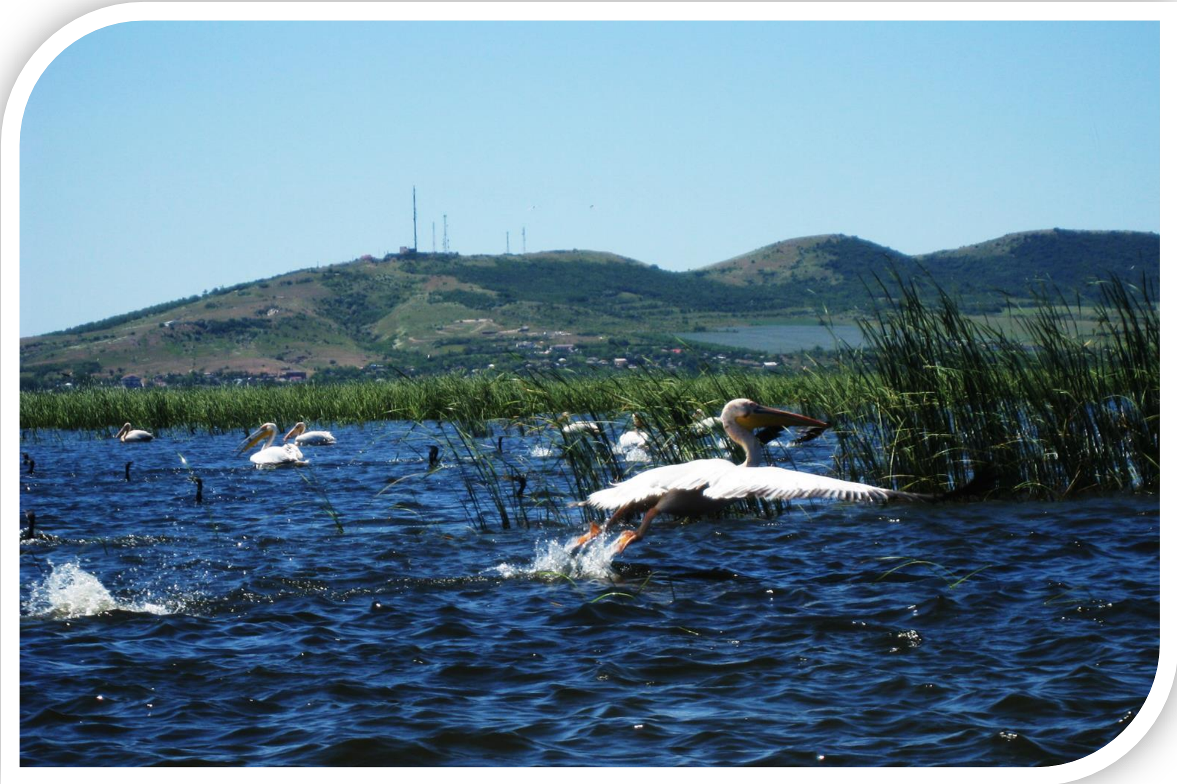

ROMANIA'S INFORMATIVE INVENTORY REPORT 2021

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 1990-2019

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Table of Contents

EXECUTIVE SUMMARY

The Romania's Informative Inventory Report (IIR) contains information on the Romania's inventories for the years 1990 to 2019, including descriptions of methods, data sources, key categories analysis and trends analysis.

New NFR categories were estimated and some recalculations for period 1990-2019 have been carried out, due to updated statistics and correlations with the activity data, according with the Emission Inventory review conducted in 2020.

New NFR categories were estimated and recalculations for period 1990-2019 on the following criteria:

- the recommendations from TERT in the NECD Review 2020;
- updated statistics;
- updated emission factors in the 2019 EMEP/EEA Guidebook;
- consistency/correlation with all relevant inventories.

Following the Emission Inventory Reviews in 2017-2020, 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. 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 shares of the emissions from the energy sector in the național total in 2019 are provided in the table below:

Pollutant	Share of energy sector in the national total (%)	Pollutant	Share of energy sector in the national total (%)
NOx	89	Hg	69
NMVOC	48	As	70
SOx	90	Cr	54
NH_3	6	Cu	94
$PM_{2.5}$	93	Ni	67
PM_{10}	71	Se	95
TSP	50	Zn	85
BC	98	PCDD	60
CO	83	PAHs	87
Pb	34	HCB	62
Cd	75	PCBs	30

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 estimations include mainly measured values of TSP, SOx and NOx for LCP installations.

The public power sector was in 2019 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 78% for NOx, 92% for SOx and 92% for PM_{10}. Compared to 2005, the emissions decreased with 67% for NOx, 90% for SOx, 88% for PM_{10} and 86% for $PM_{2.5}$. 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 (NFRs 1A4-1A5), including the off-road mobile machineries, is the main contributor to the national emissions for particulate matter, BC, part of heavy metals, PCDD/F and PAH. Within the small combustion sector, the residential combustion (NFR 1A4bi) is a key source for many pollutants, contributing to the 2019 national total with the following percentages: 81% for PM2.5, 76% for PAH, 70% for BC, 61% for PM10, 59.8% for Zn, 60% for CO, 55% for Cd and 53% for PCDD/PCDF. The emissions originates mainly from the combustion of biomass (wood) for residential heating. Biomass consumption increased along the time-series, reached a maximum in 2010 and varied very slightly in the following period 2010-2019. This evolution is consistent with the shift from central to individual heating in small and medium cities and with the decrease of power plants activity and emissions. Compared to 2005, the biomass consumption increased with 11% in 2019.

Road transport was for 2019 the key category for NOx (39.23% of National Total), NMVOC (8.93% of National Total), BC (15.80% of National Total) CO (12.64% of National Total), Cu (81.40% of National Total) and Zn (7.14% of National Total).

For the years 2005-2019, emissions were estimated with COPERT 5.4 ultimate version.

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 (69.37% of National Total), Pb emissions (63.53% of National Total), Cr emissions (45.49% Nationl Total), NMVOC emissions (24.97% of National Total), TSP emissions (33.77% of National Total), As (27.12% of National Total) for the year 2019.

In 2019, 2.D.3.g includes first estimation the emissions for SNAP 060310 (asphalt blowing)

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 NH_3 emission (89.29%) is related to the agricultural sector. For the year 2019, the distribution of NH_3 emissions by agriculture sources was as follows: 39.58% from manure management, 60.42% from manure applied to soils and only 0.0049% from burning fields. For the year 2019, the contribution of NMVOC share from agriculture accounts for 20.43% of the national total. The distribution of NMVOC emissions by agricultural sources was as follows: 78.43% from manure management, 21.54% from manure applied to soils and only 0.0267% 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 NH_3, has led to a change in the amount of NH_3, 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 NH_3 emissions with Tier 2 approach.

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.iii Clinical waste incineration, covers the emissions from the activities of clinical waste incineration, and for the whole 1990-2019 time series, emissions have been calculated for the first time.

The waste sector contributes to the PCDD/PCDF emissions of the Inventory (22.10% of National Total) and HCB emissions (35.12% Nationl Total), for the year 2019.

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	x		Table 3.5, biomass, 2019 EMEP/EEA

NFR	Source/sector name	PM emissions: the condensable component is included	excluded	EF reference and comments
	manufacturing industries and construction (all 1A2 industry)			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

NFR	Source/sector name	PM emissions: the condensable component is included	excluded	EF reference and comments
				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:

NFR	Timeseries	Pllutants	Reason
1A2gvii	1992-2018	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO	Upgrade to Tier2 method (Review 2020, Ref. Number RO-1A2gvii-2020-0001).
1A3bi-1A3bvii	2005-2018	All pollutants, except PAH and HCB	Upgrade to Copert 5.4.36; Correction of Sulphur content error in Copert.
1A3c	2018	Benzo(a), benzo(b)	Error correction (the two values were interchanged).
1A3di(i)	2010	SOx	Sulphur content in fuel reviewed (error correction).
1A3di, 1A3dii	1990-2018	PAH added (previously NE); corrected As, Cu and Se	EF changes in the Guidebook.
1A3dii	2006	SOx	S content in fuel error correction.
1A4aii	1992-2018	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO	Upgrade to Tier2 method (Review 2020, Ref. Number, RO-1A4aii-2020-0001).
1A4cii	1992-2018	All pollutants except SOx	Improvement of the calculation method (gasoline split on 2 Stroke/4 stroke technology and diesel split on agriculture/forestry).
1B2aiv	1990-2018	All pollutants in the time series	Improving the calculation method to Tier 2.
1B2av	1990-2011	NMVOC	Recalculation of NMVOC due to the correct application of pollutant reduction efficiency according to the legislation.
2C7a	1990-2008	All pollutants	Improving the calculation method to Tier 2.
2D3f	2005 -2018	NMVOC	Improving the calculation method to Tier 2.
2D3g	1990-2018	AD+pollutants	Improvement: new SNAP 060310 asphalt blowing.
2D3i	2016-2018	AD+NMVOC	Improvement of activity data (statistical NIS population).
3B1a-3B4gii	1990-2018	NH_3, NMVOC, NOx	Recalculation cf. EMEP/EEA Guidebook 2019.
3B2	1994	AD	Correction for number of heads (=10896.573).
3Da1	2013/2016-2018	AD (IFA only)->NH_3	IFA Activity data changed for 2013 and 2016-2018 (data from NIS unchanged). Significant changes (> 2kt NH_3) in 2017 and 2018.
3Da2a	1990-2018	AD+NOx	Correction of activity data (provided by GES).
3Da2a,3Da3	1990-2018	NH_3	Recalculation cf. EMEP/EEA Guidebook 2019.

3Da2a,3Da3	1990-2018	NMVOC	Change notation to IE (according to Review question RO_3Da2a_2020_0001).
3Da2b	1990-2018	NH_3	EF correction, GB2019, EF(NH_3) = 0.006629.
5A	2011-2018	NMVOC	Recalculation of activity data (GES data for CH_4 estimation).
5A	1990-2018	TSP, $PM_{2.5}$, PM_{10}	Change of activity data (from CH_4 only to CH4/waste deposit on land).
5B1	2007	NH_3	Typing error correction for NH_3.
5B2	1990-2018	PAHs	Recalculation (Guidebook 2019 update).
5C1bi	1992-2018	AD+pollutants	AD and emissions recalculation (Tier1 for 1992-2007, Tier2 for 2008-2018).
5D3	2016-2018	AD+ NH_3	AD recalculation for latrines (NIS population number improvement).

1. INTRODUCTION

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

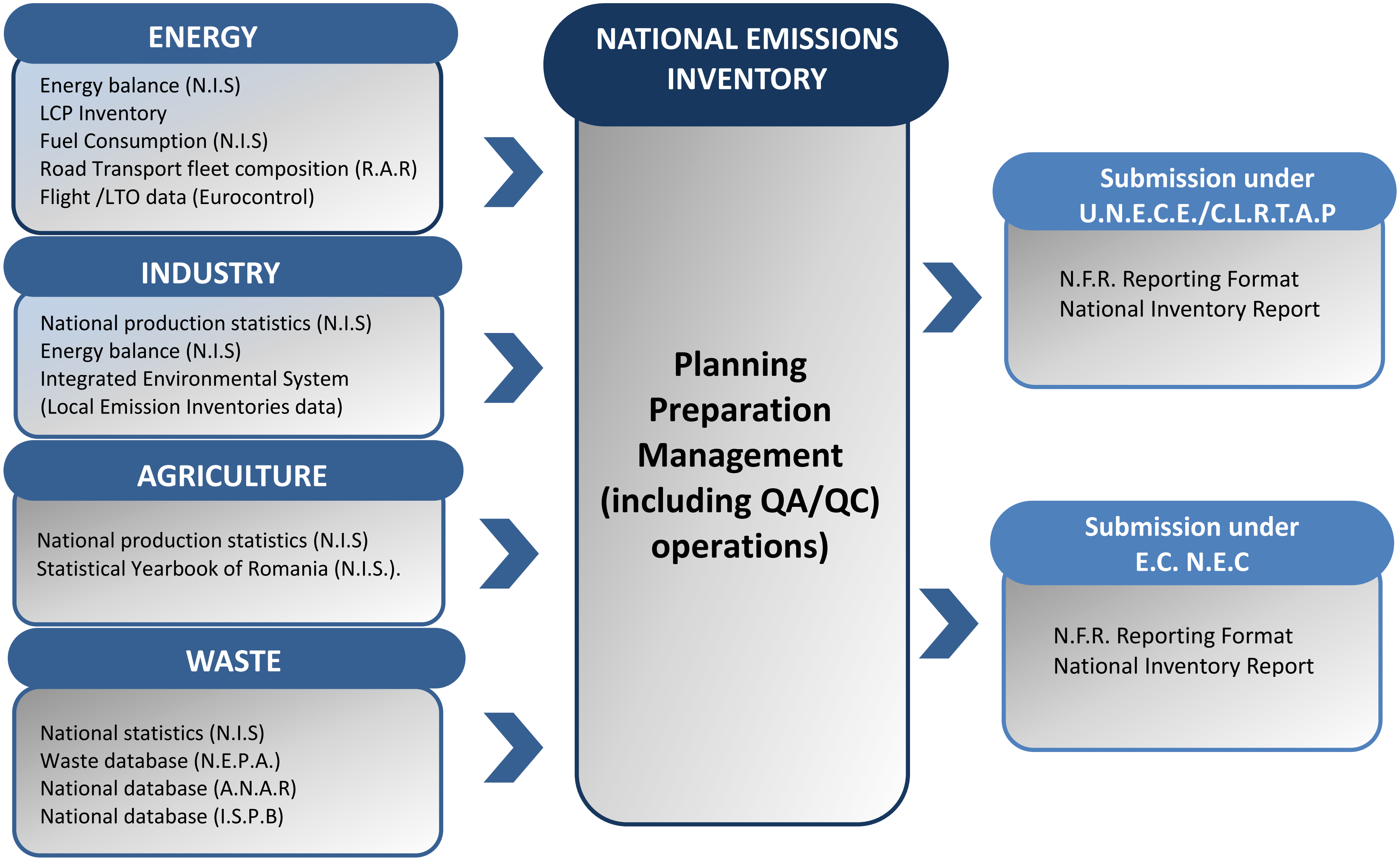
Romania prepares, maintains and reports on a yearly basis the National Emissions Inventory and the whole inventory time series, if required. Emission time series are resubmitted if any recalculation occurred due to the methodology/emission factors changes, new sources identification, updated activity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

The methodology for estimating and reporting emissions is consistent with the “EMEP/EEA air pollutant emission inventory guidebook – 2019” and 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) and Romania Public Health Institute (I.S.P.B.).

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.

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

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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 (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A3biii	Road transport: Heavy duty vehicles and buses	44.138	20.29%	20.29%	1
1A1a	Public electricity and heat production	32.151	14.78%	35.08%	2
1A3bi	Road transport: Passenger cars	28.614	13.16%	48.23%	3
3Da1	Inorganic N-fertilizers (includes also urea application)	18.239	8.39%	56.62%	4
1A4bi	Residential: Stationary	13.517	6.22%	62.83%	5
1A3bii	Road transport: Light duty vehicles	12.480	5.74%	68.57%	6
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	9.516	4.38%	72.95%	7
3Da2a	Animal manure applied to soils	8.674	3.99%	76.94%	8
1A3c	Railways	6.677	3.07%	80.01%	9

Table 1.3.2 Key Categories for NMVOC (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	73.7781	32.14%	32.14%	1
2D3a	Domestic solvent use including fungicides	18.4810	8.05%	40.19%	2
3B1a	Manure management - Dairy cattle	15.7245	6.85%	47.03%	3
2D3g	Chemical products	14.0680	6.13%	53.16%	4
3De	Cultivated crops	10.1019	4.40%	57.56%	5
1A3bi	Road transport: Passenger cars	8.5443	3.72%	61.28%	6
2H2	Food and beverages industry	8.0761	3.52%	64.80%	7
1A3bv	Road transport: Gasoline evaporation	6.6596	2.90%	67.70%	8
3B1b	Manure management - Non-dairy cattle	5.6324	2.45%	70.16%	9
1B1a	Fugitive emission from solid fuels: Coal mining and handling	5.4918	2.39%	72.55%	10
2D3i	Other solvent use (please specify in the IIR)	5.1635	2.25%	74.80%	11
2B10a	Chemical industry: Other (please specify in the IIR)	4.1563	1.81%	76.61%	12
3B4gi	Manure mangement - Laying hens	4.0286	1.75%	78.36%	13
3B4gii	Manure mangement - Broilers	3.7407	1.63%	79.99%	14
2D3d	Coating applications	3.6589	1.59%	81.59%	15

Table 1.3.3 Key Categories for SOx (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	52.2512	52.75%	52.75%	1
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	19.1429	19.33%	72.08%	2
1B2aiv	Fugitive emissions oil: Refining / storage	9.1059	9.19%	81.27%	3

Table 1.3.4 Key Categories for NH_3 (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
3Da2a	Animal manure applied to soils	46.5915	26.14%	26.14%	1
3Da1	Inorganic N-fertilizers (includes also urea application)	29.7738	16.70%	42.84%	2
3B3	Manure management - Swine	24.8982	13.97%	56.81%	3
3Da3	Urine and dung deposited by grazing animals	19.7176	11.06%	67.87%	4
3B1a	Manure management - Dairy cattle	13.9220	7.81%	75.68%	5
1A4bi	Residential: Stationary	8.8066	4.94%	80.62%	6

Table 1.3.5 Key Categories for $PM_{2.5}$ (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	90.9718	81.20%	81.20%	1

Table 1.3.6 Key Categories for PM_{10} (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	93.3899	61.01%	61.01%	1
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	18.3244	11.97%	72.98%	2
2D3b	Road paving with asphalt	5.2701	3.44%	76.42%	3
2A5a	Quarrying and mining of minerals other than coal	4.4292	2.89%	79.32%	4
2A2	Lime production	3.5854	2.34%	81.66%	5

Table 1.3.7 Key Categories for TSP (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	98.2789	42.14%	42.14%	1
2D3b	Road paving with asphalt	24.5940	10.54%	52.68%	2
2B10a	Chemical industry: Other (please specify in the IIR)	21.7723	9.33%	62.02%	3
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	18.3244	7.86%	69.87%	4
2A2	Lime production	9.2196	3.95%	73.83%	5
2A5a	Quarrying and mining of minerals other than coal	9.0357	3.87%	77.70%	6
3B4gi	Manure mangement - Laying hens	7.7384	3.32%	81.02%	7

Table 1.3.8 Key Categories for BC (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	9.3230	70.11%	70.11%	1
1A3bi	Road transport: Passenger cars	0.8608	6.47%	76.58%	2
1A3biii	Road transport: Heavy duty vehicles and buses	0.6556	4.93%	81.51%	3

Table 1.3.9 Key Categories for CO (2019)

NFR CODE	CATEGORY	Latest year estimate (kt)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	511.4292	57.23%	57.23%	1
1B2aiv	Fugitive emissions oil: Refining / storage	106.9340	11.97%	69.20%	2
1A3bi	Road transport: Passenger cars	80.3228	8.99%	78.19%	3
1A4aii	Commercial/institutional: Mobile	42.4298	4.75%	82.93%	4

Table 1.3.10 Key Categories for Pb (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
2C1	Iron and steel production	24.0795	59.02%	59.02%	1
1A4bi	Residential: Stationary	3.6615	8.98%	68.00%	2
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	2.8478	6.98%	74.98%	3
1A1a	Public electricity and heat production	2.7187	6.66%	81.64%	4

Table 1.3.11 Key Categories for Cd (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	1.6588	55.14%	55.14%	1
2C1	Iron and steel production	0.3929	13.06%	68.20%	2
1A1a	Public electricity and heat production	0.3241	10.77%	78.98%	3
1B2aiv	Fugitive emissions oil: Refining / storage	0.1727	5.74%	84.72%	4

Table 1.3.12 Key Categories for Hg (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	0.5165	35.72%	35.72%	1
2C1	Iron and steel production	0.2274	15.73%	51.45%	2
1B2aiv	Fugitive emissions oil: Refining / storage	0.1919	13.28%	64.73%	3
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.1822	12.60%	77.33%	4
1A4bi	Residential: Stationary	0.0930	6.43%	83.76%	5

Table 1.3.13 Key Categories for As (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	2.5262	64.04%	64.04%	1
2C1	Iron and steel production	0.9957	25.24%	89.29%	2

Table 1.3.14 Key Categories for Cr (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
2C1	Iron and steel production	5.4420	44.61%	44.61%	1
1A4bi	Residential: Stationary	2.9497	24.18%	68.78%	2
1A1a	Public electricity and heat production	1.6213	13.29%	82.07%	3

Table 1.3.15 Key Categories for Cu (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A3bvi	Road transport: Automobile tyre and brake wear	20.7507	81.28%	81.28%	1

Table 1.3.16 Key Categories for Ni (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	3.0635	30.09%	30.09%	1
1B2aiv	Fugitive emissions oil: Refining / storage	1.6726	16.43%	46.52%	2
2C1	Iron and steel production	1.3956	13.71%	60.23%	3
1A1c	Manufacture of solid fuels and other energy industries	1.2289	12.07%	72.30%	4
1A5a	Other stationary (including military)	1.0757	10.57%	82.86%	5

Table 1.3.17 Key Categories for Se (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	7.627	90.38%	90.38%	1

Table 1.3.18 Key Categories for Zn (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	65.606	59.87%	59.87%	1
2C1	Iron and steel production	13.585	12.40%	72.27%	2
1A3bvi	Road transport: Automobile tyre and brake wear	7.702	7.03%	79.30%	3
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	4.284	3.91%	83.21%	4

Table 1.3.19 Key Categories for PCDD/PCDF (2019)

NFR CODE	CATEGORY	Latest year estimate (g I-TEQ)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	99.4716	53.45%	53.45%	1
2C1	Iron and steel production	32.3382	17.38%	70.83%	2
5C1biii	Clinical waste incineration	30.0409	16.14%	86.98%	3

Table 1.3.20 Key Categories for Total PAHs (2019)

NFR CODE	CATEGORY	Latest year estimate (t)	Level assessment (%)	Cumulative total	Rank
1A4bi	Residential: Stationary	44.528	76.61%	76.61%	1
2C1	Iron and steel production	6.618	11.39%	87.99%	2

Table 1.3.21 Key Categories for HCB (2019)

NFR CODE	CATEGORY	Latest year estimate (kg)	Level assessment (%)	Cumulative total	Rank
1A1a	Public electricity and heat production	1.171	37.75%	37.75%	1
5C1biii	Clinical waste incineration	1.073	34.59%	72.34%	2
1A4bi	Residential: Stationary	0.638	20.57%	92.91%	3

Table 1.3.22 Key Categories for PCBs (2019)

NFR CODE	CATEGORY	Latest year estimate (kg)	Level assessment (%)	Cumulative total	Rank
2C1	Iron and steel production	13.888	69.37%	69.37%	1
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	3.613	18.04%	87.41%	2

Table 1.3.23 Key Categories by activity/pollutant – Main pollutants (2019)

Category		Main Pollutants (%)								
		NOx	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$**	**PM_{10}**	**TSP**	**BC**	**CO**
1A1a	Public electricity and heat production	14.78%		52.75%						
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel			19.33%						
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4.38%								
1A3bi	Road transport: Passenger cars	13.16%	3.72%						6.47%	8.99%
1A3bii	Road transport: Light duty vehicles	5.74%								
1A3biii	Road transport: Heavy duty vehicles and buses	20.29%							4.93%	
1A3bv	Road transport: Gasoline evaporation		2.90%							
1A3c	Railways	3.07%								
1A4aii	Commercial/Institutional: Mobile									4.75%
1A4bi	Residential: Stationary	6.22%	32.14%		4.94%	81.20%	61.01%	42.14%	70.11%	57.23%
1B1a	Fugitive emission from solid fuels: Coal mining and handling		2.39%							
1B2aiv	Fugitive emissions oil: Refining and storage			9.19%						11.97%
2A2	Lime production						2.34%	3.95%		
2A5a	Quarrying and mining of minerals other than coal						2.89%	3.87%		
2B10a	Chemical industry: Other (please specify in the IIR)		1.81%					9.33%		
2D3a	Domestic solvent use including fungicides		8.05%							
2D3b	Road paving with asphalt						3.44%	10.54%		
2D3d	Coating applications		1.59%							
2D3g	Chemical products		6.13%							
2D3i	Other solvent use (please specify in the IIR)		2.25%							
2H2	Food and beverages industry		3.52%							
3B1a	Manure management - Dairy cattle		6.85%		7.81%					
3B1b	Manure management - Non-dairy cattle		2.45%							
3B3	Manure management - Swine				13.97%					
3B4gi	Manure management - Laying hens		1.75%					3.32%		
3B4gii	Manure management - Broilers		1.63%							
3Da1	Inorganic N-fertilizers (includes also urea application)	8.39%			16.70%					
3Da2a	Animal manure applied to soils	3.99%			26.14%					
3Da3	Urine and dung deposited by grazing animals				11.06%					
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products						11.97%	7.86%		
3De	Cultivated crops		4.40%							
Cumulatively		**80.01%**	**81.59%**	**81.27%**	**80.62%**	**81.20%**	**81.66%**	**81.02%**	**81.51%**	**82.93%**

Table 1.3.24 Key Categories by activity/pollutant – Heavy Metals (2019)

Category		Heavy Metals (%)								
		Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1A1a	Public electricity and heat production	6.66%	10.77%	35.72%	64.04%	13.29%		30.09%	90.38%	
1A1c	Manufacture of solid fuels and other energy industries							12.07%		
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	6.98%		12.60%						
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)									3.91%
1A3bvi	Road transport: Automobile tyre and brake wear						81.28%			7.03%
1A4bi	Residential: Stationary	8.98%	55.14%	6.43%		24.18%				59.87%
1A5a	Other stationary (including military)							10.57%		
1B2aiv	Fugitive emissions oil: Refining and storage		5.74%	13.28%				16.43%		
2C1	Iron and steel production	59.02%	13.06%	15.73%	25.24%	44.61%		13.71%		12.40%
Cumulatively		**81.64%**	**84.72%**	**83.76%**	**89.29%**	**82.07%**	**81.28%**	**82.86%**	**90.38%**	**83.21%**

Table 1.3.25 Key Categories by activity/pollutant – POPs (2019)

Category		POPs (%)			
		PCDD/F	Total PAHs	HCB	PCBs
1A1a	Public electricity and heat production			37.75%	
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel				18.04%
1A4bi	Residential: Stationary	53.45%	76.61%	20.57%	
2C1	Iron and steel production	17.38%	11.39%		69.37%
5C1biii	Clinical waste incineration	16.14%		34.59%	
Cumulatively		**86.98%**	**87.99%**	**92.91%**	**87.41%**

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

A general uncertainty evaluation is one of the planned improvements in the future by the Commission contract on ‘Capacity building for Member States regarding the development of national emission inventories’.

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 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
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 are not estimated in Copert.
1A3bvii										NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Emissions are not estimated in Copert.
1A3c										NE		NE	NE						NE				Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3dii				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	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
2H2					NE	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
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
5C1biii				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 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	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
3B4f	IE	IE		IE	IE	IE	IE																3B4f
3Da2a		IE																					
3Da3	IE	IE																					3D2a
3Dc		IE																					3De
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, BC and CO

Year/Pollutant	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	428.808	326.123	819.311	366.322	76.720	132.363	285.304	5.475	831.835
1991	365.449	275.005	700.130	305.330	63.901	108.444	218.826	5.154	650.629
1992	386.383	264.480	696.959	268.854	61.539	100.320	222.405	6.848	617.586
1993	348.399	244.998	699.691	263.735	64.041	105.146	220.765	6.803	585.500
1994	348.200	258.473	665.368	244.471	67.078	107.128	212.418	7.786	570.296
1995	353.873	268.224	696.080	248.028	72.305	113.807	235.480	7.986	591.210
1996	392.435	314.152	698.717	249.113	109.663	151.920	276.839	12.440	891.608
1997	375.595	321.164	614.050	230.672	129.757	168.282	258.497	14.577	1030.944
1998	327.478	296.007	494.444	225.773	116.374	152.047	219.573	13.208	974.960
1999	284.340	270.414	474.712	209.978	107.910	140.248	219.608	12.002	855.927
2000	293.749	289.749	491.577	197.027	105.541	138.539	232.760	12.035	887.930
2001	301.603	274.198	509.134	189.922	86.183	120.670	210.297	10.169	817.412
2002	309.012	278.496	508.791	196.478	89.124	122.991	212.861	10.757	832.930
2003	314.440	292.781	587.568	199.816	105.013	143.278	257.987	12.090	892.249
2004	314.833	301.924	557.957	212.157	118.189	161.147	286.900	13.162	994.045
2005	330.930	324.568	602.518	214.610	120.841	159.056	297.863	14.216	1202.771
2006	328.533	325.794	647.538	215.789	116.104	155.366	272.182	13.842	1119.657
2007	309.071	304.378	515.735	216.298	114.580	157.608	293.773	13.824	1108.861
2008	303.005	321.603	522.195	213.021	133.671	172.418	316.595	15.586	1149.777
2009	255.808	278.401	442.904	204.842	126.409	162.550	270.267	14.751	1036.805
2010	241.681	267.564	355.602	186.504	129.779	166.832	286.572	15.025	1037.308
2011	250.501	258.709	326.008	187.185	119.558	158.149	284.117	13.893	988.670
2012	246.308	258.937	260.971	182.990	122.519	163.241	283.301	14.458	973.684
2013	226.540	250.708	210.090	184.766	114.990	153.216	256.273	13.557	953.009
2014	222.085	245.334	183.222	186.094	115.057	153.467	258.227	13.431	956.265

Year/Pollutant	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2015	220.368	238.913	157.703	189.939	110.092	147.510	235.398	13.131	870.251
2016	211.482	236.799	108.741	184.863	110.165	144.830	217.328	13.318	884.881
2017	219.936	239.961	88.604	181.634	111.177	143.659	206.849	13.561	891.612
2018	222.127	235.934	84.321	181.588	110.703	147.149	223.869	13.347	890.639
2019	217.494	229.583	99.051	178.249	112.030	153.075	233.236	13.298	893.612

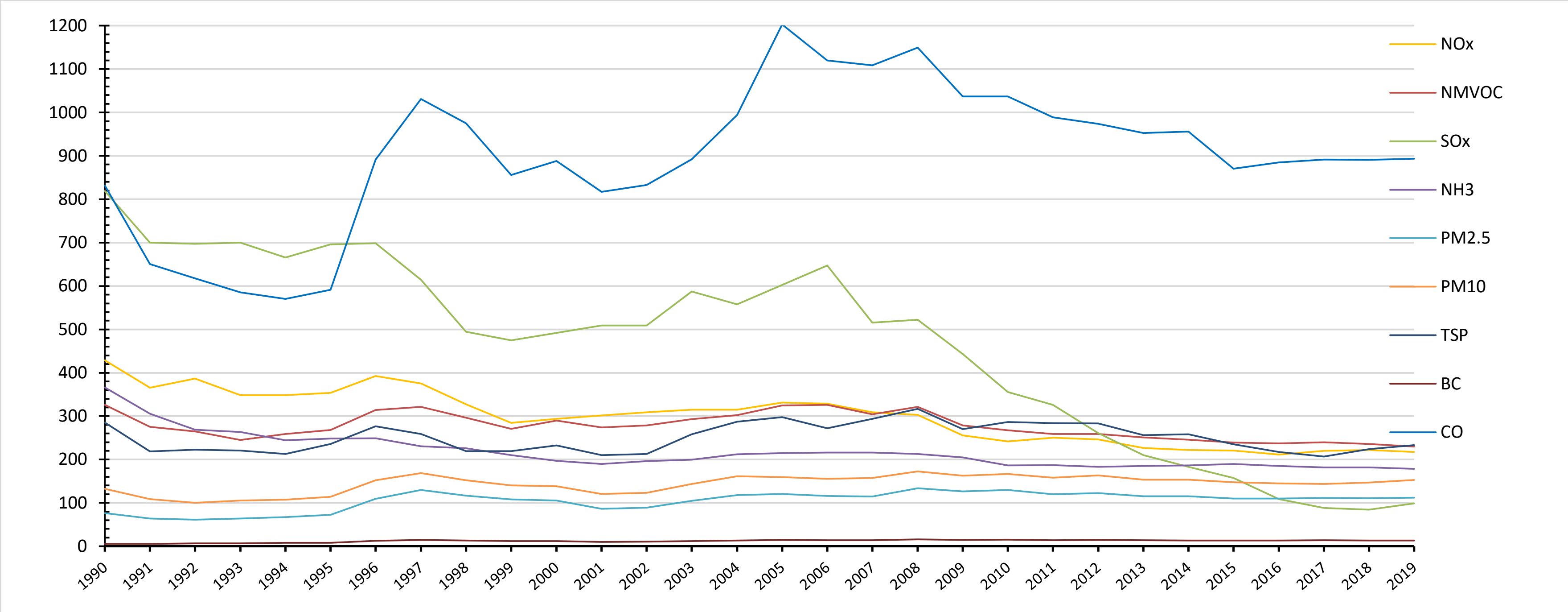


Figure 2.1.1. Total Emission trends (kt) for Main Pollutants, Particulate Matter, BC and CO

The chart shows the total emission trend for main pollutants, particulate matter, BC and CO between 1990-2019.

First of all, the most important variation can be noticed for SOx, starting from 819kt/year in 1990 ending with less than 99kt/year in 2019.

Since 2009, 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 49% in 2019, compared to 1990 and with 34% in 2019, 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 29% in 2019 compared to 2005, from 324kt in 2005 to 229kt in 2019. In the period 1990-2019, the NMVOC emissions did not have strong variations.

NH_3 emission have gone down slightly from 214.6kt in 2005 to 178.2kt in 2019. 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 112kt in 2019. Compared to 2005, in 2019 $PM_{2.5}$ emission decreased by almost 7%.

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	728.173	5.024	4.187	72.571	25.139	9.430	113.017	19.617	124.631
1991	458.891	4.024	3.258	46.413	18.913	7.779	87.744	16.266	98.402
1992	323.302	3.483	2.524	33.967	15.458	9.743	70.435	16.648	81.234
1993	341.126	3.617	2.431	36.133	15.756	8.557	72.528	16.430	84.982
1994	359.253	3.699	2.490	37.521	16.744	8.061	63.773	15.187	89.072
1995	355.546	3.909	2.743	36.864	19.063	8.527	63.960	15.684	98.482
1996	343.955	4.618	2.609	35.919	19.656	10.136	69.594	15.983	122.921
1997	348.356	4.792	2.308	35.241	21.731	9.676	75.038	13.241	143.290
1998	265.112	4.113	2.027	26.403	20.087	8.344	54.582	10.478	125.392
1999	144.093	3.653	1.766	15.256	15.115	7.027	45.215	10.594	105.748
2000	50.015	3.377	2.555	5.776	14.735	6.799	34.522	11.716	103.273
2001	51.130	3.027	2.591	5.953	14.599	6.251	42.096	11.348	94.080
2002	57.740	3.039	2.607	6.300	16.873	6.585	33.660	11.679	98.849
2003	62.352	3.433	3.103	6.962	17.902	6.465	31.583	13.851	112.621
2004	65.862	3.551	3.232	6.733	18.399	6.757	27.095	13.126	119.060
2005	67.989	3.655	3.243	6.435	18.603	19.698	24.543	12.369	125.159
2006	67.239	3.670	3.396	7.000	18.405	20.145	22.826	14.299	122.023
2007	65.306	3.664	3.149	6.922	18.464	20.397	19.088	14.455	121.640
2008	57.362	3.855	3.022	6.564	16.656	21.701	16.918	14.933	128.680
2009	36.689	3.384	2.121	5.140	11.969	20.320	14.692	12.689	113.313
2010	43.574	3.571	2.177	4.985	12.500	20.000	14.322	11.821	120.820
2011	43.782	3.501	2.583	5.732	12.318	20.460	15.832	14.312	111.531
2012	40.554	3.453	1.948	5.246	11.845	21.560	14.104	13.110	113.653
2013	37.452	3.166	1.584	4.304	11.391	20.839	12.550	9.989	107.829
2014	38.203	3.151	1.597	4.289	11.394	20.995	11.304	10.116	107.780
2015	40.345	3.011	1.529	4.471	12.088	21.060	10.012	10.362	107.189
2016	39.384	3.048	1.463	4.107	11.877	22.294	8.460	9.184	108.442
2017	39.408	3.100	1.475	4.093	11.637	23.446	10.456	9.257	109.284
2018	40.717	3.074	1.489	4.116	11.959	24.418	9.862	9.101	108.730
2019	40.796	3.008	1.446	3.944	12.200	25.528	10.181	8.438	109.572

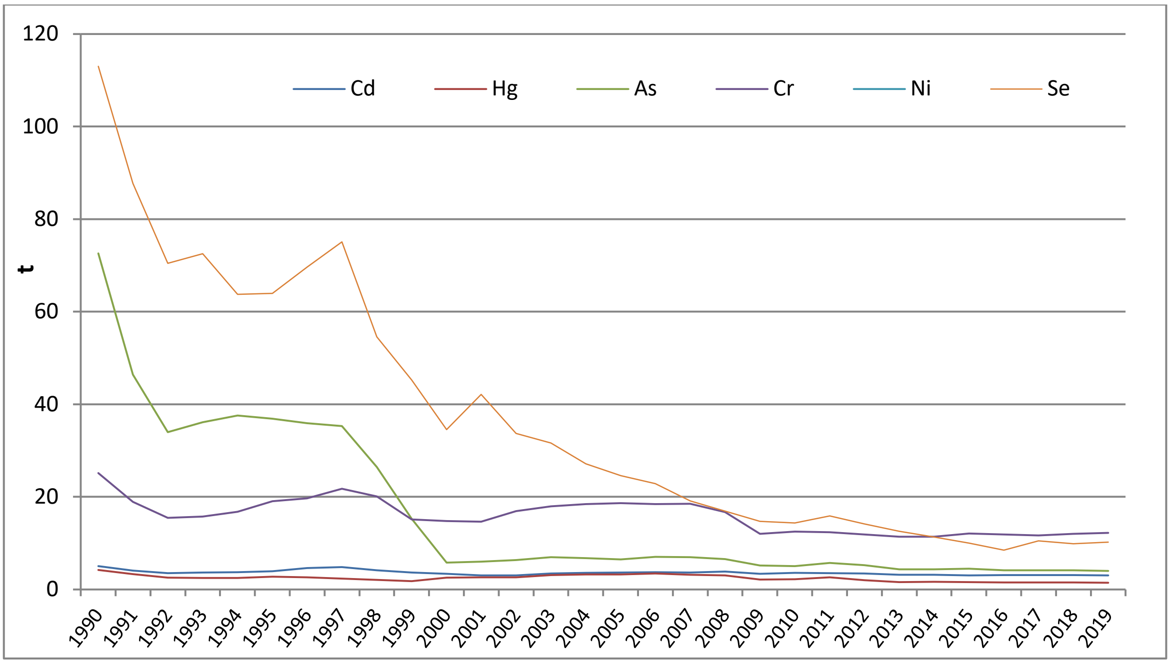


Figure 2.2.1.a Total Emission trends (t) for Cd, Hg, As, Cr, Ni and Se

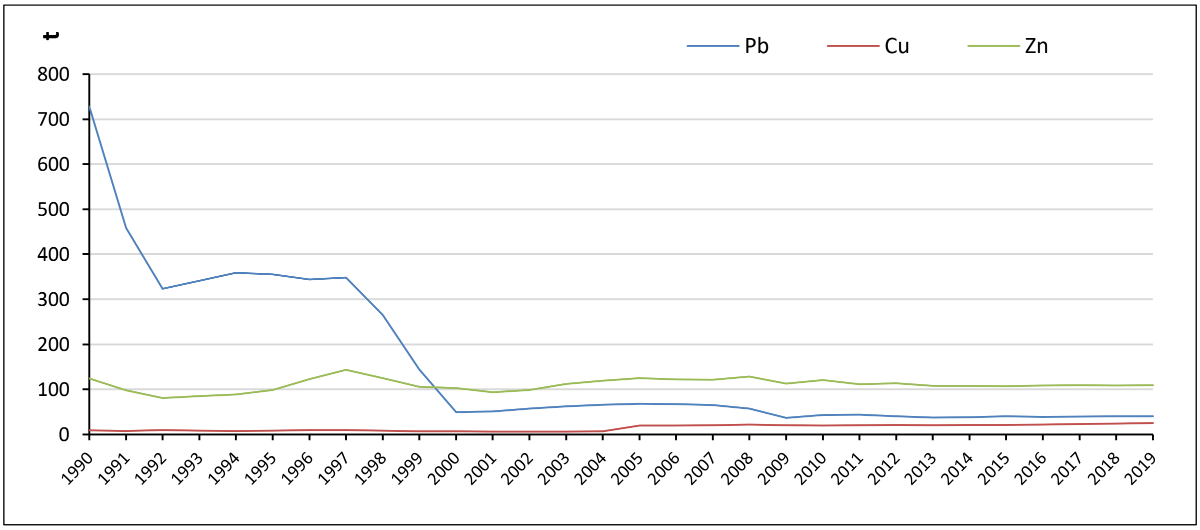


Figure 2.2.1.b Total Emission trends (t) for Pb, Cu and Zn

The graphs describes the total emission trends for heavy metals over the period 1990-2019.

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

Se, 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 Se 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	183.812	76.701	2.842	61.689
1991	137.037	54.562	2.571	45.431
1992	118.583	43.917	2.697	34.249
1993	119.894	40.574	2.795	30.897
1994	125.044	39.429	2.790	32.143
1995	144.002	45.513	2.923	38.638
1996	180.824	63.085	3.144	35.899
1997	211.610	75.376	3.004	39.789
1998	197.510	66.800	2.699	37.546
1999	189.416	56.601	3.283	26.003
2000	203.032	56.380	3.875	28.115
2001	193.495	45.802	4.174	29.459
2002	197.877	49.916	4.086	34.175
2003	221.683	57.820	4.675	37.050
2004	241.568	66.109	4.508	38.970
2005	251.853	65.858	4.179	38.732
2006	216.096	62.932	4.201	37.905
2007	202.089	62.546	3.952	35.972
2008	208.496	70.865	3.730	30.300
2009	170.306	61.236	3.179	17.421
2010	187.713	64.203	3.190	20.987
2011	179.136	58.233	3.433	20.193
2012	183.081	59.738	3.347	18.588
2013	166.284	56.811	2.859	17.618
2014	170.797	58.442	2.916	18.126
2015	168.068	58.022	3.008	20.378
2016	169.978	57.606	2.938	19.937
2017	178.898	57.009	3.100	18.775
2018	180.440	57.344	3.118	19.900
2019	186.088	58.126	3.102	20.021

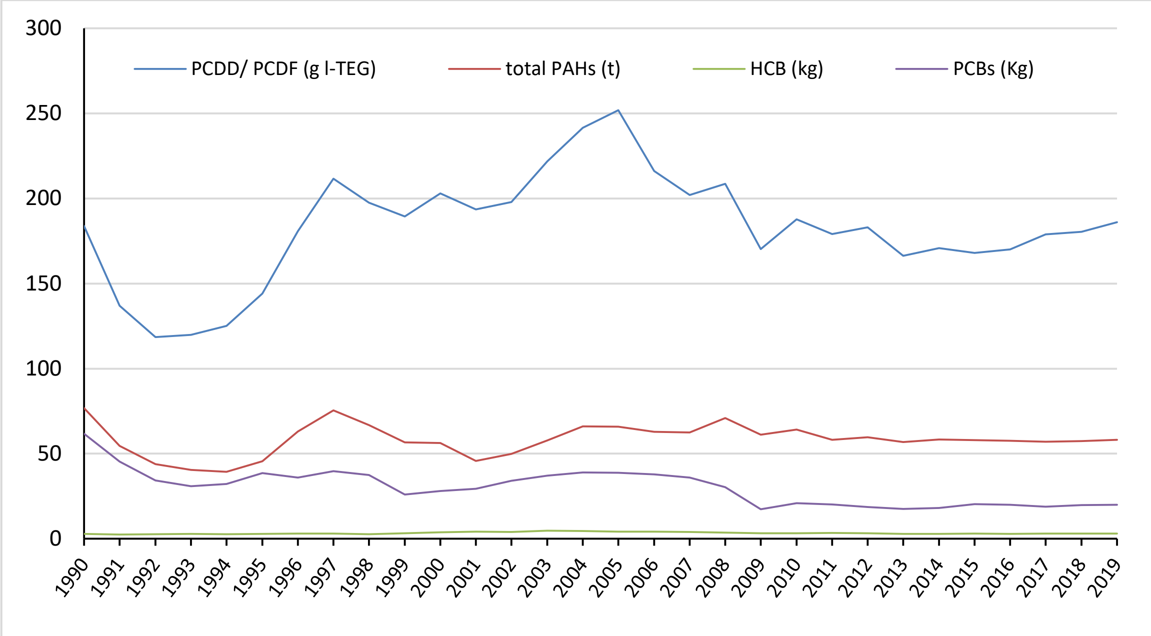


Figure 2.3.1 Total Emission trends for Dioxines (g I-TEQ), total PAHs (t), HCB and PCBs (kg)

The graph provides the total emission trend for POP's between 1990-2019.

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 26% in 2019 compared with 2005.

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 2019 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 the energy industry (NFR 1.A.1) and in the 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 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 in this chapter.

Following the Emission Inventory reviews in 2017-2020, 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) - 2017-2019, 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* • 2017-2019, 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)* • 2016-2019: 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;* • 2017-2019: EUROSTAT ENERGY Questionnaires, National Institute of Statistics
1.A.2.b Non-ferrous Metals	IE – included in NFR 1.A.2.a
1.A.2.c Chemicals	• 1990-2016: EUROSTAT complete energy balances, annual data (nrg_110a): *Final energy consumption/Industry/Chemical and Petrochemical;* • 2017-2019: 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; • 2017-2019: 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;* • 2017-2019: 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;* • 2017-2019: 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; • 2017-2019: 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; • 2017-2019: EUROSTAT ENERGY Questionnaires, National Institute of Statistics;

NFR	Activity data source
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; 2017-2019: 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; 2017-2019: 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;* 2017-2019: 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;* 2017-2019: 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; 2017-2019: 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);* 2017-2019: 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, are shown in the table 3.2.1 and figure 3.2.1:

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

Pollutant	1A1a	National Total	Unit	% 1A1a in national total
NOx	32.15	217.49	kt	14.78
NMVOC	0.64	229.58	kt	0.28
SOx	52.25	99.05	kt	52.75
$PM_{2.5}$	1.71	178.25	kt	1.53
PM_{10}	2.65	112.03	kt	1.73
TSP	3.43	153.08	kt	1.47
BC	0.05	233.24	kt	0.35
CO	7.27	13.30	kt	0.81
Pb	2.72	893.61	t	6.66
Cd	0.32	40.80	t	10.77
Hg	0.52	3.01	t	35.72
As	2.53	1.45	t	64.04
Cr	1.62	3.94	t	13.29
Cu	0.36	12.20	t	1.41
Ni	3.06	25.53	t	30.09
Se	7.63	10.18	t	90.38
Zn	3.34	8.44	t	3.05
PCDD/PCDF	2.16	109.57	g I-TEQ	1.16
Total PAH	0.01	186.09	t	0.05
HCB	0.01	58.13	kg	0.04
PCBs	0.01	3.10	kg	0.08

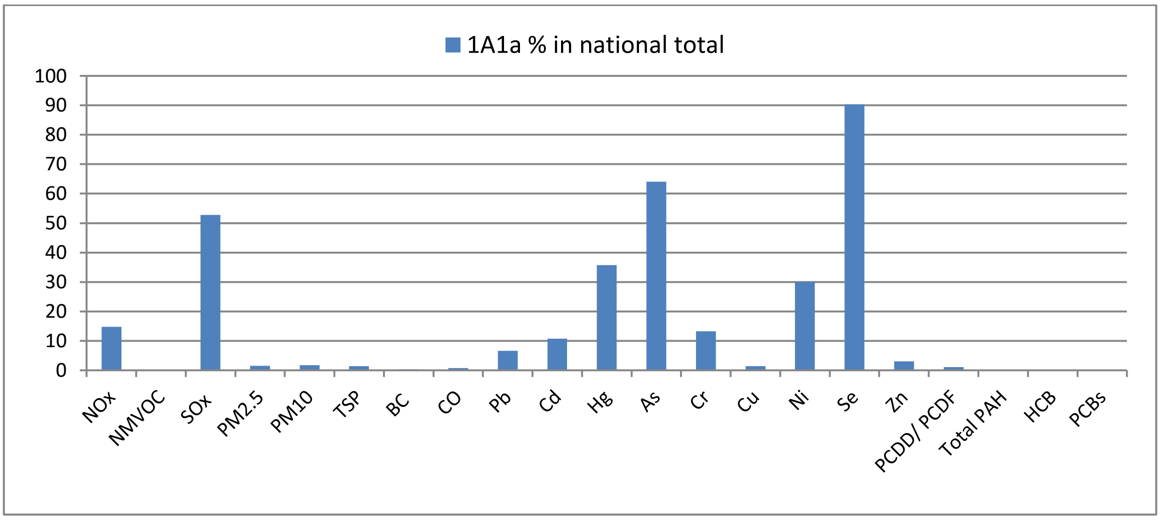


Figure 3.2.1 Share of 1A1a emissions by pollutant in the national total in 2019

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 1990-2019 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 2005-2019 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 40 g/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 a. the discrepancy between the measured values of TSP and the Guidebook estimation was too high (the measured values much higher than estimated ones) and b. only TSP is currently largely monitored at stack. Therefore, the following method was used:
1st step: for the years where measured TSP values were available (2005-2019), the emissions of TSP, PM_{10}, $PM_{2.5}$ 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 PM_{10}/TSP,

$PM_{2.5}$/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, which were determined based on Tier1 estimation. 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.

Table 3.2.1. Emissions 1990-2019 NFR 1.A.1.a. NOx, SOx, Particulate Matter, Black Carbon and CO

Year/Pollutant (kt)	NOx	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	146.59	646.90	16.26	33.15	47.83	0.48	21.32
1991	128.62	561.55	14.09	28.72	41.44	0.41	19.76
1992	148.51	589.74	15.21	31.01	44.75	0.45	27.75
1993	149.49	619.81	15.97	32.56	46.98	0.47	25.97
1994	125.65	582.34	14.62	29.80	43.00	0.43	18.24
1995	126.97	599.84	15.05	30.68	44.28	0.44	17.75
1996	130.09	601.00	15.10	30.78	44.42	0.44	18.77
1997	107.99	504.96	12.64	25.76	37.18	0.37	14.64
1998	90.76	400.70	10.03	20.43	29.49	0.29	14.24
1999	86.20	405.94	10.11	20.61	29.74	0.30	12.05
2000	87.41	427.71	10.64	21.69	31.30	0.31	11.57
2001	88.89	442.86	11.01	22.45	32.39	0.32	10.85
2002	86.14	438.00	11.03	22.48	32.45	0.32	10.67
2003	98.51	508.79	12.58	25.64	37.00	0.37	11.84
2004	90.02	473.54	11.80	24.04	34.70	0.35	10.77
2005	99.24	518.81	12.08	21.63	31.00	0.40	9.67
2006	105.17	565.52	11.54	21.47	30.77	0.35	10.54
2007	87.69	445.80	8.37	15.03	21.62	0.29	10.06
2008	86.52	453.33	6.86	14.40	20.83	0.14	9.31
2009	65.56	396.06	5.74	11.53	16.63	0.14	7.69
2010	56.47	302.13	4.87	9.89	14.14	0.10	7.63
2011	61.04	275.42	5.74	11.74	16.80	0.12	8.48
2012	56.51	214.31	4.57	9.15	13.02	0.09	8.06
2013	45.42	163.53	3.80	7.74	11.00	0.07	7.01
2014	44.29	138.35	3.48	6.60	9.17	0.07	6.90
2015	42.40	109.62	2.90	5.07	6.87	0.07	7.46
2016	32.43	61.27	2.44	3.97	5.22	0.06	7.35
2017	33.48	45.91	2.01	3.19	4.18	0.05	8.14
2018	35.67	39.31	1.79	2.84	3.71	0.05	8.19
2019	32.15	52.25	1.71	2.65	3.43	0.05	7.27

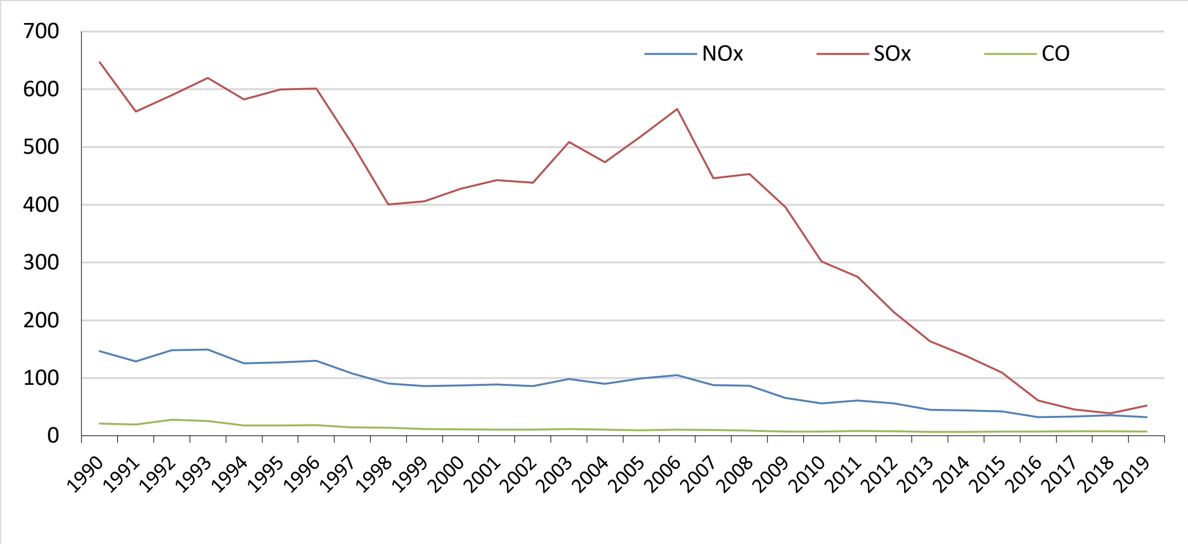


Figure 3.2.1.a Emission Trends (kt) for NFR 1.A.1.a. for NOx, SOx and CO

Compared to 1990 emissions, there was a significant decrease of emissions in the public power sector. For main pollutants, decreases are as high as 78% for NOx, 92% for SOx and 92% for PM_{10}. Compared to 2005, the emissions decreased with 67% for NOx, 90% 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.

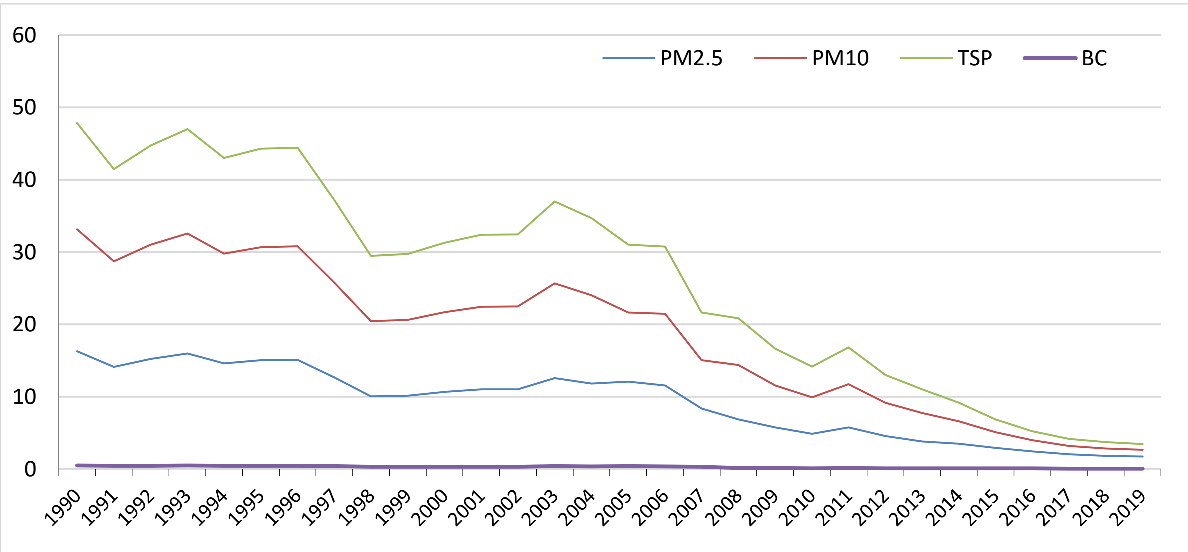


Figure 3.2.1.b. Emission Trends (kt) for NFR 1.A.1.a. for TSP, PM_{10}, $PM_{2.5}$ and BC

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

Table 3.2.2. Emissions 1990-2019 NFR 1.A.1.a. 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
2019	2.719	0.324	0.516	2.526	1.621	0.360	3.063	7.627	3.344

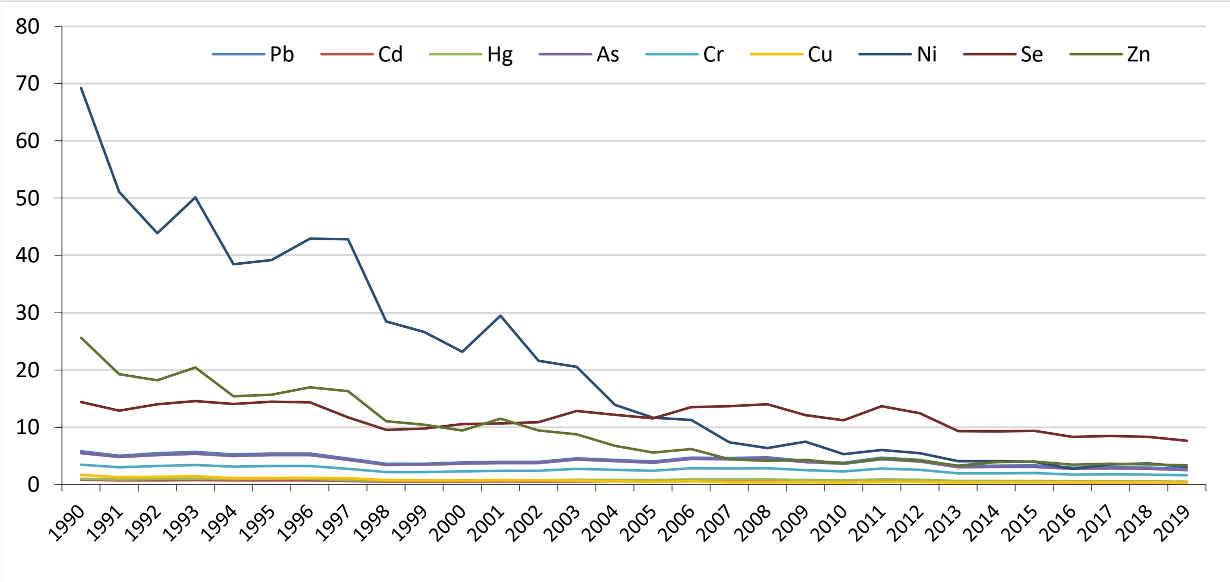


Figure 3.2.2. Emission Trends (t) for NFR 1.A.1.a. for Heavy Metals

Compared to the first year of the estimation, emissions of heavy metals in 2019 decreased between 47% (Se) and 95% (Ni). The highest decrease took place before 2007; in the last years (2014-2019), the trend of emissions of heavy metals is steady.

The table and chart below give the fuel consumption values and trend for 1990-2019.

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
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
2019	5152	169011	128806	7759

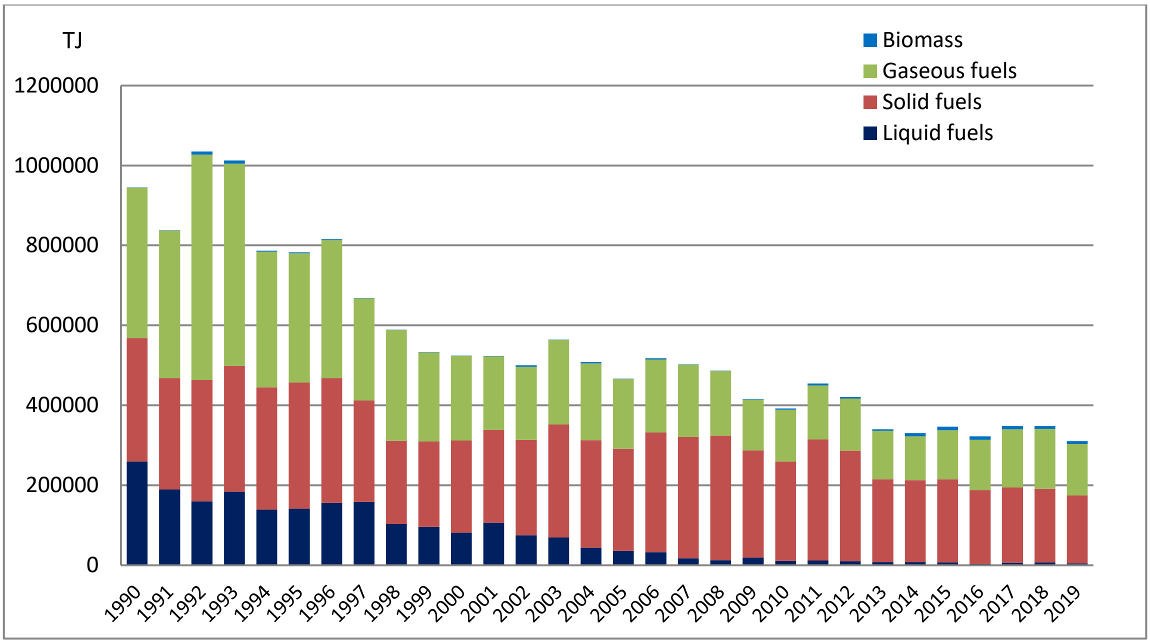


Figure 3.2.3 Fuel consumption [TJ], by fuel type, for NFR 1.A.1.a.

The general decrease in emissions are consistent with the decrease of fuel consumption and technology improvement in power plants. In the last years, the fuel consumption in the energy sector as well as emissions levels were nearly 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 1990-2019 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.

Tables and charts below show the emissions trend and fuel consumption for the category NFR 1.A.1.b., years 1990-2019.

Table 3.3.1. Emissions for NFR 1.A.1.b, 1990-2019

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

Year/Pollutant	NOx (kt)	NMVOC (kt)	SOx (kt)	PM_{10} (kt)	CO (kt)	Ni (t)
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	0.011
2019	2.146	0.061	0.221	0.031	0.920	0.110

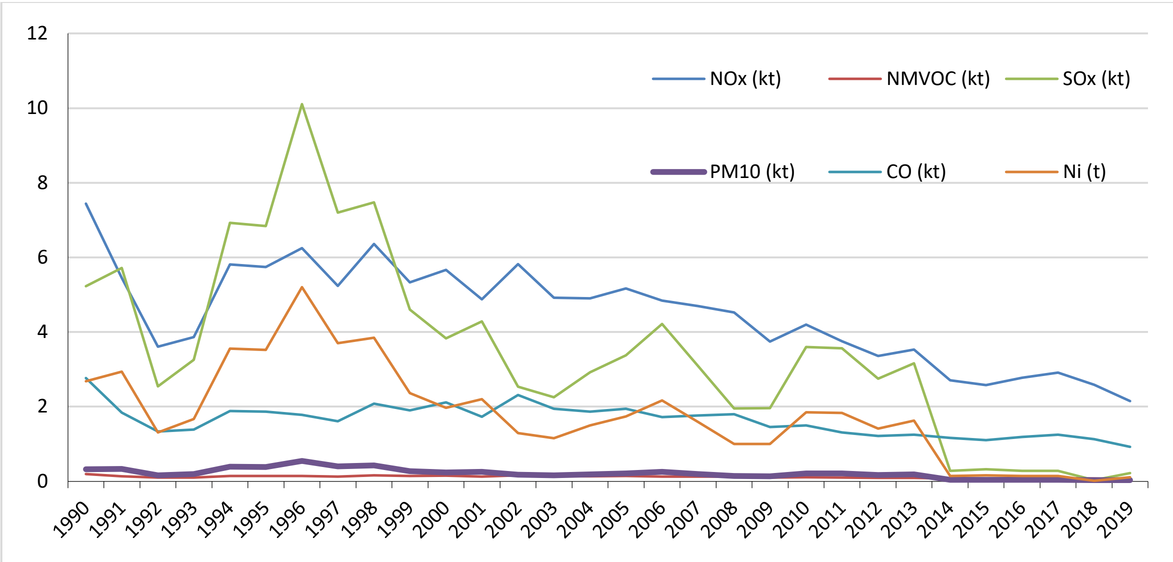


Figure 3.3.1. Emissions for NFR 1.A.1.b, 1990-2019

Emissions trends are consistent with the fuel consumption variation along the time series 1990-2019. 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. The strong decrease of liquid fuel in 2014 relates to the sharp decrease of certain emissions in 2014 compared to previous years.

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

Year/Fuel type (TJ)	Liquid fuels	Gaseous fuels	Biomass
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
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
2019	434.3	23420	1.0

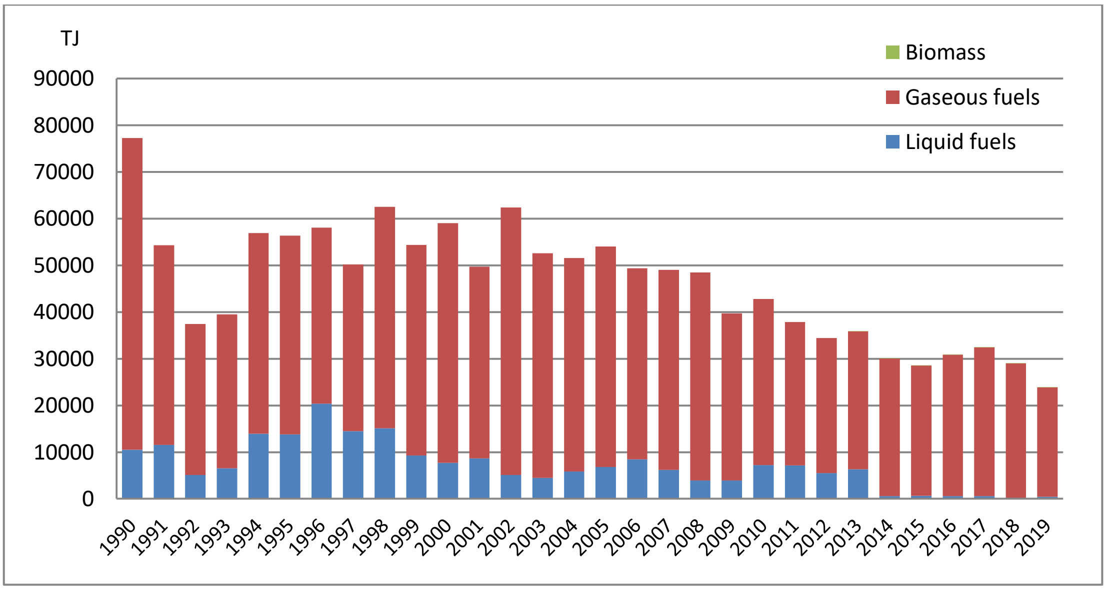


Figure 3.3.2. Fuel consumption [TJ] trends, by fuel type, for NFR 1.A.1.b

3.1 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 1990-2019 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 2017-2019 was provided by the N.I.S via Eurostat Energy questionnaires. Before 2018 submission, 1A1c category included only coke ovens emissions. Starting with 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.

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

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

Year/Pollutant (kt)	NOx	NMVOC	SOx	CO	$PM_{2.5}$	PM_{10}	TSP
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
2019	3.532	0.361	0.929	1.122	0.183	0.203	0.203

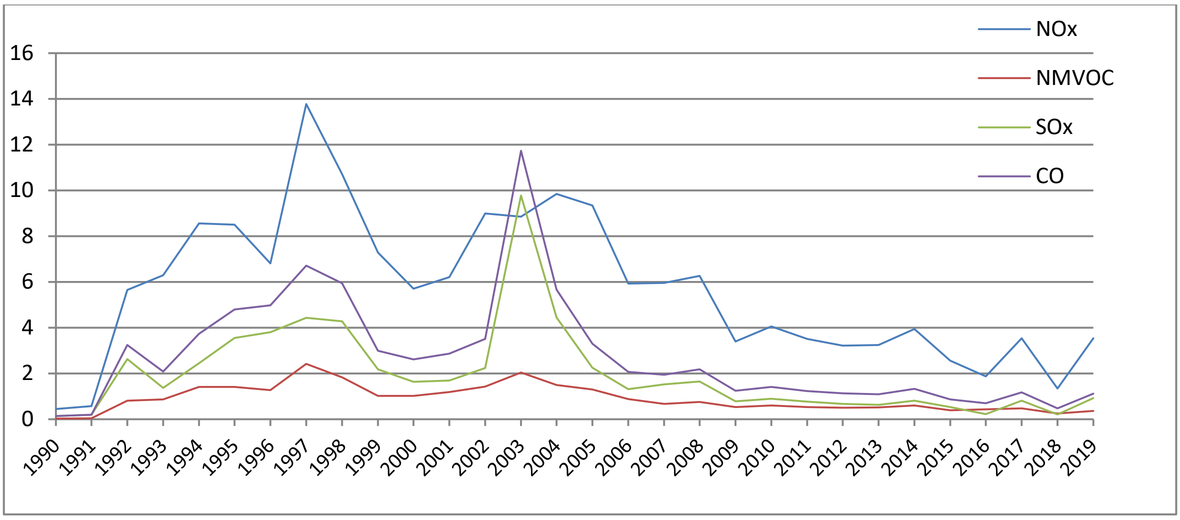


Figure 3.4.1a Emissions (kt) of NOx, NMVOC, SOx and CO for NFR 1.A.1.c.

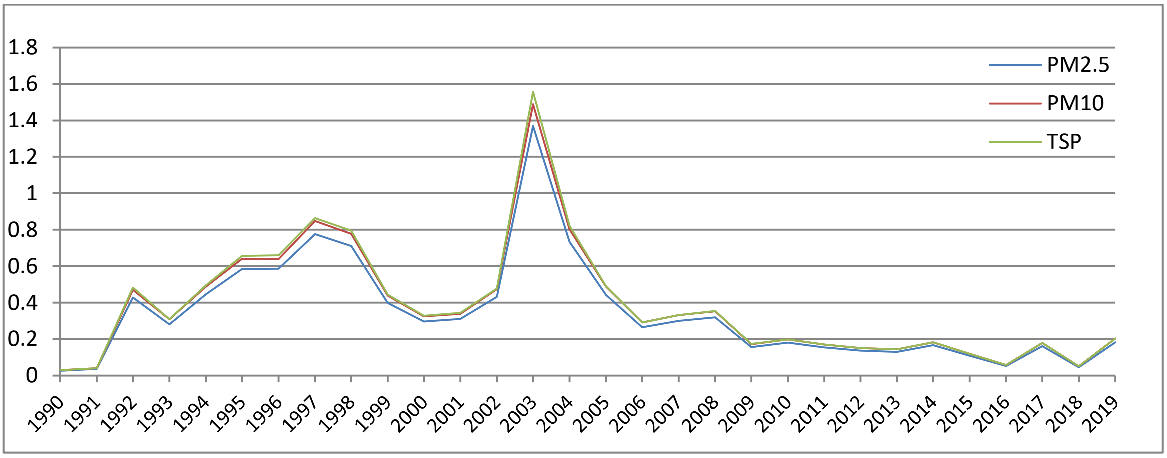


Figure 3.4.1b Emissions (kt) of TSP, PM_{10}, $PM_{2.5}$ for NFR 1.A.1.c.

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

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
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	2138	1.6	9281	0.5
2019	9830	0.34	7079	3.9

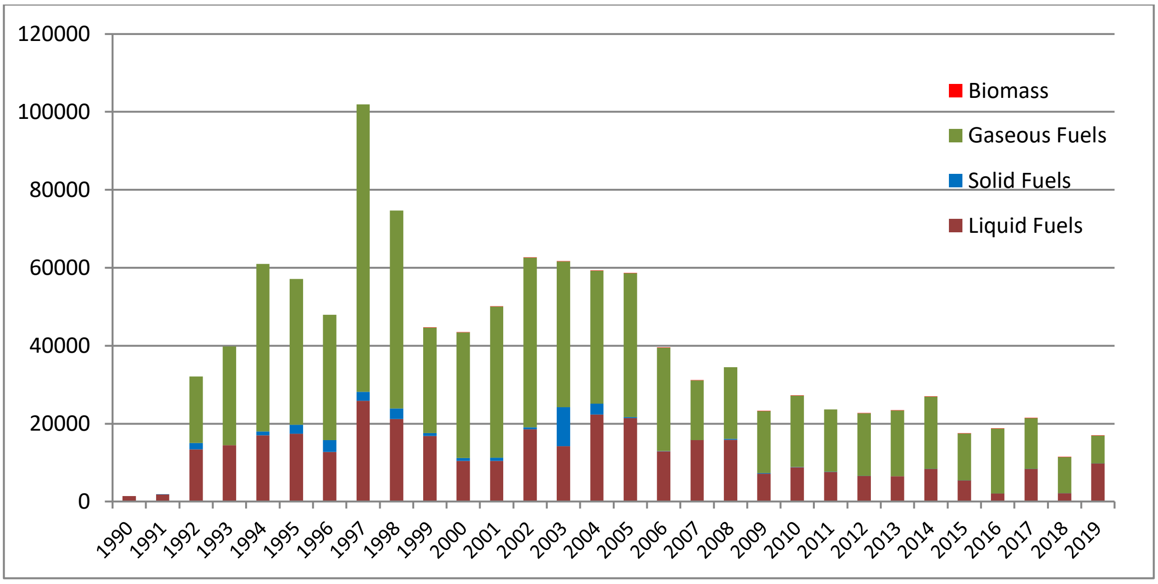


Figure 3.4.2 Fuel consumption [TJ], by fuel type, for NFR 1.A.1.c, 1990-2019

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 2019, key sources from NFR 1A2 sector, combustion in industry, are:

- NFR 1A2a - Iron and steel industry, for SOx (19.33%), Pb (6.98%) and Hg (12.6%), PCBs (18.04%);
- NFR 1A2f - Non-metallic minerals, for NOx (4.38%);
- NFR 1A2gviii-Other,for Zn (3.91%).

