2024

Republic of Türkiye

Ministry of

Environment, Urbanization and Climate Change

General Directorate for Environmental Management

Air Management Department

REPUBLIC OF TÜRKİYE
MINISTRY OF ENVIRONMENT, URBANIZATION AND CLIMATE CHANGE

Türkiye's

Informative Inventory Report

IIR 2024

Submission under the UNECE Convention Long Range Transboundary Air Pollution for 1990-2022

[INFORMATIVE INVENTORY REPORT TÜRKİYE 2024]

MINISTRY OF ENVIRONMENT, URBANIZATION AND CLIMATE CHANGE

GENERAL DIRECTORATE FOR ENVIRONMENTAL MANAGEMENT

ANKARA, 2024

DATA SHEET

Report No.: AMD/MMD Technical Report No. 2024001-1

Title: Annual Türkiye’s Informative Inventory Report to UNECE

Year of publication: 2024

Editing completed: 2024

Contacts:

İrde ÇETİNTÜRK GÜRTEPE; Head of Air Management Department

Ministry of Environment, Urbanization and Climate Change

Tel.:+ 90 312 586 31 52

email: irde.gurtepe@csb.gov.tr

Canan Esin KÖKSAL; Senior Environmental Expert

Ministry of Environment, Urbanization and Climate Change

Tel.:+ 90 312 586 31 55

email: cesin.koksal@csb.gov.tr

Content

FIGURES

TABLES

ABBREVIATIONS

CLRTAP	Convention on Long Range Transboundary Air Pollution
EEA	European Environment Agency
EF	Emissions factor
EMEP	European Monitoring and Evaluation Programme
EU	European Union
EUAS	State Electricity Generating Company
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies (IIASA)
GB	EMEP/EEA Emissions Inventory Guidebook
GDP	Gross Domestic Product
GHG	Green House Gas
HDV	Heavy Duty Vehicle (HGV: Heavy Goods Vehicle)
IE	(Emissions) Included elsewhere
IEA	International Energy Agency
IEC	Improving Emission Control
IIASA	International Institute for Applied Systems Analysis
IIR	Informative Inventory Report
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
IT	Information Technologies
KCA	Key category analysis
LDV	Light-duty vehicle

LTO	Landing and take-off
MoEUCC	Ministry of Environment, Urbanization, and Climate Change
N	Nitrogen
NA	Not Applicable
N_2O	Nitrous oxide
NE	Not estimated
NECD	National Emission Ceilings Directive
NFR	Nomenclature for reporting
NH_3	Ammonia
NMVOCs	Non-methane volatile organic compounds
NO	Not occurring
NOx	Oxides of nitrogen
QA/QC	Quality assurance / quality control
SO_2	Sulphur dioxide
TA	Technical Assistance
TURKSTAT	Turkish Statistical Institute
UA	Uncertainty analysis
VKM	Vehicle-kilometers

Executive Summary

Türkiye has ratified the United Nations Convention on the Long-Range Transboundary Air Pollution (CLRTAP) in 1983 and EMEP Protocol in 1985 thus has to report emission data annually.

As a party to the Convention and EMEP Protocol, National Air Pollutants Emission Inventory has been reported since 2011. Türkiye inventory team thanks to Improving of Emission Control project experts for their valuable efforts during establishment of inventory process.

Inventory Awards-2013 have been conferred in six categories, most comprehensive IIR (Finland), best small country IIR (Croatia and Estonia), most transparent/good looking IIR (Sweden), significant IIR improvements (Poland), most complete reporting in 2013 (Spain) and most improved inventory reporting within the last 3 years (**Türkiye**).

Inventory Awards-2015 have been conferred in six categories, most comprehensive IIR (Denmark and Portugal), good looking IIR (Canada), best small country IIR (Luxembourg), significant IIR improvements (Italy and **Türkiye**), most complete reporting in 2015 (Switzerland) .

By the reporting cycle of Türkiye, the country in-depth reviews were organized in 2012, 2016, 2019 and specifically for PM-condensable which focused on the sectors of residential heating and road transport in 2022. The suggestion from the review reports were noted and planned to be fulfilled systematically and periodically. This is the 12nd IIR for the UNECE CLRTAP air pollutant emission inventory and was prepared under the reporting guidelines.

This year, priory heavy metals (Pb, Cd, Hg) and fine particulate matter pollutants ($PM_{2.5}$) emissions are submitted for selected sectors. Still the inventory for heavy metals is not completed yet. Therefore, KCA for these parameters are not covering all NFR sectors. Step by step the heavy metals inventory will be completed and the KCA for heavy metals will be complete as well.

The trends in the other emissions calculated for the submission on 2023 are highlighted below;

Key category analysis carried out to present major sources of national total for each pollutant. NFR 1A1a "Public Electricity and Heat Production" is the dominant key source for SO_2 and NO_x, "Road Transport- Heavy Duty Vehicles" is the second source of NO_x. All of the key sources for NH_3 are belong to agriculture sector. "NFR 3B1a Manure management: dairy cattle" is the first category for NMVOCs. "2B10a Chemical Industry" is the first sector for the PM_{10} emissions and residential combustion is the second for PM. Residential combustion is also responsible for NMVOC and NO_x emissions as key category.

The emission inventory management task under the Ministry of Environment, Urbanization and Climate Change is developing parallel with the conditions of the knowledge within the air quality and related sectors regarding emission inventory compilation, improvement, data gap filling, data modelling, GIS integration, spatial/temporal distributions and emission abatement together with the projections. In this context, national funded project was finalized in 2016 to establish the web based "national air pollution emission management system". Having the system established, the automatization was secured, and the inventory was improved by the algorithms of the system structure, especially for aviation and road transport. Plant specific data is being collected and archived within "Air Emission Management (HEY) Portal" for the whole country and the plant specific inventory needs to be integrated and completed. The requirements for this improvement are still under progress.

Recently, the HEY Portal is extended including the flow of the solid fuel consumption/distribution in Türkiye and the related modules are active in the Portal. Together with the financing by a national funded project, the operational center in the premises of the Ministry is maintaining the tasks of the modelling, mapping, and emission inventory compilation. The report provides summary information on legal institutional and procedural arrangements in Türkiye. Furthermore, the report describes calculation methods, activity data and selected emission factors. Emission trends and significant emission sources highlighted in relevant chapters.

Chapter 1 includes general information on organizational structure of Ministry of Environment, Urbanization, and Climate Change, institutional arrangements for data flow to the inventory and institutional responsibilities for the inventory planning, preparation, and management. **Chapter 2** provides information on key trends of emissions in sectoral basis and also shares of NFR subcategories in air pollutants are presented as tables. **Chapter 3-9** involves emission trends, emission factors, calculation methods and emissions in NFR sectors energy, industry, product use, agriculture, waste respectively. **Chapter 10** includes improvement plans for the inventory.

This report was prepared by Air Management Department under the General Directorate for Environmental Management on the behalf of MoEUCC.

By the close support of the Head of Air Management Department Mrs. İrde ÇETİNTÜRK GÜRTEPE, following the requirements and checking the template together with the calculations and methodology under the Division of Modelling and Mapping together with the Operational Center on Modelling and Mapping specific responsibilities for the preparation IIR 2024 have been as follows:

∗ Energy Sector:	Canan Esin KÖKSAL
∗ Transportation Sector:	İsmail Tarık ŞENKAL
∗ Industry-Solvent Use Sector:	Ümmühan DEMİREZEN
	İsmail Tarık ŞENKAL
∗ Agriculture Sector:	İsmail Tarık ŞENKAL
∗ Waste Sector:	İsmail Tarık ŞENKAL

1 INTRODUCTION

1.1 National Inventory Background

The central governmental environmental structure in Türkiye is the MoEUCC. The main responsibilities of the Ministry relate to the development of environmental strategy, policies and legislation concerning:

- protection and improvement of the environment,
- prevention and monitoring of environmental pollution,
- bringing in sustainable development principles, clean production, use of renewable resources,
- permitting, licensing, auditing, monitoring of all kinds of activities in case there might be environmental impacts,

MoEUCC is also responsible for enforcing legislative tools it developed and for providing coordination among stakeholders in environmental issues.

MoEUCC organisation includes eight General Directorates and several Departments in coordination of the Undersecretary who is directly subordinated by the Minister. The organization structure is presented in Ministry website www.csb.gov.tr

DG Environmental Management, which directly involves into preparation of this report through the Air Management Department, comprises seven Departments:

- Water and Soil Management Department
- Zero Waste Applications Department
- Circular Economy and Waste Management Department
- Air Management Department
- Chemicals Management Department
- Marine and Coastal Management Department

- Administrative Affairs and Finance Department

Explicitly, the Air Management Department retains the following main responsibilities:

- To prepare national emission inventory for air pollutants,
- To determine emission ceilings,
- To prepare emission projections,
- To prepare air quality maps,
- To transpose and coordinate the implementation of all air related Directives,
- To give opinion regarding the legislation for air pollution.

By the way MoEUCC enacted the By-Law on Control of Air Pollution Caused by Industry Facilities (03.07.2009 O.J. 27277) amending the By-Law on Control of Air Pollution from Industrial Plants (BCAPIP) published in O.J.26236, dated on 22.07.2006, amended by 10/10/2011 and 28080, setting facilities classification according to their capacities, and the related permitting competencies shared between Ministry of Environment, Urbanization and Climate Change and Provisional Directorates.

Moreover, there is other 5 By-Laws besides BCAPIP. These are,

- By-law on reduction in the sulphur content of certain liquid fuels
- By-law on control of environmental noise
- By-law on control of air pollution from heating
- By-law on control of the emissions from odor
- By-law on control of exhaust gas emissions

In each of the 81 Provinces a Provincial Directorate sub-coordinated to the MoEUCC is established. The Provincial Directorates have the responsibility to implement environmental legislation at local level by means of permitting and inspection for facilities falling under their competencies according to the Environmental Law.

Many of the EU funded projects have been completed in MoEUCC. Air related projects are listed below:

"Air Pollution Measurement and Monitoring Systems": It is a national project, which has been finalized in 2002.

"Analysis of Environmental Legislation in Türkiye": This project was completed in 2002. An analysis of Turkish environmental legislation and the gaps according to EU legislation were given.

"Strengthening of the implementation of the Council Directive 96/62/EC and Council Decision 97/101/EC on ambient air quality assessment and management, and reciprocal information exchange in the Refik Saydam Hygiene Centre (RSHC), MoH, Türkiye": Project has been carried out in the period of January 2003-December 2004 within the framework of the MATRA Pre-Accession Projects Program (MAT02/TR/9/2).

"Capacity Building (Human Resources Aspect) on the adoption of Integrated Pollution Prevention and Control Directive (IPPC-96/61/EC)": The project was supported by the Dutch PSO Program. The objective of the project was to develop in-depth understanding of the IPPC Directive and design an action plan for adoption and implementation in Türkiye. The project was finalised in 2004.

EU-Twinning Project **"Air Quality, Chemicals, Waste-Component 1: Air Quality"** was completed in 2006. The transpositions of the Council-Directive 96/62/EC (Air Quality Framework Directive) including the 4 Daughter Directives and the Directive 2001/80/ EC (Large Combustion Plant Directive) into Turkish Legislation were drafted and agreed. Under this Project a series of studies related to air quality management were completed.

"IPPC Implementation in Türkiye" MATRA programme was started in January 2006. The project purpose was to assist the Ministry of Environment, Urbanization, and Climate Change with the implementation of the IPPC Directive. More specifically, the project leads to the preparation of a roadmap towards full implementation of the IPPC Directive in Türkiye. The project completed in January 2008.

Under the IPA-1 2007 Programme, the project on **"Institutional Building of Air Quality in Marmara Region"** was finalized in 2013 aiming to implement the Air Quality

Framework Directive and daughter directives’ requirements, building up technical and administrative capacity and assessment and management of air quality.

“Support for Implementation of IPPC Directive in Türkiye” project was accepted in IPA-2008 NP and has been conducted between 2011-2014.

"Improving Emissions Control" Project that aims to transpose 2001/81/EC National Emission Ceiling Directive (NECD) Technical Assistance part and Twinning part were completed respectively in 2013.

“Control of Industrial Volatile Organic Compound Emissions” Project part of IPA 2009 NP has the overall objective to enhance the Control of Volatile Organic Compound (VOC) emissions to improve environmental quality in Türkiye and to reduce or prevent the potential risks to human health and to prevent ground level ozone pollution Twinning component on VOC control. The project is structured in two components: a Twinning component and a Technical Assistance component. Project finalized in 2014.

This submission includes the reporting details of the NECD pollutants SO_2, NO_x, NMVOC and NH_3 as well as CO and PM_{10} and together with the selected heavy metals with $PM_{2.5}$ for the period 1990 – 2022.

1.2 Institutional Arrangements

Air Management Department is responsible for inventory compilation. The department consist of four divisions as follows: “modelling and mapping”, “emission management policies”,” transport and mobility”,” sustainability strategy zero pollution”.

Data provider connections, working group strategy of the related institutions on the air emissions inventory, data flow chart within the inventory compilation process and the inventory management cycle were assessed and the national funded project (which will be written as EMISSION-111G037 here and after) has served the strong basis and the structure of the whole chart of the air pollutant emission inventory. EMISSION-111G037 is the key for the continuous improvement only with the structure of itself. Data collection is set with an agenda between the data providers and collected data is integrated directly to the system as input files by the support of the Air Emission Management- HEY Portal.

Together with the methodological revision under UNFCCC reporting guidelines, the air pollutant emission inventory serves the calculation itself directly to the pollutants which are same in the GHG emission inventory. By 2015, IPCC 2006 Guidelines are cited in the calculations and in the emission inventory compilation of the emissions of pollutants in the GHG inventory which are mentioned under UNECE CLRTAP EMEP/EEA Guidebook. Therefore, the unique air pollutant emission calculation and inventory structure is unavoidable. TURKSTAT is also aware of this situation and within the meetings which were held to understand the differences between the two inventories resulted in the agreed conclusion.

The secondary air pollutants under the GHG inventory are used from our inventory submissions since 2016.

1.3 Inventory Preparation Process

Inventory preparation includes three stages;

- inventory planning,
- inventory compilation and
- inventory management.

1.3.1 Inventory Planning

Inventory was prepared by Modelling and Mapping Division staff under Air Management Department together with the members of the Operational Center under AMD.

Ministry of Energy and Natural Resources, Ministry of Transport, Maritime Affairs and Communication and Ministry of Food, Agriculture and Livestock, TURKSTAT were the main data providers.

Data flow for years is being integrated within the HEY Portal to be followed every year annually and to be archived, controlled and updated. After the revision of the Guidebook, the new versions used which are mentioned under the EMEP/EEA Guidebook and Reporting Instructions on www.ceip.at

1.3.2 Inventory Preparation

For this inventory the calculations of all emissions for the whole period and all NFR sectors were carried out by national inventory experts from MoEUCC coordinated under the DG for Environmental Management. Excel-based database (raw data, calculation sheets and output data) was prepared by the MoEUCC as well.

"Raw data" folder consists of subfolders for each of the NFR sectors. Folders are also consisting of the reference documents, background documents, downloads, emails, etc. "Calculation sheets" folder includes excel spreadsheets for each NFR sector. Spreadsheets also keep the emission factors used within the calculations of each sectors' emissions. "Outputs" folder involves revised template files that used for submission.

By the support of the HEY Portal, the data flow is automatically set and obtained. The required data from related stakeholders are taken via official letter in special circumstances. COPERT software calculations are also taken via the support of the HEY Portal which is integrated to be executed within the Portal interface.

Starting from the year of 2022 and the submission of 1990-2020 the Operational Center dedicated for the task within the premises of the MOEUCC will be calculating and working on the emission inventory and submission files and separately divided into the categories required under the EMEP/EEA Guidebook.

1.3.3 Inventory Management

The task and the responsibility of inventory compilation and management is given to the Modelling and Mapping Division under DG for Environmental Management, MoEUCC.

Database folders with all relevant information (calculation sheets, documentation, activity data, downloaded documents, reference papers and other relevant information) are placed in one computer in the Ministry. All members of inventory team were defined as users of this computer. Data management and archive system were established.

Quality management system for the inventory will be configured and further implemented by Modelling and Mapping Division in MoEUCC.

1.4 Methods and Data Sources

Emission estimates were prepared in line with EMEP/EEA Emission Inventory Guidebook (latest version). Mostly default factors were used for calculations while national factors are not available. Summary information on source of activity data and selected emission factors is presented in Table 1.1. Road transport – COPERT software is used for the emission calculation covering years 1994-2020.

The national energy balance tables are key sources of information, in particular the use of fuel in different sectors. However, there are some significant limitations with these data. For instance, the fuel used in the road transport sector is simply reported as "petroleum", with no petrol/diesel split. The format of National Energy Balance Tables was changed in specific years, some of the industrial sectors were resolved. Therefore, calculation sheets were changed accordingly covering these year's calculations. The same situation was remained. The sub-sectors in the energy balance table were again reorganized.

Source of activity data and methods that used in calculations are given in the Annex.

1.5 Key Category Analysis

The identification of key categories is described in the "Good Practice Guidance for LRTAP Emission Inventories" (Chapter 2 of the EMEP/EEA emission inventory guidebook and IPCC Good Practice Guidance (IPCC-GPG, 2000), Chapter 7). It stipulates "***a key category is one that is prioritised within the National System because its estimate has a significant influence on a country's total inventory of air emission in terms of the absolute level of emissions, the trend in emissions, or both.***"

As stated in the "Good Practice Guidance for LRTAP Emission Inventories", it is good practice to identify the national key categories in a systematic and objective manner. This can be achieved by a quantitative analysis of the relationship between the magnitude of emission in any one year (level) and the change in emission year to year (trend) of each category's emissions compared to the total national emissions; to choose the parameter which is considered as key also depends on the application of the inventory; for compliance assessments the trend is essential, whereas in the case that emission reporting obligations are formulated as emission ceilings, the emission level uncertainty is relevant.

All notations, descriptions of identification and results for key categories included in this chapter are based on the Good Practice Guidance.

The identification includes all NFR categories and all reported gases:

SO_2, NO_x, NMVOC, NH_3, CO, PM_{10}, $PM_{2.5}$, Pb, Hg, and Cd.

1.5.1 Methodology – Approach 1

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

1.5.2 Results of the key category analysis (KCA)

NFR 1A1a "Public Electricity and Heat Production" is the dominant key source for SO_2 and NO_x, "Road Transport- Heavy Duty Vehicles" is the major other category after 1A NFR category for NOx. All of the key sources for NH_3 are belong to agriculture sector. NFR 3Da3 is the first category for NMVOCs. "1A4bi Residential Combustion" is the first sector for the PM_{10} emissions and chemical industry is the second for PM_{10}. Residential combustion is also responsible for NMVOC and NO_x emissions as key category.

All key categories are listed in the Table 1.1.

Table 1.1 KCA for 2022 emissions

Component	Key Categories											Total (%)
SO_2	**1A1a**	**1A2f**	**1A4bi**									88,0%
	69.71%	9.92%	8.37%									
NO_x	**1A1a**	**1A2f**	**1A1b**	**1A4ci**	**1A3biii**	**1A4bi**						82.1%
	37.36%	13.64%	11.81%	7.06%	6.2%	6.02%						
NH_3	**3B1a**	**3B2**	**3Da1**	**3B1b**	**3B4gii**							81.9%
	21.39%	18.81%	15.99%	14.27%	11.48%							
NMVOC	**3Da3**	**2D3d**	**2D3a**	**3B1a**	**2H2**	**1A4bi**	**3B1b**	**5A**	**2D3e**	3B4gii	1A2f	82.1%
	20.72%	9.48%	9.05%	8.4%	8.08%	7.34%	6.69%	4.11%	3.73%	2.4%	2.2%	
CO	**1A4bi**	**1A2f**	**1A3biii**	**1A2a**	**1A1b**							82.5%
	44.31%	13.39%	10.4%	10.00%	4.44%							
PM_{10}	**1A4bi**	**1A2f**	**2B10a**	**1A1a**	**1A2a**	**2A1**						81.5%
	42.70%	10.07%	8.50%	7.43%	7%	5.84%						
$PM_{2.5}$	**1A4bi**	**1A2f**	**1A2a**	**1A1a**								80.7%
	54.03%	12.14%	8.3%	6.18%								
Pb	**1A3bvi**	**1A3biii**	**1A3bi**									80.1%
	47.20%	18.06%	14.81%									
Hg	**5C1biii**											92.6%
	92.59%											
Cd	**5C1biii**	**5C2**										98.48%
	49.24%	49.24%										

1.6 QA/QC and Verification Methods

General quality check regarding calculation sheets was performed. Quality control manager at Air Quality Assessment Division was nominated however, quality management system is not established yet. By the mid of 2014 the system preparation was started and the studies for the management of the quality system are ongoing.

The best practice has been used in setting up QA/QC routines and several verification checks have been performed within the first submission, and the content is still being used.

All of the calculation sheets used in the inventory have a QA/QC sheet. In addition, information on the colour coding convention that is used in the inventory is also included in the QA/QC sheet and presented in **Hata! Başvuru kaynağı bulunamadı.**.

QAQC COLOUR CODING	
Input Data	Extrapolated/Interpolated data
Calculation/Linked cells (internal)	Assumptions/Assumed values
Data from another spreadsheet	QA & cross checks
From the literature (emission factors)	General notes
Conversion factors & constants	Warnings or things to check
Final Emissions	

Figure 1.1 QA/QC Colour Coding

This colour coding convention is used throughout the entire inventory. It is a powerful tool in allowing a user for quickly interpreting the data in complex spreadsheets. For example, a time series of activity data that is blue, with sections of orange clearly indicate where the data is genuine input data, and where the data has been extrapolated/interpolated to address data gaps.

In addition to this, the calculation sheets are thoroughly commented, to include any additional explanation this is required. These comments all include a date, and an indication of the author. Calculation sheets also include a number of internal quality checks (colour coded in pink). These are usually difference checks (which should return a zero value) or ratio checks (which should return a value of 1).

A sheet called “***Notes and Explanations***” is included in the calculation sheets. Aim of this sheet is to record date and time worked on the sheet, problems and solutions faced in the cycle which is important for the sustainability of the work.

1.7 General Assessment of Completeness

The Stage-3 review of our country underlined the situation under the Key Findings topic that *“The ERT recommends Türkiye to complete the inventory for all pollutants, sources and years.”*

Not complete yet additional parameters are added within the 2023 submission. The missing parts will be completed step by step for other sectors periodically.

2 CHAPTER 2: EXPLANATION OF KEY TRENDS

Türkiye has been reporting data about national total and sectoral emissions under LRTAP Convention since 2011. Total emissions between 1990 and 2022 are given in **Hata! Başvuru kaynağı bulunamadı.** and trends are illustrated in Figure 2.1.

Table 2.1 Emission of SO_2, NO_x, NMVOC, NH_3, CO, PM_{10}, $PM_{2.5}$ between 1990-2022

Year	SO_2	NO_x	NMVOC	NH_3	CO	PM_{10}	$PM_{2.5}$
1990	571.91	132.29	727.86	628.21	856.75	143.20	37.84
1991	593.31	138.80	757.22	648.14	870.23	165.72	39.88
1992	597.95	153.21	767.67	658.81	891.78	168.99	39.16
1993	581.47	160.74	776.48	672.03	874.00	169.54	40.14
1994	1725.89	1082.16	1353.18	639.62	6068.19	413.68	81.44
1995	1808.88	1034.21	1317.08	612.50	5746.74	422.45	79.74
1996	1937.87	1184.27	1383.31	628.72	6275.38	439.29	98.92
1997	2108.50	1397.52	1478.97	608.33	7330.46	453.94	111.99
1998	2186.99	1544.21	1570.95	647.31	8193.97	447.75	115.01
1999	2115.67	543.83	1016.25	659.48	2242.36	393.34	75.79
2000	726.72	1274.05	1448.17	635.39	7635.11	219.53	170.34
2001	1947.59	1374.16	1479.70	583.82	7932.72	389.43	308.20
2002	1831.87	1054.21	1298.07	576.43	5889.69	385.06	305.41
2003	663.65	794.34	1088.50	608.07	4081.80	214.43	149.49
2004	646.09	1195.46	1035.50	617.78	3151.96	219.03	173.40
2005	626.34	1081.07	969.35	631.06	2764.22	217.41	170.62
2006	697.87	1049.28	949.56	647.88	2561.27	223.32	172.47
2007	2498.58	1215.10	989.29	612.35	3381.51	406.12	322.25
2008	2526.33	1127.49	1088.30	594.59	3546.83	431.57	343.68
2009	2626.18	1055.53	1096.36	575.59	3528.92	438.34	351.21
2010	2473.12	981.77	1104.85	590.14	3400.29	440.96	350.33
2011	2469.97	948.35	1074.38	612.76	2937.01	396.18	306.68
2012	2280.99	941.69	1101.71	680.82	2803.64	372.63	320.74
2013	1902.88	873.64	1084.00	715.12	2433.03	313.81	272.54
2014	2153.81	902.18	1089.49	728.52	2367.89	307.47	266.57
2015	1959.86	964.58	1095.71	695.97	2370.10	351.81	303.47
2016	2274.82	996.75	1106.14	764.36	2344.41	344.39	292.05
2017	2379.59	977.02	1133.13	799.42	2171.50	339.68	279.58
2018	2528.31	963.29	1109.85	803.90	1655.69	255.60	199.48

2019	2533.37	974.70	1137.78	844.08	1762.59	289.59	227.02
2020	2310.87	957.35	1177.43	921.21	1920.47	315.00	244.97
2021	2700.19	980.37	1174.63	913.77	1786.77	305.58	235.50
2022	2738.20	986.91	1143.01	898.88	1618.07	289.02	223.35
Trend 1990-2022	379%	646%	57%	43%	89%	102%	490%
Trend 2021-2022	1%	1%	-3%	-2%	-9%	-5%	-5%

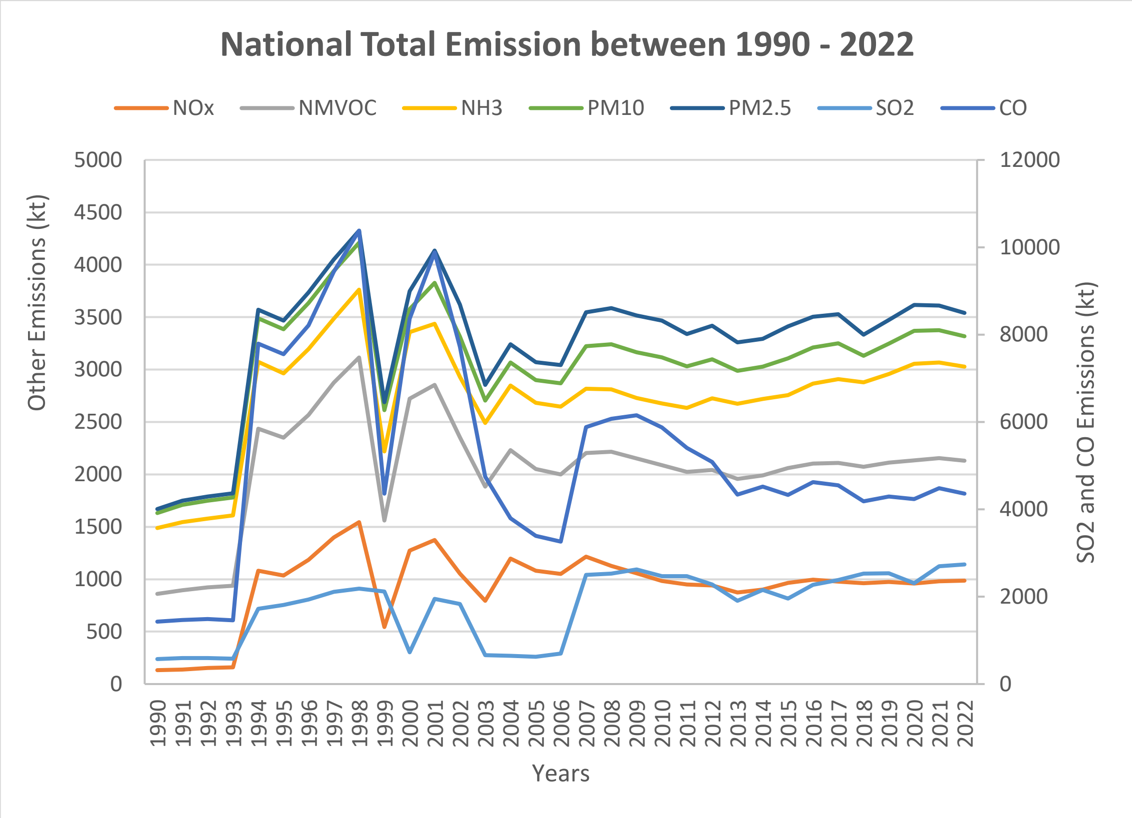

Figure 2.1 National Total Emission of SO_2, NO_x, NMVOC, NH_3, CO, PM_{10}, $PM_{2.5}$ between 1990 - 2022

From the emissions of Table 2.1, Figure 2.1 shows the 1990-2022 trends in total.

2.1 SO_2 Emissions

In 1990 national total for SO_2 emissions were 571.91 kt and has increased to 2738.20 kt in 2022. As presented in Figure 2.2.

Main source for SO_2 emissions in Türkiye is NFR sector 1.A.1.a public electricity and heat production activities with a share of 69.71 %.

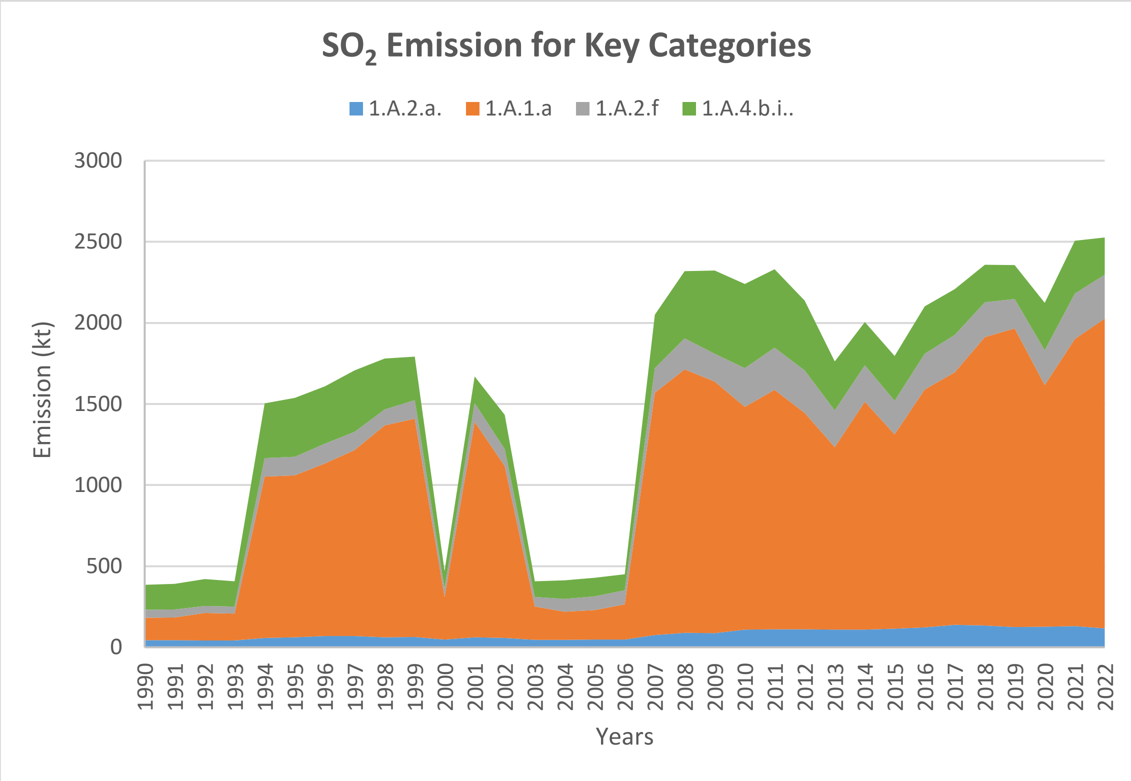

Figure 2.2 National SO_2 Emissions between 1990-2022 for Key Categories

2.2 NO_x Emissions

In 1990 national total for NO_x emissions were 132.29 kt and has increased to 986.91 kt in 2022. As presented in Figure 2.3.

Main sources for NO_x emissions in Türkiye are 1.A.1.a electricity generation sector with a share of 37.36 %.

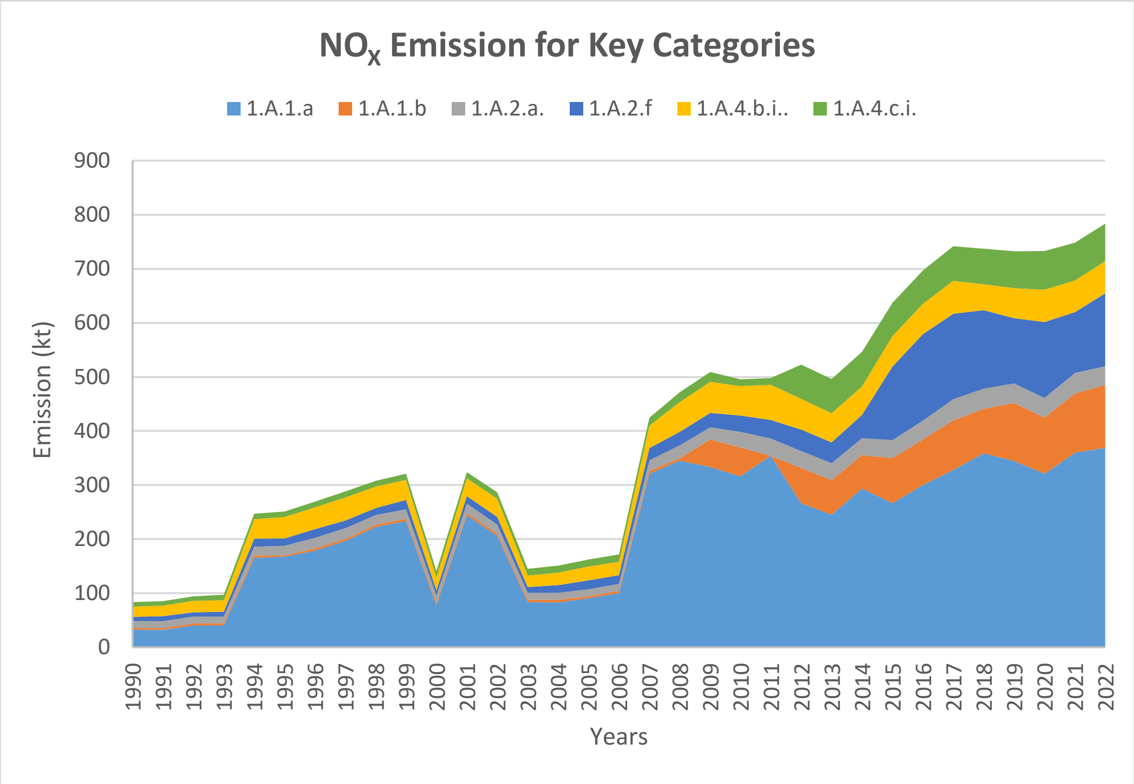

Figure 2.3 National NO_x Emissions between 1990-2022 for Key Categories

2.3 NMVOC Emissions

In 1990 national total for NMVOC emissions were 727.86 kt and has increased to 1143.01 kt in 2022. As presented in Figure 2.4.

Main source for NMVOC emissions in Türkiye is from agricultural sectors with a share of 36.7 %.

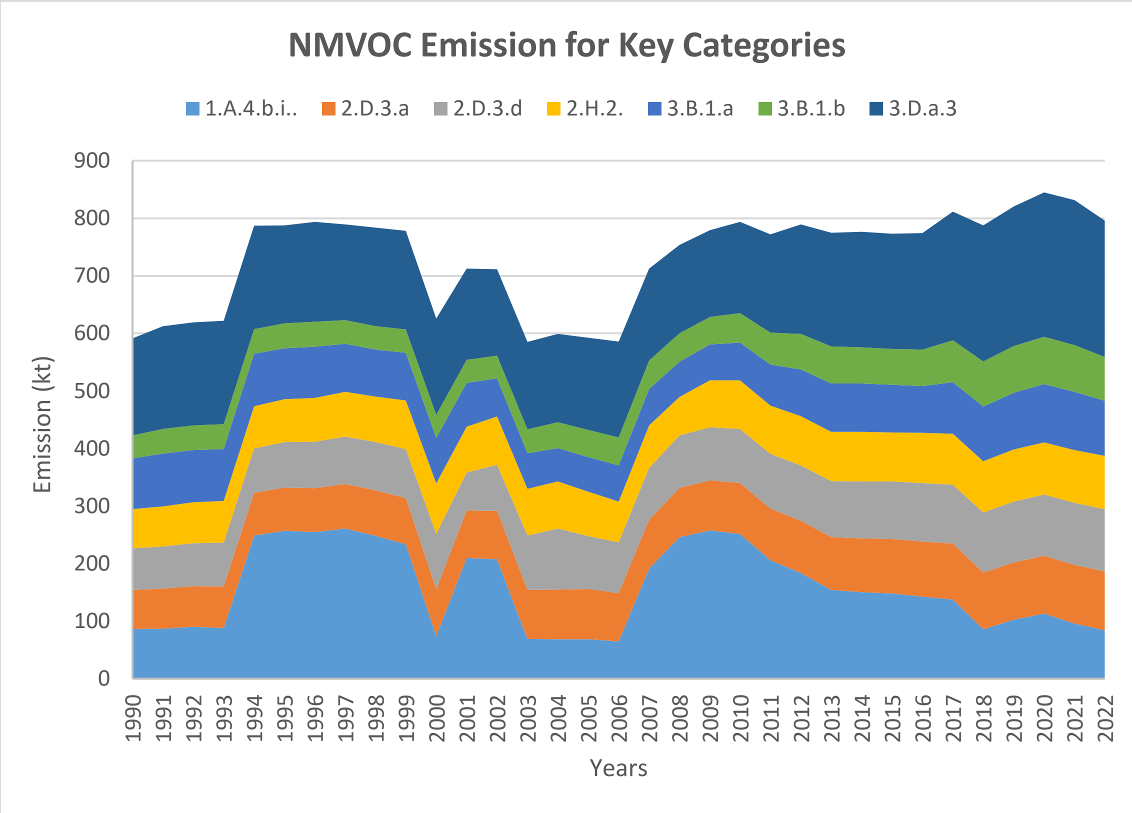

Figure 2.4 National NMVOC Emissions between 1990-2022 for Key Categories

2.4 NH_3 Emissions

In 1990 national total for NH_3 emissions were 628.21 kt and has increased to 898.88 kt in 2022. As presented in Figure 2.5.

Main source for NH_3 emissions in Türkiye is Agriculture sector with a share of 89.69 % and the total key categories are coming from NFR 3 category.

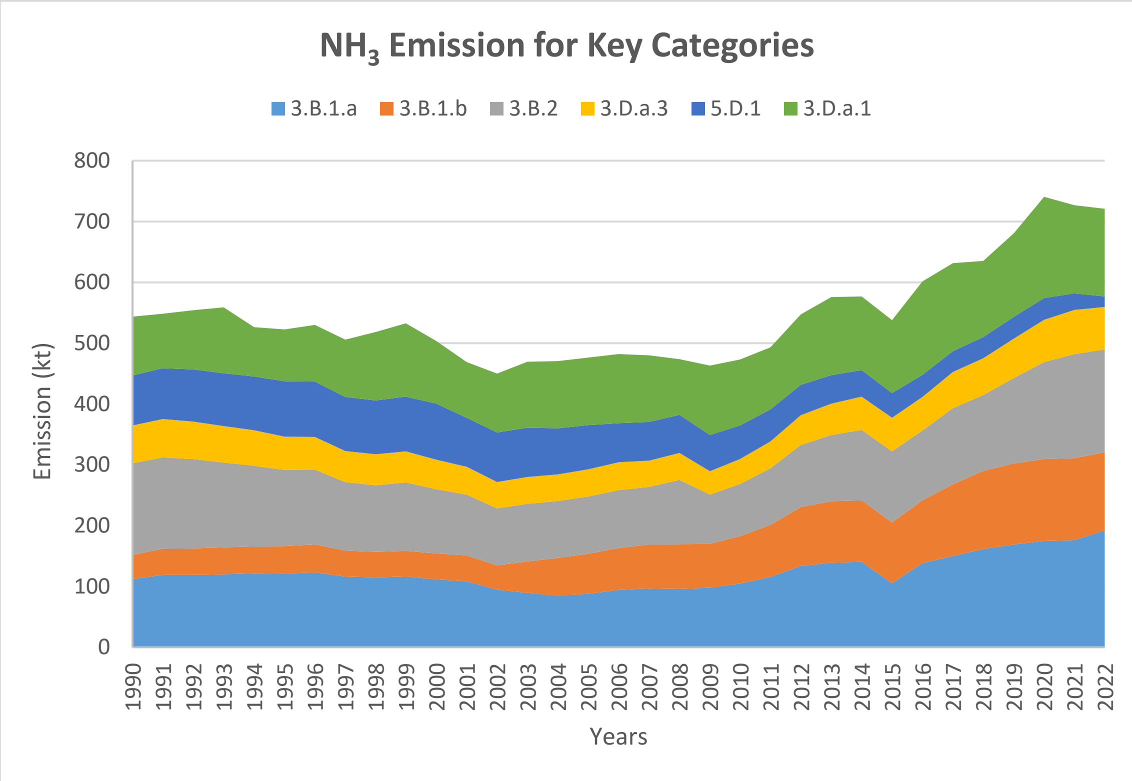

Figure 2.5 National NH_3 Emissions between 1990-2022 for Key Categories

Agricultural emission percentages show parallel leaning between 1990-2022. The emission factor revision and the EMEP/EEA GB revision is the main factor of the big increase in the sector of fertiliser. Waste sector also has an additive emission percentage on NH_3 totals.

2.5 CO Emissions

In 1990 national total for CO emissions were 856.75 Kt and has increased to 1618.07 kt. As presented in Figure 2.6.

Main source for CO emissions in Türkiye is 1. A.4.bi residential combustion activities with a share of 44.31 %.

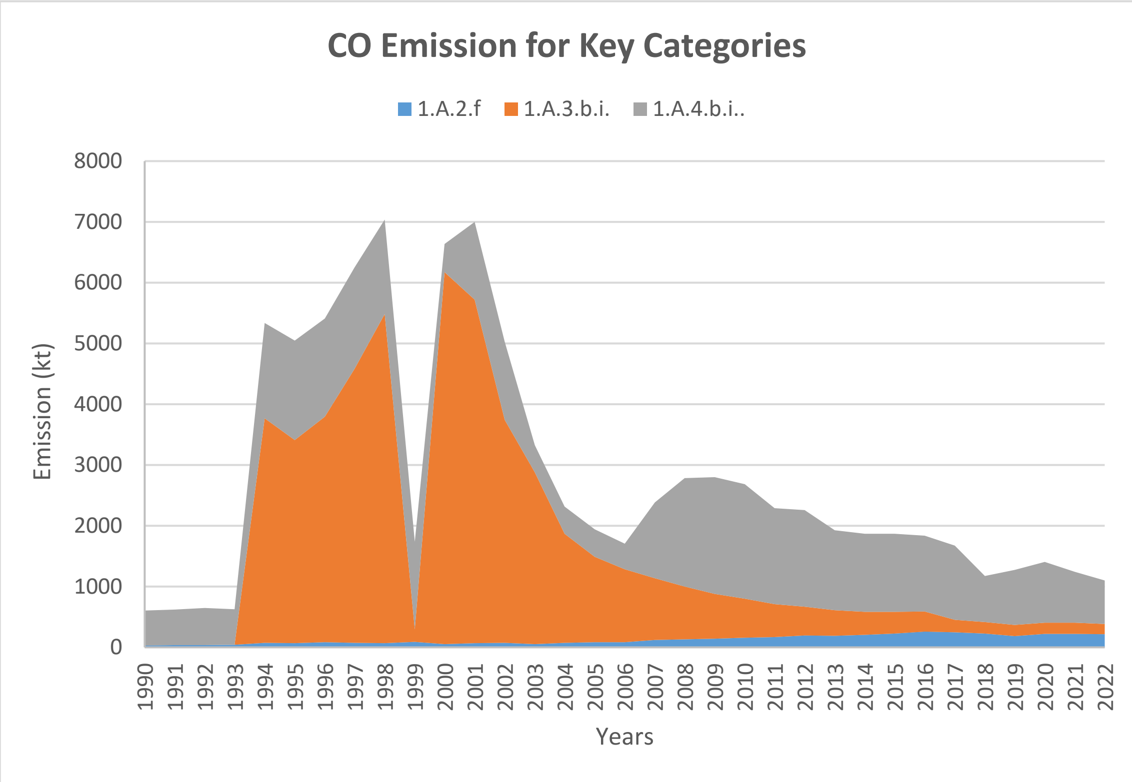

Figure 2.6 National CO Emissions between 1990-2022 for Key Categories

CO emissions are nearly same level of 1990s. Share of residential combustion is fluctuated due to consumers preferences about fuel types for heating.

2.6 PM_{10} Emissions

In 1990 national total for PM_{10} emissions were 143.20 Kt and has increased to 289.02 kt in 2022. As presented in Figure 2.7.

Main source for PM_{10} emissions in Türkiye is 1. A.4.bi with a share of 42.70%.

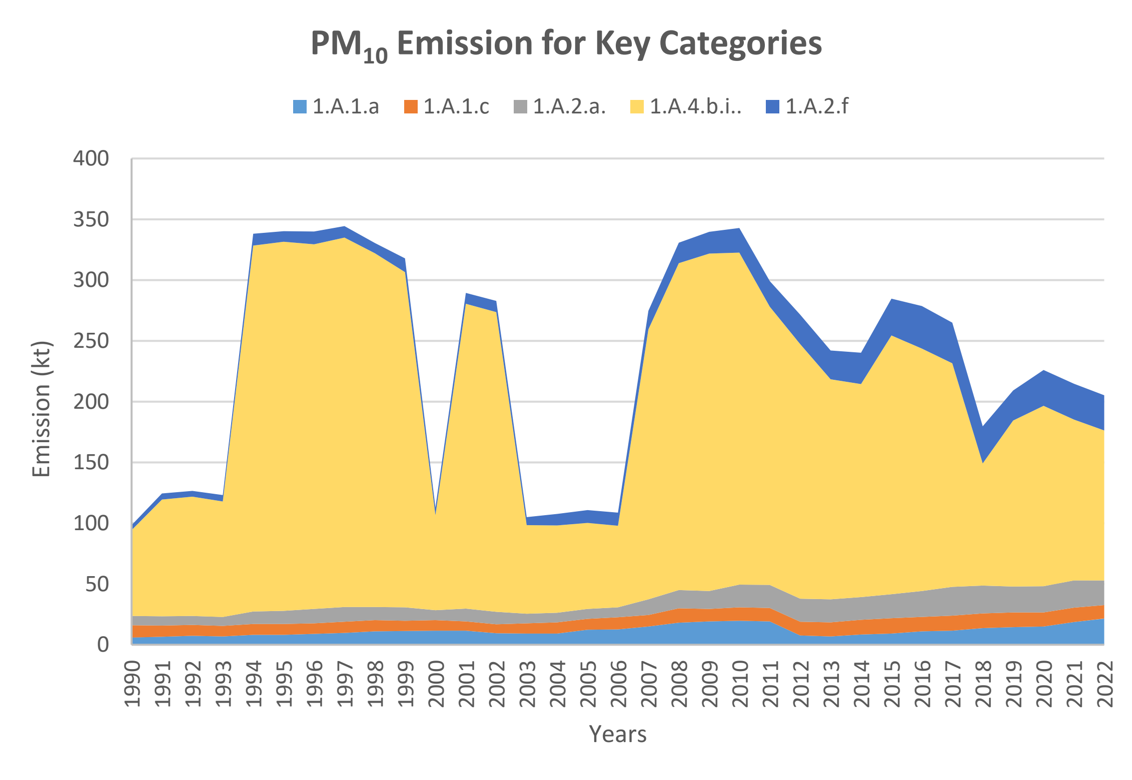

Figure 2.7 National PM_{10} Emissions between 1990-2022 for Key Categories

2.7 $PM_{2.5}$ Emissions

In 1990 national total for $PM_{2.5}$ emissions were 37.84 kt and has increased to 223.35 kt in 2022. As presented in Figure 2.8.

Main source for $PM_{2.5}$ emissions in Türkiye is 1. A.4.bi with a share of 54.03 %.

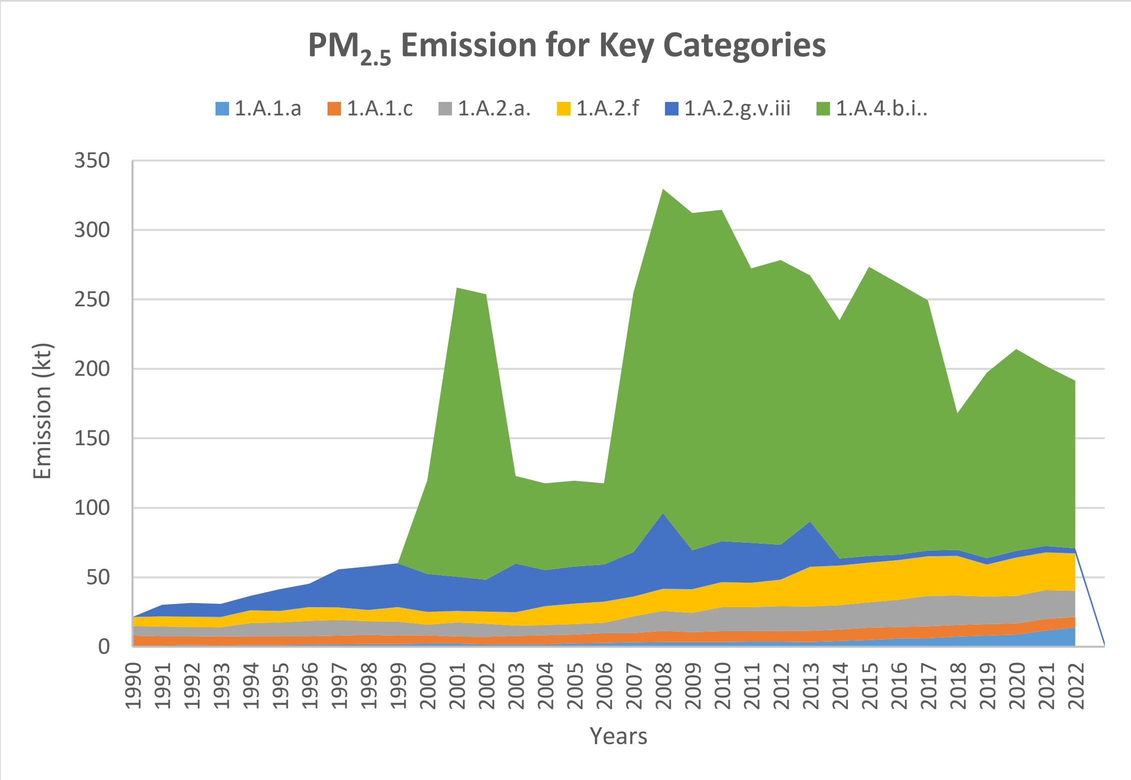

Figure 2.8 National $PM_{2.5}$ Emissions between 1990-2022 for Key Categories

3 CHAPTER 3: ENERGY (NFR SECTOR 1)

NFR sector 1 energy includes subsectors below:

- 1.A Combustion
  - 1.A.1 Combustion in Energy Industries
  - 1.A.2 Combustion in Manufacturing Industries and Construction
  - 1.A.3 Transport
  - 1.A.4 Small Combustion
- 1.B Fugitive Emissions from Fuels
  - 1.B.1 Solid Fuels
  - 1.B.2 Oil and Gas Fuels

3.1. NFR 1.A.1 Combustion in Energy Industries

Emission totals are figured and given in the figure and table below:

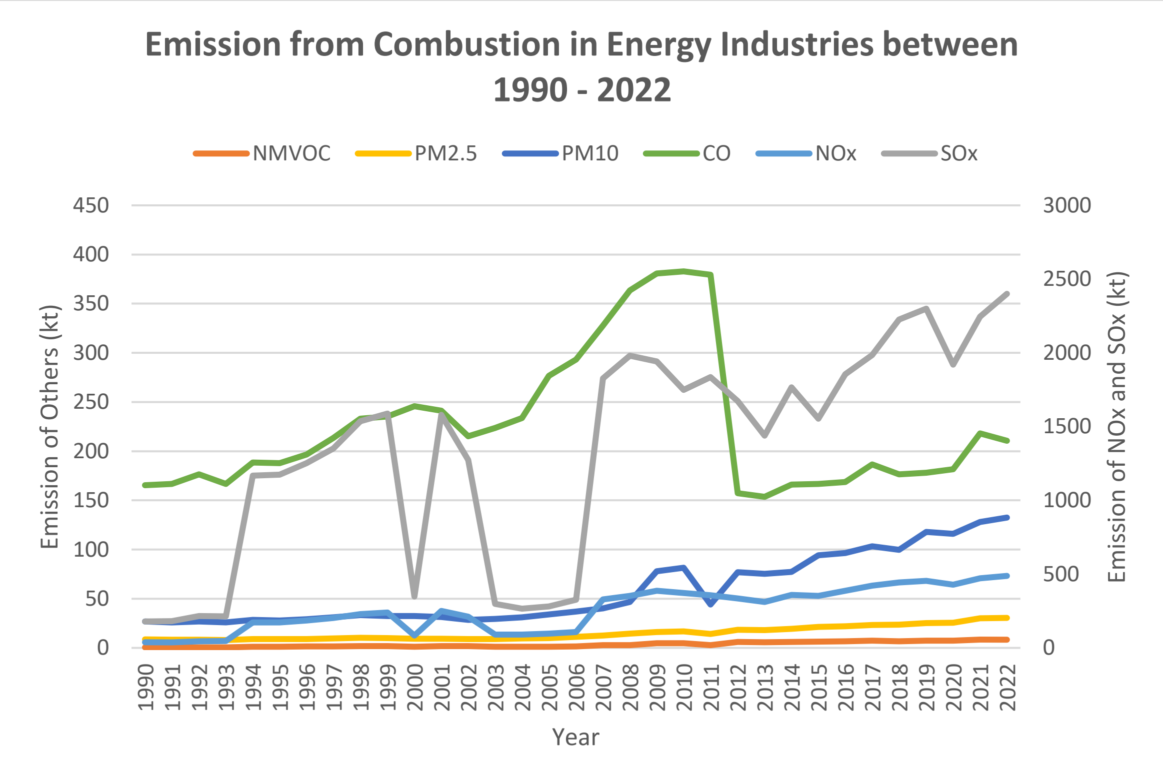

Figure 3.1 Emission Totals for 1.A.1 Energy Sector Between 1990-2022 years

Table 3.1 Emissions in Kt from 1.A.1 Energy Industries

Years	NOx	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	CO
	kt	**kt**	**kt**	**kt**	**kt**	**kt**
1990	37.94	0.60	141.25	8.18	18.13	138.57
1991	37.42	0.59	143.17	7.66	17.77	140.67
1992	45.72	0.61	170.81	7.62	18.51	149.61
1993	45.98	0.62	167.46	7.36	17.97	140.69
1994	171.60	1.30	996.04	7.68	19.64	159.72
1995	172.58	1.29	1001.48	7.64	18.87	160.14
1996	185.29	1.39	1066.57	7.70	20.05	167.34
1997	202.88	1.52	1148.79	8.20	21.49	182.19
1998	229.24	1.69	1307.98	8.55	23.04	199.80
1999	239.67	1.79	1348.45	8.12	22.39	202.93
2000	83.43	1.01	264.07	8.41	22.88	213.57

2001	250.27	1.93	1329.46	7.53	21.90	209.88
2002	212.40	1.77	1060.68	7.14	19.73	186.56
2003	89.65	1.13	207.89	7.89	20.49	194.06
2004	89.71	1.16	177.12	8.41	21.52	202.66
2005	96.33	1.25	185.44	8.80	23.84	242.70
2006	106.66	1.37	220.76	9.87	25.57	256.55
2007	328.76	2.70	1498.16	9.93	27.58	287.38
2008	352.38	2.85	1629.43	11.65	32.32	316.71
2009	386.77	4.72	1555.21	11.43	61.93	302.60
2010	372.17	4.79	1375.66	12.09	64.54	301.44
2011	357.19	2.77	1478.33	11.27	30.14	335.29
2012	334.79	5.95	1337.15	12.53	58.51	80.40
2013	311.92	5.74	1126.08	12.45	57.14	78.30
2014	358.38	6.13	1407.99	13.38	57.77	88.80
2015	353.34	6.46	1201.07	14.89	72.78	72.68
2016	387.26	6.60	1468.75	15.35	74.50	72.24
2017	422.75	7.32	1561.56	16.06	79.97	83.33
2018	444.26	6.83	1781.87	16.92	76.13	76.67
2019	455.24	7.34	1844.89	17.94	92.52	60.33
2020	427.43	7.27	1492.06	18.33	90.22	65.73
2021	472.41	8.43	1773.28	21.59	97.91	90.10
2022	488.14	8.40	1912.03	22.10	102.01	78.20
Trend 1990 - 2022	1186.77%	1303.52%	1253.66%	170.18%	345.89%	-63.38%
Trend 2021 - 2022	3.33%	-0.28%	7.82%	2.37%	4.18%	-13.20%

3.1.1 NFR 1.A.1.a Public Electricity and Heat Production

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: Yes (SO_2, NO_x,PM_{10}, $PM_{2.5}$)

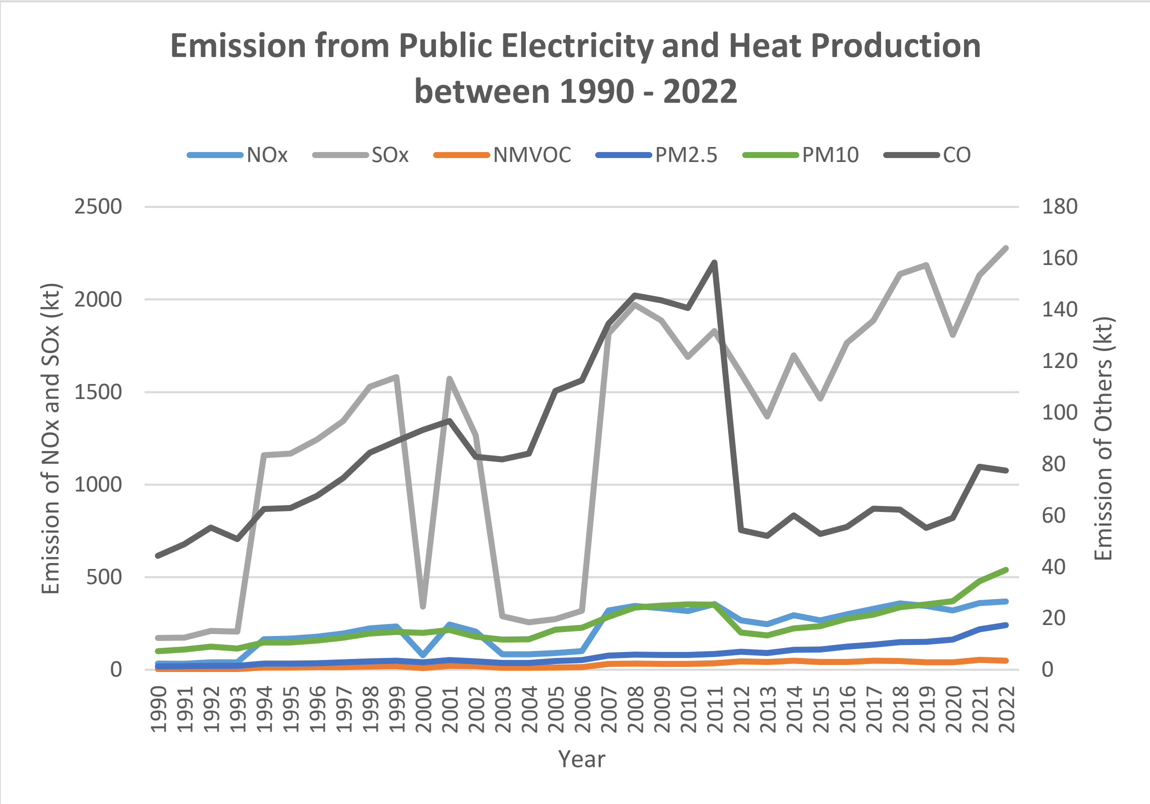

Figure 3.2 Emissions from NFR 1.A.1.a Public Electricity and Heat production

Table 3.2 Emissions in Kt from sector 1.A.1.a public electricity and heat production

Years	NOx	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	32.61	0.23	139.07	1.06	5.92	37.09
1991	32.32	0.24	141.18	1.15	6.50	40.94
1992	40.54	0.27	168.93	1.31	7.40	46.35
1993	40.42	0.26	165.78	1.21	6.76	42.63
1994	165.38	0.88	993.84	1.47	8.28	51.86
1995	167.41	0.91	999.33	1.48	8.24	52.24
1996	179.12	0.97	1064.44	1.59	8.85	56.15
1997	196.37	1.08	1146.54	1.75	9.67	62.03
1998	222.51	1.24	1305.69	1.98	10.93	70.30
1999	233.42	1.37	1346.33	2.08	11.22	74.27
2000	77.71	0.65	262.50	2.22	11.47	78.89
2001	243.99	1.52	1327.61	2.27	11.64	81.30
2002	206.12	1.37	1058.86	1.95	9.54	69.95
2003	83.43	0.76	205.90	1.90	9.09	70.09
2004	82.74	0.76	174.04	1.93	9.18	72.18
2005	90.42	0.88	183.01	2.48	12.24	92.89
2006	100.04	0.97	217.73	2.77	12.61	96.23
2007	320.65	2.23	1494.46	3.33	14.99	114.00
2008	345.01	2.37	1625.35	3.49	18.26	121.46
2009	333.10	2.30	1552.51	3.50	19.17	118.70
2010	316.20	2.26	1372.74	3.52	19.63	115.31
2011	354.29	2.46	1475.73	3.66	19.21	133.04
2012	266.62	3.21	1334.15	3.74	7.55	39.77
2013	245.35	3.07	1122.99	3.42	6.83	38.71
2014	293.75	3.53	1404.84	4.16	8.37	43.94
2015	266.44	2.96	1197.66	4.89	9.13	35.86
2016	300.06	3.07	1465.51	5.87	10.92	35.66
2017	328.21	3.48	1558.23	6.29	11.69	41.20
2018	358.88	3.38	1778.59	7.33	13.65	37.87
2019	344.81	2.86	1841.50	8.00	14.56	29.70
2020	320.68	2.94	1488.80	8.76	14.90	32.42
2021	359.75	3.85	1769.95	11.83	18.68	44.60
2022	368.67	3.54	1908.82	12.71	19.04	38.68

Trend 1990 - 2022	1030.38%	1445.12%	1272.55%	1103.38%	65.94%	-50.97%
Trend 2021 - 2022	2.48%	-8.02%	7.85%	7.44%	1.90%	-13.28%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables. (Source: Ministry of Energy and Natural Resources 2022).

Methodological Issues

The applied methodology is TIER 1 in terms of energy balance table data and the emission factors of EMEP/EEA GB.

