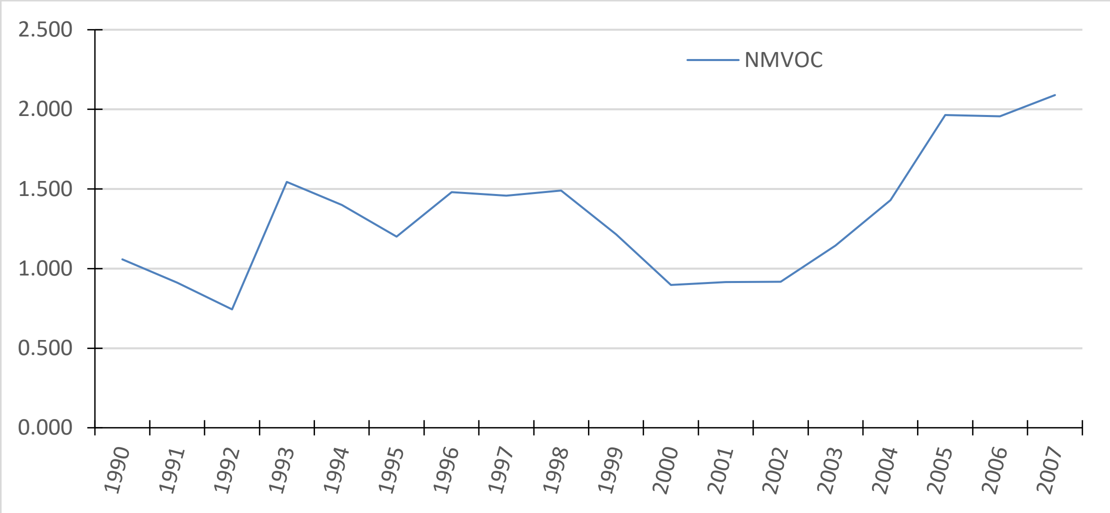


Figure 4.21.1. Emission trends (kt) for 2.D.3.d Coating applications

The emissions of NMVOC from the coating applications follow the activity data trends which varied substantially from year to year due to high variation of industry outputs.

For the 2008 - 2018 series, the activity data, respectively the solvent consumption (kt) and the NMVOC emission, are obtained from the economic operators by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75/EU on industrial emissions (IED). At SNAP 060101 “Manufacture of automobiles” and SNAP 060108 “Other industrial paint application” solvent consumption (kt) and NMVOC emissions(kt) from SNAPs: 060106 “Boat building” and 060107 “Wood” were added.

The tables below shows the variation of solvent consumption (kt) and NMVOC emissions (kt) in the time period 2008-2018.

Table 4.21.2. Activity data trends (kt solvent consumption) for NFR 2.D.3.d Coating applications

Year	Solvent consumption (kt)
2008	13.341
2009	10.616
2010	11.805
2011	8.889
2012	10.654
2013	10.756
2014	10.545
2015	11.545
2016	10.512
2017	10.596
2018	11.195

Table 4.21.3. Emission trends (kt) for NFR 2.D.3.d Coating applications

Year/Pollutant	NMVOC (kt)
2008	6.187
2009	5.117
2010	4.397
2011	3.351
2012	4.872
2013	5.311
2014	5.365
2015	6.115
2016	5.650
2017	4.745
2018	4.642

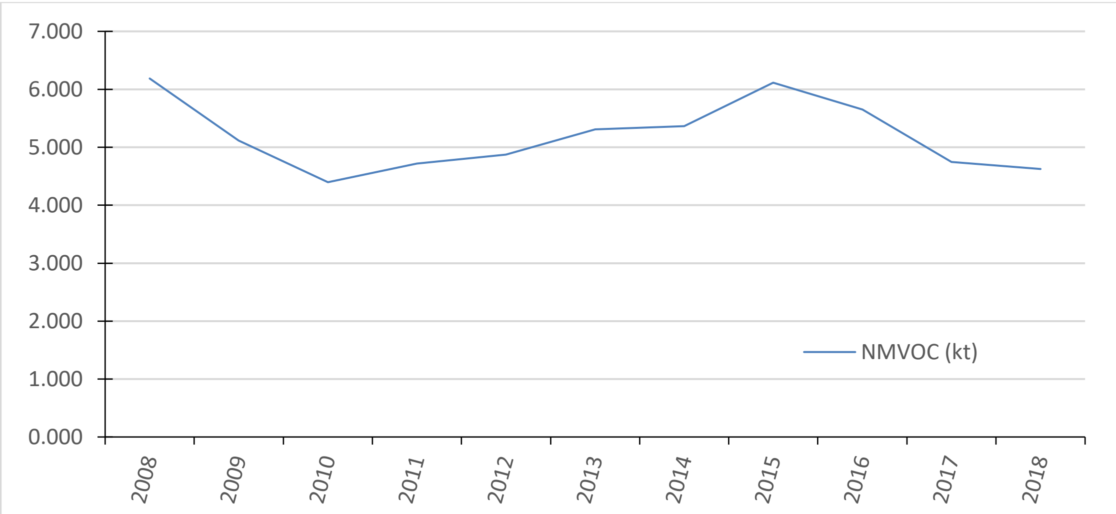


Figure 4.21.3. Emission trends (kt) for 2.D.3.d Coating applications

Recalculations and improvements: first estimate emissions for the time series 1990-1994 with Tier 2 and using solvent consumption as activity data as well as NMVOC emissions from economic operators for entire time series 2008-2018.

4.22 NFR 2.D.3.e Degreasing

In the 2019 EMEP/EEA Guidebook this source category is defined as: ,,Degreasing is a process for cleaning products from water-insoluble substances such as grease, fats, oils, waxes, carbon deposits, fluxes and tars. In most cases the process is applied to metal products, but also plastic, fibreglass, printed circuit boards and other products are treated by the same process."

The methodology for estimating emissions from this source applies the general equation:

$$Epollutant = ARproduction \times EFpollutant,$$

The default emission factor used to calculate the emissions is from 2019 EMEP/EEA Guidebook, chapter 2.D.3.e Degreasing, Tier 1 (Table 3-1).

The activity data are from EUROSTAT for PRODROM code 20302279; the activity data for time series 2005 -2017 were corrected with the datas from EUROSTAT and added time series 2000-2004.

Table 4.22.1. Activity data trends (kt) for NFR 2.D.3.e Degreasing

Year	kt solvent
2000	2.078
2001	2.984
2002	6.505
2003	3.720
2004	4.464
2005	5.681
2006	7.381
2007	6.585
2008	5.631
2009	3.634
2010	3.551
2011	4.711
2012	4.036
2013	4.113
2014	3.905
2015	3.225
2016	3.582
2017	3.476
2018	3.476

The emission trends are shown below in the following table and figure.

Table 4.22.2. Emission trends (kt) for NFR NFR 2.D.3.e Degreasing

Year	NMVOC (kt)
2000	0.956
2001	1.373
2002	2.992
2003	1.711
2004	2.054
2005	2.613
2006	3.395
2007	3.029
2008	2.590
2009	1.672
2010	1.633
2011	2.167
2012	1.857
2013	1.892
2014	1.797
2015	1.483

Year	NMVOC (kt)
2016	1.648
2017	1.599
2018	1.484

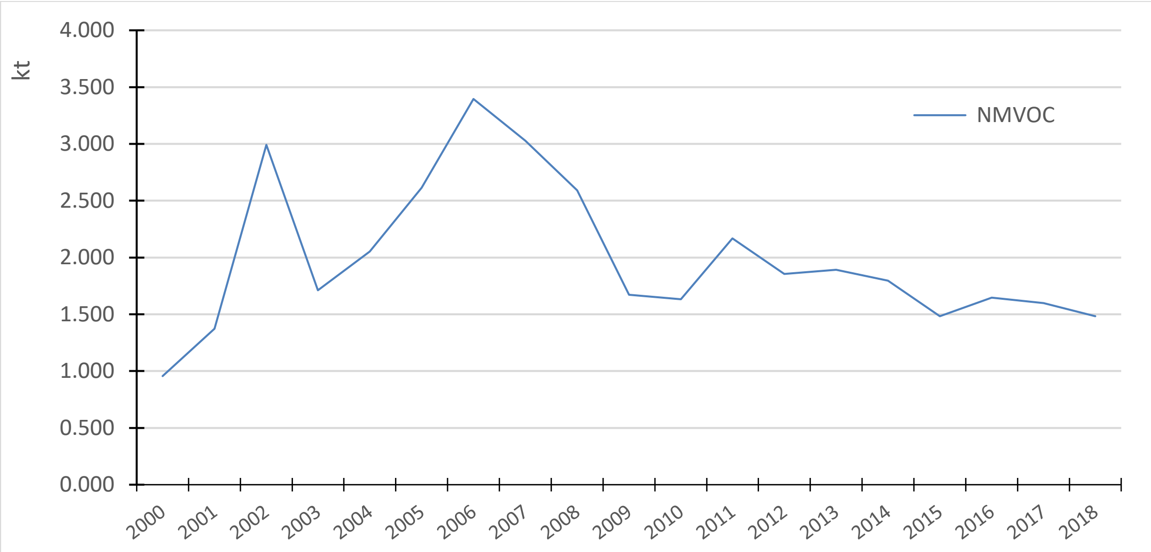


Figure 4.22.2. Emission trends (kt) for NFR NFR 2.D.3.e Degreasing

The emissions of NMVOC from degreasing activities follow the activity data trends which varied substantially from year to year due to high variation of industry outputs.
Recalculations and improvements: first estimate to time series 2000-2004; 2005-2017 corrected.

4.23 NFR 2.D.3.f. Dry cleaning

This source category refers to NMVOC emissions from processes using organic solvents to remove contamination furs, leather, down leathers, textiles or other objects made of fibres. This was a key category for emissions of NMVOC in 2018,with 2.45% level assessement from national total.

The methodology for estimating emissions from this source is to multiply the population of the country with a default emission factor based on the inhabitants. Based on the 2019 EMEP/EEA Guidebook “if the amount of textile treated as activity data is not available, a default emission factor Tier 1 based on the inhabitants can be used. The factor is 0.3 kg/inhabitant/ year.”

The activity data represents the total population of Romania and is provided by N.I.S. (see Table 4.18.1.).The emission trends are shown below in the following table and figure.

Table 4.23.1. Emission trends (kt) for NFR 2.D.3.f Dry cleaning

Year	NMVOC (kt)
1990	6.958
1991	6.943
1992	6.936
1993	6.928
1994	6.919
1995	6.902
1996	6.882
1997	6.866
1998	6.856
1999	6.848
2000	6.843
2001	6.834
2002	6.488
2003	6.456
2004	6.415
2005	6.377
2006	6.339
2007	6.191
2008	6.132
2009	6.088
2010	6.060
2011	6.029
2012	6.006
2013	5.986
2014	5.963
2015	5.928
2016	5.893
2017	5.859
2018	5.822

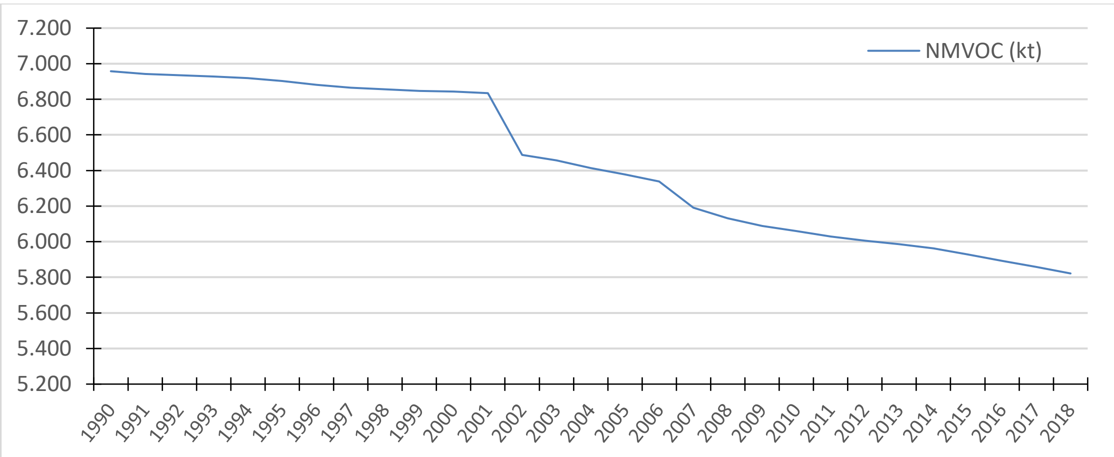


Figure 4.23.1. Emission trends (kt) for NFR 2.D.3.f Dry cleaning

The emissions of NMVOC from dry cleaning activities follow the activity data trend with varied substantially from year to year due to variations in statistical population data.

Recalculations and improvements: first estimate emissions for the time series 1990-1994.

4.24 NFR 2.D.3.g Chemical products

The following chemical products are included:

- 060302 Polyvinylchloride processing;
- 060303 Polyurethane foam processing (not available between 1990-2004);
- 060304 Polystyrene foam processing (not available between 1990-2000);
- 060305 Rubber processing ;
- 060306 Pharmaceutical products manufacturing;
- 060307 Paints manufacturing;
- 060308 Inks manufacturing (not available between 1990-2007);
- 060309 Glues manufacturing.
- 060313 Leather tanning

The methodology for estimating emissions from chemical products applies the general equation:

$$\mathrm{Epollutant} = \sum_{\mathrm{technologies}} \mathrm{ARuse, technology} \times \mathrm{EFtechnology, pollutant}$$

where:

- ARuse,technology = the use of a specific chemical product,
- EFtechnology,pollutant = the emission factor for this technology and this pollutant.

For SNAP 060302 (polyvinylchloride processing), SNAP 060303 (polyurethane foam processing), SNAP 060304 (polystyrene foam processing), SNAP 060305 (rubber processing - for time series 1990-2007), SNAP 060307 (paints manufacturing), SNAP 060308 (inks manufacturing) and SNAP 060309 (glues manufacturing), the activity data consist of the total productions of each product. These data are provided by the N.I.S. in the Statistical Yearbook and by the economic operators.
The emissions were estimated, based on 2019 EMEP/EEA Guidebook, chapter NFR 2.D.3.g Chemical products Table 3-1, Table 3-3, Table 3-4, Table 3-5, Table 3-11.

For SNAP 060306 (pharmaceutical products manufacturing), SNAP 060313 (leather tanning) the activity data consist of the total solvents used and were obttained obttained from the economic operators by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75 / EU on industrial emissions (IED), as well as NMVOC emissions (for the time series 2008-2018); same thing for SNAP 060305 (rubber processing) on the 2008-2018 period.

For SNAP 060306 (pharmaceutical products manufacturing), SNAP 060313 (leather tanning) on the time period 2008-2018 the NMVOC emissions were obtained from the economic operators by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75 / EU on industrial emissions (IED); same thing for SNAP 060305 (rubber processing) on the 2008-2018 period.

Table 4.24.1. Activity data trends (kt solvents;kt product) for NFR 2.D.3.g Chemical products

Year	Kt solvents	Kt product
1990		751.0000
1991		622.0000
1992		478.0000
1993		223.2270
1994		252.1390
1995		269.7210
1996		247.8120
1997		264.9900
1998		235.1570
1999		208.5100
2000		217.4270
2001		256.9330
2002		274.6570
2003		312.5850
2004		378.6540
2005		375.8088
2006		515.7655
2007		585.5670
2008	0.8175	658.5140
2009	0.7161	367.6458
2010	1.0942	387.6710
2011	1.0592	417.2107
2012	1.2369	572.8836
2013	1.2971	632.6787
2014	1.4205	642.2068
2015	1.4321	646.3930
2016	1.1473	616.4490
2017	1.4307	560.5139
2018	1.4420	560.8974

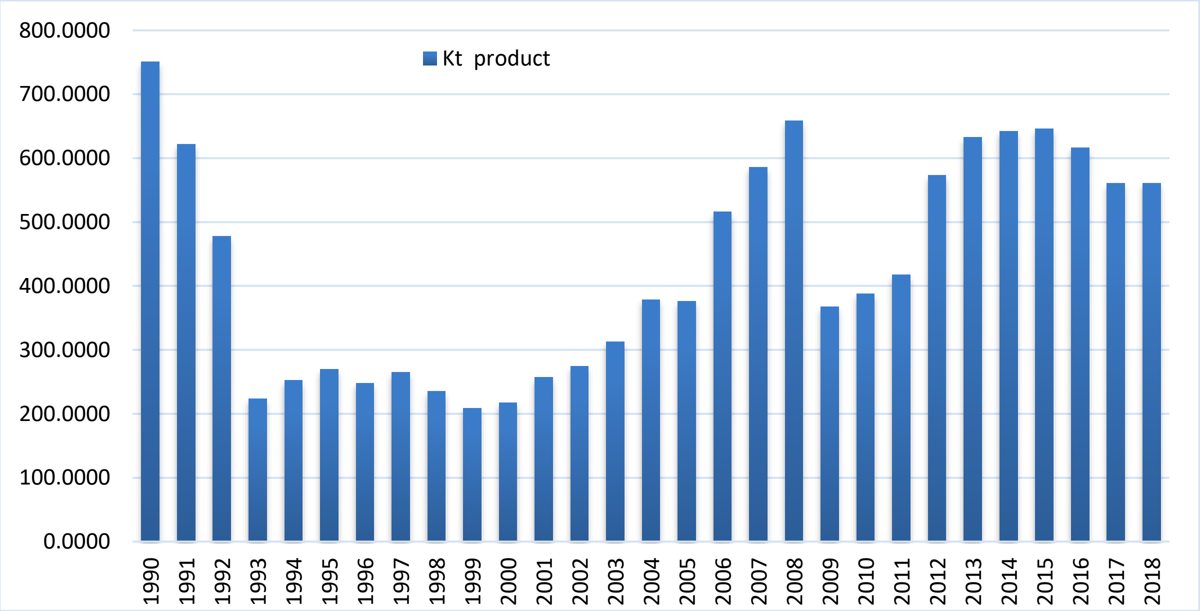


Figure 4.24.1. Activity data trends Kt products for NFR 2.D.3.g Chemical products

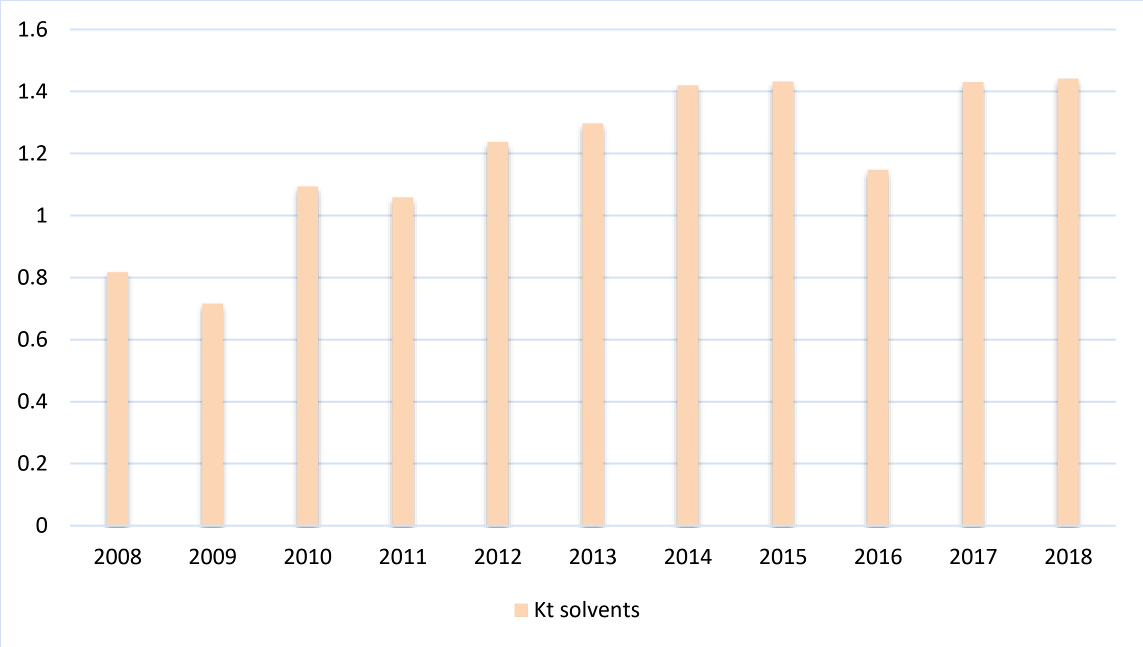


Figure 4.24.2. Activity data trends Kt solvents for NFR 2.D.3.g Chemical products

Table 4.24.2. Emission trends (kt) for NFR 2.D.3.g Chemical products

Year/Pollutant	NMVOC
1990	7.8000
1991	6.5640
1992	5.0590
1993	2.2689
1994	2.5544
1995	2.7130
1996	2.4919
1997	2.6956
1998	2.3958
1999	2.1147
2000	2.1988
2001	2.6210
2002	2.8486
2003	3.4516
2004	4.3741
2005	5.0393
2006	22.0728
2007	22.1831
2008	21.2427
2009	7.6001
2010	8.2606
2011	8.6695
2012	11.7061
2013	13.2419
2014	11.7200
2015	10.7173

Year/Pollutant	NMVOC
2016	10.8915
2017	10.5999
2018	11.1927

The emission trends are shown below in the following table and figure.

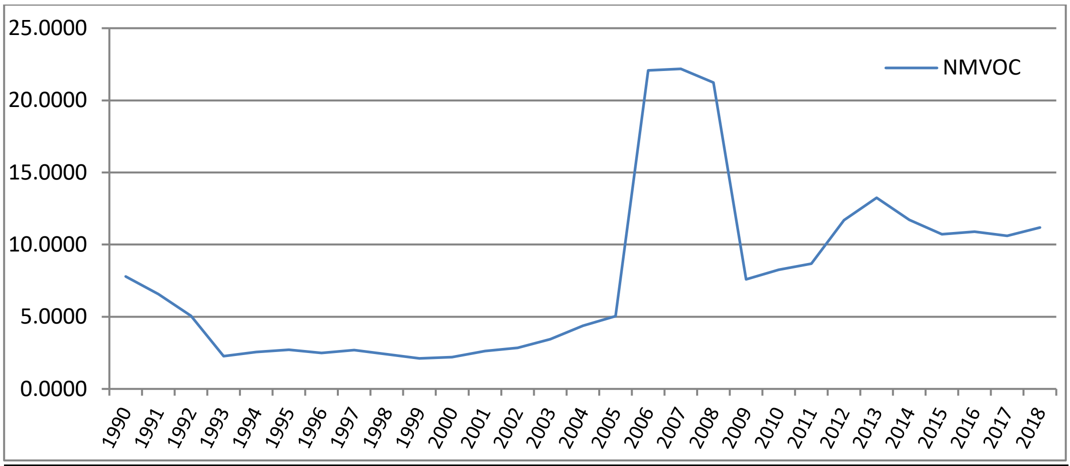


Figure 4.24.3. Emission trends (kt) for NFR 2.D.3.g Chemical products

The emissions of NMVOC from the NFR 2.D.3.g Chemical products follow the activity data trends which varied substantially from year to year due to high variation of industry outputs.

NMVOC emissions from this category are the key source, representing 4.72% of the total national emissions of NMVOCs in 2018.
Recalculations and improvements:

- First estimate emission for the SNAP 060306 (pharmaceutical products manufacturing), SNAP 060313 (leather tanning);

- First estimate emission for the time series 1990-1994;

- Recalculated emission for the time series 2008-2018.

4.25 NFR 2.D.3.h Printing

This chapter covers emissions from printing industry.

The methodology for estimating emissions applies the general equation:

Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate
- EFpollutant is the emission factor for this pollutant.

The emissions were estimated, based on 2019 EMEP/EEA Guidebook, chapter NFR 2.D.3.h Printing, Table 3-1.

The activity data for the 2005 , 2006 and 2007 years, represent the total ink consumption for printing activities. For 2008-2018 time period, the activity data represent the total solvents used, the emissions were obtained from the economic operators by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75 / EU on industrial emissions (IED) as well as NMVOC emissions For time period 1990-2004 there are no informations.

Table 4.25.1. Activity data trends (kt Ink used) for NFR 2.D.3.h Printing

Year	Kt solvents	kt Ink used
2005		0.0810
2006		0.4930
2007		0.5010
2008	2.4570	
2009	2.4092	
2010	3.0327	
2011	3.2410	
2012	3.3160	
2013	3.3773	
2014	3.2453	
2015	3.8248	
2016	3.3136	
2017	3.7530	
2018	2.2833	

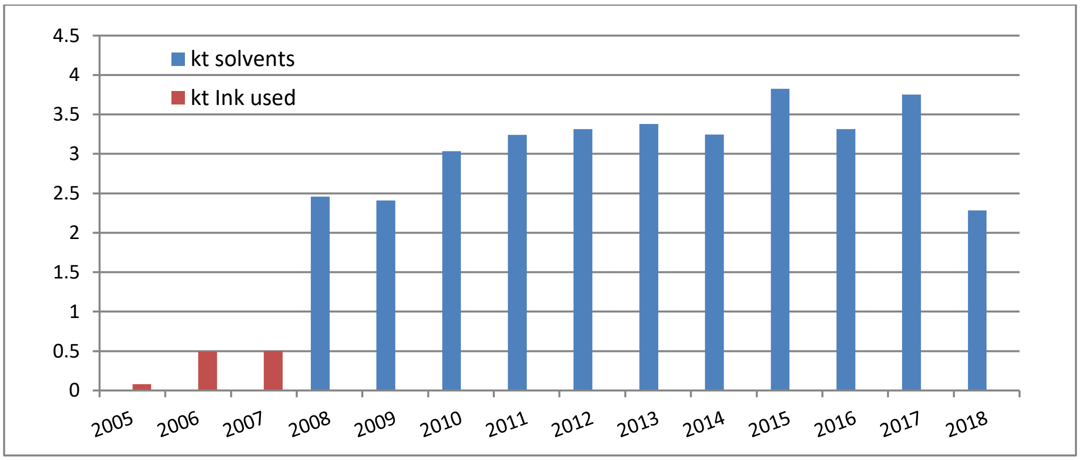


Figure 4.25.1. Activity data trends (kt Ink used and kt solvents) for NFR 2.D.3.h Printing

The emission trends are shown below in the following table and figure.

Table 4.25.2. Emission trends (kt) for NFR 2.D.3.h Printing

Year/Pollutant	NMVOC
2005	0.0406

Year/Pollutant	NMVOC
2006	0.2467
2007	0.2505
2008	1.3164
2009	0.9891
2010	1.1509
2011	1.2320
2012	0.6689
2013	0.5720
2014	0.6847
2015	0.6551
2016	0.5340
2017	0.6668
2018	0.4875

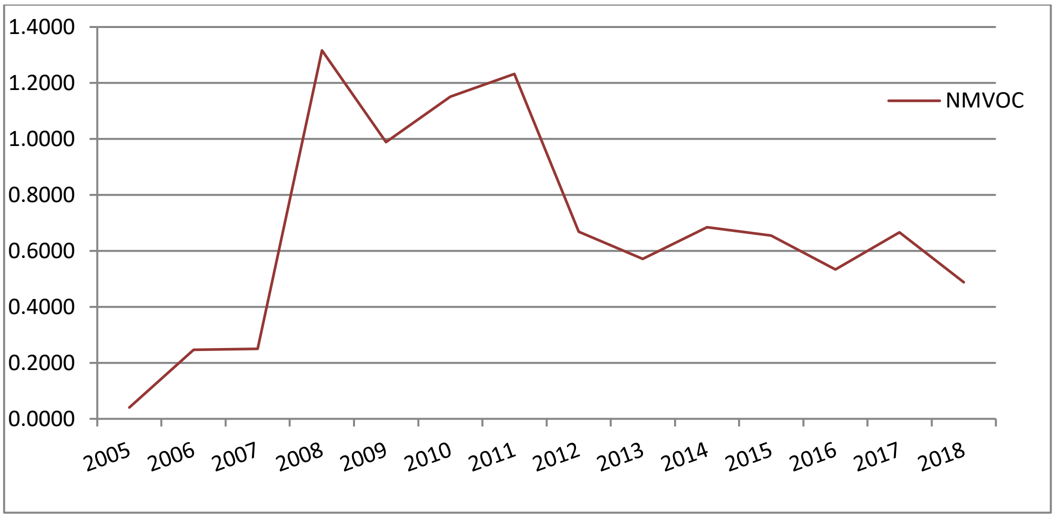


Figure 4.25.2. Emission trends (kt) for NFR 2.D.3.h Printing

The emissions of NMVOC follow the activity data trends from printing industry which varied from year to year and total solvents used in printing industry.

Recalculations and improvements: for the 2008-2018 time period, the NMVOC emissions were obtained from the economic operators by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75 / EU on industrial emissions (IED).

4.26 NFR 2.D.3.i Other solvent use

The following " Other solvent use" are included:

- SNAP 060404 Fat, edible and non-edible oil extraction;
- SNAP 060405 Application of glues and adhesives;
- SNAP 060406 Preservation of wood;
- SNAP 060407 Underseal treatment and conservation of vehicles

For SNAP 060407 the activity data used are the total population provided by N.I.S. in the Statistical Yearbook; for the calculation of the NMVOC emissions was used the weighted average emission factor of IIASA (2019 EMEP/EEA Guidebook, Table 3-10). For the SNAP 060404, SNAP 060405, SNAP 060406 on the2008-2018 time period, the activity data represent the total solvents used, the emissions were obtained from the economic operators, by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75 / EU on industrial emissions (IED), as well as NMVOC emissions.

The methodology for estimating emissions of SNAP 060407 (preservation of wood) applies the general equation:

$Epollutant = ARproduction \times EFpollutant$ where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate
- EFpollutant is the emission factor for this pollutant.

Table 4.26.1. Activity data trends (kt solvents,total population) for NFR 2.D.3.i. Other solvent use

Year/Pollutant	Kt solvents	Population [caput]
1990		23192274
1991		23143860
1992		23118745
1993		23093262
1994		23062448
1995		23009075
1996		22938405
1997		22885802
1998		22852905
1999		22825288
2000		22809546
2001		22779441
2002		21627509
2003		21521142
2004		21382354
2005		21257016
2006		21130503
2007		20635460
2008	0.0406	20440290
2009	0.2467	20294683
2010	0.2505	20199059
2011	1.3164	20095996
2012	0.9891	20020074
2013	1.1509	19953089
2014	1.2320	19875542
2015	0.6689	19760585
2016	0.5720	19644350
2017	0.6847	19530631
2018	0.6551	19405156

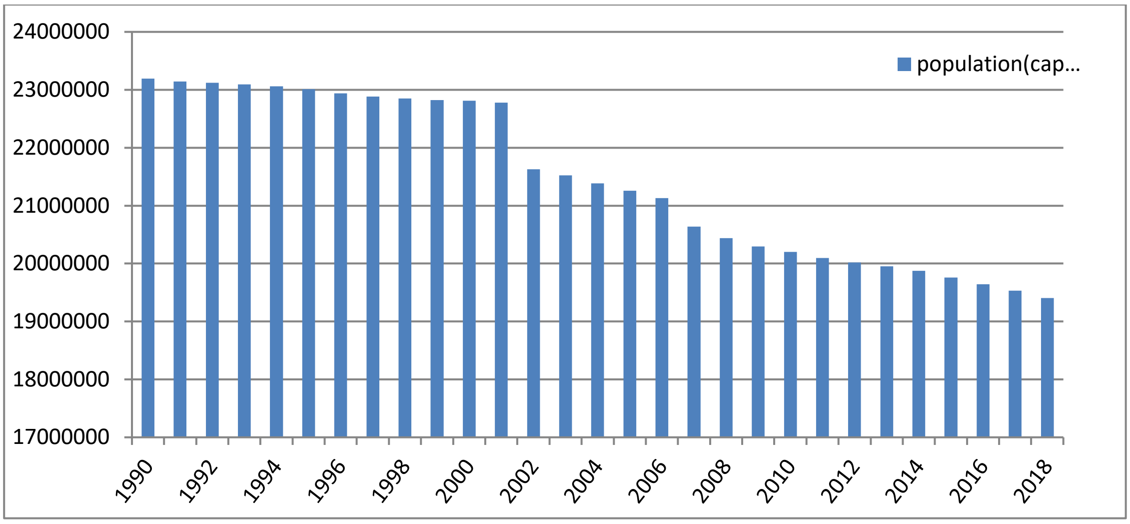


Figure 4.26.1. Activity data trends (total population) for NFR 2.D.3.i. Other solvent use

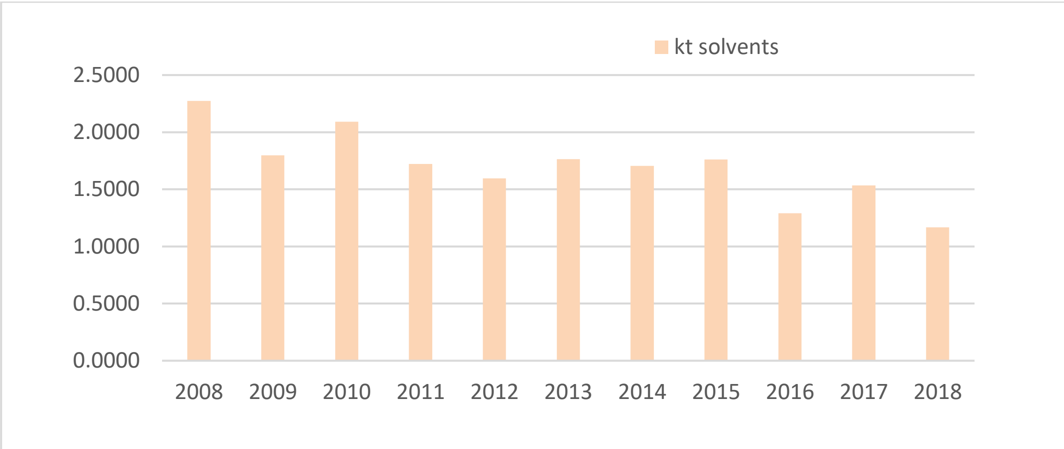


Figure 4.26.2. Activity data trends (kt solvents) for NFR 2.D.3.i. Other solvent use

Table 4.26.3. Emission trends (kt) for NFR 2.D.3.i Other solvent use

Year/Pollutant	NMVOC
1990	4.6385
1991	4.6288
1992	4.6237
1993	4.6187
1994	4.6125
1995	4.6018
1996	4.5877
1997	4.5772
1998	4.5706
1999	4.5651
2000	4.5619
2001	4.5559
2002	4.3255
2003	4.3042
2004	4.2765
2005	4.2510
2006	4.2261
2007	4.1271

Year/Pollutant	NMVOC
2008	5.2562
2009	5.0571
2010	5.2883
2011	5.1636
2012	5.2391
2013	5.3717
2014	5.1760
2015	5.1727
2016	4.6526
2017	4.8664
2018	4.5078

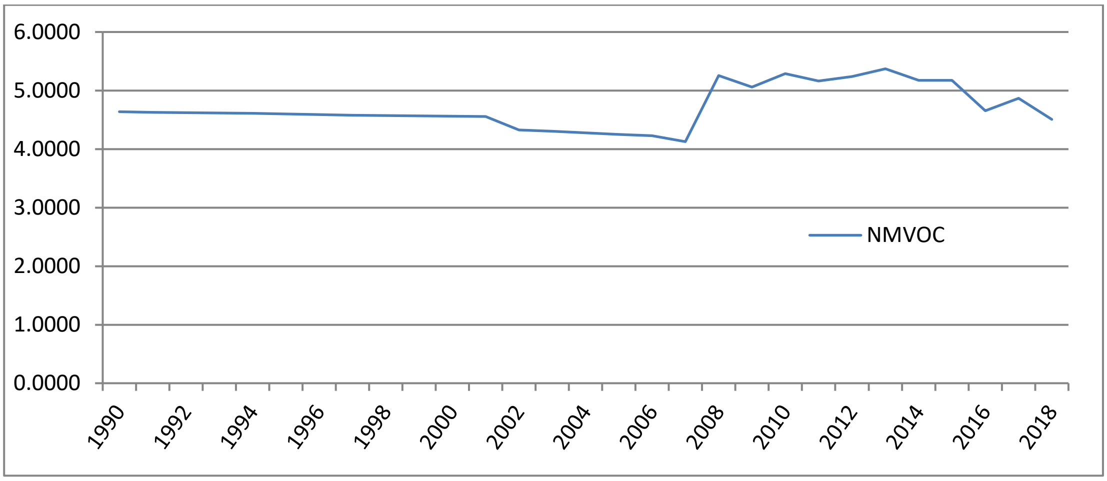


Figure 4.26.3. Emission trends (kt) for NFR 2.D.3.i Other solvent use

The emissions of NMVOC follow the activity data trends from NFR 2.D.3.i Other solvent use. The NMVOC pollutant is the key source for NFR 2.D.3.i Other solvent use and represents 1.90% of total national NMVOC emissions for the year 2018.

Recalculations and improvements:
- First estimate emissions for SNAP 060404 (fat, edible and non-edible oil extraction), SNAP 060405(application of glues and adhesives), SNAP 060406 (preservation of wood).
- First estimate emissions for the time series 1990-1994;
- Recalculated emission for the time series 2008-2018.

4.27 NFR 2.G Other product use

The emissions due to the use of fireworks, smoking tobacco and use of shoes are reported here.

The main emissions to air from this sector comprise a wide range of pollutants, the most important being the carbon monoxide (CO), particulate matter ($PM_{2.5}$,PM_{10},TSP), volatile organic compounds (NMVOC) and heavy metals (Pb, Cd, Cu, Ni, Zn).

The emissions due to use of fireworks are calculated using Tier2 approach, by multiplying the fireworks consumption and the emission factor from 2019 EMEP/EEA Guidebook, chapter 2D3i, 2.G, Other solvent and product use, Table 3-14 - Consumption of fireworks = Production + Import – Export (the amount used equals the production amount plus the imported amount minus the exported amount).

No activity data are available for production in Romania, the import-export data are available since 1992.

The emissions from the combustion (smoking) of tobacco are calculated using Tier2 approach, by multiplying the tobacco consumption and the emission factor from 2019 EMEP/EEA Guidebook, chapter 2.G, Table 3-15 - Consumption of tobacco = Production + Import – Export.

The emissions from the use of shoes are reported as measured NMVOC emissions, reported by economic operators , from 2008-2018 period, by drawing up a solvent management plan according to Annex VII part 7 of the Directive 2010/75/EU on industrial emissions (IED).

The production, import and export data of tobacco and of fireworks are provided by the N.I.S.

Table 4.27.1. Activity data trend (t) for NFR 2.G Other product use

Year	Tobacco (t)	Fireworks (t)
1990	27000.00	0
1991	39570.00	0
1992	42670.00	8.00
1993	37204.00	31.00
1994	35224.00	33.00
1995	45281.00	6.00
1996	33690.00	8.00
1997	31431.00	17.00
1998	31277.00	22.00
1999	32828.93	41.23
2000	36788.78	138.03
2001	42037.65	402.58
2002	37288.89	715.48
2003	40034.45	940.11
2004	43648.88	1574.32
2005	43856.45	1592.65
2006	40534.33	846.95
2007	31444.26	70.88
2008	33998.31	624.52
2009	30510.81	260.92
2010	18957.80	792.29
2011	24879.21	651.49
2012	25013.45	498.31
2013	22870.60	735.46
2014	20124.44	623.84
2015	21959.88	795.50
2016	26902.60	296.41
2017	22949.89	640.94
2018	27847.12	915.25

The emission trends are shown below in the following tables and figures.

Table 4.27.2. Emission Trends (kt) for NFR 2.G Other product use

Year/Pollutant	NMVOC	PM 2.5	PM10	TSP	CO
1990	0.131	0.729	0.729	0.729	1.488
1991	0.192	1.068	1.068	1.068	2.180
1992	0.207	1.153	1.153	1.153	2.351
1993	0.180	1.006	1.008	1.008	2.050
1994	0.170	0.953	0.954	0.955	1.941
1995	0.219	1.223	1.223	1.223	2.495
1996	0.163	0.910	0.910	0.911	1.856
1997	0.152	0.850	0.850	0.851	1.732
1998	0.151	0.846	0.847	0.847	1.724
1999	0.159	0.889	0.891	0.891	1.809
2000	0.178	1.000	1.007	1.008	2.028
2001	0.203	1.156	1.175	1.179	2.319
2002	0.180	1.044	1.078	1.085	2.060
2003	0.194	1.130	1.175	1.184	2.213
2004	0.211	1.260	1.336	1.351	2.416
2005	0.212	1.267	1.343	1.359	2.428
2006	0.196	1.138	1.179	1.187	2.239
2007	0.152	0.853	0.856	0.857	1.733
2008	1.025	0.950	0.980	0.987	1.878
2009	0.951	0.837	0.850	0.852	1.683
2010	0.902	0.553	0.591	0.599	1.050
2011	1.079	0.706	0.737	0.743	1.376
2012	1.056	0.701	0.725	0.730	1.382
2013	1.047	0.656	0.691	0.698	1.265
2014	0.908	0.576	0.606	0.612	1.113
2015	1.059	0.634	0.672	0.680	1.216
2016	0.807	0.742	0.756	0.759	1.484
2017	0.807	0.653	0.684	0.690	1.269
2018	0.505	0.799	0.843	0.852	1.541

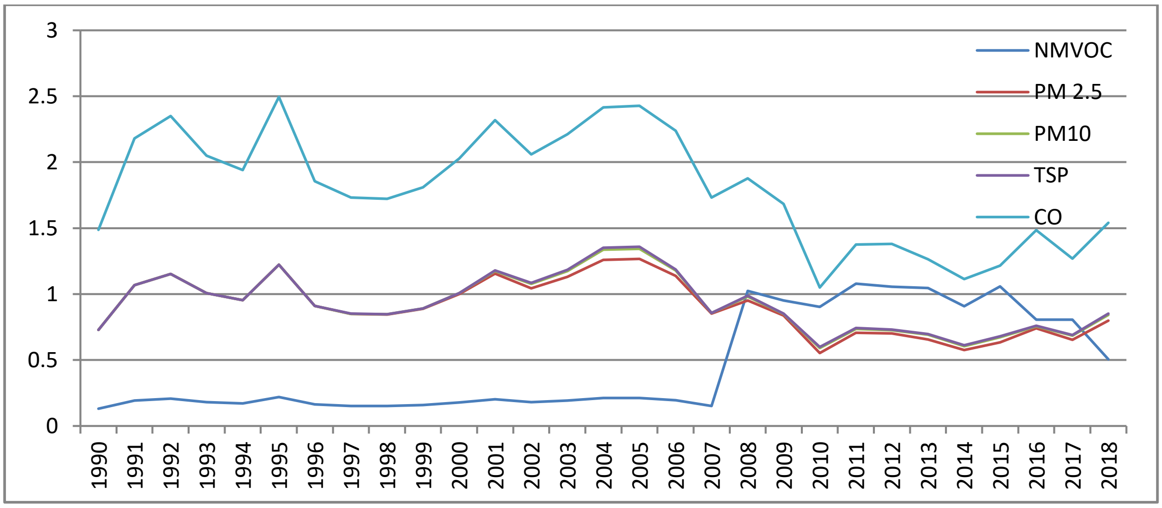


Figure 4.27.1. Emission Trends for NFR 2.G Other product use (kt)

The emissions of all pollutants vary for the time series together with the variation activity data; the NMVOC trend does not follow the curves of the other emissions due to the sum of the measured emissions for the new category "Use of shoes”.
Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.
- The new category “use of shoes”was added at this NFR, with Tier 3 approach for 2008-2018 time series.