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	27.194	217.494	kt	12.503
NMVOC	9.863	229.583	kt	4.296
SOx	29.776	99.051	kt	30.061
NH_3	0.014	178.247	kt	0.008
$PM_{2.5}$	5.425	112.030	kt	4.842

Pollutant	1A2	National Total	Unit	1A2 in national total %
PM_{10}	5.743	153.075	kt	3.752
TSP	6.037	233.236	kt	2.588
BC	0.909	13.298	kt	6.837
CO	50.850	893.612	kt	5.690
Pb	4.572	40.796	t	11.207
Cd	0.189	3.008	t	6.285
Hg	0.331	1.446	t	22.862
As	0.144	3.944	t	3.642
Cr	0.680	12.200	t	5.577
Cu	1.174	25.528	t	4.600
Ni	0.462	10.181	t	4.535
Se	0.075	8.438	t	0.889
Zn	12.286	109.572	t	11.213
PCDD/PCDF	7.591	186.088	g I-TEQ	4.079
Total PAH	5.364	58.126	t	9.229
HCB	0.069	3.102	kg	2.227
PCBs	5.461	20.021	kg	27.278

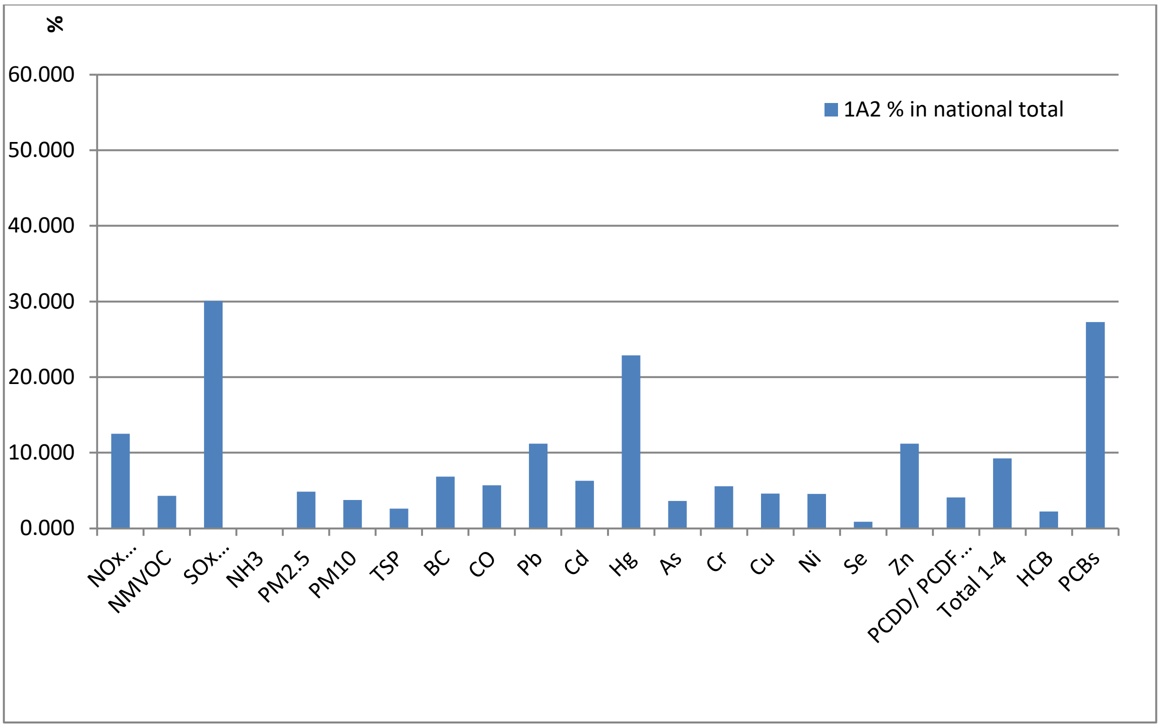


Figure 3.5.1 Share of 1A2 emissions by pollutant in the national total (%) 2019

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, 2019

NFR	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
1A2a	0.1	21250.2	26458.2	0.1
1A2c	466.1	1719.9	44405.5	154.4
1A2d	0.0	142.6	3933.1	86.8
1A2e	5.9	277.6	14823.5	1177.9
1A2f	13597.0	8694.3	13878.5	100.7
1A2gvii	13631.2	-	-	-
1A2gviii	100.9	36.3	25349.6	8311.6

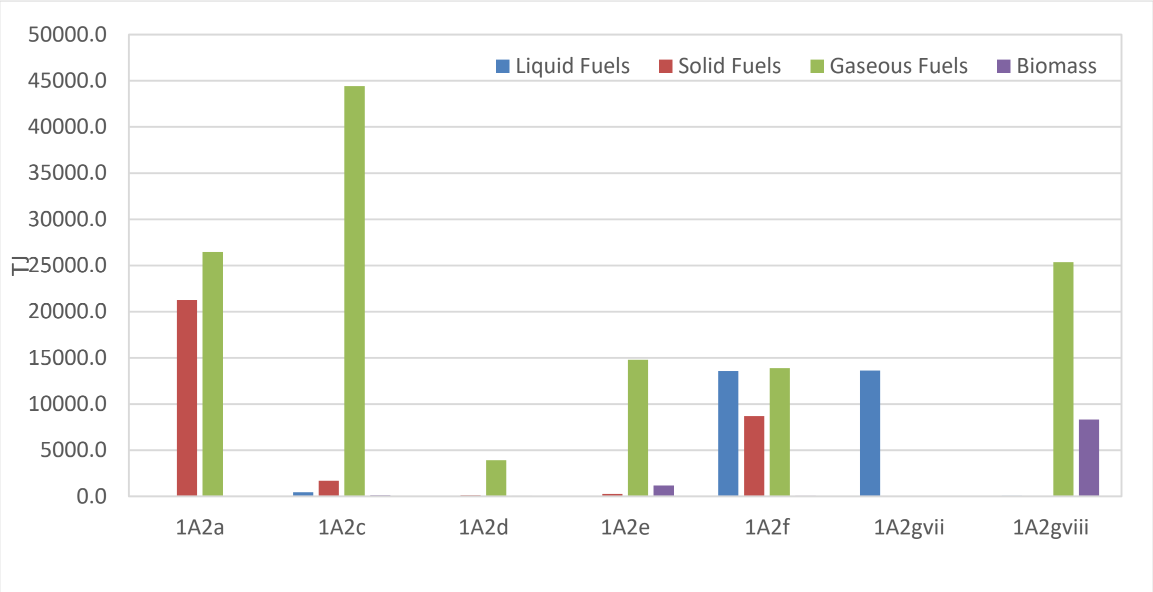


Figure 3.5.2 NFR 1A2 - Fuel consumption [TJ] by fuel type and subcategory, 2019

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

Year/Fuel type (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
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
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
2019	27801	32121	128848	9831

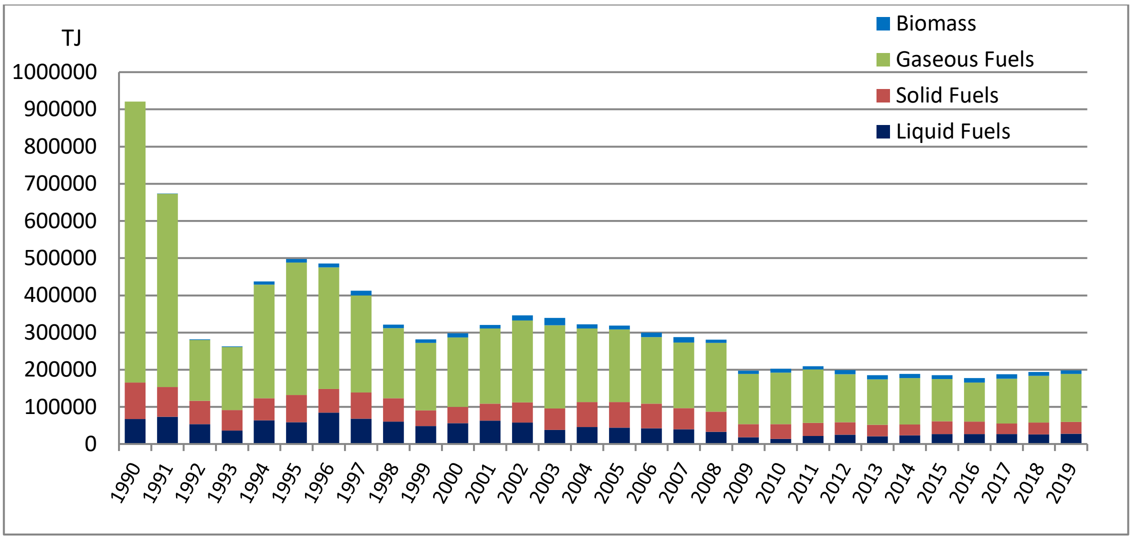


Figure 3.5.3 Fuel consumption (TJ) in industry (NFR 1A2), by fuel type 1990-2019

Total fuel consumption in industry decreased from 1990 to 2019 with about 78,4% (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 2019, 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, 1990-2019 (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

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
1992	15.853	4.305	0.175	1.090	7.762	18.890	7.452
1993	17.396	5.742	0.106	1.238	6.257	8.910	3.884
1994	19.457	13.267	1.175	4.700	6.220	17.144	9.865
1995	20.988	15.192	2.013	5.514	6.976	14.117	9.866
1996	19.855	15.069	2.019	5.384	8.039	27.215	10.120
1997	20.098	11.539	1.611	4.602	6.597	19.030	9.827
1998	19.449	5.822	1.628	1.653	7.021	17.939	7.812
1999	14.651	5.670	1.395	2.313	5.691	13.504	8.747
2000	14.396	8.778	1.247	2.148	10.238	16.398	4.839
2001	12.987	12.087	1.314	2.189	11.966	19.199	4.439
2002	13.872	10.431	1.372	1.707	11.481	19.968	4.731
2003	14.280	9.758	1.765	1.685	6.873	14.799	4.337
2004	16.812	7.641	1.058	1.833	10.408	12.441	4.904
2005	18.296	7.653	0.907	2.452	8.466	12.896	3.028
2006	18.826	6.987	0.739	1.657	6.145	12.913	4.046
2007	12.762	6.025	0.852	1.535	5.372	18.365	4.188
2008	11.116	7.024	0.238	1.445	5.900	12.124	5.211
2009	7.081	5.801	0.178	1.338	3.885	6.499	2.426
2010	7.354	5.560	0.347	1.475	2.721	5.662	2.702
2011	6.933	6.082	0.091	1.600	4.795	6.552	2.868
2012	5.542	5.256	0.127	1.787	7.265	6.882	2.596
2013	5.836	4.287	0.136	1.218	6.107	5.731	2.632
2014	5.749	4.131	0.170	1.235	7.410	5.297	2.586
2015	6.600	3.417	0.216	1.177	8.399	5.697	2.367
2016	6.470	2.670	0.239	1.294	8.590	5.012	2.472
2017	5.785	3.289	0.362	1.440	8.695	4.605	2.478
2018	5.660	3.471	0.242	1.144	9.270	4.236	2.591
2019	5.634	3.837	0.324	1.255	9.516	3.939	2.690

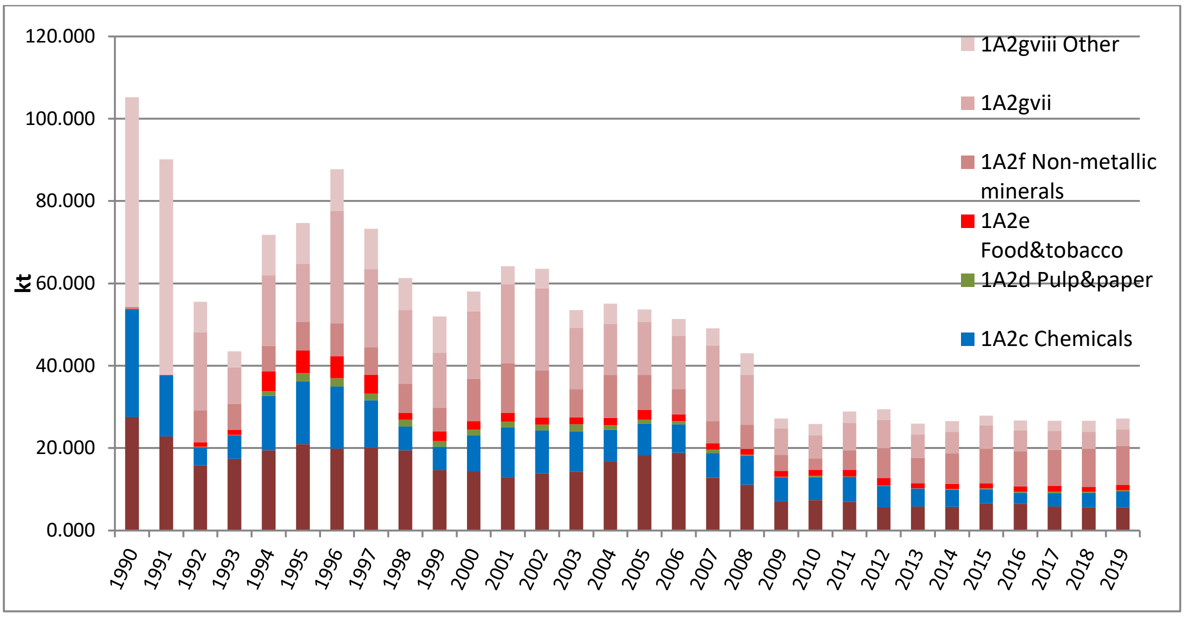


Figure 3.5.4 NOx emissions (kt) for 1A2 sector by NFR, 1990-2019

Table 3.5.5 NMVOC (kt) emissions for 1A2 sector by NFR, 1990-2019

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
1992	6.254	1.411	0.022	0.290	1.119	10.430	1.435
1993	6.170	1.279	0.006	0.310	0.909	3.708	1.175
1994	6.887	2.744	0.059	1.191	0.953	3.673	3.940
1995	7.929	4.103	0.937	1.339	1.007	1.841	3.184
1996	7.143	3.564	0.916	1.274	1.101	9.393	3.224
1997	7.805	2.345	0.942	1.008	1.000	6.524	4.017
1998	6.966	1.510	0.918	0.468	0.891	9.571	2.801
1999	4.733	1.406	0.854	0.628	0.800	5.976	3.157
2000	4.615	2.075	1.186	0.582	1.032	7.402	2.902
2001	4.442	2.675	1.091	0.623	1.254	6.267	2.557
2002	5.026	2.967	1.823	0.453	1.255	13.591	3.262
2003	5.448	3.167	3.029	0.537	0.799	6.948	3.728
2004	6.360	2.388	1.323	0.650	1.089	5.854	2.728
2005	6.626	2.300	1.304	0.817	1.113	7.913	2.190
2006	6.556	1.949	1.283	0.615	0.949	5.515	2.984
2007	5.541	1.944	1.085	0.615	0.945	4.966	3.685
2008	4.949	2.318	0.210	0.505	1.145	2.829	2.938
2009	2.882	1.943	0.161	0.676	1.145	2.041	2.274
2010	3.362	1.921	0.150	0.741	1.118	1.420	2.690
2011	3.141	2.083	0.054	0.687	1.075	1.065	2.282
2012	2.426	1.835	0.074	0.825	1.784	0.946	2.601
2013	2.531	1.540	0.065	0.698	1.744	0.933	2.665
2014	2.484	1.478	0.070	0.766	1.503	0.878	2.771
2015	2.882	1.259	0.091	0.742	1.473	0.986	2.630
2016	2.876	0.951	0.094	0.630	1.617	0.852	3.266
2017	2.497	1.106	0.157	0.794	1.683	0.825	3.027
2018	2.461	1.167	0.102	0.667	1.501	0.694	3.130
2019	2.496	1.232	0.129	0.719	1.461	0.744	3.082

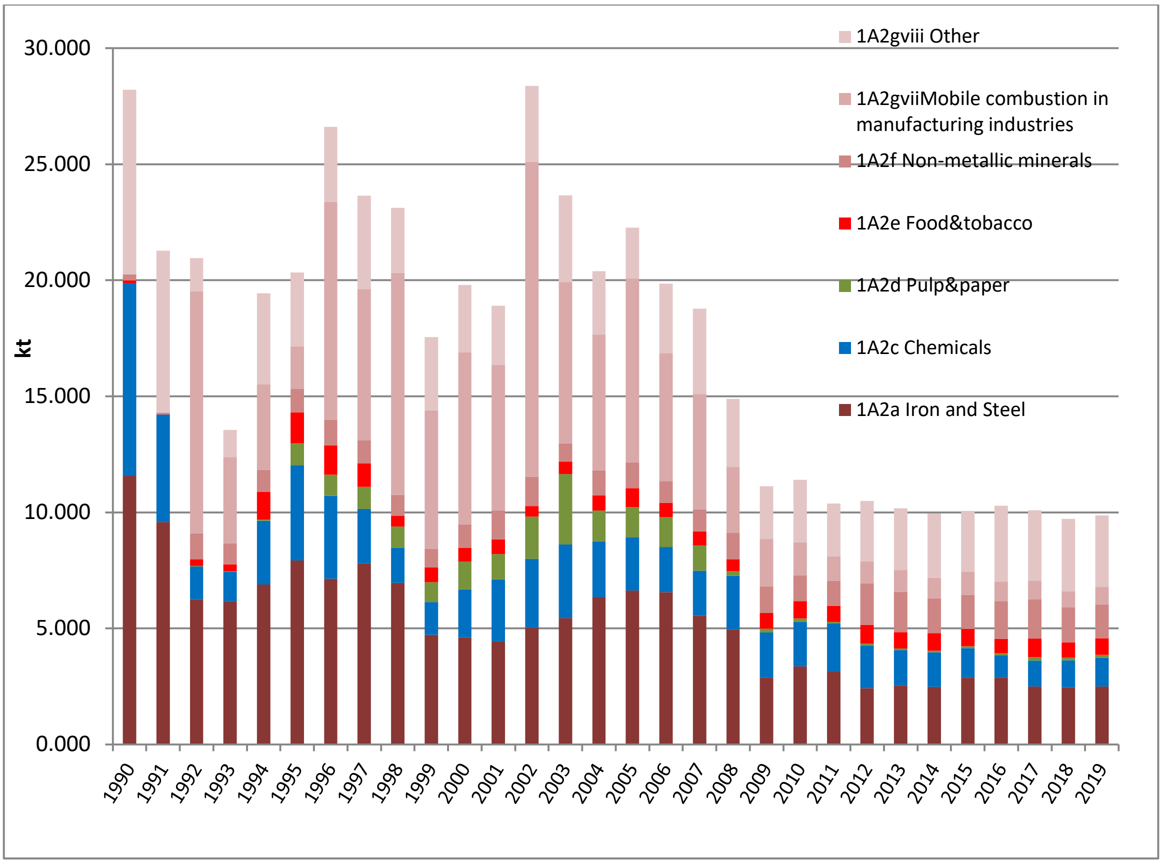


Figure 3.5.5 NMVOC emissions (kt) for 1A2 sector by NFR, 1990-2019

Table 3.5.6 $PM_{2.5}$ (kt) emissions for 1A2 sector by NFR, 1990-2019

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	1.332	0.504
1993	5.706	0.387	0.004	0.124	0.253	0.612	0.280
1994	6.271	0.332	0.046	0.293	0.228	1.131	1.414
1995	7.089	0.925	0.404	0.362	0.293	0.915	1.204
1996	6.139	0.920	0.388	0.347	0.380	1.843	1.210
1997	7.373	0.617	0.398	0.320	0.248	1.288	1.479
1998	6.392	0.620	0.405	0.139	0.301	1.260	1.060
1999	4.131	0.670	0.372	0.195	0.219	1.251	1.119
2000	4.052	0.912	0.519	0.186	0.423	1.444	1.043
2001	4.031	1.222	0.475	0.123	0.543	1.583	0.878
2002	4.762	1.230	0.807	0.113	0.442	1.672	1.243
2003	5.248	1.085	1.363	0.128	0.292	1.160	1.435
2004	6.250	0.994	0.586	0.178	0.530	0.944	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	0.891	1.047
2007	5.327	0.688	0.472	0.152	0.462	1.150	1.450
2008	4.847	0.747	0.072	0.101	0.757	0.726	1.010
2009	2.796	0.722	0.056	0.198	0.724	0.395	0.813
2010	3.354	0.727	0.025	0.248	0.599	0.346	1.014

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
2011	3.076	0.735	0.014	0.205	0.486	0.399	0.831
2012	2.219	0.724	0.019	0.317	1.231	0.414	0.999
2013	2.267	0.593	0.013	0.276	1.075	0.336	1.018
2014	2.174	0.532	0.011	0.289	0.987	0.300	1.063
2015	2.657	0.515	0.015	0.271	1.013	0.320	1.014
2016	2.761	0.268	0.015	0.217	1.112	0.277	1.324
2017	2.249	0.275	0.034	0.278	1.117	0.246	1.190
2018	2.195	0.305	0.026	0.198	1.210	0.219	1.227
2019	2.316	0.251	0.031	0.207	1.236	0.195	1.189

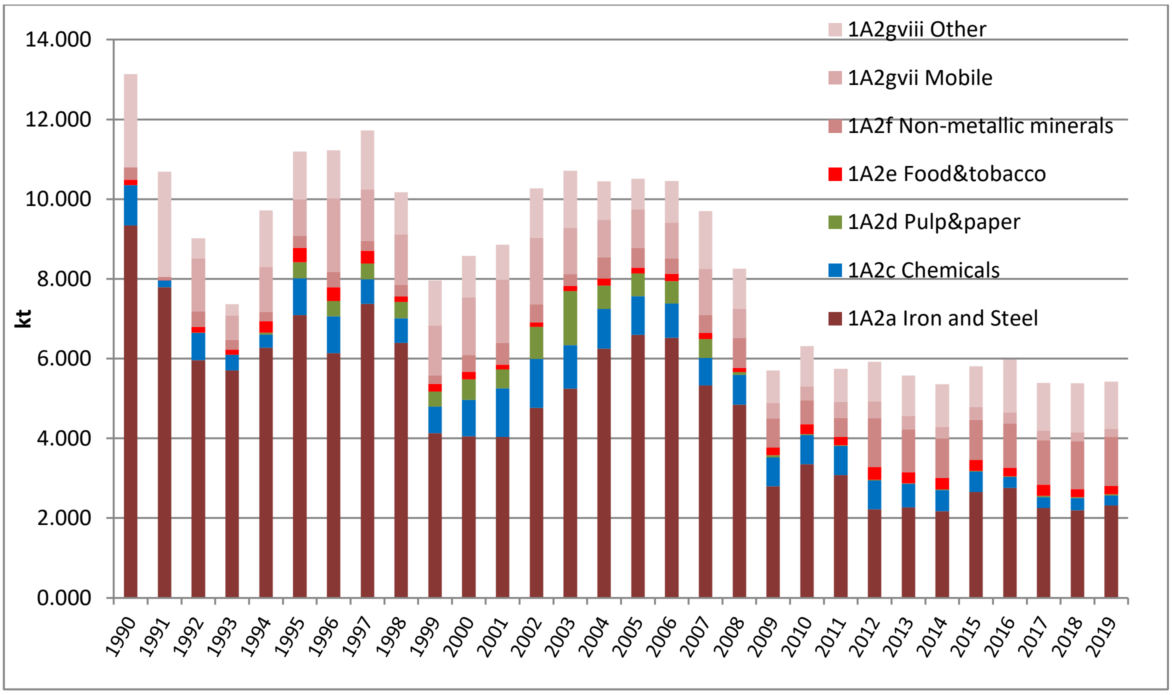


Figure 3.5.6 $PM_{2.5}$ emissions (kt) for 1A2 sector by NFR, 1990-2019

Table 3.5.7 SOx emissions for 1A2 sector by NFR, 1990-2019

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

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gvii	1A2gviii
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
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
2019	19.143	1.601	0.132	0.273	8.474	0.006	0.146

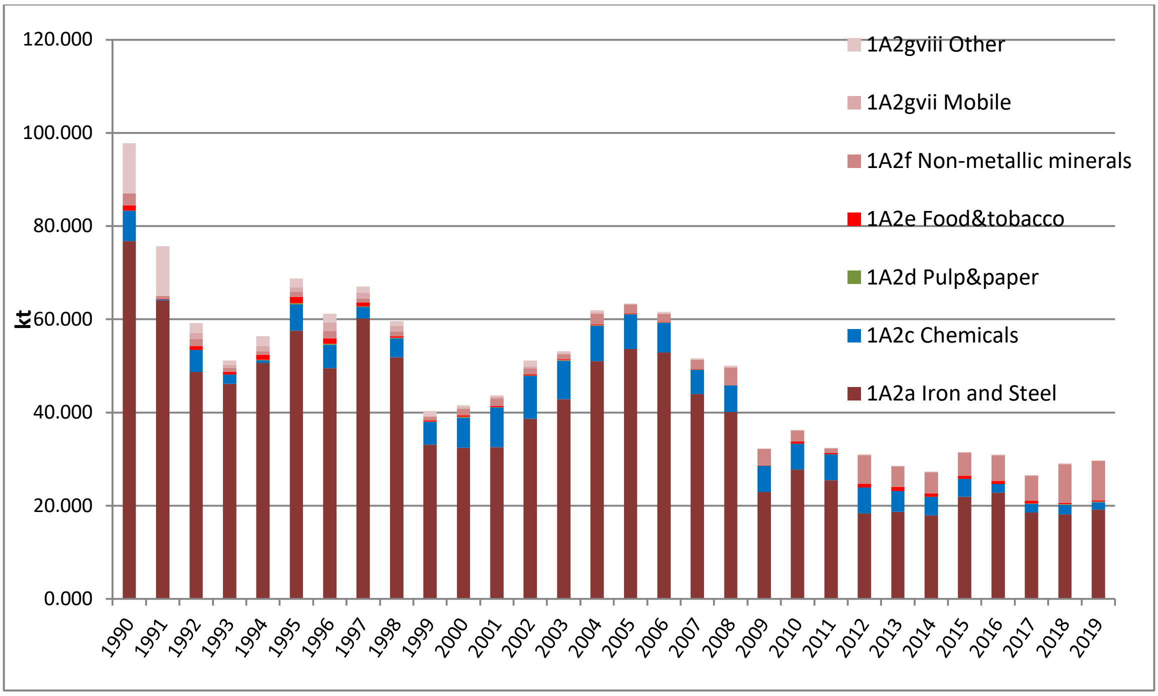


Figure 3.5.7 SOx emissions (kt) for 1A2 sector by NFR, 1990-2019

Table 3.5.8 Pb (t) emissions for 1A2 sector by NFR, 1990-2019

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

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
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
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
2019	2.848	0.235	0.021	0.069	1.169	0.230

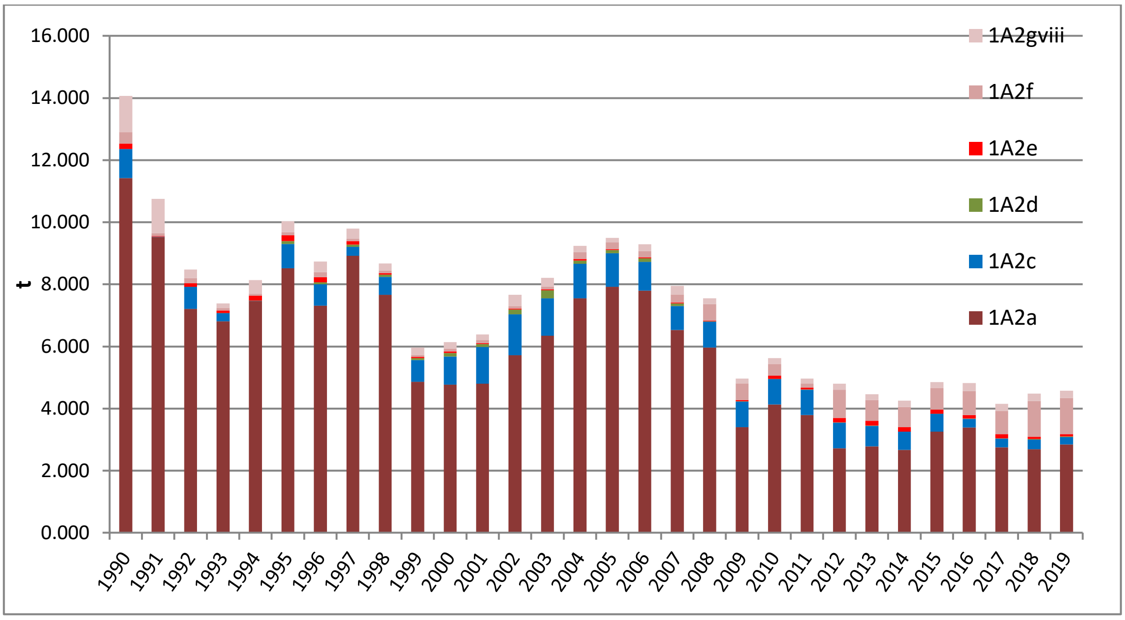


Figure 3.5.8 Pb emissions (t) for 1A2 sector by NFR, 1990-2019

Table 3.5.9 Hg (t) emissions for 1A2 sector by NFR, 1990-2019

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

year	1A2a	1A2c	1A2d	1A2e	1A2f	1A2gviii
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
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
2019	0.182	0.038	0.003	0.011	0.078	0.019

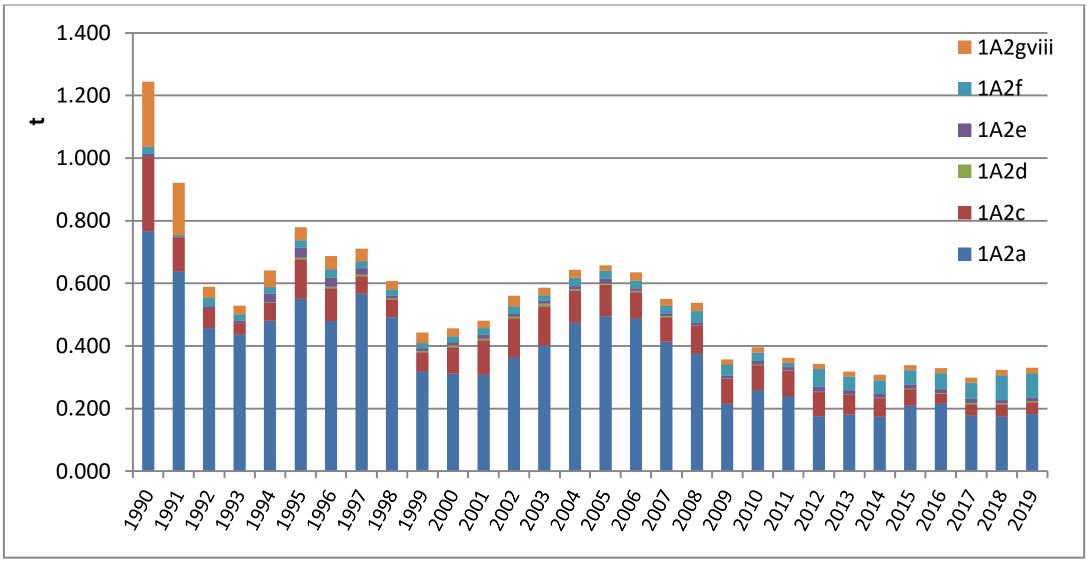


Figure 3.5.9 Hg emissions (t) for 1A2 sector by NFR, 1990-2019

Table 3.5.10 PCBs (kg) emissions for 1A2 sector by NFR, 1990-2019

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
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
2019	3.613	0.292	0.024	0.047	1.478	0.007

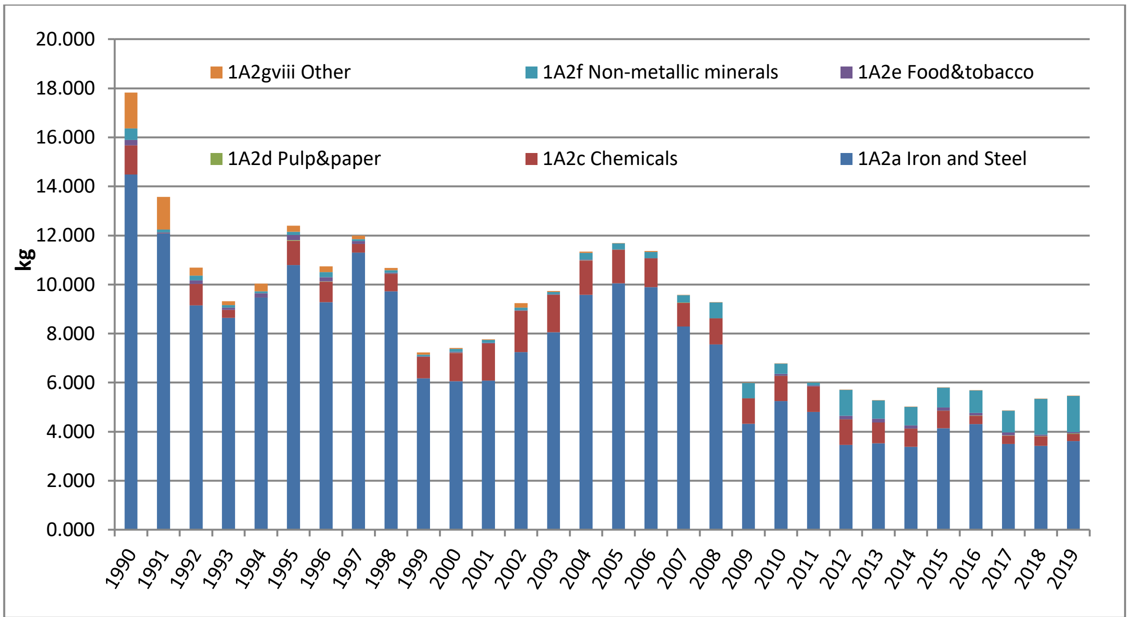


Figure 3.5.10 PCBs emissions (kg) for 1A2 sector by NFR, 1990 -2019

The next subchapters give details on NFR categories which are key sources in 2019.

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). 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 (19.33%), Pb (6.98%), Hg (12.6%) and PCBs(18.04%) in 2019.
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, 1990-2019

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	14,48
1991	22.79	9.58	64.10	8.93	0.50	70.33	14.51	10.43	12,09
1992	15.85	6.25	48.68	6.82	0.43	52.13	10.97	7.98	9,15
1993	17.40	6.17	46.13	6.52	0.44	49.68	10.37	7.61	8,64
1994	19.46	6.89	50.59	7.16	0.49	54.64	11.38	8.35	9,47
1995	20.99	7.93	57.53	0.01	7.09	7.66	12.97	10.80	10,80
1996	19.86	7.14	49.51	0.01	6.14	6.63	11.15	9.27	9,27
1997	20.10	7.81	60.19	0.00	7.37	7.97	13.56	11.31	11,31
1998	19.45	6.97	51.87	0.00	6.39	6.91	11.65	9.72	9,72
1999	14.65	4.73	33.10	0.00	4.13	4.46	7.41	6.17	6,17
2000	14.40	4.62	32.46	0.00	4.05	4.37	7.27	6.05	6,05
2001	12.99	4.44	32.56	0.00	4.03	4.35	7.30	6.09	6,09
2002	13.87	5.03	38.68	0.00	4.76	5.15	8.69	7.25	7,25
2003	14.28	5.45	42.87	0.00	5.25	5.68	9.64	8.05	8,05
2004	16.81	6.36	51.03	0.00	6.25	6.76	11.47	9.58	9,58
2005	18.30	6.63	53.64	0.00	6.59	7.13	12.04	10.05	10,05
2006	18.83	6.56	52.87	0.00	6.52	7.05	11.85	9.89	9,89
2007	12.76	5.54	43.96	0.00	5.33	5.77	9.93	8.29	8,29
2008	11.12	4.95	40.09	0.00	4.85	5.25	9.05	7.56	7,56
2009	7.08	2.88	22.97	0.00	2.80	3.03	5.18	4.32	4,32
2010	7.35	3.36	27.79	0.00	3.35	3.63	6.28	5.25	5,25
2011	6.93	3.14	25.47	0.00	3.08	3.33	5.75	4.81	4,81
2012	5.54	2.43	18.33	0.00	2.22	2.40	4.14	3.46	3,46

Year/Pollutant	NOx (kt)	NMVOC (kt)	SOx (kt)	TSP (kt)	BC (kt)	CO (kt)	PCDD (g)	PAH (t)	PCBs (kg)
2013	5.84	2.53	18.71	0.00	2.27	2.45	4.23	3.53	3,53
2014	5.75	2.48	17.93	0.00	2.17	2.35	4.06	3.38	3,38
2015	6.60	2.88	21.93	0.00	2.66	2.88	4.96	4.14	4,14
2016	6.47	2.88	22.83	0.00	2.76	2.99	5.16	4.31	4,31
2017	5.79	2.50	18.55	0.00	2.25	2.43	4.19	3.50	3,50
2018	5.66	2.46	18.12	2.52	0.14	19.57	4.10	2.95	3,42
2019	5.63	2.50	19.14	2.66	0.15	20.55	4.33	3.12	3,61

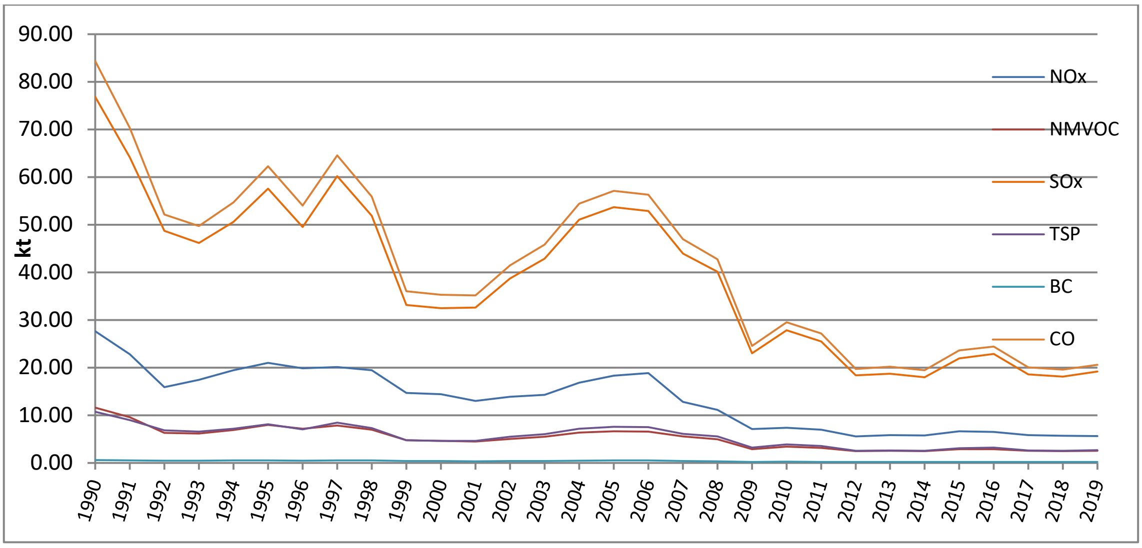


Figure 3.5.1.1 Emissions of NOx, SOx, NMVOC, NH_3, TSP, BC and CO (kt) for NFR 1A2a, 1990-2019

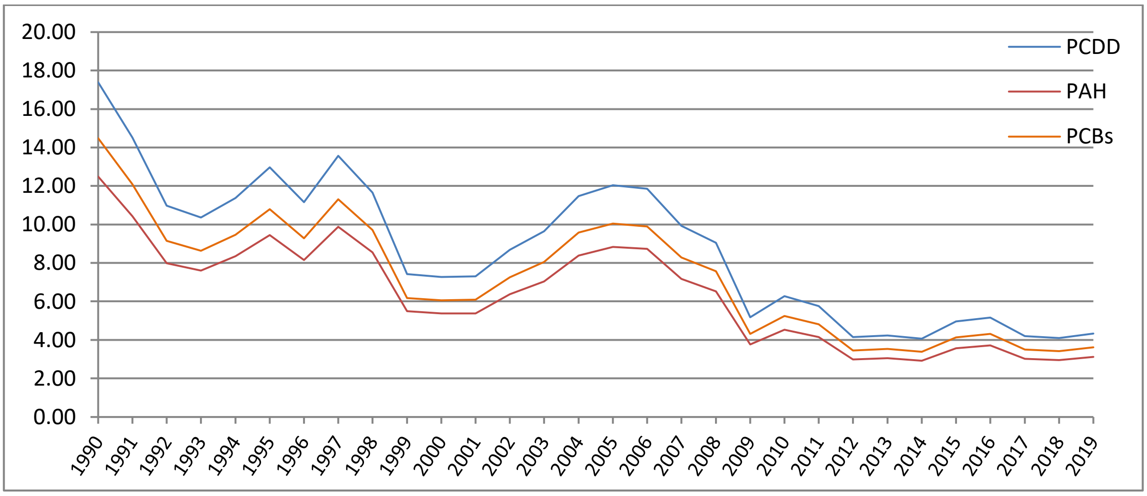


Figure 3.5.1.2 Emissions of PCDD/PCDF (g), PAH (t) and PCBs (kg) for NFR 1A2a, 1990-2019

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
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
2019	2.848	0.038	0.182	0.088	0.287	0.372	0.277	0.040	4.269

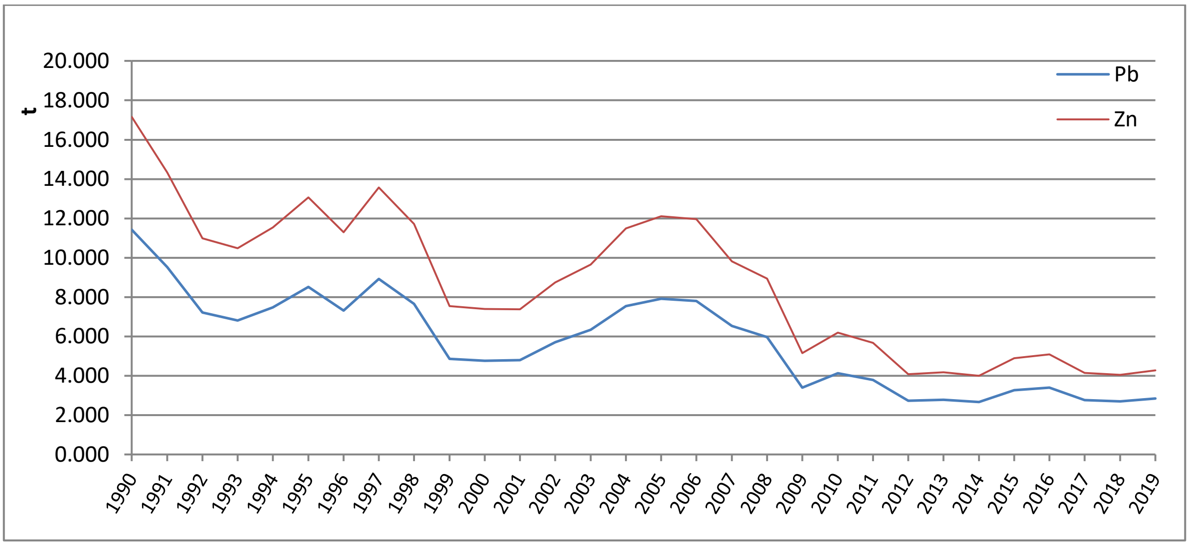


Figure 3.5.1.2.a Emissions of Pb and Zn (t) for NFR 1.A.2.a, 1990-2019

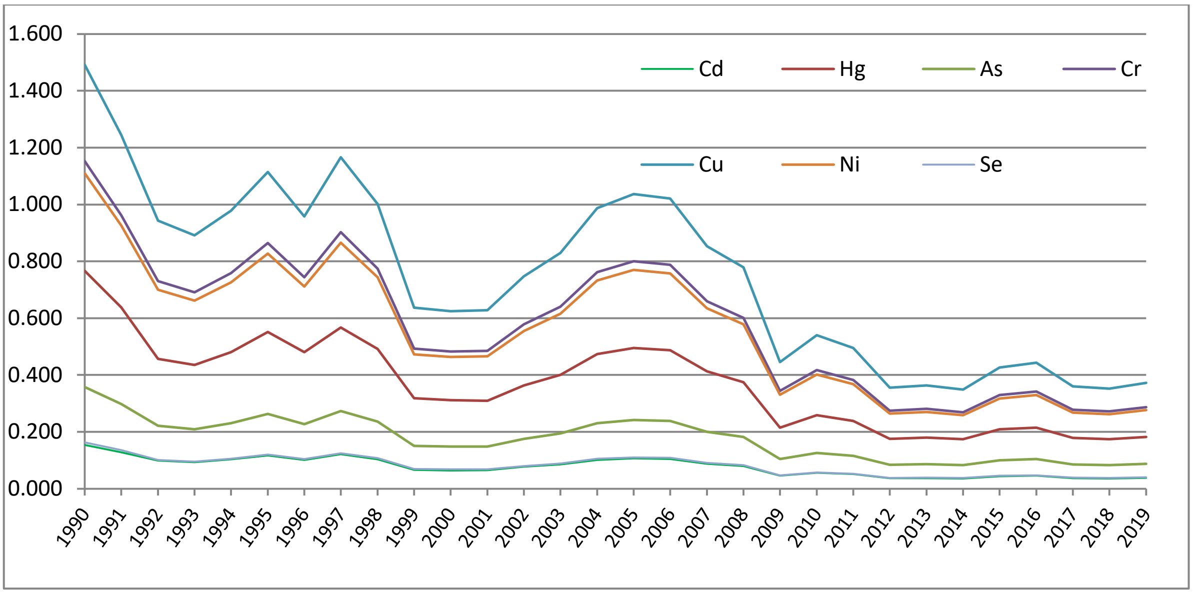


Figure 3.5.1.2.b Emissions of As, Cd, Cr, Cu, Hg, Ni and Se (t) for NFR 1.A.2.a,1990-2019

All heavy metals emissions showed important decreases in 2019 compared to 1990 emissions, around 75% 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

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
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	22.82	20107.51	29322.51	0.176
2019	0.086	21250.20	26458.23	0.088

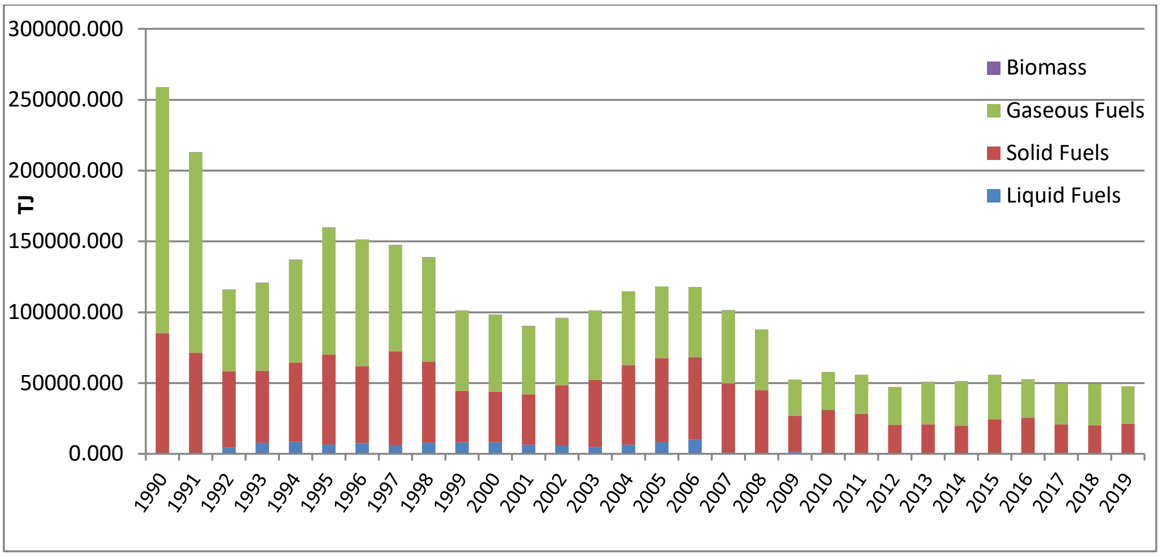


Figure 3.5.1.3 Fuel consumption (TJ), by fuel type, for NFR 1.A.2.a, 1990-2019

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 2019 (4.38%).

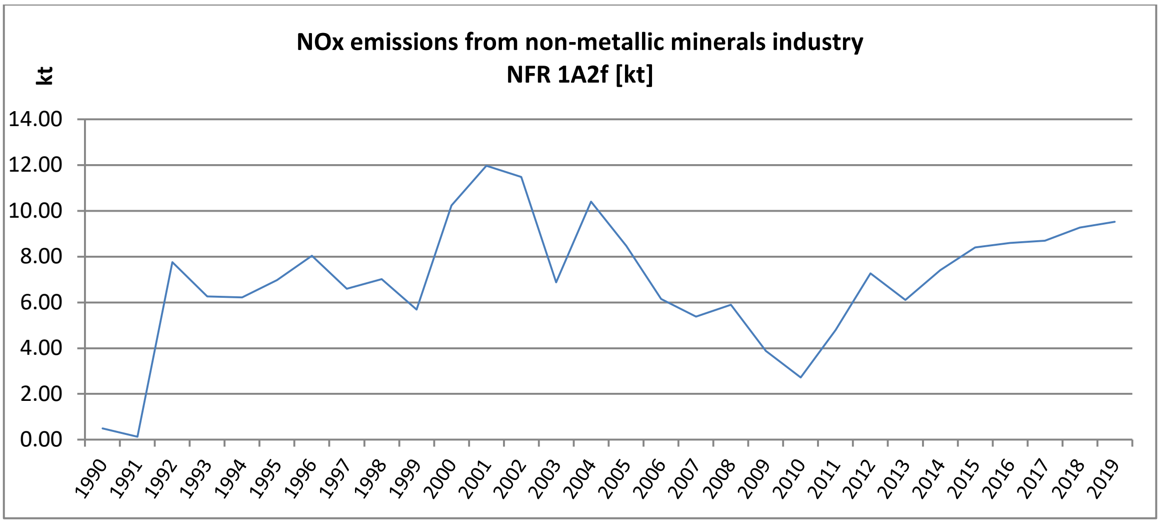


Figure 3.5.2.1 Emission Trend (kt) of NOx for NFR 1.A.2.f Non-metallic minerals – stationary combustion, 1990-2019

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, 1990-2019

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

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
2015	12982	4801	10296	1617
2016	13021	5375	10943	1875
2017	13018	5224	12558	2016
2018	12692	8610	17048	91
2019	13597	8694	13878	101

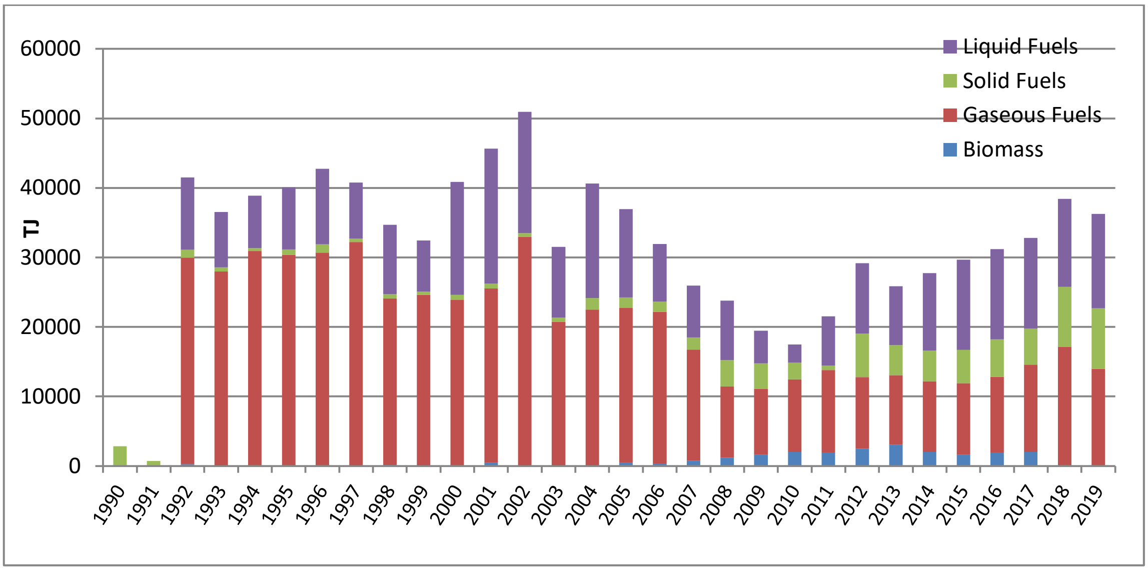


Figure 3.5.2.2 Fuel consumption (TJ), by fuel type, for NFR 1.A.2.f, 1990-2019

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 2019, NFR1A2gviii was a key source for Zn (3.91%).

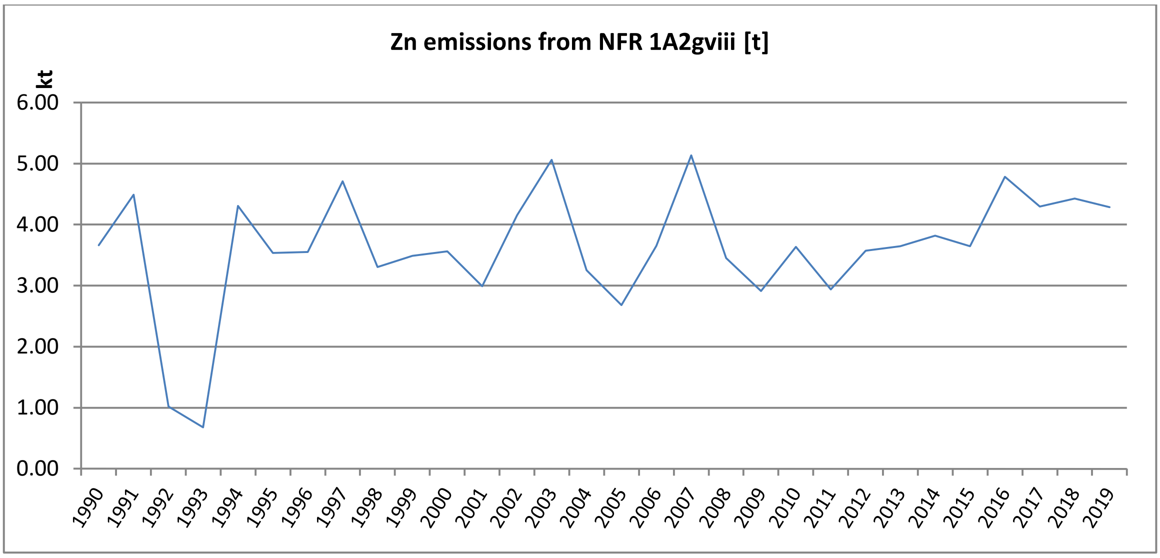


Figure 3.5.3.1 Emission Trend (t) of Zn for NFR 1.A.2.g.viii Other industries, 1990-2019

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

Table 3.5.3.2. Emissions trend (kt) for NFR 1.A.2.g.viii, Other industries, 1990-2019

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
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

Year/Pollutant(kt)	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
2018	2.591	3.130	0.141	1.227	1.253	5.621
2019	2.690	3.082	0.146	1.189	1.215	5.513

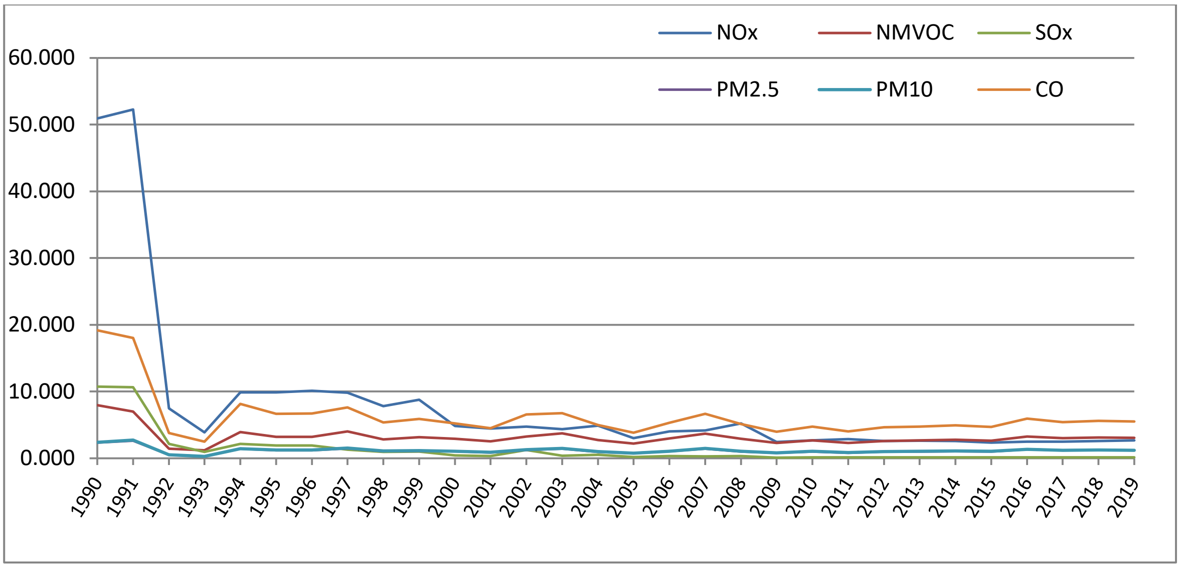


Figure 3.5.3.2 Emission trends (kt) for NFR 1.A.2.g.viii, Other industries, 1990-2019

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 3.5.3.3 Fuel consumption, by fuel type, for NFR 1.A.2.g.viii, Other industries, 1990-2019

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

Year/Fuel (TJ)	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
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
2019	101	36	25350	8312

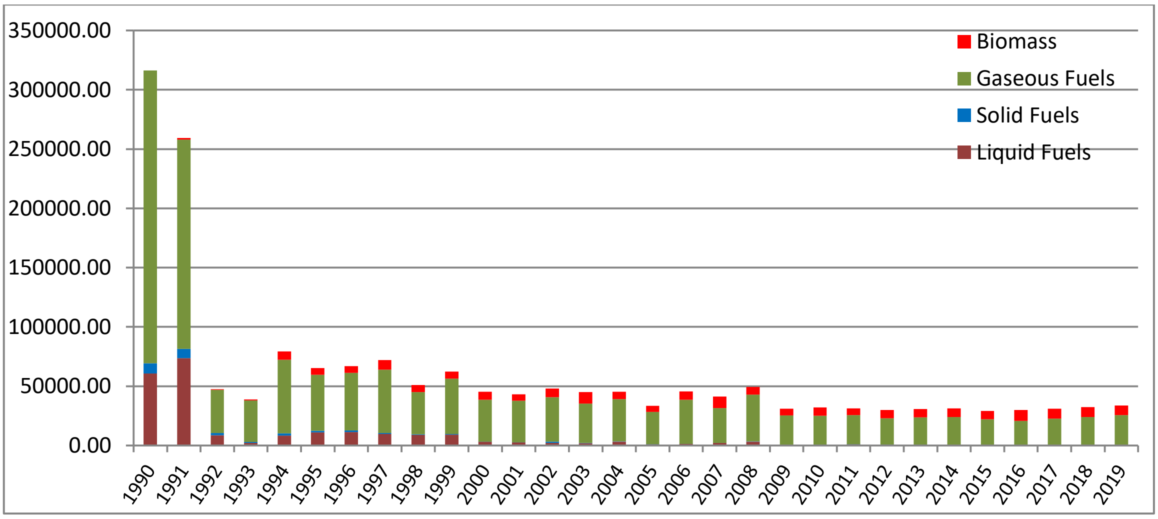


Figure 3.5.3.3 Fuel consumption [TJ], by fuel type, for NFR 1.A.2.g.viii, Other industries, 1990-2019

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), before 2017, and Eurostat ENERGY questionnaires, for 2017 - 2019. The activity data are given by the consumption of diesel and gasoline in all industries, category *Final energy consumption/Industry (all).* Activity data and emissions of 1990-1992 are included at NFR 1A3 (no separate data in the Energy statistics available).

The category 1A2gvii-*Mobile combustion in manufacturing industries and construction* is not a key source for any pollutant in 2019.

Improvements and recalculations:

Questions (PTC) were raised in 2019 and 2020 Reviews regarding this NFR (RO-1A2gvii-2019-0001 and RO-1A2gvii-2020-0001, as a key category for NOx and NMVOC assessed based on Tier 1 methodology. The actual submission includes the Tier 2 recalculations of NOx and NMVOC submitted by Romania during the 2020 Review. To ensure consistency, recalculation was performed based on the same methods, for all pollutants and years for which the Guidebook provides Tier 2 emission factors and fuel shares. Where data for splitting the fuel on technologies are not available (i.e., before 1999), Tier 1 estimation was applied, same for heavy metals and PAH.

The emission factors for Tier 2 calculation are given by Table 3-2 - *Tier 2 emission factors for off-road machinery,* 1.A.2.g.vii, Guidebook 2019, chapter "Non road mobile machinery" (NRMM). There are no relevant national data on split of the fuel consumption by engine age and technologies, therefore, the alternative approach provided by the Guidebook 2019, data derived from Winther (2016) and Winther & Nielsen (2006) was applied. The data used for splitting the fuel for Tier 2 estimation are given in the following Guidebook tables: Table 3-3 *Split (%) of total fuel consumption per engine age, for diesel-fueled non-road machinery*, 1.A.2.g.vii (Industry) and Table 3-4 *Share of total fuel consumption per engine age (irrespective of inventory year) for gasoline-fueled two-stroke and four-stroke non-road machinery* (1.A.2.g.vii (Industry) and tables from the electronic NRMM annex *1.A.4 Non road mobile machinery Annex 2019.xlsx*: Table 3-7, *Split of the total fuel consumption into engine technology layers for each inventory year*, diesel, Table 3-8, *Split of the total fuel consumption into engine technology layers for each inventory year,* gasoline two-stroke technology and Table 3-9, *Split of the total fuel consumption into engine technology layers*, *for each inventory year*, gasoline four-stroke technology.

For splitting gasoline consumption in 2019 between two-stroke and four-stroke machinery, the percentage split (20/80) is used (expert judgement).

Recalculation decreased the emission values, for the main pollutants. For NOx, the difference between revised estimates and original ones are slightly above the threshold of significance, in absolute values, in the last years (highlighted in the examples below):

	Revised Estimate (kt)		Difference between Original Estimate and Revised Estimate (kt)		Threshold values	
Year	**NOx**	**NMVOC**	**NOx**	**NMVOC**	**NOx**	**NMVOC**
2005	12.89	7.91	0.90	-5.43	6.54	6.30
2010	5.66	1.42	-1.50	-3.92	4.80	5.18
2015	5.70	0.99	-4.47	-3.08	4.44	4.74
2018	4.24	0.69	-5.63	-2.31	4.51	4.75

The heavy metals, PCDD, PAH, HCB and PCBs were not recalculated, for there are no Tier2 indications for these pollutants in the Guidebook.

The following table and chart provide the time trend of emissions:

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	18.89	10.43	54.22
1993	8.91	3.71	18.71
1994	17.14	3.67	16.41
1995	14.12	1.84	6.81
1996	27.22	9.39	46.22
1997	19.03	6.52	32.07
1998	17.94	9.57	49.60
1999	13.50	5.98	28.29
2000	16.40	7.40	35.58
2001	19.20	6.27	28.51
2002	19.97	13.59	70.11
2003	14.80	6.95	34.53
2004	12.44	5.85	29.34
2005	12.90	7.91	41.15
2006	12.91	5.51	27.88
2007	18.37	4.97	45.42
2008	12.12	2.83	25.65
2009	6.50	2.04	23.30
2010	5.66	1.42	17.22
2011	6.55	1.06	11.57
2012	6.88	0.95	8.76
2013	5.73	0.93	10.73
2014	5.30	0.88	10.63
2015	5.70	0.99	12.52
2016	5.01	0.85	10.81
2017	4.60	0.82	11.17
2018	4.24	0.69	8.94
2019	3.94	0.74	10.67

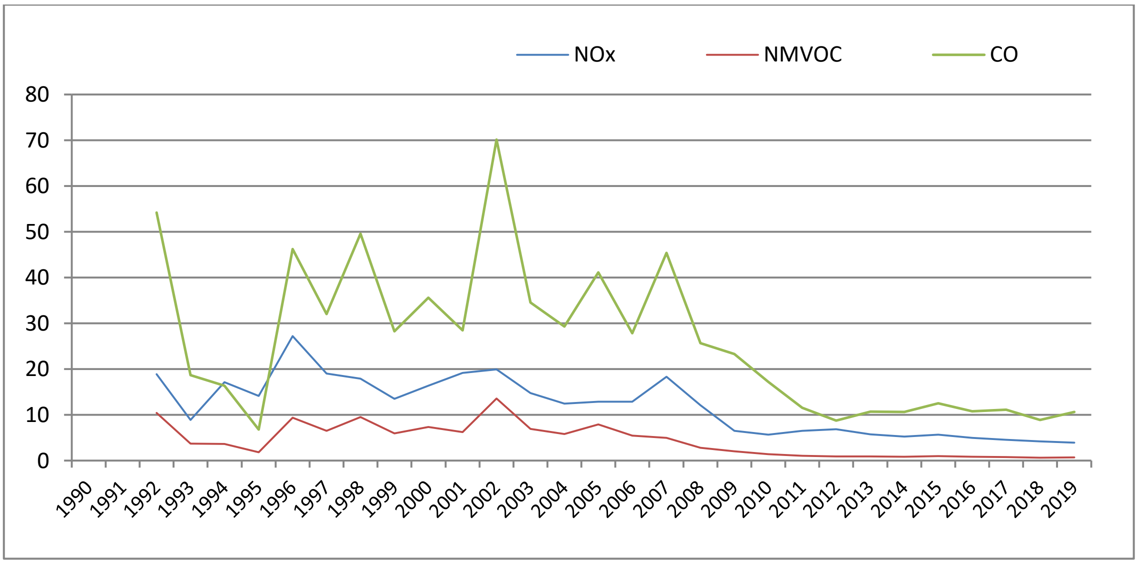


Figure 3.6.1 Emissions of NOx, NMVOC and CO (kt) for NFR 1.A.2.gvii

Emission time trends follow the fuel consumption variation. Most of the fuel is diesel, 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
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	12685	484	13169
2018	12732	367	13099
2019	13172	458	13631

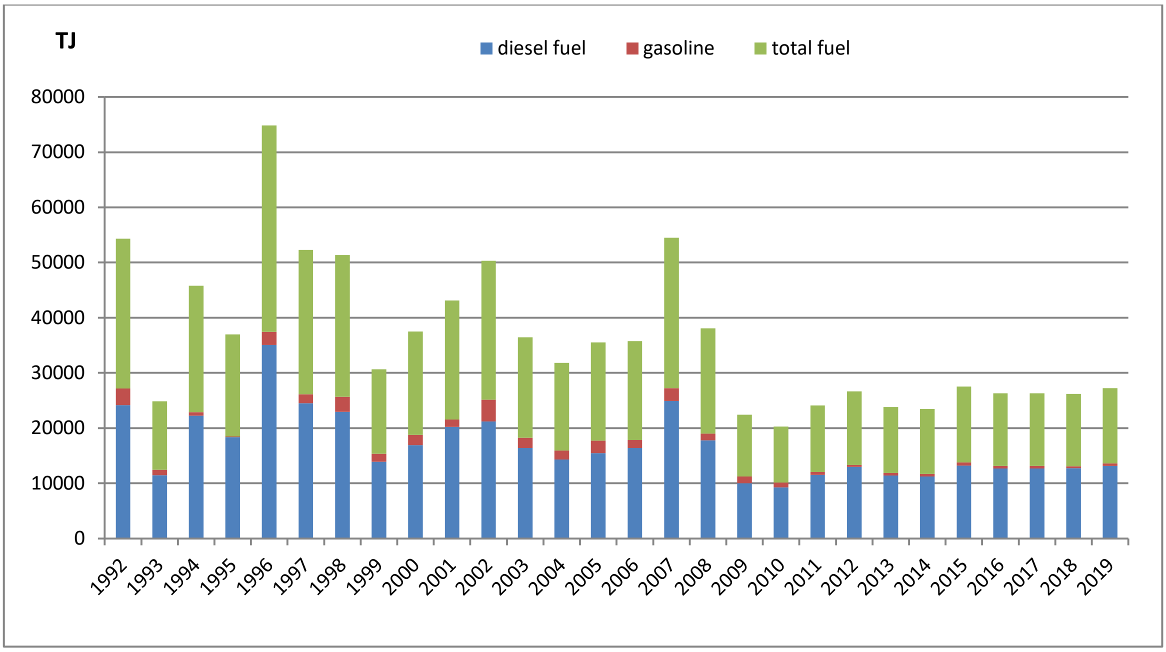


Figure 3.6.2 Fuel consumption (TJ) for NFR 1.A.2.gvii

3.7 NFR 1.A.4. Small combustion

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 provided 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 (all, kt)	National total (kt)	Unit	% in national total
NOx	23.75	217.49	kt	10.92
NMVOC	78.90	229.22	kt	34.42
SOx	4.87	99.05	kt	4.91
NH_3	8.98	178.25	kt	5.04
$PM_{2.5}$	92.17	112.03	kt	82.27
PM_{10}	94.65	153.08	kt	61.83
TSP	99.57	233.24	kt	42.69
BC	9.72	13.30	kt	73.07
CO	564.73	893.61	kt	63.20
Pb	3.98	40.80	t	9.75
Cd	1.72	3.01	t	57.33
Hg	0.11	1.45	t	7.81

Pollutant	1A4 (all, kt)	National total (kt)	Unit	% in national total
As	0.06	3.94	t	1.47
Cr	3.20	12.20	t	26.21
Cu	1.47	25.53	t	5.76
Ni	1.76	10.18	t	17.32
Se	0.28	8.44	t	3.32
Zn	68.83	109.57	t	62.82
PCDD	100.17	186.09	g I-TEQ	53.83
Total PAH	44.83	58.13	t	77.12
HCB	0.66	3.10	t	21.40
PCBs	0.43	20.02	t	2.13

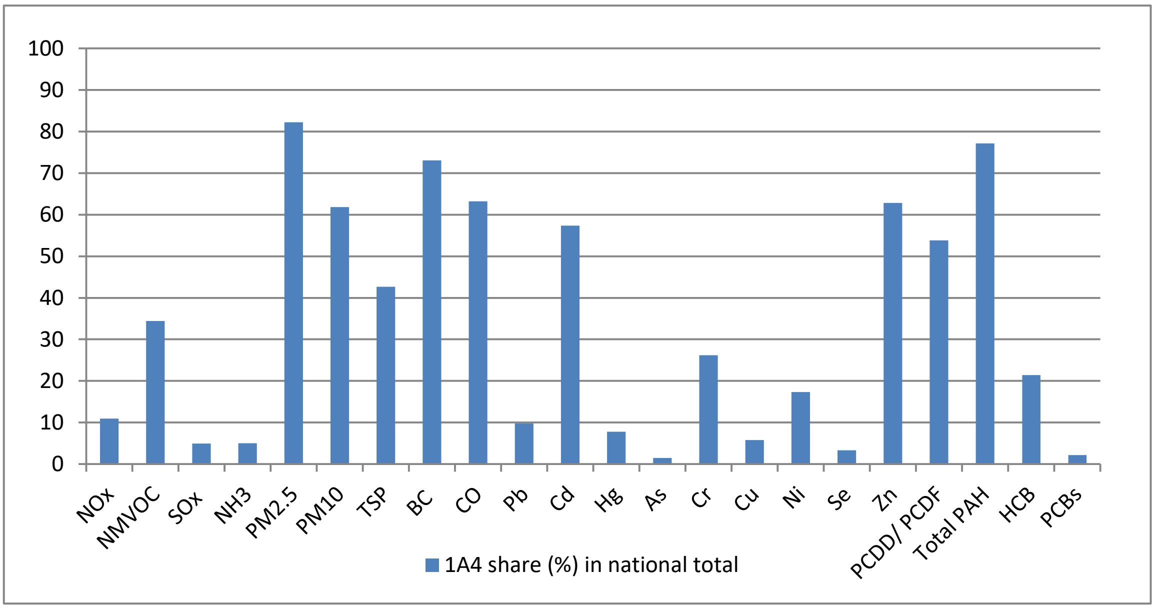


Figure 3.7.1 Share of emissions from 1A4 small combustion, including non-road, in the national total

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

The 1990-2019 emissions 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 activity data from EUROSTAT energy balances, annual data nrg_110a, category *Final energy consumption/Other Sectors/Services.* Data for 2019 fuel consumption were provided by N.I.S., in EUROSTAT ENERGY questionnaires. The diesel and gasoline consumption of this category are not included in 1A4ai but allocated to 1A4aii - Mobile machineries.

NFR 1.A.4.ai was not a key source for any pollutant in 2019.

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
2019	3.306	2.167	0.194	0.729	0.1897	3.652

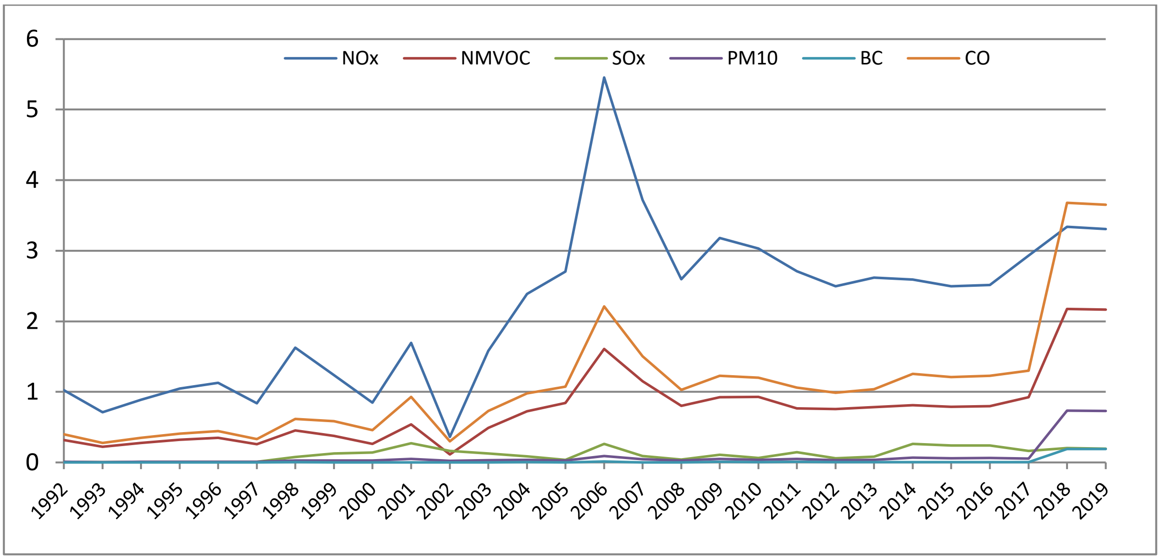


Figure 3.8.1 Emissions (kt) of NOx, NMVOC, SOx, PM_{10}, BC and CO for NFR 1.A.4.a.i

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. The increase of emissions in 2018-2019 is due to the increase of the biomass consumption allocated to this estimation, which previously or null or very low. This is explained by the change of the statistic allocation of certain values, included in the EUROSTAT ENERGY Questionnaires, which provides the activity data. Starting 2018, the Solid Biofuel, which in previous years was allocated to Other sectors / Not elsewhere specified, has been allocated to Other sectors/Commercial and public services in the Romanian ENERGY statics. This change explains the increase of emissions for NFR 1A4ai and the decrease of emissions and biomass for NFR 1A5a.

Regarding this issue, a question was raised during the 2020 Review. The TERT noted the high annual change of several pollutants between 2017 and 2018 (RO-1A4ai-2020-0001). Following the Review question, we have questioned the National Institute of Statistic on the issue whether the reallocation of Solid Biofuel in the EUROSTAT ENERGY Questionnaires from 'Other sectors/Not elsewhere specified' to 'Other sectors/Commercial and public services' will be operated on the entire time-series and found out that there is no foreseen activity on this reallocation. We have not taken yet any decision whether to apply or not a correction to fuel consumption and emissions for the entire time-series in the emission inventory, because this action would produce inconsistencies between the activity data in the inventory compared to the data source (EUROSTAT).

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

Year/Fuel type	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass
2015	86	253	32774	32
2016	43	254	33176	46
2017	47	157	39017	38
2018	73	152	39293	4191
2019	24	143	39104	4181

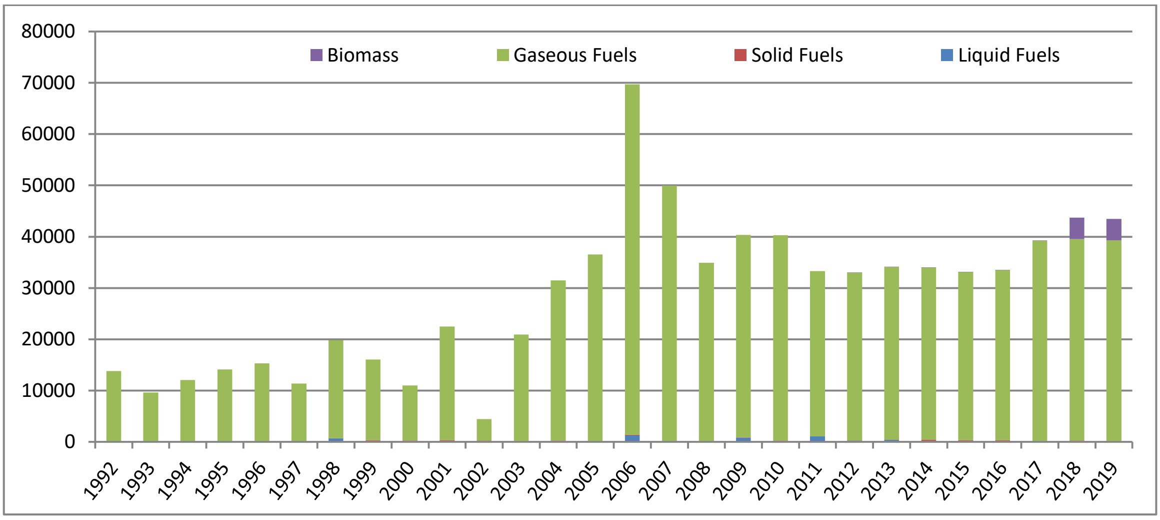


Figure 3.8.2 Fuel consumption (TJ), by fuel type, for NFR 1.A.4.a.i

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, provided in the EUROSTAT energy balances, category Final energy consumption/Other Sectors/Services. Data for 2017 were provided in the Eurostat Energy questionnaires.

Improvements and recalculations:

A question (RO-1A4aii-2020-0001) was raised in 2020 regarding this NFR, as a key category for NMVOC, assessed based on Tier 1 methodology. The actual submission includes the Tier2 NMVOC recalculations submitted by Romania during the 2020 Review. To ensure consistency of the method, recalculation was performed for all pollutants and years for which the Guidebook provides Tier 2 emission factors and fuel shares. Following recalculation, NMVOC is no longer a key source for this NFR. In 2019, NFR 1A4aii was a key source for CO (4.7%). Compared to 2005, CO decreased for this NFR with 40% in 2019.
Where data for splitting the fuel on technologies are not available (i.e., before 1999), Tier 1 estimation was applied, same for heavy metals and PAH (2019 EMEP/EEA Guidebook, NFR 1.A.4 Non road mobile machinery, Table 3.1). SOx is estimated based on sulphur content in the fuel.

The emission factors for Tier 2 calculation are given by Table 3-2 - *Tier 2 emission factors for off-road machinery,* 1.A.4.aii, Guidebook 2019, chapter "Non road mobile machinery" (NRMM). There are no relevant national data on split of the fuel consumption by engine age and technologies, therefore, the alternative approach provided by the Guidebook 2019, data derived from Winther (2016) and Winther & Nielsen (2006) was applied. The data used for splitting the fuel for Tier 2 estimation are given in the following Guidebook tables: Table 3-3 *Split (%) of total fuel consumption per engine age, for diesel-fueled non-road machinery*, 1.A.2.g.vii and Table 3-4 *Share of total fuel consumption per engine age (irrespective of inventory year) for gasoline-fueled two-stroke and four-stroke non-road machinery* and tables from the electronic NRMM annex *1.A.4 Non road mobile machinery Annex 2019.xlsx*: Table 3-7, *Split of the total fuel consumption into engine technology layers for each inventory year*, diesel, Table 3-8, *Split of the total fuel consumption into engine technology layers for each inventory year,* gasoline two-stroke technology and Table 3-9, *Split of the total fuel consumption into engine technology layers*, *for each inventory year*, gasoline four-stroke technology.

For splitting gasoline consumption in 2019 between two-stroke and four-stroke machinery, the percentage split (20/80) is used (expert judgement).

Recalculation decreased the NMVOC values and is no longer key source. CO increased significantly and became key source in the actual approach.

The difference between revised estimates of NMVOC and original ones are above the threshold of significance, in absolute values, in the years highlighted in the table below:

NMVOC			
Year	**Revised Estimate (kt)**	**Difference between Original Estimate and Revised Estimate (kt)**	**Threshold values**
2005	12.49	-10.398	6.303
2010	0.919	-3.494	5.181
2015	0.973	-5.0	4.743
2018	1.838	-9.837	4.747

The heavy metals, PCDD, PAH, HCB and PCBs were not recalculated, for there are no Tier2 indications for these pollutants in the Guidebook.
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	0.06	1.52	8.61
1993	0.14	3.43	19.37
1994	0.05	1.14	6.46
1995	0.03	0.63	3.58
1996	0.11	2.79	15.79
1997	0.42	10.54	59.57
1998	0.78	7.04	39.64
1999	0.47	1.46	8.06
2000	1.28	5.35	29.83
2001	1.32	9.90	55.59
2002	6.84	4.89	25.34
2003	3.47	6.86	37.72
2004	3.06	7.05	39.00
2005	2.21	12.50	70.14
2006	0.70	8.29	46.73
2007	0.89	5.87	72.45
2008	0.54	2.96	37.57
2009	0.38	0.96	13.70
2010	0.81	0.92	14.76
2011	0.76	1.78	35.70
2012	0.78	0.92	18.06
2013	0.53	1.21	24.98
2014	0.53	1.02	21.18
2015	0.53	0.97	20.45
2016	0.53	1.35	29.05
2017	0.51	1.37	29.80
2018	0.55	1.84	40.10
2019	0.57	1.93	42.43

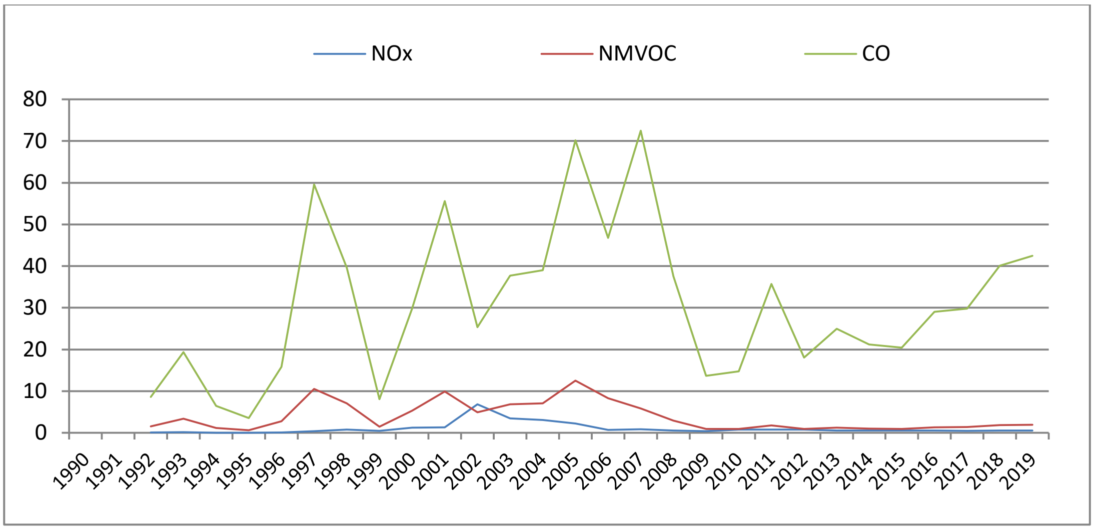


Figure 3.8.1.1 Emissions of NOx, NMVOC and CO (kt) for NFR 1.A.4.a.ii

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
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
2019	890	2271	3161

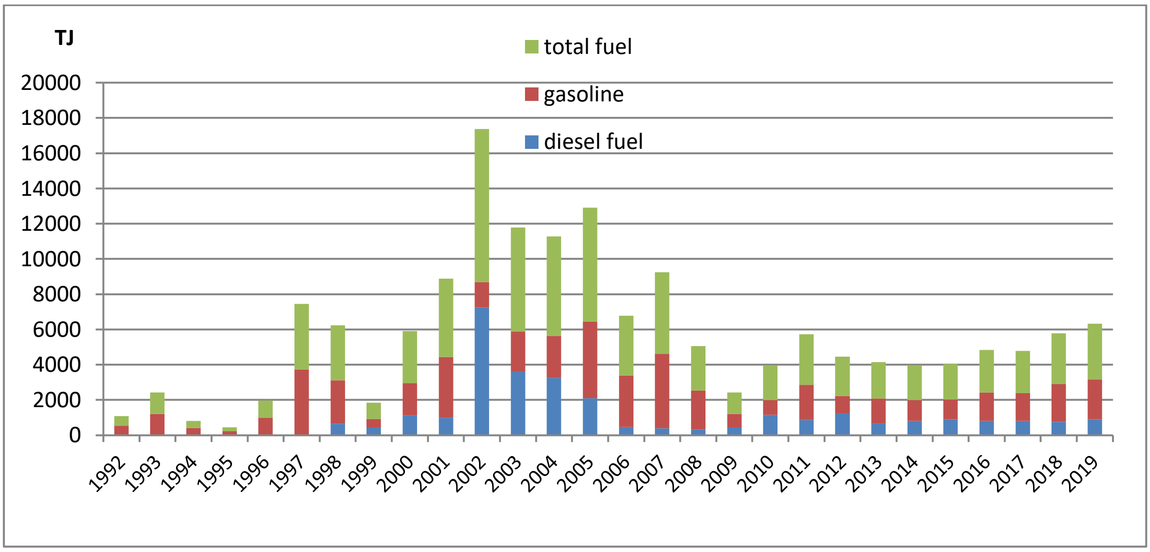
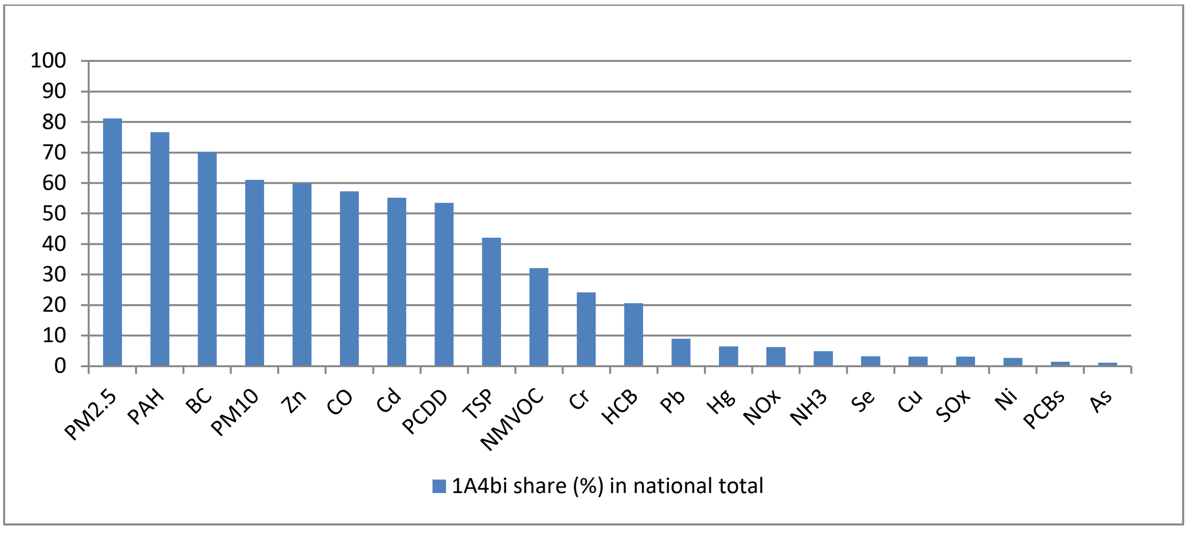


Figure 3.8.1.2 Fuel consumption (TJ) for NFR 1.A.4.a.ii

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

Residential heating is, as for 2019, key source category for many pollutants, accounting for the following contributions to the national total: $PM_{2.5}$ (81.2%), PAH (76.6%), BC (70.1%), PM_{10} (61.0%), Zn (59.8%), CO (60.2%), Cd (55.14%), PCDD/PCDF (53.45%), TSP (42.1%), NMVOC (32.2%), Cr (24.2%), HCB (20.5%), Pb (8.9%), Hg (6.43%), NOx (6.2%), NH_3 (4.94%).