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Table 3.3 Emission factors (EF) used sector 1.A.1.a public electricity and heat production

Fuel	Unit	Ef	Reference	Table No.
NOx				
H. Coal	g/GJ	209	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using hard coal	Table 3-2
Lignite	g/GJ	247	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	Table 3-3
Asphaltite	g/GJ	247	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal,	*(assumption covers the brown coal from GB and NCVs from NIR)*
Wood (Biomass)	g/GJ	81	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source	Table 3-7

			category 1.A.1.a using biomass	
Petroleum	g/GJ	89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
N. Gas	g/GJ	89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
SO_2				
H. Coal	g/GJ	820	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using hard coal	Table 3-2
Lignite	g/GJ	1680	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	Table 3-3

Asphaltite	g/GJ	1680	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	page 16
Wood	g/GJ	11	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using biomass	Table 3-7
Petroleum	g/GJ	0.3	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
N. Gas	g/GJ	0.3	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4

NMVOC				
H. Coal	g/GJ	1	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using hard coal	Table 3-2
Lignite	g/GJ	1.4	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	Table 3-3
Asphaltite	g/GJ	1.4	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	Table 3-3
Wood	g/GJ	7.3	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using biomass	, page 19

Petroleum	g/GJ	2.6	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
N. Gas	g/GJ	2.6	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
CO				
H. Coal	g/GJ	8.7	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using hard coal	Table 3-2
Lignite	g/GJ	8.7	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	Table 3-3
Asphaltite	g/GJ	8.7	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1	Table 3-3

			emission factors for source category 1.A.1.a using brown coal	
Wood	g/GJ	90	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using biomass	Table 3-7
Petroleum	g/GJ	39	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
N. Gas	g/GJ	39	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	Table 3-4
PM_{10}				
H. Coal	g/GJ	7.7	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using hard coal	, page 15

Lignite	g/GJ	7.7	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	, page 16
Asphaltite	g/GJ	7.9	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using brown coal	, page 16
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using biomass	, page 19
Petroleum	g/GJ	0.89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels	, page 17
N. Gas	g/GJ	0.89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a	, page 17

	using gaseous fuels

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables cited at the web site of the official statistics.

Planned Improvements

Plant specific emissions and emission factors will be obtained/calculated and be used for further submissions together with the petroleum split data.

3.1.2 NFR 1.A.1.b Petroleum Refining

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: Yes (NO_x, CO)

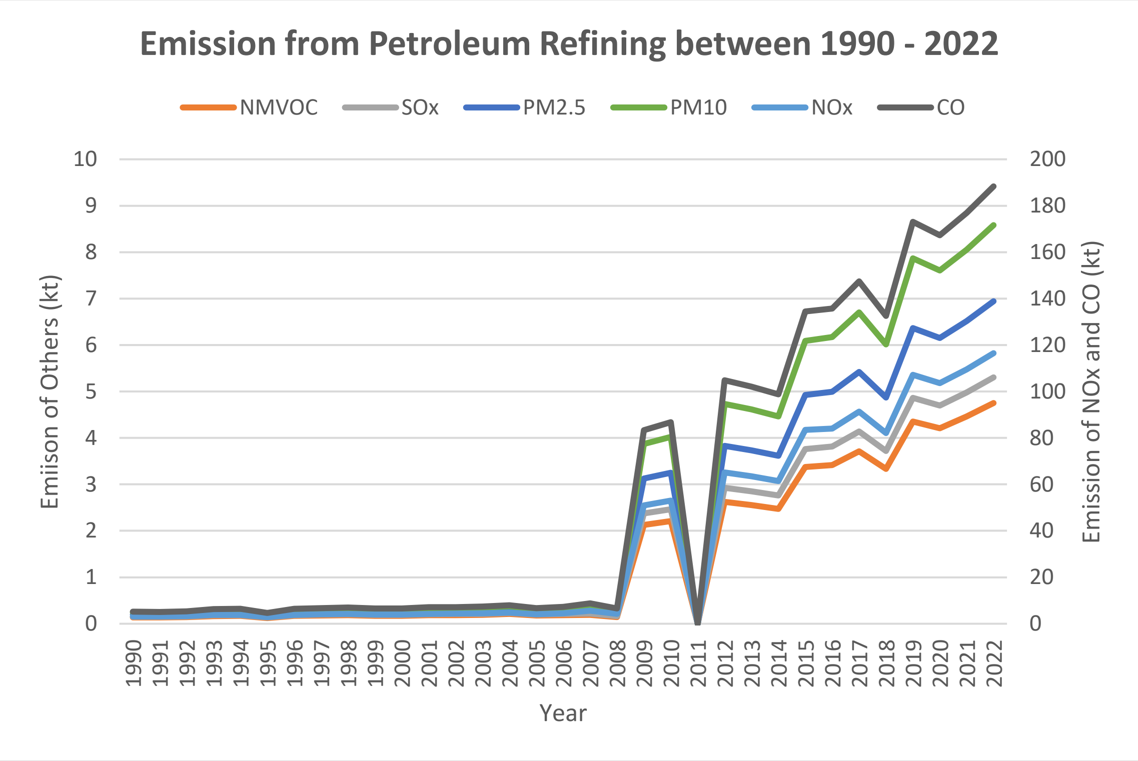

Figure 3.3 Emissions from petroleum refining

Table 3.4 Emissions from sector 1.A.1.b petroleum refining

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	3.14	0.14	0.02	0.05	2.04	37.09
1991	3.06	0.13	0.02	0.05	1.99	40.94
1992	3.27	0.14	0.02	0.05	2.12	46.35
1993	3.79	0.16	0.02	0.06	2.46	42.63
1994	3.87	0.17	0.02	0.06	2.52	51.86
1995	2.84	0.12	0.01	0.04	1.84	52.24
1996	3.86	0.17	0.02	0.06	2.51	56.15
1997	4.07	0.18	0.02	0.06	2.64	62.03
1998	4.25	0.18	0.02	0.06	2.76	70.30
1999	3.96	0.17	0.02	0.06	2.58	74.27
2000	3.99	0.17	0.02	0.06	2.60	78.89
2001	4.30	0.19	0.02	0.07	2.80	81.30
2002	4.33	0.19	0.02	0.07	2.81	69.95
2003	4.45	0.19	0.02	0.07	2.89	70.09
2004	4.84	0.21	0.02	0.07	3.15	72.18
2005	4.03	0.17	0.02	0.06	2.62	92.89
2006	4.44	0.19	0.02	0.07	2.84	96.23
2007	5.55	0.19	0.02	0.07	3.22	114.00
2008	4.21	0.14	0.02	0.06	2.42	121.46
2009	50.93	2.13	0.25	0.75	32.45	118.70
2010	53.00	2.21	0.26	0.78	33.73	115.31
2011	IE	IE	IE	IE	IE	133.04
2012	65.16	2.62	0.30	0.90	39.63	39.77
2013	63.46	2.55	0.30	0.88	38.60	38.71
2014	61.43	2.47	0.29	0.85	37.37	43.94
2015	83.53	3.37	0.39	1.16	50.96	35.86
2016	84.04	3.42	0.40	1.18	51.66	35.66
2017	91.30	3.71	0.43	1.28	56.10	41.20
2018	82.15	3.33	0.39	1.15	50.35	37.87
2019	107.21	4.36	0.51	1.50	65.82	29.70
2020	103.65	4.21	0.49	1.45	63.64	32.42
2021	109.52	4.46	0.52	1.54	67.42	44.60
2022	116.51	4.75	0.55	1.64	71.83	38.68

Trend 1990 - 2022	3607.65%	3389.96%	3414.55%	3349.58%	2666.90%	-50.97%
Trend 2021 - 2022	6.38%	6.54%	6.57%	6.54%	6.54%	-13.28%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables. (source: Ministry of Energy and Natural resources 2022). Due to energy balance table identifications notations were used for the data belong to the categories of the fuel used within the NFR topic.

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emissionpollutant = \sum ADfuel * EFfuel$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Emission factors are presented in Table 3.1-5.

These are calculated in the Emission Factors sheet. EFs in energy terms are taken from the GB. These are then converted into EFs in mass terms by combining with calorific values (Reference; NIR).

Table 3.5 Emission factors (EF) used sector 1.A.1.b petroleum refining

Fuel	Unit	Ef	Reference	Table No.
NOx				
Petroleum	g/GJ	63	EMEP/EEA (2016), Chapter 1.A.1.b Petroleum refining, Tier 1 emission factors for source category 1.A.1.b, refinery gas	Table 4-2
N. Gas	g/GJ	89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using natural gas	Table 3-4
SO2				
Petroleum	g/GJ	0.3	EMEP/EEA (2016), Chapter 1.A.1.b Petroleum refining, Tier 1 emission factors for source category 1.A.1.b, refinery gas	Table 4-2
Fuel	Unit	Ef	Reference	Table No.
N. Gas	g/GJ	0.3	EMEP/EEA (2016), Chapter 1.A.1.a Stationary Combustion, Tier 1 emission factors for source category 1.A.1.a using natural gas	Table 3-4
NMVOC				
Petroleum	g/GJ	2.6	EMEP/EEA (2016), Chapter 1.A.1.b Petroleum refiningTier 1 emission factors for source category 1.A.1.b, refinery gas	Table 4-2

N. Gas	**g/GJ**	**2.6**	**EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using natural gas**	**Table 3-4**
CO				
Petroleum	**g/GJ**	**39**	**EMEP/EEA (2016), Chapter 1.A.1.b Petroleum refining, Tier 1 emission factors for source category 1.A.1.b, refinery gas**	**Table 4-2**
N. Gas	**g/GJ**	**39**	**EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using natural gas**	**Table 3-4**
PM10				
Petroleum	**g/GJ**	**0.89**	**EMEP/EEA (2016), Chapter 1.A.1.b Petroleum refining, Tier 1 emission factors for source category 1.A.1.b, refinery gas**	**Table 4-2**
N. Gas	**g/GJ**	**0.89**	**EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using natural gas**	**Table 3-4**

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

Recalculations were checked and applied until 1990 due to fuel type typos.

Planned Improvements

Plant specific emissions and emission factors will be obtained/calculated and be used for further submissions together with the petroleum split data.

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

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, NH_3, $PM_{2.5}$

Key Source: No

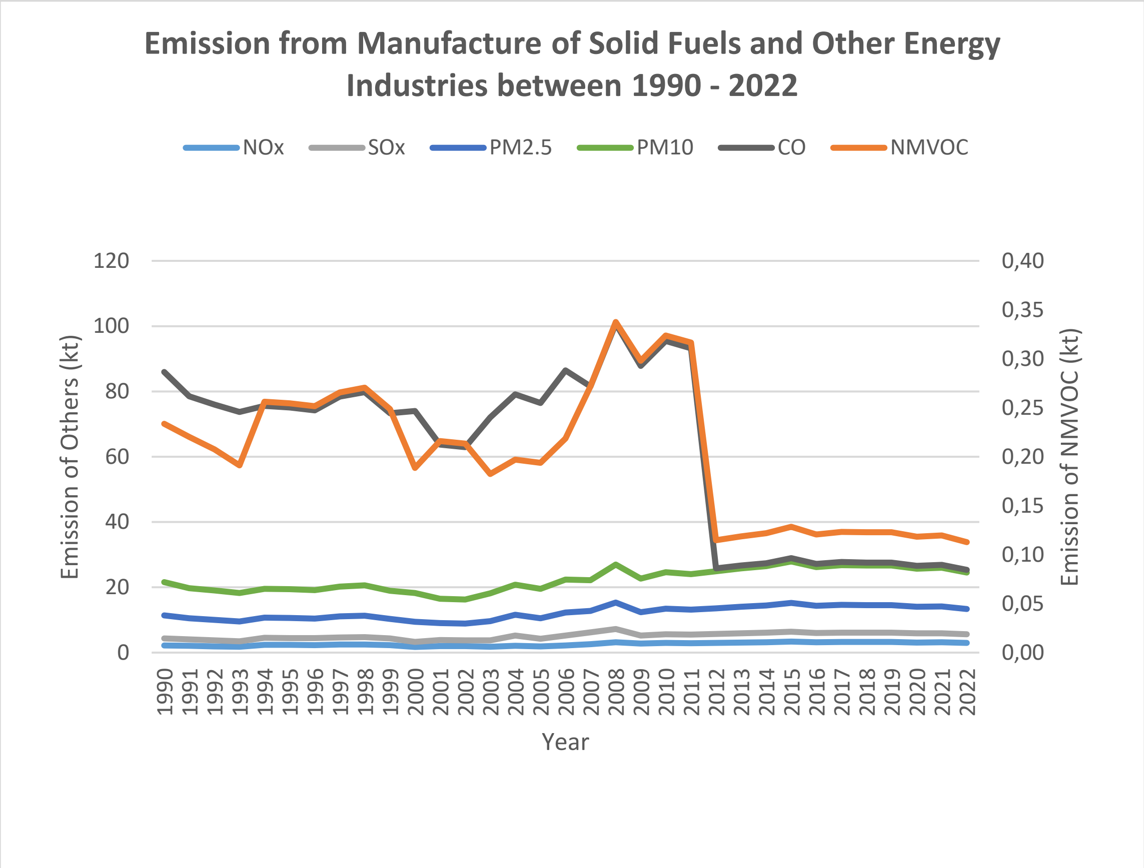

Figure 3.4 Emissions from manufacture of solid fuels and other energy industries

The specific decrease of CO emissions belongs to the data change in the fuel split of the energy balance tables.

Table 3.6 Emissions from sector 1.A.1.c manufacture of solid fuels and other energy industries

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	2.18	0.23	2.16	7.08	10.16	64.39
1991	2.04	0.22	1.98	6.46	9.28	58.79
1992	1.91	0.21	1.86	6.25	8.98	56.91
1993	1.77	0.19	1.66	6.09	8.75	55.42
1994	2.35	0.26	2.18	6.16	8.84	56.00
1995	2.33	0.25	2.14	6.12	8.79	55.67
1996	2.31	0.25	2.11	6.05	8.69	55.04
1997	2.44	0.27	2.23	6.39	9.18	58.13
1998	2.48	0.27	2.27	6.51	9.35	59.21
1999	2.28	0.25	2.09	5.98	8.59	54.39
2000	1.73	0.19	1.55	6.13	8.81	55.78
2001	1.98	0.22	1.83	5.20	7.46	47.27
2002	1.96	0.21	1.80	5.13	7.37	46.67
2003	1.77	0.18	1.97	5.92	8.50	53.88
2004	2.13	0.20	3.06	6.41	9.20	58.31
2005	1.88	0.19	2.40	6.25	8.98	56.92
2006	2.18	0.22	3.01	7.04	10.11	64.08
2007	2.57	0.27	3.68	6.53	9.37	59.38
2008	3.16	0.34	4.06	8.11	11.65	73.78
2009	2.73	0.30	2.45	7.17	10.30	65.21
2010	2.97	0.32	2.66	7.79	11.18	70.82
2011	2.90	0.32	2.60	7.61	10.93	69.22
2012	3.01	0.11	2.70	7.89	11.33	0.86
2013	3.11	0.12	2.79	8.15	11.71	0.89
2014	3.20	0.12	2.86	8.37	12.02	0.91
2015	3.37	0.13	3.02	8.84	12.69	0.96
2016	3.17	0.12	2.84	8.30	11.93	0.91
2017	3.24	0.12	2.90	8.48	12.18	0.93
2018	3.22	0.12	2.89	8.44	12.13	0.92
2019	3.22	0.12	2.89	8.45	12.13	0.92
2020	3.10	0.12	2.78	8.13	11.67	0.89
2021	3.14	0.12	2.81	8.22	11.81	0.90
2022	2.96	0.11	2.65	7.75	11.14	0.85

Trend 1990 - 2022	35.92%	-51.71%	22.64%	9.57%	26.45%	-98.48%
Trend 2021 - 2022	-5.69%	-5.69%	-5.69%	-5.69%	-5.69%	-5.69%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables. (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Emission factors for are in mass terms and have been taken from the GB Emission factors are presented in Table 3.7.

Table 3.7 Emission factors (EF) used sector 1.A.1.c manufacture of solid fuels and other energy industries

Fuel	Unit	Ef	Reference	Table No.
NOx				
H. Coal G	g/GJ	21	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1. A.1.c	Table 5-1
Lignite	g/GJ	21	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1. A.1.c	Table 5-1
Coke	g/GJ	21	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Petroleum	g/GJ	89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using gaseous fuels, page 17	Table 3-4
SO2				
H. Coal G	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission	Table 5-1

			factors for source category 1.A.1.c	
Lignite	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Coke	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Petroleum	g/GJ	2.81	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using other liquid fuels	Table 3-4
NMVOC				
H. Coal G	g/GJ	0.8	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Lignite	g/GJ	0.8	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Coke	g/GJ	0.8	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid	Table 5-1

			fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	
Petroleum	g/GJ	2.6	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using other liquid fuels	Table 5-1
NH3				
H. Coal G	g/GJ	-	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	-
Lignite	g/GJ	-	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	-
Coke	g/GJ	-	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	-
CO				
H. Coal G	g/GJ	6	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission	Table 5-1

			factors for source category 1.A.1.c	
Lignite	g/GJ	6	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Coke	g/GJ	6	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Petroleum	g/GJ	39	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using other liquid fuels	Table 3-4
		PM10		
H. Coal G	g/GJ	79	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Lignite	g/GJ	79	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid fuels and other energy industries, Tier 1 emission factors for source category 1.A.1.c	Table 5-1
Coke	g/GJ	79	EMEP/EEA (2016), Chapter 1.A.1.c Manufacture of solid	Table 5-1

			fuels and other energy industries, Table 5-2 Tier 1 emission factors for source category 1.A.1.c	
Petroleum	g/GJ	0.89	EMEP/EEA (2016), Chapter 1.A.1.a, Tier 1 emission factors for source category 1.A.1.a using other liquid fuels	Table 3-4

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

Planned Improvements

Plant specific emissions and emission factors will be obtained/calculated and be used for further submissions together with the petroleum split data.

3.2 NFR 1.A.2 Combustion in Manufacturing Industries and Construction

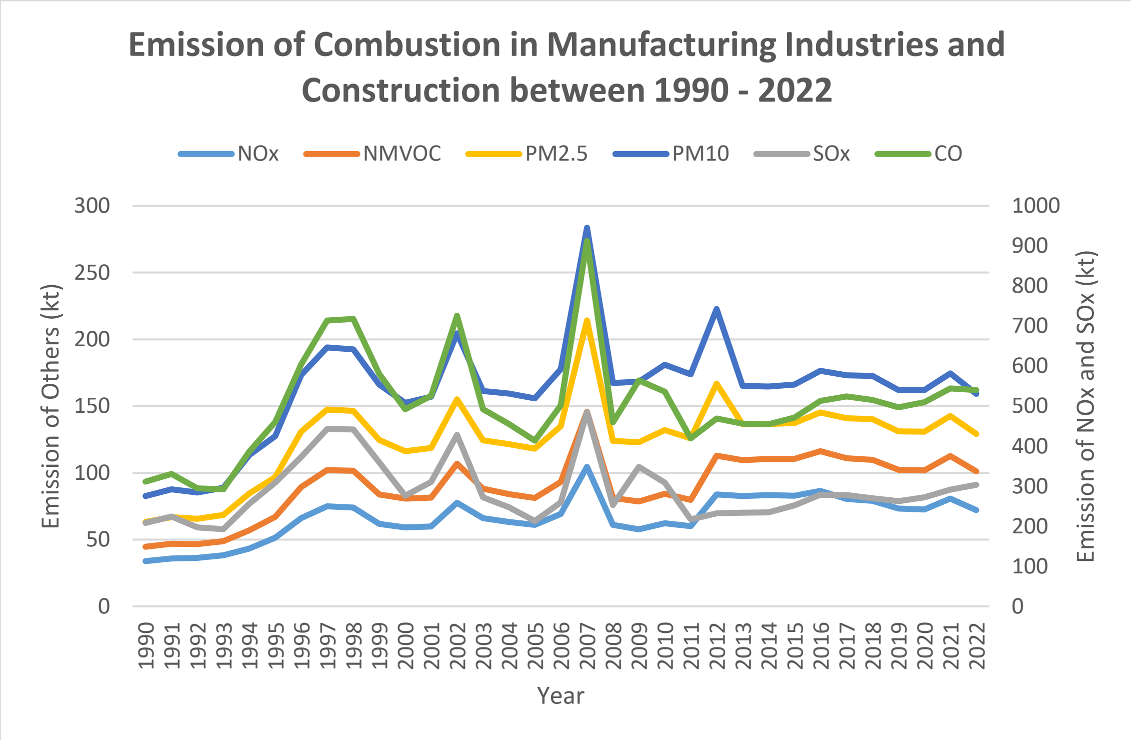

Figure 3.5 Emissions of Combustion in Manufacturing Industries between 1990 - 2022

Table 3.8 Emissions of Combustion in Manufacturing Industries between 1990 – 2022

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	33.89	10.75	207.97	18.60	19.38	103.46
1991	35.73	11.14	223.97	20.04	20.81	107.03
1992	36.28	10.31	197.22	19.04	19.76	97.11
1993	38.13	10.58	192.76	19.75	20.46	99.58
1994	43.40	13.46	256.28	27.74	28.68	130.01
1995	51.34	15.64	308.72	29.74	30.73	151.27
1996	66.13	23.27	372.70	41.39	42.45	231.46
1997	75.06	27.08	442.88	45.35	46.42	271.19
1998	74.03	27.47	442.14	44.98	46.00	275.93
1999	61.83	22.06	359.74	40.62	41.64	220.11
2000	59.06	21.67	276.05	35.40	36.21	216.40
2001	59.88	21.47	310.79	37.31	38.37	214.83
2002	77.52	29.44	428.38	48.26	49.26	297.56

2003	66.11	22.09	272.10	36.21	36.96	219.75
2004	63.24	20.91	247.66	37.27	38.05	207.98
2005	61.08	20.00	213.43	36.96	37.71	200.10
2006	69.22	23.89	259.58	41.90	42.64	242.19
2007	104.54	41.32	485.09	68.37	69.41	427.52
2008	61.10	20.21	252.71	42.53	43.61	206.32
2009	57.60	20.92	348.13	44.34	45.39	215.91
2010	62.33	22.04	309.03	47.66	49.02	227.44
2011	59.99	19.83	217.25	45.93	47.97	202.43
2012	83.79	29.07	232.50	53.93	55.98	236.73
2013	82.62	26.88	233.49	26.95	28.68	222.75
2014	83.44	26.97	234.52	26.29	27.99	220.04
2015	82.80	27.75	252.65	26.82	28.68	218.58
2016	86.54	29.69	278.56	29.11	31.13	234.61
2017	80.47	30.36	277.48	30.01	32.12	246.63
2018	79.00	30.80	269.86	30.35	32.47	245.53
2019	73.37	29.01	262.60	28.80	30.77	234.32
2020	72.58	29.28	272.33	29.07	31.16	237.34
2021	80.72	32.02	291.63	29.77	31.92	252.23
2022	72.04	29.17	303.26	27.95	29.97	237.16
Trend 1990 - 2022	112.58%	171.37%	45.82%	50.29%	-17.23%	9.60%
Trend 2021 - 2022	-10.76%	-8.90%	3.99%	-6.13%	-6.12%	-5.97%

3.2.1 NFR 1.A.2.a Iron and Steel

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: Yes (CO, PM_{10}, $PM_{2.5}$)

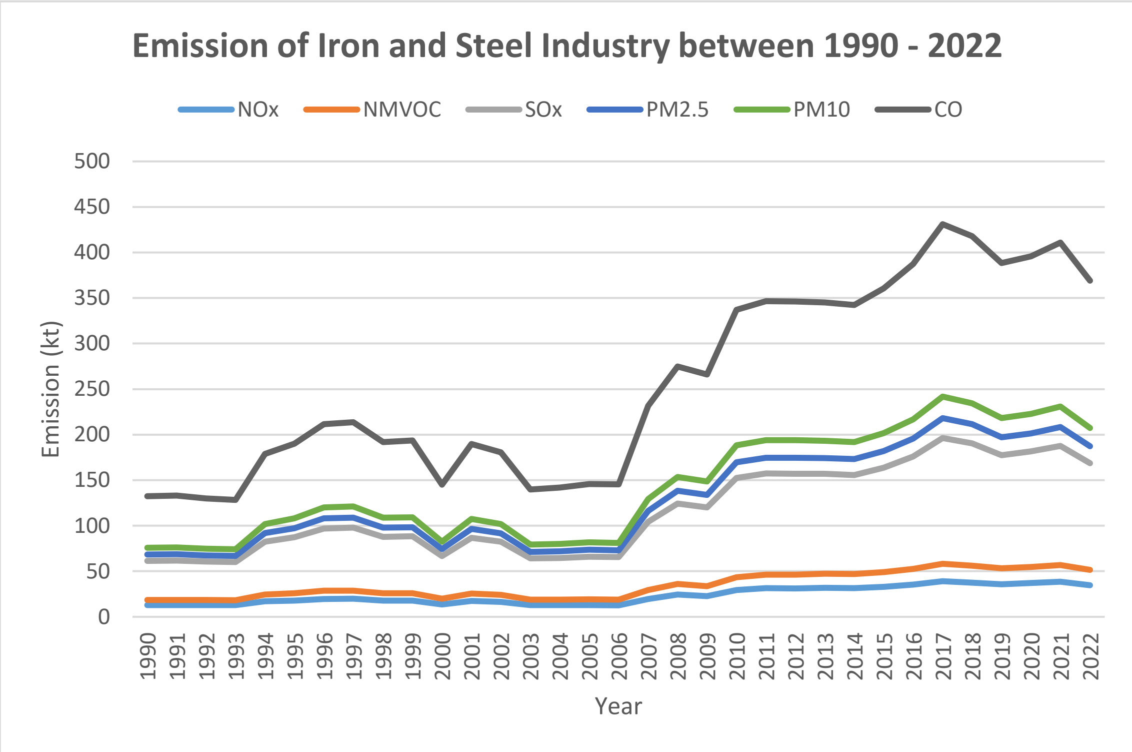

Figure 3.6 Emissions from Iron and Steel Manufacturing Industries between 1990 - 2022

Table 3.9 Emission Totals from Iron and Steel - Stat. Comb. In Manufacturing Ind.

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	12.76	5.54	43.00	6.94	7.50	56.51
1991	12.99	5.57	43.23	6.98	7.54	56.75
1992	12.95	5.42	42.30	6.82	7.37	54.97
1993	12.83	5.35	41.93	6.75	7.30	54.17
1994	16.91	7.52	58.00	9.37	10.14	76.97
1995	17.73	8.01	61.54	9.95	10.77	82.24
1996	19.66	8.91	68.44	11.07	11.98	91.58
1997	19.73	9.00	69.05	11.17	12.09	92.66
1998	17.80	8.08	62.02	10.03	10.85	83.03
1999	17.70	8.16	62.43	10.11	10.94	84.12
2000	13.66	6.10	47.04	7.60	8.22	62.58
2001	17.35	8.01	61.27	9.92	10.73	82.59
2002	16.48	7.62	58.23	9.43	10.20	78.55
2003	12.98	5.88	45.18	7.31	7.91	60.42
2004	12.87	5.99	45.70	7.40	8.01	61.80
2005	12.91	6.17	46.99	7.60	8.22	63.95
2006	12.59	6.16	46.70	7.56	8.18	64.14
2007	19.62	9.82	74.71	12.03	12.99	102.56
2008	24.36	11.57	88.26	14.11	15.17	121.22
2009	22.57	11.20	86.45	13.72	14.73	117.36
2010	29.38	14.19	108.89	17.35	18.63	148.68
2011	31.65	14.58	111.25	17.23	19.09	152.77
2012	31.08	15.26	110.78	17.60	19.06	152.40
2013	31.77	15.46	109.62	17.49	18.95	151.82
2014	31.55	15.34	108.80	17.35	18.80	150.61
2015	32.93	16.11	114.67	18.29	19.81	158.67
2016	35.26	17.24	123.44	19.66	21.30	170.52
2017	39.09	19.13	138.08	21.83	23.65	189.29
2018	37.64	18.51	134.21	21.18	22.94	183.63
2019	35.80	17.41	124.12	19.62	21.25	170.32
2020	36.94	17.73	126.86	19.83	21.56	172.77
2021	38.41	18.56	130.52	20.75	22.47	180.26
2022	34.74	16.69	117.07	18.63	20.18	161.85

Trend 1990 - 2022	172.28%	201.21%	172.26%	168.44%	145.34%	158.62%
Trend 2021 - 2022	-9.55%	-10.10%	-10.31%	-10.20%	-10.20%	-10.22%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

Emissionpollutant = emissions of pollutant i for the period concerned in the inventory (kt)

ADfuel = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Emission factors are presented in Table 3.2.2

Table 3.10 Emission factors (EF) used sector 1.A.2.a Iron and Steel

Fuel	Unit	EF	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4

N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission	Table 3-2

			factors 1.A.2 Combustion in industry using hard or brown coal	
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

Wood	g/GJ	10.8*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	Table 3-4

			(combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	7.31*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission	Table 3-5

			factors 1.A.2 Combustion in industry using solid fuels	
Wood	g/GJ	90*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5

Uncertainty

Estimation of uncertainties based on default values from EMEP/EEA emission inventory Guidebook.

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

Planned Improvements

Plant specific emissions and emission factors will be obtained/calculated and be used for further submissions together with the petroleum split data.

3.2.2 NFR 1.A.2.b Non-ferrous Metals

Source Category Description

Emissions**:** NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: No

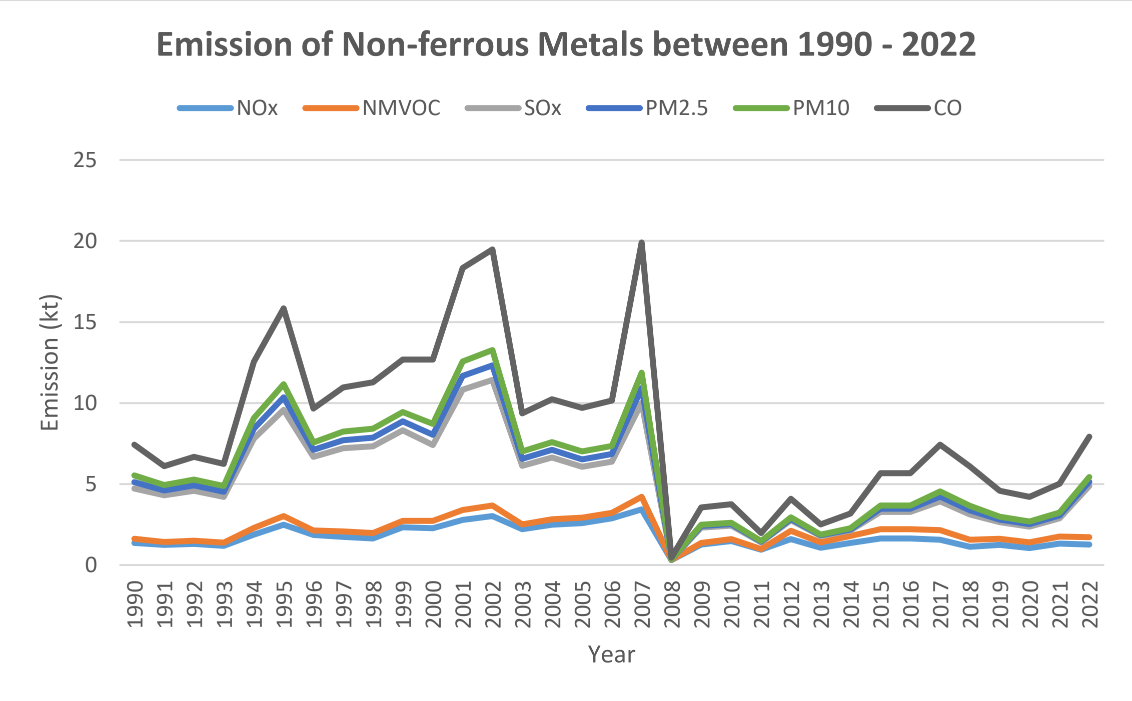

Figure 3.7 Emissions from Non-Ferrous Metals between 1990 - 2022

Table 3.11 Emissions from non-ferrous metals

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	1.37	0.25	3.10	0.39	0.42	1.89
1991	1.24	0.18	2.87	0.31	0.33	1.17
1992	1.31	0.20	3.06	0.34	0.36	1.40
1993	1.19	0.19	2.83	0.32	0.34	1.36
1994	1.87	0.41	5.52	0.61	0.65	3.47
1995	2.49	0.54	6.56	0.77	0.81	4.69
1996	1.86	0.28	4.53	0.44	0.46	2.10
1997	1.73	0.33	5.14	0.50	0.53	2.74
1998	1.64	0.35	5.35	0.53	0.56	2.86
1999	2.34	0.38	5.60	0.55	0.58	3.22
2000	2.27	0.45	4.69	0.63	0.67	3.97
2001	2.78	0.62	7.42	0.85	0.90	5.76
2002	3.01	0.67	7.74	0.90	0.95	6.21
2003	2.21	0.30	3.61	0.44	0.46	2.36
2004	2.50	0.33	3.82	0.46	0.48	2.65
2005	2.59	0.33	3.13	0.47	0.49	2.69
2006	2.88	0.34	3.15	0.48	0.49	2.81
2007	3.43	0.77	5.81	0.91	0.95	8.03
2008	0.30	0.01	0.03	0.01	0.01	0.11
2009	1.26	0.10	0.94	0.09	0.09	1.05
2010	1.48	0.11	0.83	0.09	0.09	1.13
2011	0.94	0.05	0.41	0.04	0.04	0.49
2012	1.61	0.50	0.65	0.08	0.09	1.15
2013	1.07	0.32	0.40	0.04	0.04	0.62
2014	1.37	0.43	0.34	0.06	0.07	0.92
2015	1.64	0.57	1.08	0.19	0.20	2.00
2016	1.64	0.57	1.08	0.19	0.20	2.00
2017	1.55	0.59	1.78	0.30	0.32	2.88
2018	1.12	0.44	1.55	0.26	0.28	2.43
2019	1.24	0.39	1.02	0.16	0.17	1.60
2020	1.05	0.35	0.98	0.15	0.17	1.52
2021	1.33	0.43	1.12	0.18	0.19	1.77
2022	1.27	0.45	3.15	0.27	0.29	2.49

Trend 1990 - 2022	-7.53%	81.44%	1.56%	-32.54%	-57.03%	-37.21%
Trend 2021 - 2022	-4.55%	5.94%	181.03%	50.11%	50.26%	41.04%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Emission factors are presented in Table 3.11

Table 3.12 EFs for Non-Ferrous Metals Industry

Fuel	Unit	Ef	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Combustion in industry using solid fuels	
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal, page 15	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2	Table 3-4

			Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels, page 15	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Wood	g/GJ	10.8*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2	Table 3-4

			Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels, page 15	Table 3-5
Wood	g/GJ	7.31*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	Table 3-4

			(combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				

H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1	Table 3-4

			emission factors 1.A.2 Combustion in industry using liquid fuels, page 16	
N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels, page 15	Table 3-5
Wood	g/GJ	155*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

Planned Improvements

Plant specific emissions and emission factors will be obtained/calculated and be used for further submissions together with the petroleum split data.

3.2.3 NFR 1.A.2.c Chemicals

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: No

Within the structural changes in the EMEP/EEA GB, chemicals category covers the total of subcategories chemicals, petrochemical and fertilizer.

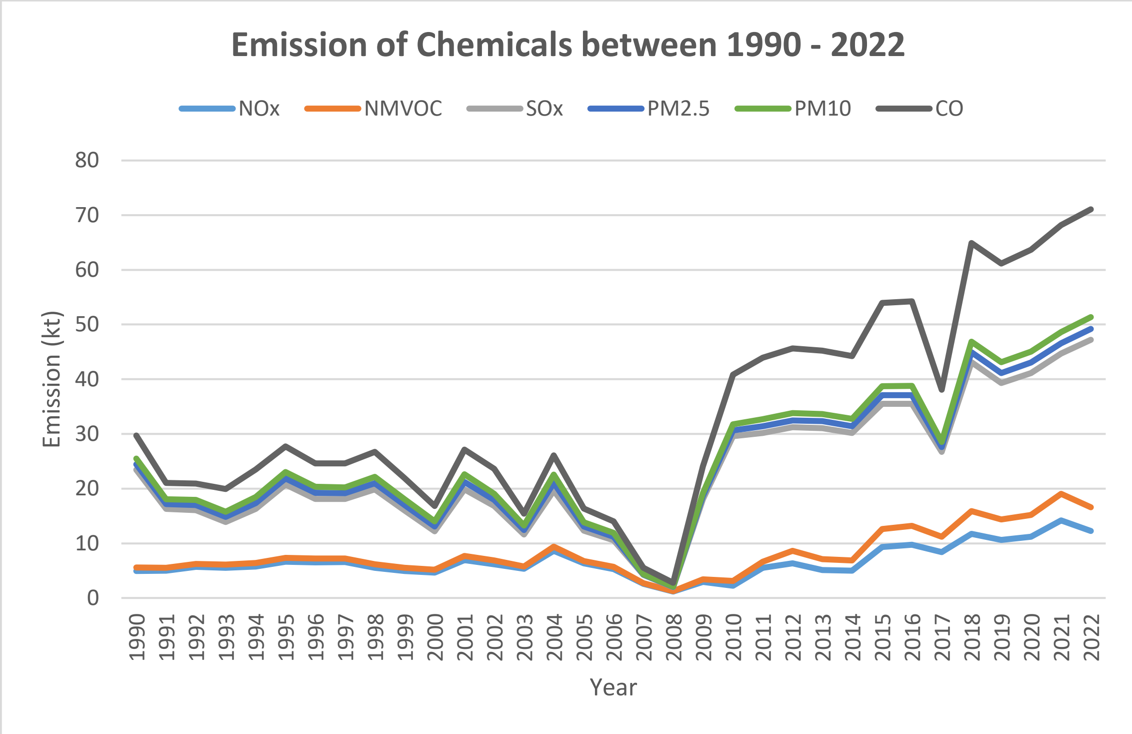

Figure 3.8 Emission of Chemical Manufacturing between 1990 - 2022

Table 3.13 Emission of Chemical Manufacturing between 1990 - 2022

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	4.94	0.62	17.86	1.01	1.07	4.19
1991	4.99	0.50	10.83	0.85	0.89	2.97
1992	5.70	0.53	9.85	0.91	0.95	2.97
1993	5.55	0.59	7.79	0.90	0.94	4.15
1994	5.73	0.68	9.90	1.04	1.09	5.05
1995	6.64	0.70	13.41	1.12	1.18	4.66
1996	6.54	0.66	10.92	1.08	1.13	4.29
1997	6.59	0.65	10.88	1.03	1.07	4.39
1998	5.51	0.67	13.70	1.10	1.16	4.55
1999	4.91	0.59	10.52	0.99	1.04	3.89
2000	4.65	0.50	7.06	0.89	0.93	2.80
2001	6.93	0.77	12.16	1.36	1.43	4.51
2002	6.18	0.67	9.98	1.08	1.13	4.56
2003	5.32	0.44	5.88	0.78	0.82	2.19
2004	8.64	0.76	10.23	1.43	1.50	3.48
2005	6.32	0.46	5.51	0.77	0.80	2.49

2006	5.30	0.39	4.84	0.66	0.69	2.12
2007	2.58	0.12	1.52	0.08	0.08	1.16
2008	1.18	0.07	0.73	0.05	0.05	0.70
2009	2.95	0.48	14.62	0.56	0.58	4.88
2010	2.26	0.87	26.45	1.07	1.12	9.06
2011	5.54	1.08	23.56	1.24	1.29	11.24
2012	6.32	2.29	22.62	1.23	1.33	11.85
2013	5.12	1.96	24.00	1.23	1.33	11.56
2014	4.97	1.91	23.29	1.23	1.33	11.51
2015	9.35	3.26	22.92	1.54	1.67	15.21
2016	9.74	3.44	22.35	1.55	1.68	15.50
2017	8.41	2.80	15.53	0.87	0.94	9.52
2018	11.75	4.13	27.26	1.79	1.94	18.04
2019	10.62	3.76	24.92	1.84	2.00	18.04
2020	11.21	3.96	25.98	1.89	2.05	18.61
2021	14.19	4.86	25.63	1.90	2.06	19.55
2022	12.28	4.30	30.63	1.99	2.16	19.71
Trend 1990 - 2022	148.66%	595.32%	71.53%	96.84%	132.02%	604.90%
Trend 2021 - 2022	-13.41%	-11.54%	19.49%	4.94%	4.90%	0.81%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal. Emission factors are presented in Table 3.14

Table 3.14 Emission factors for 1.A.2

Fuel	Unit	EF	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in	Table 3-2

			industry using hard or brown coal	
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3

AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4

N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Wood	g/GJ	10.8*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in	Table 3-2

			industry using hard or brown coal	
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in	Table 3-5

			industry using solid fuels	
Wood	g/GJ	7.31*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing	Table 3-2

			industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing	Table 3-3

			industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing	Table 3-2

			industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	Table 3-4

			(combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	155*	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in	*(*assumption covers the brown coal from GB and NCVs from NIR)*

industry using solid fuels

Uncertainty

Estimation of uncertainties based on default values from EMEP/EEA emission inventory GB.

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

Planned Improvements

Plant specific emissions and emission factors will be obtained/calculated and be used for further submissions together with the petroleum split data.

3.2.4 NFR 1.A.2.d Pulp, Paper, and Print

Source Category Description

Emissions: IE from 1990-2010,

by 2011; NOx, SO2, NMVOC, CO, PM10, $PM_{2.5}$

Key Source: No

Source of Activity Data

Fuel data were not resolved in the energy balance tables. Since it is not adequate for calculations, it is assumed that it is included in the fuel that has been allocated to stationary sources, so emissions were reported as “IE” under this section from 1990-2010.

By 2011, energy balance tables were configured by the subcategories under manufacturing industries. Therefore, emissions were calculated separately under the topic of Pulp, Paper, and Print.

Activity data is originated from different type of fuels used in this sector and are taken from the energy balance tables (Source: Ministry of Energy and Natural resources 2022).

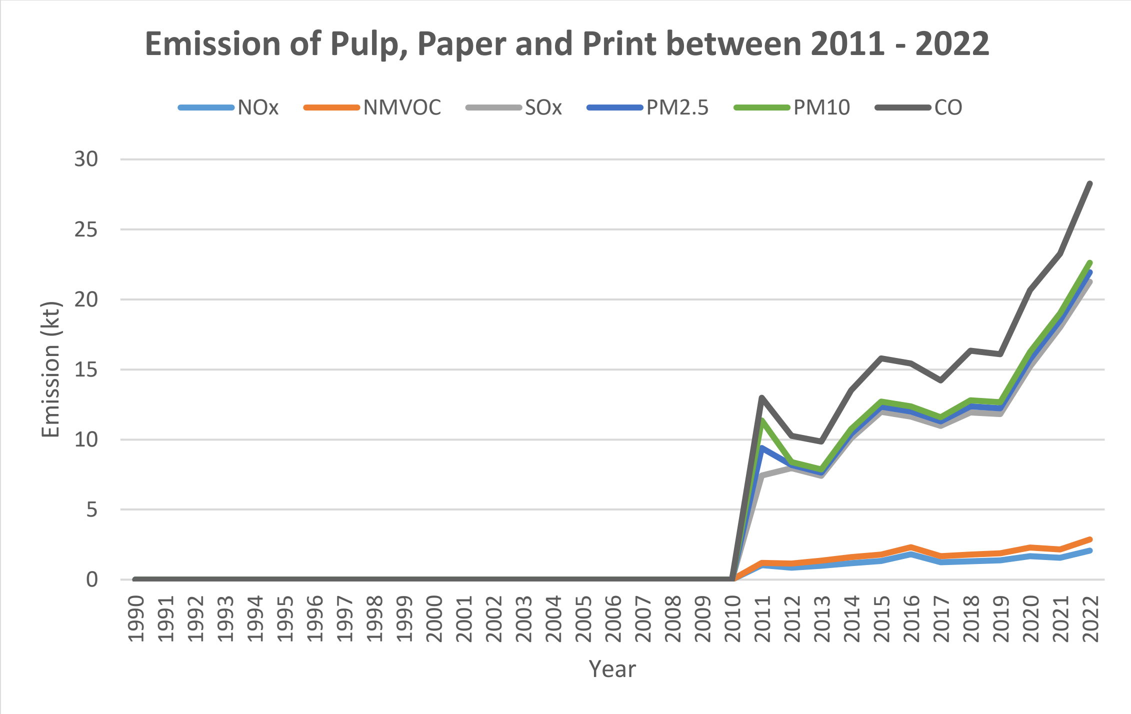

Figure 3.9 Emissions from 1.A.2.d Pulp, Paper, and Print between 1990-2022

Table 3.15 Emissions from 1.A.2.d Pulp, Paper and Print between 1990-2022

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	**kt**	**kt**	**kt**	**kt**	**kt**
1990	IE	IE	IE	IE	IE	IE
1991	IE	IE	IE	IE	IE	IE
1992	IE	IE	IE	IE	IE	IE
1993	IE	IE	IE	IE	IE	IE
1994	IE	IE	IE	IE	IE	IE
1995	IE	IE	IE	IE	IE	IE
1996	IE	IE	IE	IE	IE	IE
1997	IE	IE	IE	IE	IE	IE
1998	IE	IE	IE	IE	IE	IE
1999	IE	IE	IE	NE	IE	IE
2000	IE	IE	IE	NE	IE	IE
2001	IE	IE	IE	NE	IE	IE
2002	IE	IE	IE	NE	IE	IE
2003	IE	IE	IE	NE	IE	IE
2004	IE	IE	IE	NE	IE	IE
2005	IE	IE	IE	NE	IE	IE

2006	IE	IE	IE	NE	IE	IE
2007	IE	IE	IE	NE	IE	IE
2008	IE	IE	IE	NE	IE	IE
2009	IE	IE	IE	NE	IE	IE
2010	IE	IE	IE	NE	IE	IE
2011	1.04	0.15	6.24	1.96	1.96	1.62
2012	0.85	0.29	6.81	0.22	0.22	1.87
2013	0.99	0.36	6.07	0.23	0.23	1.99
2014	1.17	0.43	8.49	0.33	0.33	2.76
2015	1.34	0.46	10.18	0.37	0.37	3.07
2016	1.81	0.50	9.31	0.37	0.37	3.06
2017	1.25	0.43	9.30	0.31	0.31	2.62
2018	1.30	0.49	10.14	0.43	0.43	3.55
2019	1.37	0.51	9.95	0.41	0.41	3.44
2020	1.67	0.64	12.89	0.53	0.53	4.42
2021	1.56	0.60	15.84	0.51	0.51	4.24
2022	2.07	0.80	18.39	0.68	0.68	5.65
Trend 2011 - 2022	99.26%	427.90%	194.89%	-65.40%	-65.40%	248.10%
Trend 2021 - 2022	32.72%	32.50%	16.12%	33.43%	33.43%	33.30%

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Table 3.16 Emission Factors

Fuel	Unit	EF	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	Table 3-4

			(combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2	Table 3-2

			Combustion in industry using hard or brown coal	
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing	*(*assumption covers the brown*

			industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*coal from GB and NCVs from NIR)*
Wood	g/GJ	10.8	EMEP/EEA (2016), Chapter 1.A.2Manufacturingindustries and construction(combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2	Table 3-2

			Combustion in industry using hard or brown coal	
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	7.31	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				

H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier	Table 3-3

			1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1	*(*assumption covers the brown coal from GB and NCVs from NIR)*

	emission factors 1.A.2 Combustion in industry using solid fuels

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

Planned Improvements

For further inventorial management, data info will be obtained from the sector groups.

3.2.5 NFR 1.A.2.e Food Processing, Beverages, and Tobacco

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}

Key Source: No

By 2011, sugar and food-drink were separately calculated. After the revision of the GB, food, beverages, and tobacco were calculated under the same NFR category and therefore summed up. Together with the amendments of the energy balance tables this category covers the sum of sugar, food, drink and tobacco under the topic of manufacturing. Emission trend of the food, beverages and tobacco manufacturing is presented in Figure 3.10.

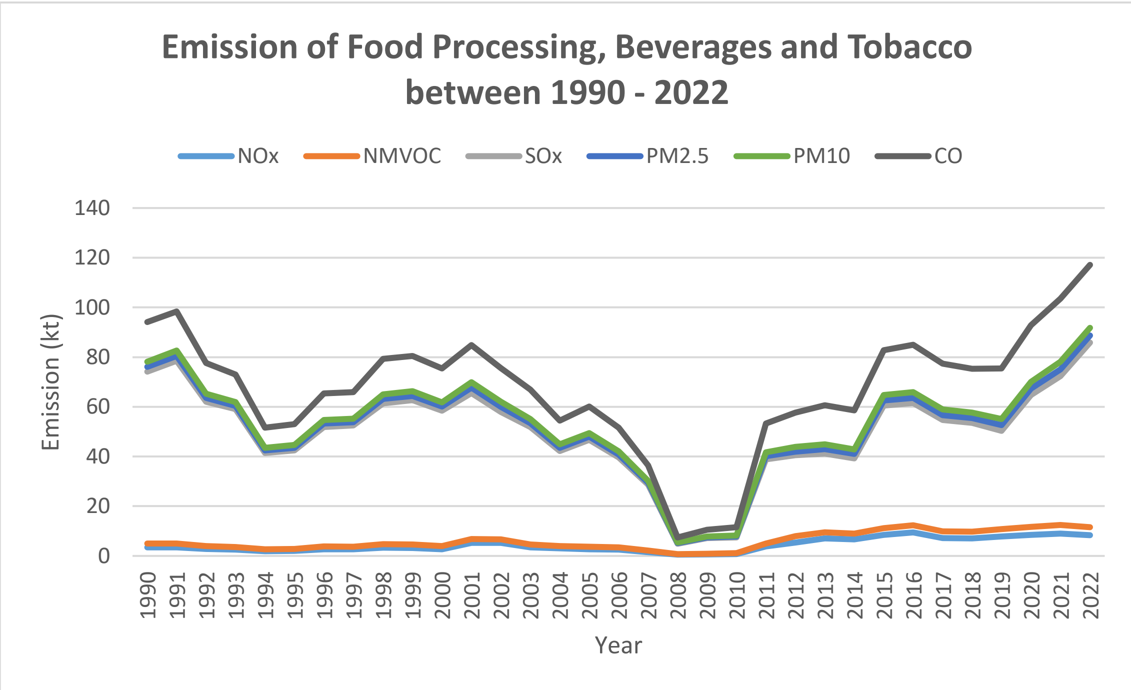

Figure 3.10 Emissions from NFR 1.A.2.e Stationary combustion in manufacturing industries and construction: Food Processing, Beverages, and Tobacco between 1990-2022

Table 3.17 Emissions from NFR 1.A.2.e Stationary combustion in manufacturing industries and construction: Food processing, beverages, and tobacco

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	3.49	1.55	69.07	1.96	2.09	15.88
1991	3.46	1.54	73.57	1.94	2.08	15.77
1992	2.79	1.21	58.04	1.53	1.64	12.35
1993	2.52	1.09	55.46	1.37	1.47	11.10
1994	1.87	0.79	38.83	1.00	1.07	8.04
1995	2.02	0.82	39.64	1.03	1.11	8.36
1996	2.73	1.06	48.12	1.34	1.44	10.75
1997	2.65	1.05	48.77	1.33	1.42	10.71
1998	3.32	1.41	56.63	1.79	1.91	14.29
1999	3.19	1.38	58.06	1.75	1.86	14.16
2000	2.70	1.31	54.45	1.61	1.72	13.69
2001	5.21	1.57	58.78	2.12	2.25	14.87
2002	5.18	1.45	51.34	2.00	2.13	13.40
2003	3.46	1.20	47.20	1.56	1.67	11.83
2004	3.01	0.98	38.24	1.28	1.36	9.57
2005	2.66	1.05	43.01	1.32	1.40	10.72
2006	2.55	0.94	36.19	1.18	1.25	9.54
2007	1.55	0.61	26.52	0.76	0.81	6.17
2008	0.52	0.20	4.17	0.25	0.27	2.02
2009	0.59	0.26	6.32	0.32	0.34	2.64
2010	0.78	0.32	6.32	0.40	0.42	3.34
2011	3.86	1.13	33.85	1.37	1.44	11.67
2012	5.43	2.49	32.68	1.41	1.85	13.75
2013	7.06	2.45	31.72	1.78	1.89	15.77
2014	6.63	2.32	30.25	1.79	1.90	15.71
2015	8.47	2.66	49.36	2.04	2.20	18.01
2016	9.45	2.92	49.13	2.14	2.31	19.00
2017	7.17	2.68	44.80	2.05	2.21	18.43
2018	7.10	2.68	43.79	1.94	2.10	17.67
2019	7.78	2.98	39.60	2.24	2.43	20.33
2020	8.46	3.25	53.05	2.53	2.73	22.78
2021	8.92	3.53	59.85	2.81	3.04	25.32
2022	8.28	3.30	74.27	2.85	3.08	25.34

Trend 1990 - 2022	137.00%	112.66%	7.53%	45.43%	78.98%	85.05%
Trend 2021 - 2022	-7.16%	-6.50%	24.10%	1.29%	1.33%	0.08%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Table 3.18 Emission Factors

Fuel	Unit	EF	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-2

			using hard or brown coal	
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81	EMEP/EEA (2016), Chapter 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and	Table 3-2

			construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Combustion in industry using solid fuels	
Wood	g/GJ	10,8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	23	EMEP/EEA(2016), Chapter1.A.2 Manufacturing industries andconstruction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2	Table 3-5

			Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	
Wood	g/GJ	7,31	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	Table 3-2

			(combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in	Table 3-3

			industry using natural gas or derived gases	
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in	Table 3-2

			industry using hard or brown coal	
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4

N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

Recalculations

Recalculations were checked and applied until 1990 due to typos.

3.2.6 NFR 1.A.2.f Non-Metallic Minerals

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5,}$

Key Source: Yes (SO_2, NO_x, NMVOC, CO, PM_{10}, $PM_{2.5}$)

After the revision of the GB, ceramics, glass, and cement were calculated under the same NFR category and therefore summed up. Emission trend of non-metallic minerals is presented in Figure 3-2-6.

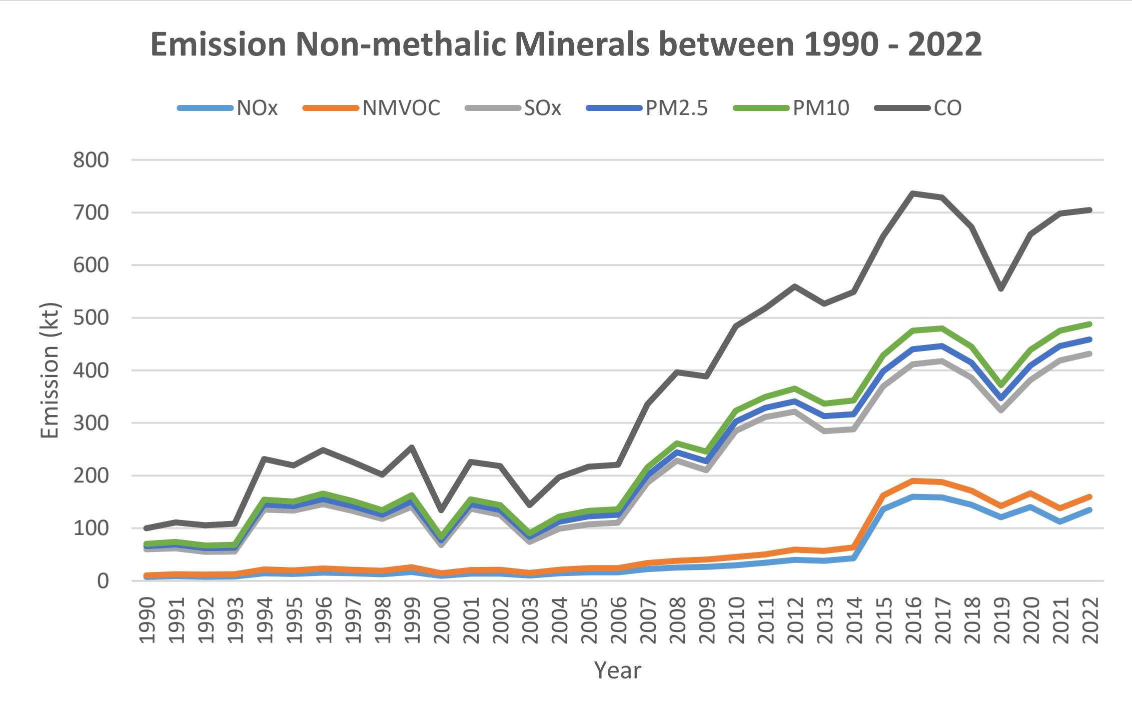

Figure 3.11 Emissions from NFR 1.A.2.f. Stationary combustion in manufacturing industries and construction: Non-Metallic Minerals, 1990-2022

Table 3.19 Emissions from NFR 1.A.2.f. Stationary combustion in manufacturing industries and construction: Non-Metallic Minerals

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	7.54	2.97	49.36	6.34	4.09	29.71
1991	8.96	3.64	49.48	7.34	4.95	36.82
1992	8.09	3.69	43.47	7.15	4.90	38.25
1993	8.59	3.91	43.55	7.31	5.21	40.41
1994	14.68	7.34	113.79	9.13	9.68	76.79
1995	13.33	6.59	113.89	8.22	8.72	68.76
1996	15.83	7.89	121.90	9.82	10.43	82.45
1997	14.24	7.13	111.93	8.92	9.42	74.63
1998	12.76	6.44	98.78	8.02	8.51	67.37
1999	17.16	8.63	115.41	10.37	11.39	90.34
2000	9.80	4.86	53.28	9.20	6.42	50.76
2001	13.66	6.84	116.77	8.48	9.03	71.51
2002	14.08	7.08	104.87	8.77	9.34	74.02
2003	10.22	5.10	58.83	9.79	6.73	53.27
2004	14.24	7.15	77.51	13.49	9.44	74.87
2005	16.21	8.01	83.40	14.86	10.60	83.62
2006	16.32	8.08	86.15	15.10	10.69	84.38
2007	22.52	11.41	152.50	14.26	15.04	119.60
2008	25.21	12.85	190.54	16.00	16.95	134.66
2009	26.74	13.65	170.03	16.97	17.99	142.97
2010	30.00	15.34	239.93	17.74	20.21	160.71
2011	34.45	16.03	260.83	17.48	21.01	167.96
2012	39.92	19.39	262.44	19.18	24.29	194.02
2013	38.37	18.84	227.06	28.53	23.79	189.98
2014	42.92	20.83	224.68	28.53	25.79	206.31
2015	136.19	26.22	207.21	28.53	30.33	226.18
2016	159.90	30.15	221.62	28.53	35.08	260.80
2017	158.62	29.20	229.82	28.53	33.54	248.63
2018	144.60	26.72	214.61	28.53	30.61	227.07
2019	120.69	21.79	181.63	23.11	24.72	182.88
2020	140.45	25.93	215.33	27.58	29.59	219.51
2021	112.32	25.40	281.14	27.19	29.27	222.76
2022	134.63	25.46	271.51	27.12	29.11	216.66

Trend 1990 - 2022	1684.45%	757.53%	450.05%	327.91%	353.32%	326.81%
Trend 2021 - 2022	19.86%	0.23%	-3.43%	-0.25%	-0.55%	-2.74%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Table 3.20 Emission Factors

Fuel	Unit	Ef	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-2

			using hard or brown coal	
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81	EMEP/EEA (2016), Chapter 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and	Table 3-2

			construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Combustion in industry using solid fuels	
Wood	g/GJ	10,8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-2

			using hard or brown coal	
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-3

			using natural gas or derived gases	
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	7,31	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4

N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion),Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2	Table 3-2

			Manufacturing industries and construction (combustion),Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and	Table 3-4

			construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	
N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

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

Source Category Description: IE

Emissions: NOx, SO2, NMVOC, CO, PM10

Key Source: No

Emissions were assumed and calculated under the ‘stationary other’ NFR category.

3.2.8 NFR 1.A.2.g viii Mobile Combustion in manufacturing industries and Construction: Other

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: No

By 2011, textile and motor vehicle manufacturing were separately given in the energy balance. By 2013, after the revision of the GB ‘stationary other’ NFR category covers the textile, motor vehicle manufacturing and the ‘other’ manufacturing industry. “Other” subcategory covers under the listing of energy balance tables, fabric metal products, wood and products, mining, machine, electrical, electronical products, other transport vehicles manufacturing, furniture and other products, construction and other.

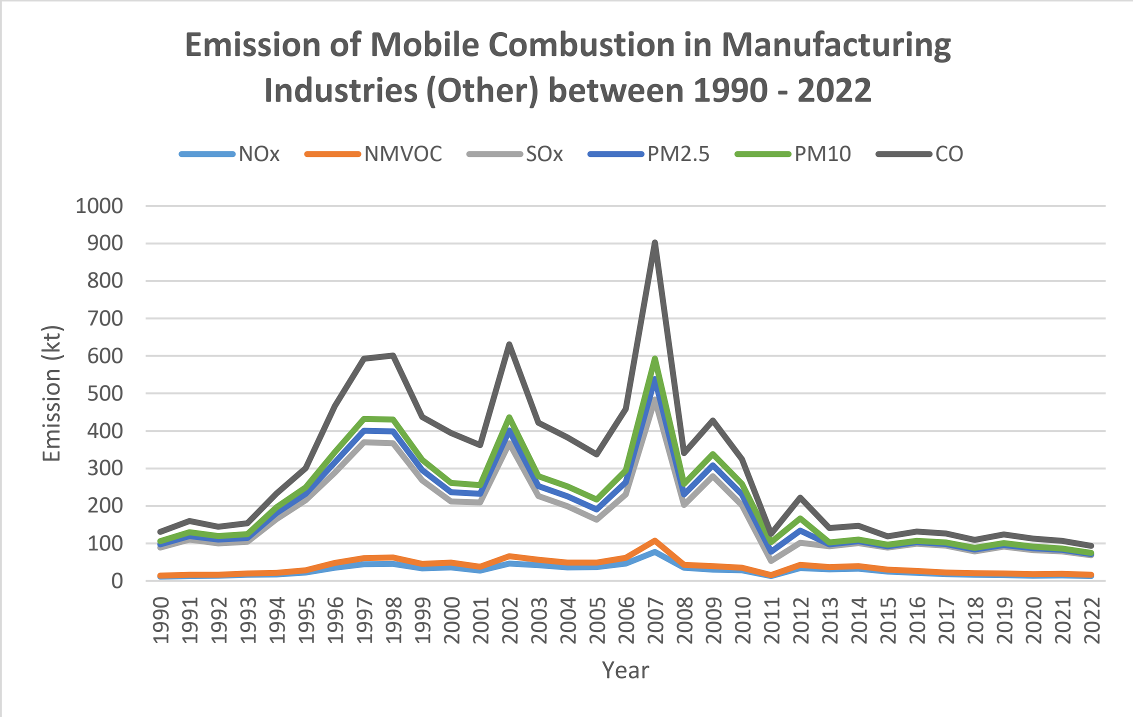

Figure 3.12 SO_2, NOx, NMVOC, NH_3, CO and PM_{10} emissions from NFR 1.A.2.gviii.

Stationary combustion in manufacturing industries and construction: Other from 1990- 2022 Emission totals are given in the table 3.20.