4.28 NFR 2.H.1 Pulp and paper industry

The activity data is represented by the total pulp and paper production from the Statistical Yearbook, provided by the N.I.S. and are confidential. Since 2009 no production have been reported.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

4.29 NFR 2.H.2 Food and beverages industry

The following products from food and beverages manufacturing are included:

- Bread;
- Wine;
- Beer;
- Spirits;
- Sugar;
- Margarine;
- Coffee roasting.

This was a key source category for emissions of NMVOC in 2018, sharing 2.94% from the total national emisssions of this pollutant.
The NMVOC emissions from food and beverages manufacturing are taken into account for this subcategory.
The methodology for estimating emissions applies the general equation:

$$\text{Epollutant} = \sum_{\text{technologies}} \text{ARproduction, technology x EFtechnology, pollutant}$$

where:

- ARproduction,technology = the production rate within the source category, using this specific technology;
- EFtechnology,pollutant = the emission factor for this technology and this pollutant.

Due to the confidentiality purposes, the presentation of emission factors used to estimate emissions from foods and beverages industry is not included.

The activity data is taken from the Statistical Yearbook, from the "PRODROM" statistics, provided by the N.I.S. and from Eurostat statistics. These data are confidential since 2010.

The emission trends are shown below in the following table and figure.

Table 4.29.1. Emission trends (kt) for NFR 2.H.2 Food and beverages industry

Year/Pollutant	NMVOC
1990	6.412
1991	4.489
1992	3.825
1993	2.695
1994	12.809
1995	14.657
1996	16.834
1997	14.619
1998	13.831
1999	13.496
2000	14.055
2001	9.900
2002	10.280
2003	11.030
2004	10.645
2005	10.083
2006	11.037
2007	9.347
2008	9.962
2009	9.184
2010	7.791
2011	8.967
2012	9.489
2013	9.844
2014	9.877
2015	10.878
2016	10.127
2017	10.225
2018	6.989

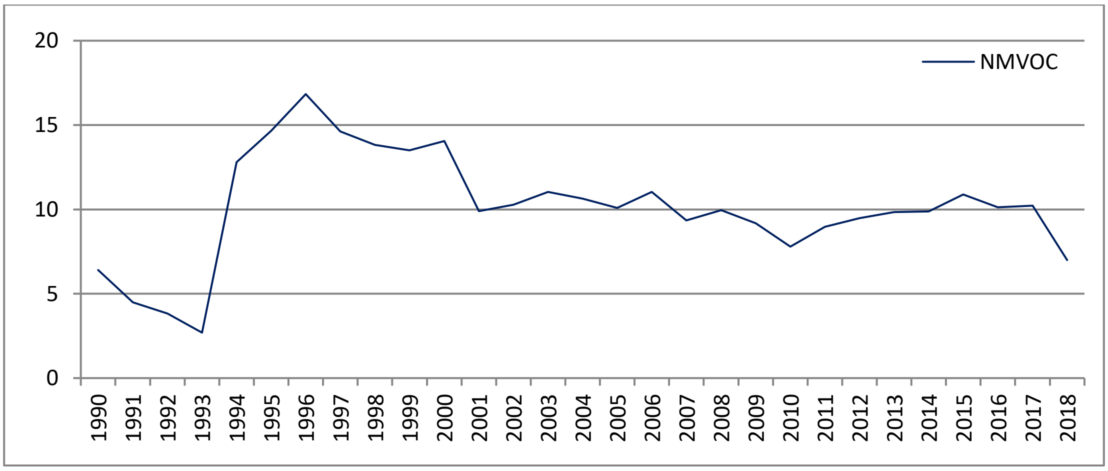


Figure 4.29.1. Emission trends (kt) for NFR 2.H.2 Food and beverages industry

The emissions of NMVOC from food and beverages industry follow the activity data trends which varied substantially from year to year due to high variation of industry outputs.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994. For 1990-1999 wine production was extrapolated the ratio of white to red wine to the NMVOC emissions calculation.

4.30 NFR 2.I Wood Processing

This category refers to the manufacture of wood and products, manufacture of plywood, reconstituted wood products and engineered wood products and is important for particulate emissions only.

The TSP emissions from wood processing are taken into account for this subcategory.

The methodology for estimating emissions from wood processing applies the general equation:

Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant;
- ARproduction is the activity rate for the wood processing;
- EFpollutant is the emission factor for this pollutant.

The emission factors used to calculate the emissions from wood production are from 2019 EMEP/EEA Guidebook, chapter 2.I Wood processing, Table 3.1.

The activity data used for emission calculations is the annual national total timber production from the Statistical Yearbook, provided by the N.I.S. The activity data is multiplied with the density 0.883 t per m^3.

Table 4.30.1. Activity data (1000 m^3) for NFR 2.I Wood Processing

Year/Activity data	1000 m^3 product
1990	2932.00
1991	2443.00
1992	2094.00
1993	1876.00
1994	1723.00
1995	1636.00
1996	1767.00
1997	1738.00
1998	1617.57
1999	1448.92
2000	1404.65
2001	2530.00
2002	2706.00

Year/Activity data	1000 m³ product
2003	2568.00
2004	2987.00
2005	3018.00
2006	3126.00
2007	3369.00
2008	3509.00
2009	3913.00
2010	4416.00
2011	5145.00
2012	5175.00
2013	5836.00
2014	5909.00
2015	5868.00
2016	5452.00
2017	5140.00
2018	5143.00

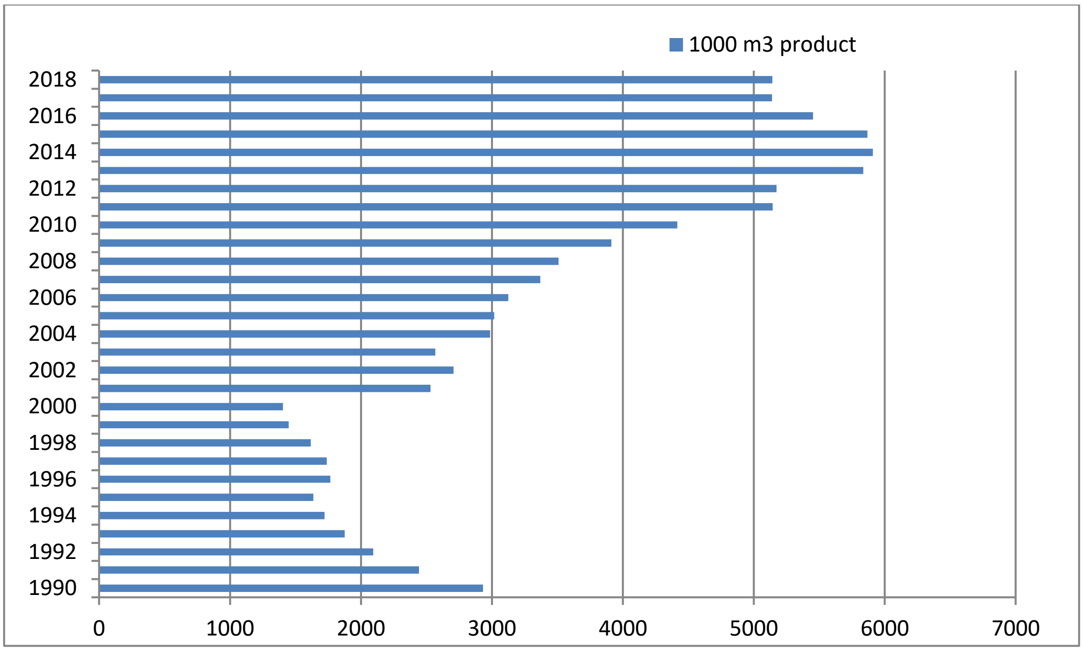


Figure 4.30.1. Activity data trend for NFR 2.I Wood Processing

The emission trends are shown below in the following table and figure.

Table 4.30.2. Emission trends (kt) for NFR 2.I Wood Processing

Year/Pollutant	TSP (kt)
1990	2.589
1991	2.157
1992	1.849
1993	1.657
1994	1.521
1995	1.445
1996	1.560
1997	1.535
1998	1.428

Year/Pollutant	TSP (kt)
1999	1.279
2000	1.240
2001	2.234
2002	2.389
2003	2.268
2004	2.638
2005	2.665
2006	2.760
2007	2.975
2008	3.098
2009	3.455
2010	3.899
2011	4.543
2012	4.570
2013	5.153
2014	5.218
2015	5.181
2016	4.814
2017	4.539
2018	4.541

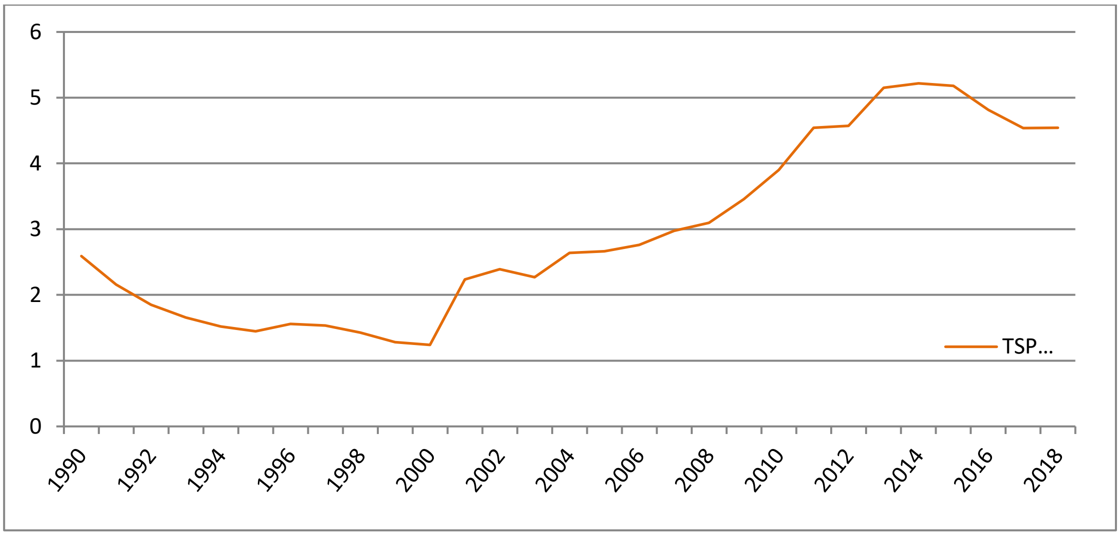


Figure 4.30.2. Emission trends (kt) for NFR 2.I Wood Processing

The emissions of TSP from wood processing activities follow the activity data trends which varied substantially from year to year due to high variation of industry outputs, with increasing interest in this industry over the last years.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

5. AGRICULTURE (NFR sector 3)

The agricultural sector includes emissions from manure management (NFR 3.B), agricultural soils (NFR 3.D) and fields burning of agricultural residue (NFR 3.F).

The emission calculation is based on the methodologies provided in the 2016 EMEP/EEA Guidebook for 3.B categories and the new edition 2019 for the NFR 3D and NFR 3F.

Animal populations, data on fertilizers usage and crop productions are taken from the Statistical Yearbook provided by the N.I.S. and from the Romania's Greenhouse Gas Inventory – N.I.R., improving the consistency between data for NFR and CRF, considering that many of the agricultural activities data for estimation of air pollutants are the same as for greenhouse gas emissions (TERT recommendations).

The emission from the agricultural activities covers a range of pollutants.

Table 5.1 An overview of sources and pollutants in agricultural activities

NFR codes	Long name	Main pollutants			Particulate matter					Other pollutants		
		NOx (as NO_2)	NMVOC	SOx (as SOx)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	HM [a)]	POPs [b)]
3B	Manure Management	x	x		x	x	x	x				
3Da	Agricultural soils	x			x							
3Dc	Farm-level agricultural operations					x	x	x				
3De	Cultivated crops		x									
3F	Field burning of agricultural residues	x	x	x	x	x	x	X	x	x	x	x

[a)] *As, Cd, Cr, Cu, Hg, Ni, Pb, Se and Zn*

[b)] *Dioxins and furanes (PCDD/F) and polycyclic aromatic hydrocarbons (PAH – benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoran-thene and indeno(1,2,3-cd)pyrene*

Table 5.2 - The agricultural contribution of total national emissions in 2018

	NH_3	NOx	SOx	NMVOC	$PM_{2.5}$	PM_{10}	TSP
National total (kt)	175.61	225.38	82.47	237.37	110.74	146.43	222.77
Agriculture total (kt)	156.37	25.34	0.000806	32.43	1.19	19.06	29.62
Weight percentage (%)	89.04%	11.24%	9.82E-04%	13.66%	1.07%	13.02%	13.30%

For the year 2018, the main part of the NH_3 emission (89.04%) is related to the agricultural sector, while the contribution of NMVOC share from agriculture accounts for almost 14% of the national total. The TSP, PM_{10} and $PM_{2.5}$ emissions from manure management are 13%, 13% and 1%, respectively, of the national total. The inventory also includes the NOx emissions from application of inorganic fertilisers and animal manure, which results in 11.24 % of the national total. The total SOx emissions from agriculture is lower than 0.01% from the national total.

Tabel 5.3 – Key Sources Categories for Agricultural Sector – NFR 3

Key Sources	**NFR Codes**	**Long name Category**
NOx	3Da1	Inorganic N-fertilizers
NMVOC	3De	Cultivated crops
	3B1a	Manure management - Dairy cattle
	3B4gii	Manure management - Broilers
NH3	3Da2a	Animal manure applied to soils
	3Da1	Inorganic N-fertilizers
	3B1a	Manure management - Dairy cattle
	3B3	Manure management - Swine
	3Da3	Urine and dung deposited by grazing animals
	3B4gi	Manure management - Laying hens
PM10	3Dc	Farm-level agricultural operations
TSP	3Dc	Farm-level agricultural operations
	3B4gi	Manure management - Laying hens

Information on which source sectors include the condensable component of particulate matter, as provided by the Guidebook 2019 (pg. 8) is presented in the sector 3D Crop production and agricultural soils: *"The processes which result in particulate emissions are largely low-temperature mechanical activities, and emissions are unlikely to include substantial quantities of condensable particulate material"*.

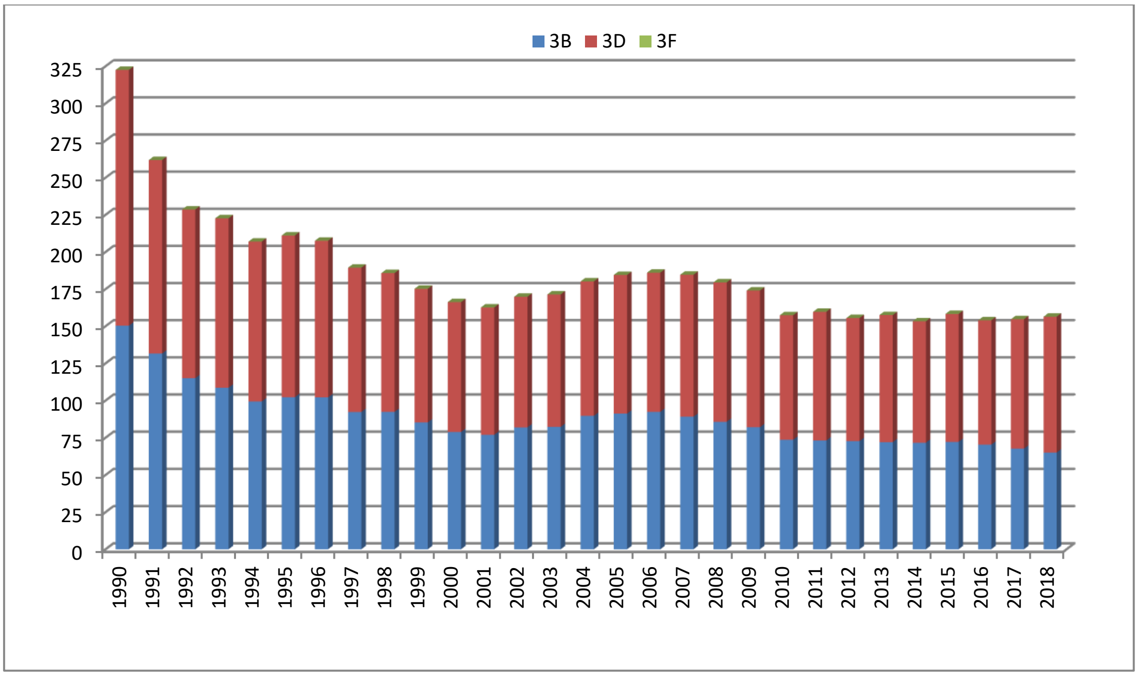


Figure 5.1 Distribution of the NH_3 emission by the agricultural sources for the 1990-2018 period

For the year 2018, the distribution of NH3 emissions by agriculture sources was as follows: 41.56% from manure management, 58.43% from manure applied to soils and only 0.0045% from burning fields.

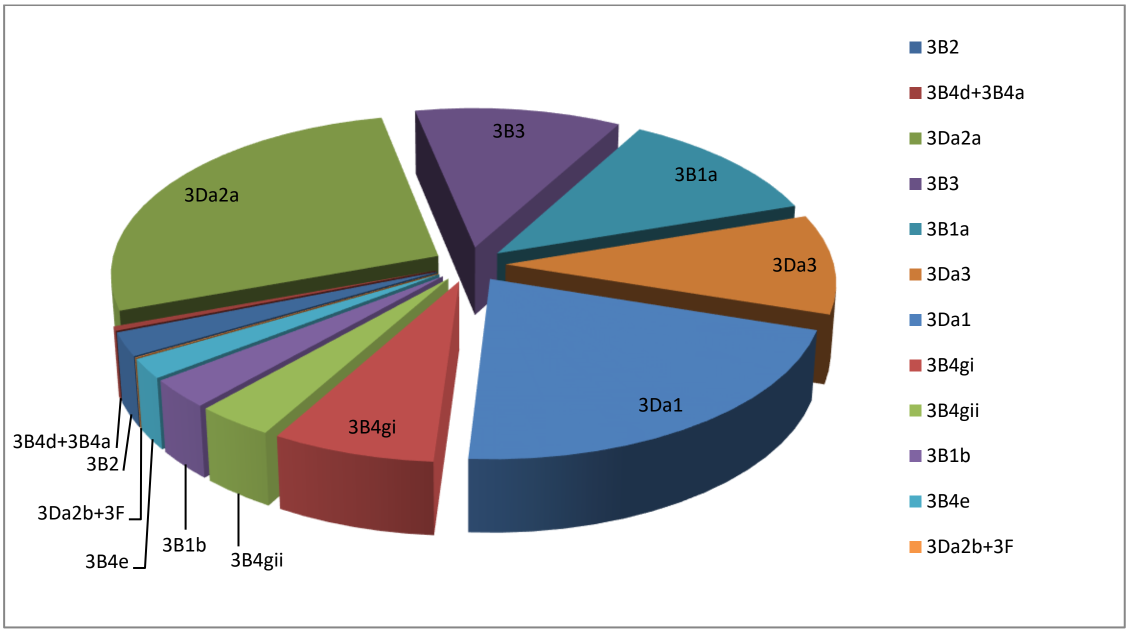


Figure 5.2 - Share of NH_3 emissions by the agriculture sector for 2018

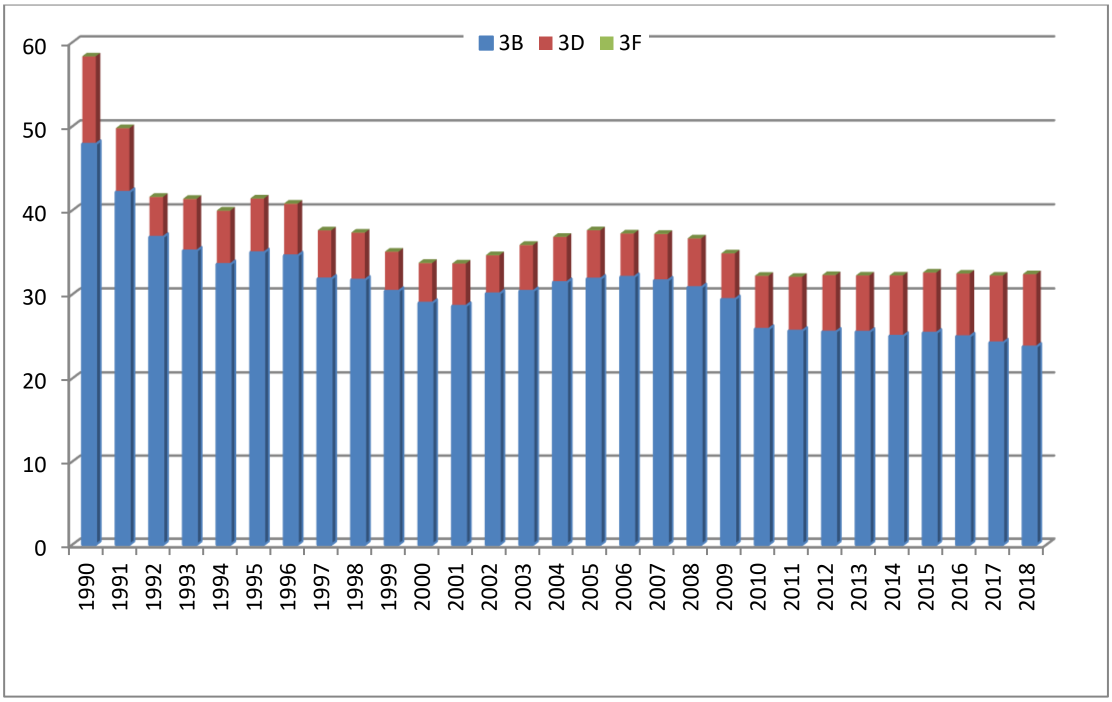


Figure 5.3 Distribution of the NMVOC emissions by the agricultural sources for 1990-2018 period

For the year 2018, the distribution of NMVOC emissions by agricultural sources was as follows: 73.34% from manure management, 26.62% from manure applied to soils and only 0.0342% from burning fields. Implementation of Tier 2 method for emissions calculation of the key sources: dairy cattle, non-dairy cattle and laying hens has led to a decrease in the amount of NMVOCs for the entire time series, compared to previous submission.

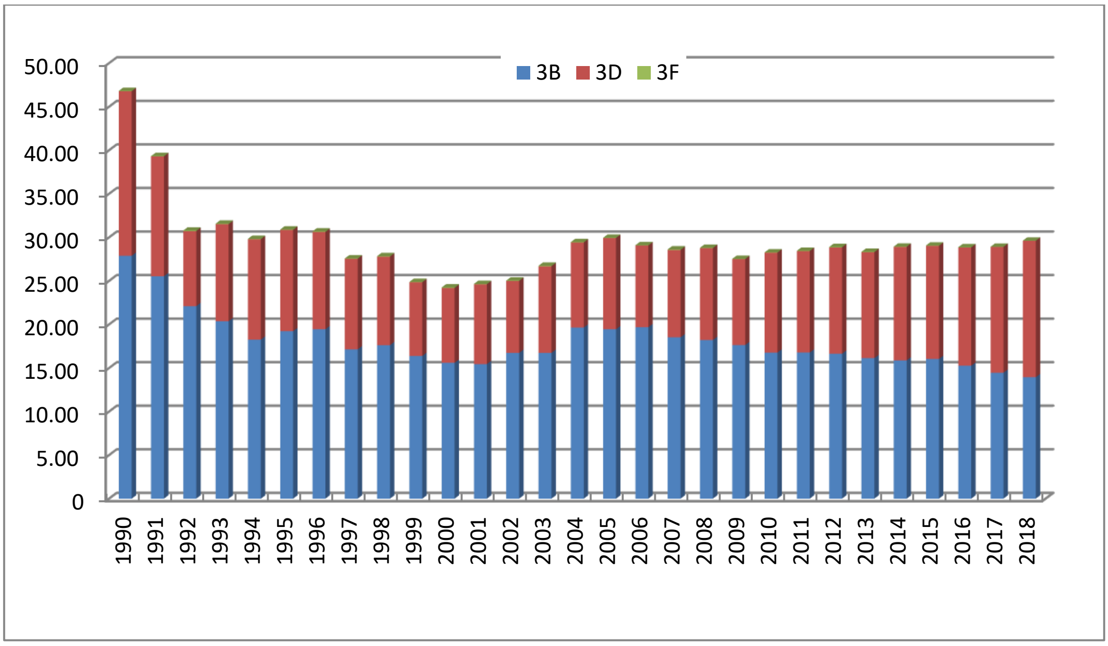


Figure 5.4 Distribution of TSP emissions by the agricultural sources for the 1990-2018 period

For the year 2018, the distribution of TSP emissions by the agricultural sources was as follows: 47.06% from manure management, 52.87 % from manure applied to soils and only 0.062% from burning fields.

3B Manure Management

Description

This sector comprises emissions arising from the agricultural and zoo technical activities, including housing, manure storage and grazing, manure treatment and manure application.

The management of manure has to be considered as the most important source of pollutants, with 40.78% of all agriculture emissions in 2018. This chapter contains emissions stemming from animal husbandry. This includes emissions from animal manure, except NFR categories 3.Da.2a - Animal manure applied to soils and 3.Da.3 - Urine and dung deposited by grazing animals.

In 2018, the majority of the emissions originate from the production of cattle (dairy and non-dairy cattle) and swine, which contributed with 32%, respectively 23% to the total emissions from manure management.

For this sector, in 2018, the key categories were represented as percentage from total national emissions, as follow:

- NMVOC : dairy cattle (2.72%) and broilers (1,63%);
- NH_3: dairy cattle (10.49%), swine (10.12%), laying hens (6.41%);
- TSP: laying hens (3.25%).

After the period 2001÷2002, the species of animals raised in Romania recorded fluctuations in the number of animals due to the economic context, and led to the emergence of the various associative forms in a new transition economy and the interest shown by farmers for the growth of certain species. So, the interest in dairy products, non-dairy cattle, sheep and goats manifested itself by increasing the number for these categories.

The livestock for these animal's categories have been taken from N.I.S. database and refined to correlate with the values of the GHG (UNFCCC)- CRF database.

The national data on the proportions of the days that livestock spend in open yard areas are not available. In the absence of country-specific data, the used value of daily TAN deposited to yards by different categories was that provided by the 2016 EMEP/EEA Guidebook.

The polluants from manure management were represented by NH_3, NMVOC, PM10, TSP and $PM_{2.5}$ and the values were according to the 2016 EMEP/EEA Guidebook, part Manure Management.

Tabel 5.4 –The categories and the metodology for emissions calculation in Manure Management

NFR code	Long Name Category	NH_3	NOx	NMVOC	$PM_{2.5}$	PM_{10}	TSP
3B1a	Dairy-cattle	T2	T1	T2	T1	T1	T1
3B1b	Non-dairy cattle	T2	T1	T2	T1	T1	T1
3B2	Sheep	T2	T1	T1	T1	T1	T1
3B3	Swine	T2	T1	T1	T1	T1	T1
3B4a	Buffalo	T1	T1	T1	T1	T1	T1
3B4d	Goats	T1	T1	T1	T1	T1	T1
3B4e	Horses	T1	T1	T1	T1	T1	T1
3B4gi	Laying hens	T2	T1	T2	T1	T1	T1
3B4gii	Broilers	T1	T1	T1	T1	T1	T1

Each emission factor reflects the sum of the emissions from animal housing and manure storage. The emissions resulting from the application of manure to soils and from grazing are reported separately under the NFR categories 3.Da.2.a and 3.Da.3.

Romania has implemented Tier 2 methodology for calculations of the ammonia (NH_3) emissions for subcategory: dairy cattle (NFR 3.B.1a), non-dairy cattle (NFR 3.B.1b), swine (NFR 3.B.3- fattening pigs and sows), sheep (NFR 3.B.2) and laying hens (NFR 3.B.4.g.i), as follows: Manure management (3B) based on the Excel spreadsheet "3B manure management – appendix B" and the values from Table 3.7 – length of housing period, Nex, annual straw use in litter-based, Ncontent of straw, Table 3.9 – NH_3 default EF's and associated parameters, Table 3.10 – proportion of TAN storage for solid and slurry (2016 EMEP/EEA Guidebook). For the rest of subcategories were used Table 3.2 and Table 3.3 values, Tier 1 methodology, 2016 EMEP/EEA Guidebook.

The proportion of livestock storage on slurry-based system was made available by *"Romanian Projections for Pollutants Emissions to 2030"* for certain livestock categories, as follow: dairy cattle, non-dairy cattle, buffalos – 3% until 2013, 30% since 2014; fattening pigs – 40% until 2013, 60% since 2014; sows -30%until 2013, 60% since 2014. These values produced not only a change in ammonia emissions, but also in NMVOC and NOx emissions.

The **Annex B , 3B-Manure Management calculations**, are presented the calculations of the emissions factors in Tabel 1 and Tabel 2.

For the calculation of NMVOC Romania implements Tier 2 methodology for dairy cattle (NFR 3.B.1a), non-dairy cattle (NFR 3.B.1b) and laying hens (NFR 3.B.4.g.i), using the equations described in 2016 EMEP/EEA Guidebook with the default emissions factors from Table 3.11 and Excel spreadsheet "3B manure management – Appendix B". The values for feed intake (GE), included in calculation for subcategory diary-cattle and non-diary cattle were provided by Romania's Greenhouse Gas reporting, as the volatile excretion (VS), for laying hens subcategory. Tier1 method for calculation was used for the rest of subcategories with values from table 3.4 (2016 EMEP/EEA Guidebook).

Implementation the percent of silage feeding for dairy cattle, non-dairy cattle(10%), sheep, goats and buffalos (3%) according to the study "Romanian Projections for Pollutants Emissions to 2030" has led to a decrease in the amount of NMVOCs for the entire time series.

Another reason for change was the slurry/ FYM percentage in the manure storage, with involvement in NH3 emission factor for the categories with Tier2 calculations, so in NMVOC emissions values.

The **Annex B, 3B-Manure Management calculations**, presents the calculations of the emissions factors in Tabels 3 to 6.

The PM emissions were recalculated by using the default Tier 1 PM2.5 EFs provided in the 2016 Guidebook (Table 3.5), based on the default housing period (Table 3.7) for entire time series, 1990-2018.

The Tabel no. 7 present the values for emissions factors calculation in the **Annex B**.

The calculation of NOx emissions is based on Tier 1 methodology (Table 3.3 – NO stored manure) of the 2016 EMEP/EEA Guidebook. For the emissions factor calculation, the study *"Romanian Projections for Pollutants Emissions to 2030"* provided the proportion of livestock housed on slurry-based system for certain livestock, as mentioned above.

The Tabel no. 8 present the values for calculation in the **Annex B**.

Every category of livestock is described by the trend of the activity data and the main pollutants over the period 1990-2018.

Table 5.5 - Activity data trends (*Population Size (1000 head)*) for the livestock categories in Romania

Year/Pollutant	Dairy cattle	Non-dairy cattle	Sheep	Fatting pigs	Sows	Buffalos	Goats	Horses	Laying hens	Broilers
1990	3002	2314	14062	11052	951	65	1005	670	51475	69904
1991	2430	1873	13879	10183	771	52	954	749	50213	55819
1992	2055	1584	12079	9060	792	44	805	721	42406	45319
1993	2007	1547	11499	8584	678	43	776	751	37981	38551
1994	1942	1497	10897	7182	576	42	745	784	36233	33924
1995	1950	1504	10381	7370	590	42	705	806	38574	41950
1996	1916	1477	9663	7651	584	41	654	816	38883	39596
1997	1805	1391	8938	6591	506	39	610	822	35089	31531
1998	1753	1352	8409	6679	515	38	585	839	37272	32207
1999	1702	1312	8121	5443	405	37	558	858	38497	30646
2000	1601	1234	7657	4474	323	34	538	864	40760	29316
2001	1562	1204	7251	4113	334	34	525	860	42156	29258
2002	1606	1238	7312	4696	362	35	633	879	44667	32712
2003	1616	1246	7447	4810	335	35	678	897	44122	32495
2004	1566	1208	7425	6069	426	34	661	840	51889	35126
2005	1626	1191	7611	6128	494	45	687	834	49725	36827
2006	1639	1254	7678	6295	520	41	727	805	50278	34713
2007	1573	1214	8469	6122	442	32	865	862	45208	36828
2008	1483	1170	8882	5797	376	30	898	820	45529	38844
2009	1419	1063	9141	5434	359	30	917	764	45046	38797
2010	1179	797	8417	5073	356	25	1241	611	44504	36341
2011	1154	814	8533	4983	381	21	1236	596	45464	34378
2012	1147	842	8834	4836	399	20	1266	575	45402	34734
2013	1155	849	9136	4797	384	18	1313	548	42541	36899
2014	1173	825	9518	4663	378	20	1417	525	42739	32708
2015	1176	898	9810	4552	375	18	1440	503	43663	34985
2016	1177	853	9875	4347	361	20	1483	520	40833	34857
2017	1160	832	9982	4056	350	19	1503	481	38312	34977
2018	1143	815	10176	3616	309	19	1539	448	38134	35859

5.1 NFR 3.B.1.a Manure management - Dairy cattle

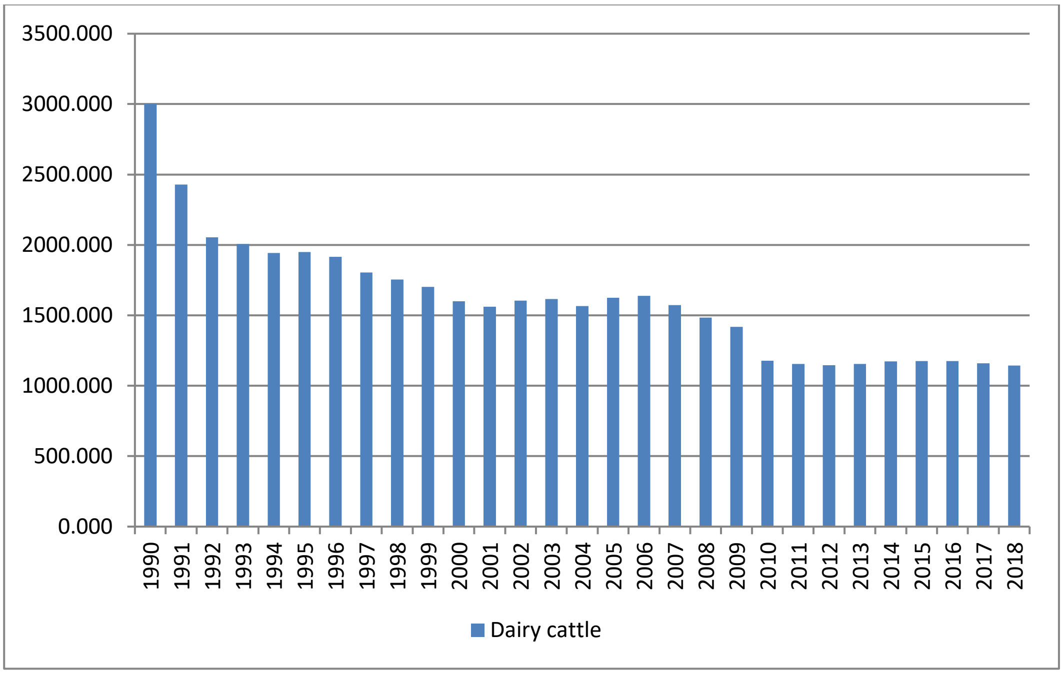


Figure 5.1.1. Activity data trends (*Population Size (1000 head)*) for NFR 3.B.1.a Manure management - Dairy cattle

Activity data for dairy cattle with which the graph was obtained are presented in table 5.5 above.

Table 5.1.1. Emission trends (kt) for NFR 3.B.1.a Manure management - Dairy cattle

Year/Pollutant	NMVOC	NH_3
1990	13.526	46.698
1991	11.418	37.794
1992	9.948	31.962
1993	9.889	31.216
1994	9.955	30.209
1995	10.150	30.339
1996	10.053	29.810
1997	9.581	28.074
1998	9.300	27.276
1999	9.019	26.477
2000	8.596	24.907
2001	8.525	24.299
2002	8.781	24.976
2003	8.944	25.141
2004	8.817	24.366
2005	9.037	25.288
2006	9.243	25.501
2007	8.811	24.467
2008	8.378	23.073
2009	7.901	22.073

Year/Pollutant	NMVOC	NH_3
2010	6.691	18.333
2011	6.656	17.951
2012	6.531	17.841
2013	6.590	17.963
2014	6.727	18.913
2015	6.671	18.960
2016	6.599	18.968
2017	6.507	18.702
2018	6.447	18.430

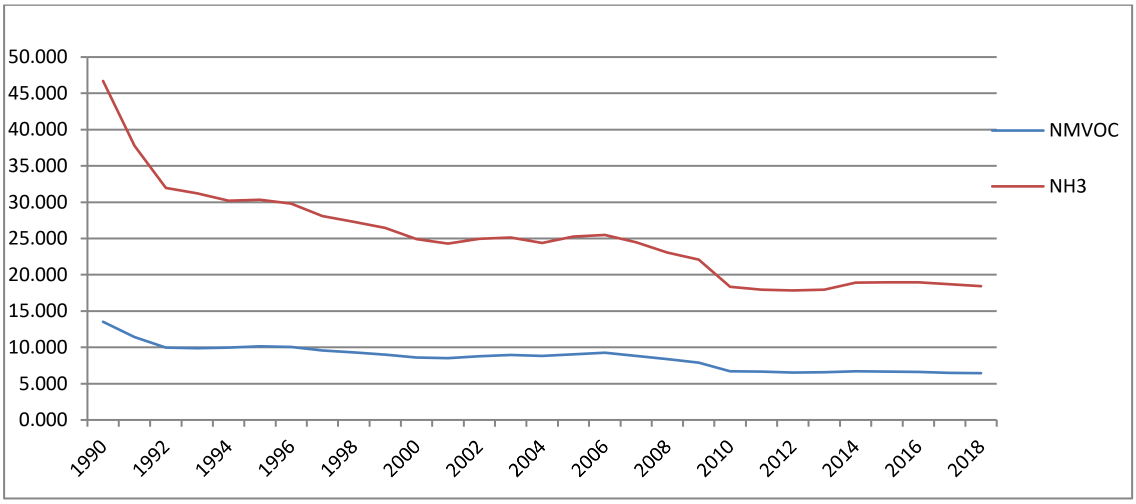


Figure 5.1.2. Emission trends (kt) for NFR 3.B.1.a Manure management - Dairy cattle

The emissions of NMVOC and NH_3 from manure management – dairy cattle follow the activity data trends which varied from year to year due variations in livestock.

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

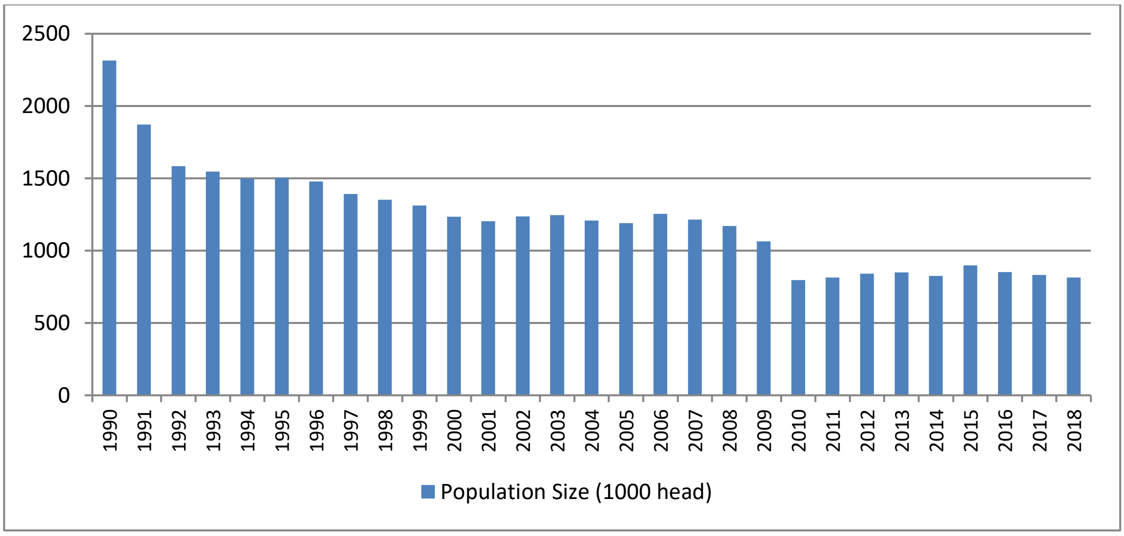


Figure 5.2.1 Activity data trends (*Population Size (1000 head)*)
for NFR 3.B.1.b Manure management - Non-dairy cattle

Activity data for non-dairy cattle with which the graph was obtained are presented in table 5.5 above.

Table 5.2.1 Emission trends (kt) for NFR 3.B.1.b Manure management - Non-dairy cattle

Year/Pollutant	NMVOC	NH_3
1990	8.2217	12.3885
1991	6.6540	10.0264
1992	5.6273	8.4792
1993	5.4959	8.2812
1994	5.3186	8.0142
1995	5.3416	8.0487
1996	5.2484	7.9083
1997	4.9428	7.4478
1998	4.8022	7.2360
1999	4.6616	7.0242
2000	4.3851	6.6075
2001	4.2781	6.4463
2002	4.3973	6.6259
2003	4.4263	6.6697
2004	4.2909	6.4656
2005	4.2316	6.3762
2006	4.4535	6.7106
2007	4.3123	6.4978
2008	4.1571	6.2640
2009	3.7775	5.6919
2010	2.8317	4.2668
2011	2.8906	4.3556
2012	2.9910	4.5069
2013	3.0173	4.5465
2014	2.9292	4.6319
2015	3.1898	5.0440
2016	3.0297	4.7909
2017	2.9564	4.6749
2018	2.8951	4.5780

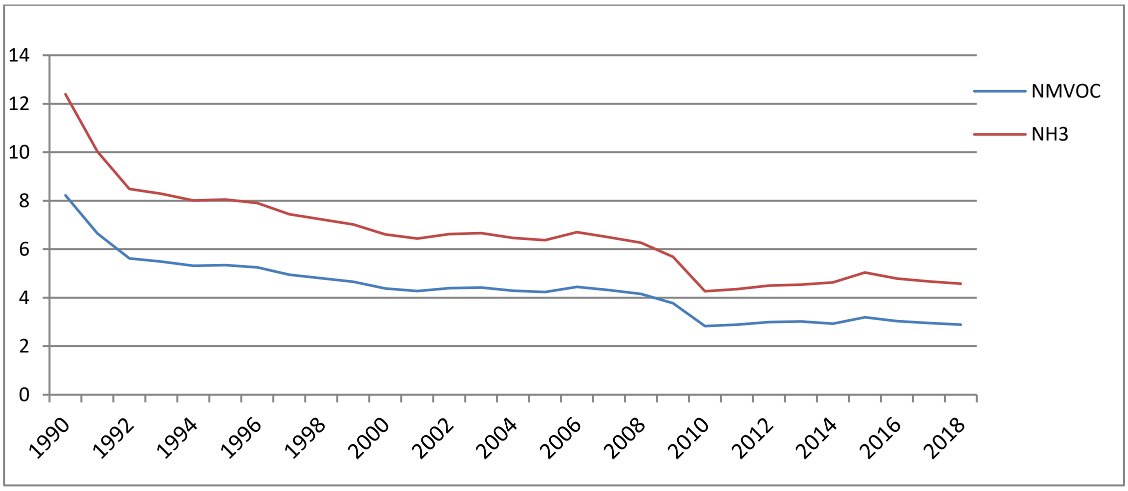


Figure 5.2.2 Emission trends (kt) for NFR 3.B.1.b Manure management - Non-dairy cattle for NMVOC and NH_3

The emissions of NMVOC and NH_3 from manure management-non-dairy cattle follow the activity data trends which varied from year to year due variations in livestock.