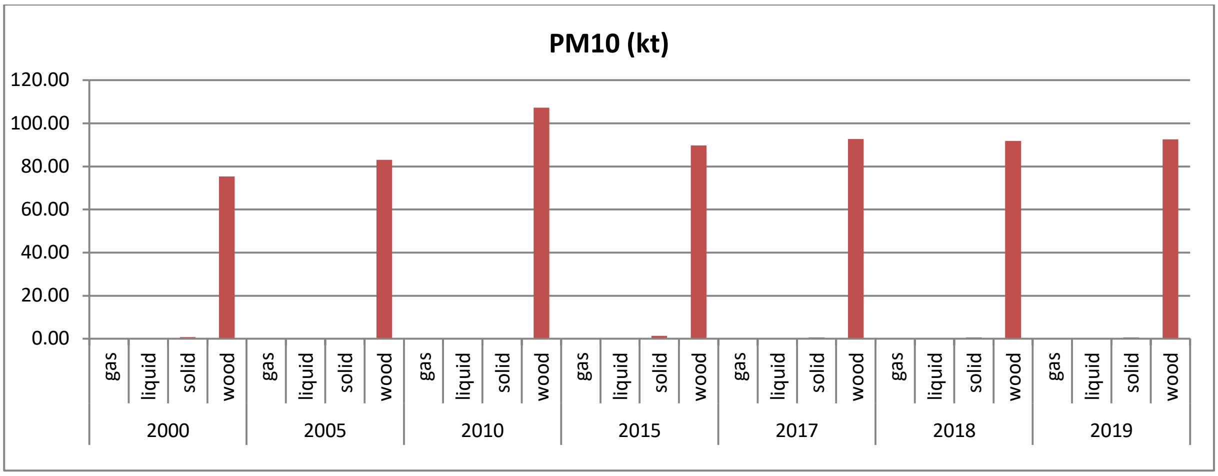
The activity data consist of fuel consumption provided, for the years 1990-2016, by EUROSTAT (energy balances, annual data - nrg_110a, *Final energy consumption/Other Sectors/Residential)* and for 2017-2019 by the N.I.S, in the forms of the EUROSTAT ENERGY questionnaires.

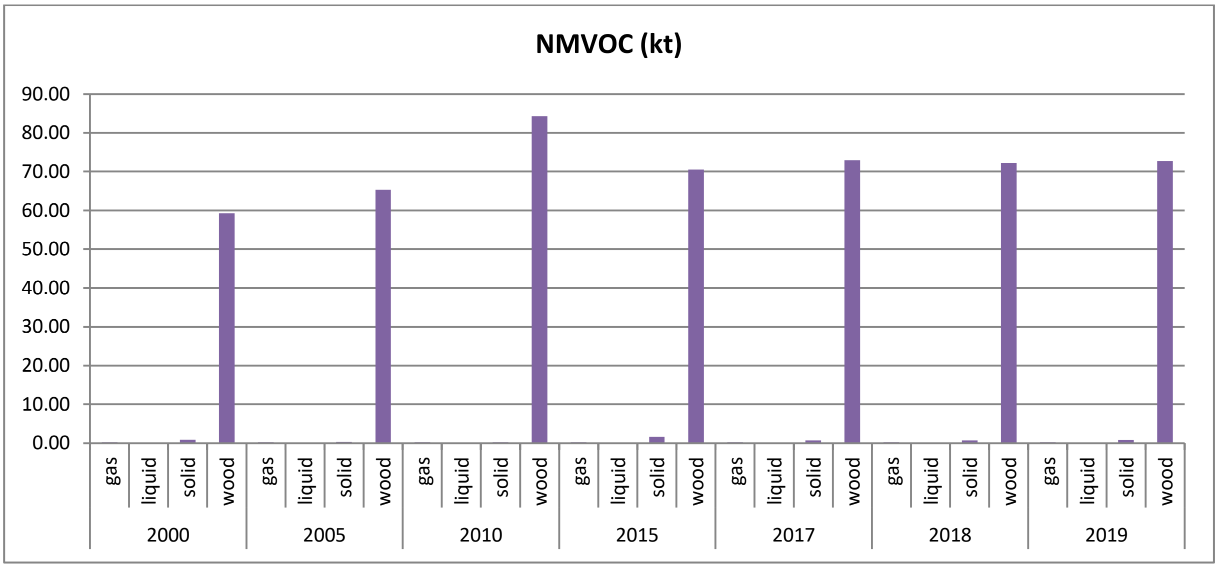
The emission factors are given by the 2019 EMEP/EEA Guidebook.

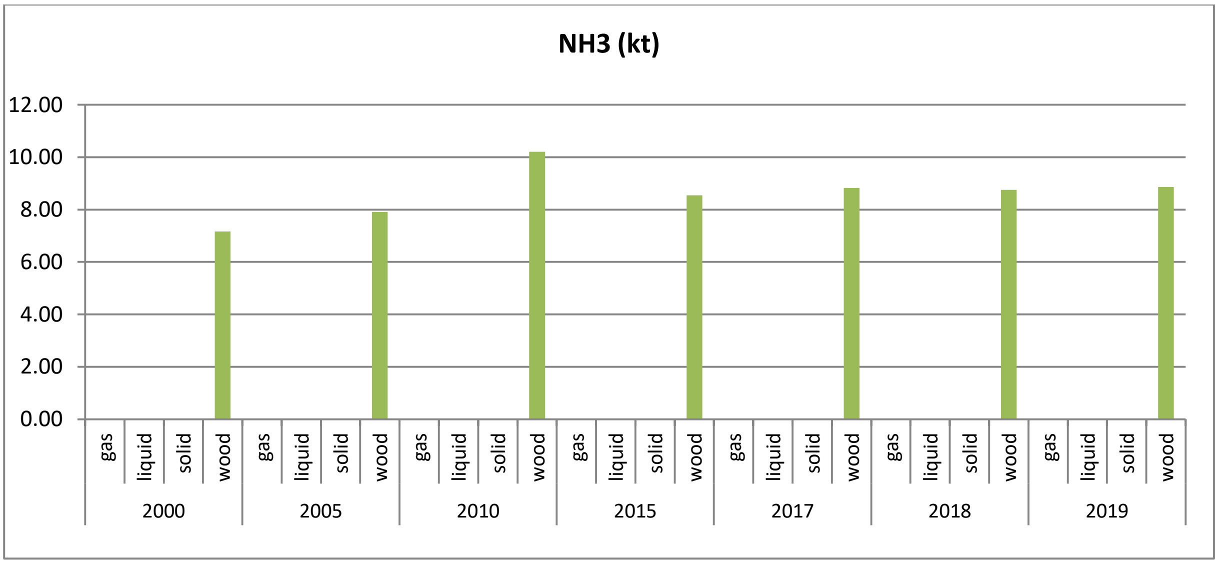
Tier 2 methodology was applied for wood combustion, with following percentages of technologies in 2019: conventional stoves burning wood and similar wood waste 91% (*Small combustion, Table 3.40 Tier 2 emission factors for NFR category 1.A.4.b.i*), conventional boilers < 50 kW burning wood and similar 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.*

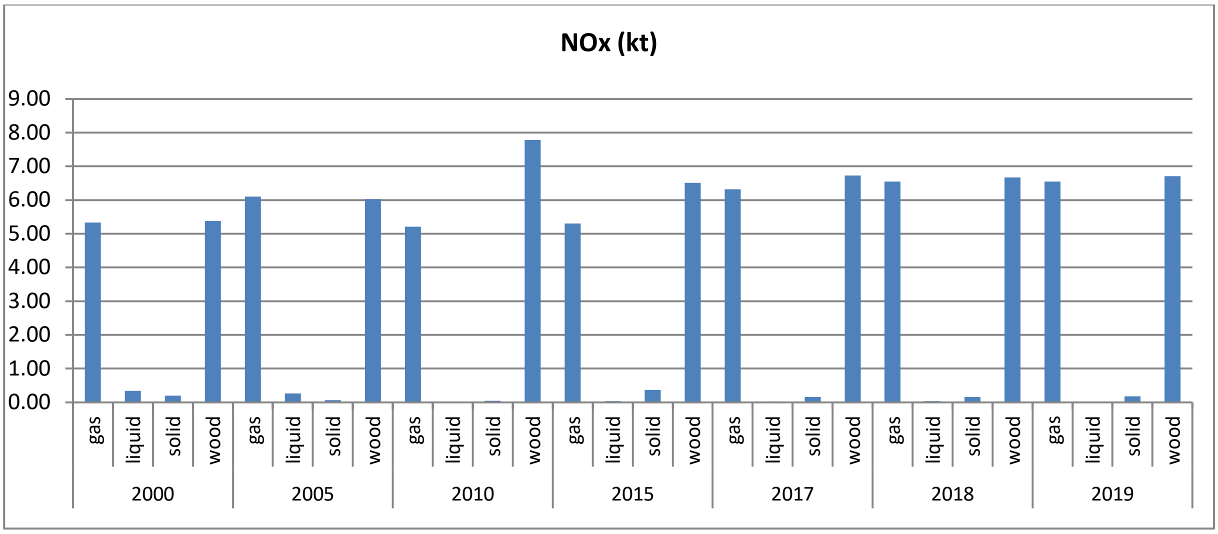
The reason for this approach is illustrated below.

For NFR category 1A4bi, relevant fuels are solid Biomass (wood) and natural gas (see Figure 3.9.1). Biomass is assessed based on Tier 2, the other fuels based on Tier 1 emission factors. The contribution to emissions on type of fuels for the main pollutants NOx, NH_3, $PM_{2.5}$, NMVOC is shown in charts below.


PM10 (kt)
120.00
100.00
80.00
60.00
40.00
20.00
0.00
gas
liquid
solid
wood
2000
2005
2010
2015
2017
2018
2019


NMVOC (kt)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
gas
liquid
solid
wood
2000
2005
2010
2015
2017
2018
2019


NH3 (kt)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
gas
liquid
solid
wood
2000
2005
2010
2015
2017
2018
2019



Biomass gives most of emissions. Gaseous fuels contribute significantly only to NOx emissions. The pollutants for gaseous fuels are 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. 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.

The tables and charts below provide the trends of emissions and fuel consumption in residential sector. Gasoline and diesel fuels are 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

Year/Pollutant	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
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
2019	13.51	73.77	3.05	90.97	93.38	98.27	9.32	511.42

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

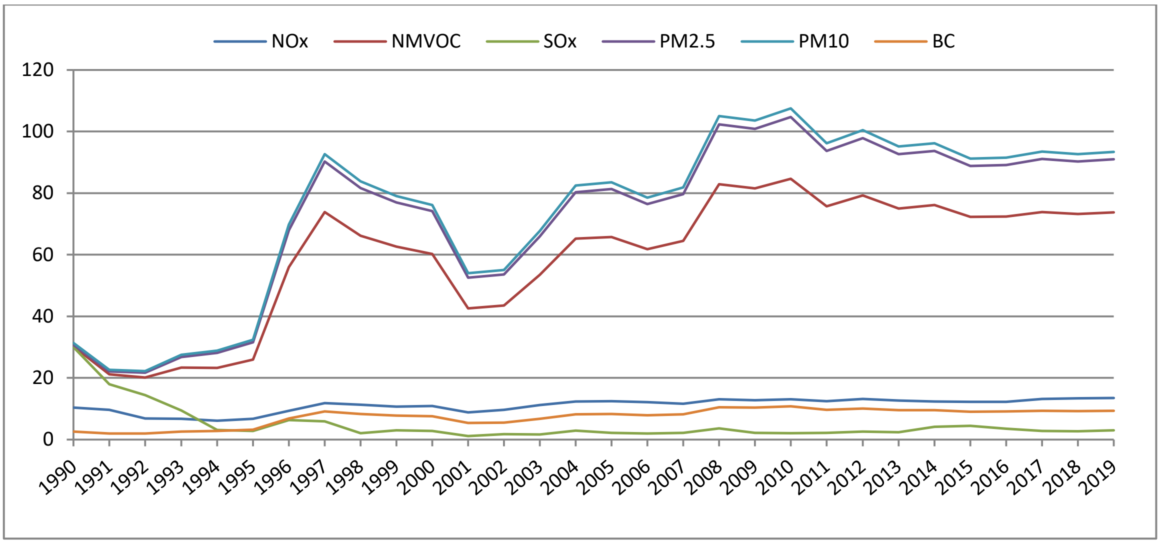


Figure 3.9.1 Emissions (kt) of NOx, NMVOC, SOx, PM_{10}/$PM_{2.5}$ for NFR 1.A.4.b.i

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

Year/Pollutant	Pb (t)	Cd (t)	Cr (t)	Zn (t)	HCB (kg)
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
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
2019	3.661	1.658	2.949	65.605	0.638

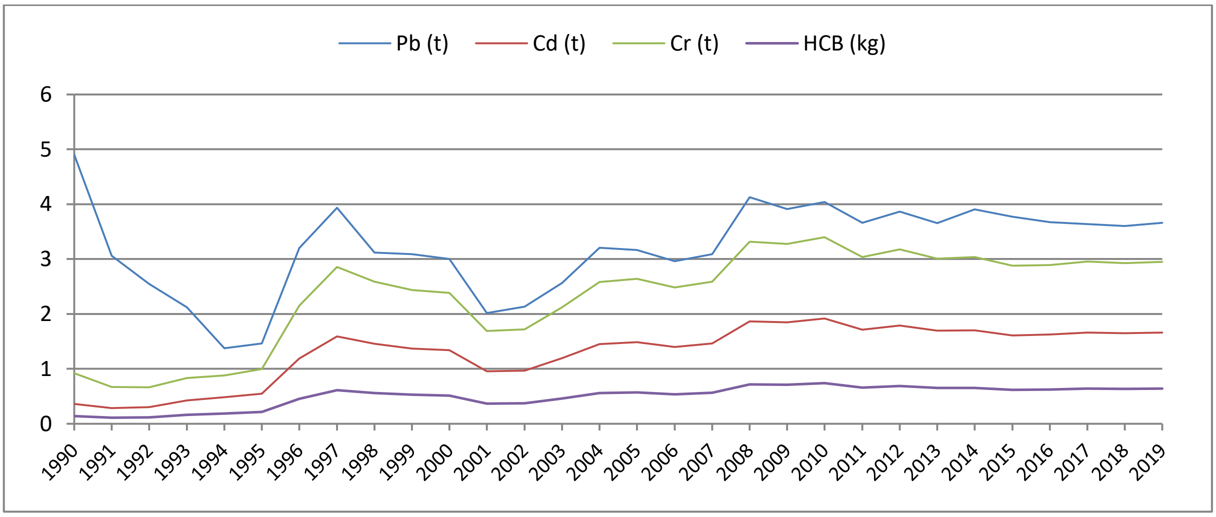


Figure 3.9.2 Emissions of Pb, Cd, Cr and HCB for category NFR 1.A.4.bi

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

Year/Pollutant	PCDD/F (g I-TEQ)	Total 4 PAHs (t)	PCB (kg)
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
2016	97.76	44.09	0.409
2017	99.49	44.42	0.252
2018	98.64	44.03	0.247
2019	99.47	44.52	0.29

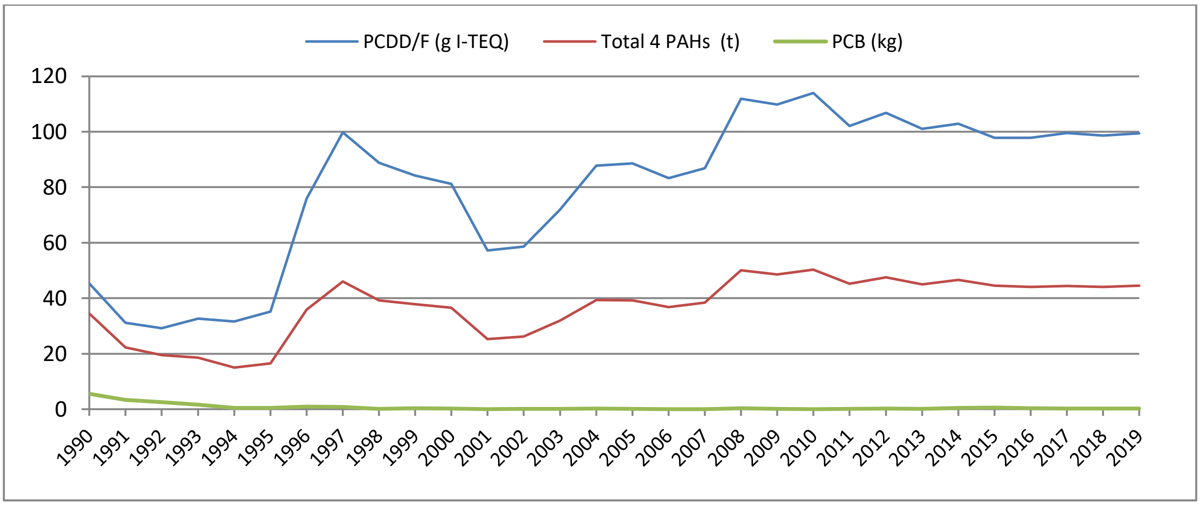


Figure 3.9.3 Emissions of PCDD/F (g I-TEQ) and Total PAHs (t) for NFR 1.A.4.b.i

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 2019 increased with 1.07 kt for NOx, 0.91 kt for SOx, 7.98 kt for NMVOC, 0.89 kt for NH_3 and 9.65 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
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
2019	1223	1703	128500	127402

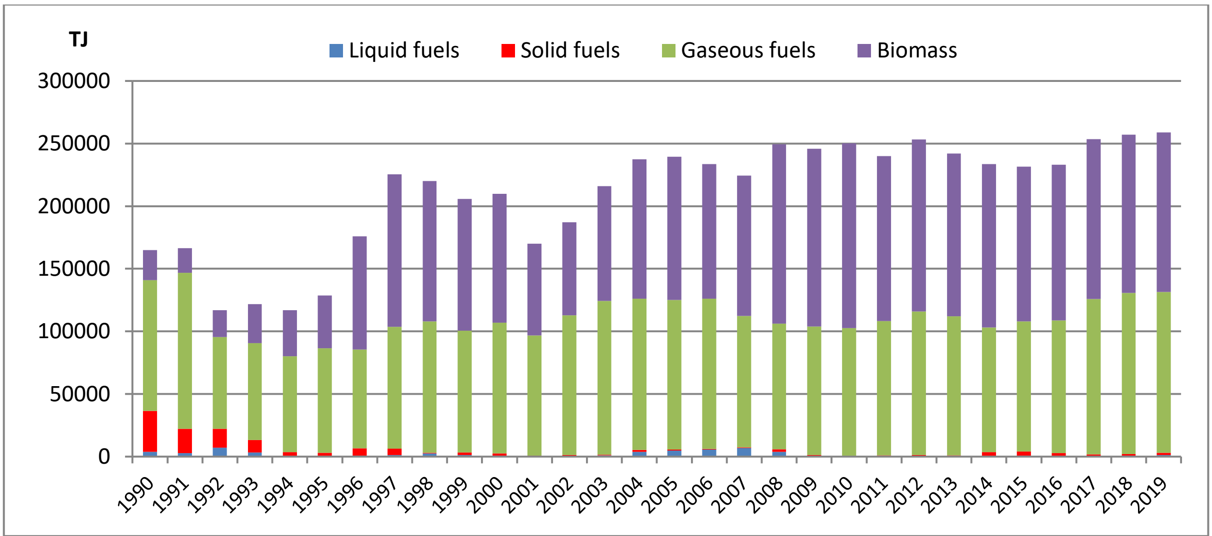


Figure 3.9.4 Fuel consumptions trend (TJ) for Residential heating (NFR 1.A.4.bi)

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 are estimated based on sulphur content in the fuel.

Following the Review recommendations RO-1A4aii-2017-0001 and RO-1A4aii-2018-0001, several years in the time series have been recalculated, for the years where the diesel and gasoline for population consumption (1A4bii) were available in the national statistics. Where data are not available separately, the estimation is included in NFRs 1A3b (same for 2019).

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

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
2019	IE	IE	IE	IE

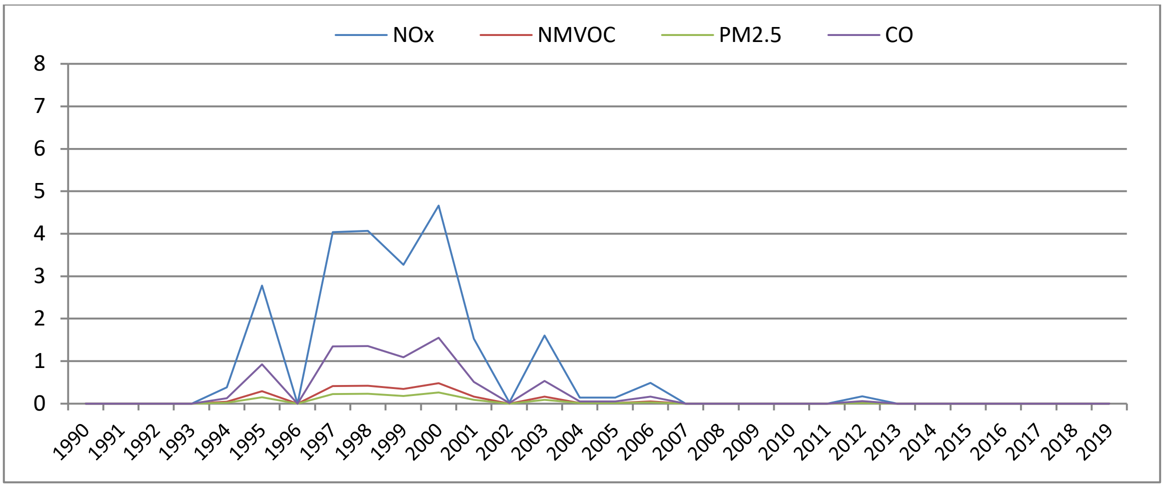


Figure 3.9.1.1 Emissions of main pollutants (kt) from NFR 1A4bii

The fuel consumption for the time-series 1990-2019 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
2019	0

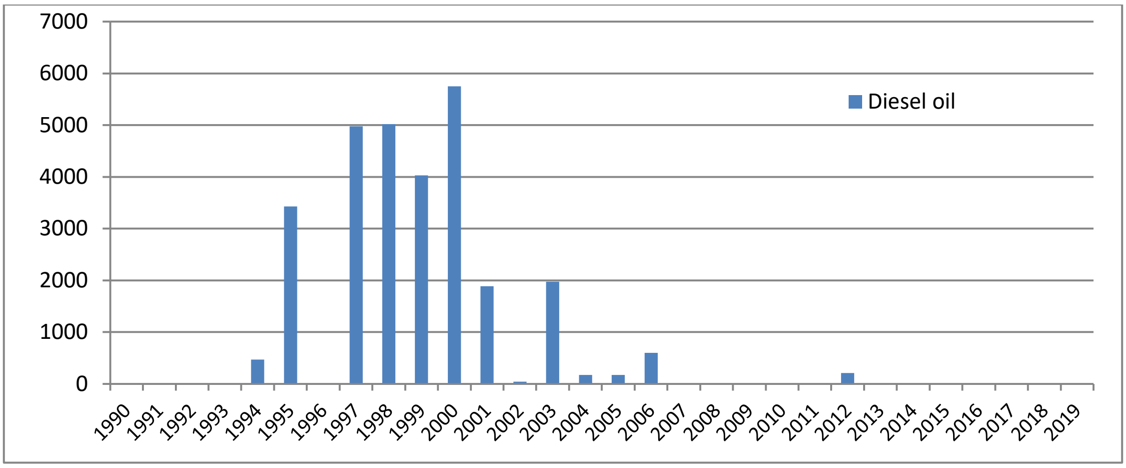


Figure 3.9.1.2 Fuel consumption (TJ) for NFR 1A4bii

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

The emissions for 1990-2019 are estimated by applying Tier 1 emission factors (2019 EMEP/EEA Guidebook, NFR 1.A.4 Small combustion, Tables 3.7 – 3.10) to the fuel consumption provided in EUROSTAT energy balances: *Final energy consumption/Other Sectors/Agriculture/Forestry*. From oil category, 100% of 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.

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

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM_{10}	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

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM_{10}	BC	CO	Pb
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
2019	1.416	0.344	0.798	0.198	0.051	1.207	0.116

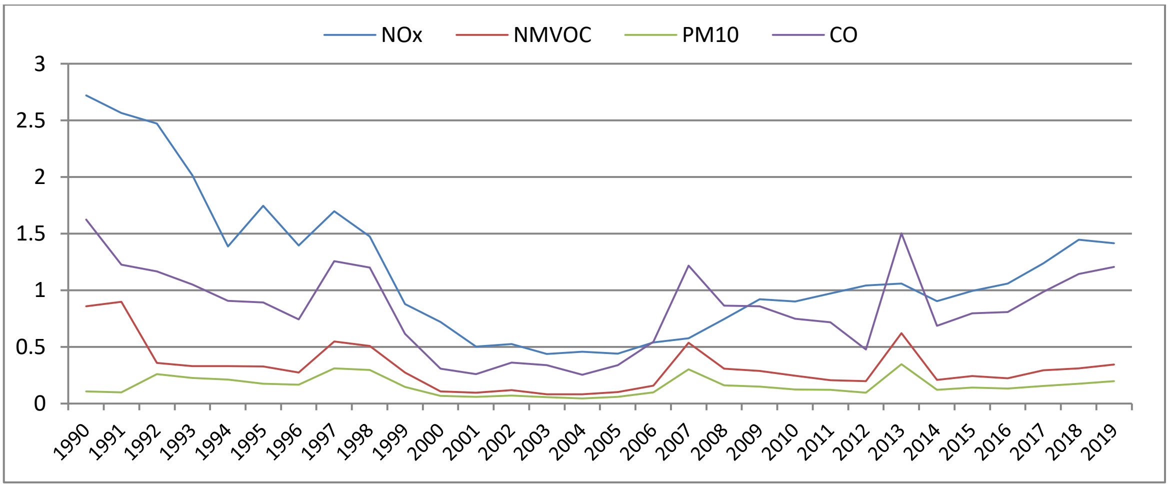


Figure 3.10.1 Emission Trends of main pollutants for NFR 1.A.4.c.i

The fuel consumption for the time-series 1990-2019 for this category is provided 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

Year/Fuel (TJ)	Liquid fuels	Solid fuels	Gaseous fuels	Biomass
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
2017	2371	496	5439	254
2018	2922	625	5723	218
2019	2917	615	5177	375

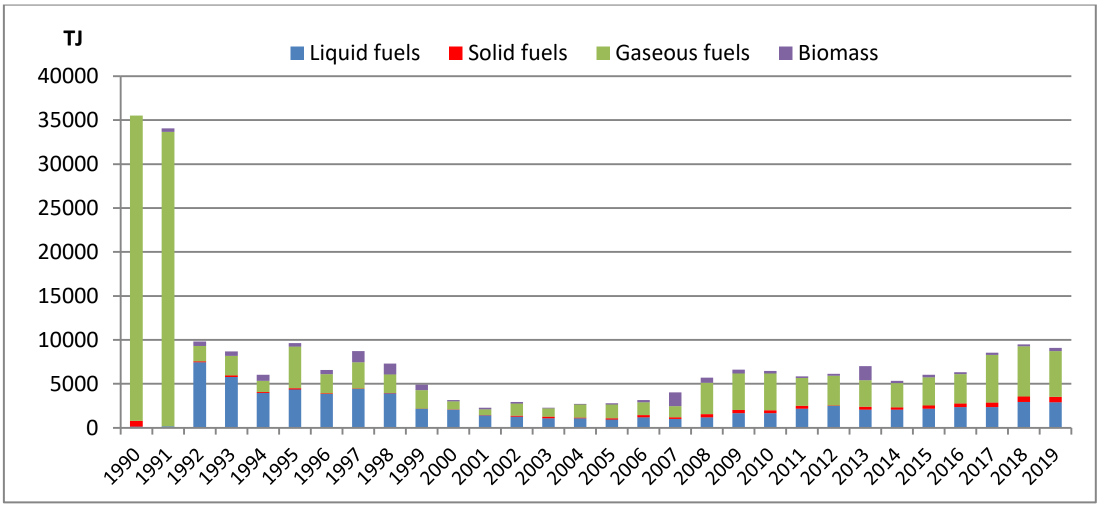


Figure 3.10.2 Fuel consumptions (TJ) for NFR 1.A.4.c.i: Agriculture/Forestry/Fishing, stationary

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 machinery, 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. NFR 1A4cii is not a key source for any pollutant.

Starting with 2020 submission, following the Review recommendation RO-1A4cii-2019-0001, the emissions are estimated on Tier2 level, for all pollutants and years for which the Guidebook provides default values for splitting the fuel consumption by engine age and technologies.
Improvement of the calculation method:
The whole time-series was recalculated, to be consistent with the method applied for other non-road mobiles NFR categories, regarding the gasoline (split on technologies, two

strokes/four strokes engines). Due to low consumption of gasoline in agriculture/forestry, the corrections are low. The highest corrections are for NMVOC (decrease with 0.6 kt in 2018, compared to 2020 reporting) and CO (increase with 0.45 kt in 2018 compared to previous reporting).

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 - 2019 are provided by N.I.S. in the Eurostat Energy questionnaires.
The activity data considered in the actual estimation consist of 80% of the Gas/Diesel oil and 100% of the Motor Gasoline provided in the category *Final energy consumption/Other Sectors/Agriculture/Forestry/Fishing*. 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 national data on split of the fuel consumption 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 1998-2019 interval. 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 for all years, using the emission factors in Table 3.11.1, NFR 1.A.4 Non road mobile machinery, Guidebook 2019. SOx are estimated based on sulphur content in the fuel.

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	22.56	4.03	1.377	1.15	0.67	17.88
1993	17.47	2.40	1.068	0.88	0.52	9.82
1994	11.94	1.38	0.730	0.60	0.35	5.21
1995	13.19	1.87	0.806	0.66	0.39	7.74
1996	11.82	3.01	0.719	0.61	0.35	14.49
1997	13.54	2.16	0.827	0.69	0.40	9.29
1998	11.93	2.64	0.727	0.61	0.35	12.37
1999	8.92	1.59	0.140	0.48	0.26	6.41
2000	8.80	2.44	0.137	0.47	0.25	11.35
2001	5.99	1.12	0.094	0.31	0.17	4.71
2002	5.16	0.89	0.084	0.26	0.14	3.71
2003	4.55	0.93	0.068	0.21	0.12	4.26
2004	3.86	0.86	0.071	0.18	0.10	4.01
2005	3.19	0.65	0.009	0.14	0.08	3.03
2006	3.80	1.92	0.011	0.19	0.10	10.16

Year/Pollutant (kt)	NOx	NMVOC	SOx	PM_{10}	BC	CO
2007	2.90	0.43	0.009	0.12	0.07	3.11
2008	2.55	0.51	0.009	0.11	0.07	4.49
2009	3.99	0.51	0.003	0.17	0.10	3.51
2010	3.79	0.55	0.003	0.16	0.10	4.21
2011	4.47	0.49	0.004	0.18	0.11	3.01
2012	4.97	0.99	0.005	0.19	0.12	9.15
2013	2.53	0.50	0.004	0.09	0.06	4.68
2014	3.30	0.44	0.004	0.12	0.08	3.57
2015	3.13	0.79	0.004	0.11	0.07	8.06
2016	2.90	0.42	0.004	0.10	0.07	3.68
2017	2.54	0.40	0.004	0.09	0.06	3.59
2018	2.74	0.48	0.005	0.09	0.06	4.55
2019	2.31	0.51	0.005	0.08	0.05	5.21

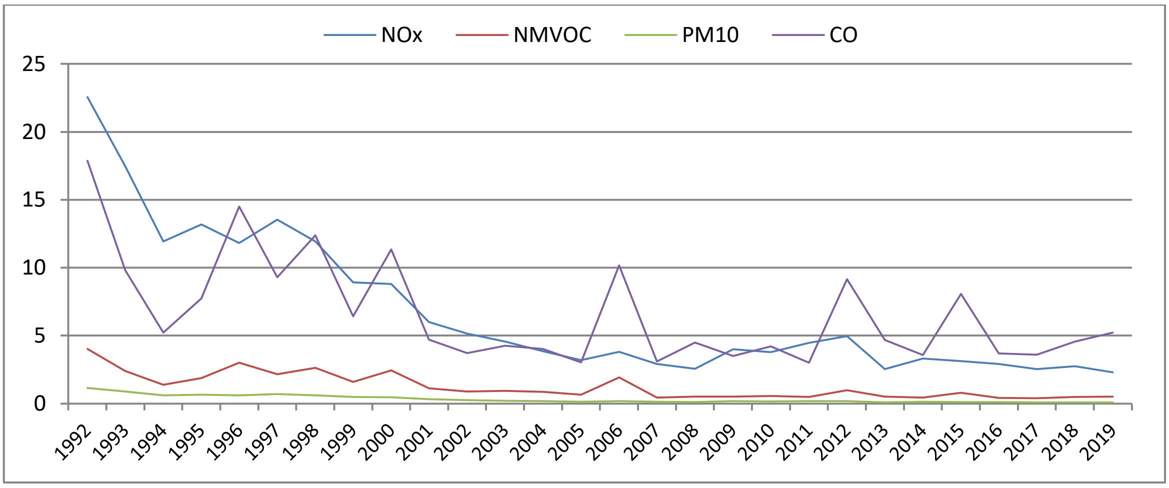


Figure 3.10.1.1 Emissions (kt) of NOx, NMVOC, PM_{10} and CO for NFR 1.A.4.c.ii, 1992-2019

Compared to 2005, the emissions decreased in 2019 with 0.88 kt for NOx and 0.14 kt for NMVOC.

The emission trends are consistent with the variation of the fuel consumption.

The fuel consumption for the time-series 1992-2019 for this category is provided in the table and chart below.

Table 3.10.1.2 Fuel consumptions (TJ) for 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

Year/Fuel (TJ)	Gasoline	Diesel fuel	Total liquid fuel
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
2014	131	10227	10358
2015	392	10906	11298
2016	131	11627	11758
2017	127	11648	11775
2018	159	11518	11677
2019	199	11321	11520

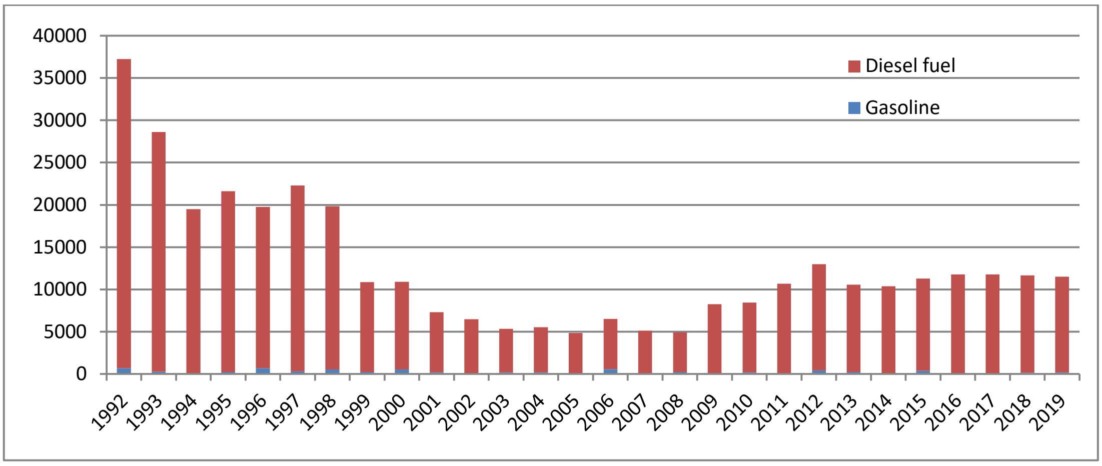


Figure 3.10.1.2 Fuel consumption (TJ) for NFR 1.A.4.c.ii, off road Agriculture/Forestry/Fishing

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

The emissions reported at NFR 1A5 - Other stationary (including military) for the years 1990-2019 are based on Eurostat Energy data and Tier 1 emission factors. The data for 1990-2016 are provided in the EUROSTAT annual energy balances (nrg_110), in the category: *Final energy consumption/Other Sectors/Non-specified (Oth*er). Data for 2017-2019 are 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.

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, 1990-2019

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
2019	2.63	0.17	0.81	0.18	0.09	0.80	1.08

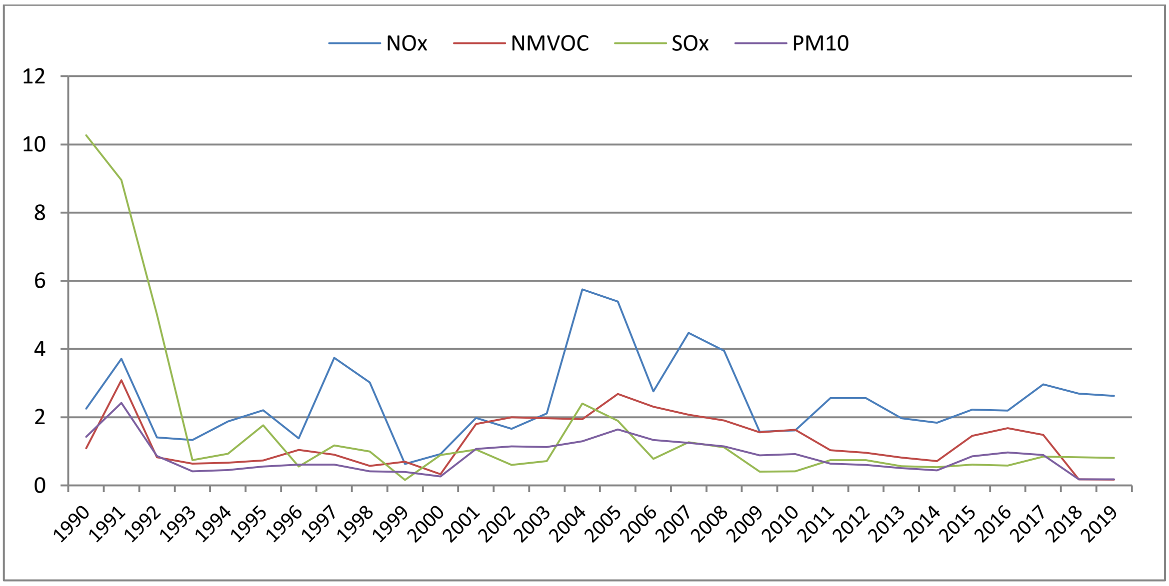


Figure 3.11.1 Emissions for NFR 1A5, 1990-2019

The emissions are consistent with the variation of the fuel consumption in the Energy statistics. The fuel consumption for the time-series 1990-2019 for this category is given in the table and chart below.

Table 3.11.2 Fuel consumption (TJ), 1A5, 1990-2019

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
2019	8605	0	0	0

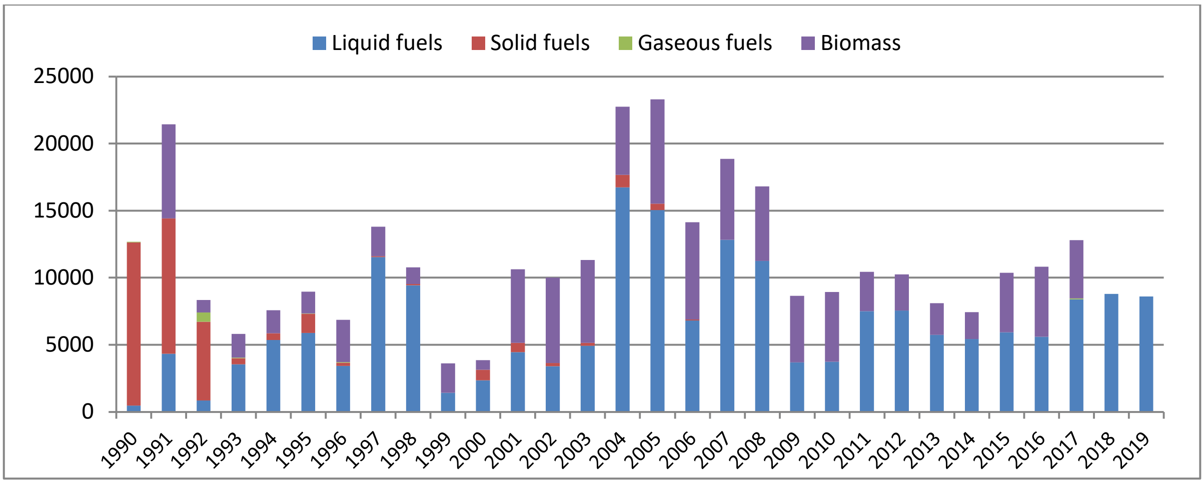


Figure 3.11.2 Fuel consumption (TJ), 1A5, 1990-2019

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 (914.4m), 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).

A new flight category was added in 2020 EUROCONTROL report, undetermined, defined as "*Flights recorded as departing from a domestic aerodrome and returning to the same aerodrome, without intermediary stop* ("ADEP=ADES" flight type). For most of these flights, the existence of at least one stop in a domestic or international aerodrome can be supposed but cannot be confirmed."

The values of pollutants of this new category were included in Domestic aviation LTO (civil) and Domestic aviation cruise (civil) for 2019.

This category does not include military aviation activities. The values of pollutants due to the aviation activities for the period 2005-2019 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].

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

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.

Table 3.12.1. Fuel burnt (tonnes), in 2005-2019, 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
2019*	58431.69	8388.67	382815.34	17583.88

** Included fuel burn of new category added in 2020 – UNDETERMINED.*

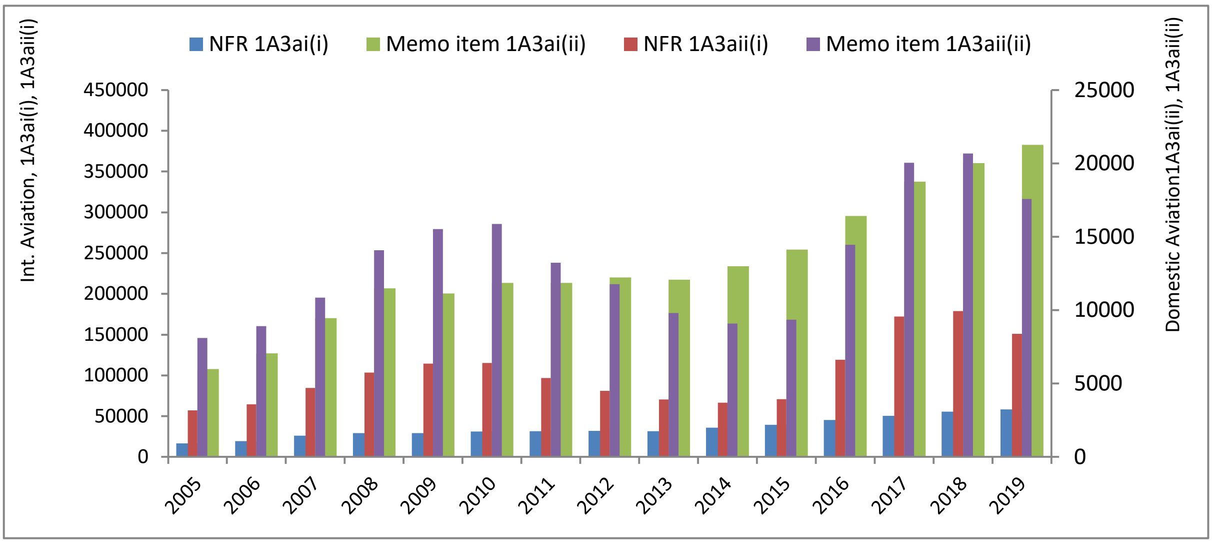


Figure 3.12.1. Fuel burnt (tonnes), in 2005-2019, Aviation transport

Table 3.12.2. Emissions trends (kt), NFR 1.A.3.aii(i) - Domestic aviation LTO (civil), 2005-2019

Year/Pollutant	NOx [kt]	NMVOC [kt]	SOx [kt]	CO [kt]	Σ ($PM_{2.5}$ 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

Year/Pollutant	NOx [kt]	NMVOC [kt]	SOx [kt]	CO [kt]	∑ ($PM_{2.5}$ PM_{10})[kt]
2009	0.071488	0.008925	0.005350	0.091709	0.000795
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
2019*	0.096804	0.008545	0.007046	0.096612	0.001295

** * Included fuel burn of new category added in 2020 – UNDETERMINED.*

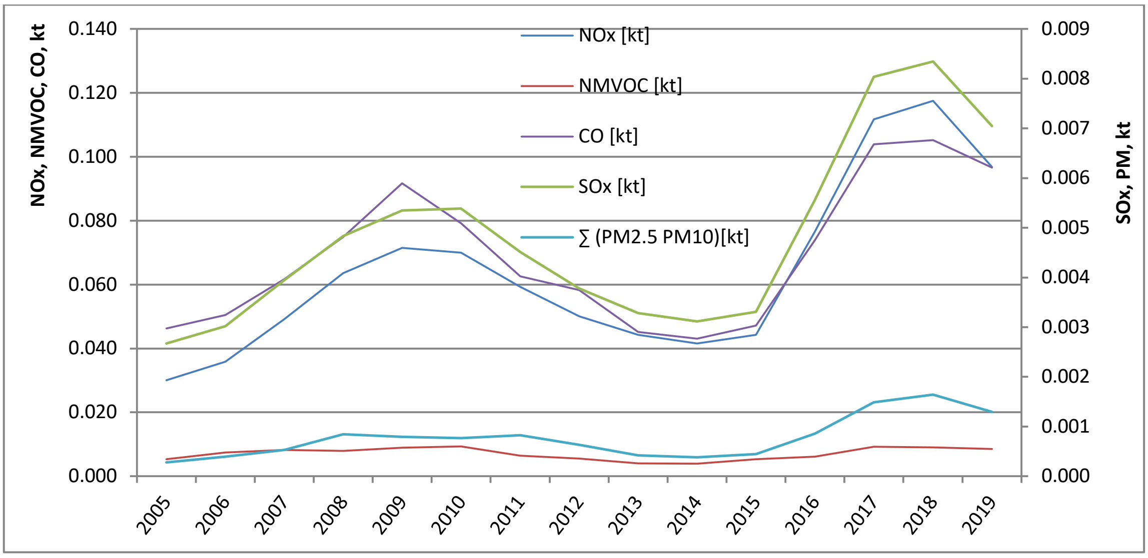


Figure 3.12.2. Emissions trends (kt), NFR 1.A.3.aii(i) - Domestic aviation LTO (civil)

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. For 2019 have included emissions for new category added, UNDETERMINED.

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 2019, for NOx with 39.23% of the total, NMVOC with 8.93% of total, BC with 15.8% of the total, CO with 12.64% of the total, Cu with 81.40% of the total and Zn with 7.14% of the total.

Table 3.13.1. Share of emissions (%) from 1A3b in the national total in 2019

Pollutant	1A3bi	1A3bii	1A3biii	1A3biv	1A3bv	1A3bvi	1A3bvii	1A3b
NOx	13.156%	5.738%	20.294%	0.040%	-	-	-	39.228%
NMVOC	3.728%	0.787%	1.168%	0.353%	2.905%	-	-	8.928%
SOx	0.056%	0.015%	0.037%	0.000%	-	-	-	0.109%
NH_3	0.495%	0.032%	0.037%	0.000%	-	-	-	0.565%
$PM_{2.5}$	0.997%	0.551%	0.994%	0.014%	-	0.865%	0.434%	3.855%
PM_{10}	0.730%	0.403%	0.728%	0.010%	-	1.190%	0.588%	3.649%
TSP	0.479%	0.265%	0.478%	0.007%	-	1.020%	0.772%	3.020%
BC	6.473%	3.505%	4.930%	0.019%	-	0.729%	0.144%	15.799%
CO	8.989%	1.818%	1.383%	0.454%	-	-	-	12.643%
Pb	0.007%	0.001%	0.002%	0.000%	-	6.258%	-	6.268%
Cd	0.011%	0.002%	0.003%	0.000%	-	0.389%	-	0.405%
Hg	1.313%	0.299%	0.679%	0.007%	-	-	-	2.299%
As	0.013%	0.002%	0.005%	0.000%	-	0.746%	-	0.766%
Cr	0.172%	0.052%	0.129%	0.001%	-	7.764%	-	8.118%
Cu	0.056%	0.017%	0.041%	0.000%	-	81.285%	-	81.400%
Ni	0.031%	0.003%	0.004%	0.000%	-	1.464%	-	1.502%
Se	0.005%	0.001%	0.002%	0.000%	-	0.230%	-	0.238%
Zn	0.063%	0.014%	0.030%	0.000%	-	7.029%	-	7.136%
PCDD/PCDF	0.914%	0.240%	0.234%	0.004%	-	-	-	1.392%
Total PAH	0.436%	0.126%	0.254%	0.001%	-	-	-	0.818%
HCB	0.055%	0.014%	0.009%	0.000%	-	-	-	0.078%
PCBs	0.002%	0.001%	0.000%	0.000%	-	-	-	0.003%

Note - Only three decimals are displayed in the table

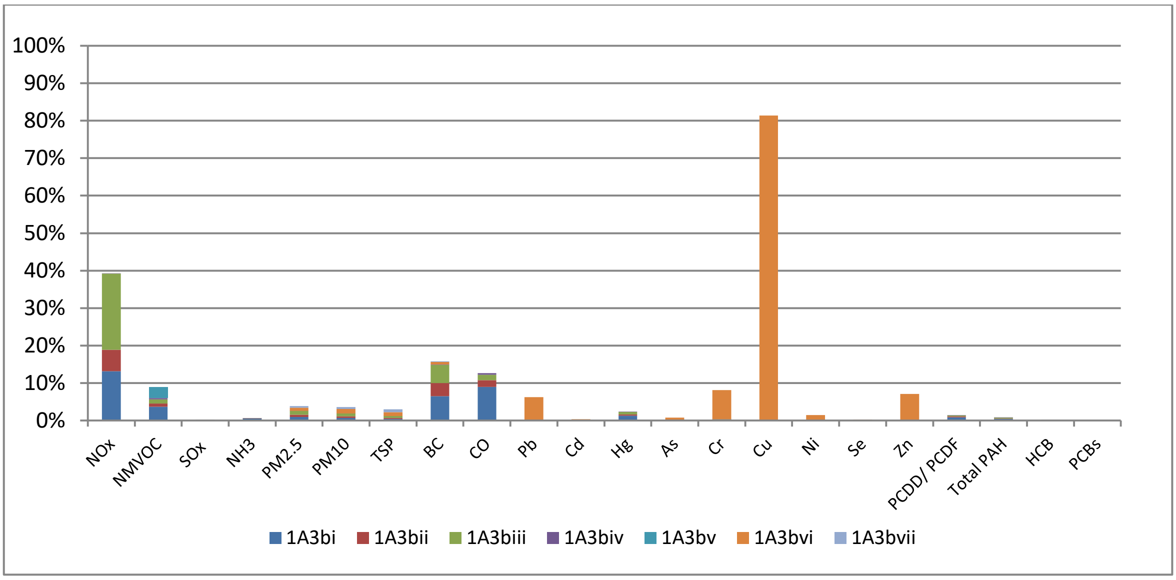


Figure 3.13.1 Share of emissions (%) from 1A3b in the national total in 2019

In 2019, 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 pollutants in the national total in 2019 (%)

NFR/Pollutant	NOx	NMVOC	BC	CO	Cu	Zn
1A3bi Road transport: Passenger cars	13.16%	3.73%	6.47%	8.99%		
1A3bii Road transport: Light duty vehicles	5.74%					
1A3biii Road transport: Heavy duty vehicles and buses	20.29%		4.93%			
1A3bv Road transport: Gasoline evaporation		2.91%				
1A3bvi Road transport: Automobile tyre and brake wear					81.28%	7.03%
Total	39.19%	6.64%	11.40%	8.99%	81.28%	7.03%

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 SO_2 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 2005-2019:

Emissions for 2019 were estimated by importing data from COPERT 4 into COPERT 5.4.36 version and the 2005-2018 series was also updated with this version.
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.

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).

Default COPERT, sulphur and heavy metals contents have been taken into account for emission estimates.

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/ number of vehicles	Passenger Cars – Gasoline+ LPG	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
2019	4039798	3230053	117230	707833	949	400223	225028

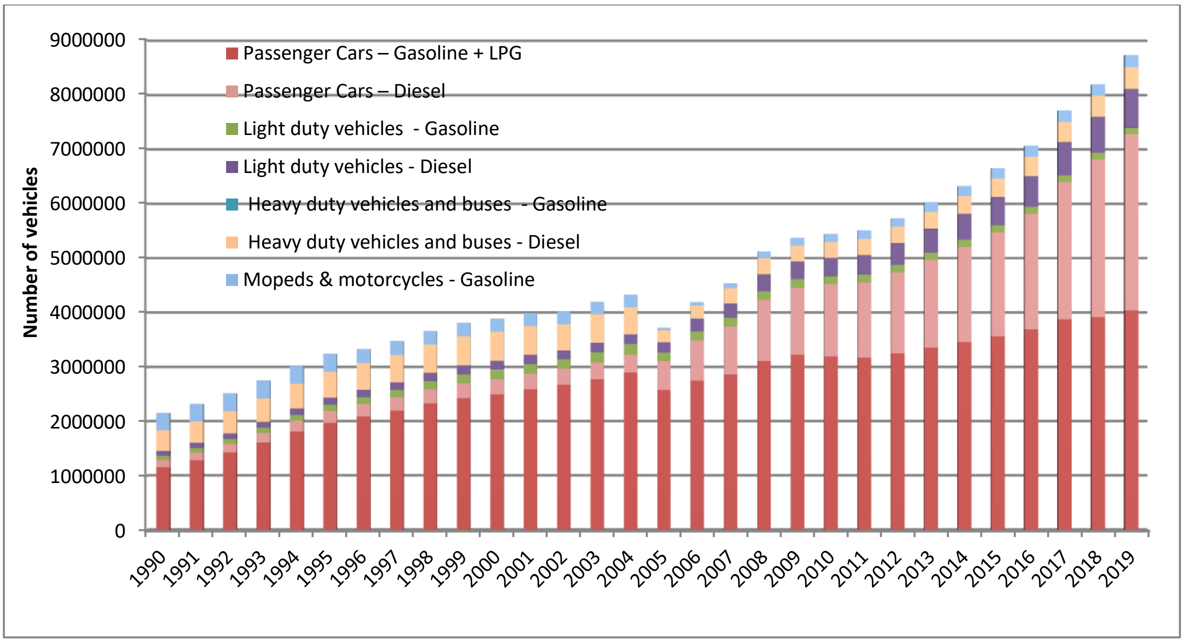


Figure 3.13.2. Fleet evolution (number of vehicles)

Compared to 2005 data, in 2019 the number of vehicles increased by 608% for diesel cars, 532% for gasoline mopeds and motorcycles, 375% for light diesel vehicles and 183% for heavy diesel vehicles and buses.

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

Year/fuel consumption	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

Year/fuel consumption	Gasoline	Diesel	LPG
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
2019	55365	184714	4129

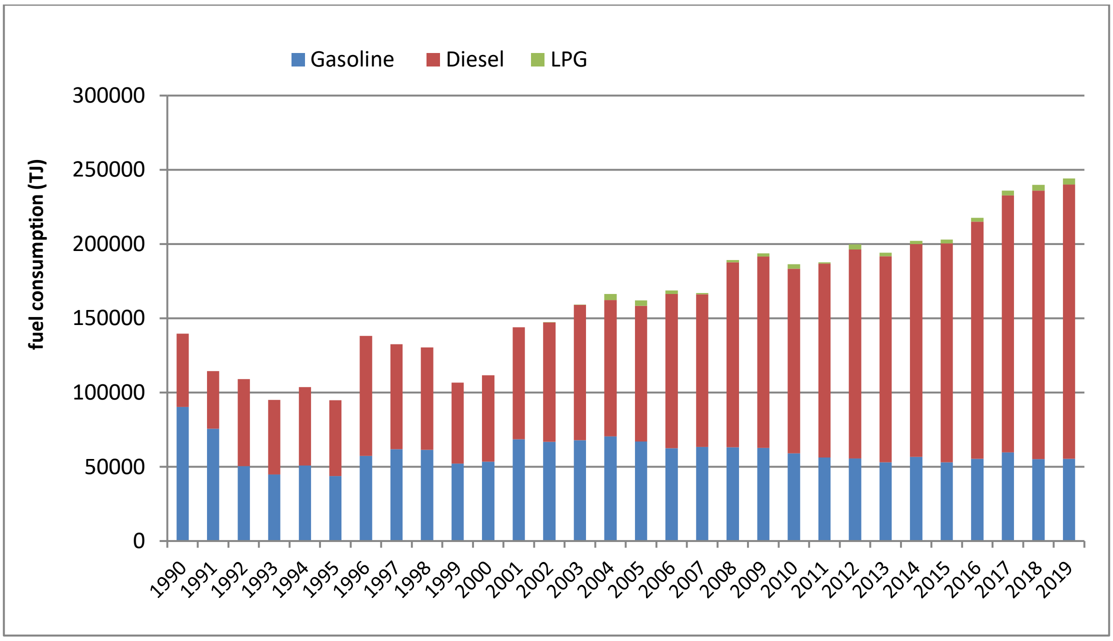


Figure 3.13.3. Fuel consumption (TJ), for Road Transport 1.A.3.b.

NFR 1.A.3.b.i., 1.A.3.b.ii, 1.A.3.b.ii are key source for emissions of NOx in 2019.

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

Year/NOx	1A3bi	1A3bii	1A3biii	1A3biv
1990	18.050	2.615	33.299	0.1453
1991	14.867	2.403	26.254	0.1468
1992	10.565	2.685	39.047	0.1503
1993	9.379	2.486	33.101	0.1450
1994	10.528	3.024	34.046	0.1514
1995	8.966	2.821	33.538	0.1527
1996	12.611	3.812	52.512	0.1185
1997	13.049	3.710	46.046	0.1165
1998	12.837	3.929	44.674	0.1143
1999	10.508	3.639	35.244	0.1127
2000	10.840	3.914	37.502	0.1111
2001	14.463	4.594	47.927	0.1105
2002	14.729	4.824	49.925	0.1110
2003	15.042	5.392	56.992	0.1096
2004	15.985	4.940	60.683	0.1090
2005	33.599	9.052	52.526	0.0173

Year/NOx	1A3bi	1A3bii	1A3biii	1A3biv
2006	31.691	9.249	54.862	0.0220
2007	28.928	7.357	52.880	0.0360
2008	27.929	9.454	55.467	0.0435
2009	27.457	8.856	54.208	0.0475
2010	24.864	8.183	50.604	0.0475
2011	23.431	8.498	50.955	0.0482
2012	27.037	10.848	48.422	0.0475
2013	23.999	9.636	50.907	0.0562
2014	25.225	8.812	51.821	0.0625
2015	24.378	10.395	48.879	0.0607
2016	25.999	11.404	50.260	0.0644
2017	28.022	11.937	50.017	0.0788
2018	28.958	12.206	48.361	0.0924
2019	28.614	12.480	44.138	0.0872

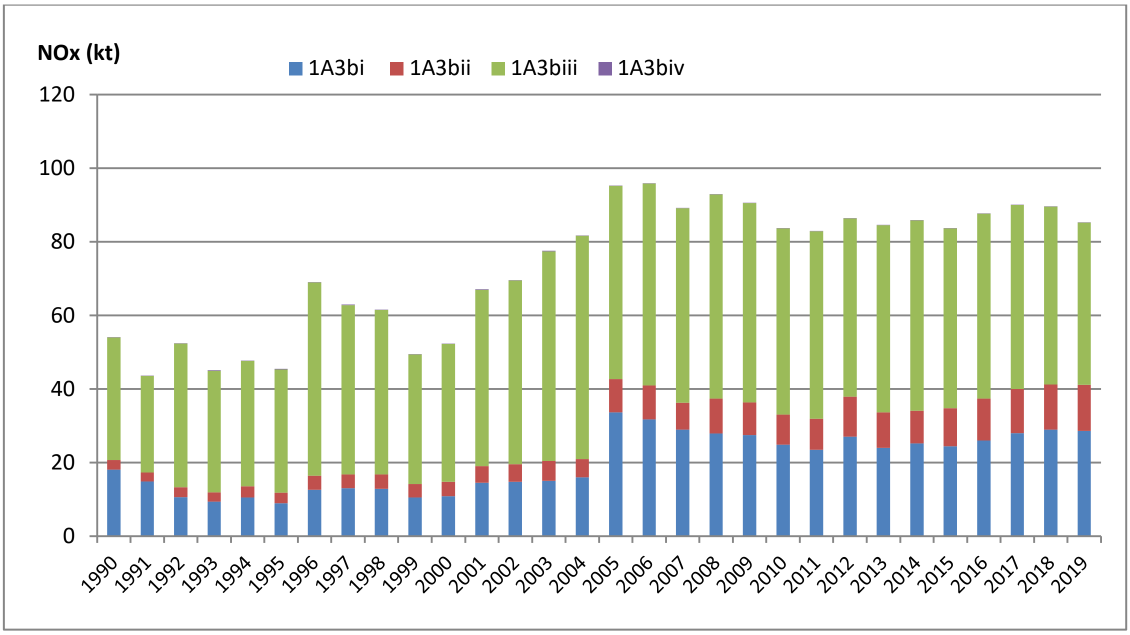


Figure 3.13.4. NOx emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.i. and 1.A.3.b.v are key source for emissions of NMVOC in 2019.

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

Year/NMVOC (kt)	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

Year/NMVOC (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3bv
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	29.840	4.346	5.529	0.768	9.812
2006	25.818	3.945	5.506	0.730	9.399
2007	21.992	3.270	5.336	0.588	8.755
2008	19.411	3.155	5.084	0.650	8.321
2009	17.065	2.784	4.696	0.666	8.097
2010	13.867	2.379	4.218	0.644	7.388
2011	12.216	2.239	4.028	0.636	6.859
2012	12.335	2.418	3.620	0.532	6.784
2013	11.082	2.140	3.666	0.527	6.609
2014	10.905	2.000	3.602	0.622	6.563
2015	9.951	2.010	3.295	0.598	6.404
2016	10.114	2.100	3.316	0.619	6.719
2017	9.849	2.091	3.232	0.751	6.783
2018	9.118	1.985	3.070	0.766	6.847
2019	8.544	1.805	2.678	0.810	6.660

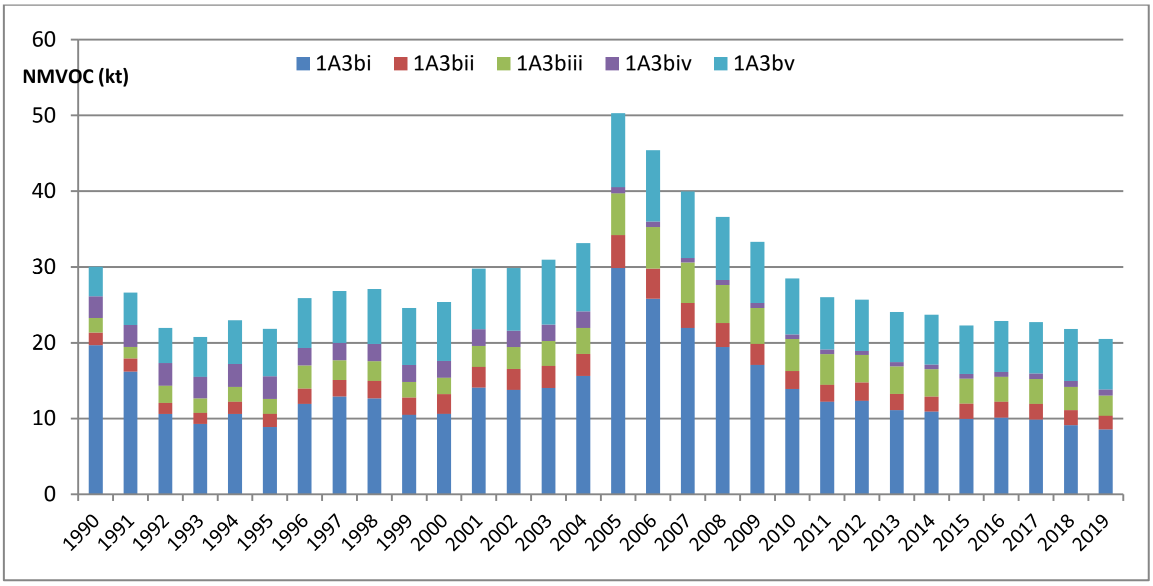


Figure 3.13.5. NMVOC emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.i. and 1.A.3.b.iii are key source for emissions of BC in 2019.

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

Year/BC (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3bvi	1A3bvii
1990	0.0560	0.0687	0.4971	0.0053	NE	NE
1991	0.0461	0.0526	0.3920	0.0054	NE	NE
1992	0.0734	0.0827	0.5830	0.0055	NE	NE
1993	0.0708	0.0702	0.4942	0.0053	NE	NE
1994	0.0722	0.0944	0.5083	0.0055	NE	NE
1995	0.0678	0.0756	0.5007	0.0056	NE	NE
1996	0.1175	0.1226	0.7840	0.0043	NE	NE
1997	0.0982	0.1098	0.6874	0.0042	NE	NE

Year/BC (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3bvi	1A3bvii
1998	0.0991	0.1112	0.6670	0.0042	NE	NE
1999	0.0737	0.0975	0.5262	0.0041	NE	NE
2000	0.0850	0.0977	0.5599	0.0041	NE	NE
2001	0.1186	0.1303	0.7155	0.0040	NE	NE
2002	0.1448	0.1444	0.7454	0.0040	NE	NE
2003	0.1497	0.1694	0.8509	0.0040	NE	NE
2004	0.1143	0.1428	0.9060	0.0040	NE	NE
2005	0.5520	0.3982	1.0760	0.0022	0.0547	0.0107
2006	0.6302	0.4341	1.1051	0.0021	0.0583	0.0114
2007	0.5730	0.3031	1.0433	0.0019	0.0600	0.0120
2008	0.6765	0.4704	1.0354	0.0021	0.0679	0.0134
2009	0.7027	0.4178	0.9809	0.0022	0.0695	0.0138
2010	0.6689	0.3845	0.8988	0.0022	0.0671	0.0133
2011	0.6720	0.4042	0.8824	0.0022	0.0684	0.0136
2012	0.8495	0.5334	0.8176	0.0015	0.0767	0.0149
2013	0.7174	0.4579	0.8432	0.0014	0.0733	0.0146
2014	0.7527	0.3416	0.8439	0.0019	0.0759	0.0154
2015	0.7270	0.4864	0.7833	0.0019	0.0770	0.0155
2016	0.7813	0.5252	0.7949	0.0019	0.0842	0.0168
2017	0.8816	0.5443	0.7817	0.0024	0.0896	0.0178
2018	0.9097	0.5340	0.7476	0.0024	0.0933	0.0184
2019	0.8608	0.4661	0.6556	0.0026	0.0969	0.0191

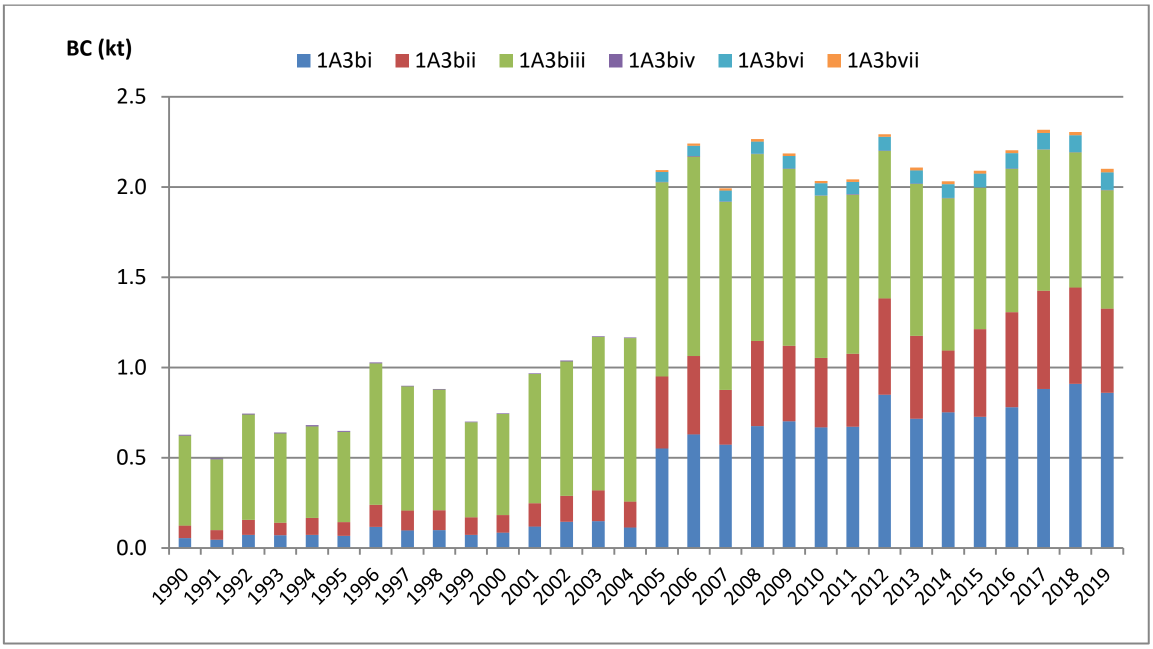


Figure 3.13.6. BC emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.i. is key source for emissions of CO in 2019.

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

Year/CO (kt)	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

Year/CO (kt)	1A3bi	1A3bii	1A3biii	1A3biv
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	268.969	45.958	15.250	2.300
2006	234.250	41.313	15.799	2.319
2007	196.366	35.051	15.317	2.299
2008	170.502	32.669	15.596	2.548
2009	152.194	28.594	14.951	2.677
2010	125.460	23.975	13.829	2.645
2011	110.114	22.020	13.789	2.631
2012	111.005	22.972	13.077	1.955
2013	101.035	20.358	13.747	2.491
2014	100.640	19.338	14.015	2.900
2015	92.563	18.748	13.251	2.802
2016	94.270	19.402	13.660	2.942
2017	92.009	19.110	13.607	3.497
2018	85.378	17.825	13.179	3.807
2019	80.323	16.244	12.358	4.059

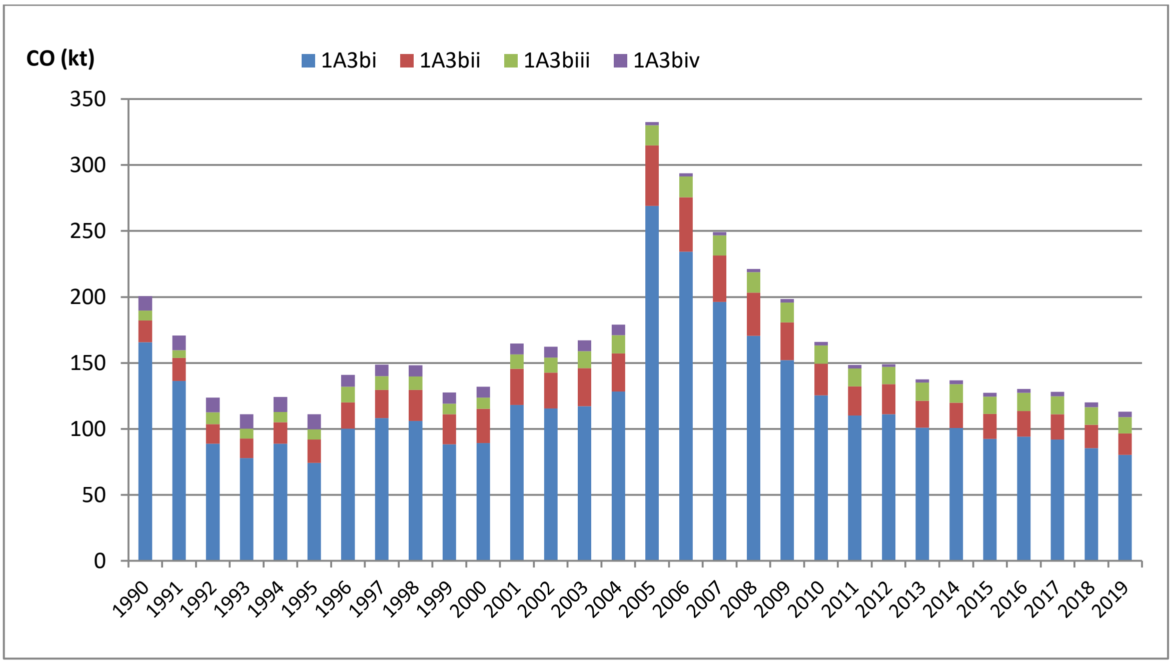


Figure 3.13.7. CO emissions trend (kt) for Road Transport 1.A.3.b. by NFR

NFR 1.A.3.b.vi. is key source for emissions of Cu and Zn in 2019. These emissions are estimate for the 2005-2019 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/1.A.3.b.vi	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
2019	20.751	7.702

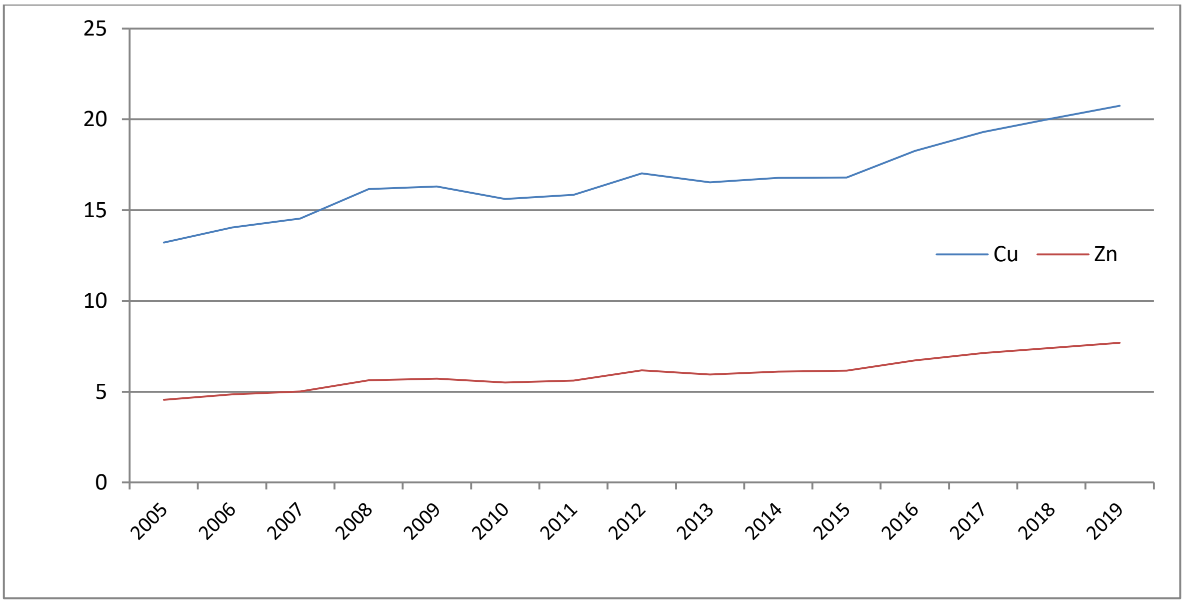


Figure 3.13.8. Cu and Zn (t) emissions for NFR 1.A.3.b.vi Road transport: Automobile tyre and brake wear

Recalculations and improvements:

- Updating the time series 2005-2018 in Copert 5.4.36. The changes are not significant. This version estimates the BC emissions for NFR 1A3bvi and 1A3bvii;
- Correction of sulphur content error in COPERT (for 2005-2018 changing of the sulfur content for petrol and diesel class 2 from zero to the same value as petrol and diesel class 1; for 2005 changing the error in fuel specifications; for 2009 the percentage of sulfur in the fuel changed from 50 to 10).

  SO_2 emissions have increased significantly due to recalculation (except for 2009 which decreased), while the impact on national emissions is not significant.

Table 3.13.10. Differences in SO_2 emissions between 2021 and 2020 submissions for Road Transport 1.A.3.b. by NFR

Submission 2021

Year/SO2 (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3b total
2005	0.6303	0.2414	0.8456	0.00116	1.7185
2006	0.6948	0.2721	0.9069	0.00130	1.8751
2007	0.1721	0.0415	0.1337	0.00057	0.3479
2008	0.1891	0.0557	0.1469	0.00069	0.3924
2009	0.0392	0.0107	0.0291	0.00015	0.0792
2010	0.0380	0.0100	0.0276	0.00015	0.0756
2011	0.0377	0.0104	0.0283	0.00015	0.0766
2012	0.0443	0.0134	0.0276	0.00013	0.0854
2013	0.0408	0.0119	0.0296	0.00015	0.0824
2014	0.0437	0.0111	0.0311	0.00017	0.0862
2015	0.0433	0.0128	0.0308	0.00017	0.0871
2016	0.0476	0.0141	0.0332	0.00018	0.0951
2017	0.0521	0.0148	0.0342	0.00022	0.1013
2018	0.0547	0.0152	0.0344	0.00025	0.1046

Submission 2020

Year/SO_2 (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3b total
2005	0.3312	0.1281	0.4522	0.00060	0.9121
2006	0.3660	0.1446	0.4850	0.00068	0.9963
2007	0.0901	0.0219	0.0715	0.00030	0.1839
2008	0.0992	0.0295	0.0785	0.00035	0.2076
2009	0.1028	0.0285	0.0778	0.00038	0.2095
2010	0.0199	0.0053	0.0148	0.00008	0.0400
2011	0.0198	0.0055	0.0151	0.00008	0.0406
2012	0.0233	0.0071	0.0147	0.00007	0.0452
2013	0.0214	0.0063	0.0158	0.00008	0.0436
2014	0.0230	0.0059	0.0166	0.00009	0.0457
2015	0.0228	0.0068	0.0165	0.00009	0.0462
2016	0.0251	0.0075	0.0177	0.00009	0.0504
2017	0.0275	0.0079	0.0183	0.00011	0.0538
2018	0.0289	0.0081	0.0184	0.00013	0.0555

Differences between 2021 and 2020

Year/SO_2 (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3b total
2005	0.2991	0.1133	0.3933	0.00056	0.8064
2006	0.3288	0.1275	0.4219	0.00063	0.8788
2007	0.0820	0.0196	0.0622	0.00028	0.1641
2008	0.0899	0.0262	0.0683	0.00033	0.1847
2009	-0.0636	-0.0177	-0.0487	-0.00023	-0.1303
2010	0.0180	0.0047	0.0128	0.00007	0.0356
2011	0.0179	0.0049	0.0132	0.00007	0.0360
2012	0.0210	0.0063	0.0128	0.00006	0.0401
2013	0.0193	0.0056	0.0138	0.00007	0.0387

Year/SO_2 (kt)	1A3bi	1A3bii	1A3biii	1A3biv	1A3b total
2014	0.0207	0.0052	0.0145	0.00008	0.0405
2015	0.0205	0.0060	0.0143	0.00008	0.0409
2016	0.0225	0.0066	0.0154	0.00009	0.0447
2017	0.0246	0.0069	0.0159	0.00011	0.0476
2018	0.0259	0.0071	0.0160	0.00012	0.0491

The trend of SO_2 emissions for 1990-2019 is shown in the table below.