Table 3.21 Emissions from NFR 1. A.2.gviii. Other Stationary combustion in manufacturing industries and construction

Years	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	CO
	kt	kt	kt	kt	kt	kt
1990	11.32	2.79	74.94	8.29	8.29	24.99
1991	13.04	3.35	93.46	9.96	9.96	30.36
1992	13.52	2.95	83.97	9.45	9.45	25.41
1993	16.04	3.37	84.76	10.41	10.41	28.79
1994	17.02	4.06	144.03	15.72	15.72	36.48
1995	22.47	5.58	187.57	16.87	16.87	51.31
1996	35.34	12.36	240.69	27.46	27.46	122.73
1997	44.35	16.03	309.04	31.31	31.31	160.68
1998	45.76	16.97	304.44	31.52	31.52	171.20
1999	33.69	11.54	223.13	27.23	27.23	114.72
2000	35.78	13.31	162.82	24.66	24.66	133.36
2001	27.62	10.49	171.16	23.06	23.06	107.09
2002	46.67	19.03	301.09	34.85	34.85	194.83
2003	42.13	14.27	170.24	26.12	26.12	142.96
2004	36.22	12.86	149.68	26.69	26.69	130.48
2005	36.62	11.99	114.79	26.80	26.80	120.25
2006	45.90	16.05	168.70	32.03	32.03	163.57
2007	77.35	29.99	376.54	54.58	54.58	309.60
2008	34.74	8.36	159.52	28.11	28.11	82.28
2009	30.22	8.88	239.80	29.66	29.66	89.98
2010	28.43	6.55	166.53	28.75	28.75	65.23
2011	13.08	2.40	37.66	25.08	25.08	22.37
2012	34.71	8.04	58.72	32.72	32.72	54.79
2013	30.67	5.92	55.58	5.04	5.04	38.47
2014	32.74	6.30	61.88	4.76	4.76	36.73
2015	25.09	4.71	58.75	3.99	3.99	22.50
2016	21.81	4.75	72.34	4.13	4.13	24.10
2017	17.94	4.70	71.77	4.20	4.20	24.02
2018	16.10	4.64	58.21	4.53	4.53	21.63
2019	15.35	4.35	71.42	4.85	4.85	22.86
2020	13.74	3.91	64.74	4.61	4.61	20.97
2021	14.93	4.16	59.88	3.58	3.58	20.45
2022	13.20	3.57	51.69	3.14	3.14	18.72

Trend 1990 - 2022	16.58%	27.81%	-31.02%	-62.12%	-87.26%	-85.96%
Trend 2021 - 2022	-11.57%	-14.30%	-13.68%	-12.35%	-12.35%	-8.48%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Table 3.22 Emission Factors

Fuel	Unit	EF	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-2

			using hard or brown coal	
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81*	EMEP/EEA (2016), Chapter 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and	Table 3-2

			construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			Combustion in industry using solid fuels	
Wood	g/GJ	10,8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-2

			using hard or brown coal	
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Table 3-2 Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Table 3-4 Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Table 3-3 Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-3

			using natural gas or derived gases	
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	7,31	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing	Table 3-3

			industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1	Table 3-2

			emission factors 1.A.2 Combustion in industry using hard or brown coal	
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4

N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels, page 15	*(*assumption covers the brown coal from GB and NCVs from NIR)*

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

3.3 NFR 1.A.3 Transport

3.3.1 NFR 1.A.3.a Civil aviation

3.3.1.1 NFR 1.A.3.a ii(i) Civil Aviation, Domestic LTO and NFR 1.A.3.a i(i) International LTO

Source Category Description

Emissions: NOx, CO, NMVOC, SO_2

Key Source: No

Emission Trends:

- NO_x emissions increased from 2.34 Kt in 1990 to 21.97 Kt in 2022.
- CO emissions increased from 1.08 Kt in 1990 to 12.72 Kt in 2022.
- NMVOC emissions increased from 0.54 Kt in 1990 to 5.41 Kt in 2022.
- SO_2 emissions increased from 0.14 Kt in 1990 to 1.63 Kt in 2022.

Emission trends are presented in Figure 3.13 and Figure 3.14 Flight traffic has decreased during the COVID-19 pandemic. It has led to large decrease in fuel use and aviation emissions in 2020. Then, an increment has detected year conjunction with the increase in transportation on the following.

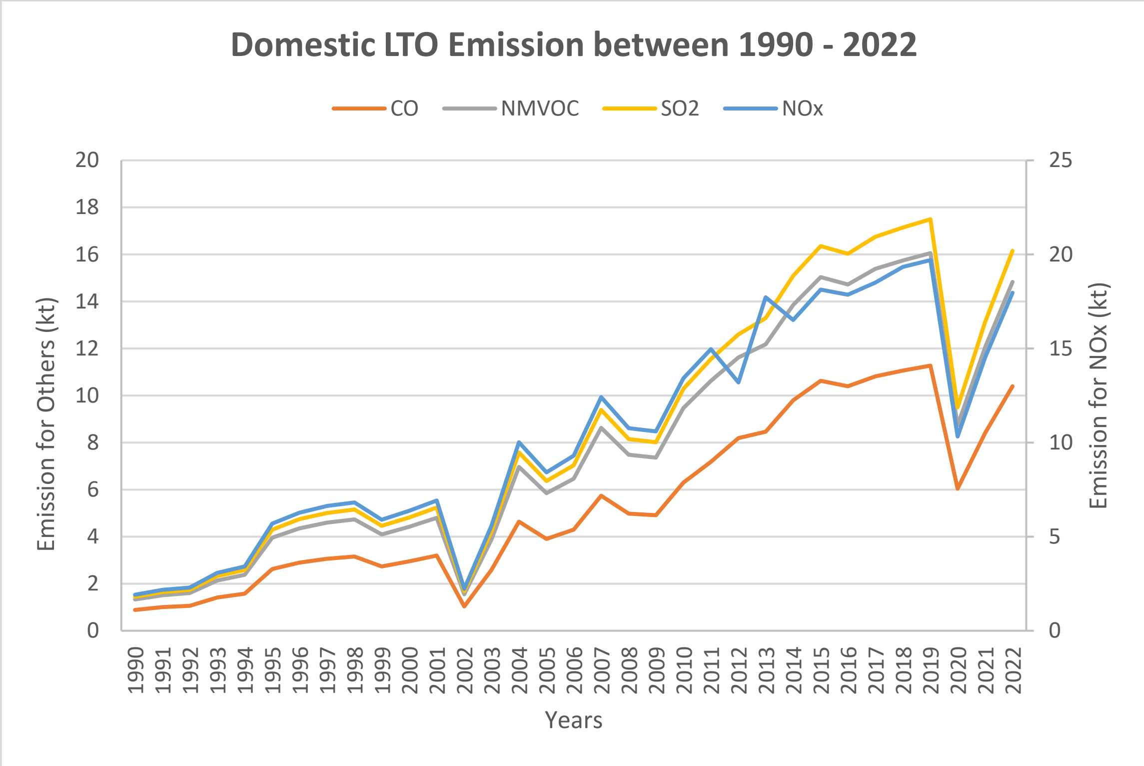

Figure 3.13 Emission Trends for Domestic LTO between 1990 - 2022

Table 3.23 Emissions from sector NFR 1.A.3.a.ii (i) Civil Aviation, Domestic (LTO) for the period 1990 to 2022

Years	SO_2	NO_x	NMVOC	CO
	kt	kt	kt	kt
1990	1.92	0.89	0.45	0.12
1991	2.17	1.00	0.50	0.13
1992	2.30	1.07	0.53	0.14
1993	3.07	1.42	0.71	0.19
1994	3.42	1.58	0.79	0.21
1995	5.69	2.63	1.32	0.35
1996	6.27	2.90	1.46	0.38
1997	6.63	3.07	1.54	0.41
1998	6.81	3.15	1.58	0.42
1999	5.90	2.73	1.37	0.36
2000	6.37	2.95	1.48	0.39
2001	6.92	3.20	1.61	0.42
2002	2.24	1.03	0.52	0.14
2003	5.58	2.58	1.30	0.34
2004	10.02	4.64	2.33	0.61
2005	8.43	3.90	1.96	0.52
2006	9.30	4.30	2.16	0.57
2007	12.41	5.74	2.88	0.76

2008	10.77	4.98	2.50	0.66
2009	10.60	4.91	2.46	0.65
2010	13.43	6.30	3.17	0.83
2011	14.97	7.19	3.44	0.93
2012	13.20	8.20	3.42	0.98
2013	17.73	8.46	3.72	1.11
2014	16.51	9.80	4.05	1.24
2015	18.13	10.62	4.41	1.32
2016	17.86	10.40	4.32	1.31
2017	18.51	10.82	4.57	1.36
2018	19.33	11.07	4.67	1.41
2019	19.70	11.27	4.78	1.44
2020	10.32	6.04	2.70	0.76
2021	14.53	8.41	3.65	1.07
2022	17.96	10.40	4.42	1.33
Trend 1990 - 2022	836.97%	1072.38%	893.97%	1032.68%
Trend 2021 - 2022	23.67%	23.71%	21.07%	23.96%

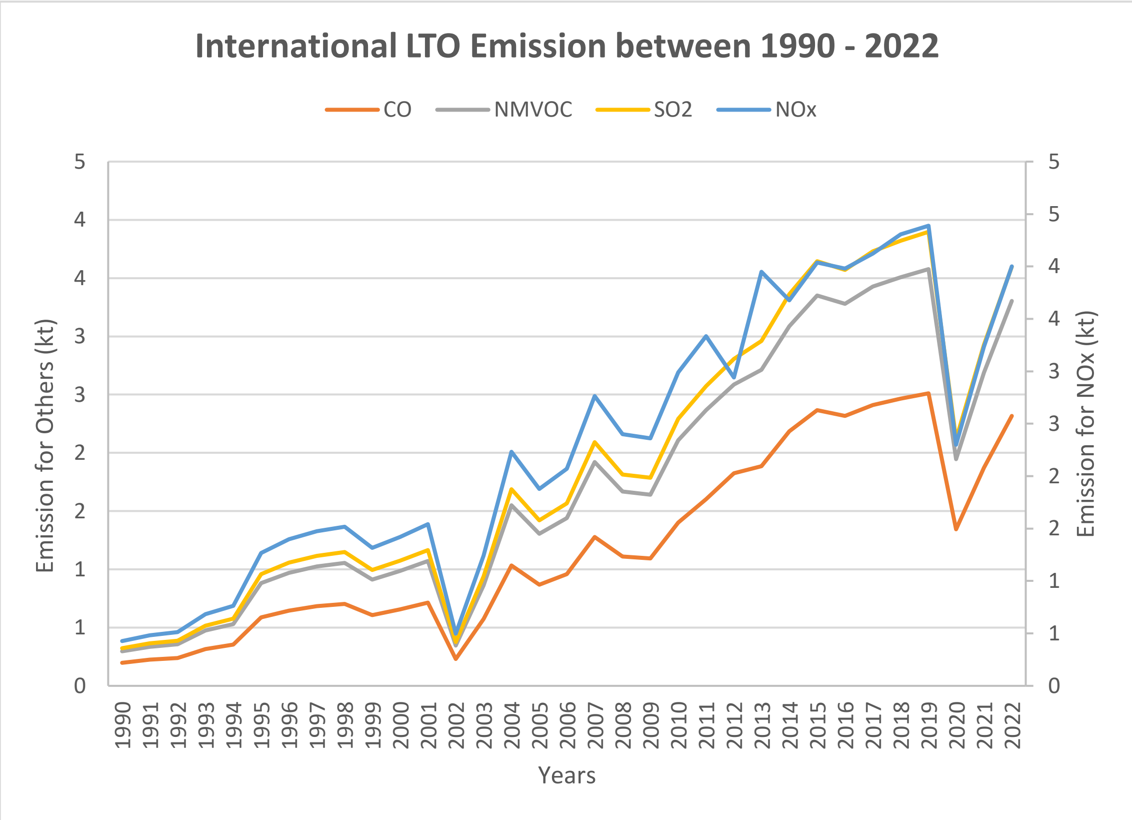

Figure 3.14 Emission Trends for International LTO between 1990 - 2022

Table 3.24 Emissions from sector NFR 1.A.3.a.i (i) International Aviation (LTO) for the period 1990 to 2022

Years	SO_2	NO_x	NMVOC	CO
	kt	kt	kt	kt
1990	0.43	0.20	0.10	0.03
1991	0.48	0.22	0.11	0.03
1992	0.51	0.24	0.12	0.03
1993	0.68	0.32	0.16	0.04
1994	0.76	0.35	0.18	0.05
1995	1.27	0.59	0.29	0.08
1996	1.40	0.65	0.32	0.09
1997	1.48	0.68	0.34	0.09
1998	1.52	0.70	0.35	0.09
1999	1.31	0.61	0.31	0.08
2000	1.42	0.66	0.33	0.09
2001	1.54	0.71	0.36	0.09
2002	0.50	0.23	0.12	0.03
2003	1.24	0.58	0.29	0.08
2004	2.23	1.03	0.52	0.14
2005	1.88	0.87	0.44	0.12
2006	2.07	0.96	0.48	0.13
2007	2.76	1.28	0.64	0.17
2008	2.40	1.11	0.56	0.15
2009	2.36	1.09	0.55	0.14
2010	2.99	1.40	0.71	0.18
2011	3.33	1.60	0.77	0.21
2012	2.94	1.83	0.76	0.22
2013	3.95	1.89	0.83	0.25
2014	3.68	2.18	0.90	0.28
2015	4.04	2.37	0.98	0.29
2016	3.98	2.32	0.96	0.29
2017	4.12	2.41	1.02	0.30
2018	4.31	2.47	1.04	0.31
2019	4.39	2.51	1.07	0.32
2020	2.30	1.34	0.60	0.17
2021	3.24	1.87	0.81	0.24
2022	4.00	2.32	0.99	0.30
Trend 1990 - 2022	836.97%	1072.38%	893.97%	1032.68%
Trend 2021 - 2022	23.67%	23.71%	21.07%	23.96%

Source of Activity Data

Domestic LTO

For domestic aviation the number of LTO per aircraft type is available for the years 2009-2021. To complete the whole time series, the existing 2009 data are extrapolated using the total fuel sales for aviation form the energy balance. Each LTO per aircraft type was multiplied with an ordinary fuel use per LTO.

International LTO

These are calculated by taking the domestic LTO emissions and rescaling by the fuel used for International LTO vs. Domestic LTO.

Source of Emission Factors

The LTO emission factors by aircraft type are taken from the existing emissions model from the Ministry of Transport and Infrastructure (which agree with literature values in the EMEP/EEA Guidebook and IPCC Guidance). These are emissions per LTO cycle, except for SO_2 which is calculated throughout this sector on a fuel basis. For calculation EMEP/EEA Guidebook 2019 is used.

Table 3.25 Emission factor (EF) used sector 1.A.3.a Aviation LTO

EF	NOx	CO	NMVOC
	kg/LTO	**kg/LTO**	**kg/LTO**
median (min – max)	10.2 (0.74 - 65)	8.1 (2.33 - 45)	2.6 (0.26 - 75.9)

Table 3.26 Emission factor (EF) used sector 1.A.3.a Aviation LTO, EMEP 2016

EF	NOx	CO	NMVOC
	kg/LTO	**kg/LTO**	**kg/LTO**
median (min – max)	10.8 (10.8- 38.20)	5.5 (5.5 -82.9)	0.10 (0.10 – 13.20)

Uncertainty

Estimation of uncertainties based on default values from EMEP/EEA Emission Inventory Guidebook 2019. The uncertainty may however lie between 20–30 % for LTO factors.

Recalculations

Recalculations were applied due to the revision of the number of LTO's per aircraft type from The Ministry of Transport and Infrastructure. Recalculations has been done for 2017-2021 years.

Planned Improvements

International LTO

It is currently assumed that the LTO: Cruise fuel use for international is the same as domestic. This is a significant assumption and is not likely to be accurate, because international flights are longer than domestic flights. So the cruise component will account for a higher percentage of the total fuel use. However, without any data this has been the only sensible approach, and it is not expected to have a particular large impact on the total emissions (because the total fuel use is still the same).

There are several steps needed to improve these emission estimates. The first and most important is to obtain international (bunker) aviation fuel data for the entire time series. This issue will be handled for next submissions between the Ministry of Transport and Infrastructure and MoEUCC.

Starting with 2022 submission, numbers of international LTOs will be available, then an estimate of the International LTO fuel use could be analysed, and hence the total split into LTO and cruise components.

3.3.1.2 NFR 1.A.3.a.ii (ii) Civil Aviation, Domestic Cruise (Memo Items) and NFR 1.A.3.a i (ii) International Aviation Cruise (Memo Items)

Source Category Description

Emissions: NO_x, NMVOC, SO_2, CO

Key Source: No

Emission Trend

- NO_x emissions increased from 2.75 Kt in 1990 to 29.96 Kt in 2022.
- CO emissions increased from 1.49 Kt in 1990 to 16.93 Kt in 2022.
- NMVOC emissions decreased from 0.15 Kt in 1990 to 1.69 Kt in 2022.
- SO_2 emissions decreased from 0.21 Kt in 1990 to 2.42 Kt in 2022.

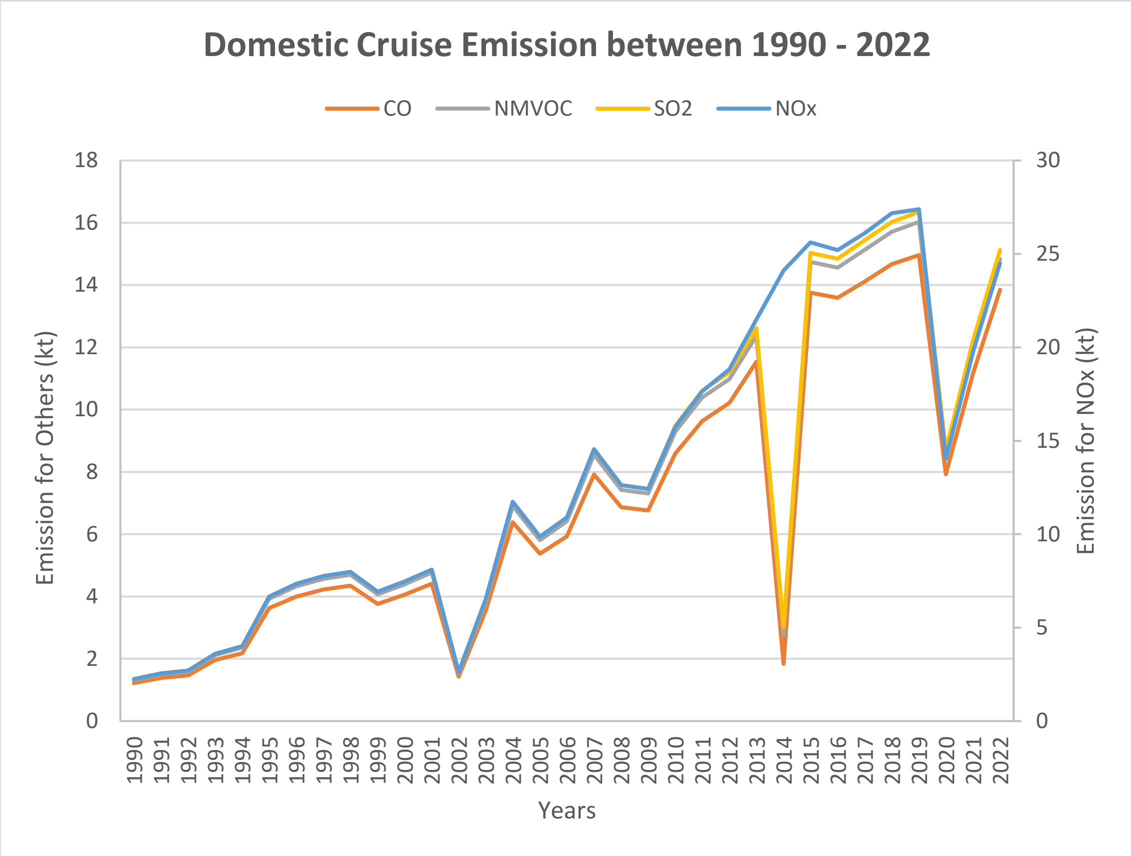

Figure 3.15 Emission Trends for Domestic Cruise between 1990 – 2022

Table 3.27 Emissions from sector Domestic Cruise for the period 1990 to 2022

Years	SO_2	NO_x	NMVOC	CO
	kt	kt	kt	kt
1990	2.25	1.22	0.12	0.17
1991	2.54	1.38	0.14	0.20
1992	2.70	1.47	0.15	0.21
1993	3.60	1.96	0.20	0.28
1994	4.01	2.18	0.22	0.31
1995	6.67	3.63	0.36	0.52
1996	7.35	4.00	0.40	0.57
1997	7.76	4.22	0.42	0.60
1998	7.98	4.34	0.43	0.62
1999	6.92	3.76	0.38	0.54
2000	7.47	4.06	0.41	0.58
2001	8.11	4.41	0.44	0.63
2002	2.62	1.43	0.14	0.20
2003	6.54	3.56	0.36	0.51
2004	11.74	6.39	0.64	0.91
2005	9.88	5.37	0.54	0.77
2006	10.90	5.93	0.59	0.85
2007	14.54	7.91	0.79	1.13

2008	12.62	6.87	0.69	0.98
2009	12.42	6.76	0.68	0.97
2010	15.75	8.59	0.86	1.23
2011	17.65	9.63	0.96	1.38
2012	18.82	10.22	1.02	1.46
2013	21.49	11.54	1.15	1.65
2014	24.11	1.84	1.29	1.84
2015	25.61	13.76	1.38	1.97
2016	25.21	13.59	1.36	1.94
2017	26.12	14.12	1.41	2.02
2018	27.18	14.67	1.47	2.10
2019	27.39	14.96	1.50	2.14
2020	14.03	7.93	0.79	1.13
2021	19.75	11.17	1.12	1.60
2022	24.50	13.85	1.38	1.98
Trend 1990 - 2022	990.67%	1032.68%	1032.68%	1032.68%
Trend 2021 - 2022	24.05%	23.96%	23.96%	23.96%

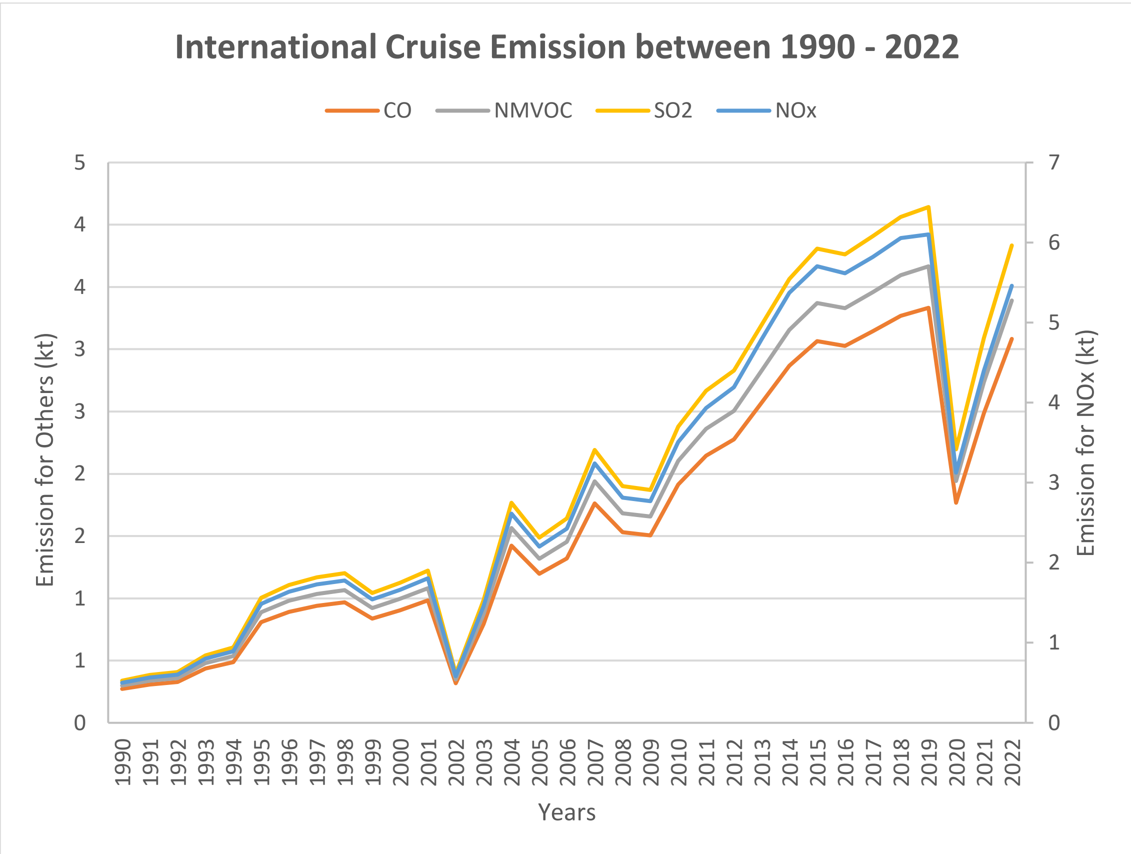

Figure 3.16 Emission Trends for International Cruise between 1990 – 2022

Table 3.28 Emissions from sector International Cruise for the period 1990 to 2022

Years	SO_2	NO_x	NMVOC	CO
	kt	kt	kt	kt
1990	0.50	0.27	0.03	0.04
1991	0.57	0.31	0.03	0.04
1992	0.60	0.33	0.03	0.05
1993	0.80	0.44	0.04	0.06
1994	0.89	0.49	0.05	0.07
1995	1.49	0.81	0.08	0.12
1996	1.64	0.89	0.09	0.13
1997	1.73	0.94	0.09	0.13
1998	1.78	0.97	0.10	0.14
1999	1.54	0.84	0.08	0.12
2000	1.66	0.90	0.09	0.13
2001	1.81	0.98	0.10	0.14
2002	0.58	0.32	0.03	0.05
2003	1.46	0.79	0.08	0.11
2004	2.62	1.42	0.14	0.20
2005	2.20	1.20	0.12	0.17
2006	2.43	1.32	0.13	0.19
2007	3.24	1.76	0.18	0.25
2008	2.81	1.53	0.15	0.22
2009	2.77	1.51	0.15	0.22
2010	3.51	1.91	0.19	0.27
2011	3.93	2.15	0.21	0.31
2012	4.19	2.28	0.23	0.33
2013	4.79	2.57	0.26	0.37
2014	5.37	2.87	0.29	0.41
2015	5.71	3.06	0.31	0.44
2016	5.62	3.03	0.30	0.43
2017	5.82	3.14	0.31	0.45
2018	6.05	3.27	0.33	0.47
2019	6.10	3.33	0.33	0.48
2020	3.12	1.77	0.18	0.25
2021	4.40	2.49	0.25	0.36
2022	5.46	3.08	0.31	0.44
Trend 1990 - 2022	990.67%	1032.68%	1032.68%	1032.68%
Trend 2021 - 2022	24.05%	23.96%	23.96%	23.96%

Source of Activity Data

The total fuel used for cruise is split into the different aircraft types by assuming that the fuel used in the cruise phase is in proportion to that used for LTO (i.e. for each aircraft type, the fraction of total fuel used in cruise is assumed to be the same as the fraction for LTO).

The total fuel used for domestic aviation is available from the energy balance tables. The fuel used for the LTO component has been estimated (above) from the number of LTO movements, it is therefore possible to estimate the fuel used for domestic cruise by difference.

$Fuel_{\text{domestic cruise}} = Fuel_{\text{domestic total}} – Fuel_{\text{domestic LTO}}$

After 2010, domestic cruise fuel was calculated by the cruise/LTO ratio in 2009 was multiplied with domestic LTO fuel. This calculation has applied for the years 2010-2021.

Source of Emission Factors

The emission factors are taken from the existing emissions model from the the Ministry of Transport and Infrastructure (which agrees with literature values in the GB and IPCC Guidance). For cruise the emission factors are fuel-based emissions factors (which is different to the LTO based emission factors). For calculation EMEP/EEA Guidebook 2019 is used. Emission factor is presented in Table 3-2-19.

Table 3.29 Emission factor (EF) used sector 1.A.3.a Aviation (Domestic Cruise)

EF	kg/ton	kg/ton	kg/ton	kg/ton
	NOx	**CO**	**NMVOC**	**SO_2**
median (min – max)	11 (7,2 - 16,1)	7 (7 - 7)	0,7 (0,7 - 0,7)	1 (1 - 1)

Uncertainty

Estimation of uncertainties based on default values from GB.

The uncertainty may however lie between 20–45 % for the cruise factors.

Recalculations

Recalculations have been done for 2010-2021 due to the revision of domestic cruise fuel.

Planned Improvements

The availability of LTO data by aircraft type is going to be obtained yearly from the Ministry of Transport and Infrastructure.

International LTO

It is currently assumed that the LTO: Cruise fuel use for international is the same as domestic. This is a significant assumption and is not likely to be accurate, because international flights are longer than domestic flights. So, the cruise component will account for a higher percentage of the total fuel use. However, without any data this has been the only sensible approach, and it is not expected to have a particular large impact on the total emissions (because the total fuel use is still the same).

There are several steps needed to improve these emission estimates. The first and most important is to obtain international (bunker) aviation fuel data for the entire time series. This issue will be handled for next submissions between the Ministry of Transport and Infrastructure and MoEUCC.

Starting with 2022 submission, numbers of international LTOs will be available, then an estimate of the International LTO fuel use could be analysed, and hence the total split into LTO and cruise components.

3.3.2. NFR 1.A.3.b Road Transportation

Source Category Description

Emissions: NO_x, SO_2, NMVOC, NH_3, CO, PM_{10}, Pb, Cd

Key Source: Yes (NO_x (1A3biii), CO(1A3bi), Pb (1A3bvi, 1A3biii, 1A3bi))

Emission Trends

- Emission calculation is applied by COPERT software.
- NO_x emissions decreased from 1045.43 Kt in 2000 to 103.47 Kt in 2022.
- NMVOC emissions decreased from 427.50 Kt in 2000 to 60.12 Kt in 2022.

- NH_3 emissions decreased from 0.54 Kt in 2000 to 0.56 Kt in 2022.
- CO emissions decreased from 6727.39 Kt in 2000 to 290.16 Kt in 2022.
- PM_{10} emissions decreased from 44.38 Kt in 2000 to 9.71 Kt in 2022.
- Pb emissions increased from 0.24 Kt in 2000 to 5.31 Kt in 2022.
- Cd emissions decreased from 0.24 Kt in 2000 to 0.02 Kt in 2022.

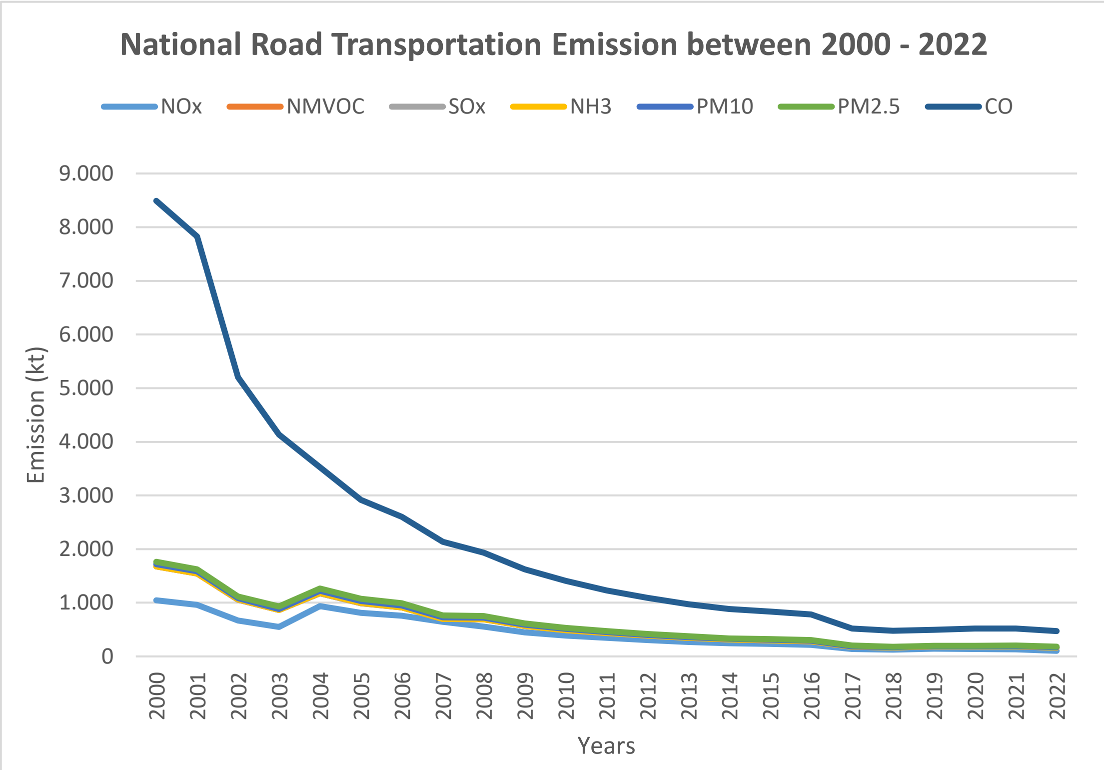

Figure 3.17 Road Transportation Emissions between 2000 - 2022 (COPERT)

Table 3.30 Road Transportation Emissions between 2000 - 2022 (COPERT)

Years	NO_x	NMVOC	SO_x	NH_3	PM_{10}	$PM_{2.5}$	CO
	kt	kt	kt	kt	kt	kt	kt
2000	1045.4	631.9	0.1	0.6	40.9	44.4	6727.4
2001	963.9	583.1	0.0	0.5	37.4	40.7	6199.6
2002	667.3	391.8	0.0	0.8	26.4	28.9	4084.8
2003	551.4	311.4	0.0	1.1	22.3	46.2	3200.7
2004	936.6	240.1	0.1	2.6	41.3	46.2	2259.0
2005	814.8	178.2	0.1	2.5	36.8	41.2	1843.4
2006	757.7	155.2	0.1	2.4	34.6	38.8	1612.0
2007	642.5	54.7	0.1	2.1	29.6	33.2	1375.7
2008	557.5	135.6	0.1	2.0	26.1	29.3	1182.9
2009	449.7	116.9	0.1	1.8	21.9	24.7	1006.1
2010	386.4	103.5	0.1	1.9	19.0	21.6	874.6
2011	344.6	91.8	0.1	1.5	16.3	18.5	758.5

2012	304.1	83.1	0.1	1.3	14.4	16.3	671.1
2013	269.6	76.0	0.1	1.1	12.7	14.5	600.5
2014	243.9	70.4	0.1	1.0	11.5	8.9	544.7
2015	231.6	67.3	0.1	1.0	10.9	12.4	512.4
2016	217.3	63.8	0.1	0.9	10.2	11.8	476.0
2017	135.2	44.2	0.1	0.6	7.6	15.8	315.0
2018	123.9	42.2	0.2	0.5	6.9	8.9	294.5
2019	141.3	42.8	0.2	0.6	6.9	7.9	295.1
2020	135.5	48.2	0.0	0.8	6.3	7.5	321.0
2021	134.5	49.8	0.0	0.7	7.8	8.9	319.1
2022	103.5	60.1	0.0	0.5	7.8	9.7	290.2
Trend 1990 - 2022	9.9	10.3	10.3	10.3	9.9	10.3	10.3
Trend 2021 - 2022	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Emission trends from road transport are presented for 2000-2022. COPERT software input dataet is prepared by the support of the HEY Portal which requires files structured via R codes and outputs are obtained from the HEY Portal as well. The latest version of the COPERT software is prepared/compared with the input dataets in the Portal but the control of the dataet and the integration of the software with the PORTAL required more time than foreseen. Here; recalculation of the whole series of the data of COPERT calculation due to the latest version of COPERT will be applied in the next submission.

Source of Activity Data

Activity data are in the form of the amount of fuel used in this sector and are taken from the energy balance tables. TURKSTAT data for vehicle submission and the split given in their website as official dataets are cited. Additionally the Ministry's own software for the vehicle electronical exhaust emissions will be analysed for the compariosn and integration of the dataet.

Fleet number

The data in the model are vehicle numbers for each year, split into vehicle type and fuel type (assumptions are made regarding the petrol/diesel split for LDVs). The petrol/diesel split for annual car sales were taken directly from the emissions calculation method used by the Ministry of Transport.

This information on the petrol and diesel cars and LDVs entering the fleet each year were applied to the vehicle numbers in a stepwise approach through the years. It was therefore possible to have a figure for e.g. 2000 that accounted for the petrol and diesel sales in each of the ten previous years. This is how total vehicle numbers, split by type and petrol/diesel were generated for each year in the time series.

Age Distribution of Vehicle Fleet and Technology

The fraction of the fleet complying with the different emission standards were calculated for each year in the time series. This was done by using annual data on sales and removals from the vehicle fleet, allowing the age profile of the vehicle fleet to be determined for each year in the time series.

For example, to create the 1991 vehicle fleet by age, the vehicle removals in 1991 were subtracted from the previous year (1990), and the sales were added. This provides the total number of vehicles in 1990 and indicates whether they were new in 1990 or 1991. This process is then repeated, stepping through the entire time series, removing cars (assumed to be distributed uniformly through the fleet by age) and adding in the sales figures, to generate a total for the next year. In this way, it is possible to construct vehicle numbers for each year of the time series broken down by their age.

As the years at which the different Euro standards were introduced in Türkiye are known, the ages of the vehicles were then translated into Euro standards. This enabled, for each year of the time series, the vehicle fleet to be broken down into defined technology standards for each vehicle type.

Annual kilometers by Road class

Data on the use of different road types by different vehicles were provided byHEY Portal. It is necessary to split the rural roads into single- and dual-carriageways. It is assumed that 75% of vehicle kilometers (vkm) on rural roads were undertaken on single carriageway roads, with the remaining 25% on dual carriageway.

Fraction of vehicles on different roadways

In the year 2021 Türkiye has about 2159 km of toll roads, 31213 km of state highways, and 33065 km of provincial roads and in total 66437 km.

Annual kilometers by Vehicle Type

It was not possible to obtain annual vehicle km data from official sources. So the data had to be re-generated with information that was available. A large dataet of vehicle data was obtained previously from the TUVTURK (vehicle inspection) studies. This provided the odometer reading from a very large sample of vehicles, as well as the vehicle type and age. Theoretically, it would then be possible to use these data to deduce information about the typical annual vehicle kms driven by different vehicle types in different years. However, it was clear that the output would be very variable and that some assumptions would need to be made about smoothing the data so as to arrive at sensible estimates. Hence the dataet was sorted so that results could be expressed according to different vehicle types. For each vehicle type, the following analysis was undertaken:

- The data were screened for outliers, and where possible these were removed.
- The odometer readings for vehicles originating in the same year were then averaged. For example, by 2010 a heavy goods vehicle originating in 1998 had undertaken an average of 408,500 kms; these vehicles had been on the road for 13 years and had been driven an average of 31,423 kms/year (Note: no account was taken of the fact that newer vehicles do more kms/year than older ones; hence vkms in earlier years are likely to be underestimated whilst vkms in more recent years are likely to be overestimated).
- These data were plotted, and it was clear that there was substantial noise in the sample. So simple straight line fits were applied to the plots to represent the changing annual vehicle kms across the time series.

It is recognised that there is a large degree of subjectivity in deciding on these best fits, and it is important that improvements be made – not by making small improvements to the existing method, but by sourcing alternative (preferably official) dataets on the annual vehicle-kms of the different vehicle types.

PM_{10} Brake & Tyre Wear

PM_{10} emissions from brake and tyre wear were calculated by combining international default emission factors with vehicle-km data.

Evaporative Emissions

Emissions of NMVOC arise from evaporation from petrol vehicles as well as exhaust emissions. Emissions are estimated from different evaporative components: diurnal losses, hot soak and running losses using a standard approach from the EMEP/EEA Guidebook.

Cold Start Emissions

There are increased emissions of NO_x and PM_{10} from vehicles which start cold, as opposed to vehicles which already have a warm engine.

A method from the EMEP/EEA Guidebook is used to calculate the ratio of emissions including cold start over the emissions excluding cold start (Ecold/Ehot). This ratio is combined with the emissions already estimated to adjust the emission total to include the impact of cold start emissions.

Emission calculations

The vehicle-kms and corresponding EFs were combined to give emissions for each year in some detail. Carbon emissions are also calculated for reasons given in later sections.

Total emission estimates are obtained by collating the calculated emissions, on a vehicle-km basis, for the following:

- Exhaust emissions for NO_x, NMVOC, NH_3, PM_{10}, Pb, and Cd.
- NO_x and PM_{10} cold start emissions
- NMVOC evaporative emissions (reported as a specific NFR category)
- PM_{10} tyre and brake wear emissions (reported as a specific NFR category)
- Carbon emissions (calculated on a vkm basis)
- SO_2 emissions (calculated by combining the fuel use and S content of fuels).

Adjusting Emission Estimates using Fuel Consumption

The emissions calculated on a vehicle-km basis are accompanied by a calculation of the fuel use. This is compared with the actual fuel use data from the national energy balance tables. Emissions are rescaled by: fuel used/calculated fuel use. This is so that the final emissions are completely consistent with the national fuel data from the energy balance tables and, presumably, with the emission estimates in the GHG emissions inventory.

The following figure shows the impact of rescaling emissions by the fuel use. It is noticeable that the rescaling has the largest impact on HGV vehicles in the most recent years. This may be partly due to tank tourism: Türkiye has one of the highest fuel prices in Europe. But is it also likely to be caused by some of the uncertainties in the methodology. In particular it should be noted that the energy balance tables do not provide information on petrol and diesel use – merely total petroleum. Also, there is a high level of uncertainty associated with the annual vehicle kms that have been assigned to HGVs across the time series.

Source of Emission Factors

It is based on the most currently available information on EFs from sources such as COPERT.

The EFs are dependent on speed, and set speeds are assumed for each vehicle type travelling on different road classes. The speeds that are assumed are given in Table 3.30.

Table 3.31 Speed per street and vehicle type used sector 1.A.3.b road transport

km/hr	Within Residential Areas	Inter-city	Inter-city, separated roads	Highway
Passenger Cars	50	90	110	120
Minibus	50	80	90	100
Buses and Coaches	50	80	90	100
Light Duty Vehicles	50	80	85	95
Heavy Goods Vehicles, Rigid	50	80	85	90
Heavy Goods Vehicles, Articulated	50	80	85	90
Motorcycles	50	90	110	120

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

No recalculation has been done for this inventory. For next submission, recalculation will be applied.

Planned Improvements

The national energy balance tables do not split the road transport fuel use into petrol and diesel. So, assumptions had to be made about the use of these two different types of fuel. Improvements need to be made by obtaining real data on the use of petrol and diesel individually.

Compressed natural gas (CNG) has not been included in the emissions inventory. It is known that taxis and other vehicles use this fuel. Emissions per km may not be large for this fuel type, but it seems that the data may be available to allow its inclusion in the inventory in future.

Improvements are needed to reduce the uncertainties associated with the annual vehicle km data by vehicle type that are used across the time series.

PM_{10} emissions from road abrasion have not been estimated yet.

3.3.3. NFR 1.A.3.c Railways

Source Category Description

Emissions: NOx, SO_2, NMVOC, CO, PM_{10}, $PM_{2,5}$, Cd

Key Source: No

Exhaust emissions from railways arise from diesel-powered engines used in freight and passenger rail, line-haul, and switch locomotives. EPA Method is applied.

Emission Trends

- NO_x emissions decreased from 9.86 Kt in 1990 7.65 Kt in 2022,
- NMVOC emissions decreased from 1.12 Kt in 1990 to 0.68 Kt in 2022,

- CO emissions decreased from 4.33 Kt in 1990 to 1.56 Kt in 2022,
- PM_{10} emissions decreased from 0.47 Kt in 1990 to 0.21 Kt in 2022.

Emission trends are illustrated in Figure 3.18. The decreases of all emissions in this sector were mainly due to hard coal rails were not used after 2000.

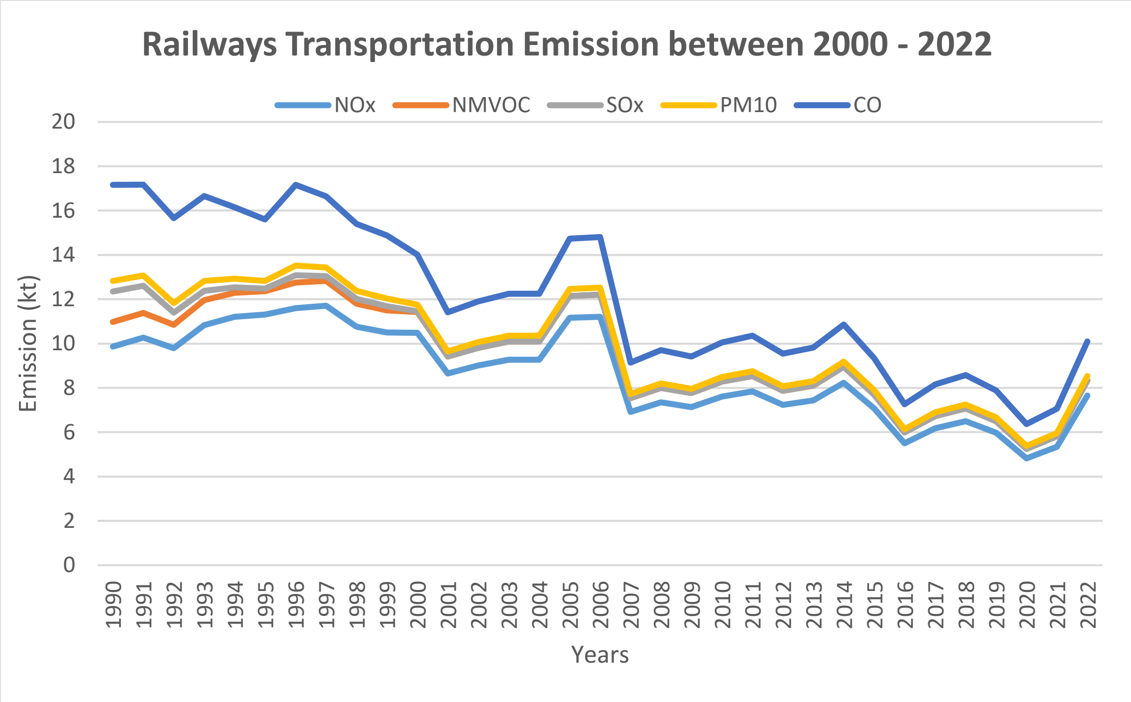

Figure 3.18 Emissions from NFR 1.A.3.c for the period 1990 to 2022

Table 3.32 Emissions from sector 1.A.3.c. Railways

Years	NO_x	NMVOC	PM_{10}	CO
	kt	kt	kt	kt
1990	9.86	1.12	0.48	4.33
1991	10.27	1.12	0.46	4.10
1992	9.79	1.06	0.44	3.82
1993	10.83	1.13	0.45	3.83
1994	11.21	1.09	0.39	3.22
1995	11.31	1.05	0.35	2.77
1996	11.59	1.16	0.44	3.64
1997	11.71	1.12	0.40	3.20
1998	10.76	1.04	0.37	3.01
1999	10.50	1.00	0.35	2.84
2000	10.48	0.94	0.30	2.26

2001	8.65	0.77	0.24	1.77
2002	9.01	0.80	0.25	1.84
2003	9.27	0.82	0.25	1.89
2004	9.27	0.82	0.25	1.89
2005	11.16	0.99	0.31	2.28
2006	11.21	1.00	0.31	2.29
2007	6.92	0.61	0.19	1.41
2008	7.35	0.65	0.20	1.50
2009	7.13	0.63	0.20	1.46
2010	7.61	0.68	0.21	1.55
2011	7.84	0.70	0.22	1.60
2012	7.23	0.64	0.20	1.48
2013	7.44	0.66	0.20	1.52
2014	8.23	0.73	0.23	1.68
2015	7.07	0.63	0.19	1.44
2016	5.50	0.49	0.15	1.12
2017	6.18	0.55	0.17	1.26
2018	6.50	0.58	0.18	1.33
2019	5.97	0.53	0.16	1.22
2020	4.82	0.43	0.13	0.98
2021	5.34	0.47	0.15	1.09
2022	7.65	0.68	0.21	1.56
Trend 1990 - 2022	-22.41%	-39.12%	-56.29%	-63.95%
Trend 2021 - 2022	43.14%	43.14%	43.14%	43.14%

Source of Activity Data

Activity data is annual fuel consumption data for railways in National Energy Balance Tables.

Methodological Issues

The applied methodology is TIER 1, which is a specific locomotive usage methodology and uses the algorithm below:

$$Emission_{pollutant} = \sum ADfuel * EFfuel$$

Where:

Emission $_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

ADfuel = fuel consumption of fuel type (tons)

EFfuel = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Emission factors for are in mass terms and have been coverted from the EMEP/EEA GB 2019 Table 3.1 energy based factors using national net calorific values. Emission factors are presented in Table 3.32.

Table 3.33 Emission factor (EF) used sector 1.A.3.c railways

Fuel	Unit	EF	Reference
NOx			
Petroleum	kg/ton	52.4	EMEP/EEA (2019), Chapter 1.A.3.c railways Tier 1 emission factors
Lignite	t/kt	1	
H coal	t/kt	3	
SO2			
petroleum	kg/ton	-	EMEP/EEA (2019), Chapter 1.A.3.c railways Tier 1 emission factors
Lignite	t/kt	46	
H coal	t/kt	30	

NMVOC			
petroleum	kg/ton	4.65	EMEP/EEA (2019), Chapter 1.A.3.c railways Tier 1 emission factors
Lignite	t/kt	4.45	
H_{coal}	t/kt	12.2	
CO			
petroleum	kg/ton	10.7	EMEP/EEA (2019), Chapter 1.A.3.c railways Tier 1 emission factors
Lignite	t/kt	42	
H_{coal}	t/kt	117	
PM10			
petroleum	kg/ton	6.2	EMEP/EEA (2019), Chapter 1.A.3.c railways Tier 1 emission factors
Lignite	t/kt	3.72	
H_{coal}	t/kt	10.2	

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

No recalculation has been done for this inventory.

Planned Improvements

Improvement is planned to use HEY Portal algorithms.

3.3.4. NFR 1.A.3.d Navigation

3.3.4.1. NFR 1.A.3.d.i (ii) International inland waterways

Source Category Description

Emissions: *NE*

Source of Activity Data

The national energy balance tables do not include bunker fuel, and therefore international shipping in inland waters was not included in the emissions inventory.

So, this source is reported as NE (not estimated).

Planned Improvements

If bunker fuel can be obtained, then it will be possible to include the international component of shipping. However, it is likely that all of this will be assigned to international shipping (reported in the memo items), unless this could be split into marine and inland waterways components.

3.3.4.2. NFR 1.A.3.d.ii National navigation (Shipping)

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, Cd, Pb, Hg

Key Source: *No*

For national navigation, emission estimates have been made, although it has not been possible to resolve the emissions from fishing boats (so the latter is reported as IE). Exhaust emissions from shipment arise from the combustion of petroleum in diesel engines.

Emission Trends

- NO_x emissions increased from 11.01 Kt in 1990 to 24.88 Kt in 2022.
- SO_2 emissions increased from 3.06 Kt in 1990 to 6.91 Kt in 2021.
- NMVOC emissions increased from 0.27 Kt in 1990 0.60 Kt in 2022.
- CO emissions increased from 0.58 Kt in 1990 to 1.32 Kt in 2022.

- PM_{10} emissions increased from 0.89 Kt in 1990 to 2.02 Kt in 2021.

Emission trends are illustrated in Figure 3.19.

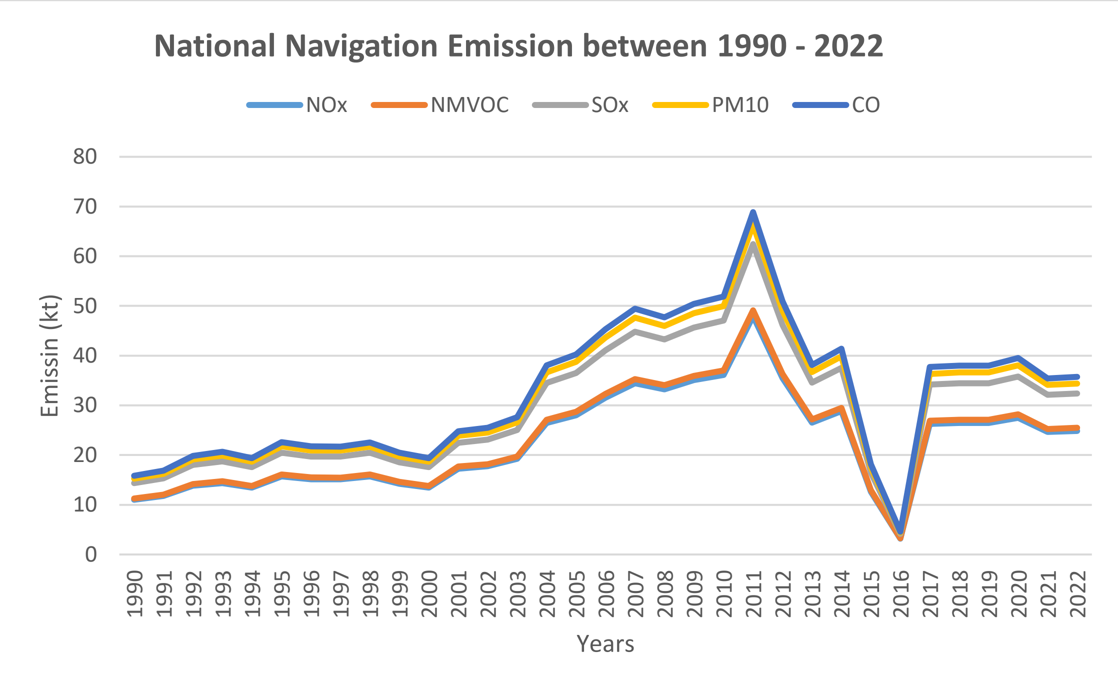

Figure 3.19 Emissions from NFR 1.A.3.d.ii national navigation for the period 1990 to 2022

Table 3.34 Emissions from sector 1.A.3.d.ii national navigation

Years	NO_x	NMVOC	SO_x	PM_{10}	CO
	kt	kt	kt	kt	kt
1990	11.01	0.27	3.06	0.89	0.58
1991	11.75	0.28	3.26	0.95	0.62
1992	13.82	0.33	3.84	1.12	0.73
1993	14.37	0.35	3.99	1.16	0.76
1994	13.48	0.33	3.75	1.09	0.72
1995	15.73	0.38	4.37	1.27	0.84
1996	15.14	0.37	4.21	1.23	0.80
1997	15.11	0.37	4.20	1.22	0.80
1998	15.71	0.38	4.36	1.27	0.83
1999	14.23	0.34	3.96	1.15	0.76
2000	13.47	0.33	3.74	1.09	0.72
2001	17.28	0.42	4.80	1.40	0.92
2002	17.74	0.43	4.93	1.44	0.94

2003	19.23	0.46	5.34	1.56	1.02
2004	26.49	0.64	7.36	2.15	1.41
2005	28.02	0.68	7.79	2.27	1.49
2006	31.55	0.76	8.77	2.56	1.68
2007	34.43	0.83	9.57	2.79	1.83
2008	33.23	0.80	9.23	2.69	1.77
2009	35.08	0.85	9.75	2.84	1.86
2010	36.14	0.87	10.04	2.93	1.92
2011	47.96	1.16	13.32	3.89	2.55
2012	35.45	0.86	9.85	2.87	1.88
2013	26.53	0.64	7.37	2.15	1.41
2014	28.81	0.70	8.01	2.34	1.53
2015	12.65	0.31	3.51	1.02	0.67
2016	3.18	0.08	0.88	0.26	0.17
2017	26.26	0.63	7.30	2.13	1.39
2018	26.47	0.64	7.35	2.14	1.41
2019	26.47	0.64	7.35	2.14	1.41
2020	27.50	0.66	7.64	2.23	1.46
2021	24.67	0.60	6.85	2.00	1.31
2022	24.88	0.60	6.91	2.02	1.32
Trend 1990 - 2022	125.88%	125.88%	125.88%	125.88%	125.88%
Trend 2021 - 2022	0.84%	0.84%	0.84%	0.84%	0.84%

Source of Activity Data

Activity data are in the form of amount petroleum used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is Tier 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum ADfuel * EFfuel$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Emission factors for are in mass terms and have been taken from the GB. Emission factors are presented in Table 3.34.

Table 3.35 Emission factor (EF) used sector 1.A.3.d.ii national navigation

Fuel	Unit	EF	Reference
NOx			
petroleum	kg/ton	59.1	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16

SO2			
petroleum	kg/ton	19.2	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16
NMVOC			
petroleum	kg/ton	1.67	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16
CO			
petroleum	kg/ton	3.67	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16
PM10			
petroleum	kg/ton	5.2	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16
Cd			

petroleum	kg/ton	0.18	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16
Pb			
petroleum	kg/ton	0.02	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16
Hg			
petroleum	kg/ton	0.02	EMEP/EEA (2019), Chapter 1.A.3.d shipping, Tier 1 emission factors for ships using bunker fuel oil, page 16

Uncertainty

Estimation of uncertainties based on default values from GB.

Activity data uncertainty: ±10%

Emission factor uncertainty: NOx ±20%, SOx ±10%, NMVOC ±25% and PM ±25%

Recalculations

No recalculation has been done for this inventory.

Planned Improvements

It would be a considerable improvement if the petroleum from the energy balance tables could be split into different types of petroleum. This is true for all of the petroleum fuels being reported by the energy balance tables.

3.3.5. NFR 1.A.3.e.i Pipeline compressors

Source Category Description

Emissions: NO_x, SO_2, NMVOC, PM_{10}, CO, Cd, Pb, Hg

Key Source: No

This chapter covers the emissions of pipeline compressors, which is mainly important for greenhouse gases (methane leaks). Emissions occur from combustion in gas driven compressor in compressor stations.

Emission Trends

Emissions in this sector were reported since 2006. Before, there is no activity data available. Emissions from pipeline compressors have only minor importance to the total emissions in Türkiye. Emission trends are illustrated in Figure 3.18.

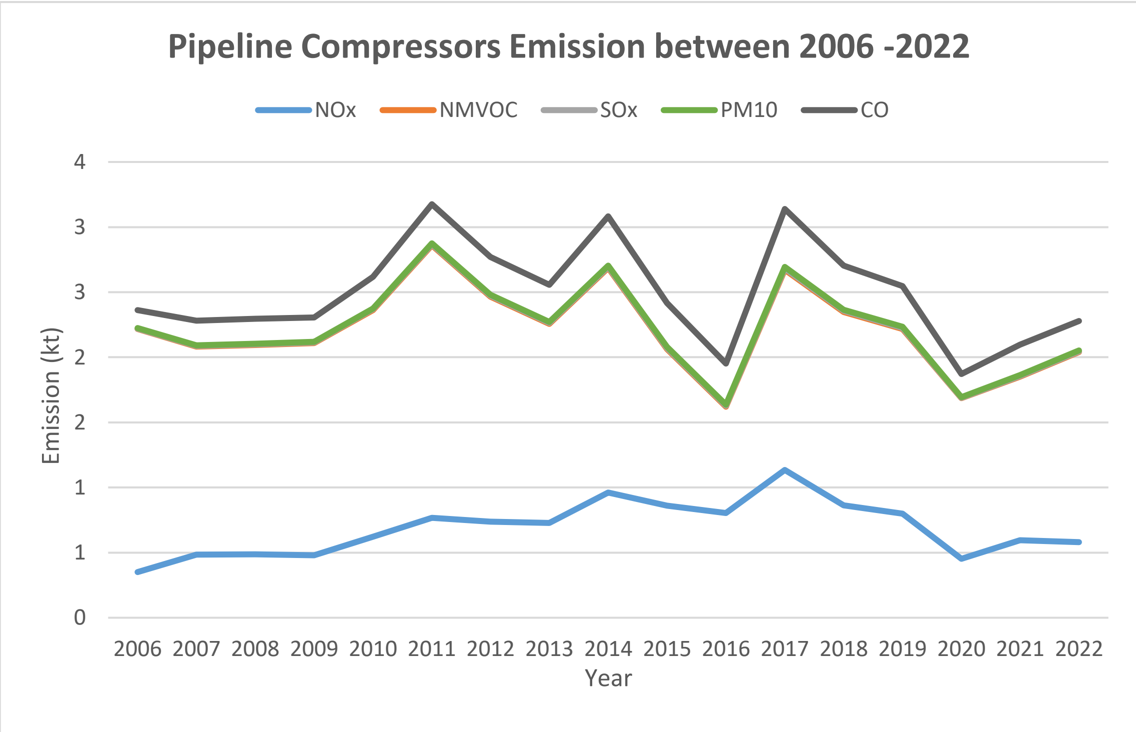

Figure 3.20 Emissions from NFR 1.A.3.e for the period 1990 to 2022

Table 3.36 Emissions from sector 1.A.3.e.i pipeline compressors

Years	NOx	NMVOC	SOx	PM10	CO
	kt	kt	kt	kt	kt
2006	0.35	1.87	0.00	0.00	0.14
2007	0.48	1.60	0.00	0.01	0.19
2008	0.49	1.61	0.00	0.01	0.19
2009	0.48	1.63	0.00	0.01	0.19
2010	0.62	1.74	0.01	0.01	0.24
2011	0.77	2.09	0.01	0.01	0.30
2012	0.74	1.73	0.01	0.01	0.29
2013	0.73	1.53	0.01	0.01	0.29
2014	0.96	1.73	0.01	0.01	0.38
2015	0.86	1.20	0.01	0.01	0.34
2016	0.81	0.82	0.01	0.01	0.32
2017	1.13	1.54	0.01	0.01	0.44
2018	0.86	1.48	0.01	0.01	0.34
2019	0.80	1.42	0.01	0.01	0.31
2020	0.45	1.23	0.00	0.00	0.18
2021	0.60	1.26	0.01	0.01	0.23
2022	0.58	1.46	0.01	0.01	0.23
Trend 2006 - 2022	65.43%	-21.76%	65.43%	65.43%	65.43%
Trend 2021 - 2022	-2.58%	16.31%	-2.58%	-2.58%	-2.58%

Source of Activity Data

Activity data are in the form of the amount of gas used in this sector and are taken from the energy balance tables. The original units are in m^3. These are converted into an energy term (using a calorific values from the literature), to match the available emission factors (source: Ministry of Energy and Natural resources 2022). Before 2006 there is no activity data available.

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$Emission_{pollutant}$ = ∑ ADfuel * EFfuel

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

$AD_{fue}l$ = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Emission factors are taken from the GB and are in energy terms. Emission factors are presented in Table 3.36.

Table 3.37 Emission Factor (EF) Used Sector 1.A.3.e i - Pipeline Compressors

Fuel	Unit	EF	Reference
NOx			
Natural Gas	g/GJ	74	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37

SO2			
Natural Gas	g/GJ	0.67	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37
NMVOC			
Natural Gas	g/GJ	23	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37
CO			
Natural Gas	g/GJ	29	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a,

			using gaseous fuels, page 37
PM10			
Natural Gas	g/GJ	0.78	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37
Cd			
Natural Gas	mg/GJ	0.0009	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37
Pb			
Natural Gas	mg/GJ	0.011	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR

			source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37
Hg			
Natural Gas	mg/GJ	0.1	EMEP/EEA (2019), Chapter 1.A.4.a/c, 1.A.5.a Small Combustion, Table 3-8 Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using gaseous fuels, page 37

Uncertainty

Estimation of uncertainties based on default values from GB.

Recalculations

No recalculation has been done for this inventory.

Planned Improvements

There is no plan for improvement.

3.3.6. NFR 1.A.4 Small Combustion

3.3.6.1. NFR 1.A.4.a.i Commercial/Institutional (Stationary)

Source Category Description: IE

No emission estimates have been made for this sector. This is because the energy balance tables do not resolve the fuel used for the Commercial/Institutional sector. It is assumed that the fuel used in this sector has been included in either Other Industry or Residential ("Housing and Services"). Emissions are reported as IE.

The energy balance tables split on the petroleum still isn't available on the web under the topic of statistics. The meeting results which were succeeded on the petroleum split will be used in the future submissions.

3.3.6.2. NFR 1.A.4.a.ii Commercial/Institutional (Mobile)

Source Category Description: IE

No emission estimates have been made for this sector. This is because the energy balance tables do not resolve the fuel used for mobile machinery in this sector from other sources. Emissions are reported as IE due to energy balance split.

The 1st alternative is to improve the detail of the fuel data from the energy balance tables to allow fuel for this sector be resolved, then these fuel data could be combined with either emission factors from the GB. The 2nd alternative would be use a bottom-up approach. It might be possible to make some very approximate estimates of the number of different types of machinery being used in Türkiye, and their hours of operation. This approach is outlined in the GB. The results from this would give emission estimates for mobile machinery, as well as an estimate of the fuel that is consumed each year (presumably diesel and petrol).

It would be necessary to subtract this amount of fuel from the fuel that is currently assigned to stationary combustion in the various categories above.

These alternatives will be assessed fo future submissions.

3.3.6.3. NFR 1.A.4.b.i Residential (Stationary)

Source Category Description

Emissions: NO_x, SO_2, NMVOC, PM_{10}, CO, NH_3, $PM_{2.5}$

Key Source: Yes (PM_{10}, $PM_{2.5}$, NMVOC, CO, SO_2, NO_x)

Emission trend is given in the Figure 3.21.