5.3 NFR 3.B.2 Sheep

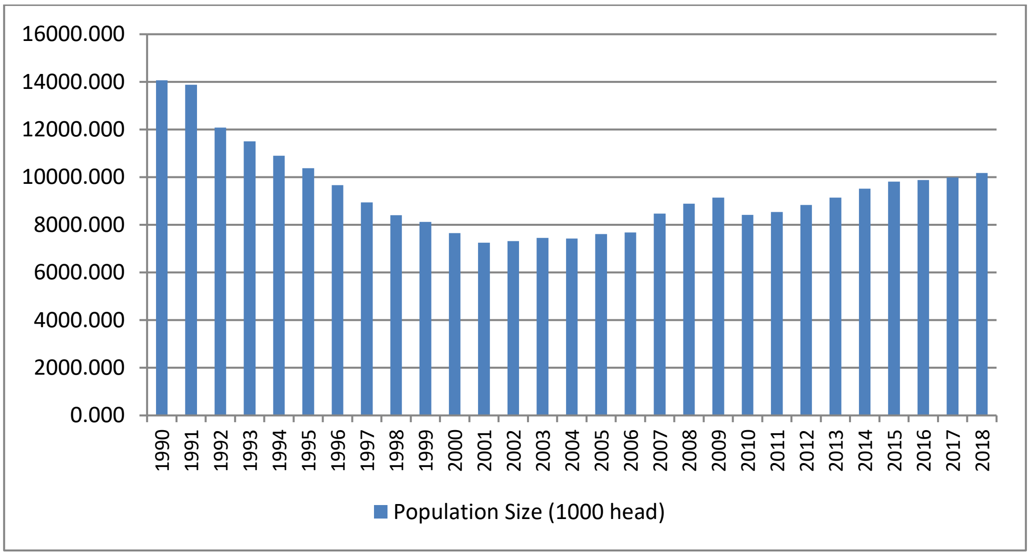


Figure 5.3.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.2 Manure management – Sheep

Activity data for sheep with which the graph was obtained are presented in table 5.5 above.

Table 5.3.1 Emission trends (kt) for 3.B.2 Manure management – Sheep

Year/Pollutant	NMVOC	NH_3
1990	2.4229	5.1737
1991	2.3914	5.1063
1992	2.0812	4.4441
1993	1.9813	4.2308
1994	1.8775	4.0091
1995	1.7886	3.8193
1996	1.6649	3.5550
1997	1.5400	3.2883
1998	1.4489	3.0938
1999	1.3992	2.9879
2000	1.3193	2.8171
2001	1.2494	2.6678
2002	1.2599	2.6904
2003	1.2831	2.7398
2004	1.2794	2.7319
2005	1.3114	2.8002
2006	1.3229	2.8250
2007	1.4592	3.1160
2008	1.5303	3.2677
2009	1.5751	3.3633
2010	1.4503	3.0969

Year/Pollutant	NMVOC	NH_3
2011	1.4703	3.1396
2012	1.5221	3.2501
2013	1.5741	3.3612
2014	1.6400	3.5019
2015	1.6902	3.6091
2016	1.7015	3.6334
2017	1.7199	3.6725
2018	1.7534	3.7441

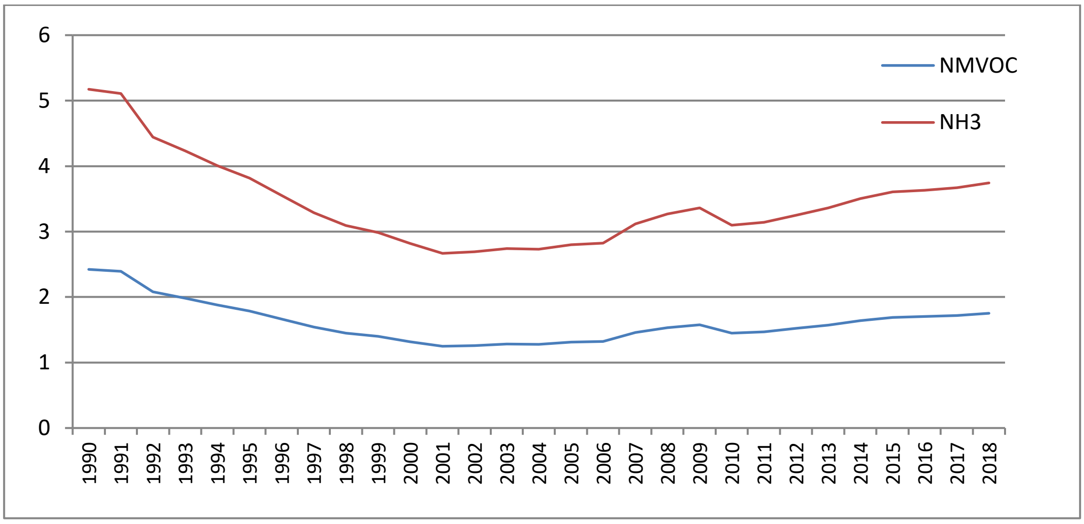


Figure 5.3.2 Emission trends (kt) for NMVOC, NH_3 for 3.B.2 Manure management – Sheep

The emissions of NMVOC, NH_3 and TSP from the manure management-sheep follow the activity data trends which varied from year to year due variations in livestock.

5.4 NFR 3.B.3 Swine

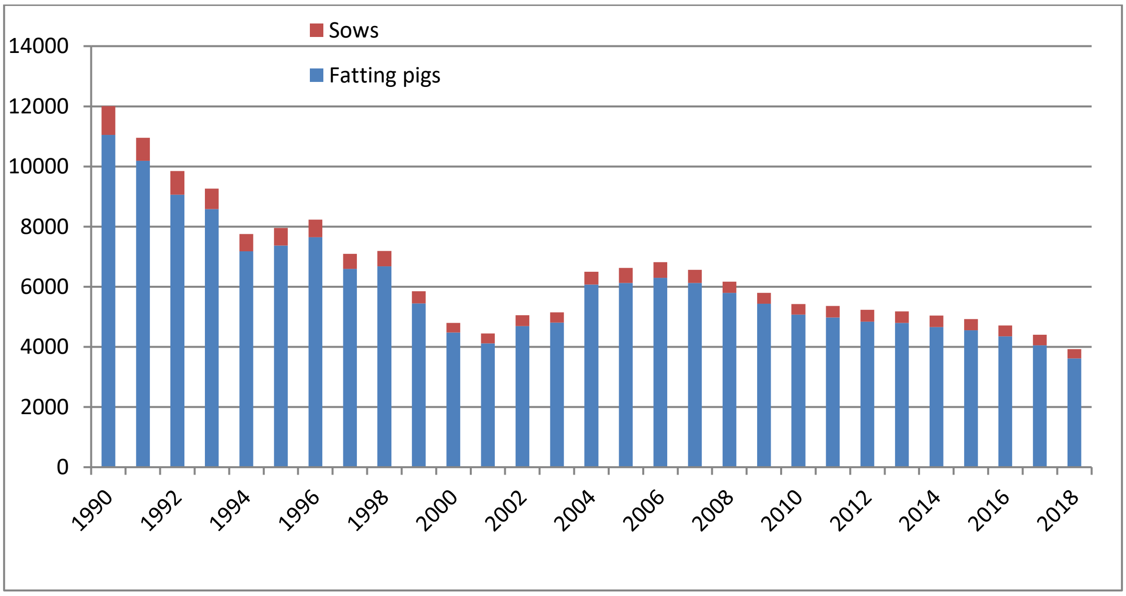


Figure 5.4.1 Activity data trends (Population Size (1000 head))
for NFR 3.B.3 Manure management – Swine

Activity data for swine with which the graph was obtained are presented in table 5.5 above.

Table 5.4.1 Emission trends (kt) for NFR 3.B.3 Manure management - Swine

Year/Pollutant	NMVOC fatting pigs	NH_3 fatting pigs	NMVOC sows	NH3 sows
1990	1.6205	44.7759	6.0897	10.2480
1991	1.3138	41.2553	5.6108	8.3083
1992	1.3496	36.7056	4.9921	8.5346
1993	1.1553	34.7771	4.7298	7.3061
1994	0.9815	29.0971	3.9573	6.2070
1995	1.0054	29.8587	4.0609	6.3578
1996	0.9951	30.9972	4.2157	6.2932
1997	0.8622	26.7027	3.6316	5.4526
1998	0.8776	27.0592	3.6801	5.5496
1999	0.6901	22.0517	2.9991	4.3643
2000	0.5504	18.1259	2.4652	3.4806
2001	0.5691	16.6634	2.2663	3.5992
2002	0.6168	19.0253	2.5875	3.9009
2003	0.5708	19.4872	2.6503	3.6100
2004	0.7259	24.5879	3.3440	4.5906
2005	0.8418	24.8261	3.3765	5.3286
2006	0.8861	25.5000	3.4685	5.6084
2007	0.7540	24.8043	3.3735	4.7681
2008	0.6414	23.4869	3.1943	4.0565
2009	0.6122	22.0157	2.9942	3.8718
2010	0.6059	20.5513	2.7950	3.8320
2011	0.6485	20.1889	2.7457	4.1012
2012	0.6795	19.5907	2.6644	4.2970
2013	0.6538	19.4325	2.6429	4.1344
2014	0.6447	18.7798	2.5696	3.9235
2015	0.6384	18.3322	2.5083	3.8850
2016	0.6155	17.5035	2.3949	3.7457
2017	0.5962	16.3341	2.2349	3.6283
2018	0.5262	14.5636	1.9927	3.2023

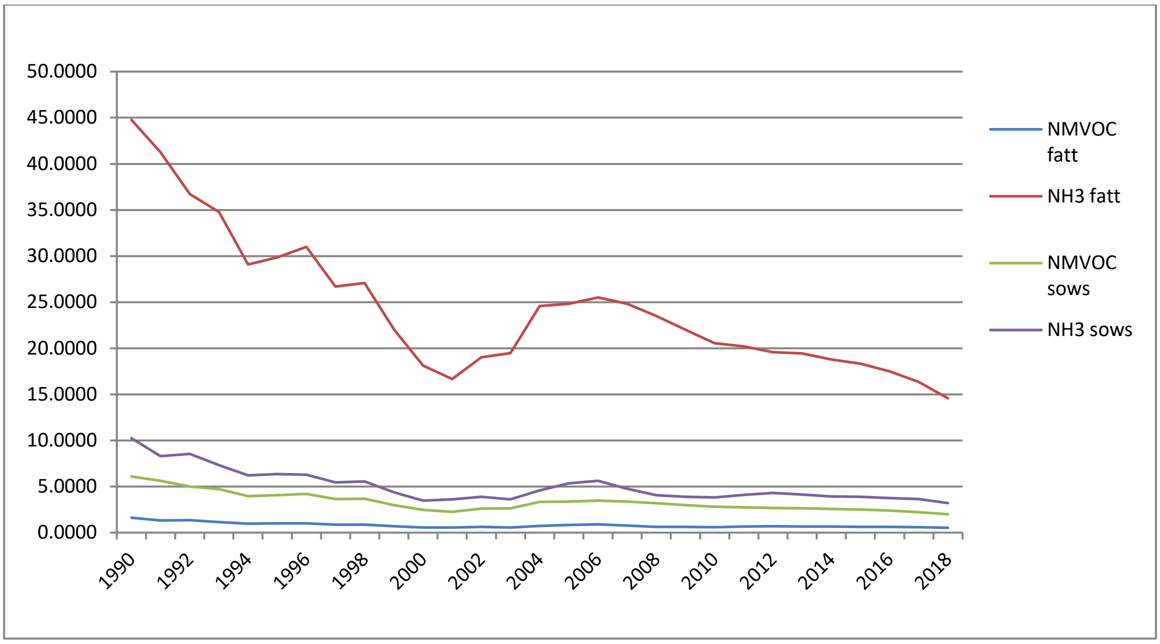


Figure 5.4.2 Emission trends (kt) for 3.B.3 Manure management – Swine

The NMVOC and NH_3 emissions from manure management - swine follow the activity data trends which varied from year to year due variations in livestock.

5.5 NFR 3.B.4.a Buffalo

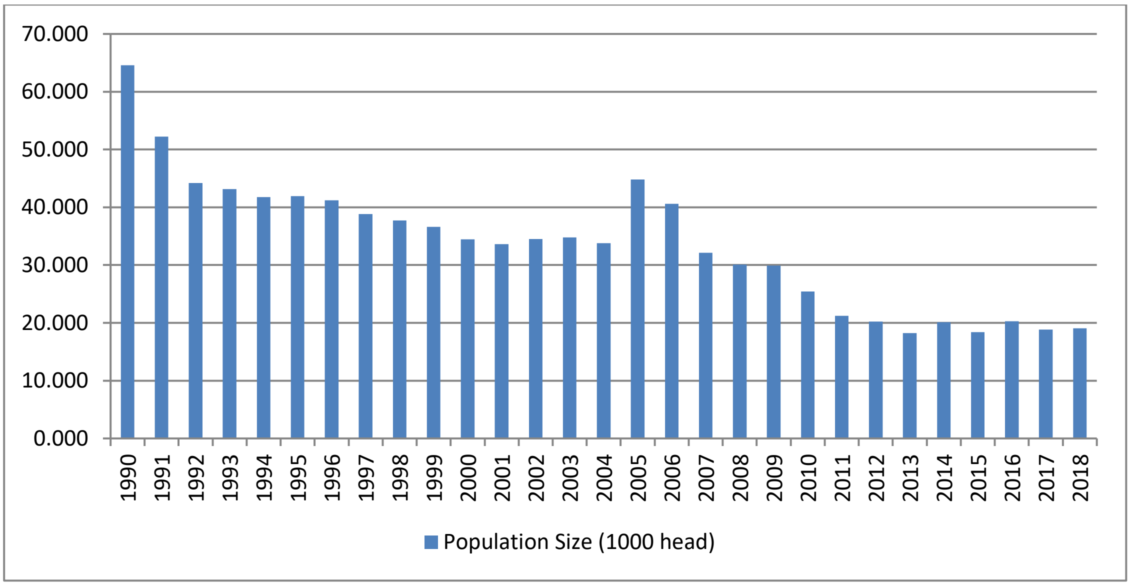


Figure 5.5.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.a Manure management – Buffalo

Activity data for buffalos with which the graph was obtained are presented in table 5.5 above.

Table 5.5.1 Emission trends (kt) for NFR 3.B.4.a Manure management – Buffalo

Year/Pollutant	NMVOC	NH_3
1990	0.2843	0.2777
1991	0.2301	0.2247
1992	0.1946	0.1900
1993	0.1900	0.1856
1994	0.1839	0.1796
1995	0.1847	0.1804
1996	0.1815	0.1772
1997	0.1709	0.1669
1998	0.1661	0.1622
1999	0.1612	0.1574
2000	0.1516	0.1481
2001	0.1479	0.1445
2002	0.1521	0.1485
2003	0.1531	0.1495
2004	0.1488	0.1453
2005	0.1973	0.1927
2006	0.1787	0.1745
2007	0.1416	0.1383
2008	0.1325	0.1294
2009	0.1317	0.1287
2010	0.1120	0.1094
2011	0.0934	0.0912
2012	0.0891	0.0870
2013	0.0802	0.0784
2014	0.0884	0.0864
2015	0.0809	0.0791
2016	0.0893	0.0872
2017	0.0829	0.0809
2018	0.0840	0.0820

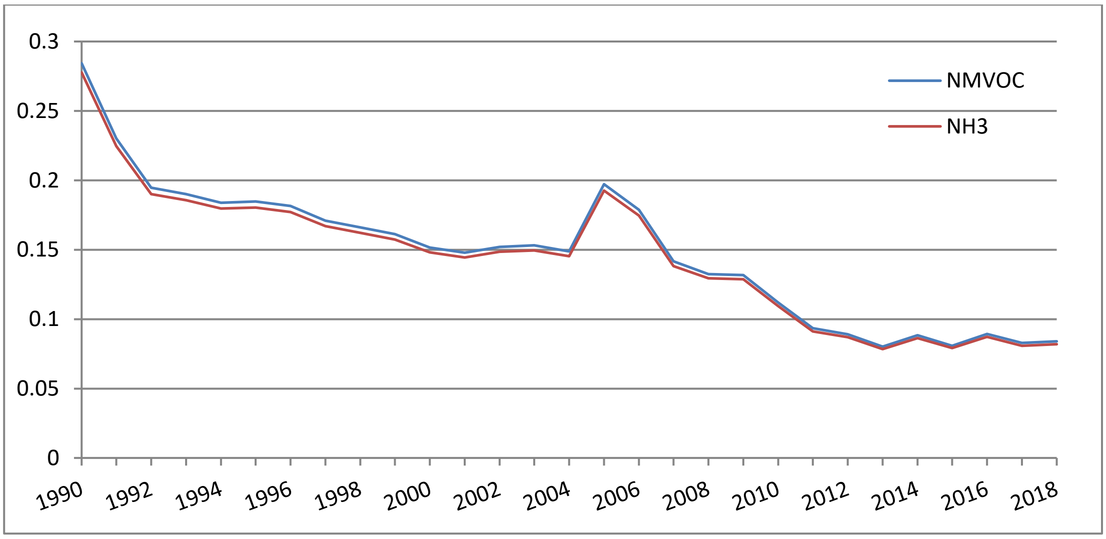


Figure 5.5.2 Emission trends (kt) for NFR 3.B.4.a Manure management - Buffalo

The emissions of NMVOC and NH_3 from manure management-buffalo follow the activity data trends which varied from year to year due variations in livestock.

5.6 NFR 3.B.4.d Goats

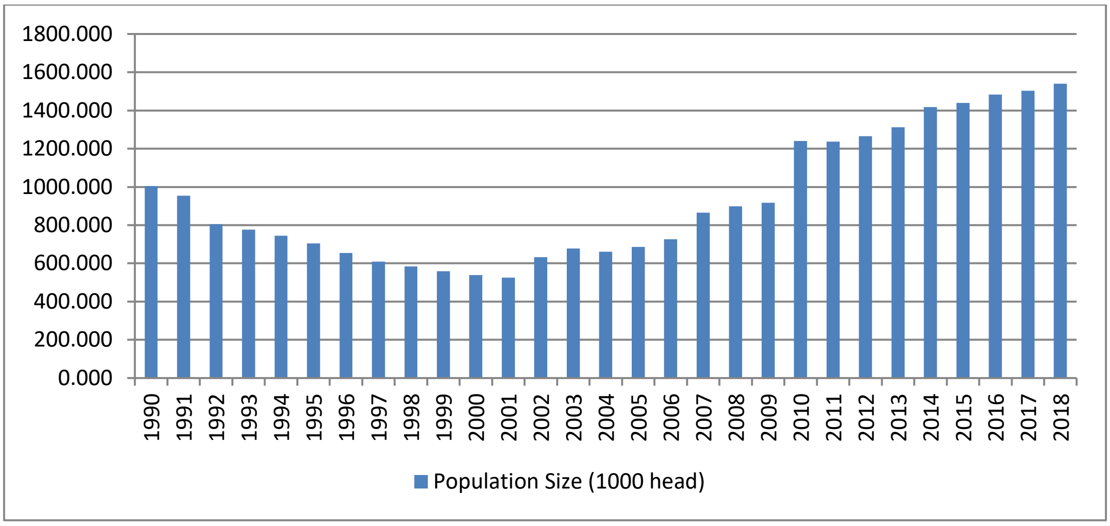


Figure 5.6.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.d Manure management – Goats

Activity data for goats with which the graph was obtained are presented in table 5.5 above.

Table 5.6.1 Emission trends (kt) for NFR 3.B.4.d Manure management - Goats

Year/Pollutant	NMVOC	NH_3
1990	0.5472	0.4020
1991	0.5194	0.3816
1992	0.4383	0.3220
1993	0.4227	0.3105
1994	0.4057	0.2980
1995	0.3840	0.2821
1996	0.3563	0.2618
1997	0.3319	0.2439
1998	0.3184	0.2339
1999	0.3039	0.2233
2000	0.2929	0.2152
2001	0.2859	0.2101
2002	0.3446	0.2532
2003	0.3692	0.2712
2004	0.3597	0.2643
2005	0.3739	0.2747
2006	0.3958	0.2910
2007	0.4710	0.3460
2008	0.4891	0.3593
2009	0.4994	0.3669
2010	0.6756	0.4963
2011	0.6730	0.4945

Year/Pollutant	NMVOC	NH_3
2012	0.6891	0.5063
2013	0.7149	0.5252
2014	0.7716	0.5669
2015	0.7841	0.5761
2016	0.8075	0.5933
2017	0.8185	0.6013
2018	0.8381	0.6157

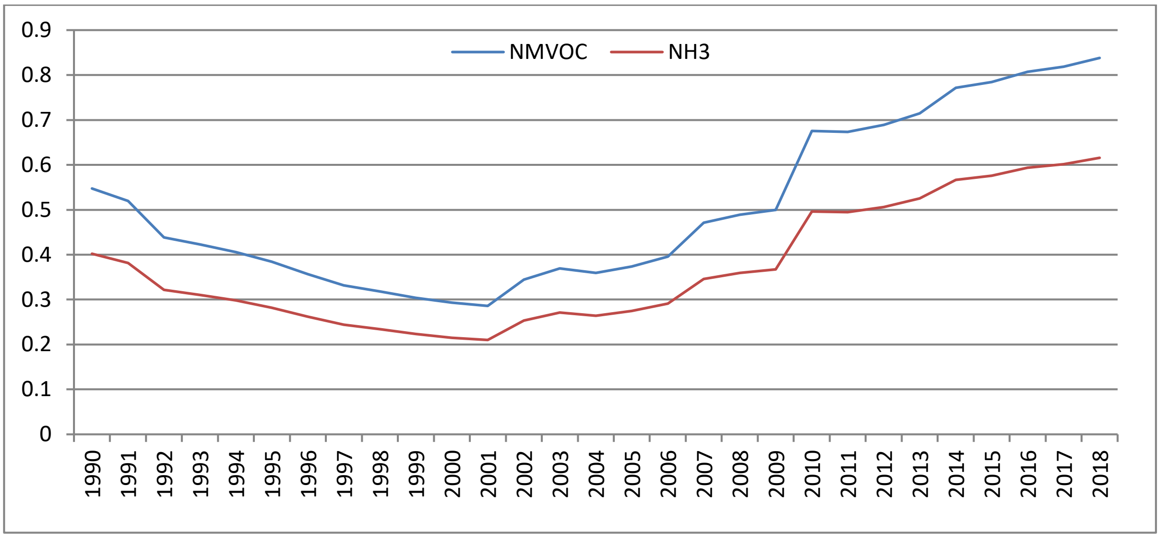


Figure 5.6.2 Emission trends (kt) for NFR 3.B.4.d Manure management – Goats

The emissions of NMVOC and NH_3 from manure management - goats follow the activity data trends which varied from year to year due variations in livestock.

5.7 NFR 3.B.4.e Manure management - Horses

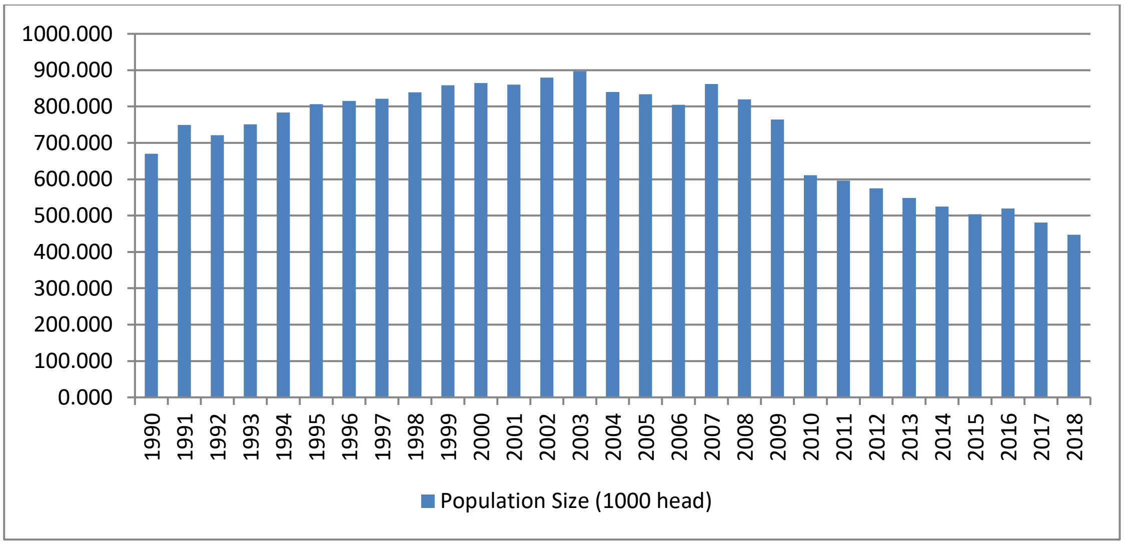


Figure 5.7.2 Activity data trends (*Population Size (1000 head)*)
for NFR 3.B.4.e Manure management – Horses

Activity data for horses with which the graph was obtained are presented in table 5.5 above. The mules and donkeys are included in horses category.

Table 5.7.1 Emission trends (kt) for NFR 3.B.4.e Manure management - Horses

Year/Pollutant	NMVOC	NH_3
1990	4.0388	4.6900
1991	4.5150	5.2430
1992	4.3462	5.0470
1993	4.5278	5.2579
1994	4.7247	5.4865
1995	4.8610	5.6448
1996	4.9169	5.7097
1997	4.9530	5.7517
1998	5.0596	5.8754
1999	5.1726	6.0067
2000	5.2110	6.0512
2001	5.1859	6.0221
2002	5.3009	6.1557
2003	5.4062	6.2779
2004	5.0610	5.8771
2005	5.0271	5.8377
2006	4.8525	5.6350
2007	5.1961	6.0340
2008	4.9400	5.7366
2009	4.6053	5.3479
2010	3.6822	4.2760
2011	3.5950	4.1747
2012	3.4639	4.0224
2013	3.3048	3.8377
2014	3.1631	3.6732
2015	3.0349	3.5243
2016	3.1340	3.6393
2017	2.8979	3.3652
2018	2.6993	3.1345

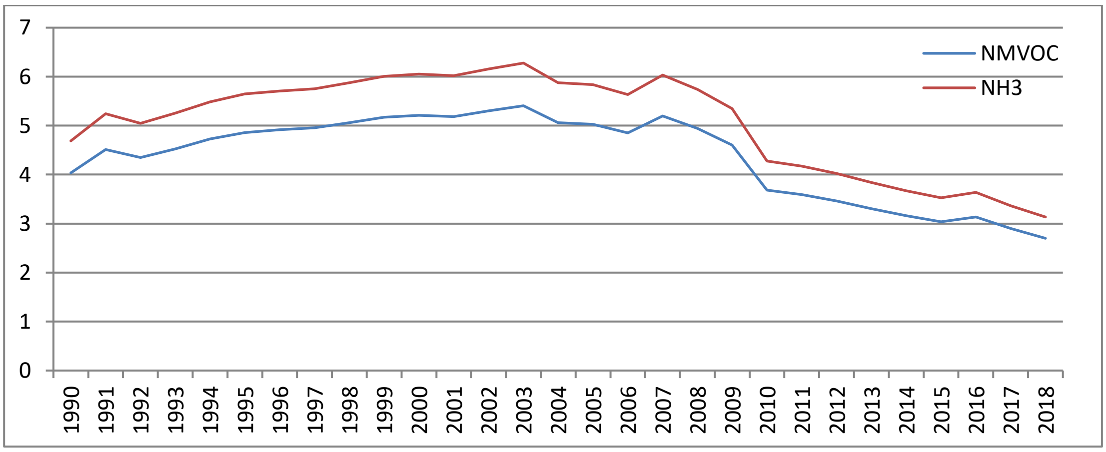


Figure 5.7.2 Emission trends (kt) for NFR 3.B.4.e Manure management - Horses

The emissions of NMVOC and NH_3 from manure management - horses follow the activity data trends which varied from year to year due variations in livestock.

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

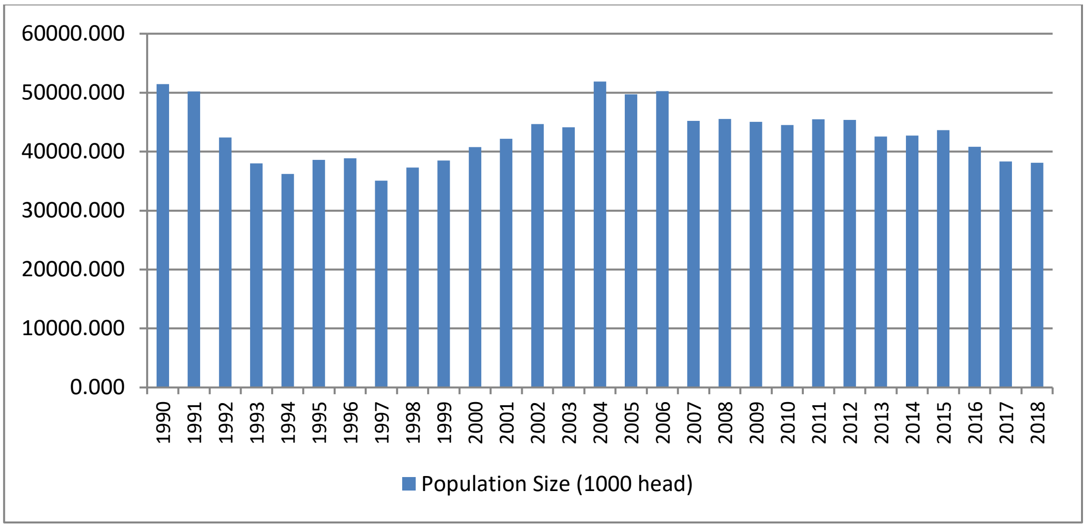


Figure 5.8.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.g.i Manure management - Laying hens

Activity data for laying hens with which the graph was obtained are presented in table 5.5 above

Table 5.8.1 Emission trends (kt) for NFR 3.B. 4.g.i Manure management - Laying hens

Year/Pollutant	NMVOC	NH_3	TSP
1990	3.6137	15.2045	9.7803
1991	3.5251	14.8317	9.5405
1992	2.9770	12.5257	8.0571
1993	2.6663	11.2185	7.2163
1994	2.5436	10.7024	6.8843
1995	1.9073	11.3939	7.3291
1996	1.9226	11.4850	7.3877
1997	1.7350	10.3644	6.6669
1998	1.8430	11.0094	7.0818
1999	1.9035	11.3711	7.3145
2000	2.0154	12.0395	7.7444
2001	2.0844	12.4517	8.0096
2002	2.2086	13.1934	8.4866
2003	2.1816	13.0325	8.3831
2004	2.5657	15.3267	9.8589
2005	2.4587	14.6876	9.4478
2006	2.4860	14.8509	9.5528
2007	2.2353	13.3534	8.5895
2008	2.2512	13.4482	8.6505

Year/Pollutant	NMVOC	NH_3	TSP
2009	2.2273	13.3054	8.5587
2010	2.2005	13.1453	8.4557
2011	2.2480	13.4289	8.6381
2012	2.2449	13.4106	8.6264
2013	2.1035	12.5657	8.0828
2014	2.1132	12.6239	8.1203
2015	2.1589	12.8969	8.2959
2016	2.0190	12.0611	7.7583
2017	1.8944	11.3165	7.2793
2018	2.6771	11.2639	7.2455

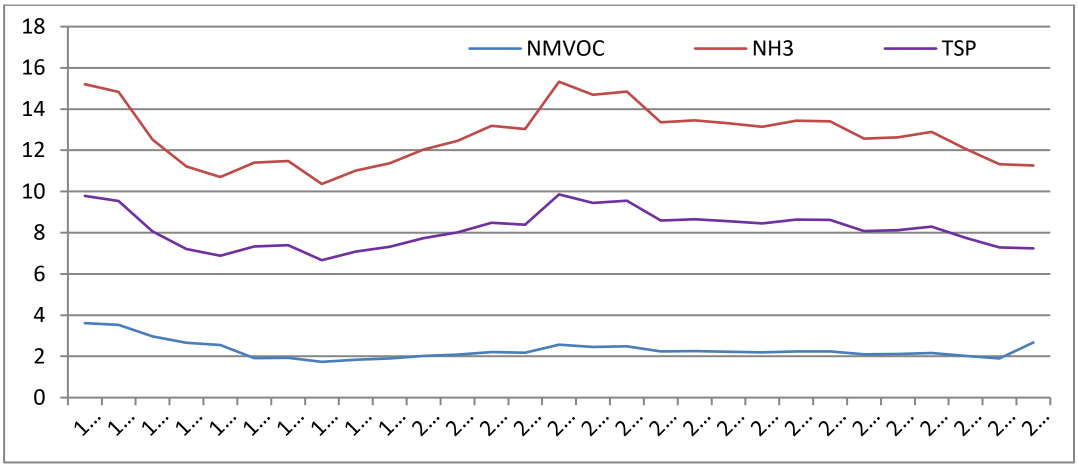


Figure 5.8.2 Emission trends (kt) for NFR 3.B.4.g.i Manure management - Laying hens

The emissions of NMVOC, NH_3 and PM_{10} from manure management – laying hens follow the activity data trends which varied from year to year due variations in livestock.

5.9 NFR 3.B.4.g.ii Manure management – Broilers

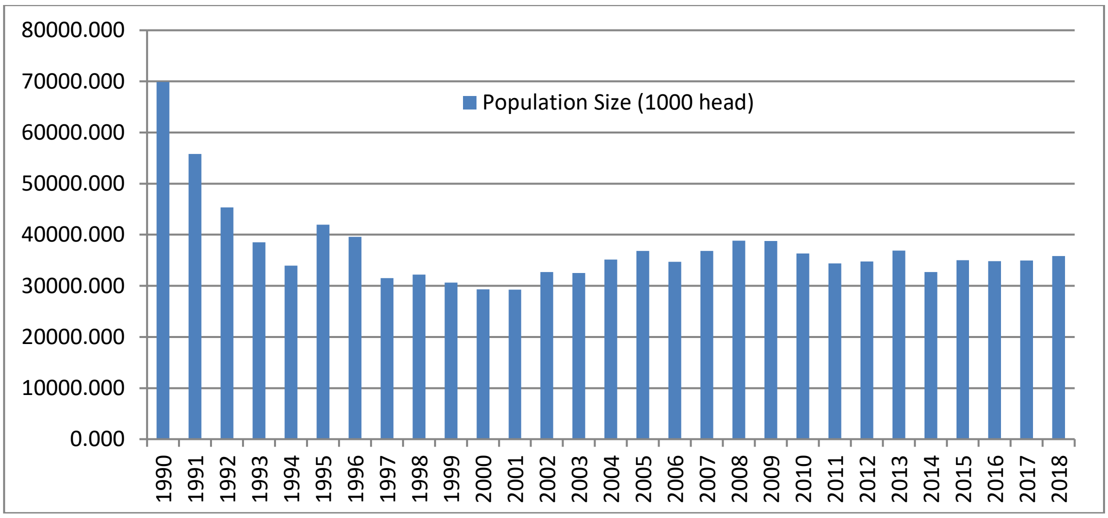


Figure 5.9.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.g.ii Manure management – Broilers

Activity data for broilers with which the graph was obtained are presented in table 5.5 above.

Table 5.9.1 Emission trends (kt) for NFR 3.B.4.g.ii Manure management - Broilers

Year/Pollutant	NMVOC	NH_3
1990	7.5496	10.4856
1991	6.0285	8.3729
1992	4.8945	6.7979
1993	4.1635	5.7827
1994	3.6637	5.0885
1995	4.5306	6.2925
1996	4.2763	5.9394
1997	3.4054	4.7297
1998	3.4784	4.8311
1999	3.3097	4.5969
2000	3.1661	4.3973
2001	3.1598	4.3887
2002	3.5329	4.9069
2003	3.5094	4.8742
2004	3.7936	5.2688
2005	3.9773	5.5241
2006	3.7490	5.2068
2007	3.9774	5.5242
2008	4.1952	5.8266
2009	4.1901	5.8196
2010	3.9249	5.4512
2011	3.7128	5.1567
2012	3.7512	5.2101
2013	3.9851	5.5348
2014	3.5325	4.9062
2015	3.7784	5.2478
2016	3.7645	5.2285
2017	3.7775	5.2465
2018	3.8728	5.3789

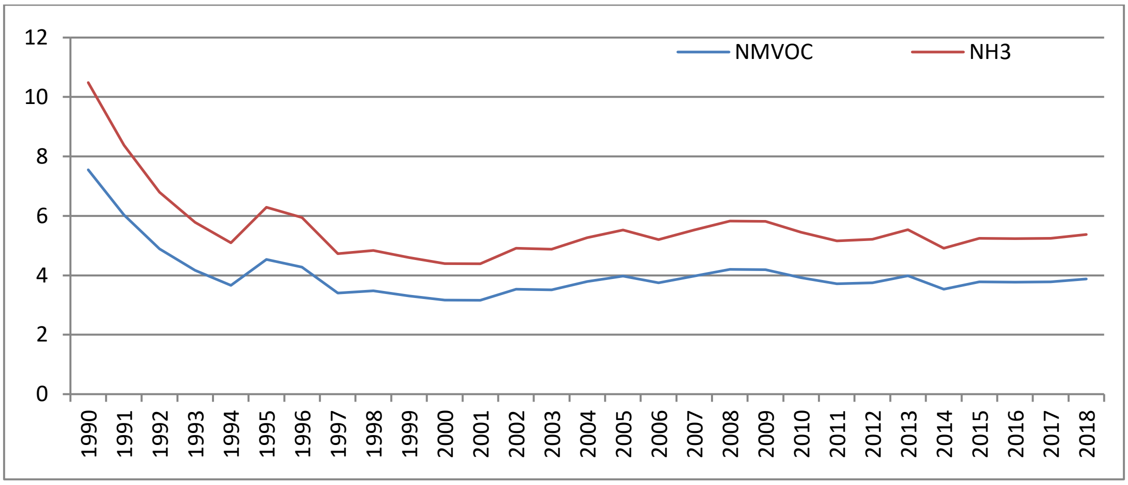


Figure 5.9.2 Emission trends (kt) for NFR 3.B.4.g.ii Manure management – Broilers

The emissions of NMVOC, NH_3 and PM_{10} from manure management - broilers follow the activity data trends which varied from year to year due variations in livestock.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- Recalculation the entire time series for horses PM2.5 values, due to an error of emissions factor calculation;
- The values of the slurry/liquid storage proportion in manure management available in "Romanian Projections for pollutants Emissions to 2030"study in 2018, led to a decrease in NH3 emissions mainly, with effects on NMVOC and NO2 emissions calculations, for the livestock categories calculated with Tier2 method: dairy cattle, non-dairy cattle, sheep, swine and laying hens.
- The silage feeding proportion available in "Romanian Projections for pollutants Emissions to 2030" study in 2018, led to a change in NMVOC calculation and emissions for entire time series for certain categories of livestock: dairy cattle, non-dairy cattle, sheep, goats and buffalos.

Implementation of Review recommendations:

-RO-3B1a-2019-0001 - recalculation of NMVOC emissions, with the terms of ammonia emissions involved in the calculation of Tier 2 – implemented.

Planned improvements:

- Studying for introducing and applying country-specific data for all pollutants as much as possible for a real estimation of emissions for this sector.
- Applying the approach of the new Guidebook 2019 and the Manure Management N-flow tool for NFR 3B emissions calculation.

5.10 NFR 3.D.a.1 Inorganic N-fertilizers (includes also urea application)

The inorganic N-fertiliser sector represents a key category for agricultural sector for which the emission of NH_3 and NOx were estimated.

The emission of NH_3 from inorganic fertiliser contributes in 2018 with 21.06% of the emission for the agricultural sector and emission of NOx contributes in 2018 with 73.97% of the emission for the agricultural sector, representing the first source of NOx emissions of the Agriculture sector.

The emission factors for ammonia used in the calculation were provided by Table 3-2 which corresponds to the Tier 2 methodology (EMEP/EEA Guidebook -2019), assuming soils with normal pH and cool climate for Romania.

Table 5.10.1 EFs for NH3 emissions from fertilizers (in g NH3 (kg N applied)$^{-1}$)

N-ammonia fertilizers categories	Climate-Cool, Normal pH
Ammonium nitrate (AN)	15
Ammonium phosphates (AP)	50
Ammonium sulphate (AS)	90
Calcium ammonium nitrate (CAN)	8
NK Mixtures	15
NPK Mixtures	50
NP Mixtures	50
N solutions	98
Other straight N compounds	10
Urea	155

The total inorganic N fertilizer applied to soil activity data is provided by N.I.S., but without information about the amount of N used in different fertilizer types, in accordance with the requirements of the Tier2 approach. At the recommendation of TERT, Romania studied the possibility of splitting data, according to the IFA source (https://www.fastat.org/databases/plant-nutrition). The calculation consisted in obtaining the proportions for each type of fertilizers provided by source IFA and applying then on the national data from N.I.S. The categories for N-fertilizers applied to soils vary over time, the ammonia applied direct to the fields is not used in our country.

The activity data for this categories were correlate with the CRF (UNFCCC) report.

The emissions factor for NOx used is 0.04 kg NO kg^{-1} fertiliser N applied, based on the value given in 2019 EMEP/EEA Guidebook, Table 3.1, for the entire time series, 1990-2018.