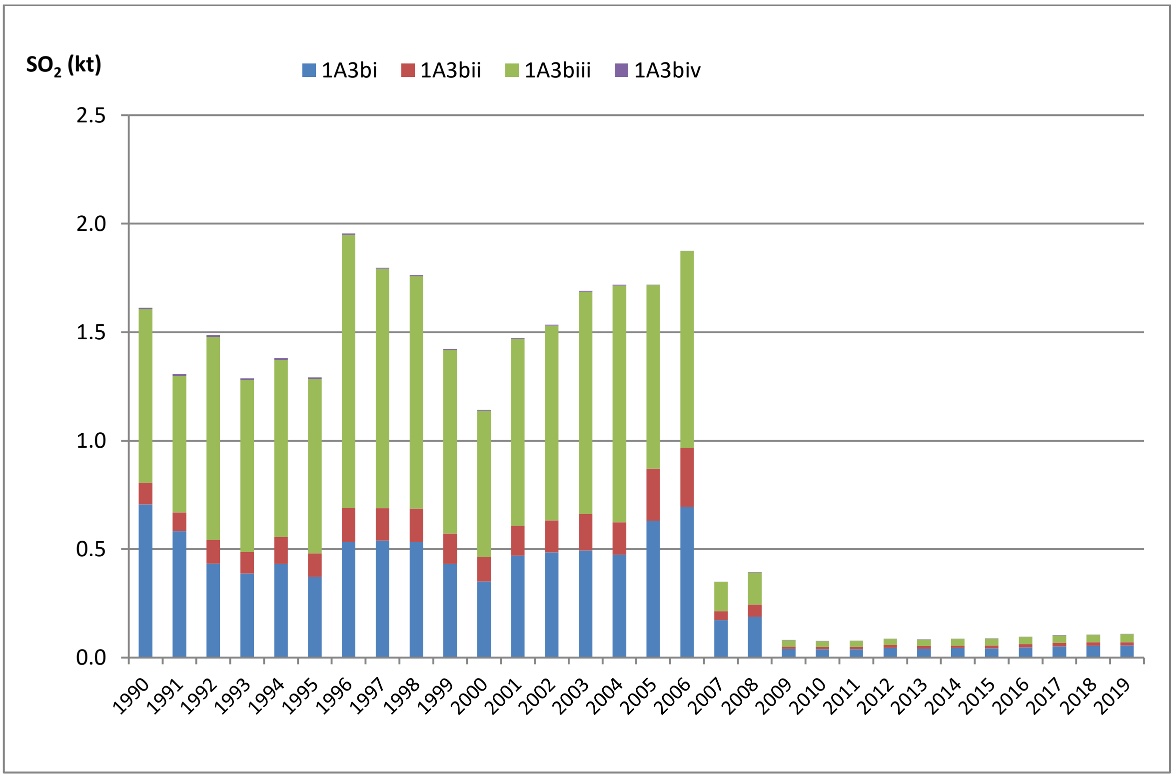


Figure 3.13.9. SO_2 (kt) emissions for NFR 1.A.3.b Road transport

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

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
2011	193000
2012	182000
2013	161000
2014	107000
2015	111000
2016	108000
2017	113870
2018	92581
2019	127425

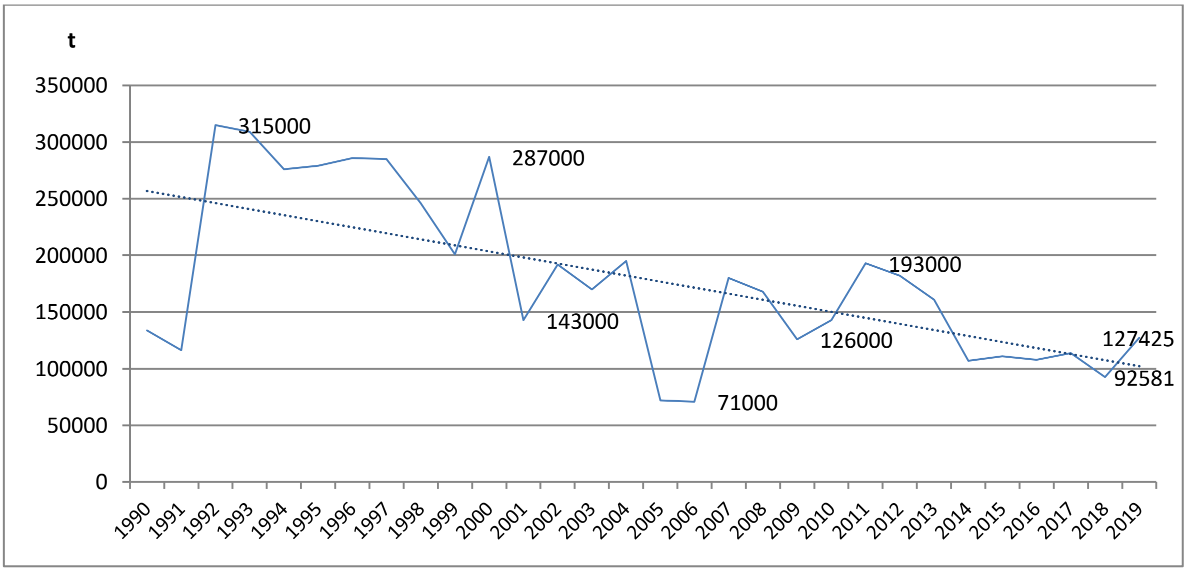


Figure 3.14.1. Fuel consumption (t) for NFR 1.A.3.c – Railway

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%), in 2019 increasing to 127425t (by almost 38% compared to 2018).

In 2019 NFR 1.A.3.c is a key source for NOx pollutant, rank 9 and 3% of the national total.

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	0.00094	0.1835	1.4333
1991	6.0899	0.5404	0.2324	0.00081	0.1592	1.2435
1992	16.5060	1.4648	0.6300	0.00221	0.4316	3.3705
1993	16.1916	1.4369	0.6180	0.00216	0.4233	3.3063
1994	14.4624	1.2834	0.5520	0.00193	0.3781	2.9532
1995	14.6196	1.2974	0.5580	0.00195	0.3822	2.9853
1996	14.9864	1.3299	0.5720	0.00200	0.3918	3.0602
1997	14.9340	1.3253	0.5700	0.00200	0.3905	3.0495
1998	12.8904	1.1439	0.4920	0.00172	0.3370	2.6322
1999	10.5324	0.9347	0.1407	0.00141	0.2754	2.1507
2000	15.0388	1.3346	0.2009	0.00201	0.3932	3.0709
2001	7.4932	0.6650	0.1001	0.00100	0.1959	1.5301
2002	10.0608	0.8928	0.1344	0.00134	0.2630	2.0544
2003	8.9080	0.7905	0.1190	0.00119	0.2329	1.8190
2004	10.2180	0.9068	0.1365	0.00137	0.2672	2.0865
2005	3.7728	0.3348	0.0072	0.00050	0.0986	0.7704
2006	3.7204	0.3302	0.0071	0.00050	0.0973	0.7597
2007	9.4320	0.8370	0.0180	0.00126	0.2466	1.9260
2008	8.8032	0.7812	0.0168	0.00118	0.2302	1.7976
2009	6.6024	0.5859	0.0126	0.00088	0.1726	1.3482
2010	7.4932	0.6650	0.0029	0.00100	0.1959	1.5301
2011	10.1132	0.8975	0.0039	0.00135	0.2644	2.0651
2012	9.5368	0.8463	0.0036	0.00127	0.2493	1.9474
2013	8.4364	0.7487	0.0032	0.00113	0.2206	1.7227
2014	5.6068	0.4976	0.0021	0.00075	0.1466	1.1449
2015	5.8164	0.5162	0.0022	0.00078	0.1521	1.1877
2016	5.6592	0.5022	0.0022	0.00076	0.1480	1.1556
2017	5.9668	0.5295	0.0023	0.00080	0.1560	1.2184
2018	4.8512	0.4305	0.0019	0.00065	0.1268	0.9906
2019	6.6771	0.5925	0.0025	0.00089	0.1746	1.3634

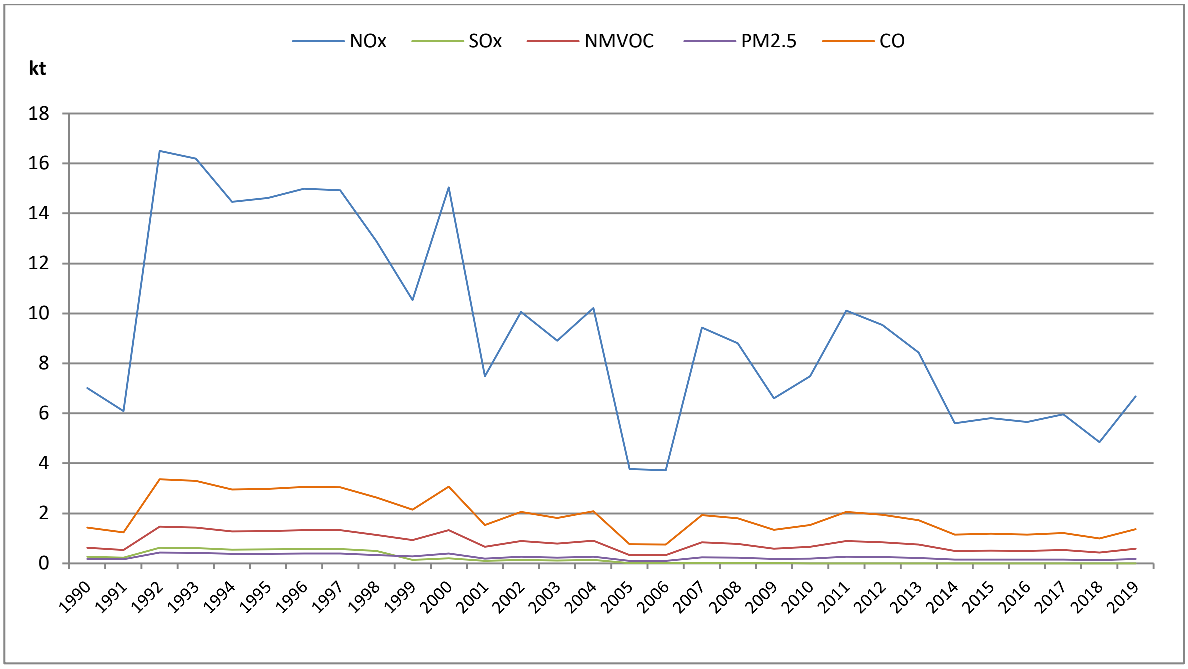


Figure 3.14.2. Emissions trend (kt) of NOx, NMVOC, SOx, $PM_{2.5}$ and CO for NFR 1.A.3.c – Railway

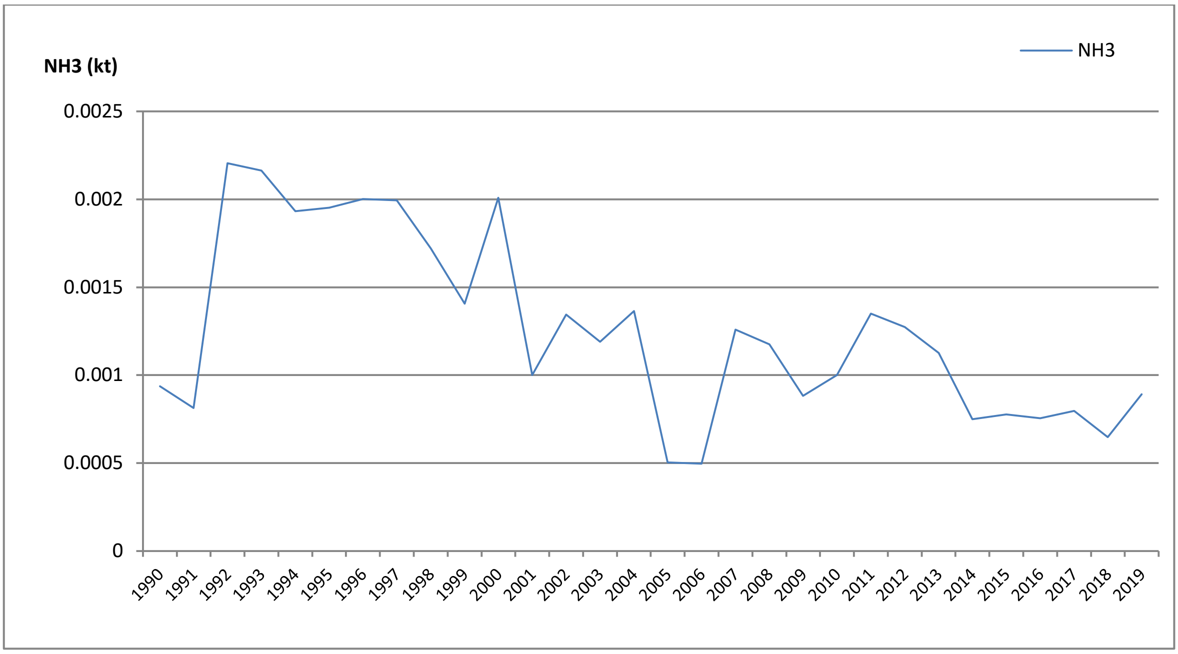


Figure 3.14.3. Emissions trend (kt) of NH_3 for NFR 1.A.3.c – Railway

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

Recalculations and improvements:

- error correction for year 2018 (the benzo(a) pyrene and benzo(b) fluoranthene emissions were interchanged).

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 2019, for NOx with 1.55% of the total, NMVOC with 0.05% of the total, SOx with 0.09% 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.
Cu, Se and As emissions were recalculated over the entire time series using the newest emission factors and the added PAHs emissions (in the previous guidebook it was NE).
For the period 1990-2006, category 1.A.3.dii included fuel oil and marine diesel and therefore emission values are higher.

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

Year	Fuel oil (t)	Marine diesel oil (t)
2010	-	58000
2011	-	51000
2012	-	42000
2013	-	41000
2014	-	37000
2015	-	43000
2016	-	40000
2017	-	39853
2018	-	39812
2019	-	42975

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	25.9311	0.8829	17.6580	1.8312	2.4198
1991	31.6407	1.0773	21.5460	2.2344	2.9526
1992	27.9730	0.9682	13.6600	1.4616	2.6196
1993	10.5742	0.3683	4.3760	0.4774	0.9916
1994	10.2674	0.3562	4.7320	0.5096	0.9620
1995	8.2072	0.2858	3.4160	0.3724	0.7696
1996	11.9271	0.4136	5.5580	0.5978	1.1174
1997	27.2737	0.9421	13.9660	1.4868	2.5530
1998	17.5574	0.6053	9.3920	0.9954	1.6428
1999	17.4773	0.6027	9.2940	0.9856	1.6354
2000	8.9978	0.3131	3.8240	0.4158	0.8436
2001	8.2368	0.2821	5.0440	0.5278	0.7696
2002	8.3025	0.2865	4.1700	0.4620	0.7770
2003	5.5406	0.1903	3.1300	0.3374	0.5180
2004	3.3146	0.1154	1.2680	0.1512	0.3108
2005	3.2193	0.1147	0.2140	0.0616	0.3034
2006	3.1408	0.1119	0.1860	0.0602	0.2960
2007	6.4370	0.2296	0.3280	0.1148	0.6068
2008	5.4950	0.1960	0.2800	0.0980	0.5180
2009	4.2390	0.1512	0.2160	0.0756	0.3996
2010	4.5530	0.1624	0.1160	0.0812	0.4292
2011	4.0035	0.1428	0.1020	0.0714	0.3774
2012	3.2970	0.1176	0.0840	0.0588	0.3108
2013	3.2185	0.1148	0.0820	0.0574	0.3034
2014	2.9045	0.1036	0.0740	0.0518	0.2738
2015	3.3755	0.1204	0.0860	0.0602	0.3182
2016	3.1400	0.1120	0.0800	0.0560	0.2960
2017	3.1285	0.1116	0.0797	0.0558	0.2949
2018	3.1252	0.1115	0.0796	0.0557	0.2946
2019	3.3735	0.1203	0.0860	0.0602	0.3180

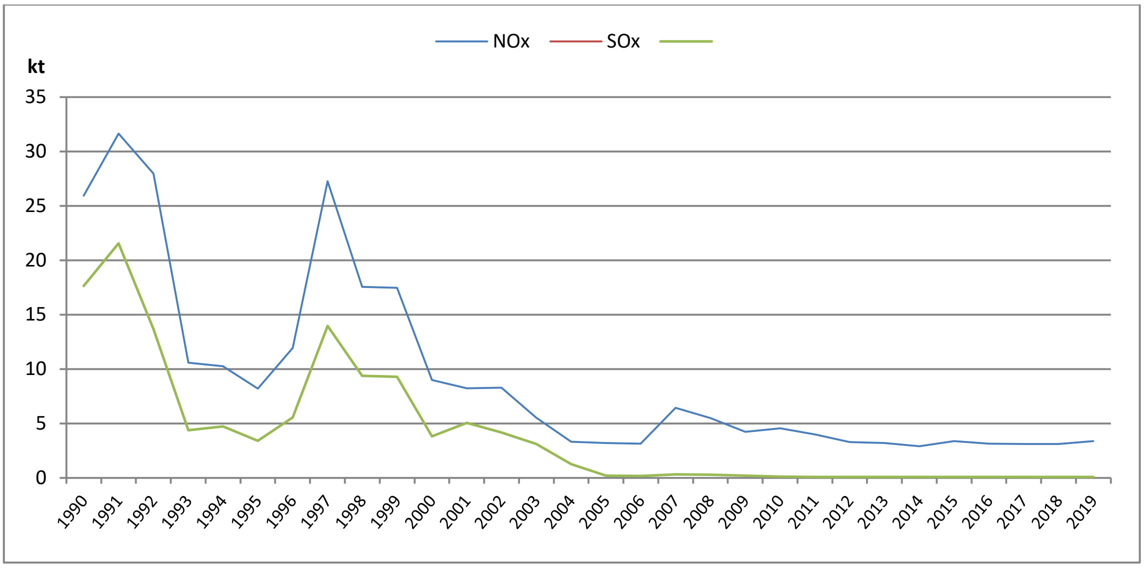


Figure 3.15.1. Emissions trend (kt) of NOx and SOx for NFR 1.A.3.dii - National navigation

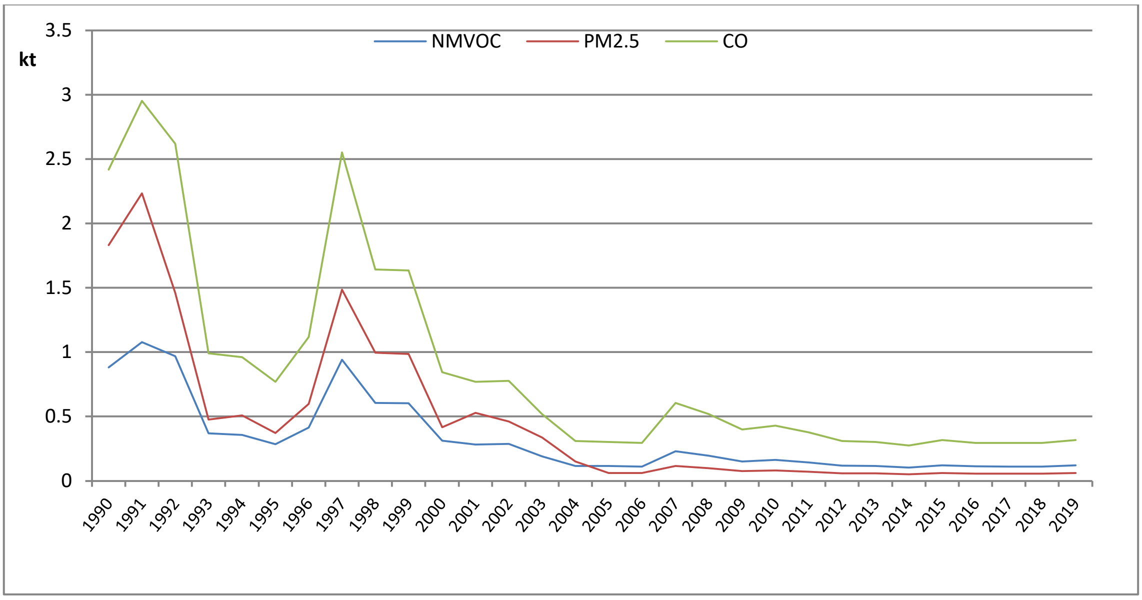


Figure 3.15.2. Emissions trend (kt) of NMVOC, $PM_{2.5}$ and CO for NFR 1.A.3.dii - National navigation

Table 3.15.3. Emissions trend (t) of PAHs for NFR 1.A.3.dii - National navigation

Year/Pollutant	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4
1990	0.00164	0.00981	0.00654	0.00294	0.02093
1991	0.00200	0.01197	0.00798	0.00359	0.02554
1992	0.00140	0.00814	0.00584	0.00219	0.01757
1993	0.00048	0.00272	0.00203	0.00069	0.00591
1994	0.00049	0.00286	0.00208	0.00075	0.00619
1995	0.00037	0.00212	0.00158	0.00054	0.00461
1996	0.00058	0.00335	0.00243	0.00089	0.00725
1997	0.00141	0.00823	0.00584	0.00226	0.01773

Year/Pollutant	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4
1998	0.00093	0.00548	0.00385	0.00153	0.01179
1999	0.00093	0.00543	0.00382	0.00151	0.01168
2000	0.00041	0.00236	0.00175	0.00060	0.00512
2001	0.00048	0.00286	0.00195	0.00083	0.00612
2002	0.00044	0.00255	0.00180	0.00071	0.00549
2003	0.00031	0.00184	0.00127	0.00053	0.00395
2004	0.00015	0.00086	0.00064	0.00022	0.00187
2005	0.00009	0.00043	0.00042	0.00005	0.00098
2006	0.00008	0.00042	0.00041	0.00005	0.00096
2007	0.00016	0.00082	0.00082	0.00008	0.00189
2008	0.00014	0.00070	0.00070	0.00007	0.00161
2009	0.00011	0.00054	0.00054	0.00005	0.00124
2010	0.00012	0.00058	0.00058	0.00006	0.00133
2011	0.00010	0.00051	0.00051	0.00005	0.00117
2012	0.00008	0.00042	0.00042	0.00004	0.00097
2013	0.00008	0.00041	0.00041	0.00004	0.00094
2014	0.00007	0.00037	0.00037	0.00004	0.00085
2015	0.00009	0.00043	0.00043	0.00004	0.00099
2016	0.00008	0.00040	0.00040	0.00004	0.00092
2017	0.00008	0.00040	0.00040	0.00004	0.00092
2018	0.00008	0.00040	0.00040	0.00004	0.00092
2019	0.00009	0.00043	0.00043	0.00004	0.00099

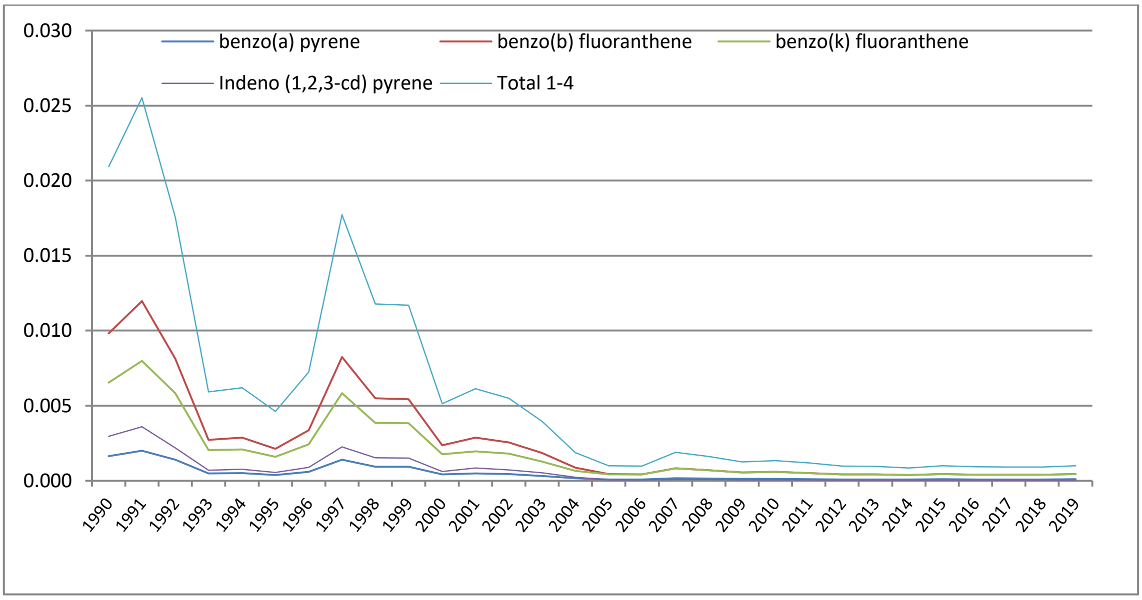


Figure 3.15.3. Emissions trend (t) of PAHs for NFR 1.A.3.dii - National navigation

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 for NFR 1A3di(i) 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.

Cu, Se and As emissions were recalculated over the entire time series using the newest emission factors and the added PAHs emissions (in the previous guidebook it was NE).
For the period 2007-2010, category 1.A.3.di(ii) included fuel oil and marine diesel oil and therefore emission values are higher.

Table 3.15.4. International maritime bunkers (t) for memo item, NFR 1.A.3.di(i)

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

Year	2016	2017	2018	2019
Marine diesel oil (t)	31000	27527	17853	33720

Recalculations and improvements:

NFR 1 A3dii- National navigation (shipping)

- Cu, Se and As emissions were recalculated over the entire time series using the newest emission factors (emissions have decreased significantly due to recalculation, while the impact on national emissions is not significant);
- PAHs emissions were added using the newest emission factors (previously NE);
- Error correction for SOx emissions for 2006.

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

- Cu, Se and As emissions were recalculated over the entire time series using the newest emission factors (emissions have decreased significantly due to recalculation, while the impact on national emissions is not significant);
- PAHs emissions were added using the newest emission factors (previously NE);
- Error correction for SOx emissions for 2010.

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 2019 NFR 1.B.1.a was a key source of NMVOC with 2.39% from the national total.

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
2019	5.492

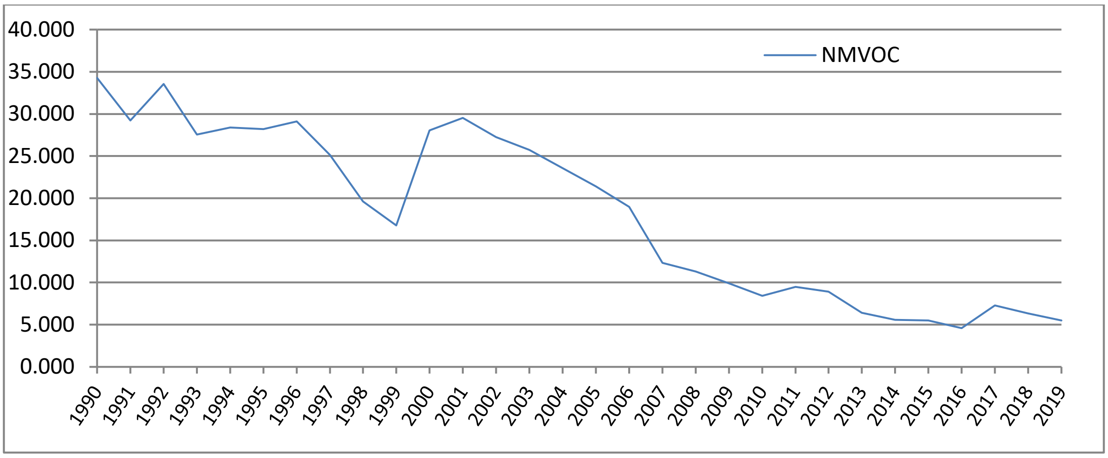


Figure 3.16.1 Emissions Trend NMVOC (kt) for NFR 1.B.1.a

It can be noted the NMVOC emissions trend have the same variation as the activity datas.

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 Tier 1 emission factors were used. The pollutants emissions are calculated based on Tier 1 methodology, applying the general equation:

Epollutant = ARproduction× EFpollutant, where:

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

Coke production has been decreasing from 3965000 t in 1990 down to 0 t in 2010 and has been 0 t for the time period 2011 -2019.

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

Year	AD (t coke production)
2001	1413000
2002	1866000
2003	1638000
2004	1675000
2005	1891000
2006	1790000
2007	1647000
2008	1138000
2009	341000

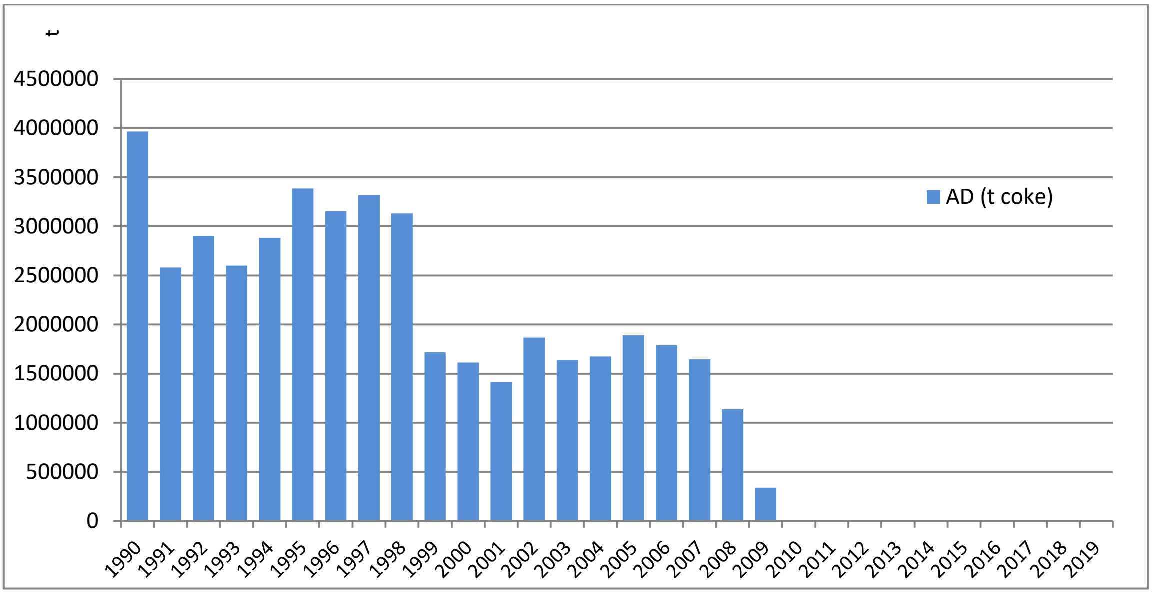


Figure 3.17.1. Activity data trends (t product) for NFR 1.B.1.b coke production

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

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. 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:

Epollutant = ARproduction× EFpollutant, 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).

Activity data fluctuates,increasing and decreasing during the 1990-2019 time series.

Pollutant emissions trend for NMVOC varies according to the activity data variation as in the table and graphic shown below.

Table 3.18.1 Emissions Trend (kt) for NFR 1.B.2.a.i for NMVOC 1990-2019

Year	NMVOC (kt)
1990	4.797
1991	3.038
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	2.350
2019	2.421

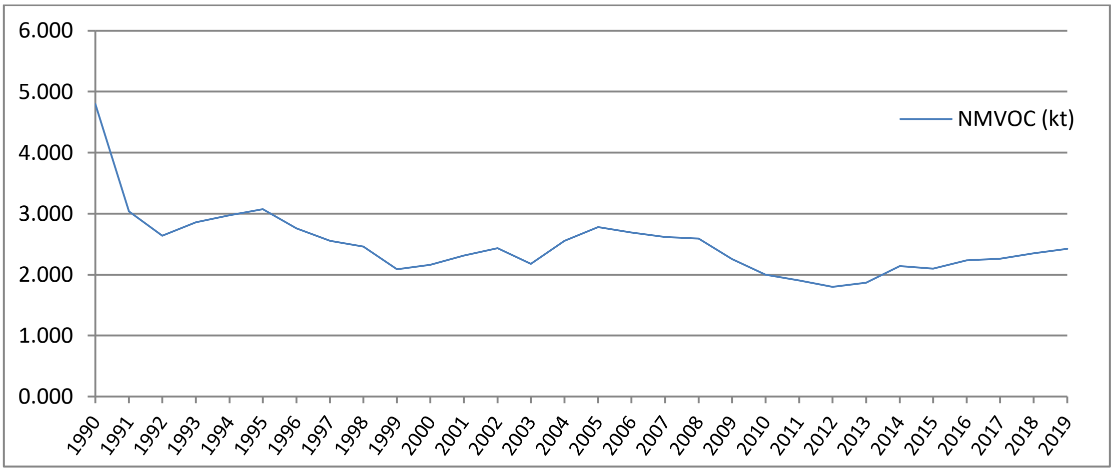


Figure 3.18.1 Emissions Trend (kt) for NFR 1.B.2.a.i for NMVOC

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

This chapter treats emissions from the petroleum refining industry. This industry converts crude oil into many refined products, such as liquid fuel,by-product fuels and feedstock and primary petrochemicals.

In previous submission for NFR 1.B.2.a.iv, although it was the key source, the emissions were calculated based on Tier 1 methodology activity data were 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).

During the desk Review 2020 in RO-1B2aiv-2020-0001 ”the TERT notes with reference to the NFR 1B2aiv Fugitive emissions oil/Refining and storage, SO_2 that a Tier 1 method is used for a key category”. 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 to economic operators.

As a result, it splited NFR 1B2aiv into three SNAPs:

- 040102 - Fluid catalytic cracking-CO boiler with default 2019 EMEP/EEA Guidebook emission factors (Tier 2, Table 3-2) and activity data represented by the total annual amount of fresh feed (mc) obtained from economic operators;
- 040103 - Sulphur recovery plants with default 2019 EMEP/EEA Guidebook emission factors (Tier 2, Table 3-5) and activity data represented by amount of sulphur produced (t) obtained from economic operators;
- 040104 – Storage and handling of petroleum products in refinery with default 2019 EMEP/EEA Guidebook emission factors (Tier 2, Table 3-6) and activity data represented by annual crude oil throughput (t) obtained from economic operators.

Following RO-1B2aiv-2020-0001 the pollutant emissions for the 2015-2018 time series were calculated with the Tier 2 methodology, but reduction efficiencies were applied from table 3-7, page 20 of the EMEP/EEA/Guidebook 2019 for pollutants CO, NMVOC and NH_3. TERT considered that for CO, NMVOC and NH_3 emission factors in Table 3-2 of 2019 EMEP/EEA Guidebook must be applied. As a result RO-1B2aiv-2020-0001 it received Technical Correction.

In this submission, the mistakes were corrected and the pollutant emissions for 1990-2019 were calculated and reported using activity data from economic operators and the Tier 2 calculation methodology.

In 2019 NFR 1B2aiv was key source for SOx (9.2%), CO (12%), Cd (5.74%), Hg (13.28%) and Ni (16.43%) from national total. The tables and figures below show trends in activity data and pollutants for which NFR 1B2aiv was the key source.

Tabel 3.19.1 Activity data trends (m^3) total annual amount of fresh feed for NFR 1.B.2.a.iv 1990-2019

Year	AD (mc)
1990	3927181.0
1991	2948699.0
1992	2475178.0
1993	2751162.5
1994	2576603.0
1995	2667846.8
1996	3056951.0
1997	2428522.8
1998	2808448.1
1999	3221215.0
2000	3321559.0
2001	3407212.3
2002	3039462.0
2003	2835001.3
2004	3149508.0
2005	3402793.5
2006	3644495.0
2007	3444667.0
2008	3391529.4
2009	3254223.9
2010	3501450.5
2011	3941221.6
2012	3463216.5
2013	3970462.0
2014	4026669.0
2015	2354456.6
2016	2584587.5
2017	2652851.2
2018	2659303.0
2019	2741899.0

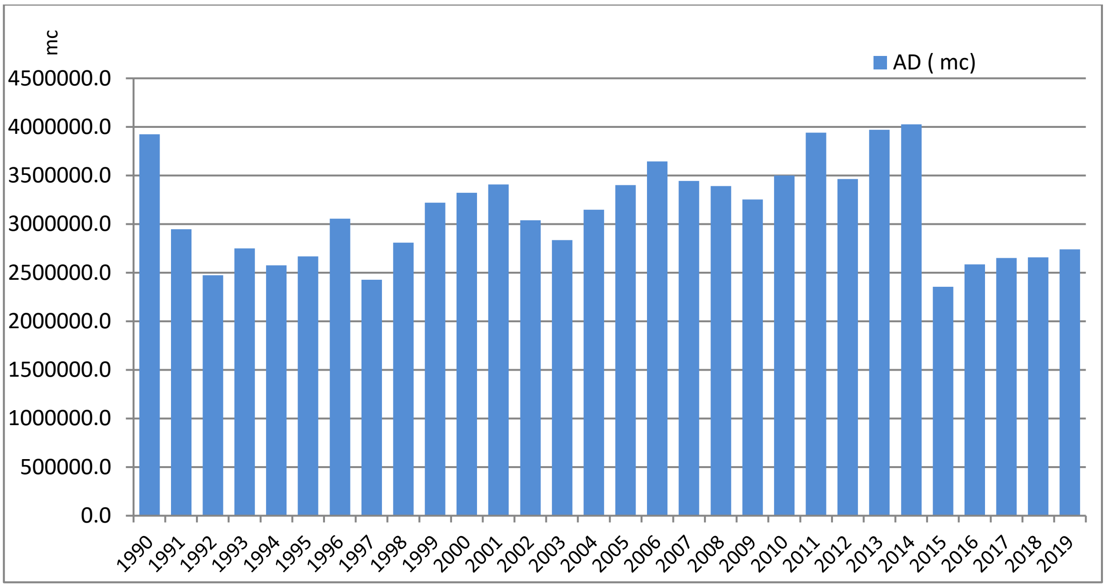


Figure 3.19.1 Activity data trends (m^3 total annual amount of fresh feed) for NFR 1.B.2.a.iv

Tabel 3.19.2 Emissions Trend (kt) for NFR 1.B.2.a.iv for SO_x and CO, 1990-2019

Year	SOx	CO
1990	5.498	153.160
1991	4.128	114.999
1992	3.465	96.532
1993	3.969	110.565
1994	3.607	100.488
1995	3.735	104.046
1996	4.324	119.221
1997	3.456	94.712
1998	4.266	109.529
1999	5.206	125.627
2000	5.391	129.541
2001	5.333	132.881
2002	4.255	118.539
2003	3.969	110.565
2004	4.549	122.831
2005	6.673	132.709
2006	7.583	142.135
2007	7.303	134.342
2008	7.350	132.270
2009	7.188	126.915
2010	8.341	136.557
2011	8.748	153.708
2012	7.132	135.065
2013	8.274	154.848
2014	9.772	157.040
2015	7.412	91.823
2016	8.825	100.799
2017	8.575	103.461
2018	9.029	103.713
2019	9.106	106.934

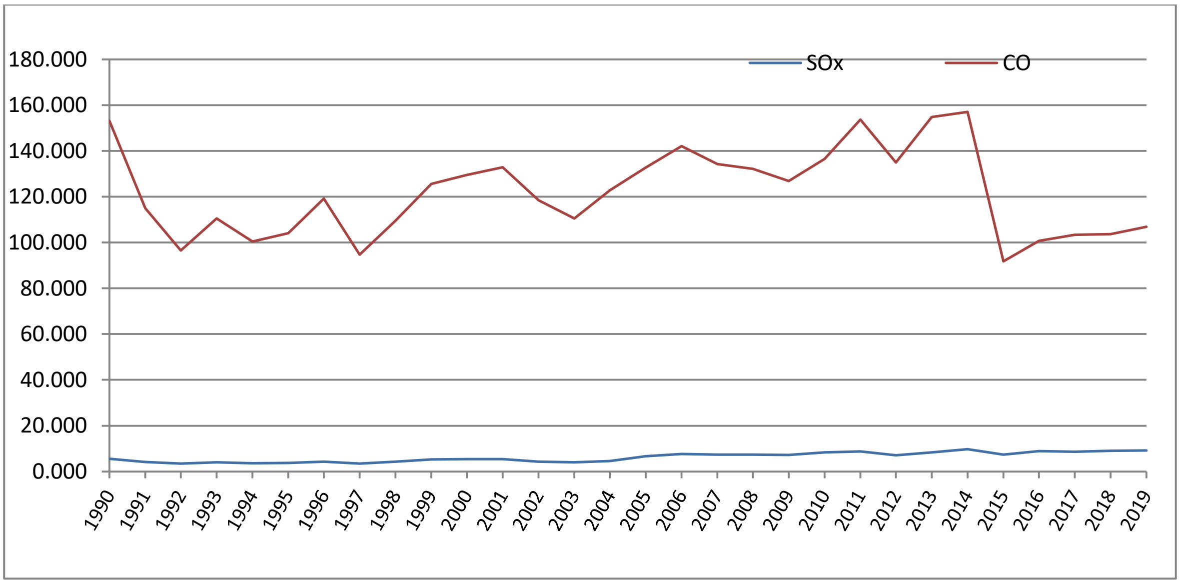


Figure 3.19.2 Emissions Trend (kt) for NFR 1.B.2.a.iv for SO_x and CO

Tabel 3.19.3 Emissions Trend (t) for NFR 1.B.2.a.iv for Cd,Hg and Ni for 1990-2019

Year	Cd	Hg	Ni
1990	0.247	0.275	2.396
1991	0.186	0.206	1.799
1992	0.156	0.173	1.510
1993	0.179	0.198	1.729
1994	0.162	0.180	1.572
1995	0.168	0.187	1.627
1996	0.193	0.214	1.865
1997	0.153	0.170	1.481
1998	0.177	0.197	1.713
1999	0.203	0.225	1.965
2000	0.209	0.233	2.026
2001	0.215	0.239	2.078
2002	0.191	0.213	1.854
2003	0.179	0.198	1.729
2004	0.198	0.220	1.921
2005	0.214	0.238	2.076
2006	0.230	0.255	2.223
2007	0.217	0.241	2.101
2008	0.214	0.237	2.069
2009	0.205	0.228	1.985
2010	0.221	0.245	2.136
2011	0.248	0.276	2.404
2012	0.218	0.242	2.113
2013	0.250	0.278	2.422
2014	0.254	0.282	2.456
2015	0.148	0.165	1.437
2016	0.163	0.181	1.577
2017	0.167	0.186	1.618
2018	0.168	0.186	1.622
2019	0.173	0.192	1.673

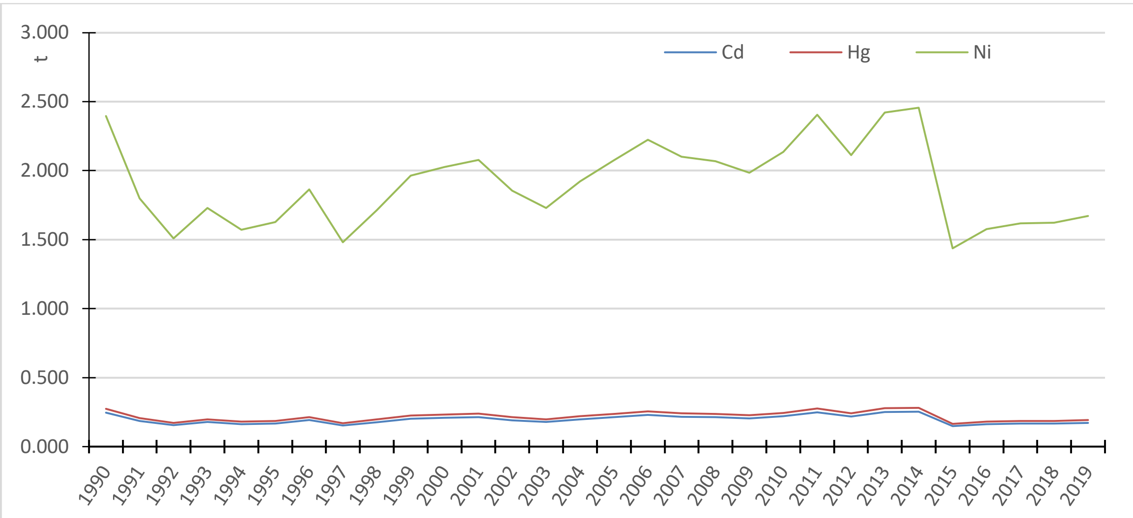


Figure 3.19.3 Emissions Trend (t) for NFR 1.B.2.a.iv for Cd,Hg and Ni

It is observed that pollutant emissions follow the activity data trends of NFR 1B2aiv.

Recalculations and improvements: TC of RO-1B2aiv-2020-0001 implemented for entire time series 1990-2019.

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).

During the desk Review 2020, in RO–1B2av-2020-0001 "the TERT notes that Stage I and Stage II abatement efficiencies have been applied for all years, and not only for the years after the respective government decisions. This may lead to an underestimation for the years before the government decisions." This mistake has been corrected and below, you find the calculation of the Romanian country specific Tier 2 emission factor and recalculating abatement efficiencies as it is noted the TERT.

TVP = RVP x 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)	IEF NMVOC =EF abated*TVP (g/mc) 1990-2000	IEF NMVOC =EF abated*TVP (g/mc) 2001-2011	IEF NMVOC =EF abated*TVP (g/mc) 2012-2019
Service stations	Storage tank filling without Stage I (table 3-8)	24	95% (stage I)	25	600	30	30
	Storage tank breathing (table 3-9)	3		25	75	75	75
	Automobile refueling with no emission controls in operation (table 3-10)	37	85% (stage II)	25	925	925	138.75
	Automobile refueling: drips and minor spillage (table 3-11)	2		25	50	50	50
SUM					**1650**	**1080**	**293.75**
					no stage	stage I	stage II
					2.260274	**1.4794521**	**0.4023973**

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). The same calculation was made for the stage I and for no stage.

Tabel 3.20.1. Emissions Trend (kt) for NFR 1.B.2.a.v for NMVOC 1990 -2019

Year	NMVOC (kt)
1990	4.721
1991	3.842
1992	4.540
1993	2.251
1994	2.398
1995	3.684
1996	3.017
1997	4.115
1998	4.073
1999	3.295
2000	3.431
2001	2.573

Year	NMVOC (kt)
2002	2.392
2003	2.431
2004	2.281
2005	2.341
2006	2.102
2007	2.473
2008	2.105
2009	2.510
2010	2.366
2011	1.943
2012	0.529
2013	0.523
2014	0.543
2015	0.524
2016	0.566
2017	0.589
2018	0.531
2019	0.550

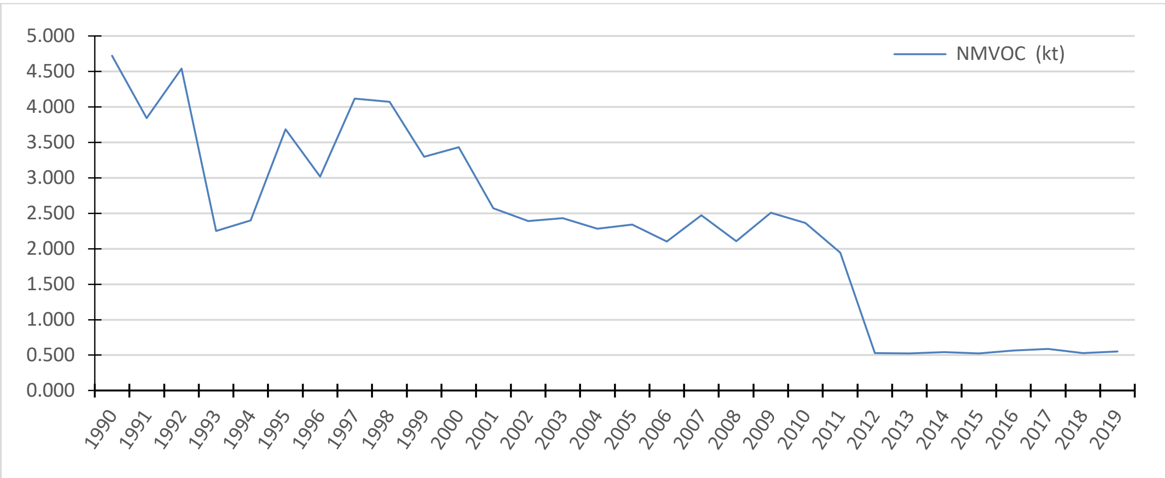


Figure 3.20.1. Emissions Trend (kt) for NFR 1.B.2.a.v for NMVOC

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: RO–1B2av-2020-0001 implemented and reported.

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. The emissions were calculated, applying the general equation:

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

where:

- Epollutant - is the emission of a pollutant (g);
- ARproduction - is the annual volume of gas extracted and imported (in m^3);
- EFpollutant - is the emission factor of the relevant pollutant (in g pollutant/m^3 gas).

Tabel 3.21.1. Emissions Trend (kt) for NFR 1.B.2.b. for NMVOC 1990-2019

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
2019	1.264

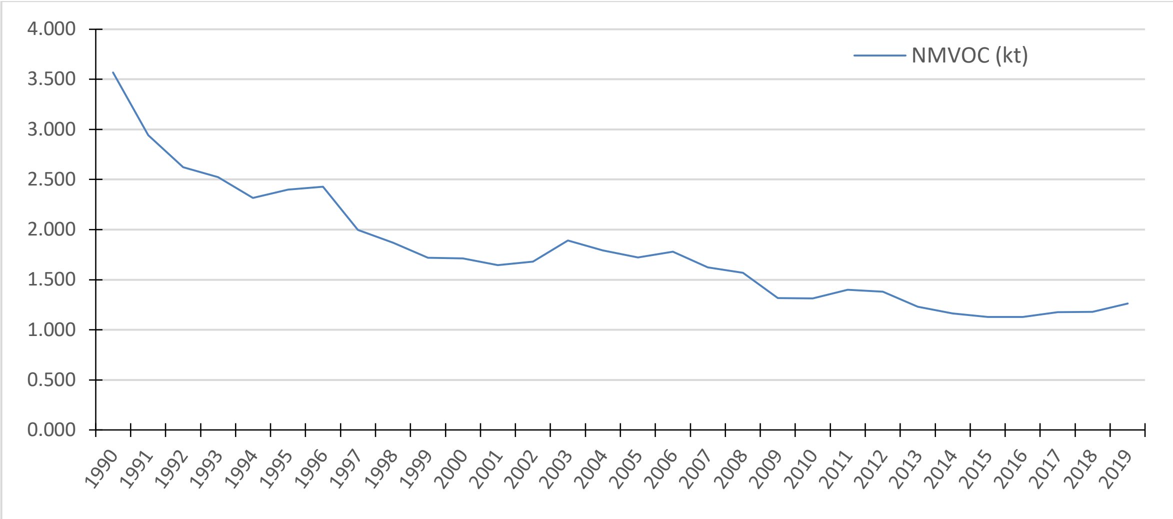


Figure 3.21.1. Emissions Trend (kt) for NFR 1.B.2.b. for NMVOC

It is observed that the emissions trend of NMVOC is decreasing for the 1990-2019 time series.

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 2012-2019, activity data is represented by refinery gases flared (m^3).

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:

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

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 SOx and NOx 1990-2019

Year	SO_X (kt)	NOx (kt)
1990	0.002	0.263
1991	0.010	1.028
1992	0.008	0.840
1993	0.010	1.092
1994	0.013	1.393
1995	0.007	0.793
1996	0.007	0.710
1997	0.002	0.196
1998	0.004	0.446
1999	0.005	0.571
2000	0.004	0.452
2001	0.005	0.561
2002	0.002	0.263
2003	0.010	1.028
2004	0.008	0.840
2005	0.006	0.616
2006	0.008	0.877
2007	0.006	0.642
2008	0.008	0.856
2009	0.012	1.324
2010	0.006	0.646
2011	0.006	0.668
2012	0.004	0.472
2013	0.005	0.509
2014	0.005	0.490
2015	*0.061*	*0.063*
2016	*1.112*	*0.797*
2017	*0.060*	*0.055*
2018	*1.117*	*0.795*
2019	*0.813*	*0.579*

NOx and SOx emissions presented in above table with italic font are calculated for the time series 2012-2019 with activity data from economic operators. The chart below show the variation of the pollutants for 1.B.2.c

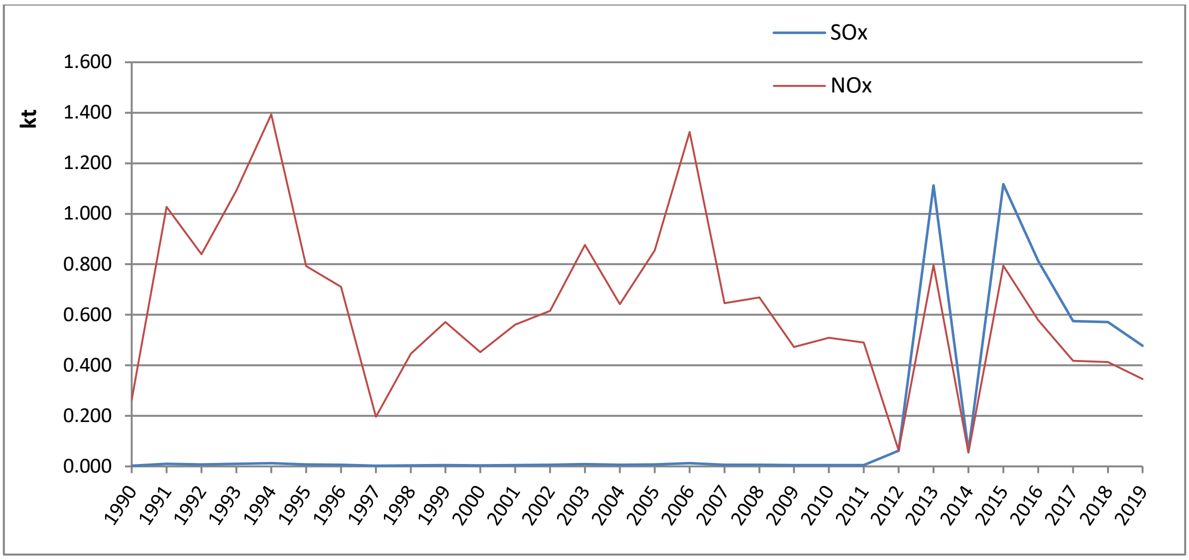


Figure 3.22.1. Emissions Trend (kt) for NFR 1.B.2.c for,SO_X and NOx

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 (2019)

Pollutant	NFR code	Category	Level assessment (%)
NMVOC	2D3a	Domestic solvent use including fungicides	8.05%
NMVOC	2D3g	Chemical products	6.13%
NMVOC	2H2	Food and beverages industry	3.52%
NMVOC	2D3i	Other solvent use	2.25%
NMVOC	2B10a	Chemical industry: Other (please specify in the IIR)	1.81%
NMVOC	2D3d	Coating applications	1.59%
PM_{10}	2D3b	Road paving with asphalt	3.44%
PM_{10}	2A5a	Quarrying and mining of minerals other than coal	2.89%
PM_{10}	2A2	Lime production	2.34%
TSP	2D3b	Road paving with asphalt	10.54%
TSP	2B10a	Chemical industry: Other (please specify in the IIR)	9.33%
TSP	2A2	Lime production	3.95%
TSP	2A5a	Quarrying and mining of minerals other than coal	3.87%
Pb	2C1	Iron and steel production	59.02%
Cd	2C1	Iron and steel production	13.06%
Hg	2C1	Iron and steel production	15.73%
As	2C1	Iron and steel production	25.24%
Cr	2C1	Iron and steel production	44.61%
Ni	2C1	Iron and steel production	13.71%
Zn	2C1	Iron and steel production	12.40%
PCDD/F	2C1	Iron and steel production	17.38%

Pollutant	NFR code	Category	Level assessment (%)
PAHs	2C1	Iron and steel production	11.39%
PCBs	2C1	Iron and steel production	69.37%

Industrial processes and product use sector mainly contributes to the PCBs emissions of the Inventory (69.37% of the total national), Pb emissions (63.53% of the total national), Cr emissions (45.49% of the total national), NMVOC emissions (24.97% of the total national), TSP emissions (33.77% of the total national), As (27.12% of the total national) and with a relatively low contribution to the emissions of the rest of pollutants reported.

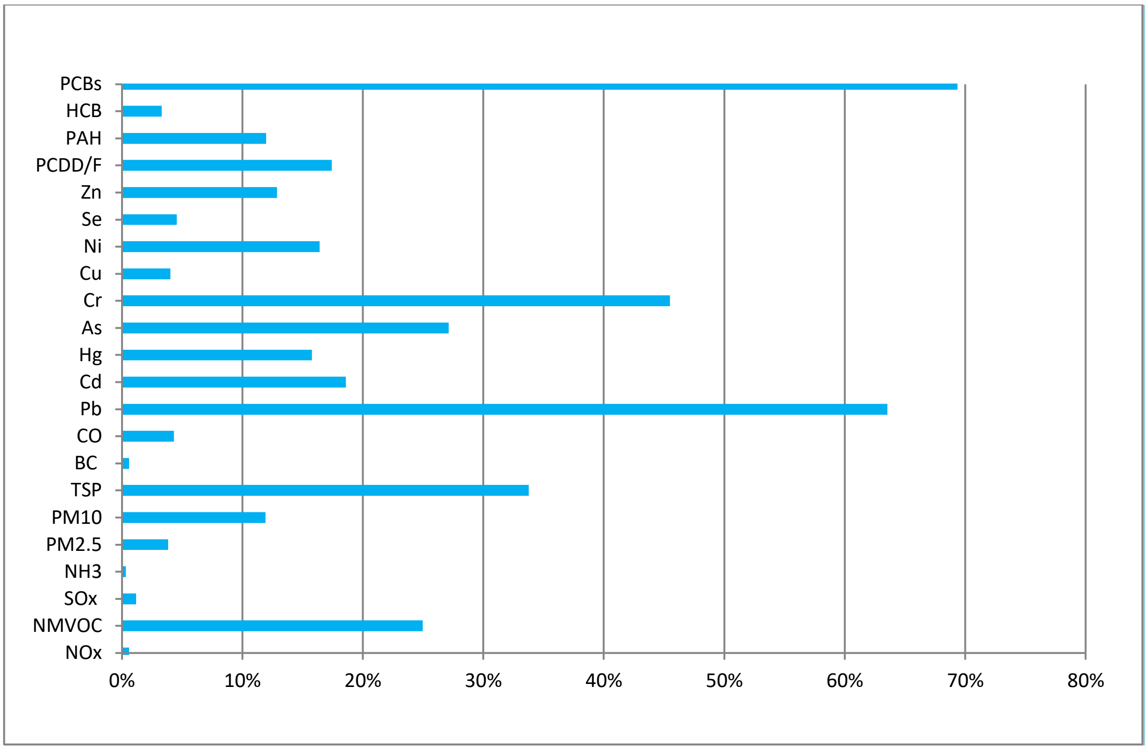


Figure 4.1. Emissions of pollutants (%) for IPPU sector in 2019

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 PM_{10} and $PM_{2.5}$, 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, 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”.

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 NH_3 — 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× Efpollutant, 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
2010	5202

Year	kt product
2011	5751
2012	5874
2013	5062
2014	5467
2015	6203
2016	5933
2017	6190
2018	6587
2019	7208

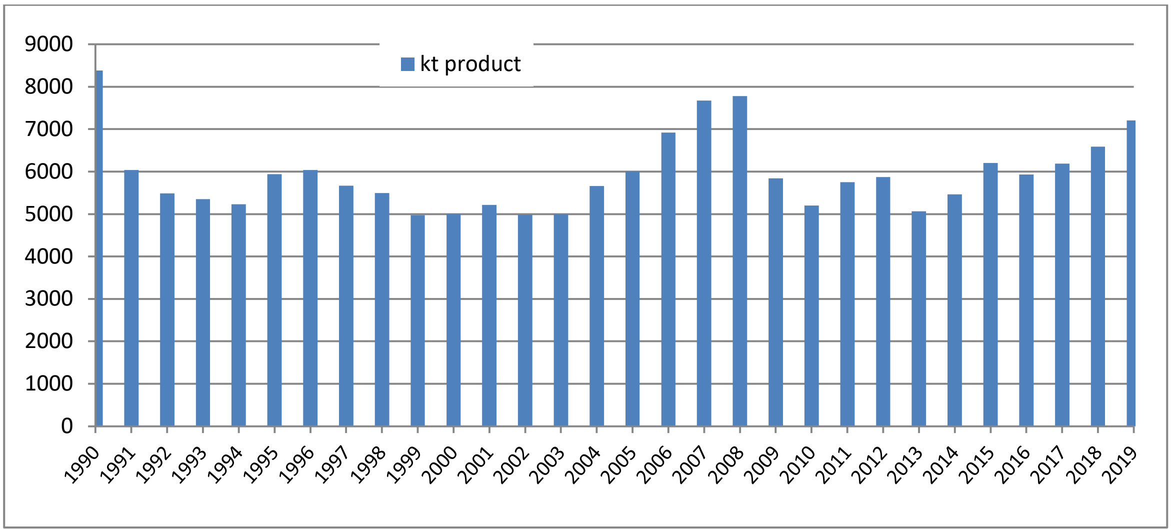


Figure 4.1.1. Activity data trend (kt product) for NFR 2.A.1. Cement production

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
2019	0.937	1.687	1.874

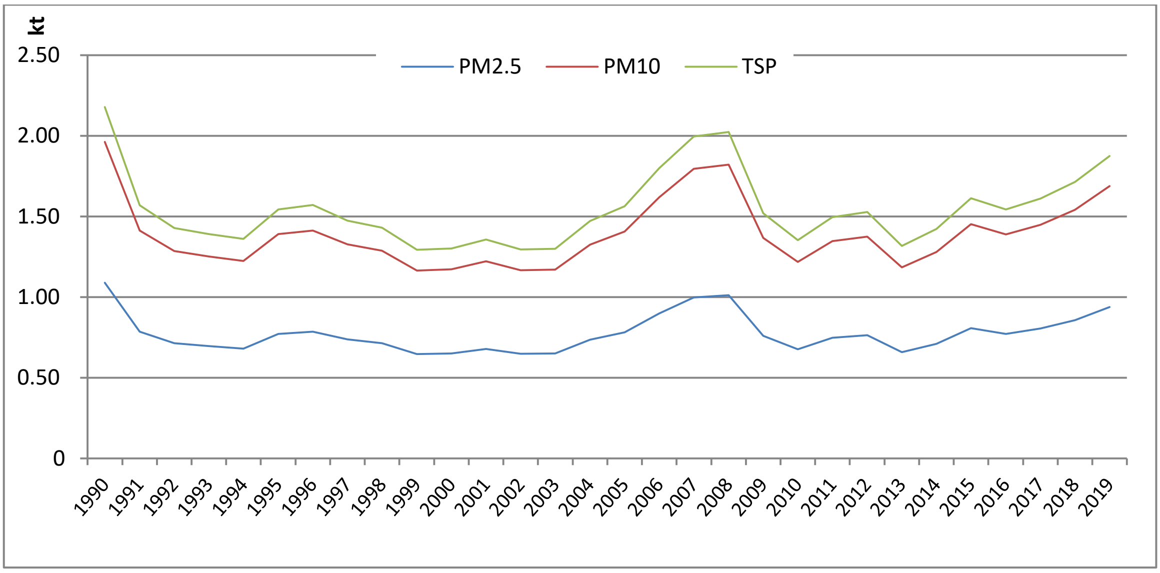


Figure 4.1.2. Emission Trends (kt) for NFR 2.A.1 Cement Production

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 2010-2019 time period emissions recorded variations related to clinker production activity.

Recalculations and improvements:

- 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 a 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:

Epollutant = ARproduction× Efpollutant, 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 2009-2019 calcium quicklime production is taken from the economic operators. For dolomitic lime produced, the N.I.S. activity data are used for the 2000-2019 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
2019	1024

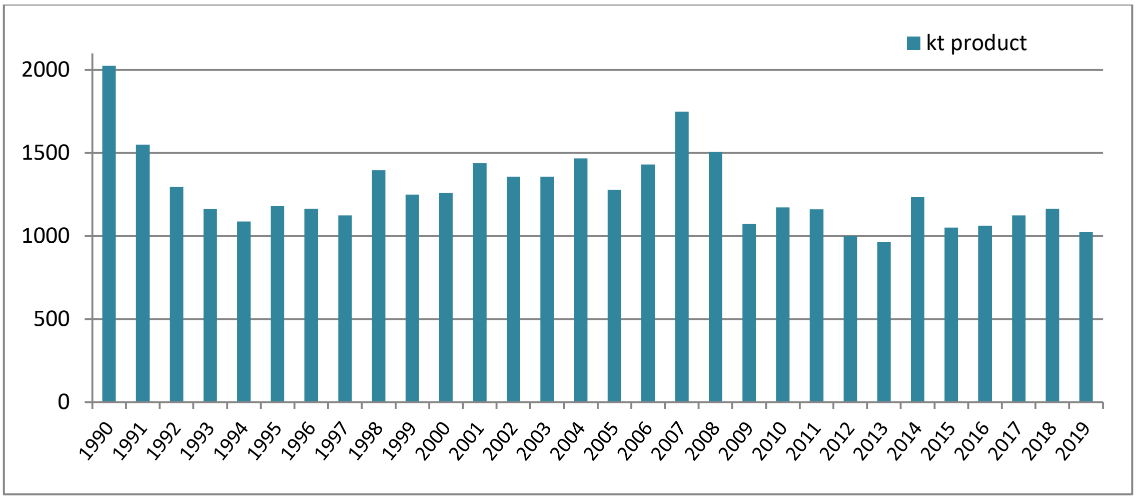


Figure 4.2.1. Activity data Trend (kt) for NFR 2.A.2. Lime production

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
2019	0.717	3.585	9.219

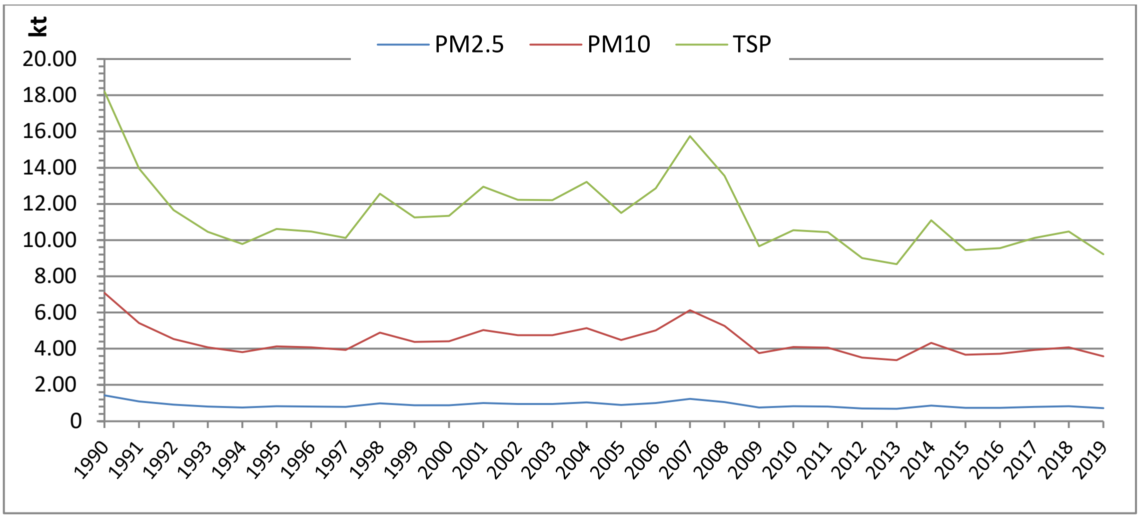


Figure 4.2.2. Emission Trends (kt) for NFR 2.A.2. Lime production

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:

- There were no recalculations and improvements for this category.

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
2016	411.33
2017	401.93
2018	394.28
2019	358.70

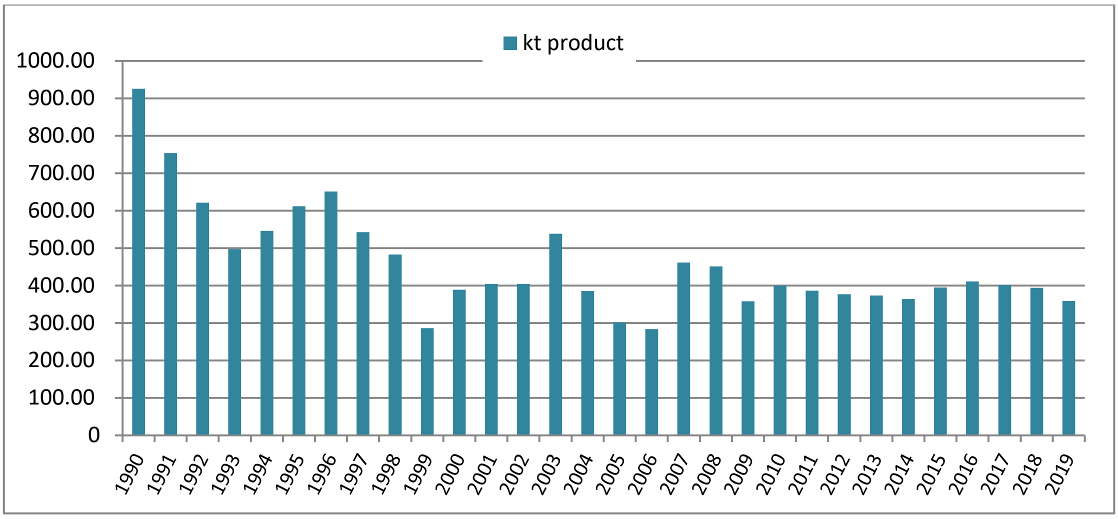


Figure 4.3.1. Activity data Trend (kt) for NFR 2.A.3. Glass production

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
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
2019	0.612	0.033	0.067	0.157	0.308

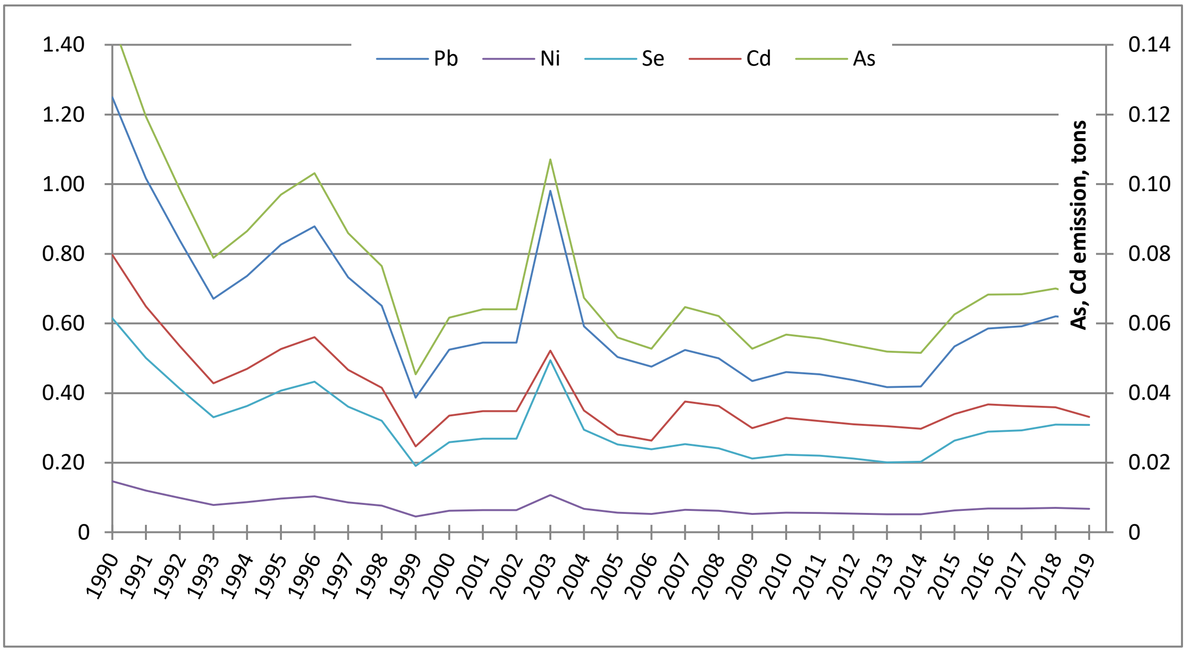


Figure 4.3.2. Emission Trends (t) for NFR 2.A.3. Glass production

The emissions of Pb, Cd, As, Ni and Se follow the activity data trends for glass production.

Recalculations and improvements:

- There were no recalculations and improvements for this category.

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 3.87% 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
2016	75636.95
2017	64266.14
2018	68275.00
2019	88584.84

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
2019	0.443	4.429	9.036

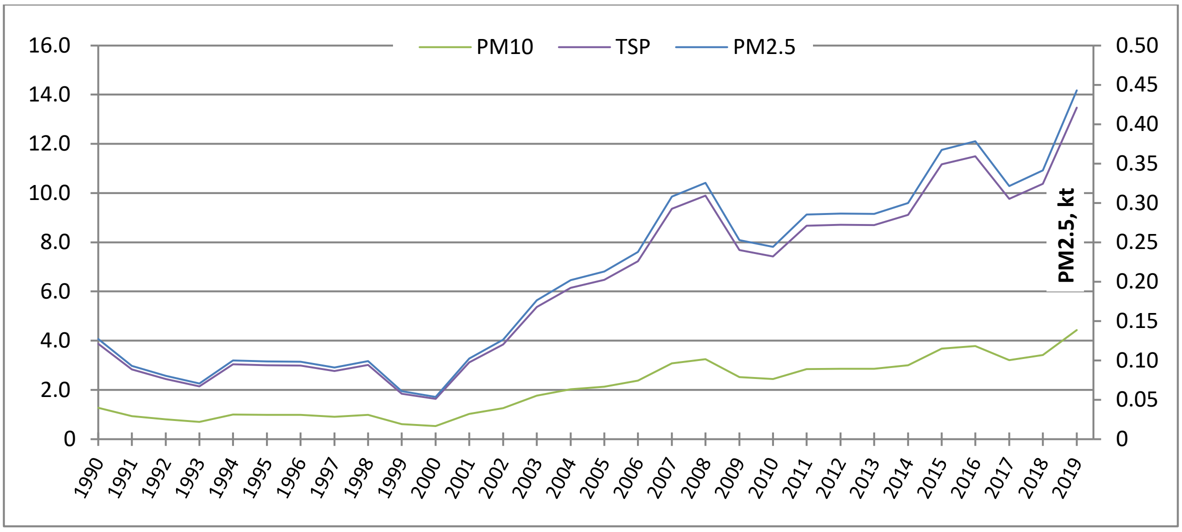


Figure 4.4.1. Emission Trends (kt) for NFR 2.A. 5.a Quarrying and mining of minerals other than coal

Recalculations and improvements:

- There were no recalculations and improvements for this category.

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/[m^2 · year])
- A affected = area affected by construction activity (m^2)
- 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
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
2019	4320969	2727524	2950948	1548000

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

Year/Pollutant	$PM_{2.5}$	PM_{10}	TSP
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
2019	0.169	1.691	5.633

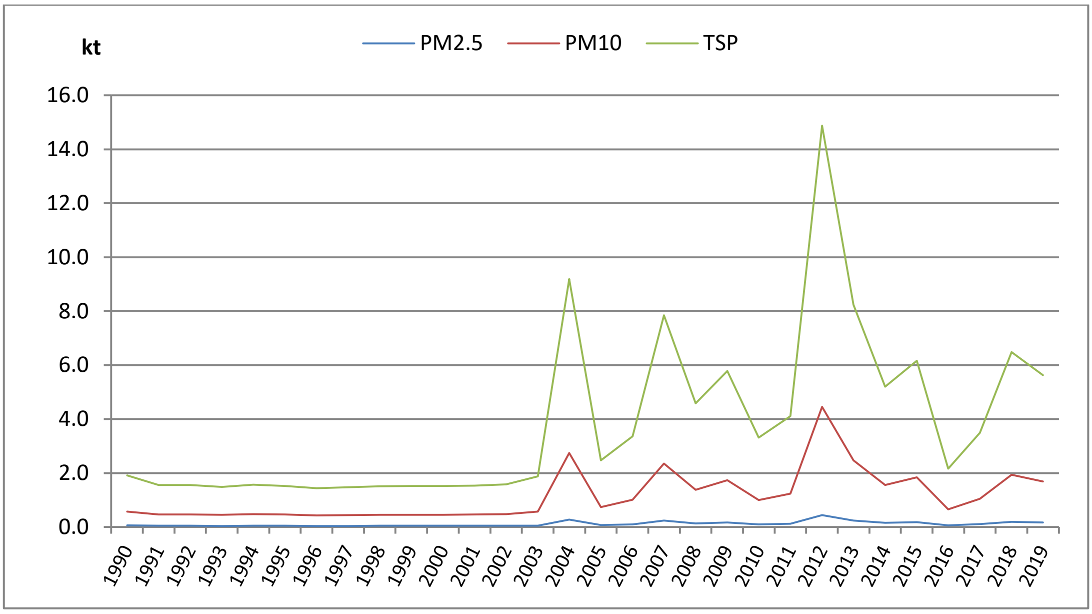


Figure 4.5.1. Emission Trends (kt) for NFR 2.A.5.b Construction and demolition

Particulate matter emissions followed the trend of activity data, with peaks in the years when new roads were built.

Recalculations and improvements:

- There were no recalculations and improvements for this category.

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

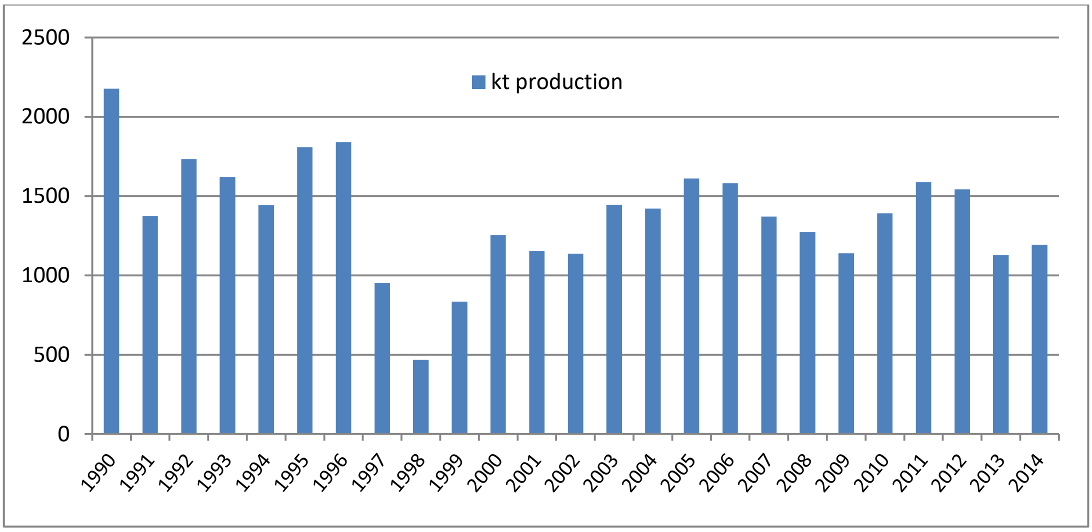


Figure 4.6.1. Activity data trend (t) for NFR 2.B.1. Ammonia production

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
2019	0.570	0.006	0.057

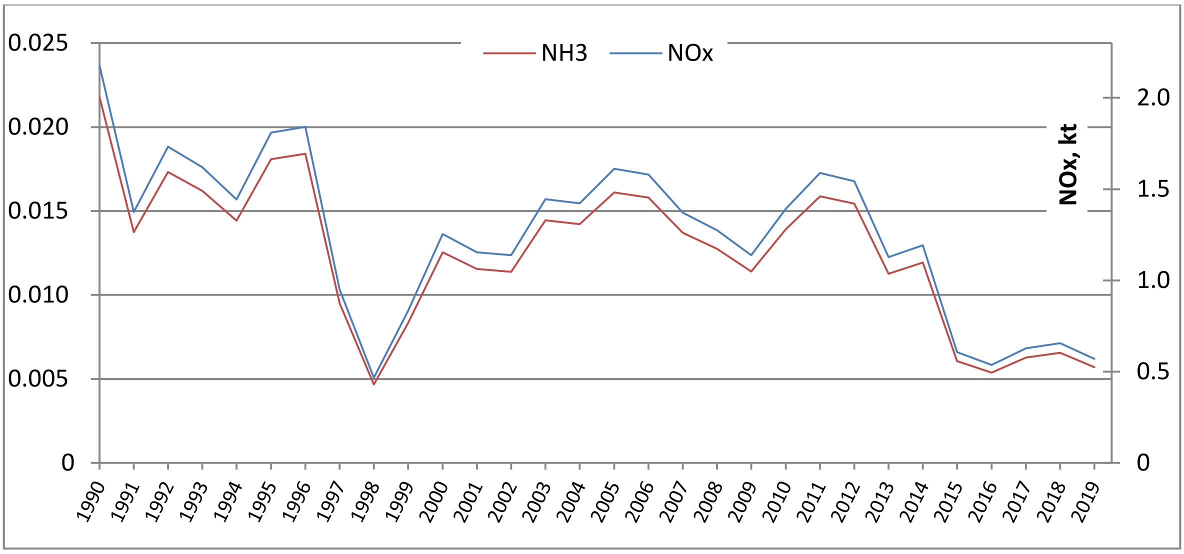


Figure 4.6.2a Total Emission Trends (kt) for NOx and NH_3 for NFR 2.B.1. Ammonia production

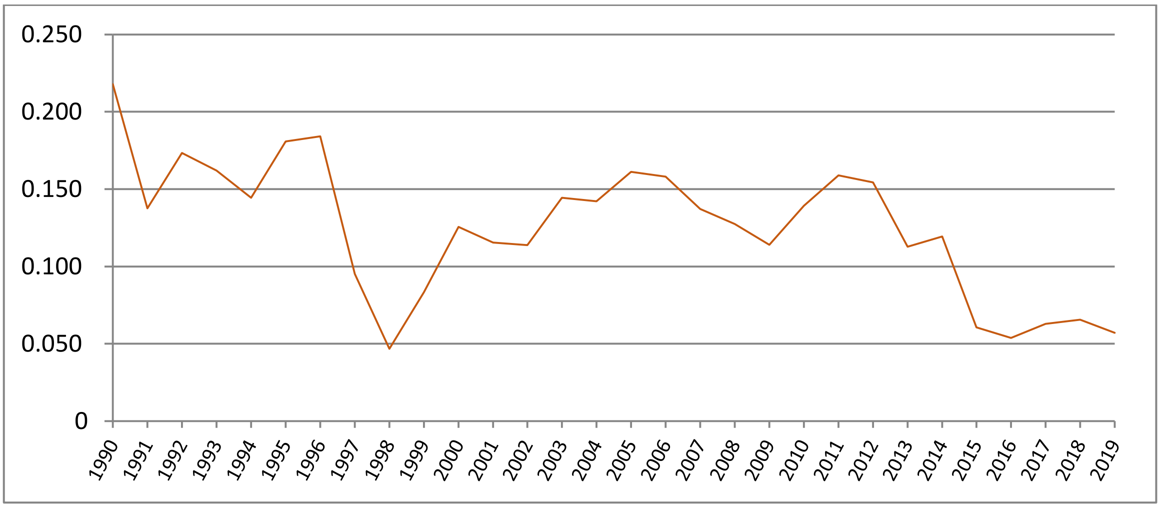


Figure 4.6.2b Total Emission Trends (kt) for CO for NFR 2.B.1. Ammonia production

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:

- There were no recalculations and improvements for this category.

