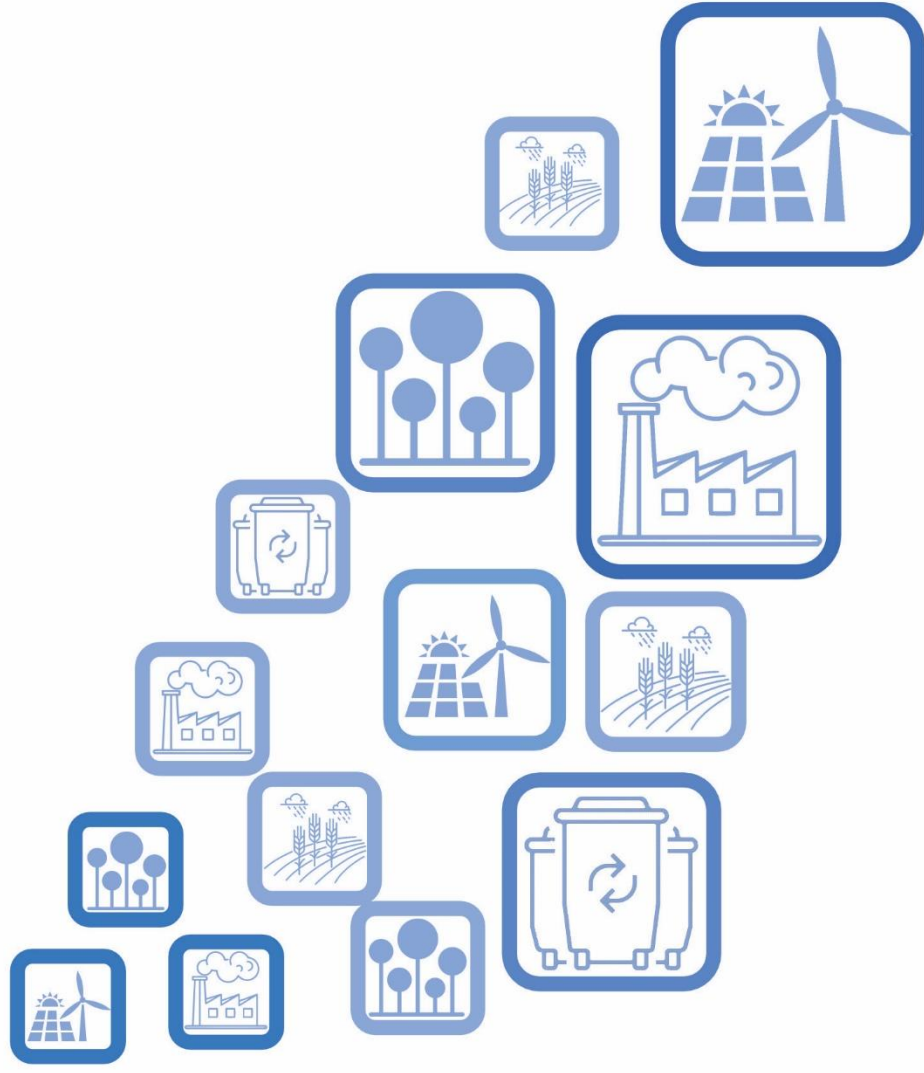


**1990-2023**



# **INFORMATIVE INVENTORY REPORT**

## **Republic of North Macedonia**

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## INFORMATIVE INVENTORY REPORT

1990 – 2023

Submission under the

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## LIST OF ABBREVIATIONS

<b>AE-DEM</b>	<b>Air Emissions Data Exchange Module</b>
<b>CARDS</b>	<b>Community Assistance for Reconstruction Development and Stabilization</b>
<b>CPAPRNM</b>	<b>Cadastre of polluters and air pollutants in Republic of North Macedonia</b>
<b>CRF</b>	<b>Common Reporting Format</b>
<b>EB</b>	<b>Executive Body</b>
<b>EEA</b>	<b>European Environment Agency</b>
<b>EMEP</b>	<b>Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe</b>
<b>ETC/ACC</b>	<b>European Topic Centre on Air and Climate Change</b>
<b>ERT</b>	<b>Expert Review Team</b>
<b>EU</b>	<b>European Union</b>
<b>GB</b>	<b>Guidebook</b>
<b>GHGs</b>	<b>Greenhouse Gases</b>
<b>GPG</b>	<b>Good Practice Guidance (of the IPCC)</b>
<b>HDVs</b>	<b>Heavy-Duty Vehicles</b>
<b>HM</b>	<b>Heavy Metals</b>
<b>IPCC</b>	<b>Intergovernmental Panel on Climate Change</b>
<b>KCA</b>	<b>Key Category Analysis</b>
<b>LDTs</b>	<b>Light-Duty Trucks</b>
<b>LE</b>	<b>Law on Environment</b>
<b>LHV</b>	<b>Low Heating Value</b>
<b>LPS</b>	<b>Large Point Source</b>
<b>MAFWS</b>	<b>Ministry of Agriculture, Forestry and Water Supply</b>
<b>ME</b>	<b>Ministry of Economy</b>
<b>MEIC</b>	<b>Macedonian Environmental Informative Centre</b>
<b>MEPP</b>	<b>Ministry of Environment and Physical Planning</b>
<b>MOI</b>	<b>Ministry of Interior</b>
<b>MS</b>	<b>Member State</b>
<b>NAPFUE</b>	<b>Nomenclature for Air Pollution of Fuels</b>
<b>NERP</b>	<b>National Emission Reduction Plan</b>
<b>NEAP</b>	<b>National Environmental Action Plan</b>
<b>NFR</b>	<b>Nomenclature For Reporting</b>
<b>PCs</b>	<b>Passenger Cars</b>



<b>POPs</b>	<b>Persistent Organic Pollutants</b>
<b>QA/QC</b>	<b>Quality Assurance/Quality Control</b>
<b>RM</b>	<b>Republic of Macedonia</b>
<b>SNAP</b>	<b>Selected Nomenclature for Air Pollution</b>
<b>SSO</b>	<b>State Statistical Office</b>
<b>UNECE/ CLRTAP</b>	<b>United Nations Economic Commission for Europe/Convention on Long-range Transboundary Air Pollution</b>
<b>UNFCCC</b>	<b>United Nations Framework Convention on Climate Change</b>
<b>CORINAIR</b>	<b>CORE INventory AIR emissions</b>
<b>EAF</b>	<b>Electric Arc Furnace</b>
<b>WWTP</b>	<b>Wastewater Treatment Plants</b>
<b>CAA</b>	<b>Civil Aviation Agency</b>
<b>NEIT</b>	<b>National Emission Inventory Team</b>
<b>MOD</b>	<b>Ministry of Defense</b>
<b>PEMF</b>	<b>Public eEnterprise Macedonian Forests</b>
<b>MAFWS</b>	<b>Ministry of Agriculture, Forestry and Water Supply</b>
<b>2W</b>	<b>Two Wheelers</b>
<b>AS</b>	<b>Amonium Sulfate</b>
<b>AN</b>	<b>Amonium Nitrate</b>
<b>CAN</b>	<b>Calcium Amonium Nitrate</b>

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# EXECUTIVE SUMMARY



## EXECUTIVE SUMMARY

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Republic of North Macedonia has an emission inventory reporting obligation towards the Convention on trans-boundary air pollution (CLRTAP) and its eight protocols as well as to the international organizations such as the European environmental agency (EEA). The reporting obligations to the relevant international organizations and to the Executive body (EB) of the LRTAP convention are set down in Article 27-d of the Law on ambient air quality (LAAQ)<sup>1</sup>.

As a party to the UNECE/LRTAP convention and its protocols Republic of North Macedonia is required to annually report data on emissions of air pollutants covered by the Convention and its protocols. These are the main pollutants: nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), non-methane volatile organic compounds (NMVOC), ammonia (NH<sub>3</sub>), persistent organic compounds (POPs) and heavy metals (HM). To be able to meet the obligations, Republic of North Macedonia compiles annually an emission inventory and reports the base year emissions (1980, 1987, 1988 and 1990) in accordance with the protocols' obligations.

This report is compiled according to the Annexes 2023 Reporting Guidelines under the UNECE/LTRAP convention and its protocols, which define the standards for the national emission inventory<sup>2</sup>. The country has also used the latest emissions reporting template for this reporting round.

The report contains eleven chapters, five appendixes and references. The content was reconstructed to achieve compliance with Recommended structure for the Informative Inventory Report which was updated in 2021. The chapter introduction provides general information on the inventory preparation background, key source analysis, methodology and data sources used, QA/QC and completeness. The chapter Trend presents trends on different pollutants and discusses the main reasons for incline and decline of the values. Chapters 4-8 include detailed information on activity data emission factors used per Nomenclature for reporting (NFR) source category. This report contains subchapters on source-specific uncertainty analysis, QA/QC, recalculations, and planned improvements. The chapter Projections gives information on the current situation and planned activities regarding the obligation set down in the current Gothenburg protocol. Chapters on reporting LPS and gridded data are referring to preparation and reporting of LPS and gridded data. Sources used for the gathering of the activity data and information are presented in Reference chapter. The Appendix chapter has 5 Appendixes; the first one is on Key category analysis, the second is on summary whether source sector use PM emission factor that include/exclude condensable component, then Appendix 3 which refers to further elaboration of completeness. Preliminary Energy balance for 2023 is presented in Appendix 4, while Appendix 5 refers to Additional information, here, the emissions for 2023 which are reported in the NFR reporting format are presented. Appendixes 6 and 7 form the Guidance are optional and are not part of the IIR.

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<sup>1</sup>Law on Ambient Air Quality (Official Gazette of RM No. 67/2004, 92/2007, 83/2009, 35/10, 47/11, 100/12, 163/13, 10/15, 146/15, 151/21)

<sup>2</sup><https://www.ceip.at/reporting-instructions/annexes-to-the-2023-reporting-guidelines>

## 1.1. Summary of the main differences in the inventory since the last submission

This report contains emissions of the whole time series 1990-2023. The submissions prior to 2004 and some of the following years included data on emissions of the basic pollutants as the country was not in position to report for the whole reporting period.

For the preparation of the 2016 and 2017 emission inventory submission and Informative Inventory Reports (IIRs) in those years, the Ministry of Environment and Physical Planning (MEPP) was supported by Austrian experts engaged within the framework of the EU funded Twinning Project “Further strengthening the capacities for effective implementation of the acquis in the field of air quality” (MK 12 IB EN 01) which was finalized in January 2017. Starting from 2018, the reporting has been conducted by an established national expert emission inventory team. In this previous reporting round recalculations were made mainly due to remarks received from the Stage 3 review report in 2020 and sectorial Stage 3 review report for agriculture sector<sup>3</sup>, final activity data from the Energy balance and revised activity data from the MAKSTAT database<sup>4</sup>. The major recalculations were done due to use of higher Tier methodology in the frame of the activities of the current IPA II project “Support in implementation of the air quality directives” in the further text referred as IPA II air quality project. Main recalculations were carried out in Off road categories 1.A.gvii, 1A4aai, 1A4bii and 1A4cii as well as in 1A4bi, for which models were developed and Tier 2 methodology was used. Tier 2 methodology was used also for categories 2D3e and 2D3f. In the Solvents sectors NFR categories: 2D3g, 2G were improved with more detail activity data. Additionally, in the energy sector input data from the preliminary energy balances are replaced with final data for 2022.

The report presents trend analysis of the country’s data for the period 1990 – 2023. The evaluation of the status of the emission trends is based on emission inventories and key source analysis. Generally, the main reason for reduction of the main pollutants is reduced use of coal for electricity production, as well as closure of installations or reduced production in the sector industry. Furthermore, emission reduction is also due to the introduction of BAT in major installations as well as the increase of use of gas and pellets and decrease of solid fuels in the category 1.A.4.

A decreasing trend is noticed for NO<sub>x</sub> and SO<sub>x</sub> emissions starting from 2011. The reduction of NO<sub>x</sub> is a result of the modernization of plants and extended working lifetime. Additionally, the reduced operating hours of the power plant REK Oslomej from twelve to few months per year, and the decrease in coal consumption including gasification of the heating plant Toplana Zapad has supported the reduction of NO<sub>x</sub>. With regards to SO<sub>x</sub> emissions, the trends vary and depend on the coal consumption considering that electricity production is the main source for SO<sub>x</sub> emissions. Desulfurization units are still not in place in this installation, so mainly SO<sub>x</sub> emissions depend on the content and quantity of the consumed coal. The trend was decreasing until 2017 and in the last few years emission have increased, however, the consumption of coal and content of sulfur is not the reason for increasing the SO<sub>x</sub> emissions. Therefore, for 2022-2023, SO<sub>x</sub> emissions are calculated with use of EF since monthly measurements are not representative and have high uncertainty.

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<sup>3</sup>[https://www.ceip.at/fileadmin/inhalte/ceip/00\\_pdf\\_other/2020\\_s3/mk\\_s3\\_rr\\_2020\\_final.pdf/](https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020_s3/mk_s3_rr_2020_final.pdf/)  
[https://webdab01.umweltbundesamt.at/download/review/MK/2023/MK\\_2023\\_Stage3RR\\_FINAL.pdf?cgiproxy\\_skip=1](https://webdab01.umweltbundesamt.at/download/review/MK/2023/MK_2023_Stage3RR_FINAL.pdf?cgiproxy_skip=1)

<sup>4</sup> MAKSTAT database - <http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>

The trend on NMVOC emissions is variable. These emissions are coming from different sectors but mainly Industry and Other sector, and there is slight reduction and stable trend in the last few years.

The trend of ammonia emissions is constantly decreasing (54% compared to 1990), which is related to decreasing livestock numbers due to the trend of moving of people from rural to urban areas and implementation of Best available technics which refer to the bigger farms for swines and polutry.

**Table 1 Emission trends 1990 – 2023 for the main air pollutants and CO**

Year	Emission in kt				
	NO <sub>x</sub>	NMVOC	SO <sub>2</sub>	NH <sub>3</sub>	CO
1990	45.52	40.83	112.40	14.72	106.66
1991	37.76	35.77	91.44	13.89	89.63
1992	39.72	37.34	88.66	13.92	99.35
1993	41.25	39.79	91.13	14.13	105.44
1994	36.87	33.92	90.27	14.12	94.56
1995	39.42	38.73	96.53	13.91	100.05
1996	38.79	36.78	90.54	12.86	96.61
1997	38.09	38.03	94.84	12.45	99.79
1998	43.39	38.70	109.37	12.19	103.99
1999	40.59	38.88	99.31	12.31	105.17
2000	43.84	39.84	106.26	12.18	112.88
2001	40.89	34.49	108.28	11.68	89.01
2002	40.80	31.53	96.12	11.08	91.11
2003	35.72	31.08	94.71	10.95	89.26
2004	36.97	31.42	95.64	11.02	94.01
2005	35.10	23.24	94.77	10.61	74.13
2006	34.97	24.48	93.18	10.88	69.77
2007	38.02	25.16	98.52	10.72	70.77
2008	33.92	24.98	76.88	10.65	66.08
2009	34.79	23.05	103.10	9.87	62.19
2010	36.18	24.31	85.69	10.06	61.33
2011	38.28	24.93	103.45	10.38	62.94
2012	35.78	25.00	91.34	9.56	65.34
2013	28.16	24.48	82.06	9.55	62.93
2014	25.76	24.25	82.71	9.61	60.67
2015	20.94	23.73	75.02	9.57	58.57
2016	23.97	23.40	63.29	9.72	61.47
2017	22.61	23.93	54.74	9.66	53.73
2018	21.78	23.25	59.82	9.31	53.01
2019	22.27	22.92	115.44	7.96	53.57
2020	19.11	21.72	93.45	8.13	48.82

2021	19.95	21.81	88.61	7.60	50.07
2022	21.11	22.15	94.94	7.30	46.61
2023	20..15	21.26	105.12	6.79	44.18
<b>Trend 1990-2023</b>	<b>-54%</b>	<b>-48%</b>	<b>-6%</b>	<b>-54%</b>	<b>-59%</b>

The trend of the particulates is variable with inclines and declines due to variable operation of the installations for ferroalloys production as one of key sources in the national total particulates' emissions. The contribution from the 1.A.4 Other Sectors (residential heating) has changed due to introduction of clean fuel; however, biomass remains the main fuel used for household heating. The main reason for the decreasing trend and the reduction of around 70-73% in total of the particulates in 2023 compared to 1990, is the reduced production of ferroalloys in the country. The calculated PM2.5, PM10 and TSP and BC emissions in 2023 are reduced compared to 2022, by 6, 4, 4 and 8 % respectively due to the higher use of clean fuels for heating.

**Table 2 Emission trends for particulate matter 1990-2023**

Year	Emissions			
	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]
1990	28.28	43.76	56.52	2.68
1991	24.74	38.33	49.27	2.33
1992	30.78	46.38	58.17	2.98
1993	26.54	40.12	50.88	2.55
1994	24.57	37.73	48.37	2.24
1995	24.86	38.37	49.34	2.27
1996	27.77	42.77	55.11	2.59
1997	26.86	41.43	53.01	2.43
1998	31.48	48.16	61.56	2.88
1999	26.42	40.40	51.98	2.37
2000	24.34	37.83	51.14	2.17
2001	14.19	23.64	32.48	1.04
2002	14.73	24.06	32.44	1.19
2003	24.50	37.45	48.04	2.11
2004	26.89	40.93	52.45	2.38
2005	24.14	37.41	48.81	2.43
2006	21.76	34.03	44.42	2.16

Year	Emissions			
	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]
2007	17.48	27.82	36.84	1.76
2008	18.17	28.40	37.66	1.85
2009	12.86	22.31	32.01	1.24
2010	15.97	28.40	35.56	1.64
2011	21.82	35.32	46.26	2.13
2012	21.48	34.35	45.49	2.16
2013	23.71	36.98	49.45	2.41
2014	17.12	26.90	37.46	1.73
2015	14.77	22.42	28.07	1.44
2016	12.94	19.68	24.79	1.37
2017	8.90	14.25	18.52	0.98
2018	8.52	14.46	17.46	0.93
2019	8.83	13.97	17.99	0.96
2020	8.71	13.79	17.72	0.94
2021	8.62	13.54	17.65	0.96
2022	8.13	13.32	17.57	0.89
2023	7.63	12.80	16.94	0.82
<i>Trend 1990–2023</i>	<b>-73%</b>	<b>-71%</b>	<b>-70%</b>	<b>-70%</b>

The concentrations of Pb have decreased significantly starting from 2003, mainly because of the closure of the smelter company “Zletovo” – Veles and the use of unleaded gasoline in transportation. The closure of the smelter company is also manifested in declined emissions of Hg, Cd and PCBs. Additionally, the reduction of these pollutants’ emissions has been positively influenced with the introduction of unleaded petrol and BAT in the installations.

**Table 3 Emission trends for heavy metals 1990-2023**

Year	Emissions		
	Cd [Mg]	Hg [Mg]	Pb [Mg]
1990	236.19	1.53	0.67
1991	199.29	1.44	0.61
1992	230.35	1.38	0.56
1993	214.95	0.98	0.54
1994	205.69	0.93	0.45
1995	224.03	2.03	0.48
1996	231.37	2.24	0.53
1997	246.83	1.07	0.57
1998	261.89	1.32	0.63
1999	210.22	0.99	0.57

Year	Emissions		
	Cd [Mg]	Hg [Mg]	Pb [Mg]
2000	196.93	0.84	0.59
2001	173.76	0.75	0.62
2002	172.01	0.73	0.65
2003	133.47	0.52	0.49
2004	47.04	0.45	0.47
2005	7.92	0.29	0.36
2006	8.57	0.26	0.37
2007	8.96	0.26	0.40
2008	7.45	0.26	0.38
2009	6.74	0.25	0.33
2010	7.89	0.25	0.34
2011	9.53	0.27	0.38
2012	8.28	0.27	0.36
2013	5.84	0.25	0.31
2014	7.32	0.25	0.31
2015	7.32	0.25	0.30
2016	4.70	0.24	0.28
2017	4.78	0.23	0.26
2018	5.00	0.23	0.23
2019	5.93	0.24	0.26
2020	5.77	0.22	0.20
2021	6.22	0.24	0.21
2022	6.56	0.23	0.19
2023	6.60	0.23	0.20
<b>Trend 1990–2023</b>	<b>-85%</b>	<b>-71%</b>	<b>-97%</b>

Regarding PAHs the trends are variable but still decreasing trend can be noticed from 2005 onwards. The largest source of emissions for these pollutants is the energy sector (mainly residential heating) with a share of 76%. Regarding PCB and HCB, we can notice decreasing trend due to emission reduction coming from the metal production. The trend of PCDD/F depends mainly on combustion of fuels as well as waste incineration activities. Emissions are increased in 2000 due to introduction of medical waste incineration activity but reduced in 2018 due to installation of dust filter. High levels before 2000 are due to higher solid fuel consumption.

**Table 4 Emission trends for POPs 1990-2023**

Year	Emissions			
	PAHs [t]	PCDD/F [g – I TEQ ]	HCB [kg]	PCB [kg]
1990	14.58	4.94	44.26	381.18



Year	Emissions			
	PAHs [t]	PCDD/F [g – I TEQ ]	HCB [kg]	PCB [kg]
1991	13.08	4.45	39.19	382.73
1992	12.74	4.69	25.80	382.95
1993	11.73	4.88	24.15	369.80
1994	10.56	4.42	25.01	340.60
1995	13.60	4.52	18.60	355.78
1996	13.42	4.03	19.67	384.21
1997	10.69	4.27	27.85	396.25
1998	12.54	5.04	29.31	403.01
1999	11.87	4.94	53.94	366.49
2000	17.63	5.48	38.28	342.85
2001	20.50	4.48	34.12	332.37
2002	22.16	4.53	52.65	330.10
2003	22.61	4.95	42.94	287.40
2004	25.24	5.02	8.48	240.53
2005	26.81	4.84	7.54	207.01
2006	25.15	4.95	11.67	207.78
2007	26.51	5.14	8.87	208.58
2008	25.82	4.82	7.74	208.28
2009	27.30	4.16	8.28	208.07
2010	29.50	4.47	9.58	208.85
2011	35.72	4.68	10.50	209.21
2012	38.92	5.12	9.47	209.19
2013	40.04	4.86	6.35	209.02
2014	39.90	4.67	4.19	209.48
2015	49.40	4.72	0.96	216.33
2016	50.97	4.65	0.77	220.78
2017	51.37	3.94	2.06	228.69
2018	8.72	3.86	1.53	236.92
2019	9.21	4.16	4.43	238.14
2020	8.43	3.79	0.16	236.77
2021	9.05	4.01	0.16	238.29
2022	8.14	3.49	0.15	242.35
2023	7.73	3.23	0.10	358.56
<b>Trend 1990–2023</b>	<b>-35%</b>	<b>-47%</b>	<b>-100%</b>	<b>-6%</b>

The main inconsistency of the trends origin from the Transport sector is due to the use of different calculation methodology (Tier 1 for the calculation of emissions in the period 1990-2004 and Tier 3 for the calculation of emissions in the period 2005-2023). The COPERT V has been established during the three TAEIX expert missions carried out in the period October – December 2020. Within this project 2005-2019 transport emissions were calculated. The emissions coming from transport in 2020-2023, were calculated by the national transport expert.

## **1.2. Priorities for improvement**

Since emissions from the Transport sector for period 2005-2023 have been calculated using the Tier 3 method using Copert V model, this method would be used in the forthcoming year for calculation of historical emissions coming from this sector to secure consistency for the whole reporting period. This is important since the Transport sector is one of the key sources of CO and NO<sub>x</sub> national emissions. The second national priority is the use of Tier 2 by using of N-fow tool in Agriculture sector which is key sector for ammonia emissions. Several Categories in solvent sector are also planned to be improved during current technical IPA II project for air quality.

## **1.3. Information on recalculation – main reasons for recalculations**

In the Energy sector, the emissions for the year 2023 were recalculated, using final activity data from the energy balance regarding fuel consumption. Emissions were recalculated in the following NFR categories due to use of higher Tier 2 methodology implemented by KEY expert 2 in the frame of the IPA II project for air quality: 1A4bi, 1A2gvii, 1A4aii, 1A4bii, 1A4cii, 2D3f and 2D3e. Activity data were gathered and improved for the following categories for several activities: 2D3i and 2G (use of fireworks), 2D3g (leather tanning), 2D3a (disinfectants).

## **1.4. Explanation of differences between reported national totals**

National totals are reported for the entire territory. There are no differences in national totals reported in the NFR tables.

## **1.5. Clarification of the reason for differences in reported national totals for the entire territory with NECD report**

As we are not a Member of the European Union, we are not obliged to report emissions under the EU's National Emissions Ceiling Directive (NECD). However, the NEC directive 2001/81/EC has been transposed in the national legislation and national emission ceilings for NO<sub>x</sub>, NMVOC, SO<sub>x</sub> and NH<sub>3</sub> have been defined. The new NEC Directive (2016/2284/EU) on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC will be transposed in the Law on ambient air quality and sub legislation as part of a technical project, which is programed in IPA 2 program "Support in implementation of the air quality directives", that is planned to start at the end of 2024. However, based on the regular preparation of the emission inventory, the gridded data and LPS data starting from and the annual IIR, it can be ascertained that several obligations coming from the new NEC directive are already implemented by our country.

# INTRODUCTION



## 2. INTRODUCTION

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### 2.1. National Inventory background

#### International commitments

Reporting of emission data to the Executive Body (EB) of the Convention on Long-range Trans-boundary Air Pollution (CLRTAP) is required to fulfill the obligations referring to the strategies and policies in compliance with the implementation of Protocols under the Convention. Parties should use the reporting procedures and are required to submit annual national emissions of SO<sub>2</sub>, NO<sub>x</sub>, NMVOC, CO and NH<sub>3</sub>, particulate matter (PM), various HM and POPs.

The United Nations, Economic Commission for Europe (UNECE), adopted the LRTAP Convention in 1979. The LRTAP Convention came into force in 1983 and it has been extended by eight specific protocols. The status of ratification to LRTAP Convention and its Protocols for the Republic of North Macedonia is shown below:

- Convention on Long-Range Trans boundary Air Pollution (LRTAP) (Geneva, 1979). The Convention was ratified by means of the Law on Ratification („Official Gazette of the SFRY” No. 11/86). The Convention was taken over by the Republic of North Macedonia by means of succession with the date of effect of 30.12.1997.
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on long-term financing of the Cooperative Program for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (“Official Gazette of the Republic of Macedonia” No.24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on reduction of sulfur emissions or their trans boundary transmission by at least 30 percentages (“Official Gazette of the Republic of Macedonia” No.24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on the control of nitrogen oxides or their trans boundary fluxes (“Official Gazette of the Republic of Macedonia” No. 24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on the control of volatile organic compounds or their trans boundary fluxes (“Official Gazette of the Republic of Macedonia” No. 24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution concerning further reduction of sulfur emissions (“Official Gazette of the Republic of Macedonia” No.24/2010).
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Rang trans boundary Air Pollution on heavy metals emissions (“Official Gazette of the Republic of Macedonia” No.135/2010).
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Rang trans boundary Air Pollution on persistent organic pollutants (“Official Gazette of the Republic of Macedonia” No.135/2010).
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Rang trans boundary Air Pollution to abate acidification, eutrophication, and ground-level ozone (“Official Gazette of the Republic of Macedonia” No.135/2010).
- Regarding the Gothenburg Protocol, negotiations were ongoing in the period 2011-2014, on the proposed figures on the base year emission levels (1990 national emissions) and national emission ceilings (2010 national emissions). The Executive Body of the Convention on its 32nd Meeting,

decided to accept the last proposed figures for Annex II of the Gothenburg Protocol and Annex II of the Protocol on sulfur of 1994. With the adoption of the proposed amendments to Annex II of the Gothenburg Protocol, in September 2014, Republic of North Macedonia became a full Party to these protocols as well as first Party to the among developed countries. Republic of North Macedonia will consider ratification of the amendments of the protocol after calculation of emission reduction commitments which activity is planned to be carried out in the same project. Status of ratification of the protocols under CLRTAP is presented in the table below.

**Table 5 Status of ratification of the protocols under CLRTAP**

Tools of UNECE Convention on Long-Range trans boundary Air Pollution (LRTAP)		Parties	entered into force	Signed (S) / Ratified (R) / Succession (d) / Accession (a) by North Macedonia
1979	Geneva Convention on Long-Range trans boundary Air Pollution		16.03.1983	30 Dec 1997 (d) <sup>5</sup>
1984	Geneva Protocol on Long-term Financing of the Cooperative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP)	47	28.01.1988	10 Mar 2010 (a)
1985	Helsinki Protocol on the Reduction of Sulfur Emissions or their trans boundary Fluxes by at least 30 per cent	25	02.09.1987	10 Mar 2010 (a)
1988	Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their trans boundary Fluxes	35	14.02.1991	10 Mar 2010 (a)
1991	Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their trans boundary Fluxes	24	29.09.1997	10 Mar 2010 (a)
1994	Oslo Protocol on Further Reduction of Sulfur Emissions	29	05.08.1998	5 Jun 2014 (a)
1998	Aarhus Protocol on Heavy Metals	31	29.12.2003	1 Nov 2010 (a)
	Aarhus Protocol on Heavy Metals, as amended on 13 December 2012	28	08.02.2022	/
1998	Aarhus Protocol on Persistent Organic Pollutants (POPs)	33	23.10.2003	1 Nov 2010 (a)
	Aarhus Protocol on Persistent Organic Pollutants, as amended on 18 December 2009 <sup>6</sup>	27	20.01.2022	/
1999	Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone	31	17.05.2005	5 Jun 2014 (a)
	Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, as amended on 4 May 2012 <sup>7</sup>	31	7.10.2019	Preparatory activities in progress

In the context of air pollution and Climate Change the Republic of North Macedonia has ratified the following conventions:

- United National Framework Convention on Climate Change (UNFCCC) (New York, 1992). The Convention was ratified by means of the Law on Ratification („Official Gazette of RM” No. 61/97) and entered into force in Republic of North Macedonia on 28.04.1998.

<sup>5</sup>[https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg\\_no=XXVII-1&chapter=27&clang=en](https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-1&chapter=27&clang=en)

<sup>6</sup><http://www.unece.org/fileadmin/DAM/env/lrtap/full%20text/ece.eb.air.104.e.pdf>

<sup>7</sup>[http://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE.EB.AIR.114\\_ENG.pdf](http://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE.EB.AIR.114_ENG.pdf)

- Kyoto Protocol under the United Nations Framework Convention on Climate Change the Republic of North Macedonia. The Protocol was ratified by means of the Law on Ratification („Official Gazette of RM” No. 49/04).
- Stockholm Convention on Persistent Organic Pollutants. Republic of North Macedonia signed the Convention in Stockholm, Sweden, on 22.05.2001. The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.17/04).
- Vienna Convention for the Protection of the Ozone Layer (Vienna, March 1985). The Convention was ratified by means of the Law on Ratification („Official Gazette of SFRY No.1/90). Republic of North Macedonia has taken over by means of succession on 10.03.1994.
  - Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, September 1987). The Protocol was ratified by means of the Law on Ratification („Official Gazette of SFRY No.16/90). Republic of North Macedonia has taken over by means of succession on 10.03.1994.
    - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-London. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.25/98).
    - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-Copenhagen. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.25/98).
    - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-Montreal. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.51/99).
    - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-Beijing, 1991. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.13/02).
- Convention on Environmental Impact Assessment in a trans boundary Context (Espoo, February 1991). The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.44/99).
- Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters (Aarhus Convention). The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.40/99).
- Basel Convention on the Control of trans-boundary Movements of Hazardous Wastes and Their Disposal. The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.49/97).
- Minamata convention on mercury. The convention has been signed on 24.07.2014.

At its thirty-second session<sup>8</sup> (Geneva, 9–13 December 2013), the Executive Body (EB) for the LRTAP Convention adopted revised guidelines for reporting emissions and projections data under the Convention (ECE/EB.AIR/122/Add.1, decisions 2013/3 and 2013/4). Revised 2021 Reporting guidelines and the Annex for IIR content is followed in this report.

### National legislation

In accordance with the Law on ambient air quality Article 27-g (2), the Air Pollutant Emissions inventory for the territory of Republic of North Macedonia is performed through:

- 1) Calculation of emission quantities of pollutants in the air in Republic of North Macedonia.
- 2) Preparation of report on the annual emission inventory with emission projections.

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<sup>8</sup><http://www.unece.org/index.php?id=33605#/>

- 3) Preparation of report on implementation of emission reduction measures to fulfill the requirements toward the 1979 Convention on Long-Range trans-boundary Air Pollution and its amendments (hereinafter: LRTAP convention).

The reporting obligations to the European Environmental Agency and other relevant international organizations and to the Executive body of the LRTAP convention are set down in Article 27-d of the LAAQ.

The methodology for preparation of the inventory is prescribed in the Rulebook on the methodology for inventory and establishment of the levels of polluting substances emission into the atmosphere in tons per year concerning all types of activities, as well as other data to be submitted to the European Monitoring and Evaluation Program (EMEP), Official Gazette of the Republic of Macedonia No. 142/07<sup>9</sup>.

The national emission ceilings for 2010 according to the old NEC Directive are defined in the Rulebook on the amounts of emission ceilings of polluting substances for the purpose of setting projections for a certain period concerning the polluting substances emission reduction at annual level<sup>10</sup>.

Analysis of transposition and implementation of the National Emissions Ceilings (NEC) Directive (2016/2284/EU) have started in the IPA II project "Support in implementation of the air quality directives" that began in November 2024..

### **Practical implementation and development of the inventory work**

In 2005 Republic of North Macedonia via the Ministry of Environment and Physical Planning (MEPP) established a National Methodology for Air pollutants emission inventory. This was part of the implementation of the EMEP Program, for the purpose of the implementation of the CLRTAP in the Republic of North Macedonia, carried out through European Topic Centre on Air and Climate Change (ETC/ACC) with financial support by the Community Assistance for Reconstruction Development and Stabilization (CARDS) Program. The objective of the project was to establish an air pollutant emission inventory and reporting system for Republic of North Macedonia that complies with the international requirements of the European Union (EU) and adaptation towards comparability with the data of the EU Member States. In 2006, the consulting company TEHNOLAB Ltd authorized by the MEPP, has prepared the first Air pollutant emission Inventory and Informative Inventory Report (IIR) which covered information on air pollutant emissions for year 2004<sup>11</sup> and has been based EMEP/EEA Guidebook<sup>12</sup> for 2006 (in the further text GB 2006). The history of the development of the inventory is described below.

For the 2005, 2006, 2007, 2009 inventory years, according to the requirements of CLRTAP, MEPP has updated the air pollutant emission data only for the three main SNAP<sup>13</sup> sectors (1, 2 and 3), without submitting an IIR Report.

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<sup>9</sup> [Rulebook on the methodology for inventory and establishment of the levels of polluting substances emission into the atmosphere in tons per year concerning all types of activities, as well as other data to be submitted to the European Monitoring and Evaluation Program \(EMEP\) \(Official Gazette of RM no.142/2007\)](#)

<sup>10</sup> [Rulebook on the amounts of emission ceilings of polluting substances for the purpose of setting projections for a certain period concerning the polluting substances emission reduction at annual level \(Official Gazette of RM No.2/2010,156/11\)](#)

<sup>11</sup> [CLRTAP- Macedonia's Informative Inventory Report, 2004, MEPP, March 2006](#)

<sup>12</sup> [EMEP/CORINAIR Emission Inventory Guidebook - 2006](#)

<sup>13</sup> [SNAP Selected Nomenclature on Air Pollutants. \[https://en.eustat.eus/documentos/elem\\\_13173/definicion.html\]\(https://en.eustat.eus/documentos/elem\_13173/definicion.html\)](#)



In 2007 Republic of North Macedonia complying with CLRTAP as part of the national legislation has enforced the “Rulebook on inventory making and establishment of the level of polluting substances emission in ambient air in tons per year for all types of activities, as well as other data to be delivered to the Environmental Monitoring Program of Europe (EMEP)”.

In 2010, MEPP engaged the second time TEHNOLAB Ltd, a consulting company, to prepare a complete Air pollutant emission inventory and IIR for year 2008 emissions<sup>14</sup>.

In 2011 air pollutant emissions data (only for the three main SNAP sectors (1, 2 and 3)) for 2009 were updated without submission of an IIR Report.

Republic of North Macedonia, in 2011 participated in Stage 3 in depth review<sup>15</sup> of Air Emission Inventories and replied promptly on the questions sent by the Expert review team (ERT).

Review made by ERT, as well as the sent questions, were of great use and importance for further development and improvement of the Macedonian air pollutant emission inventory in accordance with GB 2009<sup>16</sup>. Hence, recommendations from Stage 3 review were considered in the Inventory submissions in the following years.

In relation to air pollutant emissions inventory submission in 2012, MEPP secured financial resources for both a full inventory and preparation of the report, improved in line with the Stage 3 Review report recommendations. MEPP involved Tehnolab Ltd, to carry out the inventory and the preparation of IIR for 2010. This Inventory was improved in accordance with some remarks given in the Stage 3 review report, including full series of heavy metal emissions.

In 2013, the air pollutant emission inventory for 2011 was extended for the first time to cover emissions of PM2.5, PM10, dioxins and furans. Emissions for the baseline years 1980 (SOx), 1987 (NOx), 1988 (NMVOC) and 1990 (POPs) were delivered to the Convention on Long-range trans-boundary Air Pollution in accordance with the requirements of protocols.

In 2014 and 2015 the air pollutant emission inventory for all pollutants was prepared. A calculation for the missing years and recalculation for the previously reported years was carried out, including calculation of the emissions in the baseline years of 1980 (SOx), 1987 (NOx), 1988 (NMVOC) and 1990 (POPs) due to improved activity data, as well as in accordance with the updated version of the EMEP/EEA Emission Inventory Guidebook 2013<sup>17</sup> for most of the source categories.

The IIR submitted in 2016 covered information on anthropogenic emissions of air pollutants for 2014 for all pollutants, the entire time series starting from 1990, and it included documentation of methods, data sources, completeness of the Inventory, quality assurance and quality control (QA/QC) activities carried out, as well as sectorial methodologies for emission estimations by category (NFR). Emission data, activity data and emission factors are presented in separate chapters of this IIR. NFR 14-2 tables are used to report the emissions.

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<sup>14</sup>CLRTAP- Macedonia's Informative Inventory Report, 2008, MEPP, March 2010

<sup>15</sup>[http://www.ceip.at/fileadmin/inhalte/emep/pdf/2011/MK\\_Stage3\\_Review\\_Report\\_2011.pdf](http://www.ceip.at/fileadmin/inhalte/emep/pdf/2011/MK_Stage3_Review_Report_2011.pdf);

<sup>16</sup> EMEP/EEA air pollutant emission inventory guidebook - 2009

<sup>17</sup> EMEP/EEA air pollutant emission inventory guidebook - 2013



In 2016, Republic of North Macedonia again participated in a Stage 3 in depth review of Air Emission Inventories. Based on this review, additional improvements were made in the inventory. The IIR, submitted in 2017 described these improvements and for the first time contained a quantitative uncertainty assessment. Furthermore, in most of the categories updated emission factors from the EMEP/EEA Emission Inventory Guidebook 2016<sup>18</sup> were used. For the previous reporting round additionally in most of the categories, EMEP/EEA Emission Inventory Guidebook 2019<sup>19</sup> and 2016 has been used, while older versions were rarely used due to limitation of activity data. The previous submission and inventory submitted in 2022 were improved with final activity data considered in the revised MAKSTAT database, as well as several categories were improved and additional categories were added according to Stage 3 review recommendations [3]. The present IIR submitted during this year contains improvements made during expert missions in the IPA II air quality project regarding offroad emissions, emissions coming from combustion in households and solvent sector. The overall view of the gradual improvement of the inventory work is presented in the following table.

**Table 6 Development of the inventory work in North Macedonia**

Year of reporting	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2005	<ul style="list-style-type: none"> <li>National Methodology for Air pollutants emission inventory</li> <li>Establishment of an emission inventory and reporting system</li> </ul>	Basic pollutants /SNAP sector 1,2,3	2003	EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition October 2002 UPDATE  Emission measurements	MEPP	X			
2006	<ul style="list-style-type: none"> <li>First Air pollutant emission Inventory according CORINAIR methodology and Informative Inventory Report (IIR)</li> </ul>	Basic pollutants /all sectors	2004	EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition October 2002 UPDATE Emission measurements	ETC/ACC. (EMEP Program) TEHNOLAB Ltd	X			X

<sup>18</sup> [EMEP/EEA air pollutant emission inventory guidebook - 2016](#)

<sup>19</sup> [EMEP/EEA air pollutant emission inventory guidebook - 2019](#)

Year of reporting	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2007	<ul style="list-style-type: none"> <li>Rulebook on inventory making and establishment of the level of polluting substances emission in ambient air in tons per year for all types of activities, as well as other data to be delivered to the EMEP</li> </ul>	Basic pollutants	2005		MEPP	X			
2008 and 2009	<ul style="list-style-type: none"> <li>Update</li> </ul>	Basic pollutants SNAP sector 1, 2 and 3	On yearly base according to the rule n-2	EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition October 2002 UPDATE  Emission measurements	MEPP		X		
2010	<ul style="list-style-type: none"> <li>Air pollutant emission Inventory and IIR</li> </ul>	Basic pollutants	2008		TEHNOLAB Ltd		X		X
2011	<ul style="list-style-type: none"> <li>Stage 3 in depth review</li> <li>Update</li> </ul>	Basic pollutants  SNAP sector 1, 2 and 3		EMEP/EEA GB 2009	MEPP & TEHNOLAB Ltd		X		
2012	<ul style="list-style-type: none"> <li>Inventory and preparation of the report</li> </ul>	All including heavy metals (HM)	Full time series		MEPP & TEHNOLAB Ltd		X		X
2013	<ul style="list-style-type: none"> <li>Air pollutant emission Inventory</li> <li>Emissions for the baseline years 1980 (SOx), 1987 (NOx), 1988 (NMVOC) and 1990 (POPs)</li> </ul>	All + HM including PM2.5, PM10, dioxins and furans		EMEP/EEA GB 2009	MEPP		X		
2014 2015	<ul style="list-style-type: none"> <li>Recalculation including baseline years</li> </ul>	All with exception of BC	Baseline years + 2012 and 2013	EMEP/EEA Emission Inventory Guidebook - 2009, 2013	MEPP			X	

Year of reporting	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2016	<ul style="list-style-type: none"> <li>Recalculation of all pollutants, time series starting from 1990</li> <li>documentation of methods, data sources, completeness of the Inventory, QA/QC, sectorial methodologies for emission estimations by category (NFR)</li> </ul>	All with exception of BC	1990 – 2014	EMEP/EEA Emission Inventory Guidebook - 2009, 2013	MEPP Twinning			X	X
2017	<ul style="list-style-type: none"> <li>Introduction of uncertainty trend analysis and key source analysis as well as QA/QC procedures implemented and improved, most of the Stage 3 review comments<sup>20</sup> implemented</li> </ul>	All + BC	1990-2015	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP Twinning			X	X
2018	<ul style="list-style-type: none"> <li>Data quality improvement, introduction of new QA/QC procedures</li> </ul>	All + BC	1990-2016	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP			X	X
2019	<ul style="list-style-type: none"> <li>Data quality improvement, introduction of new QA/QC procedures</li> </ul>	All + BC	1990-2017	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP			X	X
2020	<ul style="list-style-type: none"> <li>Data quality improvement, introduction of new QA/QC procedures, Several NFR sectors added for first time, use of Tier 2 methodology in several categories, use of EF from 2019 GB.</li> </ul>	All + BC	1990-2018	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016, 2019	MEPP			X	X

<sup>20</sup> [UNECE/CEIP/S3.RR/2016/Macedonia19/10/2016](https://unece.org/ceip/S3.RR/2016/Macedonia19/10/2016)

Year of reporting	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2021	• Data quality improvement, Inclusion of Stage 3 Review report, Several NFR sectors added for the first time	All + BC	1990-2019	EMEP/EEA Emission Inventory Guidebook – 2019 (rarly older versions are used due to limitation of activity data)	MEPP			X	X
2022	• Data quality improvement	All + BC	1990-2020	EMEP/EEA Emission Inventory Guidebook – 2019 (rearly older versions are used due to limitation of activity data)	MEPP			X	X
2023	• Data quality improvement	All + BC	1990-2021	EMEP/EEA Emission Inventory Guidebook – 2019 (rearly older versions are used due to limitation of activity data)	MEPP			X	X
2024	• Data quality improvement	All + BC	1990-2022	EMEP/EEA Emission Inventory Guidebook – 2023 (rearly older versions are used due to limitation of activity data)	MEPP			X	X
2025	• Tier 2 methodology introduced	All + BC	1990-2023	EMEP/EEA Emission Inventory Guidebook – 2023 (rearly older versions are used due to limitation of activity data)	MEPP together with KEY expert 2 from IPA II project “Support in implementati on of air quality directives”			X	X

## 2.2. Institutional arrangements

According to the Article 40 of the Law on environment (LE)<sup>21</sup>, the Macedonian Environmental Informative Center (MEIC), a department within the Ministry of Environment and Physical Planning (MEPP) is the Single National Entity (SNE) responsible for the preparation of emission inventories. MEIC within the MEPP has the overall responsibility and submits the inventory report to CLRTAP.

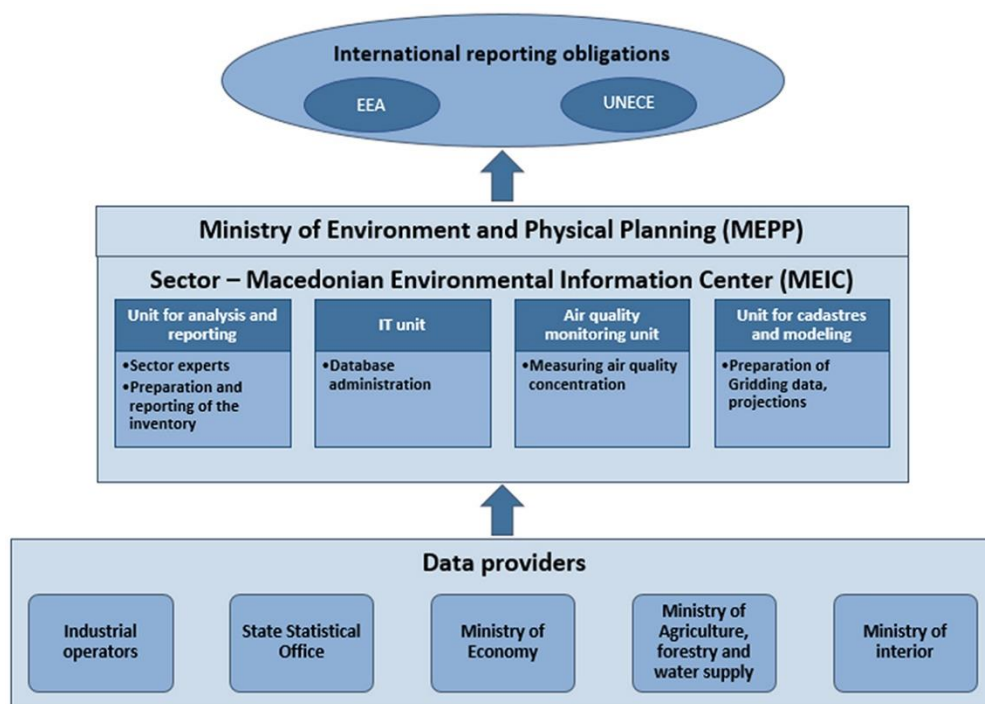
<sup>21</sup> [Law on environment Official Gazette of RM num. 53/2005, 81/2005, 24/2007, 159/2008, 83/09, 48/10, 124/10, 51/11,123/12, 93/13, 44/15, 151/21](#)

Within the MEIC, experts from four different departments are contributing, whereby experts from the division of Analysis and Reporting are compiling and reporting the inventory.

Data needed for the preparation of the inventory are provided by either industrial operator, State statistical office (SSO), Ministry of Economy (MOE), Ministry of defense (MOD), Ministry of agriculture, forestry, and water supply (MAFWS), or Ministry of Interior (MOI) etc. MEPP has signed memorandum of understanding for data exchange with the SSO and starting from 2016 with MOI on detailed vehicles fleet data. MOI during 2023 has provided activity data per vehicle category for the 2023. Therefore, Tier 3 calculation methodology has been implemented for period 2005-2023.

The other ministries / institutions mentioned above are delivering the data on voluntary basis and upon MEIC requirements. The plant operators are reporting the data due to their obligation under PRTR and national sub legislation under the Law on ambient air quality.

The institutional arrangements for the inventory system currently used in Republic of North Macedonia are presented in Figure 1. The Macedonian Environmental Informative Center (MEIC) within the MEPP has the overall responsibility and submits the inventory report to CLRTAP.



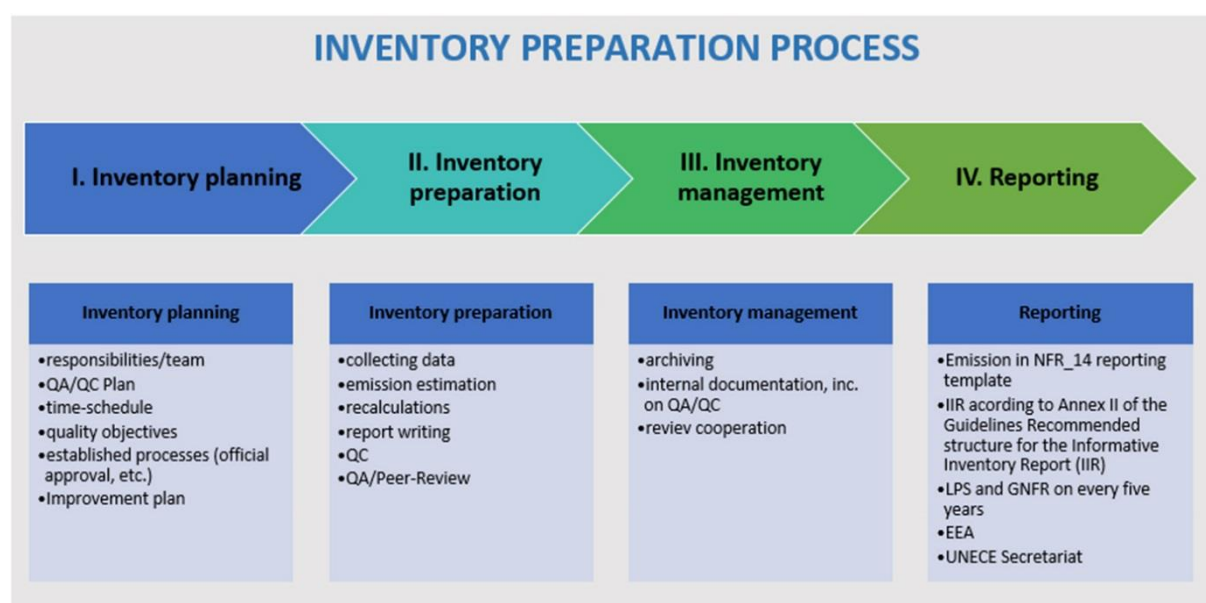
**Figure 1 Institutional arrangements**

### 2.3. Inventory preparation process

The preparation of the Inventory includes the following stages:

- a) Planning
- b) Preparation
- c) Data management

## d) Reporting



**Figure 2 Scheme of inventory preparation process**

### a) Inventory planning

The planning of the Inventory includes organizational aspects, related to appointment of the team of key and deputy key experts within the department, description of specific tasks and responsibilities, development of operational procedures about data collection and data calculation on the activity rate and emission factors included in the database of the National Emission Inventory. Currently, six persons are involved in the inventory work, but for only two of them the preparation of the emission inventory is primary task. Five of them are distributed as key experts and deputy experts between sectors, but since preparation of the inventory is not their main task, they need further training to be independent in the preparation of the sector inventory, which is currently done with the support of Energy expert acting as emission inventory coordinator. The Energy expert is also responsible for update of the NFR reporting tool, KCA, Trend analysis and NFR reporting table on yearly base. Further improvement and safe sustainability of the inventory will be entirely ensured by increasing of the trained staff and dedication of the experts to inventory work as their primary task. In the frame of the document A document for the timeline of the inventory preparation has been prescribed and has been used by the experts within preparation of this inventory round.