Table 5.10.2 The activity data of the N-fertilizer categories obtained by applying IFA source percentages to national data, Tier2 calculation

Year	AN (kt)	AS (kt)	CAN (kt)	N sol. (kt)	Other N (kt)	Urea (kt)	AP (kt)	NK (kt)	NPK (kt)	Other NP (kt)	TOTAL N-fert (kt)
1990	257.16	21.43	0.00	42.86	0.00	141.44	0.00	0.00	0.00	193.21	**656.09**
1991	109.97	15.00	0.00	10.00	0.00	39.99	0.00	0.00	0.00	99.98	**274.94**
1992	96.84	0.00	10.68	0.00	0.00	37.03	0.00	0.00	0.00	113.21	**257.76**
1993	131.19	0.00	12.61	0.00	0.00	58.87	0.00	0.00	0.00	142.97	**345.65**
1994	109.75	4.81	12.52	0.00	0.00	70.42	0.00	0.00	0.00	115.53	**313.04**
1995	105.02	3.94	0.00	0.00	0.00	65.64	0.00	0.00	0.00	131.28	**305.88**
1996	85.59	6.04	0.00	0.00	0.00	50.34	0.00	0.00	0.00	125.86	**267.84**
1997	108.43	4.77	0.00	0.00	0.00	56.00	0.00	0.00	0.00	92.94	**262.14**
1998	137.28	0.00	0.00	0.00	0.00	41.66	0.00	0.00	0.00	74.79	**253.73**
1999	106.41	0.00	0.00	0.00	0.00	61.86	0.00	0.00	0.00	56.92	**225.19**
2000	106.68	0.00	0.00	0.00	0.00	81.75	0.00	0.00	0.00	50.85	**239.28**
2001	109.99	0.00	0.00	0.00	0.00	70.49	0.00	0.00	0.00	87.99	**268.47**
2002	94.99	0.00	0.00	0.00	0.00	64.99	0.00	0.00	0.00	79.09	**239.07**
2003	94.70	0.00	0.00	0.00	0.00	65.11	0.00	0.00	0.00	92.33	**252.14**

Year	AN (kt)	AS (kt)	CAN (kt)	N sol. (kt)	Other N (kt)	Urea (kt)	AP (kt)	NK (kt)	NPK (kt)	Other NP (kt)	TOTAL N-fert (kt)
2004	145.11	0.00	0.00	0.00	0.00	43.53	0.00	0.00	81.49	0.00	**270.13**
2005	148.85	0.00	8.68	0.25	0.00	48.38	0.00	0.00	93.03	0.00	**299.20**
2006	143.22	0.00	0.00	0.22	0.00	59.23	0.00	0.00	49.54	0.00	**252.20**
2007	106.46	0.00	0.00	0.16	0.00	75.34	0.00	0.00	83.53	0.00	**265.49**
2008	113.58	0.00	4.06	0.00	0.00	81.13	0.00	0.00	81.13	0.00	**279.89**
2009	120.14	0.00	4.29	0.00	0.00	85.81	0.00	0.00	85.81	0.00	**296.06**
2010	156.15	2.45	6.54	6.54	0.82	87.48	11.45	0.82	12.26	21.26	**305.76**
2011	127.52	2.43	12.75	4.86	1.21	107.48	8.50	1.21	20.04	27.33	**313.33**
2012	130.22	4.05	14.47	2.32	3.47	85.66	13.89	1.74	12.73	21.41	**289.96**
2013	154.88	8.99	9.68	15.90	2.77	87.12	18.81	1.38	17.29	27.66	**344.47**
2014	113.98	6.50	27.76	13.58	2.36	76.78	17.72	1.18	14.76	28.94	**303.56**
2015	141.95	7.07	27.33	9.27	3.62	99.17	16.93	0.48	20.56	30.96	**357.35**
2016	119.28	10.13	31.80	6.85	4.10	88.50	28.51	1.02	23.77	30.35	**344.31**
2017	108.55	6.57	33.19	12.64	4.79	116.96	24.34	1.00	39.88	33.42	**381.34**
2018	133.40	8.08	40.79	15.54	5.89	143.73	29.91	1.23	49.01	41.07	**468.64**

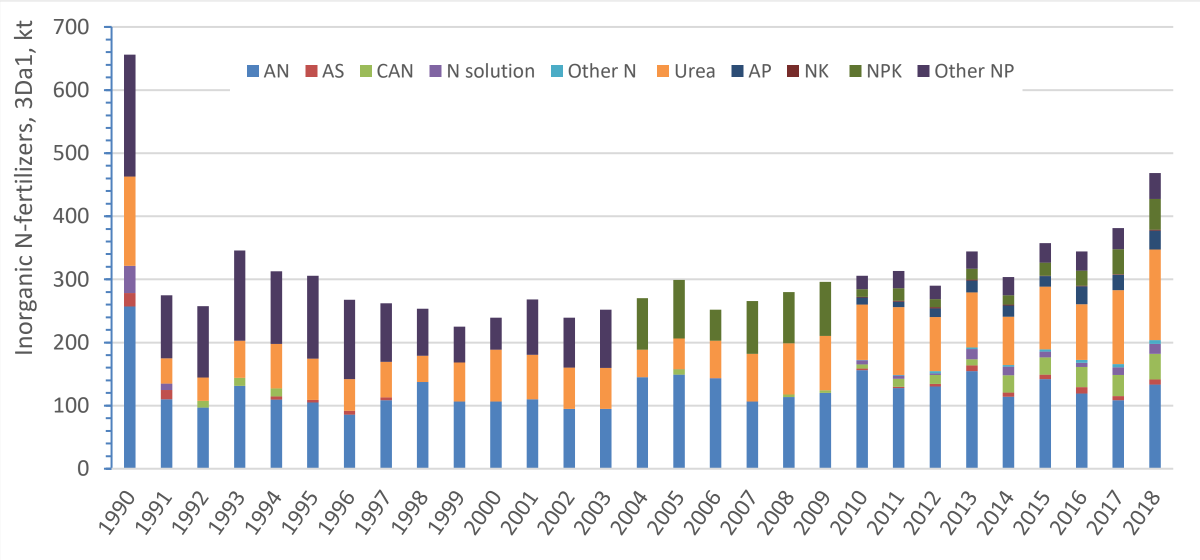


Figure 5.10.1 Trends of proportions of the categories of N-fertilizers(kt) for NFR 3Da1 Inorganic N-fertilizers

Table 5.10.3 The proportions obtained for each of the N-fertilizer categories used in the Tier2 calculation

N-Fertilizers	1990	1995	2000	2005	2010	2015	2016	2017	2018
Ammonia dir. applic. (N)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Ammonium nitrate (N)	39.20%	34.30%	44.60%	49.80%	51.10%	39.70%	34.60%	28.50%	28.50%
Ammonium sulphate (N)	3.30%	1.30%	0.00%	0.00%	0.80%	2.00%	2.90%	1.70%	1.70%
Calc. amm. nitrate (N)	0.00%	0.00%	0.00%	2.90%	2.10%	7.60%	9.20%	8.70%	8.70%
Nitrogen solutions (N)	6.50%	0.00%	0.00%	0.10%	2.10%	2.60%	2.00%	3.30%	3.30%
Other N straight (N)	0.00%	0.00%	0.00%	0.00%	0.30%	1.00%	1.20%	1.30%	1.30%
Urea (N)	21.60%	21.50%	34.20%	16.20%	28.60%	27.80%	25.70%	30.70%	30.70%
Ammonium phosphate (N)	0.00%	0.00%	0.00%	0.00%	3.70%	4.70%	8.30%	6.40%	6.40%
N K compound (N)	0.00%	0.00%	0.00%	0.00%	0.30%	0.10%	0.30%	0.30%	0.30%
N P K compound (N)	0.00%	0.00%	0.00%	31.10%	4.00%	5.80%	6.90%	10.50%	10.50%
Other NP (N)	29.40%	42.90%	21.30%	0.00%	7.00%	8.70%	8.80%	8.80%	8.80%

The total amount of N-fertilizers used in agriculture were correlate with the CRF (UNFCCC) report database.

Table 5.10.2 Emission trends (kt) for NFR 3Da1 Inorganic N-fertilizers

Year/Pollutant	NOx, kt	NH_3,kt
1990	26.244	41.569
1991	10.997	15.176
1992	10.310	12.938
1993	13.826	18.342
1994	12.521	18.871
1995	12.235	18.668
1996	10.713	15.924
1997	10.486	15.383
1998	10.149	12.256
1999	9.007	14.031
2000	9.571	16.814
2001	10.739	16.976
2002	9.563	15.453
2003	10.086	16.129
2004	10.805	12.999
2005	11.968	14.477
2006	10.088	13.826
2007	10.619	17.467
2008	11.195	18.367
2009	11.842	19.428
2010	12.230	19.084
2011	12.533	22.193
2012	11.599	18.400
2013	13.779	21.507
2014	12.142	18.860
2015	14.294	22.730
2016	13.772	21.532
2017	15.254	26.797
2018	18.746	32.932

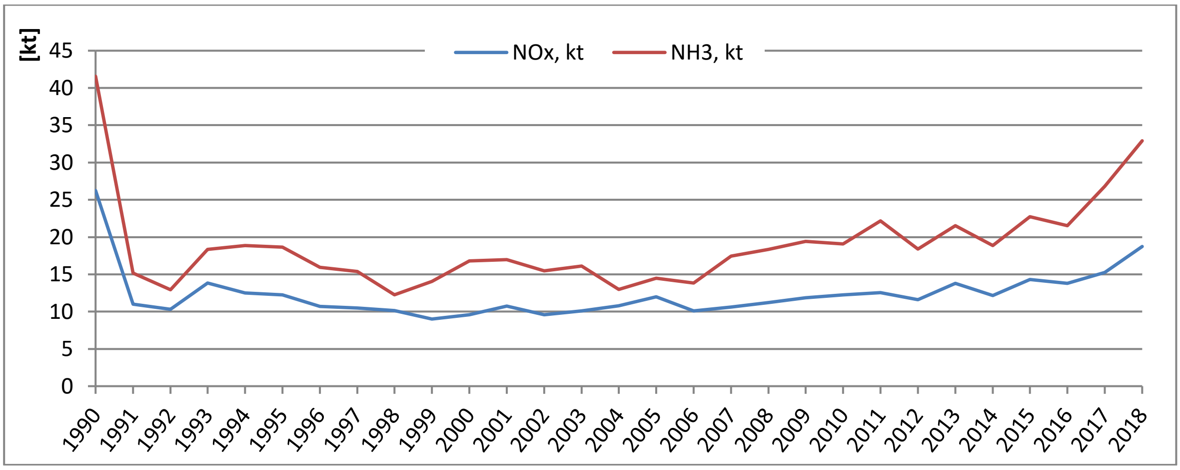


Figure 5.10.2 Emission trends (kt) for
NFR 3Da1 Inorganic N-fertilizers

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- Implementing the Tier 2 methodology for ammonia pollutant for the entire time series, 1990-2018.

Implementation of Review recommendations:

- RO-3Da1-2019-0001- the current estimation corrected with the total amount of N fertilizers – implemented;
- RO-3Da1-2019-0002 - the Tier 2 calculation of NH_3 pollutant - implemented.

5.11 NFR 3.D.a.2.a Animal manure applied to soils

For the sector animal manure applied to soils, the emission of NH_3 and NOx were estimated. The emissions of NH_3 from animal manure applied to soils contributes in 2018 with 27.24% from the ammonia emission of the agricultural sector and represent a key source, with 24.25% from total national emissions.

The methodology used to calculate the emissions is described in chapter 3B Manure Management, considering these emissions as part of a chain of sources, enabling to estimated the impact of NH_3 and other N emissions in different stage.

Activity data from the application of animal manure to soils represents a percentage of the total manure from all animal species in source category 3B, as is specified in 2016 EMEP/EEA Guidebook.

The emission factors for ammonia were calculated according to 2016 EMEP/EEA Guidebook, with the Tier 2 method for dairy cattle, non dairy cattle, pigs, sheep and laying hens. The rest of the categories are calculated with Tier 1 methodology. Compared to the previous year, the emission factors are calculated for two periods, 1990-2013 and 2014-2018, depending on the percentage of liquid from the manure deposited, as mentioned in the 2018 study "*Romanian Projections for pollutants Emissions to 2030*". The emissions of NH_3 for NFR 3Da2a have been calculated by splitting the NH_3 emissions from manure in NFR 3B, NFR 3Da2a and NFR 3Da3 according the 2016 EMEP/EEA Guidebook.

The emissions factors are presented in Table 2, Annex A, 3B – Manure Management calculations from this document.

The activity data for NOx estimation was the amount of animal manure applied to soils – value reported by Romania in the CRF document and the Tier 1 approach from 2019 Guidebook EMEP/EEA, table 3.1, was used to calculate the emissions for this pollutant.

Table 4.11.1 Activity data trends for NFR 3Da2a for pollutant NOx

Year	Animal manure applied to soils, Kg N
1990	336498035.1
1991	286964779.5
1992	251391199.9
1993	245137603.7
1994	225925922.9
1995	224462960.6
1996	224182206.2
1997	201265489.4
1998	198325452.6
1999	182392541.3
2000	165506431.0
2001	161900716.5
2002	171019875.7
2003	178890397.7
2004	191418280.7
2005	201319736.8
2006	200403547.3
2007	195257613.5
2008	185738551.2
2009	178912035.2
2010	155232228.4
2011	152028036.4
2012	150175816.3
2013	150356425.9
2014	150265936.7
2015	149710393.0
2016	144632271.8
2017	142654683.3
2018	136917096.0

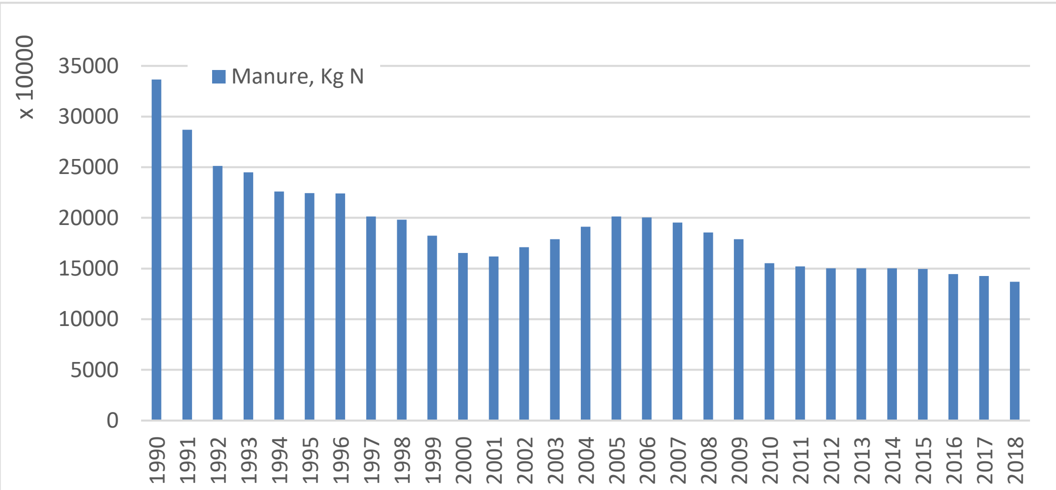


Figure 5.11.1 Activity data trends for NFR 3Da2a – pollutant NOx

Table 5.11.2 Emission trends (kt) for NFR 3Da2a Animal manure applied to soils

Year	NOx	NH_3
1990	13.4599	104.0953
1991	11.4786	90.3880
1992	10.0556	78.8380
1993	9.8055	74.4499
1994	9.0370	68.0119
1995	8.9785	69.6981
1996	8.9673	69.6286
1997	8.0506	62.8721
1998	7.9330	62.7733
1999	7.2957	57.8118
2000	6.6203	53.2027
2001	6.4760	51.8478
2002	6.8408	55.1617
2003	7.1556	55.3848
2004	7.6567	60.4473
2005	8.0528	61.5087
2006	8.0161	62.5317
2007	7.8103	59.9473
2008	7.4295	57.5248
2009	7.1565	55.0380
2010	6.2093	49.3190
2011	6.0811	49.0912
2012	6.0070	48.9107
2013	6.0143	48.4315
2014	6.0106	46.9818
2015	5.9884	47.3689
2016	5.7853	46.0112
2017	5.7062	44.3248
2018	5.4767	42.5943

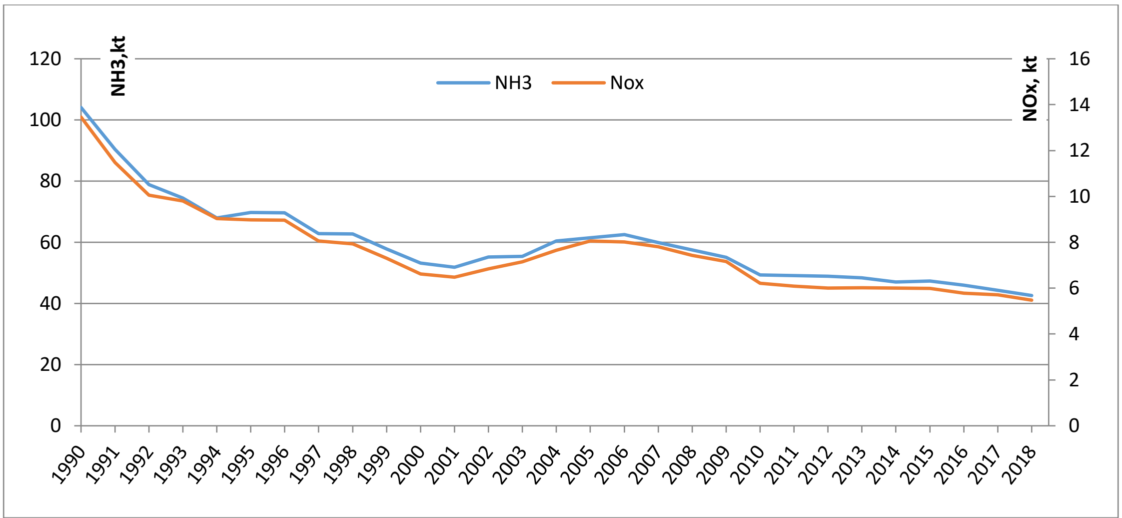


Figure 5.11.2 Emission trends (kt) for NFR 3Da2a Animal manure applied to soils

The emissions of NH_3 and NOx from animal manure applied to soils follow the activity data trend.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- Recalculation of NH_3 emissions together to 3B, and 3Da3 for the entire time series 1990-2018.

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

The emissions for this NFR is generated in sewage treatment works consisting in removing biologically degradable organic matter from wastewater, preventing pollution of freshwater and coastal marine ecosystems. [....] [2] .

The NH_3 and NOx emissions were estimated here, with a minor share in the total: 0.08% of the NOx emission from the agricultural sector and 0.04% of the NH_3 national emissions at 2018 level, so there are no key category at this NFR.

The methodology used to calculate the emissions is Tier 1 describes in the 2019 EMEP/EEA Guidebook, tabel 3.1, for NH_3 and NOx pollutants.

The calculation used population related to wastewater treatment plants as activity data from National Institute for Statistics, for 2006÷2018 period, completed with values for 1990÷2005 period from a Romania's Greenhouse Gas study[3].

Table 5.12.1. Activity data (population size) for NFR 3Da2b - Sewage sludge applied to soils

Year	**Population** on wastewater treatment plants (1000 head)
1990	2836.99
1991	2824.29
1992	2782.66
1993	2791.40
1994	2796.21
1995	1744.01
1996	1737.56
1997	1736.66
1998	1728.70
1999	1722.38
2000	2460.77
2001	3254.53
2002	3935.02
2003	4788.86
2004	5203.79
2005	5738.36

[2] EMEP/EEA air pollutant emission inventory guidebook 2016, Annex 1, pg. 30
[3] "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation"

Year	Population on wastewater treatment plants (1000 head)
2006	6068.66
2007	6130.40
2008	6215.16
2009	6236.53
2010	6541.22
2011	8568.77
2012	8641.24
2013	8883.58
2014	8998.26
2015	9089.71
2016	9415.52
2017	9710.08
2018	10035.29

Table 5.12.2 Emission trends (kt) for 3Da2b - Sewage sludge applied to soils

Year	NOx	NH_3
1990	0.00567	0.01872
1991	0.00565	0.01864
1992	0.00557	0.01837
1993	0.00558	0.01842
1994	0.00559	0.01846
1995	0.00349	0.01151
1996	0.00348	0.01147
1997	0.00347	0.01146
1998	0.00346	0.01141
1999	0.00344	0.01137
2000	0.00492	0.01624
2001	0.00651	0.02148
2002	0.00787	0.02597
2003	0.00958	0.03161
2004	0.01041	0.03435
2005	0.01148	0.03787
2006	0.01214	0.04005
2007	0.01226	0.04046
2008	0.01243	0.04102
2009	0.01247	0.04116
2010	0.01308	0.04317
2011	0.01714	0.05655
2012	0.01728	0.05703
2013	0.01777	0.05863
2014	0.01800	0.05939
2015	0.01818	0.05999
2016	0.01883	0.06214
2017	0.01942	0.06409
2018	0.02007	0.06623

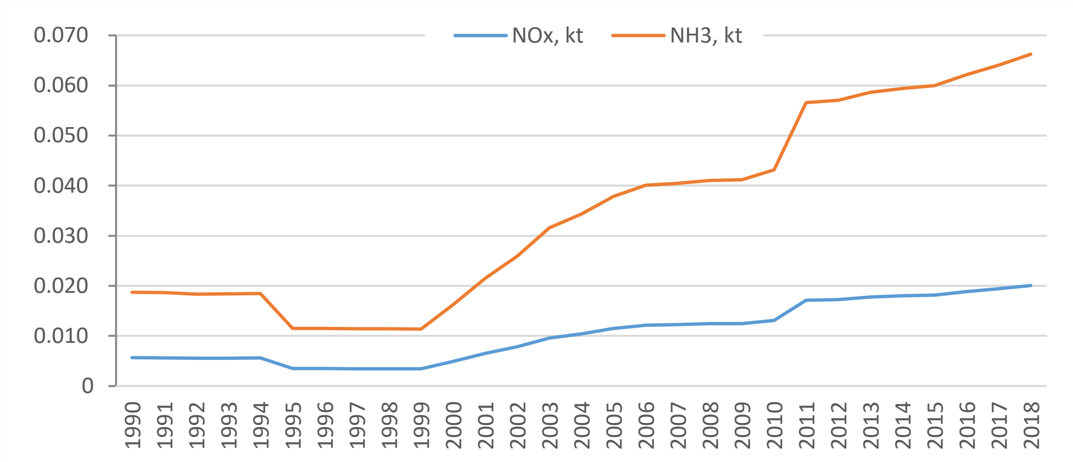


Figure 5.12.1 Emission trends (kt) for 3Da2b - Sewage sludge applied to soils

Recalculations and improvements:

- First estimate of emissions for the time series 1990 -1995;
- Recalculation with the emission factor (actual, EF is 0.0066 kg NH3 capita^{-1} a^{-1}, from 2019 EMEP/EEA Guidebook).

5.13 NFR 3.D.a.3 Urine and dung deposited by grazing animals

For this sector, the emission of NH_3 were estimated. The emission of NH_3 from animal manure - urine and dung deposited by grazing animals contributed in 2018 with 8.99% of the national total NH_3 emissions and represents 10.09% of the NH_3 emission from the agricultural sector.

The emission factors for ammonia were calculated according to 2016 EMEP/EEA Guidebook, with the Tier 2 method for dairy cattle, non dairy cattle, pigs, sheep and laying hens. The rest of the categories are calculated with Tier 1 methodology. Compared to the previous year, the emission factors are calculated for two periods, 1990-2013 and 2014-2018, depending on the percentage of liquid from the manure deposited, as mentioned in the 2018 study "Romanian Projections for pollutants Emissions to 2030”. The emissions of NH_3 for NFR 3Da3 have been calculated by splitting the NH_3 emissions from manure in NFR 3B, NFR 3Da2a and NFR 3Da3 according the 2016 EMEP/EEA Guidebook.

The emissions factors are presented in Table 2, Annex A, 3B – Manure Management calculations from this document.

Table 5.13.1 Emission trends (kt) for
NFR 3Da3 - Urine and dung deposited during grazing animals

Year/Pollutant	NH_3, kt
1990	26.4841
1991	24.7112
1992	21.6911
1993	21.2364
1994	20.7170
1995	20.4606
1996	19.8058

1997	18.8499
1998	18.3491
1999	18.0368
2000	17.3399
2001	16.8537
2002	17.2607
2003	17.5441
2004	16.9845
2005	17.3152
2006	17.2964
2007	18.0973
2008	17.8742
2009	17.4738
2010	15.3120
2011	15.2337
2012	15.3521
2013	15.4798
2014	15.7519
2015	15.9241
2016	16.0811
2017	15.8687
2018	15.7825

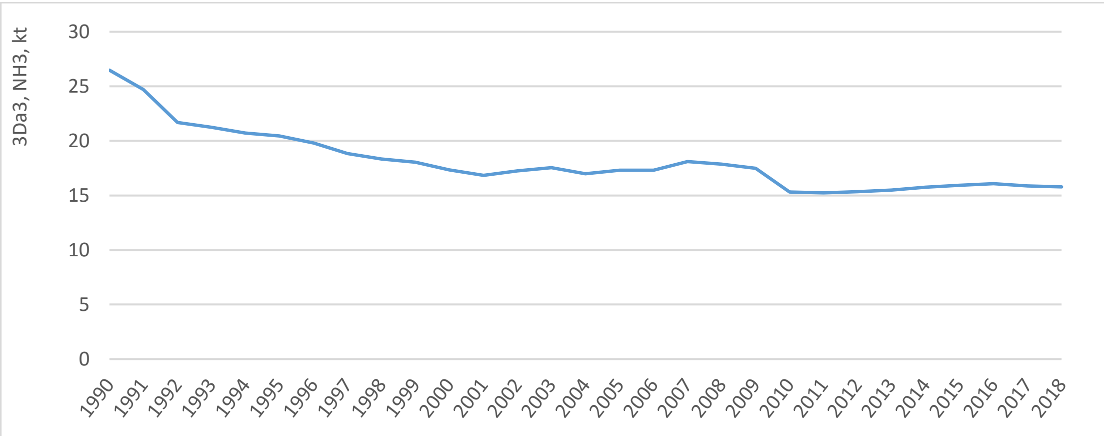


Figure 5.13.1 Emission trends (kt) for
NFR 3Da3 - Urine and dung deposited during grazing animals

Table 5.13.2 Comparison between the split of NH_3 for NFR 3B , 3Da2a, 3Da3

Year	3B-NH_3, kt	3Da2a-NH_3, kt	3Da3-NH_3, kt
1990	150.344	104.095	26.484
1991	131.544	90.388	24.711
1992	115.008	78.838	21.691
1993	108.566	74.450	21.236
1994	99.291	68.012	20.717
1995	102.218	69.698	20.461
1996	102.137	69.629	19.806

Year	3B-NH_3, kt	3Da2a-NH_3, kt	3Da3-NH_3, kt
1997	92.222	62.872	18.850
1998	92.327	62.773	18.349
1999	85.261	57.812	18.037
2000	78.789	53.203	17.340
2001	76.893	51.848	16.854
2002	81.876	55.162	17.261
2003	82.253	55.385	17.544
2004	89.624	60.447	16.985
2005	91.136	61.509	17.315
2006	92.303	62.532	17.296
2007	89.049	59.947	18.097
2008	85.648	57.525	17.874
2009	81.985	55.038	17.474
2010	73.558	49.319	15.312
2011	73.083	49.091	15.234
2012	72.722	48.911	15.352
2013	71.980	48.431	15.480
2014	71.607	46.982	15.752
2015	72.154	47.369	15.924
2016	70.250	46.011	16.081
2017	67.622	44.325	15.869
2018	64.993	42.594	15.783

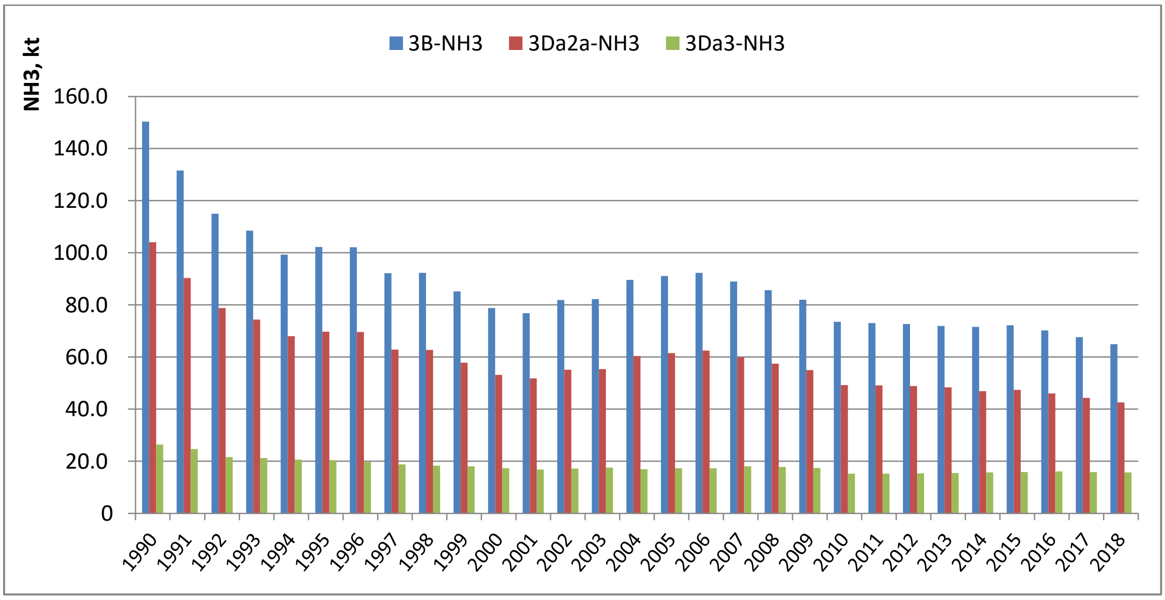


Figure 5.13.2 Comparison between the split of NH_3 [kt] for category 3B, 3Da2a, 3D3

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

5.14 NFR 3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products

Particulate emissions occur during agricultural operations, such as soil cultivation, harvesting, cleaning, drying and transportation. The emissions of PM_{10} and TSP from field operations contribute with 10.70% of the total national emissions of PM_{10}, respectively with 7.03% of the total national emissions of TSP in 2018.

The emissions of particulate matters from field operations are calculated by area of cultivated crops multiplied with emission factor, using the Tier 1 methodology, according to the 2019 EMEP/EEA Guidebook.

As activity data, the area of cultivated crops is used, as provided by the N.I.S. and in correlation with GHG (UNFCCC) - CRF database.

Table 5.14.1. Activity data (area of cultivated crops, ha) for NFR 3Dc Farm-level agricultural operations

Year/Activity data	ha
1990	12111900
1991	8818293
1992	5524686
1993	7145286
1994	7389015
1995	7447588
1996	7156908
1997	6669130
1998	6512917
1999	5418761
2000	5502443
2001	5874452
2002	5292608
2003	6370573
2004	6267177
2005	6711748
2006	6015346
2007	6422910
2008	**6766070**
2009	**6317769**
2010	**7357786**
2011	**7466912**
2012	**7821665**
2013	**7800421**
2014	**8359262**

2015	**8328061**
2016	**8702268**
2017	**9262254**
2018	**10039777**

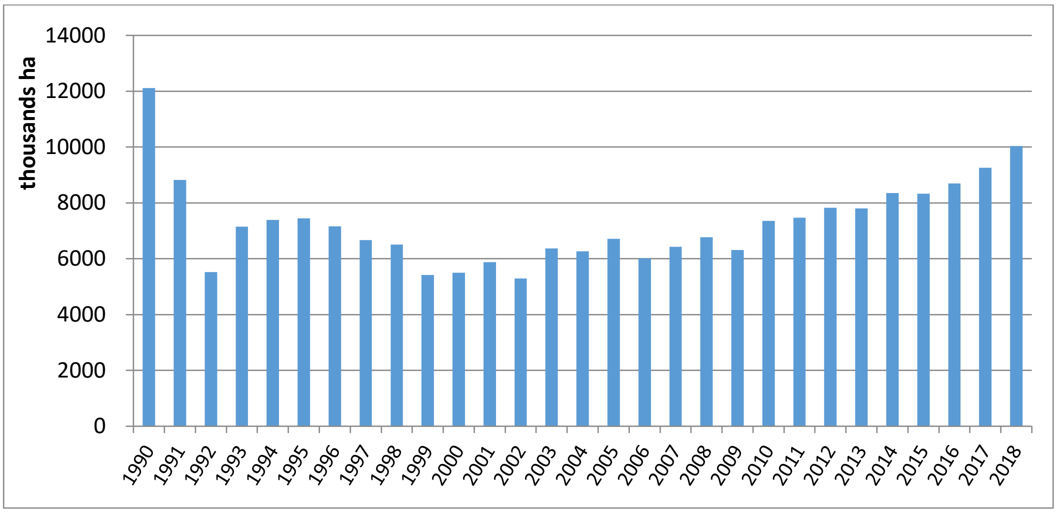


Figure 5.14.1 Activity data trends (ha) for NFR 3Dc Farm-level agricultural operations

The emissions represented here are from $PM_{2,5}$ and PM_{10}, the TSP having the same values (i.e. emission factor) as PM_{10}.

Table 5.14.2 Emission trends (kt) for NFR 3Dc Farm-level agricultural operations

Year/Pollutant	**$PM_{2.5}$**	**PM_{10}**
1990	0.727	18.895
1991	0.529	13.757
1992	0.331	8.619
1993	0.429	11.147
1994	0.443	11.527
1995	0.447	11.618
1996	0.429	11.165
1997	0.400	10.404
1998	0.391	10.160
1999	0.325	8.453
2000	0.330	8.584
2001	0.352	9.164
2002	0.318	8.256
2003	0.382	9.938
2004	0.376	9.777
2005	0.403	10.470
2006	0.361	9.384
2007	0.385	10.020
2008	0.406	10.555
2009	0.379	9.856
2010	0.441	11.478
2011	0.448	11.648
2012	0.469	12.202

Year/Pollutant	$PM_{2.5}$	PM_{10}
2013	0.468	12.169
2014	0.502	13.040
2015	0.500	12.992
2016	0.522	13.576
2017	0.556	14.449
2018	0.602	15.662

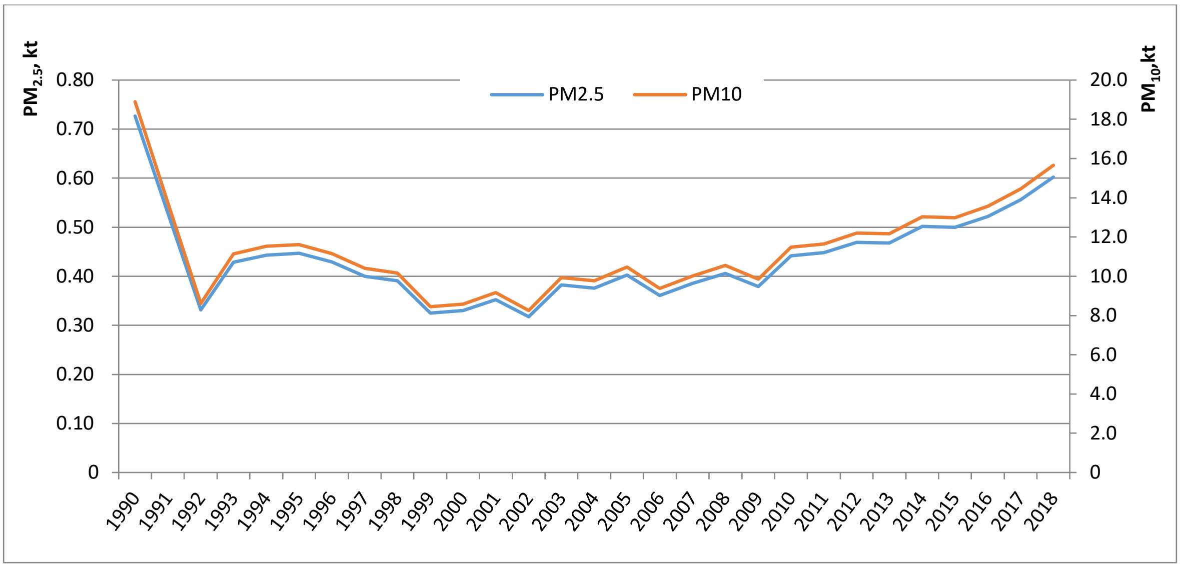


Figure 5.14.2 Emission trends (kt) for NFR 3Dc Farm-level agricultural operations

The emissions of particulate matter from farm-level agricultural operations follow the activity data trend.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

5.15 NFR 3.D.e Cultivated crops

For the cultivated crops sector the emission of NMVOC were estimated, with a percent of 3.66% from the total national of NMVOC emissions.

The emission of NMVOC from cultivated crops were calculated by area of cultivated crops multiplied with the emission factor.

For the activity data, the area of cultivated crops was by the N.I.S.

The emission factor used are based on 2019 EMEP/EEA Guidebook, table 3.1.

Table 5.15.1 Emission trends (kt) for NFR 3De - Cultivated crops

Year/Pollutant	NMVOC
1990	10.416
1991	7.584
1992	4.751
1993	6.145

1994	6.355
1995	6.405
1996	6.155
1997	5.735
1998	5.601
1999	4.660
2000	4.732
2001	5.052
2002	4.552
2003	5.479
2004	5.390
2005	5.772
2006	5.173
2007	5.524
2008	5.819
2009	5.433
2010	6.328
2011	6.422
2012	6.727
2013	6.708
2014	7.189
2015	7.162
2016	7.484
2017	7.966
2018	8.634

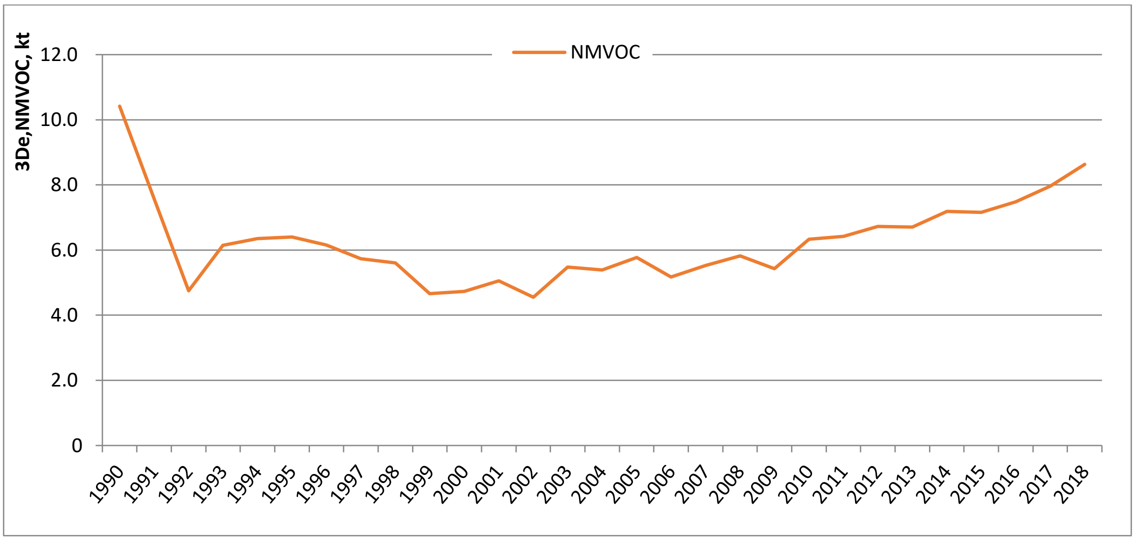


Figure 5.15.1 Emission trends (kt) for NFR 3De - Cultivated crops, NMVOC, kt

The emissions of NMVOC from cultivated crops follow the activity data trend.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994.

5.16 NFR 3.F Field Burning of Agricultural Residues

This category includes emission for the open burning of crop residue on arable land after harvesting. This activity does not include the burning of crop products that are burnt after having been used on the farm, wich is reported under NFR code 5.C.2 Open burning of waste. Emissions of NOx, NMVOC, SOx, NH_3, particulate matter, BC, CO, heavy metals and PAHs are included under this NFR. These emissions contribute with less than 1% from total national emissions.

The methodology for estimating emissions from field burning of agricultural residues is based on the use of the 2019 EMEP/EEA Guidebook, Tier 2 approach, applies the general equation:

$$E_{pollutant} = AR_{residue\_burnt} \cdot Ef_{pollutant}, \quad \text{where :}$$

- $AR_{residue\_burnt}$ = activity rate, mass of residue burnt (kg dry matter)
- $EF_{pollutant}$ = emission factor for pollutant (kg kg-1 dry matter).

This equation is applied at the national level, using annual national total amount of residue burnt for each crop type (wheat, maize, barley, rye and other cereals).

The mass of crop residue burned is calculated with the following equation:

$$AR_{residue\_burnt} = A \cdot Y \cdot s \cdot d \cdot p_b \cdot Cf, \quad \text{where :}$$

- A (ha) is the area of land on which crops are grown whose residues are burned
- Y (kg ha^{-1} fresh weight) is the average yield of those crops
- s is the ratio between the mass of crop residues and the crop yield
- d is the dry matter content of that yield
- p_b is proportion of those residues that are burned
- Cf is the combustion factor (proportion of the fuel present at the time of the fire that is actually burned).

According to EMEP / EEA 2019, Chapter 3.F, the following values are used:

- for wheat: Y = 3.6, Cf = 0.9; for maize: Y = 11.8, Cf = 0.8; rice: Y = 4.6, Cf = 0.8
- default values of s is from Table 3–2
- d = 0.85, for consistency with IPCC (2006, chapter 2.4)
- the value of 1 is used for p_b.

For crops other than wheat, maize and rice, the values for wheat are used.

The emission factors used to calculate the emissions are from 2019 EMEP/EEA Guidebook, chapter 3.F Field Burning of Agricultural Residues, Table 3-3, Table 3-4 and Table 3-5.

The area of land on which crops are grown whose residues are burned are provided by from the Romania's Greenhouse Gas Inventory – N.I.R., improving the consistency between data for NFR and CRF.

Table 5.15.1 Area of land on which crops are grown whose residues are burned - A (ha)

Year	Wheat	Maize	Barley	Rye	Other cereals
1990	444740	147840	486885	8773	1271
1991	384778	181776	459915	11216	1366
1992	467155	200948	1066809	4665	4488
1993	586778	163836	788419	6641	2137
1994	524073	170560	648191	6245	2080
1995	512199	641941	120104	4253	1528
1996	501259	921952	144989	4511	2889
1997	436244	550267	113480	2919	1456
1998	513455	795404	131481	3458	2862
1999	361935	650988	89764	2487	1126
2000	707551	1112039	150197	5131	2172
2001	538444	628900	111819	2603	2755
2002	579364	729904	145950	3094	3805
2003	493104	909235	93655	3639	6331
2004	385308	549462	71245	3676	2037
2005	459515	487817	89934	3833	625
2006	423134	529841	69727	3625	524
2007	764523	977304	140828	4681	1356
2008	411008	475514	76743	2535	1915
2009	461997	502834	111265	3337	1543
2010	383204	371863	91410	2580	2601
2011	315051	419041	67882	1999	2656
2012	549196	750583	116635	2384	7055
2013	355001	424902	83636	1812	4296
2014	337540	401433	82433	1624	3559
2015	385162	476196	85659	1755	2942
2016	337803	407844	76103	1653	2183
2017	244521	54249	286110	1142	393
2018	216826	43393	249992	1052	283

Table 5.16.2 Mass of residue burnt - ARresidue_burnt (kg dry matter)

Year	Wheat	Barley	Maize	Rye	Other cereals
1990	1592257	488581	3906762	38655	4550
1991	1377583	600732	3690360	49424	4891
1992	1672510	664094	8560079	20557	16067
1993	2100782	541446	6326278	29264	7652
1994	1876285	563667	5201083	27517	7448
1995	1833775	396920	5150934	18738	5469
1996	1794607	479158	7397745	19877	10343
1997	1561842	375028	4415344	12864	5214

1998	1838272	434519	6382323	15235	10248
1999	1295801	296653	5223528	10958	4032
2000	2533176	496373	8923003	22611	7778
2001	1927738	369539	5046296	11471	9864
2002	2074238	482336	5856747	13635	13623
2003	1765411	309511	7295704	16034	22665
2004	1379480	235449	4408887	16200	7292
2005	1645156	297212	3914243	16890	2236
2006	1514905	230434	4251445	15974	1877
2007	2737146	465408	7841886	20625	4855
2008	1471491	253622	3815521	11170	6857
2009	1654042	367709	4034737	14702	5525
2010	1371946	302092	2983829	11367	9314
2011	1127944	224336	3362385	8809	9511
2012	1966230	385454	6022682	10507	25259
2013	1270974	276400	3409412	7984	15380
2014	1208460	272424	3221096	7158	12743
2015	1378958	283085	3821000	7734	10534
2016	1209402	251505	3272542	7284	7814
2017	875435	179282	2295747	5032	1408
2018	776280	143405	2005934	4634	1012

PAHs emissions trends are shown below in the following table and figure.