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

Year/Pollutant	NOx
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
2019	0.276

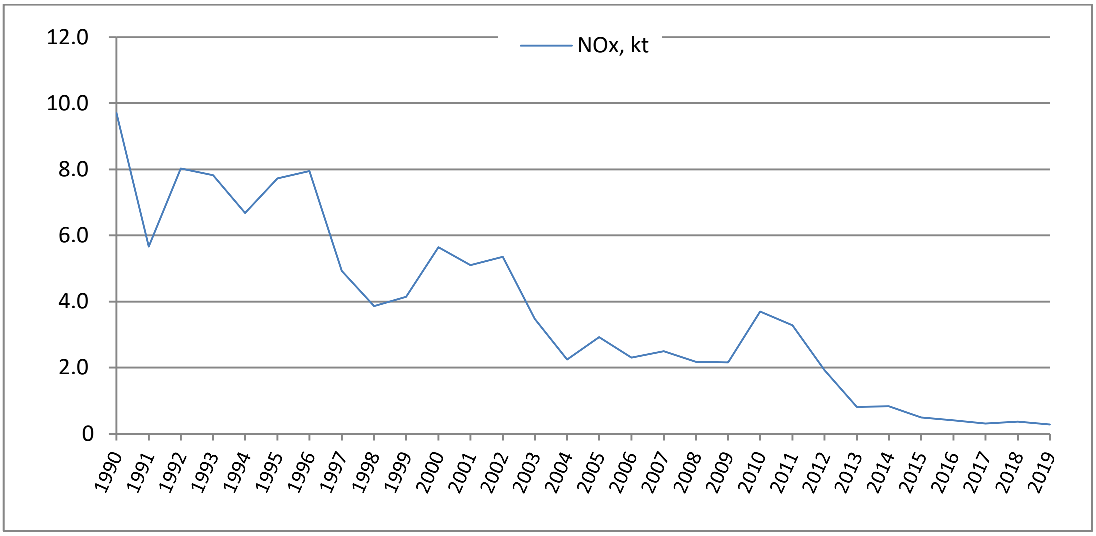


Figure 4.7.1. Emission trends (kt) for NOx for NFR 2.B.2. Nitric acid production

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:

- There were no recalculations and improvements for this category.

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
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

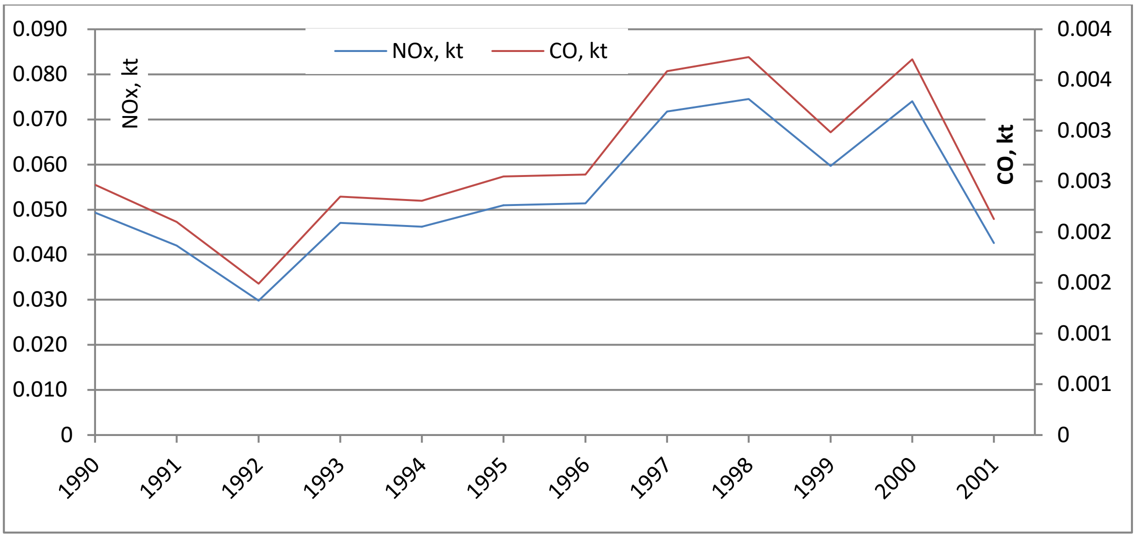


Figure 4.8.1. Emission trends (kt) for NFR 2.B.3 Adipic acid production

Recalculations and improvements:

- There were no recalculations and improvements for this category.

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

Year	kt production
2002	53
2003	45
2004	63
2005	34
2006	20

The emission trends are shown below in the following figure.

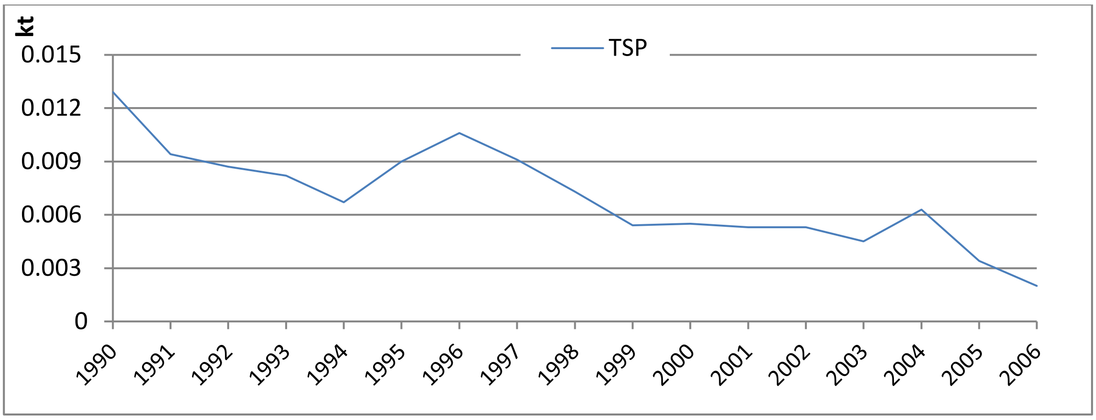


Figure 4.9.1. Total Emission trends (kt) for TSP for NFR 2.B.5 Carbide production

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

Recalculations and improvements:

- 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
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
2019	0.3087	0.0343	3.0870

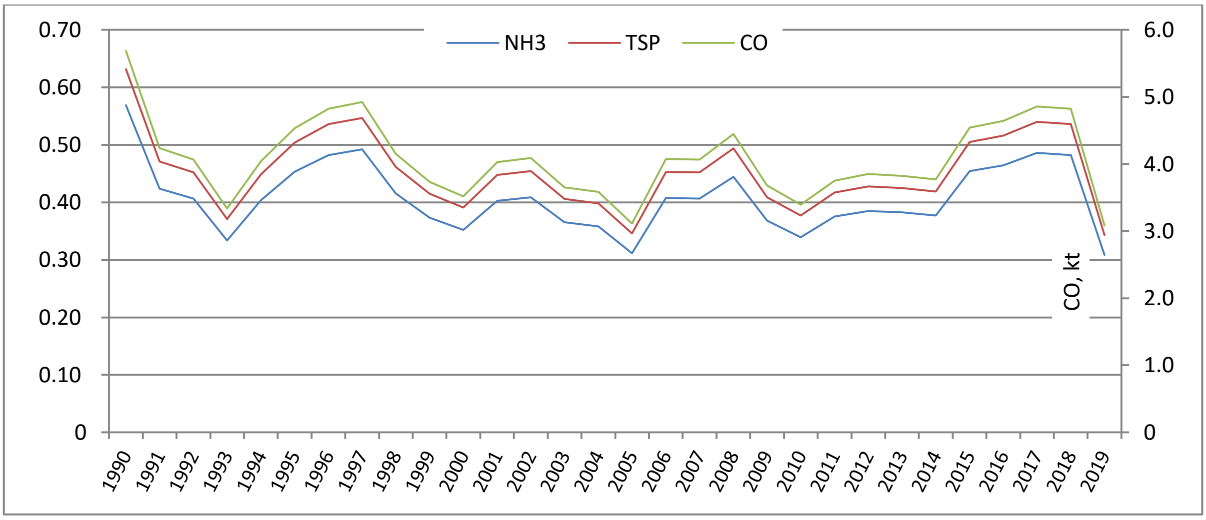


Figure 4.10.1. Emission trends (kt) for NFR 2.B.7 Soda Ash production

The emissions of NH_3 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:

- 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 in 2019.

The methodology for estimating emissions from chemical 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

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.
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. Other pollutants such as NOx, SOx, NH_3 and CO are estimated only for the period in which 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
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
2019	4.156	0.051	0.071	21.772	NO

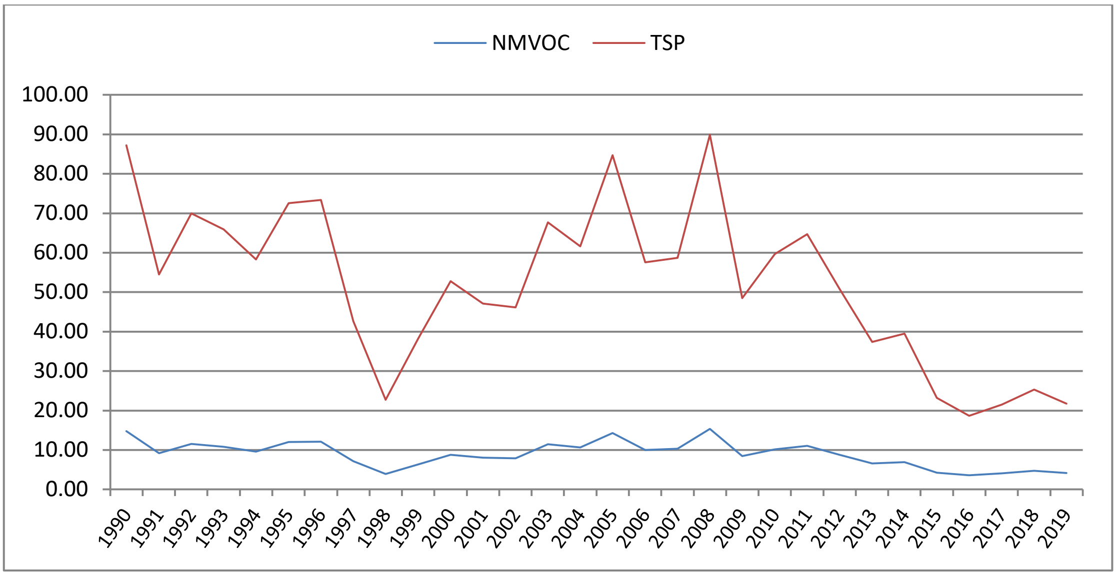


Figure 4.11.1 Emission Trends (kt) of NMVOC and TSP for NFR 2.B.10.a Other chemical industry

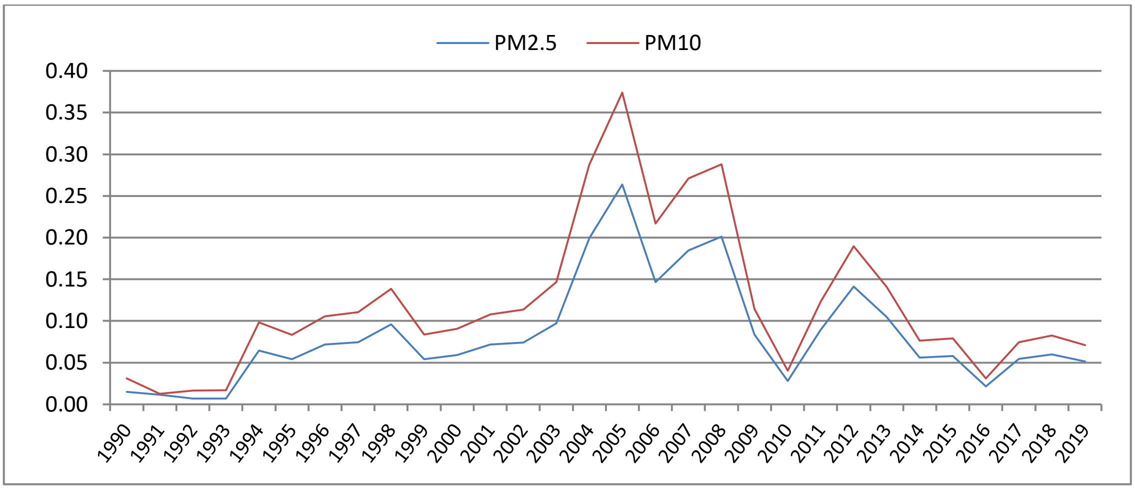


Figure 4.11.2 Emission Trends (kt) of $PM_{2.5}$ and PM_{10} for NFR 2.B.10.a Other chemical industry

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:

- There were not recalculations since the previous submission.

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 in 2019.
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 2007.

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

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Ni (t)	Zn (t)	PCDD/F (g I-TEQ)	PAHs (t)	PCBs (kg)
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
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
2019	24.080	0.393	0.227	0.996	5.442	1.396	13.585	32.338	6.618	13.888

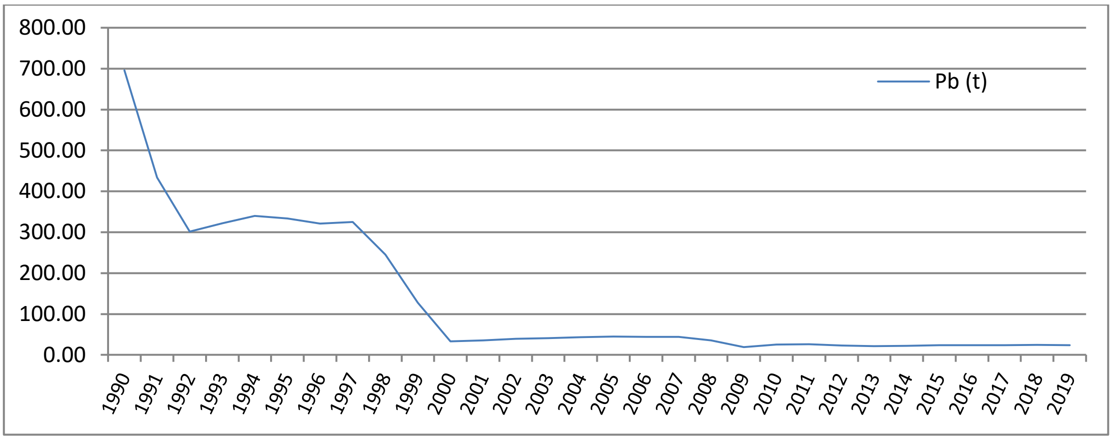


Figure 4.12.1.a Emission Trends of Pb (t) for NFR 2.C.1. Iron and steel production

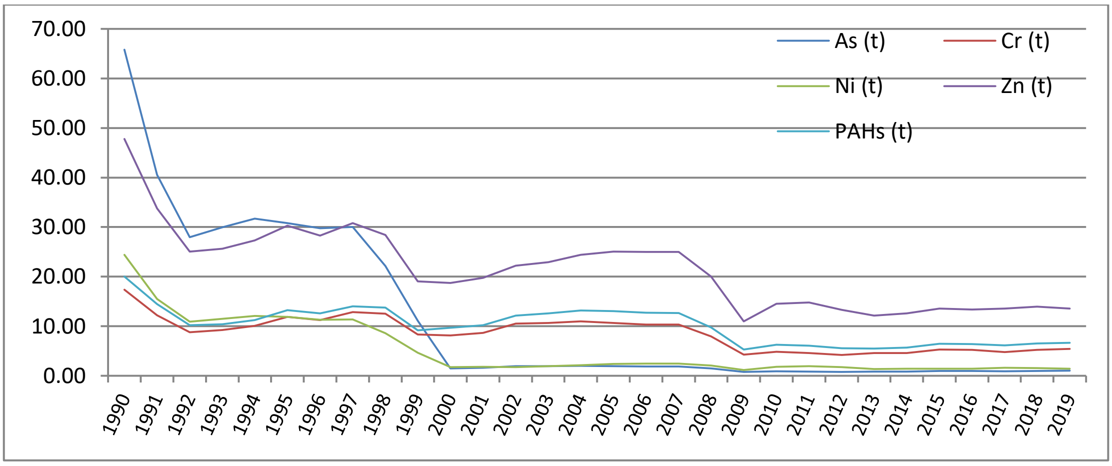


Figure 4.12.1.b Emission Trends of As, Cr, Ni, Zn and PAHs (t) for NFR 2.C.1. Iron and steel production

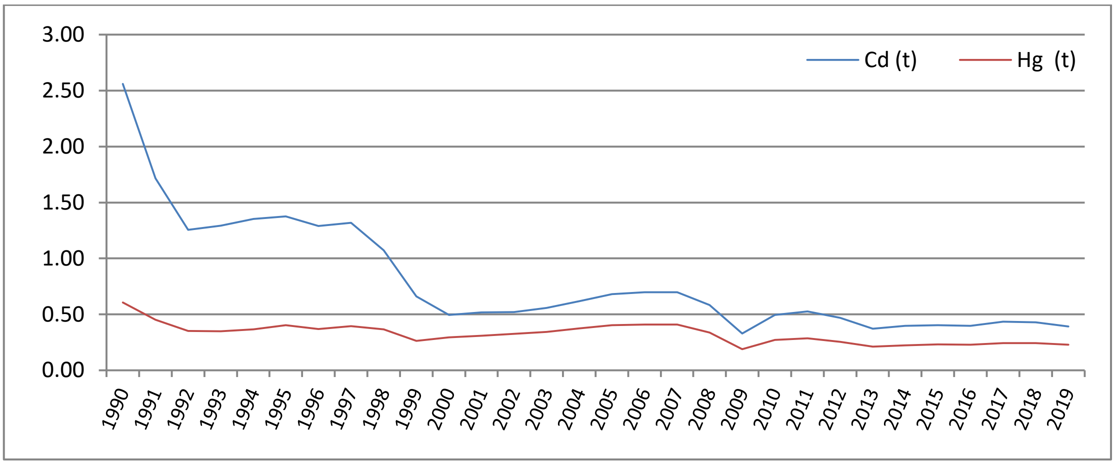


Figure 4.12.1.c Emission Trends of Cd, Hg (t) for NFR 2.C.1. Iron and steel production

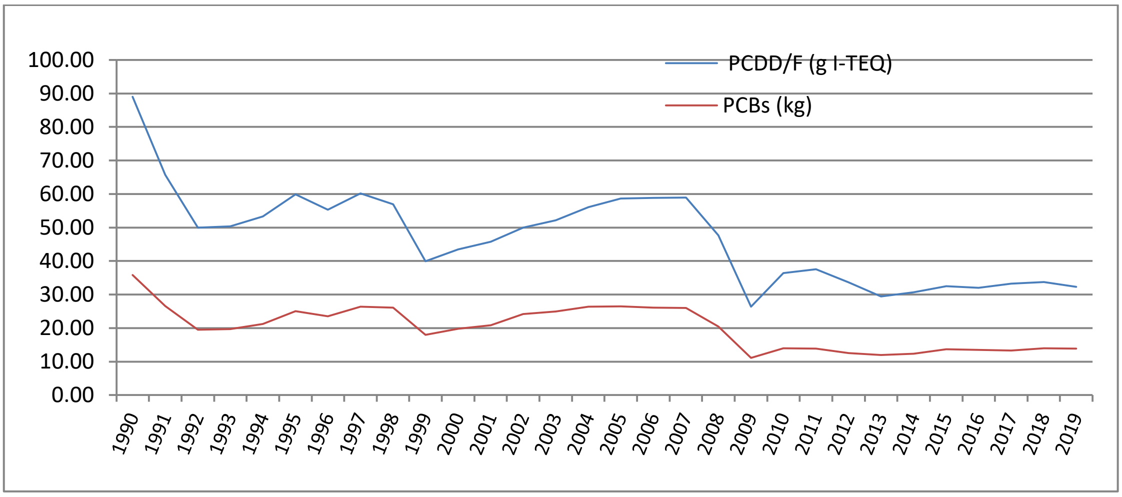


Figure 4.12.1.d Emission Trends of PCDD/F (g I-TEQ) and PCBs (kg) for NFR 2.C.1. Iron and steel production

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:

- There were not recalculations since the previous submission.

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
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

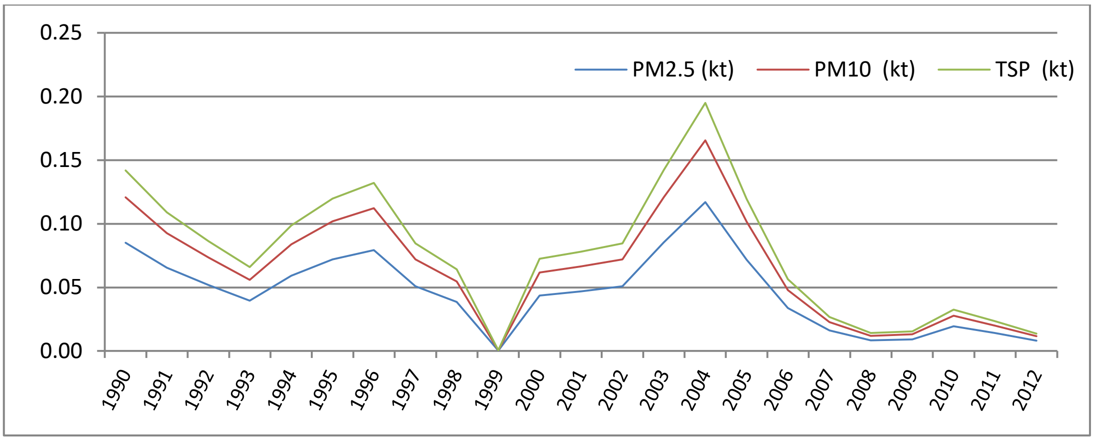


Figure 4.13.1. Total Emission Trends for NFR 2.C.2 Ferroalloys production for $PM_{2.5}$, PM_{10}, TSP (kt)

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:

- 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.

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
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
2019	24.041

The emissions of CO follow the activity data trends for aluminium production which varied substantially from year to year with a peak in 2008.

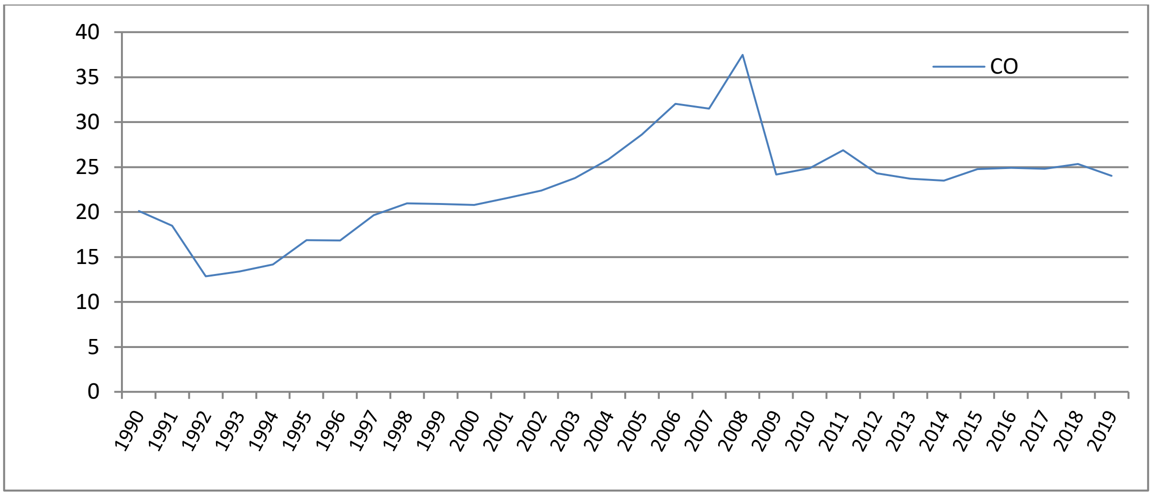


Figure 4.14.1. Emission Trends for CO (kt) for NFR 2.C.3. Aluminum production

Recalculations and improvements:

- There were not recalculations since the previous submission.

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	0.05330	0.0078
1991	0.04100	0.0060
1992	0.03690	0.0054
1993	0.04920	0.0072
1994	0.06150	0.0090
1995	0.07380	0.0108
1996	0.05330	0.0078
1997	0.05330	0.0078
1998	0.06148	0.0090
1999	0.05527	0.0081
2000	0.08375	0.0116
2001	0.09175	0.0134
2002	0.09330	0.0137
2003	0.11522	0.0169
2004	0.10069	0.0147
2005	0.12003	0.0167
2006	0.09269	0.0126
2007	0.11814	0.0163
2008	0.11654	0.0161
2009	0.02007	0.0024
2010	0.02450	0.0028
2011	0.01631	0.0020
2012	0.00214	0.0002
2013	0.00450	0.0007
2014	0.00527	0.0008
2015	0.00541	0.0008
2016	0.01568	0.0008
2017	0.01938	0.0009
2018	0.01636	0.0007
2019	0.01732	0.0008

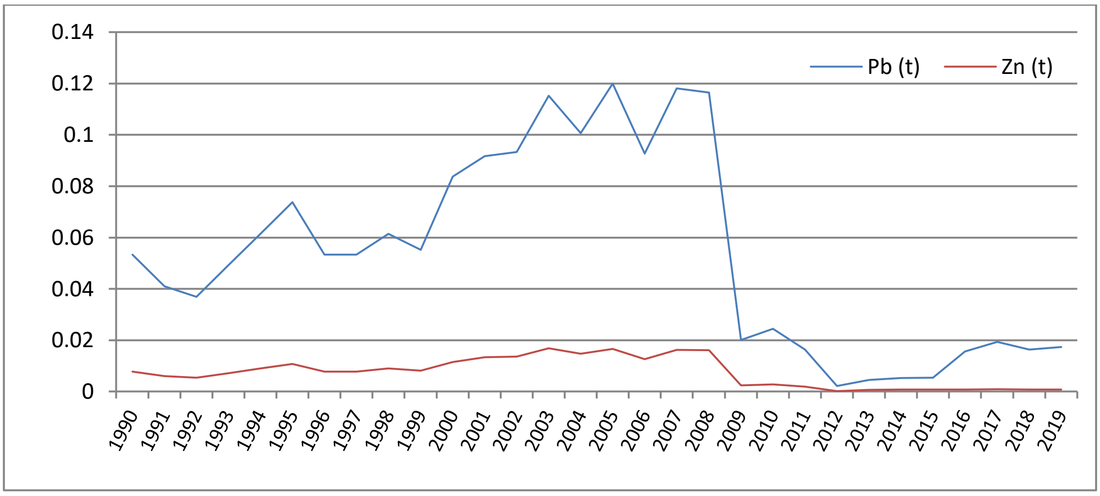


Figure 4.15.1 Total Emission Trends for NFR 2.C.5 Lead production

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.

There were no recalculations and improvements for this category.

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

Year/Pollutant	Pb (t)	Zn (t)
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
2019	0.00008	0.0021

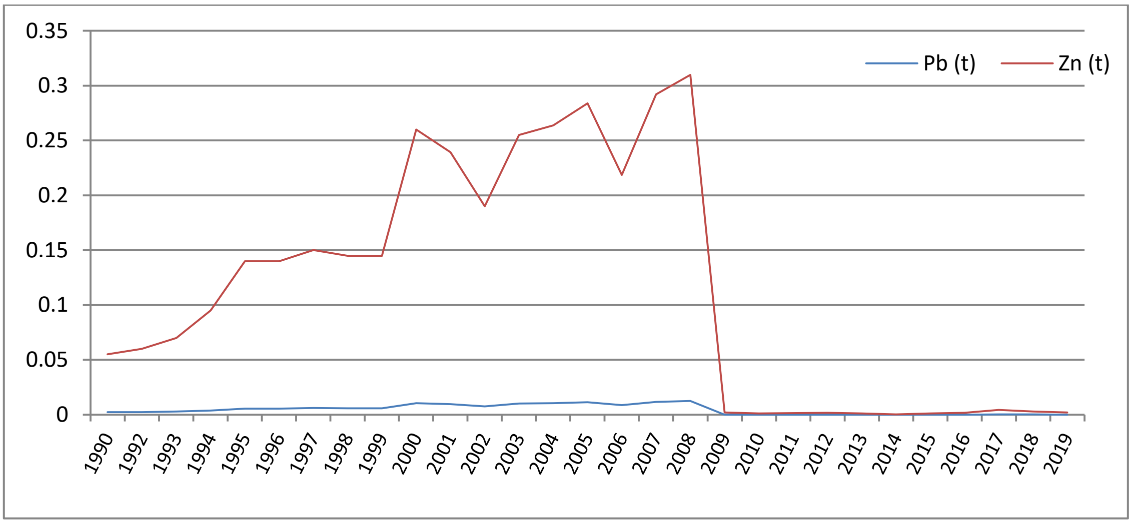


Figure 4.16.1 Total Emission Trends (t) for NFR 2.C.6 Zinc production

The 2019 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.

There were no recalculations and improvements for this category.

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 primary and secondary copper production, from the "PRODROM" statistics, provided by the N.I.S. The time series covers the years 1990-2008, when production stopped.

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	1.048	2.296	0.478

Year/Pollutant	Pb (t)	Cu (t)	Cd (t)
1991	1.072	2.324	0.480
1992	1.096	2.352	0.482
1993	1.016	2.182	0.448
1994	0.896	1.927	0.396
1995	0.896	1.927	0.396
1996	1.224	2.693	0.562
1997	0.952	2.069	0.428
1998	0.804	1.655	0.329
1999	0.888	1.956	0.408
2000	0.630	1.365	0.282
2001	0.567	1.006	0.175
2002	0.417	0.826	0.159
2003	0.473	0.724	0.106
2004	0.590	0.690	0.057
2005	0.498	0.581	0.048
2006	0.518	0.604	0.050
2007	0.439	0.512	0.042
2008	0.320	0.373	0.031

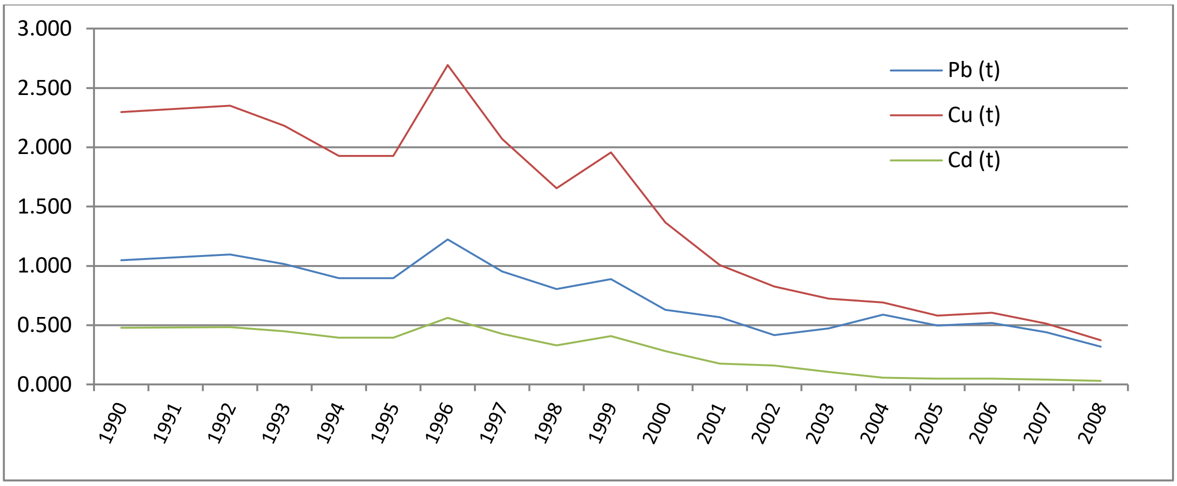


Figure 4.17.1 Total Emission Trends (t) for NFR 2.C.7a Copper production

Recalculations and improvements:

- Recalculation and upgrading for the whole 1990-2008 series to Tier 2 method, as a reviewing recommendation, reference question RO-2C7a-2019-0001.

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. In this submission, the years 2016 and 2017 the NMVOC emissions were recalculated because the country's population was updated by N.I.S.; years 2018 and 2019 were calculated using the Tier 2 methodology.

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	19643949

Year/Activity data	caput
2017	19533481

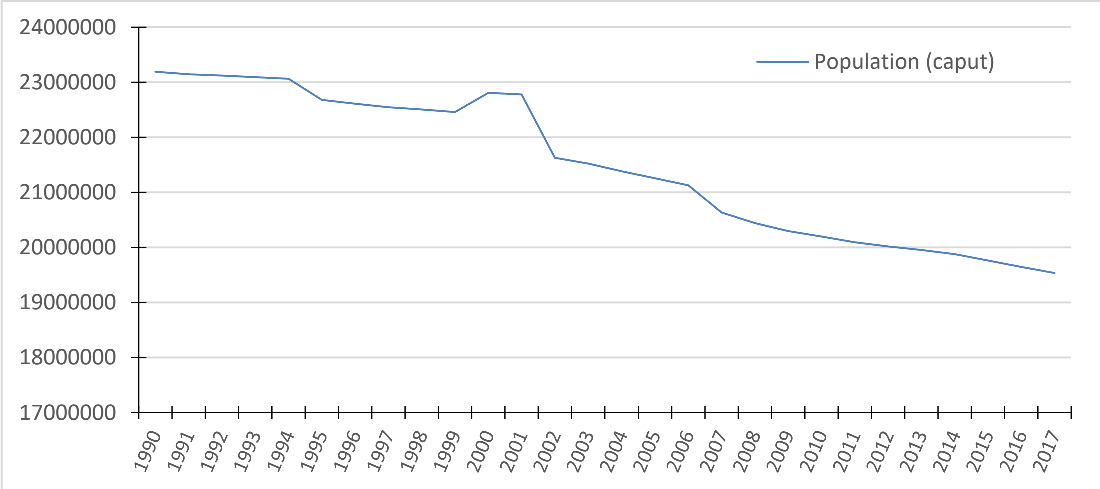


Figure 4.18.1. Activity data trends (caput) for NFR 2.D.3.a Domestic solvent use including fungicides

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

Year	NMVOC (kt)
2015	23.7127
2016	23.5728
2017	23.4402

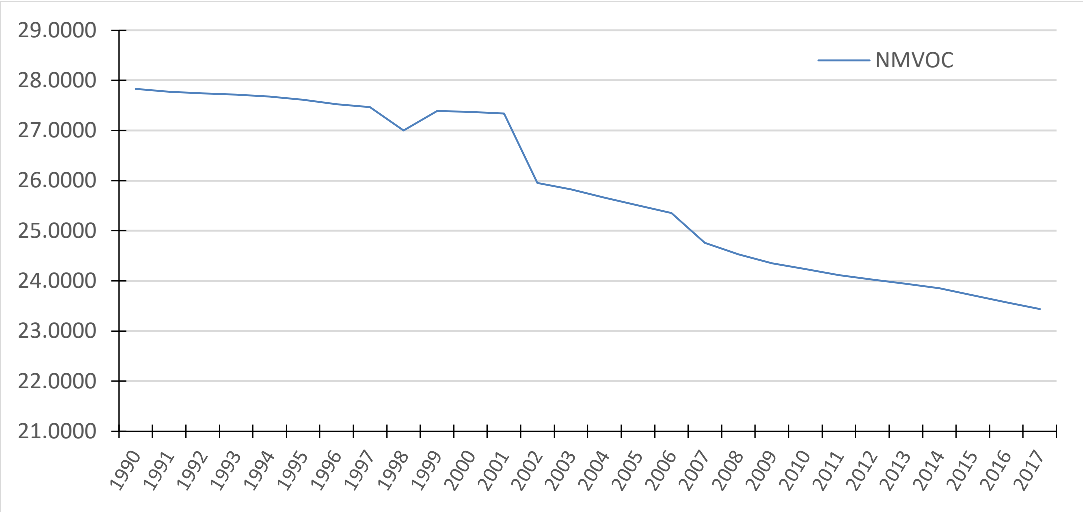


Figure 4.18.2. Emission trends (kt) for NFR 2.D.3.a Domestic solvent use including fungicides

The NMVOC emissions follow the activity data trends for NFR 2D3a Domestic solvent use including fungicides, which varied substantially from year to year due to variations in statistical population data.

During the desk Review 2020 in response to RO-2D3a-2017-0001 it was explained details regarding the activity data, EF_s used (Tier 2) and NMVOC emissions. The Tier 2 methodology for calculating NMVOC emissions was used only for 2018 and 2019 because our N.I.S. provided us with consistent data only for these two years.

Consumption data were calculated in according to the equation:

AD =Consumption= (Production + Imports) – Exports (kt), where:

- production (kg) – provided by N.I.S.
- imports (kg) - provided by N.I.S.
- exports (kg) - provided by N.I.S.

Were applied Tier2 emission factor, Table 3.4 from 2019 EMEP/EEA Guidebook for the following product types:

- Cosmetics and toiletries (all): AD = production (confidential), import and export for the following PRODROM codes: 204211500, 204213000, 204216300, 204216500, 204217000, 204218501, 204219450, 204219600, EF_{NMVOC}=127 g/kg product. Production of cosmetics and toiletries is provided by N.I.S. in pieces for the PRODROM codes listed above and converted into kilograms by approximating the weight of each type of product. For 2019, only production was used as the activity data, because import and export data were not available at the time of reporting.

- Household products (all): AD = production (confidential), import and export for the following PRODROM codes: 204132500, 204132700, 204144000, EF_{NMVOC}=127 g/kg product;
- Car care products (all): AD = production (confidential), import and export for the following PRODROM codes: 205943301, 205943501, 205943502, EF_{NMVOC}=180 g/kg product;
- Do it yourself (DIY)/buildings: AD = production (confidential), import and export for the following PRODROM codes: 203012250, 203012290, 203012300, 203012500, 203012700, 203012901, 203012902, EF_{NMVOC}= 45 g/kg product;
- Pesticides: AD = production (confidential), import and export for the following PRODROM codes: 202012300, 202012700, 202012900, EF_{NMVOC}= 150 g/kg product.

In 2019 NFR 2D3a was key categories for NMVOC with level assessment 8.05% from national total 229.583 kt of NMVOC.

Table 4.18.3. Emission trends (kt) for NFR 2.D.3.a Domestic solvent use including fungicides

Year	NMVOC (kt)
2018	24.8065
2019	18.4810

Improvements: studying the possibility of obtaining activity data for historical time series for the calculation of pollutant emissions using the Tier 2 methodology.

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 2019, with a share of 10.54% from the national emissions of TSP and 3.44% from the national emissions of PM_{10}.

The 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	1.242
1991	5.306	1.137
1992	5.138	1.101
1993	4.466	0.957
1994	4.754	1.019
1995	4.854	1.040
1996	4.904	1.051
1997	4.268	0.915
1998	2.693	0.577
1999	2.402	0.515
2000	3.125	0.670
2001	2.176	0.466
2002	2.182	0.468
2003	2.664	0.571
2004	13.33	2.856
2005	9.470	2.029
2006	13.292	2.848
2007	33.513	7.181
2008	7.461	1.599
2009	19.376	4.152
2010	23.028	4.934
2011	22.049	4.725
2012	25.251	5.411
2013	28.249	6.053
2014	29.286	6.275
2015	29.345	6.288
2016	20.707	4.437
2017	5.628	1.206
2018	15.610	3.345
2019	24.594	5.270

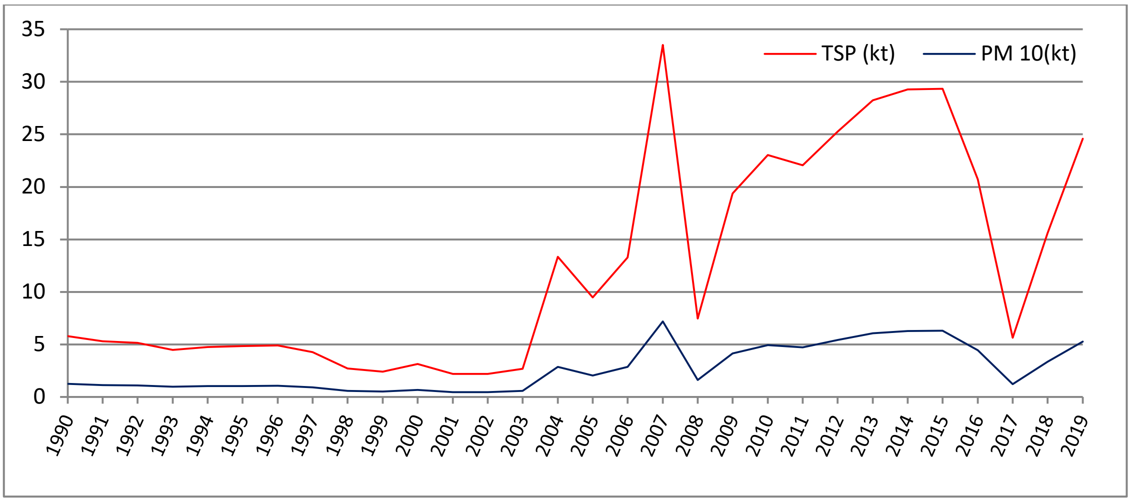


Figure 4.19.1. Total Emission Trends (kt) for NFR 2.D.3.b Road paving with asphalt

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.

There were no recalculations and improvements for this category.

4.20 NFR 2.D.3.c Asphalt Roofing

This activity covers emissions from the asphalt roofing industry.

The 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:

$$Epollutant = ARproduction \times EFpollutant$$

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 2006-2007 and 2010-2019.

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
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

Year/Pollutant	NMVOC (kt)	TSP (kt)
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
2019	0.000003	0.000036

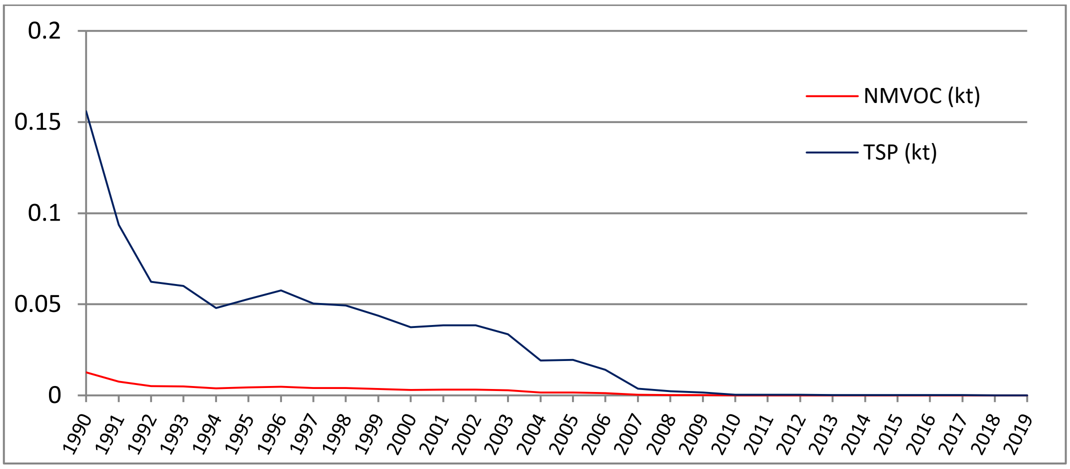


Figure 4.20.2. Total Emission Trends (kt) for NFR 2.D.3.c Asphalt Roofing

After 2009 there was a significant decrease in the asphalt roofing industry, and all emissions followed this trend.

There were no recalculations and improvements for this category.

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 “ Other solvent and product use (SNAP 060405)”.
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

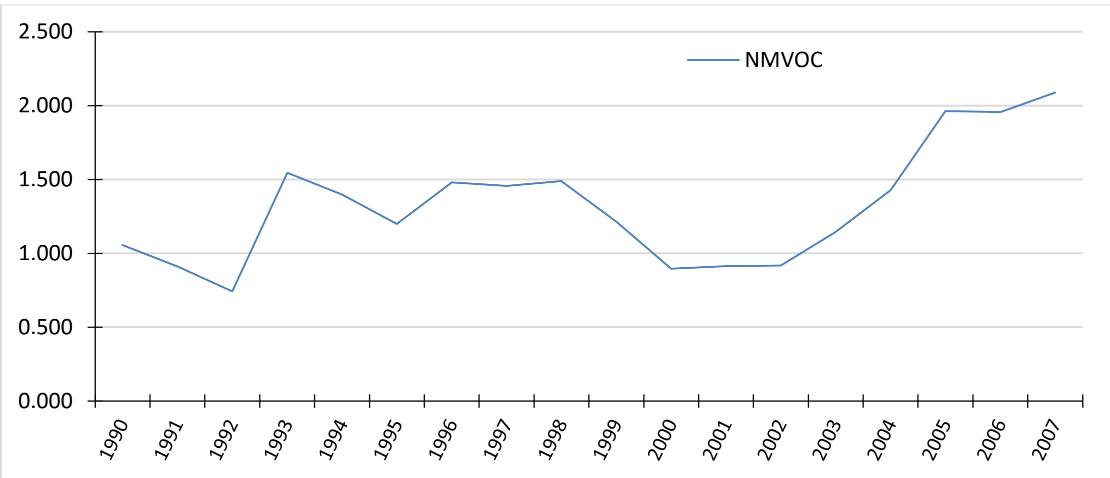


Figure 4.21.1. Emission trends (kt) for 2.D.3.d Coating applications

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 2008-2019 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. In 2019, NFR 2D3d was key source for NMVOC with 1.59% from national total.

The tables below shows the variation of solvent consumption (kt) and NMVOC emissions (kt) in the time period 2008-2019.

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
2019	9.778

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
2019	3.659

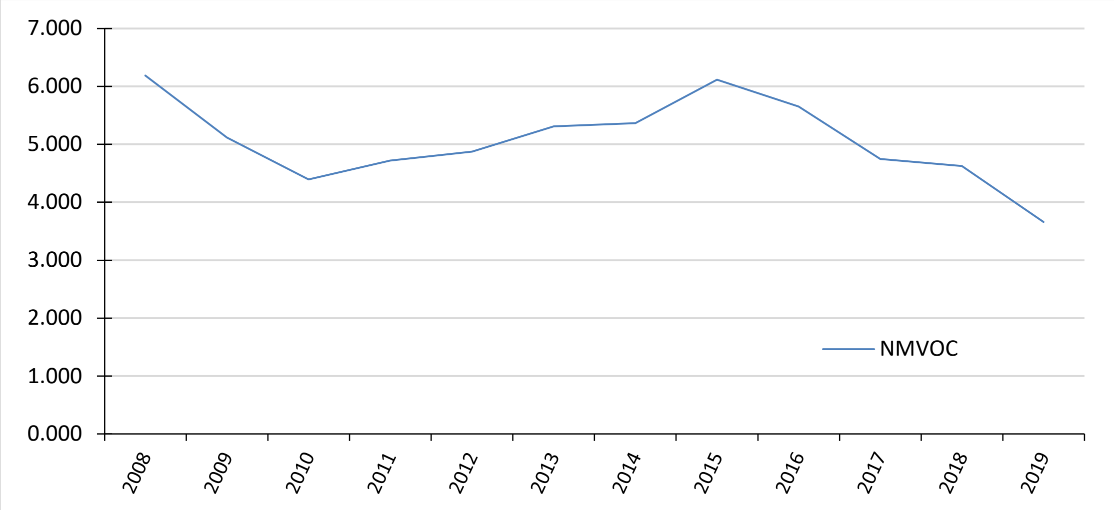


Figure 4.21.3. Emission trends (kt) for 2.D.3.d Coating applications

During the desk Review 2020, in RO-2D3d-2020-0001, the TERT "notes that significant recalculations have been applied (>10% change) for the key category 2D3d for the pollutants NMVOC and years 2008-2017. Regarding Romania 2020 IIR, section 4.21, recalculations are justified by using solvent consumption as activity data as well as NMVOC emissions from economic operators for entire time series 2008-2018. These recalculations introduce a time series inconsistency between the years before 2008 and after." Romania responded that it will start an analysis of the possibilities of collecting activity data for the period 1990-2007 for SNAP's 060106 "Boat building" and 060107 "Wood". Romania requested from N.I.S. this data, but N.I.S. does not have activity data regarding solvent consumption for time series 1990-2007.
Improvement: studying the possibility of obtaining activity data for historical time series for SNAP's 060106 "Boat building" and 060107 "Wood".

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 activity data are from EUROSTAT for PRODROM code 20302279. 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).

Table 4.22.1. Activity data trends (kt) for NFR 2.D.3.e Degreasing

Year	kt solvent
2000	2.08
2001	2.98
2002	6.51
2003	3.72
2004	4.46
2005	5.68
2006	7.38
2007	6.58
2008	5.63
2009	3.63
2010	3.55
2011	4.71
2012	4.04
2013	4.11
2014	3.91
2015	3.22
2016	3.58
2017	3.48
2018	3.23
2019	4.35

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
2016	1.648
2017	1.599
2018	1.484
2019	2.002

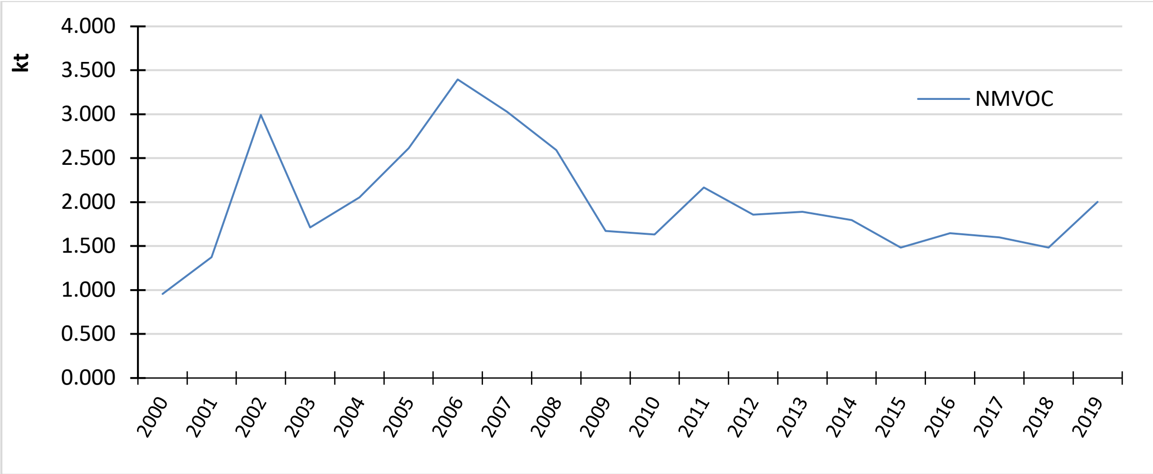


Figure 4.22.2. Emission trends (kt) for NFR NFR 2.D.3.e Degreasing

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. No plan improvement for NFR 2D3e.

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.

The methodology for estimating emissions from this source for time series 1990-2004 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

Year	NMVOC (kt)
2002	6.488
2003	6.456
2004	6.415

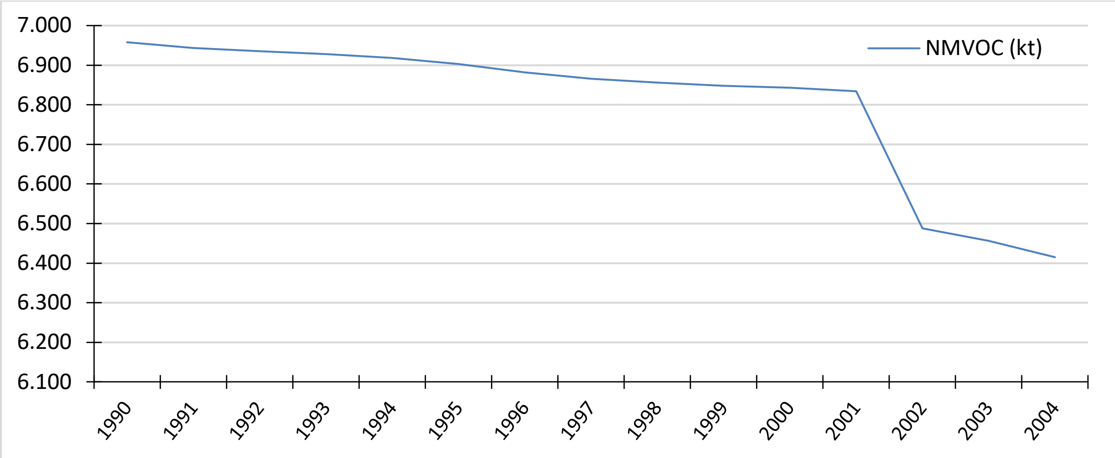


Figure 4.23.1. Emission trends (kt) for NFR 2.D.3.f Dry cleaning

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.

During the desk Review 2020, in RO-2D3f-2019-0001 ”the TERT notes that Romania uses a tier 1 methodology for NMVOC emissions from source category 2D3f, dry cleaning, which has become a key category”, so NMVOC emissions were calculated using the Tier2 methodology. Was taken into account perchlorethylene (PER) as a solvent used for dry cleaning. We assumed the entire amount of perchlorethylene (PER) as a solvent used for dry cleaning. PER consumption was calculated with:

AD = Consumption = Production + Imports – Exports (kg).

Production/import/export data were provided by N.I.S. for time series 2005-2019

The second paragraph of section 3.2.1 Dry cleaning from 2019 GB explains “ solvent emissions directly from the cleaning machine into the air represent little more than 40% for a closed-circuit machine”. Romania used in dry cleaning branch closed-circuit equipement following the European Solvents Directive. So, has been calculated an emission factor for NMVOC, expressed in g NMVOC/kg solvent which is 400 g NMVOC/kg PER. The activity data and emission trends are shown below in the following tables and figure. For 2007 NMVOC emissions and PER consumption were extrapolated due to data inconsistency.

Table 4.23.2. Activity data trends (kt) for NFR 2.D.3.f Dry cleaning for time series 2005-2019

Year	Consumption of PER (kt)
2005	1.34
2006	2.96
2007	1.87
2008	0.78
2009	0.64

Year	Consumption of PER (kt)
2010	0.45
2011	0.42
2012	0.34
2013	0.32
2014	0.34
2015	0.40
2016	0.32
2017	0.43
2018	0.44
2019	0.42

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

Table 4.23.3. Emission trends (kt) for NFR 2.D.3.f Dry cleaning

Year	NMVOC (kt)
2005	0.537
2006	1.183
2007	0.747
2008	0.311
2009	0.255
2010	0.181
2011	0.168
2012	0.135
2013	0.130
2014	0.137
2015	0.159
2016	0.128
2017	0.171
2018	0.174
2019	0.169

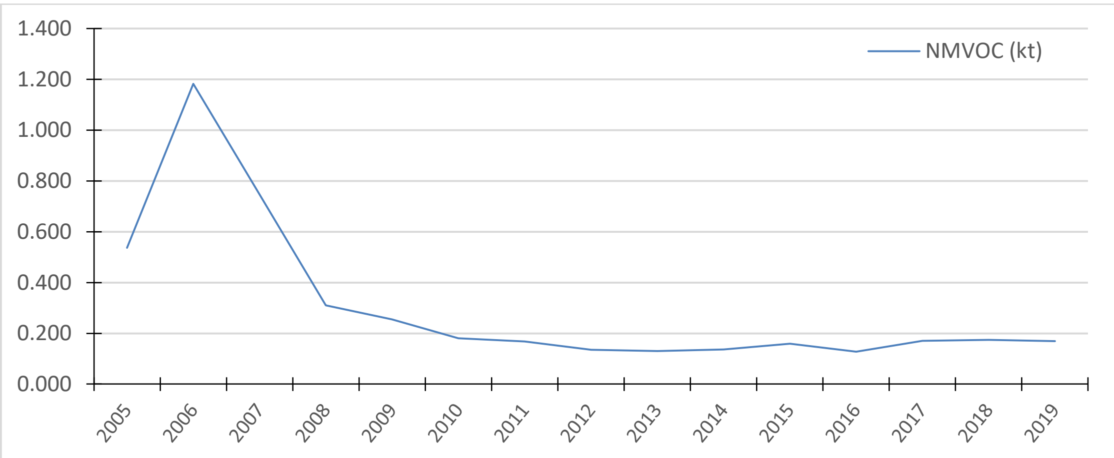


Figure 4.23.3. Emission trends (kt) for NFR 2.D.3.f Dry cleaning

The NMVOC emission trends follow the activity data trend with varied substantially from year to year due to variations in PER consumption.

Improvement: studying the possibility of obtaining activity data for historical time series for the calculation of pollutant emissions using the Tier 2 methodology.

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 1990-1994);
- 060305 Rubber processing;
- 060306 Pharmaceutical products manufacturing;
- 060307 Paints manufacturing;
- 060308 Inks manufacturing (not available between 1990-2007);
- 060309 Glues manufacturing.
- 060310 Asphalt blowning
- 060313 Leather tanning

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

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

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), SNAP 060309 (glues manufacturing) and SNAP 060310 (asphalt blowning) 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 (for SNAP 060302-polyvinylchloride processing), Table 3-3 (for SNAP 060303-polyurethane foam processing), Table 3-4 (for SNAP 060304-polystyrene foam processing), Table 3-5 (for SNAP 060305-rubber processing - for time series 1990-2007), Table 3-8 (for SNAP 060310-asphalt blowning), Table 3-11 (for SNAP 060307-paints manufacturing, SNAP 060308-inks manufacturing, SNAP 060309-glues manufacturing).

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 2008-2019); same thing for SNAP 060305 (rubber processing) on the 2008-2019 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		1165.00000
1991		1001.00000
1992		845.00000
1993		542.22700
1994		597.20000
1995		621.41500
1996		602.02200
1997		573.44500
1998		478.61600
1999		413.68000
2000		474.11800
2001		440.65700
2002		443.60100
2003		516.64400
2004		582.04200
2005		533.02376
2006		757.76750
2007		745.56500
2008	0.81754	898.76201
2009	0.71614	529.14682
2010	1.09419	465.92197
2011	1.05917	471.20870
2012	1.23695	617.90164
2013	1.29707	678.81573
2014	1.42045	703.52280
2015	1.43206	727.28803
2016	1.14729	707.29919
2017	1.43066	656.88790
2018	1.44199	663.02345
2019	1.24077	658.62817

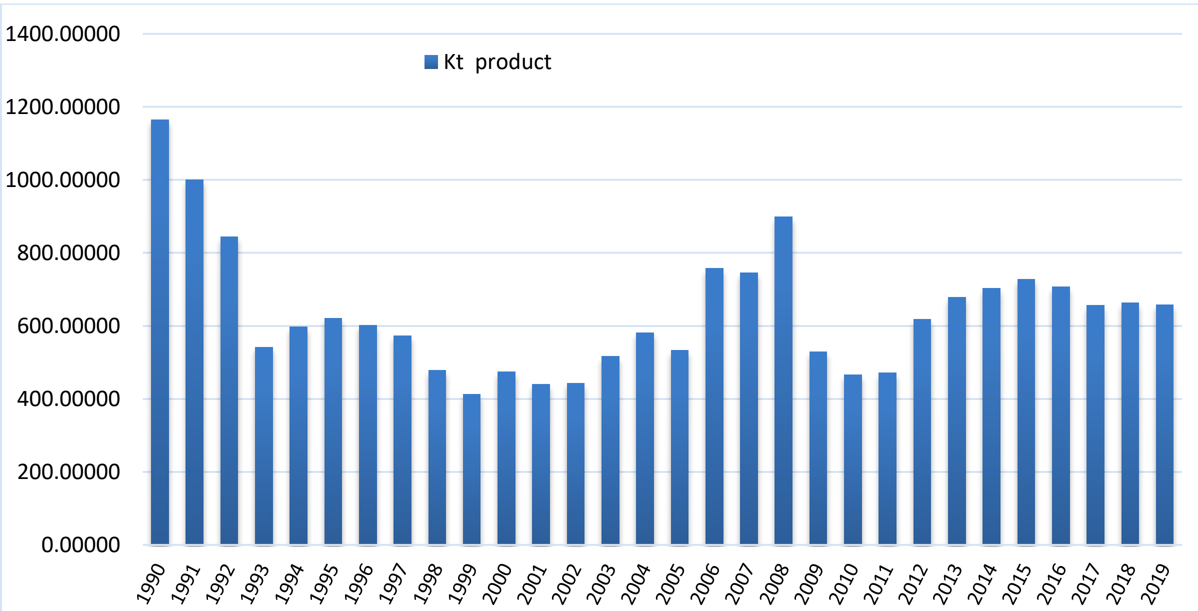


Figure 4.24.1. Activity data trends Kt products for NFR 2.D.3.g Chemical products

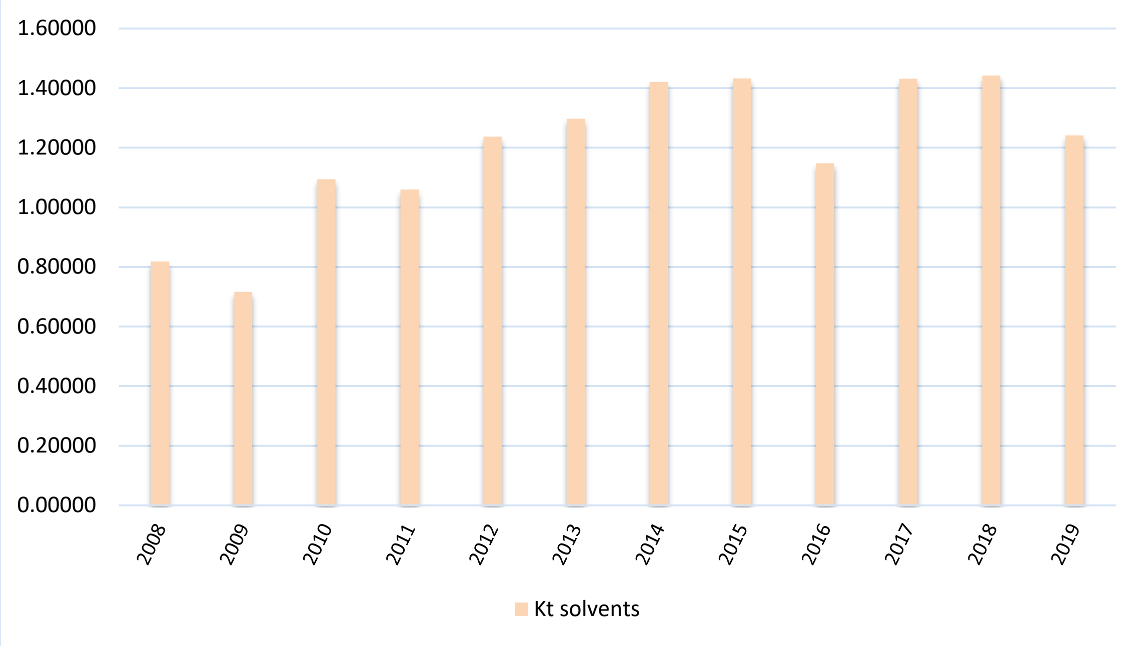


Figure 4.24.2. Activity data trends Kt solvents for NFR 2.D.3.g Chemical products

Table 4.24.2. Emission trends (kt) for NFR 2.D.3.g Chemical products

Year/Pollutant	NMVOC
1990	19.06080
1991	16.87280
1992	15.04140
1993	10.94574
1994	12.10603
1995	12.43306
1996	12.26445
1997	11.19890
1998	9.08318
1999	7.71891
2000	9.18359
2001	7.61832
2002	7.44381
2003	9.00197
2004	9.90621
2005	9.31562
2006	28.65527
2007	26.53513
2008	27.77747
2009	11.99302
2010	10.38904
2011	10.13827
2012	12.93066
2013	14.49685
2014	13.38778
2015	12.93013
2016	13.36262

Year/Pollutant	NMVOC
2017	13.22128
2018	14.00583
2019	14.06795

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

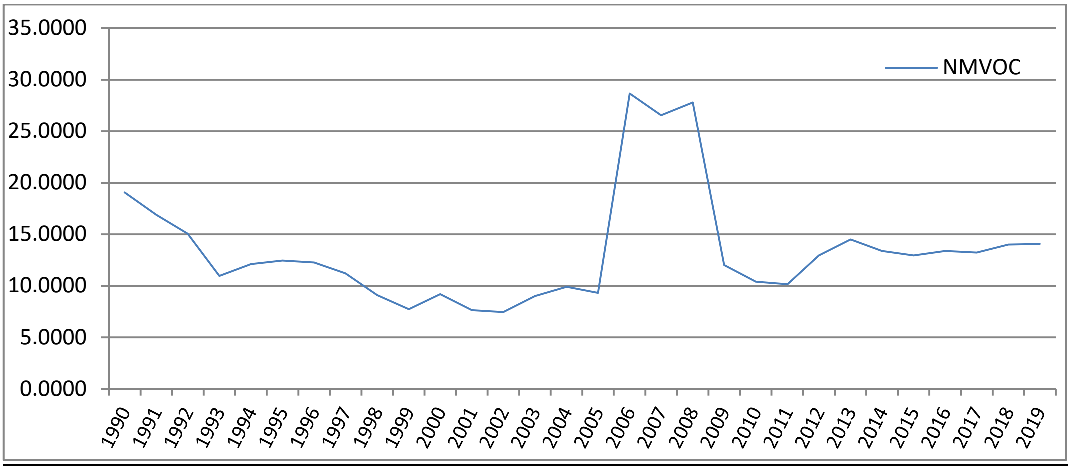


Figure 4.24.3. Emission trends (kt) for NFR 2.D.3.g Chemical products

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 6.13% of the total national emissions of NMVOC in 2019.
Recalculations: first estimate emission for the SNAP 060310 Asphalt blowing.
Improvement: studying the possibility of obtaining activity data for the historical time series for the calculation of pollutant emissions using the Tier 2 methodology.

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 2008-2019 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	
2019	3.8463	

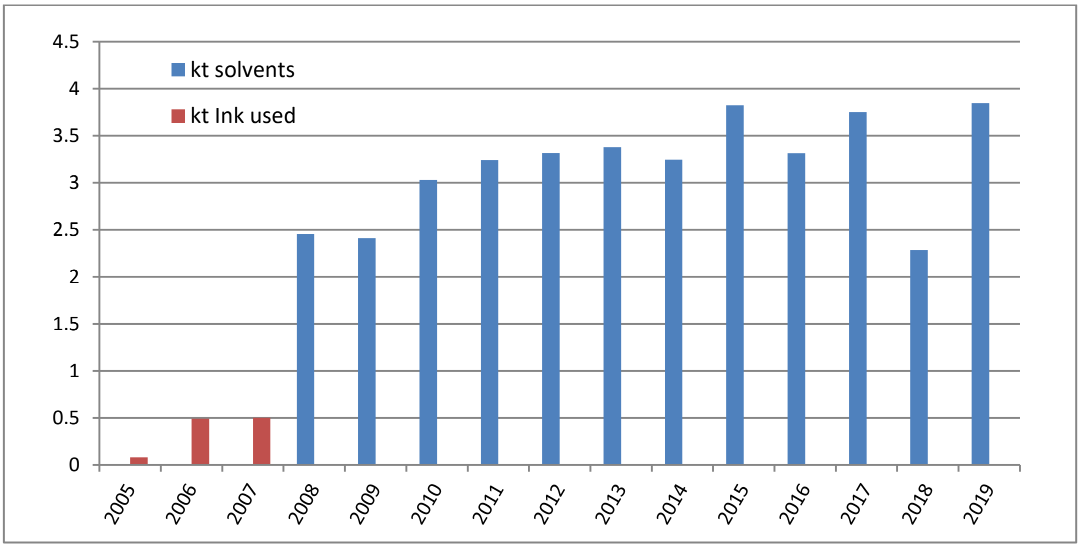


Figure 4.25.1. Activity data trends (kt Ink used and kt solvents) for NFR 2.D.3.h Printing

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	0.04057
2006	0.24673
2007	0.25050

Year/Pollutant	NMVOC
2008	1.31641
2009	0.98909
2010	1.15090
2011	1.23200
2012	0.66891
2013	0.57201
2014	0.68466
2015	0.65510
2016	0.53404
2017	0.66677
2018	0.48747
2019	0.49345

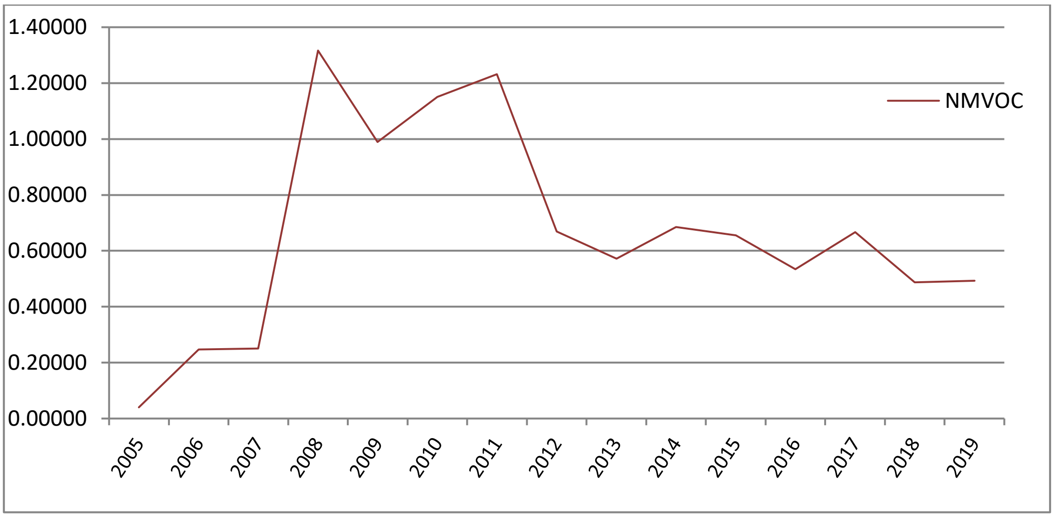


Figure 4.25.2. Emission trends (kt) for NFR 2.D.3.h Printing

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.

There were no recalculations for this category

Improvement:: studying the possibility of obtaining activity data for historical time series for the calculation of pollutant emissions using the Tier 2 methodology.

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 the2008-2019 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× 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	2.27452	20440290
2009	1.79863	20294683
2010	2.09140	20199059
2011	1.72281	20095996
2012	1.59474	20020074
2013	1.76444	19953089
2014	1.70412	19875542
2015	1.76127	19760585
2016	1.29195	19643949
2017	1.53516	19533481
2018	1.16881	19414458
2019	1.80527	19317984

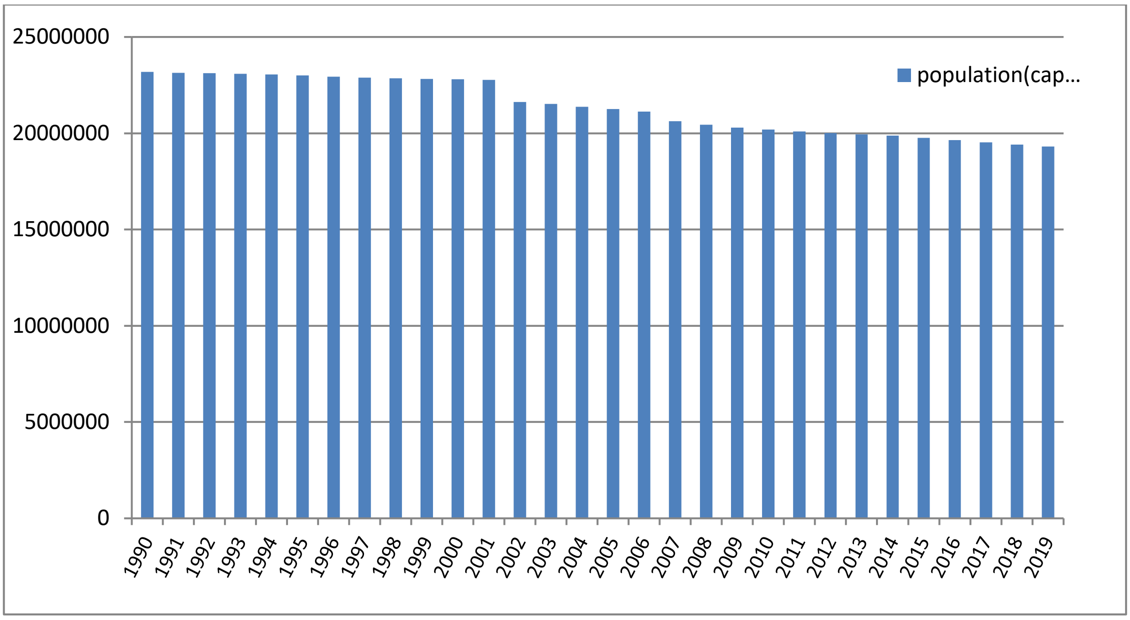


Figure 4.26.1. Activity data trends (total population) for NFR 2.D.3.i. Other solvent use

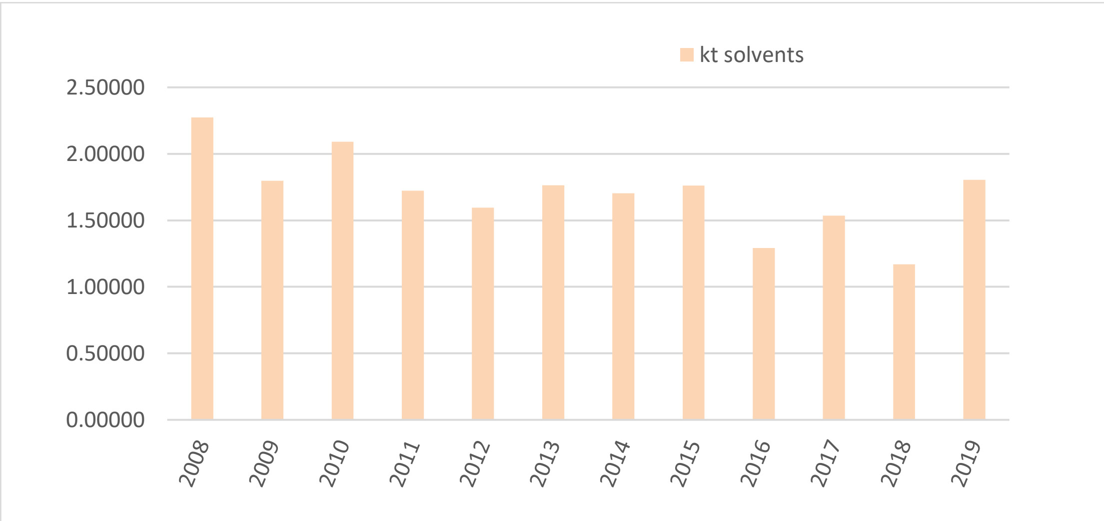


Figure 4.26.2. Activity data trends (kt solvents) for NFR 2.D.3.i. Other solvent use

Table 4.26.3. Emission trends (kt) for NFR 2.D.3.i Other solvent use

Year/Pollutant	NMVOC
1990	4.63845
1991	4.62877
1992	4.62375
1993	4.61865
1994	4.61249
1995	4.60182
1996	4.58768
1997	4.57716
1998	4.57058
1999	4.56506
2000	4.56191

Year/Pollutant	NMVOC
2001	4.55589
2002	4.32550
2003	4.30423
2004	4.27647
2005	4.25100
2006	4.22610
2007	4.12709
2008	5.25621
2009	5.05710
2010	5.28832
2011	5.16358
2012	5.23910
2013	5.37170
2014	5.17602
2015	5.17270
2016	4.65253
2017	4.86702
2018	4.50962
2019	5.16348

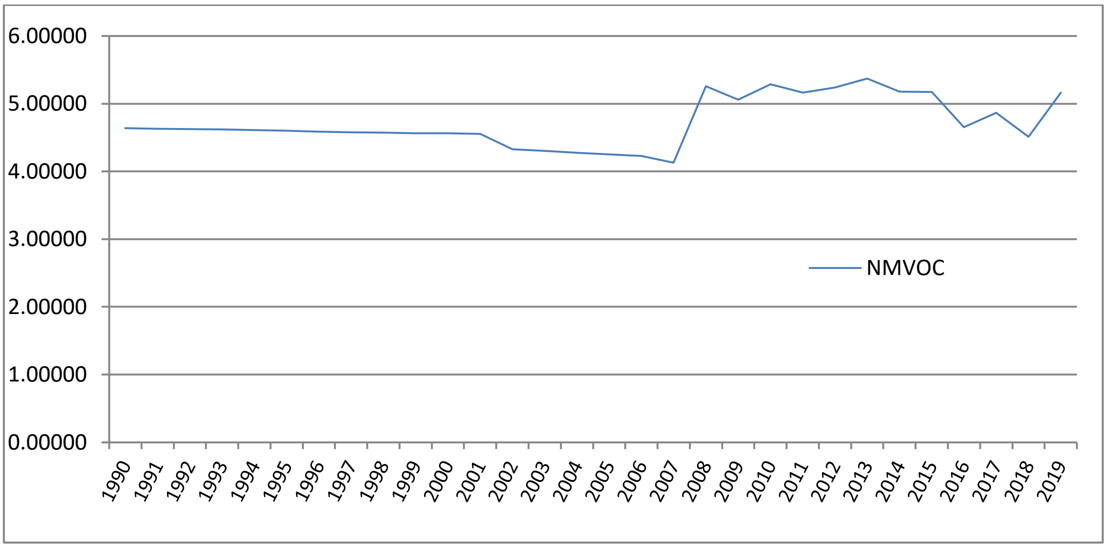


Figure 4.26.3. Emission trends (kt) for NFR 2.D.3.i Other solvent use

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 2.25% of total national NMVOC emissions for the year 2019.

Recalculations:
- For the SNAP 060407 (preservation of wood) for the years 2016, 2017 and 2018 the NMVOC emissions were recalculated because the country's population was updated by N.I.S.
Improvement: studying the possibility of obtaining activity data for historical time series for the calculation of pollutant emissions using the Tier 2 methodology.

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 2008-2019 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

Year	Tobacco (t)	Fireworks (t)
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
2019	24786.13	1543.93

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	$PM_{2.5}$	PM_{10}	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	1.001	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	2.240
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	1.485
2017	0.807	0.653	0.684	0.690	1.269
2018	0.505	0.799	0.843	0.852	1.541
2019	0.477	0.730	0.804	0.819	1.337

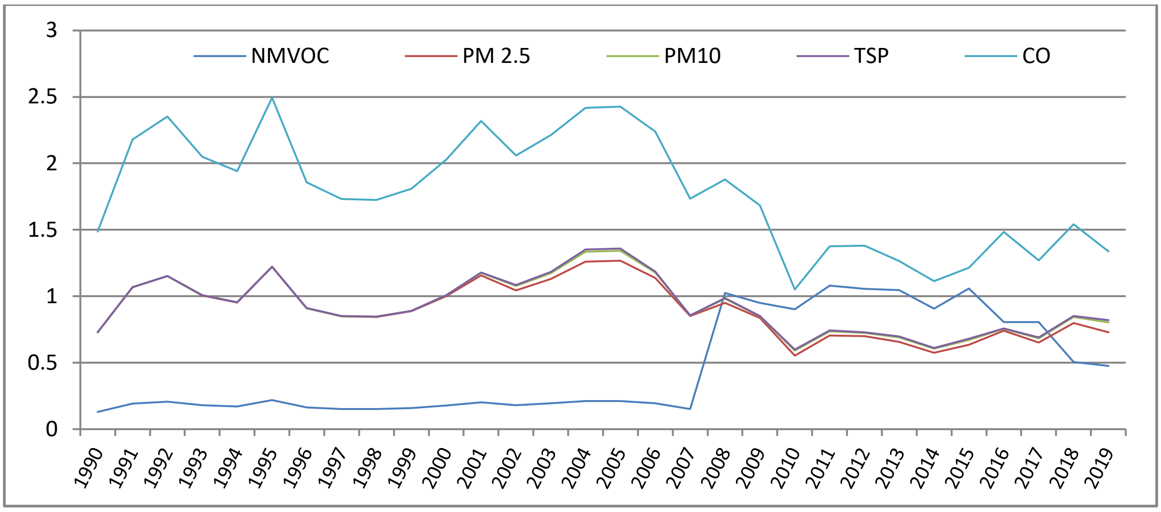


Figure 4.27.1. Emission Trends for NFR 2.G Other product use (kt)

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”.