### b) Inventory preparation

In the context of this Inventory preparation, each of the experts is involved in the identification of the sources of pollution, definition of the relevant data sources and data collection (activity data). All other activities concerning the Inventory preparation and development have been organized through this approach.

As part of QA/QC procedure deputy experts per sectors have checked in more detail manner activity data and emissions calculations as well as links in the excel preparatory files prepared by the nominated key experts per sector according to the workflow matrix.

- **Identification of sources of pollution**

In the framework of the Inventory preparation, great attention has been devoted to the identification of the sources of pollution. This was necessary for two basic reasons: the first is based on the geographical position of the Republic of North Macedonia (e.g.: there are no sources of pollution of marine or river traffic), and the second on the level of industrial and economic development of the country (there are no nuclear power plants, gas turbines, etc.).

- **Data sources**

Data from several sources have been used on the different sectors, including:

- Statistical Yearbooks of Republic of North Macedonia 1990-2023<sup>22</sup>; (starting from 2000 data are available on web)
- MAKSTAT DATABASE from SSO
- Publications published by SSO in different areas (Transport, Industry in the Republic of North Macedonia, Industry and Energy, Livestock, Agriculture and Forestry);
- Energy Balance of the Republic of North Macedonia by Ministry of economy<sup>23</sup>
- Measurements data from the industrial operators and waste incineration plant
- International web page databases (FAO, Eurostat etc.).
- Data from relevant national ministries and agencies (MOD, PEMF, MAFWS and others)

**c) Data management and processing**

Emission factors and activity data for different source categories are collected and calculated in separate NFR excel tables, for the period from 1990 to 2023. NFR tables are categorized in separate folders (ENERGY, INDUSTRY and SOLVENT PRODUCT USE, AGRICULTURE, WASTE, TRANSPORT, NATURAL SOURCES).

During each inventory preparation cycle, evaluation, and update of selected emission factors of previous years is conducted, if there is an available updated version of EMEP/EEA Guidebook. In this reporting round EF from GB 2019 were checked and excel calculations sheets and IIR tables were updated.

QA/QC activities include comparison of the value of input data with the previous year's value. If there are large deviations, the value was checked for errors such as typing or unit errors. If necessary, the primary data providers were contacted for an explanation.

The basic approach in the selection of the methodology used in the calculation of emissions and selection of emission factors for each source is driven by availability of activity data. The availability of data and possible time series inconsistencies are described for each source category in the sectorial chapters, further below. Mainly the problem is coming from the fact that data coming from the Statistical publications are not detailed enough. The last census was carried in 2021, however did not include detail data needed in different categories. Additionally, compared to the other European countries, we have started with preparation of whole time series emission inventory for all pollutants only in 2014. These effects in use of different methodology in the older statistical yearbook, and higher use of data gap filling methods that result with trend inconsistency in some sectors, as well as higher

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<sup>22</sup> <http://www.stat.gov.mk/PublikaciiPoOblast.aspx?id=34&rbrObl=37>

<sup>23</sup> <http://www.stat.gov.mk/PrethodniSooostenijaOblast.aspx?id=64&rbrObl=21>

uncertainty. However lately with introduction of MAKSTAT database the activity data are revised, more detail and historical data are introduced, which enable us to improve in this field.

Considering such difficulties in the collection of data on activity rates, as well as the fact that Republic of North Macedonia does not yet have national emission factors with exception of those provided for the major industries, Tier 1 methodologies and the corresponding emission factors from GB 2023 were used to estimate emissions from most sources in this Inventory with exception of some categories in which due to limitation of activity data, older versions of Guidebooks are used. Only in 1.A.1. and 2.C.2 implied emission factors are used. These factors were calculated based on emissions reported in the previous years and fuel used/production.

Calculation of emissions with use of Tier 2 method was carried out in the following sources: NFRs 1.B.1.a (Fugitive emission from solid fuels), 2.A.3 (Glass production), 2.D.3.a (Domestic solvent use including fungicides), 2.D.3.g (Chemical products), 2.D.3i and 2.G (Other solvents and product use) and 2.H.2 (Food and beverages industry), 5.A and 5.D.2, for the whole reporting period. Implied emission factors (IEFs) have been used in NFR categories 1.A.1.a (Public electricity and heat production), 2.A.1 (Cement production) 2.C.1 (Metal production) and 2.C.2 (Ferroalloy's production). Tier 2 has been also introduced in 2.C.5 (Lead production) and 2.C.6 (Zinc Production). The higher Tier 2 methodology was switched on Tier 2 for the following categories: 1A4bii, 1A2gii, 1A4bii, 1A4cii, 2D3e and 2D3f. The activity data were improved and included in the categories 2G and 2D3g.

Tier 3 method for calculation was used for calculation of NFR categories under 1.A.3.b for the period 2005-2023. Emission measurement data for NO<sub>x</sub>, CO, SO<sub>x</sub> and TSP considered as Tier 3 were used in the NFR category 1.A.1.a.

Regarding the specification of emission factors for certain number of emission sources, mainly for point sources (Facilities), data from the manual monthly and yearly emissions measurements of pollutant, measurements done with automated systems, carried out at the various facilities, has been used (see chapter References).

Detailed overview and explanation of activity data and emission factors for each of the NFR sectors are presented in Chapters 4.0 to 7.0.

#### **d) Reporting**

For reporting of emissions, data from separated calculated sheets tables per NFR, containing EFs, activity data and calculated emissions per pollutant, were linked to the NFR table for reporting. This was carried out with the support of a NFR Reporting Tool, which was developed within the EU Twinning project and implemented by an IT expert from MEPP. The NFR Reporting Tool transposes columns to rows, includes data analysis, and provides emission trends. NFR Reporting tool is linked with the NFR\_14 reporting template and reporting towards UNECE and EEA is carried out within the given deadline. For this year the air emission inventory was reported on 14.02.2024 and the resubmission was carried out on 15 and 25.04.2025.

During the preparation of the current submission of Informative Inventory Report in 2025, the below listed guidelines were followed:

- Revised 2014 Reporting guidelines (ECE/EB.AIR.125);



- Annex II of the Guidelines Recommended structure for the Informative Inventory Report (IIR) - Documentation of methods, trends, recalculations, activity data and other information relevant for understanding the inventory.
- EMEP/EEA air pollutant emission inventory guidebook — 2009;
- EMEP/EEA air pollutant emission inventory guidebook — 2013;
- EMEP/EEA air pollutant emission inventory guidebook — 2016;
- EMEP/EEA air pollutant emission inventory guidebook — 2019;
- EMEP/EEA air pollutant emission inventory guidebook — 2023;

The structure of the above-mentioned guidelines was followed by the authors, to achieve transparency, consistency, completeness, comparability, and accuracy of reported emission data. This IIR as the previous one, was reported after the given deadline, namely in June due to the expert's engagement in other duties, especially the activities in the current IPA project on air quality. It is planned in the future to respect the given reporting deadline also for the IIR, but this is difficult due to the fact that experts are involved in other tasks than inventory. This will be possibly if a division dedicated only on inventory work is established as proposed by the latest Institutional and Functional Review of Air Quality Management in North Macedonia of World Bank.

## 2.4. Methods and data sources

### Methodology

The methodology of the Macedonian air pollutant emission inventory is based on the UNECE CLRTAP Reporting Guidelines and the EMEP/EEA Emission Inventory Guidebook 2023, targeting on transparency, completeness, consistency, comparability, and accuracy of emissions data. In cases where we are limited with activity data, emission factors from older EMEP/EEA Emission Inventory Guidebook have been used.

The calculation of emissions is based on activity data (AD), which represents the magnitude or volume of an activity generating emissions, while an emission factor (EF) is the mass of emissions per unit of activity. Activity data is either available from official statistics, from the industry or from special studies, inquiries or e.g., from the literature. Default emission factors presented in the Guidebook have been used in the calculation of emissions. In the future there is a need to develop national emission factors in some key sectors that would more accurately correspond to the national conditions.

### Data sources

Activity data needed for emissions calculation are extracted from regular publications and databases of the State Statistical Office and other relevant governmental organizations and ministries, or also from the industry and inquiries carried out by MEIC. For sub-sectors and source categories, more detailed data are required than those published in official statistical reports, such as disaggregated energy balance, vehicle fleet etc. In the Table 7, the official activity data sources in relation to the NFR sectors are presented. The web pages for those data that are available are given in the chapter references. Data requested upon official letters or e-mails but are not available publicly are reported only here in the following table.

**Table 7 Activity data sources**

NFR Sector	Data source	Data provider
Energy	Statistical Yearly reports 1990-2023 [22] Energy balance 2009-2023 [23] Energy statistics for 2000-2010 [24] MAKSTAT database-Energy [25]	Ministry of economy MEPP State statistical office
Transport	State Statistical Office of the Republic of North Macedonia, Transport, and other communications, 2007-2015 [26], MAKSTAT database data on transport [27] MOI car fleet database 2005-2023	Ministry of Interior State statistical office
Industrial Processes	Industry in the Republic of North Macedonia, 2002-2007,2003-2003-2008,2004-2009,2005-2010,2006-2011,2007-2012,2008-2013,2009-2014, 2010-2015 [28] MAKSTAT database industrial data [29] Statistical Yearly reports 1990-2023 [22] Questionnaire for emissions in environment 2014-2023 <a href="http://minerals.usgs.gov/minerals/pubs/country/europe.html#mk">http://minerals.usgs.gov/minerals/pubs/country/europe.html#mk</a> [30]	State statistical office  MEPP
Solvent and Other Product Use	State Statistical Office of the Republic of North Macedonia. Commodity international exchange in the Republic of North Macedonia, 2006-2015 [31] Industry in the Republic of North Macedonia, 2002-2007,2003-2003-2008,2004-2009,2005-2010,2006-2011,2007-2012,2008-2013,2009-2014, 2010-2015 [28] MAK STAT database on solvent [29] Statistical Yearly reports 1990-2023 [22] Questionnaire for emissions in environment -2014-2023 Data required from SSO for activity data through info email	State statistical office  MEPP
Agriculture	State Statistical Office of the Republic of North Macedonia, Field crops, orchards and vineyards, 2007-2017 [32] Yearly Statistical reports 1990-2023 [22] State Statistical Office of the Republic of North Macedonia, Livestock, 2007-2015 [33] MAK STAT database agriculture [34] State Statistical Office of the Republic of North Macedonia, Forestry, 2000–2015 [35], Census of agriculture, 2007, Individual agricultural holdings grouped by total available land, by regions, 2008 [36] State agriculture inspectorate	State statistical office MAKSTAT database MAFWS FAO
Waste	Statistical Yearly reports 1990-2023 [22] Feasibility study on Drisla landfill, book 1of 2, General overview, Final report, August 2011 [37] “Drisla” landfill web page [38] Drisla, Yearly environmental reports, 2013, 2014, 2015, 2016,2017,2018, 2019,2020,2021,2022,2023 Data on treated communal water 1990-2023 reported by wastewater treatment plants. PRTR database in MEPP [39]	State statistical office Public enterprise “Drisla” landfill EUROSTATE Wastewater treatment plants
Natural sources	State Statistical Office of the Republic of North Macedonia, Forestry, 2007–2014 [35] Data on fires (burned area, burned forests) reported by Macedonian forest fires 1990-2023	State statistical office Public enterprise Macedonian forests

## 2.5. Key Categories

Key Category Analysis (KCA) was prepared on NFR subcategory basis for all reported pollutants.

According to the UNECE CLRTAP Reporting Guidelines sources contributing to an accumulated 80% to total emissions are defined as key sources.

Furthermore, the section on emission trends (see chapter 3) has been included to the Macedonian IIR. Description of trends and main emission sources are available for all pollutants.

Identification of key source categories of individual pollutant was made using methodology that follows the quantitative Approach 1, described in “EMEP/EEA air pollutant emission inventory guidebook 2016”. As described in Approach 1, key categories are identified using a predetermined cumulative emissions threshold. Key categories are those which when summed together cumulatively add up to 80% of the total level.

The analysis of key sources in Republic of Macedonia includes all pollutants reported under CLRTAP: pollutants which cause acidification, eutrophication, and Ground-level ozone (NO<sub>x</sub>, NMVOC, SO<sub>x</sub>, NH<sub>3</sub> and CO), Particles (TSP) and heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn). Cumulative Table 8 presents the key sources for all reported pollutants.

The KCA table shows that the energy 1A3biii (30.7%), 1A1a (26.9%), 1A2gviii (13.0%), 1A3bi (9.4%) and 1A3bii (4.8) are main sources of NO<sub>x</sub>. Energy sector emissions are mainly from power plants using lignite. 1A1a is key category for SO<sub>x</sub>, contributing with 97.2%, because of high content of sulphur in the dosmesic lignite used for electricity production. This source is key category for many metals like Hg, As, Cr, Ni and Se.

Fugitive emissions 1B2av (22.4%) from and Domestic heating are the main key sources for NMVOC followed by NFR categories from the solvent sector like 2D3d (14.2%) and 2D3a (12%).

Agriculture is main source for ammonia and the main NFR categories contributing to this pollutant are 3Da2a (18%) followed by the categories 3B1a and 3Da3, both contributing with 16%, 3B3 (13%) and 3Da1 (12.5%).

Combustion in residential combustion plants is main sources for particulates (PM<sub>10</sub> (41.2%), PM<sub>2.5</sub> (67%), TSP (32.7%) CO (65%) and HM (Zn and Cd) and POPs (PAHs (74%), DIOX (71%) pollutants. For HCB due to the closure of aluminium production installation, the in the last decade is the key category is clinical waste incineration 5C1biii, contributing with 58% followed by 1A4bi with 38%.

The key categories for all air pollutants are presented in Table 8. Key categories for pollutants under CLRTAP for 2023 are in compliance with those calculated by CEIP as checked through the REPDAP system on CEIP webpage.

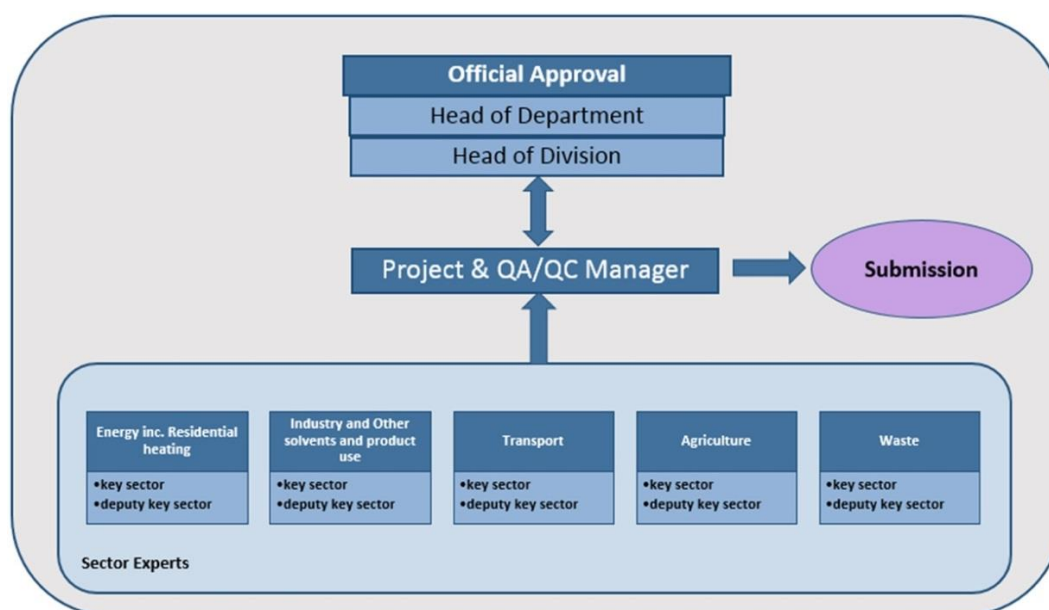
**Table 8 Key categories for all air pollutants for 2023**

Component	Key categories (Sorted from high to low from left to right)							Total (%)
NO <sub>x</sub>	1A3biii	1A1a	1A2gviii	1A3bi	1A3bii			84.7%

<b>NM VOC</b>	1B2av	1A4bi	2D3d	2D3a	3De	3B1a	1B1a	80.3%
<b>SO<sub>2</sub></b>	1A1a							97.2%
<b>NH<sub>3</sub></b>	3Da2a	3B1a	3Da3	3B3	3Da1	3B4gi		82.9%
<b>PM<sub>2.5</sub></b>	1A4bi	1A1a						80.3%
<b>PM<sub>10</sub></b>	1A4bi	1A1a	3Dc	2G				81.5%
<b>TSP</b>	1A4bi	1A1a	3Dc	2A5b	2A5a			80.7%
<b>CO</b>	1A4bi	1A3bi	5A	1A2gviii				82.9%
<b>BC</b>	1A4bi	1A3biii						82.5%
<b>Pb</b>	2G	1A1a	2C1					85.1%
<b>Cd</b>	1A4bi	1A1a	2C1					84.9%
<b>Hg</b>	1A1a	1A2gviii	2C1	2K				87.6%
<b>As</b>	1A1a							87.4%
<b>Cr</b>	1A1a	1A4bi	1A3bvi	2G	1A2a			81.8%
<b>Cu</b>	2G	1A3bvi						90.9%
<b>Ni</b>	1A1a							90.7%
<b>Se</b>	1A4bi	1A1a						99.2%
<b>Zn</b>	1A4bi	1A1a	2C1	1A3bvi				82.0%
<b>DIOX</b>	1A4bi	2C1						81.8%
<b>PAH</b>	1A4bi	1A2gviii						80.5%
<b>HCB</b>	5C1biii	1A4bi						95.8%
<b>PCBs</b>	2K	2C5						99.7%

## 2.6. QA/QC and Verification methods

QA/QC activities are part of the annual inventory preparation process as described under this chapter. A management process has been set up, defining roles and responsibilities. The inventory team in North Macedonia consists of seven experts, partly having double roles. The energy expert is also responsible for the QA/QC procedures and compiles the emissions for one sector and support industry and solvent expert (see Figure below).



**Figure 3 Roles in inventory preparation and submission**

The sector experts are responsible for selection of methods. Collection of input data, emissions calculation as well as QC, are carried out at sector level. The project Manager-Generalist oversees coordination of activities, timely preparation, and completeness of IIR, as well as cross-cutting tasks such as basic QC of report, implementation and maintaining of a QA/QC plan, review coordination within the team, as well as for key category analysis and of Review communication. The update of uncertainty analysis, KCA, trend assessment and recalculations files are done by QA/QC Manager..

### QA/QC Plan and quality objectives

A QA/QC plan still not developed due to limitation of time. The plan will lay down all procedural and technical issues to produce an inventory that complies with the reporting obligations. It will also include a list of data quality objectives, against which the Macedonian inventory can be measured, such as:

- Transparency
- Accuracy
- Completeness
- Consistency
- Comparability
- Timeliness

Progress in transparency and completeness as well as timeliness is analyzed annually. The analysis is carried out by counting the total number of data records, as well as those reported as “not estimated” and “included elsewhere” (for all air pollutants). Then the share of “NE” and “IE” to total data records is determined. The results of this year’s analysis, and a comparison with the previous submission is shown in Table below. As shown, completeness has been improved since last submission, since activity data for some sectors were made available.

The timeliness parameter of the IIR containing 2022 emission data was set to 95%, as the IIR report was submitted after the official deadline of 15<sup>th</sup> March defined in the CLRTAP Reporting Guidelines

(ECE/EP.AIR/125), due to engagement of the experts in other work overload, especially with the IPA II air quality project. Submission of emission data, i.e. NFR Tables to CEIP was however done in time on 14<sup>th</sup> February, and resubmission was done on 15<sup>th</sup> and 27<sup>th</sup> April this year.

For next year's submission it is planned to submit both, NFR tables and IIR by the set deadlines of the UNECE CLRTAP Reporting Guidelines.

**Table 9 Completeness Analysis 2023**

Sector	Submission 2024		Submission 2025			Plan Submission 2026		
	1990	2023	1990	2023	2024	1990	2023	2024
Transparency (IE)	98%	98%	98%	98%	98%	98%	98%	98%
Completeness (NE)	89%	94%	90%	95%	95%	90%	96%	97%
Completeness (IIR)	~ 342pages		~ 360 pages			~ 400 pages		
Timeliness (Submission)	95%*		96%*			100%		

Accuracy, consistency, and comparability were checked during the EMEP/EEA Reviews. Recommendations from the Stage 3 reviews (2011, 2016, 2020 and 2022), have been partially implemented as can be seen from sectorial chapters. Those that have not been implemented and will be implemented in future submission are presented in the improvement plan below. Recommendations given by the KEY expert 2 of the project "Support for implementation of Air quality directives" are also presented in the Improvement plan below.

The Workflow matrix has been prepared, and the following QA/QC activities were carried out to ensure the quality of the inventory:

**Table 10 Annual time schedule**

<b>Task</b>	<b>Description</b>	<b>Responsibility</b>	<b>Deadline</b>
AD collection and QC input data for all sectors	Requesting input data	<i>Sector expert</i>	<i>April 30</i>
	Quality control (QC) input data	<i>Sector expert</i>	<i>June 30</i>
Review results	Implementation of review recommendations	<i>Sector expert</i>	<i>October 30</i>
Emissions calculation	Estimation of emissions for all sources	<i>Sector expert</i>	<i>October 30</i>
QC (general and category specific)	Quality Checks of sectoral inventories (category-specific QC): results, emission trends, recalculations	<i>Deputy sector expert</i>	<i>November 30</i>
NFR compilation	Compilation of NFR/(aggregated) data tables	<i>Data Manager</i>	<i>December 31</i>
NFR submission	Submission of NFR tables	<i>QA/QC expert</i>	<i>February 15</i>
Time series reports & Recalculations & KCA & UA	Recalculation Analysis, Key Category Analysis, Uncertainty Analysis	<i>QA/QC expert</i>	<i>January 31</i>
IIR sectorial chapters	Compilation of the IIR – updating of methodological issues	<i>Sector expert</i>	<i>February 15</i>
Preparation of “Informative Inventory Report”	Compilation of a draft IIR report	<i>QA/QC expert</i>	<i>February 28</i>
	Provide the IIR report for Peer-Review; revision of the IIR pursuant to comments received or inclusion of recommendations in planned improvements (both from reviews and internal comments)	<i>Head of Division</i>	<i>March 1</i>
QC IIR	QC of IIR (requirements fulfilled, completeness, etc.)	<i>QA/QC expert</i>	<i>March 10</i>
Approval of submission	Official approval of the IIR report	<i>Head of Unit</i>	<i>March 15</i>
UNECE Submission	Submission of the IIR	<i>NRC</i>	<i>March 15</i>

\*These deadlines for preparation and reporting of the IIR will be respected from future submissions. During this reporting round we usually postponed submission of the IIR by June, since emission inventory experts beside inventory are also engaged in other tasks, especially this year in the IPA II project on air quality.

### 2.6.1. Quality control procedures

QC activities are an important component in the annual inventory preparation process. The basic aim is to ensure the quality of estimates and reporting and to improve the inventory. Sector related QC is performed by sector experts during (category-specific QC) and after (general QC) the inventory preparation. General checks relate to calculations and data processing. The completeness of the inventory is checked to meet the current situation of sources in the country and the pollutants likely to be emitted. Documentation/archiving of the inventory are applicable to all source categories. Category-specific quality checks relate to input data, emission data and emission factors.

- Plausibility check of data received from operators (category-specific);
- Analysis of time series data;
- If anything is unclear, questions for clarification are sent to the data provider (category-specific);
- Assessment of needs for recalculations (category-specific);
- Check of gap filled data/check interpolation and extrapolation methods (category-specific);
- Comparison of country specific emission factors with default values (category-specific);
- Documentation of actions taken in calculation sheets to ensure transparency;
- Comparison of emissions calculated and imported to the NFR template (general);
- Check of consistency within NFR template (general);
- Correct use of notation keys;

- Check if all data sources have a reference (general);
- Correct and complete description of methods.

After finalization of the IIR report, before official approval and submission, the whole report is checked by the QA/QC manager, or some other expert appointed for:

- Completeness of reporting per sector (e.g. all sectors updated);
- Completeness of general reporting (information on recalculations, KCA, UA included);
- Complete citing of references;
- Implementation of improvements;
- Consistency data tables and text in the inventory report;
- Correct and consistent information on key category analysis;
- Explanation of significant trends in the time series.

During this year, the format, consistency, and completeness of the inventory before submitted to UNECE/CEIP tables were checked through REPdap and corrections were made according to the received output file from RepDab (RepDab Report). This year minor corrections were proposed by CEIP.

### 2.6.2. Quality assurance procedures

The IIR report itself is annually sent for approval by the Head of division and one air quality expert that have not been included in the preparation process, one week before submission.

The air emission inventory reported under the LRTAP Convention is submitted to the Center of Emission Inventories and Projections (CEIP). Here, a technical review of national inventories is carried out, to improve transparency, consistency, comparability, completeness, and accuracy of submitted data.

The review consists of three stages, whereby stage 1 and 2 are carried out annually, and the third stage – the in-depth review – on an irregular basis. Findings in the Stage 1 and 2 review report are elaborated in the chapter emission trends and recalculations. The Stage 3 review of the Macedonian Inventory was carried out in May – September 2023, for emissions coming from agriculture sector and in 2024 for Solvents and product use. In 2025 projections were reviewed, however no projections were provided. Some of recommendations were incorporated in this report. Those recommendations that are planned to be implemented in the following submissions are listed in the chapter for planned improvements.

### 2.6.3. Archiving and documentation

The inventory team uses one server, where all the inventory related information is stored. As far as possible, important information used as direct input data for calculation is stored electronically (scans of hardcopies).

Each sector has a common folder system, where calculation files, raw data, references, background material and inventory report contributions are stored. Whenever a reporting cycle has been finished, the folders are closed. This is to ensure the reproducibility and transparency of the calculation for a specific reporting year. Furthermore, after each reporting cycle, all data files, spreadsheets, and electronic documents are archived as 'read-only-files', so that they are protected against unintentional change and estimates, and can be clearly traced back, e.g., during the review process. Back-up copies (DVD) of the server are made at regular intervals. Access to files is limited to the inventory team.



In the next year, the “old” files will be copied, and used as the basis for the new inventory preparation. This shall ensure consistency in the methods and data used.

Assumptions and methodological issues related to the calculation (e.g., extrapolation or gap filling), are documented in the respective calculation files. All calculation files have a sheet called “info” at the beginning, defining the person responsibility for these calculations, noting the last update, noting problems encountered, improvements needed, data sources and the status. This is important to document the work, and keep an overview, which is especially essential when one person is responsible for numerous sectors and categories.

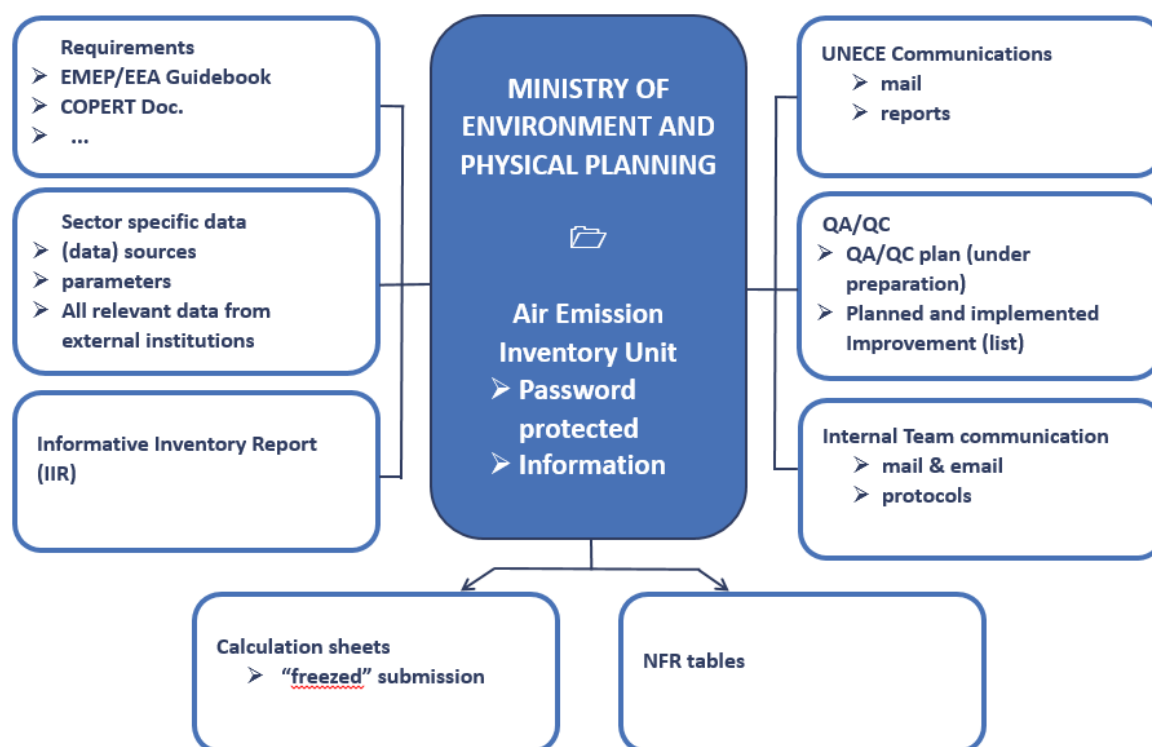
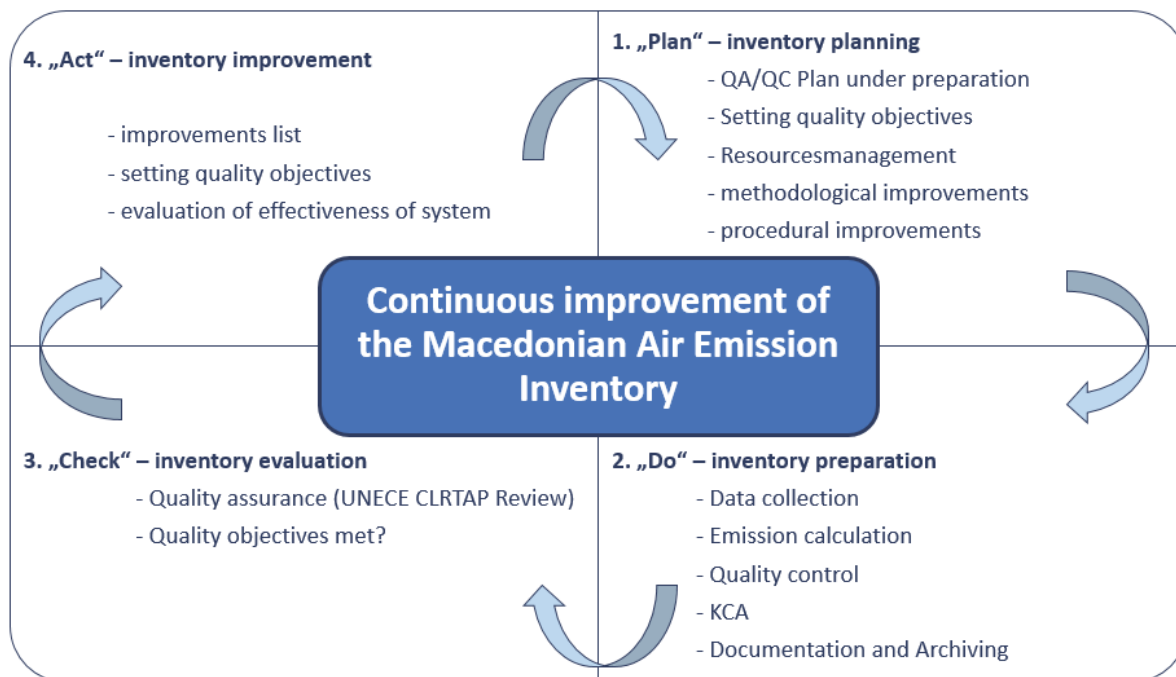


Figure 4 Archiving system

#### 2.6.4. Continuous improvement

The Macedonian inventory is subject to continuous improvement.



**Figure 5 Improvement Cycle**

For documentation and monitoring purposes, an improvement list was introduced (updated after each reporting cycle), where suggestions for improvements are collected and their implementation is monitored.

The improvement list is filled by the sector experts based on their notes in the calculation sheets. General (cross-cutting) issues are identified and collected by the project and QA/QC manager in an own list.

Sources of improvements are CLRTAP review findings, but also improvement ideas from the inventory experts, or suggestions from outside experts (in the frame of QA). Besides the source, the list includes concrete improvement measures, prioritization, and timeline for implementation of the measures as well as a documentation field for the status of implementation (“finished”).

During an internal inventory team meeting the improvements needed are discussed and prioritized based on KCA and UCA results.

## 2.7. General uncertainty evaluation

The uncertainty assessment of the main pollutants ( $\text{SO}_2$ ,  $\text{NO}_x$ , NMVOC,  $\text{NH}_3$  and  $\text{PM}_{2.5}$ ) has been carried out. The assessment was carried out for the base year 1990 and for the year 2023. An update of the uncertainty calculations will be done during the IPA II project “Support in implementation of air quality directives”.

The method for the assessment of uncertainty is described in the “EMEP/EEA air pollutant emission inventory guidebook 2016” (EEA 2016). For the Macedonian uncertainty analysis, the Tier 1 method was implemented for the main pollutants. By using the error propagation method, the uncertainties

for a specific source category can be estimated. By combining these uncertainties an overall uncertainty can be calculated. To estimate the overall uncertainty per pollutant, an uncertainty value for each activity data and emission factor in every sector had to be estimated. This assessment was based on guidance stated in Table 11 for activity and Table 12 for emission factors.

**Table 11 Rating definitions for activity data**

Data source	Error range
The national (official) statistics	-
An update of last year's statistics, using gross economic growth factors	0-2%
IEA energy statistics	OECD: 2-3% non-OECD: 5-10%
UN data bases	5-10%
Default values, other sectors and data sources	30-100%

Source: Table 3-1 Rating definitions, Chapter 5 of the EMEP/EEA emission inventory guidebook 2016.

**Table 12 Rating definitions for emission factors**

Rating	Definition	Typical Error Range
A	An estimate based on a large number of measurements made at a large number of facilities that fully represent the sector	10 to 30%
B	An estimate based on a large number of measurements made at a large number of facilities that represent a large part of the sector	20 to 60%
C	An estimate based on a number of measurements made at a small number of representative facilities, or an engineering judgment based on a number of relevant facts	50 to 200%
D	An estimate based on single measurements, or an engineering calculation derived from a number of relevant facts	100 to 300%
E	An estimate based on an engineering calculation derived from assumptions only	order of magnitude

Source: Table 3-2 Rating definitions, Chapter 5 of the EMEP/EEA emission inventory guidebook 2016.

### 2.7.1. Results

The quantitative assessment was performed with the Tier 1 method for the pollutants SO<sub>2</sub>, NO<sub>x</sub>, NMVOC, NH<sub>3</sub> and PM<sub>2.5</sub>, for the year 2022 and the respective level and trend uncertainties. The results of the uncertainty analysis are presented in following tables.

**Table 13 Result of overall uncertainty estimation for the main pollutants SO<sub>2</sub>, NO<sub>x</sub>, NMVOC, NH<sub>3</sub> and PM<sub>2.5</sub>**

Pollutants	Emissions 2023	Level uncertainty 2023	Trend uncertainty 1990 - 2023
SO <sub>2</sub>	105.1 kt	20.0%	6.6%
NOX	20.1 kt	20.1%	6.2%
NMVOC	21.3 kt	0.4 kt	0.1 kt
NH <sub>3</sub>	6.8 kt	1.0 kt	0.2 kt
PM2.5	7.6 kt	86.8%	16.1%

A more detailed presentation of the uncertainties on sectorial level is given in the following tables below.

**Table 14 Uncertainty estimation of SO<sub>2</sub> emissions 1990 and 2023**

Member State: MK												
Reporting year: 2023												
NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Mg	Mg	%	%	%	%	%	%	%	%	%
	SO2	Input data	Input data	input data Note A	input data Note A	$(E^2 + F^2)^{1/2}$	$(G^2 + D^2)^{1/2}$	Note B	D/Summe (C)	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1 A 1 a	SO2	102,1	102,2	5,0	20,0	20,62	401,61	0,06	0,91	1,17	6,43	42,70
1 A 1 b	SO2	0,8	NO	5,0	20,0	20,62						
1 A 2 a	SO2	1,4	1,3	10,0	20,0	22,36	0,08	0,00	0,01	0,00	0,16	0,03
1 A 2 b	SO2	2,1	0,0	10,0	20,0	22,36	0,00	-0,02	0,00	-0,35	0,00	0,12
1 A 2 c	SO2	0,0	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 d	SO2	0,3	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,05	0,00	0,00
1 A 2 e	SO2	0,2	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,03	0,00	0,00
1 A 2 g 8	SO2	0,4	1,0	10,0	20,0	22,36	0,05	0,01	0,01	0,11	0,13	0,03
1 A 3 a	SO2	0,0	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00
1 A 3 b	SO2	0,7	0,0	10,0	20,0	22,36	0,00	-0,01	0,00	-0,11	0,00	0,01
1 A 3 d	SO2	0,0	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 a	SO2	0,2	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,02	0,00	0,00
1 A 4 b	SO2	0,3	0,1	20,0	20,0	28,28	0,00	0,00	0,00	-0,03	0,03	0,00
1 A 4 c	SO2	0,2	0,1	10,0	20,0	22,36	0,00	0,00	0,00	-0,02	0,01	0,00
1 B 2 a	SO2	0,8	-	10,0	20,0	22,36	0,00	-0,01	0,00	-0,13	0,00	0,02
1 B 2 c	SO2	0,0	NO	20,0	20,0	28,28						
5 C	SO2	0,0	0,0	10,0	200,0	200,25	0,00	0,00	0,00	0,00	0,00	0,00
Total Uncertainties						Uncertainty in total inventory %:	20,04	Trend uncertainty %				6,55

**Table 15 Uncertainty estimation of NO<sub>x</sub> emissions 1990 and 2023**

Member State:	MK											
Reporting year:	2023											
NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emission
		Mg	Mg	%	%	%	%	%	%	%	%	%
		Input data	Input data	input data Note A	input data Note A	$(E^2 + F^2)^{1/2}$	$(G^2 + D^2) / \text{Summe}(D)^2$	Note B	D / Summe(C)	I <sup>2</sup> F Note C	J <sup>2</sup> E <sup>2</sup> sqrt(2) Note D	K <sup>2</sup> + L <sup>2</sup>
1 A 1 a	NOX	23,8	5,4	5,0	20,0	20,62	31,09	-0,11	0,12	-2,21	0,84	5,59
1 A 1 b	NOX	0,3	NO	5,0	20,0	20,62						
1 A 2 a	NOX	1,8	0,6	10,0	40,0	41,23	1,30	-0,01	0,01	-0,22	0,17	0,08
1 A 2 b	NOX	0,7	0,0	10,0	40,0	41,23	0,00	-0,01	0,00	-0,25	0,01	0,06
1 A 2 c	NOX	0,1	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,02	0,01	0,00
1 A 2 d	NOX	0,1	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,01	0,00	0,00
1 A 2 e	NOX	0,9	0,3	10,0	40,0	41,23	0,37	0,00	0,01	-0,07	0,09	0,01
1 A 2 g 7	NOX	3,8	0,3	10,0	40,0	41,23	0,40	-0,03	0,01	-1,22	0,10	1,50
1 A 2 g 8	NOX	2,0	2,6	10,0	40,0	41,23	28,85	0,04	0,06	1,52	0,81	2,97
1 A 3 a	NOX	0,3	0,5	10,0	40,0	41,23	1,08	0,01	0,01	0,32	0,16	0,13
1 A 3 b	NOX	8,9	9,0	10,0	40,0	41,23	338,60	0,11	0,20	4,42	2,78	27,27
1 A 3 c	NOX	0,4	0,0	10,0	40,0	41,23	0,01	0,00	0,00	-0,10	0,02	0,01
1 A 3 d	NOX	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 a	NOX	0,1	0,3	10,0	40,0	41,23	0,28	0,00	0,01	0,17	0,08	0,04
1 A 4 b	NOX	0,5	0,4	20,0	40,0	44,72	0,84	0,00	0,01	0,16	0,26	0,09
1 A 4 c	NOX	0,8	0,1	10,0	40,0	41,23	0,04	-0,01	0,00	-0,21	0,03	0,04
1 B 2 a	NOX	0,3	-	10,0	40,0	41,23	0,00	0,00	0,00	-0,11	0,00	0,01
1 B 2 c	NOX	0,0	NA	20,0	40,0	44,72						
2 G	NOX	0,0	0,0	20,0	40,0	44,72	0,00	0,00	0,00	-0,02	0,00	0,00
3 B 1	NOX	0,1	0,1	5,3	40,0	40,35	0,02	0,00	0,00	0,01	0,01	0,00
3 B 2	NOX	0,0	0,0	10,2	40,0	41,28	0,00	0,00	0,00	0,00	0,00	0,00
3 B 3	NOX	0,0	0,0	6,1	40,0	40,46	0,00	0,00	0,00	0,00	0,00	0,00
3 B 4	NOX	0,1	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,01	0,01	0,00
3 Da	NOX	0,3	0,3	50,0	40,0	64,03	0,97	0,00	0,01	0,17	0,48	0,26
5 C	NOX	0,1	0,0	10,0	200,0	200,25	0,17	0,00	0,00	0,08	0,01	0,01
Total Uncertainties						Uncertainty in total inventory %:	20,10	Trend uncertainty %				6,17

Member State:	MK											
Reporting year:	2023											
NRF sector	Pollutant	Base year emission	Year t emission	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emission
		Mg	Mg	%	%	%	%	%	%	%	%	%
		Input data	Input data	input data Note A	input data Note A	(E²+ F²)^(1/2)	(G'D)/2/Summe (D')²	Note B	D'Summe( C)	F'F Note C	J'E'sqrt(2) Note D	K² + L²/2
1 A 1 a	NM/OC	0,1	0,1	5,0	200,0	200,06	0,74	0,00	0,00	0,22	0,02	0,05
1 A 1 b	NM/OC	0,0	NO	5,0	200,0	200,06						
1 A 2 a	NM/OC	0,2	0,2	10,0	200,0	200,25	2,76	0,00	0,00	0,35	0,06	0,13
1 A 2 b	NM/OC	0,2	0,0	10,0	200,0	200,25	0,00	0,00	0,00	-0,55	0,00	0,31
1 A 2 c	NM/OC	0,0	0,0	10,0	200,0	200,25	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 d	NM/OC	0,0	0,0	10,0	200,0	200,25	0,00	0,00	0,00	-0,07	0,00	0,00
1 A 2 e	NM/OC	0,1	0,1	10,0	200,0	200,25	0,28	0,00	0,00	0,13	0,02	0,02
1 A 2 g 7	NM/OC	0,8	0,0	10,0	40,0	41,23	0,00	-0,01	0,00	-0,37	0,01	0,14
1 A 2 g 8	NM/OC	0,1	0,2	10,0	40,0	41,23	0,12	0,00	0,00	0,12	0,06	0,02
1 A 3 a	NM/OC	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 3 b	NM/OC	14,8	0,9	10,0	40,0	41,23	3,22	-0,17	0,02	-6,61	0,32	43,74
1 A 3 c	NM/OC	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,01	0,00	0,00
1 A 3 d	NM/OC	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 a	NM/OC	0,0	0,1	10,0	40,0	41,23	0,01	0,00	0,00	0,05	0,02	0,00
1 A 4 b	NM/OC	5,8	4,1	20,0	40,0	44,72	75,76	0,03	0,10	1,08	2,87	9,37
1 A 4 c	NM/OC	0,1	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,01	0,01	0,00
1 B 1 a	NM/OC	1,3	0,8	10,0	20,0	22,36	0,71	0,00	0,02	0,05	0,28	0,08
1 B 2 a	NM/OC	2,9	4,7	10,0	20,0	22,36	24,93	0,08	0,12	1,58	1,64	5,20
1 B 2 c	NM/OC	0,0	NO	20,0	20,0	28,28						
2 A 3	NM/OC	0,0	NO	10,0	40,0	41,23						
2 C 1	NM/OC	0,1	0,0	2,0	125,0	125,02	0,01	0,00	0,00	-0,16	0,00	0,03
2 D	NM/OC	6,5	6,1	20,0	125,0	126,59	1.327,71	0,07	0,15	8,38	4,24	88,17
2 G	NM/OC	0,5	0,0	20,0	40,0	44,72	0,01	-0,01	0,00	-0,22	0,03	0,05
2 H	NM/OC	1,2	0,6	20,0	40,0	44,72	1,47	0,00	0,01	-0,02	0,40	0,16
3 B 1	NM/OC	2,7	1,4	5,3	40,0	40,35	7,33	0,00	0,03	0,03	0,26	0,07
3 B 2	NM/OC	0,4	0,1	10,2	40,0	41,28	0,04	0,00	0,00	-0,10	0,04	0,01
3 B 3	NM/OC	0,1	0,1	6,1	40,0	40,46	0,06	0,00	0,00	0,06	0,03	0,00
3 B 4	NM/OC	1,6	0,4	10,0	40,0	41,23	0,59	-0,01	0,01	-0,44	0,14	0,21
3 D a	NM/OC	-	-	50,0	40,0	64,03	0,00	0,00	0,00	0,00	0,00	0,00
3 G	NM/OC											
3 H	NM/OC											
3 I	NM/OC	NE	NE									
5 A	NM/OC	0,0	0,1	50,0	125,0	134,63	0,26	0,00	0,00	0,18	0,14	0,05
5 B	NM/OC	-	-</									

**Table 17 Uncertainty estimation of NH<sub>3</sub> emissions 1990 and 2023**

Member State:	MK											
Reporting year:	2023											
NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emission
		Mg	Mg	%	%	%	%	%	%	%	%	%
	PM2.5	Input data	Input data	input data Note A	input data Note A	(E <sup>2</sup> +F <sup>2</sup> )^(1/2)	(G <sup>2</sup> +D <sup>2</sup> +Summe(D) <sup>2</sup> )^(1/2)	Note B	D/Summe( C)	I <sup>2</sup> F Note C	J <sup>2</sup> E <sup>2</sup> sqrt(2) Note D	K <sup>2</sup> + L <sup>2</sup>
1 A 1 a	PM2.5	3,5	1,1	5,0	125,0	125,10	311,19	0,00	0,04	0,16	0,09	0,39
1 A 1 b	PM2.5	0,0	NO	5,0	40,0	40,31						
1 A 2 a	PM2.5	0,2	0,2	10,0	40,0	41,23	0,87	0,00	0,01	0,16	0,09	0,03
1 A 2 b	PM2.5	0,3	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,10	0,00	0,01
1 A 2 c	PM2.5	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 d	PM2.5	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,01	0,00	0,00
1 A 2 e	PM2.5	0,1	0,0	10,0	40,0	41,23	0,02	0,00	0,00	0,02	0,01	0,00
1 A 2 g 7	PM2.5	0,5	0,0	10,0	125,0	125,40	0,05	0,00	0,00	-0,52	0,01	0,27
1 A 2 g 8	PM2.5	0,1	0,1	10,0	125,0	125,40	5,75	0,00	0,01	0,55	0,07	0,31
1 A 3 a	PM2.5	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 3 b	PM2.5	0,0	0,4	10,0	40,0	41,23	4,17	0,01	0,01	0,51	0,19	0,30
1 A 3 c	PM2.5	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 3 d	PM2.5	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 a	PM2.5	0,0	0,0	10,0	125,0	125,40	0,26	0,00	0,00	0,11	0,02	0,01
1 A 4 b	PM2.5	6,9	5,1	20,0	125,0	126,59	7.195,30	0,11	0,18	14,16	5,08	226,30
1 A 4 c	PM2.5	0,1	0,0	10,0	125,0	125,40	0,17	0,00	0,00	0,03	0,01	0,00
1 B 1 a	PM2.5	0,0	0,0	10,0	200,0	200,25	0,40	0,00	0,00	0,09	0,01	0,01
1 B 2 a	PM2.5	0,0	-	10,0	200,0	200,25	0,00	0,00	0,00	-0,01	0,00	0,00
2 A 1	PM2.5	0,1	0,0	2,0	200,0	200,01	0,55	0,00	0,00	0,08	0,00	0,01
2 A 2	PM2.5	0,0	NO	5,0	200,0	200,06						
2 A 3	PM2.5	0,0	NO	10,0	200,0	200,25						
2 A 5	PM2.5	0,1	0,1	10,0	200,0	200,25	5,57	0,00	0,00	0,50	0,04	0,25
2 C 1	PM2.5	0,1	0,0	2,0	40,0	40,05	0,00	0,00	0,00	-0,04	0,00	0,00
2 C 2	PM2.5	14,7	0,0	5,0	40,0	40,31	0,00	-0,14	0,00	-5,56	0,00	30,87
2 C 3	PM2.5	0,0	NE	2,0	40,0	40,05						
2 C 5	PM2.5	0,2	0,0	5,0	40,0	40,31	0,00	0,00	0,00	-0,07	0,00	0,01
2 C 6	PM2.5	0,0	NO	5,0	40,0	40,31						
2 D	PM2.5	0,0	0,0	20,0	40,0	44,72	0,00	0,00	0,00	-0,01	0,00	0,00
2 G	PM2.5	0,9	0,4	20,0	40,0	44,72	4,44	0,00	0,01	0,15	0,36	0,15
3 B 1	PM2.5	0,1	0,0	5,3	200,0	200,07	1,28	0,00	0,00	0,15	0,01	0,02
3 B 2	PM2.5	0,0	0,0	10,2	200,0	200,26	0,10	0,00	0,00	0,00	0,01	0,00
3 B 3	PM2.5	0,0	0,0	6,1	200,0	200,09	0,00	0,00	0,00	0,01	0,00	0,00
3 B 4	PM2.5	0,0	0,0	10,0	200,0	200,25	0,06	0,00	0,00	0,01	0,00	0,00
3 D a	PM2.5	-	-	50,0	200,0	206,16	0,00	0,00	0,00	0,00	0,00	0,00
5 A	PM2.5	0,0	0,0	50,0	200,0	206,16	0,00	0,00	0,00	0,00	0,00	0,00
5 B	PM2.5	-	-	-	-	-	-	0,00	0,00	-	-	-
5 C	PM2.5	0,1	0,1	10,0	200,0	200,25	2,04	0,00	0,00	0,25	0,03	0,06
5 D	PM2.5	-	-	-	-	-	-	0,00	0,00	-	-	-
Total		28,198	7,6				7.532,21		259,01			
Total Uncertainties						Uncertainty in total inventory %:	86,79	Trend uncertainty %				16,09

**Table 18 Uncertainty estimation of PM2.5 emissions 1990 and 2023**

Member State: MK												
Reporting year: 2023												
NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation paramete	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissio
		Mg	Mg	%	%	%	%	%	%	%	%	%
	NH3	Input data	Input data	input data Note A	input data Note A	$(E^2 + F^2)^{1/2}$	$(G^2 D^2 + \text{Summe}(D)^2)$	Note B	D/Summe( C)	I^F Note C	J^E'sqrt(2) Note D	K^2 + L^2
1 A 1 a	NH3	NA	NA	5,0								
1 A 1 b	NH3	NE	NO	5,0								
1 A 1 c	NH3	NO	NO									
1 A 2 a	NH3	NA	0,0	10,0					0,00		0,00	
1 A 2 b	NH3	NA	10,0									
1 A 2 c	NH3	NA	NA	10,0								
1 A 2 d	NH3	NA	0,0	10,0					0,00		0,00	
1 A 2 e	NH3	NA	0,0	10,0					0,00		0,00	
1 A 2 f	NH3	NO	NO									
1 A 2 g 7	NH3	0,0	0,0	10,0	125,0	125,40	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 g 8	NH3	0,0	0,0	10,0				0,00	0,00		0,00	
1 A 3 a	NH3	-	-	10,0				0,00	0,00		0,00	
1 A 3 b	NH3	-	0,1	10,0	125,0	125,40	3,55	0,01	0,01	0,86	0,10	0,76
1 A 3 c	NH3	0,0	0,0	10,0	125,0	125,40	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 b	NH3	0,1	0,1	20,0	125,0	126,59	1,10	0,00	0,00	0,18	0,11	0,05
1 A 4 c	NH3	0,0	0,0	10,0	125,0	125,40	0,00	0,00	0,00	0,00	0,00	0,00
1 B 2 a	NH3	0,0	-	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
2 A 3	NH3	0,0	NO	10,0	40,0	41,23						
3 B 1	NH3	2,9	1,6	5,3	125,0	125,11	837,36	0,02	0,11	1,90	0,80	4,25
3 B 2	NH3	0,9	0,2	10,2	125,0	125,42	18,89	-0,01	0,02	-1,60	0,23	2,60
3 B 3	NH3	0,9	0,9	6,1	125,0	125,15	279,95	0,03	0,06	4,28	0,53	18,57
3 B 4	NH3	2,4	0,7	10,0	125,0	125,40	150,12	-0,03	0,04	-3,73	0,64	14,34
3 D a	NH3	7,4	3,1	50,0	200,0	206,16	9.025,60	-0,02	0,21	-3,99	15,00	240,84
3 D b	NH3	NE	NE									
3 D d	NH3	NE	NE									
3 D e	NH3	NA	NA									
3 F	NH3	NE	NE									
3 G	NH3											
3 H	NH3											
3 I	NH3	NE	NE									
5 A	NH3	0,0	0,0	50,0				0,00	0,00		0,01	
5 B	NH3	-	0,0					0,00	0,00			
5 C	NH3	-	-	10,0				0,00	0,00		0,00	
5 D	NH3	-	-					0,00	0,00			
Total		14,7	6,8				10.316,57					281,40
Total Uncertainties						Uncertainty in total inventory %:	101,57	Trend uncertainty %				16,78

## 2.7.2. Background information

### ENERGY

For the calculation of the energy balance, the methodology "Energy Statistics Methodology, Eurostat F4, 1998" is used. The Energy balance is prepared in accordance with Regulation No 1099/2008 on energy statistics.