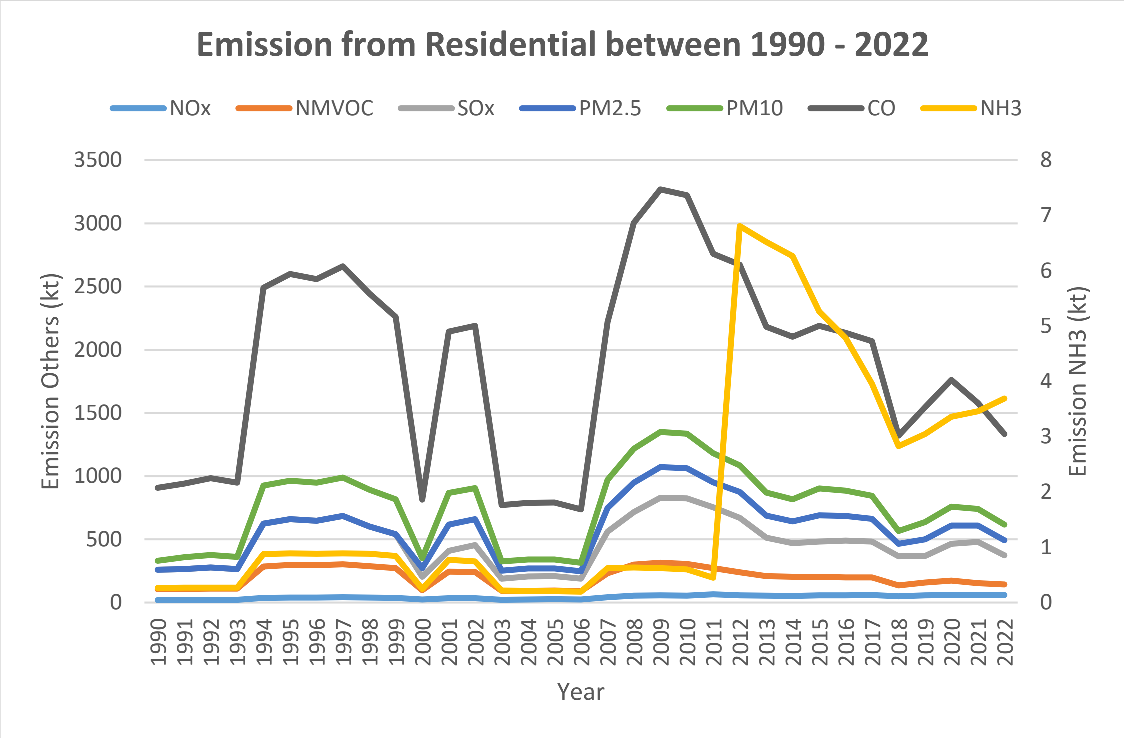

Figure 3.21 Emission trend for residential combustion

Table 3.38 Emission totals for residential stationary combustion

Years	NOx	NMVOC	SOx	NH3	PM2.5	PM10	CO
	kt	kt	kt	kt	kt	kt	kt
1990	19.16	86.49	153.32	0.27	NE	70.70	578.49
1991	19.74	87.10	156.54	0.27	NE	96.11	582.37
1992	21.32	90.05	166.36	0.27	NE	98.03	607.68
1993	21.62	88.32	154.96	0.27	NE	95.19	588.86
1994	36.27	249.07	337.72	0.88	NE	301.24	1566.98
1995	39.90	257.14	361.76	0.89	NE	303.69	1636.39
1996	40.53	254.69	352.78	0.89	NE	299.96	1611.71
1997	42.85	261.01	380.39	0.89	NE	304.05	1670.76
1998	39.85	248.49	313.43	0.88	NE	290.84	1552.19
1999	37.72	233.82	268.72	0.84	NE	275.70	1444.33
2000	23.68	74.08	106.59	0.25	67.29	77.98	463.34
2001	33.53	209.80	164.81	0.77	208.09	250.61	1276.84
2002	33.95	207.63	211.77	0.75	205.28	246.51	1284.42
2003	21.89	69.43	97.75	0.22	63.13	72.79	447.27
2004	23.26	68.87	114.87	0.21	62.26	71.66	447.95
2005	25.82	68.69	114.72	0.20	61.59	70.70	450.62

2006	24.71	64.83	99.41	0.20	58.35	67.09	422.57
2007	41.35	191.51	328.74	0.62	186.68	222.20	1247.67
2008	54.71	245.93	414.61	0.64	233.39	268.73	1786.55
2009	57.44	257.58	513.96	0.62	242.81	277.48	1919.13
2010	54.67	251.71	517.62	0.60	238.49	273.09	1886.62
2011	65.29	205.86	483.01	0.45	197.55	228.86	1577.31
2012	56.61	183.89	429.24	6.81	204.97	209.27	1588.56
2013	53.78	154.13	303.69	6.52	176.99	180.79	1313.18
2014	52.74	150.59	267.49	6.26	171.66	175.34	1285.60
2015	56.16	148.11	277.36	5.26	208.14	212.74	1287.06
2016	56.21	142.72	291.08	4.78	195.13	199.38	1247.55
2017	60.57	137.71	283.23	3.96	180.17	184.00	1221.14
2018	48.41	86.01	231.49	2.83	98.47	100.51	756.23
2019	55.74	102.41	209.30	3.05	133.55	136.39	907.23
2020	59.73	113.18	291.68	3.36	145.22	148.30	1002.62
2021	58.37	96.10	324.36	3.46	129.55	132.38	837.87
2022	59.36	83.95	229.22	3.69	120.67	123.40	716.91
Trend 2006 - 2022	209.89%	-2.93%	49.50%	1292.17 %	79.31%	74.54%	23.93%
Trend 2021 - 2022	1.71%	-12.64%	-29.33%	6.71%	-6.86%	-6.79%	-14.44%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$\text{Emission}_{\text{pollutant}} = \sum \text{AD}_{\text{fuel}} * \text{EF}_{\text{fuel}}$$

Where:

$\text{Emission}_{\text{pollutant}}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel}	=	fuel consumption of fuel type (tons)
EF_{fuel}	=	emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Asphaltite has the same EFs as the H coal, lignite, and coke.

Table 3.39 EFs for residential combustion

Fuel	Unit	Ef	Reference	Table No.
NOx				
H. Coal	g/GJ	110	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-3
Lignite	g/GJ	110	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-3
Coke	g/GJ	110	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-3
Petroleum	g/GJ	51	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-4

N. Gas	g/GJ	51	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-4
AP Waste	g/GJ	80	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-6
Wood	g/GJ	80	EMEP/EEA (2016), Chapter 1. A.4.b Residential combustion, Tier 1 emission factors	Table 3-6
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Petroleum	g/GJ	70	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-5

N. Gas	g/GJ	0,3	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-4
AP Waste	g/GJ	11	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-6
Wood	g/GJ	11	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-6
NMVOC				
H. Coal	g/GJ	484	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Lignite	g/GJ	484	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Coke	g/GJ	484	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Petroleum	g/GJ	0,69	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-5

N. Gas	g/GJ	1,9	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-4
AP Waste	g/GJ	600	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-6
Wood	g/GJ	600	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-6
CO				
H. Coal	g/GJ	4600	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Lignite	g/GJ	4600	EMEP/EEA (2016), Chapter 1.A.4.b Residential combustion, Tier 1 emission factors	Table 3-3
Coke	g/GJ	4600	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-3
Petroleum	g/GJ	57	EMEP/EEA (2016), Chapter 1.A.4.b Residential combustion, Tier 1 emission factors	Table 3-4

N. Gas	g/GJ	26	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-5
AP Waste	g/GJ	4000	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-6
Wood	g/GJ	4000	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	Table 3-6
PM_{10}				
H. Coal	g/GJ	117*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Lignite	g/GJ	117*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Coke	g/GJ	117*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Petroleum	g/GJ	20*	EMEP/EEA (2016), Chapter 1. A.4.bResidential	*(*assumption covers the brown coal from GB and NCVs from NIR)*

			combustion, Tier 1 emission factors	
N. Gas	g/GJ	0.78*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
AP Waste	g/GJ	143*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Wood	g/GJ	155*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NH_3				
H. Coal	g/GJ	117*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Lignite	g/GJ	117*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Coke	g/GJ	117*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Petroleum	g/GJ	20*	EMEP/EEA (2016), Chapter 1. A.4.bResidential	*(*assumption covers the brown coal from*

			combustion, Tier 1 emission factors	GB and NCVs from NIR)
N. Gas	g/GJ	0.78*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
AP Waste	g/GJ	143*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*
Wood	g/GJ	155*	EMEP/EEA (2016), Chapter 1. A.4.bResidential combustion, Tier 1 emission factors	*(*assumption covers the brown coal from GB and NCVs from NIR)*

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

3.3.6.4. NFR 1.A.4.b.ii Residential Household and Gardening (Mobile)

Source Category Description: IE

No emission estimates have been made for this sector. Emissions are reported as IE due to the energy balance structure.

3.3.6.5. NFR 1.A.4.c.i Agriculture/Forestry/Fishing (Stationary)

Source Category Description

Emissions: NO_x, SO_2, NMVOC, CO, PM_{10}, $PM_{2.5}$

Key Source: Yes (NO_x)

Emission trend is given in the figure 3.22.

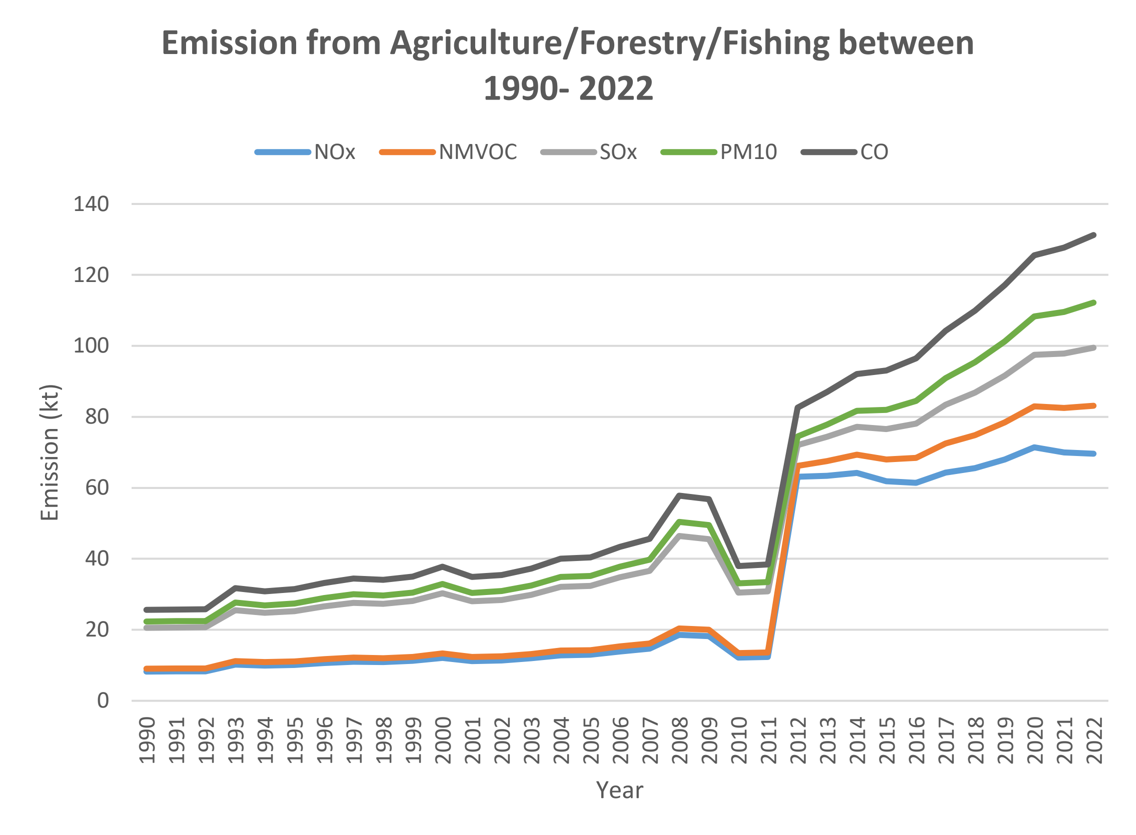

Figure 3.22 Emission trend for 1.A.4.ci

Table 3.40 Emissions from 1.A.4.c Agriculture/Forestry/Fisheries

Years	NOx	NMVOC	SOx	PM10	CO
	kt	kt	kt	kt	kt
1990	8.23	0.82	11.52	1.77	3.29
1991	8.26	0.83	11.57	1.78	3.30
1992	8.28	0.83	11.60	1.78	3.31
1993	10.20	1.02	14.28	2.19	4.08
1994	9.91	0.99	13.87	2.13	3.96
1995	10.11	1.01	14.15	2.17	4.04
1996	10.66	1.07	14.92	2.29	4.26
1997	11.05	1.10	15.46	2.37	4.42
1998	10.94	1.09	15.32	2.35	4.38

1999	11.24	1.12	15.74	2.42	4.50
2000	12.12	1.21	16.97	2.61	4.85
2001	11.21	1.12	15.69	2.41	4.48
2002	11.38	1.14	15.93	2.45	4.55
2003	11.96	1.20	16.74	2.57	4.78
2004	12.85	1.29	17.99	2.76	5.14
2005	12.96	1.30	18.15	2.79	5.19
2006	13.93	1.39	19.50	2.99	5.57
2007	14.66	1.47	20.52	3.15	5.86
2008	18.57	1.86	26.00	3.99	7.43
2009	18.21	1.82	25.54	3.92	7.33
2010	12.18	1.22	17.04	2.62	4.87
2011	12.36	1.23	17.23	2.65	4.94
2012	63.15	3.09	5.78	2.46	8.14
2013	63.44	4.13	6.80	3.47	9.20
2014	64.18	5.21	7.85	4.49	10.34
2015	61.87	6.10	8.64	5.40	11.05
2016	61.43	7.06	9.61	6.39	11.97
2017	64.31	8.21	10.87	7.50	13.35
2018	65.54	9.34	11.96	8.54	14.57
2019	68.02	10.45	13.19	9.64	15.89
2020	71.43	11.56	14.52	10.78	17.27
2021	69.99	12.51	15.38	11.72	18.11
2022	69.66	13.47	16.36	12.71	19.04

Trend 2006 - 2022	746.79%	1537.32%	42.03%	618.46%	292.76%
Trend 2021 - 2022	-0.46%	7.66%	6.36%	8.45%	5.15%

Source of Activity Data

Activity data are in the form of the amount of different type of fuels used in this sector and are taken from the energy balance tables (source: Ministry of Energy and Natural resources 2022).

Methodological Issues

The applied methodology is TIER 1, which is a fuel-based methodology and uses the general equation:

$$Emission_{pollutant} = \sum AD_{fuel} * EF_{fuel}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD_{fuel} = fuel consumption of fuel type (tons)

EF_{fuel} = emission factor of pollutant i for each unit of fuel type m used (kg/tons)

Source of Emission Factors

Several assumptions are made in assuming that some fuels are equivalent to brown coal.

Asphaltite has the same EFs as the h coal, lignite, and coke.

Table 3.41 Emissions from 1.A.4.c Agriculture/Forestry/Fisheries

Fuel	Unit	Ef	Reference	Table No.
NOx				
H. Coal	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	173	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	513	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4

N. Gas	g/GJ	74	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	91	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	81	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
SO_2				
H. Coal	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Lignite	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	900	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	47	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.67	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	11	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	*(*assumption covers the brown coal from*

			(combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*GB and NCVs from NIR)*
Wood	g/GJ	10,8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
NMVOC				
H. Coal	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	88.8	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2	Table 3-2

			Combustion in industry using hard or brown coal	
Petroleum	g/GJ	25	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	23	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors	Table 3-3
AP Waste	g/GJ	300	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	7,31	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
CO				
H. Coal	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing	Table 3-2

			industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	
Lignite	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Coke	g/GJ	931	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	66	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	29	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry	Table 3-3

			using natural gas or derived gases	
AP Waste	g/GJ	570	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	90	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*(*assumption covers the brown coal from GB and NCVs from NIR)*
PM_{10}				
H. Coal	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Lignite	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2

Coke	g/GJ	117	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using hard or brown coal	Table 3-2
Petroleum	g/GJ	20	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using liquid fuels	Table 3-4
N. Gas	g/GJ	0.78	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using natural gas or derived gases	Table 3-3
AP Waste	g/GJ	143	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction (combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	Table 3-5
Wood	g/GJ	155	EMEP/EEA (2016), Chapter 1.A.2 Manufacturing industries and construction	*(*assumption covers the brown coal from*

		(combustion), Tier 1 emission factors 1.A.2 Combustion in industry using solid fuels	*GB and NCVs from NIR)*

Recalculations

Recalculations were checked and applied until 1990 due to the revision of the energy balance tables.

3.3.6.6. NFR 1A4cii Agriculture/Forestry/Fishing (Off-Road Vehicles and other machinery)

Source Category Description

Emissions: IE

3.3.6.7. NFR 1A4ciii Agriculture/Forestry/Fishing: National Fishing

Source Category Description

Emissions: IE

3.3.6.8. NFR 1A5a and 1A5b

Source Category Description

Emissions: IE

3.3.7. NFR 1.B Fugitive Emissions from Fuels

3.3.7.1.NFR 1 B 1 a Fugitive emission from solid fuels: Coal mining and handling

Emission estimates were not made for this source. The main pollutant emitted from this activity is PM10. However, emissions of NMVOC also arise and it would be good to include these estimates in the emissions inventory.

3.3.7.2.NFR 1 B 1 b Fugitive emission from solid fuels: Solid fuel transformation

Source Category Description

Emissions: NE

An example of a source included in this sector is the coke oven gas leaking through the coke oven doors, or a similar source during the manufacture of other solid fuels. This is not a particularly large source. Coke production and fuel consumption data will be integrated for next submissions.

3.3.7.3. NFR 1 B 1 c Other fugitive emissions from solid fuels

Source Category Description

Emissions: NE

3.3.7.4.NFR 1 B 2 a i Fugitive Emissions oil: Exploration, production, transport

Source Category Description

Emissions: NE

This can be a large source of NMVOC where countries are significant producers of oil. In Türkiye it was thought that this was not a large source, so no particular efforts were made to arrive at an emission estimate. EMISSION project will be used for further data compilation.

Planned Improvements

When information is available on the amounts of petroleum that are produced, then it would be sensible to make emissions estimate for this source for further submissions.

3.3.7.5.NFR 1 B 2 a iv Fugitive Emissions oil: Refining / storage

Source Category Description

Emissions: NE

This can be a large source of NMVOC depending on the volumes of oil stored in refineries, and whether there is good management in ensuring that emissions of NMVOCs are minimised. Refining emissions are reported as NE.

The volumes of oil products held by refineries would need to be determined to allow an emission estimate to be made. This has not yet been done because no activity data were sourced. However, it would be sensible to include, at least, an initial estimate of what the emissions might be from this source to determine the amount of effort that should be spent on improving the current situation – which is no information at all.

The legislation is under revision. Therefore, the data required to be included here will be integrated after the finalisation of the legislative steps.

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

Source Category Description

Emissions: NE

This source can amount to several percent of the NMVOC emissions in total but not yet calculated under the category. The category is reported as NE.

An emission estimate has not yet been made, because no activity data were sourced. However, it would be sensible to include, at least, an initial estimate of what the emissions might be from this source. This would determine the amount of effort that should be spent on improving the current lack of information.

A simple emissions estimate is possible by considering the amount of petrol consumed by road transport (although this would require the petroleum data from the energy balance tables to be split), the number of tanker deliveries that this would equate to, and the number of car refills that this would equate to. A simple NMVOC emission estimate for each of the different transport or delivery stages could then be calculated.

By the EMISSION project mentioned in the introduction sections of the IIR, the service stations' emissions together with the data for amount of gasoline sold and pipeline storage will be obtained for the submissions afterwards, this NFR category also will be integrated to the inventory and the IIR.

3.3.7.7. NFR 1 B 2 b Fugitive Emissions from Natural gas (exploration, production, processing, transmission, storage, distribution and other)

Source Category Description

Emissions: NE

This source is not trivial, but is not expected to be particularly large because, in comparison to many other European countries, there is little use of natural gas. As a result, there is not an extensive network of gas mains pipes.

Making a simple estimate of gas leakage (and hence the NMVOC emission from this source) can be difficult without information on the number of kms of gas mains pipe.

3.3.7.8. NFR 1 B 2 c Venting and flaring (oil, gas, combined oil and gas)

Source Category Description

Emissions: NE

This can be a significant source of NMVOC where gas is being extracted. However, for Türkiye this is not expected to be a particularly large source. Therefore, adding in emission estimates for this source is not considered to be a particularly high priority.

4 CHAPTER INDUSTRIAL PROCESSES AND PRODUCT USE (NFR SECTOR 2)

NFR sector 2 includes below subsectors

- 2.A Mineral Industry
    - 2.A.1 Cement production
    - 2.A.2 Lime production
    - 2.A.3 Glass production
    - 2.A.5.a Quarrying and mining of minerals other than coal
    - 2.A.5.b Construction and demolition
    - 2.A.5.c Storage, handling and transport of mineral products
    - 2.A.6 Other mineral products
- 2.B Chemical Industry
    - 2.B.1 Ammonia production
    - 2.B.2 Nitric acid production
    - 2.B.3 Adipic acid production
    - 2.B.5 Carbide production
    - 2.B.6 Titanium dioxide production
    - 2.B.7 Soda ash production
    - 2.B.10.a Other chemical industry
    - 2.B.10.b Storage, handling, transport of chemical products
- 2.C Metal Industry
    - 2.C.1 Iron and Steel Production

    - 2.C.2 Ferroalloys production
    - 2.C.3 Aluminium production
    - 2.C.4 Magnesium production
    - 2.C.5 Lead Production
    - 2.C.6 Zinc Production
    - 2.C.7.a Copper Production
    - 2.C.7.b Nickel production
    - 2.C.7.c Other metal production
    - 2.C.7.d Storage, handling and transport of metal products
- 2.D Solvent Use
    - 2.D.3.a Domestic solvent use including fungicides
    - 2.D.3.b Road paving with asphalt
    - 2.D.3.c Asphalt roofing
    - 2.D.3.d Coating applications
    - 2.D.3.e Degreasing
    - 2.D.3.f Dry cleaning
    - 2.D.3.g Chemical Products
    - 2.D.3.h Printing
    - 2.D.3.i Other Solvent Use
- 2.G&H Other Production Industry
    - 2.G Other product use
    - 2.H.1 Pulp and paper industry

- 2.H.2 Food and beverages industry
- 2.H.3 Other industrial processes

4.1 NFR 2.A Mineral Industry

4.1.1 NFR 2.A.1 Cement Production

Source Category Description

Emissions: PM10

Emissions from cement production are estimated from fuel consumption data and reported aggregated under NFR 1A2fi.

There are a total of 70 cement factories in Türkiye, 52 of which are integrated cement plants and 18 of which are grinding-packaging plants (İşbank-Department of Economic Research-Cement Sector-May 2016).

Regarding the production technology, most of wet furnaces had been converted to the dry technology since 1974. There are 2 small wet furnaces in Türkiye.

Emission Sources

Production of cement involves four stages: extraction of raw materials, pyro processing, blending of clinker and storage. Simplified process scheme in the GB is illustrated in Figure 4.1

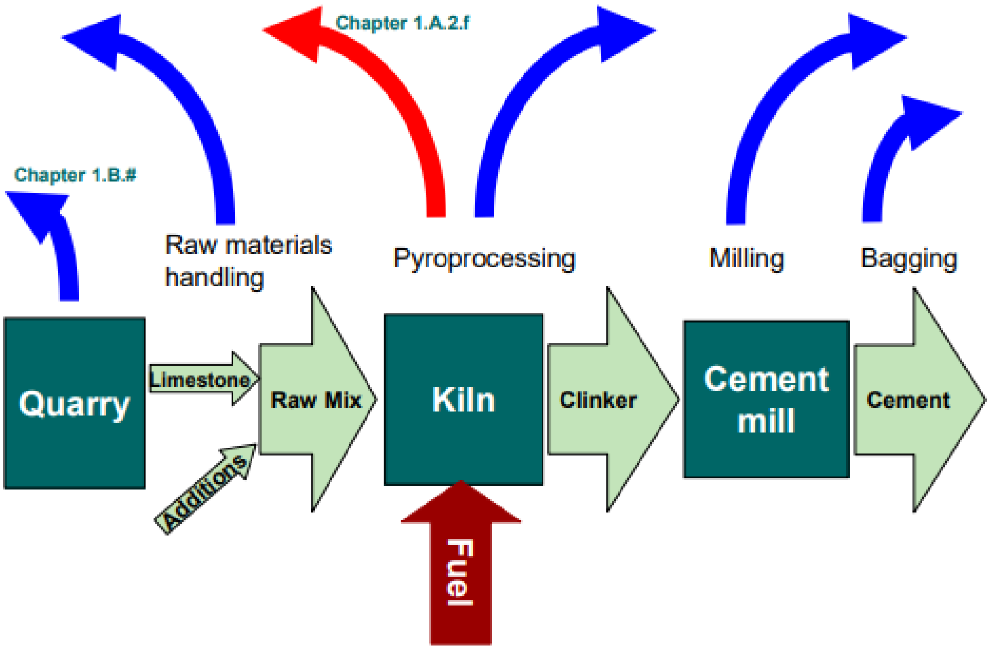

Figure 4.1 Process scheme of Ammonia production

Emission Trends

PM10 emissions increased by about 158.07 % from 3.64 kt in 1999 to 9.38 kt in 2022.

Emission trends are illustrated in Figure 4.2 and emissions and activity data are presented in Table 4.1.

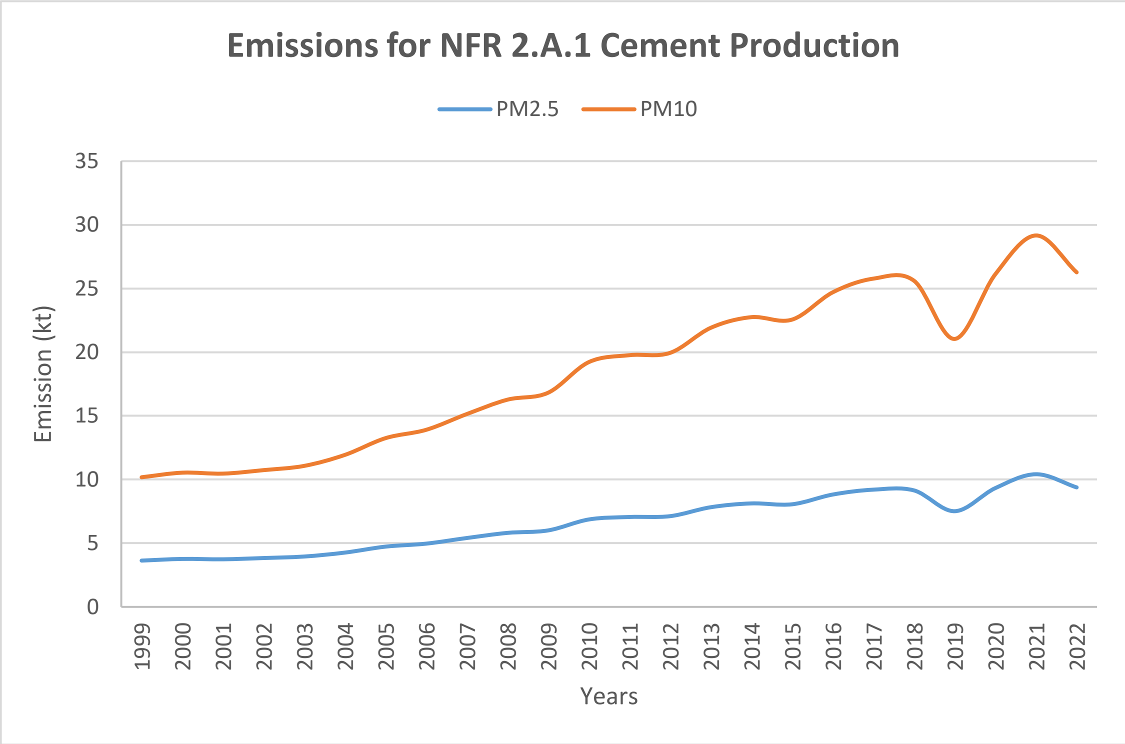

Figure 4.2 Emissions from NFR 2.A.1 cement production for the period 1999 to 2022

Production of cement increased linearly between 1999-2018, decreased in 2019, and increased in 2020-2021 then again decrease in 2022.

Table 4.1 Emissions from NFR sector 2.A.1 Cement production and activity data

Years	PM_{10}	$PM_{2.5}$	Clinker Production
Units	**kt**	**kt**	**Mega tons**
1990	N.A	N.A	N.A
1991	N.A	N.A	N.A
1992	N.A	N.A	N.A
1993	N.A	N.A	N.A
1994	N.A	N.A	N.A
1995	N.A	N.A	N.A
1996	N.A	N.A	N.A
1997	N.A	N.A	N.A
1998	N.A	N.A	N.A
1999	3.64	6.54	27.97
2000	3.76	6.77	28.95
2001	3.74	6.73	28.75

2002	3.83	6.90	29.50
2003	3.95	7.12	30.42
2004	4.26	7.67	32.79
2005	4.73	8.52	36.40
2006	4.97	8.94	38.20
2007	5.41	9.73	41.60
2008	5.81	10.46	44.70
2009	6.01	10.81	46.20
2010	6.86	12.36	52.80
2011	7.06	12.71	54.30
2012	7.12	12.82	54.80
2013	7.83	14.09	60.20
2014	8.13	14.63	62.50
2015	8.06	14.50	61.97
2016	8.82	15.88	67.86
2017	9.21	16.57	70.81
2018	9.14	16.46	70.34
2019	7.51	13.52	57.80
2020	9.33	16.79	71.77
2021	10.42	18.75	80.12
2022	9.38	16.89	72.17
Trend 1999 - 2022	158.07%	158.07%	158.07%
Trend 2021 - 2022	-9.92%	-9.92%	-9.92%

Source of Activity Data

Production data was available in website of Turkish Cement Manufacturer's Associations for 1999-2022.

Methodological Issues

The applied methodology is TIER 1 uses the general equation:

$$Emission_{pollutant} = \sum AD * EF$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (Kt)

i = PM10

AD = annual national clinker production (Kt)

EF = emission factor of pollutant i for clinker production (kg/tons clinker)

Source of Emission Factors

Default emission factors (Tier 1) for cement production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.2.

Table 4.2 Emission factor (EF) used sector 2.A.1 Cement production

	Unit	EF	Reference
PM_{10}	g/Mg Clinker	234	EMEP/EEA (2023), Chapter 2.A Mineral Industry, Table 3-1 , page 10,Tier 1
$PM_{2.5}$	g/Mg Clinker	130	

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

To improve the emission estimation, more information needs to be received on the process and abatement techniques used by plants in Türkiye. It is possible to improve the methodology by obtaining information on the performance of production processes, i.e. data on possible emission measurements from which calculation of typical emission levels (kg/tons of product) could be carried out.

These improvements are scheduled to be carried out in next coming years.

4.1.2 NFR 2.A.2 Lime Production

Source Category Description

Emissions: NE

Emissions from lime production are estimated from fuel consumption data and in the present inventory included under NFR 1.A.2fi.

Process emissions from lime production are not estimated.

Total annual production volume was determined as 4.700.000 tons in 1998, out of which 58% belongs to private lime production plants, 42 % belongs to sugar, iron and steel, paper plants. (Development plan 2007-2013)

Planned improvements

It is planned to estimate separately particle emissions from lime production process. To perform the estimation, lime production volumes are needed, emission factors for particle emissions are available in the GB.

4.1.3 NFR 2.A.3 Glass Production

Source Category Description

Emissions: NE

Emissions from glass production are not included in the inventory at the moment.

Planned improvements

It is planned to include emission estimates from glass production in Türkiye in the inventory after more information on the activity in Türkiye is collected.

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

Source Category Description

Emissions: NE

Emissions from quarrying and mining of other minerals than coal are not included in the inventory at the moment.

Quarrying and mining is a source of TSP, PM_{10}, $PM_{2.5}$, heavy metals (Pb, Cd, As, Cr, Ni, Zn) emissions. Emission factors for particle emissions exist in the GB.

Quarrying and mining of minerals can be classified metal ores (copper, iron, lead, zinc etc.) and ores that are raw materials for industry.

Data for mineral production of copper, lead and zinc is available but cannot be used due to limited time. Next year emissions from this activity will be calculated.

Graphite, calcite, fluorite, titanium are quarried for general industry. Phosphate, sulphur, alunite, boron salt, sodium sulphate are quarried for chemical industry. Magnesite, dolomite, cement raw materials are quarried for soil industry. Gypsum, aggregate, sand, paint soils are quarried for construction.

Planned improvements

It is planned to include emission estimates for at least particle emissions from quarrying and mining of minerals in Türkiye after information on the volume of mined mineral ores in Türkiye has been collected. The methodology to be used for estimating particle emissions is available in GB and emission factors for the other pollutants in the IIR reports of other countries.

4.1.5 NFR 2.A.5b Construction and Demolition

Source Category Description

Emissions: NE

Emissions from construction and demolition are not included in the inventory at the moment.

Construction and demolition is a source of particle (TSP, PM_{10}, $PM_{2.5}$) emissions.

Emission factors for these are available in the GB.

No information is available for sector in Türkiye.

Planned improvements

It is planned to include emission estimates from construction and demolition activities in Türkiye after related activity data to estimate emissions has been collected (area of constructed and demolished buildings). The methodology to be used for estimating these emissions is available in GB.

4.1.6 NFR 2.A.5c Storage, handling and transport of mineral products

Source Category Description

Emissions: NE

Emissions from storage, handling and transport of mineral products are not included in the inventory at the moment.

Storage, handling and transport of mineral products is a source of particle (TSP, PM_{10}, $PM_{2.5}$) emissions. Emission factors for these are available in the GB.

No information is available for sector in Türkiye.

Planned improvements

It is planned to include emission estimates from activities related to storage, handling and transport of mineral products in Türkiye after information of these activities in Türkiye has been obtained. The methodology to be used for estimating these emissions is available in the GB.

4.1.7 NFR 2.A.6 Other Mineral Products (e.g. Glass Industry falls under this category)

Source Category Description

Emissions: NE

Emissions from this source category are not included in the inventory at the moment.

In Türkiye, emissions under this category are at least occurring from the following industries:

Glass industry (typical emissions include NO_X, NMVOC, SO_X, TSP, PM_{10}, $PM_{2.5}$, PCDD/F, heavy metals (Pb, Cd, Cu, Se, Zn) which has 1.6-million-ton production capacity (National Development plan 2001)

Fiberglass, Mineral wool and rock wool industry: 3 facilities in Türkiye which have approximately 0.08-million-ton production capacity in 2001.

Planned improvements

It is planned to include emission estimates from activities related to other mineral products in Türkiye after information of these activities in Türkiye has been obtained. The methodologies to be used for estimating these emissions are available in GB.

4.2 NFR 2B Chemical Industry

Figure 4.2 and Table 4.4 presents the emissions, trend and share within NFR 2.B.Chemical Industry.

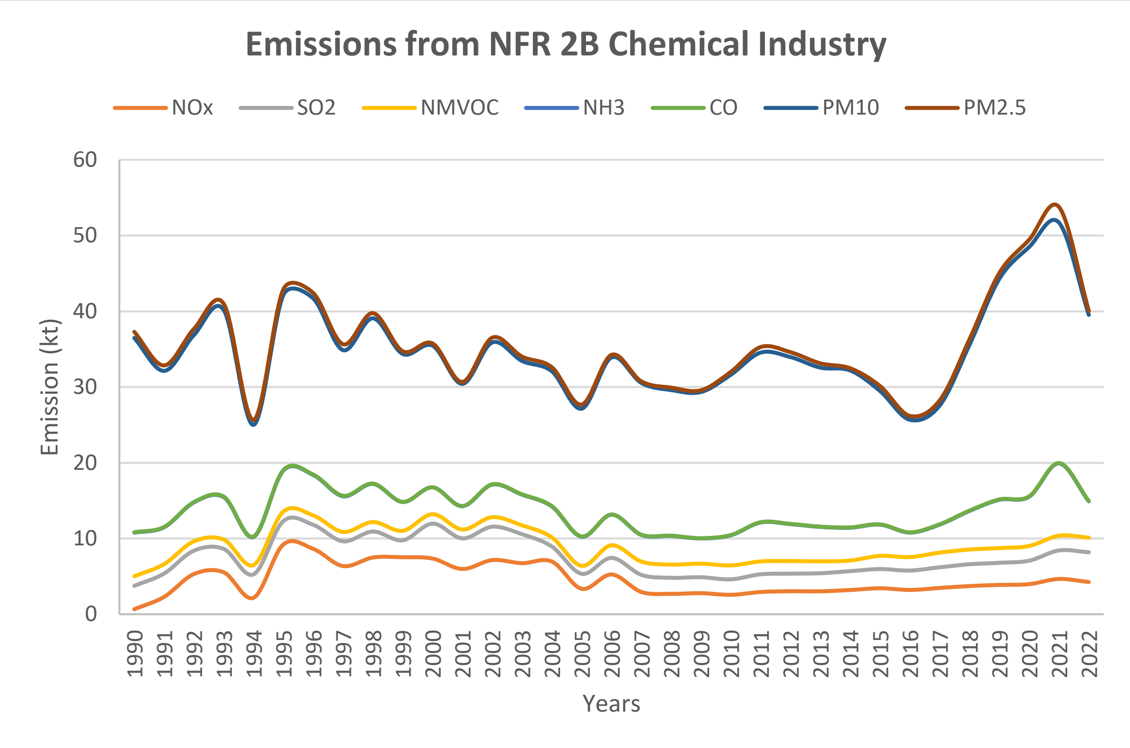

Figure 4.3 Emissions from NFR 2.B.Chemical Industry

Table 4.3 Emissions from NFR 2.B.Chemical Industry

Years	NO_x	SO_2	NMVOC	NH_3	CO	PM_{10}	$PM_{2.5}$
Units	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**
1990	0.66	3.09	1.26	0.00	0.04	25.65	0.81
1991	2.29	3.09	1.24	0.00	0.04	20.61	0.72
1992	5.31	3.09	1.24	0.00	0.04	22.06	0.81
1993	5.54	3.09	1.23	0.01	0.06	24.64	0.81
1994	2.18	3.09	1.24	0.01	0.05	14.75	0.64
1995	9.22	3.09	1.25	0.01	0.06	23.13	0.76
1996	8.63	3.17	1.24	0.01	0.06	23.25	0.72
1997	6.36	3.27	1.24	0.01	0.06	19.22	0.77
1998	7.49	3.43	1.25	0.00	0.04	21.83	0.69
1999	7.53	2.24	1.25	0.00	0.01	19.53	0.35
2000	7.35	4.61	1.24	0.00	0.01	18.71	0.29
2001	5.98	4.03	1.18	0.00	0.01	16.14	0.26

2002	7.15	4.41	1.25	0.00	0.04	18.73	0.63
2003	6.74	3.82	1.18	0.00	0.04	17.62	0.57
2004	6.96	1.98	1.21	0.00	0.04	17.80	0.54
2005	3.36	1.98	1.05	0.00	0.04	16.87	0.54
2006	5.25	2.19	1.67	0.00	0.01	20.75	0.33
2007	2.94	2.26	1.76	0.00	0.03	20.04	0.20
2008	2.70	2.12	1.74	0.00	0.03	19.22	0.32
2009	2.78	2.11	1.79	0.00	0.03	19.30	0.23
2010	2.57	2.04	1.84	0.00	0.03	21.17	0.38
2011	2.94	2.34	1.70	0.00	0.03	22.39	0.73
2012	3.04	2.32	1.67	0.00	0.03	22.02	0.65
2013	3.03	2.38	1.57	0.00	0.03	20.99	0.57
2014	3.20	2.49	1.40	0.00	0.04	20.72	0.29
2015	3.43	2.54	1.74	0.00	0.04	17.61	0.65
2016	3.21	2.56	1.78	0.00	0.04	14.85	0.51
2017	3.47	2.73	1.94	0.00	0.04	15.69	0.67
2018	3.72	2.88	1.94	0.00	0.04	21.89	0.73
2019	3.87	2.92	1.94	0.00	0.04	29.12	0.77
2020	3.98	3.10	1.94	0.00	0.04	32.93	0.96
2021	4.66	3.77	1.94	0.01	0.05	31.74	2.06
2022	4.25	3.93	1.93	0.00	0.05	24.56	0.54
Trend 1990 - 2022	541.15%	27.45%	52.69%	5.24%	5.24%	-4.25%	-33.43%
Trend 2021 - 2022	-8.70%	4.38%	-0.72%	-8.70%	-8.70%	-22.59%	-74.01%

4.2.1 NFR 2.B.1 Ammonia Production

Source Category Description

Emissions: NO_x, NH_3, CO

Key Source: No

Emission Sources

Ammonia is produced reaction of nitrogen and hydrogen basically. Hydrogen is derived from natural gas with steam reforming reaction and nitrogen is derived from air. Simplified process scheme in the GB is illustrated in Figure 4.3

There are two facilities for ammonia production with total capacity of 0.07 million tons/year. Detailed information about production and abatement technologies will be collected next coming years.

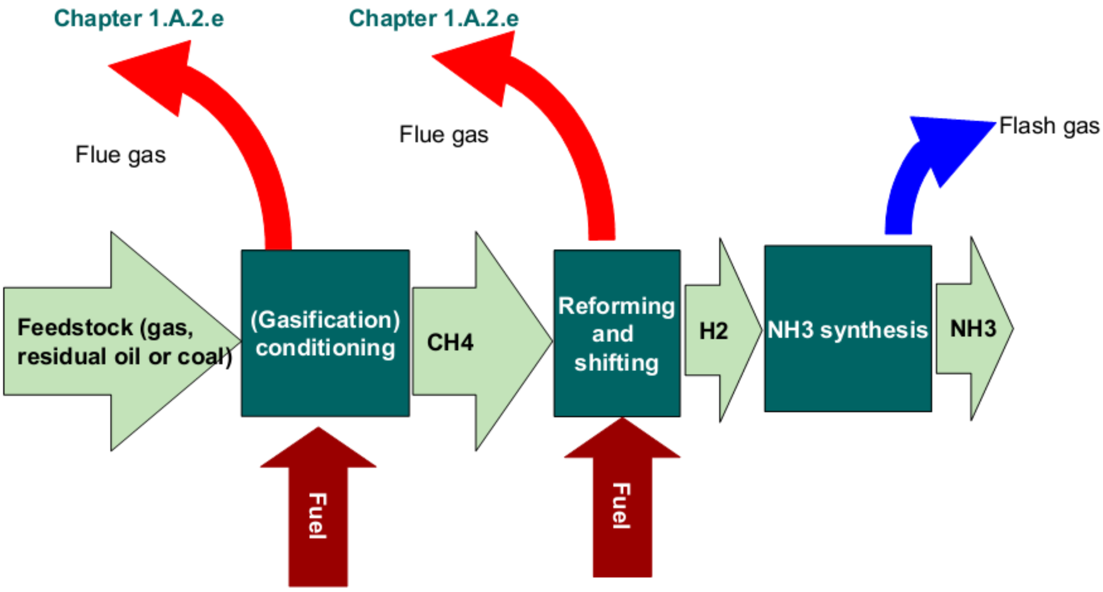

Figure 4.4 Process scheme of Ammonia production

Emission Trends

- NO_x emissions increased by about 5.24 % from 0.45 kt in 1990 to 0.47 kt in 2022.
- NH_3 emissions increased by about 5.24 % from 0.004 kt in 1990 to 0.005 k in 2022.
- CO emissions increased by about 5.24 % from 0.04 kt in 1990 to 0.05 kt in 2022.
- Emission trends are illustrated in Figure 4.5 and emissions and activity data are presented in Table 4.4

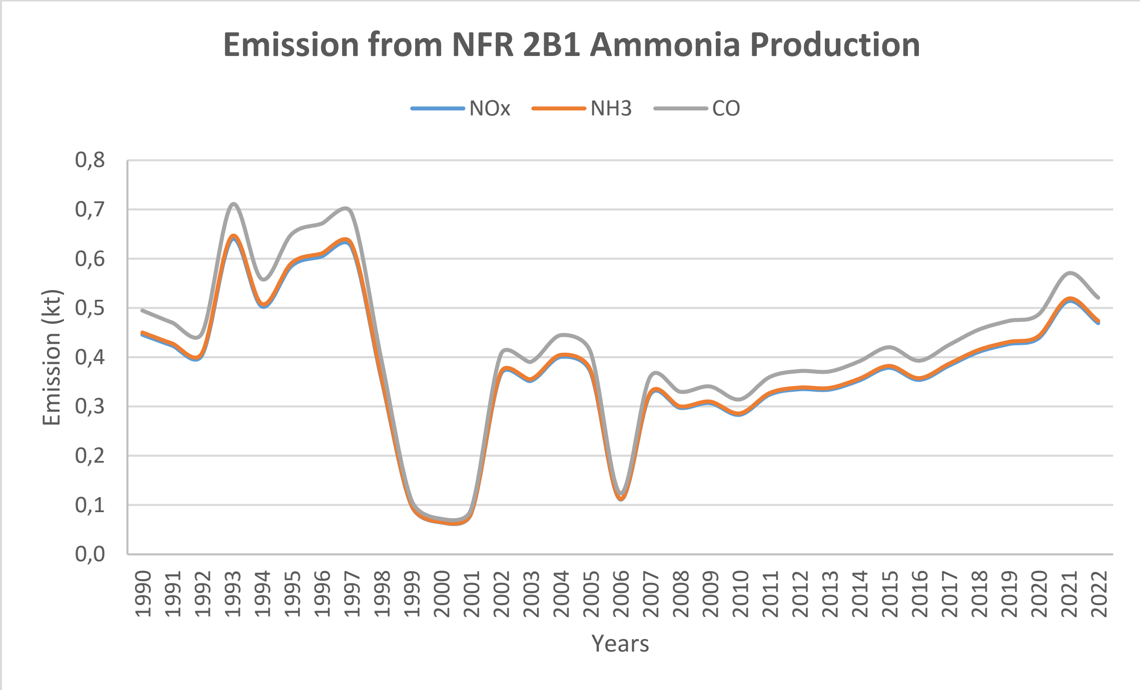

Figure 4.5 Emissions from NFR 2.B.1 ammonia production for the period 1990 to 2022

Production of ammonia decreases due to high operation while imported ammonia is preferred as a raw material of fertiliser industry. That is the reason for the decreases of emissions after 2005.

Table 4.4 Emissions from NFR sector 2.B.1 Ammonia production and activity data

Years	NOx	NH_3	CO	NH_3 Production
Units	**kt**	**kt**	**kt**	**kt**
1990	0.45	0.00	0.04	445.92
1991	0.42	0.00	0.04	423.79
1992	0.40	0.00	0.04	404.66
1993	0.64	0.01	0.06	639.46
1994	0.50	0.01	0.05	503.26
1995	0.59	0.01	0.06	585.64
1996	0.60	0.01	0.06	604.76
1997	0.62	0.01	0.06	624.02
1998	0.36	0.00	0.04	356.66
1999	0.10	0.00	0.01	100.25
2000	0.07	0.00	0.01	65.01
2001	0.08	0.00	0.01	81.64
2002	0.37	0.00	0.04	365.65
2003	0.35	0.00	0.04	351.96

2004	0.40	0.00	0.04	400.78
2005	0.37	0.00	0.04	370.58
2006	0.11	0.00	0.01	111.52
2007	0.32	0.00	0.03	324.45
2008	0.30	0.00	0.03	297.40
2009	0.31	0.00	0.03	307.06
2010	0.28	0.00	0.03	283.31
2011	0.32	0.00	0.03	324.22
2012	0.34	0.00	0.03	335.20
2013	0.33	0.00	0.03	334.45
2014	0.35	0.00	0.04	353.01
2015	0.38	0.00	0.04	378.76
2016	0.35	0.00	0.04	354.14
2017	0.38	0.00	0.04	382.93
2018	0.41	0.00	0.04	410.96
2019	0.43	0.00	0.04	426.86
2020	0.44	0.00	0.04	438.61
2021	0.51	0.01	0.05	513.98
2022	0.47	0.00	0.05	469.29
Trend 1990 - 2022	5.24%	5.24%	5.24%	5.24%
Trend 2021 - 2022	-8.70%	-8.70%	-8.70%	-8.70%

Source of Activity Data

Production data was available in CRF tables for 1990-2006. 2007-2022 data is extrapolated according to Eurostat Türkiye Industry Production Index-Manufacture of Fertiliser and Nitrogen Compounds. 2005 is used as base year for extrapolation.

Methodological Issues

The applied methodology is Tier 1 uses the general equation:

$$Emission_{pollutant} = \sum AD * EF$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (Kt)

i = NO_x, CO, NH_3

AD = annual national ammonia production (Kt)

EF = emission factor of pollutant i for ammonia production (kg/tons NH_3)

Source of Emission Factors

Default emission factors (Tier 1) for ammonia production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.5.

Table 4.5 Emission factor (EF) used sector 2.B.1 Ammonia production

	Unit	EF	Reference
NO_x	kg/ton NH_3	1	EMEP/EEA (2023), Chapter 2.B Chemical Industry, Table 3-2 , page 15,Tier 1
NH_3	kg/ton NH_3	0.01	
CO	kg/ton NH_3	0.1	

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

It is planned to use plant specific data in next coming years. To improve the emission estimation, more information needs to be received on the process and abatement techniques used by plants in Türkiye. It is possible to improve the methodology by obtaining information on the performance of production processes, i.e. data on possible emission measurements from which calculation of typical emission levels (kg/tons of product) could be carried out.

These improvements are scheduled to be carried out in upcoming years.

4.2.2 NFR 2.B.2 Nitric Acid Production

Source Category Description

Emissions: NO_x

Key Source: No

Emission Sources

Nitric acid production involves the catalytic oxidation of ammonia by air yielding nitrogen oxide then oxidized in to nitrogen dioxide and absorbed in the water. This process results weak acid, for strong acid nitrogen dioxide absorbed in nitric acid. Simplified process scheme in the GB is illustrated in Figure 4.6 This process is a source of NO_x emissions at least.

One plant produces both high and low concentration nitric acid in Türkiye.

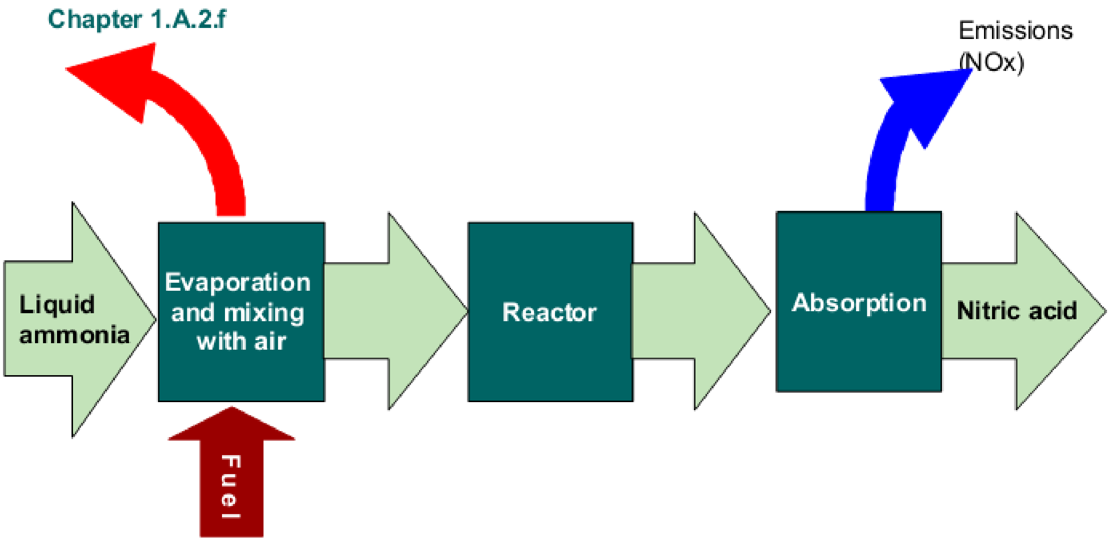

Figure 4.6 Process scheme of nitric acid production

Emission Trends

NO_x emissions increased by about 1640.07 % from 0.22 kt in 1990 to 3.78 kt in 2022.

Emission trends are illustrated in Figure 4.6 and emissions and activity data are presented in Table 4.7

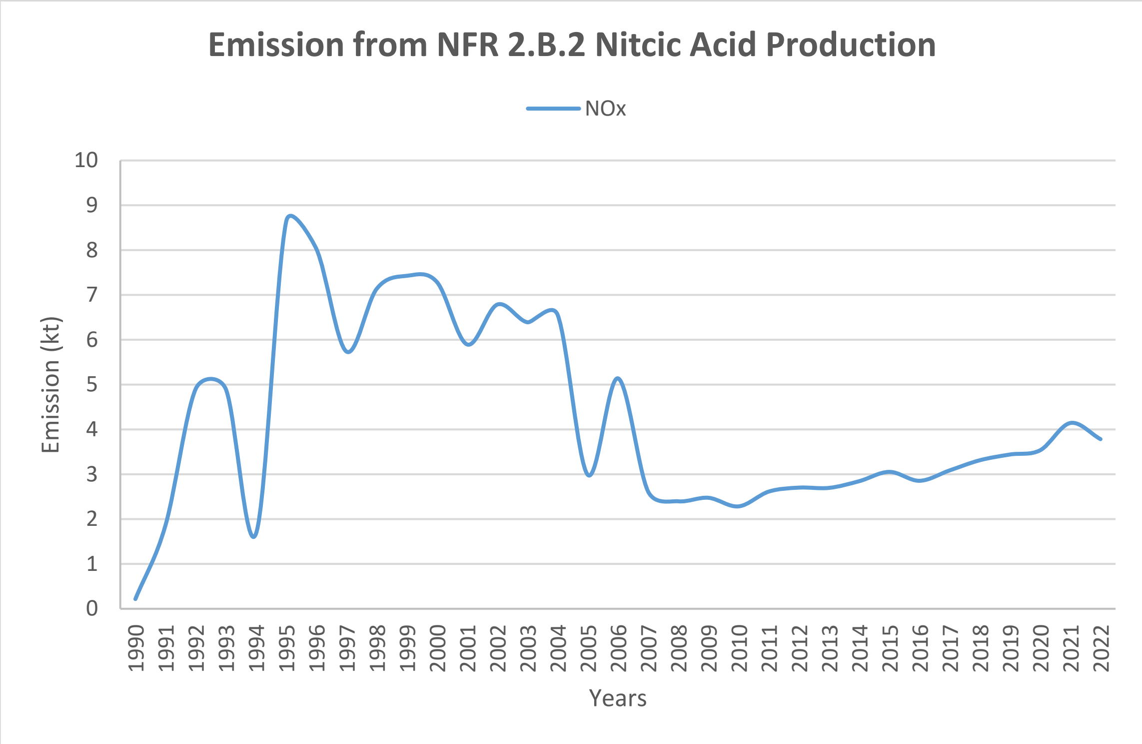

Figure 4.7 Emissions from NFR 2.B.2 nitric acid production for the period 1990 to 2022

Table 4.6 Emissions from NFR sector 2.B.2 Nitric Acid production and activity data

Years	NO_x	HNO_3 Production
Units	**kt**	**kt**
1990	0.22	21.75
1991	1.87	186.73
1992	4.90	490.50
1993	4.90	489.85
1994	1.68	167.96
1995	8.64	863.89
1996	8.03	802.89
1997	5.74	573.70
1998	7.14	713.64
1999	7.43	742.76
2000	7.29	728.73
2001	5.90	589.62
2002	6.79	678.63
2003	6.39	639.07
2004	6.56	655.76
2005	2.99	298.81
2006	5.14	514.06
2007	2.62	261.61
2008	2.40	239.80
2009	2.48	247.59

2010	2.28	228.44
2011	2.61	261.43
2012	2.70	270.28
2013	2.70	269.67
2014	2.85	284.64
2015	3.05	305.40
2016	2.86	285.55
2017	3.09	308.76
2018	3.31	331.36
2019	3.44	344.19
2020	3.54	353.66
2021	4.14	414.43
2022	3.78	378.40
Trend 1990 - 2022	1640.07%	1640.07%
Trend 2021 - 2022	-8.70%	-8.70%

Source of Activity Data

Production data was available in CRF tables for 1990-2006. 2007-2022 data is extrapolated according to Eurostat Türkiye Industry Production Index-Manufacture of Fertiliser and Nitrogen Compounds. 2005 is used as base year for extrapolation.

Methodological Issues

The applied methodology is Tier 1 uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (Kt)

i = NO_x,

AD = annual national nitric acid production (Kt)

EF = emission factor of pollutant i for nitric acid production(kg/tons NH_3)

Source of Emission Factors

Default emission factors (Tier 1) for nitric acid production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.7.

Table 4.7 Emission factor (EF) used sector 2.B.2 Nitric Acid production

	Unit	EF	Reference
NOx	kg/Mg HNO_3	10	EMEP/EEA Guidebook(2023) Chapter 2B.Chemical Industry Table 3-3, page 15, Tier 1

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculations have been done for this inventory.

Planned improvements

Plant specific information will be collected to better emission estimates.

These improvements are scheduled to be carried out in next coming years.

4.2.3 NFR 2.B.3 Adipic Acid Production

Source Category Description

Emissions: NO

No emission from adipic acid production is estimated in this inventory.

Emission Sources

Adipic acid is raw material for nylon, polyurethane and polyester manufacturing. Adipic acid production involves oxidizing of cyclohexane to cyclohexanol and cyclohexanon mixture. Then mixture oxidized with nitric acid to produce adipic acid.

Adipic acid production is a source for at least NO_x and CO emissions but major pollutant is nitrous oxide(N_2O) which is greenhouse gas.

Adipic acid production does not occur in Türkiye and emission estimates were not also included to greenhouse gas emission inventory.

4.2.4 NFR 2.B.5 Carbide Production

Source Category Description

Emissions: NO_x, CO, PM10

Key Source : No

Emission Sources

Production of calcium carbide involves heating lime and carbon mixture in an electrical arc furnace up to 2100 ^{0}C. Calcium carbide and carbon monoxide occurs in the reaction. Carbide production is a source for NO_x and CO emissions. Simplified process scheme in the GB is illustrated in Figure 4.8.

Carbide production occurs in Türkiye, but accurate information on the volume of the industry, nor on the production processes has been available for the work.

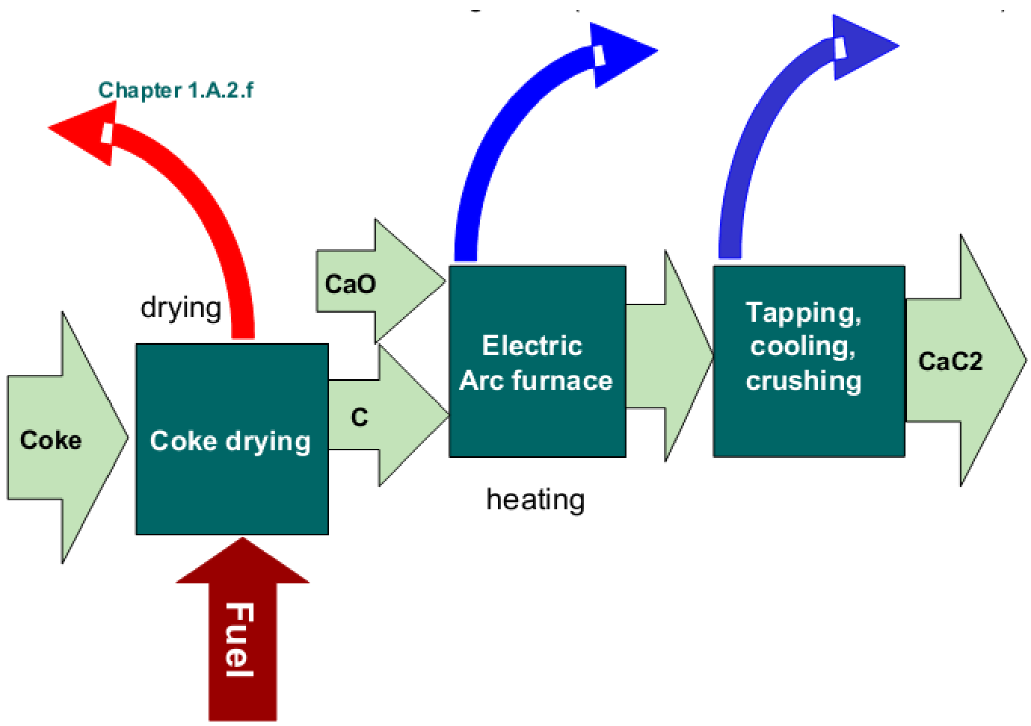

Figure 4.8 Process scheme for carbide production

Emission Trends

- PM_{10} emissions increased by about 8.63 % from 0.003 kt in 1990 to 0.003 kt in 2022.

Emission trends are illustrated in Figure 4.9 and emissions and activity data are presented in Table 4.8

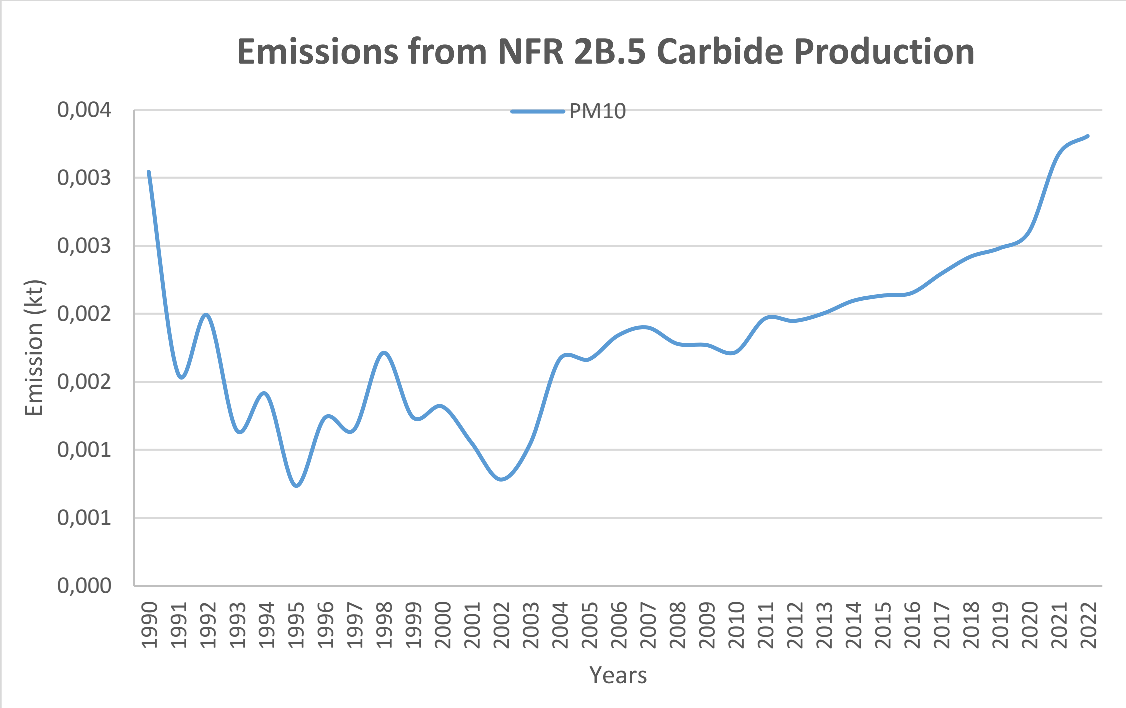

Figure 4.9 Emissions from NFR 2.B.5 carbide production for the period 1990 to 2022

Table 4.8 Emissions from NFR sector 2.B.5 Carbide production and activity data

Years	PM_{10}	Carbide Production
Units	**kt**	**kt**
1990	0.003	38.05
1991	0.002	19.50
1992	0.002	24.85
1993	0.001	14.29
1994	0.001	17.61
1995	0.001	9.20
1996	0.001	15.44
1997	0.001	14.35
1998	0.002	21.42
1999	0.001	15.49
2000	0.001	16.49
2001	0.001	13.15
2002	0.001	9.77
2003	0.001	13.05
2004	0.002	20.81
2005	0.002	20.81
2006	0.002	23.02
2007	0.002	23.74

2008	0.002	22.25
2009	0.002	22.13
2010	0.002	21.47
2011	0.002	24.56
2012	0.002	24.35
2013	0.002	25.04
2014	0.002	26.19
2015	0.002	26.67
2016	0.002	26.91
2017	0.002	28.67
2018	0.002	30.24
2019	0.002	30.72
2020	0.003	32.53
2021	0.003	39.60
2022	0.003	41.33
Trend 1990 – 2022	8.63%	8.63%
Trend 2021 - 2022	4.38%	4.38%

Source of Activity Data

Production data was available in CRF tables for 1990-2004. 2005 is assumed same as 2004 data. 2006-2020 data is extrapolated according to Eurostat Türkiye Industry Production Index-Manufacture of Chemicals and chemical products. 2005 is used as base year for extrapolation.