There were no recalculations and improvements for this category.

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.

There were no recalculations and improvements for this category.

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 2019, sharing 3.5% 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
2019	8.076

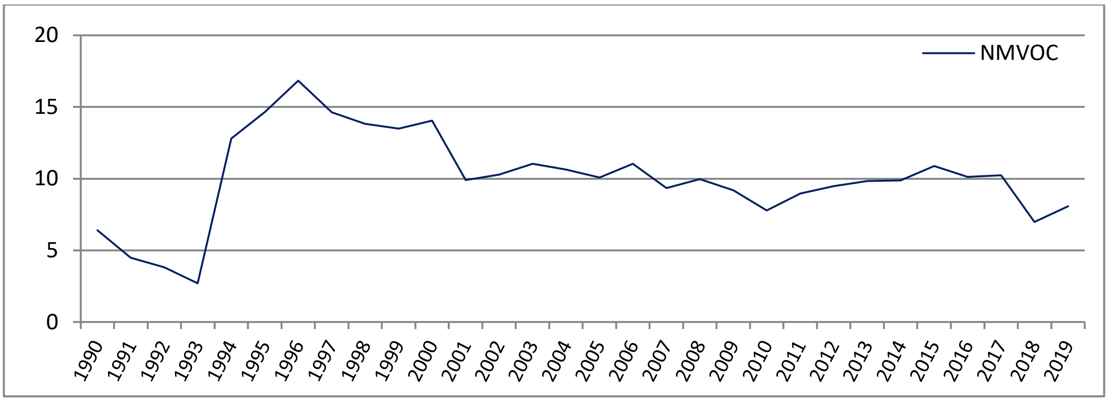


Figure 4.29.1. Emission trends (kt) for NFR 2.H.2 Food and beverages industry

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.

There were no recalculations and improvements for this category.

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

Year/Activity data	1000 m^3 product
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
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
2019	5144.21

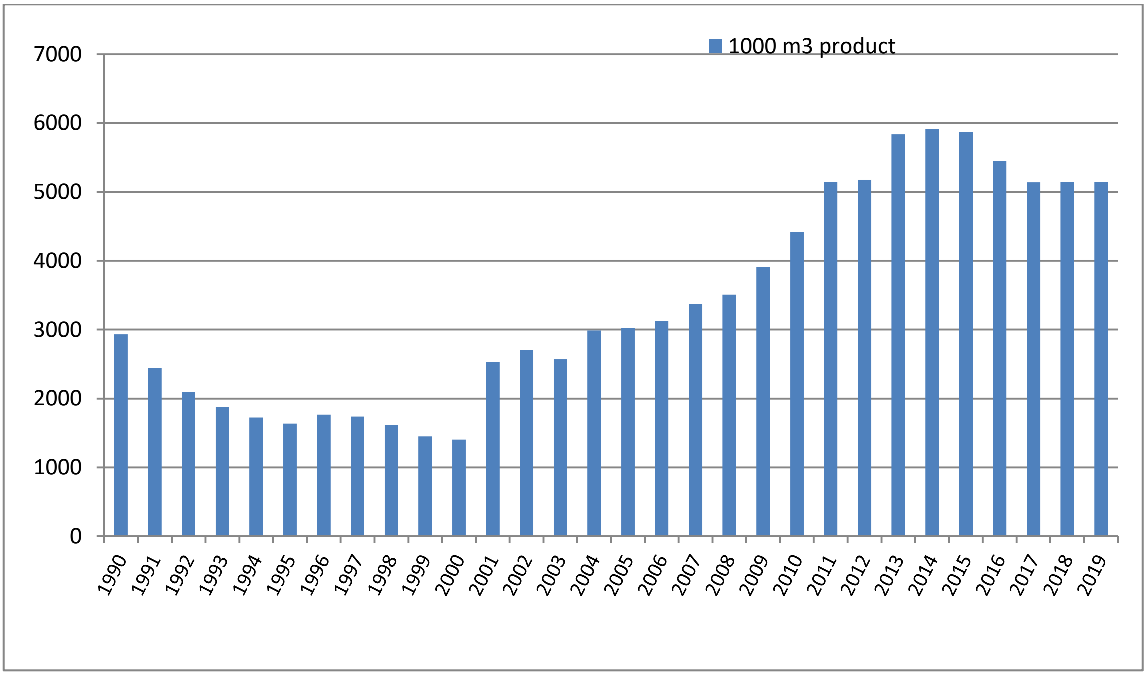


Figure 4.30.1. Activity data trend for NFR 2.I Wood Processing

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
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
2019	4.542

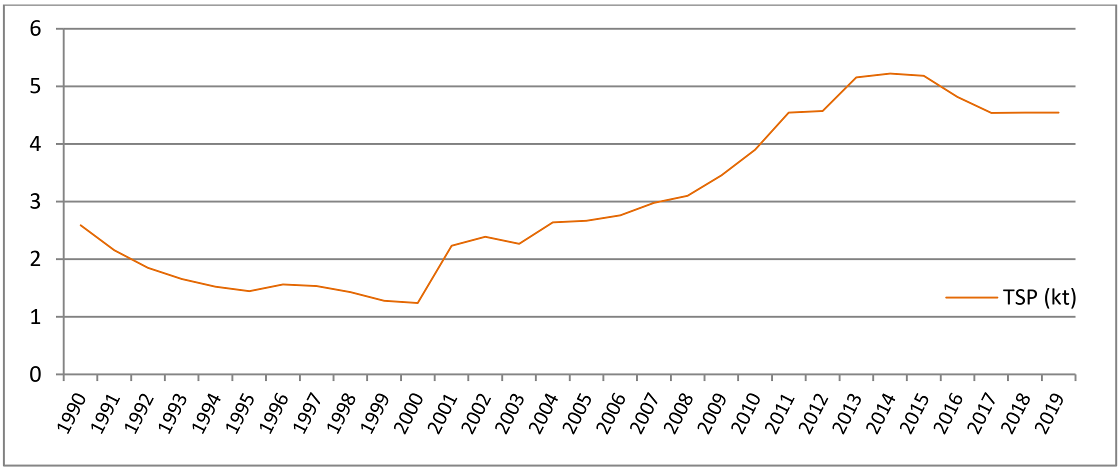


Figure 4.30.2. Emission trends (kt) for NFR 2.I Wood Processing

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.

There were no recalculations and improvements for this category.

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 2019 EMEP/EEA Guidebook.

Animal populations, data on fertilizers usage and crop productions were 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 2019

	NH_3	NOx	SOx	NMVOC	$PM_{2.5}$	PM_{10}	TSP
National total (kt)	178.25	217.49	99.05	229.58	112.03	153.08	233.24
Agriculture total (kt)	159.15	29.87	0.00089	46.90	1.29	21.78	32.60
Weight percentage (%)	89.28%	13.73%	0.0009%	20.43%	1.15%	14.23%	13.98%

For the year 2019, the main part of the NH_3 emission (89.28%) from the national total is related to the agricultural sector, while the contribution of NMVOC share from agriculture accounts for 20.43% of the national total. The TSP, PM_{10} and $PM_{2.5}$ emissions from manure management are 13.98%, 14.23% and 1.15%, respectively, of the national total. The inventory also includes the NOx emissions from application of inorganic fertilisers and animal manure, which results in 13.73% of the national total. The total SOx emissions from agriculture is lower than 0.001% 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
	3Da2a	Animal manure applied to soils
NMVOC	3B1a	Manure management - Dairy cattle
	3De	Cultivated crops
	3B1b	Manure management - Non-dairy cattle
	3B4gi	Manure management - Laying hens
	3B4gii	Manure management - Broilers
NH3	3Da2a	Animal manure applied to soils
	3Da1	Inorganic N-fertilizers
	3B3	Manure management - Swine
	3Da3	Urine and dung deposited by grazing animals
	3B1a	Manure management - Dairy cattle
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*".

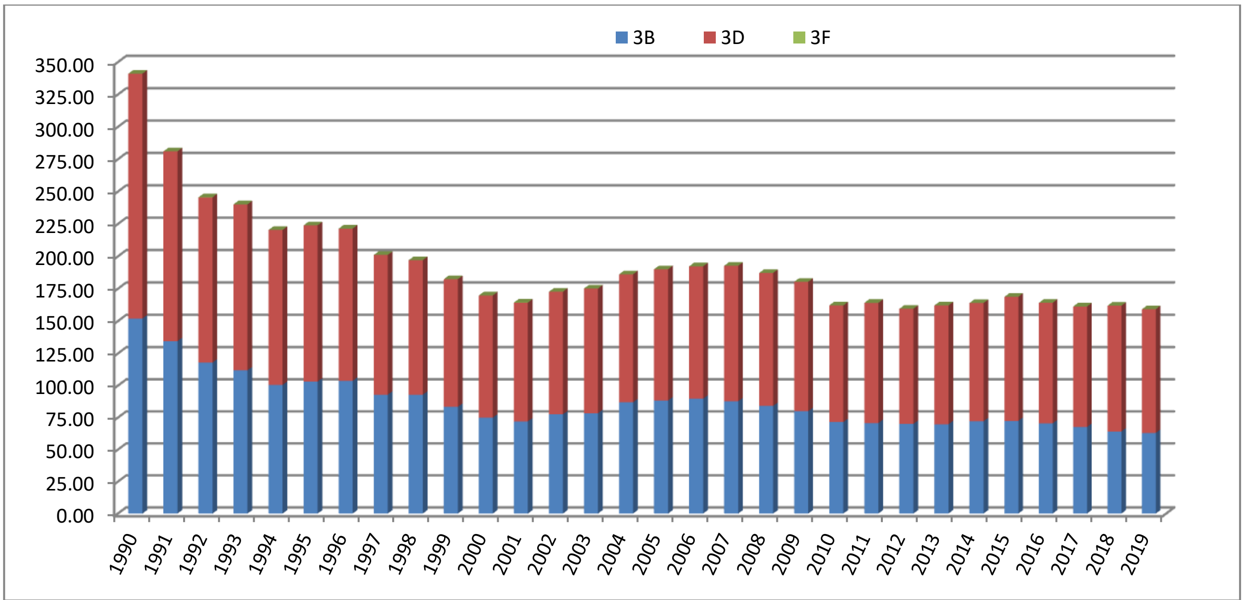


Figure 5.1 Distribution of the NH_3 emission by the agricultural sources for the 1990-2019 period

For the year 2019, the distribution of NH_3 emissions by agriculture sources was as follows: 39.58% from manure management, 60.42% from manure applied to soils and only 0.0049% from burning fields.

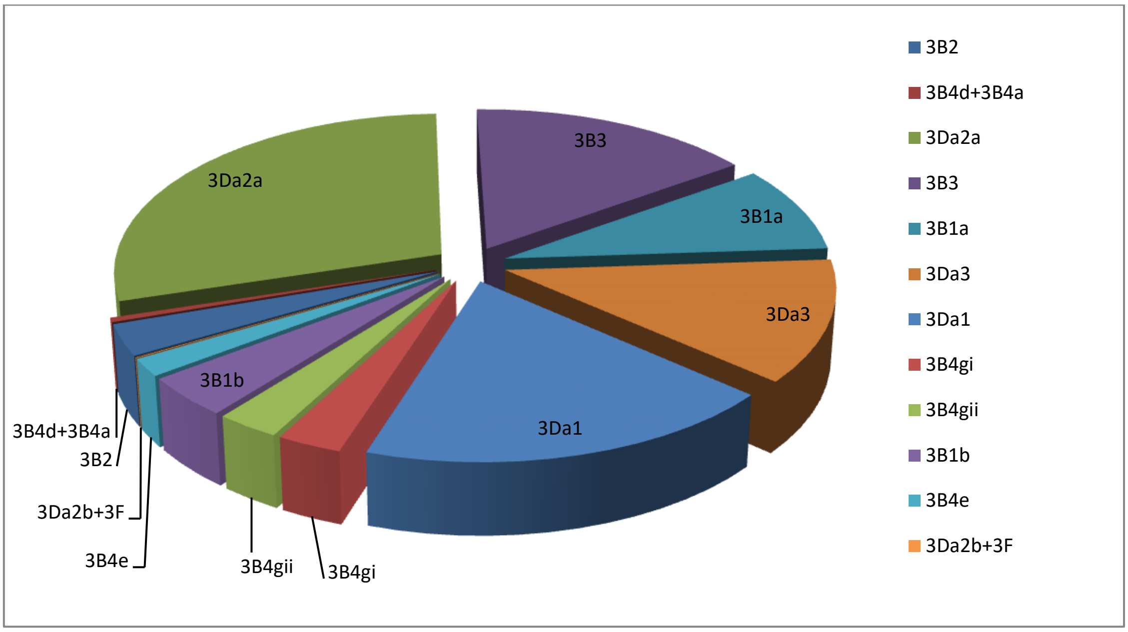


Figure 5.2 - Share of NH_3 emissions by the agriculture sector for 2019

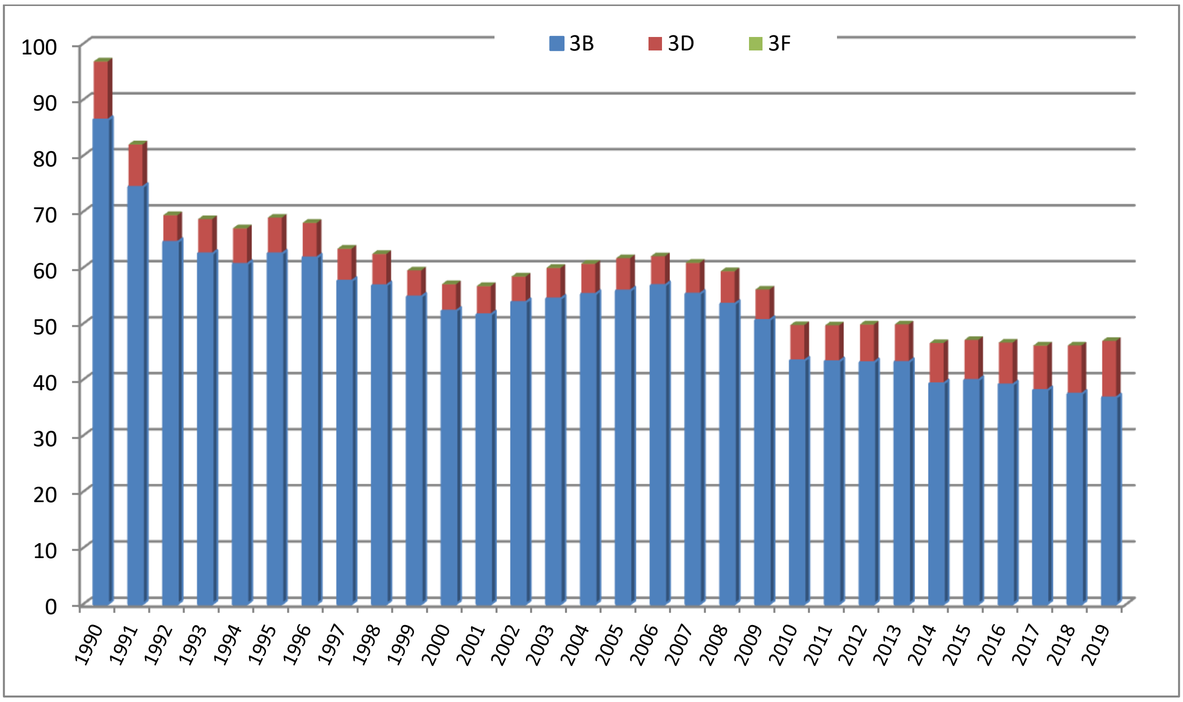


Figure 5.3 Distribution of the NMVOC emissions by the agricultural sources for 1990-2019 period

For the year 2019, the distribution of NMVOC emissions by agricultural sources was as follows: 78.43% from manure management, 21.54% from manure applied to soils and only 0.0267% from burning fields. Implementation of new emissions factors for NH_3 from 2019

Guidebook EMEP/EEA in emissions calculation of the key sources: dairy cattle, non-dairy cattle and laying hens has led to an increase in values for 3B categories and a change in the share of NMVOC emissions in agriculture subsectors.

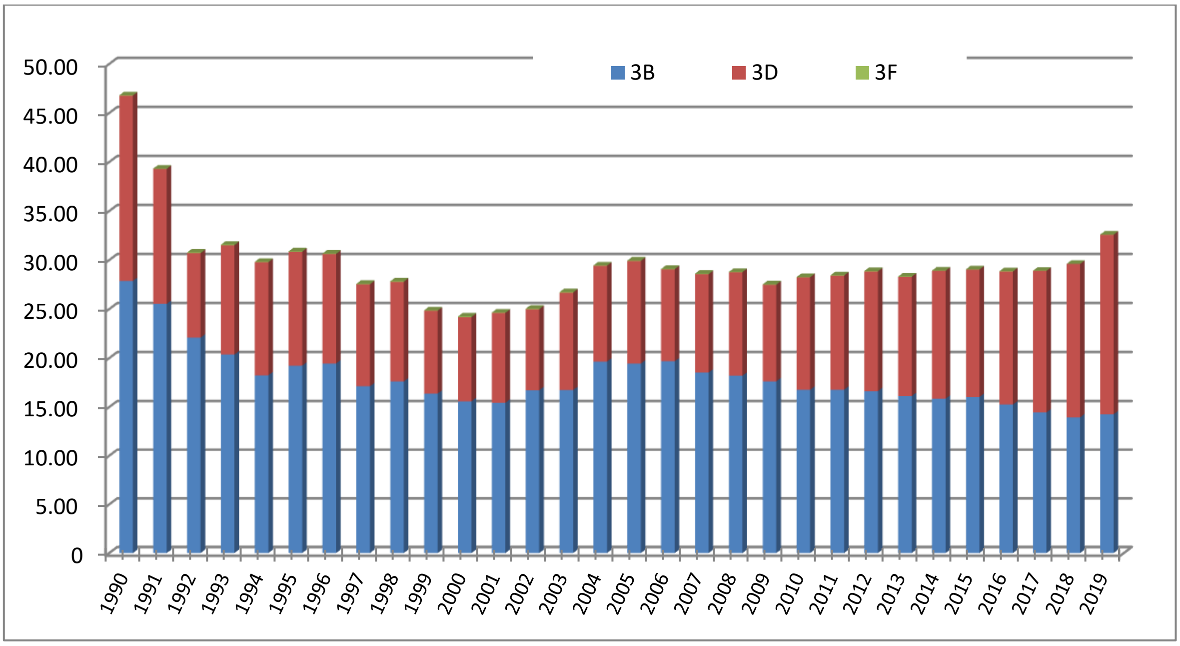


Figure 5.4 Distribution of TSP emissions by the agricultural sources for the 1990-2019 period

For the year 2019, the distribution of TSP emissions by the agricultural sources was as follows: 43.74% from manure management, 56.20% 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 important source of pollutants of all agriculture emissions in 2019. 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 2019, the majority of the emissions is generated by the production of swine (finishing pigs and sows categories) and cattle (dairy and non-dairy cattle).

For this sector, in 2019, the key categories were represented as percentage from total national emissions, as follow:

- NMVOC: dairy cattle (6.9%), non-dairy cattle (2.5%), laying hens (1.8%) and broilers (1.6%);
- NH_3: swine (14%), dairy cattle (7.8%);

- TSP: laying hens (3.3%).

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 2019 EMEP/EEA Guidebook.

The polluants from manure management were represented by NH_3, NMVOC, PM_{10}, TSP and $PM_{2.5}$ and the values were according to the 2019 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 "Manure Management N-flow tool" in which the default parameters of the 2019 EMEP/EEA Guidebook were used (tables 3.7, 3.8, 3.9, 3.10) except where there were national values (average weight of animals, amount of solid/liquid stored). For the rest of the subcategories, the values of Table 3.2 and Table 3.3, Tier 1 methodology, 2019 EMEP/EEA Guidebook were used. 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; finishing pigs – 40% until 2013, 60% since 2014; sows – 30% until 2013, 60% since 2014. These values produced a change in ammonia emissions, but also in NMVOC and NOx emissions.

The **Annex A, 3B-Manure Management calculations**, presents 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 2019 EMEP/EEA Guidebook with the default emissions factors from Table 3.11, Table 3.12 and Excel spreadsheet "Manure Management N-flow tool". 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 (2019 EMEP/EEA Guidebook).

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" was used in calculation.

The **Annex A, 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 $PM_{2.5}$ EFs provided in the 2019 Guidebook (Table 3.5), based on the default housing period (Table 3.7) for entire time series, 1990-2019.

The Tabel no. 7 presents the values for emissions factors calculation in the **Annex A**.

The calculation of NOx emissions is based on Tier 1 methodology (Table 3.3 – NO stored manure) of the 2019 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 presents the values for calculation in the **Annex A**.

Every category of livestock is described by the trend of the activity data and the main pollutants over the period 1990-2019.

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

Year/Pollutant	Dairy cattle	Non-dairy cattle	Sheep	Fatting pigs	Sows	Buffalos	Goats	Horses	Laying hens	Broilers
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
2019	1124	779	10358	3525	308	19	1594	406	40728	34636

5.1 NFR 3.B.1.a Manure management - Dairy cattle

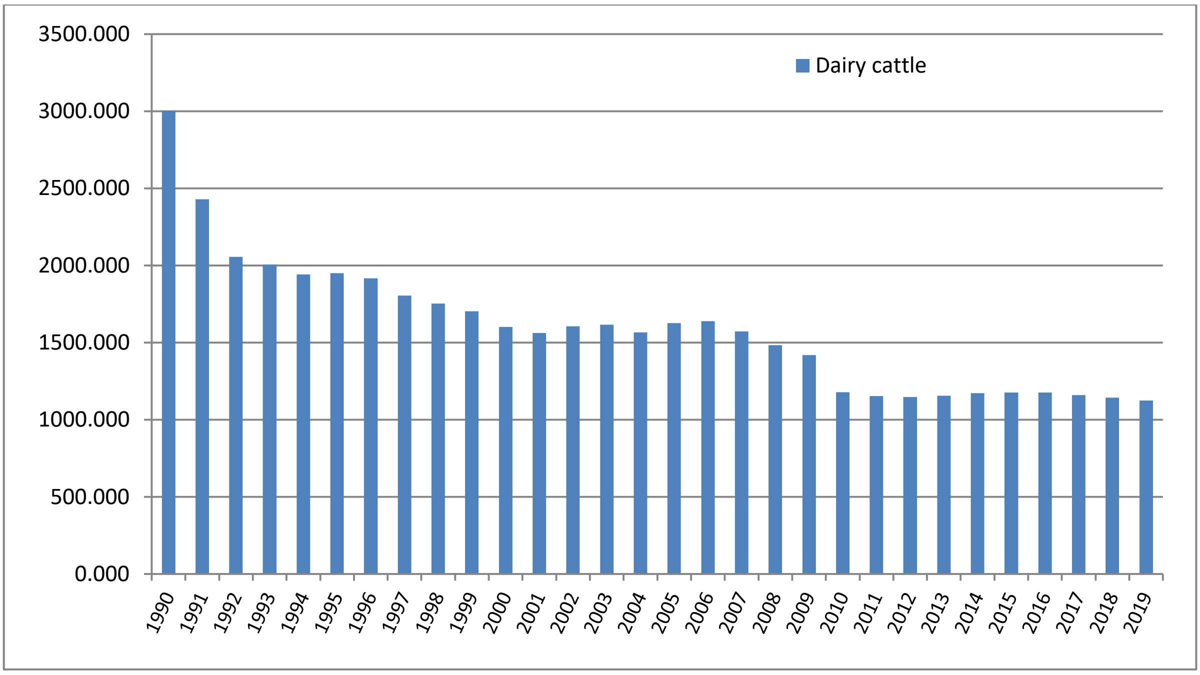


Figure 5.1.1. Activity data trends (*Population Size (1000 head)*)
for NFR 3.B.1.a Manure management - Dairy cattle

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	36.657	32.471
1991	30.942	26.280
1992	26.959	22.225
1993	26.799	21.706
1994	26.978	21.006
1995	27.507	21.096
1996	27.245	20.728
1997	25.966	19.521
1998	25.202	18.966
1999	24.442	18.411
2000	23.295	17.319
2001	23.101	16.896
2002	23.796	17.367
2003	24.238	17.482
2004	23.893	16.943
2005	24.490	17.584
2006	25.048	17.732
2007	23.879	17.013
2008	22.705	16.044
2009	21.411	15.349
2010	18.133	12.748
2011	18.037	12.482
2012	17.699	12.406
2013	17.858	12.491
2014	16.704	14.521
2015	16.566	14.557
2016	16.386	14.563
2017	16.157	14.359
2018	16.008	14.150
2019	15.724	13.922

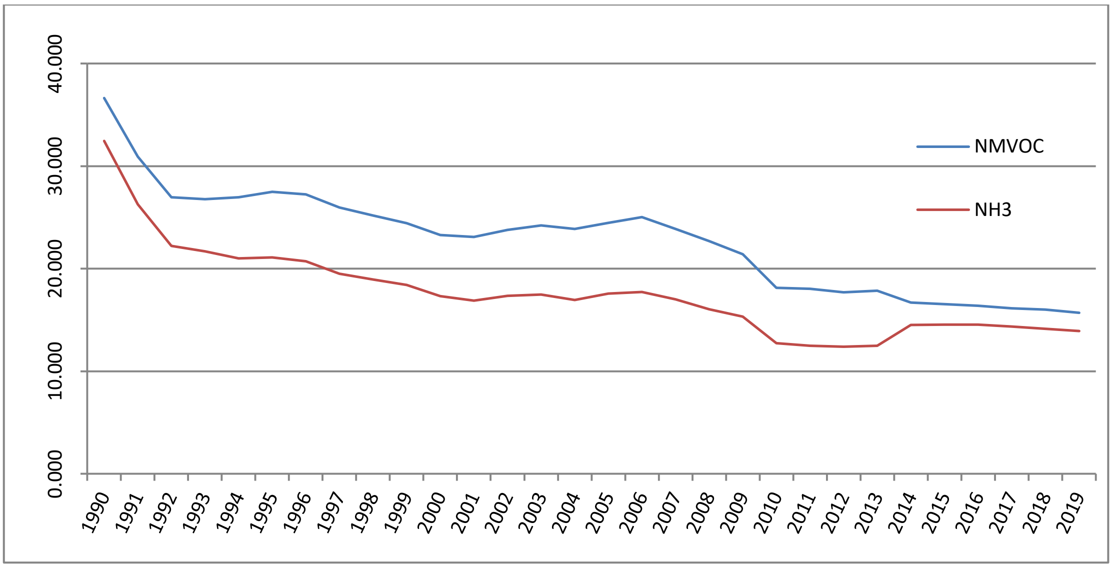


Figure 5.1.2. Emission trends (kt) for NFR 3.B.1.a Manure management - Dairy cattle

The new estimates of NH_3 and NMVOC emissions obtained with the 2019 EMEP/EEA Guidebook recommendation are observed on trends from 2014, the year of a change in the manure management system for this category.

5.2 NFR 3.B.1.b Manure management - Non-dairy cattle

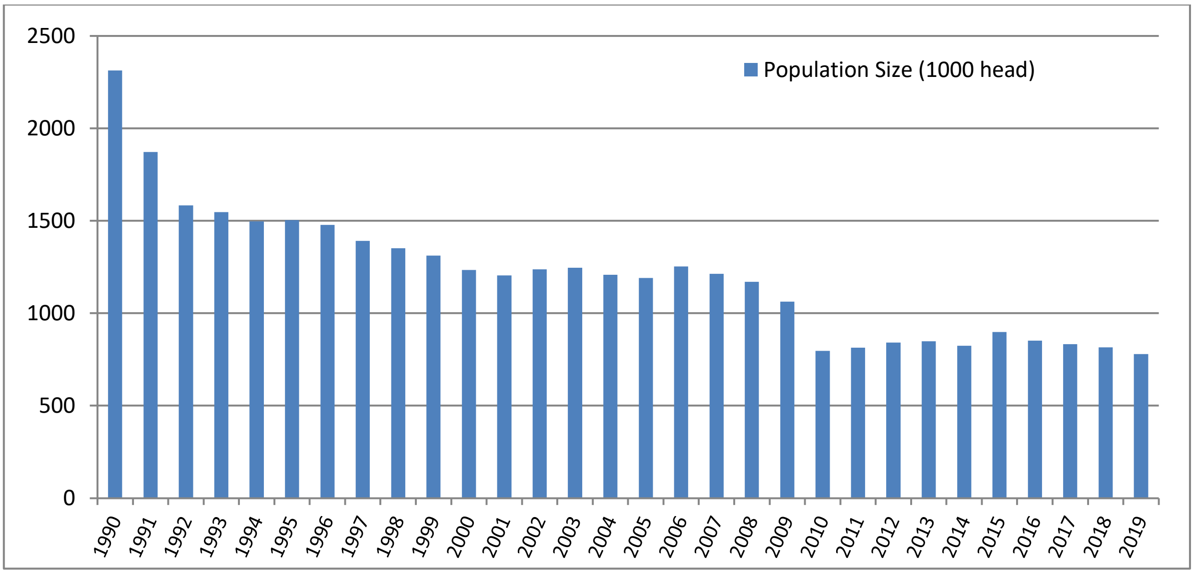


Figure 5.2.1 Activity data trends (*Population Size (1000 head)*)
for NFR 3.B.1.b Manure management - Non-dairy cattle

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	22.0796	16.1714
1991	17.8697	13.0880

Year/Pollutant	NMVOC	NH_3
1992	15.1123	11.0684
1993	14.7594	10.8100
1994	14.2834	10.4614
1995	14.3450	10.5065
1996	14.0947	10.3231
1997	13.2740	9.7221
1998	12.8965	9.4456
1999	12.5190	9.1691
2000	11.7763	8.6251
2001	11.4891	8.4148
2002	11.8092	8.6492
2003	11.8871	8.7063
2004	11.5234	8.4399
2005	11.3641	8.3233
2006	11.9600	8.7597
2007	11.5809	8.4820
2008	11.1641	8.1767
2009	10.1446	7.4300
2010	7.6046	5.5697
2011	7.7628	5.6856
2012	8.0325	5.8831
2013	8.1031	5.9349
2014	5.9581	6.8769
2015	6.4883	7.4889
2016	6.1626	7.1130
2017	6.0134	6.9408
2018	5.8887	6.7969
2019	5.6324	6.5011

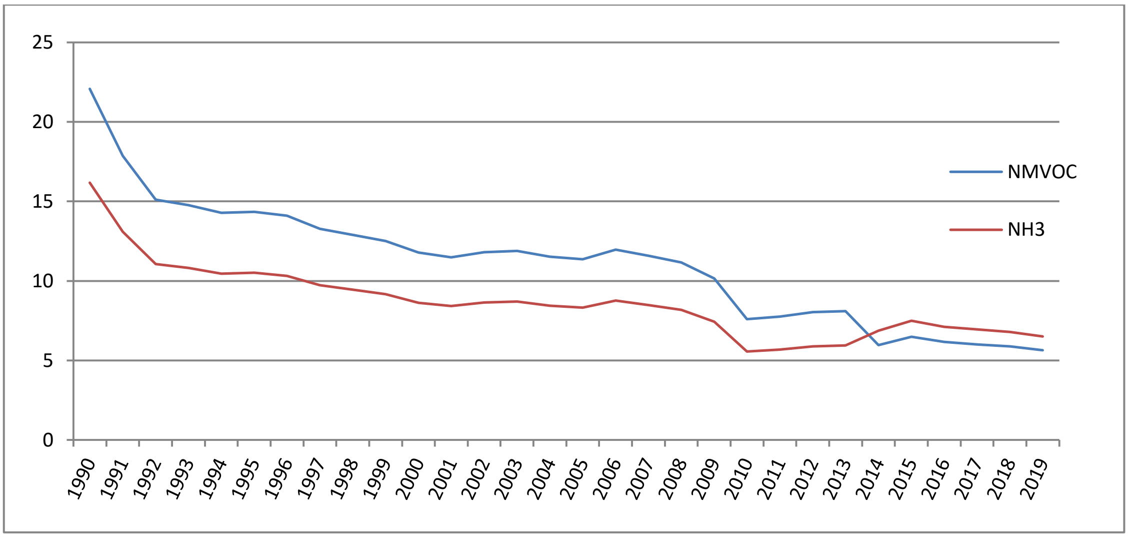


Figure 5.2.2 Emission trends (kt) for NFR 3.B.1.b Manure management - Non-dairy cattle for NMVOC and NH_3

The new estimates of NH_3 and NMVOC emissions obtained with the 2019 EMEP/EEA Guidebook recommendation are observed on trends from 2014, the year of a change in the manure management system for this.

5.3 NFR 3.B.2 Sheep

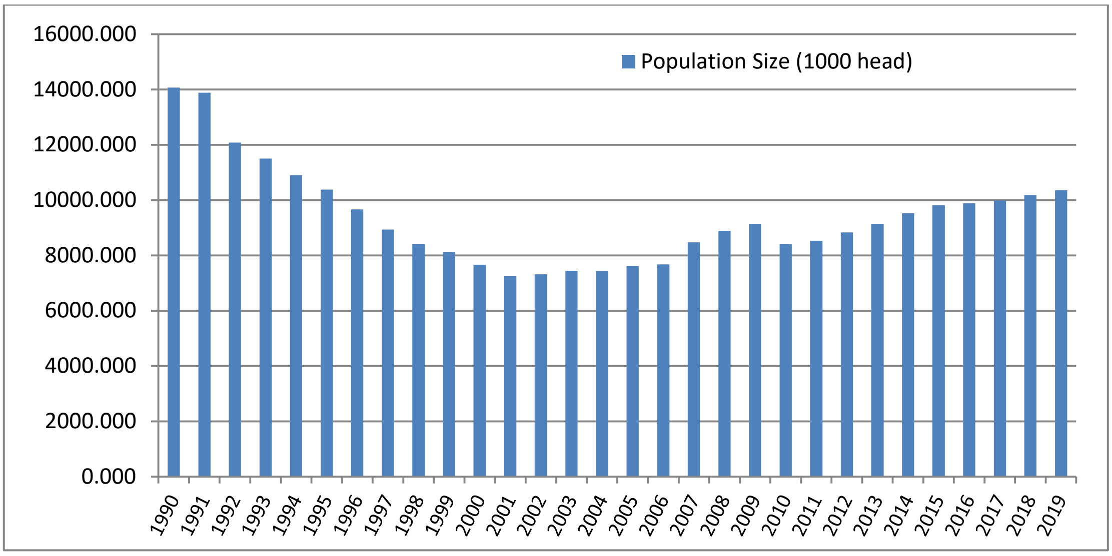


Figure 5.3.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.2 Manure management – Sheep

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	6.8316
1991	2.3914	6.7427
1992	2.0812	5.8682
1993	1.9813	5.5866
1994	1.8775	5.2938
1995	1.7886	5.0433
1996	1.6649	4.6943
1997	1.5400	4.3421
1998	1.4489	4.0852
1999	1.3992	3.9453
2000	1.3193	3.7198
2001	1.2494	3.5228
2002	1.2599	3.5525
2003	1.2831	3.6178
2004	1.2794	3.6074
2005	1.3114	3.6976
2006	1.3229	3.7302
2007	1.4592	4.1145
2008	1.5303	4.3149
2009	1.5751	4.4411
2010	1.4503	4.0894
2011	1.4703	4.1457
2012	1.5221	4.2917
2013	1.5741	4.4383
2014	1.6400	4.6241
2015	1.6902	4.7657
2016	1.7015	4.7977
2017	1.7199	4.8494
2018	1.7534	4.9439
2019	1.7848	5.0325

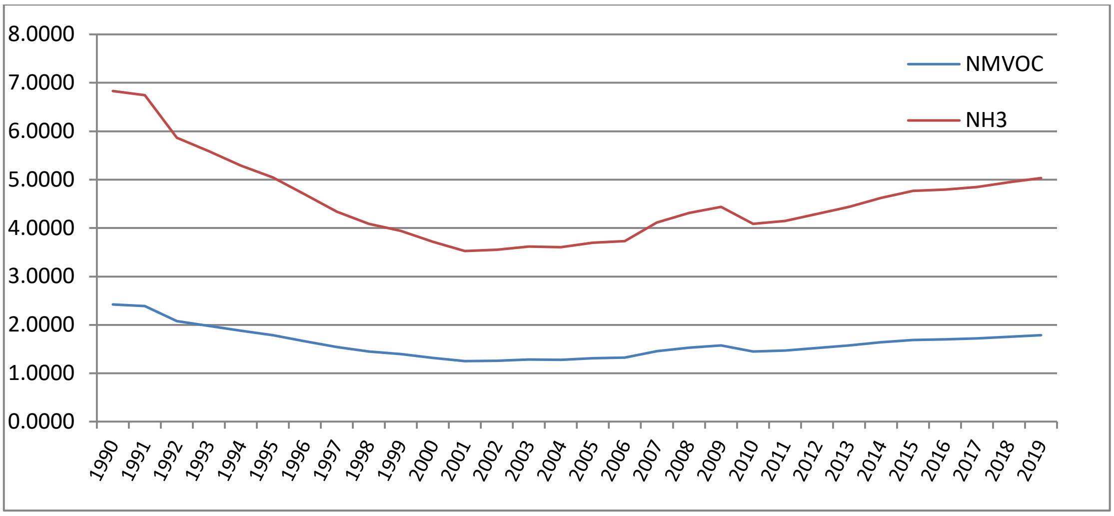


Figure 5.3.2 Emission trends (kt) for NMVOC, NH_3 for 3.B.2 Manure management – Sheep

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

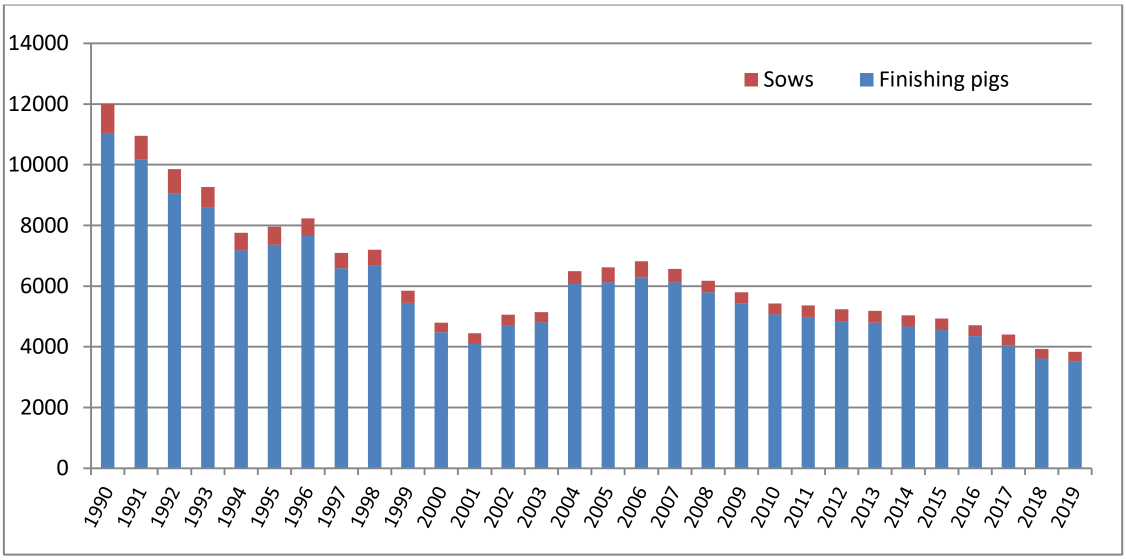


Figure 5.4.1 Activity data trends (Population Size (1000 head))
for NFR 3.B.3 Manure management – Swine

Activity data for swine (finishing pigs and sows) 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 finishing pigs	NH_3 finishing pigs	NMVOC sows	NH_3 sows
1990	6.0897	70.4188	1.6205	5.8569
1991	5.6108	64.8819	1.3138	4.7484
1992	4.9921	57.7266	1.3496	4.8777
1993	4.7298	54.6937	1.1553	4.1756
1994	3.9573	45.7608	0.9815	3.5474

Year/Pollutant	NMVOC finishing pigs	NH_3 finishing pigs	NMVOC sows	NH_3 sows
1995	4.0609	46.9586	1.0054	3.6336
1996	4.2157	48.7490	0.9951	3.5967
1997	3.6316	41.9952	0.8622	3.1163
1998	3.6801	42.5559	0.8776	3.1717
1999	2.9991	34.6806	0.6901	2.4943
2000	2.4652	28.5065	0.5504	1.9893
2001	2.2663	26.2064	0.5691	2.0570
2002	2.5875	29.9210	0.6168	2.2294
2003	2.6503	30.6474	0.5708	2.0632
2004	3.3440	38.6692	0.7259	2.6236
2005	3.3765	39.0439	0.8418	3.0454
2006	3.4685	40.1038	0.8861	3.2053
2007	3.3735	39.0096	0.7540	2.7251
2008	3.1943	36.9377	0.6414	2.3184
2009	2.9942	34.6240	0.6122	2.2128
2010	2.7950	32.3210	0.6059	2.1901
2011	2.7457	31.7510	0.6485	2.3439
2012	2.6644	30.8102	0.6795	2.4558
2013	2.6429	30.5614	0.6538	2.3629
2014	2.5696	30.1677	0.6447	2.5643
2015	2.5083	29.4486	0.6384	2.5391
2016	2.3949	28.1175	0.6155	2.4481
2017	2.2349	26.2390	0.5962	2.3714
2018	1.9927	23.3949	0.5262	2.0929
2019	1.9426	22.8063	0.5259	2.0919

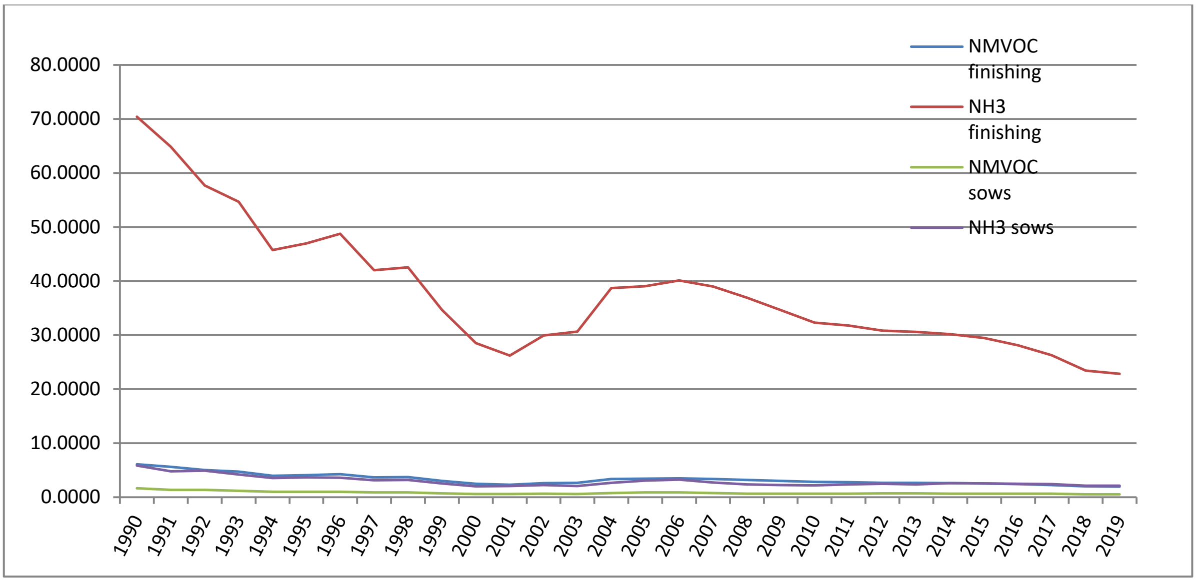


Figure 5.4.2 Emission trends (kt) for 3.B.3 Manure management – Swine

The new estimates of NH_3 and NMVOC emissions obtained with the 2019 EMEP/EEA Guidebook recommendation are observed on trends from 2014, the year of a change of the manure management system for this category.

5.5 NFR 3.B.4.a Buffalo

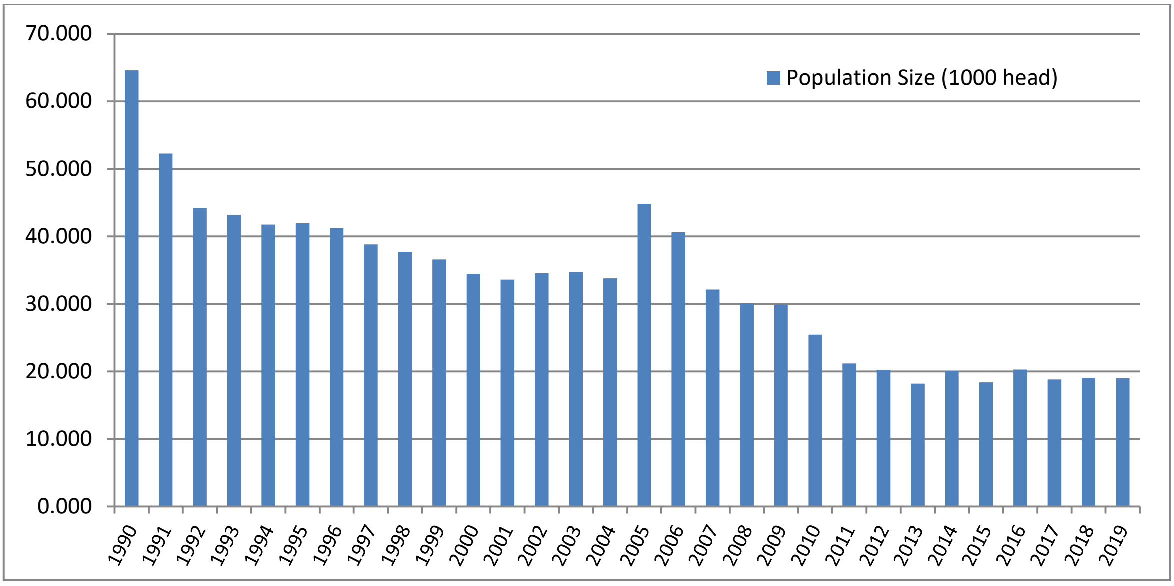


Figure 5.5.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.a Manure management – Buffalo

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

Year/Pollutant	NMVOC	NH_3
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
2019	0.0837	0.0818

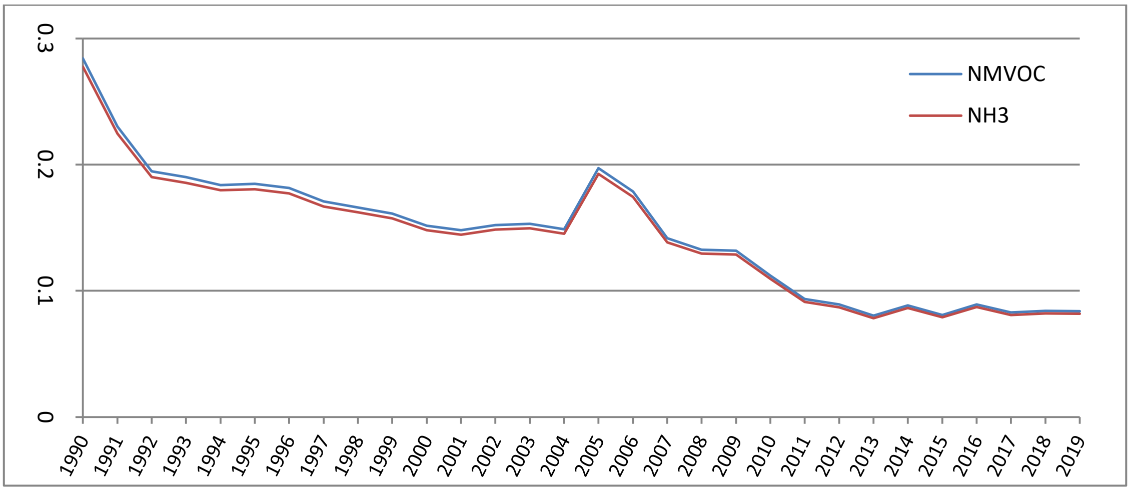


Figure 5.5.2 Emission trends (kt) for NFR 3.B.4.a Manure management - Buffalo

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

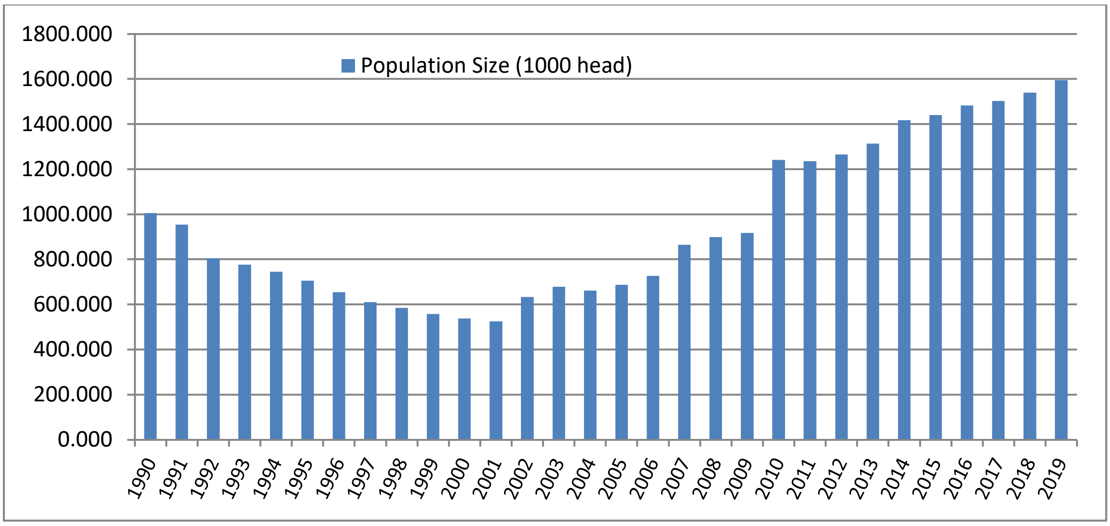


Figure 5.6.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.d Manure management – Goats

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
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
2019	0.8683	0.6379

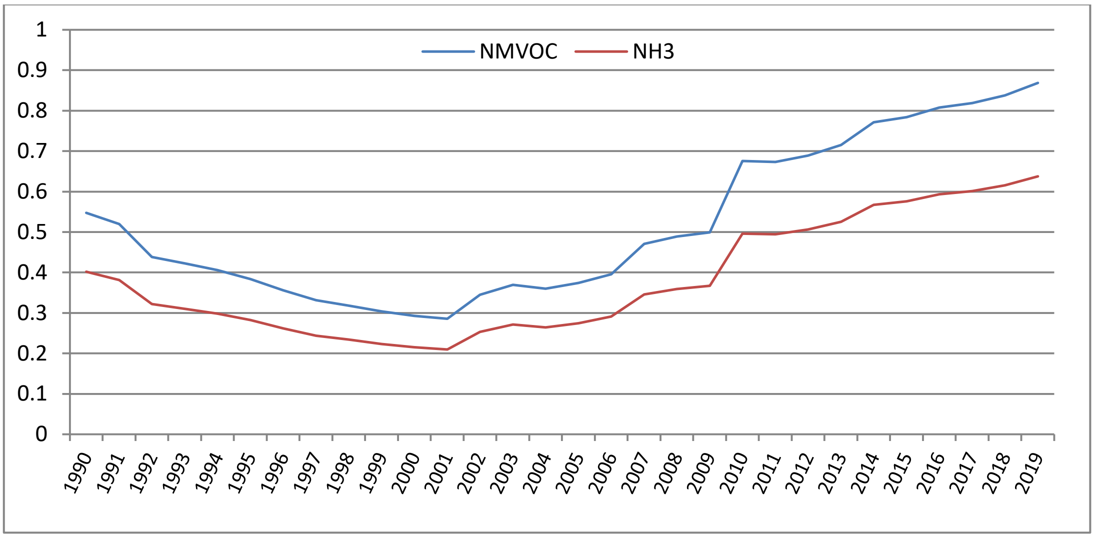


Figure 5.6.2 Emission trends (kt) for NFR 3.B.4.d Manure management – Goats

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

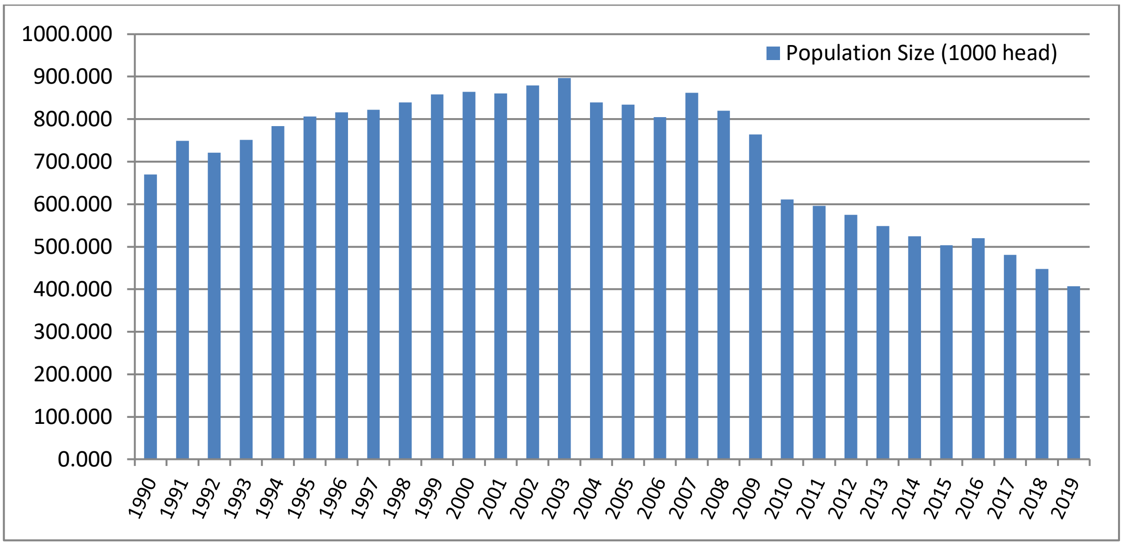


Figure 5.7.2 Activity data trends (*Population Size (1000 head)*)
for NFR 3.B.4.e Manure management – Horses

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

Year/Pollutant	NMVOC	NH_3
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
2019	2.4516	2.8469

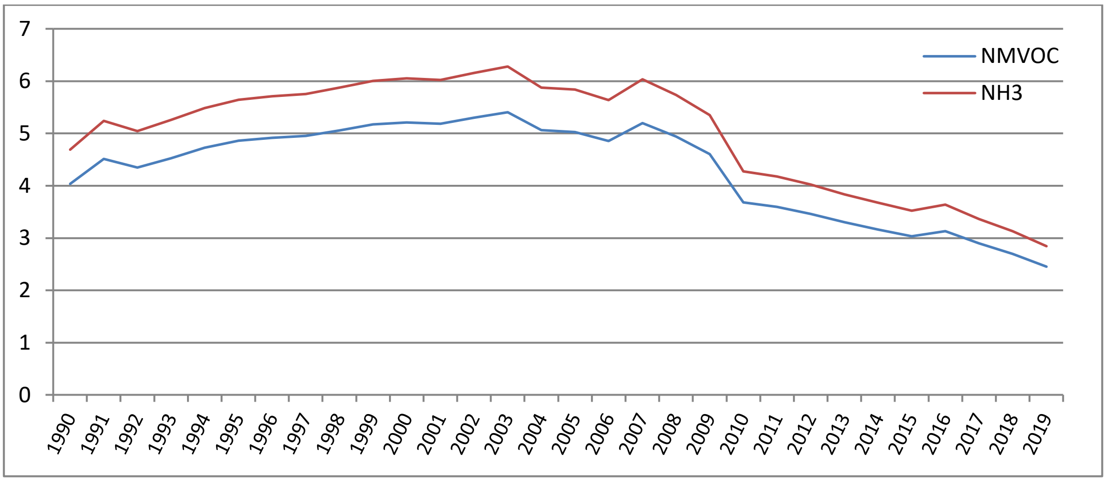


Figure 5.7.2 Emission trends (kt) for NFR 3.B.4.e Manure management - Horses

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

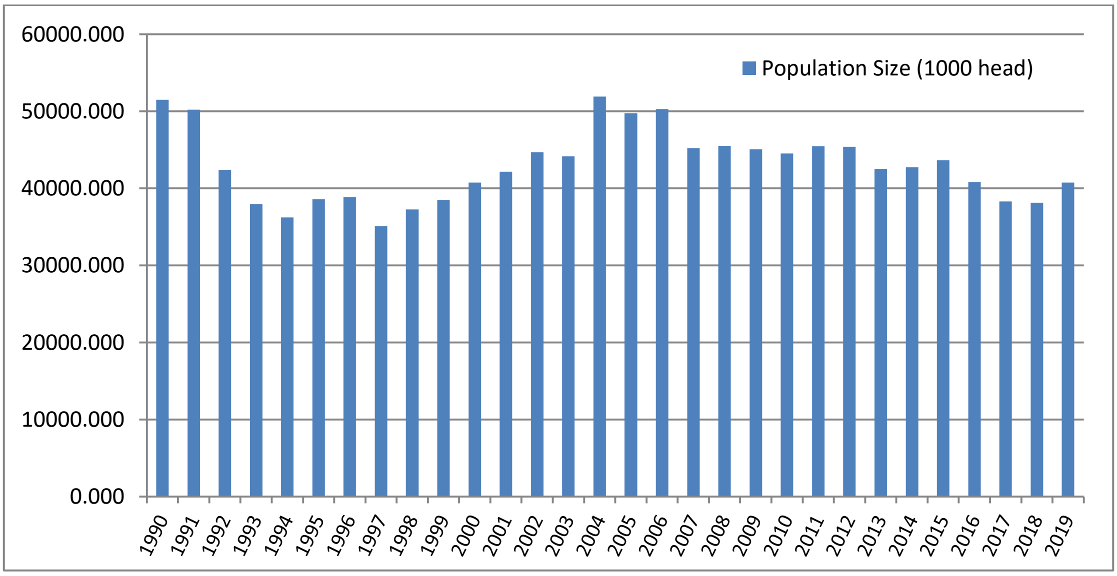


Figure 5.8.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.g.i Manure management - Laying hens

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	5.0916	5.7725	9.7803
1991	4.9668	5.6310	9.5405
1992	4.1946	4.7555	8.0571
1993	3.7568	4.2592	7.2163
1994	3.5840	4.0632	6.8843
1995	3.8156	4.3258	7.3291
1996	3.8461	4.3604	7.3877
1997	3.4708	3.9349	6.6669
1998	3.6868	4.1798	7.0818
1999	3.8079	4.3171	7.3145
2000	4.0318	4.5709	7.7444
2001	4.1698	4.7274	8.0096
2002	4.4182	5.0090	8.4866
2003	4.3643	4.9479	8.3831
2004	5.1326	5.8189	9.8589
2005	4.9185	5.5762	9.4478
2006	4.9732	5.6383	9.5528
2007	4.4717	5.0697	8.5895
2008	4.5035	5.1057	8.6505
2009	4.4557	5.0515	8.5587
2010	4.4021	4.9907	8.4557
2011	4.4971	5.0984	8.6381
2012	4.4909	5.0914	8.6264
2013	4.2080	4.7707	8.0828
2014	4.2275	4.7928	8.1203
2015	4.3189	4.8964	8.2959
2016	4.0390	4.5791	7.7583
2017	3.7896	4.2964	7.2793
2018	3.7720	4.2764	7.2455
2019	4.0286	4.5674	7.7384

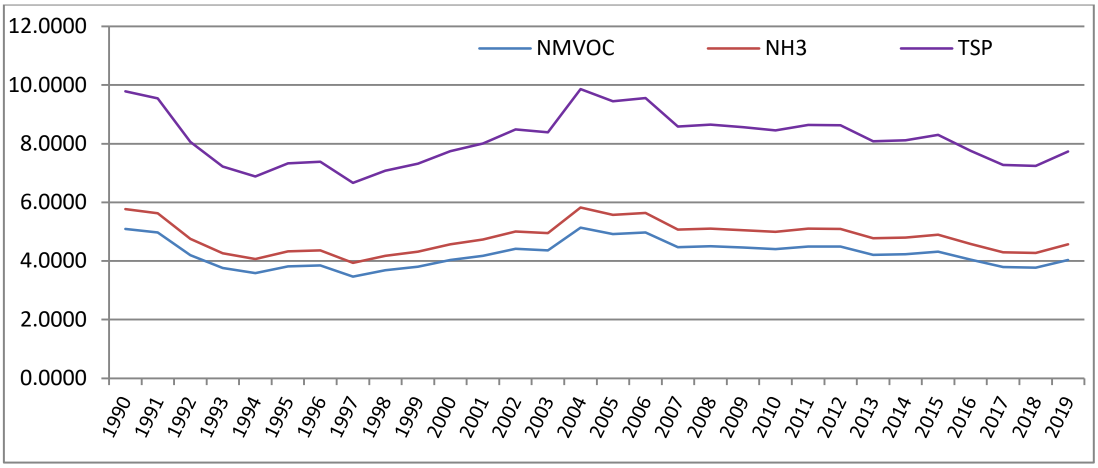


Figure 5.8.2 Emission trends (kt) for NFR 3.B.4.g.i Manure management - Laying hens

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

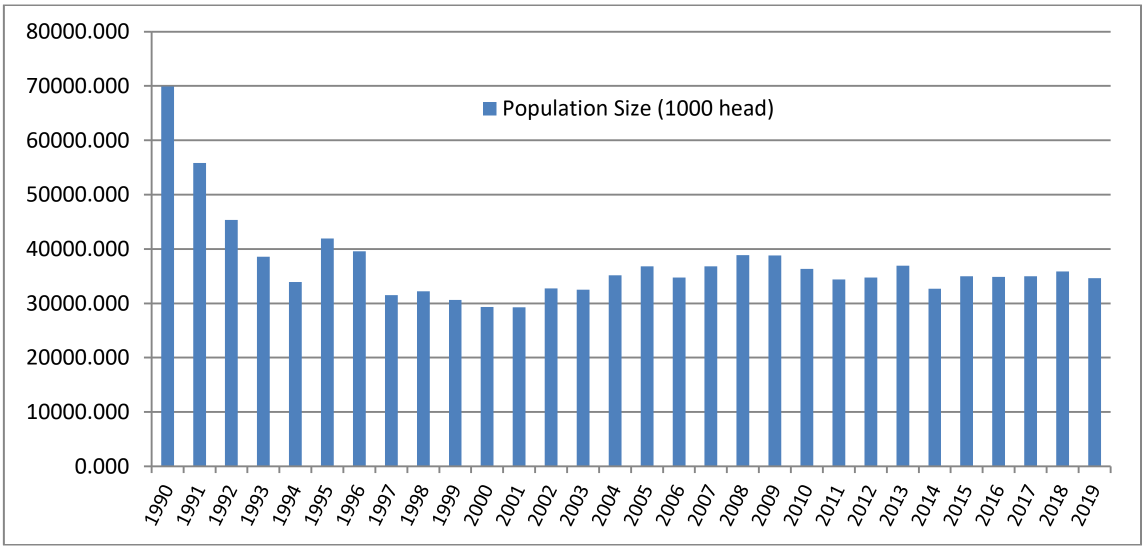


Figure 5.9.1 Activity data trends (*Population Size (1000 head)*) for NFR 3.B.4.g.ii Manure management – Broilers

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	7.550	9.088
1991	6.029	7.256
1992	4.895	5.891
1993	4.164	5.012

1994	3.664	4.410
1995	4.531	5.453
1996	4.276	5.147
1997	3.405	4.099
1998	3.478	4.187
1999	3.310	3.984
2000	3.166	3.811
2001	3.160	3.804
2002	3.533	4.253
2003	3.509	4.224
2004	3.794	4.566
2005	3.977	4.788
2006	3.749	4.513
2007	3.977	4.788
2008	4.195	5.050
2009	4.190	5.044
2010	3.925	4.724
2011	3.713	4.469
2012	3.751	4.515
2013	3.985	4.797
2014	3.533	4.252
2015	3.778	4.548
2016	3.765	4.531
2017	3.778	4.547
2018	3.873	4.662
2019	3.741	4.503

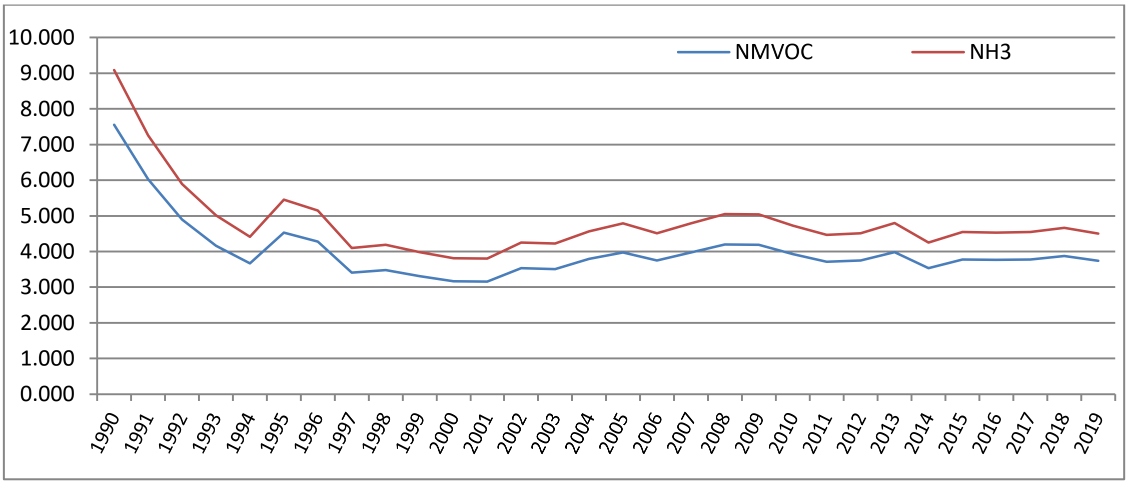


Figure 5.9.2 Emission trends (kt) for NFR 3.B.4.g.ii Manure management – Broilers

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:

- Recalculation the entire time series for all categories for NH_3 with "Manure Management 3B Tool", considering the 2019 Guidebook EMEP/EEA guidelines, with effects on NMVOC emissions calculations, for the livestock categories calculated with Tier2 method: dairy cattle, non-dairy cattle and laying hens.

- Improving emissions estimates by entering national values for the weights of the categories of animals whose emissions have been calculated at level 2 in the "Manure Management Tool 3B".

Planned improvements:

- Improving the estimation for NFR 3B4gii - broilers, key source for NMVOC emissions in 2019, with Tier 2 approach;
- Studying for introducing and applying country-specific data for all pollutants as much as possible for a real estimation of emissions for this sector.

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 2019 with 18.71% of the emission for the agricultural sector and emission of NOx contributes in 2019 with 61.07% 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 the normal acidity of the soil (pH) and cool climate for Romania.

Table 5.10.1 EFs for NH_3 emissions from fertilizers (in g NH_3 (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 Tier 2 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, 1990-2019.

Table 5.10.2 The activity data of the N-fertilizer categories obtained by applying IFA source percentages to national data, Tier 2 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**
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	119.62	10.16	31.89	6.86	4.11	88.75	28.59	0.05	23.84	30.43	**344.31**
2017	121.59	12.50	35.46	14.25	4.47	91.79	34.38	1.19	33.54	32.18	**381.34**
2018	141.39	10.60	53.52	15.62	6.22	128.03	28.28	0.07	46.02	38.88	**468.64**
2019	137.57	10.32	52.07	15.20	6.05	124.57	27.51	0.07	44.78	37.83	**455.96**

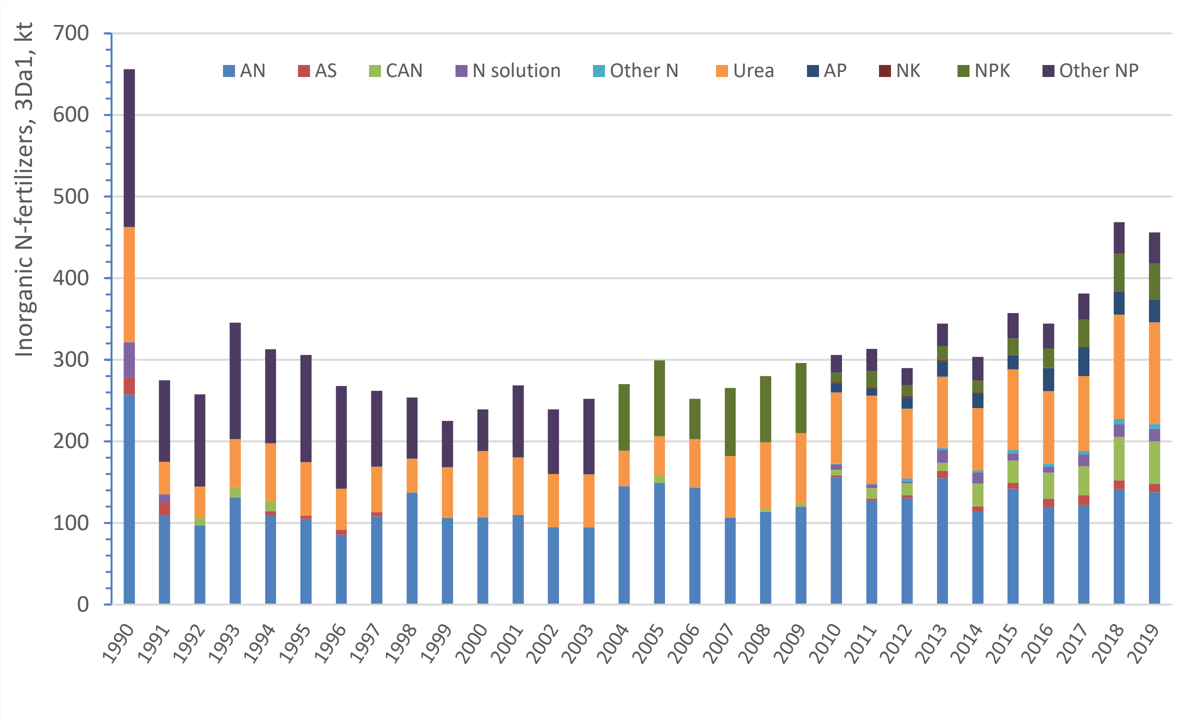


Figure 5.10.1 Trends of proportions of the categories of N-fertilizers(kt) for NFR 3Da1 Inorganic N-fertilizers

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	2017	2018	2019
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%	51.07%	39.72%	31.88%	30.17%	30.17%
Ammonium sulphate (N)	3.30%	1.30%	0.00%	0.00%	0.80%	1.98%	3.28%	2.26%	2.26%
Calc. amm. nitrate (N)	0.00%	0.00%	0.00%	2.90%	2.14%	7.65%	9.30%	11.42%	11.42%
Nitrogen solutions (N)	6.50%	0.00%	0.00%	0.10%	2.14%	2.59%	3.74%	3.33%	3.33%
Other N straight (N)	0.00%	0.00%	0.00%	0.00%	0.27%	1.01%	1.17%	1.33%	1.33%
Urea (N)	21.60%	21.50%	34.20%	16.20%	28.61%	27.75%	24.07%	27.32%	27.32%
Ammonium phosphate (N)	0.00%	0.00%	0.00%	0.00%	3.74%	4.74%	9.02%	6.03%	6.03%
N K compound (N)	0.00%	0.00%	0.00%	0.00%	0.27%	0.13%	0.31%	0.02%	0.02%
N P K compound (N)	0.00%	0.00%	0.00%	31.10%	4.01%	5.75%	8.79%	9.82%	9.82%
Other NP (N)	29.40%	42.90%	21.30%	0.00%	6.95%	8.66%	8.44%	8.30%	8.30%

The total amount of N-fertilizers used in agriculture were correlate with the CRF (UNFCCC) report database.

Table 5.10.4 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

Year/Pollutant	NOx, kt	NH_3,kt
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
2019	18.239	29.774

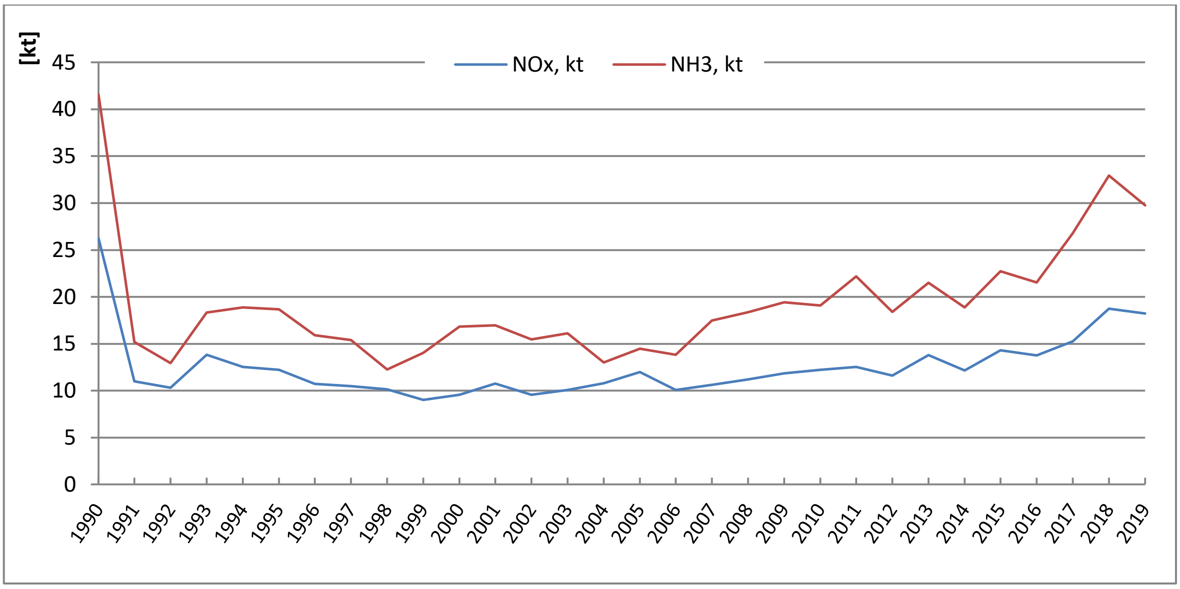


Figure 5.10.2 Emission trends (kt) for NFR 3Da1 Inorganic N-fertilizers

Recalculations and improvements:

- Changes in the calculated values of ammonia emissions due to changes in the quantities of fertilizer categories recalculated by IFA for 2017, 2018.

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 2019 with 26.14% from the ammonia emission of the agricultural sector and represent a key source, with 29.28% 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 2019 EMEP/EEA Guidebook.

The emission factors for ammonia were calculated according to 2019 EMEP/EEA Guidebook Manure Management N-flow tool, with the Tier 2 method for dairy cattle, non dairy cattle, swine, sheep and laying hens. The rest of the categories are calculated with Tier 1 methodology. 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 2019 EMEP/EEA Guidebook as mentioned above.

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, provided by the N.I.S. and in correlation with GHG (UNFCCC) - CRF database; the Tier 1 approach from 2019 Guidebook EMEP/EEA, table 3.1, was used to calculate the emissions for this pollutant.

Table 5.11.1 Activity data trends for NFR 3Da2a for pollutant NOx

Year	Animal manure applied to soils, Kg N
1990	478138096.2
1991	414358496.5
1992	362274497.2
1993	359393103.6
1994	336213928.3
1995	331292846.9
1996	327467769.3
1997	297879860.2
1998	291512626.5
1999	272871367.5
2000	251094374.3
2001	245466977.1
2002	255399990.3
2003	265685726.6

Year	Animal manure applied to soils, Kg N
2004	276822750.9
2005	288468068.8
2006	290370960.7
2007	285282856.8
2008	273335099.5
2009	265618409.3
2010	230419389.4
2011	227153331.7
2012	226580070.3
2013	228034707.3
2014	230671798.9
2015	231245446.9
2016	231572353.6
2017	223742023.3
2018	217969485.0
2019	216848588.2

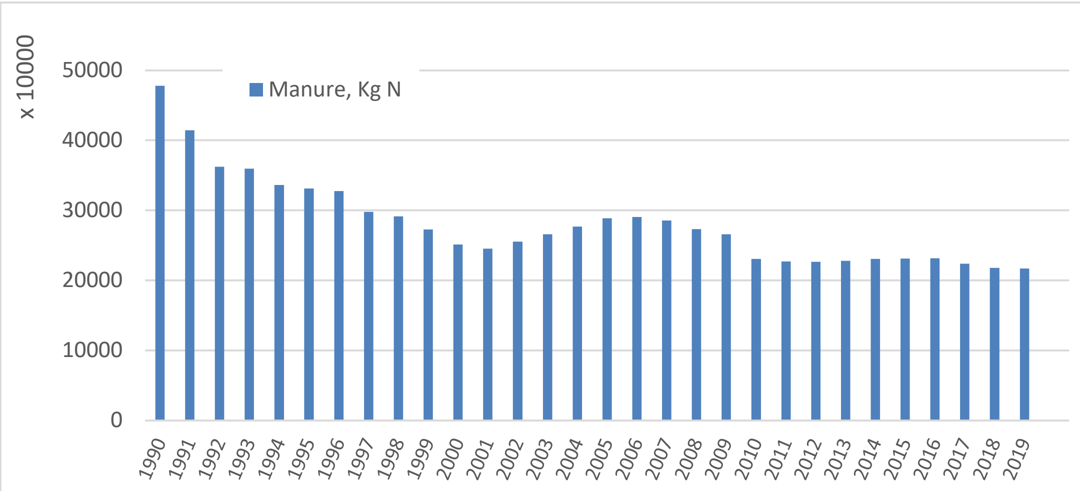


Figure 5.11.1 Activity data trends for NFR 3Da2a – pollutant NOx

Table 5.11.2 Emission trends (kt) for NFR 3Da2a Animal manure applied to soils

Year	NOx	NH_3
1990	19.1255	112.4888
1991	16.5743	99.2204
1992	14.4910	86.5859
1993	14.3757	82.4200
1994	13.4486	74.3700
1995	13.2517	75.8876
1996	13.0987	76.3401
1997	11.9152	68.6663
1998	11.6605	68.5292
1999	10.9149	62.0056
2000	10.0438	56.0959
2001	9.8187	53.9849

Year	NOx	NH_3
2002	10.2160	57.8814
2003	10.6274	58.4859
2004	11.0729	64.6756
2005	11.5387	65.3527
2006	11.6148	66.6995
2007	11.4113	64.6698
2008	10.9334	62.0896
2009	10.6247	58.9389
2010	9.2168	52.4511
2011	9.0861	52.0889
2012	9.0632	51.6915
2013	9.1214	51.3286
2014	9.2269	53.1415
2015	9.2498	53.4613
2016	9.2629	51.7974
2017	8.9497	49.6709
2018	8.7188	47.1877
2019	8.6739	46.5916

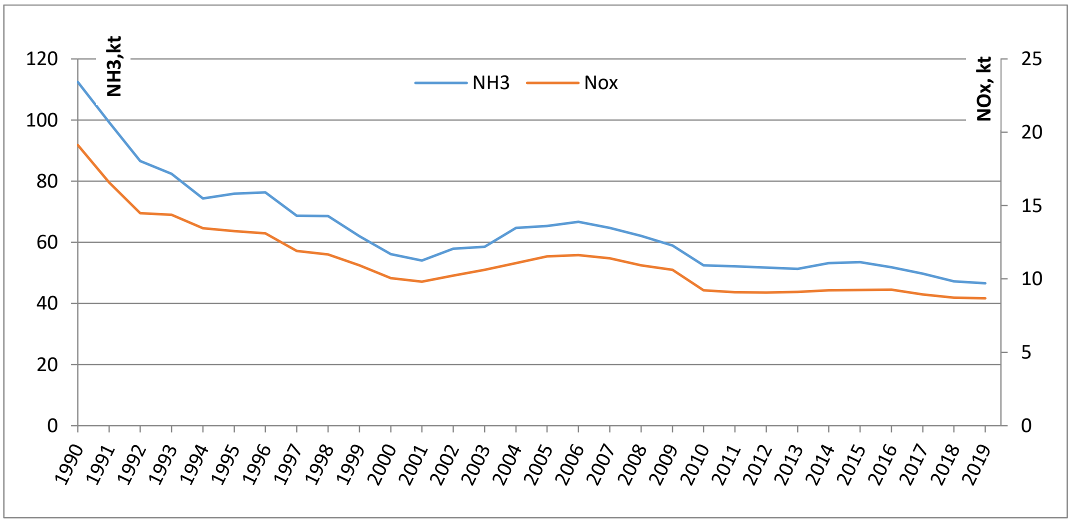


Figure 5.11.2 Emission trends (kt) for NFR 3Da2a Animal manure applied to soils

The emissions of NH_3 and NOx from animal manure applied to soils follow the activity data trend.