#### a) Energy balance 2023

The data for the whole year 2023 has been taken from the State Statistical Office (SSO).

In the preparation of the balance of network energy (electricity and gas), predictions and forecasts of consumption and losses in the systems were used. The data was obtained from the operators and anticipated needs of large customers, as well as forecasts for production of electricity generators.

The data for crude oil and petroleum products, and coal (coke, lignite and coal) was obtained from manufacturers, importers of energy (traders and/or large consumers).

### Households



The estimates in the survey on energy consumption in households during 2014, are generally in the form of totals and averages. The scope of estimation is the total number of households in Republic of North Macedonia divided between the eight statistical regions. The estimation procedures of SECH data were performed by weighting the probabilities of a sample selection, with a certain adjustment for non-response to the survey and calibrating the weight, according to population estimates from the regional demographic distributions by sex and five-year age groups, as well as the estimated number of households in the regions. Calculations were performed in SAS 9.1 using the CALMAR module for calibrating weights. The non-response rate in SECH 2014 is 6.5% and the refusal rate is 3.6%. Because of calculations of the sample and rounding up calculated results to one number, sometimes deviations are possible in the total of the results, obtained by summing up individual items. The survey results affect the activity data on biomass consumption for 2015 and onwards within the energy balance.

### Transport

Data sources for road transport statistics are the regular monthly and annual reports submitted by business entities, whose main activity according to National Classification of Activities is road transport. Data on the number of registered road motor vehicles, type of vehicles and year of production, vehicle by type of fuel, road traffic accidents and data on cross-border traffic of passengers and vehicles, are taken from the Ministry of Internal Affairs. Data on road network are taken from the Agency for State Roads, while the data on local road network are obtained from the units of local self-government (municipalities). Regular cross-border passenger traffic is performed based on regular international travel documents for passengers and vehicles, without restriction on final destination. Small-scale border traffic of passengers is performed based on bilateral agreements with neighboring countries, only in areas covered by the agreements.

### Industry

The State Statistical Office of the Republic of North Macedonia, in cooperation with the regional statistical offices, has collected data included in this chapter from the existing records of the enterprises and their units distributed in the field of industry. This data is covered in the Monthly Industrial Report and the Annual Industrial Report. The data from the Monthly Industrial Report are the basis for calculating the indices of the production, stocks and the employees. The data on the industrial production in natural indicators are collected by the Annual Industrial Report. The coverage goes until 1999 in the Monthly Industrial Report and until 1998 in the Annual Industrial Report; data on industry were collected according to the Uniform Classification of Economic Activities (UCEA); since 1999 and 2001 in the Annual Industrial Report and the Monthly Industrial Report, respectively, data are collected according to the National Classification of Activities NKD Rev.1. In 2010, in the Annual Industrial Report for 2009, the National Classification of Activities NKD Rev.2 and the National Nomenclature of Industrial Products NNIP 2008, were implemented. All business entities with 10 and more employees in main, auxiliary, or supporting manufacturing activities are included.

### Agriculture

The estimates in the Livestock Survey are in the forms of totals and ratios. The domain of estimates is the whole country and the eight regions. Sample selection weights were used in the estimation procedures of the 2016 Livestock Survey, with certain adjustments made regarding the survey non-response rate. The errors are calculated as relative errors. All calculations were made with the SAS statistical software package. The non-response rate in the Livestock Survey 2016 was 5.3%. The following table shows the calculated relative errors of the main categories of livestock in the survey

for 2016. For 2022 data are gathered from MAKSTAT database. There are no available data for uncertainty since these data are no longer published.

**Table 19 Relative errors of livestock survey 2015**

Relative errors	Cattle	Pigs	Sheep	Poultry	Goats
Republic of North Macedonia	5.3	6.1	10.2	7.7	9.4

## Waste

Municipal waste is waste collected by, or on behalf of municipal authorities. It consists of waste from the households, including the massive waste, similar waste from commercial and trade industries, official buildings, institutions and small business, waste from gardens, street waste, the content of waste containers and the waste from market cleaning. The definition excludes waste from the municipal sewage networks, and the waste from construction and demolition. The data presented here were obtained through the regular annual statistical survey on municipal waste, which was carried out in 2009 (reference year 2008) for the first time, in accordance with the national legislation and European standards. Reporting units are the municipal enterprises in Republic of North Macedonia. Data on the total amount of collected municipal waste, as well as data on the treatment of collected municipal waste, have been obtained based on the reports filled in by the reporting units. On the basis of the obtained data and the data on the number of populations, estimation has been made of the total generated municipal waste on the territory of the Republic of North Macedonia. The obtained indicator of the annual amount of municipal waste per person in kg is a ratio of the total annual amount of generated municipal waste and the total population estimated for the reference year (as at 01.01. in the reference year).

## 2.8. General assessment of completeness

Notation keys are used according to the revised 2014 Reporting guidelines (ECE/EB.AIR.125) (see table below), to indicate where emissions are not occurring in North Macedonia, where emissions have not been estimated or have been included elsewhere as suggested by GB 2023.

**Table 20 Notation keys used in the NFR**

Abbreviation	Meaning	Objective
NA	not applicable	Is used for activities in each source category which are believed not to result in significant emissions of a specific compound;
NE	not estimated	For activity data and/or emissions by sources of pollutants which have not been estimated but for which a corresponding activity may occur within a Party. Where NE is used in an inventory to report emissions of pollutants, the Party should indicate in the IIR why such emissions have not been estimated. Furthermore, a Party may consider that a disproportionate amount of effort would be required to collect data for a pollutant from a specific category that would be insignificant in terms of the overall level and trend in national emissions and in such cases use the notation key NE. The Party should provide in the IIR justifications for their use of NE notation keys, e.g., lack of robust data, lack of methodology, etc. Once emissions from a specific category have been reported in a previous submission, emissions from this specific category should be reported in subsequent inventory submissions;
IE	included elsewhere	For emissions by sources of pollutants estimated but included elsewhere in the inventory instead of under the expected source category. Where IE is used in an inventory, the Party should indicate, in the IIR, where in the inventory the emissions for the displaced source category have been included, and the Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality;
C	confidential	(Confidential information), for emissions by sources of pollutants of which the reporting could lead to the disclosure of confidential information. The source category where these emissions are included should be indicated;
NO	not occurring	For categories or processes within a particular source category that do not occur within a Party;

Abbreviation	Meaning	Objective
NR	not relevant	According to paragraph 37 in the Guidelines, emission inventory reporting for the main pollutants should cover all years from 1990 onwards if data are available. However, NR is introduced to ease the reporting where reporting of emissions is not strictly required by the different protocols, e.g., emissions for some Parties prior to agreed base years.

### 2.8.1. Sources not estimated (NE)

**Table 21 Number of “not estimated” (NE) per sector and pollutant in 2023**

	Energy	Fugitives	IPPU	Agriculture	Waste	Other
NOx	2	0	4	2	0	0
(as NO2)	2	0	2	1	0	0
NMVOC	2	0	5	0	0	0
SOx	2	0	4	2	5	0
(as SO2)	3	0	4	2	1	0
NH3	3	0	4	2	1	0
PM2.5	2	0	4	2	1	0
PM10	3	0	6	0	1	0
TSP	2	0	3	1	0	0
BC	3	0	5	0	1	0
CO	3	0	5	0	1	0
Pb	3	0	5	0	1	0
Cd	3	0	4	0	1	0
Hg	3	0	3	0	1	0
As	3	0	4	0	1	0
Cr	3	0	5	0	1	0
Cu	3	0	5	0	0	0
Ni	3	0	4	0	0	0
Se	4	1	6	0	1	0
Zn	4	0	2	0	0	0
PCDD/ PCDF (dioxins/ furans)	4	0	7	0	0	0
PAHs (Total 1-4)	4	0	6	0	0	0
HCB	2	0	4	2	0	0
PCBs	2	0	2	1	0	0

Not estimated categories are due to not available activity data in the country, mainly for historical emissions since statistical data are now more detail and not summarized as previously. For some categories there is no available default EF to make the calculations.

### 2.8.2. Sources included elsewhere (IE)

**Table 22 Number of “included elsewhere” (IE) per sector and pollutant in 2023**

Pollutant	Energy	Fugitives	IPPU	Agriculture	Waste	Other
NOx (as NO2)	0	0	3	3	0	0
NMVOC	0	0	3	3	0	0
SOx (as SO2)	0	0	3	1	0	0

NH3	0	0	3	1	0	0
PM2.5	0	0	3	1	0	0
PM10	0	0	3	1	0	0
TSP	0	0	3	1	0	0
BC	0	0	3	0	0	0
CO	0	0	3	0	0	0
Pb	0	0	3	0	0	0
Cd	0	0	3	0	0	0
Hg	0	0	3	0	0	0
As	0	0	3	0	0	0
Cr	0	0	3	0	0	0
Cu	0	0	3	0	0	0
Ni	0	0	3	0	0	0
Se	0	0	3	0	0	0
Zn	0	0	3	0	0	0
PCDD/ PCDF (dioxins/ furans)	0	0	3	0	0	0
PAHs (Total 1-4)	0	0	3	0	0	0
HCB	0	0	3	0	0	0
PCBs	0	0	3	0	0	0

The notation key -" included elsewhere" (IE) is used in those source categories for which activity data are not available in the required details in the statistical yearbooks but have been included in other source categories. For example, in case of category 1.A.5.b there are available data for the last three years, while emissions from the previous years are noted as IE as these emissions are accounted in offroad transport sector. For category 1.A.4.a.ii, there are available data for the period 2005-2023 while for the previous years, emissions are noted as IE as emissions included in 1A4ai. For 1A2f emissions are included in 1A2gviii. In the agriculture sector emissions for NO<sub>x</sub> and NMVOC in the categories 3Da2a and are included in 3Da3a. Abbreviation IE is used in cases where there is a lack of detail activity data.

The other notation keys used in the reporting are NA and NO. Use of the NA is due to missing EF in the EMEP Guidebook, while NO is used for processes mostly in the industry sector which are not occurring in the country. Most of processes like Nitric acid, ammonia, pulp production, cremation, municipal waste incineration are not occurring. Some activities started later in the reporting period like clinical waste incineration in 2000, or some stopped like production of oil or other metal and glass production. The number of used NO and NA notation keys are given in the following table.

**Table 23 Number of "Not available" (NA) per sector and pollutant in 2023**

Pollutant	Energy	Fugitives	IPPU	Agriculture	Waste	Other
<b>NO<sub>x</sub></b> <b>(as NO<sub>2</sub>)</b>	3	3	20	6	8	0
<b>NMVOC</b>	2	1	11	7	5	0

SOx (as SO <sub>2</sub> )	4	3	19	21	8	0
NH <sub>3</sub>	9	2	22	6	3	0
PM <sub>2.5</sub>	1	2	10	8	7	0
PM <sub>10</sub>	1	2	10	8	7	0
TSP	3	2	8	8	6	0
BC	2	3	15	22	7	0
CO	3	3	20	21	7	0
Pb	8	3	18	22	7	0
Cd	3	3	17	22	7	0
Hg	10	2	18	22	8	0
As	9	2	18	22	7	0
Cr	3	3	20	22	7	0
Cu	3	3	20	22	7	0
Ni	3	3	19	22	8	0
Se	4	3	20	22	9	0
Zn	3	3	20	22	9	0
PCDD/ PCDF (dioxins/ furans)	9	3	17	22	7	0
PAHs (Total 1- 4)	5	3	19	16	7	0
HCB	9	3	19	16	7	0
PCBs	9	3	17	16	8	0

**Table 24 Number of “Not occurring” (NO) per sector and pollutant in 2023**

Pollutant	Energy	Fugitives	IPPU	Agriculture	Waste	Other
NOx (as NO <sub>2</sub> )	3	6	16	4	5	1
NMVOC	3	6	16	4	5	1
SOx (as SO <sub>2</sub> )	3	6	16	4	5	1
NH <sub>3</sub>	3	6	16	4	5	1
PM <sub>2.5</sub>	3	6	16	4	5	1
PM <sub>10</sub>	3	6	16	4	5	1
TSP	3	6	16	4	5	1
BC	3	6	15	4	5	1
CO	3	6	16	4	5	1
Pb	3	6	16	4	5	1
Cd	3	6	16	4	5	1
Hg	3	6	16	4	5	1
As	3	6	16	4	5	1
Cr	3	6	16	4	5	1
Cu	3	6	16	4	5	1
Ni	3	6	16	4	5	1
Se	3	6	16	4	5	1
Zn	3	6	16	4	5	1

<b>PCDD/ PCDF (dioxins/ furans)</b>	3	5	16	4	5	1
<b>PAHs</b>	3	6	17	10	6	1
<b>HCB</b>	3	6	17	10	6	1
<b>PCBs</b>	3	6	17	10	6	1

# EXPLANATION OF KEY TRENDS



### 3. EXPLANATION OF KEY TRENDS

This chapter describes the trends and the drivers of the air pollutants required for the report.

#### 3.1. Emission Trends for the Main Air Pollutants and CO

National total emissions and trends for the main air pollutants (NO<sub>x</sub>, NMVOC, SO<sub>2</sub> and NH<sub>3</sub>) and CO, which are covered by the Gothenburg Protocol, from 1990-2023 are presented in the following table.

**Table 25 Emission trends 1990 – 2023 for the main air pollutants and CO**

Year	Emission in kt				
	NO <sub>x</sub>	NMVOC	SO <sub>2</sub>	NH <sub>3</sub>	CO
1990	45.52	40.83	112.40	14.72	106.66
1991	37.76	35.77	91.44	13.89	89.63
1992	39.72	37.34	88.66	13.92	99.35
1993	41.25	39.79	91.13	14.13	105.44
1994	36.87	33.92	90.27	14.12	94.56
1995	39.42	38.73	96.53	13.91	100.05
1996	38.79	36.78	90.54	12.86	96.61
1997	38.09	38.03	94.84	12.45	99.79
1998	43.39	38.70	109.37	12.19	103.99
1999	40.59	38.88	99.31	12.31	105.17
2000	43.84	39.84	106.26	12.18	112.88
2001	40.89	34.49	108.28	11.68	89.01
2002	40.80	31.53	96.12	11.08	91.11
2003	35.72	31.08	94.71	10.95	89.26
2004	36.97	31.42	95.64	11.02	94.01
2005	35.10	23.24	94.77	10.61	74.13
2006	34.97	24.48	93.18	10.88	69.77
2007	38.02	25.16	98.52	10.72	70.77
2008	33.92	24.98	76.88	10.65	66.08
2009	34.79	23.05	103.10	9.87	62.19
2010	36.18	24.31	85.69	10.06	61.33
2011	38.28	24.93	103.45	10.38	62.94
2012	35.78	25.00	91.34	9.56	65.34
2013	28.16	24.48	82.06	9.55	62.93
2014	25.76	24.25	82.71	9.61	60.67
2015	20.94	23.73	75.02	9.57	58.57
2016	23.97	23.40	63.29	9.72	61.47
2017	22.61	23.93	54.74	9.66	53.73
2018	21.78	23.25	59.82	9.31	53.01
2019	22.27	22.92	115.44	7.96	53.57

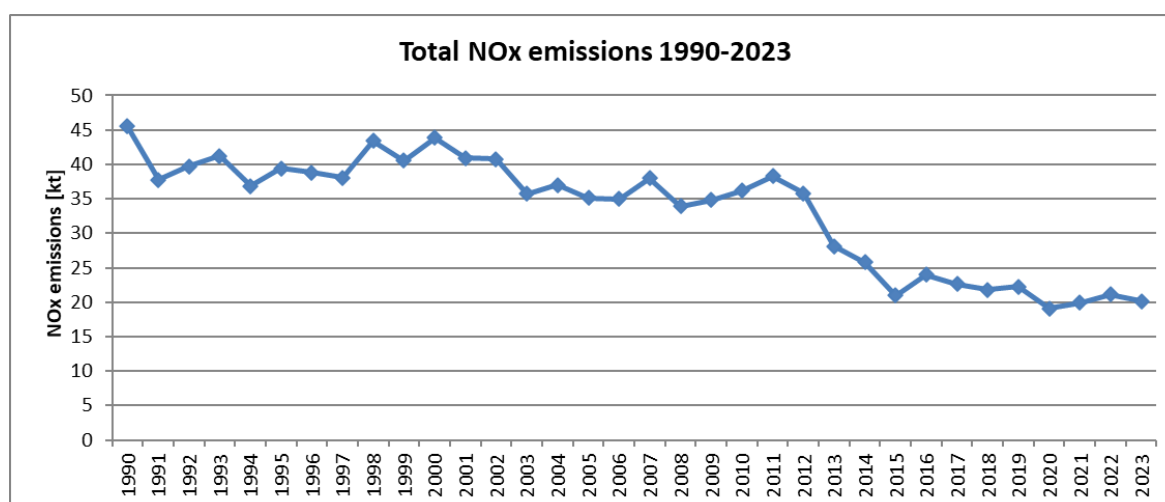


2020	19.11	21.72	93.45	8.13	48.82
2021	19.95	21.81	88.61	7.60	50.07
2022	21.11	22.15	94.94	7.30	46.61
2023	16.94	21.18	105.12	6.78	43.39
<b>Trend 1990-2023</b>	<b>-54%</b>	<b>-48%</b>	<b>-6%</b>	<b>-54%</b>	<b>-60%</b>

### 3.1.1. NOx emissions

#### Emission trend

In 1990 national total NOx emissions amounted to around 46 kt. Since then, the emissions decreased by 50%. In 2023 emissions were on the level of about 20.147 kt. The trend is variable but with minor pics and deeps until 2021. The sharp fall of emissions between 2012 and 2015 is owned to the lower consumption of coal in the major power plants and the modernization of boilers in the power plant REK Bitola. In the period 2016–2023, the emissions are stable without sharp deeps and jams. Compared to 2023, emissions in 2022 are lower for 5% owing to lower emissions in Transport, due to lower emissions in NFR category 1A3biii.



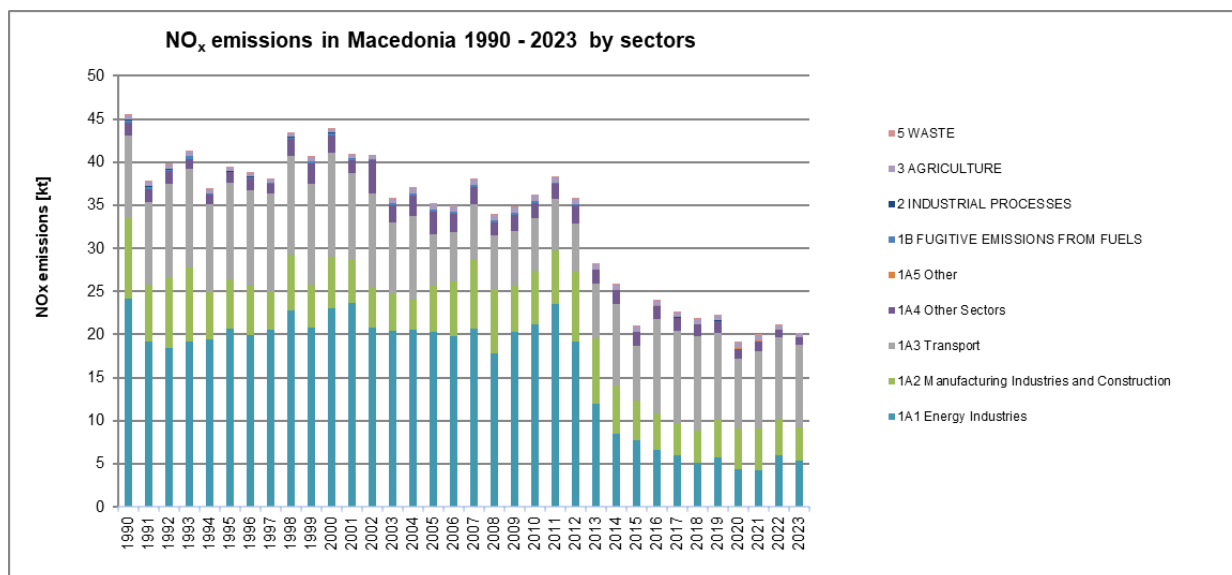
**Figure 6 National total NOx emissions 1990-2023**

The target value for NOx according to the Gothenburg Protocol for the year 2010 is 39 kt. Republic of North Macedonia which is party to the UNECE Gothenburg protocol since 2014 regularly meets that target value and starting from this year the emissions trend is stable. The country is also in compliance with the Protocol in controlling the nitrogen oxides or their trans-boundary fluxes, meaning that NOx emissions in 2023 are less than the NOx emissions reported for 1987. With regards to LCPs, according to the NERP prepared under Energy community agreement, the emissions from LCPs were below national emission ceiling for 2023, which is accounting 8.422Gg.

#### Main emission sources in North Macedonia

Almost all NOx emissions are coming from the sector Energy, Namely, the main emission sources in 2022 are NFR source categories: 1.A.3 Transport, 1.A.1 Energy Industries and 1.A.2 Manufacturing Industries and Construction which contributed with 48% (21% in 1990), 27% (53% in 1990) and 19% (21% in 1990) respectively, of the national total NOx emissions. Due to the increase of the number of vehicles during the reporting period and the lower consumption of coal as well as heavy fuel oil during

the reporting period, the primary source of emissions in 2023 is found to be transportation, as opposed to 1990, when the energy sector and heat production were the largest source of emissions. The Contribution of NFR source category 1.A.2 - Manufacturing Industries is 21% and has not changed significantly in comparison to the value in 1990 of 21%. NFR sectors 1.A.4 Other sectors and 3.Agriculture contribute with 4% and 2% respectively, while 1.B Fugitive emissions, 2 Industrial Processes and Product Use and 5 Waste are minor sources of NO<sub>x</sub> emissions.

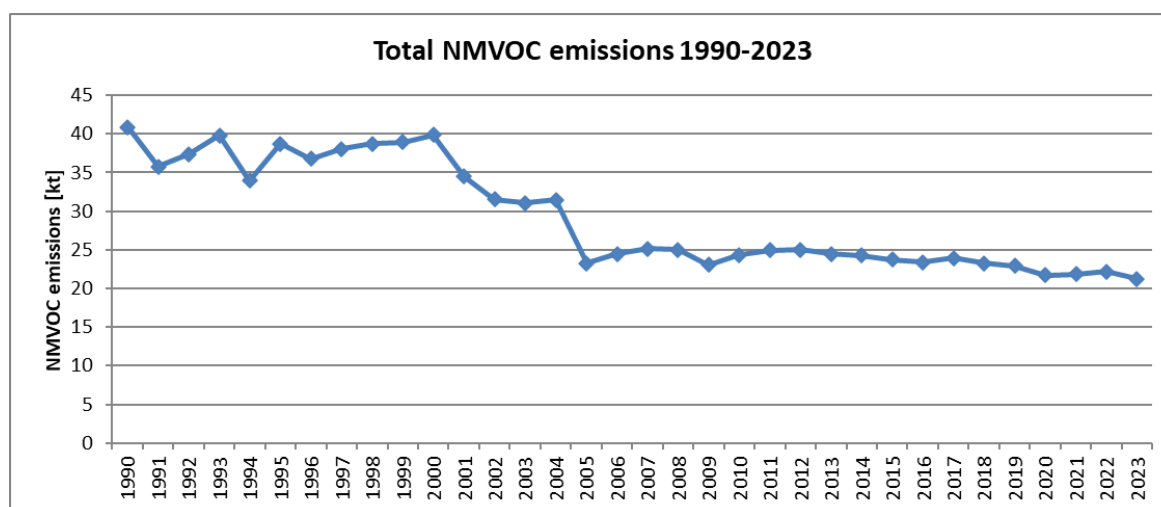


**Figure 7 NO<sub>x</sub> emissions in North Macedonia 1990-2023 by sectors**

### 3.1.2. NMVOC emissions

#### Emission trend

In 1990, the total national NMVOC emissions amounted to about 40.8 kt. Compared to 2023, the emissions are down by 48% amounting to around 21.3 kt. Calculated emissions in 2023 compared to 2022 emissions decreased only by 4%.



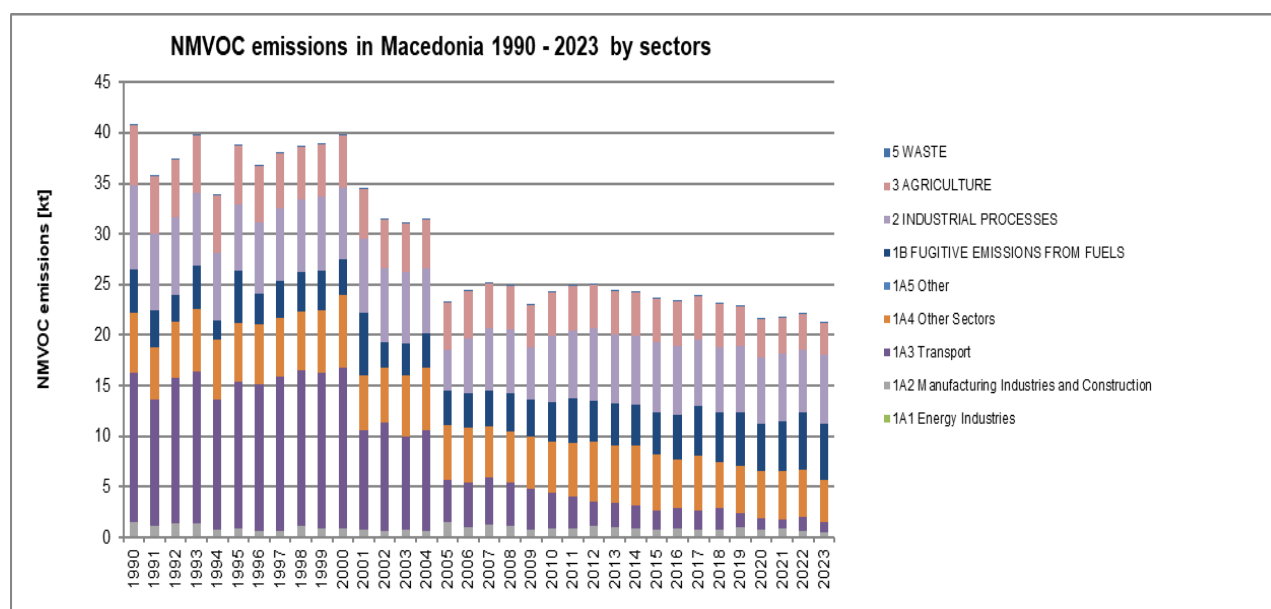
**Figure 8 National total NMVOC emissions 1990-2023**

Target value for NMVOC according to Gothenburg Protocol for year 2010 is 30 kt NMVOC. The emissions in 2023 are below the target value by 25%. The country is also in compliance with the Protocol on the control of volatile organic compounds or their Trans boundary fluxes since 1988, NMVOC emissions (48 kt) in 2023 in amount of 21.23 kt are reduced by 49% compared to 1988.

#### Main emission sources in North Macedonia

NMVOC emissions are emitted from different sources. The key category source in 2023 are NFR source categories is 2 Industrial pollution, contributing with 32% (20% in 1990) followed by 1.A.4 Other Sectors (mainly residential heating) and 1B (fugitive emissions), which contributed with 20% and 26% (15% and 10% in 1990, respectively), to the national total NMVOC emissions. Agriculture is contributing with around 15%, while NFR source category 1.A.3 Transport and 1.A.2 contributed with 4% and 2% of total calculated national NMVOC emissions, respectively.

NFR categories 1.A.1.a, 1.A.1.b and 1.A.5.b are minor sources of NMVOC emissions.

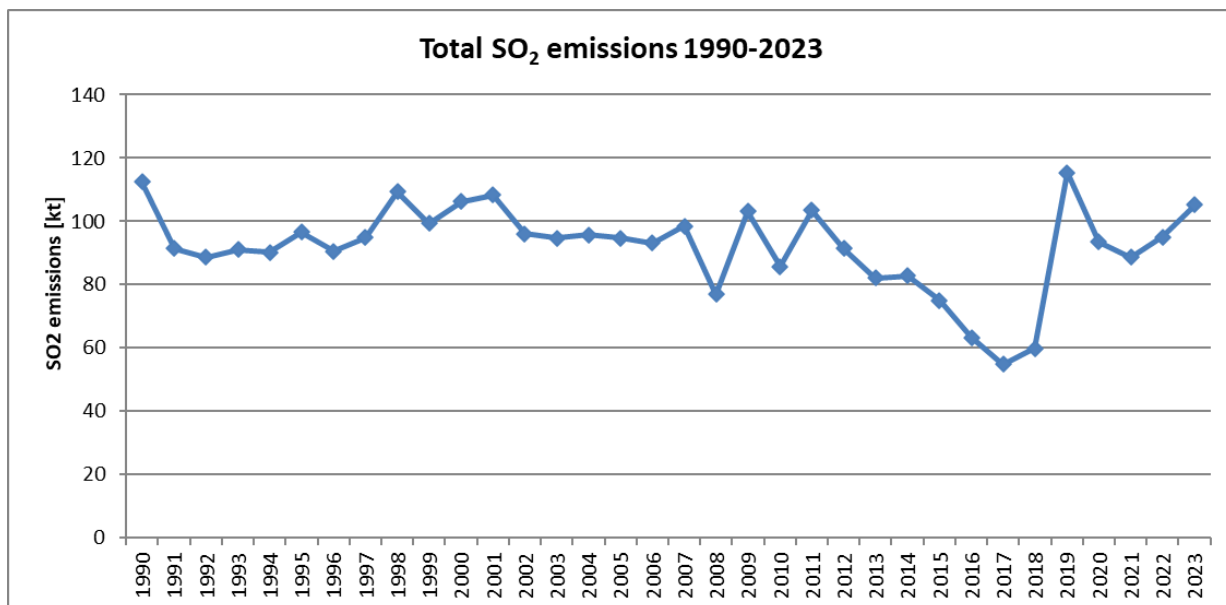


**Figure 9 NMVOC emissions in North Macedonia 1990-2023 by sectors**

### 3.1.3. SO<sub>2</sub> emissions

#### Emission trend

In 1990, the national total SO<sub>2</sub> emissions amounted to 112 kt. In the period 2011–2016 there was a decrease of emissions due to the decrease of coal consumption and lower capacity of work of the second largest (by capacity) power plant REK Oslomej (from 12 to 5 months), attributed to limited amounts of coal. In 2019 there is a sharp increase due to increased use of coal with higher sulfur content and higher production of electricity compared to 2018. But in 2020 the emissions are again decrease due to lower consumption of coal and heavy fuels, but not on the level of 2018. Compared to 2022 the emissions in 2023 are increased by 11%, and compare to 1990 emissions are decreased by 6%.



**Figure 10 National total SO<sub>2</sub> emissions 1990-2023**

North Macedonia is a party to the three protocols, under LRTAP convention, concerning sulfur. The emissions of sulfur dioxide in 2023 are below the base year 1990 emissions and the respective ceiling in 2010, which reflects compliance with the 1994 Protocol on further reduction on sulfur and the Gothenburg protocol.

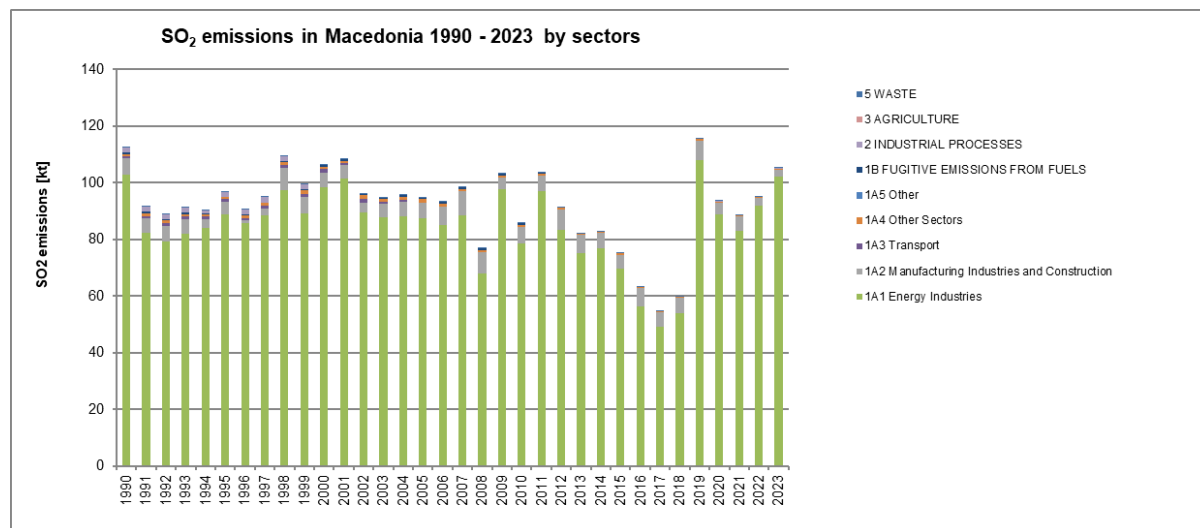
The country is still in non-compliance with the 1985 Protocol on reduction of sulfur emissions or their trans-boundary transmission by at least 30 percent, because the emissions have not been reduced by the designated percentage between now and 1980. Because the major source of this pollutant is power production, compliance with the oldest protocol on sulfur is expected to be achieved with installation of a desulfurization unit in the Power plant REK Bitola. According to the agreement with the Energy community, the compliance with SO<sub>x</sub> emission limit values, which will also mean compliance with the protocol, should be reached with implementation of a desulfurization unit, that should be implemented in accordance with the time dynamics set in the revised National Plan for reduction of emissions from large combustion plants approved by the Government in April 2017. With regards to LCPs, the emissions in 2023 as in the previous years were not below national emission ceiling of 15.855 Gg, indicating that compliance with the set limit values was not reached. In 2023 SO<sub>x</sub> emissions have not reached values below the emission ceiling defined in the NERP since desulfurization unit is still not implemented in the major power plant. The year in which desulfurization unit should be established is 2027 according to A-IPPC permit licence.

#### Main emission sources in North Macedonia

Almost all SO<sub>2</sub> emissions are resulting from Energy sector. Consequently, the main emission source in 2023 is as expected NFR source category 1.A.1 Energy Industries (Public electricity and heat production), which contributed with 92% in 1990, and with 97% in 2023 of the national total SO<sub>2</sub>

emissions. About 5% in 1990 and 2% in 2023 of the total emissions are stemming from NFR source category 1.A.2 Manufacturing Industries.

Other NFR sectors produce minor SO<sub>2</sub> emissions.

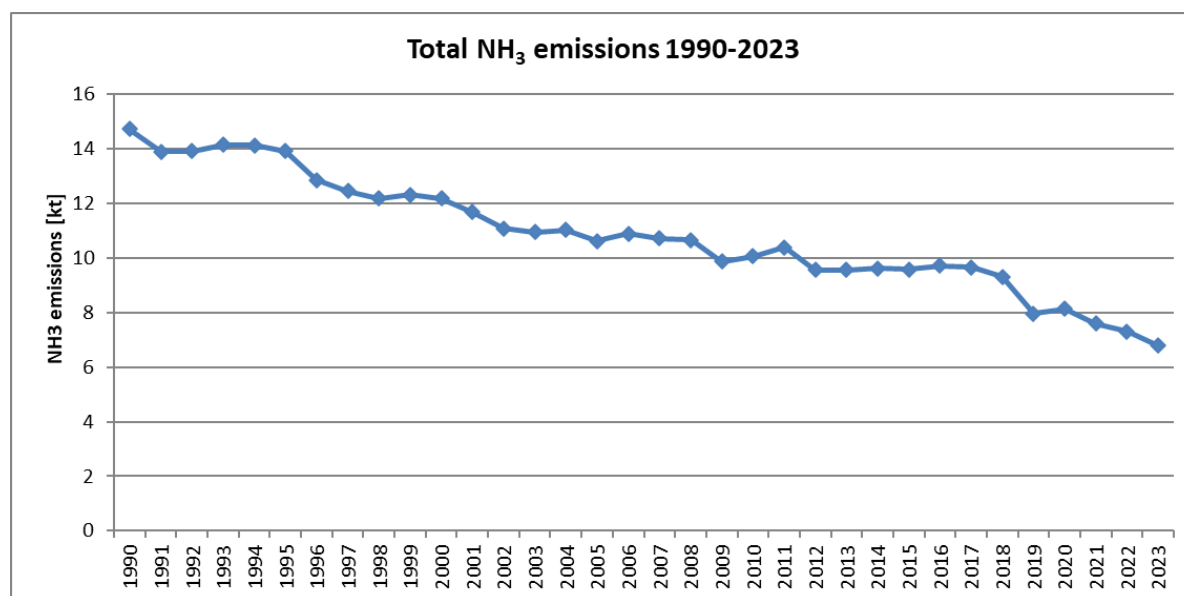


**Figure 11 SO<sub>2</sub> emissions in North Macedonia 1990–2023 by sectors**

### 3.1.4. NH<sub>3</sub> emissions

#### Emission trend

In 1990 national total NH<sub>3</sub> emissions, amounted to about 14.7 kt. In 2023, the emissions were down by 54% compared to 1990, amounting to 6.8 kt. Main reasons for the decline are decreasing emissions from Agriculture (Manure Management) related to decreasing livestock numbers. From 2022 to 2023 emissions decreased by 7%.

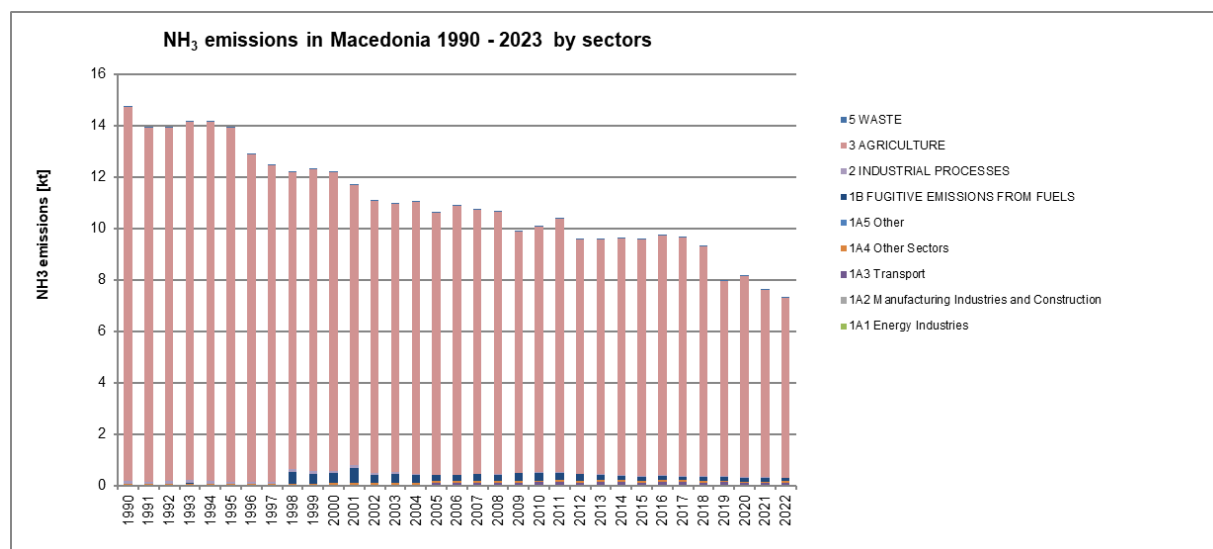


**Figure 12 National total NH<sub>3</sub> emissions 1990-2023**

Emissions of NH<sub>3</sub> are well below the respective ceiling. Emissions in 2023 were below national ceiling value (12 Gg NH<sub>3</sub>) for 2010.

### Main emission sources in North Macedonia

NH<sub>3</sub> emissions are mainly resulting from the agriculture sector contributing with 96% (99% in 1990) to national total NH<sub>3</sub> emissions. Within Agriculture sector, NH<sub>3</sub> is almost exclusively emitted by source category 3.B Manure Management (48% in 2023) and emissions from cattle (22%). The situation is similar in 1990, with the exception of much lower contribution of emissions from other livestock and poultry. NFR sectors 1.A.4 Other sectors 1.B Fugitive emissions. 1.A.3 Transport and 2 Industrial processes are minor sources of NH<sub>3</sub> emissions.

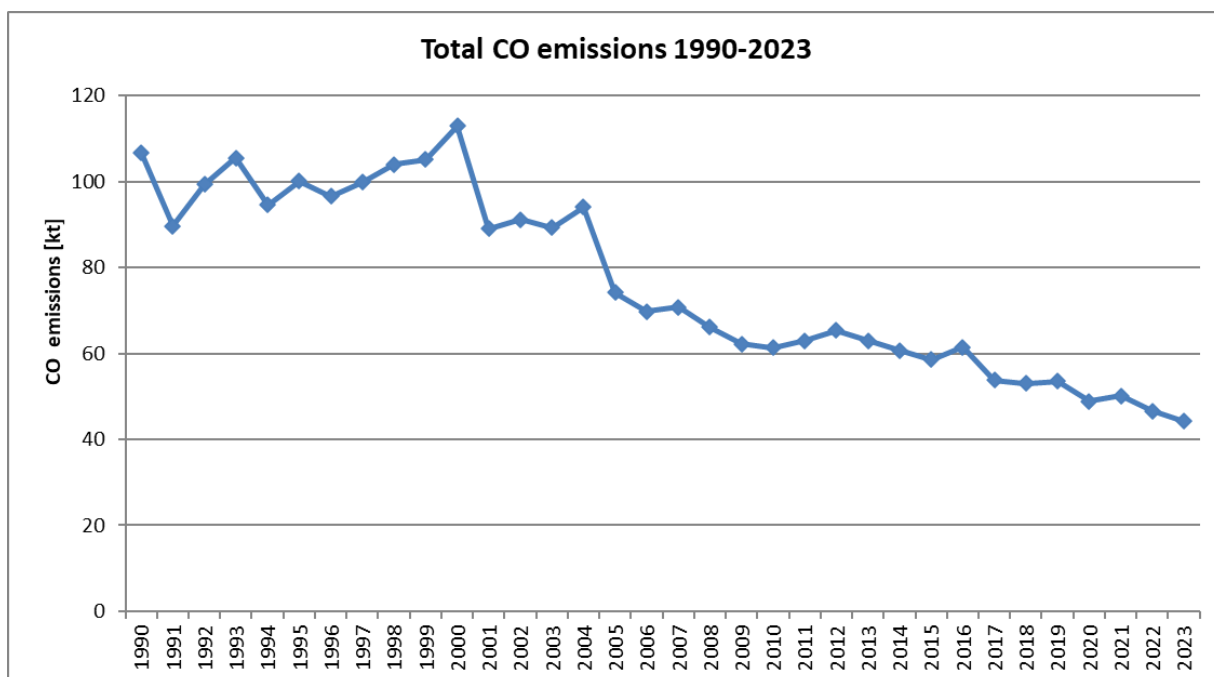


**Figure 13 NH<sub>3</sub> emissions in North Macedonia 1990-2023 by sectors**

### 3.1.5. CO emissions

#### Emission trend

In 1990 the national total CO emissions amounted to 106.66kt. The decreasing trend started in 2000 and could be attributed to lower solid fuel consumption in 1.A.4 sector, but the trend is not stable. In 2023, the emissions amounted at 44 kt and decreased by 59%. From 2022 to 2023 emissions are decreased by 5% due to minor decrease of emission creased coming for the category 1A2 and 1A4bii.

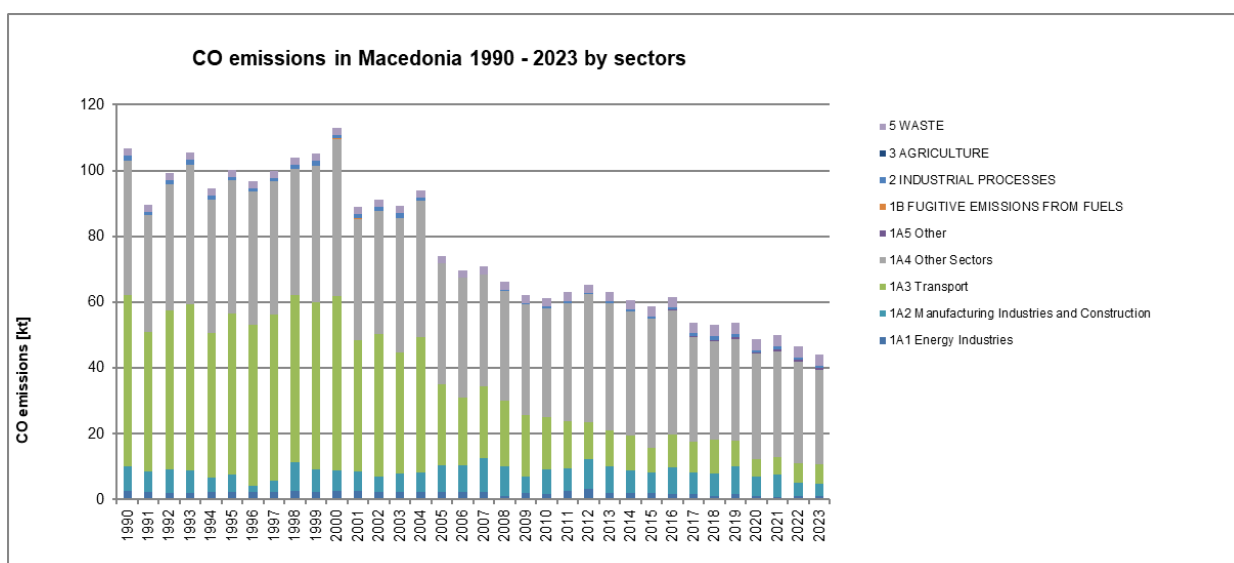


**Figure 14 National total CO emissions 1990-2023**

#### Main emission sources in North Macedonia

Almost all CO emissions are resulting from the Energy sector. As a Result, the main emission sources in 2023 are NFR sectors 1.A.4 Other Sectors (residential heating) and 1.A.3 Transport, contributing with 65% (38% in 1990) and 13% (49% in 1990) following by 1.A.2. Manufacturing Industries to the national total with 8% (7% in 1990). Further smaller emission sources in 2023 are 5 Waste and 1.A.1 Energy Industries with shares 8% and 3% respectively.