Table 5.15.3 Emission trends (t) for NFR 3.F Field Burning of Agricultural Residues

Year/Pollutant	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene
1990	0.029	0.017	0.009	0.010
1991	0.027	0.016	0.009	0.010
1992	0.062	0.033	0.020	0.021
1993	0.047	0.026	0.015	0.016
1994	0.038	0.022	0.012	0.013
1995	0.038	0.021	0.012	0.013
1996	0.054	0.029	0.017	0.019
1997	0.033	0.018	0.010	0.011
1998	0.047	0.025	0.015	0.016
1999	0.038	0.020	0.012	0.013
2000	0.065	0.035	0.021	0.023
2001	0.037	0.021	0.012	0.013
2002	0.043	0.024	0.014	0.015
2003	0.053	0.028	0.017	0.018
2004	0.032	0.018	0.010	0.011
2005	0.029	0.016	0.009	0.010
2006	0.031	0.017	0.010	0.011

Year/Pollutant	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene
2007	0.058	0.032	0.018	0.020
2008	0.028	0.016	0.009	0.010
2009	0.030	0.017	0.010	0.010
2010	0.022	0.013	0.007	0.008
2011	0.025	0.014	0.008	0.009
2012	0.044	0.024	0.014	0.015
2013	0.025	0.014	0.008	0.009
2014	0.024	0.013	0.008	0.008
2015	0.028	0.016	0.009	0.010
2016	0.024	0.013	0.008	0.008
2017	0.017	0.009	0.005	0.006
2018	0.015	0.008	0.005	0.005

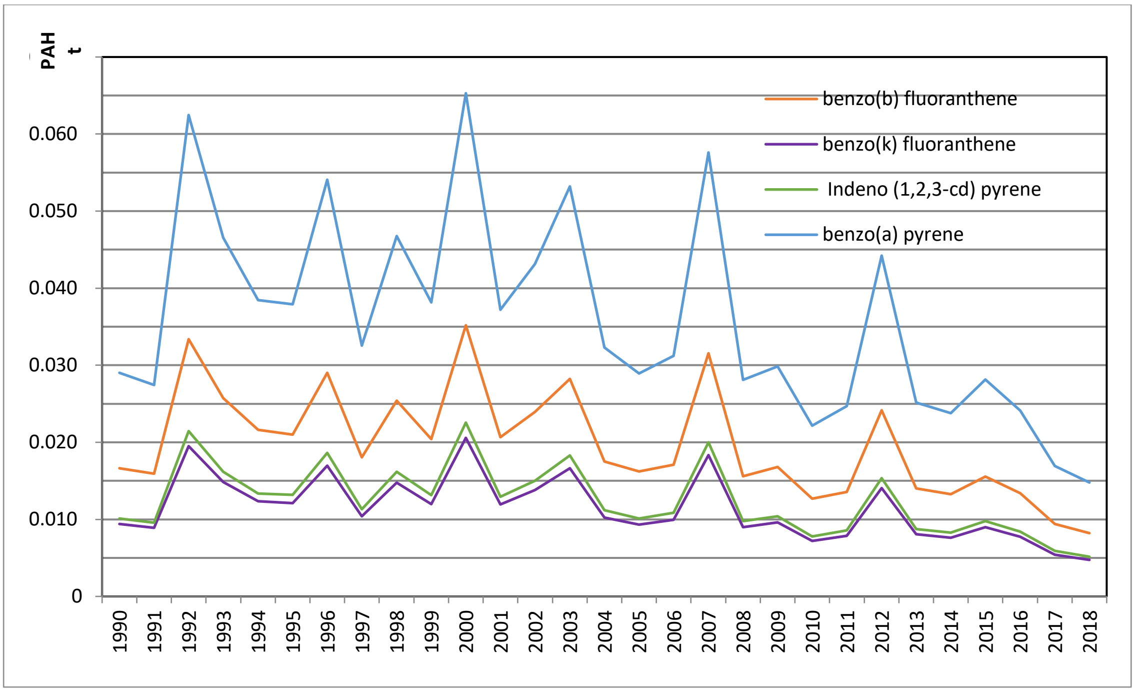


Figure 5.15.1 Emission trends (t) for NFR 3.F Field Burning of Agricultural Residues

The emissions of PAHs follow the activity data trend.

Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;
- The emissions have been recalculated for all time series due to correction of the emission factor for PAHs pollutants (RO-3F-2019-0001**)**.

6. WASTE (NFR sector 5)

This sector covers emissions from the solid wastes disposal on land, clinical and industrial wastes incineration, cremation, small scale waste burning and compost manufacturing, wastewater handling and other waste(car fires and house fires).

6.1. NFR 5.A. Biological treatment of waste - Solid waste disposal on land

Activity data are the total CH_4 emissions from the IPCC inventory. Using the expert judgment it has been considered that 98.7% of the total CH_4 emissions are landfill gase.

The NMVOC emissions were recalculated for the period 1990-2018 using emission factors from the 2019 EMEP/EEA Guidebook. Also, for the first time the TSP, $PM_{2.5}$ and PM_{10} emissions were estimated and calculated for this NFR category using the emision factors in the 2019 EMEP/EEA Guidebook and following the Tier 1 methodology (Table 3-1).

The emissions were calculated based on the Tier 1 methodology by applying the general equation:

Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate (CH_4 in Gg)
- EFpollutant is the emission factor for each pollutant.

The emission factors used to calculate the emissions are from the 2019 EMEP/EEA Guidebook (Tier 1, Table 3.1).

The activity data is presented by the total CH_4 emissions from the GHG/IPCC inventory.

Table 6.1.1 Activity data trends (*CH_4 from annual deposition of MSW at the SWDS [Gg]*) for NFR 5.A Biological treatment of waste - Solid waste disposal on land

Year	CH_4 (Gg)
1990	49.376
1991	50.858
1992	52.278
1993	53.529
1994	54.691
1995	55.797
1996	59.104
1997	62.250
1998	63.016
1999	65.153
2000	76.872
2001	82.242
2002	87.014
2003	92.810
2004	98.014
2005	102.603

Year	CH_4 (Gg)
2006	104.645
2007	111.380
2008	114.531
2009	118.820
2010	124.093
2011	105.120
2012	128.409
2013	140.325
2014	140.625
2015	140.606
2016	142.672
2017	144.519
2018	145.559

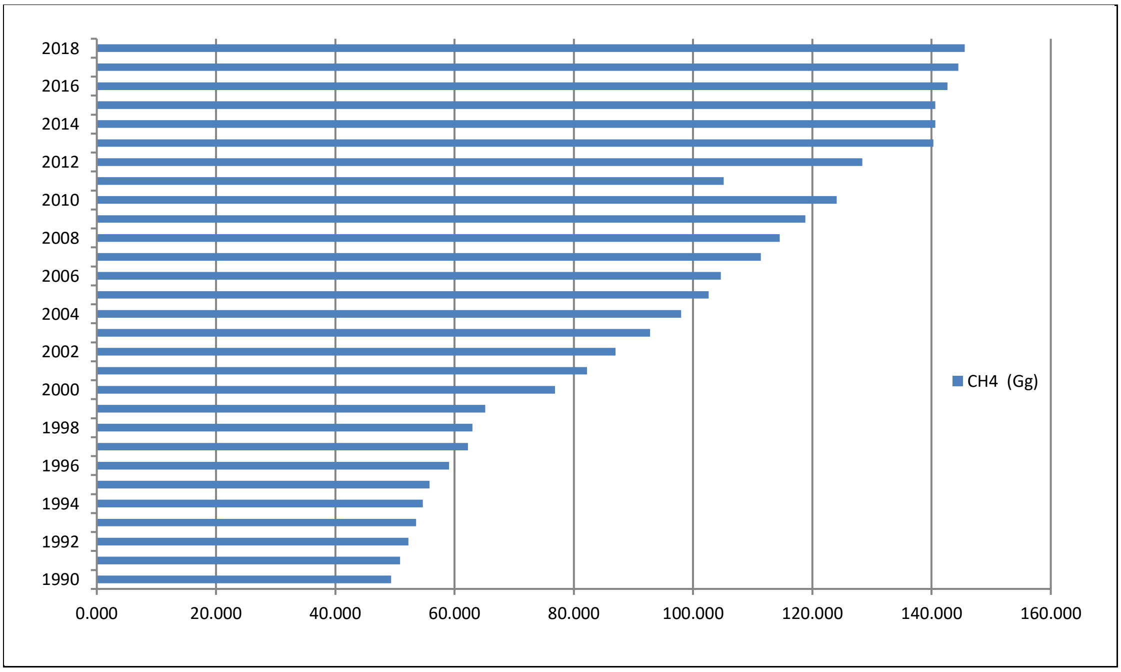


Figure 6.1.1 Activity data trends (*CH_4 from annual deposition of MSW at the SWDS [Gg]*) for NFR 5.A Biological treatment of waste - Solid waste disposal on land

Table 6.1.2 Emission trends (kt for NMVOC) for NFR 5.A Biological treatment of waste –Solid waste disposal on land

Year	NMVOC (kt)
1990	0.650
1991	0.670
1992	0.689
1993	0.705
1994	0.720
1995	0.735
1996	0.778
1997	0.820
1998	0.830
1999	0.858
2000	1.012
2001	1.083

Year	NMVOC (kt)
2002	1.146
2003	1.222
2004	1.291
2005	1.351
2006	1.378
2007	1.467
2008	1.509
2009	1.565
2010	1.634
2011	1.385
2012	1.691
2013	1.848
2014	1.852
2015	1.852
2016	1.879
2017	1.903
2018	1.917

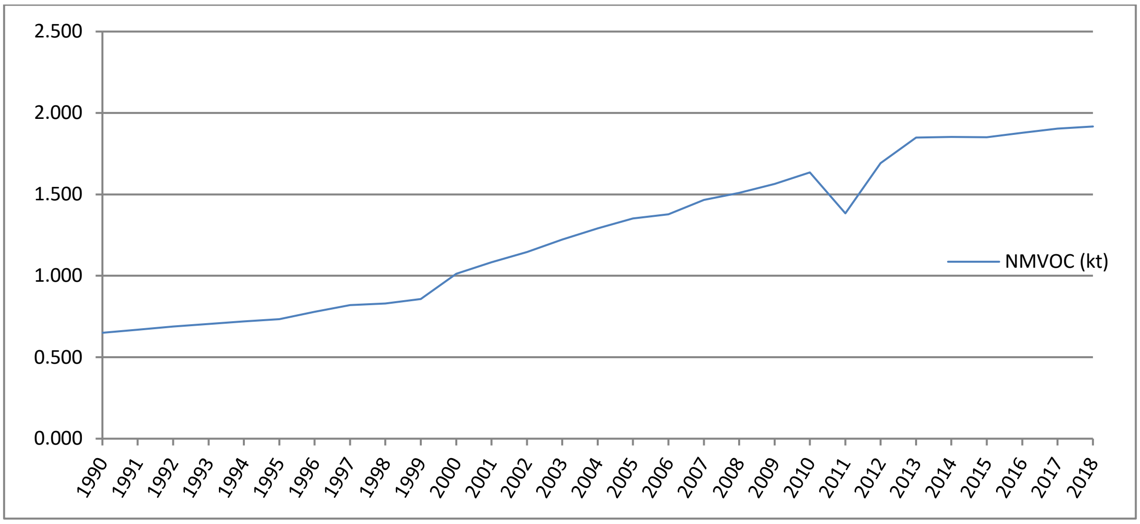


Figure 6.1.2 Emission trends (*kt for NMVOC*) for NFR 5.A Biological treatment of waste – Solid waste disposal on land

NMVOC emissions trend follows the activity data trend - total CH_4 emissions from the IPCC inventory.

Table 6.1.3 Emission trends (*kt for $PM_{2.5}$, PM_{10}. TSP*) for NFR 5.A Biological treatment of waste – solid waste disposal on land

Year	$PM_{2.5}$ (kt)	PM_{10} (kt)	TSP (kt)
1990	0.0000138	0.0000913	0.0001930
1991	0.0000142	0.0000940	0.0001988
1992	0.0000146	0.0000967	0.0002044
1993	0.0000149	0.0000990	0.0002093
1994	0.0000152	0.0001011	0.0002138
1995	0.0000155	0.0001032	0.0002181
1996	0.0000165	0.0001093	0.0002310
1997	0.0000173	0.0001151	0.0002433

Year	$PM_{2.5}$ (kt)	PM_{10} (kt)	TSP (kt)
1998	0.0000176	0.0001165	0.0002463
1999	0.0000182	0.0001205	0.0002547
2000	0.0000214	0.0001421	0.0003005
2001	0.0000229	0.0001521	0.0003215
2002	0.0000242	0.0001609	0.0003402
2003	0.0000259	0.0001716	0.0003628
2004	0.0000273	0.0001812	0.0003832
2005	0.0000286	0.0001897	0.0004011
2006	0.0000292	0.0001930	0.0004090
2007	0.0000310	0.0002060	0.0004350
2008	0.0000319	0.0002120	0.0004480
2009	0.0000331	0.0002200	0.0004640
2010	0.0000346	0.0002290	0.0004850
2011	0.0000293	0.0001944	0.0004109
2012	0.0000358	0.0002374	0.0005020
2013	0.0000391	0.0002595	0.0005486
2014	0.0000392	0.0002600	0.0005487
2015	0.0000392	0.0002600	0.0005496
2016	0.0000398	0.0002638	0.0005577
2017	0.0000403	0.0002672	0.0005649
2018	0.0000406	0.0002691	0.0005690

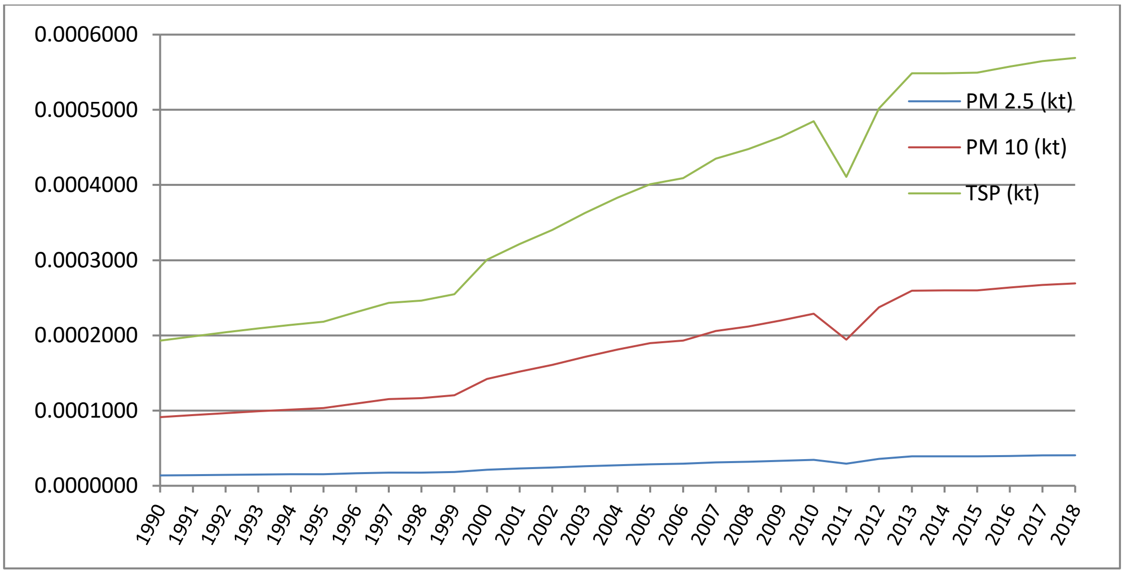


Figure 6.1.3 Emission trends (*kt for $PM_{2.5}$, PM_{10}. TSP*) for NFR 5.A Biological treatment of waste –solid waste disposal on land

The $PM_{2.5}$, PM_{10} and TSP emissions trend follows the activity data trend - total CH_4 emissions from the IPCC inventory.
Recalculations and improvements:

- First estimate of emissions for the time series 1990-1994;

6.2. NFR 5.B.1 Biological treatment of waste – Composting

This category includes emissions from the compost production.

The emissions for NFR 5.B.1 are NH_3 and were calculated for the 2005-2018 using the 2019 EMEP/EEA Guidebook Tier 2 Table 3-1. There are no activity data for the 1990-2004 period (N.E.P.A. does not any information).
Emissions are calculated based on Tier 2 methodology and applies the general equation:
$E_{pollutant} = AR_{production} \times EF_{pollutant}$ where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate (total quantity of compost produced)
- EFpollutant is the emission factor for this pollutant

The emission factors used to calculate the emissions are from the 2019 EMEP/EEA Guidebook, Tier 2, Table 3-1.
The activity data is represented by the total quantity of compost produced and is taken from waste related data collected by N.E.P.A.

Table 6.2.1 Activity data trends (kt compost) for NFR 5.B.1 Biological treatment of waste – Composting

Year	Kt compost
2005	0.220
2006	0.325
2007	2.344
2008	2.360
2009	2.920
2010	1.214
2011	15.095
2012	20.553
2013	30.328
2014	17.150
2015	36.826
2016	50.841
2017	86.121
2018	64.989

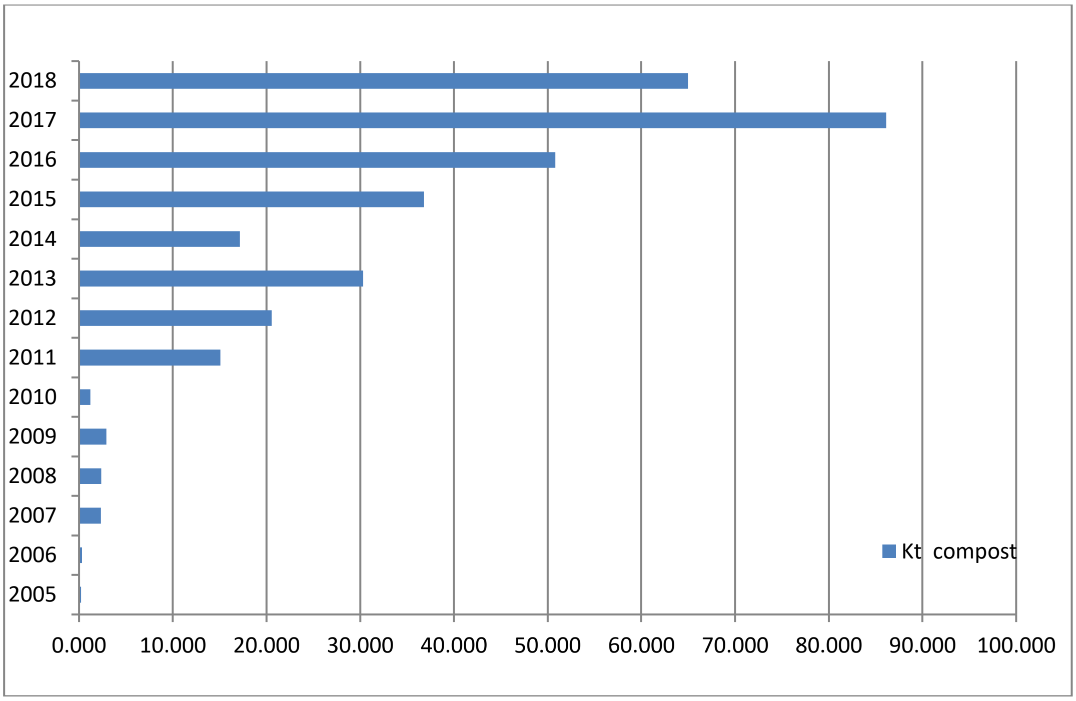


Figure 6.2.1 Activity data trends *(kt compost)* for NFR 5.B.1
Biological treatment of waste – Composting

Table 6.2.2 Emission trends *(kt for NH_3)* for NFR 5.B.1
Biological treatment of waste – Composting.

Year	NH_3
2005	0.00005
2006	0.00008
2007	0.00008
2008	0.00057
2009	0.00070
2010	0.00029
2011	0.00362
2012	0.00493
2013	0.00728
2014	0.00410
2015	0.00884
2016	0.01220
2017	0.02067
2018	0.01560

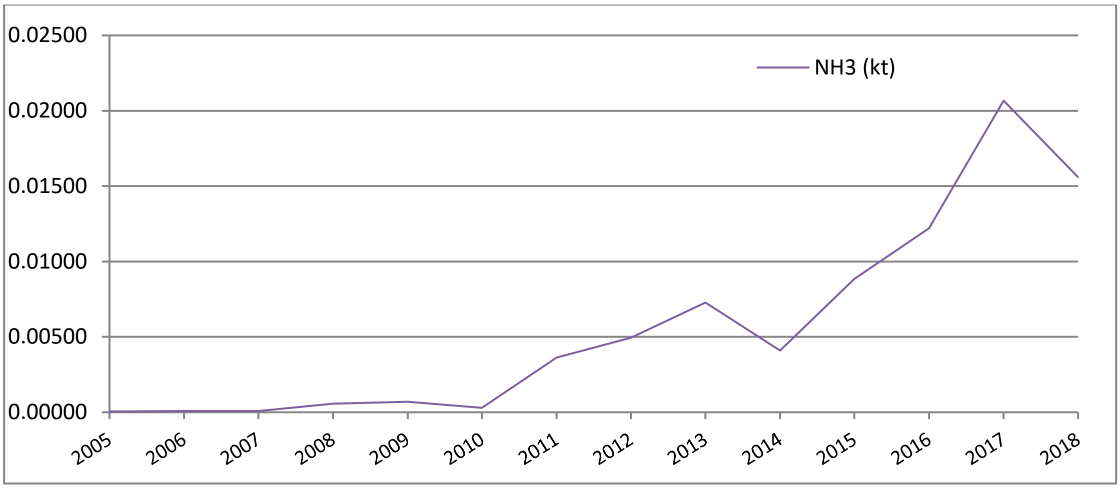


Figure 6.2.2 Emission trends (*kt for NH_3*) NFR 5.B.1
Biological treatment of waste – Composting

The NH_3 emissions from compost production follow the activity data trend.

6.3. NFR 5.C.1.b.i Industrial waste incineration

According to the Implementation Plan for the Directive 2000/76/EC on waste incineration (document issued within negociations for accession of Romania to EU) all plants for industrial waste incineration which, in 2004, did not fully comply to the directive regarding the emissions reduction equipments, had to be brought into compliance by 31December 2006. Therefore, for NFR 5C1bi industrial waste incinerated the period 1995-2006, the calculation for the PCDD/F emissions was estimated with Tier1, and starting with 1 January 2007, the Tier2 method, provided by EMEP/EEA Guidebook 2019 for NFR 5.C.b.i, considering that all industrial waste incineration plants comply with the European Directive.

The emissions from industrial waste incinaration were calculated using the 2019 EMEP/EEA Guidebook (Tier 1 Table 3-1) for 1995-2006 time period; for 2007-2018 period the emissions were calculated using the 2019 EMEP/EEA Guidebook (Tier 2 Table 3-1) The Tier 2 approach is similar to the Tier 1 approach. The PCDD/PCDF emission were calculated by replacing the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{tehnologyabated} = (1-\dot{\eta}_{abatement}) \, X \, EF_{tehnology\ abated}$$

the EF for PCDD/PCDF = 3.5μg/Mg

The emissions were calculated based on Tier1(Tier2) methodology by applying the general equation:

$E_{pollutant} = AR_{production} \times EF_{pollutant}$ where:

- $E_{pollutant}$ is the emission of the specified pollutant
- $AR_{production}$ is the activity rate (industrial waste incinerated)
- $EF_{pollutant}$ is the emission factor for each pollutant

The emission factors used to calculate the emissions are from the 2019 EMEP/EEA Guidebook (Tier 1, Table 3-1), for 1995-2006 time period. For the 2007-2018 time period the emission factor used to calculate the emissions are from the 2019 EMEP/EEA Guidebook Tier 2, Table 3-The Tier 2 approach is similar to the Tier 1 approach

The activity data is represented by the total industrial waste incinerated (in kt) from N.E.P.A.'s inventory.

There are no activity data for the 1990-2004 period (N.E.P.A. does not any information).

The NFR 5.1.b.iv Sewage sludge incineration was included under NFR 5.C.1.b.i Industrial waste incineration.

The NFR 5.C.1.b.iii Clinical waste incineration was included under the NFR 5.C.1.b.i Industrial waste incineration.

Table 6.3.1 Activity data trends (*Waste incinerated [kt]*) for NFR 5.C.1.b.i Industrial waste incineration

Year	Waste incinerated [kt]
1995	35.000
1996	15.000
1997	11.000
1998	3.000
1999	5.200
2000	22.600
2001	40.000
2002	57.500
2003	23.383
2004	9.158
2005	15.563
2006	16.453
2007	3.306
2008	4.004
2009	4.530
2010	33.321
2011	84.821
2012	107.982
2013	64.700
2014	18.453
2015	28.920
2016	56.916
2017	104.200
2018	31.116

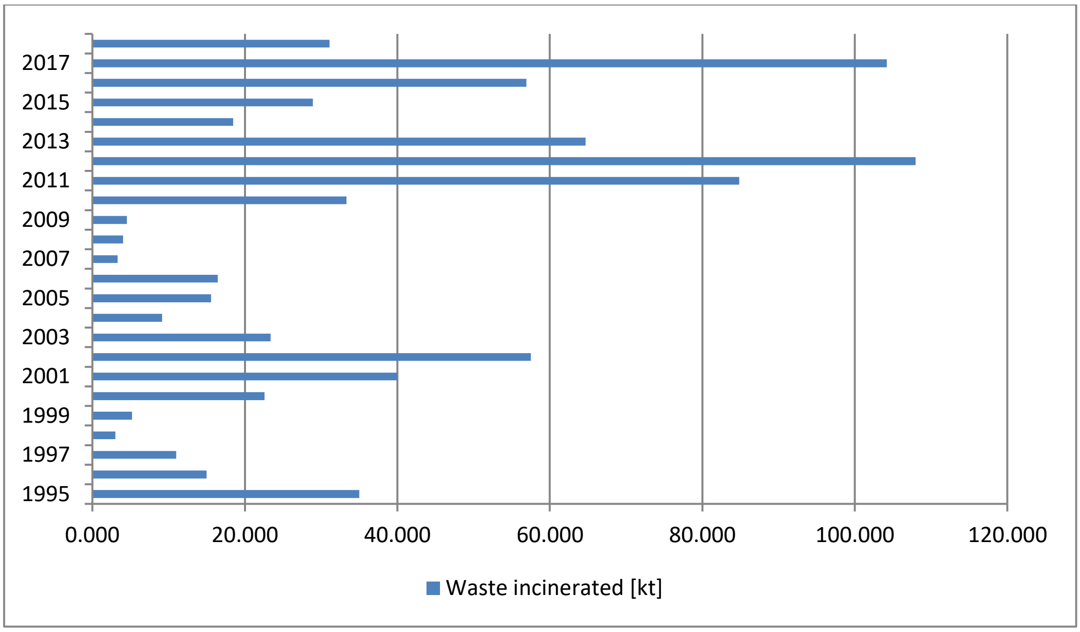


Figure 6.3.1 Activity data trends (*kt waste*) for NFR 5.C.1.b.i Industrial waste incineration

Table 6.3.2 Emission trends (*kt for NOx and NMVOC, t for Pb and g I-TEQ for dioxins*) for NFR 5.C.1.b.i Industrial waste incineration

Year	NOx (kt)	NMVOC (kt)	Pb (t)	PCDD/F (g I-TEQ)
1995	0.0305	0.2590	0.0455	12.250
1996	0.0131	0.1110	0.0195	5.250
1997	0.0096	0.0814	0.0143	3.850
1998	0.0026	0.0222	0.0039	1.050
1999	0.0045	0.0385	0.0068	1.820
2000	0.0197	0.1672	0.0294	7.910
2001	0.0348	0.2960	0.0520	14.000
2002	0.0500	0.4255	0.0748	20.125
2003	0.0203	0.1730	0.0304	8.184
2004	0.0080	0.0678	0.0119	3.205
2005	0.0135	0.1152	0.0202	5.447
2006	0.0143	0.1218	0.0214	5.759
2007	0.0029	0.0245	0.0043	0.012
2008	0.0035	0.0296	0.0052	0.014
2009	0.0039	0.0335	0.0059	0.016
2010	0.0290	0.2466	0.0433	0.117
2011	0.0738	0.6277	0.1103	0.297
2012	0.0939	0.7991	0.1404	0.378
2013	0.0563	0.4788	0.0841	0.226
2014	0.0161	0.1366	0.0240	0.065
2015	0.0252	0.2140	0.0376	0.101
2016	0.0496	0.4212	0.0740	0.199
2017	0.0907	0.7711	0.1355	0.365
2018	0.0271	0.2303	0.0405	0.109

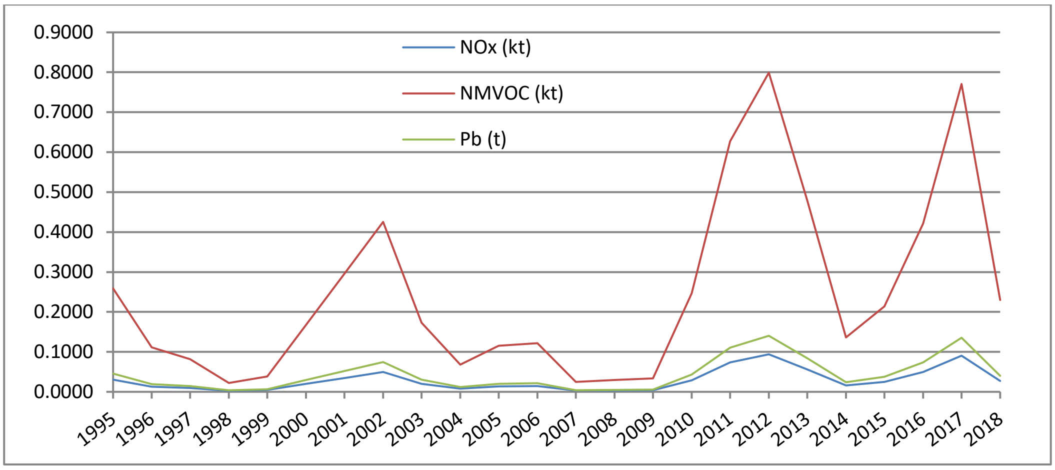


Figure 6.3.2.a. Emission trends (*Kt for NOx and NMVOC, t for Pb*)
for NFR 5.C.1.b.i Industrial waste incineration

Emission trends for NOx, NMVOC and Pb follow the waste incineration activity data trend.

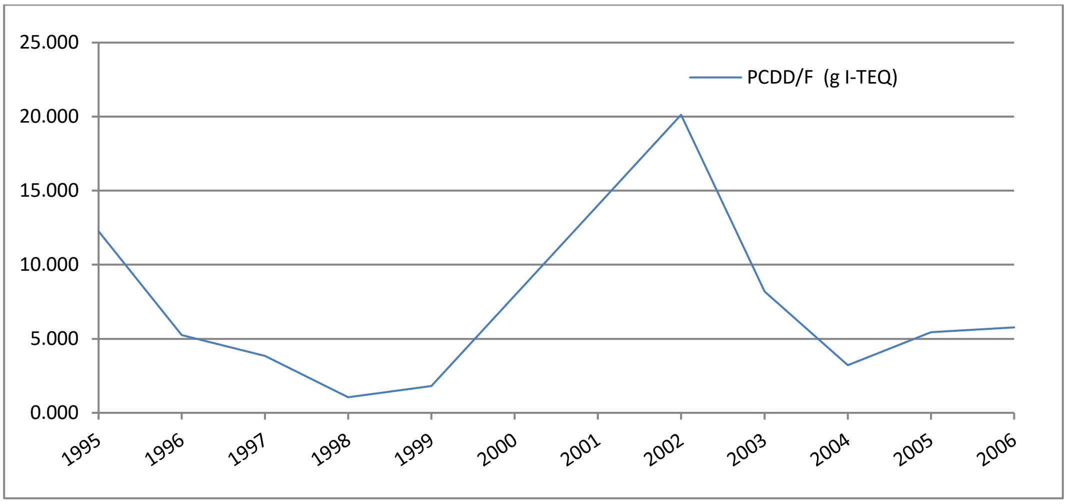


Figure 6.3.2.b. Emission trends on 1995-2006 period (*g I-TEQ for PCDD/F Tier1*) for
NFR 5.C.1.b.i Industrial waste incineration

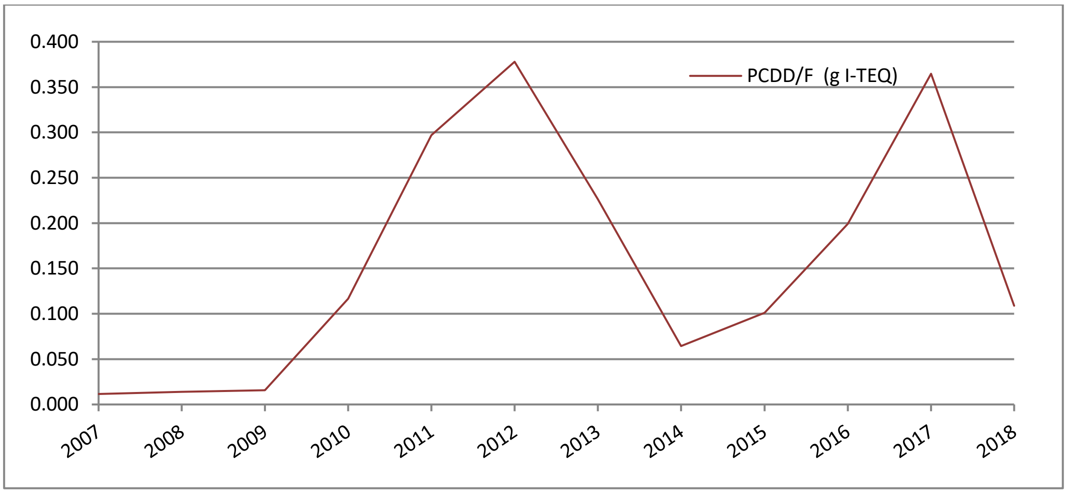


Figure 6.3.2.c. Emission trends on 2007-2018 period (*g I-TEQ for PCDD/F Tier2*) for
NFR 5.C.1.b.i Industrial waste incineration

Emission trends for PCDD/F follow the waste incineration activity data trend.

All emissions trends follow the activity data trend – total amounts of incinerated industrial waste taken from NEPA`s waste inventory.

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

To aviod double counting of pollutant emissions, NFR 5.C.1.b.iii Clinical waste incineration was included under the NFR 5.C.1.b.i Industrial waste incineration.

6.5. NFR 5.C.1.b.v Cremation

This chapter is the new source and covers the atmospheric emissions from the incineration of human bodies in a crematorium.

Romania is a predominantly Christian-Orthodox country and according to the tradition and the Romanian Christian Church, the dead human bodies are buried; there are few incinerated human bodies (there are only 3 Human Crematoriums) The contribution of crematoria to national emissions is comparatively small for all pollutants.

The emissions for NFR 5.C.1.b.v were calculated for the 1990-2018 period using the 2019 Guidebook EMEP/EEA Tier 1 Table 3-1.

Emissions are calculated based on Tier 1 applying the general equation:
Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate (number corpses)
- EFpollutant is the emission factor for each pollutant

The emission factors used to calculate: NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO, Heavy Metals, POPs, (PCDD/F, HCB, PCBs) emissions are from the 2019 EMEP/EEA Guidebook, Tier1, Table3-1.
Activity data represents the number of human bodies incinerated per year (the activity data were obtained from the 3 Human Crematoriums in Romania)

Table 6.5.1 Activity data trends (*number*) for NFR 5.C.1.v Cremation

Year/Activity data	Corpses (number)
1990	1408
1991	1577
1992	1636
1993	1659
1994	1445
1995	1410
1996	1434
1997	1394
1998	1200

Year/Activity data	Corpses (number)
1999	1195
2000	1170
2001	1073
2002	1121
2003	1002
2004	884
2005	820
2006	862
2007	796
2008	776
2009	788
2010	853
2011	854
2012	883
2013	941
2014	1041
2015	1322
2016	1588
2017	1848
2018	2116

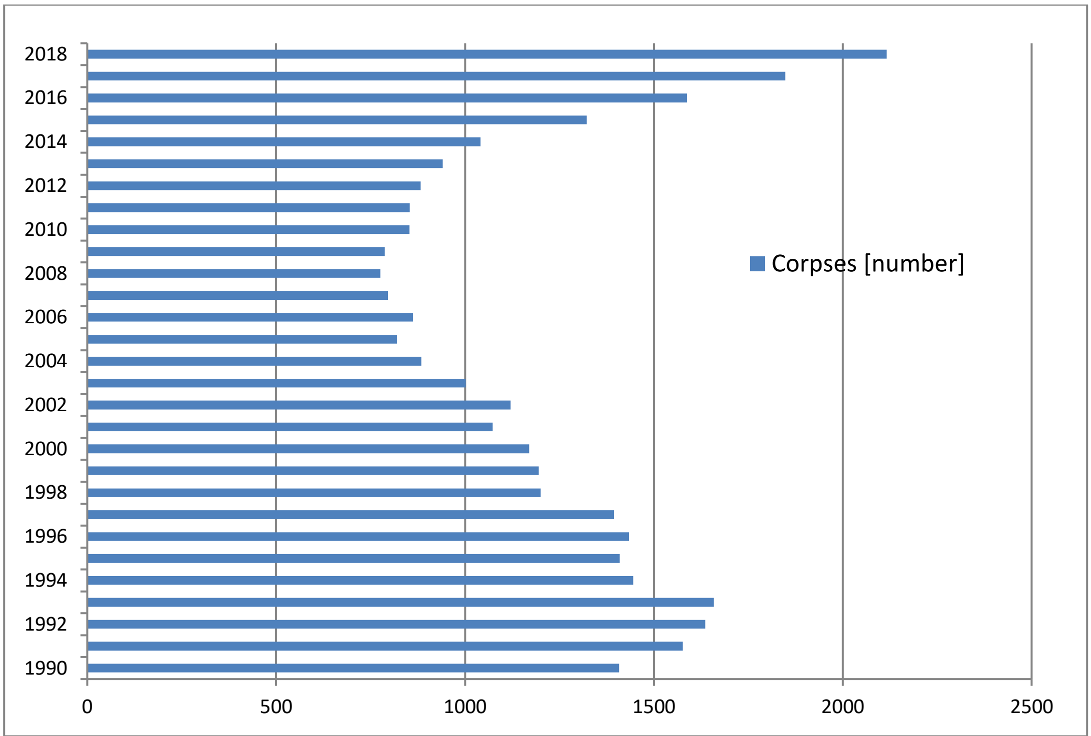


Figure 6.5.1 Activity data trends (*number corpses*) for NFR 5.C.1.b.v Cremation

Table 6.5.2. Emission trends *Kt for NOx, NMVOC, $PM_{2.5}$, SOx and Hg (t)*)
for NFR 5.C.1.b.v Cremation

Year	NOx (kt)	NMVOC (kt)	$PM_{2.5}$ (kt)	SOx(kt)	Hg (t)
1990	0.001162	0.000018	0.000049	0.000159	0.002098
1991	0.001301	0.000021	0.000055	0.000178	0.002350
1992	0.001350	0.000021	0.000057	0.000185	0.002438
1993	0.001369	0.000022	0.000058	0.000187	0.002472
1994	0.001192	0.000019	0.000050	0.000163	0.002153

Year	NOx (kt)	NMVOC (kt)	$PM_{2.5}$ (kt)	SOx(kt)	Hg (t)
1995	0.001163	0.000018	0.000049	0.000159	0.002101
1996	0.001183	0.000019	0.000050	0.000162	0.002137
1997	0.001150	0.000018	0.000048	0.000158	0.002077
1998	0.000990	0.000016	0.000042	0.000136	0.001788
1999	0.000986	0.000016	0.000041	0.000135	0.001781
2000	0.000965	0.000015	0.000041	0.000132	0.001743
2001	0.000885	0.000014	0.000037	0.000121	0.001599
2002	0.000925	0.000015	0.000039	0.000127	0.001670
2003	0.000827	0.000013	0.000035	0.000113	0.001493
2004	0.000729	0.000011	0.000031	0.000100	0.001317
2005	0.000677	0.000011	0.000028	0.000093	0.001222
2006	0.000711	0.000011	0.000030	0.000097	0.001284
2007	0.000657	0.000010	0.000028	0.000090	0.001186
2008	0.000640	0.000010	0.000027	0.000088	0.001156
2009	0.000650	0.000010	0.000027	0.000089	0.001174
2010	0.000704	0.000011	0.000030	0.000096	0.001271
2011	0.000705	0.000011	0.000030	0.000097	0.001272
2012	0.000728	0.000011	0.000031	0.000100	0.001316
2013	0.000776	0.000012	0.000033	0.000106	0.001402
2014	0.000859	0.000014	0.000036	0.000118	0.001551
2015	0.001091	0.000017	0.000046	0.000149	0.001970
2016	0.001310	0.000021	0.000055	0.000179	0.002366
2017	0.001525	0.000024	0.000064	0.000209	0.002754
2018	0.001746	0.000028	0.000073	0.000239	0.003153

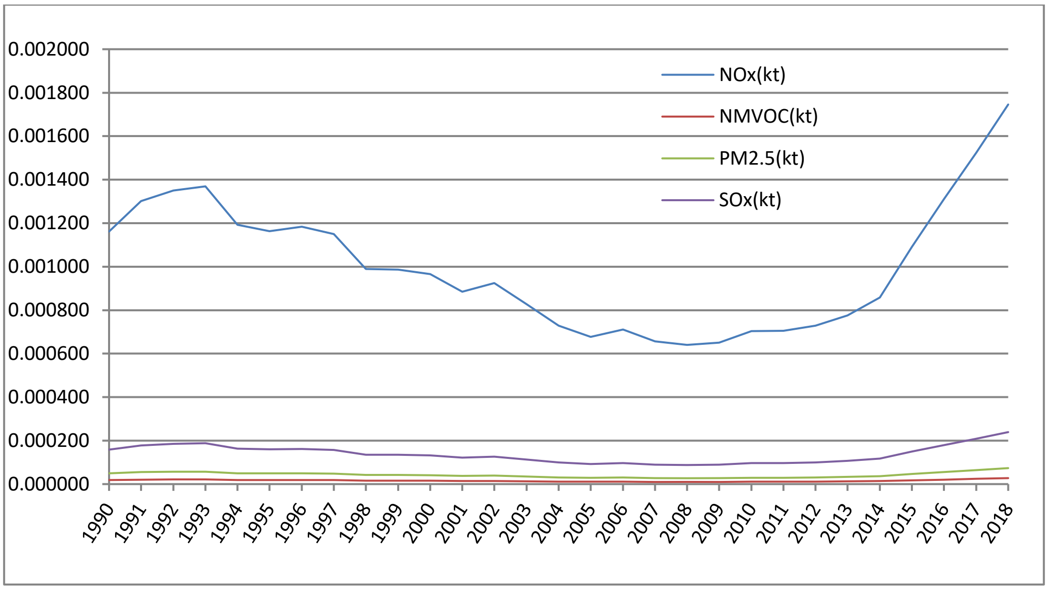


Figure 6.5.2.a. Emission trends (*Kt for NOx, NMVOC, $PM_{2.5}$ and SOx*)
for NFR 5.C.1.b.v Cremation

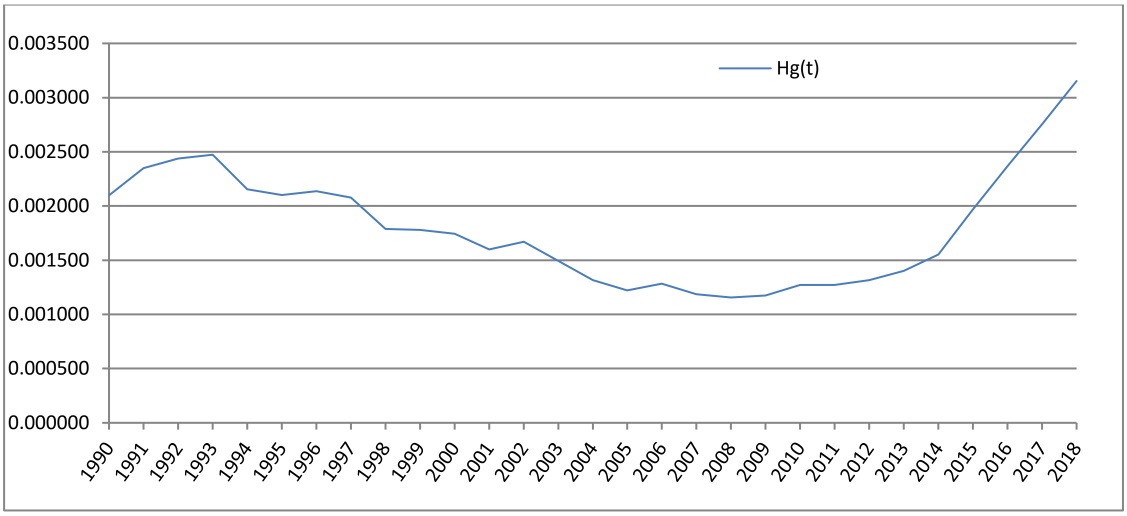


Figure 6.5.2.b. Emission trends (*t for Hg,*)
for NFR 5.C.1.b.v Cremation

The contribution of crematoria to national emissions is comparatively small for all pollutants.