Recalculations and improvements:

- According to RO-3Da2a-2020-0001, non-methane volatile organic compounds (NMVOC) emissions, included in calculation of NFR 3B, was changed with IE notation in reported CLRTAP Annex I;
- 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 national values.

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÷2019 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
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
2019	10264.30

Table 5.12.2 Emission trends (kt) for 3Da2b - Sewage sludge applied to soils

[2] EMEP/EEA air pollutant emission inventory guidebook 2019, Annex 1, pg. 26.
[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	NOx	NH_3
1990	0.00567	0.01929
1991	0.00565	0.01921
1992	0.00557	0.01892
1993	0.00558	0.01898
1994	0.00559	0.01901
1995	0.00349	0.01186
1996	0.00348	0.01182
1997	0.00347	0.01181
1998	0.00346	0.01176
1999	0.00344	0.01171
2000	0.00492	0.01673
2001	0.00651	0.02213
2002	0.00787	0.02676
2003	0.00958	0.03256
2004	0.01041	0.03539
2005	0.01148	0.03902
2006	0.01214	0.04127
2007	0.01226	0.04169
2008	0.01243	0.04226
2009	0.01247	0.04241
2010	0.01308	0.04448
2011	0.01714	0.05827
2012	0.01728	0.05876
2013	0.01777	0.06041
2014	0.01800	0.06119
2015	0.01818	0.06181
2016	0.01883	0.06403
2017	0.01942	0.06603
2018	0.02007	0.06824
2019	0.02053	0.06980

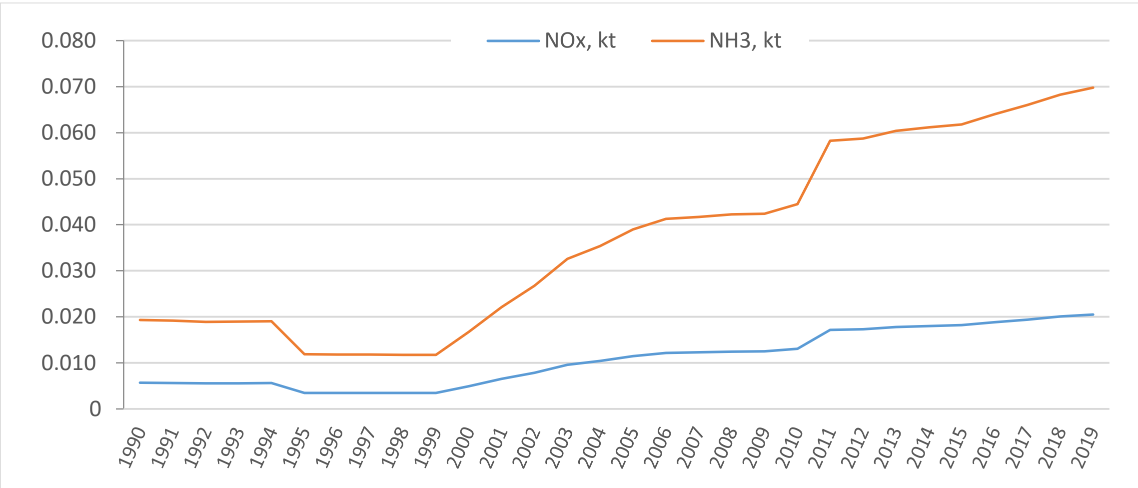


Figure 5.12.1 Emission trends (kt) for 3Da2b - Sewage sludge applied to soils

Recalculations and improvements:

- Recalculation with the emission factor (actual, EF is 0.0068 kg NH_3 capita^{-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 2019 with 11.06% of the national total NH_3 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 urine and dung deposited by grazing animals represent a percentage of the total manure from all animal species in source category 3B, as is specified in 2019 EMEP/EEA Guidebook.

The emission factors for ammonia were calculated according to 2019 EMEP/EEA Guidebook Manure Management N-flow tool, with the Tier 2 method for dairy cattle, non dairy cattle, swine, sheep and laying hens. The rest of the categories are calculated with Tier 1 methodology. 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 2019 EMEP/EEA Guidebook as mentioned above.

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	35.0541
1991	32.1641
1992	28.0647
1993	27.3995
1994	26.6334
1995	26.2861
1996	25.4185
1997	24.1022
1998	23.3952
1999	22.9266
2000	21.9432
2001	21.2994
2002	21.8011
2003	22.1324
2004	21.4750
2005	21.8285
2006	21.9553
2007	22.8181
2008	22.5632
2009	21.9784
2010	19.0483
2011	19.0202
2012	19.2562
2013	19.4640

Year/Pollutant	NH_3, kt
2014	19.7703
2015	20.1534
2016	20.2323
2017	19.9946
2018	19.9082
2019	19.7176

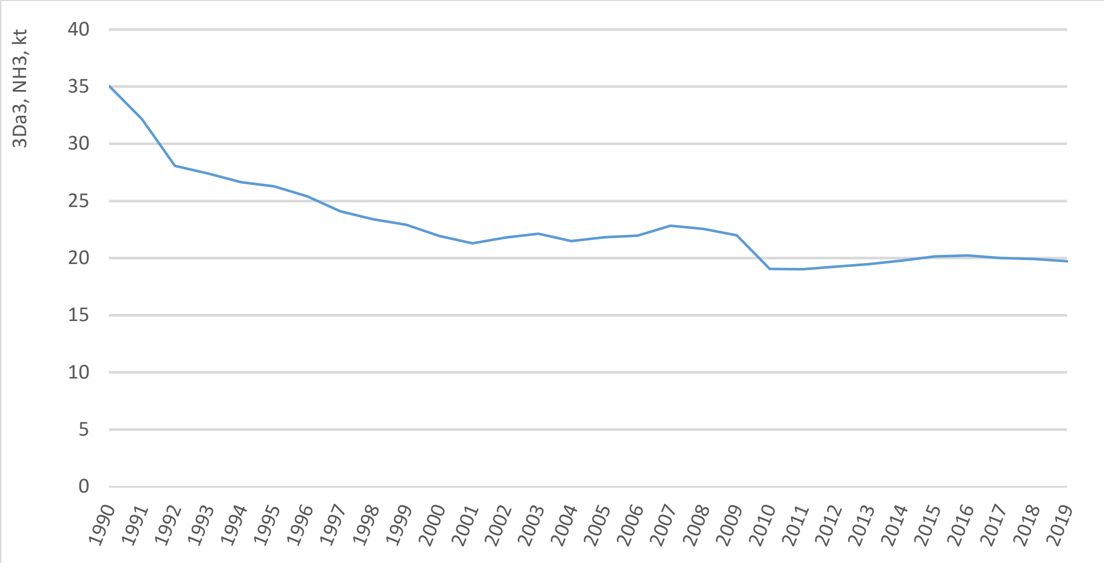


Figure 5.13.1 Emission trends (kt) for
NFR 3Da3 - Urine and dung deposited during grazing animals

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	151.979	112.489	35.054
1991	134.477	99.220	32.164
1992	117.972	86.586	28.065
1993	111.996	82.420	27.400
1994	100.506	74.370	26.633
1995	103.125	75.888	26.286
1996	103.748	76.340	25.418
1997	92.893	68.666	24.102
1998	92.863	68.529	23.395
1999	83.389	62.006	22.927
2000	74.956	56.096	21.943
2001	72.005	53.985	21.299
2002	77.538	57.881	21.801
2003	78.387	58.486	22.132
2004	86.954	64.676	21.475
2005	88.363	65.353	21.829

Year	3B-NH_3, kt	3Da2a-NH_3, kt	3Da3-NH_3, kt
2006	89.782	66.700	21.955
2007	87.720	64.670	22.818
2008	84.172	62.090	22.563
2009	79.995	58.939	21.978
2010	71.514	52.451	19.048
2011	70.736	52.089	19.020
2012	70.069	51.691	19.256
2013	69.797	51.329	19.464
2014	72.125	53.142	19.770
2015	72.424	53.461	20.153
2016	70.470	51.797	20.232
2017	67.651	49.671	19.995
2018	64.149	47.188	19.908
2019	62.990	46.592	19.718

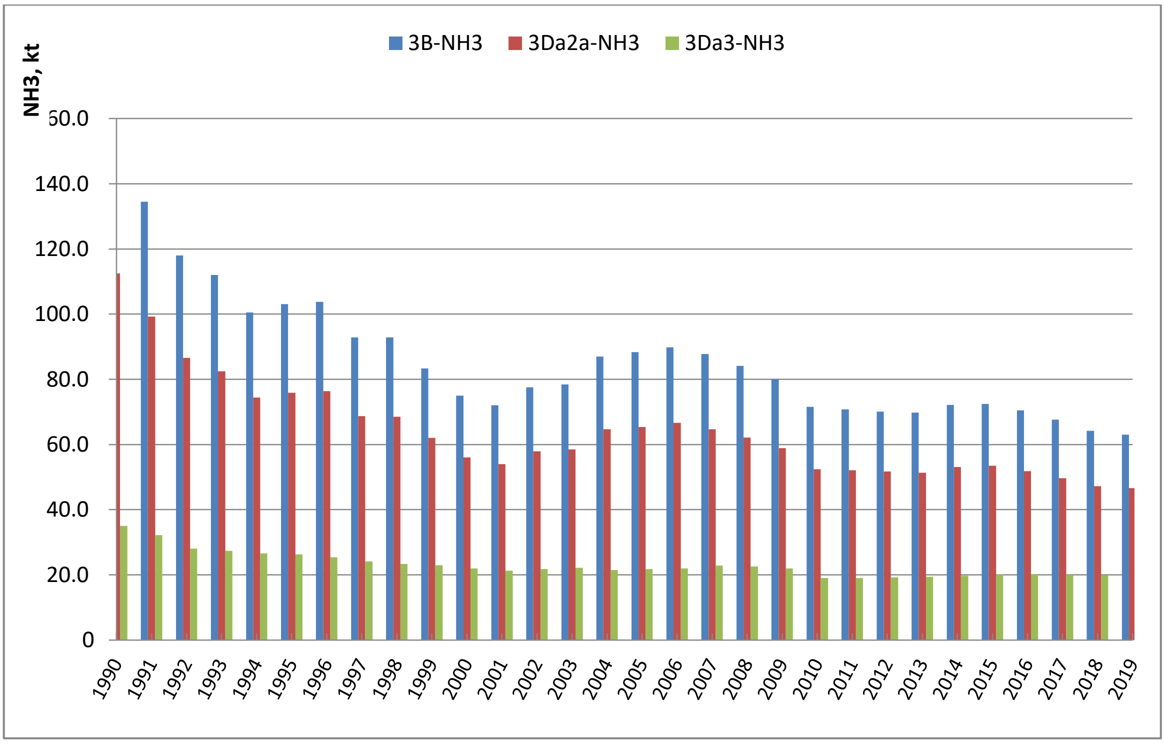


Figure 5.13.2 Comparison between the split of NH_3 [kt] for category 3B, 3Da2a, 3D3

Recalculations and improvements:

- According to RO-3Da2a-2020-0001, non-methane volatile organic compounds (NMVOC) emissions, included in calculation of NFR 3B, was changed with IE notation in reported CLRTAP Annex I.

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 11.97% of the total national emissions of PM_{10}, respectively with 7.86% of the total national emissions of TSP in 2019.

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

Year/Activity data	ha
2015	8328061
2016	8702268
2017	9262254
2018	10039777
2019	11746435

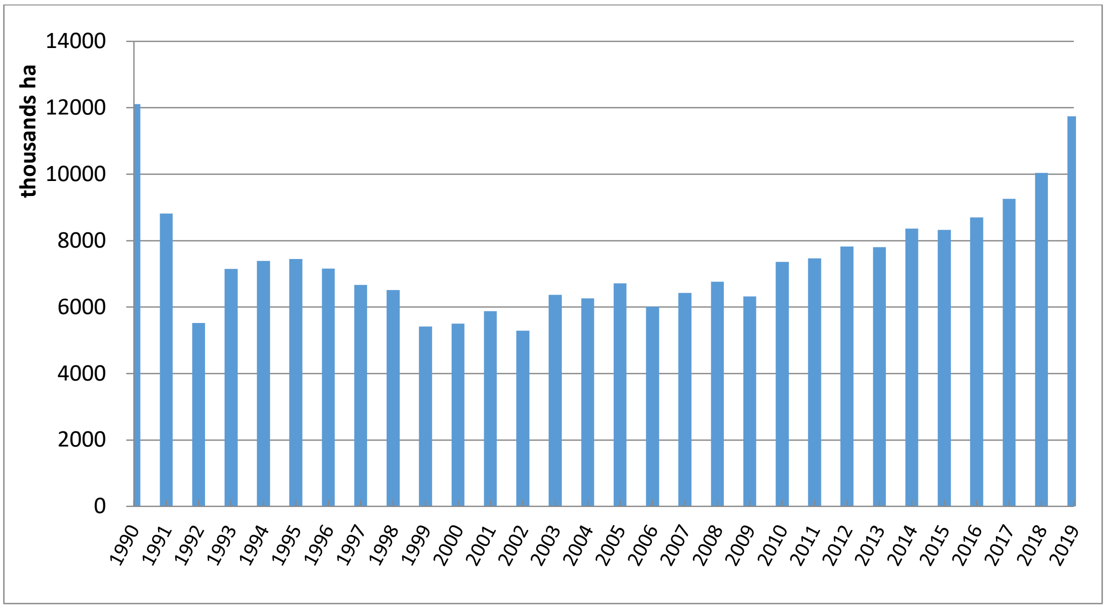


Figure 5.14.1 Activity data trends (ha) for NFR 3Dc Farm-level agricultural operations

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

Year/Pollutant	$PM_{2.5}$	PM_{10}
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
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
2019	0.704	18.324

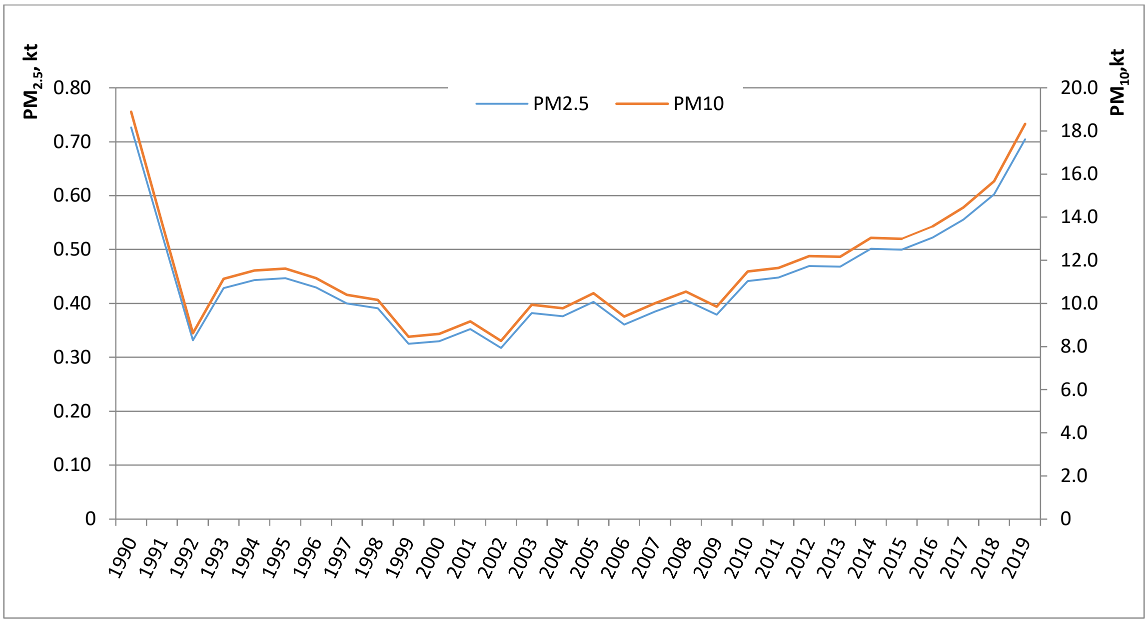


Figure 5.14.2 Emission trends (kt) for NFR 3Dc Farm-level agricultural operations

The emissions of particulate matter from farm-level agricultural operations follow the activity data trend.

5.15 NFR 3.D.e Cultivated crops

For the cultivated crops sector the emission of NMVOC were estimated, with a percent of 4.40% 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 provided 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
2019	10.102

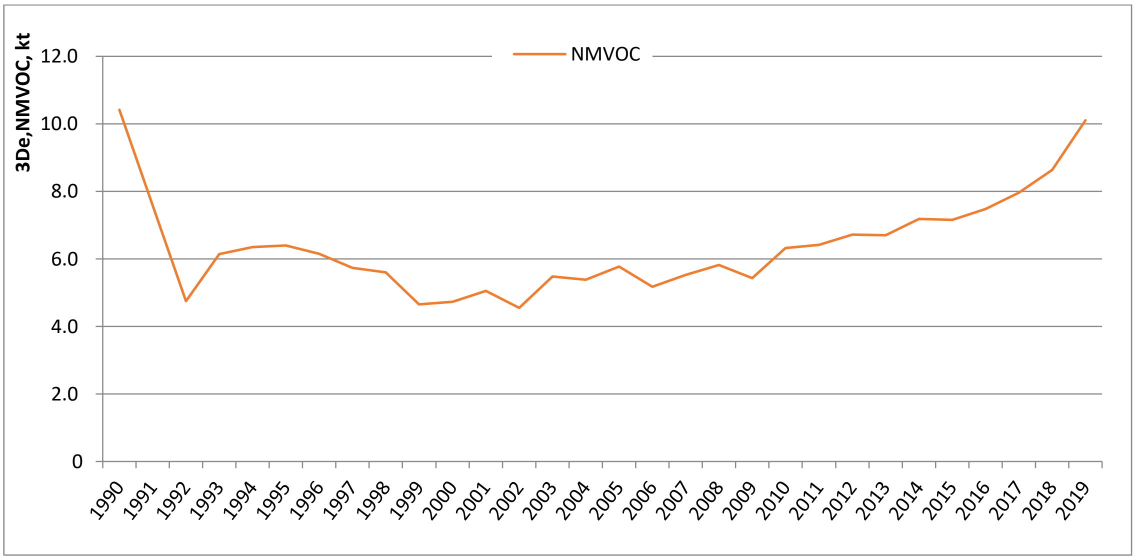


Figure 5.15.1 Emission trends (kt) for NFR 3De - Cultivated crops, NMVOC, kt

The emissions of NMVOC from cultivated crops follow the activity data trend.

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, which 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 were 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 2019 EMEP/EEA Guidebook, Tier 2 approach, applying the general equation:

$E_{pollutant} = AR_{residue\_burnt} \cdot EF_{pollutant}$, 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 the 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:

$AR_{residue\_burnt} = A \cdot Y \cdot s \cdot d \cdot p_b \cdot Cf$, 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 the crops 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	486885	147840	8773	1271
1991	384778	459915	181776	11216	1366
1992	467155	1066809	200948	4665	4488
1993	586778	788419	163836	6641	2137
1994	524073	648191	170560	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	286110	54249	1142	393
2018	216826	249992	43393	1052	283
2019	230521	284754	47721	995	93

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

Year	Wheat	Barley	Maize	Rye	Other cereals
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
2019	825311	157709	2284863	4382	335

PAHs emissions trends show 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

Year/Pollutant	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene
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
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
2019	0.017	0.009	0.005	0.006

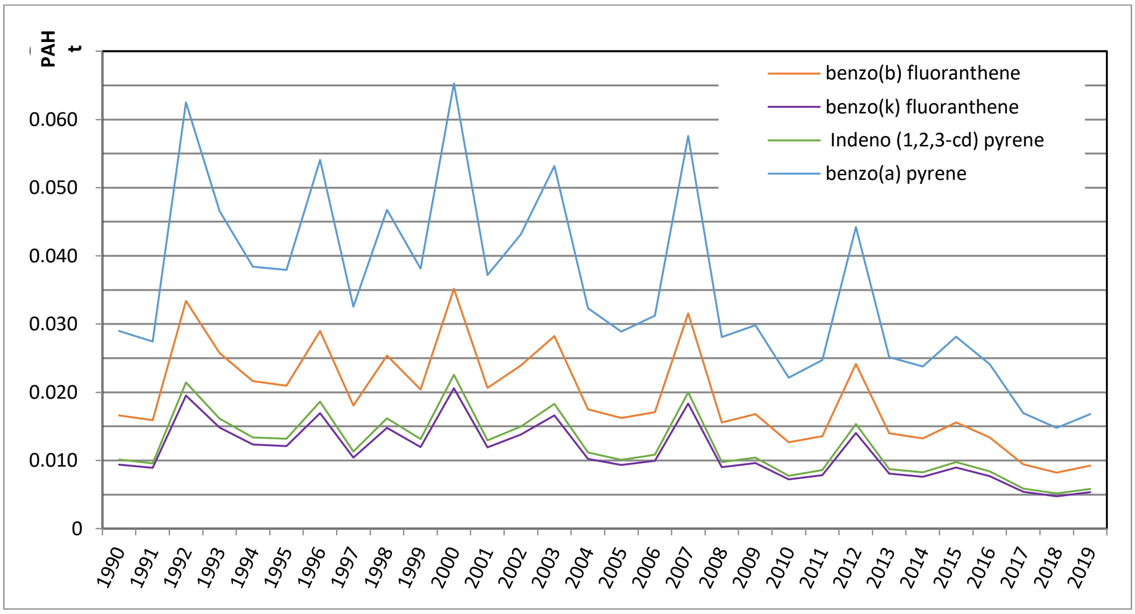


Figure 5.15.1 Emission trends (t) for NFR 3.F Field Burning of Agricultural Residues

The emissions of PAHs follow the activity data trend.

Recalculations and improvements:

- The tables 5.15.1 and 5.15.2 show the corrected values (RO-3F-2020-0001).

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 for NMVOC represent 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. For the TSP, $PM_{2.5}$, PM_{10}, activity data is the amount of waste disposed on land (SWDS total solid waste disposal sites).

The NMVOC emissions were recalculated for the period 1990-2019 using emission factors from the 2019 EMEP/EEA Guidebook. Also, for 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:

$E_{pollutant} = AR_{production} \times EF_{pollutant}$

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).

Table 6.1.1 Activity data trends (*Solid waste disposal on land and 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	Solid waste disposal on land (Gg)	CH4 (Gg)
1990	4295.031	49.376
1991	4290.069	50.858
1992	4221.985	52.278
1993	4223.518	53.529
1994	4223.557	54.691
1995	5913.262	55.797
1996	5297.580	59.104
1997	3504.374	62.250
1998	4750.406	63.016
1999	5834.110	65.153
2000	6828.846	76.872

Year	Solid waste disposal on land (Gg)	CH4 (Gg)
2001	6199.334	82.242
2002	7143.516	87.014
2003	6594.523	92.810
2004	7019.397	98.014
2005	7399.425	102.603
2006	7295.422	104.645
2007	7432.074	111.380
2008	8486.132	114.531
2009	7068.242	118.820
2010	5998.657	124.093
2011	5782.518	105.326
2012	4658.190	128.827
2013	4714.254	140.914
2014	5014.406	141.389
2015	5075.909	141.523
2016	5300.558	143.779
2017	4953.199	146.188
2018	5298.318	147.389
2019	5507.419	152.167

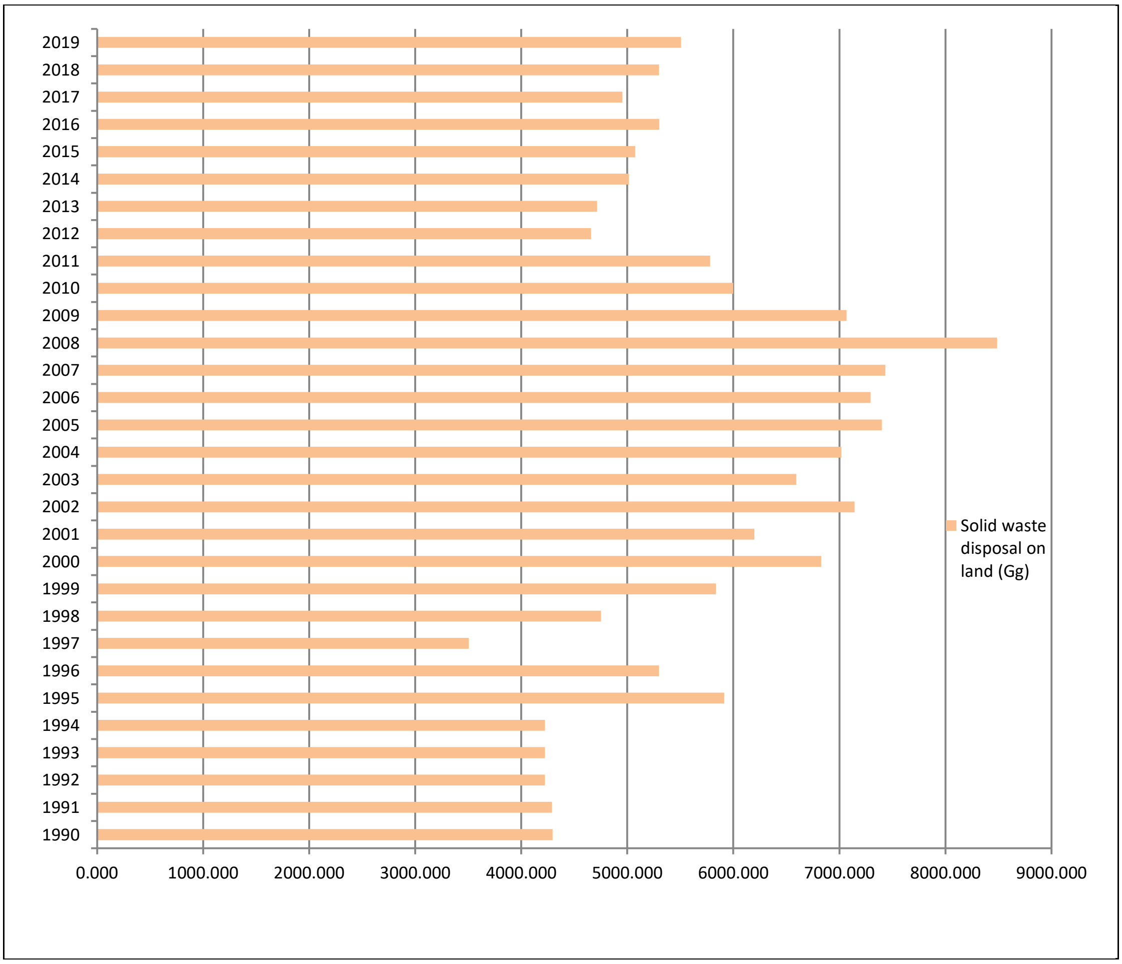


Figure 6.1.1 Activity data trends (*Solid waste disposal on land [Gg]*) for NFR 5.A

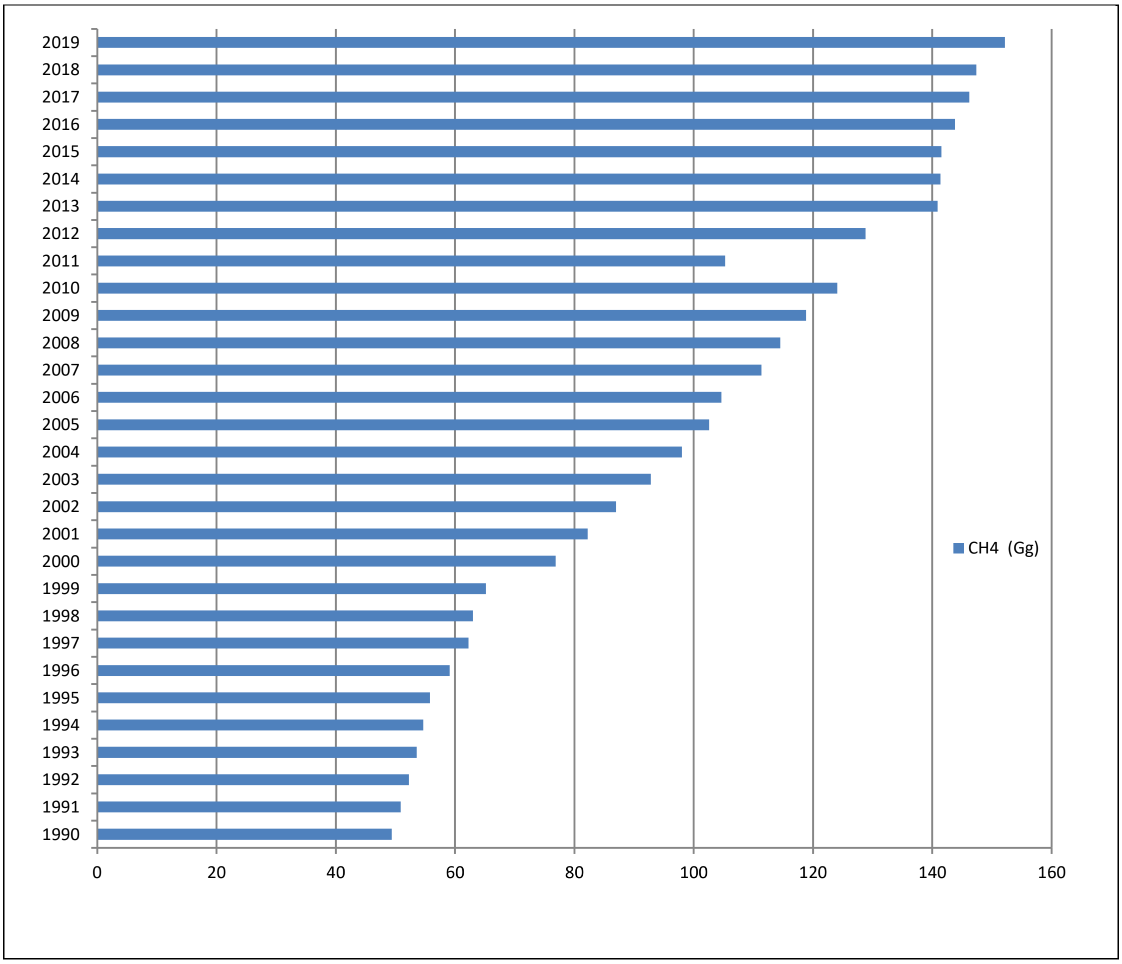


Figure 6.1.1” Activity data trends (*CH_4 from annual deposition of MSW at the SWDS [Gg]*) for NFR 5.A

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	0.6503
1991	0.6699
1992	0.6886
1993	0.7050
1994	0.7203
1995	0.7349
1996	0.7785
1997	0.8199
1998	0.8300
1999	0.8581
2000	1.0125
2001	1.0832
2002	1.1461
2003	1.2224
2004	1.2910
2005	1.3514
2006	1.3783
2007	1.4670
2008	1.5085

Year	NMVOC (kt)
2009	1.5650
2010	1.6345
2011	1.3873
2012	1.6968
2013	1.8560
2014	1.8623
2015	1.8640
2016	1.8937
2017	1.9255
2018	1.9413
2019	2.0042

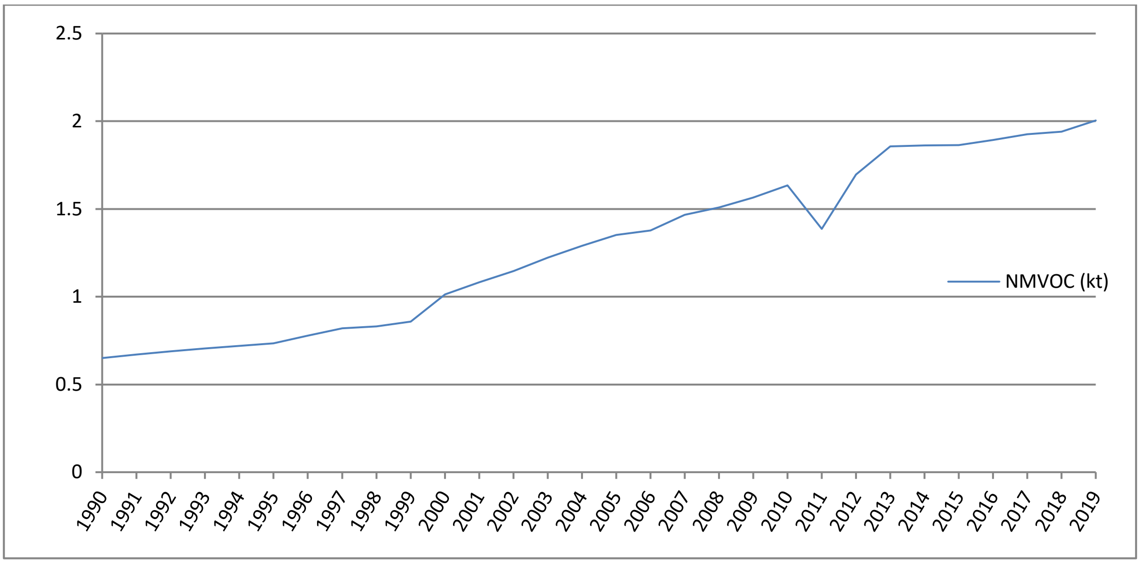


Figure 6.1.2 Emission trends (*kt for NMVOC*) for NFR 5.A Biological treatment of waste – Solid waste disposal on land

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	0.000142	0.000941	0.001989
1991	0.000142	0.000940	0.001986
1992	0.000139	0.000925	0.001955
1993	0.000139	0.000925	0.001955
1994	0.000139	0.000925	0.001956
1995	0.000195	0.001295	0.002738
1996	0.000175	0.001160	0.002453
1997	0.000116	0.000767	0.001623
1998	0.000157	0.001040	0.002199
1999	0.000193	0.001278	0.002701
2000	0.000225	0.001496	0.003162

Year	$PM_{2.5}$ (kt)	PM_{10} (kt)	TSP (kt)
2001	0.000205	0.001358	0.002870
2002	0.000236	0.001564	0.003307
2003	0.000218	0.001444	0.003053
2004	0.000232	0.001537	0.003250
2005	0.000244	0.001620	0.003426
2006	0.000241	0.001598	0.003378
2007	0.000245	0.001628	0.003441
2008	0.000280	0.001858	0.003929
2009	0.000233	0.001548	0.003273
2010	0.000198	0.001314	0.002777
2011	0.000191	0.001266	0.002677
2012	0.000154	0.001020	0.002157
2013	0.000156	0.001032	0.002183
2014	0.000165	0.001098	0.002322
2015	0.000168	0.001112	0.002350
2016	0.000175	0.001161	0.002454
2017	0.000163	0.001085	0.002293
2018	0.000175	0.001160	0.002453
2019	0.000182	0.001206	0.002550

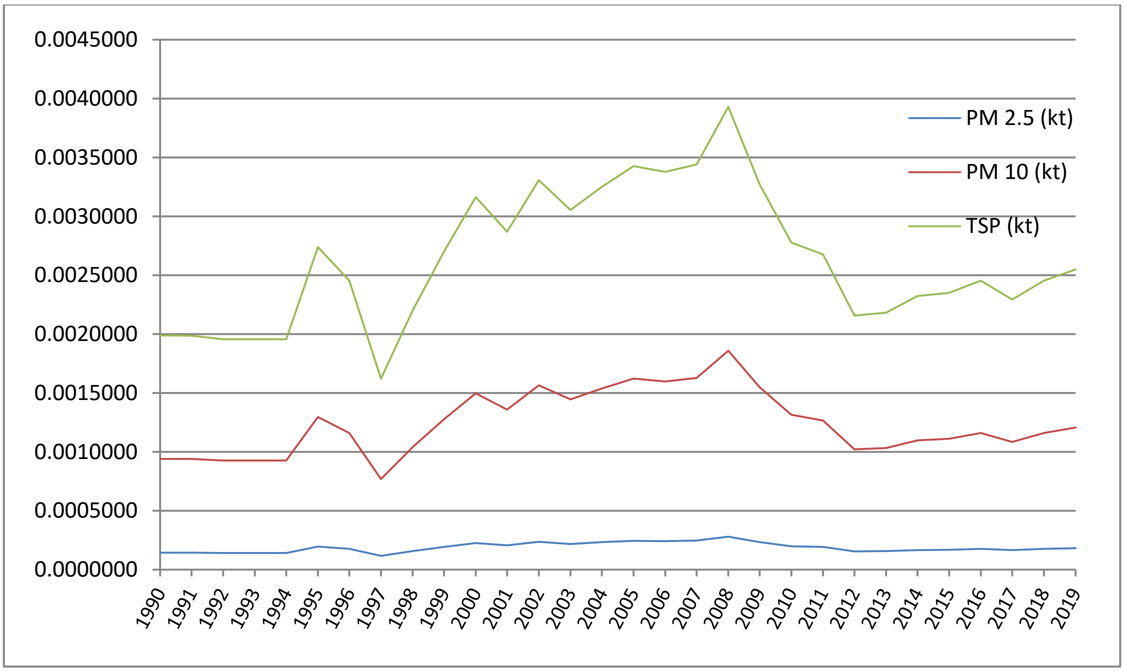


Figure 6.1.3 Emission trends (*kt for $PM_{2.5}$, PM_{10}. TSP*) for NFR 5.A Biological treatment of waste –solid waste disposal on land

The $PM_{2.5}$, PM_{10} and TSP emissions trend follows the activity data trend - total Solid waste disposal on land (Mg).

Recalculations and improvements:

- During the desk Review 2020 in response to RO-5A-2020-0001 it was explained details regarding the activity data for $PM_{2.5}$, PM_{10} and TSP; we corected the activity data for this polutants and the emission for 1990-2018 period were recalculated using the correct methodology.
- For the period 2011-2018 recalculation the emission of NMVOC (CH_4 emissions from the IPCC inventory update).

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 2005-2019 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 composting
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

Year	Kt composting
2019	122.395

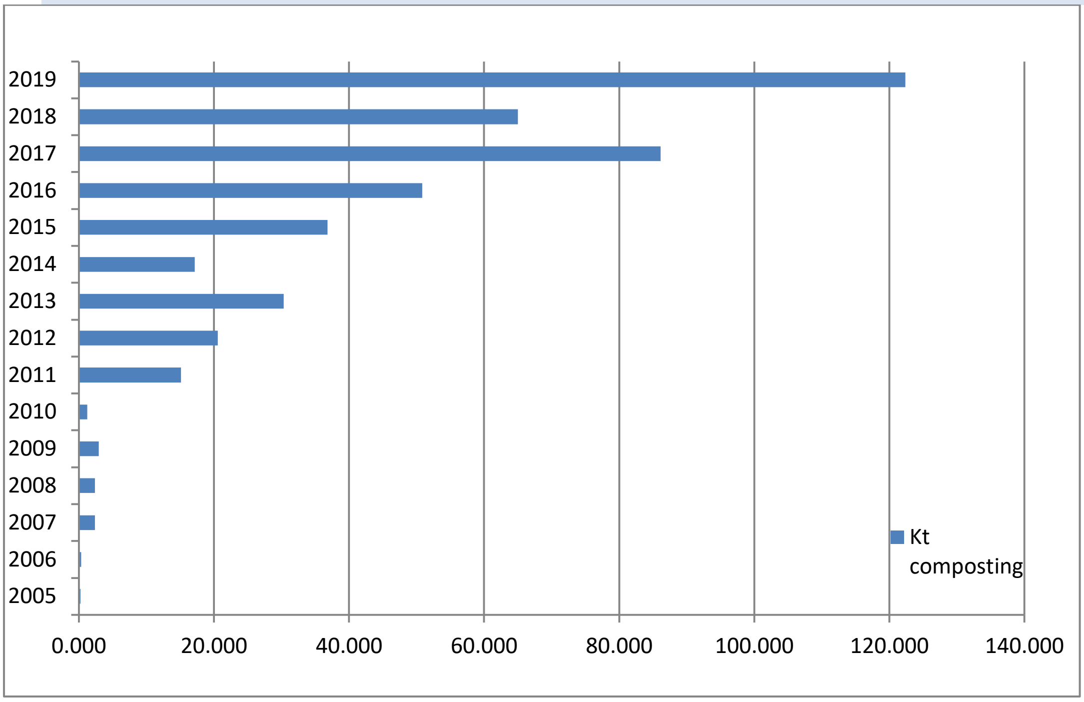


Figure 6.2.1 Activity data trends *(kt compost)* for NFR 5.B.1
Biological treatment of waste – Composting

Table 6.2.2 Emission trends *(kt for NH_3)* for NFR 5.B.1
Biological treatment of waste – Composting.

Year	NH_3 (kt)
2005	0.0000528
2006	0.0000780
2007	0.0005626
2008	0.0005664
2009	0.0007008
2010	0.0002914
2011	0.0036228
2012	0.0049327
2013	0.0072787
2014	0.0041160
2015	0.0088382
2016	0.0122018
2017	0.0206690
2018	0.0155974
2019	0.0293748

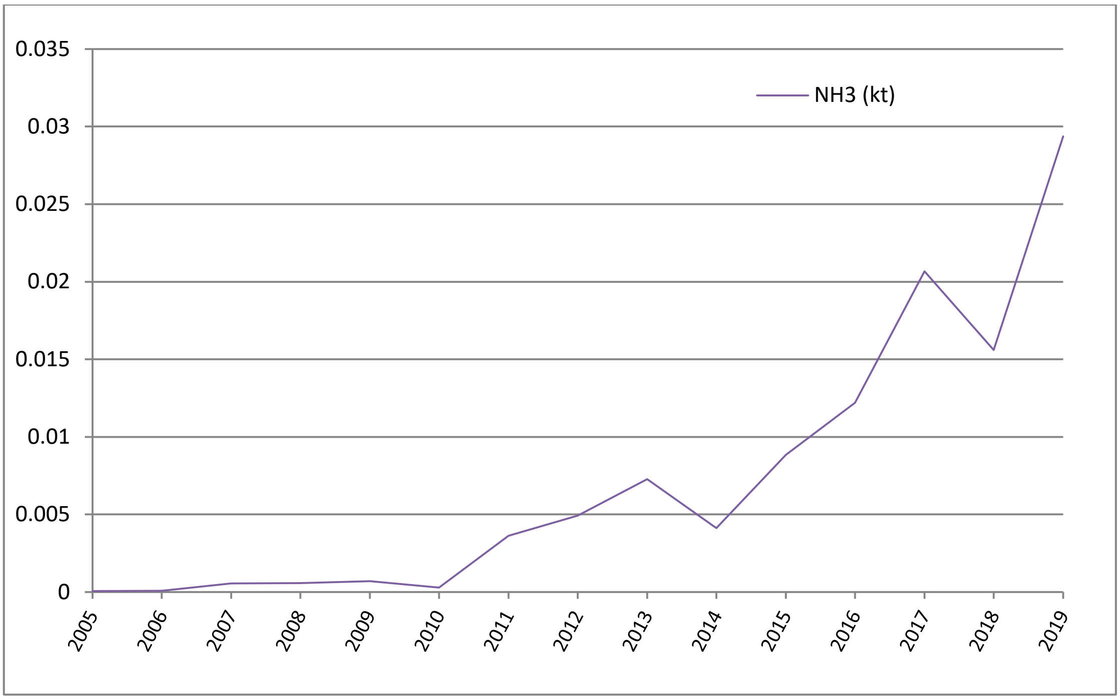


Figure 6.2.2 Emission trends (*kt for NH_3*) NFR 5.B.1
Biological treatment of waste – Composting

The NH_3 emissions from compost production follow the activity data trend.
There were no recalculations and improvements for this category.

6.3. NFR 5.C.1.b.i Industrial waste incineration

This chapter covers the atmospheric emissions from the incineration of industrial waste.

For NFR 5C1bi Industrial waste incineration, the activity data were estimated by study ("Determining the quantities of industrial waste with biodegradable contents and the quantities of sludge resulting from the treatment of wastewaters, disposed in compliant landfills (for 1989-2012) and in non-compliant landfills (for 1950-2012), performed by ISPE in 2013), according with Romanian Greenhouse Gas Inventory.
The amount of industrial waste has been increased from 2003 until 2005 because operators must comply with European regulations and they incinerated a large amount of industrial waste.
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 1992-2006, the calculation for the PCDD/F emissions was estimated with Tier 1, and starting with 1 January 2007, the Tier 2 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 1992-2006 time period; for 2007-2019 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 (2019 EMEP/EEA Guidebook Tier2, Table 3-3) as given in the formula:

$$EF_{tehnologyabated} = (1-\dot{\eta}_{abatement}) \; X \; EF_{tehnology\ abated}$$

The emissions were calculated based on Tier1(Tier2) methodology by applying the general equation:

$$Epollutant = ARproduction \times EFpollutant$$

where:

- Epollutant is the emission of the specified pollutant;
- ARproduction is the activity rate (industrial waste incinerated);
- 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), for 1992-2006 time period. For the 2007-2019 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).
This year we analyzed the entire series of existing chronological data (period 1990-2019) and according with TERT recommendations (of the last revision), activity data for this category were correlated with the Romanian Greenhouse Gas Inventory - N.I.R (for the 1990 year and the 1991 year does not have any informations).

The NFR 5.1.b.iv Sewage sludge incineration was included under 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	Industrial Waste incinerated [kt]
1990	-
1991	-
1992	6.639
1993	9.876
1994	13.112
1995	16.349
1996	19.585
1997	22.821
1998	26.058
1999	29.294
2000	32.531
2001	35.627
2002	38.058
2003	41.704

Year	Industrial Waste incinerated [kt]
2004	55.328
2005	99.536
2006	20.058
2007	0.454
2008	0.745
2009	0.530
2010	0.564
2011	1.499
2012	2.175
2013	2.939
2014	2.058
2015	2.674
2016	6.740
2017	5.045
2018	8.821
2019	8.133

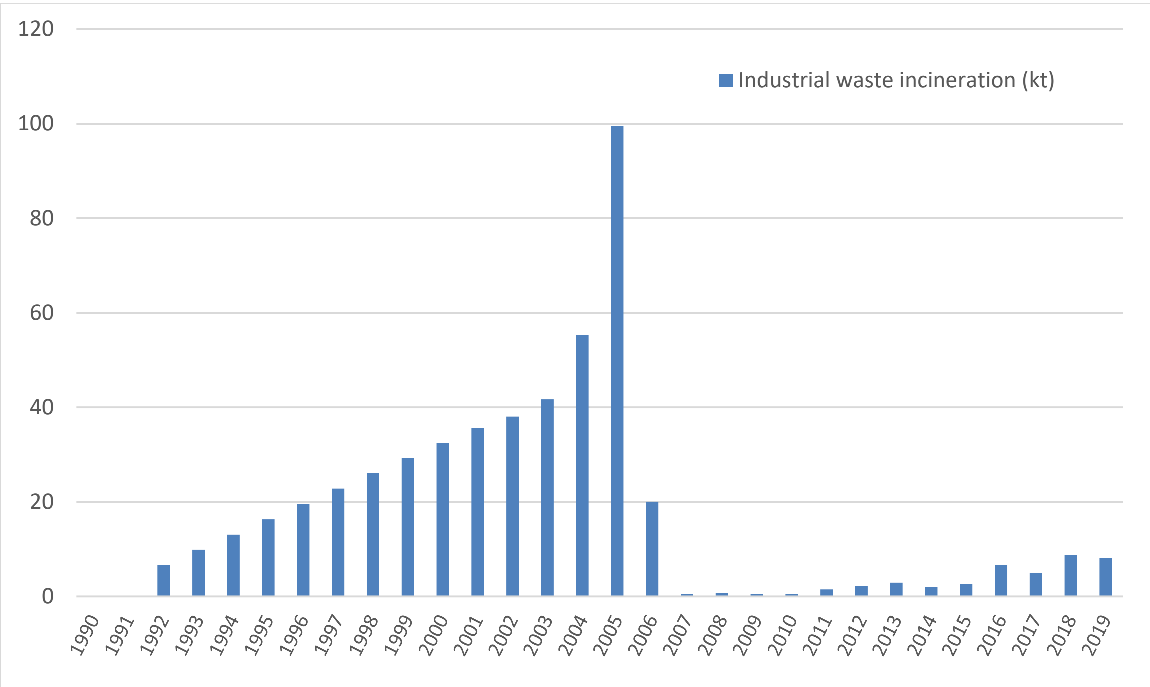


Figure 6.3.1 Activity data trends (*kt waste*) for NFR 5.C.1.b.i Industrial waste incineration

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)
1990	-	-	-	-
1991	-	-	-	-
1992	0.00578	0.04913	0.00863	2.32369
1993	0.00859	0.07308	0.01284	3.45645
1994	0.01141	0.09703	0.01705	4.58922
1995	0.01422	0.12098	0.02125	5.72198

Year	NOx (kt)	NMVOC (kt)	Pb (t)	PCDD/F (g I-TEQ)
1996	0.01704	0.14493	0.02546	6.85475
1997	0.01985	0.16888	0.02967	7.98751
1998	0.02267	0.19283	0.03388	9.12028
1999	0.02549	0.21678	0.03808	10.25304
2000	0.02830	0.24073	0.04229	11.38580
2001	0.03100	0.26364	0.04632	12.46961
2002	0.03311	0.28163	0.04948	13.32037
2003	0.03628	0.30861	0.05421	14.59631
2004	0.04814	0.40943	0.07193	19.36475
2005	0.08660	0.73656	0.12940	34.83743
2006	0.01745	0.14843	0.02608	7.02034
2007	0.00040	0.00336	0.00059	0.00159
2008	0.00065	0.00551	0.00097	0.00261
2009	0.00046	0.00392	0.00069	0.00185
2010	0.00049	0.00418	0.00073	0.00198
2011	0.00130	0.01110	0.00195	0.00525
2012	0.00189	0.01609	0.00283	0.00761
2013	0.00256	0.02175	0.00382	0.01028
2014	0.00179	0.01523	0.00268	0.00720
2015	0.00233	0.01979	0.00348	0.00936
2016	0.00586	0.04988	0.00876	0.02359
2017	0.00439	0.03733	0.00656	0.01766
2018	0.00767	0.06528	0.01147	0.03087
2019	0.00708	0.06018	0.01057	0.02847

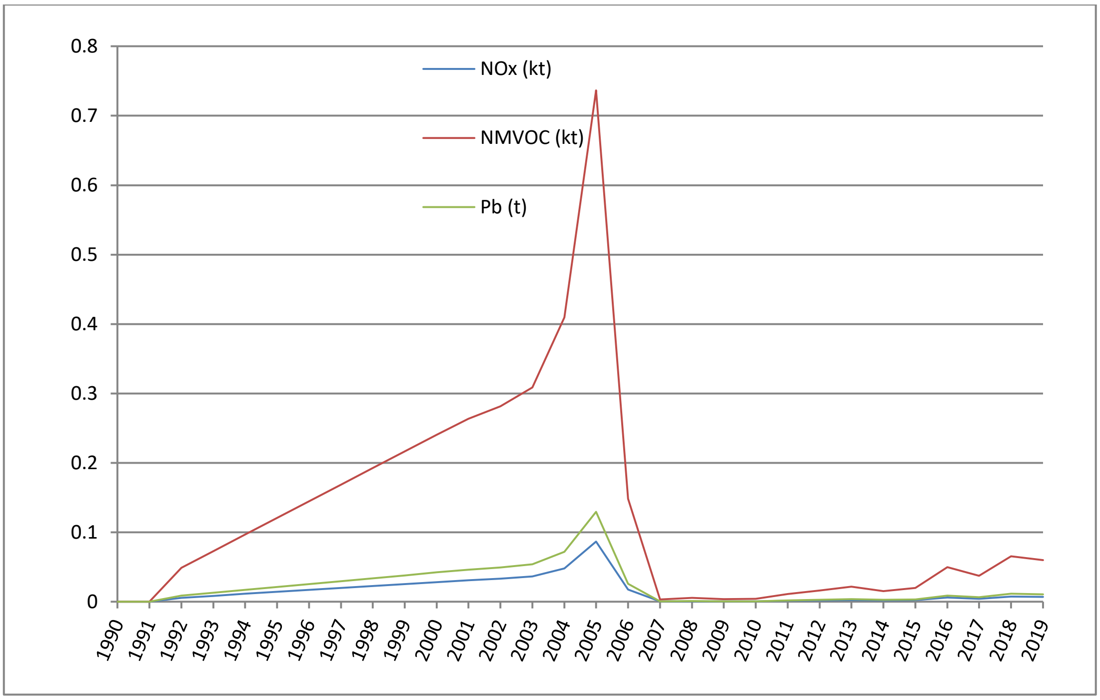


Figure 6.3.2.a. Emission trends (*Kt for NOx and NMVOC, t for Pb*)
for NFR 5.C.1.b.i Industrial waste incineration

Emission trends for NOx, NMVOC and Pb follow the waste incineration activity data trend.

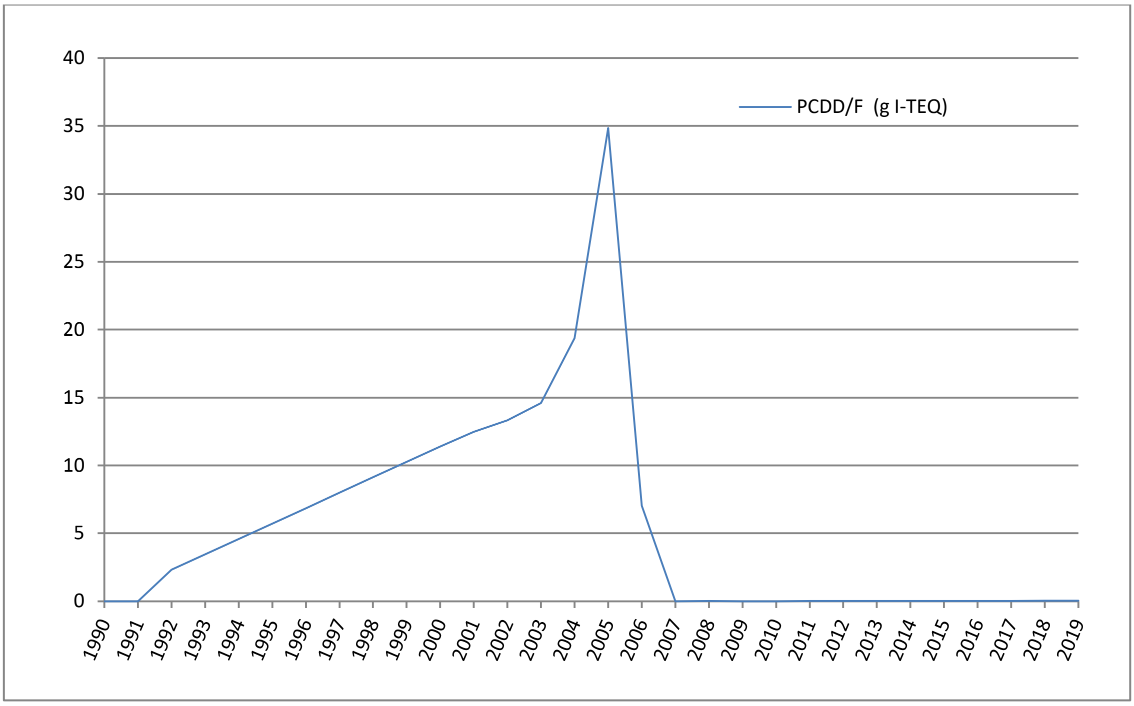


Figure 6.3.2.b. Emission trends (*g I-TEQ for PCDD/F calculating Tier1 1992-2006 and Tier 2 2007-2019*) for NFR 5.C.1.b.i Industrial waste incineration

Emission trends for PCDD/F follow the waste incineration activity data trend.

Recalculations and improvements:

- During the desk Review 2020 in response to RO-5C1bi-2020-0001 it was explained details regarding the activity data for this NFR 5C1bi, the activity data to the entire series 1992-2019 were correlated with the Romanian Greenhouse Gas Inventory - N.I.R and the polutants emission for this category were recalculated.

6.4. NFR 5.C.1.b.iii Clinical waste incineration

This category includes emissions from the incineration of hospital wastes

For NFR 5C1biii clinical waste incineration, Public Health Institute of Bucharest was provided the data on amounts of clinical waste generated and of clinical waste incinerated.
Following your observation the activity data for NFR 5C1biii clinical waste incineration correlated with the Romanian Greenhouse Gas Inventory – N.I.R., according with TERT recommendations (data consistency with the I.N.E.G.E.S. Inventory is ensured, according with TERT recommendations.).

The emissions from Clinical waste incinaration were calculated using the 2019 EMEP/EEA Guidebook (Tier 2, Table 3-2). The PCDD/F emission were calculated by replacing the technology-specific emission factor with an abated emission factor (2019 EMEP/EEA Guidebook, Tier 2, Table 3-5) and the emissions of SO_2, TSP, A_S, Cd, Hg, Ni, Pb, Cr, Cu, were calculated by replacing the technology-specific emission factor with an abated emission factor (2019 EMEP/EEA Guidebook Tier 2, Table 3-2) as given in the formula:

$$EF_{tehnologyabated} = (1-\dot{\eta}_{abatement})\ X\ EF_{tehnology\ abated}$$

The emissions were calculated based on Tier2 methodology by applying the general equation:

Epollutant = ARproduction× EFpollutant

where:

- Epollutant is the emission of the specified pollutant;
- ARproduction is the activity rate (industrial waste incinerated);
- EFpollutant is the emission factor for each pollutant.

The activity data is represented by the total clinical waste incinerated (in kt).

Tabel 6.4.1 Activity data trends (Clinical Waste incinerated [kt]) for NFR 5.C.1.b.iii Clinical waste incineration

Year	Clinical Waste incinerated [kt]
1990	2.1963
1991	2.2224
1992	2.2373
1993	2.2688
1994	2.3082
1995	2.3228
1996	2.3510
1997	2.6330
1998	3.6300
1999	10.1491
2000	15.0310
2001	19.0590
2002	17.0266
2003	18.7922
2004	17.0264
2005	13.5511
2006	12.6115
2007	9.9968
2008	6.4420
2009	4.7900
2010	5.4616
2011	5.1318
2012	5.8110
2013	5.9410
2014	6.5250
2015	7.3520
2016	8.0200
2017	9.3300
2018	9.8727
2019	10.7289

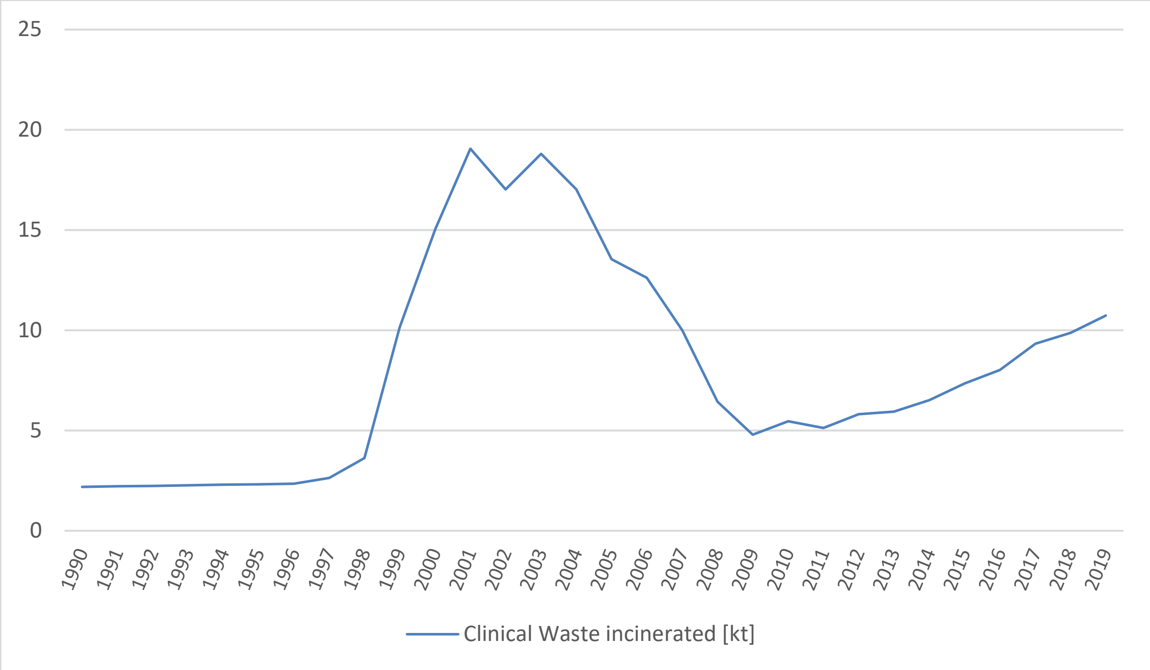


Figure 6.4.2 Trend data activity for 5.C.1.b.iii Clinical waste incineration (kt)

Tabel 6.4.2 Emission trends (*kt for NOx, NMVOC, SOx, TSP, BC, CO*)
for NFR 5.C.1.b.iii Clinical waste incineration

Year	NOx (kt)	NMVOC (kt)	SOx (kt)	TSP (kt)	BC (kt)	CO (kt)
1990	0.00395	0.00154	0.00019	0.00051	0.00001	0.00329
1991	0.00400	0.00156	0.00020	0.00051	0.00001	0.00333
1992	0.00403	0.00157	0.00020	0.00051	0.00001	0.00336
1993	0.00408	0.00159	0.00020	0.00052	0.00001	0.00340
1994	0.00415	0.00162	0.00020	0.00053	0.00001	0.00346
1995	0.00418	0.00163	0.00020	0.00053	0.00001	0.00348
1996	0.00423	0.00165	0.00021	0.00054	0.00001	0.00353
1997	0.00474	0.00184	0.00023	0.00061	0.00001	0.00395
1998	0.00653	0.00254	0.00032	0.00083	0.00002	0.00545
1999	0.01827	0.00710	0.00089	0.00233	0.00005	0.01522
2000	0.02706	0.01052	0.00132	0.00346	0.00008	0.02255
2001	0.03431	0.01334	0.00168	0.00438	0.00010	0.02859
2002	0.03065	0.01192	0.00150	0.00392	0.00009	0.02554
2003	0.03383	0.01315	0.00165	0.00432	0.00010	0.02819
2004	0.03065	0.01192	0.00150	0.00392	0.00009	0.02554
2005	0.02439	0.00949	0.00119	0.00312	0.00007	0.02033
2006	0.02270	0.00883	0.00111	0.00290	0.00007	0.01892
2007	0.01799	0.00700	0.00088	0.00230	0.00005	0.01500
2008	0.01160	0.00451	0.00057	0.00148	0.00003	0.00966
2009	0.00862	0.00335	0.00042	0.00110	0.00003	0.00719
2010	0.00983	0.00382	0.00048	0.00126	0.00003	0.00819
2011	0.00924	0.00359	0.00045	0.00118	0.00003	0.00770
2012	0.01046	0.00407	0.00051	0.00134	0.00003	0.00872
2013	0.01069	0.00416	0.00052	0.00137	0.00003	0.00891
2014	0.01175	0.00457	0.00057	0.00150	0.00003	0.00979
2015	0.01323	0.00515	0.00065	0.00169	0.00004	0.01103
2016	0.01444	0.00561	0.00071	0.00184	0.00004	0.01203

Year	NOx (kt)	NMVOC (kt)	SOx (kt)	TSP (kt)	BC (kt)	CO (kt)
2017	0.01679	0.00653	0.00082	0.00215	0.00005	0.01400
2018	0.01777	0.00691	0.00087	0.00227	0.00005	0.01481
2019	0.01931	0.00751	0.00094	0.00247	0.00006	0.01609

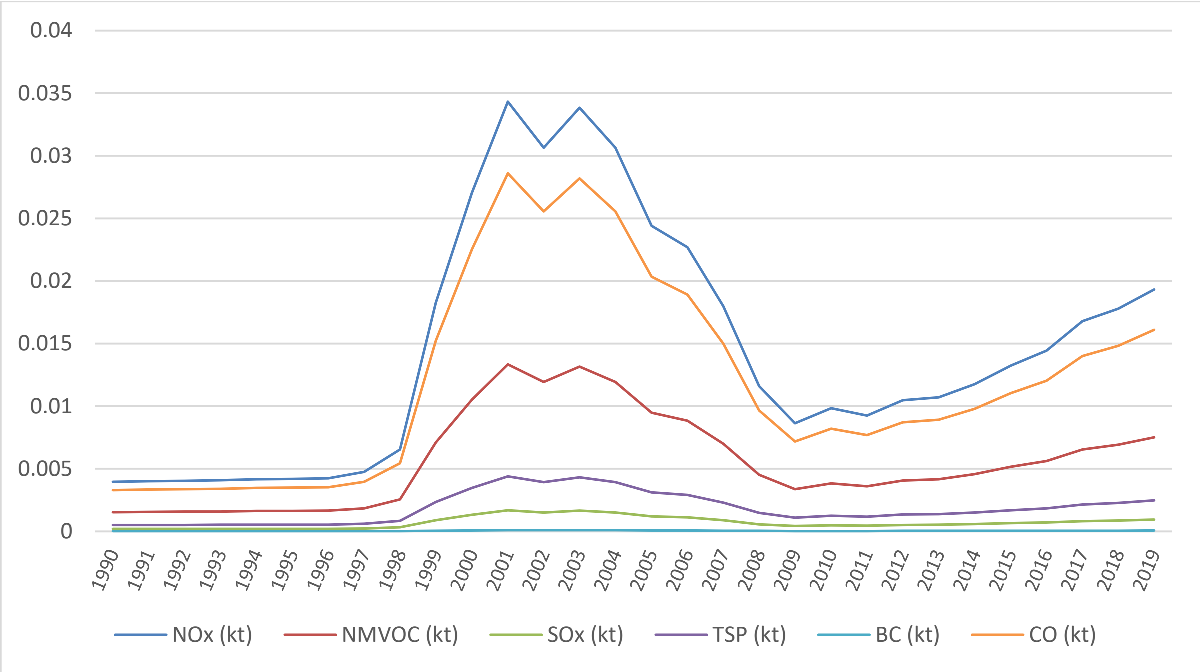


Figure 6.4.2 Trend Main Pollutants for 5.C.1.b.iii Clinical waste incineration (kt)

Emission trends for NOx, NMVOC, Sox, TSP, BC and CO follow the clinical waste incineration activity data trend.

Tabel 6.4.3 Emission trends Heavy Metals (*t for Pb, Cd, Hg, As, Cr, Cu, Ni*)
for NFR 5.C.1.b.iii Clinical waste incineration

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Cu (t)	Ni (t)
1990	0.00026	0.00356	0.00000	0.00004	0.00540	0.00066	0.00026
1991	0.00027	0.00360	0.00000	0.00004	0.00547	0.00067	0.00027
1992	0.00027	0.00362	0.00000	0.00004	0.00550	0.00067	0.00027
1993	0.00027	0.00368	0.00000	0.00004	0.00558	0.00068	0.00027
1994	0.00028	0.00374	0.00000	0.00004	0.00568	0.00069	0.00028
1995	0.00028	0.00376	0.00000	0.00004	0.00571	0.00070	0.00028
1996	0.00028	0.00381	0.00000	0.00004	0.00578	0.00071	0.00028
1997	0.00032	0.00427	0.00000	0.00004	0.00648	0.00079	0.00032
1998	0.00044	0.00588	0.00000	0.00006	0.00893	0.00109	0.00044
1999	0.00122	0.01644	0.00001	0.00016	0.02497	0.00304	0.00122
2000	0.00180	0.02435	0.00002	0.00024	0.03698	0.00451	0.00180
2001	0.00229	0.03088	0.00002	0.00030	0.04689	0.00572	0.00229
2002	0.00204	0.02758	0.00002	0.00027	0.04189	0.00511	0.00204
2003	0.00226	0.03044	0.00002	0.00030	0.04623	0.00564	0.00226
2004	0.00204	0.02758	0.00002	0.00027	0.04188	0.00511	0.00204
2005	0.00163	0.02195	0.00001	0.00022	0.03334	0.00407	0.00163

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Cu (t)	Ni (t)
2006	0.00151	0.02043	0.00001	0.00020	0.03102	0.00378	0.00151
2007	0.00120	0.01619	0.00001	0.00016	0.02459	0.00300	0.00120
2008	0.00077	0.01044	0.00001	0.00010	0.01585	0.00193	0.00077
2009	0.00057	0.00776	0.00000	0.00008	0.01178	0.00144	0.00057
2010	0.00066	0.00885	0.00001	0.00009	0.01344	0.00164	0.00066
2011	0.00062	0.00831	0.00001	0.00008	0.01262	0.00154	0.00062
2012	0.00070	0.00941	0.00001	0.00009	0.01430	0.00174	0.00070
2013	0.00071	0.00962	0.00001	0.00010	0.01461	0.00178	0.00071
2014	0.00078	0.01057	0.00001	0.00010	0.01605	0.00196	0.00078
2015	0.00088	0.01191	0.00001	0.00012	0.01809	0.00221	0.00088
2016	0.00096	0.01299	0.00001	0.00013	0.01973	0.00241	0.00096
2017	0.00112	0.01511	0.00001	0.00015	0.02295	0.00280	0.00112
2018	0.00118	0.01599	0.00001	0.00016	0.02429	0.00296	0.00118
2019	0.00129	0.01738	0.00001	0.00017	0.02639	0.00322	0.00129

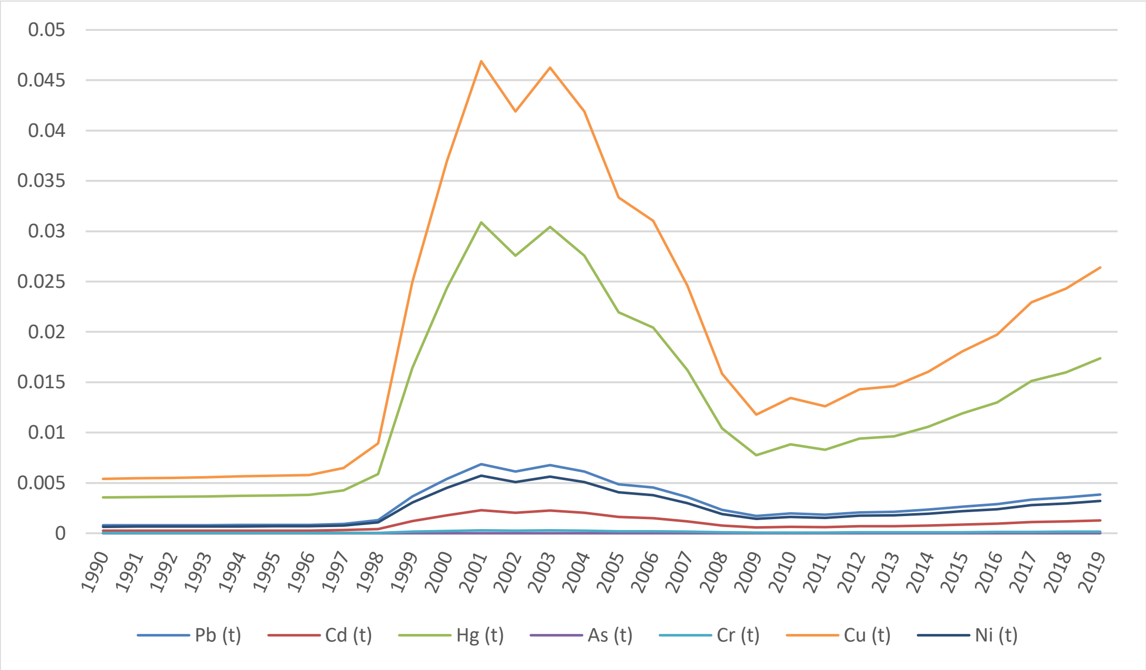


Figure 6.4.3 Trend Heavy Metals for 5.C.1.b.iii Clinical waste incineration (t)

Emission trends for Heavy Metals follow the clinical waste incineration activity data trend.

Tabel 6.4.4 Emission trends for POPs (*PCDD/PCDF (g I-TEQ), PAHs (t), HCB (kg)* for NFR 5.C.1.b.iii Clinical waste incineration

Year	PCDD/PCDF (g I-TEQ)	PAHs (t)	HCB (kg)
1990	6.14957	0.0000000879	0.21963
1991	6.22278	0.0000000889	0.22224
1992	6.26443	0.0000000895	0.22373
1993	6.35276	0.0000000908	0.22688
1994	6.46295	0.0000000923	0.23082
1995	6.50371	0.0000000929	0.23228
1996	6.58280	0.0000000940	0.23510

Year	PCDD/PCDF (g I-TEQ)	PAHs (t)	HCB (kg)
1997	7.37240	0.0000001053	0.26330
1998	10.16400	0.0000001452	0.36300
1999	28.41759	0.0000004060	1.01491
2000	42.08680	0.0000006012	1.50310
2001	53.36520	0.0000007624	1.90590
2002	47.67445	0.0000006811	1.70266
2003	52.61810	0.0000007517	1.87922
2004	47.67395	0.0000006811	1.70264
2005	37.94319	0.0000005420	1.35511
2006	35.31206	0.0000005045	1.26115
2007	27.99104	0.0000003999	0.99968
2008	18.03760	0.0000002577	0.64420
2009	13.41200	0.0000001916	0.47900
2010	15.29237	0.0000002185	0.54616
2011	14.36915	0.0000002053	0.51318
2012	16.27080	0.0000002324	0.58110
2013	16.63480	0.0000002376	0.59410
2014	18.27000	0.0000002610	0.65250
2015	20.58560	0.0000002941	0.73520
2016	22.45600	0.0000003208	0.80200
2017	26.12400	0.0000003732	0.93300
2018	27.64342	0.0000003949	0.98727
2019	30.04089	0.0000004292	1.07289

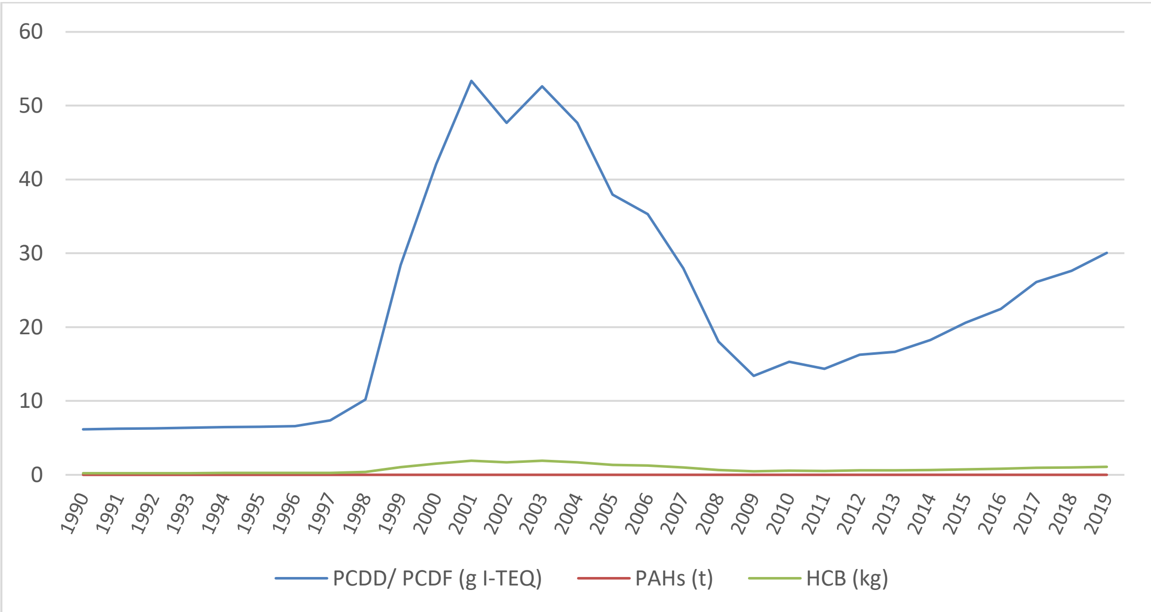


Figure 6.4.4 Trend POPs for 5.C.1.b.iii Clinical waste incineration

Emission trends for POPs follow the clinical waste incineration activity data trend.
PCDD/F emissions from this category are the key source, representing 16.13% of the total national emissions of PCDD/Fs in 2019.
HCB emissions from this category are the key source, representing 34.59% of the total national emissions of HCBs in 2019.

Recalculations and improvements:
First estimate and calculate of emissions for this NFR 5C1biii Clinical waste incineration for the entire time series 1990-2019.

6.5. NFR 5.C.1.b.v Cremation

This chapter 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 1990-2019 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, Table 3-1.