NFR sectors 1.B Fugitive emissions, 2 Industrial Processes and Product Use and 1A.5.Other sources are considered as minor sources of CO emissions.



**Figure 15 CO emissions in North Macedonia 1990-2022 by sectors**

### 3.2. Emission Trends for Particulate Matter

Particulate Matter emissions in North Macedonia mainly originate from energy industries, residential heating, and industrial processes. Emission trends and the main sources are described in more detail for PM10, PM2.5 and TSP in the following sections.

**Table 26 Emission trends for particulate matter 1990-2023**

Year	Emissions			
	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]
1990	28,28	43,76	56,52	2,68
1991	24,74	38,33	49,27	2,33
1992	30,78	46,38	58,17	2,98
1993	26,54	40,12	50,88	2,55
1994	24,57	37,73	48,37	2,24
1995	24,86	38,37	49,34	2,27
1996	27,77	42,77	55,11	2,59
1997	26,86	41,43	53,01	2,43
1998	31,48	48,16	61,56	2,88
1999	26,42	40,40	51,98	2,37
2000	24,34	37,83	51,14	2,17
2001	14,19	23,64	32,48	1,04
2002	14,73	24,06	32,44	1,19
2003	24,50	37,45	48,04	2,11
2004	26,89	40,93	52,45	2,38
2005	24,14	37,41	48,81	2,43
2006	21,76	34,03	44,42	2,16

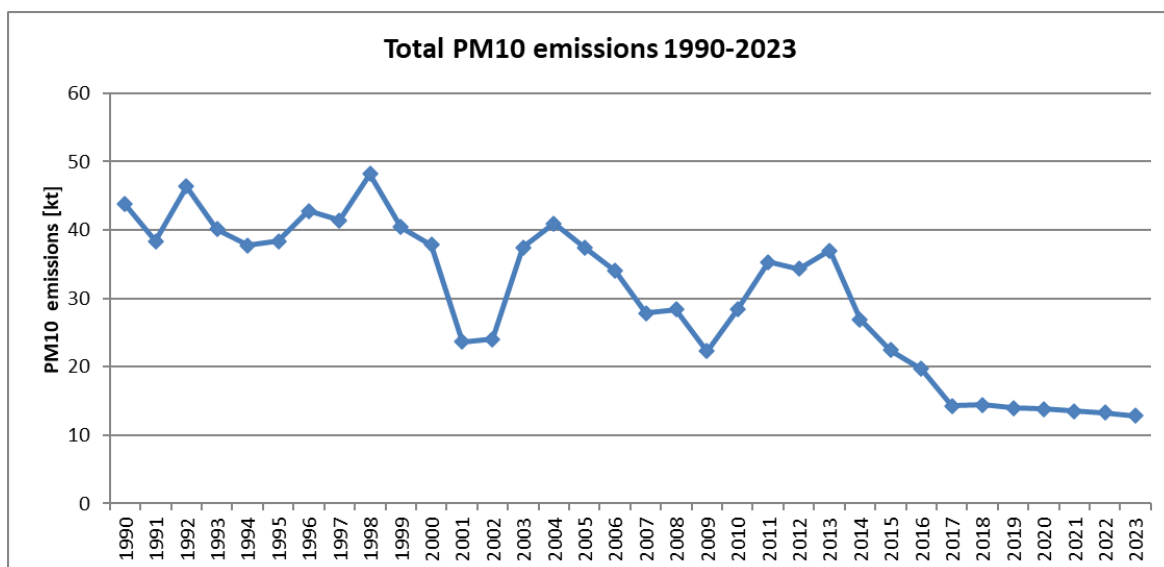


Year	Emissions			
	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]
2007	17,48	27,82	36,84	1,76
2008	18,17	28,40	37,66	1,85
2009	12,86	22,31	32,01	1,24
2010	15,97	28,40	35,56	1,64
2011	21,82	35,32	46,26	2,13
2012	21,48	34,35	45,49	2,16
2013	23,71	36,98	49,45	2,41
2014	17,12	26,90	37,46	1,73
2015	14,77	22,42	28,07	1,44
2016	12,94	19,68	24,79	1,37
2017	8,90	14,25	18,52	0,98
2018	8,52	14,46	17,46	0,93
2019	8,83	13,97	17,99	0,96
2020	8,71	13,79	17,72	0,94
2021	8,62	13,54	17,65	0,96
2022	8,13	13,32	17,57	0,89
2023	7,51	12,63	16,71	0,76
<b>Trend 1990–2023</b>	<b>-73%</b>	<b>-71%</b>	<b>-70%</b>	<b>-72%</b>

### 3.2.1. PM10 emissions

#### Emission trend

In 1990, national total PM10 emissions amounted to 44 kt. Since then, the emissions are continuously decreasing, reaching a level of 13kt in 2023 or a decrease of 71% compared to 1990. The main reason for the decrease is declining emissions from Industrial Processes (Ferroalloys Production), but also decreased use of solid fuels since 2013. Namely the deep presented in the period 2001-2002 is due to limited operation of Ferroalloys production industry. The Ferroalloys production has decreased because of a limited capacity of an installation producing ferrosilicon, between the end of 2014 and during 2015. This installation did not fulfill the obligation regulated in the IPPC license for installation of a filter for reduction of dust emissions. Additionally, this installation has been closed in November 2016 due to non-compliance with the activities for air quality protection set down in the IPPC permit referring to installation of dust filter. After 2017 there is steady trend with minor decrease up to 2023. In 2023 there is only decrease of 4%.

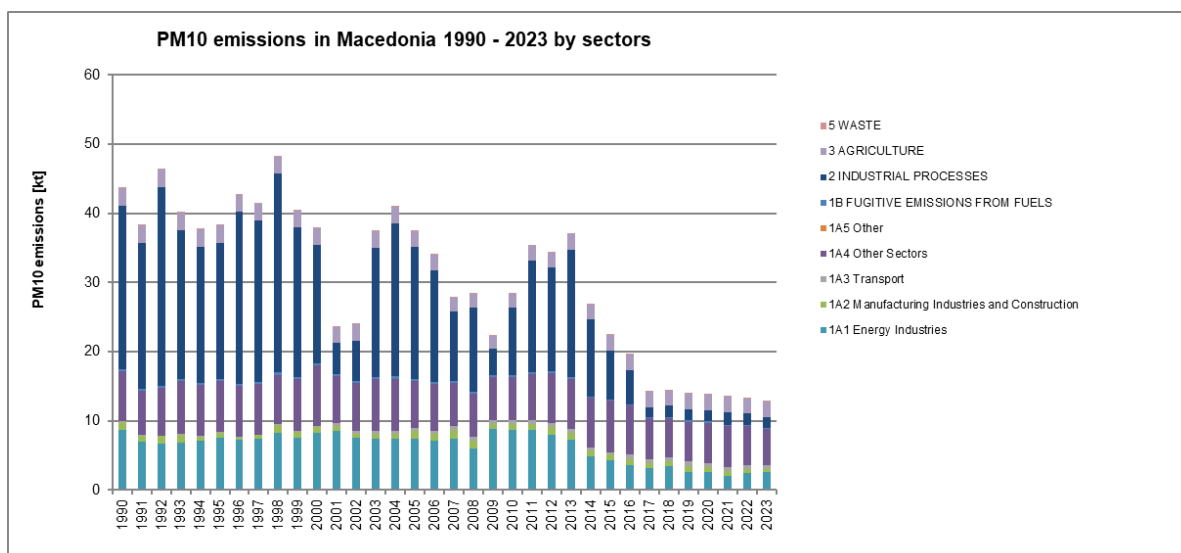


**Figure 16 National total PM10 emissions 1990-2022**

#### Main emission sources in North Macedonia

The main emission sources for PM10 in 2023 are NFR sectors 1.A.4 Other Sectors (residential and administrative heating), with a share of 41% (17% in 1990) in total PM10 emissions, 2 Industrial Processes and Product Use (mainly 2.C.2 Ferroalloys Production) with 13% (54% in 1990) and 1.A.1 Energy Industries with 21% (20% in 1990). With a share of 17% in 2023 (6% in 1990), the sector Agriculture is also contributing to the total PM10 emissions. As a result, a conclusion can be drawn that while in the past the major source for PM10 was the industry sector, mainly ferroalloys production, in the latest years that the major contributor is combustion of fuels in residential sector and administrative capacities – NFR 1.A.4 Other Sector. Transport sector as well as 1.A.2 manufacturing industries and construction are contributing with 4% and 3% in PM10 on national level. However, the transport sector has higher impact on local emissions and air quality according to PMF analysis.

NFR sectors 1B Fugitive emissions and 5 Waste are minor sources of PM10 emissions.

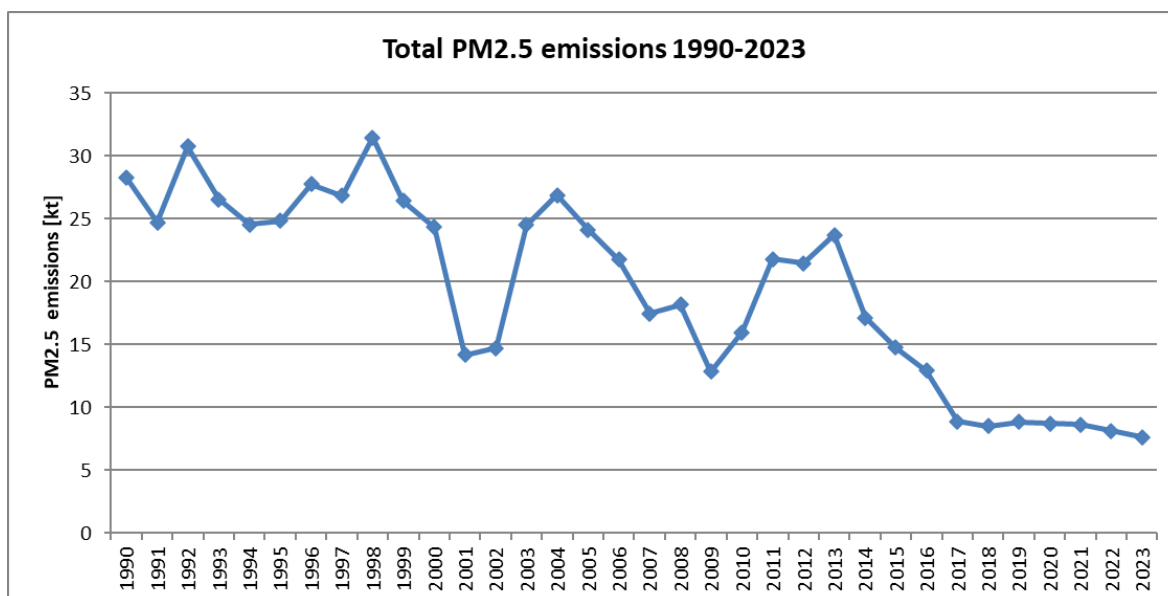


**Figure 17 PM10 emissions in North Macedonia 1990-2023 by sectors**

### 3.2.2. PM2.5 emissions

#### Emission trend

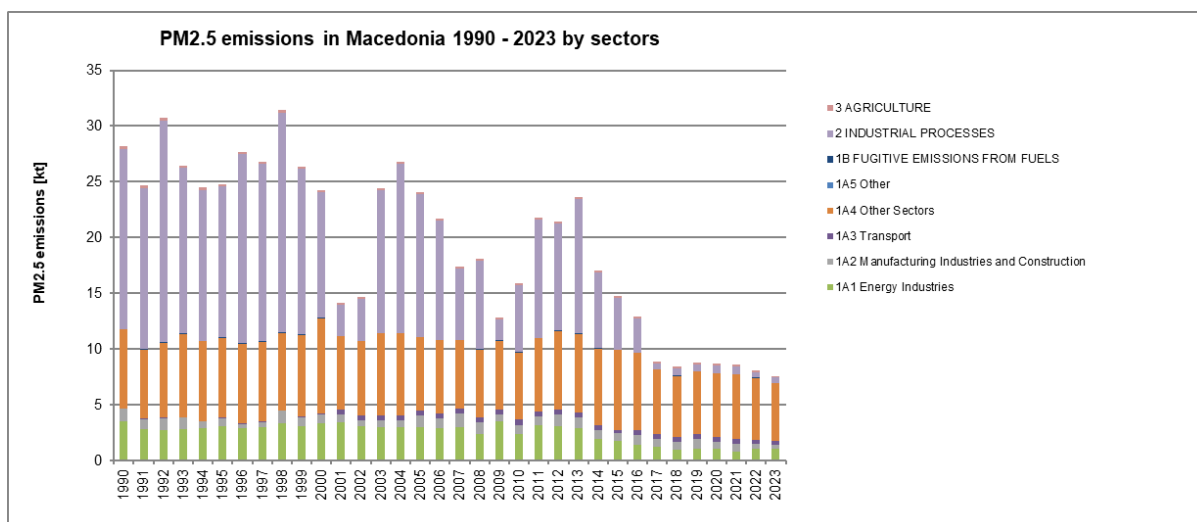
In 1990, national total PM2.5 emissions amounted to 28 kt. In 2023, compared to 1990 the emissions decreased by 73%, amounting to 7.6 kt. The main reason for the decrease is a decline of emissions from Industrial Processes (Ferroalloys Production) as well as from combustion of solid fuels from 1.A.4 due to increased use of clean fuels compared to solid fuels, like coal and biomass. For the years 2001, 2002 and 2009 emissions are very low compared to the other years. The reason is also due to low emissions from Ferroalloys Production, since in those years the company for production of ferrosilicon was operating with limited operating hours. The ferroalloys production has decreased because of the limited capacity of the installation producing ferrosilicon from the end of 2014 and during 2015, as this installation did not fulfill the obligation regulated in the IPPC license for installation of filter for reduction of dust emissions. Additionally, this installation has been closed in November 2016 due to non-compliance with the activities for air quality protection set down in the IPPC permit referring to installation of dust filter. Throughout the years, emissions from solid fuel combustion as well decreased affecting lower national emissions from particulates. After 2017, there is steady trend with slow decrease up to the last reporting year. In 2023 there is decrease of emissions up to 6%.



**Figure 18 National total PM2.5 emissions 1990-2023**

#### Main emission sources in North Macedonia

Like PM10, the main emission sources for PM2.5 in 2023 are NFR sectors 1.A.4 Other Sectors (residential heating) with a share of 67% (25% in 1990) in total PM2.5 emissions. The NFR category 1.A.1 Energy Industries with 14% (12% in 1990) and the contribution of the NFR sector - 2 Industrial Processes and Product Use (mainly 2.C.2 Ferroalloys Production) is very low, contributing only with 6% (57% in 1990). Manufacturing industry and Constructions 1.A.2 are contributing with 4% in 2023. Transport is contributing with 5% and Agriculture with 1.8%. Compared to PM10, the contribution of 1.A.4 and Energy industries is higher while the contribution from 1.A.1 Energy industries and Manufacturing industry and Constructions 1.A.2 is lower, NFR sectors 1B Fugitive emission and 5 Waste are minor sources of PM2.5 emissions.



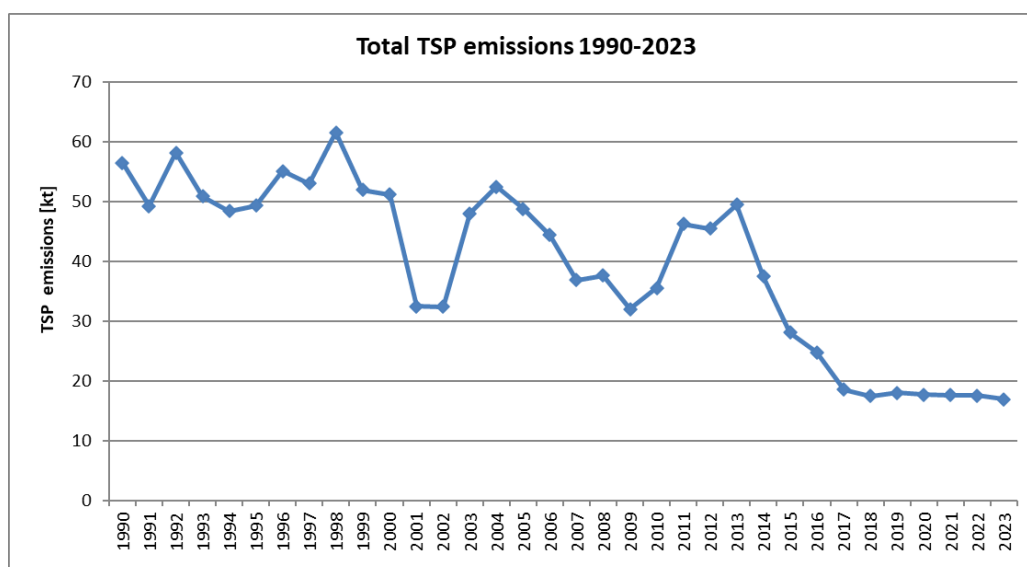
**Figure 19 PM2.5 emissions in North Macedonia 1990-2023 by sectors**

### 3.2.3. TSP emissions

#### Emission trend

In 1990, the national total TSP emissions amounted to about 57 kt. In 2023, the emissions decreased by 70% compared to 1990 amounting to about 17 kt. The main reason for the decrease is a decline of emissions from Industrial Processes (Ferroalloys Production), but also the decline of emissions coming from the 1.A.4 category due to reduced use of solid fuels. In 2023, the emissions are decreased by 4% compared to 2022 emissions.

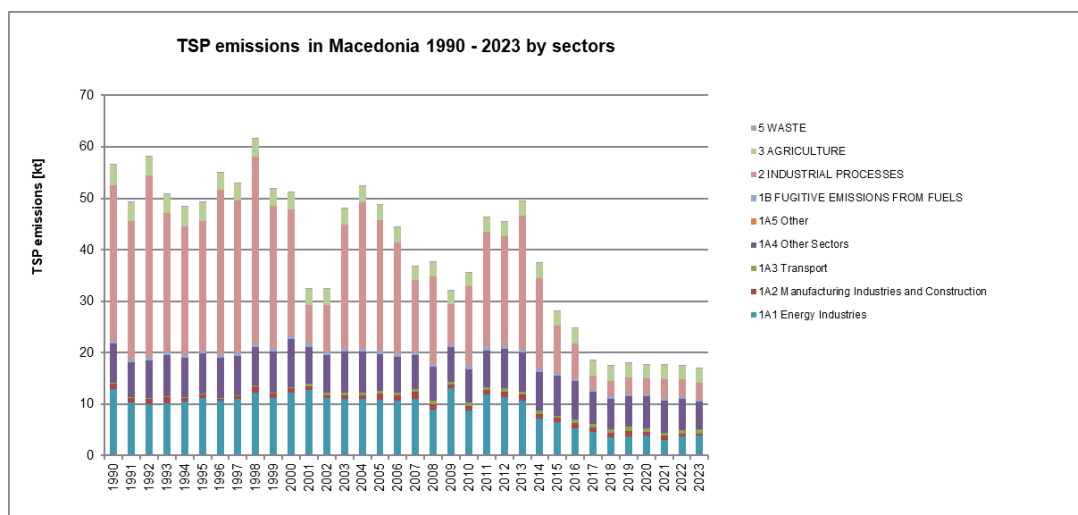
The reasons for decreasing trend in the last three years correspond to the reasons explained in the subchapter for PM10. With regards to LCPs, according to the NERP aligned with the Energy Community Treaty, the emissions in 2023, exceeded the national emission ceiling for TSP with a value of 1.738 Gg, and thus, not reaching compliance with this ceiling accordingly.



**Figure 20 National total TSP emissions 1990-2023**

### Main emission sources in North Macedonia

The main emission sources for TSP in 2023 are 1.A.4 Other Sectors (residential heating) with 33% (13% in 1990) and 1.A.1 Energy Industries with 13% in 1990 and 2023 as well. NFR sectors 2 Industrial Processes and Other Product Use (mainly NFR sector 2C2 Ferroalloys Production) with a share of 20% (53% in 1990) in total TSP emissions. Thus, it can be concluded that in the past the major source for TSP national emissions was the industry sector, mainly ferroalloys production, while in the latest years the major source is a consequence of the combustion of fuels in residential sector and administrative capacities – NFR 1.A.4. Agriculture is contributing with 16%, the category 1.A.2 is contributing with 2%, and Transport with 4%, while other categories are minor sources of this pollutant.

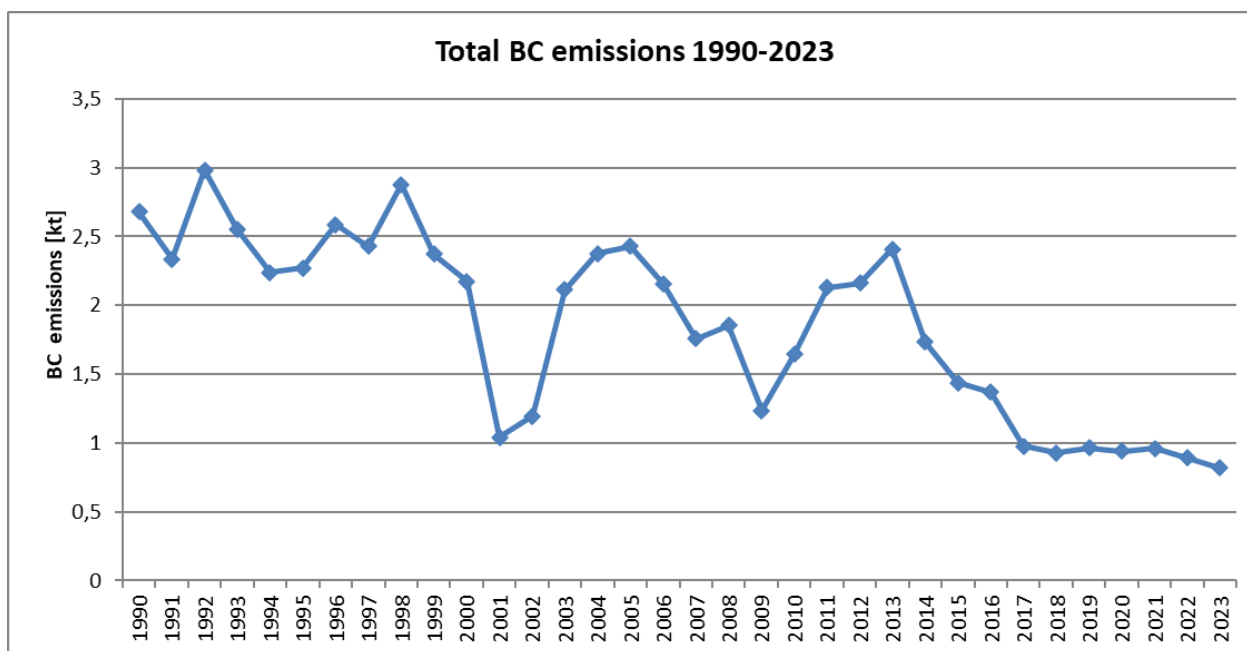


**Figure 21 TSP emissions in North Macedonia 1990-2023 by sectors**

### 3.2.4. BC emissions

#### Emission trend

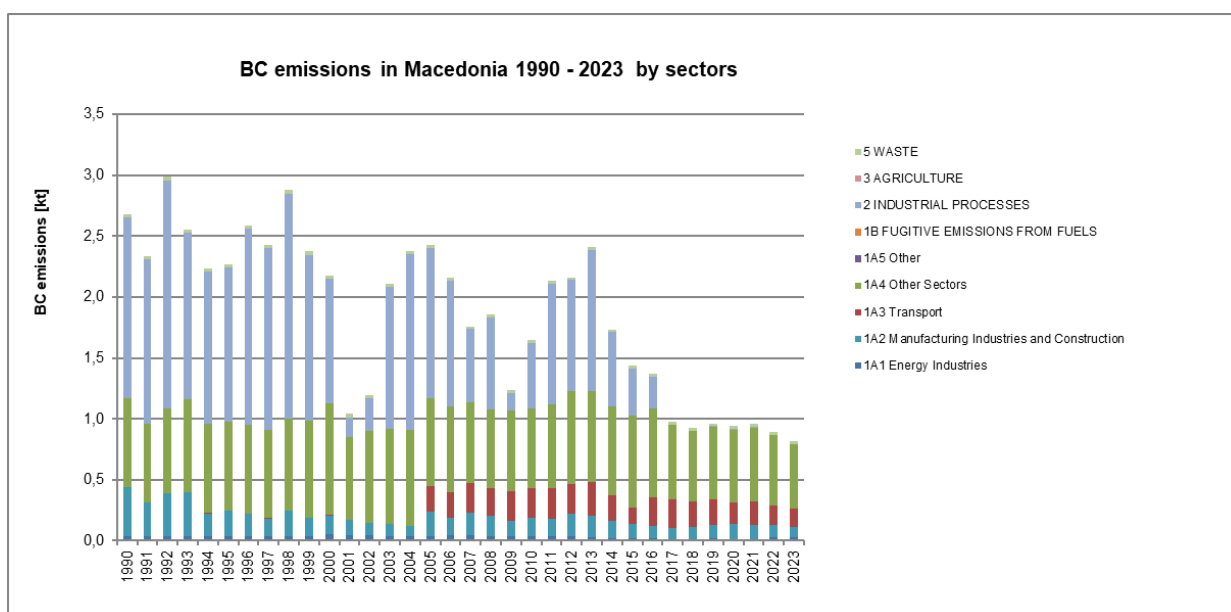
In 1990, national total BC emissions amounted to about 3 kt. In 2023, the emissions decreased by 70% compared to 1990, amounting to about 1 kt. The main reason for the decrease is a decline of emissions of PM<sub>2.5</sub>. The trend has similar pathway as that one for PM<sub>2.5</sub> due the fact that for BC emissions are calculated as given contribution in PM<sub>2.5</sub> expressed in %. Further explanation of the trend is given in PM<sub>2.5</sub> chapter.



**Figure 22 National total BC emissions 1990-2023**

#### Main emission sources in North Macedonia

As expected, the main emission sources for BC are those for PM<sub>2.5</sub>. In 2023, the NFR sectors 1.A.4 Other Sectors (residential heating) contributed with a share of 64% (27% in 1990) in total BC emissions. Transport is contributing with 19%, while 1.A.2 Manufacturing industry and constructions contributed with 10% (15% in 1990) of the total BC emissions, whereas 2 Industrial Processes and Product Use (mainly 2.C.2 Ferroalloys Production) contributed with around 0.2% (55% in 1990), while Waste sector contributed with 3% in 2023 and 1% in 1990. NFR sectors 1.A.1 Energy industries and 1.B Fugitive emissions are minor sources of PM<sub>2.5</sub> emissions.



**Figure 23 BC emissions in North Macedonia 1990-2022 by sectors**

### 3.3. Emission trends for Heavy Metals

In the following table the trends of the three priority heavy metals are presented. The detailed trend descriptions as well as the main emission sources for the respective air pollutants are provided in the following sections.

**Table 27 Emission trends for heavy metals 1990-2023**

Year	Emissions		
	Cd [Mg]	Hg [Mg]	Pb [Mg]
1990	236.19	1.53	0.67
1991	199.29	1.44	0.61
1992	230.35	1.38	0.56
1993	214.95	0.98	0.54
1994	205.69	0.93	0.45
1995	224.03	2.03	0.48
1996	231.37	2.24	0.53
1997	246.83	1.07	0.57
1998	261.89	1.32	0.63
1999	210.22	0.99	0.57
2000	196.93	0.84	0.59
2001	173.76	0.75	0.62
2002	172.01	0.73	0.65
2003	133.47	0.52	0.49
2004	47.04	0.45	0.47
2005	7.92	0.29	0.36
2006	8.57	0.26	0.37
2007	8.96	0.26	0.40
2008	7.45	0.26	0.38
2009	6.74	0.25	0.33
2010	7.89	0.25	0.34
2011	9.53	0.27	0.38
2012	8.28	0.27	0.36
2013	5.84	0.25	0.31
2014	7.32	0.25	0.31
2015	7.32	0.25	0.30
2016	4.70	0.24	0.28
2017	4.78	0.23	0.26
2018	5.00	0.23	0.23
2019	5.93	0.24	0.26
2020	5.77	0.22	0.20
2021	6.22	0.24	0.21



Year	Emissions		
	Cd [Mg]	Hg [Mg]	Pb [Mg]
2022	6.56	0.23	0.19
2023	6.60	0.23	0.20
<b>Trend 1990–2023</b>	<b>-85%</b>	<b>-100%</b>	<b>-97%</b>

Republic of North Macedonia in 2023 did not exceed emission levels set in HM Protocol. Emissions are much below the values from the reference year 1990.

### 3.3.1. Lead (Pb) emissions

#### Emission trend

National total Pb emissions amounted to 236 t in 1990; emissions have decreased steadily, and in 2023 emissions were down to 6.69 t. The most important reductions could be observed in sectors 1.A.3 Transport and 2 Industrial Processes and Other Product Use (mainly Lead Production). The big decline in the trend of Pb emissions from 2003 and 2004 is related to the main source of these emissions – Road transport and Lead production. From 2004 the content of Pb in the gasoline decreased from 0.0006 kg/l to 0.00015 kg/l. Also, in 2003 the Pb-Zn smelter “Zletovo” – Veles stopped the lead production, and zinc. From 2006 in North Macedonia. passenger cars can use only unleaded gasoline fuels which additionally reduced the Pb emissions.

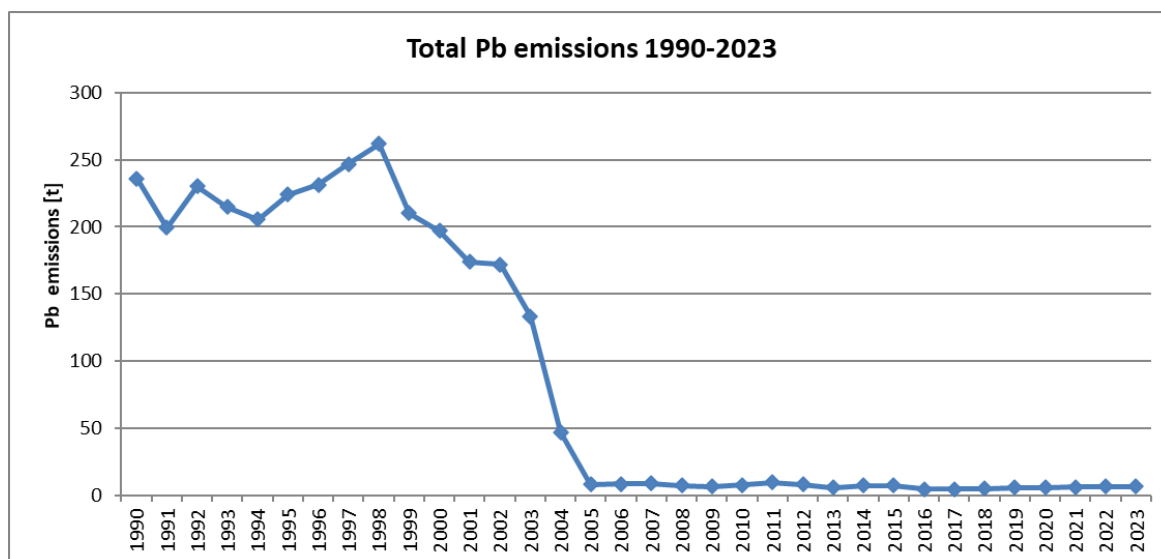
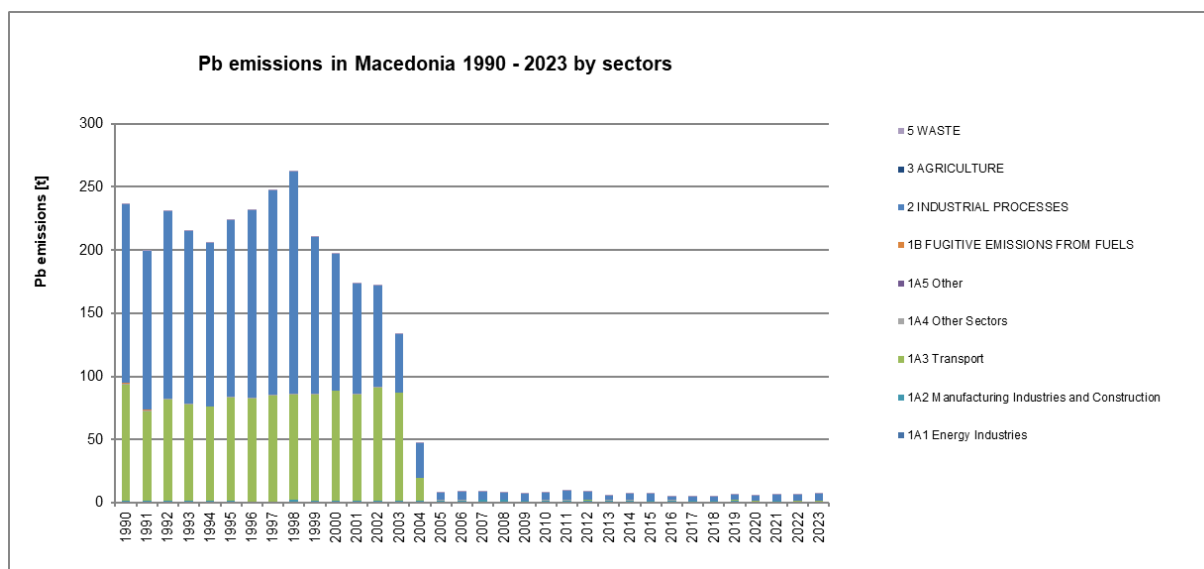


Figure 24 National total Pb emissions 1990-2023

#### Main emission sources in North Macedonia

The distribution of emissions sources is different in this submissions, due to calculation of emissions coming from fireworks (2G), therefore, 2 Industrial process is key sector contributing with 79%, while in 1990 this percentage was lower accounting of 60%. While emissions from Transport due to use of leaded petrol were higher contributing with 30%. The other emission sources of Pb in 2023 are NFR sectors 1.A Energy with shares in national total emissions of 7 % from 1.A.2 in share of 5.3 %, 1.A.3 Transport is contributing with 5 % and other sectors 1.A.4 in share of 3%, and industrial process in share of 18%. The declined values are a result of the elimination of the use of leaded petrol in 2004.

The reduction of 97% compared to 1990 is due to the elimination of the use of leaded petrol and reduction of lead emissions from lead production. However, since EF used for calculation of Pb emissions up to 2004 are not documented, there is a high uncertainty of estimation of lead emissions in 1.A.3 transport and these emissions should be recalculated with the use of COPERT V model.

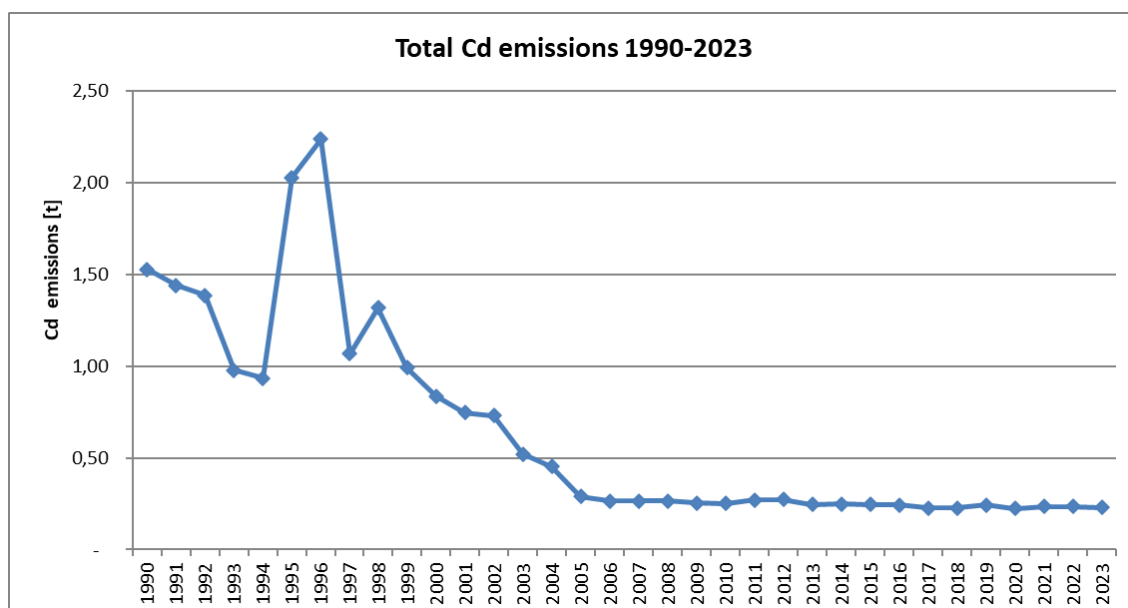


**Figure 25 Pb emissions in North Macedonia 1990-2022 by sectors**

### 3.3.2. Cadmium (Cd) emissions

#### Emission trend

National total Cd emissions amounted to 1.5 t in 1990; emissions have decreased steadily, and in the year 2023 emissions were estimated to be 0.23 t, which means they were down by 86% compared to 1990. The most important reductions could be observed in sector 2 Industrial Processes and Other Product Use (Metal Production), as Zinc Production was stopped in 2003. Between 2022 and 2023, cadmium emissions decreased by 15% due to lower emissions in the combustion processes in industry.

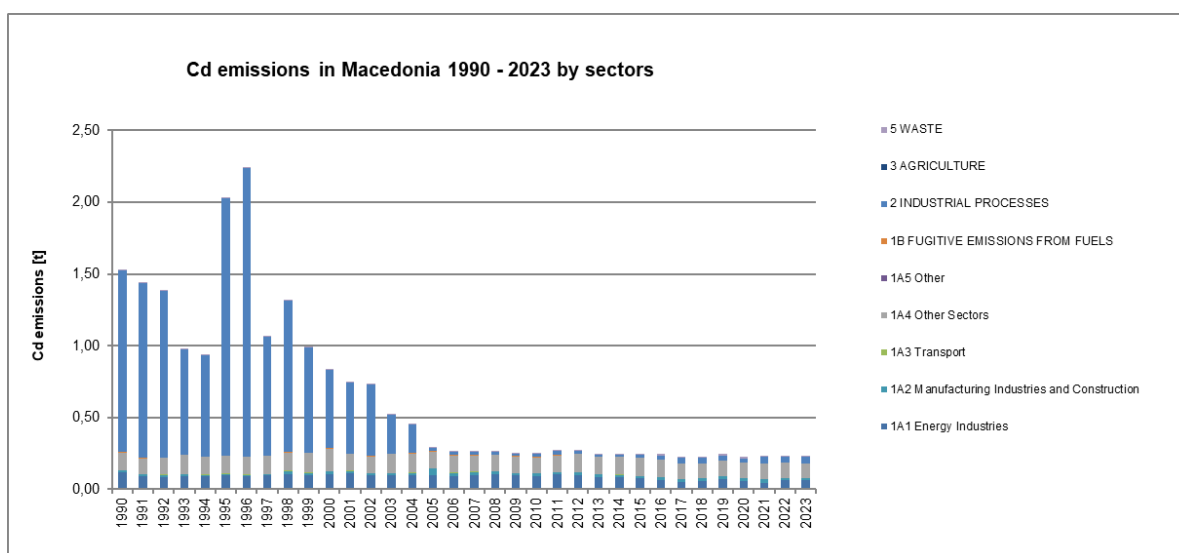


**Figure 26 National total Cd emissions 1990-2023**

#### Main emission sources in North Macedonia

The most important emission source in 2023 of Cd in the national total emissions is NFR sector 1 Energy is contributing with the following NFR categories: 1.A.4 Other Sectors Energy with 43% (8% in 1990), following by 1.A.1 Energy Industries, with a share of 28% (7% in 1990), and NFR category 2 Industrial Processes and Product use contributing with 21% (83% in 1990). The 1.A.2 Manufacturing Industries is contributing with 8% (1%), while 5 Waste sector is contributing with 2%.

Cd emissions from NFR sectors 1.B Fugitive Emissions and 3 Agriculture and are minor sources.

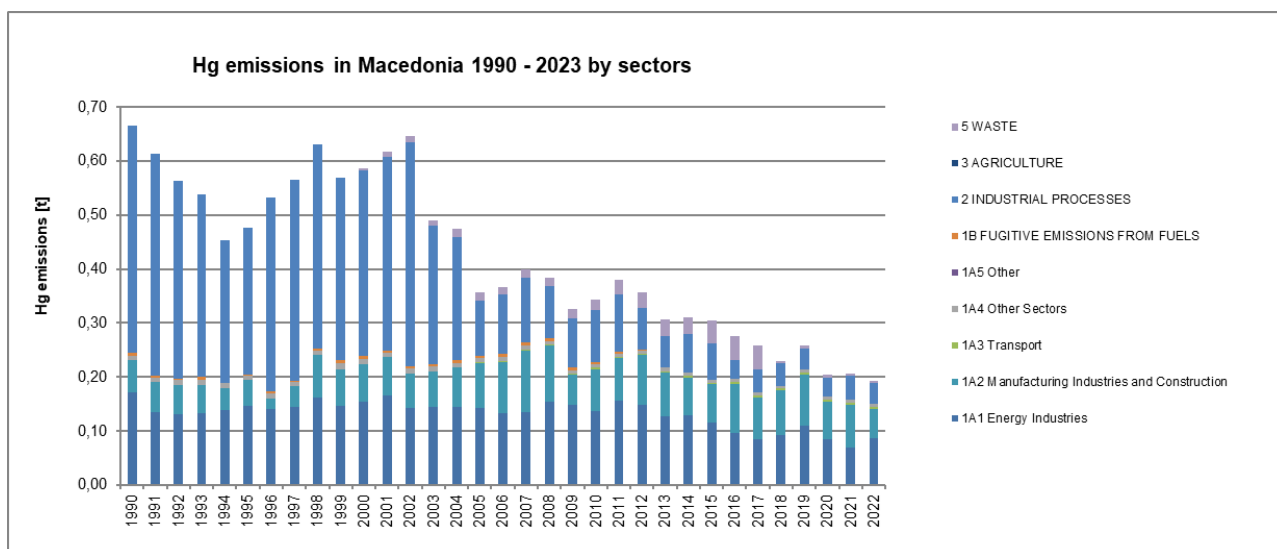


**Figure 27 Cd emissions in North Macedonia 1990-2023 by sectors**

### 3.3.3. Mercury (Hg) emissions

#### Emission trend

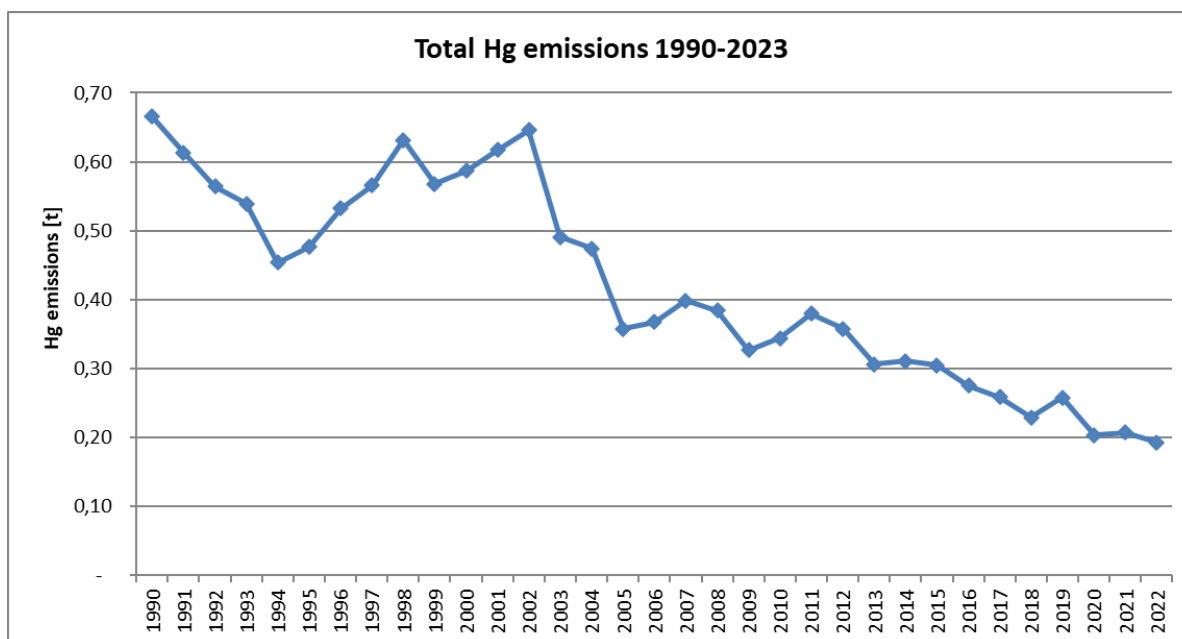
National total Hg emissions amounted to 0.67 t in 1990; emissions have decreased steadily and, in the year, 2023 emissions (0.20t) were down by 70% compared to 1990 emissions. The most important reductions could be observed in sector 2 Industrial Processes and Other Product Use (Metal Production), as Zinc production stopped in 2003. Also, fugitive emissions have been reduced significantly. Between 2023 and 2024 total Hg emissions decreased by 2%, due to lower emissions coming from 1A2 Manufacturing Industries and construction.



**Figure 28 National total Hg emissions 1990-2023**

#### Main emission sources in North Macedonia

The most important emission source in 2023 of Hg is NFR sector 1 - Energy. Within the Energy sector, the main contributors in 2023 are 1.A.1 Energy Industries with a share of 46% (26% in 1990) and 1.A.2 Manufacturing Industries and Construction with 27% (9% in 1990) of the national total emissions. NFR category 2 Industrial Processes and Product use is also one of the key sources with 21% (63% in 1990) of the national total mercury emissions. In 2023, also 1% of total mercury emissions are stemming from sector 5 Waste, while this sector has minor contribution in 1990, and 3% Hg emissions are coming from NFR sectors 1.A.4 - Other sectors and 2% from Transport. NFR sectors 1.B Fugitive Emissions and 3 Agriculture are minor sources in the whole trend period.



**Figure 29 Hg emissions in North Macedonia 1990-2023 by sectors**

### **3.4. Emission trends for POPs**

In the following table the trends of the POPs are presented. The detailed trend descriptions for the respective pollutants are provided in the following sections.

**Table 28 Emission trends for POPs 1990-2023**

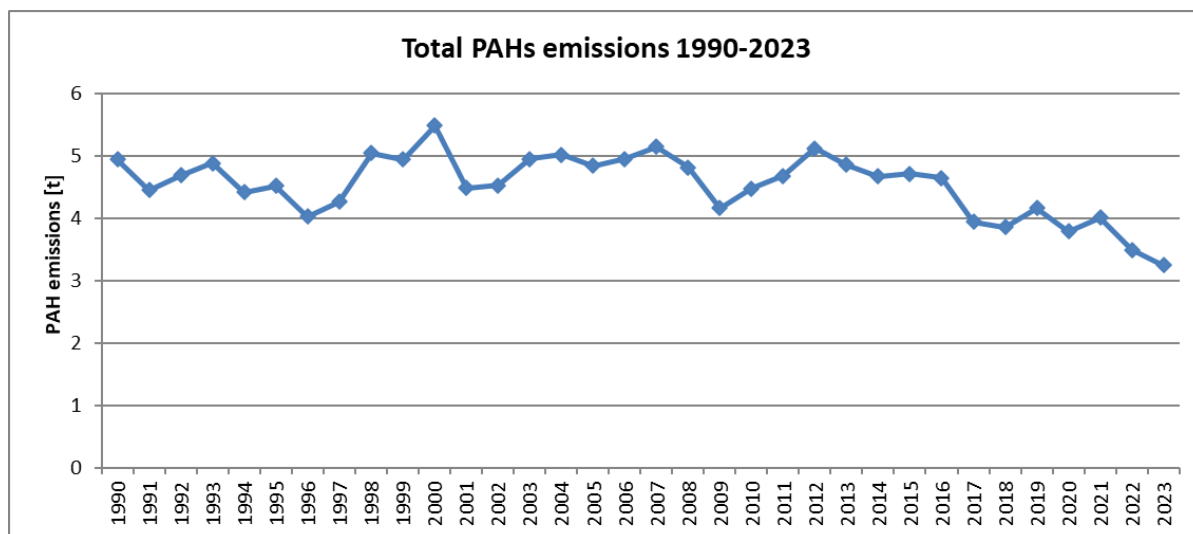
Year	Emissions			
	PAHs total [t]	PCDD/F [g – I TEQ ]	HCB [kg]	PCB [kg]
1990	14.58	4.94	44.26	381.18
1991	13.08	4.45	39.19	382.73
1992	12.74	4.69	25.80	382.95
1993	11.73	4.88	24.15	369.80
1994	10.56	4.42	25.01	340.60
1995	13.60	4.52	18.60	355.78
1996	13.42	4.03	19.67	384.21
1997	10.69	4.27	27.85	396.25
1998	12.54	5.04	29.31	403.01
1999	11.87	4.94	53.94	366.49
2000	17.63	5.48	38.28	342.85
2001	20.50	4.48	34.12	332.37
2002	22.16	4.53	52.65	330.10
2003	22.61	4.95	42.94	287.40
2004	25.24	5.02	8.48	240.53
2005	26.81	4.84	7.54	207.01
2006	25.15	4.95	11.67	207.78
2007	26.51	5.14	8.87	208.58
2008	25.82	4.82	7.74	208.28
2009	27.30	4.16	8.28	208.07
2010	29.50	4.47	9.58	208.85
2011	35.72	4.68	10.50	209.21
2012	38.92	5.12	9.47	209.19
2013	40.04	4.86	6.35	209.02
2014	39.90	4.67	4.19	209.48
2015	49.40	4.72	0.96	216.33
2016	50.97	4.65	0.77	220.78
2017	51.37	3.94	2.06	228.69
2018	8.72	3.86	1.53	236.92
2019	9.21	4.16	4.43	238.14
2020	8.43	3.79	0.16	236.77
2021	9.05	4.01	0.16	238.29
2022	8.14	3.49	0.15	242.35
2023	7.73	3.23	0.10	358.56
<b>Trend 1990–2023</b>	<b>-35%</b>	<b>-47%</b>	<b>-100%</b>	<b>-6%</b>

From the figures presented in the previous table a conclusion can be drawn that Republic of North Macedonia in 2021 did not exceeded the emission levels set in POPs Protocol. In the case of HCB, the emissions are much lower than the values from the reference year 1990.