Recalculations and improvements:

- The emissions for the NFR 5.C.1.b.v Cremation for the whole 1990-2018 time series have been calculated for the first time.

6.6. NFR 5.C.2 Open Burning of Waste

This activity covers emissions from open burning of agricultural waste.

The emissions for NFR 5.C.2 were calculated for the 1995-2018 period using the 2019 Guidebook EMEP/EEA Tier 1 Table 3-1.

Emissions are calculated based on Tier 1 applying the general equation:
Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate (amount of waste burned)
- EFpollutant is the emission factor for each pollutant

The emission factors used to calculate the emissions are from the 2019 EMEP/EEA Guidebook, Tier 1, Table 3-1.

Activity data for the amount of waste burned (in kt) is estimated by using statistical crops production data from the N.I.S. There are no activity data for the 1990-2004 period.

Table 6.6.1 Activity data trends (*kt product*) for NFR 5.C.2 Small scale waste burning

Year	Amount of waste burned (kt)
1995	161.121
1996	146.070
1997	157.994
1998	148.015
1999	134.269
2000	141.380
2001	157.373
2002	150.952
2003	138.545
2004	156.635
2005	146.642
2006	127.860
2007	128.230
2008	130.276
2009	132.061
2010	126.016
2011	130.618
2012	136.007
2013	135.530
2014	136.080
2015	136.707
2016	137.174
2017	129.809
2018	131.429

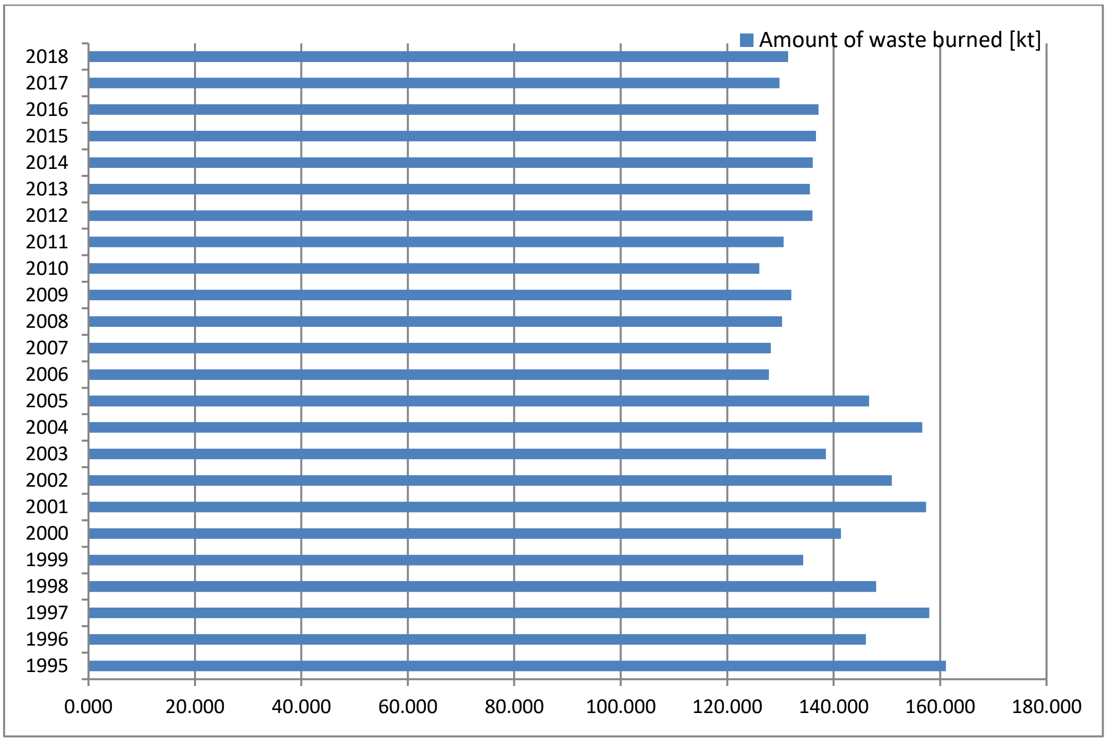


Figure 6.6.1 Activity data trends (*kt product*) for NFR 5.C.2 Small scale waste burning

Table 6.6.2 Emission trends (*kt for NMVOC, $PM_{2.5}$ and PM_{10}, g I-TEQfor PCDD/F and t for Total PAHs*) for NFR 5.C.2 Small scale waste burning

Year	NMVOC (kt)	$PM_{2.5}$ (kt)	PM_{10} (kt)	PCDD/F (g I-TEQ)	Total PAHs (t)
1995	0.1982	0.6751	0.7267	1.6112	2.0366
1996	0.1797	0.6120	0.6588	1.4607	1.8463
1997	0.1943	0.6620	0.7126	1.5799	1.9970
1998	0.1821	0.6202	0.6675	1.4801	1.8709
1999	0.1652	0.5626	0.6056	1.3427	1.6972
2000	0.1739	0.5924	0.6376	1.4138	1.7870
2001	0.1936	0.6594	0.7098	1.5737	1.9892
2002	0.1857	0.6325	0.6808	1.5095	1.9080
2003	0.1704	0.5805	0.6248	1.3855	1.7512
2004	0.1927	0.6563	0.7064	1.5663	1.9799
2005	0.1804	0.6144	0.6614	1.4664	1.8536
2006	0.1573	0.5357	0.5766	1.2786	1.6162
2007	0.1577	0.5373	0.5783	1.2823	1.6208
2008	0.1602	0.5459	0.5875	1.3028	1.6467
2009	0.1624	0.5533	0.5956	1.3206	1.6693
2010	0.1550	0.5280	0.5683	1.2602	1.5928
2011	0.1607	0.5473	0.5891	1.3062	1.6510
2012	0.1673	0.5699	0.6134	1.3601	1.7191
2013	0.1667	0.5679	0.6112	1.3553	1.7131
2014	0.1674	0.5702	0.6137	1.3608	1.7201
2015	0.1681	0.5728	0.6165	1.3671	1.7280
2016	0.1687	0.5748	0.6187	1.3717	1.7339
2017	0.1597	0.5439	0.5854	1.2981	1.6408
2018	0.1617	0.5507	0.5927	1.3143	1.6613

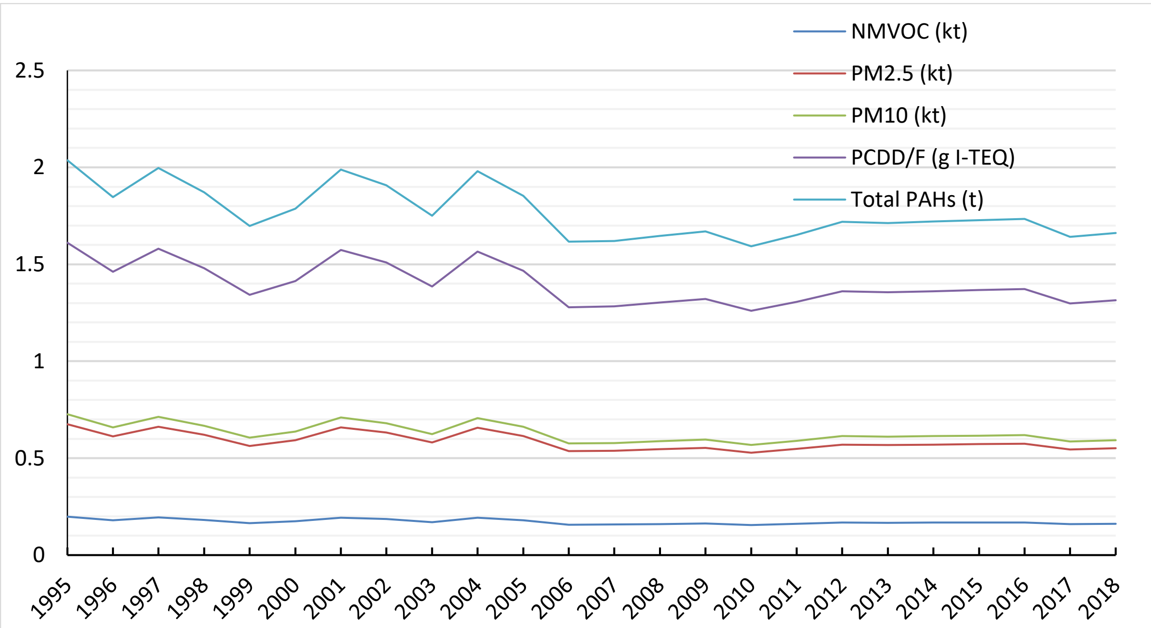


Figure 6.6.2 Emission trends (*kt for NMVOC, $PM_{2.5}$ and PM_{10}, g I-TEQ for PCDD/F and t for Total PAHs*) for NFR 5.C.2 Small scale waste burning

The emissions from this category (NMVOC, $PM_{2.5}$, PM_{10}, PCDD/F and Total PAHs) follow the activity data trend of NFR 5.C.2. Open Burning of Waste.
The NH_3 emissions from this category were not estimated (according to the 2019 EMEP/EEA Guidebook).

6.7. NFR 5.D.3 Wastewater handling Latrines

Activities from NFR 5.D.3 includes SNAP 0910 - water handling and SNAP 091007-latrines. The pollutant emissions have been estimated: NMVOC for NFR 5.D.3.-water handling and NH_3 for NFR 5.D.3.-latrines.

NFR 5.D.3. - SNAP 0910 - water handling

The emissions were calculated based on Tier 1 methodology applying the general equation:
Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate (total water handling in 1000mc)
- EFpollutant is the emission factor for this pollutant

The emission factors used to calculate the NMVOC emissions are from the 2019 EMEP/EEA Guidebook, Tier 1, Table 3-1.
The activity data is represented by the water handling taken from the A.N.A.R. (for 1990 - 1996 period the A.N.A.R does not have any informations).

NFR 5.D.3. - SNAP 091007 - latrines

The emissions are calculated based on the Tier 2 methodology applyind the general equation:
Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate (latrines)
- EFpollutant is the emission factor for this pollutant

The emission factors used to calculate the NH_3 emissions are from the 2019 EMEP/EEA Guidebook, Tier 2, Table 3-1.
The activity data for the NFR 5.D.3. - latrines have been calculated using as a work algorithm percent of the population using latrines. Activity data represents the difference between the total population and the population served by the public water supply system, which decreases by 10% percent (the population using septic tanks). The population statistics data is estimated by using statistical data from N.I.S.

The NFR 5.D.1. Domestic wastewater handling was assimilated with the SNAP 091007-Latrines and was included under NFR 5.D.3 Other wastewater handling Latrines

The NFR 5.D.2. Industrial wastewater handling was assimilated with the SNAP 0910-wastewater handling and included under NFR 5.D.3 Other wastewater handling Latrines

Table 6.7.1 Activity data trends (*waste water handling -1000 m^3*)
for NFR 5.D.3 Wastewater handling

Year	*Waste water handling [1000m3]*
1997	3137220
1998	2050930
1999	2092970
2000	2020840
2001	1679670
2002	2031810
2003	1559910
2004	1484200
2005	1432288
2006	1230988
2007	1417751
2008	1249768
2009	1394457
2010	1291500
2011	1471220
2012	1577620
2013	1977613
2014	1581360.13
2015	1578513.36
2016	1619318.61
2017	2146200
2018	2151350

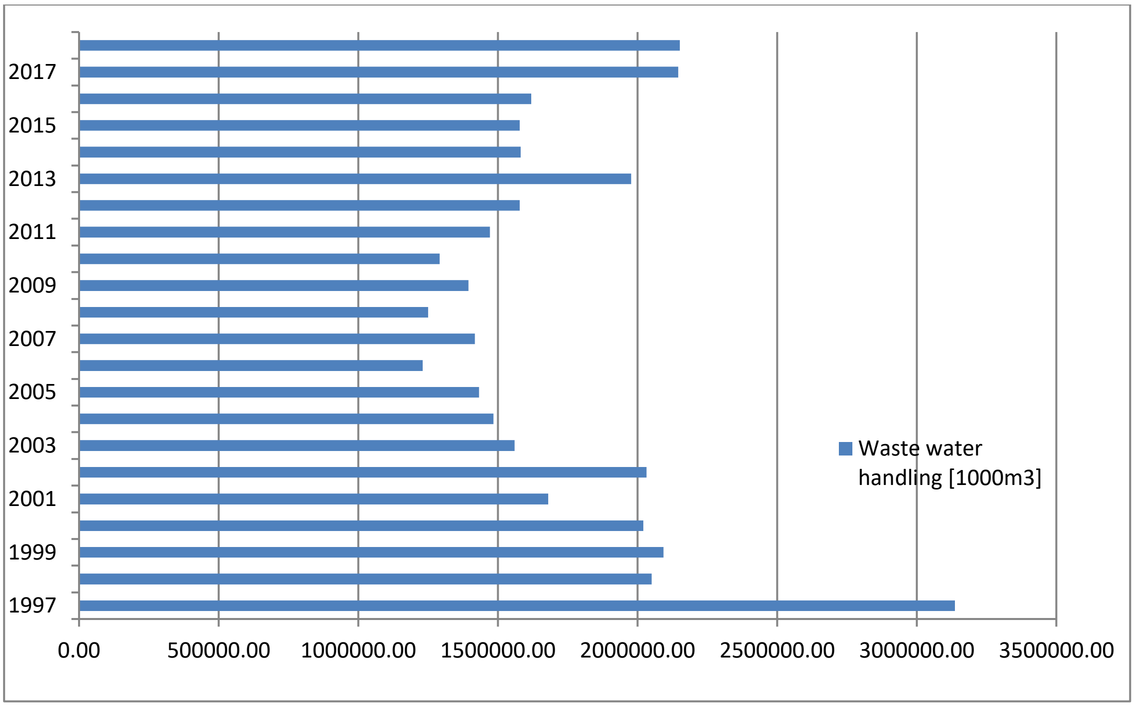


Figure 6.7.1 Activity data trends (*water handling 1000 m^3*) for NFR 5.D.3 Wastewater handling

Table 6.7.2 Emission trends *(kt for NMVOC*) for NFR 5.D.3 Wastewater handling

Year	NMVOC (kt)
1997	0.04706
1998	0.03076
1999	0.03139
2000	0.03031
2001	0.02520
2002	0.03048
2003	0.02340
2004	0.02226
2005	0.02148
2006	0.01846
2007	0.02127
2008	0.01875
2009	0.02092
2010	0.01937
2011	0.02207
2012	0.02366
2013	0.02966
2014	0.02372
2015	0.02368
2016	0.02429
2017	0.03219
2018	0.03227

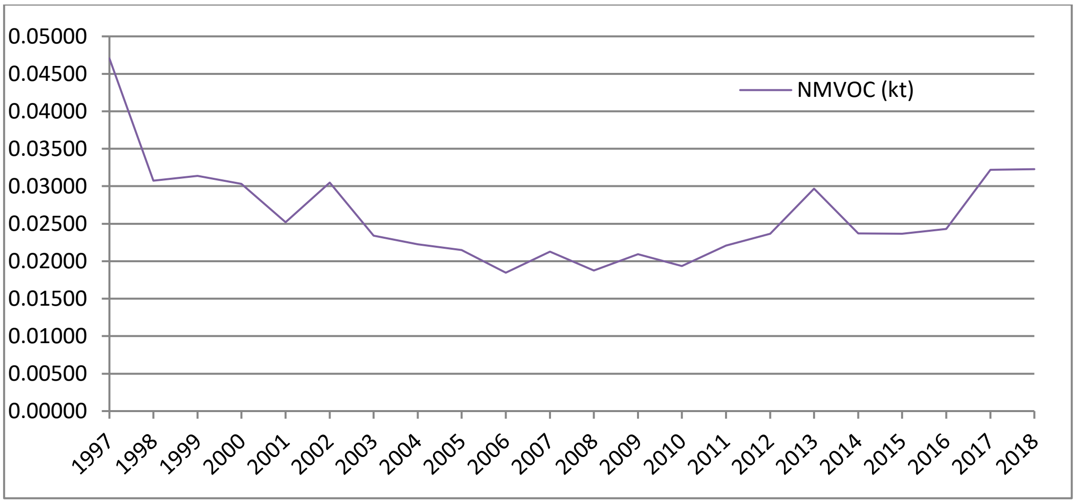


Figure 6.7.2 Emission trends (*kt for NMVOC*) for NFR 5.D.3 Wastewater handling

The NMVOC emissions from NFR 5.D.3 - wastewater handling follow the activity data trend.

Table 6.7.3 Activity data trends (*caput*) for NFR 5.D.3
Wastewater handling-Latrines

Year/Activity data	*Latrines [caput]*
1990	12413047
1991	12265974
1992	12121871

Year/Activity data	*Latrines [caput]*
1993	11972936
1994	11832703
1995	11663168
1996	11473565
1997	11318222
1998	11194115
1999	11020759
2000	10898591
2001	10781497
2002	9609758
2003	9379028
2004	9164119
2005	8600000
2006	8400000
2007	8200000
2008	8193253
2009	7653770
2010	7441243
2011	7205791
2012	7124867
2013	6916181
2014	6678570
2015	6413549
2016	6112116
2017	5670839
2018	5300577

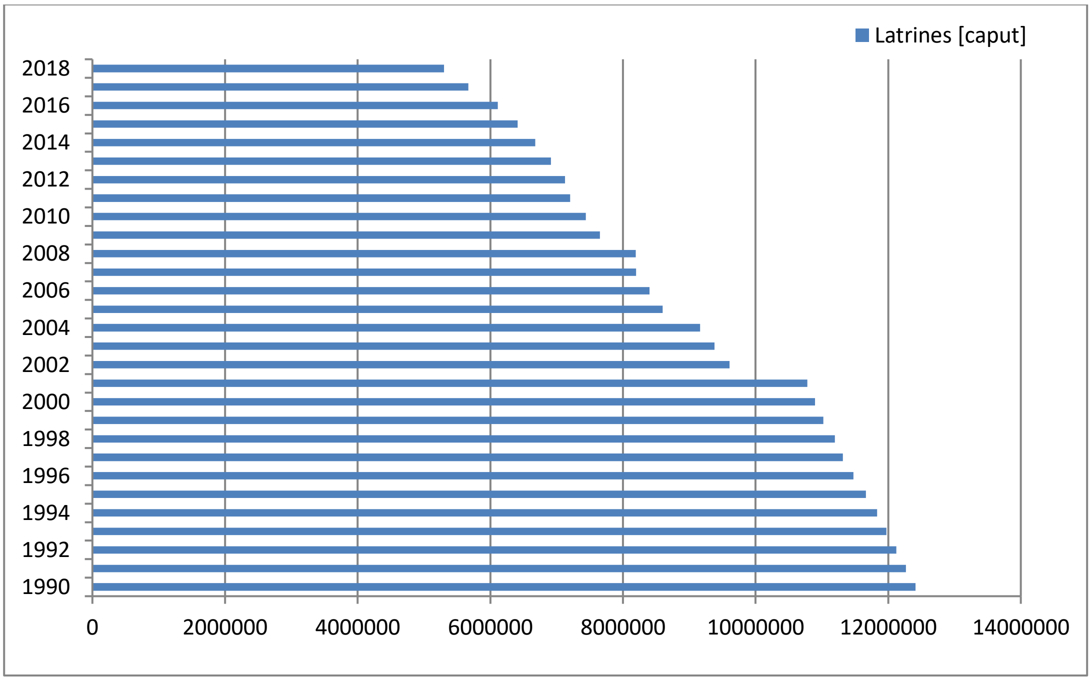


Figure 6.7.3 Activity data trends (*caput*) for NFR 5.D.3
Wastewater handling-Latrines

Table 6.7.4 Emission trends (*kt for NH_3*) for NFR 5.D.3
Wastewater handling-Latrines

Year/Pollutant	NH_3 (kt)
1990	19.861
1991	19.626
1992	19.395
1993	19.157
1994	18.932
1995	18.661
1996	18.358
1997	18.109
1998	17.911
1999	17.633
2000	17.438
2001	17.250
2002	15.376
2003	15.006
2004	14.663
2005	13.760
2006	13.440
2007	13.120
2008	13.109
2009	12.246
2010	11.906
2011	11.529
2012	11.400
2013	11.066
2014	10.686
2015	10.262
2016	9.779
2017	9.073
2018	8.481

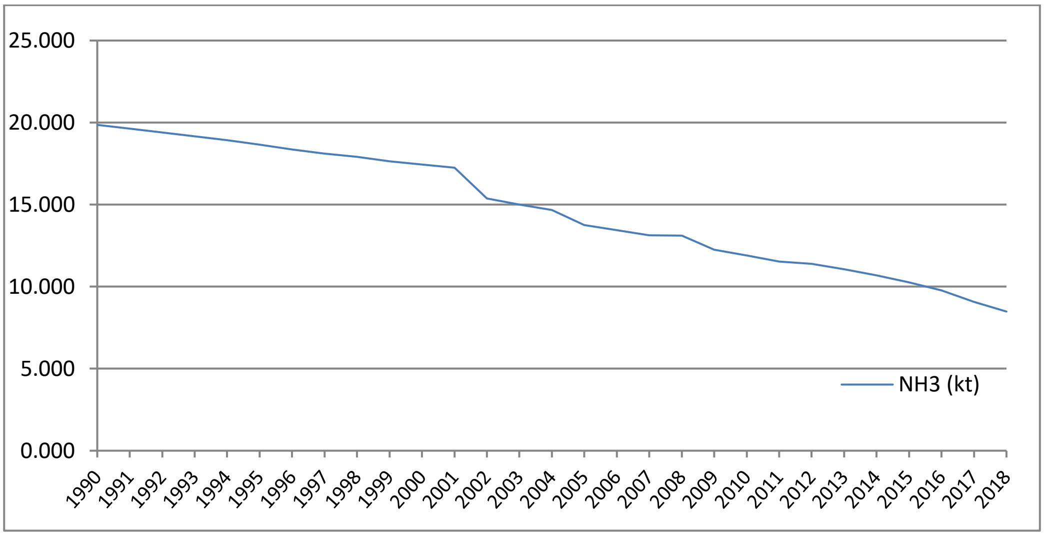


Figure 6.7.4 Emission trends (*kt for NH_3*) for NFR 5.D.3
Wastewater handling-Latrines

The NH_3 emissions from NFR 5.D.3. – latrines, decreased comparated to 1990 emission data and follow the activity data trend.

Recalculations and improvements:

- First estimate of emissions from NFR 5.D.3. - SNAP 091007 - latrines for the time series 1990-1994.

6.8. NFR 5.E. Other Waste (car fires and house fires)

The source category other waste NFR 5.E. convers the emissions from the activities car fires and house fires. Car and house fires include mostly unwanted fires in cars and various tipe of house. Types of fires house that are convered are: detached house fire(represents 40% of the house fires), undetached house fire (represents 5% of the house fires), apartament building fire(represents 33% of the house fires) and industrial building fire (represents 22% of the house fires). Activity data were obtained from the fire statistics by CTIF(Center of Fire Statistics)- Report – World Fire Statistics and IGSU(Romanian General Inspectorate for Emergency Situations – structure subordinated to the Ministry of Internal Affairs)
The Tier 2 EMEP/EEA methodology and recomended Tier 2 emissions factor from Guidebook 2019 are used for emission calculation.
The emissions are calculated based on the Tier 2 methodology applying the general equation:
Epollutant = ARproduction× EFpollutant where:

- Epollutant is the emission of the specified pollutant
- ARproduction is the activity rate
- EFpollutant is the emission factor for this pollutant

The emission factors used to calculate the $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Cr, Cu, PCDD/F emissions are from the 2019 EMEP/EEA Guidebook, Tier 2, Table 3-2 (for “car fire”), Table 3-3 (for “detached house fire”), Table 3-4 (for”undetached house”), Table 3-5 (for “apartament building fire”), Table 3-6(for”industrial building fire”).

Table 6.8.1 Activity data trends (*no. of fire for Car fire and House fire*) for NFR 5.E. Other waste(car fire and house fire)

Year	Car fire(no. of fire)	House fire(no. of fires)
1995	787	3191
1996	839	5483
1997	2617	3816
1998	3717	3246
1999	919	7226
2000	1119	4995
2001	993	4017
2002	900	4552
2003	912	3631
2004	944	3650

Year	Car fire(no. of fire)	House fire(no. of fires)
2005	1030	2981
2006	930	3020
2007	1392	1952
2008	1796	7975
2009	1075	5235
2010	1848	7150
2011	1362	11633
2012	1399	13334
2013	1246	6035
2014	1255	6047
2015	1744	2402
2016	1955	2976
2017	1998	6914
2018	1964	6911

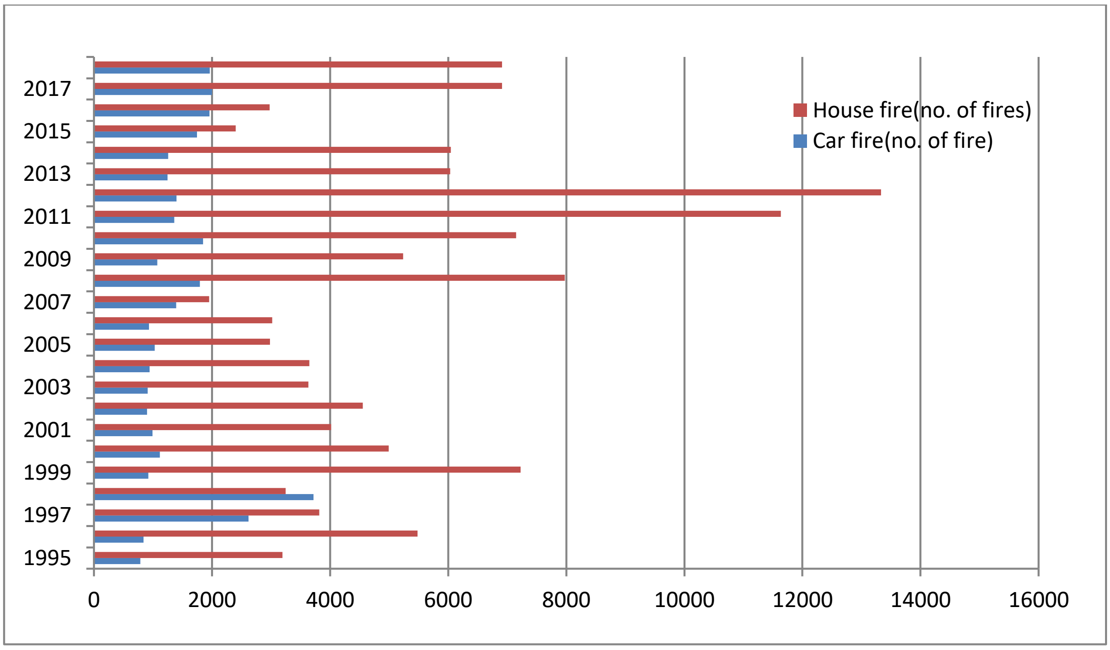


Figure 6.8.1 Activity data trends (*no. of fire*) for NFR 5.E. Other waste(car fire and house fire)

Table 6.8.2 Emission trends for NFR 5.E. Other waste(car fire and house fire)

Year/Pollutant	PM2.5 [kt]	TSP[kt]	Pb [t]	Hg [t]	Cd [t]	As [t]	Cr[t]	Cu [t]	PCDD/F (g I-TEQ)
1995	0.2604	0.2604	0.0008	0.2604	0.0015	0.0024	0.0023	0.0054	2.6276
1996	0.4463	0.4463	0.0013	0.4463	0.0026	0.0042	0.0040	0.0092	4.4903
1997	0.3153	0.3153	0.0009	0.3153	0.0018	0.0029	0.0028	0.0064	3.2227
1998	0.2716	0.2716	0.0008	0.2716	0.0016	0.0025	0.0024	0.0055	2.8129
1999	0.5878	0.5878	0.0017	0.5878	0.0035	0.0055	0.0052	0.0122	5.9087
2000	0.4074	0.4074	0.0012	0.4074	0.0024	0.0038	0.0036	0.0084	4.1077
2001	0.3278	0.3278	0.0010	0.3278	0.0019	0.0031	0.0029	0.0068	3.3079
2002	0.3710	0.3710	0.0011	0.3710	0.0022	0.0035	0.0033	0.0077	3.7376

Year/Pollutant	PM2.5 [kt]	TSP[kt]	Pb [t]	Hg [t]	Cd [t]	As [t]	Cr[t]	Cu [t]	PCDD/F (g I-TEQ)
2003	0.2964	0.2964	0.0009	0.2964	0.0017	0.0028	0.0026	0.0061	2.9907
2004	0.2980	0.2980	0.0009	0.2980	0.0017	0.0028	0.0026	0.0062	3.0077
2005	0.2440	0.2440	0.0007	0.2440	0.0014	0.0023	0.0022	0.0050	2.4688
2006	0.2469	0.2469	0.0007	0.2469	0.0014	0.0023	0.0022	0.0051	2.4957
2007	0.1614	0.1614	0.0005	0.1614	0.0009	0.0015	0.0014	0.0033	1.6511
2008	0.6505	0.6505	0.0019	0.6505	0.0038	0.0061	0.0058	0.0134	6.5587
2009	0.4268	0.4268	0.0012	0.4268	0.0025	0.0040	0.0038	0.0088	4.3003
2010	0.5837	0.5837	0.0017	0.5837	0.0034	0.0054	0.0052	0.0121	5.8916
2011	0.9460	0.9460	0.0028	0.9460	0.0056	0.0088	0.0084	0.0196	9.5067
2012	1.0839	1.0839	0.0032	1.0839	0.0064	0.0101	0.0097	0.0225	10.8890
2013	0.4920	0.4920	0.0014	0.4920	0.0029	0.0046	0.0044	0.0102	4.9578
2014	0.4930	0.4930	0.0014	0.4930	0.0029	0.0046	0.0044	0.0102	4.9680
2015	0.1987	0.1987	0.0006	0.1987	0.0012	0.0018	0.0017	0.0040	2.0332
2016	0.2457	0.2457	0.0007	0.2457	0.0014	0.0023	0.0022	0.0050	2.5092
2017	0.5650	0.5649	0.0016	0.0033	0.0033	0.0052	0.0050	0.0117	5.7073
2018	0.5646	0.5646	0.0016	0.0033	0.0033	0.0052	0.0050	0.0116	5.7032

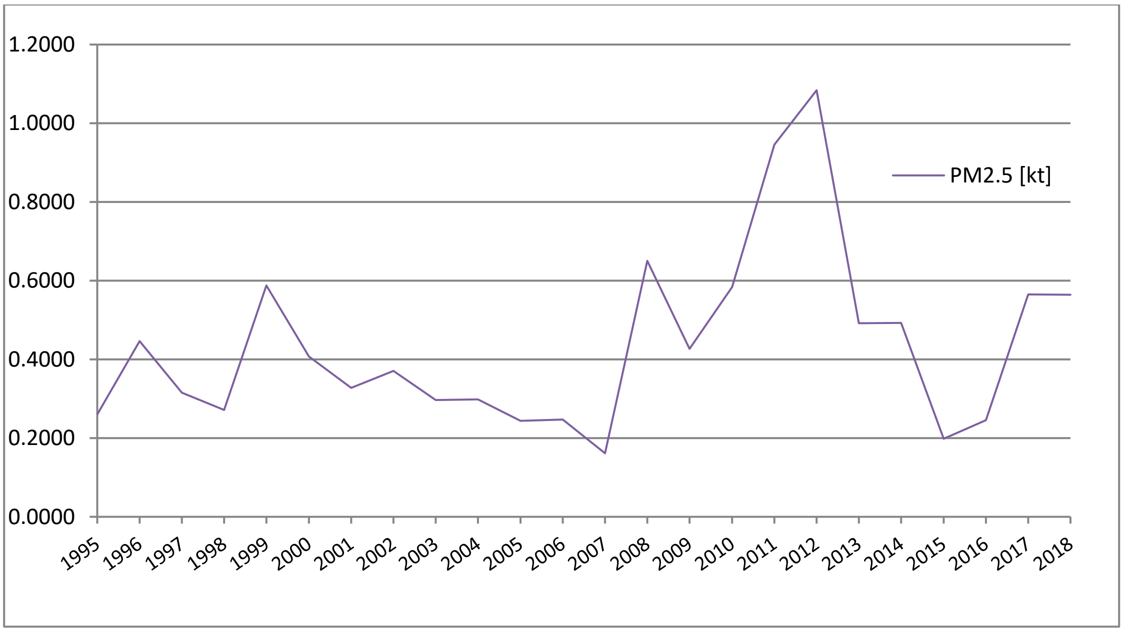


Figure 6.8.2 Emission trends (*kt for $PM_{2.5}$*) for NFR 5.E. Other waste(car fire and house fire)

Emission trends for $PM_{2.5}$ follow the activity data(car fires&house fires) trend.

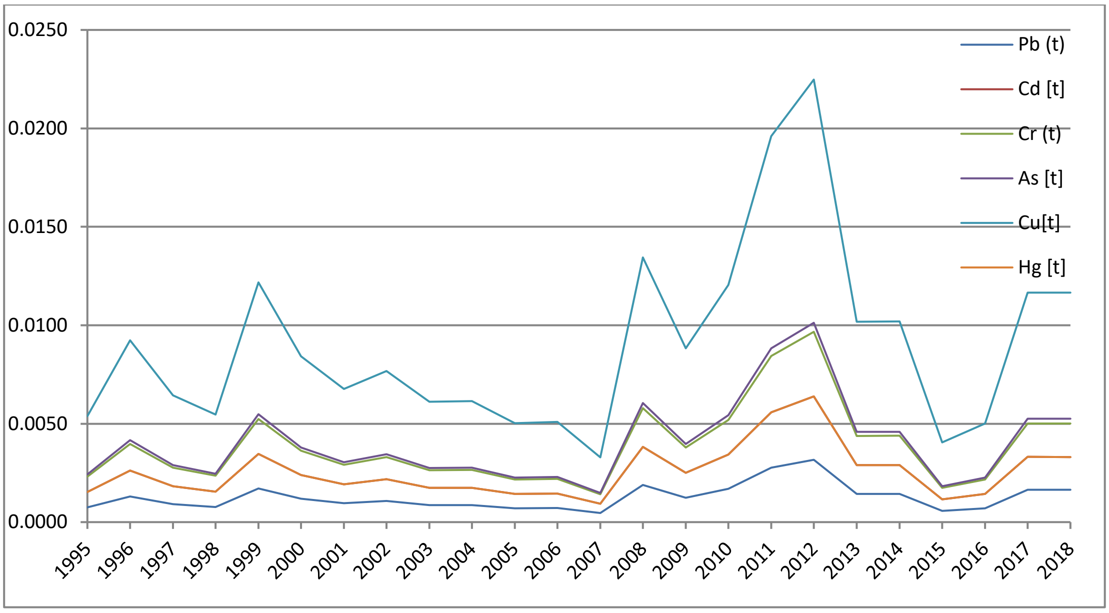


Figure 6.8.3 Emission trends (*t for heavy metals*) for NFR 5.E.
Other waste(car fire and house fire)

Emission trends for heavy metals follow the activity data (car fires&house fires) trend.

Emission trends for Hg follow the activity data (car fires&house fires) trend.

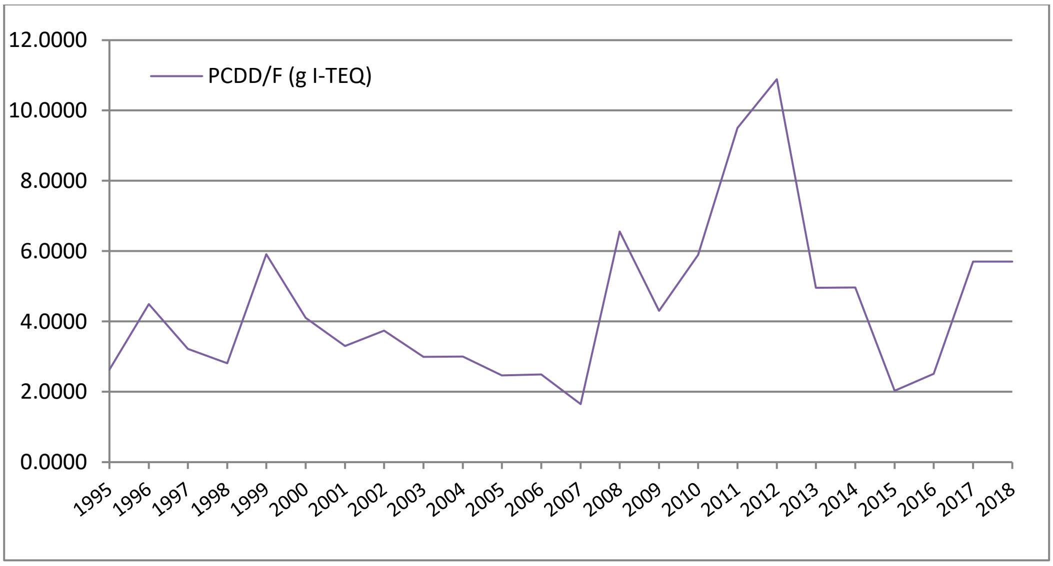


Figure 6.8.4 Emission trends (g I-TEQ for PCDD/F) for NFR 5.E.
Other waste(car fire and house fire)

Emission trends for PCDD/F follow the activity data(car fires&house fires) trend.

For 1990 -1995 period the IGSU(Romanian General Inspectorate for Emergency Situations) does not have any informations.

7. OTHER AND NATURAL EMISSIONS

Emissions from Other and Natural emissions are not estimated for Romania.

8. RECALCULATIONS AND IMPROVEMENTS

8.1. Recalculations

The main objective of recalculation is to improve the emissions inventory and the quality of the reports.
Following the Emission Inventory Review in 2017-2019, large part of recommendations from TERT were assessed and implemented.
The present report includes the first version calculations for the timeseries 1990-1994.
Significant recalculations and improvements were developed on the following categories:

- 1A4aii Non-road mobile combustion in Commercial/Institutional: separate the emissions time-series from NFR 1A4bii (implementing the Reviews recommendations RO-1A4aii-2017-0001 and RO-1A4aii-2018-0001);
- 1A4ci Agriculture/Forestry/Fishing, Stationary: Recalculation of the time series with improved activity data;
- 1A4cii Agriculture/Forestry/Fishing: Non-road vehicles and other machinery: recalculation of the time series on Tier2 level;
- NFR 1.A.3.b.vi and NFR 1.A.3.b.vii first estimate of $PM_{2.5}$, PM_{10} and TSP emissions on Tier 1 for the time series 1990-2004;
- NFR 2.A.5.b Construction and demolition – new source;
- NFR 2C3 - emissions from secondary aluminium production were estimated for the 2010-2018 time series;
- NFR 3.B Manure Management – by recalculating to Tier 1 and 2 level for NH3, NMVOC and NOx;
- NFR 3.D.a.1 Inorganic N-fertilizers- by updating to Tier 2 level assessment for NH3;
- NFR 3.D.a.2.a Animal manure applied to soils - by recalculating to Tier 1 and 2 level for NH3, as part of Manure Management;
- NFR 3.D.a.3 Urine and dung deposited by grazing animals - by recalculating to Tier 1 and 2 level for NH3, as part of Manure Management.
- NFR 5.C1bv Cremation – new source.

8.2. Planned improvements

Improvements, for the next submission, will include at least an update of the emission factors and calculations according to the 2019 EMEP/EEA Guidebook for Agriculture Sector, 3B Manure Management. Further research is necessary to gather the data and information necessary to implement the recommendations not yet implemented, specified in the following table. Program of improvement is focused on the many tasks like gathering additional activity data to include new emission sources, correlation with other reporting, improvement of QA/QC actions.

The recommendations from TERT in the NECD Review 2019 and the comments of Romania on the recommendations are presented below:

Comments of Romania on recommendations from the NECD Review Report

Recommendations from the NECD Review 2018 for NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$ that have not been implemented in the inventory submission 2019

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	RO-2D3a-2017-0001	Yes	2D3a Domestic Solvent Use Including Fungicides, NMVOC, 1990-2015	RE	PTC	Yes

Recommendation made in previous review report

For category 2D3a Domestic Solvent Use Including Fungicides and pollutant NMVOC for the years 1990-2015 the TERT noted that Romania used the emission factors from the Table 3.5 of the 2016 EMEP/EEA Guidebook that presents additional Tier 2 emission factors for product use. However, these are per-capita emission factors. The TERT noted that the Guidebook recommends that these be used only in specific cases, for instance if the product statistics for the use of the Tier 2b approach (from the Table 3.4) are not complete in terms of the product types covered by domestic solvent use. In response to a question raised during the review, Romania provided a revised estimate for the years 2000-2016 using the Tier 1 methodology and stated that it will be included in the next submission. Romania also stated that they will further investigate this issue in order to apply Tier 2 methodology. The TERT agreed with the revised estimate provided by Romania and attached them to the annex of the review report. The TERT recommends that Romania includes the revised estimate in its next submission. The TERT also recommends Romania to investigates the possibility to apply the Tier 2 methodology and to include in the IIR an overview of the steps taken for that and a supposed timetable for implementing this improvement. The TERT kindly notes that progress of inclusion of the information in the IIR will be reviewed in 2019.

Assessment of Implementation

During the 2018 review, for category 2D3a Domestic solvent use including fungicides and pollutant NMVOC for the years 1990-2015 the TERT noted that Romania used the emission factors from the Table 3.5 of the 2016 EMEP/EEA Guidebook that presents additional Tier 2 emission factors for product use. However, these are per-capita emission factors. The TERT noted that the 2016 EMEP/EEA Guidebook recommends that these be used only in specific cases, for instance if the product statistics for the use of the Tier 2b approach (from the Table 3.4) are not complete in terms of the product types covered by domestic solvent use. In response to a question raised during the review, Romania provided a revised estimate for the years 2000-2016 using the Tier 1 methodology and stated that it will be included in the next submission. As this is a key category for Romania, this question was reiterated in the 2019 review. Romania then supplied another calculation, which they proposed was a tier 2 approach, using the default EFs from table 3.5 of the 2016 EMEP/EEA Guidebook again, this time taking average EFs for the different categories of household products and weighting it using the value of the lower confidence interval for the rural population and the higher confidence interval for urban population (based on the assumption that in rural areas less solvent containing products are used). This calculation, however, was not accepted by the TERT, as it means applying a methodology differently to the way it is described in the 2016 EMEP/EEA Guidebook, which clearly states that those EFs should only be applied for gap filling if activity data based on the amount of product, as used in table 3.4, is not available for some sub-categories. Romania also stated that applying the higher and lower confidence interval of the average EF is based on Romanian expert judgement. Romania explained in a last answer that additional investigation in amounts of household products used will be necessary in order to apply a tier 2 category. It is currently not possible for the TERT to provide a numerical emission estimate based on a tier 1/tier 2 method, and therefore the issue will be flagged as Potential Technical Correction and will be assessed as a high priority item in future reviews.