Methodological Issues

The applied methodology is TIER 1 uses the general equation:

$$\text{Emission pollutant} = \sum AD * EF$$

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (Kt)

i = NOx, CO

AD = annual national carbide production (Kt)

EF = emission factor of pollutant i for carbide production (kg/tons NH3)

Source of Emission Factors

Default emission factors (Tier 1) for carbide production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.9.

Table 4.9 Emission factor (EF) used sector 2.B.5 Carbide production

	Unit	EF	Reference
TSP	g/Mg Product	100	EMEP/EEA Guidebook(2023) Chapter 2B.Chemical Industry Table 3-5, page 16, Tier1
PM_{10}	g/Mg Product	80	

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculation has been done for this inventory.

Planned improvements

To make more country-specific estimates, information on the process and abatement techniques for plants in Türkiye, as well as information on emission measurements needs to be collected.

These improvements are scheduled to be carried out in next coming years.

4.2.5 NFR 2.B.6 Titanium dioxide production

Source Category Description

Emissions: NE

No emission from titanium dioxide production is estimated in this inventory.

4.2.6 NFR 2.B.7 Soda ash production

Source Category Description

Emissions: NE

Emissions from soda ash production and use are not included in the inventory at the moment.

There is one facility in Türkiye which produce soda ash. By production capacity it is the third largest supplier in Europe, and eight in the world.

There is also another facility which was established for natural soda ash production in 2002 and had started production.

Solvay method is used for synthetic soda ash production in Türkiye. Remote control system is used in all production steps.

Planned improvements

It is planned to include emission estimates from soda ash production and use in Türkiye after data on the production and use volumes is collected. Emission factors to estimate emissions of CO, ammonia and TSP are available in the GB.

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

4.2.7.1 Fertiliser Production

Source Category Description

Emissions: NH_3, PM_{10}

Key Source: No

In Türkiye, there are seven fertilizer production facilities. Five facilities produce fertilizer as by-product. Information about production and abatement technologies will be collected next coming years.

Emission Trends

- NH_3 emissions increased by about -16.89 % from 5.76 kt in 1990 to 4.88 kt in 2022.
- PM_{10} emissions decreased by about -4.20 % from 25.63 kt in 1990 to 24.55 kt in 2022.
- $PM_{2.5}$ emissions decreased by about -33.36 % from 0.80 tk in 1990 to 0.54 kt in 2022.

Emission trends are illustrated in Figure 4.10 while emissions are presented in Table 4.10. Activity data are given in Annex C.23.

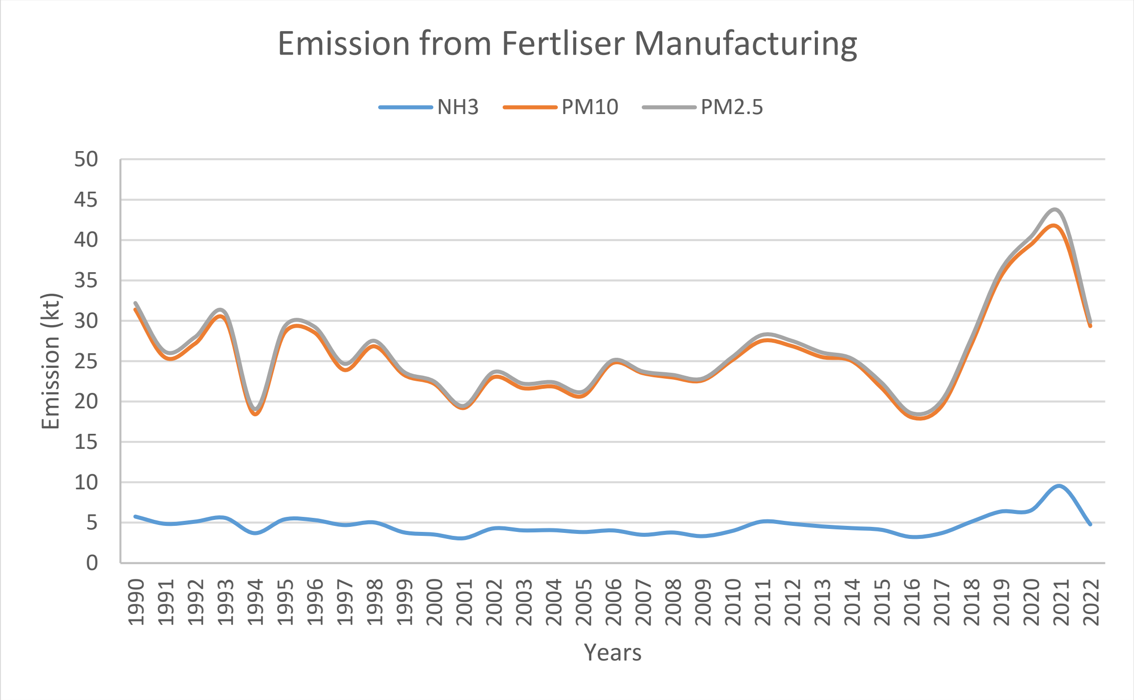

Figure 4.10 Emissions from NFR 2.B.10.a fertiliser production for the period 1990 to 2022

The annual changes in emissions reflect the changes in production volumes and parallel for both pollutants.

Table 4.10 Emissions from sector 2.B.10.a Fertiliser Production

Years	NH_3	PM_{10}	$PM_{2.5}$
Units	**kt**	**kt**	**kt**
1990	5.76	25.63	0.80
1991	4.86	20.58	0.72
1992	5.13	22.03	0.81
1993	5.60	24.62	0.81
1994	3.70	14.72	0.64
1995	5.41	23.10	0.76
1996	5.33	23.22	0.72
1997	4.71	19.20	0.77
1998	5.03	21.80	0.69
1999	3.80	19.51	0.35
2000	3.54	18.68	0.28
2001	3.08	16.12	0.26
2002	4.30	18.71	0.63
2003	4.05	17.60	0.57
2004	4.08	17.78	0.54
2005	3.84	16.85	0.54
2006	4.04	20.73	0.33
2007	3.50	20.02	0.20
2008	3.79	19.20	0.32
2009	3.33	19.27	0.23
2010	3.98	21.14	0.38
2011	5.15	22.37	0.73
2012	4.87	22.00	0.65
2013	4.54	20.97	0.56
2014	4.33	20.70	0.29
2015	4.12	17.58	0.65
2016	3.23	14.83	0.51
2017	3.69	15.66	0.67
2018	5.10	21.86	0.73
2019	6.38	29.09	0.77
2020	6.50	32.90	0.96
2021	9.54	31.71	2.06
2022	4.79	24.55	0.54
Trend 1990 – 2022	-16.89%	-4.20%	-33.36%
Trend 2021 - 2022	-49.83%	-22.57%	-74.00%

Source of Activity Data

Production data was available from web site of Ministry of Agriculture, Food and Livestock as annual statistics.

Methodological Issues

The applied methodology is Tier 2 uses the general equation:

$$\text{Emission pollutant} = \sum AD_{production} * EF_{pollutant}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (Kt)

i = NH_3,PM_{10}

AD_{fert} = activity rate for fertiliser production by type (Kt)

- Nitrogen - Ammonium nitrate
- Nitrogen - Ammonium phosphate (N)
- Nitrogen - Ammonium sulphate
- Nitrogen - Calc.amm. nitrate
- Nitrogen - N K compound (N)
- Nitrogen - N P K compound (N)
- Nitrogen - Other N straight
- Nitrogen - Other NP (N)
- Nitrogen - Urea

EF = emission factor of pollutant i for fertilizer production by type (kg/tons)

- Amonium Sulphate
- Ammonium Nitrate
- Ammonium Phosphate &NPK
- Urea

$$AD_{fert} = \text{Total N Manufacture Fert} * \text{Consumption} / \text{Total N Consumption}$$

Where:

Total N $_{ManufactureFert}$ = Total N Fertiliser Manufacture by type (Kt nutrients)

Consumption = Consumption of fertilizer (Kt nutrients)

Total N Consumption = Total N Consumption (Kt nutrients)

Source of Emission Factors

Emission factors (Tier 2) for ammonium sulphate ammonium nitrate, ammonium phosphate and urea production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.11, 4.12, 4.13 and 4.14.

Table 4.11 Emission factor (EF) used sector 2.B.10.a other chemical industry, ammonium sulphate production

	Unit	EF	Reference
TSP	kg/ton	6	EMEP/EEA (2023), Chapter 2.B Chemical Industry, Table 3-26 , page 27,Tier2, controlled emission factors are used with %90 efficiency
PM_{10}	kg/ton	4.8	Since PM10 EF is not given in the guidebook, it is assumed PM10 is 80% of TSP

Table 4.12 Emission factor (EF) used sector 2.B.10.a other chemical industry, ammonium nitrate production

	Unit	EF	Reference
NH_3	kg/ton	3	EMEP/EEA (2023), Chapter 2.B Chemical Industry, Table 3-27 , page 28
TSP	kg/ton	20	
PM_{10}	kg/ton	*16*	Since PM10 factor is not given in the guidebook, it is assumed PM10 is 80% of TSP. Controlled emission factors are used with %90 efficiency

Table 4.13 Emission factor (EF) used sector 2.B.10.a other chemical industry, ammonium phosphate production

	Unit	EF	Reference
TSP	kg/ton	0.3	EMEP/EEA (2023), Chapter 2.B Chemical Industry, Table 3-28 , page 29 EMEP/EEA
PM_{10}	kg/ton	0.240	

Table 4.14 Emission factor (EF) used sector 2.B.10.a other chemical industry, urea production

	Unit	EF	Reference
NH_3	kg/Mg	2.5	EMEP/EEA (2023), Chapter 2.B Chemical Industry, Table 3-29 , page 29
PM_{10}	kg/Mg	1.2	

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

Controlled emission factors are used since all fertilizer facility have controlled equipment's National historic activity datasets were included to calculations. Calcium ammonium nitrate production amounts were not included to emission calculation in previous submissions. EMEP/EEA guidebook classified calcium ammonium nitrate and ammonium nitrate as ammonium nitrate, therefore production amounts were summed, and emissions were recalculated.

Planned Improvements

It is possible to improve the methodology by obtaining information on the process technique and abatement technique used for each plant in the sector, as well as information on emission measurements to enable calculation of specific emissions for each plant.

These improvements are scheduled to be carried out in next coming years.

4.2.7.2 Sulphuric Acid Production

Source Category Description

Emissions: SO_2

Key Source: No

Five facilities produce sulphuric acid production in Türkiye, but not enough accurate information on the volume of the industry or on the production processes has been available for the work.

Emission Trends

- SO_2 emissions has increased by about 27.45 % from 3.09 kt in 1990 to 3.93 kt in 2022.

Emission trends are illustrated in Figure 4.11 and emissions and activity data are presented in Table 4.15

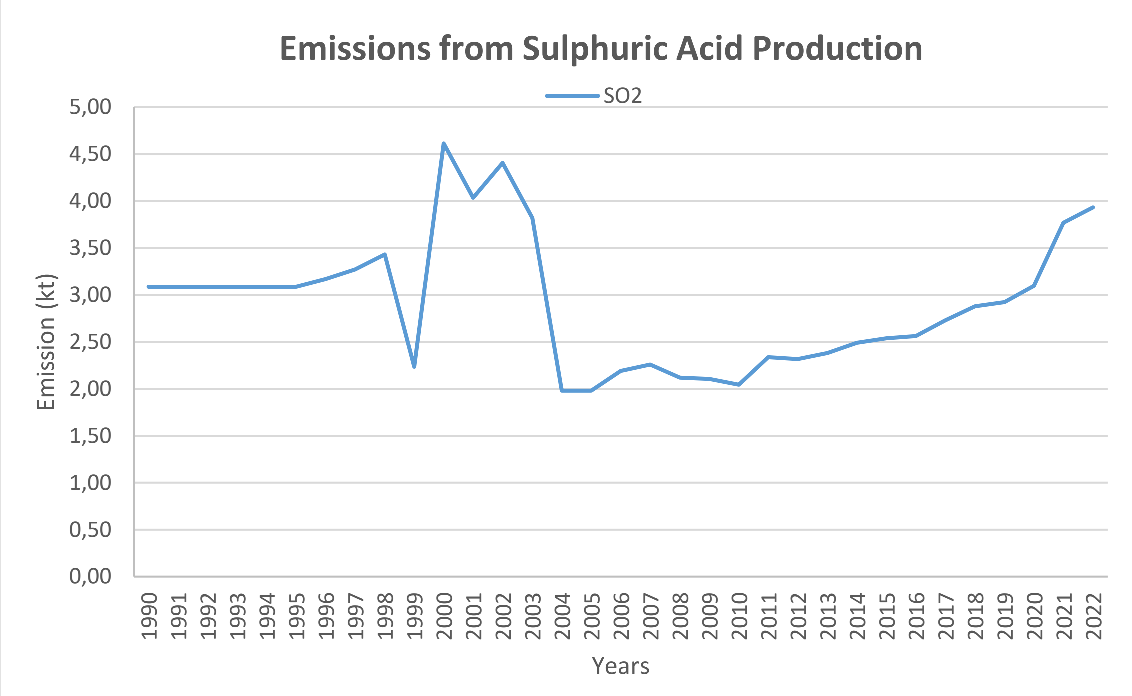

Figure 4.11 Emissions from NFR 2.B.10.a sulphuric acid production for the period 1990 to 2022

Table 4.15 Emissions from NFR sector 2.B.10.a Sulphuric Acid production and activity data

Years	NH_3	H_2SO_4 Manufacture
Units	**kt**	**kt**
1990	3.09	440.96
1991	3.09	440.96
1992	3.09	440.96
1993	3.09	440.96
1994	3.09	440.96
1995	3.09	440.96
1996	3.17	452.96
1997	3.27	467.31
1998	3.43	490.12
1999	2.24	319.53
2000	4.61	659.23
2001	4.03	576.30
2002	4.41	629.79
2003	3.82	545.93
2004	1.98	282.93
2005	1.98	282.93
2006	2.19	312.99
2007	2.26	322.78

2008	2.12	302.59
2009	2.11	300.95
2010	2.04	291.89
2011	2.34	333.95
2012	2.32	331.05
2013	2.38	340.48
2014	2.49	356.07
2015	2.54	362.60
2016	2.56	365.86
2017	2.73	389.79
2018	2.88	411.18
2019	2.92	417.71
2020	3.10	442.37
2021	3.77	538.45
2022	3.93	562.02
Trend 1990 – 2022	27.45%	27.45%
Trend 2021 - 2022	4.38%	4.38%

Source of Activity Data

Production data was available in National Development Reports for 1995-2004. 2005 is assumed same as 2004 data. 2005-2012 data is extrapolated according to Eurostat Türkiye Industry Production Index-Manufacture of Chemical and Chemical Products. 2005 is used as base year for extrapolation.1990-1994 are assumed same as 1995 data.

Methodological Issues

The applied methodology is Tier 2 uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (Kt)

i = SO_2,

AD = annual national sulphuric acid production (Kt)

EF = emission factor of pollutant i for sulphuric acid production (kg/tons NH3)

Source of Emission Factors

Default emission factors (Tier 2) for sulphuric acid production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.16.

Table 4.16 Emission factor (EF) used sector 2.B.10.a Sulphuric Acid production

	Unit	EF	Reference
SO_2	kg/Mg H_2SO_4	7	EMEP/EEA Guidebook(2023) Chapter 2B.Chemical Industry Table 3-20, page 24,Tier 2

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculation has been done for this inventory.

Planned improvements

Plant specific information will be collected to better emission estimates.

These improvements are scheduled to be carried out in next coming years.

4.2.7.3 Ethylene Manufacture

Source Category Description

Emissions: NMVOC

Key Source: No

Türkiye has 3 companies in petrochemical industry one of which produces high density and low density polyethylene. Information about production and abatement technology will be collected next coming years.

Emission Trends

- NMVOC emissions increased by about 34.1 % from 0.26 Kt in 1990 to 0.34 Kt in 2022.

Emission trends are illustrated in Figure 4.11 and emissions and activity data are presented in Table 4.17

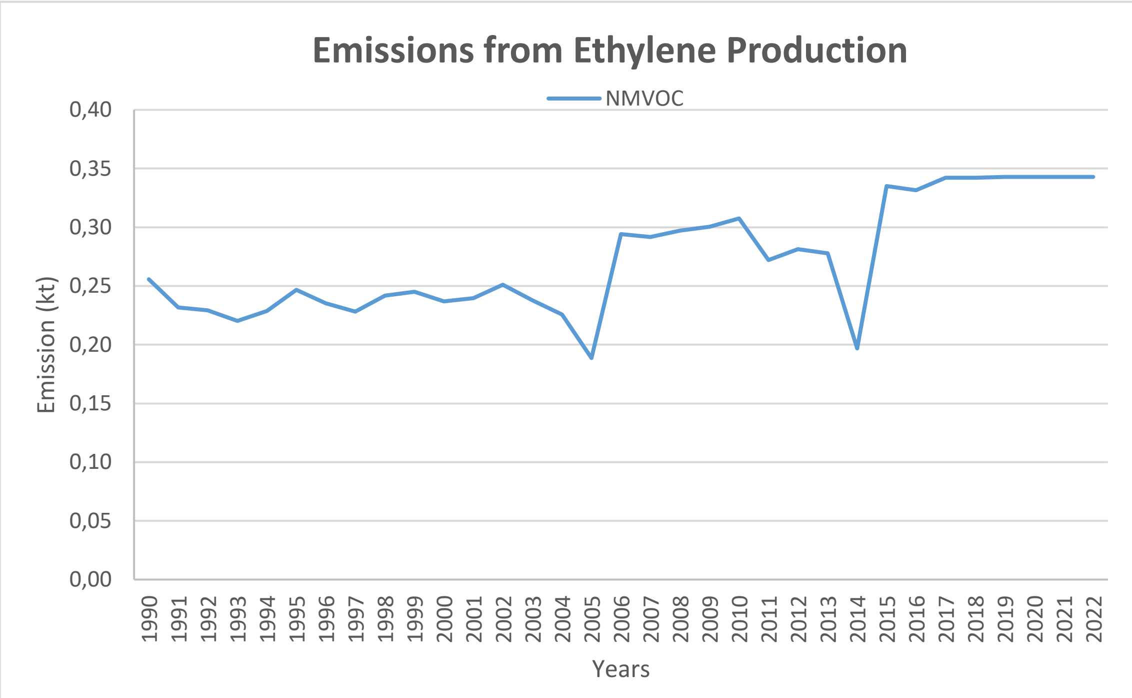

Figure 4.12 Emissions from NFR 2.B.5 ethylene production for the period 1990 to 2022

Table 4.17 Emissions from NFR sector 2.B.10.a ethylene production and activity data

Years	NMVOC	Ethylene Manufactured
Units	**kt**	**kt**
1990	0.26	426.19
1991	0.23	386.04
1992	0.23	382.08
1993	0.22	367.31
1994	0.23	381.15
1995	0.25	411.27
1996	0.24	392.27
1997	0.23	380.45
1998	0.24	402.92
1999	0.25	408.55
2000	0.24	394.89
2001	0.24	399.57
2002	0.25	418.65
2003	0.24	396.37
2004	0.23	376.31
2005	0.19	314.42
2006	0.29	490.21
2007	0.29	486.34
2008	0.30	495.37
2009	0.30	500.98
2010	0.31	512.78
2011	0.27	453.52
2012	0.28	468.97
2013	0.28	462.87
2014	0.20	328.00
2015	0.34	558.60
2016	0.33	552.72
2017	0.34	570.36
2018	0.34	570.36
2019	0.34	571.54
2020	0.34	571.54
2021	0.34	571.54
2022	0.34	571.54
Trend 1990 – 2022	34.10%	34.10%
Trend 2021 - 2022	0.00%	0.00%

Source of Activity Data

Production data was available in CRF tables for 1990-2004. Activity data for 2005-2020 were taken from PETKİM activity reports.

Methodological Issues

The applied methodology is TIER 2 uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (Kt)

i = NMVOC,

AD = annual national ethylene production (Kt)

EF = emission factor of pollutant i for ethylene production (kg/tons ethylene)

Source of Emission Factors

Default emission factors (Tier 2) for ethylene production are taken from the EMEP/EEA emission inventory guidebook 2019.

Emission factors are presented in Table 4.18

Table 4.18 Emission factor (EF) used sector 2.B.10.a Ethylene production

	Unit	EF	Reference
NMVOC	kg/ton	0.6	EMEP/EEA Guidebook(2023) Chapter 2B.Chemical Industry Table 3-36, page 34

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculations have been done.

Planned improvements

Plant specific information will be collected to better emission estimates.

These improvements are scheduled to be carried out in next coming years.

4.2.7.4 Polyethene Manufacture

Source Category Description

Emissions: NMVOC, PM_{10}

Key Source: No

Emission Trends

- NMVOC emissions increased by about 49.38 % from 0.69 kt in 1990 to 1.03 kt in 2022.

Emission trends are illustrated in Figure 4.13 while emissions are presented in Table 4.19.

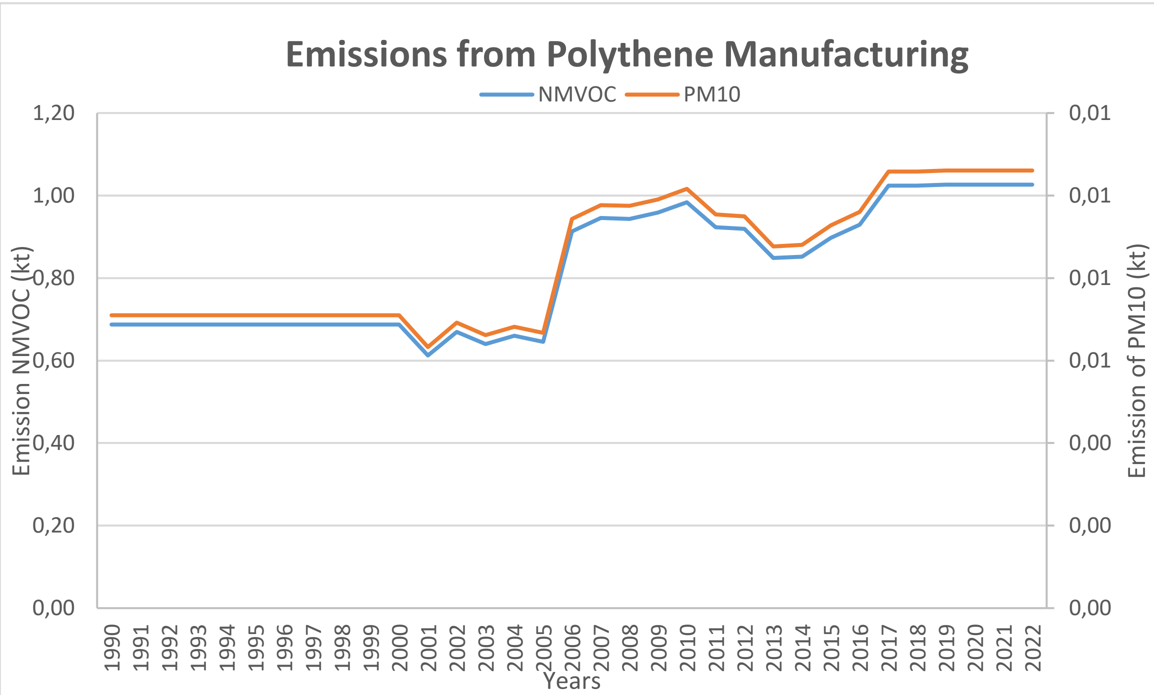

Figure 4.13 Emissions from NFR 2.B.10 Polyethene Manufacture for the period 1990 to 2022

Table 4.19 Emissions from NFR 2.B.10 Polyethene Manufacture for the period 1990 to 2022

Years	NMVOC	PM10	Polythene Manufacture
Units	**kt**	**kt**	**kt**
1990	0.69	0.01	286.29
1991	0.69	0.01	286.29
1992	0.69	0.01	286.29
1993	0.69	0.01	286.29
1994	0.69	0.01	286.29
1995	0.69	0.01	286.29
1996	0.69	0.01	286.29
1997	0.69	0.01	286.29
1998	0.69	0.01	286.29
1999	0.69	0.01	286.29
2000	0.69	0.01	286.29
2001	0.61	0.01	255.16
2002	0.67	0.01	278.97
2003	0.64	0.01	266.74
2004	0.66	0.01	275.05
2005	0.65	0.01	268.90
2006	0.91	0.01	380.34
2007	0.95	0.01	393.91
2008	0.94	0.01	393.20
2009	0.96	0.01	399.54
2010	0.98	0.01	409.81
2011	0.92	0.01	384.66
2012	0.92	0.01	382.94
2013	0.85	0.01	353.58

2014	0.85	0.01	355.00
2015	0.90	0.01	374.00
2016	0.93	0.01	387.20
2017	1.02	0.01	426.80
2018	1.02	0.01	426.80
2019	1.03	0.01	427.68
2020	1.03	0.01	427.68
2021	1.03	0.01	427.68
2022	1.03	0.01	427.68
Trend 1990 – 2022	49.38%	49.38%	49.38%
Trend 2021 - 2022	0.00%	0.00%	0.00%

Table 4.20 Emission factor (EF) used sector 2.B.10.a Polyethene Low density

	Unit	EF	Reference
NMVOC	kg/ton	2.4	EMEP/EEA (2023). Chapter 2.B.5 Polyethene Productions. Table 3-38. page 36
PM10	kg/ton	0.031*0.8	

It was assumed all polythene production is low density.

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculation has been done in this part of the inventory.

Planned Improvements

Activity data for recent years were available but it is assumed production remains same for historic data.

It will be tried to find historic data for this sector.It is possible to improve the methodology by obtaining information on the process and abatement techniques for plants in Türkiye. as well as information on emission measurements.

In addition to NMVOC. also particles are emitted from polyethylene production.

These improvements are scheduled to be carried out within coming years.

4.2.7.5 PVC Production

Source Category Description

Emissions: NMVOC. PM_{10}

Key Source: Yes (PM_{10})

Emission Trends

- NMVOC emissions decreased by about -17.45 % from 0.017 kt in 1990 to 0.014 kt in 2022.
- PM_{10} emissions decreased by about -17.45 % from 0.018 kt in 1990 to 0.015 kt in 2022.
- $PM_{2.5}$ emissions decreased by about -17.45 % from 0.001 kt in 1990 to 0.001 kt in 2022.

Emission trends are illustrated in Figure 4.14.

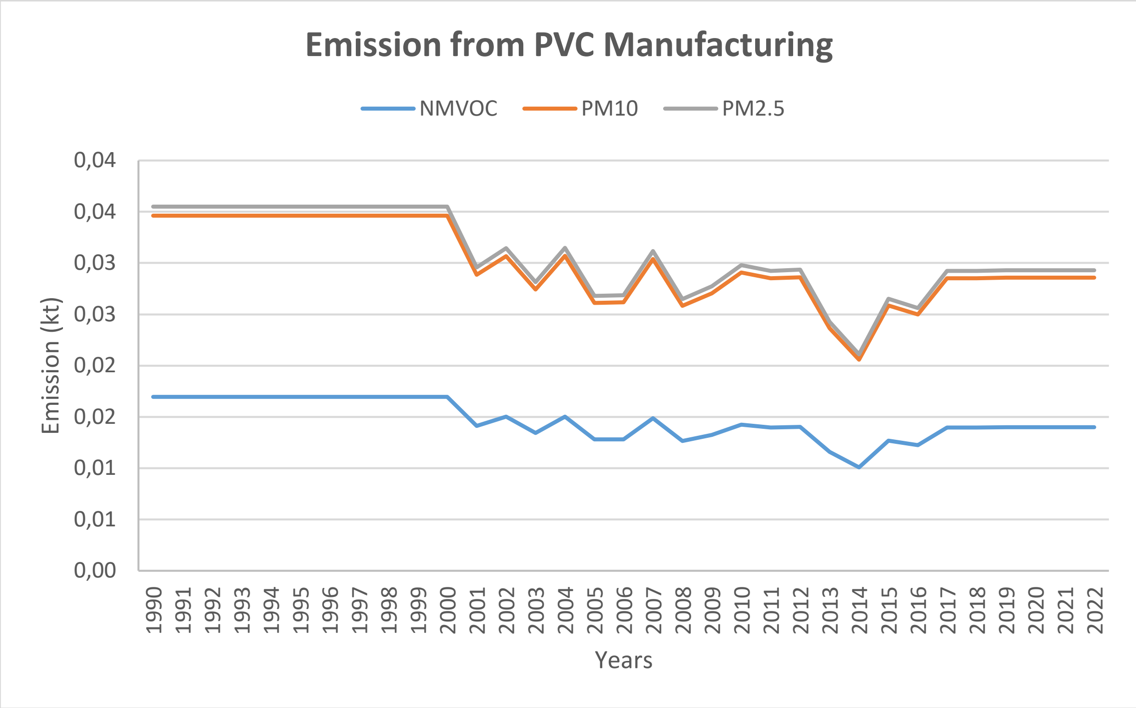

Figure 4.14 Emissions from NFR 2.B.10a PVC production for the period 1990 to 2022

Emissions and activity data from PVC production are presented in Table 4.21

Table 4.21 Emissions and activity data from sector 2.B.10.a PVC Production

Years	NMVOC	PM_{10}	$PM_{2.5}$	PVC Manufacture
Units	**kt**	**kt**	**kt**	**kt**
1990	0.017	0.018	0.001	176.63
1991	0.017	0.018	0.001	176.63
1992	0.017	0.018	0.001	176.63
1993	0.017	0.018	0.001	176.63
1994	0.017	0.018	0.001	176.63
1995	0.017	0.018	0.001	176.63
1996	0.017	0.018	0.001	176.63
1997	0.017	0.018	0.001	176.63
1998	0.017	0.018	0.001	176.63
1999	0.017	0.018	0.001	176.63

2000	0.017	0.018	0.001	176.63
2001	0.014	0.015	0.001	147.17
2002	0.015	0.016	0.001	156.53
2003	0.013	0.014	0.001	139.97
2004	0.015	0.016	0.001	156.59
2005	0.013	0.013	0.001	133.28
2006	0.013	0.013	0.001	133.57
2007	0.015	0.016	0.001	155.02
2008	0.013	0.013	0.001	131.81
2009	0.013	0.014	0.001	137.98
2010	0.014	0.015	0.001	148.29
2011	0.014	0.015	0.001	145.49
2012	0.014	0.015	0.001	146.04
2013	0.012	0.012	0.001	120.68
2014	0.010	0.011	0.001	105.00
2015	0.013	0.013	0.001	132.00
2016	0.012	0.013	0.001	127.50
2017	0.014	0.015	0.001	145.50
2018	0.014	0.015	0.001	145.50
2019	0.014	0.015	0.001	145.80
2020	0.014	0.015	0.001	145.80
2021	0.014	0.015	0.001	145.80
2022	0.014	0.015	0.001	145.80
Trend 1990 – 2022	-17.45%	-17.45%	-17.45%	-17.45%
Trend 2021 - 2022	0.00%	0.00%	0.00%	0.00%

Source of Activity Data

Production data was taken from annual activity reports of Petkim which is available on website. Due to lack of data for 1990-1999, 2000 data was used.

Methodological Issues

The Tier 2 approach for process emissions from PVC productions uses the general equation:

$Emission_{pollutant}$ = $\sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC. PM_{10}

AD = the activity rate for the PVC production (kt)

EF = emission factor of pollutant i for PVC production (g/ton)

Source of Emission Factors

Default emission factors (Tier 2) for PVC production is taken from the GB.

Emission factors are presented in Table 4.21.

Table 4.22 Emission factor (EF) used sector 2.B.10.a PVC production

	Unit	EF	Reference
NMVOC	g/ton	96	EMEP/EEA (2023). Chapter 2.B.5 PVC Productions. Table 3-40 . page 38
PM_{10}	g/ton	100	

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculation has been done in this part of the inventory.

Planned Improvements

It would be preferable to use official national datasets or plant specific data.

It is possible to improve the methodology by obtaining information on the use of production processes and abatement techniques for plants in Türkiye. as well as information on emission measurements.

These improvements are scheduled to be carried out in next coming years

4.2.7.6 Polypropylene Manufacture

Source Category Description

Emissions: NMVOC

Key Source: No

Emission Trends

- NMVOC emissions increased by about 84.32 % from 0.30 kt in 1990 to 0.56 kt in 2022.
- PM_{10} emissions increased by about 84.32 % from 0.09 kt in 1990 to 0.17 kt in 2022.

Emission trends are illustrated in Figure 4.15 and emissions and activity data are presented in Table 4.23

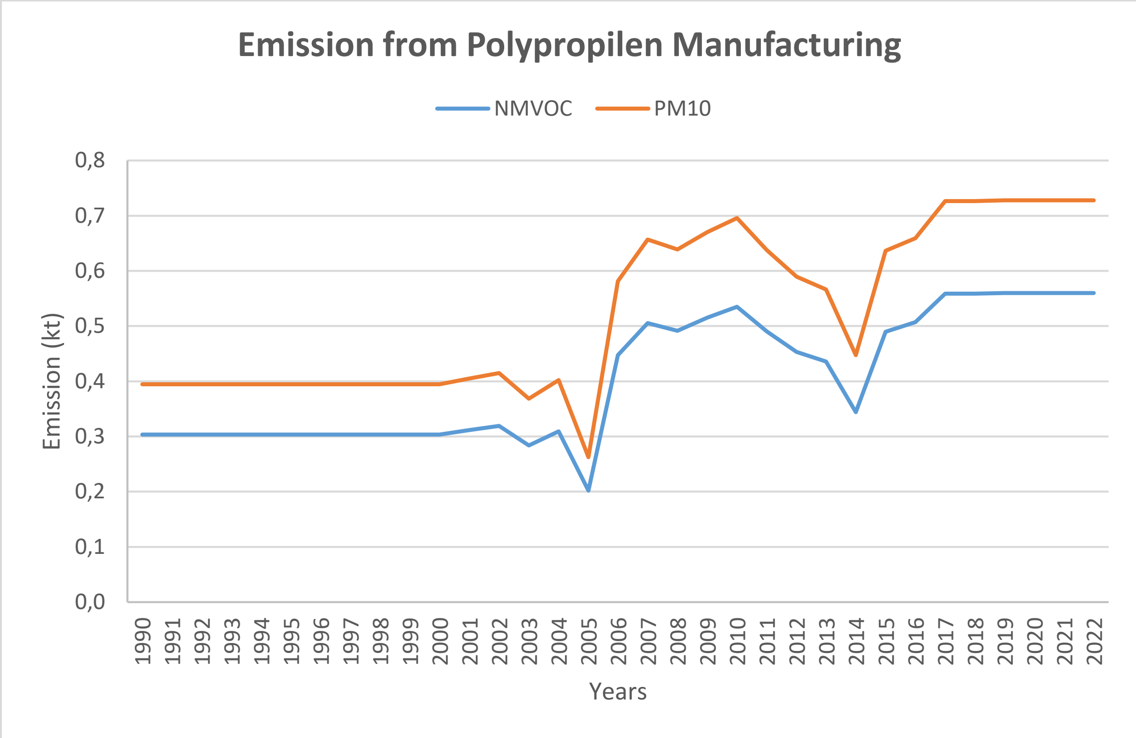

Figure 4.15 Emissions from NFR 2.B.10.a polypropylene production for the period 1990 to 2022

Table 4.23 Emissions from NFR sector 2.B.10.a Polypropylene Production and Activity Data

Years	NMVOC	PM_{10}	Polypropylene Manufacture
Units	**kt**	**kt**	**kt**
1990	0.30	0.09	75.94
1991	0.30	0.09	75.94
1992	0.30	0.09	75.94
1993	0.30	0.09	75.94
1994	0.30	0.09	75.94
1995	0.30	0.09	75.94
1996	0.30	0.09	75.94
1997	0.30	0.09	75.94
1998	0.30	0.09	75.94
1999	0.30	0.09	75.94

2000	0.30	0.09	75.94
2001	0.31	0.09	77.94
2002	0.32	0.10	79.78
2003	0.28	0.09	70.90
2004	0.31	0.09	77.31
2005	0.20	0.06	50.49
2006	0.45	0.13	111.86
2007	0.51	0.15	126.29
2008	0.49	0.15	122.84
2009	0.52	0.15	128.83
2010	0.53	0.16	133.74
2011	0.49	0.15	122.63
2012	0.45	0.14	113.36
2013	0.44	0.13	108.94
2014	0.34	0.10	86.00
2015	0.49	0.15	122.40
2016	0.51	0.15	126.72
2017	0.56	0.17	139.68
2018	0.56	0.17	139.68
2019	0.56	0.17	139.97
2020	0.56	0.17	139.97
2021	0.56	0.17	139.97
2022	0.56	0.17	139.97
Trend 1990 – 2022	84.32%	84.32%	84.32%
Trend 2021 - 2022	0.00%	0.00%	0.00%

Source of Activity Data

Production data was taken from annual activity reports of Petkim which is available on website. Due to lack of data for 1990-1999. 2000 data was used.

Methodological Issues

The applied methodology is TIER 2 uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (Kt)

i = NMVOC.

AD = annual national polypropylene production (Kt)

EF = emission factor of pollutant i for polypropylene production (kg/tons polypropylene)

Source of Emission Factors

Default emission factors (Tier 2) for polypropylene production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.24.

Table 4.24 Emission factor (EF) used sector 2.B.10.a Polypropylene production

	Unit	EF	Reference
NMVOC	kg/ton	4	EMEP/EEA Guidebook(2023) Chapter 2B.Chemical Industry Table 3-42. page 39
PM10	kg/ton	1.2	EMEP/EEA Guidebook(2023) Chapter 2B.Chemical Industry Table 3-42. page 39 (assumed 80% of TSP emission factor)

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculation has been done in this part of the inventory.

Planned improvements

Plant specific information will be collected to better emission estimates.

These improvements are scheduled to be carried out in next coming years.

4.2.8. NFR 2.B.10.b Storage. handling. transport of chemical products

Source Category Description

Emissions: NE

No emissions from storage. handling and transport of chemical products are estimated in this inventory.

Storage. handling and transport of chemical products is a source of e.g. particles. ammonia and NMVOC emissions.

Planned improvements

Particle emissions from storage and handling of fertilizers can be included in the inventory using emission factors from e.g. TNO. 2002. The Co-ordinated European Programme on Particulate Matter Emission Inventories. Projections and Guidance (CEPMEIP). http://www.air.sk/tno/cepmeip/ and by using fertilizer production as activity data. Production data needs to be collected.

These improvements are scheduled to be carried out in next coming years.

4.3 NFR 2.C Metal Industry

NFR 2.C Metal Industry includes following subsectors;

- Iron and steel production
- Ferroalloys production
- Aluminium production
- Non-Ferrous Metals production

The shares of subcategories to PM_{10} emissions in 2022 from Metal Industry are presented in Figure 4.16 below. The largest share of emissions came from iron-steel production which contributed to 97.15 % (5.85 kt) of emissions. Ferroalloys contributed to 1.21 % (0.07 kt). aluminium production contributed to 1.18%. The rest of the metal sector has 0.54 % in PM_{10} emissions in 2022.

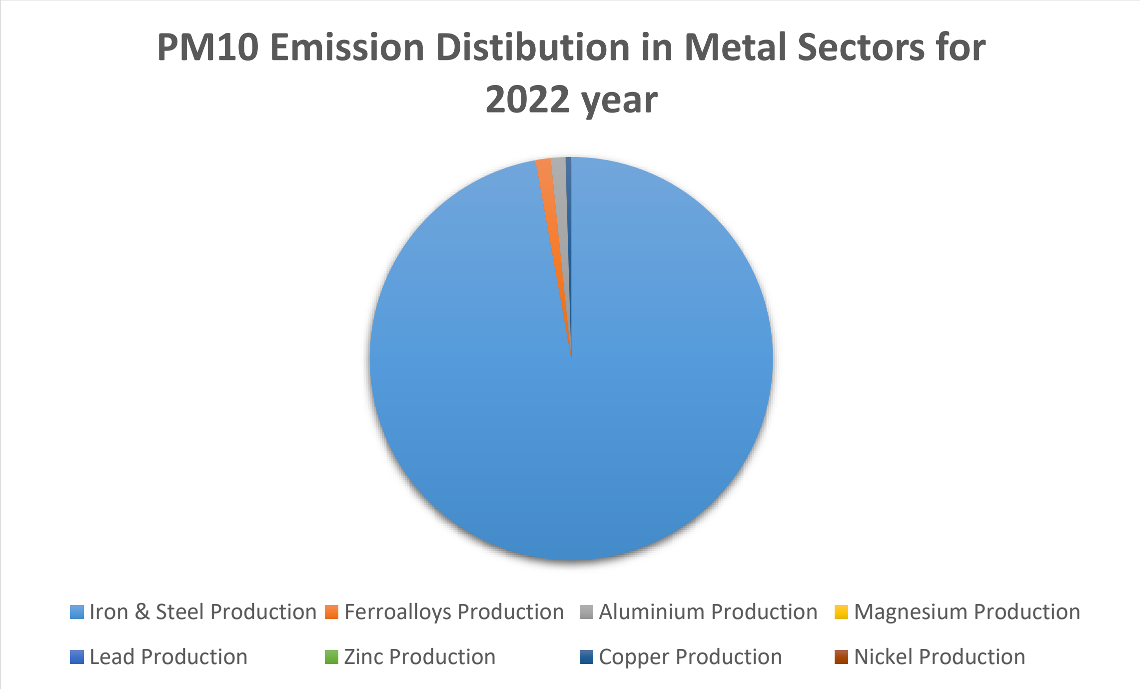

Figure 4.16 Contributions of Subsectors of Metal Industry

NFR 2.C.1 Iron and Steel Production

Source Category Description

Emissions: NMVOC. PM_{10}

IE: SO_2. NO_x. CO included in NFR 1.A.2.b

Key Source: No

Emission Sources

Iron and steel production is a large-scale industry which involves many process for instance coke production. sinter production. pellet production. iron making. steel making etc. Main processes scheme according to the GB is illustrated in Figure 4.16.

In Türkiye. there are 17 facilities with electrical arc oven and 3 integrated plants. Annual steel production capacity has increased from 9.44 Mt in 1990 to 32.5 Mt in 2022 (Türkiye's Steel Exporter's Magazine, (Turkish) Steel Magazine 154th edition November 2023, Page 17, Table of "En çok Çelik Kullanan Ülke"). Information about production and abatement technology will be collected next coming years.

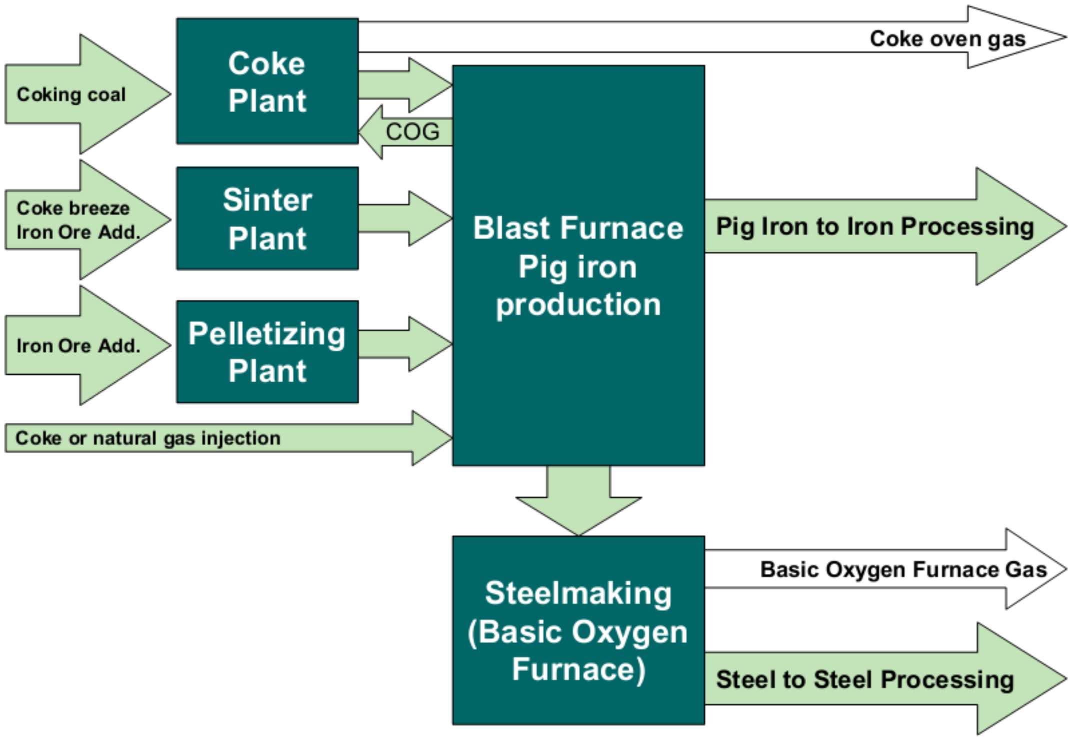

Figure 4.17 Main processes in the iron and steel industry

Emission Trends

- NMVOC emissions increased by about 224.17 % from 1.42 kt in 1990 to 4.88 kt in 2022.
- PM10 emissions increased by about 224.17 % from 1.70 Kt in 1990 to 5.85 Kt in 2022.

The increases of all emissions in this sector were mainly due to increase of production capacity which is parallel to demand.

Emission trends are illustrated in Figure 4.18.

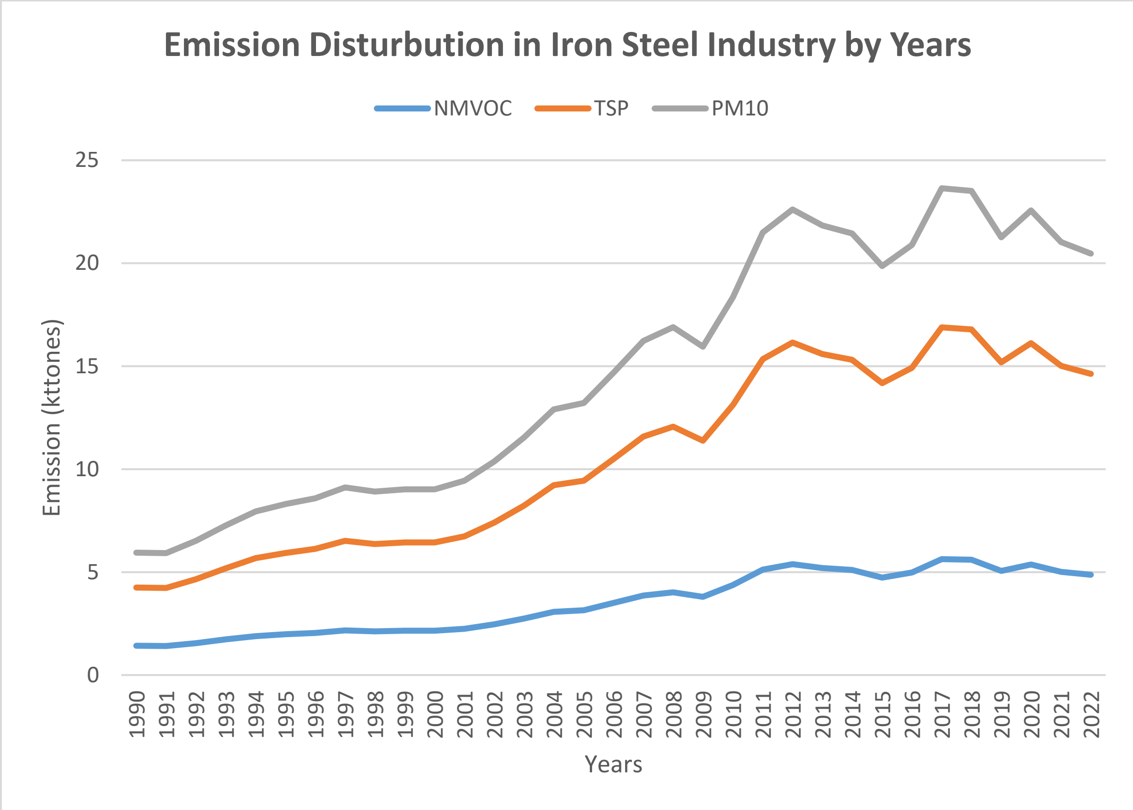

Figure 4.18 Emissions from NFR 2.C.1 Iron and Steel Production for the period 1990 to 2022

Emissions from iron and steel production and activity data are presented in Table 4.25

Table 4.25 Emissions from sector 2.C.1 Iron and Steel Production

Years	NMVOC	TSP	PM_{10}	Crude Steel Production
Units	**kt**	**kt**	**kt**	**Mt**
1990	1.42	2.83	1.70	9.44
1991	**1.41**	2.82	1.69	9.40
1992	**1.55**	3.10	1.86	10.34
1993	1.73	3.46	2.07	11.52
1994	1.89	3.79	2.27	12.62
1995	1.98	3.95	2.37	13.18
1996	2.04	4.09	2.45	13.62
1997	2.17	4.34	2.61	14.48
1998	2.12	4.24	2.55	14.14
1999	2.15	4.29	2.58	14.31
2000	2.15	4.30	2.58	14.33
2001	2.25	4.49	2.70	14.98
2002	2.47	4.94	2.96	16.47
2003	2.74	5.49	3.29	18.30
2004	3.07	6.14	3.69	20.48
2005	3.14	6.29	3.77	20.97
2006	3.50	6.99	4.20	23.32
2007	3.86	7.73	4.64	25.75
2008	4.02	8.04	4.83	26.81
2009	3.80	7.59	4.55	25.30
2010	4.37	8.74	5.25	29.14
2011	5.12	10.23	6.14	34.10

2012	5.38	10.77	6.46	35.89
2013	5.20	10.40	6.24	34.65
2014	5.11	10.21	6.13	34.04
2015	4.73	9.46	5.67	31.52
2016	4.97	9.95	5.97	33.16
2017	5.63	11.26	6.75	37.52
2018	5.60	11.19	6.72	37.31
2019	5.06	10.12	6.07	33.74
2020	5.37	10.74	6.45	35.81
2021	5.01	10.01	6.01	33.37
2022	4.88	9.75	5.85	32.50
Trend 1990 - 2022	244.17%	244.17%	244.17%	244.17%
Trend 2021 - 2022	-2.60%	-2.60%	-2.60%	-2.60%

Source of Activity Data

Production data was downloaded from http://www.worldsteel.org/statistics/statistics-archive.html for whole time series. Data was same with Iron and Steel Manufacturers Association data.

Methodological Issues

The Tier 1 approach for process emissions from an integrated steel plant uses the general equation:

$Emission_{pollutant}$ = $\sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (Kt)

i = $NMVOC.PM_{10}$

AD = the activity rate for the steel production (Mg)

EF = emission factor of pollutant i for iron and steel production (g/Mg steel)

Source of Emission Factors

Default emission factors (Tier 1) for iron and steel production is taken from the GB.

Emission factors are presented in Table 4.26

Table 4.26 Emission factor (EF) used sector 2.C.1 Iron and Steel production

	Unit	EF	Reference
NMVOC	g/Mg steel	150	EMEP/EEA (2023). Chapter 2.C.1 Iron and Steel. Table 3-1 . page 24; Tier-1
PM_{10}	g/Mg steel	180	

Uncertainty

No uncertainty analysis was made to the inventory.

Recalculations

No recalculations have been done in this inventory.

Planned Improvements

It would be preferable to use official national datasets or plant specific data.

- It is possible to improve the methodology by obtaining information on heavy metal and POP emissions which are relevant for iron and steel production. the process and abatement techniques applied in Türkiye in the sector. as well as information on emission measurements and can be calculated using production data and emission factors available from the EMEP/EEA Emission Inventory Guidebook or based on methodologies that other countries are using.

- It is planned to calculate emission in Tier 2 level. Required datasets will be asked to Iron and Steel Manufacturers Association.

These improvements are scheduled to be carried out in 3 years.

4.3.1 NFR 2.C.2 Ferroalloys Production

Source Category Description

Emissions: PM_{10}

Key Source: No

Emission Sources

Ferroalloys contain iron and one or more non-ferrous metals as alloying elements. Ferroalloys can be classified in two groups bulk ferroalloys which are produced in electrical arc furnaces and special ferroalloys which are produced in smaller quantities. Production can be carried out as primary and secondary process. Both of processes scheme in the GB is illustrated in Figure 4.18 Emissions from this subsector are not considered significant.

Ferroalloys production is a source of particle (TSP. PM_{10}. $PM_{2.5}$) emissions factors for these are available in the EMEP/EEA Guidebook.

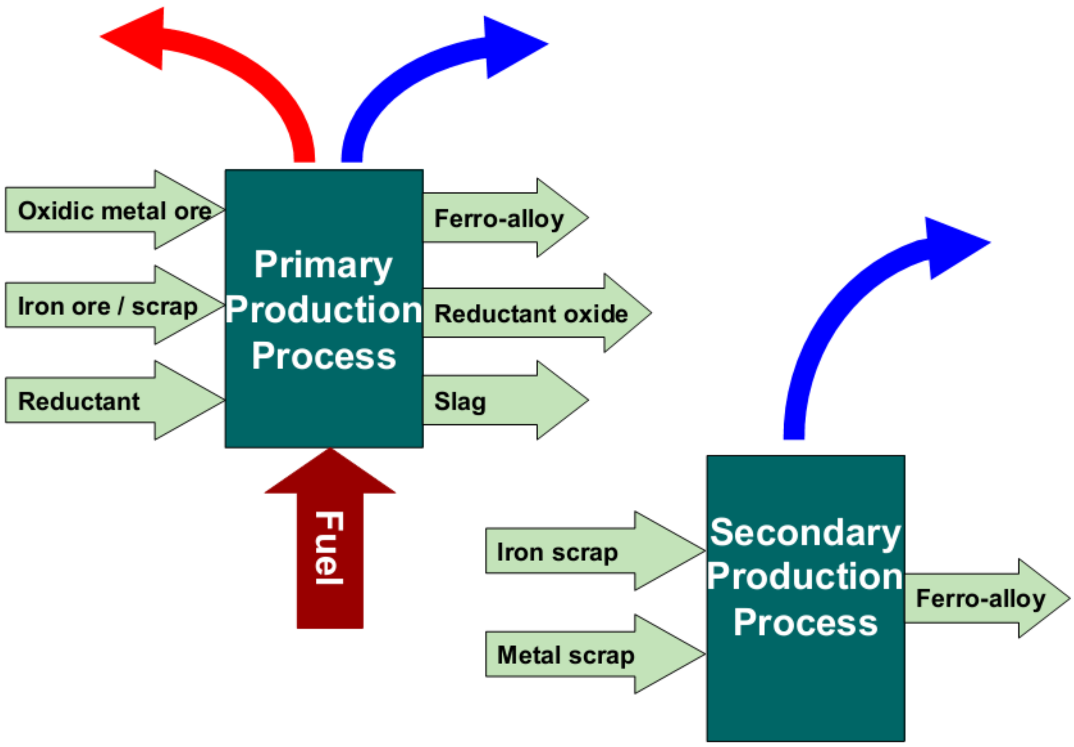

Figure 4.19 Simplified scheme for primary and secondary processes

Emission Trends

- PM_{10} emissions increased by about 8.02 % from 0.068 kt in 1990 to 0.073 kt in 2022.

Emission trends are illustrated in Figure 4.19 and emissions and activity data are presented in Table 4.26.

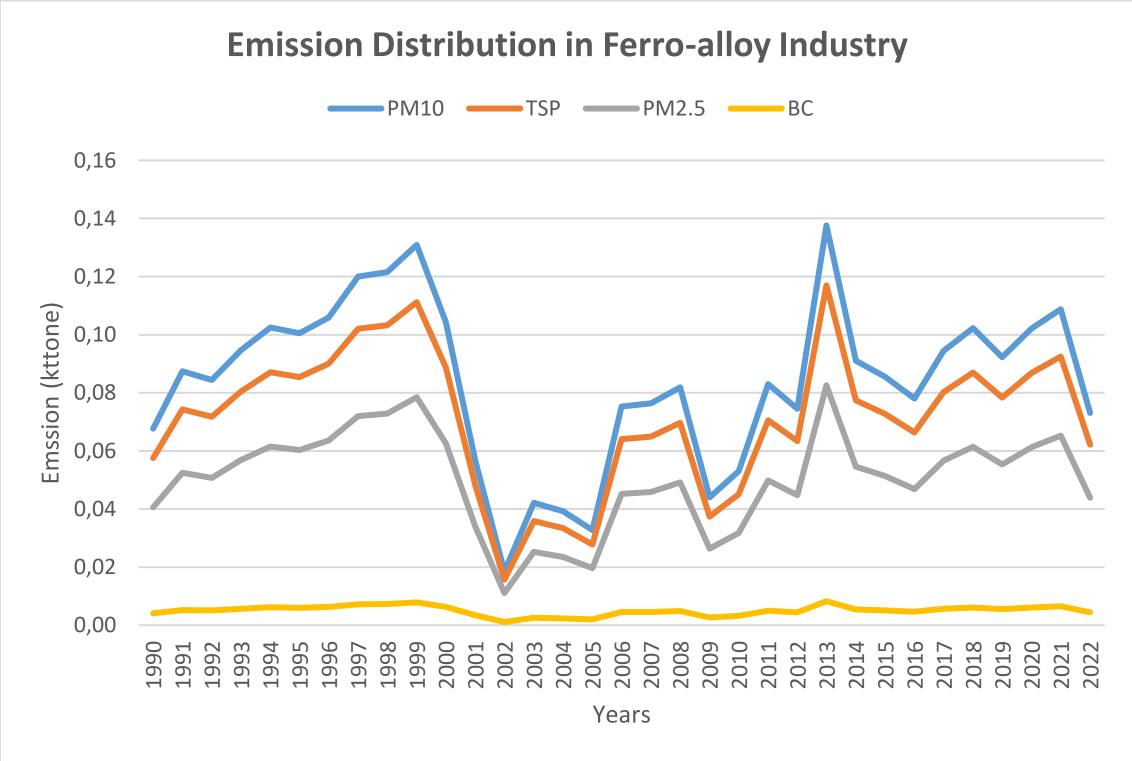

Figure 4.20 Emissions from NFR 2.C.2 ferroalloys production for the period 1990 to 2022

Table 4.27 Emissions from NFR sector 2.C.2 ferroalloys production and activity data

Years	PM_{10}	TSP	$PM_{2.5}$	BC
Units	**kt**	**kt**	**kt**	**kt**
1990	0.07	0.06	0.04	0.00
1991	**0.09**	0.07	0.05	0.01
1992	**0.08**	0.07	0.05	0.01
1993	0.09	0.08	0.06	0.01
1994	0.10	0.09	0.06	0.01
1995	0.10	0.09	0.06	0.01
1996	0.11	0.09	0.06	0.01
1997	0.12	0.10	0.07	0.01
1998	0.12	0.10	0.07	0.01
1999	0.13	0.11	0.08	0.01
2000	0.10	0.09	0.06	0.01
2001	0.06	0.05	0.03	0.00
2002	0.02	0.02	0.01	0.00
2003	0.04	0.04	0.03	0.00
2004	0.04	0.03	0.02	0.00
2005	0.03	0.03	0.02	0.00
2006	0.08	0.06	0.05	0.00
2007	0.08	0.06	0.05	0.00
2008	0.08	0.07	0.05	0.00
2009	0.04	0.04	0.03	0.00
2010	0.05	0.05	0.03	0.00
2011	0.08	0.07	0.05	0.00
2012	0.07	0.06	0.04	0.00
2013	0.14	0.12	0.08	0.01
2014	0.09	0.08	0.05	0.01
2015	0.09	0.07	0.05	0.01
2016	0.08	0.07	0.05	0.00
2017	0.09	0.08	0.06	0.01
2018	0.10	0.09	0.06	0.01
2019	0.09	0.08	0.06	0.01
2020	0.10	0.09	0.06	0.01
2021	0.11	0.09	0.07	0.01
2022	0.07	0.06	0.04	0.00

Trend 1990 - 2022	8.02%	8.02%	8.02%	8.02%
Trend 2021 - 2022	-32.79%	-32.79%	-32.79%	-32.79%

Source of Activity Data

Activity data (1990-2022) were taken from world mineral production reports. Reports were downloaded from http://www.bgs.ac.uk/mineralsuk/statistics/worldarchieve.html website. 2016-2021 assumed same as in Ferro-silico-chrome Production 2016 data. On the other hand, the other production data that considering in Ferro-Alloy Industry was taken Mineral Statistic World Archive website. On the light of these information, 2022 Ferro-Alloy Industry production was calculated.

Methodological Issues

The applied methodology is TIER 1 uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (Kt)

i = PM_{10}.

AD = annual national ferroalloy production (Kt)

EF = emission factor of pollutant i for ferroalloy production (kg/tons alloy)

Source of Emission Factors

Default emission factors (Tier 1) for ferroalloy production are taken from the EMEP/EEA Emission Inventory Guidebook 2023.

Emission factors are presented in Table 4.27

Table 4.28 Emission factor (EF) used sector 2.C.2 Ferroalloy production

	Unit	EF	Reference
PM_{10}	kg/tons alloy	0.85	EMEP/EEA Guidebook(2023) Chapter 2C.2 Ferroalloys production Table 3-1. page 6. Tier-1

Uncertainty

No uncertainty analysis was carried out for this inventory.

Recalculations

No recalculations have been done for this inventory.

Planned improvements

Plant specific information will be collected to better emission estimates.

These improvements are scheduled to be carried out in next coming years.

4.3.2 NFR 2.C.3 Aluminium Production

Source Category Description

Emissions: NO_x. SO_2. CO. PM_{10}

Key Source: No

Emission Sources

Primary aluminium is produced by electrolytic reduction of alumina which is obtained from bauxite. Secondary aluminium is produced by melting the scrap which contains aluminium. Processes schemes for primary and secondary aluminium production according to the EMEP/EEA Guidebook (2023) are illustrated in Figure 4.20 and 4.21.