### 3.4.1. PAHs total emissions

#### Emission trend

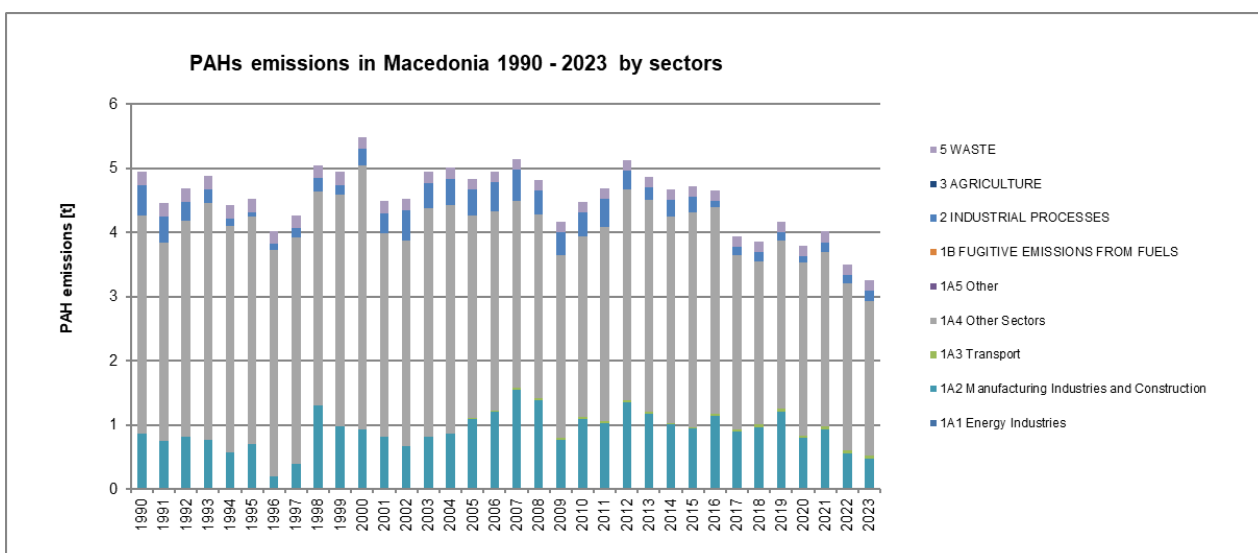
National total PAHs total emissions in 1990 amounted to 4.94 t. Since then, the emissions have been quite stable and in the year 2023 emissions were at level of 3.24 t, reflecting a reduction of 34%. The most important reductions could be observed in the sector for residential heating. Between 2022 and 2023, total PAHs emissions decreased by 7%, because of decreased emissions from residential heating in the NFR 1.A.4 - Other sectors as well in combustion in industrial processes 1.A.2.



**Figure 30 National total PAHs emissions 1990-2023**

#### Main emission sources in North Macedonia

The most important emission source in 2023 of PAHs is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2023, as in the previous years is 1.A.4 Other Sectors (residential heating). With a share of 74%, while in 1990, this sector contributed with 69%, Furthermore, 1.A.2 Manufacturing Industries is contributing with a share of 14% (17% in 1990) of the national total emissions. Waste sector and 2 Industrial processes are contributing with 5% in 2023. Other NFR sectors 1.A.1 Energy industries, 1B Fugitive emissions and 2 - Industrial Processes and Product are minor sources.



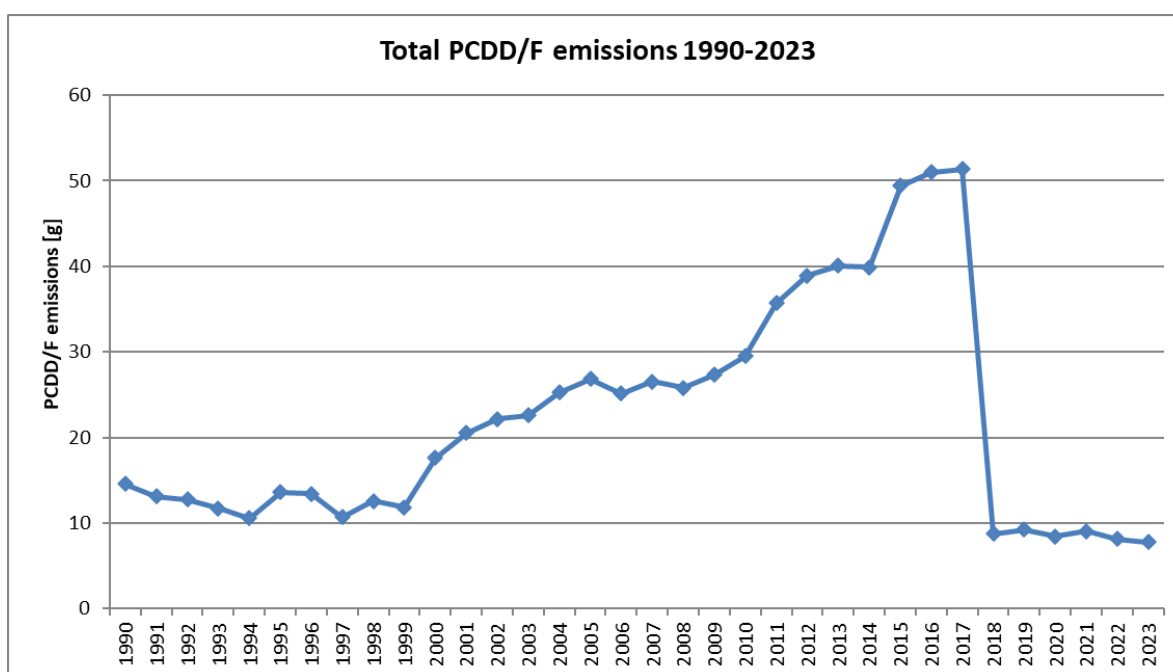
**Figure 31 PAHs total emissions in North Macedonia 1990-2023 by sectors**

### 3.4.2. Dioxin and Furan emissions (PCDD/F)

#### Emission trend

National total dioxin/furan emissions amounted to 14.58 g-I-TEQ in 1990; emissions have decreased then and, in the year, 2023 emissions were down to around 7.79 g-I-TEQ, decreasing by 47% compared to 1990.

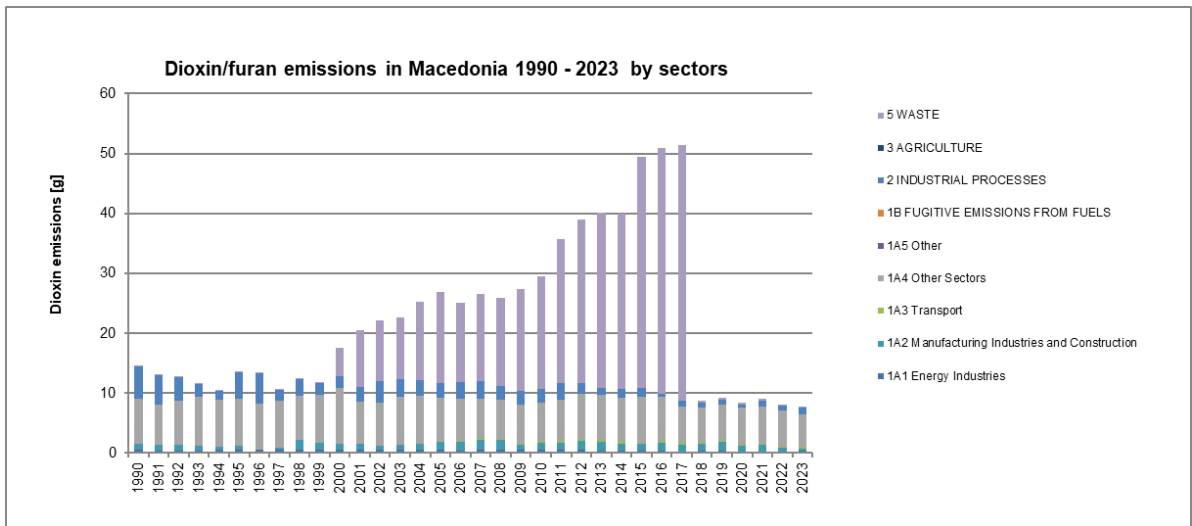
The emissions have increased continuously since 2000 due to establishment of medical waste incineration. Emissions have been increasing until 2018, when dust filter has been established in the medical waste incineration plant. Between 2022 and 2023 total dioxin/furan emissions are slightly decreased by 4% due to lower emissions in 5 Waste sector and 1A2 Manufacturing industries and construction.



**Figure 32 National total PCDD/F emissions 1990-2023**

#### Main emission sources in North Macedonia

The most important emission source in 2023 of PCDD/F is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2022 is 1.A.4 Other Sectors (mainly residential heating), with a share of 52% in 1990 and with share 71% in 2023. The Industry is contributing with 14% (36% in 1990), 1.A.2 Manufacturing Industries is contributing with a share of 6% (5% in 1990) in the national total emissions. NFR category 1.A.2 Manufacturing industry and construction is also contributing with 6% of the national total PCDD/F emissions. In the period 2000-2017, Waste has been one of the key sectors as well.

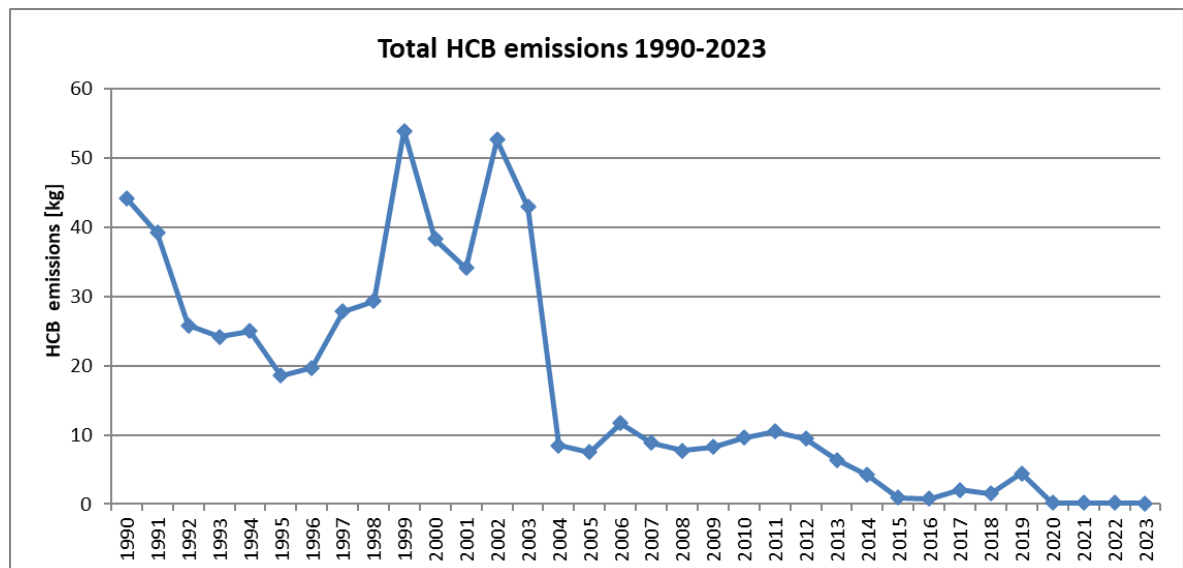


**Figure 33 Dioxin/furan emissions in North Macedonia 1990-2023 by sectors**

### 3.4.3. Hexachlorobenzene (HCB) emissions

#### Emission trend

National total HCB emissions amounted to 44 kg in 1990; emissions have decreased steadily since then and in the year 2023 emissions were down by 99%, compare to 2023 amounting to 0.1 kg. The emission peaks in 1999 and 2002 are due to higher activities of secondary aluminum production. The significant emission reduction between 2003 and 2004 is also caused by the aluminum production. From then onwards the emission level remained quite lower but still with mild fluctuations which depend on aluminum production. The most important reductions could be observed in the sector 2 Industrial Processes and Other Product Use (Aluminum Production). Due to higher activity data in aluminium production the emissions are higher in 2019 compared to 2018. But since 2020 since the emissions are sharply decreased due to the fact that the only installation for aluminum production went bankruptcy so no activity data were reported, and no emissions were calculated in this sector.

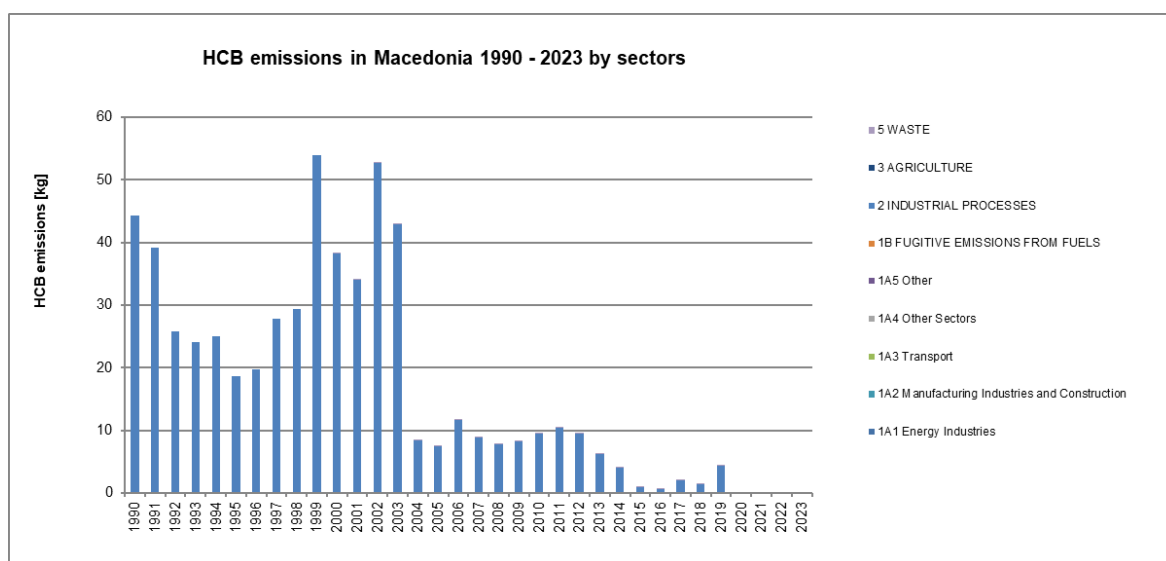




**Figure 34 National total HCB emissions 1990-2023**

#### Main emission sources in North Macedonia

During the period 1990-2023 the key emission source for HCB was NFR sector 2 Industrial Processes and Product Use. With a share of around 100% in 1990 of the national total emissions almost all HCB is emitted from this source and therefore dominating the trend. Within the category emissions are exclusively emitted from NFR sector 2.C.3 Aluminum Production. However, due to bankruptcy the main contribution to the HCB emissions in 2020-the most emissions in 2023 as in the previous three year most emissions are coming from 5 Waste secotr in amount of 58%. 1.A.4 Other sectors is the key source in 2023 contributing with 738% and 1.A.2 Manufacturing Industries is minor source contributing with 3%.

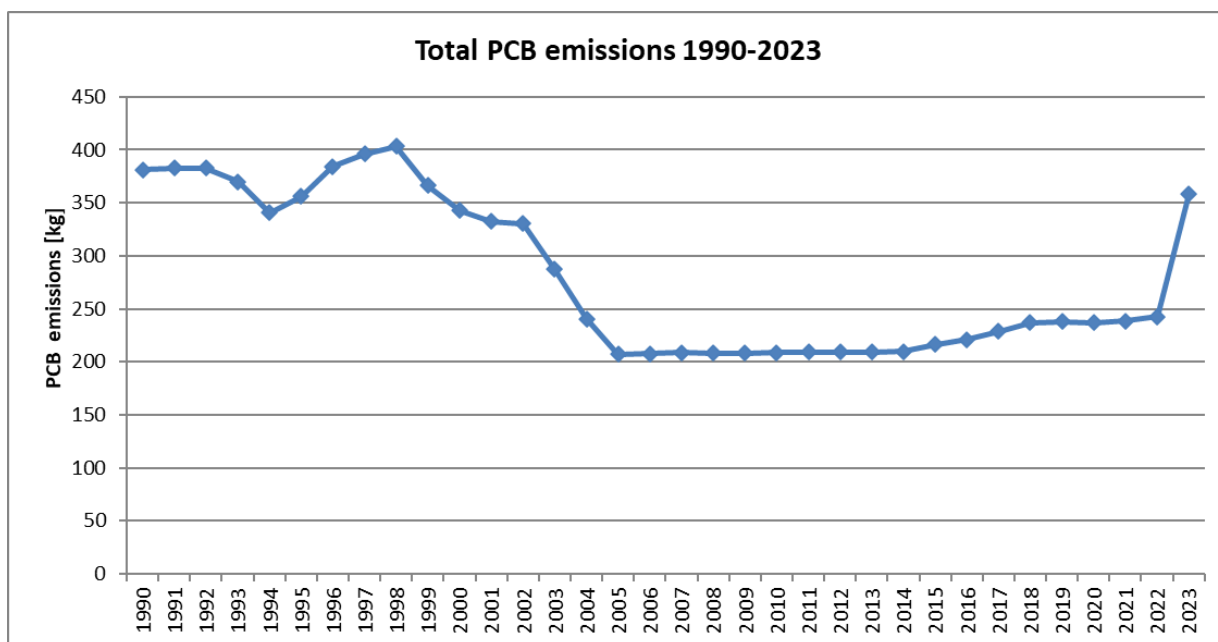


**Figure 35 HCB emissions in North Macedonia 1990-2023 by sectors**

#### 3.4.4. Polychlorinated biphenyl (PCB) Emissions

##### Emission trend

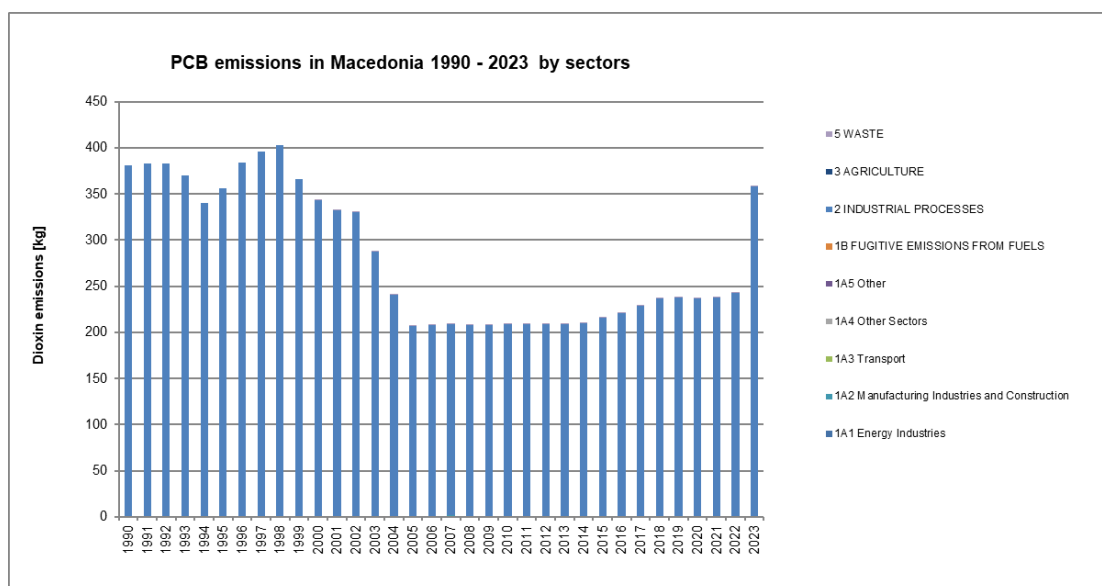
National total PCB emissions amounted to 381kg in 1990; emissions have decreased since then and, in the year, 2023 emissions were down by 6%, accounting to 358 kg. The trend emissions are not stable due to fluctuations in metal production – Lead and Zink production. This trend becomes stable in 2005 until 2014. In the last four years the emissions are continiusly increased due to use of Tier 2 methodology in 2.C sector and increased emissions from lead production. Sharp pick of total emissions in 2023 is due to higher emissions coming from the lead production by 50% compare to 2022.



**Figure 36 National total PCB emissions 1990-2023**

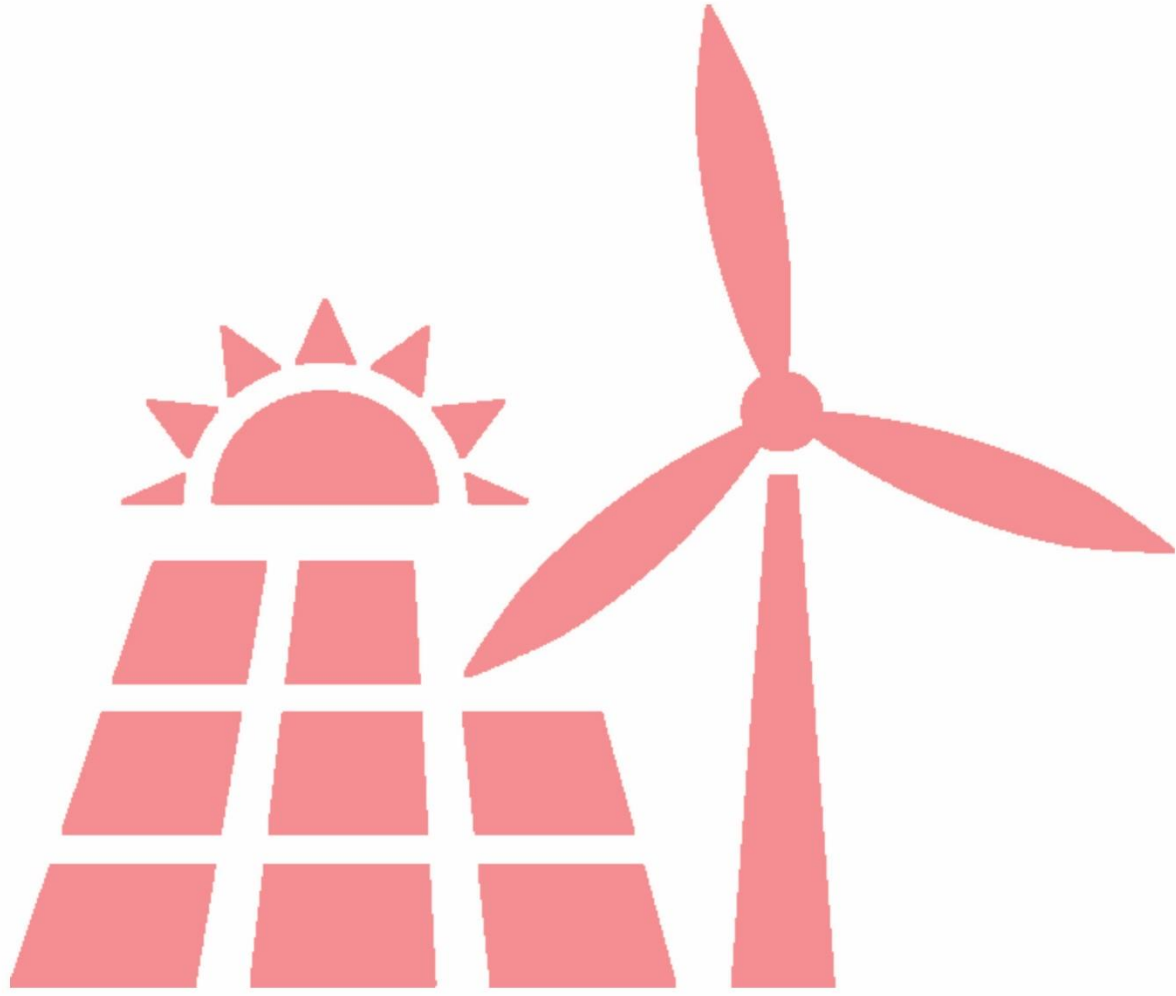
#### Main emission sources in North Macedonia

The most important emission source in 2023 of PCB is NFR sector 2 Industrial Processes and Product Use. Within this sector, the main contributor is 2.C.5 Lead Production, with a share of around 93% (around 100% in 1990) of the national total PCB emissions. PCB emissions from other NFR sectors are therefore minor. The additional key source in the nineties was the smelter company in Veles that has stopped production in 2003 and also has decline in production during the period 1998 until 2004 and rather stable trend until 2014. There is small increasing trend in the last several years due to increased lead production as well as due to use of Tier 2 methodology in 2C sector and calculation of PCB emissions from road transport with Tier 2 methodology for the period 2014-2023. High peak in 2023 is due to high increase in lead production.



**Figure 37 PCB emissions in North Macedonia 1990-2023 by sectors**

# ENERGY



## 4. ENERGY (NFR SECTOR 1)

### 4.1. Sector overview

This chapter gives an overview of category 1.A Stationary combustion activity. The energy sector is the most important sector considering that is a main contributor to the major air pollutants air emissions in the Republic of North Macedonia. Emissions from this sector arise from fuel combustion (NFR sector 1. A), and fugitive emissions from fuels (NFR sector 1. B). Following the recommendation of the previous stage 3 review to estimate emissions coming from NFRs 1.A.2.f, 1.A.3.e.i, 1.A.5.a and 1.B.2.d., the emissions under 1.B.2.d have been estimated; the notation key 1.A.2.f has been changed the to “IE” since the emissions from NFR 1.A.2.f are included in the emissions reported under NFR 2.A.1. NFR category 1.A.4.a.ii has been included in this submission while emissions from the categories 1.A.3.e.i, 1.A.5.a are still not estimated due to absence of activity data.

#### Completeness

The completed and not completed NFRs are presented in the following tables:

**Table 29 NFR categories included in Energy sector for 2023**

NFR category	Completeness
1 A 1 a Public electricity and heat production	√
1 A 1 b* Petroleum refining	√
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	√
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	√
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	√
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp. Paper and Print	√
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	√
1 A 2 gviii Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	√
1 A 2 f Stationary combustion in manufacturing industries and construction: Non-metallic minerals	IE
1 A 2 gvii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	√
1 A 3 a i (i) International aviation LTO (civil)	√
1 A 3 a i (ii) Domestic aviation LTO (civil)	√
1 A 3 b i Road transport: Passenger cars	√
1 A 3 b ii Road transport: Light duty vehicles	√
1 A 3 b iii Road transport: Heavy duty vehicles	√
1 A 3 b iv Road transport: Mopeds & motorcycles	√
1 A 3 b v Road transport: Gasoline evaporation	√
1 A 3 b vi Road transport: Automobile tire and brake wear	√
1 A 3 b vii Road transport: Automobile road abrasion	√
1 A 3 c Railways	√
1 A 4 a i Commercial / institutional: Stationary	√
1 A 4 a ii Commercial/institutional: Mobile	√

NFR category	Completeness
1 A 4 b i Residential: Stationary plants	√
1 A 4 b ii Residential: Household and gardening (mobile)	√
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	√
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	√
1A5b Other Mobile (including military, land based and recreational boats)	√
1 B 1 a Fugitive emission from solid fuels: Coal mining and handling	√
1 B 2 a iv Refining / storage	√
1 B 2 a v Distribution of oil products	√
1 B 2 c Venting and flaring	√
1 B 2 d Other fugitive emissions from energy production	√
1 A 3 d ii National navigation (Shipping)	√
<b>Memo Items</b>	
1 A 3 a i (ii) International aviation cruise(civil)	√
1 A 3 a ii (ii) Civil aviation LTO (Domestic, Cruise)	√
1A 3 Transport (fuel used)	√

**Table 30 NFR categories not included in Energy sector for 2022**

NFR category	Notation key used
1 A 1 c Manufacture of solid fuels and other energy industries	NO
1 A 3 a ii (ii) Domestic aviation cruise (civil)	NO
1 A 3 d i (ii) International inland waterways	NO
1 A 3 e Pipeline compressors	NO
1A 4 c iii Agriculture/Forestry/Fishing: National fishing	NE
1 A 5 a Other stationary (including military)	NE
1 B 1 b Fugitive emission from solid fuels: Solid fuel transformation	NO
1 B 1 c Other fugitive emissions from solid fuels	NO
1 B 2 a i Exploration Production Transport	NO
1 B 2 b Natural gas	NO
<b>Memo Items</b>	
1 A 3 d i (i) International maritime navigation	NO
1 A 3 a ii (ii) Domestic aviation cruise (civil)	NO
1 A 5 c Multilateral operations	NE

\*Petrol refining is not occurring since 2014

The NFR categories 1A.4.c iii 1.A.5.a and 1.A.5.c are not estimated due to lack of activity data. These sectors seem not to have major impact on the national emissions and will be calculated or categorized as IE when activity data or information are made available in the future submissions.

## **Methodology**

In general, the methodology is following the EMEP Tier 1 methodology, using default emission factors from the Guidebooks 2009/2013/2016/2019 and activity data from energy statistics. Plant specific emission data is considered for reporting of NO<sub>x</sub>, SO<sub>2</sub>, CO and TSP within the following sectors:

1.A.1.a - 9 power plants (one heating plant and one power plant were not operating in 2020)

1.A.1.b - 1 refinery (not in operation since 2014)

1.A.2.f - 1 cement plant

The activity data is mainly taken from the national energy statistics published annually the website of the State statistical office. Fuel consumption for 1.A.1.a-category has been provided by plant operators. Complete energy statistics was only available for the years 1998-2010 and from 2012 onwards. For some of the missing years and for specific categories, energy consumption is particularly available from other sources (national reports, older printed versions of statistics). For some years, activity data has been gap filled, as described in the sector specific chapters. Until the year 2012, energy statistics only provides consolidated data on 'diesel and other'. As of 2013, separate data for road diesel and gasoil were available. In the MAKSTAT database the separate data for road diesel and gasoil are available starting from 2015 and historical data are now available starting from 2005.

Emission factors for this submission were updated with EF from the latest available Guidebook version 2019 during last reporting cycle. At current, the default (medium range) emission factors have been selected in all cases, Implied emission factors derived from the emission measurements have been used for source category 1.A.1.a for different periods due to technology improvements and uncertain measurements results.

With regards to LHV, these values have been taken from energy balance or operators reports if they were reported in the respective annual reports. For coal mines in the country LHV - 6.36 - 7.7 TJ/10<sup>3</sup> t has been used. for imported coal – 8.29 TJ/10<sup>3</sup>t, for biomass this year separate LHV were used for fire wood – 6.7 TJ/10<sup>3</sup> m<sup>3</sup>, 10.66 TJ/10<sup>3</sup> m<sup>3</sup> for fruit wood. for wood wastes, wood briquettes and pellets – 17.00 TJ/10<sup>3</sup> t for heavy fuel – 40/40.19 TJ/10<sup>3</sup>t. for heating oil and other gasoil – 42.5 TJ/10<sup>3</sup>t, for diesel – 43/42.71 TJ/10<sup>3</sup>t for coke – 26.795 TJ/10<sup>3</sup>t. for other imported coal – 8.29 TJ/10<sup>3</sup>, for natural gas – 33.588/34.12 TJ/10<sup>6</sup> Nm<sup>3</sup>, LPG – 46/46.05 TJ/10<sup>3</sup>t and petroleum coke – 31.82 TJ/10<sup>3</sup>t.

## **4.2. Public electricity and heat production-NFR 1.A.1.a**

This category includes emissions from thermal public power and district heating plants. Public electricity production is dominated by two large plants, which are using lignite as a major fuel and fuel oil as a supporting fuel, while natural gas is not widely used for power generation. District heating plants are operated using only natural gas. At current, biofuels are not used for power or district heat generation. In 2022, seven plants under this category were operating. Emissions from non-public district heat generation (industrial auto producers) are considered in the respective subcategories of 1.A.2 or 1.A.4.a.

As it was recommended by the last stage 3 review report, information on the existence of abatement technology in the IIR to further increase the transparency of the inventory is included.

**Table 31 TPP and DHP Installation technical properties and BAT**

Num.	Plant name	Technology	Thermal input [MW]	Fuel type 1	Fuel type 2	BAT	NERP	Comments
1	REK BITOLA	Production of electricity	2025	Lignite	Heavy fuel oil	Modernization of blocs in 2013-2014, reduction of NO <sub>x</sub> , dust and CO electrostatic filter for dust $\eta=99,84\%$	Yes	
2	REK OSLOMEJ	Production of electricity	375	Lignite	Heavy fuel oil	electrostatic filter for dust $\eta=98\%$	Yes	Since 2015 limited operation only few mounts in the heating season due to limited coal reserves.
3	TEC NEGOTINO	Production of electricity	630	Heavy fuel oil			No	Not in operation since 2014 it is used as cold reserve; Due to the energy crisis the installation was put in operation in December 2021 and it is used since then
4	Balkan Energy Toplana ISTOK	Heat production	294	Natural gas		Burners for low NO <sub>x</sub> insurance	Yes	
5	Balkan Energy Toplana ZAPAD	Heat production	183	Natural gas		In 2013 Heavy fuel oil has been replaced with natural gas. Burners for low NO <sub>x</sub> insurance	Yes	
6	Toplana Sever	Heat production		Natural gas			No	Not in operation
7	TE-TO	Combined Electricity and heat production	440	Natural gas		Ecological burners for low NO <sub>x</sub> insurance and stable combustion mode	No	
8	ELEM	Heat production	100	Natural gas			No	
9	KOGEL	Combined Heat and electricity production	90	Natural gas			Yes	Started in October 2019, no data in this submission

#### 4.2.1. Methodological issues

For the years 2008 onwards. NO<sub>x</sub>. SO<sub>2</sub>. CO and TSP measured emissions from the power plants and district heating plants are considered. Currently, emissions of these plants are based on periodical (monthly) measurements. which are carried out by accredited laboratories. Automatic monitoring system is present only in TE-TO power plant. and yearly emissions are calculated by means of flue gas concentrations and flue gas volumes and reported by the operators to the Ministry of Environment and physical planning. For lignite and fuel oil the NO<sub>x</sub> SO<sub>2</sub> CO and TSP emissions from 1990 to 2007 are estimated by means of calculated implied emission factors which are derived from average 2009-2012 emissions and fuel consumption provided by plant operators. For natural gas emissions, from 1990 to 2007 the emissions are calculated with default Tier 1 emission factors as recommended in the Guidebook 2019.

Other pollutants (NH<sub>3</sub> heavy metals and POPs) are estimated by means of the EMEP 2019 default emission factors and fuel consumption. Due to modernization of power plants, in terms of reduction of NO<sub>x</sub> and dust, implied emission factors were derived for NO<sub>x</sub> and dust for the period 2013-2014, and were used for calculation of NO<sub>x</sub> and TSP emissions for 2015-2017 while PM<sub>10</sub> and PM<sub>2.5</sub> emissions were calculated by applying the share of the Guidebook emissions factors. The share of PM<sub>10</sub> in TSP is 68% and the share of PM<sub>2.5</sub> is 27%.

### **Activity data**

Activity data for fuel consumption have been provided by the plant operators. The lignite originates from inland mines and has a sulfur content of about 0.7% and very high-water content, up to 60%. Therefore, the NCV of lignite is only about 6-7 MJ/kg. Residual fuel oil (also called 'Mazut') has a sulfur content of 1% but in the early 1990s it was estimated that the sulfur content was up to 3%.

The following table shows activity data for category 1.A.1.a by type of fuel.

**Table 32 Activity data for source category 1.A.1.a Public electricity and heat production by type of fuel**

<b>Year</b>	<b>Lignite (TJ)</b>	<b>Natural gas (TJ)</b>	<b>Residual fuel oil (TJ)</b>
<b>1990</b>	58359	1000	2516
<b>1991</b>	45655	NO	3090
<b>1992</b>	44356	NO	2656
<b>1993</b>	45442	NO	3037
<b>1994</b>	47507	NO	2434
<b>1995</b>	49958	NO	2986
<b>1996</b>	47675	NO	3051
<b>1997</b>	49362	NO	3301
<b>1998</b>	55194	NO	2602
<b>1999</b>	50091	NO	2640
<b>2000</b>	51991	715	6345
<b>2001</b>	56387	673	3800
<b>2002</b>	48716	641	4286
<b>2003</b>	49091	345	2902
<b>2004</b>	49291	69	2936
<b>2005</b>	48711	52	3031
<b>2006</b>	45153	197	5152
<b>2007</b>	45697	895	6588
<b>2008</b>	52597	1627	1270
<b>2009</b>	50442	744	2267
<b>2010</b>	46386	1475	2330
<b>2011</b>	53111	1570	1431
<b>2012</b>	50549	974	1594
<b>2013</b>	43402	1522	1310



Year	Lignite (TJ)	Natural gas (TJ)	Residual fuel oil (TJ)
2014	44158	1633	1671
2015	39816	3258	1606
2016	32903	5653	1138
2017	28553	7456	933
2018	31523	6674	538
2019	37584	8290	687
2020	28740	9745	1073
2021	23445	9132	1462
2022	28794	7721	7223
2023	29770	11870	8132

The data for the fuel consumption in the reporting period shows that solid and liquid fuels are reduced, and the quantity of natural gas is increasing. However, residual fuel oil and lignite are increased in 2022 compare to 2021 due to activation of the cold reserve TEC Negotino. The consumption of lignite is also increased due to reparation of the bloks in REK Bitola.

Data on fuel consumption is reported by the installation in the format prescribed in the secondary legislation. Starting from 2008 onwards, emission measurements for the basic pollutants (SO<sub>x</sub>, NO, TSP and CO) were used but only if quality check is approved. In cases where the facility does not deliver emission measurements data, or the quality check of the emission measurement data is not reliable (for example in cases where the yearly emissions are calculated based on available measurements for several months), emissions for the basic pollutants are calculated by multiplying the implied emission factors the quantity of fuel consumed reported by the installations.

### **Emission factors**

Emission factors for this source category are presented in the following table:

**Table 33 Emission factors for source category Public electricity and heat production 1.A.1.a by type of fuel**

Pollutant	Unit	Lignite	Natural gas	Heavy fuel oil
NO <sub>x</sub>	g/GJ	389	89	389
NM VOC	g/GJ	1.4	2.6	2.3
SO <sub>2</sub>	g/GJ	1.678	0281	1.678
NH <sub>3</sub>	g/GJ	NE	NE	NE
PM <sub>2.5</sub>	g/GJ	57.4	0.9	57.4
PM <sub>10</sub>	g/GJ	141.8	0.9	141.8
BC	%PM <sub>2.5</sub>	1	2.5	5.6
TSP	g/GJ	210	0.89	210
CO	g/GJ	43	2.5	43
Pb	mg/GJ	15	0.0015	4.56
Cd	mg/GJ	1.8	0.00025	1.2
Hg	mg/GJ	2.9	0.1	0.341

Pollutant	Unit	Lignite	Natural gas	Heavy fuel oil
As	mg/GJ	14.3	0.12	3.98
Cr	mg/GJ	9.1	0.00076	2.55
Cu	mg/GJ	1	0.000076	5.31
Ni	mg/GJ	9.7	0.00051	255
Se	mg/GJ	45	0.0112	2.06
Zn	mg/GJ	8.8	0.0015	87.8
PCDD/ PCDF (dioxins/furans)	ng I-TEQ/GJ	10	0.5	2.5
benzo(a) pyren	µg/GJ	1.3	0.56	NE
benzo(b) fluoranthene	µg/GJ	37	0.84	4.5
benzo(k) fluoranthene	µg/GJ	29	0.84	4.5
Indeno (1.2.3-cd) pyren	µg/GJ	2.1	0.84	6.92
PCB	ng WHOTEG/GJ	3.3	NE	NE
HCB	µg/GJ	6.7	NE	NE

Emission factors for the basic pollutants: NO<sub>x</sub>, SO<sub>x</sub>, CO and particulates for heavy fuel and coal are implied emission factors and are presented in tables below. For the use of natural gas and other pollutants EF from GB 2023 are used.

#### **Emission measurements**

These data were used for identification of implied emission factors. Data for the yearly emission measurements are reported by the operators in a template prescribed in the national sub legislation, until 31<sup>th</sup> March each year. Installations are reporting on NO<sub>x</sub>, CO, TSP and SO<sub>x</sub> measurements, but in case of power plants, implied EF are used also for these pollutants for coal and heavy fuel oil due to low coverage of measurements. For 2023 for these pollutants, the measurements received were converted to yearly emissions and presented in the NFR reporting table with exception of SO<sub>x</sub> emissions. The measured emissions for TSP are used for calculation of PM<sub>10</sub> and PM<sub>2.5</sub> as 68 and 27% fraction from TSP.

#### **Implied emission factors**

The following table shows NO<sub>x</sub>, SO<sub>2</sub>, TSP and CO implied emission factors for category 1.A.1.a. by type of fuel for the years 2009 to 2012. and the mean value which has been used to calculate emissions from lignite and fuel oil 1990 to 2007. These emission factors were calculated with the support of Austrian energy expert in the Twining project “Further strengthening the capacities for effective implementation of the acquis in the field of Air Quality” that has been carried out in the period 2015-2017 in our Ministry. As proposed by the expert the implied EF for both heavy fuel and coal are same for the basic pollutants considered emission measurement data. The IEF were developed with the Austrian experts in the Twining project.

The problem was that only for several years there was good coverage of measurements (there is still no automatic monitoring for coal power plants), so these measurements were used to develop IEF. Default emission factors from the guidebook are not suitable since the coal is domestic. I the expert

judgment to develop same emission factors from the measurements influence on less uncertainty than to use default emission factors for Guidebook."

**Table 34 Implied Emission factors for source category Public electricity and heat production 1.A.1.a by using measurements data for period 2009 -2012**

Year	NO <sub>x</sub> (g/GJ)	SO <sub>2</sub> (g/GJ)	TSP (g/GJ)	CO (g/GJ)
2009	374.42	1.827.26	241.57	33.13
2010	411.71	1.562.94	171.77	33.88
2011	411.34	1.736.47	213.54	44.27
2012	359.25	1.584.72	213.57	61.00
Mean-IEF	389.00	1.678.00	210.00	43.00

Implied emission factors for PM2.5 and PM10 are derived as 68% and 27% from TSP and are calculated to be 57.44 g/GJ and 105.4 g/GJ respectively.

For this submission NO<sub>x</sub> and TSP values were recalculated due to lower figures of monthly measurements which is infected by the modernization boilers in the power plants.

**Table 35 Implied Emission factors for source category Public electricity and heat production 1.A.1.a by type of fuel for 2014-2017**

Year	NO <sub>x</sub> (g/GJ)	TSP (g/GJ)
2013	261.03	239.74
2014	100.66	70.92
Mean-IEF	181.00	155.00

**Table 36 Implied Emission factors for source category Public electricity and heat production 1.A.1.a by type of fuel for 2022-2023**

Year	NO <sub>x</sub> (g/GJ)	TSP (g/GJ)
2022	261.03	239.74
2023	100.66	70.92
Mean-IEF	181.00	155.00

Implied emission factors for PM2.5 and PM10 are derived as 68% and 27% from TSP and are calculated to be 41.85 g/GJ and 105.4 g/GJ respectively.

For 2022-2023 the calculation of emission amounts of SO<sub>2</sub> is made using implied emission factors instead of using measured exhaust gas volume flows and emission concentrations of SO<sub>2</sub>, due to the large difference in the values of volume flows of exhaust gases, as well as high amounts of emissions even the amount of coal is decreased in the whole time.

The implied emission factors for SO<sub>2</sub>, are calculated as the mean value of the emission factors calculated for 3 consecutive years, 2019, 2020 and 2021, for 2023 and 2020, 2021 and 2022, considering the input thermal power of the fuels in TJ and the emission amounts of the polluting substances for each year individually expressed in tons.

In the future, our assessment is that fully credible and reliable calculations for emission quantities of SO<sub>2</sub>, NO<sub>x</sub> and TSP, in tons, can be obtained if REK Bitola installs continuous monitoring of the volume

flow of exhaust gases and emission concentrations of SO<sub>2</sub>, NO<sub>x</sub> and TSP, at measuring point and calibration of the automatic monitoring system according to international standards. Therefore, starting from 2022-2023 implied emission factors will be used again.

#### 4.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty for NO<sub>x</sub> and SO<sub>x</sub> was estimated to be 20% (rating A. cf. chapter 1.7), 200% for NMVOC (rating D) and 125% for PM<sub>2.5</sub> (rating C).

#### 4.2.3. Source-specific QA/QC and verification

Quality check of these data is made by the advisor for emission data. within the division for analysis and reporting before they are used in the national inventory.

#### 4.2.4. Source-specific recalculations

Recalculations were done due to due to final consumption data for 2023 and compliance with data reported under Energy community obligations for LCPs.

#### 4.2.5. Source-specific planned improvements

Consistency of the whole trend for this category planned improvements will be part of the activity for improving of national air emission inventory in IPA II air quality project that is planned to start in the end of this year.

### 4.3. Petroleum refining – NFR 1.A.1.b

This chapter presents the entire consumption of fuels in the oil industry. Main representative of this sector was only one company “OKTA AD – Skopje”. In 1982 with the commissioning of the processing plants OKTA AD – Skopje becomes the only crude oil refinery in the country. In January 2013 production in OKTA ended, after which the company entered a transformation process from an inflexible and non-efficient heavy industry into a fast-growing client-oriented logistics services trade company. OKTA has developed a retail network of 25 petrol stations across the country, where it supplies high quality products and services to the end consumers.

#### 4.3.1. Methodological issues

The Tier 1 approach for process emissions from combustion uses the general equation:

$$E_{\text{pollutant}} = AR_{\text{fuel consumption}} \times EF_{\text{pollutant}}$$

$E_{\text{pollutant}}$  annual emission of pollutant

$EF_{\text{pollutant}}$  emission factor of pollutant

$AR_{\text{fuel consumption}}$  activity rate by fuel consumption

This equation is applied at the national level. Using annual national total fuel use (disaggregated by fuel type (refinery gas and heavy fuel oil).

#### Activity data

Data on the consumption of fuels in this sector for the period 2000-2014 have been collected by the operator itself. No production was carried out from 2015 onwards. The company became customer-

oriented. logistics and trading company. providing uninterrupted and reliable supply of fuel in the country. Request for providing data for the period 1990-1999 has been sent to the company. but these data have not been reported.

Data for 1990-1999 were calculated using the surrogate method. The estimates were related to the two trends in crude oil consumption by the refinery.

**Table 36 Activity data for source category 1.A.1.b- Petroleum refining by type of fuel**

<b>Year</b>	<b>Refinery gas (TJ)</b>	<b>Residual fuel oil (TJ)</b>
<b>1990</b>	1711	1680
<b>1991</b>	1356	1331
<b>1992</b>	797	782
<b>1993</b>	1432	1406
<b>1994</b>	201	198
<b>1995</b>	168	165
<b>1996</b>	980	961
<b>1997</b>	534	524
<b>1998</b>	1062	1042
<b>1999</b>	1077	1057
<b>2000</b>	1467	1071
<b>2001</b>	1425	1109
<b>2002</b>	912	870
<b>2003</b>	1103	1140
<b>2004</b>	1174	1181
<b>2005</b>	1373	1035
<b>2006</b>	1522	1002
<b>2007</b>	1551	1228
<b>2008</b>	1483	1304
<b>2009</b>	1368	1339
<b>2010</b>	1294	1921
<b>2011</b>	723	1815
<b>2012</b>	236	990
<b>2013</b>	68	384
<b>2014</b>	NO	107
<b>2015</b>	NO	NO
<b>2016</b>	NO	NO
<b>2017</b>	NO	NO
<b>2018</b>	NO	NO
<b>2019</b>	NO	NO
<b>2020</b>	NO	NO

Year	Refinery gas (TJ)	Residual fuel oil (TJ)
2021	NO	NO
2022	NO	NO
2023	NO	NO

### Emission factors

The emission factors for refinery gas have been taken from GB 2023. Table 4-2, Tier 1 emission factors for source category 1.A.1.b, Refinery gas and emission factors for heavy fuel oil from GB 2023. Table 4-4 Tier 2 emission factors for source category 1.A.1.b, process furnaces using residual oil.

**Table 37 Emission factors for source category 1.A.1.b- Petroleum refining**

Pollutant	Unit	Refinery gas	Heavy fuel oil
NO <sub>x</sub>	g/GJ	63	142
NMVOC	g/GJ	2.58	2.3
SO <sub>2</sub>	g/GJ	0.281	485
PM2.5	g/GJ	0.89	9
PM10	g/GJ	0.89	15
TSP	g/GJ	0.89	20
CO	g/GJ	12.2	6
Pb	mg/GJ	1.61	4.6
Cd	mg/GJ	2.19	1.2
Hg	mg/GJ	0.372	0.3
As	mg/GJ	0.352	3.98
Cr	mg/GJ	6.69	14.8
Cu	mg/GJ	3.29	11.9
Ni	mg/GJ	7.37	773
Se	mg/GJ	1.56	2.1
Zn	mg/GJ	17	49.3
"PCDD/ PCDF (dioxins/furans)"	ng I-TEQ/GJ	-	2.5
benzo(a) pyren	µg/GJ	0.669	
benzo(b) fluoranthene	µg/GJ	1.14	3.7
benzo(k) fluoranthene	µg/GJ	0.631	-
Indeno (1.2.3-cd) pyren	µg/GJ	0.631	-

#### 4.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty for NO<sub>x</sub> and SO<sub>x</sub> was estimated to be 20% (rating A. cf. chapter 1.7), 200% for NMVOC (rating D) and 40% for PM2.5 (rating B).

#### 4.3.3. Source-specific QA/QC and verification

No specific QA/QC and data verification was performed. considering that no production process is occurring in the last few years.

#### 4.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were made for this reporting period.

#### 4.3.5. Source-specific planned improvements including those in response to the review process

No planned improvements in this category.

### 4.4. Manufacturing industries and construction– NFR 1.A.2

This category includes emissions from manufacturing industries. Several industrial branches are contributing to the category, each consisting of either a single or few industrial plants with rather small capacities. Many plants have phases of non-operation or high fluctuation in their production, as a repercussion of the economic changes since the early 1990s.

For all other categories, the Tier1 methodology has been selected by using default emission factors from the GB 2019.

#### 4.4.1. Methodological issues

The Tier 1 approach for process emissions from industrial combustion installations uses the general equation:

$$E_{pollutants} = \sum AR_{fuelconsumption} \times EF_{fuel.pollutnat}$$

$E_{Pollutant}$  = emissions of pollutant (kg).