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
1999	1195
2000	1170
2001	1073
2002	1121
2003	1002
2004	884

Year/Activity data	Corpses (number)
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
2019	2368

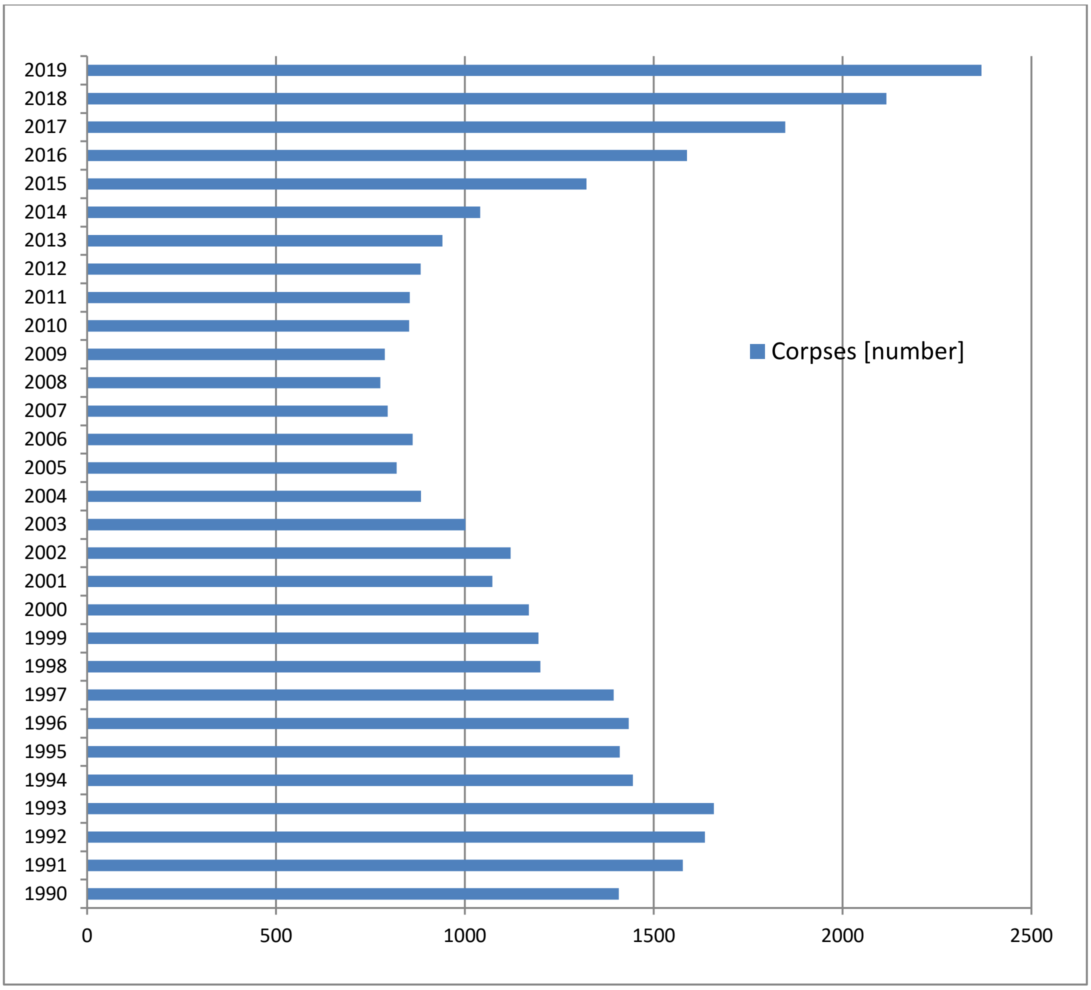


Figure 6.5.1 Activity data trends (*number corpses*) for NFR 5.C.1.b.v Cremation

Table 6.5.2. Emission trends *Kt for NOx, NMVOC, SOx, $PM_{2.5}$ and Hg (t)*)
for NFR 5.C.1.b.v Cremation

Year	NOx (kt)	NMVOC (kt)	SOx_5 (kt)	$PM_{2.5}$ (kt)	Hg (t)

Year	NOx (kt)	NMVOC (kt)	SOx_5 (kt)	$PM_{2.5}$ (kt)	Hg (t)
1990	0.0011616	0.0000183	0.0001591	0.0000489	0.0020979
1991	0.0013010	0.0000205	0.0001782	0.0000547	0.0023497
1992	0.0013497	0.0000213	0.0001849	0.0000568	0.0024376
1993	0.0013687	0.0000216	0.0001875	0.0000576	0.0024719
1994	0.0011921	0.0000188	0.0001633	0.0000501	0.0021531
1995	0.0011633	0.0000183	0.0001593	0.0000489	0.0021009
1996	0.0011831	0.0000186	0.0001620	0.0000498	0.0021367
1997	0.0011501	0.0000181	0.0001575	0.0000484	0.0020771
1998	0.0009900	0.0000156	0.0001356	0.0000416	0.0017880
1999	0.0009859	0.0000155	0.0001350	0.0000415	0.0017806
2000	0.0009653	0.0000152	0.0001322	0.0000406	0.0017433
2001	0.0008852	0.0000139	0.0001212	0.0000372	0.0015988
2002	0.0009248	0.0000146	0.0001267	0.0000389	0.0016703
2003	0.0008267	0.0000130	0.0001132	0.0000348	0.0014930
2004	0.0007293	0.0000115	0.0000999	0.0000307	0.0013172
2005	0.0006765	0.0000107	0.0000927	0.0000285	0.0012218
2006	0.0007112	0.0000112	0.0000974	0.0000299	0.0012844
2007	0.0006567	0.0000103	0.0000899	0.0000276	0.0011860
2008	0.0006402	0.0000101	0.0000877	0.0000269	0.0011562
2009	0.0006501	0.0000102	0.0000890	0.0000273	0.0011741
2010	0.0007037	0.0000111	0.0000964	0.0000296	0.0012710
2011	0.0007046	0.0000111	0.0000965	0.0000296	0.0012725
2012	0.0007285	0.0000115	0.0000998	0.0000306	0.0013157
2013	0.0007763	0.0000122	0.0001063	0.0000327	0.0014021
2014	0.0008588	0.0000135	0.0001176	0.0000361	0.0015511
2015	0.0010907	0.0000172	0.0001494	0.0000459	0.0019698
2016	0.0013101	0.0000206	0.0001794	0.0000551	0.0023661
2017	0.0015246	0.0000240	0.0002088	0.0000641	0.0027535
2018	0.0017457	0.0000275	0.0002391	0.0000734	0.0031528
2019	0.0019536	0.0000308	0.0002676	0.0000822	0.0035283

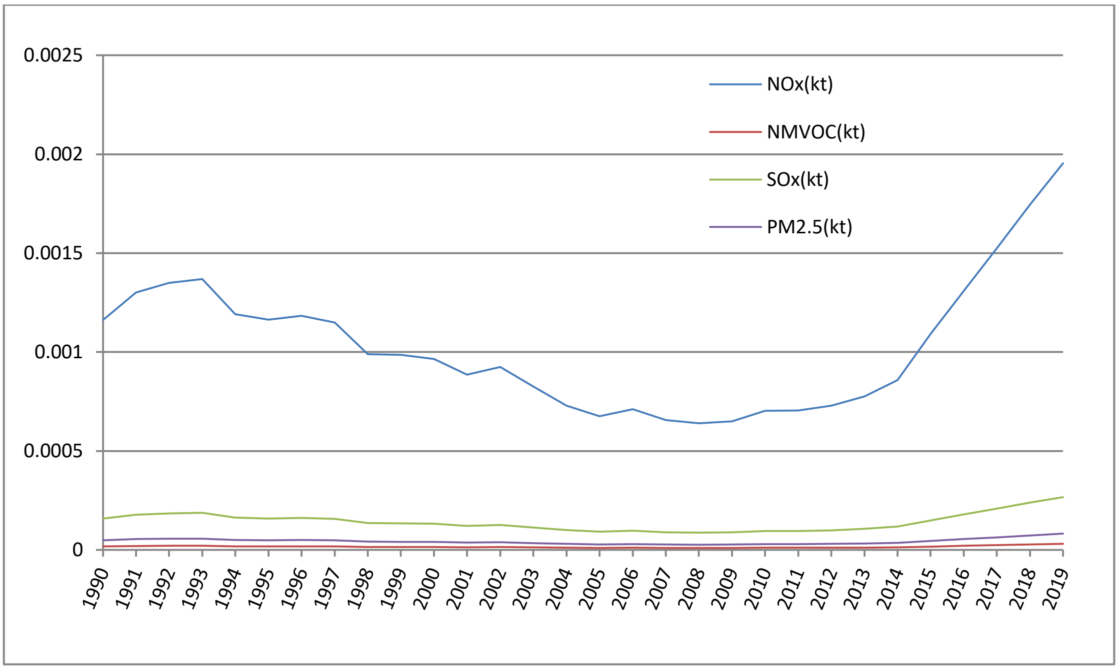


Figure 6.5.2.a. Emission trends (*Kt for NOx, NMVOC, $PM_{2.5}$ and SOx*)

for NFR 5.C.1.b.v Cremation

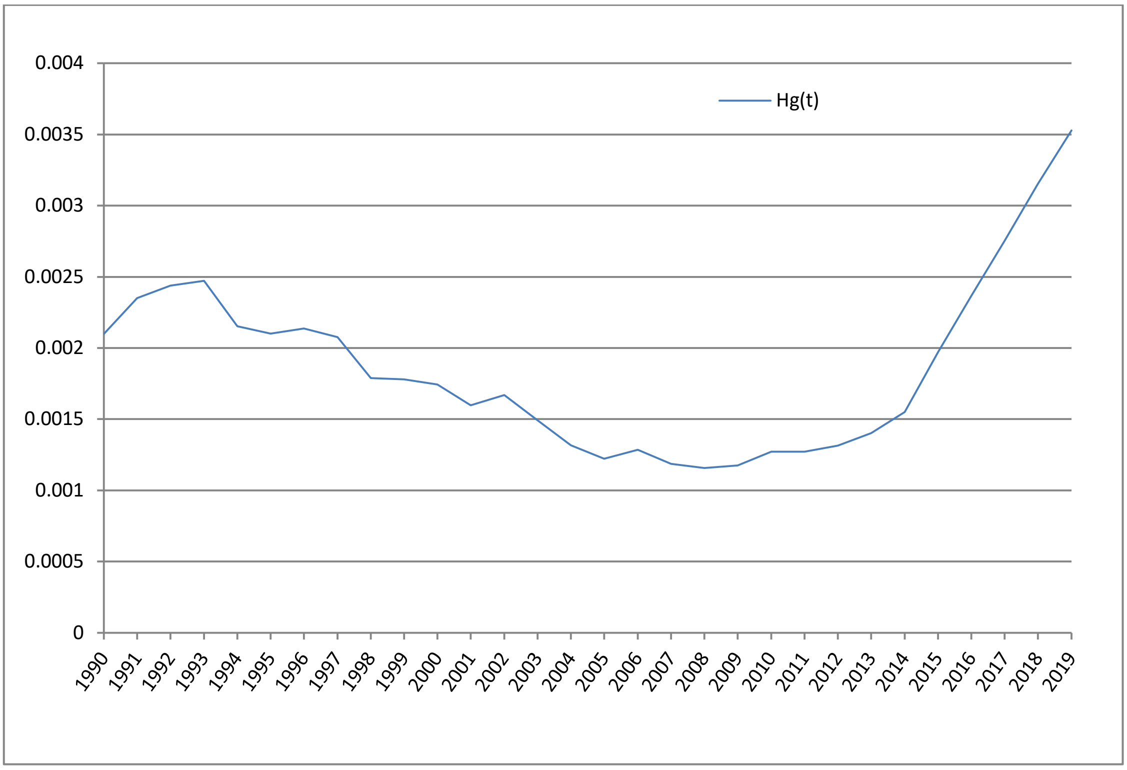


Figure 6.5.2.b. Emission trends (*t for Hg,*)
for NFR 5.C.1.b.v Cremation

The contribution of crematoria to national emissions is comparatively small for all pollutants.

There were no recalculations and improvements for this category.

6.6. NFR 5.C.2 Open Burning of Waste

This activity covers emissions from open burning of agricultural waste.

Activity data represents the amount of(agricultural) waste burned.
The methodology used to obtain the amount of(agricultural) waste burned is to the 2019 Guidebook EMEP/EEA.
The area cultivated with cereals (ha) was obtained from N.I.S. (statistical crops production).

The average amount of waste burned for arable farmland is estimated to be 25 kg/hectare(the 2019 Guidebook EMEP/EEA.
The methodology used to derive the amount of (agricultural) waste burned:
The area cultivated with cereals (ha) x 25kg/ha = the amount of waste burned (kg).

The emissions for NFR 5.C.2 were calculated for the 1990-2019 period using the 2019 Guidebook EMEP/EEA Tier 1 Table 3-1.

Emissions are calculated based on Tier 1 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 (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.

Table 6.6.1 Activity data trends (*kt product*) for NFR 5.C.2 Small scale waste burning

Year	Amount of waste burned (kt)
1990	142.600
1991	151.224
1992	144.347
1993	159.874
1994	163.939
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	130.268
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
2019	139.227

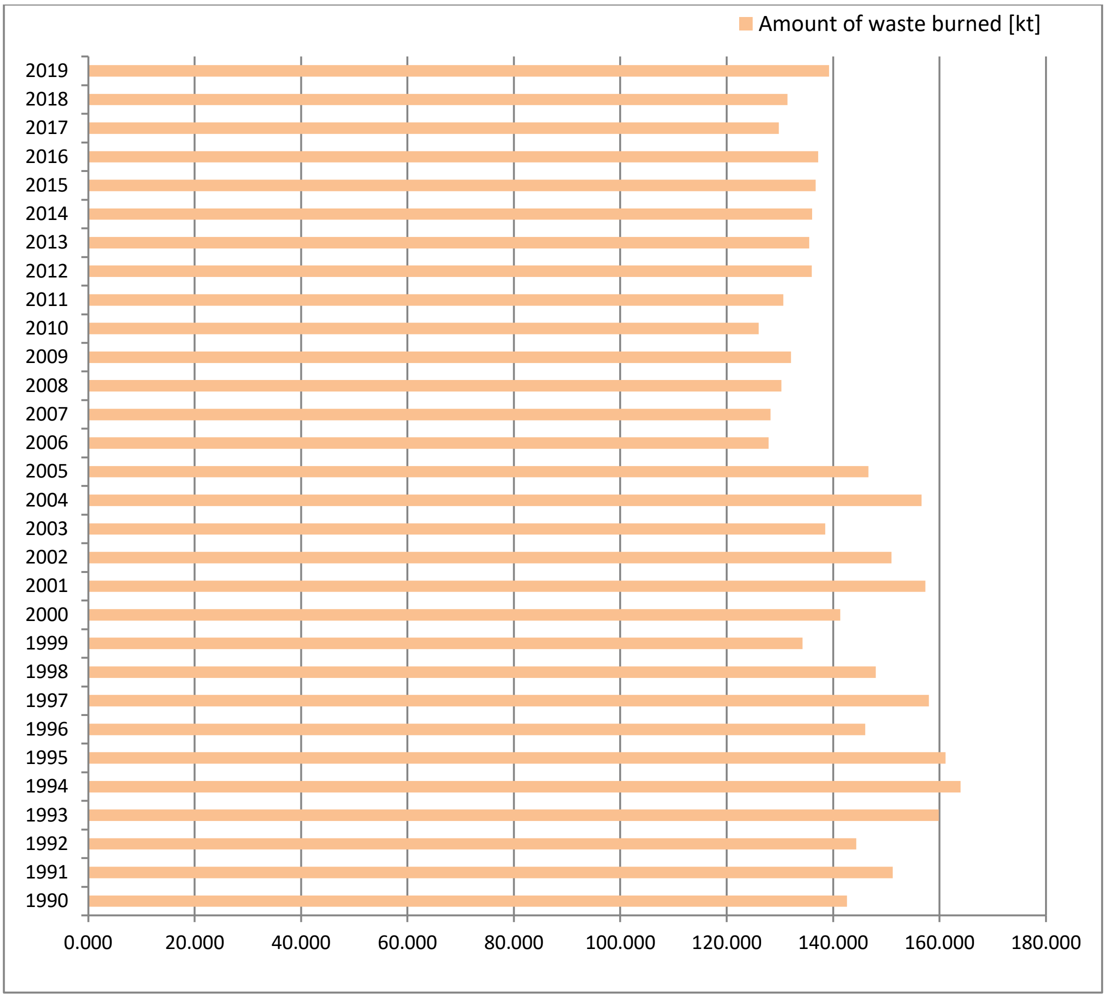


Figure 6.6.1 Activity data trends (*kt product*) for NFR 5.C.2 Small scale waste burning

Table 6.6.2 Emission trends (*kt for NOx, 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	NOx (kt)	NMVOC (kt)	$PM_{2.5}$ (kt)	PM_{10} (kt)	PCDD/F (g I-TEQ)	Total PAHs (t)
1990	0.45347	0.17540	0.59750	0.64313	1.42600	0.00870
1991	0.48089	0.18601	0.63363	0.68202	1.51224	0.00922
1992	0.45902	0.17755	0.60481	0.65101	1.44347	0.00881
1993	0.50840	0.19664	0.66987	0.72103	1.59874	0.00975
1994	0.52133	0.20165	0.68690	0.73937	1.63939	0.01000
1995	0.51237	0.19818	0.67510	0.72666	1.61121	0.00983
1996	0.46450	0.17967	0.61203	0.65877	1.46070	0.00891
1997	0.50242	0.19433	0.66200	0.71255	1.57994	0.00964
1998	0.47069	0.18206	0.62018	0.66755	1.48015	0.00903
1999	0.42697	0.16515	0.56259	0.60555	1.34269	0.00819
2000	0.44959	0.17390	0.59238	0.63762	1.41380	0.00862
2001	0.50045	0.19357	0.65939	0.70975	1.57373	0.00960
2002	0.48003	0.18567	0.63249	0.68079	1.50952	0.00921
2003	0.44057	0.17041	0.58051	0.62484	1.38545	0.00845
2004	0.49810	0.19266	0.65630	0.70642	1.56635	0.00955
2005	0.46632	0.18037	0.61443	0.66135	1.46642	0.00895
2006	0.40660	0.15727	0.53573	0.57665	1.27860	0.00780
2007	0.40777	0.15772	0.53728	0.57832	1.28230	0.00782

2008	0.41425	0.16023	0.54582	0.58751	1.30268	0.00795
2009	0.41995	0.16244	0.55334	0.59560	1.32061	0.00806
2010	0.40073	0.15500	0.52801	0.56833	1.26016	0.00769
2011	0.41537	0.16066	0.54729	0.58909	1.30618	0.00797
2012	0.43250	0.16729	0.56987	0.61339	1.36007	0.00830
2013	0.43098	0.16670	0.56787	0.61124	1.35530	0.00827
2014	0.43274	0.16738	0.57018	0.61372	1.36080	0.00830
2015	0.43473	0.16815	0.57280	0.61655	1.36707	0.00834
2016	0.43621	0.16872	0.57476	0.61865	1.37174	0.00837
2017	0.41279	0.15966	0.54390	0.58544	1.29809	0.00792
2018	0.41794	0.16166	0.55069	0.59275	1.31429	0.00802
2019	0.44274	0.17125	0.58336	0.62791	1.39227	0.00849

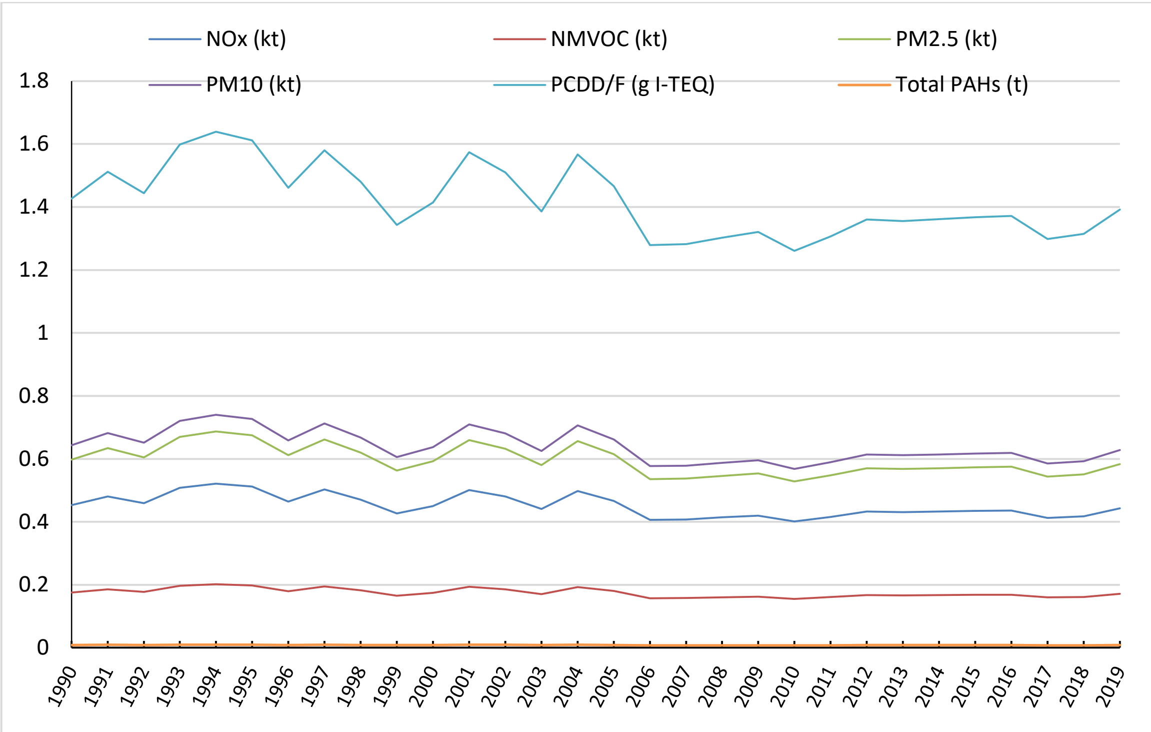


Figure 6.6.2 Emission trends (*kt for NOx, NMVOC, $PM_{2.5}$ and PM_{10}, g I-TEQ for PCDD/F and t for Total PAHs*) for NFR 5.C.2 Small scale waste burning

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).

Recalculations and improvements:

- recalculation the emissions of PAH for entire time series 1990-2019 (the 2019 EMEP/EEA Guidebook update).

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
2019	2188540

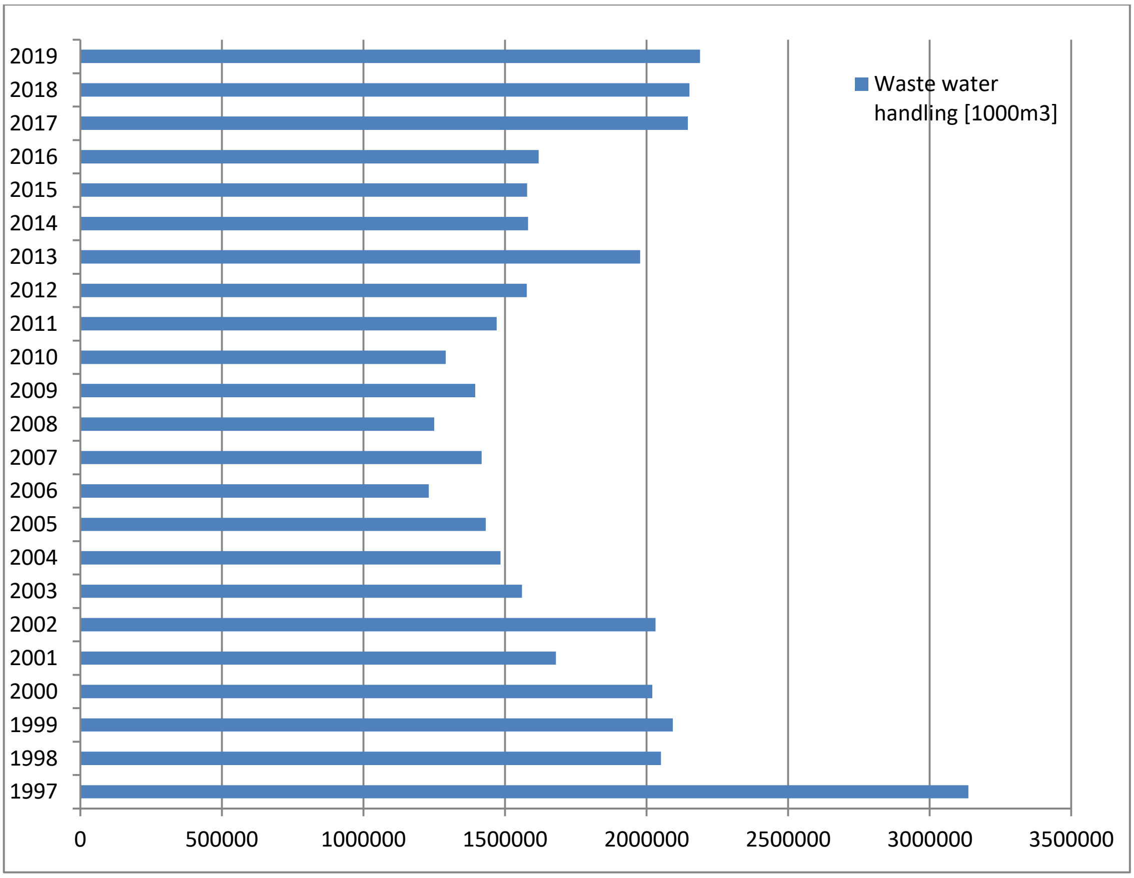


Figure 6.7.1 Activity data trends (*water handling 1000 m^3*) for NFR 5.D.3 Wastewater handling

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
2019	0.03283

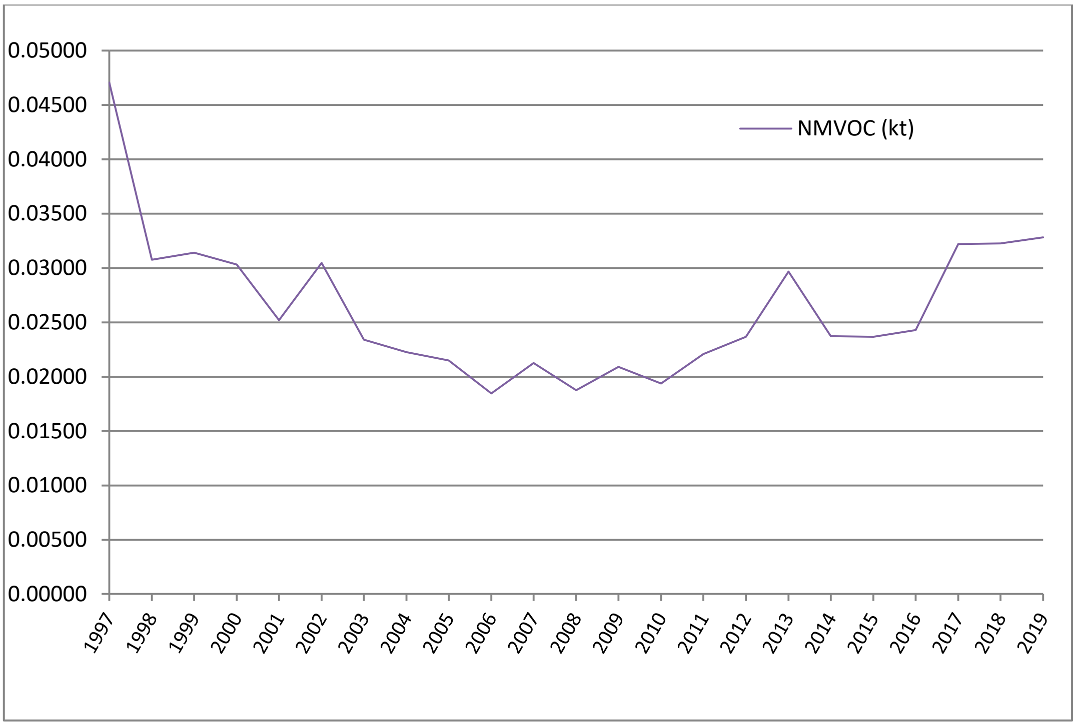


Figure 6.7.2 Emission trends (*kt for NMVOC*) for NFR 5.D.3 Wastewater handling

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
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
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2013	6916181
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2016	6111755
2017	5673403
2018	5308948
2019	5030856

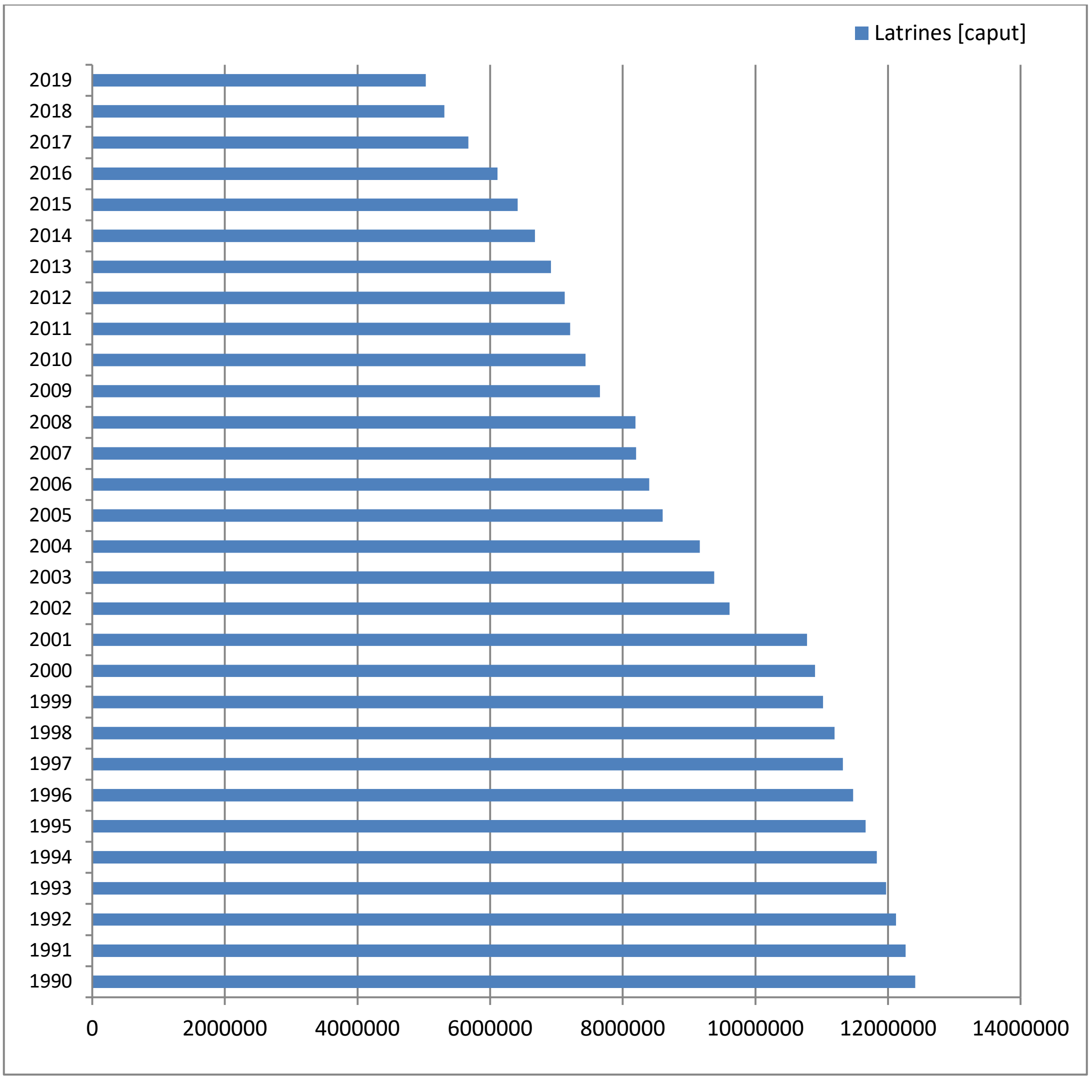

Figure 6.7.3 Activity data trends (*caput*) for NFR 5.D.3
Wastewater handling-Latrines

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

Year/Pollutant	NH_3 (kt)
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	9.077
2018	8.494
2019	

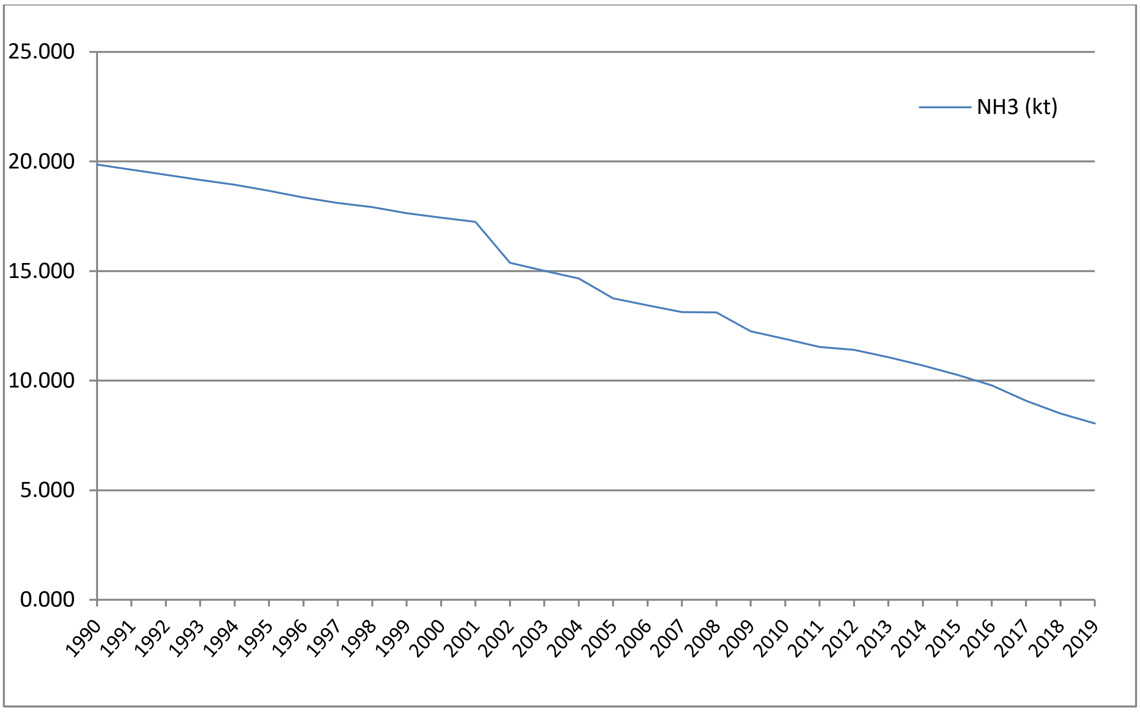

Figure 6.7.4 Emission trends (*kt for NH_3*) for NFR 5.D.3
Wastewater handling-Latrines

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:

- For the NFR 5.D.3. Wastewater handling- Latrines for SNAP 091007 - latrines for the years 2016, 2017 and 2018 the NH_3 emissions were recalculated because the country's population was updated by N.I.S.

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
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

Year	Car fire (no. of fire)	House fire (no. of fires)
2015	1744	2402
2016	1955	2976
2017	1998	6914
2018	1964	6911
2019	1575	11814

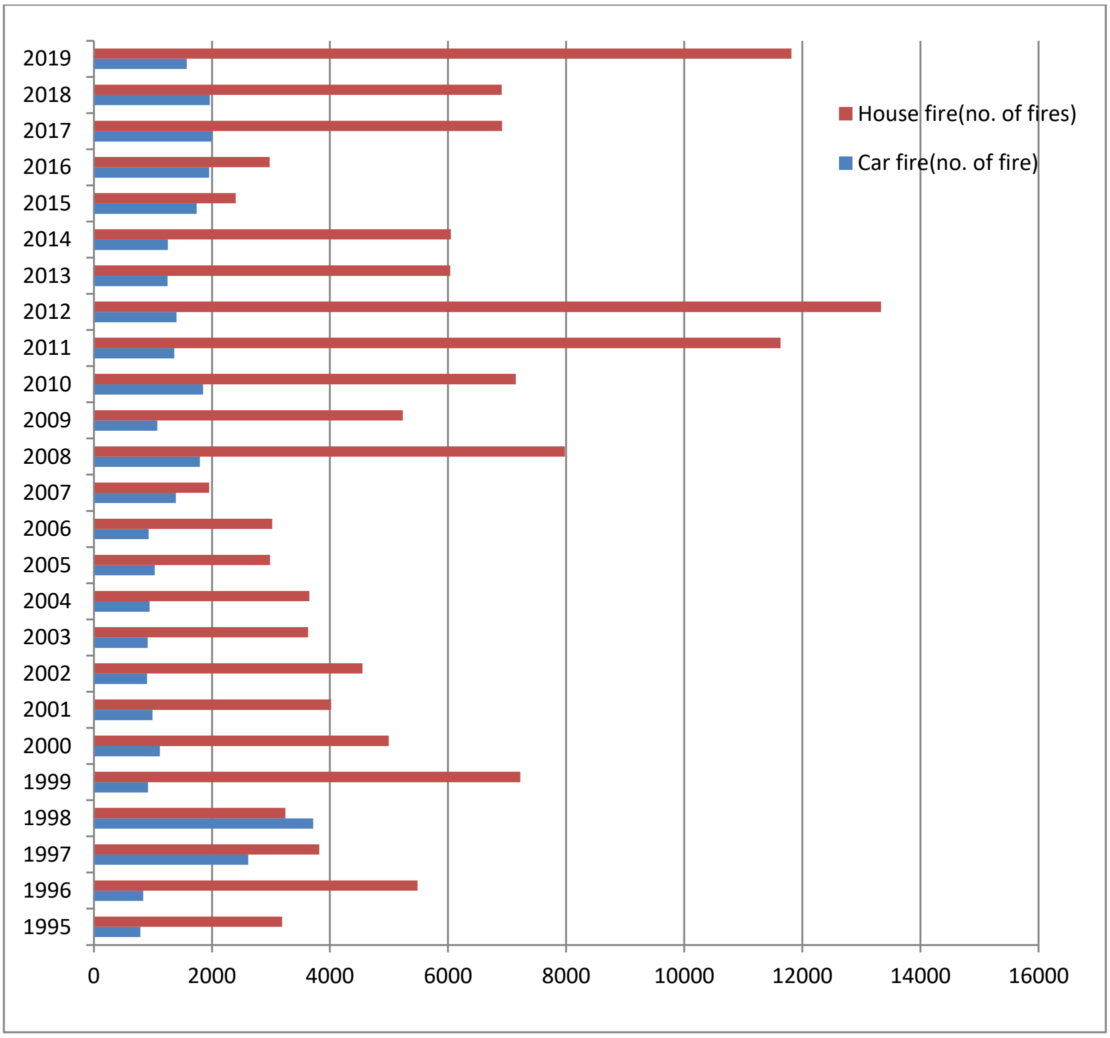

Figure 6.8.1 Activity data trends (*no. of fire*) for NFR 5.E. Other waste(car fire and house fire)

Table 6.8.2 Emission trends for NFR 5.E. Other waste(car fire and house fire)

Year/Pollutant	$PM_{2.5}$ [kt]	TSP [kt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr[t]	Cu [t]	PCDD/F (g I-TEQ)
1995	0.2604	0.2604	0.0008	0.0015	0.0015	0.0024	0.0023	0.0054	2.6276
1996	0.4463	0.4463	0.0013	0.0026	0.0026	0.0042	0.0040	0.0092	4.4903
1997	0.3153	0.3153	0.0009	0.0018	0.0018	0.0029	0.0028	0.0064	3.2227
1998	0.2716	0.2716	0.0008	0.0016	0.0016	0.0025	0.0024	0.0055	2.8129
1999	0.5878	0.5878	0.0017	0.0035	0.0035	0.0055	0.0052	0.0122	5.9087
2000	0.4074	0.4074	0.0012	0.0024	0.0024	0.0038	0.0036	0.0084	4.1077
2001	0.3278	0.3278	0.0010	0.0019	0.0019	0.0031	0.0029	0.0068	3.3079

Year/Pollutant	$PM_{2.5}$ [kt]	TSP [kt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr[t]	Cu [t]	PCDD/F (g I-TEQ)
2002	0.3710	0.3710	0.0011	0.0022	0.0022	0.0035	0.0033	0.0077	3.7376
2003	0.2964	0.2964	0.0009	0.0017	0.0017	0.0028	0.0026	0.0061	2.9907
2004	0.2980	0.2980	0.0009	0.0017	0.0017	0.0028	0.0026	0.0062	3.0077
2005	0.2440	0.2440	0.0007	0.0014	0.0014	0.0023	0.0022	0.0050	2.4688
2006	0.2469	0.2469	0.0007	0.0014	0.0014	0.0023	0.0022	0.0051	2.4957
2007	0.1614	0.1614	0.0005	0.0009	0.0009	0.0015	0.0014	0.0033	1.6511
2008	0.6505	0.6505	0.0019	0.0038	0.0038	0.0061	0.0058	0.0134	6.5587
2009	0.4268	0.4268	0.0012	0.0025	0.0025	0.0040	0.0038	0.0088	4.3003
2010	0.5837	0.5837	0.0017	0.0034	0.0034	0.0054	0.0052	0.0121	5.8916
2011	0.9460	0.9460	0.0028	0.0056	0.0056	0.0088	0.0084	0.0196	9.5067
2012	1.0839	1.0839	0.0032	0.0064	0.0064	0.0101	0.0097	0.0225	10.8890
2013	0.4920	0.4920	0.0014	0.0029	0.0029	0.0046	0.0044	0.0102	4.9578
2014	0.4930	0.4930	0.0014	0.0029	0.0029	0.0046	0.0044	0.0102	4.9680
2015	0.1987	0.1987	0.0006	0.0012	0.0012	0.0018	0.0017	0.0040	2.0332
2016	0.2457	0.2457	0.0007	0.0014	0.0014	0.0023	0.0022	0.0050	2.5092
2017	0.5650	0.5650	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
2019	0.9611	0.9611	0.0028	0.0057	0.0057	0.0090	0.0086	0.0199	9.6638

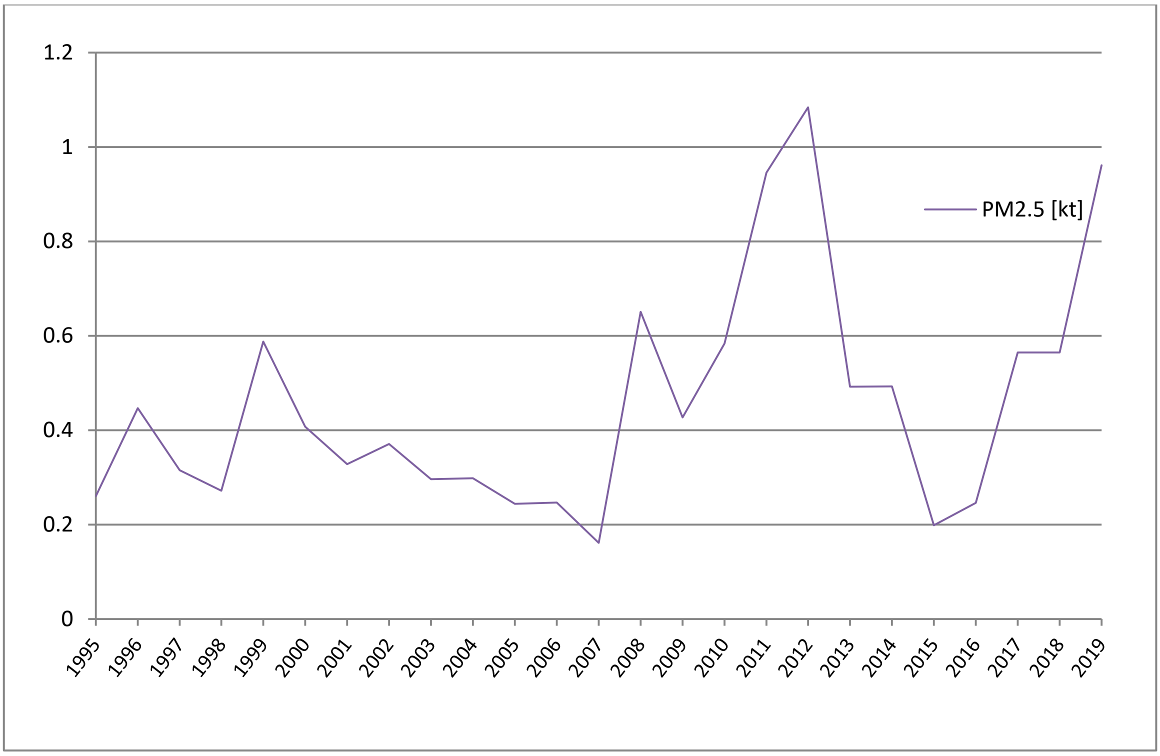

Figure 6.8.2 Emission trends (*kt for $PM_{2.5}$*) for NFR 5.E. Other waste(car fire and house fire)

Emission trends for $PM_{2.5}$ follow the activity data(car fires&house fires) trend.

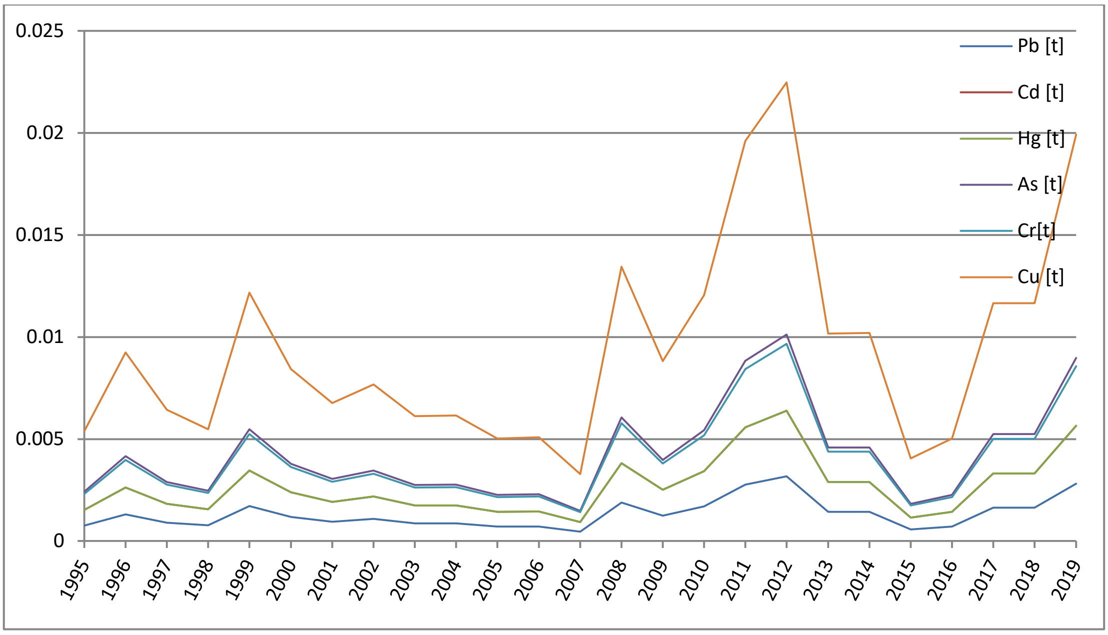

Figure 6.8.3 Emission trends (*t for heavy metals)* for NFR 5.E.
Other waste(car fire and house fire)

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.

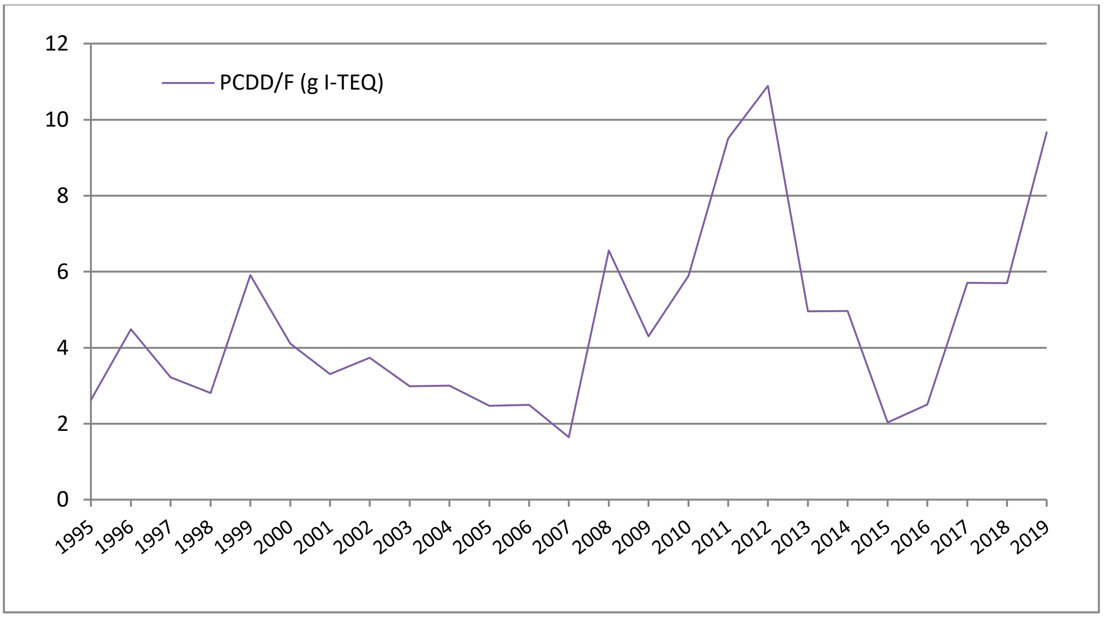

Figure 6.8.4 Emission trends (g I-TEQ for PCDD/F) for NFR 5.E.
Other waste(car fire and house fire)

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.

There were no recalculations and improvements for this category.

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 2017-2020, large part of recommendations from TERT were assessed and implemented.

Significant recalculations and improvements were developed on the following categories:

NFR	Timeseries	Pllutants	Reason
1A2gvii	1992-2018	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO	Upgrade to Tier2 method (Review 2020, Ref. Number RO-1A2gvii-2020-0001).
1A3bi-1A3bvii	2005-2018	All pollutants, except PAH and HCB	Upgrade to Copert 5.4.36; Correction of Sulphur content error in Copert.
1A3c	2018	Benzo(a), benzo(b)	Error correction (the two values were interchanged).
1A3di(i)	2010	SOx	Sulphur content in fuel reviewed (error correction).
1A3di, 1A3dii	1990-2018	PAH added (previously NE); corrected As, Cu and Se	EF changes in the Guidebook.
1A3dii	2006	SOx	S content in fuel error correction.
1A4aii	1992-2018	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO	Upgrade to Tier2 method (Review 2020, Ref. Number, RO-1A4aii-2020-0001).
1A4cii	1992-2018	All pollutants except SOx	Improvement of the calculation method (gasoline split on 2 Stroke/4 stroke technology and diesel split on agriculture/forestry).
1B2aiv	1990-2018	All pollutants in the time series	Improving the calculation method to Tier 2.
1B2av	1990-2011	NMVOC	Recalculation of NMVOC due to the correct application of pollutant reduction efficiency according to the legislation.

2C7a	1990-2008	All pollutants	Improving the calculation method to Tier 2.
2D3f	2005 -2018	NMVOC	Improving the calculation method to Tier 2.
2D3g	1990-2018	AD+pollutants	Improvement: new SNAP 060310 asphalt blowing.
2D3i	2016-2018	AD+NMVOC	Improvement of activity data (statistical NIS population).
3B1a-3B4gii	1990-2018	NH_3, NMVOC, NOx	Recalculation cf. EMEP/EEA Guidebook 2019.
3B2	1994	AD	Correction for number of heads (=10896.573).
3Da1	2013/2016-2018	AD (IFA only)->NH_3	IFA Activity data changed for 2013 and 2016-2018 (data from NIS unchanged). Significant changes (> 2kt NH_3) in 2017 and 2018.
3Da2a	1990-2018	AD+NOx	Correction of activity data (provided by GES).
3Da2a,3Da3	1990-2018	NH_3	Recalculation cf. EMEP/EEA Guidebook 2019.
3Da2a,3Da3	1990-2018	NMVOC	Change notation to IE (according to Review question RO_3Da2a_2020_0001).
3Da2b	1990-2018	NH_3	EF correction, GB2019, EF(NH_3) = 0.006629.
5A	2011-2018	NMVOC	Recalculation of activity data (GES data for CH_4 estimation).
5A	1990-2018	TSP, $PM_{2.5}$, PM_{10}	Change of activity data (from CH_4 only to CH4/waste deposit on land).
5B1	2007	NH_3	Typing error correction for NH_3.
5B2	1990-2018	PAHs	Recalculation (Guidebook 2019 update).
5C1bi	1992-2018	AD+pollutants	AD and emissions recalculation (Tier1 for 1992-2007, Tier2 for 2008-2018).
5D3	2016-2018	AD+ NH_3	AD recalculation for latrines (NIS population number improvement).

8.2. Planned improvements

Improvements, for the next submission, will include:

- studying the possibility of obtaining activity data for historical time series for the calculation of pollutant emissions using the Tier 2 methodology for solvents sector;
- the estimation for NFR 3B4gii - broilers, key source for NMVOC emissions in 2019, with Tier 2 approach;
- studying for introducing and applying country-specific data for all pollutants as much as possible for a real estimation of emissions for agriculture sector.

The improvements planned in the future by the Commission contract on “Capacity building for Member States regarding the development of national emission inventories”:

- Uncertainty estimations;
- Recommendations for improvement of IIR;
- Solvent activity data - default data or method to solve the inconsistencies for the 1990-2007 period;
- Waste sector activity data - help needed with making the time series consistent despite a lack of activity data for historical time series.

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 2020 and the comments of Romania on the recommendations are presented below:

Comments of Romania on recommendations from the NECD Review Report

All recommendations, revised estimates, technical corrections and unquantified potential technical corrections including those additionally made during the NECD Review 2020 and those not implemented from previous reviews, for NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-1B2aiv-2020-0001	Yes	1B2aiv Fugitive Emissions Oil: Refining / Storage, NMVOC, NH_3, 1990-2018	N/A	TC	Yes

Recommendation

For 1B2aiv Fugitive Emissions Oil: Refining / Storage, for SO_2 in all years in response to a question raised during the review, Romania explained that the relevant operators were contacted in order to obtain the necessary data for improving the estimation. Romania informs that the activity data were currently available only for the time series 2015-2018. For the years 2005, 2010 data were not available, so Romania has contacted the economic operators in order to obtain activity data from their archives. Details about the progress made in this regard will be included in the next submission. Romania provided revised estimates for years 2015-2018 and stated that it will be included in the next submission. The TERT agreed with the calculations provided by Romania for all pollutants NO_X, SO_2 and $PM_{2.5}$. The TERT notes that the Tier 2 EFs for CO, NMVOC and NH_3 in the Revised Estimate do not correspond the values in Table 3-2 in the 2019 EMEP/EEA Guidebook as stated in the calculations provided by Romania, and no further reference or description of the EFs are included in the answer by Romania. Therefore, the TERT cannot agree with the Revised Estimate for the pollutants CO, NMVOC and NH_3. The TERT decided to calculate a technical correction for the years 2015-2018 for NMVOC and NH_3 which was not accepted by Romania. The Technical Correction is based on Romania's Revised Estimate for NO_X, SO_2 and $PM_{2.5}$, and the TERT's calculations for NMVOC and NH_3 based on the EFs from Table 3-2 in the 2019 EMEP/EEA Guidebook. The estimates demonstrate that the issue is above the threshold of significance for SO_2 in 2018.

The TERT recommends that Romania include a revised estimate in its next submission. Further, Revised Estimates for the years 1990-2014 should be included to ensure time series consistency.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-1A2gvii-2020-0001	Yes	1A2gvii Mobile Combustion in Manufacturing Industries and Construction, NO_X, NMVOC, 2018	N/A	RE	Yes

Recommendation

For category 1A2gvii Mobile Combustion in Manufacturing Industries and Construction, for NO_X and NMVOC emissions the TERT noted that a Tier 1 method is used for a key category. This was raised during 2019 NECD review. In response to a question raised during the review, Romania explained that efforts will be made to calculate NO_X and NMVOC emissions using Tier 2 emission factors for off-road machinery, 1.A.2.g.vii, NRMM chapter, 2019 EMEP/EEA Guidebook and the fuel consumption data from EUROSTAT. Romania provided revised estimates for years 2005, 2010, 2015-2018 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 2021 NFR and IIR submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-1A4aii-2020-0001	Yes	1A4aii Commercial/Institutional: Mobile, NMVOC, 2018	N/A	RE	Yes

Recommendation

For category 1A4aii Commercial/Institutional: Mobile, for NMVOC emissions the TERT noted that a Tier 1 method is used for a key category. In response to a question raised during the review, Romania explained that an effort will be made to calculate NMVOC emissions using Tier 2 emission factors for off-road machinery, 1.A.4.aii, 2019 EMEP/EEA Guidebook, chapter “Non road mobile machinery” (NRMM) and the fuel consumption data from EUROSTAT. Romania provided revised estimates for years 2005, 2010, 2015, 2016, 2017 and 2018. The TERT agreed with the revised estimate provided by Romania.

The TERT recommends that Romania include the revised estimate in its 2021 NFR and IIR submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-1B2av-2020-0001	No	1B2av Distribution of Oil Products, NMVOC, 1990-2001	N/A	RE	No

Recommendation

For category 1B2av Distribution of Oil Products, pollutant NMVOC, years 1990-2011 the TERT noted that Romania estimates emissions from oil distribution using the 2019 EMEP/EEA Guidebook Tier 2 EFs (Chapter 1B2av, Table 3-8, 3-9, 3-10 and 3-11). Romania apply the abatement efficiencies given in the 2019 EMEP/EEA Guidebook (Chapter 1B2av, Table 3-14 and 3-15). In the IIR Romania informs that “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”. The TERT notes that Stage I and Stage II abatement efficiencies have been applied for all years, and not only for the years after the respective government decisions. In response to a question raised during the review, Romania acknowledged the issue raised by the TERT. Romania provided a revised estimate for years 2005, 2010, 2015, 2016, 2017 and 2018 with the years 2005 and 2010 updated to take into account the phase in of abatement between 2001 and 2012 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 2021 NFR and IIR submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	RO-2D3f-2019-0001	Yes	2D3f Dry Cleaning, NMVOC, 1990-2018	No	RE	Yes

Assessment of the implementation of the initial recommendation

For category 2D3f Dry Cleaning, for NMVOC emissions, for the entire time series, the TERT noted that Tier 1 is used for a key category. This was raised during the 2019 NECD review. In response to a question raised during the 2020 review, Romania explained that they do not have the right AD to apply a Tier 2 method. However, Romania provided revised estimates for 2005, 2010, 2015-18, based on PER consumption and assuming that closed-circuit equipment is the main type of machines currently used for dry cleaning in Romania. The TERT commends Romania for providing revised estimates, references and assumptions and notes the efforts undertaken by Romania to move to a higher Tier than using an EF based on the population. The TERT agreed with the revised estimate provided by Romania.

The TERT recommends that Romania include the revised estimate in its 2021 NFR and IIR submission. The TERT also recommends that Romania investigate whether the assumption of closed-circuit machines is valid for the entire time series.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2017 (4)	RO-2D3a-2017-0001	Yes	2D3a Domestic Solvent Use Including Fungicides, NMVOC, 1990-2017	UPTC	No	Yes

Assessment of the implementation of the initial recommendation

For category 2D3a Domestic Solvent Use Including Fungicides, for NMVOC emissions, for the years 1990-2017, the TERT noted, with reference to Romania 2020 NFR Tables and IIR, section 4.18, that a Tier 1 method and EF (1.2 kg/capita) is still used for a key category. This was raised during the 2017, 2018 and 2019 NECD reviews. The TERT noted that the issue is below the threshold of significance for a technical correction. The 2020 review noted that the IIR states that the issue has been included in the list of improvements and that the recommendation will be addressed in the 2021 submission.

The TERT commends Romania for its applied Tier 2 for 2018 and reiterates the recommendation that Romania implements the Tier 2 method for the other years in its 2021 NFR and improves the description of the methodology used in its 2021 IIR.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-2D3d-2020-0001	Yes	2D3d Coating Applications, NMVOC, 2008-2017	N/A	No	No

Recommendation

For the key category 2D3d Coating Applications for the pollutants NMVOC and years 2008-2017. Regarding Romania 2020 IIR, section 4.21, recalculations are justified by using solvent consumption as activity data as well as NMVOC emissions from economic operators for years 2008-2018. The TERT noted that these recalculations introduce a time series inconsistency between the years before 2008 and after: NMVOC emissions are higher by a factor 2 to 3 after 2008. In response to a question raised during the review Romania stated that they will start an analysis of the possibility of collecting and estimating data for SNAP 060106 "Boat building" and SNAP 060107 "Wood" for time series 1990-2007, and that they will also try to contact the economic operators to obtain data for to be added at SNAP 060101 "Manufacture of automobiles" and SNAP 060108 "Other industrial paint application" to ensure consistent series, and stated that information on the progress will be included in the 2021 IIR. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Romania continues working on making the timeseries consistent and estimates complete for all years for NMVOC for its 2021 NFR and to included details of the methodology changes in its 2021 IIR.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	RO-2D3g-2019-0001	No	2D3g Chemical Products, NMVOC, 1990-2007	No	No	No

Assessment of the implementation of the initial recommendation

The TERT notes that Romania does not estimate NMVOC emissions for 2D3g Chemical Products; SNAP 060306 and 060313 for the years before 2008, in response to a question raised during the review, Romania explained that they will start an analysis of the possibility of collecting and estimating data for SNAP 060306 (Pharmaceutical products manufacturing) and SNAP 060313 (Leather tanning) to ensure consistent series before 2008 year and present this improvement in the next submission. Considering the file provided by Romania during the 2020 review (NMVOC emissions by SNAP for 2005-2018), the TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Romania move forward on estimating NMVOC for 060306 and 060313 for 1990-2007 and include clear explanation of the methodology used in the IIR for the next submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-2D3i-2020-0001	Yes	2D3i Other Solvent Use, NMVOC, 2008-2017	N/A	No	No

Recommendation

For the key category 2D3i Other Solvent Use, for the pollutant NMVOC and years 2008-2017, the TERT noted a time series inconsistency between the years before 2008 and after: NMVOC emissions are higher by 27% after 2008, which is due to recalculation between the 2019 and the 2020 submission. These recalculations were justified by Romania by the first estimates of NMVOC emissions for SNAP 060404 (fat, edible and non-edible oil extraction), SNAP 060405 (application of glues and adhesives), SNAP 060406 (preservation of wood), and then recalculated emission for the years 2008-2018. In response to a question raised during the review, Romania answered that they will start, in 2020, an analysis of the possibility of collecting and estimating data for SNAPs 060404, 060405, 060406 to ensure consistency before 2008. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Romania collects data for the years 1990-2007 and implement the calculations in its 2021 NFR and describes the methodology changes in its 2021 IIR.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-3Da2a-2020-0001	No	3Da2a Animal Manure Applied to Soils, NMVOC, 1990-2018	N/A	No	No

Recommendation

The TERT noted that there is a lack of transparency regarding emissions of 3Da2a Animal Manure Applied to Soils and 3Da3 Urine and Dung Deposited by Grazing Animals, where notation key 'NA' is used for NMVOC emission for all years 1990-2018. The TERT notes that either notation 'IE' should be used (where emissions are included in 3B), or the NMVOC could be split in 3B and 3Da2a (animal manure applied) and 3Da3 (pasture). This does not have an impact on total emissions that is above the threshold of significance. In response to a question raised during the review Romania confirm that it would correct the notation key for NMVOC emissions for 3D for the next submission.

The TERT recommend that Romania consider splitting the NMVOC emission into 3B and 3D (3Da2a, 3Da3) for its 2021 submission if possible and if not to make correct use of the notation keys as explained above.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-5A-2020-0001	No	5A Biological Treatment of Waste - Solid Waste Disposal on Land, $PM_{2.5}$, 1990-2018	N/A	No	No

Recommendation

For $PM_{2.5}$ emissions from 5A Biological Treatment of Waste - Solid Waste Disposal on Land, the TERT noted that there is an under-estimate of emissions as the activity data (AD) used to estimate both NMVOC and $PM_{2.5}$, is “CH4 emissions from deposition of MSW at the SWDS”. The AD required for the estimate of $PM_{2.5}$ is the total amount of waste handled, including mineral waste handled (construction and demolition, ash etc.). In response to a question raised during the review Romania agreed and explained that it will conduct additional investigations about the activity data. The TERT noted that the issue is far below the threshold of significance for a technical correction.

The TERT recommends that Romania estimate $PM_{2.5}$ emissions from 5A using the total amount of waste handled as AD.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-5B2-2020-0001	No	5B2 Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities, NH_3, 1990-2018	N/A	No	No

Recommendation

For NH_3 emissions from 5B2 Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities, the TERT noted there is an under-estimate because emissions are not estimated despite the occurrence of activity in Romania and an EF provided in the 2016 EMEP/EEA GB. In response to a question raised during the review Romania agreed and explained that there is no information to assess the activity data and further research are required to obtain activity data. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Romania investigate further (for instance using a survey among biogas facility operators) and include an estimate of NH_3 emissions from 5B2 in the 2021 submission.

All recommendations, revised estimates, technical corrections and unquantified potential technical corrections including those additionally made during the NECD Review 2020 and those not implemented from previous reviews, for heavy metals and POPs

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	RO-5C1bi-2018-0001	No	5C1bi Industrial Waste Incineration, PCDD/F, HCB, 1990-2016	No	TC	No

Assessment of the implementation of the initial recommendation

For 55C1bi Industrial Waste Incineration, the TERT noted that Romania did not estimate emissions and reported "NE" for years 1990-2004. The TERT also noted that hazardous waste (NFR 5C1bi) and clinical waste incineration (5C1biii) are reported together in this NFR category, that there are very important annual fluctuations of the amount of waste incinerated (not justified in the IIR) and that AD are different from AD used for the GHG emissions estimates. The observation was already raised in 2018 and 2019. The TERT noted that in response to a question raised during the review, Romania provided a revised estimate. The TERT commends Romania for this very transparent RE which constitute a real improvement. However, the TERT disagreed with some methodological aspect, especially Romania use of a Tier 1 for the beginning of the time series and a Tier 2 for the end for hospital waste. This approach results in an inconsistency of the time series. The TERT decided to calculate a technical correction, using a Tier 2 for the complete time series. 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.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	RO-2C7a-2019-0001	Yes	2C7a Copper Production, PCBs, Cd, Hg, Pb, PCDD/F, 2005	No	RE	No

Assessment of the implementation of the initial recommendation

For category 2C7a Copper Production, for Cd emissions, for the year 2005, the TERT noted that Tier 1 is used for a key category. This was raised during 2019 NECD review. In response to a question raised during the review, Romania explained that they estimated separate figures for primary and secondary copper production. Romania provided revised estimates for all years 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 2021 NFR and IIR submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	RO-2D3g-2018-0001	No	2D3g Chemical Products, PAHs, 2005, 2016	No	RE	No

Assessment of the implementation of the initial recommendation

For category 2D3g Chemical Products, for asphalt blowing, for PAHs, for the entire time series, the TERT notes with reference to the Romania 2020 NFR Tables and IIR, that the observation RO-2D3g-2018-0001 has not been implemented yet. PAHs emissions are still reported as 'NE' in the 2020 NFR Tables. This was raised during 2018 and 2019 NECD reviews. In response to a question raised during the 2020 review, Romania provided revised estimates for all years using a Tier 2 EF provided in the 2019 EMEP/EEA Guidebook for asphalt blowing 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 2021 NFR and IIR submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-0A-2020-0001	No	0A National Total - National Total for the Entire Territory - Based on Fuel Sold/Fuel Used, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, PM_{10}, CO, BC, 1990 - 2018	N/A	No	No

Recommendation

The TERT noted that no information on uncertainty was provided for NECD pollutants. Romania indicated that uncertainties were not calculated within this year submission but that it plans to include uncertainty analysis as soon as all the data needed are available.

The TERT recommends that Romania starts to compile estimates of uncertainty for the main pollutants for its next submission and develops a programme to compile uncertainties for all pollutants over the coming years that will facilitate the gathering of suitable information.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	RO-1A4ai-2020-0001	No	1A4ai Commercial/Institutional: Stationary, Cd, HCB, 2017, 2018	N/A	No	No

Recommendation

For 1A4ai Commercial/institutional: Stationary, for Cd and HCB, in years 2017 and 2018 the TERT noted that there is a lack of transparency regarding the time series, which shows an annual change greater than a factor of 10 between 2017 and 2018. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Romania explained that the increase of emissions is due to an increase of the biomass consumption, which again is due to change of allocation of certain values in the statistics. From 2018, the Solid Biofuel, which in previous years was allocated to “Other sectors / Not elsewhere specified”, has been allocated to “Other sectors / Commercial and public services” in the Romanian Energy statics. This change explains the increase of emissions for NFR 1A4ai and the decrease of emissions and biomass for NFR 1A5a.

The TERT recommends that Romania use a consistent methodology for the entire time series, where the biomass consumption is allocated to the same category for all years. The TERT agree with Romania’s approach to discuss this with the National Institute of Statistics whether the reallocation of Solid Biofuel in the EUROSTAT ENERGY Questionnaires will be made for the entire time series.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	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, 1990-2018	No	No	No

Assessment of the implementation of the initial recommendation

The TERT noted that there is a lack of transparency regarding emission calculation of 3F Field Burning of Agricultural Residues. The TERT notes with reference to IIR Table 5.16.2 that the total dry matter off burned crop residue 2018 is estimated to 2931 kt dm, however, the emission for all pollutants registered in NFR submission 2020 seems too low for an AD at 2,931 kt dm. In response to a question raised during the review Romania explained that they observed an error in the Table 5.15.1 (area burned), registered area with Barley was switched with maize area for the period 1990-1994 and 2017-2018, which result in a wrong amount of dry matter in Table 5.16.2. Romania attached an Excel sheet showing the variables and calculation for the Tier2 calculation, and the TERT confirm that the calculation is correct and in accordance with the emission registered in NFR 3F for all pollutants. This does not relate to an over- or under-estimate of emissions.

The TERT recommends that Romania correct the Tables in IIR showing the area of land with crop residues burned and the amount of dry matter (ARresidue_burnt) in the next submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	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	No

Assessment of the implementation of the initial recommendation

For all relevant emissions from 5Cbii Hazardous Waste Incineration, the TERT noted that there is a lack of transparency because all emissions are reported as 'not applicable' whereas default EFs are proposed in the 2016 EMEP/EEA GB. This does not relate to an over- or under-estimate of emissions. This was raised during the 2019 NECD review. In response to a question raised during the review, Romania explained that emissions are reported under 5Cbi and stated that “IE” will be reported in the 2021 submission.

The TERT recommends that Romania report “IE” and to explain in which category emissions are reported in the IIR.

9. ADJUSTMENTS

No adjustments

I.I.R. REFERENCES

- EIONET CDR – CLRTAP Emission Inventories of ROMANIA
- 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.

ANEXA A, 3B - Manure Management calculations

Tabel 1. Default Tier 2 **NH_3**-N EFs and associated parameters for the Tier 2 methodology

Livestock class	Dairy cows (100901)	Other cattle (100902)	Fattening pigs (100903)	Sows (100904)	Sheep (100905)	Laying hens (100907)
Animal Weight	**650**	**481**	**110**	**125**	**60**	**1.9**
Nex (kg/yr)	83.038	61.448	22.083	20.988	19.710	0.569
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 NH_3 house, slurry	0.24	0.24	0.27	0.35	0	0.41
EF NH_3 house, solid	0.08	0.08	0.23	0.24	0.22	0.2
EF NH_3 yard	0.3	0.53	0.53	0	0.75	0
EF NH_3 storage, slurry	0.25	0.25	0.141	0.11	0	0.14
EF NH_3 storage, solid	0.32	0.32	0.29	0.29	0.28	0.08
EF N_2O storage, slurry	0	0	0	0	0	0
EF N_2O 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 N_2 storage, slurry	0.003	0.003	0.003	0.003	0.003	0.003
EF N_2 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 NH_3 application, slurry	0.55	0.55	0.4	0.29	0	0.69
EF NH_3 application, solid	0.68	0.68	0.45	0.45	0.9	0.45
EF NH_3 grazing	0.14	0.14	0	0.31	0.09	0

Table 2. Emission Factors for calculation **NH_3** emissions from Manure Management

Livestock class	Methods	Total EF NH_3	Housing, storage and yards	Manure application (3Da2a)	Grazed pastures (3Da3)
Dairy cows (100901) (1990-2013)	T2	18.066	8.861	6.480	2.724
Dairy cows (100901) (2014-2018)	T2	20.673	10.263	7.686	2.724
Non-dairy cattle (100902) (1990-2013)	T2	11.549	4.754	4.774	2.021
Non-dairy cattle (100902) (2014-2018)	T2	12.734	5.762	4.951	2.021
Buffalo (100914)	T1	9.2	4.3	0.9	4
Sheep (100905)	T2	1.490	0.401	0.282	0.807
Goats (100910)	T1	1.4	0.4	0.2	0.8
Horses&comp (100906)	T1	15.8	7.0	2.7	6.1
Fattening pigs (100903) (1990-2013)	T2	6.221	3.707	2.514	0.000
Fattening pigs (100903) (2014-2018)	T2	6.473	3.784	2.689	0.000
Sows (100904) (1990-2013)	T2	17.473	11.482	5.991	0.000
Sows (100904) (2014-2018)	T2	18.302	12.427	5.876	0.000
Layers (100907)	T2	0.292	0.130	0.162	0.000
Broilers (100908)	T1	0.17	0.13	0.04	0.00

The values obtained using Tier 2 methodology are based on the Excel spreadsheet "Manure management N - Flow Tool" that contains the values from Table 3.7 – length of housing period, 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, 2019 EMEP/EEA Guidebook). The average weights used in the Excel spreadsheet were provided by GHG (Romanian Greenhouse Gas).
The livestock with Tier 2 approach has been estimate for two period: 1990-2013 and 2014-2019, considering different proportion slurry/FYM, as mentioned in Capter 3B Manure Management of this document.
The values for Tier 1 methodology are based on Table 3.2 and Table 3.3 (3B – Manure Management, 2019 EMEP/EEA Guidebook).

Table 3. Equations for **NMVOC** calculation Dairy cattle (3B1a), Non-dairy catttle (3B1b), Laying hens (3B4gi) - Tier2, GB2019

Years with different slurry/FYM %	NFR	Xhouse %	$Frac_{silage\ \%}$	$Frac_{silage\_store\ \%}$	$EF_{NMVOCsilage\_feeding}$	$EF_{NMVOC,\ building}$	$EF_{NMVOC,,\ graz}$	E NH_3 storage, slurry	E NH_3 storage, solid	E NH_3 application, slurry	E NH_3 application, solid	E NH_3 house, slurry	E NH_3 house, solid
1990-2013	**3B1a**	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	3.0477	1.2871	4.9543	3.6923	0.1208	1.8232
	3B1b	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	0.7238	2.2058	1.1767	6.3279	0.1431	1.5419
2014-2019	**3B1a**	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	4.3869	0.9288	7.1313	2.6646	1.2083	1.3157
	3B1b	0.493151	0.5	0.25	0.0002	3.53E-05	6.9E-06	1.8326	1.5918	2.9790	4.5665	1.4306	1.1127
Data Sources			*3.B Manure Management, p.29, GB2019*		*Tabel 3.11. Default NMVOC Tier 2 EFs for dairy cattle and other cattle*			*3B NH_3 Manure Management N-flow, Tier 2, 2019 EMEP/EEA Guidebook*					
1990-2019	**3B4gi**	1	0	0.25	0	0.005684	0	0.015467824		0.139906468		0.0966739	
Data Sources			*3.B Manure Management, p.29, GB2019*		*Tabel 3.11. Default NMVOC Tier 2 EFs for laying hens*			*3B NH_3 Manure Management N-flow, Tier 2, 2019 EMEP/EEA Guidebook*					

Table 4. Emissions factors for **NMVOC** calculation 3B1a – Dairy cattle - Tier2, GB2019

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	$E_{NMVOC,}$ total applicated
	MJ/head/day	**MJ/head/yr**							**kg /yr/head**						
1990	233.418	85197.72	1.483	0.591	1.608	0.298	1.05143	4.20573	1.48314	3.30707	6.59661	0.29796	**11.6848**	**16.9419**	**12.2105**
1991	243.447	88858.03	1.547	0.617	1.677	0.311	1.09661	4.38642	1.54686	3.44915	6.88002	0.31076	**12.1868**	**17.6698**	**12.7351**
1992	250.808	91545.03	1.594	0.635	1.727	0.32	1.12977	4.51906	1.59364	3.55345	7.08807	0.32016	**12.5553**	**18.2041**	**13.1202**
1993	255.28	93177.24	1.622	0.647	1.758	0.326	1.14991	4.59964	1.62205	3.61680	7.21444	0.32587	**12.7792**	**18.5287**	**13.3541**
1994	265.549	96925.36	1.687	0.673	1.829	0.339	1.19617	4.78466	1.68730	3.76229	7.50465	0.33897	**13.2932**	**19.2740**	**13.8913**
1995	269.602	98404.65	1.713	0.683	1.857	0.344	1.21442	4.85768	1.71305	3.81971	7.61918	0.34415	**13.4961**	**19.5682**	**14.1033**
1996	271.771	99196.24	1.727	0.688	1.872	0.347	1.22419	4.89676	1.72683	3.85044	7.68048	0.34692	**13.6047**	**19.7256**	**14.2168**
1997	275.026	100384.47	1.748	0.697	1.894	0.351	1.23885	4.95542	1.74751	3.89656	7.77248	0.35107	**13.7676**	**19.9619**	**14.3870**
1998	274.749	100283.48	1.746	0.696	1.892	0.351	1.23761	4.95043	1.74576	3.89264	7.76466	0.35072	**13.7538**	**19.9418**	**14.3726**
1999	274.495	100190.59	1.744	0.695	1.891	0.35	1.23646	4.94585	1.74414	3.88903	7.75747	0.35039	**13.7410**	**19.9233**	**14.3593**
2000	278.12	101513.76	1.767	0.704	1.916	0.355	1.25279	5.01116	1.76717	3.94040	7.85991	0.35502	**13.9225**	**20.1865**	**14.5489**
2001	282.701	103185.92	1.796	0.716	1.947	0.361	1.27343	5.09371	1.79628	4.00530	7.98938	0.36087	**14.1518**	**20.5190**	**14.7886**
2002	283.312	103408.76	1.8	0.718	1.951	0.362	1.27618	5.10471	1.80016	4.01395	8.00664	0.36165	**14.1824**	**20.5633**	**14.8205**
2003	286.684	104639.52	1.822	0.726	1.975	0.366	1.29137	5.16547	1.82159	4.06173	8.10193	0.36595	**14.3512**	**20.8080**	**14.9969**
2004	291.587	106429.18	1.853	0.739	2.008	0.372	1.31345	5.25381	1.85274	4.13119	8.24050	0.37221	**14.5966**	**21.1639**	**15.2534**
2005	287.975	105110.72	1.83	0.729	1.983	0.368	1.29718	5.18873	1.82979	4.08002	8.13842	0.36760	**14.4158**	**20.9017**	**15.0644**
2006	292.083	106610.28	1.856	0.74	2.012	0.373	1.31569	5.26275	1.85590	4.13822	8.25452	0.37284	**14.6215**	**21.1999**	**15.2793**
2007	290.206	105925.26	1.844	0.735	1.999	0.37	1.30723	5.22894	1.84397	4.11163	8.20148	0.37045	**14.5275**	**21.0637**	**15.1812**
2008	292.619	106806.03	1.859	0.741	2.015	0.374	1.31810	5.27241	1.85930	4.14582	8.26968	0.37353	**14.6483**	**21.2389**	**15.3074**
2009	288.435	105278.67	1.833	0.731	1.987	0.368	1.29925	5.19702	1.83271	4.08653	8.15142	0.36819	**14.4389**	**20.9351**	**15.0885**
2010	294.109	107349.90	1.869	0.745	2.026	0.375	1.32482	5.29926	1.86877	4.16693	8.31179	0.37543	**14.7229**	**21.3470**	**15.3853**
2011	298.767	109050.04	1.898	0.757	2.058	0.381	1.34580	5.38319	1.89837	4.23293	8.44343	0.38138	**14.9561**	**21.6851**	**15.6290**
2012	294.989	107670.92	1.874	0.747	2.032	0.377	1.32878	5.31511	1.87436	4.17939	8.33665	0.37655	**14.7670**	**21.4108**	**15.4313**
2013	295.61	107897.61	1.878	0.749	2.036	0.377	1.33157	5.32630	1.87831	4.18819	8.35420	0.37735	**14.7980**	**21.4559**	**15.4638**

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	$E_{NMVOC,}$ total applicated
2014	297.092	108438.76	1.888	0.83	1.968	0.379	1.33825	5.35301	1.88773	3.97563	7.32630	0.37924	**13.5689**	**20.2602**	**14.2380**
2015	293.894	107271.18	1.867	0.821	1.947	0.375	1.32384	5.29538	1.86740	3.93283	7.24742	0.37516	**13.4228**	**20.0420**	**14.0847**
2016	290.583	106062.85	1.846	0.812	1.925	0.371	1.30893	5.23573	1.84637	3.88853	7.16578	0.37093	**13.2716**	**19.8163**	**13.9261**
2017	290.606	106071.11	1.847	0.812	1.925	0.371	1.30903	5.23613	1.84651	3.88883	7.16634	0.37096	**13.2726**	**19.8178**	**13.9272**
2018	292.179	106645.37	1.857	0.816	1.935	0.373	1.31612	5.26448	1.85651	3.90988	7.20514	0.37297	**13.3445**	**19.9251**	**14.0026**
2019	291.702	106471.15	1.867	0.82	1.945	0.375	1.3139706	5.2558825	1.8534731	3.9034972	7.1933651	0.3723573	**13.3227**	**19.8925**	**13.9797**

Table 5. Equations for **NMVOC** calculation 3B1b – Non-dairy cattle - Tier2, GB2019

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	$E_{NMVOC,total}$ applicated
	MJ/head/day	**MJ/head/yr**							**kg/yr/head**						
1990-2013	193.79	70733.35	1.2313417	2.140908	5.4841335	0.2473729	0.873	3.492	1.231	2.14091	5.48413	0.24737	**9.10376**	**13.46839**	**9.54022**
2014-2019	193.79	70733.35	1.2313417	1.6578861	3.6530844	0.2473729	0.873	3.492	1.231	1.65789	3.65308	0.24737	**6.78969**	**11.15432**	**7.22615**

$E_{NMVOC\_i} = AAP_{animal\_i} \cdot (E_{NMVOC,silage\_store\_i} + E_{NMVOC,silage\_feeding\_i} + E_{NMVOC,building\_i} + E_{NMVOC,store\_i} + E_{NMVOC,appl.\_i} + E_{NMVOC,graz\_i})$

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, GB2019

Year	Volatile excretion,day (VS)	Volatile excretion,year	$E_{NMVOC, sillage\_store}$	$E_{NMVOC, sillage\_feeding}$	$E_{NMVOC, house}$	$E_{NMVOC, manure\_store}$	$E_{NMVOC, appl}$	$E_{NMVOC, graz}$	$E_{NMVOC,total applicated}$
	MJ/head/day	**MJ/head/yr**				**kg/yr/head**			
1990-2019	0.018287	6.6747212	0	0	0.0379391	0.0060703	0.0549055	0	**0.0989149**

$E_{NMVOC,silage\_store\_i} = VS_{\_i} \cdot x_{building\_i} \cdot (EF_{NMVOC,\ silage\ feed\_i} \cdot Frac_{silage}) \cdot Frac_{silage\_store}$

$E_{NMVOC,silage\_feeding\_i} = VS_{\_i} \cdot x_{building\_i} \cdot (EF_{NMVOC,silage\_feeding\_i} \cdot Frac_{silage})$

$E_{NMVOC,house\_i} = VS_{\_i} \cdot x_{building\_i} \cdot (EF_{NMVOC,\ building\_i})$

$E_{NMVOC,manure\_store\_i} = E_{NMVOC,\ building\_i} \cdot (E_{NH3,storage\_i\_} / E_{NH3,\ building\_i})$

$E_{NMVOC,appl.\_i} = E_{NMVOC,\ building\_i} \cdot (E_{NH3appl.\_i} / E_{NH3building\_i})$

$E_{NMVOC,graz\_i} = kg\ VS_{\_i} \cdot (1 - x_{building\_i}) \cdot EF_{NMVOC,graz\_i}$,

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**	**$PM_{2.5}$**	**PM_{10}**	**TSP**	***$PM_{2.5}$***	***PM_{10}***	***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, 2019 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 2019**									
	Livestock	**Dairy cattle**	**Nondairy cattle**	**Sheep**	**Finishing pigs**	**Sows**	**Buffalo**	**Goats**	**Horses**	**Layers**	**Broilers**
	NFR Code	3B1a	3B1b	3B2	3B3	3B3	3B4a	3B4d	3B4e	3B4gi	3B4gii
Slurry	EF (Kg)	0.01	0.003		0.002	0.005					
Solid	EF (Kg)	0.752	0.217	0.012	0.017	0.471	0.083	0.012	0.25	0.014	0.027
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**	0.72974	0.21058	0.012	0.011	0.3312	0.083	0.012	0.25	0.014	0.027
2014-2019	**Ef (Kg) applied**	0.736418	0.212506	0.012	0.0146	0.41508	0.083	0.012	0.25	0.014	0.027