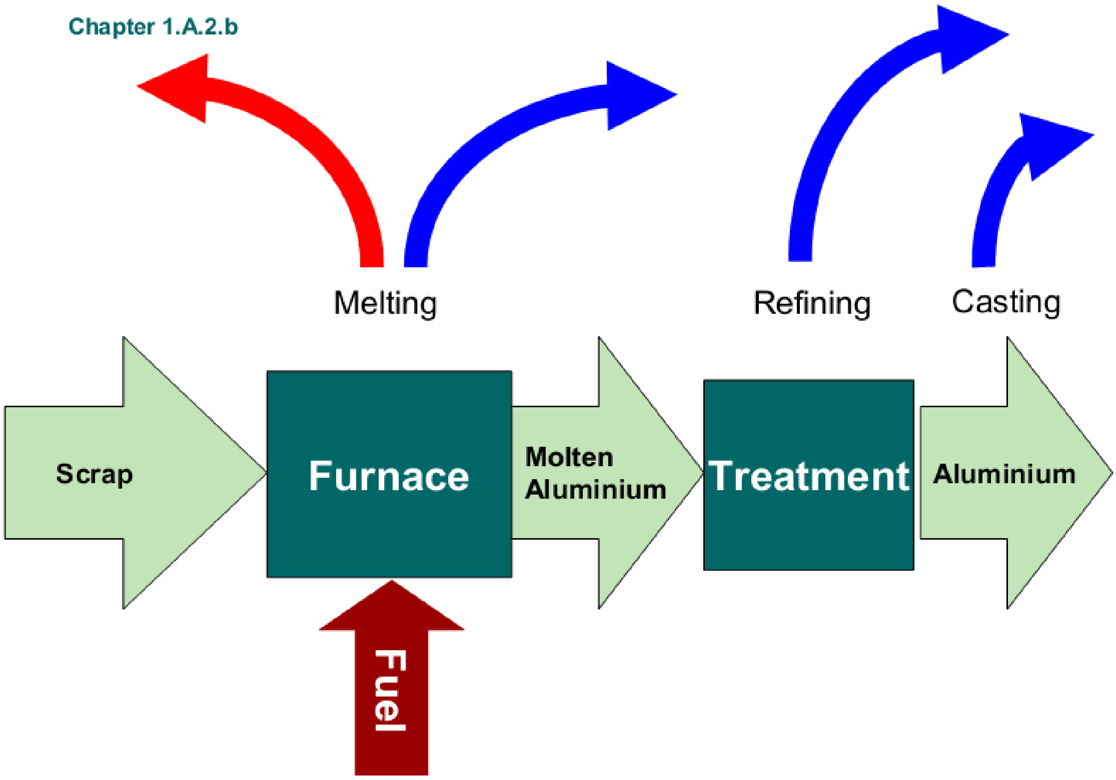

Figure 4.21 Process scheme for secondary aluminium production

Aluminium production in Türkiye includes process emissions from both primary and secondary production. Primary aluminium is produced by means of electrolytic reduction of alumina. The most important pollutants emitted from the primary aluminium electrolysis process are sulphur dioxide (SO_2). carbon monoxide (CO). polycyclic aromatic hydrocarbons (PAHs). Dust is emitted mainly during the treatment (refining and casting) in both primary and secondary aluminium production. A secondary aluminium smelter is defined as any plant or factory in which aluminium-bearing scrap or aluminium-bearing materials. other than aluminium-bearing concentrates (ores) derived from a mining operation. is processed into aluminium alloys for industrial castings and ingots.

The Turkish aluminium sector's roots go back to 1950s but the industry veritably took off with the establishment of the only primary aluminium producer in 1974. (Turkish Metal Industry Report. July 2010). The facility produces aluminium by processing bauxite reserves in the region.

Türkiye produced a total of 54.1 kt of aluminium products in 2010; extrusion. flat products and secondary aluminium constituting the major part. Aluminium Manufacturers' Union of Türkiye (TALSAD) The aluminium industry is – amongst others - (road paving with asphalt. asphalt roofing. ammonia production. other chemical productions iron and steel production. petroleum industry. pulp and paper) one of the main sources of CO emissions (National Inventory Report Türkiye. April 2011).

Emission Trends

- NO_x emissions increased by about 66.61 % from 0.06 kt in 1990 to 0.10 kt in 2022.
- CO emissions increased by about 66.61 % from 7.31 kt in 1990 to 12.18 kt in 2022.
- SO_2 emissions increased by about 66.61 % from 0.27 kt in 1990 to 0.46 kt in 2022.
- TSP emissions increased by about 66.61 % from 0.05 kt in 1990 to 0.09 kt in 2022.
- PM_{10} emissions increased by about 66.61 % from 0.04 kt in 1990 to 0.07 kt in 2022.
- $PM_{2.5}$ emissions increased by about 66.61 % from 0.04 kt in 1990 to 0.06 kt in 2022.
- BC emissions increased by about 66.61 % from 0.0008 kt in 1990 to 0.0014 kt in 2022.

Emission trends are illustrated in Figure 4.22. The emissions from aluminium production have remained constant since 1990 except for the year 2009. Due to the economic crises less aluminium was produced in 2009. This is reflected by significantly decreasing emissions in this year.

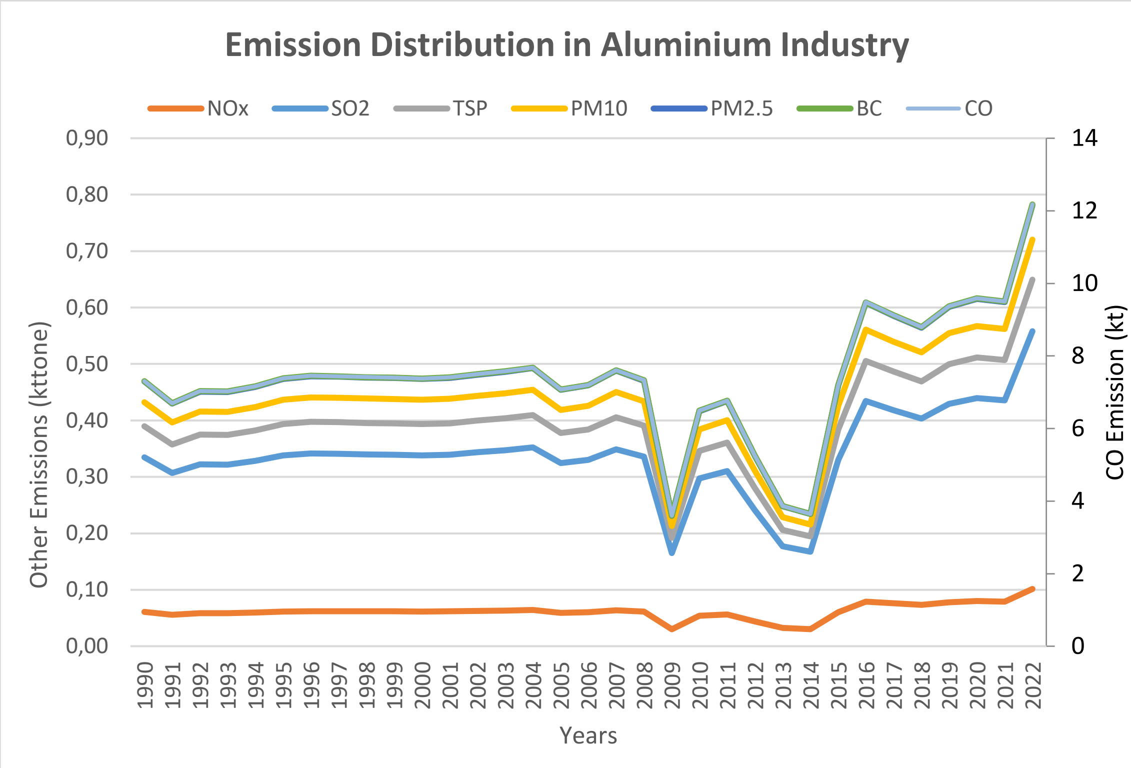

Figure 4.22 Emissions from NFR 2.C.3 for the period 1990 to 2022

Emissions from aluminium production and activity data are presented Table 4.29

Table 4.29 Emissions from NFR sector 2.C.3 Aluminium Production

Years	NO_x	CO	SO_2	TSP	PM_{10}	$PM_{2.5}$	BC
Units	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**
1990	0.06	7.31	0.27	0.05	0.04	0.04	0.00
1991	0.06	6.70	0.25	0.05	0.04	0.03	0.00
1992	0.06	7.03	0.26	0.05	0.04	0.04	0.00
1993	0.06	7.02	0.26	0.05	0.04	0.04	0.00
1994	0.06	7.16	0.27	0.05	0.04	0.04	0.00
1995	0.06	7.38	0.28	0.06	0.04	0.04	0.00
1996	0.06	7.45	0.28	0.06	0.04	0.04	0.00
1997	0.06	7.44	0.28	0.06	0.04	0.04	0.00

1998	0.06	7.42	0.28	0.06	0.04	0.04	0.00
1999	0.06	7.40	0.28	0.06	0.04	0.04	0.00
2000	0.06	7.38	0.28	0.06	0.04	0.04	0.00
2001	0.06	7.41	0.28	0.06	0.04	0.04	0.00
2002	0.06	7.50	0.28	0.06	0.04	0.04	0.00
2003	0.06	7.58	0.28	0.06	0.04	0.04	0.00
2004	0.06	7.68	0.29	0.06	0.04	0.04	0.00
2005	0.06	7.08	0.27	0.05	0.04	0.04	0.00
2006	0.06	7.20	0.27	0.05	0.04	0.04	0.00
2007	0.06	7.61	0.29	0.06	0.04	0.04	0.00
2008	0.06	7.33	0.27	0.05	0.04	0.04	0.00
2009	0.03	3.60	0.14	0.03	0.02	0.02	0.00
2010	0.05	6.49	0.24	0.05	0.04	0.03	0.00
2011	0.06	6.77	0.25	0.05	0.04	0.03	0.00
2012	0.04	5.24	0.20	0.04	0.03	0.03	0.00
2013	0.03	3.86	0.14	0.03	0.02	0.02	0.00
2014	0.03	3.65	0.14	0.03	0.02	0.02	0.00
2015	0.06	7.20	0.27	0.05	0.04	0.04	0.00
2016	0.08	9.48	0.36	0.07	0.06	0.05	0.00
2017	0.08	9.12	0.34	0.07	0.05	0.05	0.00
2018	0.07	8.80	0.33	0.07	0.05	0.04	0.00
2019	0.08	9.37	0.35	0.07	0.05	0.05	0.00
2020	0.08	9.59	0.36	0.07	0.06	0.05	0.00
2021	0.08	9.50	0.36	0.07	0.06	0.05	0.00
2022	0.10	12.18	0.46	0.09	0.07	0.06	0.00

Trend 1990 - 2022	66.61%	66.61%	66.61%	66.61%	66.61%	66.61%	66.61%
Trend 2021 - 2022	28.12%	28.12%	28.12%	28.12%	28.12%	28.12%	28.12%

Source of Activity Data

Activity data (1990-2013) were taken from world mineral production reports. Reports were downloaded from http://www.bgs.ac.uk/mineralsuk/statistics/worldarchieve.html website. Data was same with Aluminium Manufacturers' Union of Türkiye (TALSAD) data but complete time series were available in these reports. Due to lack of data 2017 data assumed same as 2016.

Methodological Issues

The applied methodology is TIER 1 and uses the general equation:

$$Emission_{pollutant} = \sum AD_{production} * EF_{pollutant}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

$AD_{production}$ = the activity rate for the aluminium production (kt)

$EF_{pollutant}$ = emission factor of pollutant i (kg/tons aluminium)

Source of Emission Factors

Emission factors for NO_x. SO_2. CO and PM_{10} have been taken from the EMEP/EEA Emission Inventory Guidebook 2023.

For NMVOC there was no emission factor available. Emission factors are presented in Table 4.29

Table 4.30 Emission factor (EF) used sector 2.C.3 Aluminium Production

	Unit	EF	Reference
NO_x	kg/ton	1	EMEP/EEA (2023). Chapter 2.C.3 Aluminium Production. Table 3-1 Tier 1 emission factors for aluminium production. page 11
SO_2	kg/ton	4.5	
CO	kg/ton	120	
PM_{10}	kg/ton Al produced	0.7	

Uncertainty

There is no information on uncertainty of the emission factor in the sector specific chapter (2. C. 3 Aluminium production of the EMEP/EEA emission inventory guidebook 2016).

As the activity data comes from BGS which collects production data on mineral. a low uncertainty 1 of about 5 % can be assumed.

No uncertainty analysis was performed for this inventory.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

Activity data for secondary aluminium needs to be included.

It would also be an improvement to use country specific emission factors. for which work more information needs to be collected on the process and abatement techniques and emission measurements for plants in Türkiye.

These improvements are scheduled to be carried out in 3 years.

4.3.3 NFR 2.C.4 Magnesium Production

Source Category Description

Emissions: TSP, SOx

Key Source: No

Emission Sources

Magnesium is produced by calcination and with dosing of some chemicals such as ferrosilis and fluorite.

Dolomite mine is crushed to smaller sizes and screened. The material which has smaller grain size is fed to the preheater silo and subjected to a pre-calcination process at 850ºC. and the heated material is fed to the rot art kiln from there.

The material fed to the rotary kiln moves in the rotary kiln and calcinates at a temperature of approximately 1350-1400ºC. The calcined material is dosed with certain proportions of ferrosilis and fluorite and ground together in a ball mill. Micron-sized mill output material is pressed on rotary rollers to form pellets. The produced pellets are fed into steel retorts at a temperature of approximately 1150ºC between 0.06-0.13 millibars. The pellets are allowed to react at high temperature. There are cooling jackets on the head of the retort. Magnesium vapor is cooled by the vacuums connected to the retort jackets and draws them towards themselves and comes together as crystal grains called crown magnesium in the sleeves in the cooling jackets. Produced crown magnesium are melted in crucibles in the refining unit and produced as pure magnesium ingots. (Korkmaz. 2020)

Emission Trends

- TSP emissions increased by about 171.43 % from 0.11 kt in 2019 to 0.3 kt in 2022.
- SOx emissions increased by about 171.43 % from 0.18 kt in 2019 to 0.49 kt in 2022.

Emission trends are illustrated in Figure 4.23.

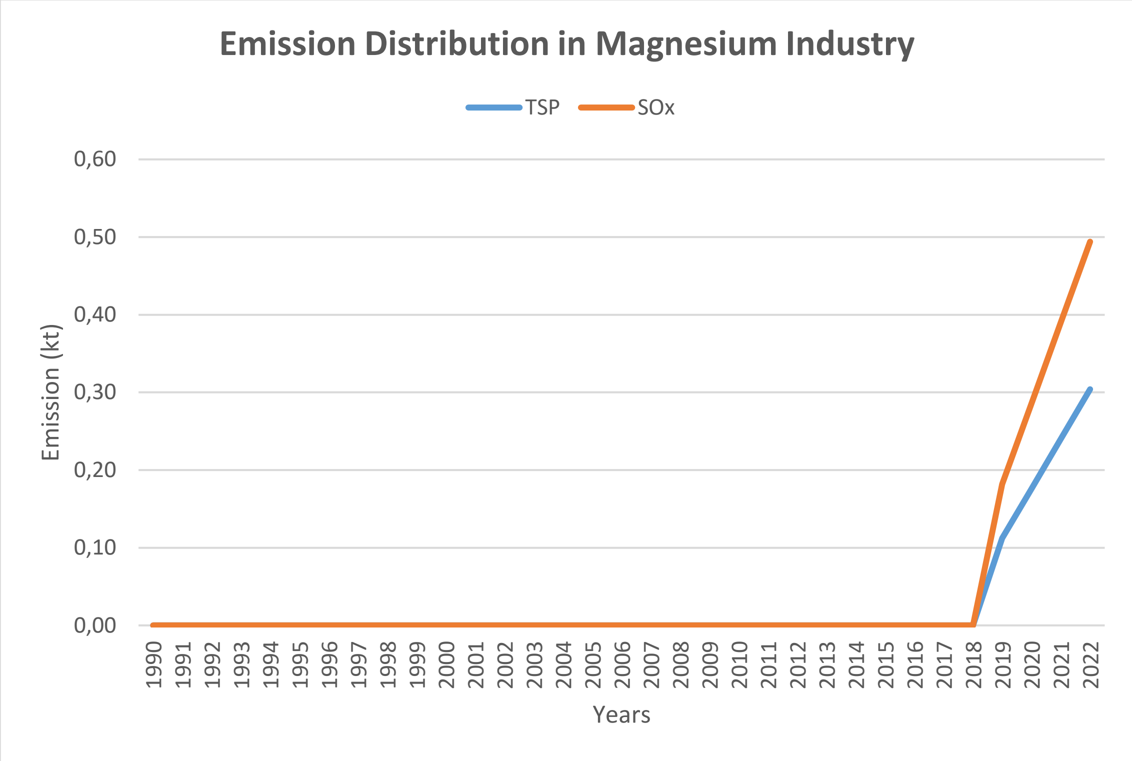

Figure 4.23 Emissions from NFR 2.C.4 for the period 2019 to 2022

Emissions from magnesium production and activity data are presented Table 4.31

Table 4.31 Emissions from NFR sector 2.C.4 Magnesium Production

Years	TSP	SOx
Units	**kt**	**kt**
2019	0.11	0.18
2020	0.18	0.29
2021	0.24	0.39
2022	0.30	0.49
Trend 2019 - 2022	171.43%	171.43%
Trend 2021 - 2022	26.67%	26.67%

Source of Activity Data

Activity data (2019-2022) were taken from world mineral production reports. Reports were downloaded from http://www.bgs.ac.uk/mineralsuk/statistics/worldarchieve.html website.

Methodological Issues

The applied methodology is TIER 1 and uses the general equation:

$$Emission_{pollutant} = \sum AD_{production} * EF_{pollutant}$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

$AD_{production}$ = the activity rate for the magnesium production (kt)

$EF_{pollutant}$ = emission factor of pollutant i (kg/tons magnesium)

Source of Emission Factors

Emission factors for PM_{10} have been taken from the EMEP/EEA Emission Inventory Guidebook 2019.

Uncertainty

No uncertainty analysis was performed for this inventory.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

Background data of the activity data for magnesium production will be improved.

4.3.4 NFR 2.C.5 Lead Production

Source Category Description

Emissions: TSP, PM_{10}, $PM_{2.5}$, SOx

Key Source: No

Emission Sources

The production of refined metallic lead from minerals dug out of the ground involves Mineral extraction i.e. mining and separation of the lead-rich mineral (ore) from the other extracted materials to produce a lead concentrate. (ILZSG World Directory for Primary and Secondary Lead Plants).

Primary lead production:

Lead is obtained from galena by smelting. This involves roasting the ore to remove the sulphur and obtain lead oxide. which is then reacted with coke in a furnace. The resulting lead bullion contains many impurities such as silver and gold as well as antimony. arsenic. copper. tin or zinc. These impurities are removed by various refining steps to obtain pure lead (INTERNATIONAL LEAD ASSOCIATION. 2008).

By smelting the lead rich mineral reacts with other ingredients. to yield impure metallic lead. This is traditionally done in two stages:

- roasting in air. turning the lead concentrate (usually lead sulphide) into lead oxide;
- heating the lead oxide in a blast furnace with coke to yield metallic lead.

  Refining is the removal of impurities and other metals from the crude lead (S. Cu. Ni. As. Sb. Bi. Ag. Au. etc.). The refining process is applied in several steps in kettles with addition of specific agents. or alternatively. smaller quantities are processed by electrolytic refining. Alloying of refined lead with other metals gives the desired composition. Processes scheme for primary copper production in the EMEP/EEA Guidebook (2023) are illustrated in Figure 4.24.

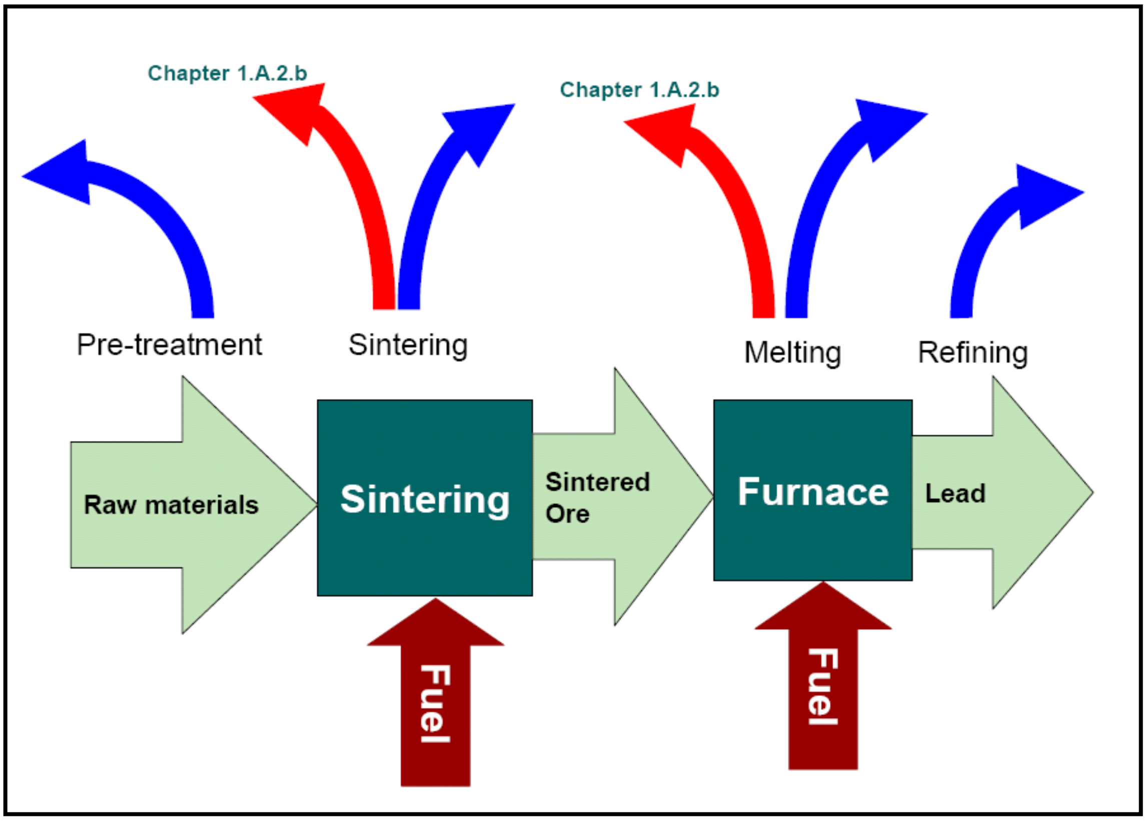

Figure 4.24 Process scheme for primary lead production

Secondary Lead Production

Secondary lead production involves the production of refined metal by processing lead scrap. It is often possible to simply re-melt scrap lead. with very little extra processing. However. compounds of lead (such as battery pastes) require smelting. Refining is often needed to remove any unwanted contamination and alloying additions in the feed material. The procedures are similar to those outlined for primary processing. but in general. fewer operations are required. (ILZSG WORLD DIRECTORY FOR PRIMARY AND SECONDARY LEAD PLANTS[2]) The main air pollutants emitted during the production of lead are sulphur dioxide (SO_2). nitrogen oxides (NO_x). carbon monoxide (CO) and carbon dioxide (CO_2). Since these are assumed to originate mainly from combustion activities. emissions of these pollutants are included in the energy sector (1.A.2.b). The most important process emissions are heavy metals (particularly lead) and dust. (EMEP/EEA

Emission Inventory Guidebook 2023) Information about sector. production and abatement technologies will be collected next coming years.

Emission Trends

- TSP emissions increased by about 355.0 % from 0.00005 kt in 1990 to 0.00025 kt in 2022.
- PM_{10} emissions increased by about 355.0 % from 0.00005 kt in 1990 to 0.00020 kt in 2022.
- $PM_{2.5}$ emissions increased by about 355.0 % from 0.00002 kt in 1990 to 0.0001 kt in 2022.
- SOx emissions increased by about 355.0 % from 0.0185 kt in 1990 to 0.0839 kt in 2022.

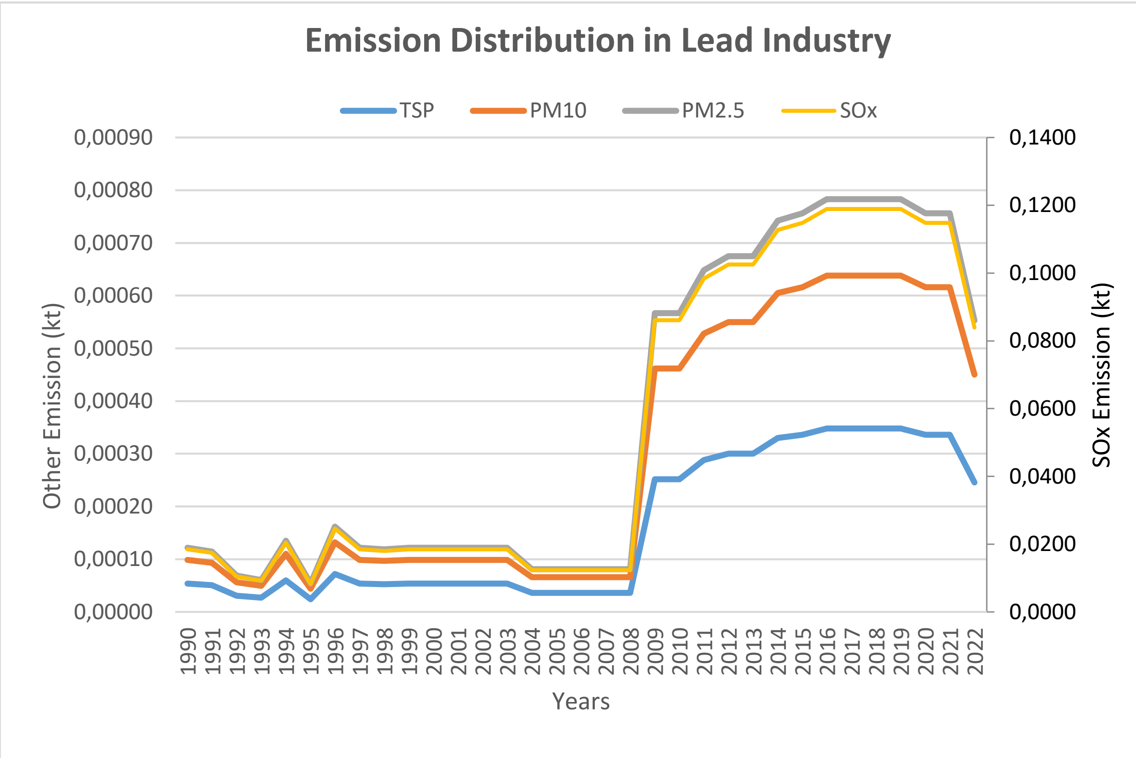

Figure 4.25 Emissions from NFR 2.C.5 b for the period 1990 to 2022

Emissions and activity data from lead production are presented in Table 4.32.

Table 4.32 Emissions from sector 2.C.5 b Lead Production

Years	TSP	PM_{10}	$PM_{2.5}$	SO_2
Units	**kt**	**kt**	**kt**	**kt**
1990	0.00005	0.00005	0.00002	0.0185
1991	0.00005	0.00004	0.00002	0.0174
1992	0.00003	0.00003	0.00001	0.0105
1993	0.00003	0.00002	0.00001	0.0092
1994	0.00006	0.00005	0.00003	0.0205
1995	0.00002	0.00002	0.00001	0.0082
1996	0.00007	0.00006	0.00003	0.0246
1997	0.00005	0.00005	0.00002	0.0185
1998	0.00005	0.00004	0.00002	0.0180
1999	0.00005	0.00005	0.00002	0.0185
2000	0.00005	0.00005	0.00002	0.0185
2001	0.00005	0.00005	0.00002	0.0185
2002	0.00005	0.00005	0.00002	0.0185
2003	0.00005	0.00005	0.00002	0.0185
2004	0.00004	0.00003	0.00002	0.0123
2005	0.00004	0.00003	0.00002	0.0123
2006	0.00004	0.00003	0.00002	0.0123
2007	0.00004	0.00003	0.00002	0.0123
2008	0.00004	0.00003	0.00002	0.0123
2009	0.00025	0.00021	0.00011	0.0861
2010	0.00025	0.00021	0.00011	0.0861
2011	0.00029	0.00024	0.00012	0.0984
2012	0.00030	0.00025	0.00013	0.1025
2013	0.00030	0.00025	0.00013	0.1025
2014	0.00033	0.00028	0.00014	0.1128
2015	0.00034	0.00028	0.00014	0.1148
2016	0.00035	0.00029	0.00015	0.1189
2017	0.00035	0.00029	0.00015	0.1189
2018	0.00035	0.00029	0.00015	0.1189
2019	0.00035	0.00029	0.00015	0.1189
2020	0.00034	0.00028	0.00014	0.1148
2021	0.00034	0.00028	0.00014	0.1148
2022	0.00025	0.00020	0.00010	0.0839
Trend 1990 - 2022	355.00%	355.00%	355.00%	355.00%

Trend 2021 - 2022	-26.88%	-26.88%	-26.88%	-26.88%

Source of Activity Data

Activity data (1990-2021) were taken from world mineral production reports. Reports were downloaded from http://www.bgs.ac.uk/mineralsuk/statistics/worldarchieve.html website. Refined lead production is used as activity data. 2022 year data assumed by looking at previous data trends from 1990 to 2021.

Methodological Issues

The applied methodology is TIER 1 and uses the general equation:

Emission PM_{10} = $\sum AD_{production} * EF\ PM_{10}$

Where:

Emission PM_{10} = emissions of pollutant i for the period concerned in the inventory (kt)

$AD_{production}$ = the activity rate for the production of lead (kt)

EF PM_{10} = emission factor of pollutant i (kg/tons lead)

Source of Emission Factors

Emission factor for PM_{10} have been taken from the EMEP/EEA Emission Inventory Guidebook 2016. Emission factor is presented in Table 4.32.

Table 4.33 Emission factor (EF) used sector 2.C.5 b Lead Production

	Unit	EF	Reference
PM_{10}	g/Mg lead	5	EMEP/EEA (2023) .Chapter 2.C.5 b Lead Production. Table 3-1 Tier 1 emission factor for lead production. page 11

Uncertainty

There is no information on uncertainty of the emission factor in the sector specific chapter.

As the activity data comes from BGS which collects production data on mineral. a low uncertainty 3 of about 10 % can be assumed.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

Production statistics sourced from an international source should be checked with data from an official Turkish source.

It would also be an improvement to use country specific emission factors for which more detailed information on the process and abatement techniques used by the Turkish plants needs to be obtained. as well as information on emission measurements.

These improvements are scheduled to be carried out in 5 years.

4.3.5 NFR 2.C.6 Zinc Production

Source Category Description

Emissions: NE

Key Source: No

Emission Sources

Primary zinc is produced from ores. Ores oxidizes with air giving zinc oxide. sulphur oxide and zinc ferro. Chlorine and fluorine are removed from the combustion gas and the sulphur oxide is converted catalytically into sulphuric acid. A secondary zinc smelter is defined as any plant or factory in which zinc-bearing scrap or zinc-bearing materials.

Two techniques are used for primary zinc production. electrochemical and thermal smelting. Processes scheme for primary nickel production by electrochemical in the EMEP/EEA Guidebook (2023) is illustrated in Figure 4.26.

Emissions of particulate matter and heavy metals (zinc and cadmium) take place during the receipt and storage of the zinc ores and during the production. The emissions during production occur from tanks. ovens and separation equipment. Pollutants released are sulphur oxides. nitrogen oxides. volatile organic gaseous compounds. carbon monoxide. carbon dioxide. nitrous oxide and ammonia.

In Türkiye. there is one facility for primary zinc production which uses waelz process for the enrichment of the ore. afterwards leach and electrolysis methodology to produce high quality zinc. Türkiye has also secondary zinc production. One facility produces zinc by leach-electrolysis method from residue. On the other hand ten facilities can produce zinc from hot galvanization residue by distillation.

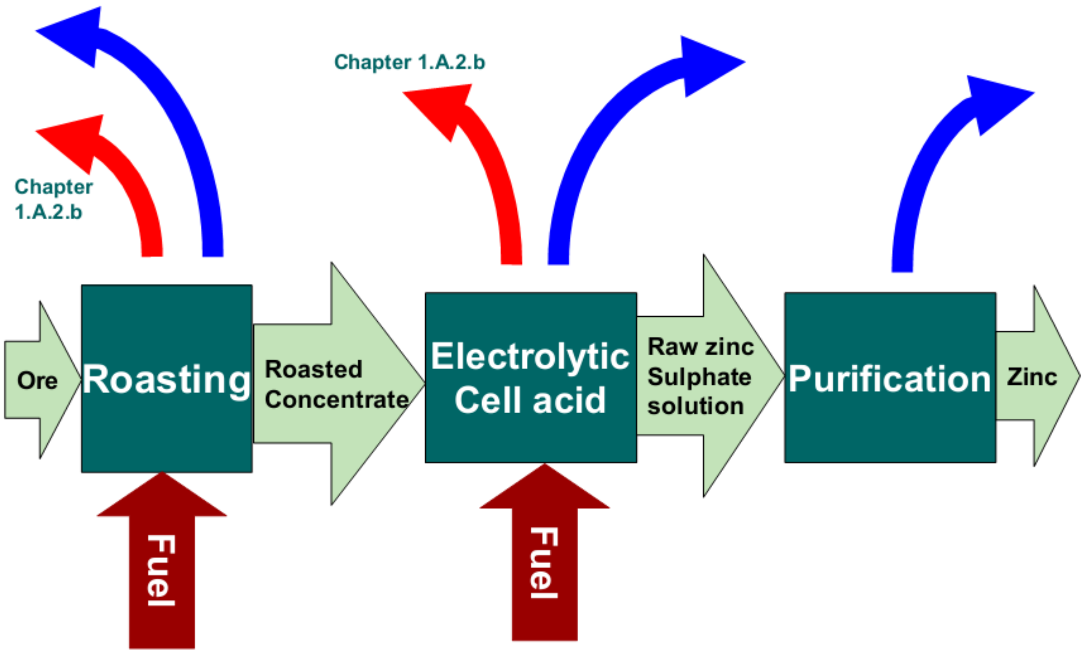

Figure 4.26 Process scheme for electrochemical zinc production

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

It would be preferable to use official national datasets or plant specific data.

It is possible to improve the methodology by obtaining information on process and abatement techniques used at Turkish plants. as well as information on emission measurements.

Zinc production is also a source for NMVOC and heavy metal (e.g. Pb. Cu. Zn) and POP (e.g. PDCC/F) emissions. which can be estimated using EFs from the EMEP/EEA Emission Inventory Guidebook or using information from other countries' IIRs.

These improvements are scheduled to be carried out in 5 years.

4.3.6 NFR 2.C.7a Copper Production

Source Category Description

Emissions: TSP, PM_{10}, $PM_{2.5}$, BC, SOx

Key Source: No

Emission Sources

Primary copper is produced by pyrometallurgical copper smelting process which involves fire refinery of blister copper and electrolytic refinery for impurity removal. Secondary copper is produced by melting the scrap which contains copper. Processes scheme for primary copper production in the EMEP/EEA Guidebook are illustrated in Figure 4.27.

Information about production and abatement technology for Türkiye will be collected within coming years.

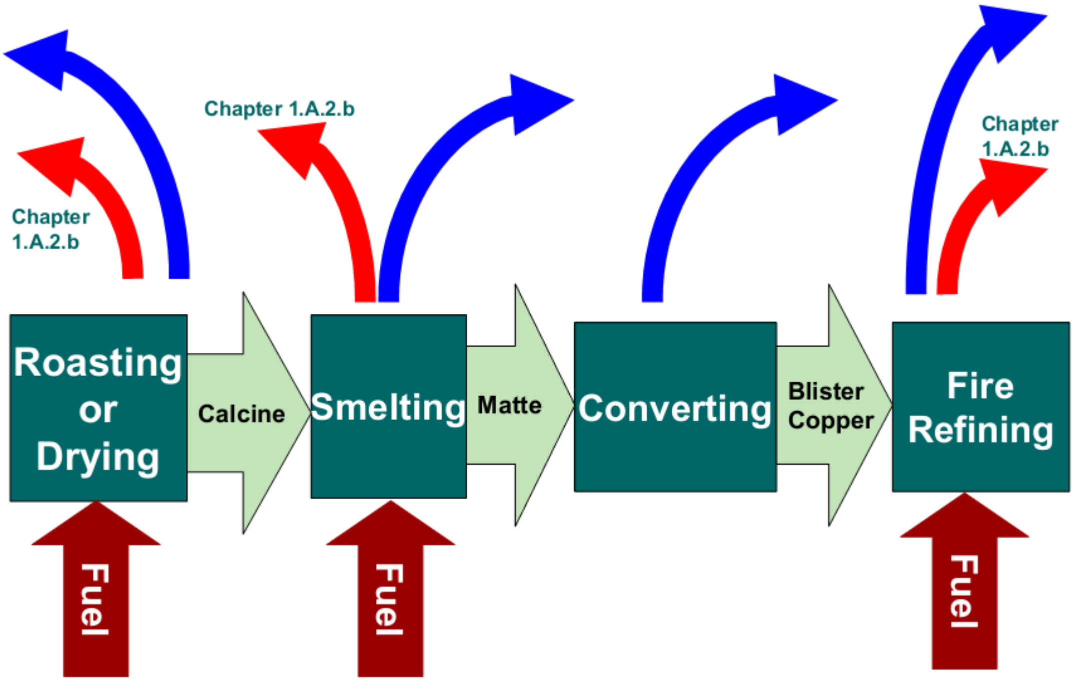

Figure 4.27 Process scheme for primary copper production

Emission Trends

Emission trends are illustrated in Figure 4.28.

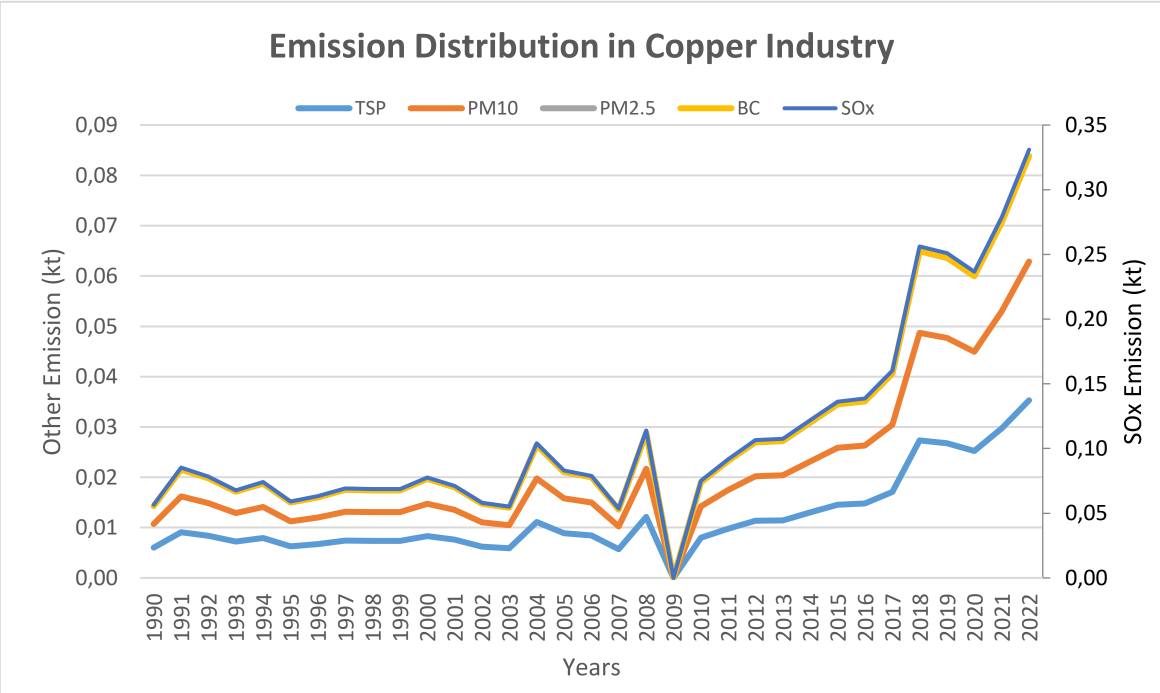

Figure 4.28 Emissions from NFR 2.C.7a for the period 1990 to 2022

Emissions from copper production and activity data are presented in Table 4.34

Table 4.34 Emissions from sector 2.C.7.a Copper Production

Years	TSP	PM_{10}	$PM_{2.5}$	SO_2
Units	**kt**	**kt**	**kt**	**kt**
1990	0.0060	0.0047	0.0036	0.0565
1991	0.0091	0.0071	0.0054	0.0851
1992	0.0083	0.0065	0.0050	0.0783
1993	0.0072	0.0057	0.0043	0.0678
1994	0.0079	0.0062	0.0047	0.0741
1995	0.0063	0.0049	0.0037	0.0591
1996	0.0068	0.0053	0.0040	0.0633
1997	0.0074	0.0058	0.0044	0.0693
1998	0.0073	0.0057	0.0044	0.0687
1999	0.0073	0.0057	0.0044	0.0687
2000	0.0083	0.0065	0.0049	0.0777
2001	0.0076	0.0059	0.0045	0.0713
2002	0.0062	0.0048	0.0037	0.0581
2003	0.0059	0.0046	0.0035	0.0552
2004	0.0111	0.0087	0.0066	0.1041
2005	0.0089	0.0069	0.0053	0.0831
2006	0.0084	0.0066	0.0050	0.0789
2007	0.0057	0.0045	0.0034	0.0537
2008	0.0122	0.0095	0.0072	0.1140
2009	0.0000	0.0000	0.0000	0.0000
2010	0.0080	0.0063	0.0048	0.0750
2011	0.0098	0.0077	0.0058	0.0918
2012	0.0114	0.0089	0.0067	0.1065
2013	0.0115	0.0090	0.0068	0.1074
2014	0.0130	0.0102	0.0077	0.1218
2015	0.0145	0.0114	0.0086	0.1362
2016	0.0148	0.0116	0.0088	0.1386
2017	0.0171	0.0134	0.0101	0.1602
2018	0.0273	0.0214	0.0162	0.2562
2019	0.0268	0.0209	0.0159	0.2511
2020	0.0252	0.0197	0.0150	0.2367
2021	0.0298	0.0233	0.0177	0.2790

2022	0.0353	0.0276	0.0210	0.3310
Trend 1990 - 2022	485.56%	485.56%	485.56%	485.56%
Trend 2021 - 2022	18.62%	18.62%	18.62%	18.62%

Methodological Issues

The applied methodology is TIER 1 and uses the general equation:

$Emission_{pollutant} = \sum AD_{production} * EF_{pollutant}$

Where:

$Emission_{pollutant}$ (kt) =emissions of pollutant i for the period concerned in the inventory

$AD_{production}$ = the activity rate for the copper production (kt)

$EF_{pollutant}$ = emission factor of pollutant i (kg/tons copper)

Source of Activity Data

Activity data (1990-2008) were taken from world mineral production reports. Reports were downloaded from http://www.bgs.ac.uk/mineralsuk/statistics/worldarchieve.html website. Smeltery production of copper is used as activity data. Due to lack of data extrapolation was made according to Eurostat Türkiye Production Index (copper production) for 2009-2019. 2005 was the base year for this extrapolation.

Source of Emission Factors

Emission factors for PM_{10} have been taken from the EMEP/EEA Emission Inventory Guidebook.

Emission factor is presented in Table 4.35.

Table 4.35 Emission factor (EF) used sector 2.C.7.a Copper Production

	Unit	EF	Reference
PM_{10}	kg/ton Cu produced	0.250	EMEP/EEA (2023). Chapter 2.C.5.a Copper Production. Table 3-1 Tier 1 emission factors for copper production. page 10

Uncertainty

There is no information on uncertainty of the emission factor in the sector specific chapter (2.C.5.a Copper production of the EMEP/EEA emission inventory guidebook)

No uncertainty calculation was performed for the inventory.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

Activity data for secondary copper needs to be included.

It would also be an improvement to use country specific emission factors which can be developed based on information on the process and abatement technique and emission measurements.

4.3.7 NFR 2.C.7b Nickel Production

Source Category Description

Emissions: NE

At this stage no emissions from nickel production is estimated.

Emission Sources

Primary nickel is produced by heating reaction of oxide or sulphide ore. Secondary nickel is produced by melting the scrap which contains nickel. Processes schemes for primary and secondary nickel production in the EMEP/EEA Guidebook (2023) are illustrated in Figure 4.29.

Nickel production occurs in Türkiye. but not enough accurate information on the volume of the industry. nor on the production processes has been available for the work.

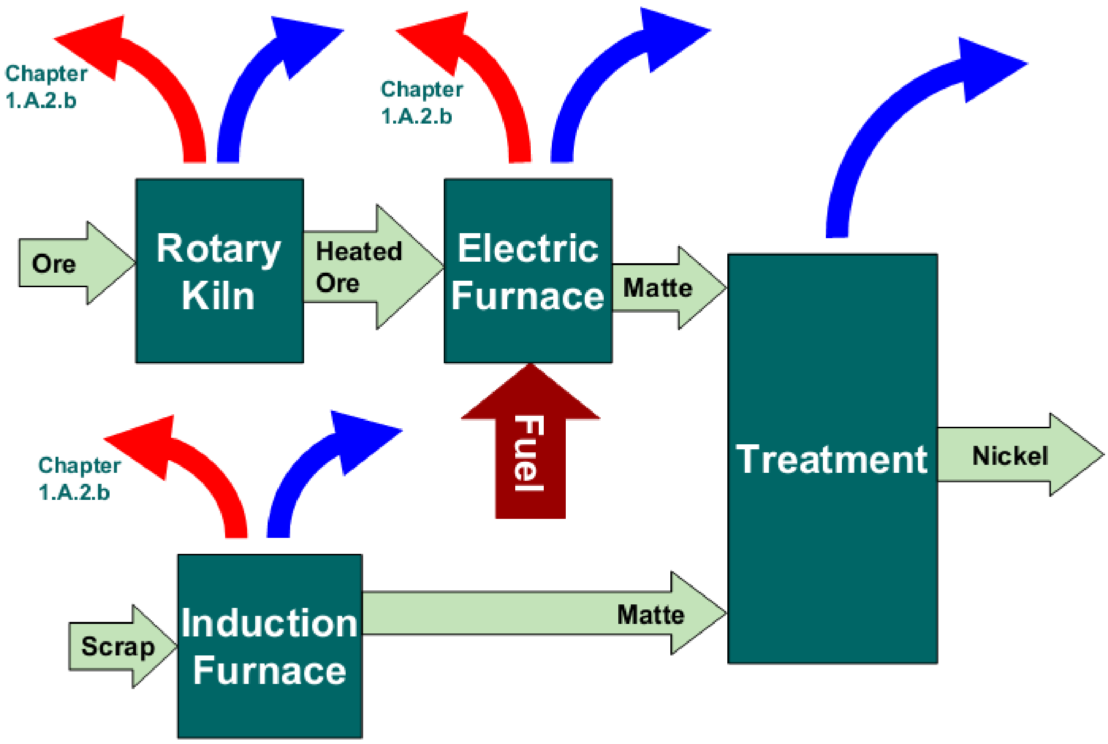

Figure 4.29 Process schemes of primary and secondary nickel production

Planned improvements

To carry out emission estimation for this source information needs to be collected on the process and abatement techniques used at Turkish plants. as well as on emission measurements to enable calculation of specific emissions for each plant.

Nickel production is a source for e.g. NMVOC. SO_x. ammonia and nickel emissions. Emission factors exist in the EMEP/EEA Guidebook for SO_x. TSP and nickel.

These improvements are scheduled to be carried out in next coming years.

4.3.8 NFR 2.C.7c Other Metal Production

Source Category Description

Emissions: NE

Gold and silver production occur in Türkiye. but not enough accurate information on the volume of the industry. nor on the production processes has been available for the work.

Planned improvements

To carry out emission estimation for this source information needs to be collected on the process and abatement techniques used at Turkish plants. as well as on emission measurements to enable calculation of specific emissions for each plant.

Production of precious metals is a likely source of PCB emissions. Emission factors exist in emission inventories for other countries.

These improvements are scheduled to be carried out in the next coming years.

4.3.9 NFR 2.C.7d Storage. handling and transport of metal products

Source Category Description

Emissions: NE

Storage. handling and transport of metal products is a source of particle emissions. At the moment. these emissions are not estimated.

Planned improvements

Particle emissions from Storage. handling and transport of metal products can be estimated using production data of metals and emission factors available from website http://www.air.sk/tno/cepmeip/ (TNO. 2002. The Co-ordinated European Programme on Particulate Matter Emission Inventories. Projections and Guidance (CEPMEIP).

Various metal ore production data was available in world mineral production reports. Reports were downloaded from http://www.bgs.ac.uk/mineralsuk/statistics/worldarchieve.html website. These improvements are scheduled to be carried out in coming years.

4.4 NFR 2.D Solvent Use

4.4.1 NFR 2.D.3a Domestic Solvent Use including fungicides

Source Category Description

Emissions: *NMVOC*

Key Source: *Yes (NMVOC)*

Emission Trends

- NMVOC emissions from NFR 2.D.3a Domestic solvent use is 68.06 kt in 1990 and 102.34 kt in 2022.

Emissions from domestic solvent use in Türkiye 1990-2022 are presented in Figure 4.30 and Table 4.36 below.

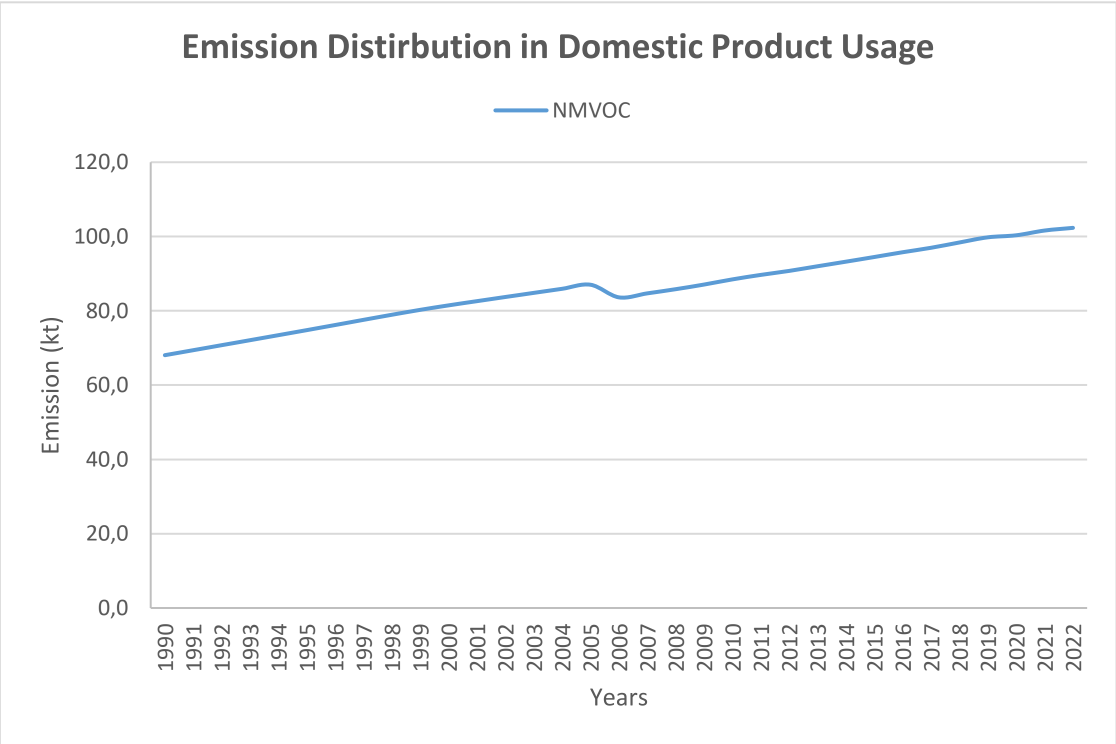

Figure 4.30 NMVOC emission from NFR 2.D.3.a Domestic Solvent Use

Table 4.36 NMVOC emission from NFR 2.D.3.a Domestic Solvent Use

Years	NMVOC
Units	**kt**
1990	68.06
1991	69.40
1992	70.75
1993	72.09
1994	73.44
1995	74.81
1996	76.18
1997	77.57
1998	78.94
1999	80.27
2000	81.47
2001	82.61
2002	83.72
2003	84.83
2004	85.93
2005	87.02
2006	83.63
2007	84.70
2008	85.82
2009	87.07
2010	88.47
2011	89.67
2012	90.75
2013	92.00
2014	93.24
2015	94.49
2016	95.78
2017	96.97
2018	98.40
2019	99.79
2020	100.34
2021	101.62
2022	102.34
Trend 1990 - 2022	50.37%
Trend 2021 - 2022	0.71%

Source of Activity Data

Population used as activity data in the calculations. 31 December data was downloaded from EUROSTAT website.

Methodological Issues

The Tier 1 approach for emissions from domestic products uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC.

AD = population (million people)

EF = emission factor of pollutant i for domestic product use (kg/person)

Source of Emission factors

Emission factors used in the calculation are presented in Table 4.37

Table 4.37 Emission factors for NFR 2.D.3a

NFR	Category	EF	Unit	Reference
2.D.3a	Domestic Solvent Use	1.2	kg NMVOC/person	EMEP/EEA Guidebook(2023) Chapter 2.D.3.a Solvent use paragraph 3.2.4

Uncertainty

No uncertainty estimation was carried out for emissions from this sector. However. uncertainty can be assumed high in those estimates where the calculation is carried out using population as activity data.

Recalculations

No recalculations have been done for this inventory.

Planned Improvements

There is no plan for improvement.

4.4.2 NFR 2.D.3b Road Paving with Asphalt

Source Category Description

Emissions: NE

Emissions from road paving with asphalt are not included in the inventory at the moment.

Road paving with asphalt is a source of NMVOC. TSP. PM_{10}. $PM_{2.5}$ and PCDD/F emissions. Emission factors exist for NMVOC. TSP. PM_{10}. $PM_{2.5}$ in the GB.

There is any information on asphalt roofing volumes.

Planned improvements

It is planned to include emission estimates for at least NMVOC. TSP. PM_{10}. $PM_{2.5}$ from road paving with asphalt in Türkiye after information on asphalt production volumes in Türkiye have been collected. The methodology to be used for estimating these emissions is available in GB.

4.4.3 NFR 2.D.3c Asphalt roofing

Source Category Description

Emissions: NE

Emissions from asphalt roofing are not included in the inventory at the moment.

Asphalt roofing is a source of CO. NMVOC and TSP emissions. Emission factors for these pollutants are available in the GB.

Asphalt roofing occurs in Türkiye and is mainly carried out in mobile plants which work less than one year and do not need a permit.

There is not any information on asphalt roofing volumes.

Planned improvements

It is planned to include emission estimates for NMVOC and TSP from asphalt roofing after information on production volumes of shingles are collected. Emission factors are available in the GB.

4.4.4 NFR 2.D.3d Coating Applications

Source Category Description

Emissions: NMVOC

Key Source: Yes (NMVOC)

Emission Sources

NMVOC emissions were estimated from total paint consumption data.

Emission Trend

Based on the results of the inventory. between 1990-2022 NMVOC emissions from the above-mentioned sources increased by about 50.37%.

Emission trend is illustrated in Figure 4.31. The increase is due to increases in the activity levels.

Due to methodology used in the estimation of emissions from total paint consumption therefore the trend has large uncertainty.

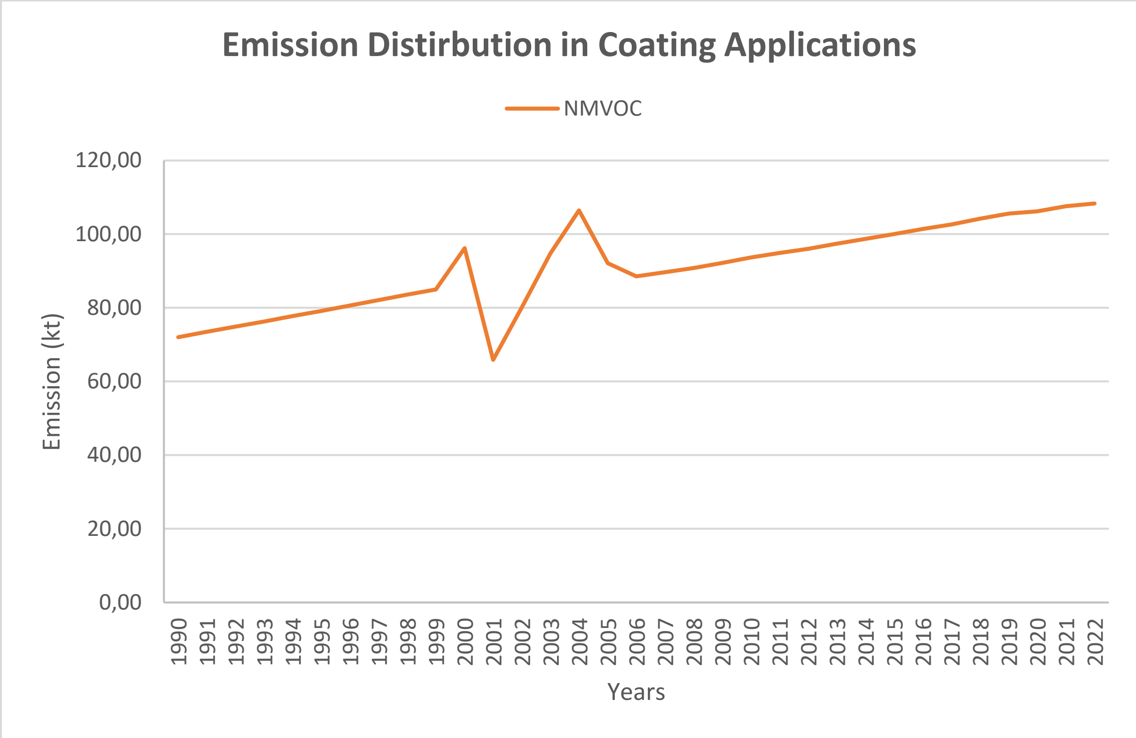

Figure 4.31 Emissions from NFR 2D.3.d Coating Applications for the period 1990 to 2020

Emissions and activity data from decorative coating application are presented in Table 4.38

Table 4.38 NMVOC Emissions (kt) from NFR 2.D.3d Coating Applications for the period 1990 to 2022

Years	NMVOC
Units	**kt**
1990	72.04
1991	73.46
1992	74.89
1993	76.31
1994	77.74
1995	79.18
1996	80.64
1997	82.11
1998	83.56
1999	84.97
2000	96.20
2001	65.88
2002	80.19
2003	94.79

2004	106.50
2005	92.12
2006	88.52
2007	89.66
2008	90.84
2009	92.17
2010	93.65
2011	94.92
2012	96.06
2013	97.39
2014	98.69
2015	100.02
2016	101.38
2017	102.65
2018	104.16
2019	105.63
2020	106.21
2021	107.56
2022	108.33
Trend 1990 - 2022	50.37%
Trend 2021 - 2022	0.71%

Source of Activity Data

Activity data for 2000-2004 was taken from National Development Report. Due to lack of data other years proportioned to the population.

Methodological Issues

The TIER 1 approach for emissions from decorative coating uses the general equation:

$Emission_{pollutant} = \sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC.

AD = population (million people)

EF = emission factor of pollutant i for decorative coating (kg/person)

Source of Emission Factors

Total paint consumption data for the country was available. emissions from NFR 3A paint application were calculated in 3A.1 Decorative coating application with average emission factor 3A.2 Industrial Coating and 3A.3 Other Coating

The emission factors and average emission factor used in the calculation are presented in Table 4.39.

Table 4.39 Emission factors for NFR 3A Paint Application

NFR	Activity	EF	EF unit	Reference
3.A.1	Decorative Coating	150	g/kg paint	EMEP/EEA Guidebook 2023 Chapter 2D.3d Table 3.1. 3.2.3.3-page 17
3.A.2	Industrial Coating	400	g/kg paint	
3.A.3	Other Coating	200	g/kg paint	
Average Emission Factor		250	g/kg paint	

Uncertainty

No uncertainty estimation was carried out for emissions from this sector.

However. uncertainty can be assumed high in those estimates where the calculation is carried out using total paint consumption as activity data and proportioned according to population.

Recalculations

No recalculation has been done for this part of the inventory.

Planned Improvements

Data gaps will be tried to fill. paint consumption data for 3A.1. 3A.2 and 3A.3 should be found for more reliable results. These improvements are likely to be carried out during coming years.

4.4.6 NFR 2.D.3.e Degreasing & NFR 2.D.3.f Dry Cleaning

Source Category Description

Emissions: *NMVOC*

Key Source: *Yes (NMVOC)*

NMVOC emissions were estimated from NFR 3B1 Degreasing and NFR 3B2 Dry cleaning.

Emission Trend

- NMVOC emissions from NFR 2.D.3.e degreasing amount in 28.36 kt in 1990 and 42.64 kt in 2022. which is an increase of about 50.37%. From 2021 to 2022 the NMVOC emission increased by 0.71%.
- NMVOC emissions from NFR 2.D.3.f Dry cleaning amount in 5.67 kt in 1990 and 8.53 kt in 2022. which is an increase of about 50.37%. From 2021 to 2022 the NMVOC emission increased by 0.71%.

Due to methodology used in the estimation of emissions from car respraying the trend is directly following the growth of population which is used as activity data and therefore the trend has large uncertainty.

Emissions from degreasing and dry-cleaning activities in Türkiye 1990-2022 are presented in Figure 4.32 and Table 4.40 below.

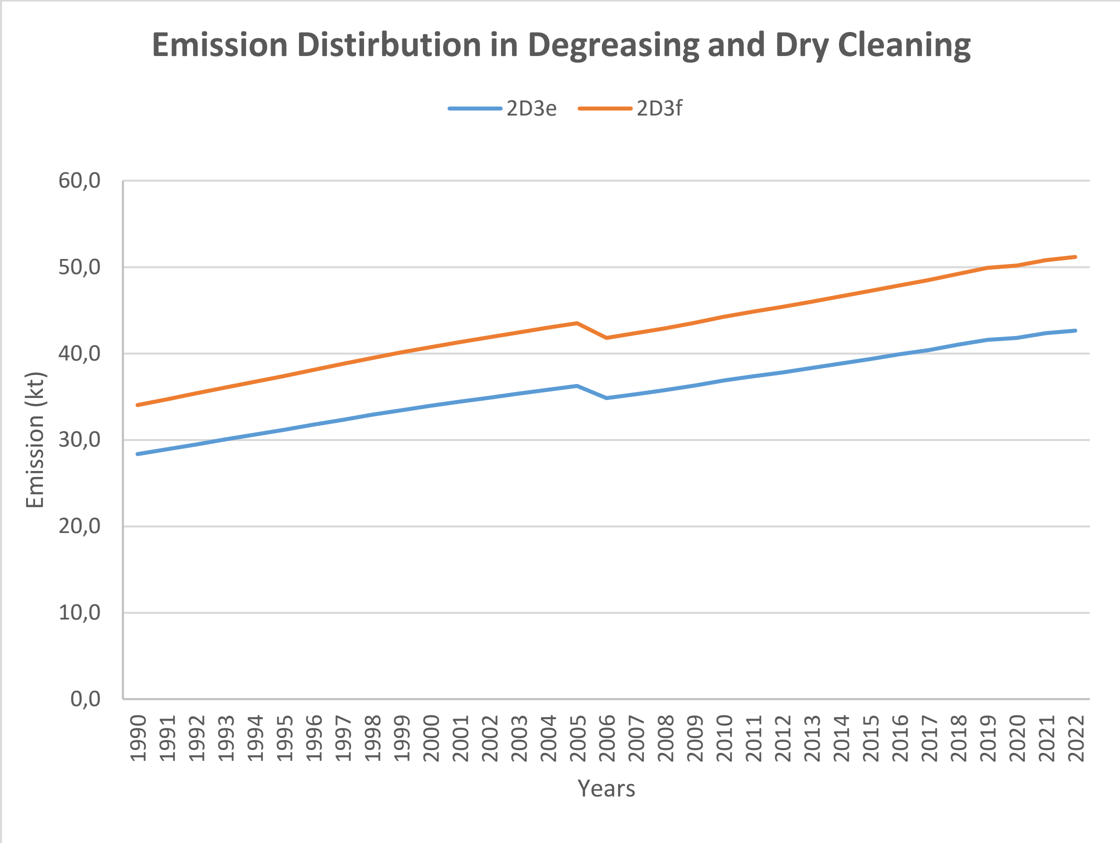

Figure 4.32 Emissions from NFR 2D.3.e and NFR 2D.3f for the period 1990 to 2022

Table 4.40 NMVOC emission from NFR 2.D.3.e Degreasing and NFR 2.D.3.f Dry Cleaning

Years	NMVOC	NMVOC
Sector	**Degreasing**	**Dry Cleaning**
Units	**kt**	**kt**
1990	28.36	5.67
1991	28.92	5.78
1992	29.48	5.90
1993	30.04	6.01
1994	30.60	6.12
1995	31.17	6.23
1996	31.74	6.35
1997	32.32	6.46
1998	32.89	6.58
1999	33.44	6.69
2000	33.95	6.79
2001	34.42	6.88
2002	34.89	6.98

2003	35.35	7.07
2004	35.81	7.16
2005	36.26	7.25
2006	34.84	6.97
2007	35.29	7.06
2008	35.76	7.15
2009	36.28	7.26
2010	36.86	7.37
2011	37.36	7.47
2012	37.81	7.56
2013	38.33	7.67
2014	38.85	7.77
2015	39.37	7.87
2016	39.91	7.98
2017	40.41	8.08
2018	41.00	8.20
2019	41.58	8.32
2020	41.81	8.36
2021	42.34	8.47
2022	42.64	8.53
Trend 1990 - 2022	50.37%	50.37%
Trend 2021 - 2022	0.71%	0.71%

Source of Activity Data

Population used as activity data in the calculations.