$AR_{fuel\ consumption}$  = fuel used in the industrial combustion (TJ) for each fuel.

$EF_{fuel.pollutant}$  = an average emission factor (EF) for each pollutant for each unit of fuel type used (kg/TJ).

#### Activity data – stationary combustion

Complete energy statistics is only available for the years 1991, 1993, 1995, 1996, 1998-2014. The missing years 1990, 1992, 1994 and 1997 have been linearly interpolated or gap-filled by means of production statistics.

The activity data for the following categories are presented in following tables:

- 1.A.2.a — Iron and steel
- 1.A.2.b — Non-ferrous metals
- 1.A.2.c — Chemicals
- 1.A.2.d — Pulp, paper and print
- 1.A.2.e — Food processing, beverages and tobacco
- 1.A.2.f — Non-metallic minerals is IE
- 1.A.2.g.vii - Other

The activity data from the NFR category 1.A.2.g.vii - Mobile Combustion in manufacturing industries and construction: for diesel fuel are presented in Table 38.

**Table 38 Activity data for source category 1.A.2.a – Stationary combustion in manufacturing industries and construction: Iron and steel**

<b>Year</b>	<b>Biomass [TJ]</b>	<b>Natural gas [TJ]</b>	<b>Lignite [TJ]</b>	<b>Heavy Fuels [TJ]</b>
1990	NA	NA	1396	3104
1991	NA	NA	2133	1184
1992	NA	NA	2451	1611
1993	NA	NA	1964	1291
1994	NA	NA	960	631
1995	NA	NA	2100	656
1996	NA	NA	NA	34
1997	NA	NA	272	179
1998	0.30	NA	5166	1793
1999	0.53	NA	3443	1414
2000	NA	27	2285	1699
2001	0.08	816	1912	780
2002	NA	960	1378	1076
2003	2.60	1119	2882	1196
2004	2.22	1226	3300	1041
2005	82.75	1413	5299	2029
2006	69.59	1456	6308	2793
2007	9.13	1465	7373	2571
2008	9.13	1201	5931	2969
2009	0.98	1141	3761	2571
2010	52.51	1126	5842	3224
2011	3.42	754	5415	2002
2012	4.00	605	6377	3000
2013	4.00	610	5220	3366
2014	3.42	754	5410	2002
2015	4.01	658	4368	1399
2016	2.41	864	4521	1142
2017	1.51	1025	2522	806
2018	101.11	994	3071	926
2019	95.70	912	4800	998
2020	503.08	845	3712	1157
2021	337.77	946	3963	986
2022	257.966	959	2195	588
2023	61.997	926	1408	463



**Table 39 Activity data for source category 1.A.2.b - Stationary combustion in manufacturing industries and construction: Iron and steel**

<b>Year</b>	<b>Biomass [TJ]</b>	<b>Natural gas [TJ]</b>	<b>Lignite [TJ]</b>	<b>Heavy Fuels [TJ]</b>
1990	NA	NA	2298	631
1991	NA	NA	1827	278
1992	NA	NA	1830	591
1993	NA	NA	1834	905
1994	NA	NA	1686	862
1995	NA	NA	1537	819
1996	NA	NA	NA	26
1997	NA	NA	920	82
1998	NA	NA	1839	139
1999	NA	NA	1754	700
2000	NA	NA	2046	771
2001	NA	NA	1919	374
2002	NA	NA	1246	615
2003	NA	NA	596	9
2004	NA	NA	NA	13
2005	NA	NA	NA	22
2006	NA	NA	NA	32
2007	NA	NA	NA	42
2008	NA	NA	NA	266
2009	NA	NA	NA	26
2010	NA	NA	NA	34
2011	NA	NA	NA	70
2012	NA	NA	NA	41
2013	NA	NA	NA	42
2014	NA	NA	NA	3
2015	NA	NA	NA	42
2016	NA	NA	NA	53
2017	NA	NA	NA	55
2018	NA	NA	NA	54
2019	NA	NA	NA	48
2020	NA	NA	NA	57
2021	0.187	NA	NA	71
2022	0.119	NA	NA	59
2023	0.068	NA	NA	63

**Table 40 Activity data for source category 1.A.2.c - Stationary combustion in manufacturing industries and construction: Chemicals**

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
1990	NA	NA	NA	169
1991	NA	NA	NA	166
1992	NA	NA	0.42527	613
1993	NA	NA	0.85054	1060
1994	NA	NA	0.746996	1136
1995	NA	NA	0.643452	1213
1996	NA	NA	2.540328	33
1997	NA	NA	2.256664	89
1998	0.84	NA	1.973	144
1999	NA	NA	NA	40
2000	NA	NA	NA	NA
2001	NA	37.518	NA	0.0838
2002	NA	40.373	NA	1.59
2003	NA	32.715	NA	0.712
2004	NA	25.964	NA	5.99
2005	NA	117.684	NA	187
2006	NA	68.480	NA	166
2007	NA	62.045	NA	158
2008	NA	57.061	NA	154
2009	NA	37.596	NA	131
2010	NA	61.877	NA	89
2011	NA	52.170	NA	100
2012	NA	38.770	NA	75
2013	0.4165	36.942	NA	72
2014	NA	35.903	NA	65
2015	NA	36.439	NA	87
2016	NA	38.813	NA	74
2017	0.03	41.272	NA	83
2018	0.03	39.053	NA	75
2019	0.57	72.027	NA	83
2020	0.56	72.027	NA	41
2021	0.19	102.217	NA	23
2022	0.79	80.241	NA	20
2023	0.68	79.127	NA	21

**Table 41 Activity data for source category 1.A.2.d - Stationary combustion in manufacturing industries and construction: Pulp. paper and print**

<b>Year</b>	<b>Biomass [TJ]</b>	<b>Natural gas [TJ]</b>	<b>Lignite [TJ]</b>	<b>Heavy Fuels [TJ]</b>
1990	NA	NA	337.1813	12.89
1991	NA	NA	337.18	16.88
1992	NA	NA	0.44	12.40
1993	NA	NA	0.22	7.92
1994	NA	NA	NA	7.76
1995	NA	NA	NA	7.60
1996	NA	NA	NA	196.99
1997	NA	NA	56.11	169.95
1998	1.90	NA	28.78	142.91
1999	0.53	NA	1.45	2.86
2000	0.50	NA	NA	0.38
2001	0.84	NA	NA	0.29
2002	0.67	NA	NA	1.93
2003	0.21	NA	NA	1.26
2004	1.00	NA	NA	1.13
2005	1.71	74.54	0.78	52.94
2006	1.88	78.19	0.65	55.17
2007	1.71	75.25	0.87	56.71
2008	1.72	76.73	2.76	129.93
2009	1.43	58.56	0.62	62.99
2010	1.57	92.12	0.32	38.51
2011	0.91	33.83	0.19	27.53
2012	0.37	23.79	0.27	17.27
2013	0.32	15.06	0.25	16.01
2014	0.20	15.04	0.96	17.75
2015	0.18	15.04	0.23	26.37
2016	2.02	14.02	0.21	18.59
2017	2.85	15.94	0.25	22.64
2018	2.74	16.24	NA	18.00
2019	3.30	19.32	NA	20.45
2020	3.42	22.384	NA	20.70
2021	4.63	23.468	NA	22.60
2022	3.51	19.727	NA	21.10
2023	3.30	19.319	NA	20.45

**Table 42 Activity data for source category 1.A.2.e - Stationary combustion in manufacturing industries and construction: Food processing. beverages. and tobacco**

<b>Year</b>	<b>Biomass [TJ]</b>	<b>Natural gas [TJ]</b>	<b>Lignite [TJ]</b>	<b>Heavy Fuels [TJ]</b>
1990	NA	NA	172	1611
1991	NA	NA	34	223
1992	NA	NA	32	414
1993	NA	NA	30	605
1994	NA	NA	22	589
1995	NA	NA	14	572
1996	NA	NA	3	137
1997	NA	NA	17	547
1998	15.54	NA	31	956
1999	18.41	NA	31	115
2000	13.19	NA	28	1614
2001	12.31	34	13	155
2002	9.67	59	18	172
2003	4.19	59	22	202
2004	5.86	51	16	155
2005	136.53	257.30	19.93	1057
2006	8.77	261.38	6.04	1002
2007	2.18	243.90	10.32	920
2008	7.38	246.31	8.76	891
2009	2.05	211.11	7.00	895
2010	9.33	238.05	9.24	862
2011	5.92	237.68	7.52	824
2012	74.28	218.77	6.78	812
2013	138.16	220.22	6.85	681
2014	188.88	204.67	4.42	660
2015	182.19	215.39	NA	701
2016	152.72	234.03	NA	687
2017	184.95	240.53	NA	666
2018	167.95	240.62	NA	345
2019	162.61	233.08	0.46	683
2020	137.88	247.68	NA	689
2021	161.04	280.78	NA	684
2022	151.07	180.879	NA	699
2023	124.092	262.100	NA	514

**Table 43 Activity data for category source category**

<b>Year</b>	<b>Biomass [TJ]</b>	<b>Natural gas [TJ]</b>	<b>Lignite [TJ]</b>	<b>Heavy Fuels [TJ]</b>	<b>Clinker [tones]</b>
1990	67	NA	111	2666	491 902
1991	67	NA	111	2727	465 375
1992	67	NA	111	2606	396 496
1993	67	NA	110	2484	413 444
1994	67	NA	123	2117	375 914
1995	67	NA	135	1749	365 121
1996	66	NA	32	6040	396 015
1997	67	NA	593	2495	475 252
1998	66	NA	668	2991	346 867
1999	69	153	517	2000	427 080
2000	67	263	634	2540	614 162
2001	35	204	649	2744	716 963
2002	30	266	687	2922	739 492
2003	38	29	1084	2731	602 569
2004	29	NA	1706	1349	643 258
2005	2068	86	332	1974	694 922
2006	179	86	263	3073	801 302
2007	124	88	265	4603	882 834
2008	186	86	213	4359	843 765
2009	126	71	170	2980	478 404
2010	100	128	134	3184	588 978
2011	104	244	104	3520	687 986
2012	113	135	113	3441	645 482
2013	84	129	141	3335	577 845
2014	113	135	113	3441	518 198
2015	52	145	939	2345	553 232
2016	61	173	2662	1027	739 807
2017	63	213	2632	1017	735 625
2018	63	235	2548	1234	748 287
2019	62	254	2327	1668	730 700
2020	53	291	301	3256	770 559
2021	52	292	1058	2979	803 735
2022	113	224	304	3407	673 837
2023	80	281	659	3097	711 254

#### 4.4.2. 1.A.2. gviii - Stationary combustion in manufacturing industries and construction: Other

##### Activity data – mobile combustion

Activity data for category 1.A.2.gvii for diesel fuel is presented in Table 44.

**Table 44 Activity data for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for diesel fuel**

Year	Heavy Fuels [TJ]	Year	Heavy Fuels [TJ]
1990	4846	2006	1013
1991	3496	2007	1369
1992	4674	2008	1725
1993	4891	2010	2285
1994	2059	2011	1146
1995	2392	2012	1182
1996	2060	2013	1198
1997	1784	2014	1096
1998	1613	2015	1089
1999	1307	2016	1048
2000	1043	2017	1127
2001	1148	2018	1165
2002	675	2019	1136
2003	545	2020	1153
2004	504	2021	1013
2005	426	2022	1369
2009	456	2023	1725

##### Emission factors – stationary combustion

Tier 1 emission factors have been used for calculation of emissions in separate categories. Emission factors for different type of fuels are presented in Tables 45-50.

**Table 45 Emission factors for source category 1.A.2 - Stationary combustion in manufacturing industries and construction for biomass**

Pollutant	Value	Unit	References
NOx	91	g/GJ	GB 2023 Table 3-5 emission factor for source category, 1.A.2. page 17
NMVOC	300	g/GJ	GB 2023 Table 3-5 emission factor for source category, 1.A.2. page 17
SOx	11	g/GJ	GB 2023 Table 3-5 emission factor for source category, 1.A.2. page 17
NH3	1.2	g/GJ	GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18
PM2.5	140	g/GJ	GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18
PM10	143	g/GJ	GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18
BC	28	% of PM2.5	GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18
TSP	150	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
CO	570	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18

Pollutant	Value	Unit	References
Pb	27	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Cd	13	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Hg	0.56	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
As	0.19	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Cr	23	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Cu	6	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Ni	2	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Se	0.5	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Zn	512	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
PCDD/PCDF	100	ng I-Teq/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
benzo(a) pyren	10	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
benzo(b) fluoranthene	16	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
benzo(k) fluoranthene	5	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
Indeno (1.2.3-cd) pyren	4	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
HCB	5	µg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18
PCBs	0.06	µg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18

**Table 46 Emission factors for source category 1.A.2 - Stationary combustion in manufacturing industries and construction for gaseous fuel**

Pollutant	Value	Unit	References
NOx	74	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
NMVOC	23	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
SOx	0.67	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
PM2.5	0.78	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
PM10	0.78	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
TSP	0.78	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
BC	4	% PM2.5	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
CO	29	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Pb	0.011	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Cd	0.0009	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Hg	0.54	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
As	0.1	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Cr	0.013	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Cu	0.0026	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Ni	0.013	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Se	0.058	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Zn	0.73	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
PCDD/PCDF	0.52	ng I-Teq/GJ	GB2023 Table 3-3 emission factor for source category 1.A.2. page 16
benzo(a) pyren	0.72	mg/GJ	GB2023 Table 3-3 emission factor for source category 1.A.2. page 16

Pollutant	Value	Unit	References
benzo(b) fluoranthene	2.9	mg/GJ	GB2023 Table 3-3 emission factor for source category 1.A.2. page 16
benzo(k) fluoranthene	1.1	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16
Indeno (1.2.3-cd) pyren	1.08	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16

**Table 47 Emission factors for source category 1.A.2 - Stationary combustion in manufacturing industries and construction for solid fuel**

Pollutant	Value	Unit	References
NOx	173	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
NMVOC	88.8	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
SOx	900	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
PM2.5	108	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
PM10	117	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
TSP	124	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
BC	6.4	% of PM2.5	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
CO	931	g/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Pb	134	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Cd	1.8	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Hg	7.9	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
As	4	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Cr	13.5	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Cu	17.5	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Ni	13	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Se	1.8	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Zn	200	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
PCDD/PCDF	203	ng I-Teq/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
benzo(a) pyren	45.5	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
benzo(b) fluoranthene	58.9	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
benzo(k) fluoranthene	23.7	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
Indeno (1.2.3-cd) pyren	18.5	mg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
HCB	0.62	µg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15
PCBs	170	µg/GJ	GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15

**Table 48 Emission factors for source category 1.A.2 - Stationary combustion in manufacturing industries and construction for liquid fuel**

Pollutant	Value	Unit	References
NOx	513	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
NMVOC	25	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17



Pollutant	Value	Unit	References
SOx	47	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
PM2.5	20	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
PM10	20	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
TSP	20	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
BC	56	% of PM2.5	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
CO	66	g/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Pb	0.08	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Cd	0.006	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Hg	0.12	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
As	0.03	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Cr	0.2	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Cu	0.22	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Ni	0.008	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Se	0.11	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Zn	29	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
PCDD/PCDF	1.4	ng I- Teq/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
benzo(a) pyren	1.9	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
benzo(b) fluoranthene	15	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
benzo(k) fluoranthene	1.7	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17
Indeno (1.2.3-cd) pyren	1.5	mg/GJ	GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17

The emission factors for clinker production are presented in Table 47.

**Table 49 Emission factors for category 1.A.2 - Stationary combustion in manufacturing industries and construction: Other for clinker**

Pollutant	Value	Unit	References
NOx	1241	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
NM VOC	18	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
SOx	374	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
CO	1455	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Pb	0.098	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Cd	0.008	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Hg	0.049	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
As	0.0265	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Cr	0.041	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Cu	0.0647	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Ni	0.049	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Se	0.0253	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Zn	0.424	g/tclinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32

Pollutant	Value	Unit	References
PCB	103	µg/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
PCDD/PCDF	4.1	ng I-TEQ/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
benzo(a) pyren	0.000065	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f, page 32
benzo(b) fluoranthene	0.00028	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
benzo(k) fluoranthene	0.000077	g/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
Indeno (1.2.3-cd) pyren	0.000043	g/tclinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32
HCB	4.6	µg/t clinker	GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32

#### Emission factors – mobile combustion

Concerning the source category 1.A.2.gvii, the emission factors for diesel fuels are presented in Tables 50 and 51.

**Table 50 Emission factors for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for HM and POPs from diesel fuel and gasoline**

Fuel	Pollutant	Units	Emission factor
Diesel	Cadmium	mg/GJ	0.234
	Copper	mg/GJ	39.808
	Chromium	mg/GJ	1.171
	Nickel	mg/GJ	1.639
	Selenium	mg/GJ	0.234
	Zinc	mg/GJ	23.416
	Benz(a)anthracene	µg/GJ	1873.301
	Benzo(b)fluoranthene	µg/GJ	1170.813
	Dibenzo(a,h)anthracene	µg/GJ	234.163
	Benzo(a)pyrene	µg/GJ	702.488
	Chrysene	µg/GJ	4683.253
	Fluoranthene	µg/GJ	10537.319
	Phenanthrene	µg/GJ	58540.661
Gasoline	Cadmium	mg/GJ	0.227
	Copper	mg/GJ	38.670
	Chromium	mg/GJ	1.137
	Nickel	mg/GJ	1.592
	Selenium	mg/GJ	0.227
	Zinc	mg/GJ	22.747

Fuel	Pollutant	Units	Emission factor
	Benz(a)anthracene	µg/GJ	1706.042
	Benzo(b)fluoranthene	µg/GJ	909.889
	Dibenzo(a,h)anthracene	µg/GJ	227.472
	Benzo(a)pyrene	µg/GJ	909.889
	Chrysene	µg/GJ	3412.084
	Fluoranthene	µg/GJ	10236.253
	Phenanthrene	µg/GJ	27296.674

**Table 51 Emission factors for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for basic pollutants from diesel fuel and gasoline**

Fuel	Pollutant	Units	<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V
Diesel	CH4	g/tonnes fuel	199	171	144	42	39	36	15	13	23
	CO	g/tonnes fuel	20690	18890	16258	6639	7135	6826	6445	6019	7352
	CO2	kg/tonnes fuel	3159,8	3159,8	3159,8	3159,8	3159,8	3159,8	3159,8	3159,8	3159,8
	N2O	g/tonnes fuel	121	128	135	137	136	136	137	137	136
	NH3	g/tonnes fuel	7	7	8	8	8	8	8	8	8
	NM VOC	g/tonnes fuel	8077	6962	5851	1725	1587	1470	625	536	930
	NOx	g/tonnes fuel	26552	33942	43552	31077	22101	15653	11933	1570	7663
	PM10	g/tonnes fuel	6207	4308	3642	1005	1034	950	98	98	116
	PM2.5	g/tonnes fuel	6207	4308	3642	1005	1034	950	98	98	116
	TSP	g/tonnes fuel	6207	4308	3642	1005	1034	950	98	98	116
	BC	g/tonnes fuel	3414	2396	2001	800	825	758	78	78	56
	f-BC	% PM2.5	0,55	0,56	0,55	0,80	0,80	0,80	0,80	0,80	0,48
Gasoline: two-stroke	CH4	g/tonnes fuel	22483	19462	17284	16979	8517				8539
	CO	g/tonnes fuel	754523	699494	621083	620519	695237				694870
	CO2	kg/tonnes fuel	3197	3197	3197	3197	3197				3197
	N2O	g/tonnes fuel	12	16	16	18	20				20

	NH3	g/tonnes fuel	2	3	3	4	4				4
	NMVOC	g/tonnes fuel	298703	258562	229630	225579	113157				111450
	NOx	g/tonnes fuel	1050	1682	1852	3445	2495				2490
	PM10	g/tonnes fuel	7037	4786	3869	3683	4299				4278
	PM2.5	g/tonnes fuel	7037	4786	3869	3683	4299				4278
	TSP	g/tonnes fuel	7037	4786	3869	3683	4299				4278
	BC	g/tonnes fuel	352	239	193	184	215				214
	f-BC	% PM2.5	0,05	0,05	0,05	0,05	0,05				0,05
Gasoline: four-stroke	CH4	g/tonnes fuel	710	910	672	650	568				468
	CO	g/tonnes fuel	1214855	836966	768445	774457	804157				778282
	CO2	kg/tonnes fuel	3197	3197	3197	3197	3197				3197
	N2O	g/tonnes fuel	56	55	59	59	60				59
	NH3	g/tonnes fuel	4	4	4	4	4				4
	NMVOC	g/tonnes fuel	20182	25852	19082	18469	16126				13293
	NOx	g/tonnes fuel	2429	5743	7129	7088	6676				5354
	PM10	g/tonnes fuel	148	147	157	159	159				159
	PM2.5	g/tonnes fuel	148	147	157	159	159				159
	TSP	g/tonnes fuel	148	147	157	159	159				159
	BC	g/tonnes fuel	7	7	8	8	8				8
	f-BC	% PM2.5	0,05	0,05	0,05	0,05	0,05				0,05

#### 4.4.3. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10 %. For the categories 1.A.2.a - 1.A.2.e as well as for 1.A.2.gviii, the emission factor uncertainty for SOx was estimated to be 20% (rating A. cf. chapter 1.7). For NOx, including category 1.A.2.gvii was estimated to be 40% (rating B. cf. chapter 1.7). For NMVOC for the categories 1.A.2.a - 1.A.2.e, the EF uncertainty is estimated to be 200% (rating D. cf. chapter 1.7) and for the category 1.A.2.gvii. it was estimated to be 40 % (rating B. cf. chapter 1.7). For the categories 1.A.2.a - 1.A.2.e for PM2.5, the EF is estimated to be 40% (rating B. cf. chapter 1.7), and for 1.A.2.gvii and 1.A.2.gviii is estimated to be 125% (rating C cf. chapter 1.7).

#### 4.4.4. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 4.4.5. Source-specific recalculations including changes made in response to the review process

Recalculations for 2022 were performed, due to the use of final data (from the energy balance) for fuel consumption. Due to updated activity data in several categories 2021 emission data were corrected.

#### 4.4.6. Source-specific planned improvements including those in response to the review process

Higher tier methodology will be performed in future submissions as soon as activity data is made available, through establishment of NEIS in 2026. Request for support of improvement and use of higher Tier methodology Tier 2 for the categories was sent to EU 4 Green project, to be implemented in the period end of 2025 and beginning of 2026.

### 4.5. Transport

#### 4.5.1. Road transport –NFR 1.A.3

This chapter covers the emissions from road transport. It provides the methodology, emission factors as well as relevant activity data necessary for calculation of the exhaust emissions for the following categories of road vehicles:

- passenger cars (NFR code 1.A.3.b.i)
- light commercial vehicles (1) (< 3.5 t) (NFR code 1.A.3.b.ii)
- heavy-duty vehicles (2) (> 3.5 t) and buses (NFR code 1.A.3.b.iii)
- mopeds and motorcycles (NFR code 1.A.3.b.iv)

Road transport inventory has improved significantly, due to the implemented change of methodology in upgrading to Tier 3 method of emission calculation applied for the period 2005-2022. Activity data acquisition for the period 1990-2004 remains the same including estimated emissions, calculated with the highest uncertainty, due to the lack of details for the vehicle fleet data.

##### 4.5.1.1. Road transport – NFR 1.A.3.bi.bii.biii.biv

##### 4.5.1.1.1. Methodology

The simplified Tier 1 methodology for emissions calculation from the road transport for the period 1990-2004 has been used: fuel quantity (expressed in heat units) is multiplied by the appropriate emission factor, which depends on the type of the fuel and type of technology of combustion in stationary sources and the type of mobile equipment and machinery, respectively.

The Tier 1 approach for exhaust emissions uses the following general equation:

$$E_i = \sum_j \left( \sum_m (FC_{j,m} \times EF_{i,j,m}) \right)$$

Where:

$E_i$  = emission of pollutant  $i$  [g].

$FC_{j,m}$  = fuel consumption of vehicle category  $j$  using fuel  $m$  [kg].

$EF_{i,j,m}$  = fuel consumption-specific emission factor of pollutant  $i$  for vehicle category  $j$  and fuel  $m$  [g/kg].

The emission data for the period 1990-2000 has been taken directly from NFR tables reported in 2013. There is no detail background data on the type of fuel consumption, or the EF used for this reporting period.

The emission factors are available for CO, NH<sub>3</sub>, NMVOC, NO<sub>x</sub>, lead, benzo (a) pyrene and Particulate Matter (PM). Concerning particulate matter, the guidebook assumes that the amount of total suspended particles is equivalent to the PM<sub>10</sub> and PM<sub>25</sub>. The Tier 2 emission factors are stated in units of grams per vehicle-kilometer and for each vehicle technology are given in the table 3.17 of the EEA Guidebook 2013.

COPERT 5 (version 5.5.1) methodology has been used for calculation of the national emissions from road transport for the period 2005-2023. The methodology is fully incorporated in the computer software program COPERT 5 (version 5.5.1) which facilitates its application. The actual calculations have been therefore performed by using this computer software.

The COPERT methodology is also part of the EMEP/EEA air pollutant emission inventory guidebook (formerly referred to as the EMEP/CORINAIR Guidebook). The Guidebook is prepared by the UNECE/EMEP Task Force on Emission Inventories and Projections (TFEIP) and published by the European Environment Agency.

The COPERT methodology is fully consistent with the Road Transport chapter of the Guidebook. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent, and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation.

To calculate emissions using the COPERT 5 software, at least the following input data is necessary: vehicle fleet data, mileage data per vehicle category and type of roads, speed data, fuel consumption and fuel characteristic, monthly air minimum and maximum temperatures, fuel vapor pressure etc.

COPERT 5 (version 5.5.1) program was used for emissions calculation of exhaust emissions and emissions from automobile tire and brake wear and road abrasion.

Exhaust emissions of NO<sub>x</sub>, SO<sub>x</sub>, NMVOC, NH<sub>3</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, TSP, Black carbon (BC), CO, Lead (Pb), Cadmium (Cd), Mercury (Hg), Arsenic (As), Chromium (Cr), Copper (Cu), Nickel (Ni), Selenium (Se), Zinc (Zn), dioxins/furans and four indicator PAHs (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene), PCB and HCB have been calculated using COPERT 5 (version 5.5.1).

Emissions of particulate matter (PM<sub>2.5</sub>, PM<sub>10</sub>, TSP, BC) from automobile tire and brake wear and road abrasion have been calculated by COPERT 5 (version 5.5.1) as well.

COPERT 5 (version 5.5.1) model also calculates emissions of heavy metals (Pb, Cd, As, Cu, Cr, Ni Se, Zn) from automobile tire and brake wear.

### **Vehicle fleet**

The fleet composition for the years 2005–2023 was taken from the official database of registered motor vehicles in North Macedonia, provided by the Ministry of Interior Affairs. Since no available database exists on motor and vehicles for the period 1990–2004, Tier 1 method of emission calculation was used for that period.

Concerning the annual average mileage of a vehicle category, the data available from the national statistics are referred to the total annual mileage of a certain vehicle, without considering the different regimes of circulation (urban, interurban, highway).

### **Fuel consumption and mileage data**

The fuel consumption and the consecutive energy consumption of the national vehicle fleet was taken from the official Energy statistic of the country/fuel consumption of the subsector road transportation. According to the national energy balance, the road transport sector mainly consumes diesel, petrol, LPG fuel, as well as small quantities of CNG.

The initial mileage data per subcategory was obtained by the EMISIA SA database for North Macedonia containing country specific activity data per vehicle class for the period 2000 -2014. This EMISIA SA database for the EU and EU accession countries has been prepared using latest official statistics available, relevant studies, and SIBYL data, as well as the road transport dataset and methodology of the TRACCS and FLEETS research projects. The quality, completeness, and consistency of TRACCS and FLEETS datasets, which have been extensively reviewed and cross-checked, together with the expertise of EMISIA on transport data, ensure that the compiled COPERT data are also of good quality.

Based on the mileage data for the period 2000 -2014, a linear interpolation of the mileage data has been done for the period 2015 - 2023. As a last step, the initial mileage data per category has been calibrated using the variables for the annual fuel consumption data and the specifics of the vehicles categories and classes. The detailed mileage matrix contains annual mileage per vehicle subcategory for new vehicles and for every vintage back in time, which determines the yearly mileage reduction percentages as a function of vehicle age. In a first step, the detailed mileage matrix is combined with corresponding fleet numbers to estimate intermediate total mileages for each year on a detailed fleet level. Next, each year's detailed (intermediate) mileage figures are scaled according to the difference between true and intermediate total mileage per vehicle subcategory.

The datasets of EMISIA SA also provided information of the mileage split between urban, rural and highway driving based on their surveys and monitoring data. This has been also crosschecked with the national statistical data to assure compliance and consistency with the present national circumstances and the national data.

### **Meteorology A**

Emissions and fuel consumption results for operationally hot engines are calculated for each year and for layer and road type. The procedure is to combine fuel consumption and emission factors (and deterioration factors for catalyst vehicles), number of vehicles, annual mileage levels and the relevant road-type shares.

Extra emissions of NO<sub>x</sub>, VOC, CH<sub>4</sub>, CO, PM, N<sub>2</sub>O, NH<sub>3</sub> and fuel consumption from cold start are simulated separately. For SO<sub>2</sub> and CO<sub>2</sub>, the extra emissions are derived from the cold start fuel consumption results.

Each trip is associated with a certain cold-start emission level and is assumed to take place under urban driving conditions. The number of trips is distributed evenly across the months. First, cold emission factors are calculated as the hot emission factor times the cold: hot emission ratio. Secondly, the extra emission factor during cold start is found by subtracting the hot emission factor from the cold emission factor. Finally, this extra factor is applied on the fraction of the total mileage driven with a cold engine (the factor) for all vehicles in the specific layer.

The cold/hot ratios depend on the average trip length and the monthly ambient temperature distribution. The meteorological data for North Macedonia as minimum and maximum monthly temperature data and the average monthly humidity for the period 2005 -2022 have been provided by the National Hydrometeorological Service of North Macedonia. The City of Skopje is taken as a reference city for this assessment and the meteorological data provided in the COPERT assessment are referring to the meteorological conditions in the city of Skopje.

Annual mileage (km/year) for each vehicle category for 2005-2018 has been taken from EMISIA database for North Macedonia. For other years the starting point is the same average yearly kilometres per vehicles class as in 2015, corrected to actual fuel consumption.

Sulfur dioxide emissions are calculated using emission factors offered by COPERT. Sulfur fuel content (ppm wt) is used as an input, according to the Decree on fuel quality:

Petrol Grade 1	10
Petrol Grade 2	10
Diesel Grade 1	10
Diesel Grade 2	10
LPG Grade 1	50
LPG Grade 2	50

### **Activity data**

Fuel consumption data used in the calculations originates from the Energy balance for 2023 published by the State Statistical Office. Data on number of vehicles is used from the Statistical yearbook for the period 1990-2002 [22], publication “Transport and other communication” for the period 2003-2004 [26]. For the period 2005-2023 detailed data from MOI database was used.

**Table 51 Activity data for source category 1.A.3.b - Road transport for period 1990-2023**

NFR	1A3bi	1A3bi	1A3bii	1A3biii	1A3biv
Year	Liquid fuels	Gas fuel	Liquid fuels	Liquid fuels	Liquid fuels
1990	7647	2064	1553	3054	101
1991	6331	1396.6	2148.1	4293.3	121
1992	7097	1565.6	2544.1	5084.8	1818



NFR	1A3bi	1A3bi	1A3bii	1A3biii	1A3biv
Year	Liquid fuels	Gas fuel	Liquid fuels	Liquid fuels	Liquid fuels
1993	7353.6	1622.2	2652.8	5302.1	198.9
1994	6674	1472.3	2300.1	4597.1	96.1
1995	7250.3	1599.4	2579.2	5154.9	152.6
1996	7202.5	1588.8	2556.6	5109.8	179
1997	7333.9	1617.8	2614.7	5225.9	227.7
1998	7320.6	1614.9	2649	5294.4	236.2
1999	7350.6	1621.5	2640.6	5277.5	232.2
2000	7597.3	1675.9	2739.8	5475.9	246.9
2001	6115.9	1395.2	2198.5	4466.2	50.5
2002	6599	1395.2	2410.2	4819	76.6
2003	6.188	1.395.2	2.260.1	4.518.8	71.8
2004	6324.3	1395.2	2005.2	3991.3	91.5
2005	6034.5	1249.3	2229.9	4460	100.6
2006	5685.8	1489.4	1868.6	4982.6	135.1
2007	6150.6	1987.7	2156.3	5763.2	152.8
2008	5943	1.953	1.656.9	4.390.4	339.3
2009	6477.3	1987.7	2971.0	5972.4	342.1
2010	7456.4	2634	3980	8045	92.5
2011	7272.1	1599.6	3464.3	6986	93.7
2012	6300.4	1543.1	3553.6	7178.4	83.3
2013	6847.1	1693	4168.3	8433.1	87.4
2014	10 298	726.0	2122.0	6990.0	51.6
2015	10 873	717.0	2826.0	7877.0	60.4
2016	11446	734.0	2288.0	11568	70.0
2017	11902	737.0	1994.0	11723	84.0
2018	12411	742.0	2077	11788	79.0
2019	12981	722.4	2170.5	11910	68.2
2020	10491	NA	3342.5	12856	13.3
2021	12215.7	NA	5293.3	13308.8	27.4
2022	12927.0	NA	2835.4	15227.2	45.0
2023	10736.2	NA	2339.5	9928.6	33.4

**Table 52 Activity data for source category 1.A.3.b Road transport for 2023**

NFR code	Fuel	Fuel consumption [TJ]
1A3bi	Gasoline	4404
	Diesel	7467
	LPG	1814
1A3bii	Gasoline	91

NFR code	Fuel	Fuel consumption [TJ]
	Diesel	3570
1A3biii	Gasoline	44
	Diesel	15586
	CNG	113
1A3biv	Gasoline	35

### Emission factors

Default emission factors for the basic pollutants, lead and particulates were taken from GB 2009 –Tier 1 emission factors, for the period 1990-2004.

Tier 3 approach used for the period 2005-2023 uses emission factors for calculating exhaust and non-exhaust emissions for NO<sub>x</sub>, SO<sub>x</sub>, NMVOC, NH<sub>3</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, dioxins/furans and PAHs (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene), HCB, PCB as default emission factors offered by the COPERT 5 (version 5.5.1).

Sulfur dioxide emissions are estimated by using the sulfur content in different periods as presented in above.

**Table 53 Emission factor for source category 1.A.3.b - Road Transport used for calculation of emissions in the period 1990-2004 by use of Tier 1 methodology**

NFR code	Fuel	NO <sub>x</sub>	NMVOC	NH <sub>3</sub>	TSP	CO	As
	Unit	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	/
1A3bi	Gasoline	14.50	14.00	0.173	0.037	132.00	/
	Diesel	11.00	1.10	0.018	1.70	4.70	/
	LPG	15.00	10.00	0.173	/	68.00	/
1A3bii	Gasoline	24.00	14.00	0.14	0.03	155.00	/
	Diesel	15.00	1.75	0.014	2.80	11.00	/
1A3biii	Diesel	37.00	1.60	0.015	1.20	8.00	/
1A3biv	Gasoline	9.50	114.00	0.063	2.70	490.00	/

#### 4.5.1.1.2. Source-specific uncertainties and time-series consistency

Tier 3 methodology has been used for calculation of the emissions for the period 2005-2023, while the calculation of the emissions for the previous years is done by use of Tier 1 method which presents a trend of inconsistency in this sector.

Acquired data for the fleet composition in Republic of North Macedonia is available for the years 2005-2023. Python generated scripts were used in raw vehicle data analysis. Scripts were applied to determine vehicle euro standard according to the year of production and to determine vehicle segment according to the Tier 3 methodology. Python scripts were used for data quality control and preparation of the vehicle stock input file to COPERT. Since, previous year data was thoroughly checked, checking was applied only on the newly registered vehicles in 2023.

During the assessment and elaboration of the vehicle data and its translation into the COPERT model, few issues has been identified and underlined as possible gaps and limitations in the national vehicle fleet database.

The database has significant number of unreliable entries. More specifically, significant number of heavy-duty vehicles/trucks are recorded as vehicles operating on petrol, which is not possible for vehicles of that certain type, since the petrol engines are not technologically appropriate for heavy duty vehicles. The database contains significant amount of “too heavy” vehicles and errors in the payload or vehicle weight entries. Manual revision and correction of the inconsistent and inappropriate entries was done.

The estimation of the mileage may entail some degree of uncertainty. Nevertheless, the magnitude of the mileage amount estimated for each category of vehicles on national level is comparable with information retrieved in other countries in Europe.

The activity data uncertainty was estimated to be 10 % (rating C. cf. chapter 1.7); the emission factor uncertainty for NO<sub>x</sub>, NMVOC and PM<sub>2.5</sub> was estimated to be 20 % (rating A. cf. chapter 1.7), for SO<sub>2</sub> and was estimated to be 40% (rating B) and NH<sub>3</sub> for (125% rating C).

#### 4.5.1.1.3. Source-specific QA/QC and verification

The activity data has been a subject to QA/QC procedures. The consumption of fuel each year has been cross checked with the previous year and compared. The calculation of the emissions using Tier 3 approach was cross checked by using reverse process to calculate the emissions from the total fuel quantities, taken from the Energy Balance of the Republic of North Macedonia as part of Statistical yearbook. This amount has been distributed to the relevant SNAP subgroups in percentage, depending (as stated above) on the number and type of vehicles in the Republic of North Macedonia.

EF from GB 2019 were inserted in the excel calculation sheet and rechecked. Calculated emissions per NFR category by use of vehicles numbers and mileage were crosschecked with fuel consumption data from the energy balance in road transport sector. There are differences between the energy balance fuel consumption and calculations done by bottom-up approach, but this is expected due to the fact that consumption from tourists that are passing through our country is not excluded and additionally there is some percentage of not registered cars especially in the rural environment.

#### 4.5.1.1.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 4.5.1.1.5. Source-specific planned improvements including those in response to the review process

Recalculation for the period 2014-2023 is planned to be done and the process is planned to be aided by an EU transport expert, as part of project activities in an IPA funded project related to emission inventory improvement. Transport emission projection calculation is planned in this period as well.

#### 4.5.1.2. Gasoline evaporation (from vehicles) –NFR 1.A.3.b.v

This chapter provides the methodology, emission factors and relevant activity data to enable evaporative emissions of NMVOCs from gasoline vehicles (NFR code 1.A.3.b.v) to be calculated. The term ‘evaporative emissions’, refers to the sum of all fuel related NMVOC emissions not deriving from fuel combustion.

Most evaporative emissions of VOCs emanate from the fuel systems (tanks, injection systems and fuel lines) of petrol vehicles. Evaporative emissions from diesel vehicles are considered negligible, due to

the presence of heavier hydrocarbons and the relatively low vapor pressure of diesel fuel and can be neglected in the calculations.

#### 4.5.1.2.1. Methodological issues

Tier 1 methodology is used to calculate evaporative emissions for the period 1990-2004

The Tier 1 approach for calculating evaporative emissions uses the general equation from EMEP/EEA Guidebook 2013:

$$E_{VOC} = \sum_j N_j \times EF_{VOC,j} \times 365$$

Where:

$E_{VOC}$  = the emissions of VOC (g/year);

$N_j$  = the number of vehicles in category j.

$EF_{VOC,j}$  = the emission factor of VOC for vehicle category j (g/vehicle/day).

j = the vehicle category (passenger cars, light-duty vehicles and two-wheel vehicles. i.e.[5])

Tier 3 method is used to calculate evaporative emissions for the period 2005-2021, using Copert 5 model

#### Activity Data

The number of vehicles in category PCs and TWs are taken directly from the statistical yearbooks for the period 1990-2004 [22] and MOI database for the period 2005 - 2023.

**Table 54 Activity data for source category 1.A.3.v - Gasoline evaporation for Tier 1 calculation**

Year	Passenger cars (PCs)	Light-duty vehicles (LDVs)	Two-wheel vehicles (TWVs)
1990	196 282	4 500	1 523
1991	212 340	4 729	1 489
1992	238 032	5 601	2 238
1993	246 638	5 841	2 448
1994	223 845	5 065	1 183
1995	243 175	5 678	1 879
1996	241 572	5 629	2 203
1997	245 979	5 757	2 803
1998	245 532	5 832	2 907
1999	246 537	5 814	2 858
2000	254 811	6 032	3 040
2001	263 294	6 312	3 654
2002	261 609	5 872	2 379
2003	254 999	5 532	1 746
2004	195 915	4 340	1 203

### **Emission factors used for Tier 1 methodology**

For the calculation of emissions for emission parameters from 1990-2004, the used emission factors were taken from the GB 2009, NMVOC emission factors for gasoline fueled road vehicles, when daily temperature range is around 10 to 25°C, were considered. This emission factor was chosen because calculated average annual temperature was 13.7°C, according to the automatic meteorological station under responsibility of HMA – Hydro Meteorological Administration.

These emission factors are presented in table below.

**Table 55 Evaporative emissions emission factors source category 1.A.3.bv - Gasoline evaporation for gasoline fueled road vehicles — when daily temperature range is around 10 to 25 °C**

Pollutant	Vehicle type	Value	Unit	References
NMVOC	Gasoline PCs	14.8	g/vehicle/day	GB 2009 1.A.3.b.v Gasoline evaporation. Table 3-2. pg. 9 evaporative emissions emission factors for gasoline fueled road vehicles — when daily temperature range is around 10 to 25 °C.
NMVOC	Gasoline LDVs	22.6	g/vehicle/day	GB 2009 1.A.3.b.v Gasoline evaporation. Table 3-2. pg. 9 evaporative emissions emission factors for gasoline fueled road vehicles — when daily temperature range is around 10 to 25 °C.
NMVOC	Two-wheel vehicles	3.0	g/vehicle/day	GB 2009 1.A.3.b.v Gasoline evaporation. Table 3-2. pg. 9 evaporative emissions emission factors for gasoline fueled road vehicles — when daily temperature range is around 10 to 25 °C.

#### **4.5.1.2.2. Source-specific uncertainties and time-series consistency**

No specific uncertainty calculations are performed in this category.

#### **4.5.1.2.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Linkage between excel sheet for vehicles numbers and calculation sheet for this category was implemented.

#### **4.5.1.2.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were carried out in this category.

#### **4.5.1.2.5. Source-specific planned improvements including those in response to the review process**

No planned improvements in this category.

### **4.5.1.3. Road vehicle tire and brake wear NFR 1.A.3.b.vi and road surface wear – NFR 1.A.3.b.vii**

This chapter covers the emissions of particulate matter (PM) which are due to road vehicle tire and brake wear (NFR code 1.A.3.b.vi) and road surface wear (NFR code 1.A.3.b.vii). PM emissions from vehicle exhaust are not included. The focus is on primary particles — in other words, those particles emitted directly because of the wear of surfaces — and not those resulting from the re-suspension of previously deposited material.

#### **4.5.1.3.1. Methodological issues**

Tier 1 method of calculation road vehicle tire and brake wear was used for the period 1990-2004.

To calculate emissions of TSP, PM10 or PM2.5 from (i) brake and tire wear combined and (ii) road surface wear, an equation can be used. This equation can be used to estimate emissions for a defined spatial and temporal resolution by selecting appropriate values for the fleet size and the activity (mileage). Emission factors are given as a function of vehicle category alone. Total traffic generated emissions for each of the NFR codes can be estimated by summing the emissions from individual vehicle categories.

$$TE = \sum_j N_j \times M_j \times EF_{i,j}$$

where:

TE= total emissions of TSP, PM10 or PM2.5 for the defined time period and spatial boundary [g]

$N_j$  = number of vehicles in category  $j$  within the defined spatial boundary

$M_j$ = average mileage driven per vehicle in category  $j$  during the defined time period [km]

$EF_{i,j}$  = mass emission factor for pollutant  $i$  and vehicle category  $j$  [g/km]

The indices are:

$i$  =TSP, PM10, PM2.5

$j$  = vehicle category (two-wheel vehicle, passenger car, light-duty truck, heavy-duty vehicle).

Two-wheel vehicles correspond to mopeds and motorcycles. Passenger cars are small or larger family cars used mainly for the carriage of people. Light-duty trucks include vans for the carriage of people or goods. Heavy-duty vehicles correspond to trucks, urban buses, and coaches.

Tier 3 method was used for the period 2004-2022, by using COPERT 5 model.

### **Activity Data**

The activity data on the number of vehicles for the category Passenger cars and Motorcycles have been taken from the publication “Transport and communication” for the period 2003-2004 [26], and from the chapter Transport from the Statistical yearbook for the period 1990-2002 [22], and for the period 2005-2023, data from the MOI database was used.

For the period 1990-2004, the number of Heavy-duty (HDV) vehicles has been calculated as the sum of the numbers of Buses + Goods vehicles + Road tractors. Information on the number of Light duty vehicles (LDV) is currently not available. In the previous years there was, however, a category called “commercial vehicles” in the Statistical yearbook for the period and later “freight cars” which represent LDVs. For the last available year 2002 the published shares were taken to calculate LDVs as a part of the total “goods vehicles”. The category “goods vehicles” plus “road tractors” now correlates to the former “special vehicles”. Yearly mileages per vehicle category were provided by the Mechanical Faculty of Skopje.

**Table 56 Activity data for the source categories 1.A.3.bvi - Road vehicle tire and brake wear and 1.A.3.b.vii Road surface wear**

Year	2W x Mileage [km]	PCs x Mileage [km]	LDTs x Mileage [km]	HDVs x Mileage [km]
1990	5 596 151	1 623 758 097	364 624 335	357 046 031
1991	5 473 324	1 756 600 415	383 221 612	379 976 496
1992	8 223 466	1 969 141 086	453 867 724	434 940 721
1993	8 996 382	2 040 332 747	473 265 390	466 679 239
1994	4 346 903	1 851 778 276	410 458 384	416 094 438
1995	6 905 315	2 011 681 586	460 129 592	474 896 809
1996	8 097 643	1 998 418 463	456 104 105	474 355 532
1997	10 302 550	2 034 879 739	466 462 083	479 719 096
1998	10 683 017	2 031 178 729	472 582 705	485 673 143
1999	10 503 269	2 039 495 446	471 076 090	496 449 478
2000	11 171 332	2 107 943 013	488 778 815	543 737 410
2001	13 430 164	2 178 121 470	511 472 201	599 046 084
2002	8 741 739	2 164 182 878	475 831 344	629 308 392
2003	6 417 000	2 109 498 000	448 265 000	654 650 000
2004	4 140 000	1 774 428 000	358 100 000	615 340 000

### **Emission factors**

Tables 58 and 59 summarize the emission factors used for the calculation of particulate emissions for the period 1990-2004, for which Tier 1 method was applied. The emission factors for the period 2005-2023 are integrated in the COPERT 5 model.

**Table 57 Emission factors for source category 1.A.3.b.vi - Road vehicle tire**

Pollutant	Vehicle type	Value	Unit	References
TSP	Two-wheelers	0.0083	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Two-wheelers	0.0064	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Two-wheelers	0.0034	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Passenger cars	0.0182	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Passenger cars	0.0138	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Passenger cars	0.0074	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Light duty trucks	0.0286	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Light duty trucks	0.0216	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Light duty trucks	0.0177	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Heavy duty vehicles	0.0777	g km <sup>-1</sup> vehicle <sup>-1</sup>	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14

Pollutant	Vehicle type	Value	Unit	References
PM10	Heavy duty vehicles	0.0590	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Heavy duty vehicles	0.0316	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14

**Table 58 Emission factors for the source category 1.A.3.bvii Road surface wear**

Pollutant	Vehicle type	Value	Unit	References
TSP	Two-wheelers	0.006	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Two-wheelers	0.003	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Two-wheelers	0.0016	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Passenger cars	0.015	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Passenger cars	0.0075	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Passenger cars	0.0041	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Light duty trucks	0.015	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Light duty trucks	0.0075	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Light duty trucks	0.0041	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Heavy duty vehicles	0.076	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Heavy duty vehicles	0.038	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Heavy duty vehicles	0.0205	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14

#### 4.5.1.3.2. Source-specific uncertainties and time-series consistency

No specific uncertainty calculations are performed in this category.

#### 4.5.1.3.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Linkage between excel sheet for vehicles numbers and calculation sheet for this category was implemented.

#### 4.5.1.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were carried out in this category.

#### 4.5.1.3.5. Source-specific planned improvements including those in response to the review process

Since different methodology is used for period 1990-2004 and 2015-2023 there is need to use Tier 3 for whole time series.



#### 4.5.2. Aviation

Methodological issues, activity data and emission factors can be found below, distinguished by domestic and international landing and take-off (LTO) and cruise. Planned improvements, QA/QC, Recalculations and Uncertainties for the whole sector 1.A.3.a, are shown at the end of this chapter.

##### 4.5.2.1. International aviation LTO – NFR 1.A.3.ai(i)

###### 4.5.2.1.1. Methodological issues

The approach is based on the number of flights which are available in the BC's transport statistics. The number of flights were divided into “international LTOs” (regular + charter) and “other operations”.

###### Activity Data

The Number of LTO was taken from the publication Transport and communications for the period 2005-2016[26]. For the previous years, surrogate method has been used. The estimates of the activity data were related to the passenger numbers.

**Table 60 Activity data for source category 1.A.3.ai (i) - International aviation LTO civil (number of LTO)**

Year	Number of LTO	Year	Number of LTO	Year	Number of LTO
1990	11 986	2002	12 767	2014	13 968
1991	11 297	2003	12 170	2015	15585
1992	10 539	2004	11 986	2016	16879
1993	14 581	2005	13 204	2017	18130
1994	14 351	2006	13 509	2018	19756
1995	14 305	2007	14 174	2019	21797
1996	12 307	2008	14 323	2020	9162
1997	11 067	2009	12 800	2021	14988
1998	13 249	2010	12 721	2022	19448
1999	24 156	2011	11 873	2023	19448
2000	23 168	2012	11 284		
2001	11 664	2013	12 380		

###### Emission factors

The calculation of emissions for emission parameters from 1990-2023 were used emission factors taken from GB 2013. The used emission factors are presented in Table 61.

**Table 59 Emission factors for source category 1.A.3.ai (i) - International aviation LTO civil**

Pollutant	Value	Unit	References
NOx	26	kg/LTO	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (LTO (kg/LTO) — average fleet (B767))
NMVOC	0.2	kg/LTO	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (LTO (kg/LTO) — average fleet (B767))
SOx	1.6	kg/LTO	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (LTO (kg/LTO) — average fleet (B767))
PM2.5	0.15	kg/LTO	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (LTO (kg/LTO) — average fleet (B767))
CO	6.1	kg/LTO	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (LTO (kg/LTO) — average fleet (B767))

#### 4.5.2.2. International aviation cruise (civil) – NFR 1.A.3.ai(ii)

The aircraft data of the national flight authority shows a relatively new fleet composition -> Tier 1 emission factors of average fleet are feasible.