The TERT recommends that Romania should calculate NMVOC emissions from 2D3a Domestic solvent use including fungicides using a tier 2 or tier 3 method for inclusion in next years' inventory submission.

Comment

Implemented for year 2018 (see section 4.18).

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	RO-1A3bvii-2017-0001	No	1A3bvii Road Transport: Automobile Road Abrasion, $PM_{2.5}$, 2005, 2010, 2015	No	No	No

Recommendation made in previous review report

For category 1A3bvii Road Transport: Automobile Road Abrasion, for pollutants $PM_{2.5}$, PM_{10} and TSP and for the years 2000-2004, the TERT noted that no emissions are reported. In response to a question raised during the review, Romania explained that this is due to lack of relevant statistical data. The TERT notes that this issue may relate to an under-estimate and recommends that Romania makes an effort to estimate the relevant activity data (total vehicle kilometres driven) by e.g. scaling proportionally to fuel consumption over the same time period. The TERT kindly notes that progress in the implementation of the improvement will be reviewed in 2019.

Assessment of Implementation

For category 1A3bvii Road Transport: Automobile Road Abrasion, for pollutants $PM_{2.5}$, PM_{10} and TSP and for the years 2000-2004 the TERT noted that no emissions are reported. This issue was raised in 2017 NECD review (observation RO-1A3bvii-2017-0001). In response to a question raised during 2019 review, Romania provided estimates for years 1995-2004 and stated that it will be included in the next submission. The TERT agreed with the estimates provided by Romania.

The TERT recommends that Romania includes the estimates in its 2020 NFR and IIR submission.

Comment

Implemented in the 2020 submission (see section 3.13).

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	RO-1A4aii-2017-0001	No	1A4aii Commercial/Institutional: Mobile, SO_2, NO_X, 2005-2015	No	No	No

Recommendation made in previous review report

For category 1A4aii Commercial/institutional: Mobile, for pollutants SO_2 and NO_X, for the time period 2005-2015 and with reference to the previous review recommendation RO-1A4aii-2017-0001, the TERT notes that the transparency regarding the calculation of emissions has not improved, since these emissions are included in 1A4ai (Stationary). In response to a question raised during the review, Romania explained that the estimates of pollutants on 1A4aii category will be reported separately in the 2019 submission of NECD reporting. The TERT notes that this issue does not relate to an over or under-estimate and recommends that the emissions from this category are reported separately in the next submission. The TERT also kindly notes that progress in the implementation of the improvement will be reviewed in 2019.

Assessment of Implementation

For category 1A4aii Commercial/Institutional: Mobile, for pollutants SO_2 and NO_X, for the time period 2005-2015 and with reference to the previous review recommendation RO-1A4aii-2017-0001, the TERT notes that the transparency regarding the calculation of emissions has not entirely improved, since these emissions are included in 1A4bii. In response to a question raised during the review, Romania explained that emissions from 1A4aii were summed up with 1A4bii, using the same method and emission factors, therefore reporting them together does not lead to a change in estimation and instead gives a more consistent time series. The TERT agreed with the explanation provided by Romania.

However, the TERT recommends that Romania tries to separate fuels on the categories 1A4aii and 1A4bii and report these emissions separately.

Comment

The emissions from NFR 1A4aii and NFR 1A4bii are reported separately in the 2020 submission, for the years where data were available in the Energy statistics, allowing the separation (see section 3.8.1 and 3.9.1).

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	RO-5C1bv-2017-0001	No	5C1bv Cremation, SO_2, NO_X, NMVOC, $PM_{2.5}$, 2005;2010;2015	No	No	No

Recommendation made in previous review report

For sector 5C1bv Cremation the TERT notes that Romania did not implement the 2017 TERT recommendation (RO-5C1bv-2017-0001). In the IIR the recommendation is included under Planned improvements without further comment. In response to the question on the issue raised during the 2018 review Romania replied that there was a lack of information on activity data needed for emission estimation. So far Romania has not estimated this source but will search for this data and will estimate and report the emissions for a later submission. The TERT recommends that Romania starts a study on collecting activity data for 5C1bv and include the activity data and emission estimates for the entire time series in its 2019 submission, or that Romania includes a schedule for the implementation of this study in its next IIR. The TERT kindly notes that progress in the implementation of the improvement will be reviewed in 2019.

Assessment of Implementation

For 5C1bv 'Cremation' the TERT noted that emissions from this category are reported as 'not estimated (NE). This was raised during the 2017 and 2018 NECD review. In response to a question raised during the review, Romania explained that plausible activity data except for 2017 are not available and that it needs further investigations. Romania provided an estimate for the year 2017 and stated that it will be included in the next submission together with emission estimates for the whole time series.

The TERT recommends that Romania includes emissions from cremation for the whole time series in its 2020 submission.

Comment

Implemented in the 2020 submission (see section 6.5).

Additional recommendations made during the NECD Review 2019 for NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-1A2gvii-2019-0001	Yes	1A2gvii Mobile Combustion in Manufacturing Industries and Construction, NO_X, 2017	PTC	Yes

Recommendation

The TERT notes with reference to category 1A2gvii Mobile Combustion in manufacturing industries and construction for NOx emissions that a tier 1 method is used for a key category. The TERT notes that using a tier 1 method is not best practice and could result in an over and/or underestimate of emissions. This over/underestimate may have an impact on total emissions that is above the threshold of significance. Romania has not provided a revised estimate. It is currently not possible for the TERT to provide a numerical emission estimate based on a tier 1/tier 2 method, and therefore the issue will be flagged as Potential Technical Correction and will be assessed as a high priority item in future reviews.

The TERT recommends that Romania calculate NOx emissions from 1A2gvii category using a tier 2 or tier 3 method for inclusion in next years' inventory submission.

Comment

So far, there are not sufficient national specific data available, in order to upgrade to Tier2 for this category. More research is needed for this improvement.

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-3B1a-2019-0001	Yes	3B1a Manure Management - Dairy Cattle, NMVOC, 2000-2016	RE	No

Recommendation

For NMVOC emission for 3B1a, 3B1b 3B1a Manure Management - Dairy Cattle and 3B4gi the TERT noted that the calculation the variables E-NH_3_building, E-NH_3_storage and E-NH_3_application was used, but should have used NH_3 emission for housing, storage and application, as described in the 2016 EMEP/EEA Guidebook Chapter 3B page 28. [explain the issue referencing NFR and IIR as appropriate]. In response to a question raised during the review, Romania provided a revised estimate for years 1995-2017 and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Romania.

The TERT recommends that Romania include the revised estimate in its 2020 NFR and IIR submission.

Comments

Implemented by recalculation the entire time series (see Section 5 and Annex B – Table no.4, 5.6)

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-3Da1-2019-0002	Yes	3Da1 Inorganic N-fertilizers (includes also urea application), NH_3, 1995-2017	TC	Yes

Recommendation

For NH_3 emissions from 3Da1 Inorganic N-fertilizers (includes also urea application) the TERT noted that a tier 1 method is used for this key category. The TERT notes that using a tier 1 method is not best practice, and results in an overestimate of emissions that is above the threshold of significance. In response to a question raised during the review Romania explained that upgrading to Tier 2 needs further analysis and collection of new data. The TERT decided to calculate a technical correction for the years 2005, 2010, 2015, 2016 and 2017 which was not accepted by Romania. The estimates demonstrate that the issue is above the threshold of significance.

The TERT recommends that Romania include a revised estimate in its next submission.

Comment

Used Tier 2 in the 2020 calculation of ammonia pollutant (see section 5.10).

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-1A4cii-2019-0001	Yes	1A4cii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery, NO_X, 2017	No	Yes

Recommendation

For category 1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery, for liquid fuels, for the pollutant NOx and for year 2017, the TERT examined the 2019 IIR submission and found that based on relevant text in page 90 of 295, Tier 1 emission factors were used from the 2016 EMEP/EEA Guidebook. In response to a question raised during the review Romania provided a detailed explanation that the method used is Tier 2.

The TERT recommends that Romania includes this detailed information in the next NIR submission, so that it is clear what method is used for the calculation of emissions from this key category.

Comment

The recommendation was implemented (See section 3.6 and Annex A)

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-2A5b-2019-0001	No	2A5b Construction and Demolition, $PM_{2.5}$, 2017	No	No

Recommendation

For category 2A5b Construction and Demolition and pollutant $PM_{2.5}$ for all years, the TERT noted that Romania did report 'NE' for $PM_{2.5}$, even though a Tier 1 method is available in the 2016 guidebook. In response to a question raised during the review, Romania explained that further research is required in order to obtain activity data necessary for the calculations. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends Romania to work on obtaining activity data necessary for estimating emissions from this source category in the 2020 submission.

Comment

Implemented in the 2020 submission (see section 4.5).

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-2D3f-2019-0001	Yes	2D3f Dry Cleaning, NMVOC, 1990-2017	No	Yes

Recommendation

For category 2D3f Dry Cleaning and pollutant NMVOC for all years, the TERT noted that Romania did apply a Tier 1 method, even though this category has become a key category. In response to a question raised during the review, Romania explained that depending on the availability of activity data, a Tier 2 method will be applied in one of the next submissions. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends Romania to work on obtaining activity data necessary for estimating emissions from this source category.

Comment

In 2020 submission still used Tier 1 method from 2019 version Guidebook.

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-2D3g-2019-0001	Yes	2D3g Chemical Products, NMVOC, 2004	No	No

Recommendation

For 2D3g Chemical Products NMVOC emissions in 2006, 2007 and 2008 the TERT noted that emissions were more than 3-fold the emissions before and after. In response to a question raised during the review Romania sent a file that showed AD differences between 2005 and 2006 for the underlying SNAPs. The TERT noted that the issue is related to a non-mandatory year.

The TERT recommends that Romania revises the data used as AD for this category or finds an explanation for this trend and include this information in the next submission.

Comment

Implemented in the 2020 submission (see section 4.24).

Recommendations from the NECD Review 2018 of POPs and heavy metals that have not been implemented in the inventory submission 2019

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	RO-0A-2018-0002	No	0A National Total - National Total for the Entire Territory - Based on Fuel Sold/Fuel Used, SO_2, NO_X, NH_3, NMVOC, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, 1990-2016	No	No

Recommendation made in previous review report
For the time series completeness for all pollutants the TERT noted that Romania has not reported emissions for the years 1990-1999. In response to a question raised during the review, Romania explained that they will estimate the emissions for 1995-1999 to the next submission in 2019 and for the years 1990-1994 in the 2020 submission. The TERT party agreed with the explanation provided by Romania. The TERT recommends that Romania completes the time series for all the years 1990-1999 in the next submission. The TERT kindly reminds that progress in the implementation of the improvement will be reviewed in 2019.

Assessment of Implementation
In the 2019 submission, Romania has improved on the completeness of the time series by reporting emissions for the years 1995-1999. Romania had indicated during the 2018 review that these years would be included in the 2019 submission and that 1990-1994 would be provided in the 2020 submission. The TERT noted that Romania has not reported emissions for the years 1990-1994. In response to a question raised during the review, Romania confirmed that they will estimate and report the emissions for 1995-1999 in the next submission in 2020.

The TERT recommends that Romania completes the time series for the years 1990-1994 in the next submission.

Comment
Implemented in the 2020 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	RO-2B10a-2018-0001	No	2B10a Chemical Industry: Other (please specify in the IIR), Hg, 2000-2016	No	No

Recommendation made in previous review report
For category 2B10a Chemical Industry: Other and pollutant Hg for the years 2000-2016 the TERT noted that the notation key 'NE' (Not Estimated) is reported for Hg emissions, which is a potential under-estimate, since the 2016 Guidebook provides an emission factor for chlorine production (the Tier 2 approach) and that there was no mention of chlorine production nor Hg emissions from this source in the IIR. In response to a question raised during the review, Romania explained that so far, they have not estimated this source and Romania will ask from the National Institute for Statistics for this data, if it exists. Romania stated that they will estimate the emissions from chlorine production and report them in the next submission. The TERT agreed with the explanation provided by Romania and recommends that Romania includes Hg emissions, if they exist, in its next submission. The TERT also recommends that if chlorine production does not currently occur or has not earlier taken place in Romania, an explanation of this will be included in the IIR of the next submission. The TERT kindly notes that progress in the implementation of the improvement will be reviewed in 2019.

Assessment of Implementation

During the 2018 review, the TERT noted that for category 2B10a Chemical Industry: Other and pollutant Hg for the years 2000-2016 the notation key ‘NE’ (Not Estimated) is reported for Hg emissions, which is a potential under-estimate, since the 2016 EMEP/EEA Guidebook provides an emission factor for chlorine production (the Tier 2 approach) and that there was no mention of chlorine production nor Hg emissions from this source in the IIR. In response to a question raised during the review, Romania explained that up until this point, they had not estimated this source and that further investigation was necessary. In the 2019 IIR it was stated that it was found that chlorine production occurs in Romania. The National Institute of Statistics collects data on chlorine production, but not on the technologies used. In the 2016 EMEP/EEA Guidebook the emission factor available for the Hg pollutant is for mercury cell process. Applying this, Hg emissions could be over-estimated, because in recent years, only diaphragm cell and membrane cell processes are being in use. Romania stated in a reply to a question raised that activity data and emissions for Hg were being investigated at the source for the years 1990-2012, and that they would be submitted in one of the next submissions.

The TERT recommends Romania to continue this efforts and to provide information on the emissions in either the 2020 or 2021 submission.

Comment

Implemented in the 2020 submission (see section 4.11).

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	RO-2C3-2018-0001	No	2C3 Aluminium Production, HCB, PCDD/F, 2000-2016	No	No

Recommendation made in previous review report

For category 2C3 Aluminium Production and pollutants HCB and PCDD/F for the years 2000-2016 the TERT noted that Romania has reported ‘NE’ (Not Estimated) although the 2016 EMEP/EEA Guidebook provides emission factors for secondary aluminium production, which may lead to under-estimating PCDD/F and HCB emissions. In response to a question raised during the review, Romania explained that no statistical secondary aluminium production data is available and further investigation is necessary in order to obtain necessary activity data. For the 2019 submission Romania is planning to estimate the emissions from this category for primary aluminium production for the years 1995-1999. The TERT agreed with the explanation provided by Romania and recommends that Romania investigates the possibility to obtain the activity data for secondary aluminium production and provide emission estimates for the whole time series since 1990 in its next submission. If that is not possible, then the TERT recommends Romania to include in the IIR the timetable for implementation of this improvement. The TERT kindly notes that progress inclusion of the information in the IIR will be reviewed in 2019.

Assessment of Implementation

During the 2018 review, the TERT noted that for category 2C3 Aluminium Production and pollutants HCB and PCDD/F for the years 2000-2016 Romania reported ‘NE’ (Not Estimated) although the 2016 EMEP/EEA Guidebook provides emission factors for secondary aluminium production, which may lead to under-estimating PCDD/F and HCB emissions. In response to a question raised during the review, Romania explained that no statistical secondary aluminium production data was available and further investigation was necessary in order to obtain necessary activity data. During the 2019 review in a response to a follow-up question, Romania provided information that secondary aluminium production has been taking place since 2010, but that HCB emissions result from the use of hexachloroethane in secondary aluminium production, which has been banned (for degassing purposes) in 2009, so further emissions are considered to be zero and the 'NA' notation key will be used instead. Emissions of PCDD/F, $PM_{2.5}$, PM_{10}, TSP and BC for the production of secondary aluminium were estimated based on activity data and process information provided by the operator and will be published in 2020 submission.

The TERT recommends Romania continue their efforts in calculating emissions for this sector, and to include data in the 2020 submission. The TERT also recommends Romania use notation key 'NO' (and not 'NA') in case emissions from this sector can be considered zero.

Comment

Implemented in the 2020 submission (see section 4.14).

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	RO-2D3g-2018-0001	No	2D3g Chemical Products, PAHs, 2005, 2016	No	No

Recommendation made in previous review report

For category 2D3g Chemical Products and PAH emissions for the years 2005 and 2016 the TERT noted that Romania reports 'NE' (Not Estimated) while the 2016 EMEP/EEA Guidebook provides EFs for benzo(a)pyrene from asphalt blowing (the Tier 2 approach). The TERT noted that no additional information on this specific source was available in the IIR. In response to a question raised during the review, Romania explained that so far, they have not estimated these emissions and that further investigation is necessary in order to obtaining activity data. Romania stated that they will estimate and report the emissions for a later submission. The TERT agreed with the explanation provided by Romania and recommends that Romania investigates the possible sources for collecting the activity data. The emission factor currently given in the Guidebook is wrong but will be replaced. The TERT recommends Romania to include emission estimates from that activity in the inventory and a methodology description in the IIR as soon as the emission factor is corrected. If that is not possible, then the TERT recommends Romania to include an explanation for that in the IIR as well as a scheduled plan for the implementation of this improvement. The TERT would like to note that progress in implementation of the improvement will be reviewed in 2019.

Assessment of Implementation

During the 2018 review, the TERT noted that in category 2D3g Chemical Products and PAH emissions for the years 2005 and 2016 the TERT noted that Romania reports 'NE' (Not Estimated) while the 2016 EMEP/EEA Guidebook provides EFs for benzo(a)pyrene from asphalt blowing (the Tier 2 approach). The TERT noted that no additional information on this specific source was available in the IIR. In response to a question raised during the review, Romania explained that so far, they have not estimated these emissions and that further investigation is necessary in order to obtaining activity data. Romania stated that they will estimate and report the emissions for a later submission. The TERT agreed with the explanation provided by Romania and recommends that Romania investigates the possible sources for collecting the activity data. During the 2019 review the TERT reiterated this question, and Romania answered that investigation in this sector is still ongoing. The TERT notes that this review is undertaken against the 2016 version of the Guidebook which includes an EF for benzo(a)pyrene in NFR 2D3g. However, the TERT is aware that this EF will be updated in the 2019 version of the Guidebook.

The TERT thus recommends that Romania continues the investigation in obtaining activity data for this sector, and review their inventory against the 2019 version of the Guidebook, and update the benzo(a)pyrene emissions in NFR 2D3g before their next submission (based on the 2019 version of the Guidebook).

Comment

We will continue the investigation to obtain the activity data for this SNAP 060310 Asphalt blowing

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	RO-5C1bi-2018-0001	No	5C1bi Industrial Waste Incineration, PCDD/F, HCB, 1990-2016	No	No

Recommendation made in previous review report For sector 5C1bi Industrial Waste Incineration the TERT noted that estimates for PCDD/F and HCB were calculated for 2005-2016 using the EF from the 2016 EMEP/EEA Guidebook and that activity data are presented in the IIR (page 172) for all of those years. The TERT also noted that no estimates and AD are presented for pre-2005 years, while the reporting obligation for these pollutants start from 1990. In response to the question on the issue raised during the 2018 review Romania replied that the activity data for the 2005-2016 period is represented by the total industrial waste incinerated (in kt) from N.E.P.A.'s inventory. The Romanian statistics do not provide information on this category prior to 2005. Further investigation is necessary in order to obtaining the activity data. The TERT recommends that Romania starts a study on getting activity data for 5C1bi and include activity data and emission estimates for the entire time series in its 2019 submission, or that Romania includes a plan with schedule for implementation of this study in its next IIR. The TERT kindly notes that progress in the implementation of the improvement will be reviewed in 2019.
Assessment of Implementation For sector 5C1bi the TERT noted that estimates for PCDD/F and HCB were calculated for 2005-2016 using the EF from the 2016 EMEP/EEA Guidebook but no emission estimates are available prior to 2005. In response to the question on the issue raised during the 2018 and 2019 review Romania replied that the collection of activity data for the years 1990-2004 is difficult and ongoing. **The TERT recommends that Romania provides emission estimates for the whole time series for the source 5Cbi in its next submission.**
Comment Implemented in the 2020 submission (see section 6.3). There are no activity data for the 1990-2004 period (N.E.P.A. does not any information).

Additional recommendations made during the NECD Review 2019 for POPs and heavy metals

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-3F-2019-0001	Yes	3F Field Burning of Agricultural Residues, PAHs, 2005, 2016	RE	No
Recommendation For 3F Field Burning of Agricultural Residues, PAH emission 1995-2017 the TERT noted that Romania used PAH EF based on an older version of the 2016 EMEP/EEA Guidebook 3F. In response to a question raised during the review, Romania responded by providing a revised estimate 1995-2017 based on the PAH EF Tier2 in the latest version of the 2016 EMEP/EEA Guidebook 3F and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Romania. **The TERT recommends that Romania include the revised estimate in its 2020 NFR and IIR submission.**				
Comment Implemented in the 2020 submission (see section 5.16).				
Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-5C1bi-2019-0001	Yes	5C1bi Industrial Waste Incineration, PCDD/F, 1995-2004	RE	Yes

Recommendation For category 5C1bi Industrial Waste Incineration and pollutants PCDD/F for years 2005-2017 the TERT noted that a Tier 1 method has been used to estimate PCDD/F emissions, although it has been identified as key category, which requires the application of a Tier 2 method. In response to a question raised during the review, Romania provided a revised estimate for year 2005-2017 and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Romania. **The TERT recommends that Romania includes the revised estimate in its 2020 NFR and IIR submission.**				
Comment Implemented in the 2020 submission (see section 6.3).				
Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-0A-2019-0001	No	0A National Total - National Total for the Entire Territory - Based on Fuel Sold/Fuel Used, PCDD/F, HCB, PCBs, BaP, Cd, Hg, NH_3, NMVOC, NO_X, PAHs, Pb, $PM_{2.5}$, SO_2, 1990-2017	No	No
Recommendation During the review, the TERT noted that a lot of cells where left blank in the NFR reporting for memo items. In response to a question raised during the review, Romania explained provided information on the notation keys proposed to be reported in the NFR. **The TERT recommends that Romania ensures that all cells in the NFR are either filled with numerical data or with an appropriate notation key.**				
Comment Resolved				
Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-1B1b-2019-0001	No	1B1b Fugitive Emission from Solid Fuels: Solid Fuel Transformation, BaP, PAHs, Cd, Hg, Pb, 2002-2004	No	No
Recommendation For 1B1b Fugitive Emission from Solid Fuels: Solid Fuel Transformation, PAH Cd, Hg and Pb and years 2002 to 2004, the TERT noted that emissions are only about 0.1% of adjacent years (e.g. for 2005) emissions while activity data and PCCD/F emissions do not show such a drop. In response to a question raised during the review, Romania provided revised data for the years 2002 to 2004 which is a factor of 1000 times higher than reported data. **The TERT recommends that Romania corrects the 2002 to 2004 data for PAHs, Cd, Hg and Pb accordingly in its next submission.**				
Comment Corrected in 2020 submission.				
Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-2C7a-2019-0001	Yes	2C7a Copper Production, PCBs, Cd, Hg, Pb, PCDD/F, 2005	No	Yes

Recommendation

For category 2C7c Copper Production and pollutant Cd for 2005, the TERT noted that in the IIR Romania states that due to the different confidentiality policies along the time series, the presentation of emission factors used to estimate emissions is not possible. Thus, it was impossible for the TERT to assess, whether a Tier 2 or higher had been applied. In response to a question raised during the review, Romania explained that for this particular year, emissions from this source were calculated using a Tier 1 approach with an EF from the 2016 guidebook (table 3.1 from the chapter on 2C7a Copper Production).

The TERT recommends Romania to include more information on the EFs used and their sources in order to enhance transparency, but also to provide information on timeline consistency.

Comment

Resolved

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-2D3a-2019-0002	Yes	2D3a Domestic Solvent Use Including Fungicides, Hg, 2005, 2016, 2017	No	No

Recommendation

For category 2D3a Domestic Solvent Use Including Fungicides and pollutant Hg for all years, the TERT noted that Romania did report emissions in the NFR, but no methodological description had been given. In response to a question raised during the review, Romania explained that it had applied the T1 EF from the 2016 EMEP/EEA Guidebook for the entire time series, based on population size and that this information will be included in the next IIR submission. This review is undertaken against the 2016 version of the Guidebook, which includes an EF for Hg. However, the TERT is aware that this EF will not be included in the 2019 version of the Guidebook, and therefore it is not currently sensible to add this source.

Therefore, the TERT recommends that Romania review their inventory against the 2019 version of the Guidebook and update it, if necessary, before their next submission.

Comment

Implemented the 2019 version of the Guidebook (see section 4.18).

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-3F-2019-0002	No	3F Field Burning of Agricultural Residues, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, BaP, PAHs, Cd, Hg, Pb, PCDD/F, 1990-2017	No	No

Recommendation

For 3F Field Burning of Agricultural Residues, $PM_{2.5}$ for 1990-2017, the TERT noted that Romania reports low emissions compared to a recent international report. During the review, the TERT provided Romania with a link to the report showing potentially high emissions from field burning. In response to a question raised during the review, Romania indicated that they would analyse the report in more detail.

The TERT recommends that Romania investigates the available information including in the report provided by the TERT and updates the emissions from field burning of agricultural residues, as appropriate, in the 2020 submission.

Comment

Further research and information is needed.

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-5C1bii-2019-0001	No	5C1bii Hazardous Waste Incineration, SO_2, NO_X, NMVOC, $PM_{2.5}$, PAHs, HCB, Cd, Hg, Pb, PCDD/F, 1995-2017	No	No

Recommendation
For category 5C1bii Hazardous Waste Incineration and pollutants SO_2, NO_X, NMVOC, $PM_{2.5}$, PAHs, HCB, Cd, Hg, Pb, PCDD/F for years 1995-2017 the TERT noted that emissions have been reported as 'not applicable' although stating in the IIR that emission are believed to be insignificant. In response to a question raised during the review, Romania explained that it will use the notation key 'not estimated' in its next submission.
The TERT partly agreed with this explanation using the notation key 'NE', but recommends that Romania includes emission estimates for 5C1bii in its next submission, as reporting guidelines do not give any thresholds for not reporting emissions.

Comment
Implemented in the 2020 submission (change key notation)

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-5C1biii-2019-0001	No	5C1biii Clinical Waste Incineration, PCDD/F, Hg, 1995-2004	No	No

Recommendation
For category 5C1biii Clinical Waste Incineration and for years 1995-2004, the TERT noted that emissions have been reported as 'not applicable', and emission prior to 1995 have not been reported. In response to a question raised during the review, Romania explained that emissions from clinical waste incineration are included in 5C1bi and are therefore reported as 'IE' for the years 2005-2017. Before 2005 these emissions should have been reported as 'not estimated'. Romania stated that this will be changed for the next submission.
The TERT agreed with the explanation and recommends that Romania estimates emissions in category 5C1bi (including incinerated clinical waste) and if this is not possible for next submission report the notation key 'NE'.

Comment
Implemented in the 2020 submission (change key notation)

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
RO-5C1biv-2019-0001	No	5C1biv Sewage Sludge Incineration, HCB, 2002	No	No

Recommendation
For category 5C1biv 'Sewage Sludge Incineration' and for years 1995-2004 the TERT noted that emissions have been reported as 'not applicable', and emission prior to 1995 have not been reported. The IIR states that emissions from sewage sludge waste incineration are included in 5C1bi and are therefore reported as 'IE' for the years 2005-2017.In response to a question raised during the review, Romania explained that before 2005 these emissions should have been reported as 'not estimated'. Romania stated that this will be changed for the next submission.
The TERT agreed with the explanation and recommends that Romania estimates emissions in category 5C1bi (including incinerated sewage sludge, reporting 'IE' for 5C1biv) for the whole time series and if this is not possible for next submission report the notation key 'NE'.

Comment
Implemented in the 2020 submission (change key notation)

9. ADJUSTMENTS

No adjustments

I.I.R. REFERENCES

- EIONET CDR – CLRTAP Emission Inventories of ROMANIA
- EMEP/EEA 2016 Air Pollution Inventory Guidebook
- EMEP/EEA 2019 Air Pollution Inventory Guidebook
- Romanian Ministerial Order No. 3.299/2012 for the approval of the methodology for compiling and reporting of air emissions inventories.

ANNEX A - Tier 2 calculation details for NFR 1.A.4.c.ii, Agriculture/ Forestry: Non-road vehicles and other machinery, diesel fuel

Table1 - Tier 2 data, NFR 1.A.4.c.ii, Agriculture, year 2018

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri-Table 3.3 G 2019 [1)]	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	0	8.88	2	Stage IIIB	BC	74	191060	0.00002
Agri	2018	0	8.88	2	Stage IIIB	CO	6087	191060	0.00195
Agri	2018	0	8.88	2	Stage IIIB	NH3	8	191060	0.00000
Agri	2018	0	8.88	2	Stage IIIB	NMVOC	544	191060	0.00017
Agri	2018	0	8.88	2	Stage IIIB	NOx	9318	191060	0.00298
Agri	2018	0	8.88	2	Stage IIIB	PM10	99	191060	0.00003
Agri	2018	0	8.88	2	Stage IIIB	PM2.5	99	191060	0.00003
Agri	2018	0	8.88	2	Stage IIIB	TSP	99	191060	0.00003
Agri	2018	0	8.88	98	Stage IV	BC	73	191060	0.00122
Agri	2018	0	8.88	98	Stage IV	CO	6024	191060	0.10029
Agri	2018	0	8.88	98	Stage IV	NH3	8	191060	0.00013
Agri	2018	0	8.88	98	Stage IV	NMVOC	530	191060	0.00882
Agri	2018	0	8.88	98	Stage IV	NOx	1587	191060	0.02642
Agri	2018	0	8.88	98	Stage IV	PM10	99	191060	0.00165
Agri	2018	0	8.88	98	Stage IV	PM2.5	99	191060	0.00165
Agri	2018	0	8.88	98	Stage IV	TSP	99	191060	0.00165
Agri	2018	1	8.44	2	Stage IIIB	BC	74	191060	0.00002
Agri	2018	1	8.44	2	Stage IIIB	CO	6087	191060	0.00186
Agri	2018	1	8.44	2	Stage IIIB	NH3	8	191060	0.00000
Agri	2018	1	8.44	2	Stage IIIB	NMVOC	544	191060	0.00017
Agri	2018	1	8.44	2	Stage IIIB	NOx	9318	191060	0.00285
Agri	2018	1	8.44	2	Stage IIIB	PM10	99	191060	0.00003
Agri	2018	1	8.44	2	Stage IIIB	PM2.5	99	191060	0.00003
Agri	2018	1	8.44	2	Stage IIIB	TSP	99	191060	0.00003
Agri	2018	1	8.44	98	Stage IV	BC	73	191060	0.00115
Agri	2018	1	8.44	98	Stage IV	CO	6024	191060	0.09526
Agri	2018	1	8.44	98	Stage IV	NH3	8	191060	0.00013
Agri	2018	1	8.44	98	Stage IV	NMVOC	530	191060	0.00838
Agri	2018	1	8.44	98	Stage IV	NOx	1587	191060	0.02510
Agri	2018	1	8.44	98	Stage IV	PM10	99	191060	0.00157
Agri	2018	1	8.44	98	Stage IV	PM2.5	99	191060	0.00157
Agri	2018	1	8.44	98	Stage IV	TSP	99	191060	0.00157
Agri	2018	2	7.99	2	Stage IIIB	BC	74	191060	0.00002
Agri	2018	2	7.99	2	Stage IIIB	CO	6087	191060	0.00177
Agri	2018	2	7.99	2	Stage IIIB	NH3	8	191060	0.00000

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri- Table 3.3 G 2019 [1)]	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consump tion Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	2	7.99	2	Stage IIIB	NMVOC	544	191060	0.00016
Agri	2018	2	7.99	2	Stage IIIB	NOx	9318	191060	0.00271
Agri	2018	2	7.99	2	Stage IIIB	PM10	99	191060	0.00003
Agri	2018	2	7.99	2	Stage IIIB	PM2.5	99	191060	0.00003
Agri	2018	2	7.99	2	Stage IIIB	TSP	99	191060	0.00003
Agri	2018	2	7.99	98	Stage IV	BC	73	191060	0.00109
Agri	2018	2	7.99	98	Stage IV	CO	6024	191060	0.09024
Agri	2018	2	7.99	98	Stage IV	NH3	8	191060	0.00012
Agri	2018	2	7.99	98	Stage IV	NMVOC	530	191060	0.00794
Agri	2018	2	7.99	98	Stage IV	NOx	1587	191060	0.02377
Agri	2018	2	7.99	98	Stage IV	PM10	99	191060	0.00148
Agri	2018	2	7.99	98	Stage IV	PM2.5	99	191060	0.00148
Agri	2018	2	7.99	98	Stage IV	TSP	99	191060	0.00148
Agri	2018	3	7.54	2	Stage IIIB	BC	74	191060	0.00002
Agri	2018	3	7.54	2	Stage IIIB	CO	6087	191060	0.00168
Agri	2018	3	7.54	2	Stage IIIB	NH3	8	191060	0.00000
Agri	2018	3	7.54	2	Stage IIIB	NMVOC	544	191060	0.00015
Agri	2018	3	7.54	2	Stage IIIB	NOx	9318	191060	0.00256
Agri	2018	3	7.54	2	Stage IIIB	PM10	99	191060	0.00003
Agri	2018	3	7.54	2	Stage IIIB	PM2.5	99	191060	0.00003
Agri	2018	3	7.54	2	Stage IIIB	TSP	99	191060	0.00003
Agri	2018	3	7.54	98	Stage IV	BC	73	191060	0.00103
Agri	2018	3	7.54	98	Stage IV	CO	6024	191060	0.08510
Agri	2018	3	7.54	98	Stage IV	NH3	8	191060	0.00011
Agri	2018	3	7.54	98	Stage IV	NMVOC	530	191060	0.00749
Agri	2018	3	7.54	98	Stage IV	NOx	1587	191060	0.02242
Agri	2018	3	7.54	98	Stage IV	PM10	99	191060	0.00140
Agri	2018	3	7.54	98	Stage IV	PM2.5	99	191060	0.00140
Agri	2018	3	7.54	98	Stage IV	TSP	99	191060	0.00140
Agri	2018	4	7.09	43	Stage IIIB	BC	74	191060	0.00043
Agri	2018	4	7.09	43	Stage IIIB	CO	6087	191060	0.03544
Agri	2018	4	7.09	43	Stage IIIB	NH3	8	191060	0.00005
Agri	2018	4	7.09	43	Stage IIIB	NMVOC	544	191060	0.00317
Agri	2018	4	7.09	43	Stage IIIB	NOx	9318	191060	0.05425
Agri	2018	4	7.09	43	Stage IIIB	PM10	99	191060	0.00058
Agri	2018	4	7.09	43	Stage IIIB	PM2.5	99	191060	0.00058
Agri	2018	4	7.09	43	Stage IIIB	TSP	99	191060	0.00058
Agri	2018	4	7.09	57	Stage IV	BC	73	191060	0.00056
Agri	2018	4	7.09	57	Stage IV	CO	6024	191060	0.04657
Agri	2018	4	7.09	57	Stage IV	NH3	8	191060	0.00006

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri-Table 3.3 G 2019 [1)]	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	4	7.09	57	Stage IV	NMVOC	530	191060	0.00410
Agri	2018	4	7.09	57	Stage IV	NOx	1587	191060	0.01227
Agri	2018	4	7.09	57	Stage IV	PM10	99	191060	0.00077
Agri	2018	4	7.09	57	Stage IV	PM2.5	99	191060	0.00077
Agri	2018	4	7.09	57	Stage IV	TSP	99	191060	0.00077
Agri	2018	5	6.65	100	Stage IIIB	BC	74	191060	0.00094
Agri	2018	5	6.65	100	Stage IIIB	CO	6087	191060	0.07733
Agri	2018	5	6.65	100	Stage IIIB	NH3	8	191060	0.00010
Agri	2018	5	6.65	100	Stage IIIB	NMVOC	544	191060	0.00691
Agri	2018	5	6.65	100	Stage IIIB	NOx	9318	191060	0.11838
Agri	2018	5	6.65	100	Stage IIIB	PM10	99	191060	0.00126
Agri	2018	5	6.65	100	Stage IIIB	PM2.5	99	191060	0.00126
Agri	2018	5	6.65	100	Stage IIIB	TSP	99	191060	0.00126
Agri	2018	6	6.21	2	Stage IIIA	BC	416	191060	0.00009
Agri	2018	6	6.21	2	Stage IIIA	CO	6035	191060	0.00126
Agri	2018	6	6.21	2	Stage IIIA	NH3	8	191060	0.00000
Agri	2018	6	6.21	2	Stage IIIA	NMVOC	1173	191060	0.00025
Agri	2018	6	6.21	2	Stage IIIA	NOx	12921	191060	0.00270
Agri	2018	6	6.21	2	Stage IIIA	PM10	550	191060	0.00011
Agri	2018	6	6.21	2	Stage IIIA	PM2.5	550	191060	0.00011
Agri	2018	6	6.21	2	Stage IIIA	TSP	550	191060	0.00011
Agri	2018	6	6.21	98	Stage IIIB	BC	74	191060	0.00086
Agri	2018	6	6.21	98	Stage IIIB	CO	6087	191060	0.07090
Agri	2018	6	6.21	98	Stage IIIB	NH3	8	191060	0.00009
Agri	2018	6	6.21	98	Stage IIIB	NMVOC	544	191060	0.00634
Agri	2018	6	6.21	98	Stage IIIB	NOx	9318	191060	0.10853
Agri	2018	6	6.21	98	Stage IIIB	PM10	99	191060	0.00115
Agri	2018	6	6.21	98	Stage IIIB	PM2.5	99	191060	0.00115
Agri	2018	6	6.21	98	Stage IIIB	TSP	99	191060	0.00115
Agri	2018	7	5.75	41	Stage IIIA	BC	416	191060	0.00188
Agri	2018	7	5.75	41	Stage IIIA	CO	6035	191060	0.02722
Agri	2018	7	5.75	41	Stage IIIA	NH3	8	191060	0.00004
Agri	2018	7	5.75	41	Stage IIIA	NMVOC	1173	191060	0.00529
Agri	2018	7	5.75	41	Stage IIIA	NOx	12921	191060	0.05827
Agri	2018	7	5.75	41	Stage IIIA	PM10	550	191060	0.00248
Agri	2018	7	5.75	41	Stage IIIA	PM2.5	550	191060	0.00248
Agri	2018	7	5.75	41	Stage IIIA	TSP	550	191060	0.00248
Agri	2018	7	5.75	59	Stage IIIB	BC	74	191060	0.00048
Agri	2018	7	5.75	59	Stage IIIB	CO	6087	191060	0.03943
Agri	2018	7	5.75	59	Stage IIIB	NH3	8	191060	0.00005

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri-Table 3.3 G 2019 [1)]	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	7	5.75	59	Stage IIIB	NMVOC	544	191060	0.00352
Agri	2018	7	5.75	59	Stage IIIB	NOx	9318	191060	0.06035
Agri	2018	7	5.75	59	Stage IIIB	PM10	99	191060	0.00064
Agri	2018	7	5.75	59	Stage IIIB	PM2.5	99	191060	0.00064
Agri	2018	7	5.75	59	Stage IIIB	TSP	99	191060	0.00064
Agri	2018	8	5.31	100	Stage IIIA	BC	416	191060	0.00422
Agri	2018	8	5.31	100	Stage IIIA	CO	6035	191060	0.06119
Agri	2018	8	5.31	100	Stage IIIA	NH3	8	191060	0.00008
Agri	2018	8	5.31	100	Stage IIIA	NMVOC	1173	191060	0.01189
Agri	2018	8	5.31	100	Stage IIIA	NOx	12921	191060	0.13100
Agri	2018	8	5.31	100	Stage IIIA	PM10	550	191060	0.00558
Agri	2018	8	5.31	100	Stage IIIA	PM2.5	550	191060	0.00558
Agri	2018	8	5.31	100	Stage IIIA	TSP	550	191060	0.00558
Agri	2018	9	4.86	100	Stage IIIA	BC	416	191060	0.00386
Agri	2018	9	4.86	100	Stage IIIA	CO	6035	191060	0.05607
Agri	2018	9	4.86	100	Stage IIIA	NH3	8	191060	0.00007
Agri	2018	9	4.86	100	Stage IIIA	NMVOC	1173	191060	0.01090
Agri	2018	9	4.86	100	Stage IIIA	NOx	12921	191060	0.12004
Agri	2018	9	4.86	100	Stage IIIA	PM10	550	191060	0.00511
Agri	2018	9	4.86	100	Stage IIIA	PM2.5	550	191060	0.00511
Agri	2018	9	4.86	100	Stage IIIA	TSP	550	191060	0.00511
Agri	2018	10	4.42	100	Stage IIIA	BC	416	191060	0.00351
Agri	2018	10	4.42	100	Stage IIIA	CO	6035	191060	0.05094
Agri	2018	10	4.42	100	Stage IIIA	NH3	8	191060	0.00007
Agri	2018	10	4.42	100	Stage IIIA	NMVOC	1173	191060	0.00990
Agri	2018	10	4.42	100	Stage IIIA	NOx	12921	191060	0.10907
Agri	2018	10	4.42	100	Stage IIIA	PM10	550	191060	0.00464
Agri	2018	10	4.42	100	Stage IIIA	PM2.5	550	191060	0.00464
Agri	2018	10	4.42	100	Stage IIIA	TSP	550	191060	0.00464
Agri	2018	11	3.96	8	Stage II	BC	483	191060	0.00029
Agri	2018	11	3.96	8	Stage II	CO	6104	191060	0.00367
Agri	2018	11	3.96	8	Stage II	NH3	8	191060	0.00000
Agri	2018	11	3.96	8	Stage II	NMVOC	1181	191060	0.00071
Agri	2018	11	3.96	8	Stage II	NOx	20612	191060	0.01240
Agri	2018	11	3.96	8	Stage II	PM10	624	191060	0.00038
Agri	2018	11	3.96	8	Stage II	PM2.5	624	191060	0.00038
Agri	2018	11	3.96	8	Stage II	TSP	624	191060	0.00038
Agri	2018	11	3.96	92	Stage IIIA	BC	416	191060	0.00290
Agri	2018	11	3.96	92	Stage IIIA	CO	6035	191060	0.04207
Agri	2018	11	3.96	92	Stage IIIA	NH3	8	191060	0.00006

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri-Table 3.3 G 2019 1)	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	11	3.96	92	Stage IIIA	NMVOC	1173	191060	0.00818
Agri	2018	11	3.96	92	Stage IIIA	NOx	12921	191060	0.09006
Agri	2018	11	3.96	92	Stage IIIA	PM10	550	191060	0.00383
Agri	2018	11	3.96	92	Stage IIIA	PM2.5	550	191060	0.00383
Agri	2018	11	3.96	92	Stage IIIA	TSP	550	191060	0.00383
Agri	2018	12	3.52	41	Stage II	BC	483	191060	0.00132
Agri	2018	12	3.52	41	Stage II	CO	6104	191060	0.01667
Agri	2018	12	3.52	41	Stage II	NH3	8	191060	0.00002
Agri	2018	12	3.52	41	Stage II	NMVOC	1181	191060	0.00323
Agri	2018	12	3.52	41	Stage II	NOx	20612	191060	0.05630
Agri	2018	12	3.52	41	Stage II	PM10	624	191060	0.00170
Agri	2018	12	3.52	41	Stage II	PM2.5	624	191060	0.00170
Agri	2018	12	3.52	41	Stage II	TSP	624	191060	0.00170
Agri	2018	12	3.52	59	Stage IIIA	BC	416	191060	0.00166
Agri	2018	12	3.52	59	Stage IIIA	CO	6035	191060	0.02409
Agri	2018	12	3.52	59	Stage IIIA	NH3	8	191060	0.00003
Agri	2018	12	3.52	59	Stage IIIA	NMVOC	1173	191060	0.00468
Agri	2018	12	3.52	59	Stage IIIA	NOx	12921	191060	0.05158
Agri	2018	12	3.52	59	Stage IIIA	PM10	550	191060	0.00220
Agri	2018	12	3.52	59	Stage IIIA	PM2.5	550	191060	0.00220
Agri	2018	12	3.52	59	Stage IIIA	TSP	550	191060	0.00220
Agri	2018	13	3.08	100	Stage II	BC	483	191060	0.00284
Agri	2018	13	3.08	100	Stage II	CO	6104	191060	0.03586
Agri	2018	13	3.08	100	Stage II	NH3	8	191060	0.00005
Agri	2018	13	3.08	100	Stage II	NMVOC	1181	191060	0.00694
Agri	2018	13	3.08	100	Stage II	NOx	20612	191060	0.12110
Agri	2018	13	3.08	100	Stage II	PM10	624	191060	0.00367
Agri	2018	13	3.08	100	Stage II	PM2.5	624	191060	0.00367
Agri	2018	13	3.08	100	Stage II	TSP	624	191060	0.00367
Agri	2018	14	2.63	100	Stage II	BC	483	191060	0.00243
Agri	2018	14	2.63	100	Stage II	CO	6104	191060	0.03068
Agri	2018	14	2.63	100	Stage II	NH3	8	191060	0.00004
Agri	2018	14	2.63	100	Stage II	NMVOC	1181	191060	0.00594
Agri	2018	14	2.63	100	Stage II	NOx	20612	191060	0.10361
Agri	2018	14	2.63	100	Stage II	PM10	624	191060	0.00314
Agri	2018	14	2.63	100	Stage II	PM2.5	624	191060	0.00314
Agri	2018	14	2.63	100	Stage II	TSP	624	191060	0.00314
Agri	2018	15	2.19	8	Stage I	BC	727	191060	0.00023
Agri	2018	15	2.19	8	Stage I	CO	6463	191060	0.00208
Agri	2018	15	2.19	8	Stage I	NH3	8	191060	0.00000