Methodological Issues

The TIER 1 approach for emissions from degrassing and dry cleaning uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC.

AD= population (million people)

EF= emission factor of pollutant i for other coating (kg/person)

Source of Emission factors

As no country-specific statistical data for this category was available. a methodology was used where “per capita" EFs were derived from the UK and Ireland emission inventories by dividing the emissions reported under NFR 3A3 by the population of the country were used for estimating NMVOC emissions from car respraying. It is therefore estimated that the emissions may slightly overestimate the Turkish emissions.

Emission factors used in the calculation are presented in Table 4.41.

Table 4.41 Emission factors for NFR 2.D.3e Degreasing and 2.D.3.f Dry Cleaning

NFR	Category	EF	Unit	Reference
2D3e	Degreasing	0.5	kg NMVOC/person	Based on UK and IE emission inventory (from years before influence of Solvents directive)
2D3f	Dry Cleaning	0.1	kg NMVOC/person	

Uncertainty

No uncertainty estimation was carried out for emissions from this sector. However. uncertainty can be assumed high in those estimates where the calculation is carried out using population as activity data.

Recalculations

No recalculation has been done for this part of the inventory.

Planned Improvements

Consistency with data used in the Turkish greenhouse gas inventory will be checked. for instance,

Availability of national data will be studied, and missing activity data collected. Information sources could be e.g.

- manufacture and use of solvents in Türkiye
- import statistics (solvents and products containing solvents)
- volume of solvent waste processed in hazardous waste treatment plants.

These improvements are likely to be carried out during coming years.

4.4.7 NFR 2.D.3.g Chemical Products

Source Category Description

Emissions: NMVOC

Key Source: No

Emission Trends

NMVOC emissions from NFR 3.C Chemical products amount in 6.80 kt in 1990 and 16.32 kt in 2022. which is an increase of about 140%. From 2021 to 2022 the NMVOC emission increased by 21%.

NMVOC emissions under NFR 3C were estimated from textile. tyres. paint. inks& glue and rubber manufacture.

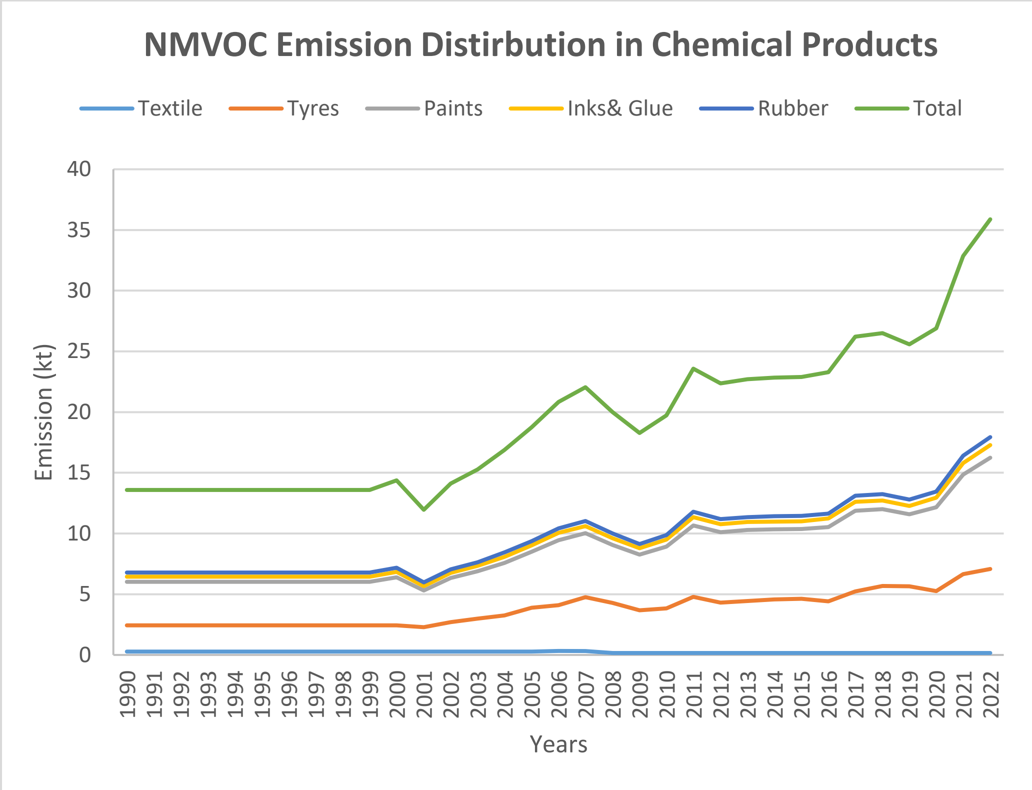

Figure 4.33 NMVOC emission from NFR 2D.3g Chemical products

Table 4.42 NMVOC emission from NFR 2D.3g Chemical products

Years	NMVOC
Units	**kt**
1990	6.80
1991	6.80
1992	6.80
1993	6.80
1994	6.80
1995	6.80
1996	6.80
1997	6.80
1998	6.80
1999	6.80
2000	7.18
2001	5.98
2002	7.06
2003	7.63
2004	8.44
2005	9.38

2006	10.42
2007	11.02
2008	10.00
2009	9.15
2010	9.86
2011	11.78
2012	11.18
2013	11.36
2014	11.42
2015	11.45
2016	11.65
2017	13.11
2018	13.26
2019	12.79
2020	13.45
2021	16.42
2022	17.94
Trend 1990 - 2022	163.97%
Trend 2021 - 2022	9.24%

4.4.7.1 Textile Industry

Textile industries producing cotton and woven fabrics as well as machined carpets were included in the inventory.

Based on results from the inventory. between 1990-2022 NMVOC emissions from textile industry decreased by about 44.28%.

Source of Activity Data

Production data 2005-2008 were available for the following parts of the textile industry from the TURKSTAT website www.tuik.gov.tr. Due to lack of data 1990-2004 data assumed same as 2005 and 2009-2019 data assumed same as 2008 data.

- Cotton fabric production (metres)
- Machined Carpet production (metres^2)
- Woven fabric production (metres).

To perform the calculations data were converted into mass equivalents using the assumptions presented below:

Table 4.43 Conversion of textile product volumes (m and m2) into mass units (g)

Assumptions	
Cotton fabric	Assume 1m is 0.01g
Machined Carpet	Assume 1m^2 is 500g
Woven fabric	Assume 1m is 0.1g

Methodological Issues

The TIER 1 approach for process emissions from textile productions uses the general equation:

$Emission_{pollutant} = \sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC

AD = the activity rate for the textile production (kt)

EF = emission factor of pollutant i for textile production (kg/ton textile)

Source of Emission Factors

The EMEP/EEA Emission Inventory Guidebook (2023) emission factor 10 kg/ton of textile was used in the calculation.

Uncertainty

No uncertainty estimation was carried out for emissions from this sector.

Recalculations

No recalculations have been done for this part of the inventory.

Planned Improvements

Availability of national data will be studied, and missing activity data collected.

Consistency with data used in the Turkish greenhouse gas inventory will be checked. availability of other emission factors applicable to Turkish data will be studied

These improvements are likely to be carried out during the next coming years.

4.4.7.2 Tyre Manufacturing

NMVOC emissions from manufacturing of tyres are included in the inventory calculations.

Based on results from the inventory. between 1990-2022 NMVOC emissions from tyre manufacturing increased by about 223.09%.

The sharp changes in emissions are due to the use of different statistics for the time series 1990-2021. The reason for the use of different statistics is the availability of data in a single source. The statistics will be checked, and emissions corrected where relevant. to the next submission.

Source of Activity Data

Numbers and mass of tyres produced in country were available in National Development Reports for 2000-2005. Due to lack of data 2000 data was assumed same for 1990-1999. 2006-2022 data was extrapolated according to Eurostat production index (Manufacture of rubber tyres and tubes)

Methodological Issues

The TIER 2 approach for process emissions from tyre production uses the general equation:

$$Emission_{pollutant} = \sum AD * EF$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC

AD = the activity rate for the tyre production (kt)

EF = emission factor of pollutant i for tyre production (kg/ton tyre)

Source of Emission Factors

The EMEP/EEA Emission Inventory Guidebook (2023) emission factor 10 kg/ton of tyres was used in the calculation.

Uncertainty

No uncertainty estimation was carried out for emissions from this sector.

Recalculations

No recalculation has been done for this part of the inventory

Planned Improvements

Missing activity data will be searched.

4.4.7.3 Paints Manufacturing

NMVOC emissions from manufacturing of paints manufacturing are included in the inventory calculations this year.

Based on results from the inventory. between 1990-2022 NMVOC emissions from tyre manufacturing increased by about 154.58%.

Source of Activity Data

Production data of decorative paints, Wood protection, Wood paints, automotive paints, metal paints, and other paints was available in National Development Report for 1999-2005. Due to lack of data 1999 data was assumed same for 1990-1998 data. For 2006-

2022 extrapolation was made with EUROSTAT production index (manufacture of paints. Varnishes.)

Methodological Issues

The TIER 1 approach for process emissions from paint production uses the general equation:

$Emission_{pollutant} = \sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC

AD = the activity rate for the production (kt)

EF = emission factor of pollutant i for production (kg/ton product)

Source of Emission Factors

The EMEP/EEA Emission Inventory Guidebook emission factor 10 kg/ton of product was used in the calculation.

Uncertainty

No uncertainty estimation was carried out for emissions from this sector.

Recalculations

No recalculation has been done for this part of the inventory

Planned Improvements

Missing activity data will be searched.

4.4.7.4 Inks& Glue Manufacturing

NMVOC emissions from manufacturing of inks and glue are included in the inventory calculations this year.

Based on results from the inventory. between 1990-2022 NMVOC emissions from inks and glue manufacturing increased by about 154.76 %.

Source of Activity Data

Production data of inks and glue was available in National Development Report for 1999-2005. Due to lack of data 1999 data was assumed same for 1990-1998 data. For 2006-2021 extrapolation was made with EUROSTAT production index (manufacture of paints. Varnishes.)

Methodological Issues

The TIER 1 approach for process emissions from paint production uses the general equation:

$Emission_{pollutant} = \sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC

AD = the activity rate for the production (kt)

EF = emission factor of pollutant i for production (kg/ton product)

Source of Emission Factors

The EMEP/EEA Emission Inventory Guidebook emission factor 10 kg/ton of product was used in the calculation.

Uncertainty

No uncertainty estimation was carried out for emissions from this sector.

Recalculations

No recalculation has been done for this part of the inventory.

Planned Improvements

Missing activity data will be searched.

4.4.7.5 SBR-CBR Rubber Manufacturing

NMVOC emissions from manufacturing of synthetic rubber are included in the inventory calculations this year.

Based on results from the inventory. between 1990-2022 NMVOC emissions from synthetic rubber manufacturing increased by about 84.63%.

Source of Activity Data

Production data of SBR-CBR rubber was available in National Development Report for 2000-2004. Due to lack of data 2000 data was assumed same for 1990-1999 data. For 2005-2022 extrapolation was made with EUROSTAT production index (manufacture of rubber and plastic products.)

Methodological Issues

The TIER 2 approach for process emissions from paint production uses the general equation:

$Emission_{pollutant} = \sum AD * EF$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC

AD = the activity rate for the production (kt)

EF = emission factor of pollutant i for production (kg/ton product)

Source of Emission Factors

The EMEP/EEA Emission Inventory Guidebook (2023) emission factor 8 kg/ton of product was used in the calculation.

Uncertainty

No uncertainty estimation was carried out for emissions from this sector.

Recalculations

No recalculation has been done for this part of the inventory

Planned Improvements

Missing activity data will be searched.

Possibilities to include other industrial activities such as

- rubber processing
- pharmaceutical products
- leather tanning
- textile finishing
- polyester. polyvinylchloride. polyurethane and polystyrene foams manufacturing and processing
- manufacture of glues. adhesives
- manufacture of magnetic tapes. films and photographs
- paints manufacture
- manufacture of inks
- asphalt blowing will be studied in the next coming years.

4.4.8 NFR 2.D.3.h Printing

Source Category Description

Emissions: NE

No emissions were estimated in this inventory. Typical emissions from this source include NMVOCs.

Planned Improvements

Possibilities to collect national data that can be used to estimate emissions in accordance with EMEP/EEA Guidebook for this source will be studied in the next coming years. such as

use of solvent containing inks. ink types and other products for different printing processes

information on process and abatement techniques

4.4.9 NFR 2.G Other product use

Source Category Description

Emissions: NE

No emissions were estimated in this inventory. Typical emissions from this source include NMVOCs.

NMVOC emission sources under NFR 3D2 include. for instance:

- glass and mineral wool enduction
- tobacco smoking
- fat and edible oil extraction
- preservation of wood
- underseal treatment and conservation of vehicles
- vehicles dewaxing

- use of pesticides in cultivations and in construction
- preservation of seeds
- use of firework
- tobacco smoking
- car and house fires
- industrial application of glues and adhesives

Planned Improvements

Possibilities to collect national data that can be used to estimate emissions in accordance with EMEP/EEA Guidebook for this source will be studied in the next coming years.

4.5 NFR 2.H Other Production Industry

4.5.1 NFR 2.H.1 Pulp and paper production

Source Category Description

Emissions: NMVOC, PM_{10}, CO, SO_2, NO_X

Key Source: No

Emission Sources

Pulp and paper production involves three major steps: pulping. bleaching and paper production. General processes scheme for pulp and paper production in the EMEP/EEA Guidebok (2023) are illustrated in Figure 4.34.

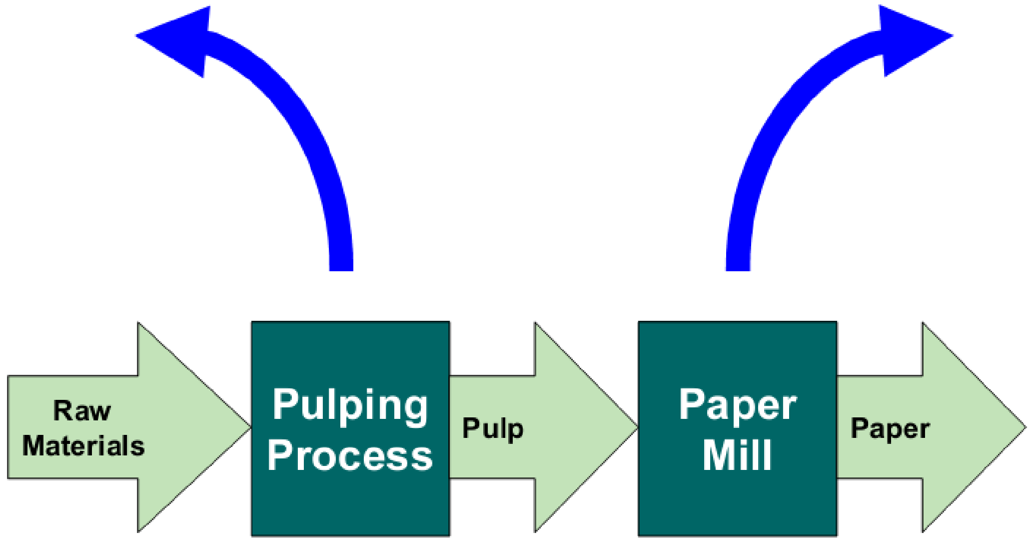

Figure 4.34 General process scheme for pulp and paper production

Pulping has three different chemical processes: kraft pulping. sulphite pulping and neutral sulphite semi-chemical (NSSC) pulping. Kraft pulping uses white liquor. sulphite pulping uses caustic solution. NSSC pulping uses neutral solution under high temperature and pressure to chemically dissolve lignin which is binder of cellulose and wood fibres.

Information about sector in Türkiye. production and abatement technologies will be collected next coming years.

Emission Trends

- NO_X emissions increased by about 32.70 % from 0.23 kt in 1990 to 0.30 kt in 2022.
- SO_2 emissions increased by about 32.70 % from 0.45 kt in 1990 to 0.60 kt in 2022.
- NMVOC emissions increased by about 32.70 % from 0.45 kt in 1990 to 0.6 kt in 2022.
- PM_{10} emissions increased by about 32.70 % from 0.18 kt in 1990 to 0.24 kt in 2022.
- CO emissions increased by about 32.70 % from 1.25 kt in 1990 to 1.66 kt in 2022.

Emission estimates prepared in this inventory are based on production volumes of paper board and paper and emission factors taken from the EMEP/EEA Guidebook that are related to production of air-dried tons of pulp. The emissions are represented in Figure 4.35 and Table 4.44.

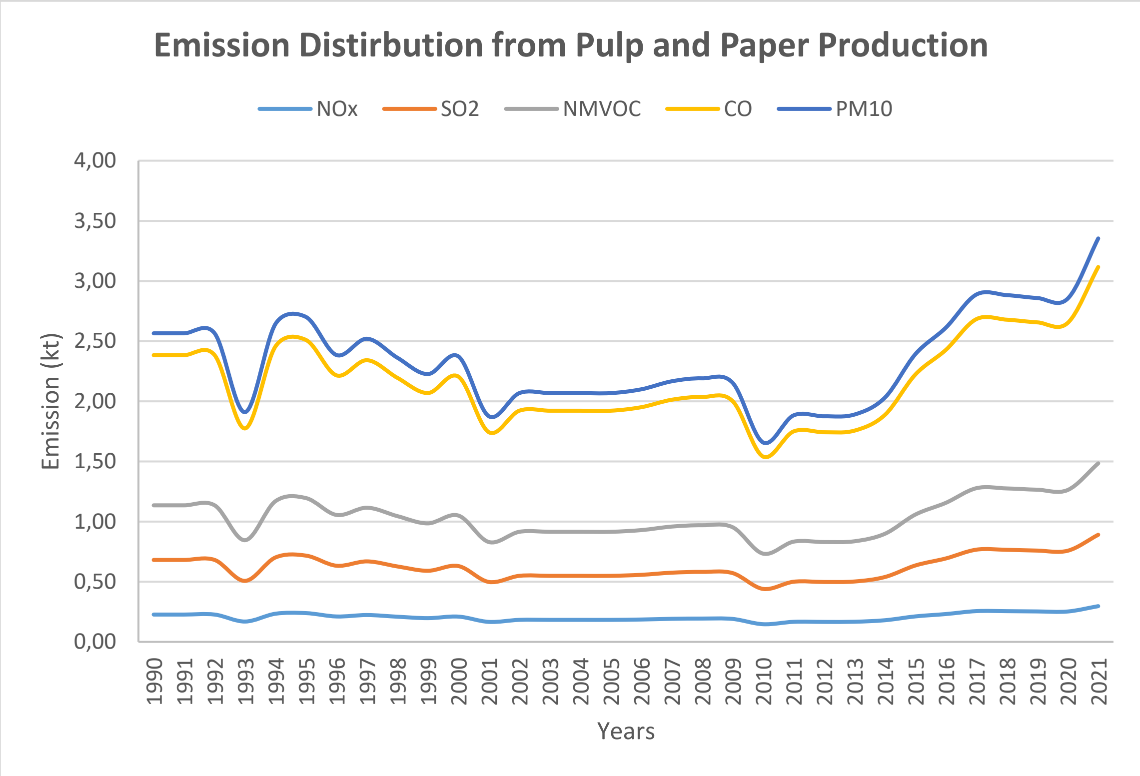

Figure 4.35 Emissions from NFR 2.H.1 Pulp and Paper Production for the period 1990 to 2022

Table 4.44 Emissions from NFR 2.H.1 Pulp and Paper Production

Years	NOx	SO2	NMVOC	CO	PM10
Units	**kt**	**kt**	**kt**	**kt**	**kt**
1990	0.23	0.45	0.45	1.25	0.18
1991	0.23	0.45	0.45	1.25	0.18
1992	0.23	0.45	0.45	1.25	0.18
1993	0.17	0.34	0.34	0.93	0.14
1994	0.23	0.47	0.47	1.29	0.19
1995	0.24	0.48	0.48	1.31	0.19

1996	0.21	0.42	0.42	1.16	0.17
1997	0.22	0.45	0.45	1.23	0.18
1998	0.21	0.42	0.42	1.15	0.17
1999	0.20	0.39	0.39	1.08	0.16
2000	0.21	0.42	0.42	1.16	0.17
2001	0.17	0.33	0.33	0.91	0.13
2002	0.18	0.37	0.37	1.01	0.15
2003	0.18	0.37	0.37	1.01	0.15
2004	0.18	0.37	0.37	1.01	0.15
2005	0.18	0.37	0.37	1.01	0.15
2006	0.19	0.37	0.37	1.02	0.15
2007	0.19	0.38	0.38	1.05	0.15
2008	0.19	0.39	0.39	1.07	0.16
2009	0.19	0.38	0.38	1.05	0.15
2010	0.15	0.29	0.29	0.81	0.12
2011	0.17	0.33	0.33	0.92	0.13
2012	0.17	0.33	0.33	0.91	0.13
2013	0.17	0.33	0.33	0.92	0.13
2014	0.18	0.36	0.36	0.99	0.14
2015	0.21	0.42	0.42	1.16	0.17
2016	0.23	0.46	0.46	1.27	0.18
2017	0.26	0.51	0.51	1.41	0.20
2018	0.26	0.51	0.51	1.40	0.20
2019	0.25	0.51	0.51	1.39	0.20
2020	0.25	0.51	0.51	1.39	0.20

2021	0.30	0.59	0.59	1.63	0.24
2022	0.30	0.60	0.60	1.66	0.24
Trend 1990 - 2022	32.70%	32.70%	32.70%	32.70%	32.70%
Trend 2021 - 2022	1.50%	1.50%	1.50%	1.50%	1.50%

Source of Activity Data

Production data was downloaded from Eurostat for 1992-2005 as chemical wood-pulp. Due to lack of data 1992 was used for 1990-1992 and extrapolation was made for 2005-2019 according to Eurostat Türkiye production index (manufacture of pulp. paper and paperboard)

Methodological Issues

The TIER 1 approach for process emissions from pulp and paper productions uses the general equation:

Emission pollutant = ∑ AD * EF

Where:

Emission pollutant =emissions of pollutant i for the period concerned in the inventory (kt)

i = NMVOC. PM_{10}.SO_2.CO.NO_x

AD = the activity rate for the air dried pulp (kt)

EF = emission factor of pollutant i for pulp and paper production (kg/kt)

Source of Emission Factors

Emissions were estimated using emission factors from the EMEP/EEA Emission Inventory Guidebook.

Table 4.45 Emission factors (EMEP/EEA Guidebook)

NO_x	SO_2	NMVOC	CO	PM_{10}
kg/ton	kg/ton	kg/ton	kg/ton	kg/ton
1	2	2	5.5	0.8

Uncertainty

No uncertainty assessment was performed for the inventory.

Recalculations

No recalculation has been done for this part of the inventory**.**

Planned Improvements

It is recommended to collect plant level data on production processes. production volumes and emission measurements. to improve the present estimates.

Possibilities to collect plant specific data for this source will be studied in the next coming years.

4.5.2 NFR 2.H.2 Food and beverages industry

Source Category Description

Emissions: NMVOC

Key Source: Yes (NMVOC)

This subsector includes NMVOC emissions from food and drink manufacturing. except emissions from vegetable oil extraction. Emissions from food manufacturing include all processes in the food production chain which occur after the slaughtering of animals and the harvesting of crops. Emissions from drink manufacturing include the production of alcoholic beverages. especially wine. beer and spirits.

Food Consumption:

Türkiye has traditional eating habits that remain stable in the majority of the population. However. the Turkish food sector is becoming more elaborated as retailers require higher standards from food manufacturers. and investments accompanied by improvements in the sector take place. Through the widespread presence of modern markets and rising disposable incomes. consumption patterns have been shifting to packaged and processed foods. such as ready-to-eat meals and frozen foods. Additionally. the increases in the number of females in full-time employment have supported the trend towards packaged. frozen and ready food. Therefore. considering that Türkiye still has the lowest per capita consumption of packaged food in Europe. there is considerable potential in the sub-sectors.

Globally. Türkiye is one of the largest markets for baked goods. since such goods have a significant share in the diets of the Turkish population. With rising incomes. packaged bread consumption presents an increase and at the same time. demand for different bread varieties. such as high-fiber and specialty artisan breads offer an opportunity for this higher profit market compared with traditional baked products.

Beverage Consumption:

The beverage sector in Türkiye can be analysed in terms of hot beverages. soft beverages and alcoholic beverages.

Hot Beverages:

Türkiye ranks 7th in the tea cultivation area within the world and 5th in dry tea production and 4th in annual per capita tea consumption. Among other hot drinks. Turkish coffee is widely consumed in Türkiye although the global coffee chains.

Soft Beverages:

According to the Federation of Food and Drink Industry Associations of Türkiye. bottled water ranks in first place with regards to the production capacities in the Turkish beverage industry. accounting for around 50 percent of the total beverage industry production capacity of 13.236 million liters.

Alcoholic Beverages:

The top four alcoholic beverages produced in Türkiye are beer. raki. wine and vodka. Beer is the main alcoholic drink. constituting 90 percent of total alcoholic drinks production in 2009. Raki. the Turkish traditional alcoholic drink constitutes 4.4 percent of the total production together with wine. In addition to the large wine producers. there are almost 300 small-sized producers located in Central Anatolia. Marmara Thrace and the Aegean region. Total capacity of the wine sector is approximately 120 million liters per annum. (Deloitte Turkish Food & Beverage Industry Report. July 2010)

In the inventory. production data were available from national development reports.

Food data as Biscuits. Sugar- crystal. Sugar- cube. Margarine is available for (1999-2008) bread. meat big. meat small. Fish and poultry production are available for 1994-2004. other years are proportioned to population. It is assumed that production is equivalent to consumption.

Drink data as beer. wine and raki are available for (1999-2008) whiskey. vodka. vermouth. liquors are available for 1994-2004. other years are proportioned to population. It is assumed that production is equivalent to consumption.

Emission Trends

NMVOC emissions increased by about 35 % from 68.1 kt in 1990 to 92.4 kt in 2022.

Emission trend is illustrated in Figure 4.36.

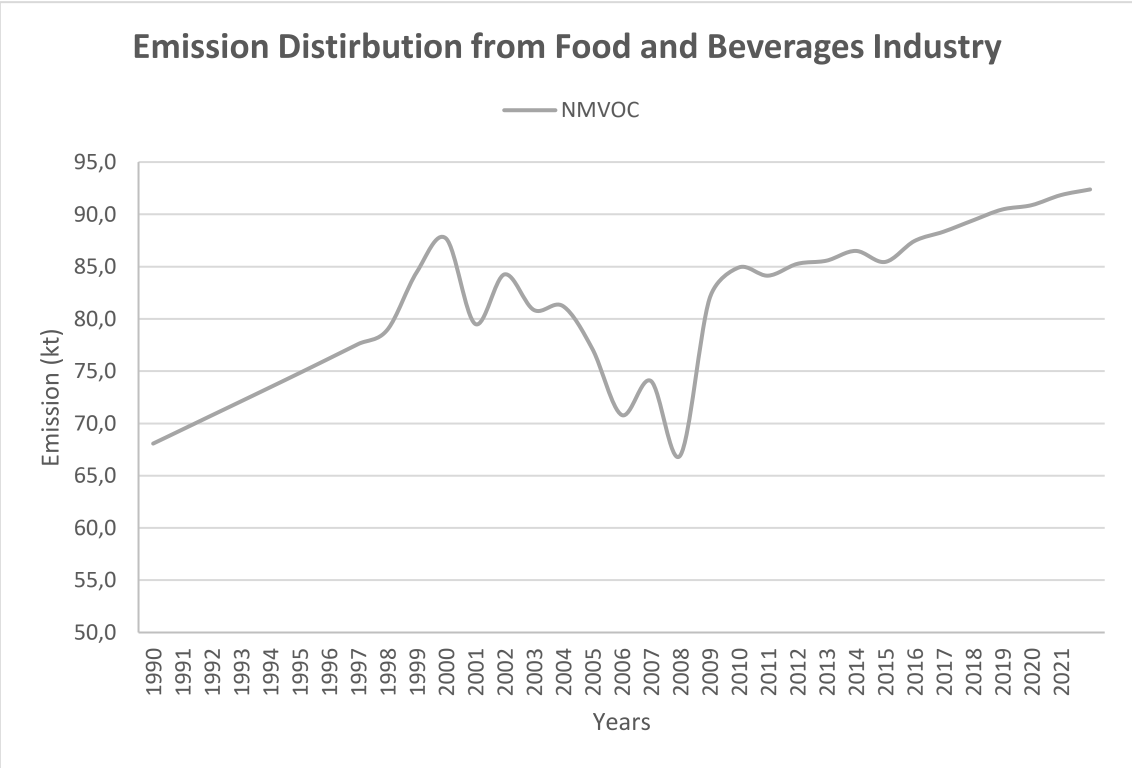

Figure 4.36 Emissions from NFR 2.H.2 for the period 1990 to 2022

Emissions from food and drink production are represented in Table 4.46.

Table 4.46 Emissions from sector 2.H.2 Food and Beverages Industry

Years	NMVOC
Units	**kt**
1990	68.07
1991	69.42
1992	70.77
1993	72.11
1994	73.46
1995	74.82
1996	76.20
1997	77.59
1998	78.96
1999	84.46
2000	87.70
2001	79.51
2002	84.26
2003	80.86
2004	81.22
2005	77.14
2006	70.81
2007	74.06
2008	66.92
2009	81.91
2010	84.92
2011	84.13
2012	85.26
2013	85.57
2014	86.50
2015	85.45
2016	87.45
2017	88.34
2018	89.42
2019	90.46
2020	90.88

2021	91.84
2022	92.38
Trend 1990 - 2022	35.71%
Trend 2021 - 2022	0.59%

Source of Activity Data

Activity data are given in tons and litres of food and drink produced per year in National Development Report. It is assumed that production is equivalent to consumption. Also non-confidential consumption data of TURKSTAT is used for calculation.

Methodological Issues

The applied methodology is TIER 2 and uses the general equation:

Emission_pollutant = ∑ ADproduction * EFpollutant

Where:

Emission_pollutant=emissions of pollutant i for the period concerned in the inventory (kt)

AD production= the activity rate for the every kind of food and drink production (kt)

EF pollutant = emission factor of pollutant i (kg/tons biscuits etc.)

Source of Emission Factors

Emission factors for NMVOC have been taken from the EMEP/EEA Emission Inventory Guidebook. Emission factors in the guidebook and used factors in the calculations are presented in Table 4.45 and 4.46

Table 4.47 Emission factors (EF) in the EMEP/EEA Guidebook

	Unit	EF	Reference
NMVOC	kg/Mg product produced	0.3 – 150	Emission factors from the EMEP/EEA Guidebook (2023) Chapter 2H.2 Food& Beverages

	Table 3.27(beer)pg19. Table3.24(wine)pg18.Table3.28(sprits)pg18.Table3.29(Whisky)pg20.Table3.32(otherspirits)pg21.Table3.18(biscuits9pg16.Table3.19(MeatFishPolutry)pg16.Table3.20(Sugar)pg16. Table 3.21(Margarine)pg17.Table3.14 (Bread)pg14.tier 2

Table 4.48 Emission factor (EF) used sector 2.H.2 Food and Beverages Industry

Product type	Unit of EF	EF
Biscuits	kg/ton	1
Sugar- crystal	kg/ton	10
Sugar- cube	kg/ton	10
Margarine	kg/ton	10
Bread	kg/ton	4.5
Meat. fish & poultry	kg/ton	0.3
Beer	kg/h litre beer	0.035
Wine	kg/h litre wine	0.08
Raki	kg/h litre of alcohol	15
Whiskey	kg/h litre of alcohol	15
Vodka	kg/h litre of alcohol	15
Vermouth	kg/h litre of alcohol	0.4
Coffee roasting	kg/ton of beans	0.55
Animal feed	kg/ton	1

Uncertainty

No uncertainty assessment was performed for the inventory.

Recalculations

No recalculation has been done for this part of the inventory.

Planned Improvements

Activity data for years which proportioned to population will be tried to find.

4.5.3 NFR 2.H.3 Other industrial processes

Source Category Description

Emissions: NE

This subsector involves particle emissions from processing of wood: manufacturing of polywood. reconstituted wood products and engineered wood products.

Wood processing is a source of particle emissions. At the moment. these emissions are not estimated.

Planned improvements

Particle emissions from wood processing can be estimated using production data and emission factors.

These improvements are scheduled to be carried out in coming years.

5 AGRICULTURE (NFR SECTOR 3)

This chapter includes information on the methodologies used for the estimation of emissions in the following NFR subsectors:

- 3B Manure management
- 3D Crop Production and Agricultural Soils

Emissions from sub-sector 3.F Field burning of agricultural wastes and Agriculture other including use of pesticides have not been estimated in the Turkish inventory (NE). Because there is no available data.

5.1 NFR3.B Manure Management

Emissions: $NH_{3.}$ NMVOC

Key Source: Yes (NH_3(3B1a, 3B1b, 3B2, 3B4gii), NMVOC (3B1a, 3B1b, 3B4gii))

Source Category Description

This source category includes ammonia emissions from the animal housings. the storage of manure and the manure application to fields. SO_2 and NO_X emissions from manure management are reported as NA. Following a recommendation of the stage 3 in-depth review under the UNECE LRTAP Convention 2012 (para 122) the notation key for NMVOC (3.B) has been changed from NA "not applicable" to calculated one and noted.

Ammonia emissions from excreta deposited by grazing animals are also calculated within sector 3.B.

Emission Trends

Firstly. we had the important meeting it should be emphasized that dairy cattle and other cattle numbers for 1990-2022 time series are recalculated according to the meetings with TURKSTAT. Also. mules and asses are shine lined as separate headings. Camels are on the other poultry assumed. NH_3 emissions increased by 61.5% from 539.92 kt in 1990 to 872.06 kt in 2022.

NMVOC emissions increased by 34.8% from 185.48 kt in 1990 to 250.07 kt in 2022.

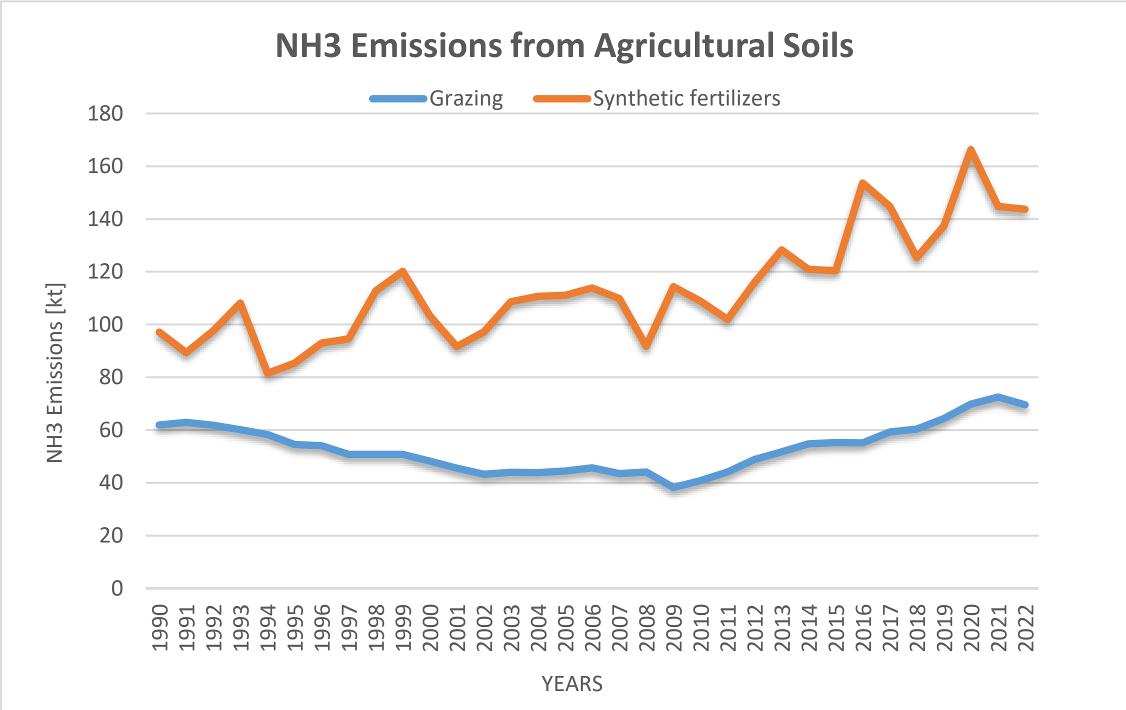

Figure 5.1 Emissions from NFR 5B-5D for the period 1990 to 2022

Table 5.1 NMVOC emissions by Manure Management-Agricultural Soil 1990-2022

Year	Total	Total
Units	kt NMVOC Manure Management	kt NMVOC Agricultural Soil
1990	168.28	17.20
1991	178.44	17.20
1992	178.85	17.20
1993	180.03	17.20
1994	179.99	17.20
1995	170.32	17.20
1996	173.18	17.20
1997	166.30	17.20
1998	170.97	17.20
1999	171.48	17.20
2000	167.48	17.20
2001	158.88	15.41
2002	150.22	15.41
2003	151.81	15.41
2004	153.39	15.41
2005	159.78	15.48
2006	166.43	15.00
2007	159.26	14.57
2008	153.52	14.57
2009	150.44	14.57
2010	158.48	14.57
2011	170.52	14.57
2012	189.94	13.30
2013	197.42	13.30
2014	200.27	13.30
2015	200.28	13.30
2016	202.54	13.30
2017	223.56	13.30
2018	236.29	13.30
2019	242.24	13.30
2020	251.10	13.30
2021	252.00	13.30
2022	236.78	13.30
Trend 1990 - 2022	40.71%	-22.69%
Trend 2021 - 2022	-6.04%	0.00%

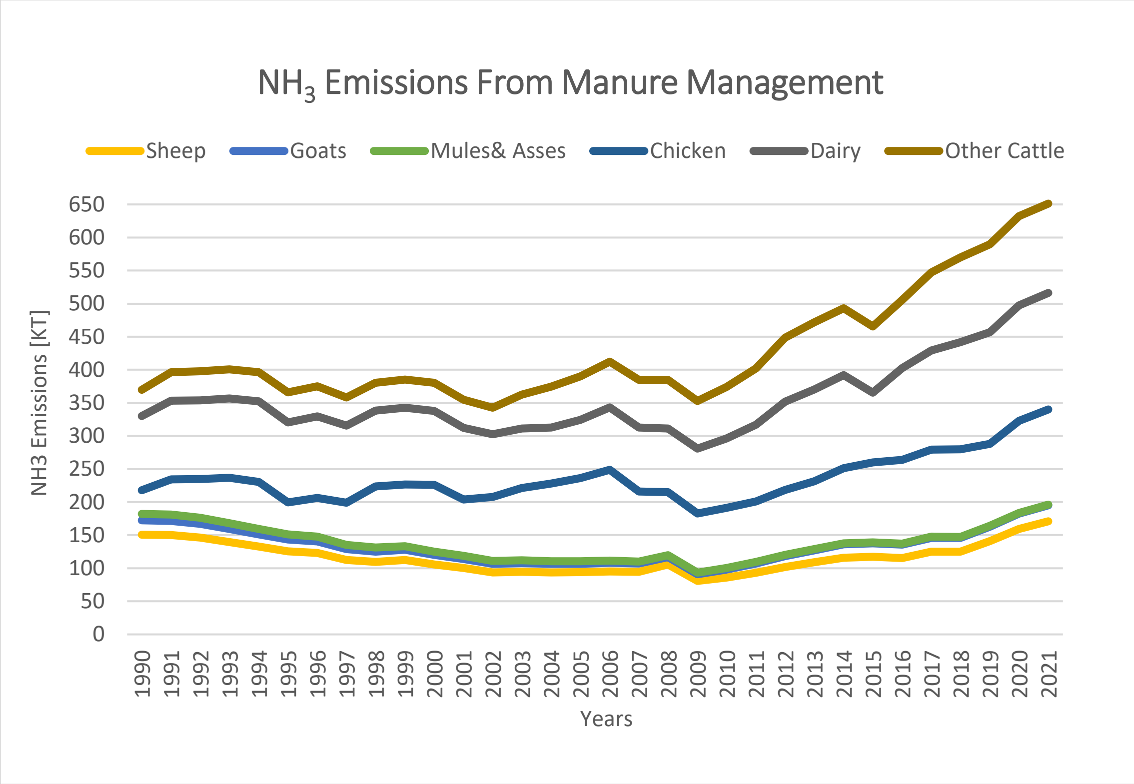

Figure 5.2 Emissions from NFR 3.B for the period 1990 to 2022

Table 5.2 Ammonia emissions by sub-categories 1990-2022(I)

Year	Dairy Cows	Other Cattle	Buffalo	Market Swine	Breeding Swine	Laying hens	Broilers
Units	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**
1990	112.37	39.47	3.62	0.04	0.00	17.63	18.12
1991	118.76	43.22	3.58	0.04	0.00	17.05	36.29
1992	119.03	43.76	3.44	0.04	0.00	17.52	41.19
1993	119.93	44.06	3.09	0.03	0.00	19.52	49.31
1994	121.86	44.08	2.98	0.03	0.00	19.41	51.67
1995	120.90	45.23	2.49	0.02	0.00	19.23	29.44
1996	123.41	45.48	2.30	0.02	0.00	18.08	40.68
1997	116.41	42.79	1.90	0.02	0.00	20.60	43.06
1998	114.67	42.33	1.72	0.02	0.00	23.39	68.69
1999	116.37	42.28	1.61	0.01	0.00	24.12	68.93
2000	111.78	42.48	1.43	0.01	0.00	21.71	79.44
2001	108.30	42.62	1.35	0.01	0.00	18.68	66.48
2002	94.72	40.12	1.18	0.01	0.00	19.17	77.46
2003	89.72	51.57	1.11	0.03	0.00	20.27	89.16
2004	84.52	62.20	1.02	0.02	0.00	19.72	97.77
2005	87.93	66.04	1.03	0.01	0.00	20.22	105.62
2006	94.20	69.02	0.98	0.00	0.00	19.70	117.49
2007	97.02	71.94	0.83	0.01	0.00	21.57	84.21
2008	95.81	73.77	0.84	0.01	0.00	21.26	74.29
2009	98.07	72.06	0.85	0.01	0.00	22.31	67.13
2010	104.69	77.92	0.83	0.01	0.00	23.80	67.34
2011	115.78	85.40	0.95	0.01	0.00	26.49	65.26
2012	133.49	97.13	1.05	0.01	0.00	28.41	69.41
2013	138.74	101.37	1.15	0.01	0.00	29.77	72.86
2014	140.75	100.69	1.19	0.01	0.00	31.46	82.12
2015	105.34	99.85	1.31	0.01	0.00	33.08	87.73
2016	138.71	102.63	1.39	0.00	0.00	36.47	90.47
2017	150.16	117.75	1.58	0.00	0.00	40.79	90.85
2018	161.81	127.95	1.58	0.00	0.00	41.62	90.85
2019	168.94	132.98	1.80	0.01	0.00	32.80	91.10
2020	174.75	134.91	1.88	0.00	0.00	32.95	105.96
2021	176.17	135.00	1.81	0.00	0.00	32.87	111.03
2022	192.23	128.28	1.68	0.00	0.00	36.84	103.19

Trend 1990 – 2022	71%	225%	-54%	-92%	-86%	109%	469%
Trend 2021 - 2022	9%	-5%	-7%	-17%	22%	12%	-7%

Table 5.3 Ammonia emissions by sub-categories1990-2022 (II)

Year	Turkeys	Ducks & Geese	Camels	Sheep	Goats	Horses	Mules and Asses
Units	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**	**kt NH3**	**Kt NH3**
1990	1.99	1.06	0.01	150.80	21.41	4.31	9.97
1991	2.01	0.96	0.01	150.35	21.09	4.16	9.54
1992	2.14	1.03	0.01	146.57	20.48	4.06	9.03
1993	2.14	1.01	0.01	139.60	19.85	3.78	8.51
1994	2.21	1.03	0.01	132.56	18.74	3.67	8.22
1995	2.11	1.04	0.01	125.66	17.85	3.49	7.56
1996	1.97	0.97	0.01	122.98	17.54	3.28	7.08
1997	3.42	1.28	0.01	112.44	16.41	2.90	6.57
1998	2.44	1.10	0.01	109.46	15.79	2.77	6.18
1999	2.41	1.05	0.01	112.51	15.23	2.60	5.71
2000	2.36	0.92	0.01	105.95	14.11	2.28	4.94
2001	2.09	0.82	0.01	100.30	13.76	2.28	4.70
2002	1.98	0.79	0.00	93.61	13.28	2.09	4.30
2003	2.56	0.76	0.00	94.57	13.27	1.91	4.11
2004	2.50	0.71	0.00	93.71	12.95	1.78	3.79
2005	2.37	0.61	0.00	94.10	12.77	1.75	3.55

2006	2.07	0.48	0.01	95.26	13.02	1.72	3.40
2007	1.72	0.53	0.01	94.68	12.32	1.58	3.06
2008	2.07	0.54	0.01	105.85	10.96	1.51	2.82
2009	1.77	0.48	0.01	80.87	10.05	1.40	2.40
2010	1.89	0.39	0.01	85.86	12.33	1.30	2.18
2011	1.64	0.38	0.01	93.08	14.26	1.27	2.08
2012	1.77	0.37	0.01	101.98	16.38	1.19	1.98
2013	1.88	0.40	0.01	108.90	18.08	1.14	1.91
2014	1.92	0.46	0.01	115.80	20.27	1.10	1.78
2015	1.81	0.44	0.01	117.16	20.41	1.03	1.66
2016	2.04	0.48	0.01	115.22	20.27	1.01	1.59
2017	2.48	0.52	0.01	125.23	20.84	0.96	1.48
2018	2.48	0.52	0.01	125.23	20.84	0.96	1.46
2019	2.91	0.59	0.01	140.80	21.96	0.86	1.31
2020	3.08	0.68	0.01	159.16	23.49	0.76	1.12
2021	3.02	0.71	0.01	170.97	24.18	0.70	0.99
2022	2.35	0.78	0.01	169.12	22.69	0.62	0.89
Trend 1990 – 2022	18%	-26%	-40%	12%	6%	-86%	-91%
Trend 2021 - 2022	-22%	9%	-1%	-1%	-6%	-11%	-11%

In the report for the stage 3 in-depth review under the UNECE LRTAP Convention 2012. Türkiye was recommended to estimate NH_3 emissions from ducks and geese (para. 124). Following Table 6.7 these animals are only held on pastures and no emissions are occurring in sector 3.B (NO). Emissions from solid manure of ducks and geese (see also Table 6.8) are included in NFR sector 3.D.2.c "N-excretion on pasture range and paddock".

Activity Data

Official annual livestock data from the TURKSTAT was used. In converting the livestock numbers into the required categories, the following assumptions were made.

- Dairy cattle and other cattle numbers are obtained from TURKSTAT, and 1990-2022 times series are recalculated.
- Horses and Mules and Asses are newly separately figured.
- Camels are assumed as other poultry part.
- Ducks and geese are accounts as other animals.
- Market swine are exactly to account. Swine make only a minor contribution to total emissions in Türkiye.

Table 5.4 Domestic livestock population and its trend 1990-2022 (I)

Years	Dairy	Other Cattle	Buffalo	Market Swine	Breeding Swine
Units	**Head**	**head**	**head**	**head**	**head**
1990	5892550	5484507	370908	10800	1200
1991	6119000	5853923	366150	9284	1032
1992	6070178	5880729	352410	10620	1180
1993	6031952	5878048	316000	8100	900
1994	6082180	5818820	305000	7200	800
1995	5885586	5903414	255000	4500	500
1996	5968211	5917789	235000	4500	500
1997	5596611	5593326	194000	4140	460
1998	5489048	5541952	176000	4500	500
1999	5537883	5516117	165000	3060	340
2000	5279573	5481427	146000	2700	300
2001	5085819	5462181	138000	2430	270
2002	4392574	5410924	121077	3236	359
2003	4134148	5653954	113356	6381	709
2004	3875722	6193624	103900	3959	440
2005	3998095	6528345	104965	1741	193
2006	4187934	6683430	100516	1226	136
2007	4229442	6807311	84705	1632	181
2008	4080242	6779700	86297	1544	173
2009	4133150	6590808	87207	1706	190
2010	4361842	7007958	84726	1402	156
2011	4761150	7625187	97632	1663	185
2012	5431403	8483509	107435	2687	299
2013	5607278	8807979	117591	2831	314
2014	5609249	8613860	122114	2390	265
2015	5535779	8458292	133766	1478	164
2016	5431720	8648435	142073	1169	130
2017	5969051	9974535	161439	1225	136
2018	6337906	10704600	178397	1472	164
2019	6580834	11107305	184192	1436	154
2020	6775321	11190161	192489	891	99
2021	6759168	11091375	185574	1218	135
2022	6401840	10450116	171835	1483	165
Trend 1990 – 2022	9%	91%	-54%	-86%	-86%
Trend 2021 - 2022	-5%	-6%	-7%	22%	22%

Table 5.5 Domestic livestock population and its trend 1990-2022 (II)

Years	Chickens (Layers)	Chickens (Broilers)	Turkeys	Ducks&Geese
Units	**Head**	**head**	**head**	**head**
1990	52541341	44135104	3106250	2471990
1991	50826656	88379548	3132676	2711846
1992	52222492	100305100	3332794	2907238
1993	58179047	120080935	3340241	2859557
1994	57842034	125842269	3441995	2906724
1995	57324654	71689773	3291000	2945088
1996	53883070	99073900	3063540	2735775
1997	61401783	104870702	5327501	3623402
1998	69722271	167275380	3805345	3110795
1999	71885207	167862730	3762516	2965740
2000	64709040	193459280	3681558	2600780
2001	55675750	161899442	3254018	2311308
2002	57139257	188637066	3092408	2232227
2003	60399520	217133076	3994093	2147685
2004	58774172	238101895	3902346	2021070
2005	60275674	257221440	3697103	1722990
2006	58698485	286121360	3226941	1355331
2007	64286383	205082159	2675407	1504540
2008	63364817	180915558	3230318	1533045
2009	66500461	163468942	2755349	1357454
2010	70933660	163984725	2942170	1112406
2011	78956861	158916608	2563330	1061739
2012	84677290	169034283	2760859	1032909
2013	88720709	177432745	2925473	1123107
2014	93751470	199976150	2990304	1311810
2015	98597340	213658294	2827731	1249081
2016	108689236	220322081	3182751	1347194
2017	121556027	221245322	3872460	1469945
2018	124054810	229506689	4043332	1613031
2019	120725299	221841860	4541102	1676624
2020	121302869	258046340	4797793	1933580
2021	121000775	270393122	4703797	2017466
2022	109806327	251289799	3669726	1817964
Trend 1990 – 2022	109%	469%	18%	-26%

Trend 2021 - 2022	-9%	-7%	-22%	-10%

Table 5.6 Domestic livestock population and its trend 1990-2022 (III)

Years	Sheep	Goats	Horses	Camels
Units	**Head**	**head**	**head**	**head**
1990	40553000	10926200	513000	2000
1991	40432340	10764198	495543	1914
1992	39415938	10453940	483290	1900
1993	37541000	10133000	450000	2000
1994	35646000	9564000	437000	2000
1995	33791336	9111000	415000	2000
1996	33072000	8951000	391000	2000
1997	30238000	8376000	345000	1400
1998	29435000	8057000	330000	1400
1999	30256000	7774000	309000	1350
2000	28492000	7201000	271000	1000
2001	26972000	7022000	271000	930
2002	25173706	6780094	248992	887
2003	25431539	6771675	227399	808
2004	25201155	6609937	212414	865
2005	25304325	6517464	207808	811
2006	25616912	6643294	204352	1004
2007	25462293	6286358	188640	1057
2008	23974591	5593561	179855	970
2009	21749508	5128285	166753	1041
2010	23089691	6293233	154702	1254
2011	25031565	7277953	151230	1290
2012	27425233	8357286	141422	1315
2013	29284247	9225548	136209	1374
2014	31140244	10344936	131480	1442
2015	31507934	10416166	122704	1543
2016	30983933	10345299	120040	1599
2017	33677636	10634672	114047	1703
2018	35194972	10922427	108076	1708
2019	37276050	11205429	102467	1651
2020	42126781	11985845	90007	1293
2021	45177690	12341514	83718	1204
2022	44687888	11577862	74359	1193

Trend 1990 – 2022	10%	6%	-86%	-40%
Trend 2021 - 2022	-1%	-6%	-11%	-1%

N excretion values

N excretion rates were taken from the IPCC 2006 Guidance. The amount of N excretion rate for dairy cattle and other dairy cattle is calculated by assuming that animals in Türkiye are the average of "Western Europe" and "Asian" animals.

Table 5.7 N excretion values for all livestock categories

Livestock	Nitrogen excretion
	[kg/animal*year]
Dairy cows	*
Other cattle	**
Buffalo	44.384
Swine average	4.10844
Layering hens	0.61
Broilers	0.8030
Turkeys	1.3505
Ducks & Geese	0.9089
Sheep	21.69414
Goats	22.50225
Horses	39.9602
Camels	36.4343

Table 5.8 N Excretion Factors

Year	N Excretion Factorsfor dairy cattle	N Excretion Factors for other cattle
1990	60.74	22.39
1991	61.82	22.97
1992	62.46	23.15
1993	63.33	23.32
1994	63.82	23.57
1995	65.43	23.84
1996	65.87	23.91
1997	66.25	23.80
1998	66.54	23.76
1999	66.93	23.85
2000	67.44	24.11
2001	67.83	24.28
2002	68.68	23.07
2003	69.13	28.38
2004	69.46	31.24
2005	70.06	31.47
2006	71.65	32.13
2007	73.06	32.88
2008	74.79	33.85
2009	75.58	34.02
2010	76.45	34.59
2011	77.46	34.84
2012	78.28	35.62
2013	78.81	35.81
2014	79.93	36.37
2015	80.49	36.73
2016	81.12	36.92
2017	82.20	36.73
2018	82.60	37.19
2019	82.50	37.25
2020	82.82	37.79
2021	83.02	37.87
2022	83.90	38.19

Animal Waste Management System (AWMS) Distribution

Differences in agricultural practices such as housing and manure management. and differences in climate have significant impacts on emissions.

Manure management system usage data of dairy. sheep. goats. horses. camel and poultry are based on expert opinion of the Ministry of Food. Agriculture and Livestock. Data for buffalo and swine was obtained from IPCC (2006). Tables 10A-5 to 10A-8.

Table 5.9 Manure management system usage: buildings and pastures

Livestock	Building	Pasture
	[%]	[%]
Dairy cows	70	30
Other cattle	70	30
Buffalo	70	30
Fattening pigs	100	0
Breeding sows	100	0
Laying hens	100	0
Broilers	100	0
Turkeys	100	0
Ducks & Geese	0	100
Sheep	40	60
Goats	20	80
Horses	40	60
Camels	40	60

Data on AWMS distribution in the buildings is country specific. based on expert judgement and information of the Ministry of Food. Agriculture and Livestock

Table 5.10 Animal waste management system distribution in the buildings

Livestock	Slurry	Solid
	[%]	**[%]**
Dairy cows	50	50
Other cattle	50	50
Buffalo	0	100
Fattening pigs	43	58
Breeding sows	43	58
Laying hens	0	100
Broilers	0	100
Turkeys	0	100
Ducks & Geese	0	100
Sheep	0	100
Goats	0	100
Horses	0	100
Camels	0	100

Ammonia emission factors and TAN proportions

NH_3 emission factors for different manure storage systems and proportions of TAN in the manure excreted are default values taken from the latest Tier 2 technology-specific approach presented in the EMEP/EEA Guidebook.

Table 5.11 NH3-N emission factors. TAN proportions and proportions stored

Livestock	System	TAN	Prop. stored	Housing	Storage	Spreading	Grazing
	Manure type	**[%]**	**[%]**	**kg NH3-N / kg TAN**	**kg NH3-N / kg TAN**	**kg NH3-N / kg TAN**	**kg NH3-N / kg TAN**
Dairy cows	slurry	60	15	0.20	0.20	0.55	0.10
	solid	60	85	0.19	0.27	0.20	0.10
Other cattle	slurry	60	15	0.20	0.20	0.55	0.06
	solid	60	85	0.19	0.27	0.79	0.06
Buffalo	slurry	50	0	0.20	0.20		
	solid	50	100	0.20	0.17	0.55	0.13
Fattening pigs	slurry	70	43	0.28	0.14	0.40	
	solid	70	58	0.27	0.45	0.81	0.25
Breeding sows	slurry	70	43	0.22	0.14	0.29	
	solid	70	58	0.25	0.45	0.81	0.25
Laying hens	slurry	70	0	-	0.14	0.69	
	solid	70	100	0.41	0.14	0.69	

Broilers	slurry	70	0	-			
	solid	70	100	0.28	0.17	0.66	
Turkeys	slurry	70	0	-			
	solid	70	100	0.35	0.24	0.54	
Ducks & Geese	slurry	70	0	-			
	solid	70	100	0.405	0.2	0.495	0.24
Sheep	slurry	50	0	-			0.10
	solid	50	100	0.22	0.28	0.90	0.10
Goats	slurry	50	0	-			0.10
	solid	50	100	0.22	0.28	0.90	0.10
Horses	slurry	60	0	-			0.10
	solid	60	100	0.22	0.35	0.90	0.10
Camels	slurry	50	0	-			0.10
	solid	50	100	0.20	0.35	0.90	0.10

The fractions of fertilizers which are stored before applicated on agricultural land are based on expert judgement and information of the experts of the Ministry of Food. Agriculture and Livestock

Default emission factors for other losses needed in the mass-flow calculation are obtained from EMEP/EEA (2010). Table 3-8.

Uncertainty

No uncertainty analyses have been carried out for this inventory

Recalculations

3.B. Manure Management

All 1990-2022 is recalculated.

Planned Improvements

N excretion rates for all animals 1990-2021 is calculated and revised with TURKSTAT technical group together work. However. pesticide calculation part sould not be achieved. Because. the new data to be collected need to have coordinated long term work. The fraction of as an example aldrin in insecticides is not known. Ministry of Agriculture and Forestry has no work started. In the future the following IIR reporting can have this complementary part. but there is no exact foreseen. Morover. Applied AWMS data reflect a first estimate which has to be further elaborated. Also number of animals. rates and whole sheet are checked by TURKSTAT on the meeting of January and February 2021 with the experts the Ministry of Environment. Urbanization. and Climate Change.There is no further meeting.

5.2 NFR 3.D Crop Production and Agricultural Soils

Emissions: NH_3. NMVOC

Key Source: Yes (NH_3 (3d1a))

Source Category Description

This source category includes emissions from synthetic fertilizer application and excreta deposited on fields by grazing animals. NO_X and SO_X emissions are reported as NA.

NH_3 emissions from manure application on agricultural soils are included in sector 3.B.

Emission Trends

NH_3 emissions from synthetic fertilizer application increased nearly by 47.9% from 97.18kt NH_3 in 1990 to 143.74 kt NH_3 in 2022. NH_3 emissions from pastured livestock increased by 73.0 % from 380.82 kt NH_3 in 1990 to 658.69 kt NH_3 in 2022.

3.D.1.a Synthetic fertilizers

Activity data

Following a recommendation of the stage 3 in-depth review under the UNECE LRTAP Convention 2012 (para 121) activity data on fertilizer use has been taken from the national statistics (TURKSTAT. eg. fertilizer statistics 2016)

Emission Factors

The Tier 1 default approach presented in the EMEP/EEA Guidebook and the default NMVOC and NH_3 emission factors have been used (EMEP/EEA revised. Table 3.xxx).

Planned Improvements

No further improvements are planned.

3 D 2 c N-excretion on pasture range and paddock unspecified

Activity Data

Official annual livestock data from the Ministry of Food. Agriculture and Livestock were used (see chapter 3.B).

Emission Factors

NH_3 emissions from grazed animals have been estimated within the calculations of sector 3.B. Default emission factors from the EMEP/EEA Guidebook revised have been used.

Planned Improvements

Improvements regarding activity data and animal waste management distribution are included in chapter 3.B ‘planned improvements.

5.3 NFR 3.F Field Burning of Agricultural Residues

The open burning of crop residue on arable land after harvesting is legally restricted by law in Türkiye. No data on illegal field burning is available.

Planned Improvements

No further improvements are planned.

6 WASTE (NFR SECTOR 5)

According to EMEP/EEA Emission Inventory Guidebook. NFR sector 5 includes subsectors as below:

5 Waste

5.A Biological Treatment of Waste: Solid Waste Disposal On Land

5.B.1 Biological Treatment of Waste: Composting

5.B.2 Biological Treatment of Waste: Anaerobic Digestion at Biogas Facilities

5.C.1.a Municipal Waste Incineration

5.C.1.b Industrial Waste Incineration Including Hazardous Waste and Sewage Sludge

5.C.1.b.iii Clinical Waste Incineration

5.C.1.b.v Cremation

5.C.2 Open Burning of Waste

5.D Wastewater Handling

5.E Other Waste

General description

According to the results of the emission inventory. emissions from waste sector mainly generates from disposal of waste and wastewater handling. In addition to this. NMVOC and NH_3 are the most significant pollutants in this sector. On the other hand. NO_x. SO_2. CO and PM_{10} are the other pollutants emitted from burning of waste in lesser amounts.

For calculating pollutant emissions. emission factors were used from EMEP/EEA Emission Inventory Guidebook 2023.

Even though one industrial waste incineration plant operates for hazardous waste exists in Türkiye. emissions from this plant could not be included in this inventory due to the lack of data.

6.1 NFR 5A Solid Waste Disposal On Land

Source Category Description

Emissions: NMVOC. TSP. PM_{10}. $PM_{2.5}$.

Key Source: Yes (NMVOC)

Emission Sources

NMVOC. TSP. PM_{10} and $PM_{2.5}$ emissions were estimated from using amount of solid waste disposal which is reported by TURKSTAT.

Major emissions from waste disposal are emissions of greenhouse gases (EMEP/EEA EMISSION INVENTORY GUIDEBOOK 2023. chapter 5.A Biological treatment of Waste-Solid waste disposal on land. page 3).

In Türkiye. by the year 2018 there are 87 landfills serving for 1134 municipalities and for 54.7 million people according to current information from Waste Management Department of MoEUCC. So, it is served 74.3 % of the Türkiye's population. Up to 2003. number of landfills was only 15 and has been increased dramatically over the years.

30110 kt of municipal solid waste have been deposited on controlled landfill sites. and 4093 kt have been deposited on dumping sites in 2022 (source: TURKSTAT). assumed to be unmanaged.

Emission Trend

- NMVOC emissions increased by about 181% from 16.69 kt in 1990 to 46.97 kt in 2022.
- Also TSP. PM_{10} and $PM_{2.5}$ emissions were calculated for this sector according to the EMEP/EEA Emission Inventory Guidebook 2023.
- TSP emissions increased from 3.53E-4 kt in 1990 to 9.94E-04 kt in 2022.
- PM_{10} emissions increased from 4.95E-03 kt in 1990 1.39E-02 kt in 2022.
- $PM_{2.5}$ emissions increased from 2.34E-3 kt in 1990 to 6.59E-3 kt in 2022.
- The increase of all emissions in this sector was mainly due to an increase in population and arising waste amounts in Türkiye and also correspondingly it was due to more secure data in this sector.

Emission trends are illustrated in Figure 6.1.