##### 4.5.2.2.1. Methodological issues

The total fuel consumption was calculated as sum from gasoline consumption and LTO fuel. The LTO fuel consumption is calculated according to this equation:

LTO fuel = number of LTOs x fuel consumption per LTO (1617 kg/LTO).

#### Activity Data

The activity data for aviation gasoline consumption has been taken from the Energy statistics 2000-2010[23] for the period 2005-2010 and from the Statistical yearbooks chapter energy balance for the period 2011-2023 [22]. For the period 2000-2004 surrogate method has been used to calculate the consumption related to the passenger numbers. The data is available in the Statistical year books in the Transport chapter for the period 1990–2004, as for the period 2005-2015 data is taken from the special publication Transport and other services [26], while data after 2015 are taken from the MAKSTAT database [27].

**Table 60 Activity data for fuel consumption for source category 1.A.3.ai(ii) - International aviation cruise (civil)**

Year	Total fuel (t)	Year	Total fuel(t)	Year	Total fuel(t)
1990	20 648	2001	25 104	2012	8 112
1991	19 461	2002	46 844	2013	10 144
1992	18 156	2003	15 973	2014	11 946
1993	25 118	2004	8 882	2015	13 371
1994	24 722	2005	6 433	2016	15 108
1995	24 643	2006	4 670	2017	19 810
1996	21 202	2007	6 861	2018	22 429
1997	19 066	2008	6 121	2019	26 473
1998	22 824	2009	2 772	2020	8637
1999	41 612	2010	6 867	2021	15 771
2000	28 266	2011	3 652	2022	25 913
				2023	11 936

#### Emission factors

Emission factors were taken from GB 2013 (Cruise (kg/t) — average fleet (B767)). These emission factors are given in Table 63 below.

**Table 61 Emission factors for 1.A.3.ai(ii) - International aviation cruise (civil)**

Pollutant	Value	Unit	References
NOx	12.8	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
NM VOC	0.5	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
SOx	1	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))

Pollutant	Value	Unit	References
PM2.5	0.2	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
CO	1.1	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))

#### 4.5.2.3. Domestic aviation cruise – NFR 1.A.3.iii(ii)

##### 4.5.2.3.1. Methodological issues

The cruise fuel is calculated according to the following equation:

Cruise fuel = total fuel consumption — LTO fuel consumption

The LTO fuel consumption is calculated according to the following equation:

LTO fuel = number of LTOs x fuel consumption per LTO (1617 kg/LTO)

#### Activity Data

The activity data for calculation of total fuel consumption is taken from the Energy balance from the Statistical yearbooks 1990-1999[21], as well as from the publication Energy statistics 2000-2010[24]. Data on jet fuel and aviation gasoline consumption are available starting from 2005. For the period 1990-2004, surrogate method has been used. The estimates of the activity data were related to the passenger numbers. The sources of number of LTO have been discussed in the previous chapter. Table 64 provides the Tier 1 calculated activity data.

Domestic Cruise is not occurring (NO) in North Macedonia as there are no flight movements with kerosene within the country. All flight movements with kerosene are international.

**Table 62 Activity data for source category 1.A.3.iii(ii) - Domestic aviation cruise (civil)**

Year	Fuel consumption (t)	Year	Fuel consumption (t)	Year	Fuel consumption (t)
1990	NO	2001	NO	2012	NO
1991	NO	2002	NO	2013	NO
1992	NO	2003	NO	2014	NO
1993	NO	2004	NO	2015	NO
1994	NO	2005	NO	2016	NO
1995	NO	2006	NO	2017	NO
1996	NO	2007	NO	2018	NO
1997	NO	2008	NO	2019	NO
1998	NO	2009	NO	2020	NO
1999	NO	2010	NO	2021	NO
2000	NO	2011	NO	2022	NO
				2023	NO

#### Emission factors

Emission factors were taken from GB 2013 for all reporting time period. These emission factors are given in Table 65 below.

**Table 63 Emission factors for NFR - 1.A.3.iii (ii)**

Pollutant	Value	Unit	References
NOx	4	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20

Pollutant	Value	Unit	References
CO	1200	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
NMVOC	19	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
TSP	0	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
PM10	0	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
PM2.5	0	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
SO <sub>2</sub>	1	kg/t fuel	GB 2023 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20

#### 4.5.2.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for NO<sub>x</sub>, NMVOC and PM<sub>2.5</sub> was estimated to be 40 % (rating B. cf. chapter 1.7) for SO<sub>2</sub> and was estimated to be 20% (rating A).

#### 4.5.2.3.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files. NFR tables and the IIR, Info sheet was inserted in the excel calculation files and data on fuel consumption were linked with energy balance. The consumption of kerosene in military has been deducted from consumption of kerosene in aviation in order not to report double consumption in two different NFR for the period 2015-2023 for which emissions in 1.A.5.b are estimated.

#### 4.5.2.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 4.5.2.3.5. Source-specific planned improvements including those in response to the review process

Check and change of used EF with EF from the GB 2023.

### 4.5.3. Railways-NFR 1.A.3.c

This chapter covers emissions from rail transport and concerns the movement of goods or people by rail. Railway locomotives generally are one of three types: diesel, electric or less frequently steam.

Diesel locomotives either use only diesel engines, for propulsion or in combination with an on-board alternator, or generator to produce electricity which powers their traction motors (diesel-electric). These locomotives fall in three categories:

- shunting locomotives;
- rail-cars;
- line-haul locomotives;

#### 4.5.3.1. Methodology

The Tier 1 approach for railways is a fuel-based methodology and uses the general equation:

$$E_i = \sum_m FC_m \times EF_{i,m}$$

Where:

$E_i$  = emissions of pollutant  $i$  for the period concerned in the inventory (kg or g)

$FC_m$  = fuel consumption of fuel type  $m$  for the period and area considered (tons)

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

$m$  = fuel type (diesel, gas oil) [5].

The Tier 2 approach is based on apportioning the total fuel used by railways to that used by different generic locomotive technology types as the measure of activity. It assumes that the fuel can be apportioned for example using statistics on the number of locomotives, categorised by type, and their average usage, e.g. from locomotive maintenance records. For this approach the algorithm used is:

$$E_i = \sum_m \sum_j (FC_{j,m} \times EF_{i,j,m})$$

where:

$E_i$  = emissions of pollutant  $i$  for the period concerned in the inventory (kg or g);

$FC_{j,m}$  = fuel consumption of fuel type  $m$  used by category  $j$  for the period and area considered (tonnes);

$EF_{i,j,m}$  = emission factor of pollutant  $i$  for each unit of fuel type  $m$  used by category  $j$  (kg/tonnes);

$m$  = fuel type (diesel, gas oil);

$j$  = locomotive category (shunting, rail-car, line-haul)

### Activity Data

The activity data for the diesel oil consumption for the period 1990, 1999-2023 was taken from the chapter Energy balance from the Statistical yearbooks for the related period [22]. For the period 1991-1998, an approach has been developed to complete lacking years in the time series by use of passenger km used as surrogate data.

**Table 64 Activity data for diesel fuel consumption in source category 1.A.3.c – Railways – Tier 1**

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1990	7300	2001	3373	2012	3169
1991	5932	2002	2328	2013	2616
1992	3233	2003	2000	2014	2616
1993	1958	2004	2138	2015	1877
1994	1987	2005	2607	2016	2008
1995	1928	2006	3597	2017	2035
1996	3559	2007	3736	2018	2193
1997	4182	2008	3701	2019	2562

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1998	4449	2009	3634	2020	1016
1999	3957	2010	3580	2021	1209
2000	4212	2011	3734	2022	1104
				2023	1104

For 2023 the Ministry of transport and communication has provided activity data needed for implementation of Tier 2 methodology. For 2023 Ministry of transport did not provide data on the fuel consumptions, therefore activity data for 2022 were used for the year 2023.

**Table 65 Activity data for diesel fuel consumption in source category 1.A.3.c – Railways for 2020 – 2023 Tier 2**

Year	Category	Diesel fuel consumption [t]
2020	Line-haul locomotives	519
	Rail cars	497
2021	Line-haul locomotives	604
	Rail cars	605
2022/2023	Line-haul locomotives	478
	Rail cars	626

### Emission factors

Emission factors from GB 2023 are used in calculating the emissions for the period 1990-2023. Emission factors used are presented in the Table 68 below.

**Table 66 Emission factors for source category 1.A.3 - Railways**

Pollutant	Value	Unit	Tier	References
NOx	52.4	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
CO	10.7	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
NM VOC	4.65	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
NH <sub>3</sub>	0.007	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
TSP	1.52	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
PM10	1.44	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
PM2.5	1.37	kg/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Cd	0.01	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Cr	0.05	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Cu	1.7	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Ni	0.07	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Se	0.01	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Zn	1	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Benzo(a)pyrene	0.03	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8
Benzo(b)fluorant hene	0.05	g/t fuel	Tier 1	GB 2023 1.A.3.c Railways, Table 3-1, pg. 8

Pollutant	Value	Unit	Tier	References
NOx	63	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
CO	18	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
NMVOC	4.8	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
NH3	10	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
TSP	1.8	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
PM10	1.1	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
PM2.5	1.2	kg/t fuel	Tier 2-Line houl locomotives	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
NOx	39.9	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-2, pg.9
CO	10.8	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-1, pg. 10
NMVOC	4.7	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-1, pg. 10
NH3	10	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-1, pg. 10
TSP	1	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-1, pg. 10
PM10	1.1	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-1, pg. 10
PM2.5	1.5	kg/t fuel	Tier 2-Rail cars	GB 2023, 1.A.3.c Railways, Table 3-1, pg. 10

#### 4.5.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for NOx, NMVOC and PM2.5 was estimated to be 40% (rating B. cf. chapter 1.7), for NH<sub>3</sub> was estimated to be 125% (rating D).

#### 4.5.3.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR, Info sheet was inserted in the excel calculation file and data on fuel consumption were linked with energy balance. Activity data were also checked in the MAKSTAT database.

#### 4.5.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 4.5.3.5. Source-specific planned improvements including those in response to the review process

National inventory team has provided detailed data from Macedonian railways, and conducted Tier 2 methodology for 2020-2023 and will make effort to implement Tier 2 methodology on whole time series in the future submissions.

#### 4.5.4. National navigation - using diesel fuel oil – NFR 1.A.3.d.ii

Emissions from fuels used by vessels of all flags that depart and arrive in the same country (excludes fishing) includes small leisure boats. Republic of North Macedonia has three natural lakes, but only

Ohrid Lake offers tourist boat transport. There were only six boats in 2023. Emissions from fuel consumption are calculated and presented below.

There is no international/maritime navigation (bunkers fuels) – so the source category International maritime bunkers are reported as “NO”.

#### 4.5.5. Methodological issues

See chapter 4.4.1

#### Activity Data

The activity data on diesel consumption in lake transport have been provided from the “Kapetanija Ohrid” within the frames of the Ministry of Transport and Communications for 2011. Within the Twinning project the data gaps were filled by using the number of boats and passenger km in lake transport. All data were taken from the Statistical yearbook – chapter transport. Data on sulfur content was reported by the Ministry of Economy.

**Table 67 Activity data for diesel consumption for source category 1.A.3.d.ii - National navigation - using diesel fuel oil 1990-2023**

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1990	87.93	2001	7.96	2012	61.18
1991	15.65	2002	26.47	2013	41.38
1992	10.96	2003	12.93	2014	50.43
1993	7.08	2004	6.26	2015	59.55
1994	10.00	2005	19.06	2016	61.11
1995	21.71	2006	21.57	2017	68.53
1996	8.71	2007	72.34	2018	73.63
1997	6.47	2008	174.22	2019	77.04
1998	25.52	2009	164.28	2020	25.59
1999	18.03	2010	111.06	2021	38.25
2000	21.85	2011	57.85	2022	60.09
				2023	55.12

#### Emission factors

For the calculation of emissions for emission parameters from 1990-2023 the used emission factors were taken from GB 2019 [19]. These emission factors are given in Table 70 below.

**Table 70 Emission factors for source category 1.A.3.d.ii – National navigation**

Pollutant	Value	Unit	References
NOx	78.5	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
CO	7.4	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
NM VOC	2.8	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15



Pollutant	Value	Unit	References
TSP	1.5	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
PM10	1.5	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
PM2.5	1.4	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Pb	0.13	kg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Cd	0.01	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Hg	0.03	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
As	0.04	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Cr	0.05	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Cu	0.88	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Ni	1	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Se	0.1	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
Zn	0.5	g/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
PCDD/PCDF	0.13	ug I-TEQ/t	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
HCB	0.08	mg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15
PCBs	0.38	mg/t fuel	GB 2019, 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii International navigation, national navigation, national fishing, Other Mobile, Table 3-2, pg. 15

**Table 68 National content of sulfur in diesel used for calculation of SO<sub>x</sub> emissions 1.A.3.dii – National navigation**

Period	% (m/m) sulfur	ppm (mg/kg)	ppm
1990 - 2006	0.2	2000	8
2006 - 2007	0.035	350	1.4
2007 - 2009	0.005	50	0.2
From 2009 onwards	0.001	10	0.04
<b>Calculations</b>			
	0.5	20	
1990 - 2006	0.2	8	0.2*20/0.5
2006 - 2007	0.035	1.4	0.035*20/0.5
2007 - 2009	0.005	0.2	0.005*20/0.5
From 2009 onwards	0.001	0.04	0.001*20/0.5

Fuel sulfur content data is provided by the Ministry of economy.

#### 4.5.5.1. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis is done for this category.

#### 4.5.5.2. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 4.5.5.3. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category

#### 4.5.5.4. Source-specific planned improvements including those in response to the review process

Change of emission factors with 2023 EMEP/EEA Guidebook.

#### 4.5.6. Other. Mobile (including military. land based and recreational boats) – NFR 1.A.5.b

Emissions from fuels used in the Military have been reported from 2015 onwards. For the previous years (years before 2015) it is assumed that they are included elsewhere, namely within the NFR categories 1.A.3bii, 1.A3biii and 1.A.3aii.

##### 4.5.6.1. Methodological issues

See chapter 4.4.1

#### **Activity Data**

The activity data on diesel consumption were obtained from the Ministry of defense. Reported data for the years 2015-2023 are presented in the following table.

**Table 69 Activity data for liquid fuel and aviation gasoline consumption for source category 1.A.5.b – Other, Mobile for 2015-2023**

Type of fuel [tons]	2015	2016	2017	2018	2019	2020	2021	2022	2023
Liquefied fuels	672	873	715	696	695	583	676	566	600
Aviation gasoline	22	166	364	284	460	310	372	459	479

Diesel fuel consumption has been reported in L and converted in tons by use of diesel density of 0.837kg/m<sup>3</sup>.

#### **Emission factors**

See tale 65.

#### 4.5.6.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis is done for this category.

#### 4.5.6.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 4.5.6.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 4.5.6.5. Source-specific planned improvements including those in response to the review process

No planned improvements in this category.

### 4.6. Small Combustion and Non-road mobile sources and machinery – NFR 1.A.4

This category includes emissions from commercial/institutional, residential, and agricultural fuel combustion, which is mainly for heating and hot water generation purpose.

#### 4.6.1. Methodological issues

The Tier 1 methodology has been selected by using default emission factors from the Guidebook 2009/2016. The Tier 1 approach for process emissions from small combustion installations uses the general equation:

$$E_{pollutants} = \sum AR_{fuel\ consumption} \times EF_{fuel.pollutnat}$$

where:

$E_{pollutant}$  = the emission of the specified pollutant.

$AR_{fuelconsumption}$  = the activity rate for fuel consumption.

$EF_{pollutant}$  = the emission factor for this pollutant.

#### 4.6.2. Source-specific uncertainties and time-series consistency

Source-specific uncertainties are described below per category, considered the uncertainty of the activity data and emission factors for 1.A.4.a, 1.A.4.b and 1.A.4.c. The jumps and deeps in the emissions in this sector are mainly due correlation of fuel consumption with the temperature as well as change of methodology in the energy balances over the years.

#### 4.6.3. Source-specific QA/QC and verification

#### 4.6.4. Source-specific recalculations including changes made in response to the review process

Standard QA/QC procedures were carried out for this source category. i.e., activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Recalculations were performed for 2022 emissions due to use of final data from energy balance for biomass, coal and liquid fuel. Source-specific planned improvements including those in response to the review process.

Use of higher Tier level will be implemented in future submissions. Establishment of National environmental information system is undergoing. When this system will be implemented detail data from administrative capacities will be gathered and activity data for use of higher Tier level will be available. Currently the system is in testing phase for bugs, and it is planned to be put in use for the next reporting round.

#### 4.6.5. Commercial/Institutional – stationary combustion – NFR 1.A.4.ai

Within the Commercial/Institutional sector, mainly liquid fuels are used. The amount of biomass and coal has been reduced over the years while contribution of natural gas in overall combustion has increased.

##### 4.6.5.1. Methodological Issues

##### Activity data

Activity data for this sector has been taken from the Statistical yearbooks – chapter energy balance for the period 1990-2023. For the period 1990-1998, activity data were taken from the GHGs inventory.

**Table 70 Activity data for the source category 1.A.4.ai Commercial/Institutional – stationary combustion**

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
1990	NA	144	NA	387
1991	NA	144	NA	NA
1992	NA	243	NA	NA
1993	NA	152	NA	NA
1994	NA	152	NA	NA
1995	NA	152	NA	NA
1996	NA	152	NA	NA
1997	NA	152	NA	NA
1998	712	152	NA	2640
1999	712	607	NA	3322
2000	848	58	NA	998
2001	NA	33	NA	705
2002	NA	196	NA	9337
2003	321	246	NA	3407
2004	325	656	NA	2450
2005	209	193	120	5169
2006	351	178	112	4094
2007	334	207	103	3844
2008	436	27	95	2154
2009	610	16	77	3700
2010	528	20	79	3527
2011	220	4	83	1509

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
2012	357	52	91	1821
2013	196	62	109	1780
2014	279	21	198	1558
2015	181	24	226	1896
2016	174	27	235	2046
2017	190	34	265	1832
2018	184	27	248	1645
2019	180	24	240	1591
2020	183	20	244	1255
2021	253	16	285	951
2022	246	9	190	56
2023	121	8	182	46

### **Emission factors**

Emission factors are taken from GB 2023. Emission factors for different type of fuels are presented in tables 74-77.

**Table 71 Emission factors for biomass for source category 1.A.4.ai - Commercial/Institutional – stationary combustion**

Pollutant	Value	Unit	References
NOx	91	g/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
NM VOC	300	g/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
SOx	11	g/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PM2.5	160	g/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PM10	163	g/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
TSP	170	g/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
BC	28	% PM2.5	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
CO	570	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Pb	27	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Cd	13	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Hg	0.56	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
As	0.19	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Cr	23	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Cu	6	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Ni	2	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Se	0.5	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Zn	512	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PCDD/ PCDF	100	ng I-TEQ/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
benzo(a) pyren	10	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39

Pollutant	Value	Unit	References
benzo(b) fluoranthene	16	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
benzo(k) fluoranthene	5	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Indeno (1.2.3-cd) pyren	4	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
HCB	5	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PCB	0.06	mg/GJ	GB 2023 Table 3-10 emission factor for source category 1.A.4.a.i. page 39

**Table 72 Emission factors for solid fuels for source category 1.A.4.ai - Commercial/Institutional – stationary combustion**

Pollutant	Value	Unit	References
NOx	173	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
NM VOC	88.8	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
SOx	900	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PM2.5	108	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PM10	117	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
BC	6.4	%PM2.5	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
TSP	124	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
CO	932	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Pb	134	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Cd	1.8	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Hg	7.9	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
As	4	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Cr	13.5	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Cu	17.5	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Ni	13	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Se	1.8	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Zn	200	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PCB	170	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PCDD/PCDF	203	ng I-TEQ/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
benzo(a) pyren	45.5	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
benzo(b) fluoranthene	58.9	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
benzo(k) fluoranthene	23.7	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Indeno (1.2.3-cd) pyren	18.5	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
HCB	0.62	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36

**Table 73 Emission factors for gaseous fuels for source category 1.A.4.ai - Commercial/Institutional – stationary combustion**

Pollutant	Value	Unit	References
NOx	74	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
NMVOC	23	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
SOx	0.67	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
PM2.5	0.78	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
PM10	0.78	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
TSP	0.78	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
BC	4	% PM2.5	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
CO	29	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Pb	0.011	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Cd	0.00009	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Hg	0.1	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
As	0.1	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Cr	0.013	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Cu	0.0026	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Ni	0.013	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Se	0.058	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Zn	0.73	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
PCDD/ PCDF	0.52	ng I-TEQ/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
benzo(a) pyren	0.72	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
benzo(b) fluoranthene	2.9	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
benzo(k) fluoranthene	1.1	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Indeno (1.2.3-cd) pyren	1.08	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 37

**Table 74 Emission factors for liquid fuels for source category 1.A.4.ai - Commercial/Institutional – stationary combustion**

Pollutant	Value	Unit	References
NOx	306	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
NMVOC	20	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
SOx	94	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PM2.5	18	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PM10	21	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
TSP	21	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
BC	56	%PM2.5	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
CO	93	g/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Pb	8	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Cd	0.15	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38

Pollutant	Value	Unit	References
Hg	0.1	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
As	0.5	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Cr	10	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Cu	3	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Ni	125	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Se	0.1	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Zn	18	mg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PCDD/ PCDF	6	ng I-TEQ/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
benzo(a) pyren	1.9	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
benzo(b) fluoranthene	15	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
benzo(k) fluoranthene	1.7	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Indeno (1.2.3-cd) pyren	1.5	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
HCB	0.22	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PCB	0.13	µg/GJ	GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 38

#### 4.6.5.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO<sub>2</sub> was estimated to be 20% (rating A. cf. chapter 1.7), for SO<sub>x</sub> and NMVOC was estimated to be 40% (rating B) and for PM<sub>2.5</sub> (125% rating C).

#### 4.6.5.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 4.6.5.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done for 2022 emissions within the category 1.A.4.ai due to use of final consumption data for this year only for biomass and liquid fuel.

#### 4.6.5.5. Source-specific planned improvements including those in response to the review process

Tier 2 methodology will be introduced when there will be available activity data. Namely, there is ongoing establishment of National environmental information system that will enable us to collect detail data from this sector in the future. It is expected that this system will function from next year.

#### 4.6.6. Commercial/Institutional – stationary combustion – NFR 1.A.4.aii

Within the Commercial/Institutional sector, liquid fuel- diesel is used. The NFR sector is for the first time introduced in the inventory due to available activity data for the period 2011-2023. For the previous years the emissions were noted as IE in 1.A.4.ai, as it was recommended by previous stage 3 review.



#### 4.6.6.1. Methodological Issues

##### Activity data

Activity data for this sector has been taken from the MAKSTAT database; activity data were available only for the period 2011-2023.

**Table 75 Activity data for the source category 1.A.4.ii Commercial/Institutional: Mobile**

Year	Diesel [TJ]
1990	IE
1991	IE
1992	IE
1993	IE
1994	IE
1995	IE
1996	IE
1997	IE
1998	IE
1999	IE
2000	IE
2001	IE
2002	IE
2003	IE
2004	IE
2005	IE
2006	IE
2007	IE
2008	IE
2009	IE
2010	IE
2011	722
2012	1486
2013	669
2014	684
2015	694
2016	708
2017	739
2018	741
2019	800
2020	704
2021	814
2022	815

Year	Diesel [TJ]
2023	815

Emission factors for the basic pollutants are same with those for the categories 1A2gvii and 1A4cii for diesel and same for all off road categories for gasoline and are presented in Table 50 and Table 51 for heavy metals. Ratio of leaded and unleaded petrol was needed to calculate Pb emissions for off-road vehicles because the gasoline consumption is known but it is not known whether it is leaded or unleaded. What is known is that leaded gasoline has been out of use since 2006. Assumption what was made is that share of gasoline leaded in 1990 was dominant with percentage share of 95%, and the rest was gasoline unleaded. In 2006 there was no more gasoline leaded in use. Percentage share of each type of gasoline for the years between 1990 and 2006 was estimated with interpolation method. In the table below ratio of leaded and unleaded petrol and EF for lead for this category are presented in the following table.

**Table 79 Emission factors for and ratio of leaded to unleaded gasoline for the period 1990 – 2023**

Lead content	Gasoline Leaded	Gasoline Unleaded	Gasoline Leaded	Gasoline Unleaded	Gasoline Leaded	Gasoline Unleaded	Residential	Gasoline Leaded	Gasoline Unleaded
Unit	g/L = kg/t	g/L = kg/t	Share	Share	g/GJ	g/GJ	GJ	GJ	GJ
1990	0,60	0,02	0,95	0,05	13,65	0,45	107309,78	101944,29	5365,489
1991	0,60	0,02	0,89	0,11	13,65	0,45	58292,816	51917,04	6375,777
1992	0,60	0,02	0,83	0,17	13,65	0,45	39960,913	33217,509	6743,404
1993	0,60	0,02	0,77	0,23	13,65	0,45	45983,624	35493,61	10490,01
1994	0,60	0,02	0,71	0,29	13,65	0,45	37015,499	26373,543	10641,96
1995	0,60	0,02	0,65	0,35	13,65	0,45	33938,201	22165,887	11772,31
1996	0,5	0,013	0,59	0,41	11,37	0,30	38861,878	23074,24	15787,64
1997	0,5	0,013	0,53	0,47	11,37	0,30	49676,382	26545,817	23130,57
1998	0,5	0,013	0,48	0,53	11,37	0,30	12924,652	6139,2095	6785,442
1999	0,5	0,013	0,42	0,58	11,37	0,30	30421,289	12643,848	17777,44
2000	0,5	0,013	0,36	0,64	11,37	0,30	43299,179	15425,332	27873,85
2001	0,5	0,013	0,30	0,70	11,37	0,30	35744,206	10611,561	25132,64
2002	0,3	0,013	0,24	0,76	6,82	0,30	19879,806	4721,4538	15158,35
2003	0,15	0,005	0,18	0,82	3,41	0,11	15903,01	2832,7236	13070,29
2004	0,15	0,005	0,12	0,88	3,41	0,11	52514,368	6236,0812	46278,29
2005	0,15	0,005	0,06	0,94	3,41	0,11	16462,841	977,48118	15485,36
2006	0,15	0,005	0,0000	1,0000	3,41	0,11	25983,385	0	25983,39
2007	0,15	0,005	0,0000	1,0000	3,41	0,11	14287,455	0	14287,46
2008	0,15	0,005	0,0000	1,0000	3,41	0,11	14199,532	0	14199,53
2009	0,15	0,005	0,0000	1,0000	3,41	0,11	14771,03	0	14771,03
2010	0,15	0,005	0,0000	1,0000	3,41	0,11	15430,451	0	15430,45
2011	0,15	0,005	0,0000	1,0000	3,41	0,11	17320,792	0	17320,79
2012	0,15	0,005	0,0000	1,0000	3,41	0,11	16661,371	0	16661,37
2013	0,15	0,005	0,0000	1,0000	3,41	0,11	16177,795	0	16177,8
2014	0,15	0,005	0,0000	1,0000	3,41	0,11	16309,679	0	16309,68
2015	0,15	0,005	0,0000	1,0000	3,41	0,11	17125,163	0	17125,16
2016	0,15	0,005	0,0000	1,0000	3,41	0,11	17467,667	0	17467,67
2017	0,15	0,005	0,0000	1,0000	3,41	0,11	17352,4	0	17352,4

2018	0,15	0,005	0,0000	1,0000	3,41	0,11	17352,4	0	17352,4
2019	0,15	0,005	0,0000	1,0000	3,41	0,11	17672,395	0	17672,39
2020	0,15	0,005	0,0000	1,0000	3,41	0,11	17318,929	0	17318,93
2021	0,15	0,005	0,0000	1,0000	3,41	0,11	18233,184	0	18233,18
2022	0,15	0,005	0,0000	1,0000	3,41	0,11	18286,404	0	18286,4
2023	0,15	0,005	0,0000	1,0000	3,41	0,11	18286,404	0	18286,4

#### 4.6.6.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was calculated for this sector.

#### 4.6.6.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files. NFR tables and the IIR.

#### 4.6.6.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done for 2022 emissions within the category 1.A.4.ai due to use of final consumption data for this year. Recalculations were done for period 1990-2023 with use of higher Tier methodology.

#### 4.6.6.5. Source-specific planned improvements including those in response to the review process

No planned activities for this category.

#### 4.6.7. Commercial/Institutional – stationary combustion – NFR 1.A.b.i

The survey “Energy consumption in households 2014” from has been conducted in 2015 by the *State Statistical Office* and published in 2016. For this survey, a representative sample of 3500 households was selected.

Beside other information, the report provides information about construction age, average area of dwellings and heated area, type of insulation and finally the total energy consumption of the approximately 559 thousand households.

The following table presents energy consumption of households in 2014.

**Table 76 Consumption and Number of households using the type of energy**

Type of energy	Consumption	Number of households using the type of energy
Electricity	3 118 365 (MWh)	559 187
Fuel wood	1 328 979 (m3)	345 658
Wood of fruit trees and other plant residues	32 243 (m3)	27 242
Wood residues. wood briquettes and pellets	19 404 (t)	8 078
Coal	4 462 (t)	2 555
LPG	5 585 (t)	87 739
Natural gas	49 460 (Nm3)	N/A

Type of energy	Consumption	Number of households using the type of energy
Heating oil	4 822 (m3)	3 633
Derived heat	327 082 (MWh)	46 590
Wood mass consumed for other purposes (for food in winter. producing brandy. etc.)	149 366	N/A

Assumption: for the years from 1990 to 2004 it is assumed that the % of fuel use/activity is the same as in 2005. Improved stove on biomass is assumed to be advanced/ecolabeled stoves, and new stove on biomass is assumed to be high-efficiency stove.

According to GAINS model (baseline scenario) in NMK there are no pellet stoves at all which is not true so national data from energy balances were incorporate in expert assumption in overall pellets systems in NMK. The % of fuel use/activity remains the same until 2015, when improved stove on biomass entered into use with exception of pellet systems that started use in 2012 according to national energy balance.

**Table 77 Distribution of households using different type of stoves on biomass**

Sector/Year	DOM_FPLACE	DOM_SHB_M	DOM_STOVE_H	Advanced / ecolabelled stoves and boilers	High-efficiency stoves	Pellets-since 2012*	TOTAL
1990	3%	2%	95%	0%	0%	0%	100%
1991	3%	2%	95%	0%	0%	0%	100%
1992	3%	2%	95%	0%	0%	0%	100%
1993	3%	2%	95%	0%	0%	0%	100%
1994	3%	2%	95%	0%	0%	0%	100%
1995	3%	2%	95%	0%	0%	0%	100%
1996	3%	2%	95%	0%	0%	0%	100%
1997	3%	2%	95%	0%	0%	0%	100%
1998	3%	2%	95%	0%	0%	0%	100%
1999	3%	2%	95%	0%	0%	0%	100%
2000	3%	2%	95%	0%	0%	0%	100%
2001	3%	2%	95%	0%	0%	0%	100%
2002	3%	2%	95%	0%	0%	0%	100%
2003	3%	2%	95%	0%	0%	0%	100%
2004	3%	2%	95%	0%	0%	0%	100%
2005	3%	2%	95%	0%	0%	0%	100%
2006	3%	2%	95%	0%	0%	0%	100%
2007	3%	2%	95%	0%	0%	0%	100%
2008	3%	2%	95%	0%	0%	0%	100%
2009	3%	2%	95%	0%	0%	0%	100%
2010	3%	2%	95%	0%	0%	0%	100%
2011	3%	2%	95%	0%	0%	0%	100%
2012	3%	2%	95%	0%	0%	0%	100%
2013	3%	2%	94%	0%	0%	1%	100%

2014	3%	2%	94%	0%	0%	1%	100%
2015	3%	2%	93%	0%	0%	1%	100%
2016	3%	2%	93%	0%	0%	2%	100%
2017	3%	2%	92%	1%	0%	2%	100%
2018	3%	2%	91%	1%	0%	2%	100%
2019	3%	2%	90%	2%	0%	3%	100%
2020	3%	2%	90%	2%	0%	3%	100%
2021	3%	2%	89%	2%	0%	3%	100%
2022	3%	2%	88%	3%	1%	3%	100%
2023	3%	2%	87%	4%	1%	3%	100%

Assumption: for the years from 1990 to 2004 it is assumed that the % of fuel use/activity is the same as in 2005. According to GAINS model, domestic share of energy there is the same % of fuel input/technology for Brown coal/lignite grade 1 and Brown coal/lignite grade 2 (also peat) so these two fuels will be seen as one. This simplification will also apply to Hard coal fuels (grade 1, grade 2 and grade 3).

Simplification 1: there is three solid fuels in MK:

1. Brown coal/lignite (also peat)
2. Derived coal (coke, briquettes) and
3. Hard coal.

Simplification 2: Single house boilers - automatic and Single house boilers - manual burning Hard coal will be seen as one Single house boilers because GB2023 does not distinguish SHB is there are only one set of Tier 2 EFs.

**Table 78 Distribution of households using different type of stoves on coal**

	DOM_SHB_M_Brown coal	DOM_STOVE_H_Brown coal	DOM_SHB_M_Derived coal	DOM_STOVE_H_Derived coal
1990	50%	50%	50%	50%
1991	50%	50%	50%	50%
1992	50%	50%	50%	50%
1993	50%	50%	50%	50%
1994	50%	50%	50%	50%
1995	50%	50%	50%	50%
1996	50%	50%	50%	50%
1997	50%	50%	50%	50%
1998	50%	50%	50%	50%
1999	50%	50%	50%	50%
2000	50%	50%	50%	50%
2001	50%	50%	50%	50%
2002	50%	50%	50%	50%
2003	50%	50%	50%	50%
2004	50%	50%	50%	50%
2005	50%	50%	50%	50%
2006	51%	49%	50%	50%
2007	52%	48%	50%	50%

2008	53%	47%	50%	50%
2009	54%	46%	50%	50%
2010	55%	45%	50%	50%
2011	56%	44%	50%	50%
2012	57%	43%	50%	50%
2013	58%	42%	50%	50%
2014	59%	41%	50%	50%
2015	60%	40%	50%	50%
2016	60%	40%	50%	50%
2017	60%	40%	50%	50%
2018	60%	40%	50%	50%
2019	60%	40%	50%	50%
2020	60%	40%	50%	50%
2021	60%	40%	55%	45%
2022	60%	40%	60%	40%
2023	60%	40%	65%	35%

#### 4.6.7.1. Methodological Issues

##### Activity data

The outcome of the survey showed that biomass consumption is a factor of 2.5 higher than the final energy consumption, published in official energy statistics. Therefore, the activity data for biomass has been adjusted by multiplying the energy consumption from energy statistics by this factor for the complete reporting period.

Energy statistics data were not available for 1991 to 1997 for this source category therefore the consumption of biomass, liquid fuels and coal has been gap filled by backward linear trend interpolation of 1998-2010 energy statistics.

The statistical data after 2005 were taken from MAKSTAT database. These numbers were more representative but still there may be some underestimation of the consumed biomass due to still existing illegal cut of woods, especially in the rural areas. Distribution of biomass and coal use per stove was done by using IIASA default contribution factors from EMEP Guidebook, as presented in the two following tables.

**Table 79 Activity data for source category 1.A.4.bi - Residential: Stationary-biomass**

Technology (TJ) / year	DOM_FPLACE	DOM_SHB_M	DOM_STOVE_H	Advanced / ecolabelled stoves and boilers	High-efficiency stoves	Pellets - since 2014*
1990	280	206	8862	0	0	0
1991	243	178	7671	0	0	0
1992	265	195	8384	0	0	0
1993	297	218	9400	0	0	0

1994	284	208	8980	0	0	0
1995	284	208	8980	0	0	0
1996	284	208	8980	0	0	0
1997	284	208	8980	0	0	0
1998	271	199	8559	0	0	0
1999	284	208	8982	0	0	0
2000	338	248	10670	0	0	0
2001	263	193	8300	0	0	0
2002	260	191	8212	0	0	0
2003	289	212	9143	0	0	0
2004	289	212	9118	0	0	0
2005	259	190	8198	0	0	0
2006	259	190	8169	0	0	0
2007	242	177	7636	0	0	0
2008	242	177	7636	0	0	0
2009	242	178	7649	0	0	0
2010	238	175	7532	0	0	0
2011	260	191	8214	0	0	0
2012	282	207	8898	0	0	28
2013	278	204	8722	0	0	59
2014	291	213	9096	0	0	95
2015	280	205	8710	9	9	123
2016	236	173	7278	36	9	130
2017	270	198	8272	75	13	179
2018	225	165	6846	90	12	175
2019	233	171	7016	121	14	207
2020	242	177	7224	155	16	242
2021	245	179	7247	203	29	253
2022	237	174	6956	242	40	253
2023	221	162	6416	268	48	243

**Table 84 Activity data for source category 1.A.4.bi - Residential: Stationary-liquid, gas and coal fuels**

Fuel	Coal	Coal	Total coal	Liquid	Gas
Technology (TJ) / year	DOM_SHB_M	DOM_STOVE_H	sum		
1990	93	93	186	397	NA
1991	166	166	333	863	NA
1992	162	162	323	921	NA
1993	157	157	313	980	NA
1994	152	152	304	1038	NA
1995	147	147	294	1097	NA
1996	142	142	284	1156	NA
1997	137	137	275	1214	NA
1998	107	107	213	1225	NA

1999	138	138	276	1316	NA
2000	118	118	235	1394	NA
2001	88	88	177	1435	NA
2002	113	113	227	1513	NA
2003	114	114	228	1577	NA
2004	124	124	248	1657	NA
2005	81	81	161	1687	NA
2006	59	56	115	1757	NA
2007	59	55	114	1890	NA
2008	38	34	72	1812	NA
2009	25	22	47	1895	NA
2010	29	24	53	1852	NA
2011	21	17	38	1896	NA
2012	23	17	40	1172	NA
2013	22	16	39	535	0
2014	16	11	27	431	2
2015	14	10	24	464	3
2016	15	10	25	476	4
2017	15	10	25	490	6
2018	12	8	19	456	8
2019	11	7	18	354	8
2020	10	7	17	354	10
2021	10	7	17	364	12
2022	3	2	5	316	6
2023	3	2	5	294	5

### **Emission factors**

For biomass, the default emission factors were updated and taken for this submission from Guidebook 2023. Emission factors for different type of stoves are presented in the four following tables.

**Table 80 Emission factors for biomass for source category 1.A.4.bi - Residential: Stationary**

Pollutant	DOM_FPLACE	DOM_SHV_M_Biomass	DOM_STOVE_H_Biomass	Advanced eco labeled	High efficient stoves	Pellets	Unit
NOx	50	80	50	95	80	80	g/GJ
NMVOC	600	350	600	250	350	10	g/GJ
SOx	11	11	11	11	11	11	g/GJ
NH3	8	8	8	4	8	1	
PM2.5	820	470	740	93	370	60	g/GJ
BC	840	480	760	95	380	60	% PM2.5
PM10	880	500	800	100	400	62	g/GJ
TSP	7	16	10	28	16	15	g/GJ
CO	4000	4000	4000	2000	4000	300	g/GJ



Pollutant	DOM_FPLACE	DOM_SHV_M_Biomass	DOM_STOVE_H_Biomass	Advanced eco labeled	High efficient stoves	Pellets	Unit
Pb	27	27	27	27	27	27	mg/GJ
Cd	13	13	13	13	13	13	mg/GJ
Hg	0,56	0,56	0,56	0,56	0,56	0,56	mg/GJ
As	0,19	0,19	0,19	0,19	0,19	0,19	mg/GJ
Cr	23	23	23	23	23	23	mg/GJ
Cu	6	6	6	6	6	6	mg/GJ
Ni	2	2	2	2	2	2	mg/GJ
Se	0,5	0,5	0,5	0,5	0,5	0,5	mg/GJ
Zn	512	512	512	512	512	512	mg/GJ
PCDD/ PCDF	800	550	800	100	250	100	ng I-TEQ/GJ
benzo(a) pyren	121	121	121	10	121	10	µg/GJ
benzo(b) fluoranthene	111	111	111	16	111	16	µg/GJ
benzo(k) fluoranthene	42	42	42	5	42	5	µg/GJ
Indeno (1.2.3-cd) pyren	71	71	71	4	71	4	µg/GJ
HCB	5	5	5	5	5	5	kg
PCB	0.06	0.06	0.06	0,007	0.03	0,01	kg

**Table 86 Emission factors for coal, for source category 1.A.4.bi - Residential: Stationary**

Pollutant	DOM_SHB_M_Coal	DOM_STOVE_H_Coal	Unit	References
NOx	51	158	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
NMVOC	1.9	174	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
SOx	0.3	900	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
PM2.5	1.2	201	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
BC	5.4	225	% PM2.5	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
PM10	1.2	261	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
TSP	1.2	6,4	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
CO	26	4787	g/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Pb	0.0015	200	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Cd	0.00025	3	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33

Pollutant	DOM_SHB_M_Coal	DOM_STOVE_H_Coal	Unit	References
Hg	0.1	6	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
As	0.12	5	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Cr	0.00076	15	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Cu	0.000076	30	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Ni	0.00051	20	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Se	0.011	2	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Zn	0.0015	300	mg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
PCDD/ PCDF	1.5	500	ng I-TEQ/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
benzo(a) pyren	0.56	270	µg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
benzo(b) fluoranthene	0.84	250	µg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
benzo(k) fluoranthene	0.84	100	µg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
Indeno (1.2.3-cd) pyren	0.84	90	µg/GJ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
HCB	0.62	0.62	κ	GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33
PCB	170	170		GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33

**Table 81 Emission factors for natural gas for source category 1.A.4.bi - Residential: Stationary**

Pollutant	Value	Unit	References
NOx	51	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
NMVOC	1.9	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
SOx	0.3	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
PM2.5	1.2	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
BC	5.4	% PM2.5	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
PM10	1.2	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
TSP	1.2	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33

Pollutant	Value	Unit	References
CO	26	g/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Pb	0.0015	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Cd	0.00025	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Hg	0.1	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
As	0.12	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Cr	0.00076	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Cu	0.000076	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Ni	0.00051	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Se	0.011	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Zn	0.0015	mg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
PCDD/ PCDF	1.5	ng I-TEQ/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
benzo(a) pyren	0.56	µg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
benzo(b) fluoranthene	0.84	µg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
benzo(k) fluoranthene	0.84	µg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33
Indeno (1.2.3-cd) pyren	0.84	µg/GJ	GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33

**Table 82 Emission factors for liquid fuels for source category 1.A.4.bi - Residential: Stationary**

Pollutant	Value	Unit	References
NOx	51	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
NMVOC	0.69	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
SOx	70	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
PM2.5	1.9	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
BC	8.5	% PM2.5	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
PM10	1.9	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
TSP	1.9	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34

Pollutant	Value	Unit	References
CO	57	g/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Pb	0.012	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Cd	0.001	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Hg	0.12	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
As	0.002	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Cr	0.2	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Cu	0.13	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Ni	0.005	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Se	0.002	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Zn	0.42	mg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
PCDD/PCDF	5.9	ng I-TEQ/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
benzo(a) pyren	80	µg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
benzo(b) fluoranthene	40	µg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
benzo(k) fluoranthene	70	µg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
Indeno (1.2.3-cd) pyren	160	µg/GJ	GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34

#### 4.6.7.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO<sub>2</sub> was estimated to be 20% (rating A. cf. chapter 1.7). for SO<sub>x</sub> and NMVOC was estimated to be 40% (rating B) and for PM<sub>2.5</sub> and NH<sub>3</sub> (125% rating C).

#### 4.6.7.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files. NFR tables and the IIR.

#### 4.6.7.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done for whole period 1990-2022 emissions due use of higher Tier 2 methodology.

#### 4.6.7.5. Source-specific planned improvements including those in response to the review process

No planned improvements.

#### 4.6.8. Residential: Household and gardening (mobile) – NFR 1.A.4.bii

The emissions of this subsector come from mobile combustion (the combustion of fuel to power the equipment) used in residential areas: households and gardening land-based mobile machinery.

The species for which it is the more important are SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, PM, CO and non-methane volatile organic compounds (NMVOCs). The emissions of CO<sub>2</sub> and SO<sub>2</sub> are predominantly fuel-based and independent of engine technology/type of equipment.

##### 4.6.8.1. Methodological Issues

For the Tier 1 approach, emissions are estimated using the equation:

$$E_{pollutants} = \sum_{fueltype} FC_{fueltype} \times EF_{pollutants.fueltype}$$

Where:

E<sub>pollutant</sub> = the emission of the specified pollutant.

FC<sub>fuel type</sub> = the fuel consumption for each fuel (diesel, LPG, four-stroke gasoline and two-stroke gasoline) for the source category

EF<sub>pollutant</sub> = the emission factor for this pollutant for each fuel type.

##### Activity data

Non road mobile machinery related emissions for whole historic trend with use of 1.A.4 Non road mobile machinery Annex 2023 model for calculation of emissions from this sector for calculation emissions from this category with Tier 2 methodology was used. Tier 2 methodology from GB2023 was used for the emission calculation. For the activity data - sold values of gasoline - for Agriculture sector from national energy balance, it was assumed that the gasoline is mainly used in the Residential sector - mobile gardening rather than in heavy machineries which are mainly on diesel. So, for this year of submission the trend of gasoline, previously used for Agriculture mobile, is transfer into Residential sector mobile. The breakdown of fuel sold for the mobile agricultural activity was assumed to be the same as assumption used in Croatian inventory due to Croatia is the near neighbouring country.

**Table 83 Activity data for source category 1.A.4.bii - Residential: Household and gardening (mobile)**

Year	Gasoline consumption [TJ]	Year	Gasoline consumption [TJ]
1990	107.31	2007	14.29
1991	58.29	2008	14.20
1992	39.96	2009	14.77
1993	45.98	2010	15.43
1994	37.02	2011	17.32
1995	33.94	2012	16.66
1996	38.86	2013	16.18
1997	49.68	2014	16.31
1998	12.92	2015	17.13
1999	30.42	2016	17.47

Year	Gasoline consumption [TJ]	Year	Gasoline consumption [TJ]
2000	43.30	2017	17.35
2001	35.74	2018	17.35
2002	19.88	2019	17.67
2003	15.90	2020	17.32
2004	52.51	2021	18.23
2005	16.46	2022	18.29
2006	25.98	2023	17.92

#### **Emission factors**

Emission factors for the basic pollutants are presented in Table 50-51. Share of leaded and unleaded petrol is presented in table 79.

#### **4.6.8.2. Source-specific uncertainties and time-series consistency**

No specific uncertainty analysis was done for this sector.

#### **4.6.8.3. Source-specific QA/QC and verification**

No specific QA/QC and verification were done in the sector.

#### **4.6.8.4. Source-specific recalculations including changes made in response to the review process**

In the frame of the IPA II project recalculations for the full-time series was conducted using higher Tier methodology.

#### **4.6.8.5. Source-specific planned improvements including those in response to the review process**

No planned activities in this category.

#### **4.6.9. Agriculture/Forestry/Fishing: Stationary – NFR 1.A.4.ci**

Within the agriculture and forestry sector, mainly liquid fuels (Residual fuel oil, gasoil and LPG) are used, while solid biomass and coal (lignite) have minor importance.

##### **4.6.9.1. Methodological Issues**

#### **Activity data**

The activity data have been taken from the Statistical yearbooks – energy sector for the whole reporting period.

**Table 90 Activity data for source category 1.A.4.ci - Agriculture/Forestry/Fishing: Stationary**

Year	Gaseous fuel [TJ]	Lignite [TJ]	Liquid Fuels [TJ]	Biomass [TJ]
1990	NA	32.782	1302	NA
1991	NA	33.415	1545	NA
1992	NA	33.083	1322	NA
1993	NA	33.322	944	NA
1994	NA	33.338	890	NA
1995	NA	33.570	985	NA
1996	NA	33.518	1125	NA

Year	Gaseous fuel [TJ]	Lignite [TJ]	Lidued Fuels [TJ]	Biomass [TJ]
1997	NA	33.675	875	NA
1998	NA	0.022	829	NA
1999	NA	0.064	959	NA
2000	NA	1.905	1261	NA
2001	NA	0.375	998	NA
2002	NA	0.008	571	NA
2003	NA	1.362	457	14.072
2004	NA	1.844	1508	18.075
2005	NA	2.802	1003	41.373
2006	NA	0.730	793	37.781
2007	NA	0.953	516	35.200
2008	NA	2.495	541	51.112
2009	NA	0.124	351	47.688
2010	NA	0.124	363	47.048
2011	NA	0.124	323	51.119
2012	NA	0.091	349	55.681
2013	NA	36.393	230	56.675
2014	NA	36.393	230	56.675
2015	NA	35.572	251	56.679
2016	NA	32.555	248	51.220
2017	NA	25.765	207	55.943
2018	NA	21.761	211	57.621
2019	NA	86.49	221	57.909
2020	NA	33.427	186	65.589
2021	NA	96.525	126	60.709
2022	NA	62.297	95	58.811
2023	NA	61.700	68	55.414

### **Emission factors**

The emission factors for all fuels have the same tables in Commercial/institutional tables 1.A.4.c.i.

#### **4.6.9.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO<sub>2</sub> was estimated to be 20% (rating A. cf. chapter 1.7), for SO<sub>x</sub> and NMVOC was estimated to be 40% (rating B) and for PM<sub>2.5</sub> and NH<sub>3</sub> (125% rating C).

#### **4.6.9.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category. I.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files. NFR tables and the IIR.

#### 4.6.9.4. Source-specific recalculations including changes made in response to the review process

In the frame of the IPA II project recalculations for the full-time serial was conducted using higher Tier methodology.

Source-specific planned improvements including those in response to the review process

No planned improvements in this category.

#### 4.6.10. Agriculture/Forestry/Fishing: Off-road vehicles and other machinery – NFR 1A4cii

##### 4.6.10.1. Methodological Issues

##### Activity data

Non road mobile machinery related emissions for whole historic trend with use of 1.A.4 Non road mobile machinery Annex 2023 model for calculation of emissions from this sector for calculation emissions from this category with Tier 2 methodology was used. Tier 2 methodology from GB2023 was used for the emission calculation. For the activity data - sold values of gasoline - for Agriculture sector from natinal energy balace, it was assumd that the gasoline is mainly used in the Residential sector - mobile gardening ruther than ih heavy machineries which are mainly on diesel. So, for this year of submission the trend of gasoline, previously used for Agriculture mobile, is tranfer into Residential sector mobile. The brakdown of fuel sold for the mobile agricultural activity was assumed to be the same asassumption used in Croatian inventory due to Cratia is the near neiburhooding county.