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri- Table 3.3 G 2019 1)	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	15	2.19	8	Stage I	NMVOC	1544	191060	0.00050
Agri	2018	15	2.19	8	Stage I	NOx	30799	191060	0.00992
Agri	2018	15	2.19	8	Stage I	PM10	947	191060	0.00030
Agri	2018	15	2.19	8	Stage I	PM2.5	947	191060	0.00030
Agri	2018	15	2.19	8	Stage I	TSP	947	191060	0.00030
Agri	2018	15	2.19	92	Stage II	BC	483	191060	0.00186
Agri	2018	15	2.19	92	Stage II	CO	6104	191060	0.02354
Agri	2018	15	2.19	92	Stage II	NH3	8	191060	0.00003
Agri	2018	15	2.19	92	Stage II	NMVOC	1181	191060	0.00455
Agri	2018	15	2.19	92	Stage II	NOx	20612	191060	0.07949
Agri	2018	15	2.19	92	Stage II	PM10	624	191060	0.00241
Agri	2018	15	2.19	92	Stage II	PM2.5	624	191060	0.00241
Agri	2018	15	2.19	92	Stage II	TSP	624	191060	0.00241
Agri	2018	16	2.11	41	Stage I	BC	727	191060	0.00121
Agri	2018	16	2.11	41	Stage I	CO	6463	191060	0.01075
Agri	2018	16	2.11	41	Stage I	NH3	8	191060	0.00001
Agri	2018	16	2.11	41	Stage I	NMVOC	1544	191060	0.00257
Agri	2018	16	2.11	41	Stage I	NOx	30799	191060	0.05122
Agri	2018	16	2.11	41	Stage I	PM10	947	191060	0.00157
Agri	2018	16	2.11	41	Stage I	PM2.5	947	191060	0.00157
Agri	2018	16	2.11	41	Stage I	TSP	947	191060	0.00157
Agri	2018	16	2.11	59	Stage II	BC	483	191060	0.00114
Agri	2018	16	2.11	59	Stage II	CO	6104	191060	0.01445
Agri	2018	16	2.11	59	Stage II	NH3	8	191060	0.00002
Agri	2018	16	2.11	59	Stage II	NMVOC	1181	191060	0.00280
Agri	2018	16	2.11	59	Stage II	NOx	20612	191060	0.04878
Agri	2018	16	2.11	59	Stage II	PM10	624	191060	0.00148
Agri	2018	16	2.11	59	Stage II	PM2.5	624	191060	0.00148
Agri	2018	16	2.11	59	Stage II	TSP	624	191060	0.00148
Agri	2018	17	2.03	37	1991-Stage I	BC	1074	191060	0.00153
Agri	2018	17	2.03	37	1991-Stage I	CO	14147	191060	0.02021
Agri	2018	17	2.03	37	1991-Stage I	NH3	8	191060	0.00001
Agri	2018	17	2.03	37	1991-Stage I	NMVOC	4493	191060	0.00642
Agri	2018	17	2.03	37	1991-Stage I	NOx	49002	191060	0.06999
Agri	2018	17	2.03	37	1991-Stage I	PM10	1974	191060	0.00282
Agri	2018	17	2.03	37	1991-Stage I	PM2.5	1974	191060	0.00282
Agri	2018	17	2.03	37	1991-Stage I	TSP	1974	191060	0.00282
Agri	2018	17	2.03	63	Stage I	BC	727	191060	0.00178
Agri	2018	17	2.03	63	Stage I	CO	6463	191060	0.01585
Agri	2018	17	2.03	63	Stage I	NH3	8	191060	0.00002

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri-Table 3.3 G 2019 1)	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	17	2.03	63	Stage I	NMVOC	1544	191060	0.00379
Agri	2018	17	2.03	63	Stage I	NOx	30799	191060	0.07555
Agri	2018	17	2.03	63	Stage I	PM10	947	191060	0.00232
Agri	2018	17	2.03	63	Stage I	PM2.5	947	191060	0.00232
Agri	2018	17	2.03	63	Stage I	TSP	947	191060	0.00232
Agri	2018	18	1.95	39	Stage I	BC	727	191060	0.00106
Agri	2018	18	1.95	39	Stage I	CO	6463	191060	0.00938
Agri	2018	18	1.95	39	Stage I	NH3	8	191060	0.00001
Agri	2018	18	1.95	39	Stage I	NMVOC	1544	191060	0.00224
Agri	2018	18	1.95	39	Stage I	NOx	30799	191060	0.04470
Agri	2018	18	1.95	39	Stage I	PM10	947	191060	0.00137
Agri	2018	18	1.95	39	Stage I	PM2.5	947	191060	0.00137
Agri	2018	18	1.95	39	Stage I	TSP	947	191060	0.00137
Agri	2018	18	1.95	61	1991-Stage I	BC	1074	191060	0.00245
Agri	2018	18	1.95	61	1991-Stage I	CO	14147	191060	0.03228
Agri	2018	18	1.95	61	1991-Stage I	NH3	8	191060	0.00002
Agri	2018	18	1.95	61	1991-Stage I	NMVOC	4493	191060	0.01025
Agri	2018	18	1.95	61	1991-Stage I	NOx	49002	191060	0.11181
Agri	2018	18	1.95	61	1991-Stage I	PM10	1974	191060	0.00450
Agri	2018	18	1.95	61	1991-Stage I	PM2.5	1974	191060	0.00450
Agri	2018	18	1.95	61	1991-Stage I	TSP	1974	191060	0.00450
Agri	2018	19	1.88	38	Stage I	BC	727	191060	0.00099
Agri	2018	19	1.88	38	Stage I	CO	6463	191060	0.00881
Agri	2018	19	1.88	38	Stage I	NH3	8	191060	0.00001
Agri	2018	19	1.88	38	Stage I	NMVOC	1544	191060	0.00211
Agri	2018	19	1.88	38	Stage I	NOx	30799	191060	0.04199
Agri	2018	19	1.88	38	Stage I	PM10	947	191060	0.00129
Agri	2018	19	1.88	38	Stage I	PM2.5	947	191060	0.00129
Agri	2018	19	1.88	38	Stage I	TSP	947	191060	0.00129
Agri	2018	19	1.88	62	1991-Stage I	BC	1074	191060	0.00239
Agri	2018	19	1.88	62	1991-Stage I	CO	14147	191060	0.03142
Agri	2018	19	1.88	62	1991-Stage I	NH3	8	191060	0.00002
Agri	2018	19	1.88	62	1991-Stage I	NMVOC	4493	191060	0.00998
Agri	2018	19	1.88	62	1991-Stage I	NOx	49002	191060	0.10884
Agri	2018	19	1.88	62	1991-Stage I	PM10	1974	191060	0.00438
Agri	2018	19	1.88	62	1991-Stage I	PM2.5	1974	191060	0.00438
Agri	2018	19	1.88	62	1991-Stage I	TSP	1974	191060	0.00438
Agri	2018	20	1.80	100	1991-Stage I	BC	1074	191060	0.00369
Agri	2018	20	1.80	100	1991-Stage I	CO	14147	191060	0.04861
Agri	2018	20	1.80	100	1991-Stage I	NH3	8	191060	0.00003

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Agri-Table 3.3 G 2019 [1)]	fuel share agri, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Agri (t)	Emission (kt) (col4*col5*col8*col9E-13)
Agri	2018	20	1.80	100	1991-Stage I	NMVOC	4493	191060	0.01544
Agri	2018	20	1.80	100	1991-Stage I	NOx	49002	191060	0.16837
Agri	2018	20	1.80	100	1991-Stage I	PM10	1974	191060	0.00678
Agri	2018	20	1.80	100	1991-Stage I	PM2.5	1974	191060	0.00678
Agri	2018	20	1.80	100	1991-Stage I	TSP	1974	191060	0.00678
Agri	2018	21	1.72	100	1991-Stage I	BC	1074	191060	0.00353
Agri	2018	21	1.72	100	1991-Stage I	CO	14147	191060	0.04651
Agri	2018	21	1.72	100	1991-Stage I	NH3	8	191060	0.00003
Agri	2018	21	1.72	100	1991-Stage I	NMVOC	4493	191060	0.01477
Agri	2018	21	1.72	100	1991-Stage I	NOx	49002	191060	0.16110
Agri	2018	21	1.72	100	1991-Stage I	PM10	1974	191060	0.00649
Agri	2018	21	1.72	100	1991-Stage I	PM2.5	1974	191060	0.00649
Agri	2018	21	1.72	100	1991-Stage I	TSP	1974	191060	0.00649

Table 2 - Tier2 data , NFR 1.A.4.c.ii, Forestry, year 2018

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Forestry-Table 3.3 G 2019 [1)]	fuel share forestry, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Forestry (t)	Emission (kt) (col4*col5*col8*col9E-13)
Forestry	2018	0	13.64	2	Stage IIIA	BC	437	81882.72	0.00011
Forestry	2018	0	13.64	2	Stage IIIA	CO	5947	81882.72	0.00155
Forestry	2018	0	13.64	2	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	0	13.64	2	Stage IIIA	NMVOC	1161	81882.72	0.00030
Forestry	2018	0	13.64	2	Stage IIIA	NOx	12845	81882.72	0.00335
Forestry	2018	0	13.64	2	Stage IIIA	PM10	573	81882.72	0.00015
Forestry	2018	0	13.64	2	Stage IIIA	PM2.5	573	81882.72	0.00015
Forestry	2018	0	13.64	2	Stage IIIA	TSP	573	81882.72	0.00015
Forestry	2018	0	13.64	98	Stage IV	BC	74	81882.72	0.00081
Forestry	2018	0	13.64	98	Stage IV	CO	5947	81882.72	0.06485
Forestry	2018	0	13.64	98	Stage IV	NH3	8	81882.72	0.00009
Forestry	2018	0	13.64	98	Stage IV	NMVOC	515	81882.72	0.00562
Forestry	2018	0	13.64	98	Stage IV	NOx	1586	81882.72	0.01730
Forestry	2018	0	13.64	98	Stage IV	PM10	99	81882.72	0.00108
Forestry	2018	0	13.64	98	Stage IV	PM2.5	99	81882.72	0.00108
Forestry	2018	0	13.64	98	Stage IV	TSP	99	81882.72	0.00108

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Forestry-Table 3.3 G 2019 1)	fuel share forestry, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Forestry (t)	Emission (kt) (col4*col5*col8*col9E-13)
Forestry	2018	1	13.64	2	Stage IIIA	BC	437	81882.72	0.00011
Forestry	2018	1	13.64	2	Stage IIIA	CO	5947	81882.72	0.00155
Forestry	2018	1	13.64	2	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	1	13.64	2	Stage IIIA	NMVOC	1161	81882.72	0.00030
Forestry	2018	1	13.64	2	Stage IIIA	NOx	12845	81882.72	0.00335
Forestry	2018	1	13.64	2	Stage IIIA	PM10	573	81882.72	0.00015
Forestry	2018	1	13.64	2	Stage IIIA	PM2.5	573	81882.72	0.00015
Forestry	2018	1	13.64	2	Stage IIIA	TSP	573	81882.72	0.00015
Forestry	2018	1	13.64	98	Stage IV	BC	74	81882.72	0.00081
Forestry	2018	1	13.64	98	Stage IV	CO	5947	81882.72	0.06485
Forestry	2018	1	13.64	98	Stage IV	NH3	8	81882.72	0.00009
Forestry	2018	1	13.64	98	Stage IV	NMVOC	515	81882.72	0.00562
Forestry	2018	1	13.64	98	Stage IV	NOx	1586	81882.72	0.01730
Forestry	2018	1	13.64	98	Stage IV	PM10	99	81882.72	0.00108
Forestry	2018	1	13.64	98	Stage IV	PM2.5	99	81882.72	0.00108
Forestry	2018	1	13.64	98	Stage IV	TSP	99	81882.72	0.00108
Forestry	2018	2	13.64	2	Stage IIIA	BC	437	81882.72	0.00011
Forestry	2018	2	13.64	2	Stage IIIA	CO	5947	81882.72	0.00155
Forestry	2018	2	13.64	2	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	2	13.64	2	Stage IIIA	NMVOC	1161	81882.72	0.00030
Forestry	2018	2	13.64	2	Stage IIIA	NOx	12845	81882.72	0.00335
Forestry	2018	2	13.64	2	Stage IIIA	PM10	573	81882.72	0.00015
Forestry	2018	2	13.64	2	Stage IIIA	PM2.5	573	81882.72	0.00015
Forestry	2018	2	13.64	2	Stage IIIA	TSP	573	81882.72	0.00015
Forestry	2018	2	13.64	98	Stage IV	BC	74	81882.72	0.00081
Forestry	2018	2	13.64	98	Stage IV	CO	5947	81882.72	0.06485
Forestry	2018	2	13.64	98	Stage IV	NH3	8	81882.72	0.00009
Forestry	2018	2	13.64	98	Stage IV	NMVOC	515	81882.72	0.00562
Forestry	2018	2	13.64	98	Stage IV	NOx	1586	81882.72	0.01730
Forestry	2018	2	13.64	98	Stage IV	PM10	99	81882.72	0.00108
Forestry	2018	2	13.64	98	Stage IV	PM2.5	99	81882.72	0.00108
Forestry	2018	2	13.64	98	Stage IV	TSP	99	81882.72	0.00108
Forestry	2018	3	13.64	2	Stage IIIA	BC	437	81882.72	0.00011
Forestry	2018	3	13.64	2	Stage IIIA	CO	5947	81882.72	0.00155
Forestry	2018	3	13.64	2	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	3	13.64	2	Stage IIIA	NMVOC	1161	81882.72	0.00030
Forestry	2018	3	13.64	2	Stage IIIA	NOx	12845	81882.72	0.00335
Forestry	2018	3	13.64	2	Stage IIIA	PM10	573	81882.72	0.00015

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Forestry-Table 3.3 G 2019 1)	fuel share forestry, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Forestry (t)	Emission (kt) (col4*col5*col8*col9E-13)
Forestry	2018	3	13.64	2	Stage IIIA	PM2.5	573	81882.72	0.00015
Forestry	2018	3	13.64	2	Stage IIIA	TSP	573	81882.72	0.00015
Forestry	2018	3	13.64	98	Stage IV	BC	74	81882.72	0.00081
Forestry	2018	3	13.64	98	Stage IV	CO	5947	81882.72	0.06485
Forestry	2018	3	13.64	98	Stage IV	NH3	8	81882.72	0.00009
Forestry	2018	3	13.64	98	Stage IV	NMVOC	515	81882.72	0.00562
Forestry	2018	3	13.64	98	Stage IV	NOx	1586	81882.72	0.01730
Forestry	2018	3	13.64	98	Stage IV	PM10	99	81882.72	0.00108
Forestry	2018	3	13.64	98	Stage IV	PM2.5	99	81882.72	0.00108
Forestry	2018	3	13.64	98	Stage IV	TSP	99	81882.72	0.00108
Forestry	2018	4	13.64	2	Stage IIIA	BC	437	81882.72	0.00011
Forestry	2018	4	13.64	2	Stage IIIA	CO	5947	81882.72	0.00155
Forestry	2018	4	13.64	2	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	4	13.64	2	Stage IIIA	NMVOC	1161	81882.72	0.00030
Forestry	2018	4	13.64	2	Stage IIIA	NOx	12845	81882.72	0.00335
Forestry	2018	4	13.64	2	Stage IIIA	PM10	573	81882.72	0.00015
Forestry	2018	4	13.64	2	Stage IIIA	PM2.5	573	81882.72	0.00015
Forestry	2018	4	13.64	2	Stage IIIA	TSP	573	81882.72	0.00015
Forestry	2018	4	13.64	48	Stage IV	BC	74	81882.72	0.00040
Forestry	2018	4	13.64	48	Stage IV	CO	5947	81882.72	0.03198
Forestry	2018	4	13.64	48	Stage IV	NH3	8	81882.72	0.00004
Forestry	2018	4	13.64	48	Stage IV	NMVOC	515	81882.72	0.00277
Forestry	2018	4	13.64	48	Stage IV	NOx	1586	81882.72	0.00853
Forestry	2018	4	13.64	48	Stage IV	PM10	99	81882.72	0.00053
Forestry	2018	4	13.64	48	Stage IV	PM2.5	99	81882.72	0.00053
Forestry	2018	4	13.64	48	Stage IV	TSP	99	81882.72	0.00053
Forestry	2018	4	13.64	50	Stage IIIB	BC	74	81882.72	0.00041
Forestry	2018	4	13.64	50	Stage IIIB	CO	5940	81882.72	0.03284
Forestry	2018	4	13.64	50	Stage IIIB	NH3	8	81882.72	0.00004
Forestry	2018	4	13.64	50	Stage IIIB	NMVOC	514	81882.72	0.00284
Forestry	2018	4	13.64	50	Stage IIIB	NOx	9454	81882.72	0.05226
Forestry	2018	4	13.64	50	Stage IIIB	PM10	99	81882.72	0.00055
Forestry	2018	4	13.64	50	Stage IIIB	PM2.5	99	81882.72	0.00055
Forestry	2018	4	13.64	50	Stage IIIB	TSP	99	81882.72	0.00055
Forestry	2018	5	13.64	2	Stage IIIA	BC	437	81882.72	0.00011
Forestry	2018	5	13.64	2	Stage IIIA	CO	5947	81882.72	0.00155
Forestry	2018	5	13.64	2	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	5	13.64	2	Stage IIIA	NMVOC	1161	81882.72	0.00030

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Forestry-Table 3.3 G 2019 [1)]	fuel share forestry, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Forestry (t)	Emission (kt) (col4*col5*col8*col9E-13)
Forestry	2018	5	13.64	2	Stage IIIA	NOx	12845	81882.72	0.00335
Forestry	2018	5	13.64	2	Stage IIIA	PM10	573	81882.72	0.00015
Forestry	2018	5	13.64	2	Stage IIIA	PM2.5	573	81882.72	0.00015
Forestry	2018	5	13.64	2	Stage IIIA	TSP	573	81882.72	0.00015
Forestry	2018	5	13.64	98	Stage IIIB	BC	74	81882.72	0.00081
Forestry	2018	5	13.64	98	Stage IIIB	CO	5940	81882.72	0.06478
Forestry	2018	5	13.64	98	Stage IIIB	NH3	8	81882.72	0.00009
Forestry	2018	5	13.64	98	Stage IIIB	NMVOC	514	81882.72	0.00561
Forestry	2018	5	13.64	98	Stage IIIB	NOx	9454	81882.72	0.10310
Forestry	2018	5	13.64	98	Stage IIIB	PM10	99	81882.72	0.00108
Forestry	2018	5	13.64	98	Stage IIIB	PM2.5	99	81882.72	0.00108
Forestry	2018	5	13.64	98	Stage IIIB	TSP	99	81882.72	0.00108
Forestry	2018	6	9.85	5	Stage IIIA	BC	437	81882.72	0.00016
Forestry	2018	6	9.85	5	Stage IIIA	CO	5947	81882.72	0.00216
Forestry	2018	6	9.85	5	Stage IIIA	NH3	8	81882.72	0.00000
Forestry	2018	6	9.85	5	Stage IIIA	NMVOC	1161	81882.72	0.00042
Forestry	2018	6	9.85	5	Stage IIIA	NOx	12845	81882.72	0.00467
Forestry	2018	6	9.85	5	Stage IIIA	PM10	573	81882.72	0.00021
Forestry	2018	6	9.85	5	Stage IIIA	PM2.5	573	81882.72	0.00021
Forestry	2018	6	9.85	5	Stage IIIA	TSP	573	81882.72	0.00021
Forestry	2018	6	9.85	95	Stage IIIB	BC	74	81882.72	0.00057
Forestry	2018	6	9.85	95	Stage IIIB	CO	5940	81882.72	0.04576
Forestry	2018	6	9.85	95	Stage IIIB	NH3	8	81882.72	0.00006
Forestry	2018	6	9.85	95	Stage IIIB	NMVOC	514	81882.72	0.00396
Forestry	2018	6	9.85	95	Stage IIIB	NOx	9454	81882.72	0.07283
Forestry	2018	6	9.85	95	Stage IIIB	PM10	99	81882.72	0.00076
Forestry	2018	6	9.85	95	Stage IIIB	PM2.5	99	81882.72	0.00076
Forestry	2018	6	9.85	95	Stage IIIB	TSP	99	81882.72	0.00076
Forestry	2018	7	6.06	100	Stage IIIA	BC	437	81882.72	0.00217
Forestry	2018	7	6.06	100	Stage IIIA	CO	5947	81882.72	0.02949
Forestry	2018	7	6.06	100	Stage IIIA	NH3	8	81882.72	0.00004
Forestry	2018	7	6.06	100	Stage IIIA	NMVOC	1161	81882.72	0.00576
Forestry	2018	7	6.06	100	Stage IIIA	NOx	12845	81882.72	0.06370
Forestry	2018	7	6.06	100	Stage IIIA	PM10	573	81882.72	0.00284
Forestry	2018	7	6.06	100	Stage IIIA	PM2.5	573	81882.72	0.00284
Forestry	2018	7	6.06	100	Stage IIIA	TSP	573	81882.72	0.00284
Forestry	2018	8	2.27	27	Stage II	BC	456	81882.72	0.00023
Forestry	2018	8	2.27	27	Stage II	CO	5940	81882.72	0.00301

1	2	3	4	5	6	7	8	9	10
Domain	Year	Age	split per engine age% , Forestry-Table 3.3 G 2019 [1)]	fuel share forestry, Table 3.5, annex 1A4cii G2016	Technology	Pollutant	Value EF (g/t fuel)	Fuel consumption Diesel Forestry (t)	Emission (kt) (col4*col5*col8*col9E-13)
Forestry	2018	8	2.27	27	Stage II	NH3	8	81882.72	0.00000
Forestry	2018	8	2.27	27	Stage II	NMVOC	1160	81882.72	0.00059
Forestry	2018	8	2.27	27	Stage II	NOx	20593	81882.72	0.01044
Forestry	2018	8	2.27	27	Stage II	PM10	595	81882.72	0.00030
Forestry	2018	8	2.27	27	Stage II	PM2.5	595	81882.72	0.00030
Forestry	2018	8	2.27	27	Stage II	TSP	595	81882.72	0.00030
Forestry	2018	8	2.27	73	Stage IIIA	BC	437	81882.72	0.00059
Forestry	2018	8	2.27	73	Stage IIIA	CO	5947	81882.72	0.00805
Forestry	2018	8	2.27	73	Stage IIIA	NH3	8	81882.72	0.00001
Forestry	2018	8	2.27	73	Stage IIIA	NMVOC	1161	81882.72	0.00157
Forestry	2018	8	2.27	73	Stage IIIA	NOx	12845	81882.72	0.01739
Forestry	2018	8	2.27	73	Stage IIIA	PM10	573	81882.72	0.00078
Forestry	2018	8	2.27	73	Stage IIIA	PM2.5	573	81882.72	0.00078
Forestry	2018	8	2.27	73	Stage IIIA	TSP	573	81882.72	0.00078

[1)] Adjuted values. The values provided in the " Table 3.3 Split (%) of total fuel consumption per engine age, (irrespective of inventory year).", 1.A.4 Non road mobile machinery, Guidebook 2019, for diesel fuel, agriculture and forestry were adjusted in order to allow the distribution of 100% of the fuel consumption and to avoid un underestimation. Due to the fact that the "Engine age" in Table 3.3 goes to 29 for Agriculture and 14 for Forestry, while the "Age" in the tables 3.5 and 3.6 of the excel Annex (1.A.4 Non road mobile machinery, Guidebook 2019) goes to 21 for Agriculture and to 8 for Forestry, applying the values in these tables would result in less than 100% distribution of the fuel, on ages and technologies. Therefore, the split % values in Table 3.3 were adjusted with a factor of 1.11 for agriculture and 1.136 for Forestry.

ANEXA B, 3B - Manure Management calculations

Tabel 1. Default Tier 2 **NH_3**-N EFs and associated parameters for the Tier 2 methodology for the calculation of the **NH_3**-N emissions from manure management

Livestock class	Dairy cows (100901)	Other cattle (100902)	Fattening pigs (100903)	Sows (100904)	Sheep (100905)	Laying hens (100907)
Nex (kg/yr)	105	41	12.1	34.5	15.5	0.77
Prop TAN	0.6	0.6	0.7	0.7	0.5	0.7
Straw , kg/yr (C54)	1500	500	200	600	20	0
N added in bedding, kg/animal/yr	6	2	0.8	2.4	0.08	0
Housing period, d	180	180	365	365	30	365
% excreta on yards (C30)	25	10	0	0	2	0
EF NH3 house, slurry	0.2	0.2	0.28	0.22	0	0.41
EF NH3 house, solid	0.19	0.19	0.27	0.25	0.22	0.41
EF NH3 yard	0.3	0.53	0.53	0	0.75	0
EF NH3 storage, slurry	0.2	0.2	0.14	0.14	0	0.14
EF NH3 storage, solid	0.27	0.27	0.45	0.45	0.28	0.14
EF N2O storage, slurry	0	0	0	0	0	0
EF N2O storage, solid	0.08	0.08	0.05	0.05	0.07	0.04
EF NO storage, slurry	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
EF NO storage, solid	0.01	0.01	0.01	0.01	0.01	0.01
EF N2 storage, slurry	0.003	0.003	0.003	0.003	0.003	0.003
EF N2 storage, solid	0.3	0.3	0.3	0.3	0.3	0.3
EF storage leaching, solid	0	0	0	0	0	0
EF NH3 application, slurry	0.55	0.55	0.4	0.29	0	0.69
EF NH3 application, solid	0.79	0.79	0.81	0.81	0.9	0.69
EF NH3 grazing	0.1	0.06	0	0	0.09	0

Table 2. Emission Factors for calculation **NH_3** emissions from Manure Management

Livestock class	Methods	EF Total NH_3	Housing, storage and yards (3B)	Manure application (3Da2a)	Grazed pastures (3Da3)
Dairy cows (100901) (1990-2013)	T2	30.519	15.555	12.056	2.908
Dairy cows (100901) (2014-2018)	T2	30.703	16.120	11.674	2.908
Non-dairy cattle (100902) (1990-2013)	T2	10.384	5.353	4.213	0.818
Non-dairy cattle (100902) (2014-2018)	T2	10.472	5.618	4.036	0.818
Buffalo (100914)	T1	9.0	4.3	0.7	4
Sheep (100905)	T2	1.388	0.368	0.258	0.762
Goats (100910)	T1	1.4	0.4	0.2	0.8
Horses&comp (100906)	T1	14.8	7	1.7	6.1
Fattening pigs (100903) (1990-2013)	T2	6.828	4.051	2.776	0
Fattening pigs (100903) (2014-2018)	T2	6.774	4.027	2.747	0
Sows (100904) (1990-2013)	T2	18.348	10.776	7.572	0
Sows (100904) (2014-2018)	T2	18.348	10.370	6.897	0
Layers (100907)	T2	0.497	0.295	0.201	0
Broilers (100908)	T1	0.22	0.15	0.07	0

The values obtained using Tier 2 methodology are based on the Excel spreadsheet "3B manure management – appendix B" and the values from Table 3.7 – length of housing period, Nex, annual straw use in litter-based, Ncontent of straw, Table 3.9 – NH_3 default EF's and associated parameters, Table 3.10 – proportion of TAN storage for solid and slurry (3B – Manure Management, 2016 EMEP/EEA Guidebook).
The livestock with Tier 2 approach has been estimate for two period: 1990-2013 and 2014-2018, considering different proportion slurry/FYM, as mentioned in Capter 3B Manure Management.
The values for Tier 1 methodology are based on Table 3.2 and Table 3.3 (3B – Manure Management, 2016 EMEP/EEA Guidebook).

Table 3. Equations for **NMVOC** calculation 3B1a - Tier2, GB2016

Years with different slurry/FYM %	NFR	Xhouse %	$Frac_{silage}$ %	$Frac_{silage\_store}$ %	$EF_{NMVOC silage\_feeding}$	$EF_{NMVOC, building}$	$EF_{NMVOC, graz}$	E NH3 storage, slurry	E NH3 storage, solid	E NH3 application, slurry	E NH3 application, solid	E NH3 house, slurry	E NH3 house, solid
1990-2013	3B1a	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	3.08	1.35	6.74	5.32	0.17	5.21
	3B1b	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	0.39	0.86	0.85	3.36	0.08	2.44
2014-2018	3B1a	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	4.4	0.52	9.64	2.04	1.69	3.76
	3B1b	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	1.01	0.47	2.21	1.83	0.8	1.76
Data Sources			3.B Manure Management, pg 27, GB2016		Tabel 3.11. Default NMVOC Tier 2 EFs for dairy cattle and other cattle			3B NH3 Manure Management Appendix B, Tier 2 Calculation, Guidebook 2013					
1990-2018	3B4gi	1	0	0.25	0	0.005684	0	0.02703085		0.201167447		0.268345	
Data Sources			3.B Manure Management, pg 27, GB2016		Tabel 3.11. Default NMVOC Tier 2 EFs for laying hens			3B NH3 Manure Management Appendix B, Tier 2 Calculation, Guidebook 2013					

Table 4. Emissions factors for **NMVOC** calculation 3B1a – Dairy cattle - Tier2, GB2016

Year	Feed intake (GE)	Feed intake	$E_{NMVOC,}$ house no silage	$E_{NMVOC,}$ manure_store no silage	$E_{NMVOC,}$ appl no silage	$E_{NMVOC,}$ graz no silage	$E_{NMVOC,}$ sillage_store	$E_{NMVOC,}$ sillage_feeding	$E_{NMVOC,}$ house silage	$E_{NMVOC,}$ manure_store silage	$E_{NMVOC,}$ appl silage	$E_{NMVOC,}$ graz silage	$E_{NMVOC,total}$ no silage	$E_{NMVOC,total}$ silage
	MJ/head/day	MJ/head/yr					kg /yr/head						kg /yr/head	kg /yr/head
1990	233.418	85197.720	1.483	0.591	1.608	0.298	1.051	4.206	1.483	0.591	1.608	0.298	**3.980**	**9.237**
1991	243.447	88858.027	1.547	0.617	1.677	0.311	1.097	4.386	1.547	0.617	1.677	0.311	**4.151**	**9.634**
1992	250.808	91545.034	1.594	0.635	1.727	0.320	1.130	4.519	1.594	0.635	1.727	0.320	**4.276**	**9.925**
1993	255.280	93177.239	1.622	0.647	1.758	0.326	1.150	4.600	1.622	0.647	1.758	0.326	**4.353**	**10.102**
1994	265.549	96925.363	1.687	0.673	1.829	0.339	1.196	4.785	1.687	0.673	1.829	0.339	**4.528**	**10.509**
1995	269.602	98404.648	1.713	0.683	1.857	0.344	1.214	4.858	1.713	0.683	1.857	0.344	**4.597**	**10.669**
1996	271.771	99196.238	1.727	0.688	1.872	0.347	1.224	4.897	1.727	0.688	1.872	0.347	**4.634**	**10.755**
1997	275.026	100384.470	1.748	0.697	1.894	0.351	1.239	4.955	1.748	0.697	1.894	0.351	**4.689**	**10.884**
1998	274.749	100283.475	1.746	0.696	1.892	0.351	1.238	4.950	1.746	0.696	1.892	0.351	**4.685**	**10.873**
1999	274.495	100190.592	1.744	0.695	1.891	0.350	1.236	4.946	1.744	0.695	1.891	0.350	**4.680**	**10.863**
2000	278.120	101513.764	1.767	0.704	1.916	0.355	1.253	5.011	1.767	0.704	1.916	0.355	**4.742**	**11.006**
2001	282.701	103185.921	1.796	0.716	1.947	0.361	1.273	5.094	1.796	0.716	1.947	0.361	**4.820**	**11.187**
2002	283.312	103408.759	1.800	0.718	1.951	0.362	1.276	5.105	1.800	0.718	1.951	0.362	**4.831**	**11.212**
2003	286.684	104639.520	1.822	0.726	1.975	0.366	1.291	5.165	1.822	0.726	1.975	0.366	**4.888**	**11.345**
2004	291.587	106429.183	1.853	0.739	2.008	0.372	1.313	5.254	1.853	0.739	2.008	0.372	**4.972**	**11.539**
2005	287.975	105110.724	1.830	0.729	1.983	0.368	1.297	5.189	1.830	0.729	1.983	0.368	**4.910**	**11.396**
2006	292.083	106610.284	1.856	0.740	2.012	0.373	1.316	5.263	1.856	0.740	2.012	0.373	**4.980**	**11.559**
2007	290.206	105925.257	1.844	0.735	1.999	0.370	1.307	5.229	1.844	0.735	1.999	0.370	**4.948**	**11.484**
2008	292.619	106806.034	1.859	0.741	2.015	0.374	1.318	5.272	1.859	0.741	2.015	0.374	**4.989**	**11.580**
2009	288.435	105278.667	1.833	0.731	1.987	0.368	1.299	5.197	1.833	0.731	1.987	0.368	**4.918**	**11.414**
2010	294.109	107349.901	1.869	0.745	2.026	0.375	1.325	5.299	1.869	0.745	2.026	0.375	**5.015**	**11.639**
2011	298.767	109050.035	1.898	0.757	2.058	0.381	1.346	5.383	1.898	0.757	2.058	0.381	**5.094**	**11.823**
2012	294.989	107670.922	1.874	0.747	2.032	0.377	1.329	5.315	1.874	0.747	2.032	0.377	**5.030**	**11.674**
2013	295.610	107897.609	1.878	0.749	2.036	0.377	1.332	5.326	1.878	0.749	2.036	0.377	**5.040**	**11.698**

Year	Feed intake (GE)	Feed intake	$E_{NMVOC,}$ house no silage	$E_{NMVOC,}$ manure_store no silage	$E_{NMVOC,}$ appl no silage	$E_{NMVOC,}$ graz no silage	$E_{NMVOC,}$ sillage_store	$E_{NMVOC,}$ sillage_feeding	$E_{NMVOC,}$ house silage	$E_{NMVOC,}$ manure_store silage	$E_{NMVOC,}$ appl silage	$E_{NMVOC,}$ graz silage	$E_{NMVOC,total}$ no silage	$E_{NMVOC,total}$ silage
	MJ/head/day	MJ/head/yr					kg /yr/head						kg /yr/head	kg /yr/head
2014	297.092	108438.756	1.888	0.830	1.968	0.379	1.338	5.353	1.888	0.830	1.968	0.379	**5.065**	**11.756**
2015	293.894	107271.181	1.867	0.821	1.947	0.375	1.324	5.295	1.867	0.821	1.947	0.375	**5.010**	**11.629**
2016	290.583	106062.852	1.846	0.812	1.925	0.371	1.309	5.236	1.846	0.812	1.925	0.371	**4.954**	**11.498**
2017	290.606	106071.106	1.847	0.812	1.925	0.371	1.309	5.236	1.847	0.812	1.925	0.371	**4.954**	**11.499**
2018	292.179	106645.371	1.857	0.816	1.935	0.373	1.316	5.264	1.857	0.816	1.935	0.373	**4.981**	**11.561**

Table 5. Equations for **NMVOC** calculation 3B1b – Non-dairy cattle - Tier2, GB2016

Years with different slurry/FYM %	Feed intake (GE)	Feed intake	$E_{NMVOC,}$ house no silage	$E_{NMVOC,}$ manure_store no silage	$E_{NMVOC,}$ appl no silage	$E_{NMVOC,}$ graz no silage	$E_{NMVOC,}$ sillage_store	$E_{NMVOC,}$ sillage_feeding	$E_{NMVOC,}$ house silage	$E_{NMVOC,}$ manure_store silage	$E_{NMVOC,}$ appl silage	$E_{NMVOC,}$ graz silage	$E_{NMVOC,total}$ no silage	$E_{NMVOC,total}$ silage
	MJ/head/day	MJ/head/yr	kg /yr/head											
1990-2013	193.79	70733.35	1.231	0.374	1.263	0.247	0.873	3.492	1.231	0.374	1.263	0.247	**3.116**	**7.481**
2014-2018	193.79	70733.35	1.231	0.439	1.200	0.247	0.873	3.492	1.231	0.439	1.200	0.247	**3.117**	**7.482**

$E_{NMVOC\_i} = AAP_{animal\_i} \cdot (E_{NMVOC,silage\_store\_i} + E_{NMVOC,silage\_feeding\_i} + E_{NMVOC,building\_i} + E_{NMVOC,store\_i} + E_{NMVOC,appl.\_i} + E_{NMVOC,graz\_i})$

Where:

i = the *i*th livestock category, MJ_i= Gross feed intake, MJ yr-1

$E_{NMVOC,silage\_store\_i} = MJ\_i \cdot x_{house\_i} \cdot (EF_{NMVOC,silage\_feeding\_i} \cdot Frac_{silage}) \cdot Frac_{silage\_store\_i}$

$E_{NMVOC,silage\_feeding\_i} = MJ\_i \cdot x_{building\_i} \cdot (EF_{NMVOC,silage\_feeding\_i} \cdot Frac_{silage})$

$E_{NMVOC,house\_i} = MJ\_i \cdot x_{building\_i} \cdot (EF_{NMVOC,house\_i})$

$E_{NMVOC,manure\_store\_i} = E_{NMVOC,building\_i} \cdot (E_{NH3,storage\_i\_} / E_{NH3,building\_i})$

$E_{NMVOC,appl.\_i} = E_{NMVOC,\ building\_i} \cdot (E_{NH3appl.\_i} / E_{NH3building\_i})$

$E_{NMVOC,graz\_i} = MJ\_i \cdot (1-x_{building\_i}) \cdot EF_{NMVOC,graz\_i}$.

Table 6. Equations for **NMVOC** calculation 3B4gi- Laying hens - Tier2, GB2016

Year	**Volatile excretion,day (VS)**	**Volatile excretion,year**	**$E_{NMVOC, sillage\_store}$**	**$E_{NMVOC, sillage\_feeding}$**	**$E_{NMVOC, house}$**	**$E_{NMVOC, manure\_store}$**	**$E_{NMVOC, appl}$**	**$E_{NMVOC, graz}$**	**$E_{NMVOC,total}$**
	MJ/head/day	**MJ/head/yr**	**kg /yr/head**						**kg /yr/head**
1990-2018	0.018287	6.674721171	0	0	0.037939115	0.003821672	0.009565756	0	**0.070202215**

$E_{NMVOC,silage\_store\_i} = VS\_{i} \cdot x_{building\_i} \cdot (EF_{NMVOC,\ silage\ feed\_i} \cdot Frac_{silage}) \cdot Frac_{silage\_store}$

$E_{NMVOC,silage\_feeding\_i} = VS\_{i} \cdot x_{building\_i} \cdot (EF_{NMVOC,silage\_feeding\_i} \cdot Frac_{silage})$

$E_{NMVOC,house\_i} = VS\_{i} \cdot x_{building\_i} \cdot (EF_{NMVOC,\ building\_i})$

$E_{NMVOC,manure\_store\_i} = E_{NMVOC,\ building\_i} \cdot (E_{NH3,storage\_i} / E_{NH3,\ building\_i})$

$E_{NMVOC,appl.\_i} = E_{NMVOC,\ building\_i} \cdot (E_{NH3appl.\_i} / E_{NH3building\_i})$

$E_{NMVOC,graz\_i} = kg\ VS\_{i} \cdot (1 - x_{building\_i}) \cdot EF_{NMVOC,graz\_i}$

Where: kg $VS_{\_i}$ = kg excreted VS yr^{-1} for livestock category i, kg yr^{-1}.

Table 7. Emission Factors for calculation **PM** emissions from Manure Management

			Table 3.5 Default Tier 1 estimates of EF for particle emissions from livestock husbandry (housing)			***Emissions Factors applied for Particulate Matter***		
Livestock class	**Housing period, d**	**% per year**	**PM2.5**	**PM10**	**TSP**	***PM2.5***	***PM10***	***TSP***
Dairy cows (100901)	180	0.493150685	0.41	0.63	1.38	0.202	0.311	0.681
Other cattle (100902)	180	0.493150685	0.18	0.27	0.59	0.089	0.133	0.291
Fattening pigs (100903)	365	1	0.006	0.14	1.05	0.006	0.140	1.050
Sows (100904)	365	1	0.01	0.17	0.62	0.010	0.170	0.620
Sheep (100905)	30	0.082191781	0.02	0.06	0.14	0.002	0.005	0.012
Laying hens (100907)	365	1	0.003	0.04	0.19	0.003	0.040	0.190
Goats (100910)	30	0.082191781	0.02	0.06	0.14	0.002	0.005	0.012
Horses etc (100906)	180	0.493150685	0.14	0.22	0.48	0.069	0.108	0.237
Broilers (100908)	365	1	0.002	0.02	0.04	0.002	0.020	0.040
Buffalos (100914)	225	0.616438356	0.44	0.67	1.45	0.271	0.413	0.894

Table 8. Emission Factors for calculation **NOx** emissions from Manure Management – Tier1, 2016 EMEP/EEA Guidebook

Manure Type		Table 3.3 Default Tier 1 EFs for NO from stored manure. According to Annex I of the NFR Reporting Guidelines, NO emissions have to be reported as NO_2, Guidebook 2016									
	Livestock	**Dairy cattle**	**Non dairy cattle**	**Sheep**	**Fattening pigs**	**Sows**	**Buffalo**	**Goats**	**Horses**	**Layers**	**Broilers**
	NFR Code	3B1a	3B1b	3B2	3B3	3B3	3B4a	3B4d	3B4e	3B4gi	3B4gii
Slurry	EF (Kg)	0.011	0.003		0.002	0.006					
Solid	EF (Kg)	0.236	0.144	0.008	0.069	0.204	0.066	0.008	0.201	0.005	0.002
Proportion of livestock housed on slurry-based system (%)	1990-2013	3	3	0	40	30					
	2014-2018	30	30	0	60	60					
1990-2013	**Ef (Kg) applied**	0.229	0.139	0.008	0.042	0.144	0.066	0.008	0.201	0.005	0.002
2014-2018	**Ef (Kg) applied**	0.231	0.141	0.008	0.058	0.18	0.066	0.008	0.201	0.005	0.002