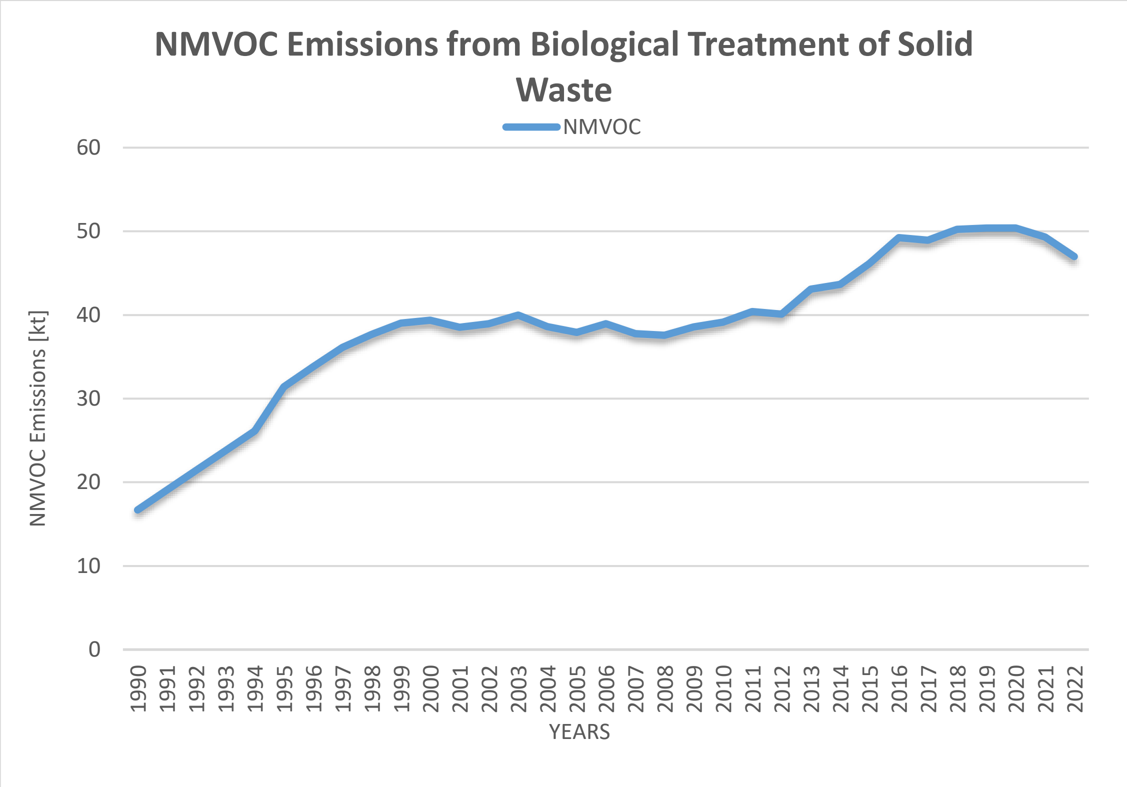

Figure 6.1 NMVOC Emissions from NFR 5.A Biological Treatment of Waste Solid Waste Disposal on Land for the Period 1990 to 2022

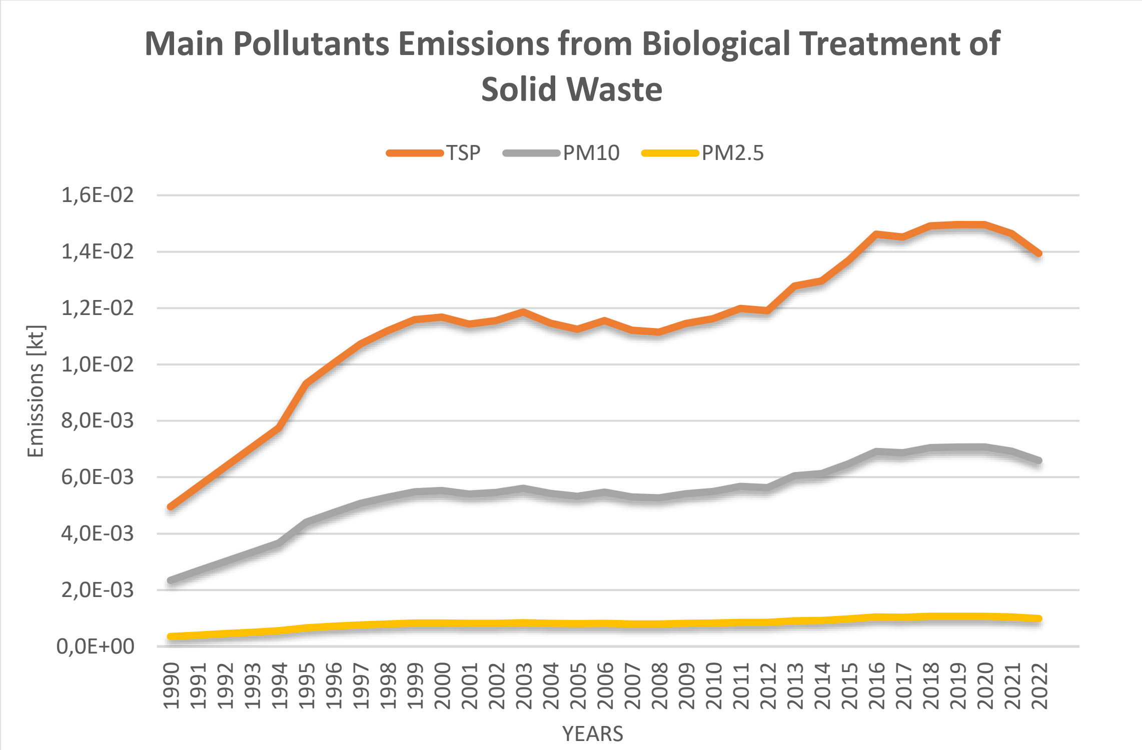

Figure 6.2 Main Pollutants Emissions from NFR 5.A Biological Treatment of Waste Solid Waste Disposal on Land for the Period 1990 to 2022

Emissions from Solid Waste Disposal on Land are presented in Table 6.1.

Table 6.1 Emissions From Sector 5.A Biological Treatment of Waste-Solid Waste Disposal On Land

Year	NMVOC	PM_{10}	$PM_{2.5}$	TSP
1990	16.69	4.95E-03	2.34E-03	3.53E-04
1991	19.05	5.66E-03	2.67E-03	4.03E-04
1992	21.42	6.36E-03	3.01E-03	4.53E-04
1993	23.78	7.06E-03	3.34E-03	5.03E-04
1994	26.14	7.76E-03	3.67E-03	5.53E-04
1995	31.41	9.32E-03	4.41E-03	6.64E-04
1996	33.81	1.00E-02	4.75E-03	7.15E-04
1997	36.13	1.07E-02	5.07E-03	7.64E-04
1998	37.70	1.12E-02	5.29E-03	7.98E-04
1999	39.03	1.16E-02	5.48E-03	8.26E-04
2000	39.35	1.17E-02	5.52E-03	8.33E-04
2001	38.51	1.14E-02	5.41E-03	8.15E-04
2002	38.93	1.16E-02	5.47E-03	8.24E-04
2003	39.98	1.19E-02	5.61E-03	8.46E-04

2004	38.62	1.15E-02	5.42E-03	8.17E-04
2005	37.92	1.13E-02	5.32E-03	8.02E-04
2006	38.94	1.16E-02	5.47E-03	8.24E-04
2007	37.78	1.12E-02	5.30E-03	7.99E-04
2008	37.56	1.11E-02	5.27E-03	7.94E-04
2009	38.57	1.14E-02	5.41E-03	8.16E-04
2010	39.15	1.16E-02	5.50E-03	8.28E-04
2011	40.40	1.20E-02	5.67E-03	8.55E-04
2012	40.10	1.19E-02	5.63E-03	8.48E-04
2013	43.07	1.28E-02	6.05E-03	9.11E-04
2014	43.66	1.30E-02	6.13E-03	9.24E-04
2015	46.15	1.37E-02	6.48E-03	9.76E-04
2016	49.26	1.46E-02	6.91E-03	1.04E-03
2017	48.92	1.45E-02	6.87E-03	1.03E-03
2018	50.24	1.49E-02	7.05E-03	1.06E-03
2019	50.39	1.50E-02	7.07E-03	1.07E-03
2020	50.40	1.50E-02	7.07E-03	1.07E-03
2021	49.33	1.46E-02	6.92E-03	1.04E-03
2022	46.97	1.39E-02	6.59E-03	9.94E-04
Trend 1990 - 2022	181.40%	181.40%	181.40%	181.40%
Trend 2021 - 2022	-4.77%	-4.77%	-4.77%	-4.77%

Methodological Issues

The applied methodology for estimation of emissions from solid waste disposal is TIER 1 and uses the general equation:

$$Emission_{NMVOC} = AD * EF_{NMVOC} / 10^6$$

Where:

$Emission_{NMVOC}$ = emissions of NMVOC for the period concerned in the inventory (kt)

AD = municipal waste (kt)

EF_{NMVOC} = emission factor of NMVOC for municipal waste (kg/ Mg)

$Emission_{TSP} = AD * EF_{TSP} / 10^9$

Where:

$Emission_{TSP}$ = emissions of TSP for the period concerned in the inventory (kt)

AD = municipal waste (kt)

EF_{TSP} = emission factor of TSP for municipal waste (g/Mg)

$Emission_{PM10} = AD * EF_{PM10} / 10^9$

Where:

$Emission_{PM10}$ = emissions of PM_{10} for the period concerned in the inventory (kt)

AD = municipal waste (kt)

EF_{PM10} = emission factor of PM_{10} for municipal waste (g/Mg)

$Emission_{PM2.5} = AD * EF_{PM2.5} / 10^9$

Where:

$Emission_{PM2.5}$ = emissions of $PM_{2.5}$ for the period concerned in the inventory (kt)

AD = municipal waste (kt)

$EF_{PM2.5}$ = emission factor of $PM_{2.5}$ for municipal waste (g/Mg)

Source of Activity Data

For calculating NMVOC. TSP. PM_{10} and $PM_{2.5}$ emissions of solid waste disposal is taken municipal solid waste disposal data. The solid waste disposal data is included total amount of "municipality's dumping site" and "waste delivered to controlled landfill site" and "burial" and "other waste". These are taken from database of waste statistics of TURKSTAT.

Source of Emission Factors

The emission factor of NMVOC. TSP. PM_{10} and $PM_{2.5}$ for biological treatment of waste-solid waste disposal on land is taken from the EMEP/EEA Emission Inventory Guidebook 2023 (TIER 1).

Emission factors are presented in Table 6.2.

Table 6.2 Emission factor (EF) used in sector 5.A Biological Treatment of Waste- Solid Waste Disposal on Land

Pollutant	Unit	EF	Reference
NMVOC	kg/Mg	1.56	EMEP/EEA (2023). Chapter 5.A Biological treatment of waste- Solid waste disposal on land. Table 3-1 Tier 1 emission factor for source category 5.A. Biological treatment of waste- Solid waste disposal on land. page 5.
TSP	g/Mg	0.463	
PM_{10}	g/Mg	0.219	
$PM_{2.5}$	g/Mg	0.033	

Uncertainty

There is no information on uncertainties in the sector specific chapter of the EMEP/EEA Emission Inventory Guidebook.

NMVOC and PM_{10} emissions are calculated using solid waste data according to Guidebook is published in 2023. The total amount of "municipality's dumping site" and "waste delivered to controlled landfill site" and "burial" and "other waste" are used for the reporting. For several years' data for municipal solid waste disposal was available from TURKSTAT. for the missing years interpolation and extrapolation was used. In addition. the calculation of several headings for waste is performed thereby used data that announced by TURKSTAT for the year of 2022. Lastly. data for the year is utilized again because data for the part is announced by TURKSTAT per two year.

Planned Improvements

As the EMEP/EEA Emission Inventory Guidebook 2023. emission of the Sector 5.A Biological treatment of Waste-Solid waste disposal on land was calculated as using data of solid waste disposal. For calculating emissions. database of waste statistic from TURKSTAT is used as activity data. But there are missing years in this waste statistic. so it was necessary to interpolate for this years. If this past data for missing years in statistic is completed. air emission inventory for this chapter can be further improved for the next year. Also. emission for the year of 2022 will be calculated again when the data for the year is announced by TURKSTAT.

6.1.1. NFR 5.C.1.a Municipal Waste Incineration

Source Category Description

Emissions: NO

Key Source: Key source analysis not carried out for this inventory.

Source of Activity Data

According to information of the Waste Management Department of the MoEUCC. there is no municipal waste incineration in operation in Türkiye between 1990 and 2021. For this reason. the emissions are reported as not occurring (NO).

Planned Improvements

Municipal wastes are usually landfilled in Türkiye. Also. incineration facilities are operated for municipal waste. It is planned that the emission calculation of the plant is added to the next report. Türkiye

6.1.2. NFR Code: 5.C.1.b Industrial Waste Incineration

Source Category Description

Emissions: NE

Source of Activity Data

There is one facility in Türkiye for incineration of hazardous industrial waste. but the activity data is not available for the whole time period. so it has not been calculated.

Other industrial plants (e.g. cement industry) are also co-incinerating industrial waste for energy purposes and should therefore be covered in the energy balance and accounted for in the energy sector.

Planned Improvements

It will be tried to obtain specific data of the one facility incinerating industrial waste. If the specific data is obtained. calculation of informative inventory is added to the next report.

6.1.3. NFR 5.C.1.b.iii Clinical Waste Incineration

Source Category Description

Emissions: NO_x. SO_2. NMVOC. CO. TSP. PM_{10}. Pb. Cd. Hg. As. Cr. Cu. Ni. PCB.

Key Source: Hg, Cd

Emission Sources

The most important pollutants from clinical waste incineration are HCl. SO_x. NO_x. NMVOC. CO. CO_2. N_2O and also heavy metals which are Pb. Cd. Hg. As. Cr. Cu Ni PCB. Carbon monoxide result when carbon in the waste is not completely oxidized to CO_2. High levels of CO normally indicate that the combustion gases were not held at a sufficiently high temperature in the presence of oxygen (O_2) for a long enough time to convert CO to CO_2. or that quenching has occurred. In addition to this. nitrogen oxides are products of all fuel/air combustion processes. NO is the primary component of NO_x; however. NO_2 and N_2O are also formed in smaller amounts. Nitrogen oxides are formed during combustion through oxidation of in the waste. and oxidation of atmospheric nitrogen. Conversion of nitrogen in the waste occurs at relatively low temperatures (less than 1090 ^{0}C) while oxidation of atmospheric nitrogen occurs at higher temperatures NO_x from hospital waste incineration is typically lower than from other waste incineration processes (EMEP/EEA Emission Inventory Guidebook 2023. Chapter 5.C.1.b.iii Clinical waste incineration. page 5).

Emission Trends

- NO_x emissions increased by about from 0.017 kt in 1990 to 0.04 kt in 2022.
- SO_2 emissions increased by about from 0.004 kt in 1990 to 0.009 kt in 2022.
- NMVOC emissions increased by about from 0.005 kt in 1990 to 0.012 kt in 2022.
- CO emissions increased by about from 0.470 tons in 1990 to 0.003 kt in 2022.
- TSP emissions increased by about from 0.129 kt in 1990 to 0.298 kt in 2022.
- PM_{10} emissions increased by about from 0.103 kt in 1990 to 0.238 kt in 2022.
- Pb emissions increased by about from 0.470 tons in 1990 to 1.085 tons in 2022.
- Cd emissions increased by about from 0.061 tons in 1990 to 0.140 tons in 2022.
- Hg emissions increased by about from 0.326 tons in 1990 to 0.753 tons in 2022.
- As emissions increased by about from 0.002 tons in 1990 to 0.004 tons in 2022.
- Cr emissions increased by about from 0.015 tons in 1990 to 0.035 tons in 2022.
- Cu emissions increased by about from 0.743 tons in 1990 to 1.715 tons in 2022.
- Ni emissions increased by about from 0.015 tons in 1990 to 0.035 tons in 2022.
- PCB emissions increased by about from 0.0002 tons in 1990 to 0.0004 tons in 2022.

The decrease of NO_x. SO_2. NMVOC. CO. TSP and PM_{10} emissions in this sector were mainly because of the decrease in the annual amount of incinerated clinical waste in Türkiye. Therefore. since all the types of pollutant emissions are calculated by the same method. they have the same trend between the years 1990 to 2022.

Some fluctuations can be observed in the time interval for 1990 to 2022 as seen in Figure 6.3 and Figure 6.4. this may be directly related to activity data. Especially for PM_{10} and TSP. fluctuations are sharper since EFs for the pollutants are biker and lead to higher emission levels. Also. fluctuations are sharper for Cu. Pb and Hg because EFs for the pollutants are biker and lead to higher emission levels for these heavy metals.

Emission trends are illustrated in Figure 6.3 and 6.4.

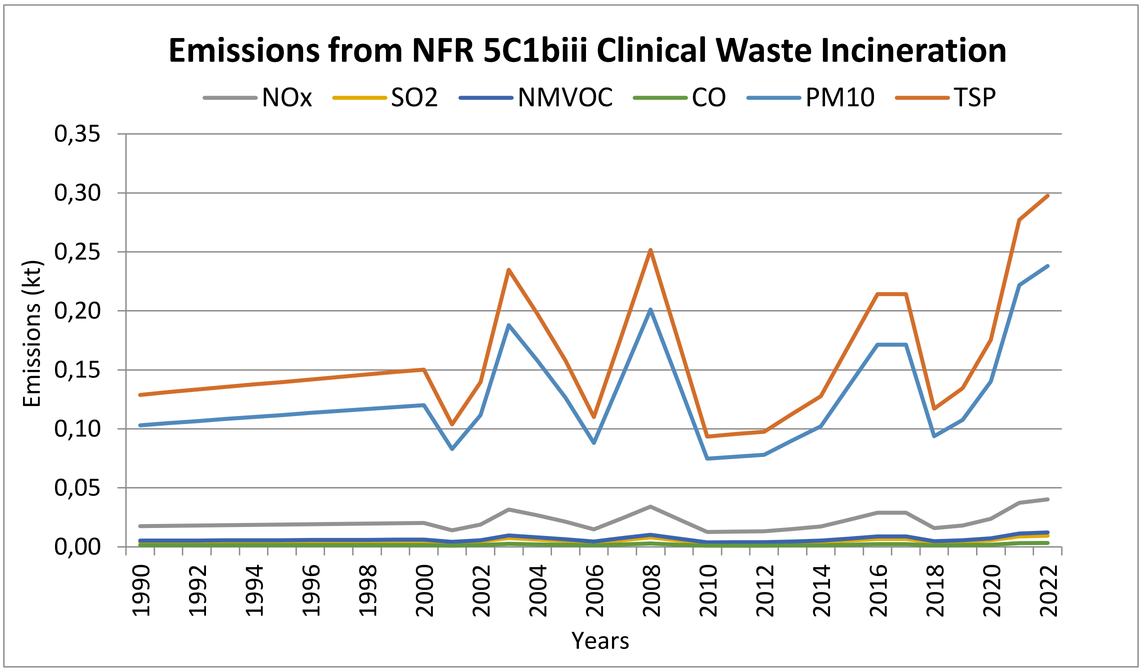

Figure 6.3 Emissions from NFR 5C1biii Clinical Waste Incineration for 1990-2022.

Emissions from clinical waste incineration are presented in Table 6.3

Table 6.3 Emissions From Sector 5C1biii Clinical Waste Incineration

Year	NO_x kt	SO_2 kt	NMVOC kt	CO kt	TSP kt	PM10 kt
1990	0.017	0.004	0.005	0.001	0.129	0.103
1991	0.018	0.004	0.005	0.001	0.131	0.105
1992	0.018	0.004	0.005	0.001	0.133	0.107
1993	0.018	0.004	0.006	0.002	0.135	0.108
1994	0.019	0.004	0.006	0.002	0.138	0.110
1995	0.019	0.004	0.006	0.002	0.140	0.112
1996	0.019	0.005	0.006	0.002	0.142	0.114
1997	0.019	0.005	0.006	0.002	0.144	0.115
1998	0.020	0.005	0.006	0.002	0.146	0.117
1999	0.020	0.005	0.006	0.002	0.148	0.119
2000	0.020	0.005	0.006	0.002	0.150	0.120
2001	0.014	0.003	0.004	0.001	0.104	0.083
2002	0.019	0.004	0.006	0.002	0.140	0.112
2003	0.032	0.007	0.010	0.003	0.235	0.188
2004	0.027	0.006	0.008	0.002	0.198	0.158
2005	0.021	0.005	0.007	0.002	0.158	0.127
2006	0.015	0.003	0.005	0.001	0.110	0.088
2007	0.024	0.006	0.007	0.002	0.181	0.145
2008	0.034	0.008	0.010	0.003	0.252	0.201
2009	0.023	0.005	0.007	0.002	0.173	0.138
2010	0.013	0.003	0.004	0.001	0.093	0.075
2011	0.013	0.003	0.004	0.001	0.096	0.076
2012	0.013	0.003	0.004	0.001	0.098	0.078
2013	0.015	0.004	0.005	0.001	0.113	0.090
2014	0.017	0.004	0.005	0.001	0.128	0.102
2015	0.023	0.005	0.007	0.002	0.171	0.137
2016	0.029	0.007	0.009	0.002	0.214	0.171
2017	0.029	0.007	0.009	0.002	0.214	0.171
2018	0.016	0.004	0.005	0.001	0.117	0.094
2019	0.018	0.004	0.006	0.002	0.134	0.108
2020	0.024	0.006	0.007	0.002	0.175	0.140
2021	0.037	0.009	0.011	0.003	0.277	0.222
2022	0.040	0.009	0.012	0.003	0.298	0.238
Trend 1990 - 2022	130.84%	130.84%	130.84%	130.84%	130.84%	130.84%
Trend 2021 - 2022	7.36%	7.36%	7.36%	7.36%	7.36%	7.36%

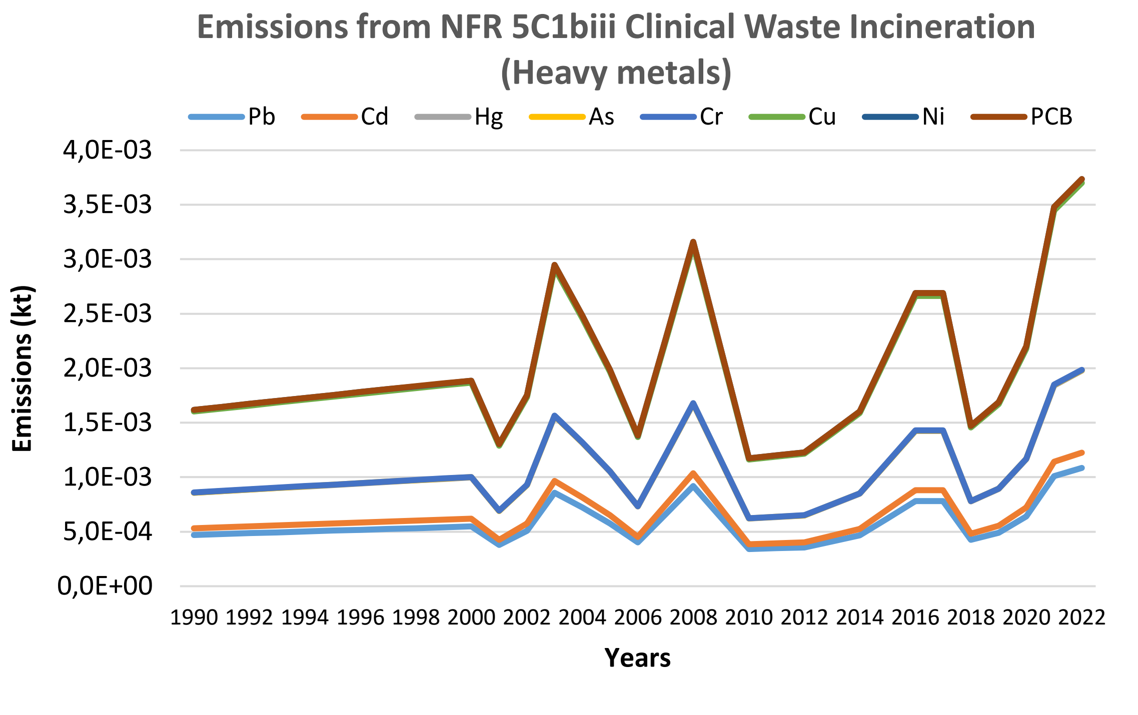

Figure 6.4 Heavy Metal Emissions from Clinical Waste Incineration (kt)

Table 6.4 Heavy Emissions From Sector 5C1biii Clinical Waste Incineration (Tons)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	PCB
1990	0.4701	0.0607	0.3261	0.0015	0.0152	0.7431	0.0152	0.0002
1991	0.4781	0.0617	0.3316	0.0015	0.0154	0.7557	0.0154	0.0002
1992	0.4860	0.0627	0.3371	0.0016	0.0157	0.7683	0.0157	0.0002
1993	0.4940	0.0637	0.3426	0.0016	0.0159	0.7808	0.0159	0.0002
1994	0.5018	0.0648	0.3480	0.0016	0.0162	0.7932	0.0162	0.0002
1995	0.5097	0.0658	0.3535	0.0016	0.0164	0.8056	0.0164	0.0002
1996	0.5175	0.0668	0.3589	0.0017	0.0167	0.8179	0.0167	0.0002
1997	0.5252	0.0678	0.3643	0.0017	0.0169	0.8302	0.0169	0.0002
1998	0.5328	0.0687	0.3695	0.0017	0.0172	0.8421	0.0172	0.0002
1999	0.5404	0.0697	0.3748	0.0017	0.0174	0.8543	0.0174	0.0002
2000	0.5480	0.0707	0.3801	0.0018	0.0177	0.8662	0.0177	0.0002
2001	0.3784	0.0488	0.2624	0.0012	0.0122	0.5981	0.0122	0.0001
2002	0.5090	0.0657	0.3530	0.0016	0.0164	0.8046	0.0164	0.0002
2003	0.8564	0.1105	0.5940	0.0028	0.0276	1.3537	0.0276	0.0003
2004	0.7212	0.0931	0.5002	0.0023	0.0233	1.1399	0.0233	0.0002
2005	0.5768	0.0744	0.4001	0.0019	0.0186	0.9118	0.0186	0.0002
2006	0.4014	0.0518	0.2784	0.0013	0.0129	0.6345	0.0129	0.0001
2007	0.6595	0.0851	0.4574	0.0021	0.0213	1.0425	0.0213	0.0002
2008	0.9177	0.1184	0.6364	0.0030	0.0296	1.4505	0.0296	0.0003
2009	0.6296	0.0812	0.4367	0.0020	0.0203	0.9952	0.0203	0.0002
2010	0.3409	0.0440	0.2364	0.0011	0.0110	0.5388	0.0110	0.0001

2011	0.3485	0.0450	0.2417	0.0011	0.0112	0.5509	0.0112	0.0001
2012	0.3562	0.0460	0.2470	0.0011	0.0115	0.5630	0.0115	0.0001
2013	0.4111	0.0530	0.2851	0.0013	0.0133	0.6497	0.0133	0.0001
2014	0.4659	0.0601	0.3231	0.0015	0.0150	0.7365	0.0150	0.0002
2015	0.6231	0.0804	0.4322	0.0020	0.0201	0.9849	0.0201	0.0002
2016	0.7812	0.1008	0.5418	0.0025	0.0252	1.2348	0.0252	0.0003
2017	0.7812	0.1008	0.5418	0.0025	0.0252	1.2348	0.0252	0.0003
2018	0.4271	0.0551	0.2962	0.0014	0.0138	0.6750	0.0138	0.0001
2019	0.4904	0.0633	0.3401	0.0016	0.0158	0.7752	0.0158	0.0002
2020	0.6394	0.0825	0.4435	0.0021	0.0206	1.0107	0.0206	0.0002
2021	1.0109	0.1304	0.7011	0.0033	0.0326	1.5978	0.0326	0.0003
2022	1.0853	0.1400	0.7527	0.0035	0.0350	1.7154	0.0350	0.0004
Trend 1990 - 2022	130.84 %	130.84 %	130.84 %	130.84 %	130.84 %	130.84 %	130.84 %	130.84 %
Trend 2021 - 2022	7.36%	7.36%	7.36%	7.36%	7.36%	7.36%	7.36%	7.36%

Methodological Issues

The applied methodology is TIER 1. which is an approach for process emissions from clinical waste incineration and uses the general equation:

$$Emission_{pollutant} = AD * EF_{pollutant} / 10^3$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD = clinical waste (kt)

$EF_{pollutant}$ = emission factor of pollutant i for clinical waste (kg/Mg)

For calculating pollutant emissions of this sector. annual amount of clinical waste is used as activity data. These are taken from database of waste statistics of TURKSTAT (Waste statistics V.2).

Source of Activity data

The amount of clinical waste incineration was taken from the clinical statistic database of TURKSTAT.

Source of Emission Factors

The emission factors for all pollutants for clinical waste incineration are taken from the EMEP/EEA Emission Inventory Guidebook 2023 (TIER 1).

Table 6.5 Emission Factor (EF) Used In Sector 5C1biii Clinical Waste Incineration

Pollutant	Unit	EF	Reference
NO_x	kg / Mg waste	2.3	EMEP/EEA (2023). Chapter 5.C.1.b.iii Clinical waste incineration. Table 3-1 Tier 1 emission factors for source category 5.C.1.b.iii Clinical waste incineration. page 8
SO_2		0.19	
NMVOC		0.7	
CO		0.54	
PM_{10} *		14*	
Pb	g / Mg waste	62	EMEP/EEA (2023). Chapter 5.C.1.b.iii Clinical waste incineration. Table 3-1 Tier 1 emission factors for source category 5.C.1.b.iii Clinical waste incineration. page 8
Hg		43	
As		0.02	
Cr		2	
Cu		98	
Ni		2	
PCB		0.02	

- Assumption: PM_{10} = 80 % of TSP

Uncertainty

There is no information on uncertainties in the EMEP/EEA Emission Inventory Guidebook 2023.

For the year 2022 same value with 2021 is taken because of lack of data on clinical waste. TURKSTAT has no announcement for 2022 data for the calculation of clinical waste. Data for the year is utilized again because data for that part is announced by TURKSTAT per two years.

Planned Improvements

There are improvements that can be made to the above emission estimates. Some of the activity data is incomplete across the time series. The calculation of emission will be performed for the year of 2022 when the data is announced by TURKSTAT for the year. Also. emission for the year of 2022 will be calculated again when the data for the year is announced by TURKSTAT.

6.2 NFR Code: 5.C.1.b.v Cremation

Source Category Description

Emissions: NO

Key Source: Key source analysis not carried out for this inventory.

Source of Activity Data

Cremation does not occur in Türkiye. and emissions are therefore reported as NO.

6.3 NFR Code: 5.C.2 Open Burning Of Waste- Small-Scale Waste Burning

Source Category Description

Emissions: NMVOC. CO. $PM_{10.}$ SO_2. TSP. $PM_{2.5}$. NO_x. Cr. Cu. Zn. As. Se. Pb. Cd.

Key Source: Cd

Source of Activity Data

Activity data were taken from TURKSTAT. whereby missing years were interpolated.

Source of Emission Factors

Default emission factors (TIER 1) were taken from the EMEP/EEA Emission Inventory Guidebook 2023. Chapter 5.C.2 Open burning of waste for NMVOC. CO. SO_2. NO_X. TSP. PM_{10}. $PM_{2.5}$. Cr. Cu. Zn. As. Se. Pb and Cd. Emission factors are constant for the whole time series.

Emission Sources

Emissions from this sector are due to open waste burning. which is reported by TURKSTAT. It is not clearly known which type of waste is included here under.

One of the main concerns regarding agricultural waste combustion is the emission of smoke/particulates. Since the combustion is usually slow and inefficient. emissions of CO and VOCs are more significant than emissions of NO_x. (EMEP/EEA Emission Inventory Guidebook 2023. Chapter 5. C.2. Open burning of waste. page 4).

Emission Trends

- CO emissions decreased from 2.4E-2 kt in 1990 to 4.9E-4 kt in 2022.
- NO_x emissions decreased from 1.3E-3 kt in 1990 to 2.8E-4 kt in 2022.
- SO_2 emissions decreased from 4.7E-5 kt in 1990 to 9.6E-7 kt in 2022.
- NMVOC emissions from 5.2E-4 kt in 1990 to 1.1E-5 kt in 2022.
- TSP emissions from 2.0E-3 kt in 1990 to 4.0E-5 kt in 2022.
- PM_{10} emissions from 1.9E-3 kt in 1990 to 3.9E-5 kt in 2022.
- $PM_{2.5}$ emissions from 1.8E-3 kt in 1990 to 3.6E-5 kt in 2022.

- Cr emissions from 0.0042 tons in 1990 to 0.0001 tons in 2022.
- Cu emissions from 0.0848 tons in 1990 to 0.0017 tons in 2022.
- Zn emissions from 7.4310 tons in 1990 to 0.1525 tons in 2022.
- As emissions from 0.1738 tons in 1990 to 0.0036 tons in 2022.
- Se emissions from 0.0297 tons in 1990 to 0.0006 tons in 2022.
- Pb emissions from 0.2077 tons in 1990 to 0.0043 tons in 2022.
- Cd emissions from 0.0424 tons in 1990 to 0.0009 tons in 2022.

All emissions were calculated for this sector according to the EMEP/EEA Emission Inventory Guidebook 2023. Since all the types of pollutant emissions are calculated by the same method. they have the same trend between the years 1990 to 2022.

Some fluctuations can be observed in the time interval for 1990 to 2022 as seen in Figure 6.5. and this may be directly related to activity data. Especially for CO. fluctuations are sharper since EFs for the pollutants are bikter and lead to higher emission levels.

Emission trends are illustrated in Figure 6.5 and emissions are presented Table 6.6.

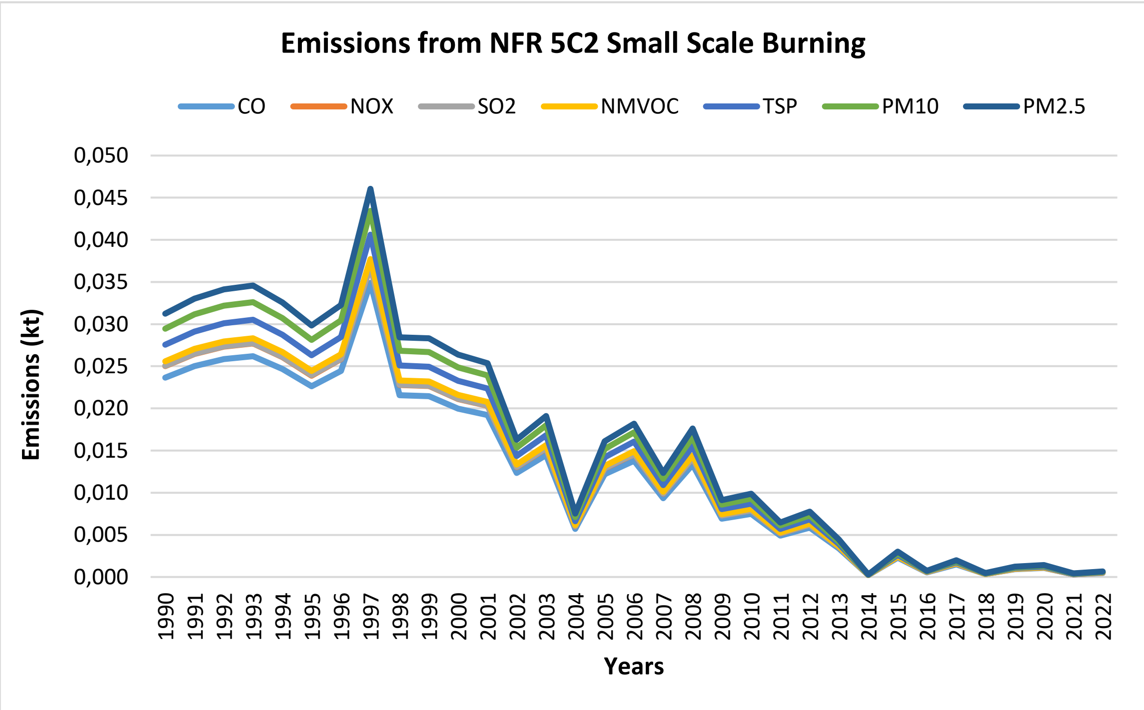

Figure 6.5 Emissions from NFR 5C2 Small-Scale Waste Burning For 1990-2022

Emissions from small scale burning are presented in Table 6.6

Table 6.6 Emissions from sector 5C2 Small-scale waste burning

Year	CO	NO_X	SO_2	NMVOC	TSP	PM_{10}	$PM_{2.5}$
	kt	kt	kt	kt	kt	kt	kt
1990	2.4E-02	1.3E-03	4.7E-05	5.2E-04	2.0E-03	1.9E-03	1.8E-03
1991	2.5E-02	1.4E-03	4.9E-05	5.5E-04	2.1E-03	2.0E-03	1.9E-03
1992	2.6E-02	1.5E-03	5.1E-05	5.7E-04	2.1E-03	2.1E-03	1.9E-03
1993	2.6E-02	1.5E-03	5.2E-05	5.8E-04	2.2E-03	2.1E-03	2.0E-03
1994	2.5E-02	1.4E-03	4.9E-05	5.4E-04	2.1E-03	2.0E-03	1.9E-03
1995	2.3E-02	1.3E-03	4.5E-05	5.0E-04	1.9E-03	1.8E-03	1.7E-03
1996	2.4E-02	1.4E-03	4.8E-05	5.4E-04	2.0E-03	2.0E-03	1.8E-03
1997	3.5E-02	2.0E-03	6.9E-05	7.7E-04	2.9E-03	2.8E-03	2.6E-03
1998	2.2E-02	1.2E-03	4.2E-05	4.7E-04	1.8E-03	1.7E-03	1.6E-03
1999	2.1E-02	1.2E-03	4.2E-05	4.7E-04	1.8E-03	1.7E-03	1.6E-03
2000	2.0E-02	1.1E-03	3.9E-05	4.4E-04	1.7E-03	1.6E-03	1.5E-03
2001	1.9E-02	1.1E-03	3.8E-05	4.2E-04	1.6E-03	1.6E-03	1.4E-03
2002	1.2E-02	7.0E-04	2.4E-05	2.7E-04	1.0E-03	1.0E-03	9.3E-04
2003	1.4E-02	8.2E-04	2.8E-05	3.2E-04	1.2E-03	1.2E-03	1.1E-03
2004	5.7E-03	3.2E-04	1.1E-05	1.3E-04	4.7E-04	4.6E-04	4.3E-04
2005	1.2E-02	6.9E-04	2.4E-05	2.7E-04	1.0E-03	9.9E-04	9.2E-04
2006	1.4E-02	7.9E-04	2.7E-05	3.0E-04	1.1E-03	1.1E-03	1.0E-03
2007	9.4E-03	5.3E-04	1.8E-05	2.1E-04	7.8E-04	7.6E-04	7.0E-04
2008	1.3E-02	7.6E-04	2.6E-05	2.9E-04	1.1E-03	1.1E-03	1.0E-03
2009	6.9E-03	3.9E-04	1.4E-05	1.5E-04	5.7E-04	5.6E-04	5.2E-04
2010	7.5E-03	4.3E-04	1.5E-05	1.6E-04	6.2E-04	6.0E-04	5.6E-04
2011	4.9E-03	2.8E-04	9.7E-06	1.1E-04	4.1E-04	4.0E-04	3.7E-04
2012	5.9E-03	3.3E-04	1.2E-05	1.3E-04	4.9E-04	4.7E-04	4.4E-04
2013	3.4E-03	1.9E-04	6.7E-06	7.4E-05	2.8E-04	2.7E-04	2.5E-04
2014	2.2E-04	1.3E-05	4.4E-07	4.9E-06	1.9E-05	1.8E-05	1.7E-05
2015	2.3E-03	1.3E-04	4.5E-06	5.0E-05	1.9E-04	1.8E-04	1.7E-04
2016	5.6E-04	3.2E-05	1.1E-06	1.2E-05	4.6E-05	4.5E-05	4.2E-05
2017	1.5E-03	8.6E-05	3.0E-06	3.3E-05	1.3E-04	1.2E-04	1.1E-04
2018	3.4E-04	1.9E-05	6.7E-07	7.5E-06	2.8E-05	2.8E-05	2.6E-05
2019	9.2E-04	5.2E-05	1.8E-06	2.0E-05	7.7E-05	7.4E-05	6.9E-05
2020	1.1E-03	6.0E-05	2.1E-06	2.3E-05	8.8E-05	8.6E-05	8.0E-05
2021	3.1E-04	1.8E-05	6.2E-07	6.9E-06	2.6E-05	2.5E-05	2.4E-05
2022	4.9E-04	2.8E-05	9.6E-07	1.1E-05	4.0E-05	3.9E-05	3.6E-05
Trend 1990 - 2022	-97.95%	-97.95%	-97.95%	-97.95%	-97.95%	-97.95%	-97.95%

Trend 2021 - 2022	54.26%	54.26%	54.26%	54.26%	54.26%	54.26%	54.26%

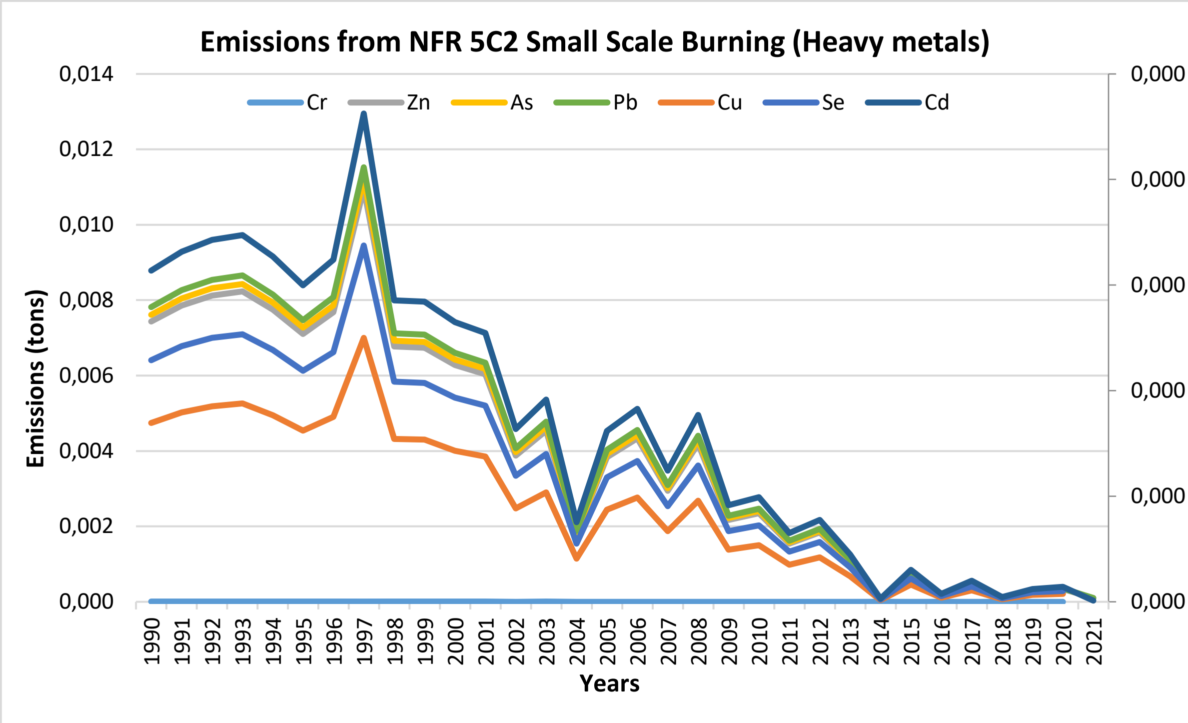

Figure 6.6 Heavy Metal Emissions from NFR 5C2 Small-Scale Waste Burning For 1990-2022

Table 6.7 Heavy Metal Emissions from sector 5C2 Small-scale waste burning

Year	Cr	Cu	Zn	As	Se	Pb	Cd
	tons	tons	tons	tons	tons	tons	tons
1990	0.0042	0.0848	7.4310	0.1738	0.0297	0.2077	0.0424
1991	0.0045	0.0897	7.8582	0.1838	0.0314	0.2197	0.0448
1992	0.0046	0.0926	8.1204	0.1899	0.0324	0.2270	0.0463
1993	0.0047	0.0939	8.2284	0.1924	0.0329	0.2300	0.0469
1994	0.0044	0.0884	7.7483	0.1812	0.0309	0.2166	0.0442
1995	0.0041	0.0810	7.0997	0.1661	0.0284	0.1985	0.0405
1996	0.0044	0.0876	7.6781	0.1796	0.0307	0.2146	0.0438
1997	0.0063	0.1250	10.9563	0.2563	0.0438	0.3063	0.0625
1998	0.0039	0.0772	6.7666	0.1583	0.0270	0.1891	0.0386
1999	0.0038	0.0768	6.7327	0.1575	0.0269	0.1882	0.0384
2000	0.0036	0.0716	6.2747	0.1468	0.0251	0.1754	0.0358
2001	0.0034	0.0688	6.0303	0.1410	0.0241	0.1686	0.0344
2002	0.0022	0.0442	3.8741	0.0906	0.0155	0.1083	0.0221
2003	0.0026	0.0518	4.5403	0.1062	0.0181	0.1269	0.0259
2004	0.0010	0.0204	1.7881	0.0418	0.0071	0.0500	0.0102
2005	0.0022	0.0437	3.8301	0.0896	0.0153	0.1071	0.0218
2006	0.0025	0.0494	4.3299	0.1013	0.0173	0.1210	0.0247
2007	0.0017	0.0335	2.9400	0.0688	0.0117	0.0822	0.0168
2008	0.0024	0.0478	4.1897	0.0980	0.0167	0.1171	0.0239
2009	0.0012	0.0248	2.1693	0.0507	0.0087	0.0606	0.0124
2010	0.0013	0.0268	2.3490	0.0549	0.0094	0.0657	0.0134
2011	0.0009	0.0176	1.5409	0.0360	0.0062	0.0431	0.0088
2012	0.0011	0.0210	1.8407	0.0431	0.0074	0.0515	0.0105
2013	0.0006	0.0121	1.0599	0.0248	0.0042	0.0296	0.0060
2014	0.0000	0.0008	0.0701	0.0016	0.0003	0.0020	0.0004
2015	0.0004	0.0081	0.7136	0.0167	0.0028	0.0199	0.0041
2016	0.0001	0.0020	0.1753	0.0041	0.0007	0.0049	0.0010
2017	0.0003	0.0054	0.4724	0.0110	0.0019	0.0132	0.0027
2018	0.0001	0.0012	0.1075	0.0025	0.0004	0.0030	0.0006
2019	0.0002	0.0033	0.2891	0.0068	0.0012	0.0081	0.0016
2020	0.0002	0.0038	0.3335	0.0078	0.0013	0.0093	0.0019
2021	0.0001	0.0011	0.0989	0.0023	0.0004	0.0028	0.0006
2022	0.0001	0.0017	0.1525	0.0036	0.0006	0.0043	0.0009
Trend 1990 - 2022	-97.95%	-97.95%	-97.95%	-97.95%	-97.95%	-97.95%	97.95%

Trend 2021 - 2022	54.26%	54.26%	54.26%	54.26%	54.26%	54.26%	54.26%

Heavy metal emissions from small scale burning are presented in Table 6.7

Methodological Issues

The applied methodology is TIER 1. which is an approach for process emissions from municipal waste incineration and uses the general equation:

$$Emission_{pollutant} = AD * EF_{pollutant} / 10^3$$

Where:

$Emission_{pollutant}$ = emissions of pollutant i for the period concerned in the inventory (kt)

AD = municipal waste (burning in an open area) (kt)

$EF_{pollutant}$ = emission factor of pollutant i for municipal waste (kg/Mg)

For calculating pollutant emissions of this sector. annual amount of open burnt waste is used as activity data. These are taken from database of waste statistics of TURKSTAT (Waste statistics V.2).

Source of Emission Factors

The emission factors for all pollutants for open waste burning are taken from the EMEP/EEA Emission Inventory Guidebook 2023 (TIER 1). Emission factors are presented in Table 6.7.

Table 6.8 Emission factor (EF) used in sector 5.C2. Small-scale waste burning

Pollutant	Unit	EF	Reference
NO_x	kg / Mg waste	3.18	EMEP/EEA (2023). Chapter 5.C.2 Open burning of waste Table 3-1 Tier 1 emission factors for source category 5.C.2 Small-scale waste burning. page 6
NMVOC		1.23	
PM_{10}		4.51	
SO_2		0.11	
CO		55.83	
TSP		4.64	
$PM_{2.5}$		4.19	
Cr	g / Mg waste	0.01	EMEP/EEA (2023). Chapter 5.C.2 Open burning of waste Table 3-1 Tier 1 emission factors for source category 5.C.2 Small-scale waste burning. page 6
Zn		17.53	
As		0.41	
As		0.41	
Se		0.07	
Pb		0.49	
Cd		0.10	

Uncertainty

There is no information on uncertainties in the EMEP/EEA Emission Inventory Guidebook.

6.4 NFR 5D Wastewater Handling

Source Category Description

Emissions: NMVOC. NH_3

Key Source: No

Emission Sources

In urban areas wastewater treatment plants results in the formation of NMVOC emissions. In general. air emissions of NMVOC. CO and NH_3 occur from wastewater treatment plants. but are mostly insignificant for national total emissions. (EMEP/EEA Emission Inventory Guidebook 2023. chapter 5D Wastewater handling. page 3).

In 2020. there are 60 physicals, 593 biological, 223 advanced and 192 natural wastewater treatment plants in Türkiye which corresponds to a rate of 91% as population served by sewerage system in total population (Main Wastewater Indicators of Municipalities. 1994-2020. TURKSTAT).

By the way according to information of the Water and Soil Management Department of the MoEUCC. there are 976 domestic wastewater treatment plants in Türkiye since December 2016

5.D. Wastewater Handling sector didn't take place at "NFR 14 Reporting Template". therefore, emission of 5.D Wastewater Handling is reported as 5.D.1 Sector at "NFR 14 Reporting Template".

Emission Trends

NMVOC emissions increased from 1.1E-6 kt in 1990 to 6.9E-5 kt in 2022. The huge increase of NMVOC emissions in this sector was mainly due to the high increase in amount of wastewater treated in Türkiye.

NH_3 emissions decreased from 82.139 kt to 17.79 kt by -78.34% between 1990 and 2022. The main reason for this decrease is that the number of people connected to the sewerage system is constantly increasing and population using latrines is decreasing as well.

Emission trends are illustrated in Figure 6.4 and Table 6.6.

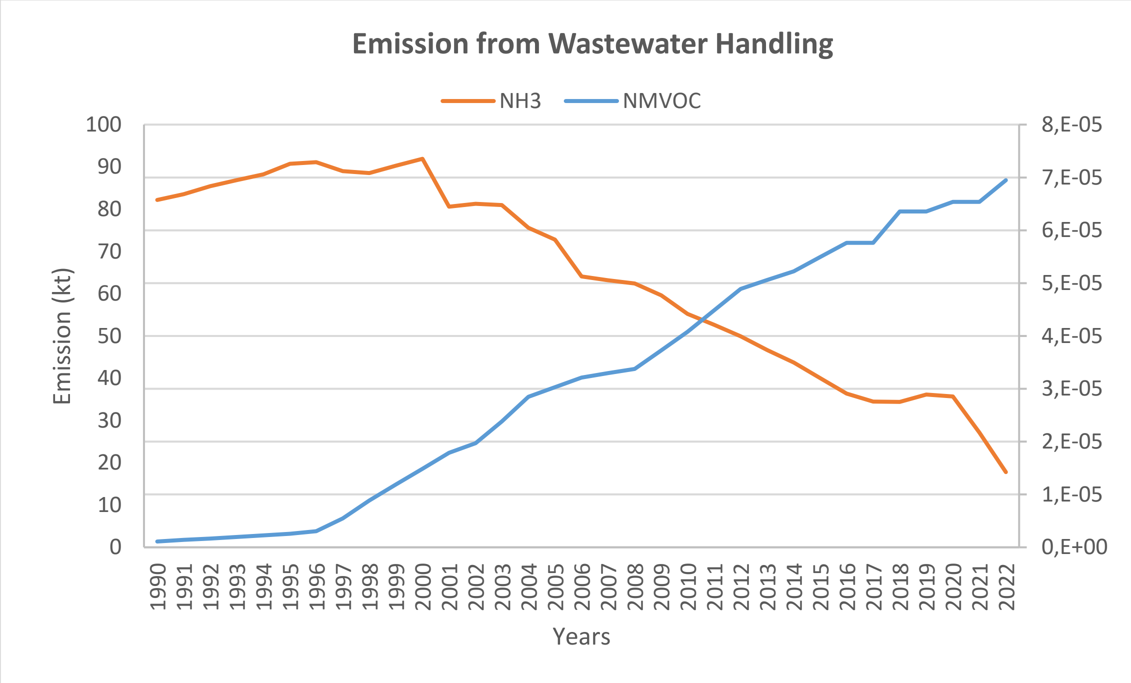

Figure 6.7 Emissions from NFR 5.D Wastewater Handling for 1990-2022.

Emissions from Wastewater Handling are presented in Table 6.9

Table 6.9 Emissions from Sector 5.D Wastewater Handling

Years	NMVOC	NH_3
	kt	kt
1990	1.1E-06	82.139
1991	1.4E-06	83.530
1992	1.7E-06	85.469
1993	2.0E-06	86.859
1994	2.3E-06	88.255
1995	2.5E-06	90.756
1996	3.0E-06	91.098
1997	5.5E-06	88.964
1998	8.8E-06	88.540
1999	1.2E-05	90.304
2000	1.5E-05	91.914
2001	1.8E-05	80.612
2002	2.0E-05	81.304
2003	2.4E-05	80.932
2004	2.9E-05	75.585
2005	3.0E-05	72.822

2006	3.2E-05	64.074
2007	3.3E-05	63.209
2008	3.4E-05	62.398
2009	3.7E-05	59.643
2010	4.1E-05	55.217
2011	4.5E-05	52.681
2012	4.9E-05	49.889
2013	5.1E-05	46.682
2014	5.2E-05	43.695
2015	5.5E-05	40.013
2016	5.8E-05	36.359
2017	5.8E-05	34.468
2018	6.4E-05	34.361
2019	6.4E-05	36.111
2020	6.5E-05	35.714
2021	6.5E-05	27.126
2020	6.9E-05	17.790
Trend 1990-2021	6231.04%	-78.34%
Trend 2020-2021	32.95%	-59.29%

Methodological Issues

The applied methodology is TIER 2. which is an approach for process emissions from wastewater handling and uses the general equations:

$$Emission_{NMVOC} = AD * EF_{NMVOC} / 10^9$$

Where:

$Emission_{NMVOC}$ = emissions of NMVOC for the period concerned in the inventory (kt)

AD = wastewater treated (1000 m^3)

EF_{NMVOC} = emission factor of NMVOC for wastewater (mg/m^3)

$$Emission_{NH3} = AD * EF_{NH3} / 10^6$$

Where:

$Emission_{NH3}$	=	emissions of NH_3 for the period concerned in the inventory (kt)
AD	=	population not on sewerage system (latrine users) (million people)
EF_{NH3}	=	emission factor of NH_3 for wastewater (kg/person/year)

Source of Activity Data

For calculating NMVOC emissions. the volume (m^3) of wastewater is used as activity data. These are taken from database of waste statistics of TURKSTAT. whereby missing years were interpolated.

For calculating NH_3 emissions. number of people not served by sewerage system is subtracted from total population for Türkiye and were used to derive activity data. The total population data were taken from statistics of EUROSTAT, but the data of municipal population served by sewerage system was taken from waste statistics of TURKSTAT.

Source of Emission Factors

A default emission factor for NMVOC emissions from wastewater handling has been derived from a Turkish study (Atasoy et al..2004) (Table 3-1. Tier 1) The emission factor of NH_3 for waste-water handling is taken from the EMEP/EEA Emission Inventory Guidebook 2023 (TIER 2).

Table 6.10 Emission Factor (EF) Used In Sector 5.D Wastewater Handling

Pollutant	Unit	EF	Reference
NMVOC	mg/m^3 wastewater handled	15	EMEP/EEA (2023). Chapter 5D Wastewater handling. Table 3-1. Tier 1 emission factor for NFR source category 5D. Wastewater handling. latrines page 7
NH_3	kg/person/year	1.6	EMEP/EEA (2023). Chapter 5D Wastewater handling. Table 3-2 Tier 2 emission factor for NFR source category 5D. Wastewater handling. latrines page 8

Uncertainty

There is no information on uncertainties in the EMEP/EEA Emission Inventory Guidebook.

6.5 NFR.5E Other Waste

Source Category Description

Emissions: NA

Source of Activity Data

Generally. under this category composting of waste is reported. but due to information received from the Waste Management Department of MoEUCC currently there isn't any composting plant in Türkiye. But further investigations are necessary together with TURKSTAT on this subject.

Planned Improvements

If specific data about other waste can be obtained. contribution of this sector can be calculated and evaluated in the next coming years. Also it should be clarified together with TURKSTAT where the reported data for composting waste is coming from and whether it is reliable or not.

7. OTHER AND NATURAL EMISSIONS

Forest Fires: No emission estimates have been made for this source because no activity data could be sourced. However, it may be that information is available. and could be incorporated into the inventory in the future.

NMVOC Emissions from Forests: No emission estimates of NMVOCs from forests have been included in the emission inventory. National estimates may exist, and studies will be checked for integrating in the inventory in the future.

8 RECALCULATIONS AND IMPROVEMENTS

8.1. Recalculations

Recalculations have been carried out under the categories of energy. aviation sector.

Recalculations were applied for aviation category due to the new dataet from the Ministry of Transport and Infrastructure.

Also there is a recalculation due to the revision of the energy balance tables within the Ministry of Energy and Natural Resources specified at the official statistics web page. Due to the revision of the energy balances 1A2 category were recalculated. The sub-category data for 1A2 sectors’ information. both calculations and recalculations are revised.

Recalculations were applied due to the revision of the number of LTO’s per aircraft type. These recalculations have been done for the years 2017-2020. For cruise aviation category, domestic cruise fuel was recalculated for the years 2010-2020 due to revision of the domestic cruise fuel.

Other areas which are prioritized previously will be tried to be integrated in the future submissions by the contributing effect of the Air Emission Management- HEY Portal and the recalculations will be added.

During the Stage 3 Review in Vienna 2022organised for PM condensable. covering especially residential heating and road transport; for the revised submission including the Recommendation of the Review Team of Experts. the time is not enough as foreseen. The recommendation and the higher Tier re-calculation will be finalized in the reporting of 2024. Additionally for the road transport calculations country specific software’s data is analysed for better integration. The results will be added for next years’ submission.

8.2. Planned improvements

Planned improvements are listed below based on pollutants and NFR sector.

8.2.1. Improving Data Provision and Consistency

The presence of institutional barriers to the exchange of information between Ministries significantly hampers the process of inventory compilation and detracts from its potential accuracy and completeness. The same comments apply to the process of preparing emission projections. ERT recommendations will be apllied within national circumstances covering the scientific background and requirements.

8.2.2. Major Improvements for Specific Pollutants

NO_x emissions: Obtaining reliable point source data is the highest priority for improving the NO_X emission estimates. The questionnaires which were previously. are planned to be used in next submissions.

NMVOC emissions: Improvements should focus on developing a more country-specific method for estimating emissions from solvent use. and checking that the generic emission factors used for residential wood combustion are appropriate.

SO_2 emissions: Improving the data sets for (i) the sulphur content of fuels (lignite especially) (ii) the extent to which flue gas desulphurisation plant is installed and (iii) the operational performance of such plant are the highest priority for improving SO_2 emission estimates. Comprehensive and reliable emissions data for large point-sources (electricity generation and other large scale industrial combustion plants) would significantly reduce the uncertainty of SO_2 emission estimates. The data obtained from the facilities to calculate specific EFs will be studied and integrated to the inventory in the next submissions.

NH_3 emissions: The methodology applied to derive these estimates used a combination of country specific data. default data from the literature and expert judgement. There are some important parameters in the methodology. such as N excretion from livestock. where the use of country-specific data would bring a significant improvement.

$PM_{2.5}$ emissions: After the recommendations of the ERT by the in-depth reviews. the emission calculations are added step by step for each submission annually for selected sectors. The NFR categories will be completed continuously.

8.2.3. Improvements for Specific NFR Sectors

Stationary Combustions Sources: A number of improvements that can be made to the emission calculations:

- This source sector makes a large contribution to several pollutants. It is therefore important to use an accurate calculation methodology. Presently a simple Tier 1 method is used primarily with default emission factors from the GB. This is not sufficiently reliable. and improvements are a high priority (and probably the most important improvement to make in the entire inventory). Region by region the facility-based data will be added to the inventory and the stationary combustions properties of national profile will be presented more accurate in the future submissions. The recommendations of the ERT from the review of 2022 Stage 3. the revision will be available for 2024.
- NFR 1B category will be calculated and included for next submissions.

Mobile Machinery: There are several NFR categories where emissions from mobile machinery are reported. However. for this emissions inventory. all are reported as IE. This is because the energy balance tables do not resolve the fuel used in a sector into stationary and mobile. and consequently, emissions from all mobile machinery is considered to be included in the corresponding stationary source sector. By the EMISSION project this issue will be studied for more valuable assumptions for Türkiye.

8.3. Preparation of a Continuous Improvement Programme

Continuous Improvement Programme has not been prepared. It is planned to discuss improvement programme in the working group of Air Management under Co-Board.

Within the results of the EMISSION project mentioned in the previous sectors. the continuous improvement steps of the new network will be planned to be used.

The in-depth reviews executed under the TFEIP are very important for Türkiye. The findings underlined in the reports of the ERT are our key steps for our continuous improvement programme to be followed.

Therefore, the points written and underlined with special importance in the Stage-3 report will be taken into account. The list of these findings’ explanations is given below:

- ✓ Full source descriptions will be analysed to be integrated for all years respectively.
- ✓ The activity data integration in the reporting of the NFR template will be analysed within the ministry to be decided by the high-level representatives.
- ✓ Fugitive emissions and geothermal category and the others which are present in Türkiye and noted in the 2nd stage-3 review findings will be analysed respectively.
- ✓ The missing pollutants in the NFR template will be studied to be covered. In the short term they will be tried to be calculated with expert assumptions if required.
- ✓ Higher Tier approach will be analysed and tried to be implemented for available categories under NFR template.
- ✓ IIR structure will be revised in the need of user-friendly perspective for the readers and users especially emission experts.

9. PROJECTIONS

Projections for NECD pollutants and scenarios have been prepared in TA component of Improving Emissions Control Project. It is needed update the road map and the results for emission management and projections first. Bilateral and international connections are tried for this process to be studied for the revised NEC Directive and to be continued by the analyses required for protocols under the LRTAP Convention for technical assessment.

Projections are planned to be first studied by national or international support.

10. REPORTING OF GRIDDED EMISSIONS AND LPS

Gridded emissions for LRTAP inventory are planned to be reported under the CLRTAP Convention together with the LPS data obligation.

This reporting obligation is under preparation within the ongoing studies of our Air Emission Management-HEY Portal.

11. ADJUSTMENTS

N/A

IIR References

- EMEP/EEA Guidebook
- TURKSTAT Official Statistics
- Ministry of Energy and Natural Resources. Energy Balance
- Eurostat Production Index
- GHG Submissions
- Institutional Progress and Activity Reports
- National Inventory Reports. Türkiye
- Steel Statistics
- Improving Emissions Control TA Project Inventory Guidelines
- Improving Emissions Control TA Inventory Report Part 1 And 2
- Improving Emissions Control TA Project Documents
- TR Development Plan
- TURKSTAT. Ministry of Development. Ministry of Finance. Ministry of Food. Agriculture and Livestock. Ministry of Transport. Maritime and Communications. Ministry of Science. Industry and Technology
- Unions. Chambers and Associations' websites in the title of industry. energy. transport. agriculture. waste and product usage
- World Mineral Report
- Sectoral Statistics