**Table 84 Activity data for source category 1.A.4.cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery**

Year	Diesel consumption [TJ]	Year	Diesel consumption [TJ]
1990	408	2007	41
1991	552	2008	56
1992	482	2009	98
1993	327	2010	156
1994	315	2011	156
1995	355	2012	161
1996	405	2013	244
1997	296	2014	257
1998	314	2015	266
1999	348	2016	279
2000	495	2017	279
2001	409	2018	280
2002	227	2019	286
2003	182	2020	286
2004	601	2021	286
2005	80	2022	285
2006	30	2023	287



### **Emission factors**

Emission factors for the basic pollutants and HM are presented in Table 50-51. Share of leaded and unleaded petrol is presented in table 79.

#### **4.6.10.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO<sub>2</sub> was estimated to be 20% (rating A. cf. chapter 1.7). for SO<sub>x</sub> and NMVOC was estimated to be 40% (rating B) and for PM<sub>2.5</sub> and NH<sub>3</sub> (125% rating C).

#### **4.6.10.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category. i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files. NFR tables and the IIR.

#### **4.6.10.4. Source-specific recalculations including changes made in response to the review process**

Recalculations was performed in this category due to use of higher tier methodology.

#### **4.6.10.5. Source-specific planned improvements including those in response to the review process**

No planned improvements.

#### **4.6.11. Agriculture/Forestry/Fishing: Off-road vehicles and other machinery – NFR 1.A.4.ciii**

According to ERT recommends the Party was asked to include an explanation in the IIR on why emissions have not been estimated, we include the following explanation: For performing activity - fishing on natural and artificial lakes in our country are used boats equipped with outboard two-stroke and four-stroke engines with power of 4-10 KW. 30-40 boats are used in Lake Ohrid. Their utilization depends on the workload at different times of the year, which makes it difficult to determine fuel consumption. Therefore, these emissions are not estimated.

### **4.7. Fugitive emission from fuels- NFR 1 B**

Fugitive emission arises from coal mining, production, distribution, storage, and distribution of oil products.

#### **4.7.1. Coal mining and handling – NFR 1.B.1.a**

##### **4.7.1.1. Methodological issues**

This is one of subcategories for which Tier 2 method was used.

$$E_{pollutants} = \sum_{technologies} AR_{production.tehnology} \times EF_{tehnology.pollutant}$$

where:

$E_{pollutant}$  = the emission of the specified pollutant.

$AR_{fuelconsumption}$  = the production rate the source category for specific technology.

$EF_{pollutant}$  = the emission factor for this technology and this pollutant

### Activity data

Data on coal mined has been taken from the Statistical Yearbook of the Republic of North Macedonia –chapter on Industrial production for the whole reporting period.

**Table 85 Activity data for source category 1.B.1.a - Fugitive emission from solid fuels: Coal mining and handling**

Year	Coal mined[Mg]	Year	Coal mined[Mg]
1990	6 643 409	2007	6 569 220
1991	6 978 171	2008	7 669 103
1992	6 472 920	2009	7 395 915
1993	6 917 774	2010	6 583 074
1994	6 859 762	2011	7 902 084
1995	7 249 237	2012	7 309 546
1996	7 145 667	2013	6 633 560
1997	7 442 876	2014	6 681 752
1998	8 144 653	2015	5 927 749
1999	7 277 623	2016	5 101 758
2000	7 513 998	2017	5 056 918
2001	8 142 082	2018	4 994 843
2002	7 571 202	2019	5 066 083
2003	7 271 202	2020	4 532 745
2004	7 296 136	2021	4 118 936
2005	6 882 862	2022	5 079 495
2006	6 653 474	2023	3 994 332

### Emission factors

In this category calculations were done by use of Tier 2 methodology starting from 2015 since all coal mines are categorized as open mines.

**Table 86 Emission factors for 1.B.1.a - Fugitive emission from solid fuels: Coal mining and handling**

Pollutant	Value	Unit	References
NM VOC	0.2	kg/Mg	GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10
PM10	0.039	kg/Mg	GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10
PM2.5	0.006	kg/Mg	GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10
TSP	0.082	kg/Mg	GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10

#### 4.7.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NO<sub>x</sub> was estimated to be 20% (rating A. cf. chapter 1.7) and 200% for PM<sub>2.5</sub>, (rating D).

#### 4.7.1.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. I.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 4.7.1.4. Source-specific recalculations including changes made in response to the review process

No recalculations were performed in this category.

#### 4.7.1.5. Source-specific planned improvements including those in response to the review process

No further improvements are planned in this category.

#### 4.7.2. Fugitive emissions oil: Refining/storage –NFR 1.B.2.aiv

Emissions of NMVOCs to the atmosphere occur in nearly every element of the oil products distribution chain. Most emissions occur due to the storage and handling of gasoline, because of the much higher volatility compared to other fuels such as gasoil, kerosene etc.

##### 4.7.2.1. Methodological issues

The Tier 1 approach for the refining industry uses the general equation:

$$E_{\text{pollutant}} = \sum AR_{\text{production}} \times EF_{\text{pollutnat}}$$

This equation is applied at national level, using the total refined oil production as production statistics. It is also possible to use the crude oil throughput as production statistics.

##### Activity data

The activity data on crude oil input are taken from the energy balance within the Statistical Yearbook of the Republic of North Macedonia for the whole reporting period and are presented in the following table. Starting from 2015 onwards no crude oil input was reported. Therefore, emissions in this category did not occur.

**Table 87 Activity data for source category 1.B.2.aiv - Fugitive emissions oil: Refining/storage**

Year	Crude oil input [Mg]	Year	Crude oil input [Mg]
1990	1 216 491	2007	1 050 007
1991	964 033	2008	1 061 736
1992	566 701	2009	972 532
1993	1 018 201	2010	853 000
1994	143 148	2011	705 144
1995	119 437	2012	259 606
1996	696 341	2013	59 676
1997	379 759	2014	7 274
1998	754 775	2015	NO
1999	765 412	2016	NO
2000	1 043 104	2017	NO
2001	1 012 872	2018	NO
2002	648 137	2019	NO

Year	Crude oil input [Mg]	Year	Crude oil input [Mg]
2003	78 749	2020	NO
2004	975 262	2021	NO
2005	946 747	2022	NO
2006	1 067 096	2023	NO

### **Emission factors**

Emission factors for emission estimations in this sector are presented in the following table and are directly taken from GB 2023.

**Table 88 Emission factors for source category 1.B.2.aiv - Fugitive emissions oil: Refining/storage**

Pollutant	Value	Unit	References
NO <sub>x</sub>	0.24	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
NM VOC	0.2	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
SO <sub>x</sub>	0.62	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
NH <sub>3</sub>	0.0011	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
PM <sub>2.5</sub>	0.0043	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
PM <sub>10</sub>	0.0099	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
TSP	0.016	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
CO	0.09	kg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Pb	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Cd	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Hg	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
As	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Cr	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Cu	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Ni	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Se	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
Zn	0.0051	g/MG crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14

Pollutant	Value	Unit	References
PCDD/ PCDF	0.0057	µg/Mg crude oil input	GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14

#### 4.7.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NMVOC and SO<sub>x</sub> was estimated to be 20% (rating A. cf. chapter 1.7). and 40% for NO<sub>x</sub> and NH<sub>3</sub> (rating B). and 200% for EF uncertainty for PM<sub>2.5</sub> (rating D).

#### 4.7.2.3. Source-specific QA/QC and verification

No QA/QC procedure is performed due to the fact the activity is not occurring.

#### 4.7.2.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this sector.

#### 4.7.2.5. Source-specific planned improvements including those in response to the review process

No planned improvements in this category.

### 4.7.3. Distribution of oil products – NFR 1.B.2.a.v

This chapter is dealing with the distribution of oil products. in particular (but not limited to) gasoline distribution.

#### 4.7.3.1. Methodological issues

The Tier 1 approach for process emissions from combustion uses the general equation:

$$E_{\text{pollutant}} = AR_{\text{production}} \times EF_{\text{pollutant}} \quad \text{where}$$

$E_{\text{pollutant}}$  = the emission of certain pollutant

$AR_{\text{production}}$  = activity rate by fuel gasoline sold

$EF_{\text{pollutant}}$  = emission factor for the selected pollutant.

#### Activity data

The oil products considered in this source category are as follows: The activity data regarding distributed oil products are calculated as the difference between produced and imported products, reduced by the quantity of exported oil products. Activity data for the produced oil products were taken from the publication industry in the Republic of North Macedonia for the period 2005-2015 [27] and the chapter for industry within the Statistical yearbooks of the Republic of North Macedonia for the previous period [21]. Activity data on the imported and exported oil products are taken from External trade chapter, within the Statistical yearbooks of the Republic of North Macedonia for the whole reporting period. The quantity of distributed oil is presented in the following table.

**Table 89 Activity data for source category 1.B.2.a.v - Distribution of oil products**

Year	Distributed oil (Mg)	Year	Distributed oil (Mg)
1990	592 133	2007	454 633
1991	457 295	2008	456 165
1992	278 185	2009	447 263

Year	Distributed oil (Mg)	Year	Distributed oil (Mg)
1993	597 143	2010	516 450
1994	117 255	2011	566 686
1995	828 450	2012	259 606
1996	334 711	2013	59 676
1997	459 252	2014	7 274
1998	484 508	2015	572 365
1999	514 251	2016	626 447
2000	394 487	2017	598 267
2001	1 012 872	2018	675 630
2002	959 035	2019	745 722
2003	178 107	2020	858 093
2004	338 459	2021	872 279
2005	383 553	2022	942 879
2006	402 385	2023	832 130

**Table 90 Emission factors for source category 1.B.2.a.v - Distribution of oil products for NMVOC**

Pollutant	Value	Unit	References
NMVOC	4.5	kg/Mg oil	GB 2023 Table 3-1 emission factor for source category 1.B.2.a.v page 12

#### 4.7.3.2. Source-specific uncertainties and time-series consistency

See chapter 2.7.1

#### 4.7.3.3. Source-specific QA/QC and verification

Comparison of data reported under this category with data reported under 1.B.a.iv.

#### 4.7.3.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done for the whole time period, but were not reported.

#### 4.7.3.5. Source-specific planned improvements including those in response to the review process

In the frame of the Technical IPA II project for air quality improvements of this category were made by collecting information from all petrol stations in the country regarding implementation of phase II and IB. Recalculated emissions will be reported in the next reporting cycle.

### 4.7.4. Venting and flaring – 1.B.2.c

#### 4.7.4.1. Methodological issues

The Tier 1 approach for process emissions from combustion uses the general equation:

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

This equation is applied at national level. using annual totals for venting and flaring.

#### Activity data

The activity data for this source category for the years 2004, 2008 and 2010, has been taken from the previous informative reports, which were originally obtained from the refinery. For the period 1990-1999, the activity data were taken from the reported data in 2013 reporting round (there is no presented source where this data is coming from). For the other years, a gap filling method has been implemented by using data on quantity of crude oil processed as surrogate data. The consumption of refinery feed has been requested from the refinery, but the data was not reported. No production process was carried out from 2015 onwards so the emissions in this category are not occurring.

**Table 91 Activity data for source category 1.B.2.c - Venting and flaring**

Year	Refinery feed [TJ]	Year	Refinery feed [TJ]	Year	Refinery feed [TJ]
1990	325	2002	129	2014	1
1991	186	2003	156	2015	NO
1992	109	2004	201	2016	NO
1993	196	2005	188	2017	NO
1994	28	2006	212	2018	NO
1995	23	2007	209	2019	NO
1996	134	2008	211	2020	NO
1997	73	2009	193	2021	NO
1998	146	2010	165	2022	NO
1999	148	2011	140	2023	NO
2000	188	2012	52		
2001	201	2013	12		

#### **Emission factors**

Emission factors are taken from the IIR 2010 expressed in TJ.

**Table 92 Emission factors for source category 1B2c Venting and flaring**

Pollutant	Value	Unit	References
NOx	100	g/GJ refinery feed	IIR 2010 Table 72. page 74
NM VOC	5	g/GJ refinery feed	IIR 2010 Table 72. page 74
SOx	15	g/GJ refinery feed	IIR 2010 Table 72. page 74
CO	24	g/GJ refinery feed	IIR 2010 Table 72. page 74

#### **4.7.4.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 20%; the emission factor uncertainty for NM VOC was estimated to be 20% (rating A. cf. chapter 1.7) and 40% for NOx (rating B).

#### **4.7.4.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category. i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files. NFR tables and the IIR. Data were crosschecked with activity data from the category 1.B.a.iv.

#### 4.7.4.4. Source-specific recalculations including changes made in response to the review process

No recalculations were performed in this category.

#### 4.7.4.5. Source-specific planned improvements including those in response to the review process

No planned improvements in this category, since the activity does not occur anymore

#### 4.7.5. Other fugitive emissions from energy production – 1.B.2.d

Emissions for NH<sub>3</sub>, Hg and As, were calculated for the period 1998-2023, where data on geothermal energy consumption were available.

#### Methodological issues

The Tier 1 approach for process emissions from combustion uses the general equation:

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

This equation is applied at the national level, using annual national statistics on the extraction of geothermal energy from the earth.

The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all different sub-processes within the geothermal energy extraction process.

#### Activity data

The activity data for this source category for the period 1998-2016 expressed in m<sup>3</sup> are taken from the Energy balance. Data are converted in Gcal which are expressed in GWh by use of conversion factor taken from the Energy balance for Republic of North Macedonia, where it is stated that 1 Gcal = 1.16 \*10<sup>-3</sup> GWh.

**Table 93 Activity data for source category 1.B.2.d - Other fugitive emissions from energy production**

Year	Geothermal energy [MWh electricity produced]	Year	Geothermal energy [MWh electricity produced]	Year	Geothermal energy [MWh electricity produced]
1990	NE	2003	153 373	2016	75 999
1991	NE	2004	136 983	2017	70 577
1992	NE	2005	115 561	2018	69 589
1993	NE	2006	116 846	2019	64 985
1994	NE	2007	124 244	2020	61 962
1995	NE	2008	115 379	2021	61 578
1996	NE	2009	141 326	2022	58 159
1997	NE	2010	141 326	2023	55733
1998	217 375	2011	142 551		
1999	178 608	2012	122 982		
2000	181 751	2013	98 741		
2001	269 512	2014	84 884		



Year	Geothermal energy [MWh electricity produced]	Year	Geothermal energy [MWh electricity produced]	Year	Geothermal energy [MWh electricity produced]
2002	151 114	2015	78 217		

### **Emission factors**

Emission factors are taken from the GB 2023, expressed in MWh electricity produced.

**Table 94 Emission factors for source category 1.B.2.d -Other fugitive emissions from energy**

Pollutant	Value	Unit	References
NH <sub>3</sub>	2100	g/MWh electricity produced	GB 2023 Table 3-4 emission factor for source category 1.B.2.d page 5
Hg	0.44	g/MWh electricity produced	GB 2023 Table 3-4 emission factor for source category 1.B.2.d page 5
As	0.025	g/MWh electricity produced	GB 2023 Table 3-4 emission factor for source category 1.B.2.d page 5

#### **4.7.5.1. Source-specific uncertainties and time-series consistency**

No specific uncertainties were calculated for this category.

#### **4.7.5.2. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category. I.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files. NFR tables and the IIR.

#### **4.7.5.3. Source-specific recalculations including changes made in response to the review process**

No recalculations were done in this sector.

#### **4.7.5.4. Source-specific planned improvements including those in response to the review process**

No planned improvements in this category.

# INDUSTRY



## 5. INDUSTRIAL PROCESSES AND PRODUCT USE (NFR SECTOR 2)

### 5.1. Sector overview

This chapter includes information on the estimation (calculation) of the emissions of NEC gases, CO, particle matter (PM), heavy metals (HM) and persistent organic pollutants (POPs) as well as activity data and their references and emission factors reported under NFR category Industrial Processes taken from EMEP Guidebooks 2023 for the period from 1990-2023 with exception of those categories where due to limitation of activity data, emission factors from older version of the Guidebook are used.

This category comprises emissions from the following subcategories: Mineral Products, Chemical Industry, Metal Production and Other products and solvents used.

Only process related emissions are considered in this Sector. Emissions due to fuel combustion in manufacturing industries are allocated in NFR Category 1.A.2 Fuel Combustion – Manufacturing Industries and Construction.

Some categories in this sector like those categorized as chemical production are not occurring (NO) in North Macedonia, as there is no such production. For some categories notation keys like not estimated (NE) or included elsewhere (IE) have been used.

### 5.2. General description

#### Completeness

**Table 95 NFR categories covered in Industrial processes sector for 2022**

NFR sector	Completeness
2.A.1 Cement production	√
2.A.2 Lime production	NO
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.B.1 Ammonia production	NO
2.B.2 Nitric acid production	NO
2.B.3 Adipic acid production	NO
2.B.4 Carbide production	NO
2.B.10.a Chemical industry: Other	√
2. B.10.b Storage, handling and transport of chemical products	IE
2.B.7 Soda ash production and use	NE
2.C.1 Iron and steel production	√
2.C.2 Ferroalloys production	√
2.C.3 Aluminum production	NE
2.C.4 Magnesium production	NO

NFR sector	Completeness
2.C.5 Lead production	√
2.C.6 Zinc production	NO
2.C.7.a Copper production	NE
2.C.7.b Nickel production	NO
2.C.7.c Other metal production	√
2.C.7.d Storage, handling and transport of metal products	IE
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.G Other product use and 2.D.3.i Other solvent use	√
2.H.1 Pulp and paper industry	NO
2.H.2 Food and beverage production industry	√
2.H.2 Other industrial processes	NE
2.I Wood processing	√
2.J Production of POPs	NO
2.K Consumption of POPs and HM	√
2.L Other production, consumption, storage, transportation or handling of bulk products	NE

## Methodology

The Tier 1 approach for process emissions from production uses the general equation:

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

where:

$E_{\text{pollutant}}$  = the emission of certain pollutant

$AR_{\text{production}}$  = the activity rate (data) for the production

$EF_{\text{pollutant}}$  = emission factor for the selected pollutant.

## 5.3. Mineral products – NFR 2.A

### 5.3.1. Cement production – 2.A.1

In the Republic of North Macedonia there is only one installation (factory) for cement production “Cementarnica USJE AD Skopje”. In this installation there are 2 (two) rotary kilns (furnace 3 and 4) where abatement (fabric filters) is used since 2001 (for furnace 3) and since 2003 (for furnace 4). For

these reasons for the period 2004-2015 we have made recalculation of the of PM2.5 emissions, PM10, TSP and BC, described below.

#### 5.3.1.1. Methodological issues

The Tier 1 approach for process emissions from cement uses the general equation:

$$E_{\text{pollutant}} = \sum AR_{\text{production}} \times EF_{\text{pollutnat}}$$

where:

$E_{\text{pollutant}}$  = the emission of a pollutant (kg),

$AR_{\text{production}}$  = the annual production of clinker (in Mg),

$EF_{\text{pollutant}}$  = is the emission factor of the relevant pollutant (in -g pollutant/Mg clinker produced)

#### Activity Data

The activity data for the whole reporting period was received from the operator itself.

**Table 96 Activity data for source category 2.A.1 - Cement production**

Year	Clinker produced (t)	Year	Clinker produced (t)
1990	491 900	2007	882 830
1991	465 380	2008	843 770
1992	396 500	2009	478 400
1993	413 440	2010	588 980
1994	375 910	2011	687 990
1995	365 120	2012	645 480
1996	396 020	2013	577 850
1997	475 250	2014	518 200
1998	346 870	2015	553 232
1999	427 080	2016	739 810
2000	614 160	2017	735 625
2001	716 960	2018	748 287
2002	739 490	2019	737 700
2003	602 570	2020	770 599
2004	643 260	2021	803 735
2005	694 920	2022	673 837
2006	801 300	2023	711 254

During the stage 3 Review, the ERT notes a jump in the clinker produced in 2000 for 44% and a dip in 2009 for 43%. And the reason behind is that the Cement Factory has been working since 2000 with a new owner who had previously made several modernizations in the production. In 2009, the decline in production was due to the economic crisis and data from then on are gradually increasing.

### Emission factors

For calculation (estimation) of emissions for PM2.5, PM10, TSP and BC for the period 1990-2003 emission factors were taken from GB 2023.

These emission factors are given in the table below:

**Table 97 Emission factors for source category 2.A.1 cement production**

Pollutant	Value	Unit	References
PM10	234	g/Mg clinker	GB 2023 2.A.1 Cement production. Table 3-1. pg. 10
PM2.5	130	g/Mg clinker	GB 2023 2.A.1 Cement production. Table 3-1. pg. 10
TSP	260	g/Mg clinker	GB 2023 2.A.1 Cement production. Table 3-1. pg. 10
BC	3	%	GB 2023 2.A.1 Cement production. Table 3-1. pg. 10

For calculation (estimation) of emissions for PM2.5, PM10 and TSP for the period 2007-2023 the total emission TSP (measured with continuous monitoring) is taken into account: the emission factors from GB 2023 have been used (Tier 1, Table 102 above) as well as Tier 2, Table 103 (GB 2023) where the abatement efficiencies are considered (namely the proportion relation for calculation of abatement efficiencies for TSP, PM10 and PM2.5 is used for each particular year).

For the period 2004-2006 (when there was no continuous monitoring installed in the installation) the calculation of PM2.5, PM10 and TSP emissions are done by considering the mass of clinker produced and the abatement efficiency, approximately 92% for TSP, 75 % for PM10 and 68,5 % for PM2.5.

For this calculation, the following equation was used:

$$EF_{\text{technology/abated}} = (1 - \eta_{\text{abatement}}) \times EF_{\text{technology/unabated}}$$

**Table 98 Abatement efficiencies ( $\eta_{\text{abatement}}$ ) for source category 2.A.1 Cement production**

Abatement technology	Pollutant	Value	References
Additional fabric filters on the oven stack; effective control of fugitive sources	particle > 10 $\mu\text{m}$	98%	GB 2023 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12
	10 $\mu\text{m}$ > particle > 2.5 $\mu\text{m}$	80%	GB 2023 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12
	2.5 $\mu\text{m}$ > particle	73%	GB 2023 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12

#### 5.3.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 2%; the emission factor uncertainty was estimated to be 200% (rating D, cf. chapter 2.7), based on expert judgment.

There has been one cement plant operating over the whole time series. Emissions follow the changes production.

#### 5.3.1.3. Source-specific QA/QC and verification

Standard QA/QC procedures are carried out for this source category, i.e. activity data are checked for plausibility and time-series consistency; emission data are checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.3.1.4. Source-specific recalculations including changes made in response to the review process

The changes in the abatement technology have also been considered. No recalculations were carried out in this category.

#### 5.3.1.5. Source-specific planned improvements including those in response to the review process

No recalculations are planned in future.

### 5.3.2. Lime production – NFR 2.A.2

#### 5.3.2.1. Methodological issues

For estimation of emission from lime production Tier 1 method is used, where lime produced was taken as activity data.

#### Activity Data

The activity data for the period 1990–1999, originates from the Statistical Yearbook - Chapter industry, while activity data for the period 2000–2013, was taken from the International Mineral yearbook [30]. No data was available for 2008 and 2014. According to the MS expert comments, data on hydraulic lime can be considered. Therefore, available data for the period 2014–2023 from the Statistical publication for Industry in the Republic of North Macedonia [29] was used as activity data. For the period 2020–2023 there is no lime production because the installation for this type of production has gone bankrupt.

**Table 99 Activity data for source category 2.A.2 - Lime production**

Year	Lime produced (t)	Year	Lime produced (t)
1990	37 452	2007	7 517
1991	29 194	2008	NE
1992	33 872	2009	2 713
1993	24 904	2010	2 700
1994	14 097	2011	2 700
1995	12 538	2012	2 700
1996	9 707	2013	2 700
1997	4 344	2014	10 836
1998	964	2015	8 003
1999	4 264	2016	8 684
2000	1 000	2017	1 399
2001	500	2018	6 834
2002	500	2019	29 236
2003	500	2020	NO
2004	500	2021	NO
2005	15 009	2022	NO
2006	12 704	2023	NO

### Emission factors

For the calculation (estimation) of emissions for PM<sub>2.5</sub>, PM<sub>10</sub> and TSP for the period 1990-2023 emission factors were taken from GB 2023.

These emission factors are given in Table 105 below.

**Table 100 Emission factors for source category 2.A.2 - Lime production**

Pollutant	Value	Unit	References
PM <sub>10</sub>	3500	g/Mg lime	GB 2023 2.A.2 Lime production, Table 3-1, pg. 8
PM <sub>2.5</sub>	700	g/Mg lime	GB 2023 2.A.2 Lime production, Table 3-1, pg. 8
TSP	9000	g/Mg lime	GB 2023 2.A.2 Lime production, Table 3-1, pg. 8
BC	0.46	% of PM <sub>2.5</sub>	GB 2023 2.A.2 Lime production, Table 3-1, pg. 8

#### **5.3.2.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

#### **5.3.2.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e., activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Activity data was checked also in the MAKSTAT database [29].

#### **5.3.2.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were carried out in this category.

#### **5.3.2.5. Source-specific planned improvements including those in response to the review process**

No planned improvements in this category.

### **5.3.3. Glass production – NFR 2.A.3**

The glass production in North Macedonia was ongoing in the installation “Staklara” during the nineties. Currently, there are small installations in which glass is only processed, but not produced.

#### **5.3.3.1. Methodological issues**

Tier 2 method, has been implemented for estimation of emissions coming from this source category bearing in mind data that were available for flat glass and glass wool produced.

$$E_{pollutants} = \sum_{technologies} AR_{production,tehnology} \times EF_{production,tehnology}$$

where:

$AR_{production, tehnology}$  = the production rate within the source category, using this specific technology,

$EF_{pollutant}$  = the emission factor for this technology and this pollutant.

### **Activity Data for source category 2.A.3 - Flat glass production**



The activity data for both flat glass production and glass wool production are presented below. The activity data for flat glass production for the period 1990-1992 are taken from the statistical yearbooks.

**Table 101 Activity data for 2.A.3 - Flat glass production**

Year	Flat glass produced [t]	Year	Flat glass produced [t]
1990	448	2007	NO
1991	32	2008	NO
1992	179	2009	NO
1993	NO	2010	NO
1994	NO	2011	NO
1995	NO	2012	NO
1996	NO	2013	NO
1997	NO	2014	NO
1998	NO	2015	NO
1999	NO	2016	NO
2000	NO	2017	NO
2001	NO	2018	NO
2002	NO	2019	NO
2003	NO	2020	NO
2004	NO	2021	NO
2005	NO	2022	NO
2006	NO	2023	NO

#### Emission factors

For the estimation of emission parameters from 1990-1992, the used emission factors were taken from GB 2023. These emission factors are given in Table 109 below.

**Table 102 Emission factors for source category 2.A.3 Flat glass production**

Pollutant		Value	Unit	References
PM10		120	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
PM2.5		100	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
TSP		130	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
BC		0.062	% of PM2.5	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Pb		0.4	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Cd		0.068	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Hg		0.003	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
As		0.08	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Cr		0.08	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Cu		0.007	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Ni		0.74	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16

Pollutant		Value	Unit	References
Se		0.15	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Zn		0.37	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16

#### **Activity Data for source category 2.A.3 - Glass wool production**

The activity data for glass wool production was taken from Statistical yearbooks - chapter industry for the period 1990-1998.

**Table 103 Activity data for source category 2.A.3 - Glass wool production**

Year	Glass wool produced [t]	Year	Glass wool produced [t]
1990	2739	2007	NO
1991	1 176	2008	NO
1992	1828	2009	NO
1993	444	2010	NO
1994	1332	2011	NO
1995	3043	2012	NO
1996	1454	2013	NO
1997	961	2014	NO
1998	960	2015	NO
1999	NO	2016	NO
2000	NO	2017	NO
2001	NO	2018	NO
2002	NO	2019	NO
2003	NO	2020	NO
2004	NO	2021	NO
2005	NO	2022	NO
2006	NO	2023	NO

#### **Emission factors**

For the estimation of emission parameters for the period 1990-1998 coming from this source category, the used emission factors were taken from GB 2023.

These emission factors are given in Table 111 below.

**Table 104 Emission factors for Glass wool production**

Pollutant	Value	Unit	References
NM VOC	500	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
NH <sub>3</sub>	1400	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
PM <sub>2.5</sub>	520	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
PM <sub>10</sub>	590	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
TSP	670	g/Mg glass	GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
BC	2	% Of PM <sub>2.5</sub>	GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19

### 5.3.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 40% for NMVOC and NH<sub>3</sub> and 200% for PM<sub>2.5</sub>, based on expert judgment.

This time series ends in 1998, as the production of flat glass and glass wool ceased by that time.

### 5.3.3.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e., activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

### 5.3.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were carried out in this category.

### 5.3.3.5. Source-specific planned improvements including those in response to the review process

No improvements are planned in this category.

## 5.3.4. Quarrying and mining of minerals other than coal – NFR 2.A.5.a

This subchapter elaborates quarrying and mining of minerals other than coal and it does not include emissions from the combustion of fuels in the plant or transport machinery.

### 5.3.4.1. Methodological issues

Tier 1 method is used for calculation of emissions in this sector. The quantities of different minerals (like marble, talk, silica, gypsum, etc.) were summarized for calculation of activity data per reporting year.

### Activity Data

The activity data for mineral produced were taken from the Statistical yearbook for the period 1990-2005[22], while activity data for the period 2005-2006 [28] were taken from the statistical publication for industry. Data for period 2007-2023 are taken from MAKSTAT database [29].

**Table 105 Emission factors for minerals produced for source category 2.A.5.a Quarrying and mining the minerals other than coal**

Year	Mineral produced [t]	Year	Mineral produced [t]
1990	6 117 811	2007	6 955 426
1991	5 730 999	2008	7 095 376
1992	5 299 552	2009	5 783 348
1993	5 246 466	2010	6 845 344
1994	4 817 372	2011	7 106 322
1995	5 215 134	2012	7 039 649
1996	5 233 110	2013	7 779 824
1997	5 528 418	2014	7 218 423
1998	5 158 798	2015	7 577 701
1999	4 658 946	2016	8 311 381
2000	4 917 560	2017	7 837 715

Year	Mineral produced [t]	Year	Mineral produced [t]
2001	3 488 792	2018	7 867 030
2002	2 855 005	2019	8 385 648
2003	739 786	2020	7 783 002
2004	347 795	2021	7 312 359
2005	2 827 908	2022	6 853 157
2006	4 605 478	2023	7 621 940

### Emission factors

For estimation of emissions for PM<sub>2.5</sub>, PM<sub>10</sub> and TSP the used emission factors were taken from GB 2023. These emission factors are given in Table 113 below.

**Table 106 Emission factors for minerals produced for 2.A.5.a source category - Quarrying and mining of minerals other than coal**

Pollutant	Value	Unit	References
TSP	102	g/Mg mineral	GB 2023 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5
PM <sub>10</sub>	50	g/Mg mineral	GB 2023 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5
PM <sub>2.5</sub>	5.0	g/Mg mineral	GB 2023 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5

#### 5.3.4.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

#### 5.3.4.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e., activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.3.4.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 5.3.4.5. Source-specific planned improvements including those in response to the review process

According to the recommendation given during the stage 3 revisions, the reason behind the deep in the quarrying and mining of minerals other than coal in 2003 for 74% and a jump in 2005 by 8 times (713%) is due to no mining activities in 2004. Furthermore, possibilities to use Tier 2 methodology in this category were investigated; however, there are no detail activity data like Average area of the hole/blast (m<sup>2</sup>) Average height of the hole/blast (m), Material density, Volume of production (m<sup>3</sup>) to be able to proceed with Tier 2 in this category. These types of required data will be included in the National environmental information system for gathering emission data which should be operational in 2025. After these data are gathered it will be possible to change the methodology of calculation.

### 5.3.5. Construction and demolition – NFR 2.A.5.b

This subchapter elaborates emissions from construction and demolition works. This activity mainly results in emissions of particulates, but other pollutants may also be emitted, depending on the materials used in the work. At construction sites, construction materials are used to construct items

including buildings and infrastructure. At demolition sites, a building, infrastructure, or other constructions are torn down, resulting in a lot of rubbish.

#### 5.3.5.1. Methodological issues

Tier 1 method has been applied for estimation of emissions coming from this source category where the activity data refer to floor area in m<sup>2</sup> of the building constructed or demolished.

#### Activity Data

Activity data on constructed (completed and unfinished) dwellings and demolished residential dwellings are taken from Statistical yearbooks - Chapter Construction for the period 1996-2023. There is only data for area in m<sup>2</sup> of constructed dwellings, as well as number of demolished dwellings. The area of demolished dwellings is calculated when the number of demolished dwellings per year is multiplied with an average dwelling area of 65 m<sup>2</sup>. The activity data and EF are presented in the following tables:

**Table 107 Activity data for constructed (completed and unfinished) individual dwellings for source category 2.A.5.b - Construction and demolition**

Year	m <sup>2</sup> /year	Year	m <sup>2</sup> /year
1990	1241459	2007	852971
1991	960298	2008	809606
1992	1012393	2009	824945
1993	876103	2010	902234
1994	827450	2011	944630
1995	848494	2012	934773
1996	456408	2013	887697
1997	394471	2014	798891
1998	311088	2015	752207
1999	874951	2016	943400
2000	841820	2017	1130883
2001	908906	2018	1109077
2002	771750	2019	1028448
2003	842519	2020	1096693
2004	962874	2021	1814779
2005	899876	2022	1696994
2006	958738	2023	1466764

#### Emission factors

Emission factors for the particulates PM<sub>2.5</sub>, PM<sub>10</sub> and TSP are taken from GB 2023. These emission factors are given in Table 115 below.

**Table 108 Emission factors for source category 2.A.5.b - Construction and demolition-Construction of apartment buildings**

Pollutant	Value	Unit	References
TSP	1	kg/m <sup>2</sup> /year	GB 2023 2.A.5.b Construction and demolition. Table 3-2. pg. 7

PM10	0.3	kg/m <sup>2</sup> /year	GB 2023 2.A.5.b Construction and demolition. Table 3-2. pg. 7
PM2.5	0.03	kg/m <sup>2</sup> /year	GB 2023 2.A.5.b Construction and demolition. Table 3-2. pg. 7

**Table 109 Activity data for constructed public dwellings for source category 2.A.5.b - Construction and demolition**

Year	m <sup>2</sup> /year	Year	m <sup>2</sup> /year
1990	NE	2007	39414
1991	NE	2008	7485
1992	NE	2009	33131
1993	NE	2010	17832
1994	NE	2011	14260
1995	NE	2012	33000
1996	471555	2013	37190
1997	449131	2014	4998
1998	482850	2015	8612
1999	65348	2016	6443
2000	56048	2017	8117
2001	48836	2018	19169
2002	100144	2019	18337
2003	110294	2020	32473
2004	58699	2021	34054
2005	61890	2022	19843
2006	57451	2023	30466

### **Emission factors**

Emission factors for the particulates PM2.5, PM10 and TSP are taken from GB 2023. These emission factors are given in Table 117 below.

**Table 110 Emission factors for source category 2.A.5.b - Construction and demolition-non-residential construction**

Pollutant	Value	Unit	References
TSP	3.3	kg/m <sup>2</sup> /year	GB 2023 2.A.5.b Construction and demolition. Table 3-3. pg. 7/8
PM10	1	kg/m <sup>2</sup> /year	GB 2023 2.A.5.b Construction and demolition. Table 3-3. pg. 7/8
PM2.5	0.1	kg/m <sup>2</sup> /year	GB 2023 2.A.5.b Construction and demolition. Table 3-3. pg. 7/8

### **5.3.5.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

### **5.3.5.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e., activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.3.5.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done in this category due to using updated activity data on constructed (completed and unfinished) dwellings and demolished residential dwellings taken from Statistical yearbooks - Chapter Construction for the period 1996-2023.

#### 5.3.5.5. Source-specific planned improvements including those in response to the review process

Currently the emissions from the source category construction and demolition refer only to the area of constructed and demolished dwellings and are underestimated. It is planned for the reporting in future to gather activity data for other types of constructed and demolished buildings. This issue will be further discussed with SSO.

#### 5.3.6. Storage, handling, and transport of mineral products – NFR 2.A.5.c

The source category refers to emissions from storage, handling, and transport of mineral products

##### 5.3.6.1. Methodological issue

In a Tier 2 approach, the emissions from storage, handling and transport of mineral products needs to be estimated separately. For this activity, only one 'technology' (the 'Tier 2 default') is available. Therefore, the equation describing the approach is the same as for Tier 1, where the activity data refer to the activity rate for the storage and handling of mineral products.

##### Activity data

Data on transported mineral by road and railway transport were taken from the statistical publication Transport and communications for the period 2009-2015 and MAKSTAT database for period 2004-2022 (road transport) and the period 2011-2023 (railroad transport).

[27]. The historical data for the quantity of transported minerals in road transport were taken from the Statistical yearbook – chapter Transport for the period 1990-2008 [22], while regarding the railway transport the content of transported minerals in the transported goods in railway transport were estimated.

**Table 111 Activity data for source category 2.A.5.c - Storage, handling, and transport of mineral products**

Year	Products transported [t]	Year	Products transported [t]
1990	246 717	2007	4 813 390
1991	143 309	2008	1 965 897
1992	96 043	2009	7 058 289
1993	152 750	2010	2 820 746
1994	49 973	2011	3 330 100
1995	57 838	2012	3 499 387
1996	34 404	2013	3 407 267
1997	106 462	2014	5 564 332
1998	189 443	2015	4 142 405
1999	152 301	2016	5 034 346
2000	48 708	2017	4 717 295
2001	575 864	2018	8 410 139

Year	Products transported [t]	Year	Products transported [t]
2002	685 869	2019	6 405 305
2003	8 006 331	2020	5 498 961
2004	10 497 726	2021	9 594 126
2005	8 475 328	2022	8 482 780
2006	16 441 405	2023	6 555 998

### Emission factors

For estimation of emissions for particulates, PM2.5, PM10 and TSP, the emission factors were taken from GB 2023. Used emission factors are given in the table below.

**Table 112 Emission factors for source category 2.A.5.c - Storage handling and transport of mineral products.**

Pollutant	Value	Unit	References
TSP	12	g/Mg	GB 2023 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7
PM10	6	g/Mg	GB 2023 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7
PM2.5	0.6	g/Mg	GB 2023 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7

### 5.3.6.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

### 5.3.6.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e, activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

### 5.3.6.4. Source-specific recalculations including changes made in response to the review process

No recalculations were carried out in this category.

### 5.3.6.5. Source-specific planned improvements including those in response to the review process

No improvements are planned in this category.

## 5.4. Chemical Industry – NFR 2B

The following NFR source categories:

- 2.B.1 - Ammonia production
- 2.B.2 - Nitric acid production
- 2.B.3 - Adipic acid production and
- 2.B.4 - Carbide production.
- 2.B.7 – Soda ash production

In the inventory, these are reported as NO since in North Macedonia this kind of production does not exist. Regarding Soda ash production this category is defined as NE since the process should be checked



#### 5.4.1. Other chemical industry – NFR 2.B.10.a

This source category is important for several pollutants. It is introduced for the first time due to recommendation given by the ERT.

##### 5.4.1.1. Methodological issues

The Tier 2 methodology for emission calculation has been used. Namely, the quantity of activity data is multiplied with the appropriate emission factor.

##### Activity data

The input data for this source category is the quantity of different type of final products. These data have been taken from the Statistical Yearbooks of the Republic of North Macedonia for the period 1990-2006 [22], and data form MAKSTAT database for period 2007-2023 [29]. As it can be seen from the table below the production of different product was unstable as it is usual in the countries in transition where factories were closed and change of ownership is frequent and, in those years, when production was stopped the notation key NO has been used.

**Table 113 Activity data for source category 2.B.10 – Other chemical industry**

Year	Chlorine production [Mg]	Phosphate Fertilizers [Mg]	Polyethylene High density [Mg]	Polyvinylchloride [Mg]	Sulfuric acid [Mg]	polyurethane [Mg]
1990	3167	2859	NO	44086	97 101	NO
1991	2439	2359	NO	24495	102 243	NO
1992	2325	1023	NO	9190	95 077	NO
1993	2358	498	NO	2120	88 814	NO
1994	2394	259	NO	NO	72 106	NO
1995	2368	NO	NO	NO	82 619	NO
1996	2562	NO	NO	3995	99 545	NO
1997	349	NO	NO	10344	105 034	NO
1998	772	NO	NO	15658	100 834	NO
1999	61	NO	NO	5134	87 770	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	NO	NO	812	1006	NO	1095
2006	NO	NO	614	NO	NO	1405
2007	NO	NO	360	645	NO	1129
2008	NO	NO	331	1975	NO	1239
2009	NO	NO	181	1731	NO	1132
2010	NO	NO	188	894	NO	1033
2011	NO	NO	319	1978	NO	1059
2012	NO	NO	89	1828	NO	1221

Year	Chlorine production [Mg]	Phosphate Fertilizers [Mg]	Polyethylene High density [Mg]	Polyvinylchloride [Mg]	Sulfuric acid [Mg]	polyurethane [Mg]
2013	NO	NO	NO	916	NO	1166
2014	NO	NO	NO	5531	NO	697
2015	NO	NO	NO	6662	NO	NO
2016	NO	NO	NO	7198	NO	896
2017	NO	NO	NO	7777	NO	1633
2018	NO	NO	NO	7970	NO	2429
2019	NO	NO	NO	9318	NO	2670
2020	NO	NO	NO	8178	NO	2815
2021	NO	NO	NO	8792	NO	4844
2022	NO	NO	NO	9354	NO	4285
2023	NO	NO	NO	10234	NO	4729

### Emission factors

Emission factors for estimation of pollutants have been taken from GB 2023 and they are presented in the table below.

**Table 114 Emission factors for source category 2.B.10.a Other chemical industry**

Pollutant	Value	Unit	References
SOx	17 000	g/Mg (100% H <sub>2</sub> SO <sub>4</sub> )	GB 2023 Table 3.24 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, sulphuric acid production, wet contact process (98% and 78% sulphuric acid)
Hg	4.8	g/Mg	GB 2023 Table 3.32 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, chlorine production
TSP	0.3	kg/ton produced	GB 2023 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers
PM 10	0.24	kg/ton produced	GB 2023 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers
PM 2.5	0.18	kg/ton produced	GB 2023 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers
NMVOC	2.3	kg/ton produced	GB 2023 Table 3.40 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyethylene high density
TSP	97	kg/ton produced	GB 2023 Table 3.40 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyethylene high density
NMVOC	96	g/ton produced	GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)
TSP	263	g/ton produced	GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)
PM 10	100	g/ton produced	GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)
PM 2.5	5	g/ton produced	GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)

#### **5.4.1.2. Source-specific uncertainties and time-series consistency**

No source specific uncertainty was done for this sector.

#### **5.4.1.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### **5.4.1.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were done in this category.

#### **5.4.1.5. Source-specific planned improvements including those in response to the review process**

Deeper analysis of activity data will be conducted for the following submissions.

### **5.5. Metal Production – NFR 2.C**

In this source category activity data, emission factors and implemented methodology is presented for the following NFR source categories: 2.C.1, 2.C.2, 2.C.3, 2.C.5, 2.C.6 and 2.C.7.c. According to Stage 3 review recommendation the NFR category 2C7d Storage, handling, and transport of metal products on p. 4, in the Tier 1 default approach, the dust emissions from storage, handling and transport of metal products are covered by the respective technical chapters. Consequently, the default emission factors are 'included elsewhere' (IE). The Notation key has been changed in accordance with the recommendation given.

#### **5.5.1. Iron and steel production – NFR 2.C.1**

In the nineties in Republic of North Macedonia there was one integrated steel plant for iron and steel where primary iron and steel was produced, as well as ingots using hot and cold rolling mills.

Due to the disintegration of Former Yugoslavia, and North Macedonia becoming an independent country, this factory has disintegrated over the years to several smaller installations with different ownership. Currently in Republic of North Macedonia, three installations have this type of production. The first one, Makstil AD Skopje, which has two units, first for steel production uses an electric arc furnace (EAF) with installed BAT (Best Available Techniques), namely fabric filter unit, since 2016, and second for producing ingots using hot rolling mills also with installed BAT and use of natural gas as a fuel. The second installation, ArcelorMittal – renamed Liberty from 2018 due to new ownership produces only ingots using cold rolling mill with BAT as well and uses natural gas as a fuel. The calculation for the period 1990-2015 is made using Tier 1, and for the period 2016-2023 using Tier 2 because since 2016 all units (electric arc furnace, hot rolling mills and cold rolling mills) in the installations are using BAT. The third one is Dojran Stil which have hot rolling mill with BAT in the period of 2008-2023 using Tier 2.

##### **5.5.1.1. Methodological Issues**

##### **Activity Data**

Activity data for the reporting period 1990-2004 have been taken from the statistical yearbooks chapter Industry [22], and for the period 2005-2015 from the publications Industry in the Republic of North Macedonia [28]. Activity data for the period of 2016-2023 are taken directly from one installation mentioned above, Makstil AD Skopje, and the activity data for cold rolling mill from period

2016-2023 are taken from Makstat database, chapter Industry. Activity data for Dojran Stil are taken directly from the installation. The activity data have variable trend due to fluctuant as market prices as well as change of the ownerships of the companies.

**Table 115 Activity data for source category 2.C.1 - Iron and steel production**

Year	Products [t]	Year	Products [t]
1990	885 015	2007	982 650
1991	755 634	2008	862 779
1992	548 462	2009	781 053
1993	353 822	2010	823 012
1994	140 045	2011	927 150
1995	83 407	2012	623 642
1996	128 117	2013	407 027
1997	230 274	2014	543 608
1998	347 846	2015	512 568
1999	237 409	2016	670 386
2000	437 934	2017	798 429
2001	583 379	2018	834 408
2002	960 178	2019	774 692
2003	760 538	2020	670 459
2004	833 328	2021	870 224
2005	807 782	2022	792 329
2006	905 272	2023	823 759

**Table 116 Activity data for steel and hot and cold ingots production in the period of 2016-2023**

Year	Name of Products	[t]
2016	Liquid steel	173 113
	Hot rolled sheet	274 721
	Cold rolled sheet	156 071
	Dojran Stil	56 907
2017	Liquid steel	277 599
	Hot rolled sheet	310 840
	Cold rolled sheet	157 756
	Dojran Stil	55 453
2018	Liquid steel	272 415
	Hot rolled sheet	309 504
	Cold rolled sheet	153 181
	Dojran Stil	97 086
2019	Liquid steel	247 017
	Hot rolled sheet	303 867
	Cold rolled sheet	142 714

Year	Name of Products	[t]
	Dojran Stil	81 094
2020	Liquid steel	185 330
	Hot rolled sheet	271 463
	Cold rolled sheet	147 623
	Dojran Stil	67 350
2021	Liquid steel	321 453
	Hot rolled sheet	312 659
	Cold rolled sheet	154 549
	Dojran Stil	81 563
2022	Liquid steel	253 468
	Hot rolled sheet	344 311
	Cold rolled sheet	98 593
	Dojran Stil	95 957
2023	Liquid steel	303 979
	Hot rolled sheet	340 847
	Cold rolled sheet	86 858
	Dojran Stil	92 075

### Emission factors

For the estimation of emissions for pollutants, emission factors were taken from GB 2023. Used emission factors are given in the table below.

**Table 117 Emission factors for source category 2.C.1 - Iron and steel production, steel making, electric arc furnace, abated by fabric filter**

Pollutant	Value	Unit	References
NOx	130	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
CO	1.7	kg/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
NMVOC	46	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
SO2	60	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
TSP	30	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
PM10	24	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
PM2.5	21	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
BC	0.36	% of PM2.5	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
Pb	1.5	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
Cd	0.12	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
Hg	0.076	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
As	0.0081	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
Cr	0.105	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
Cu	0.02	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44

Pollutant	Value	Unit	References
Ni	0.41	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
Zn	2.3	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
PCDD/F	3.0	µgI-TEQ/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
PAHs (Total)	0.48	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44
PCBs	2.5	mg/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44

**Table 118 Emission factors for source category 2.C.1 - Iron and steel production, rolling mills, cold rolling mills**

Pollutant	Value	Unit	References
TSP	96	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-21. pg. 46

**Table 119 Emission factors for source category 2.C.1 - Iron and steel production, rolling mills, hot rolling mills**

Pollutant	Value	Unit	References
NMVOG	7	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-22. pg. 46-47
TSP	9	g/Mg steel	GB 2023 2.C.1 Iron and steel production. Table 3-22. pg. 46-47

#### 5.5.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 2%; the emission factor uncertainty was estimated to be 125% for NMVOG and 40% for PM<sub>2.5</sub>, based on expert judgment.

#### 5.5.1.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Source-specific recalculations including changes were made in response to the review process.

#### 5.5.1.4. Source-specific recalculations including changes made in response to the review process

Recalculations were carried out in this category due to changing of the activity data for cold rolling mills for the period 2016-2022.

#### 5.5.1.5. Source-specific planned improvements including those in response to the review process

ERT recommends a calculation of emissions from NFR 2.C.1 for the whole time series since 1990 by using the Guidebook Default Tier 2 methods for EAF steel production, for hot and for cold rolling. Inventory experts did not receive data for the whole time and there will be a need a of expert support for calculation of historical data, therefore this issue will be resolved during the ongoing IPA project in which one of the planned activities is improving of the air emission inventory.

### 5.5.2. Ferroalloy's production – NFR 2.C.2.

Ferroalloys are master alloys containing iron and one or more non-ferrous metals as alloying elements. The ferroalloys are usually classified in two groups: bulk ferroalloys and special ferroalloys. Bulk ferroalloys are used in steel production and steel, or iron foundries exclusively, while the use of special ferroalloys is far more versatile.

Depending on the raw material that is used (primary or secondary raw material), the production of ferroalloys can be carried out as a primary or secondary process.

In the Country, there are three major installations for production of ferroalloys: ferrosilicon, ferronickel, and ferrosilicon manganese. The installation “Skopski Leguri” produces ferrosilicon manganese and was operational in the period 2007 – 2012. “Jugohrom ALZAR DOOEL” produces ferrosilicon and EURONIKEL (FENI) INDUSTRY produces ferronickel.

“Jugohrom ALZAR DOOEL” is one of the biggest industrial polluters in Republic of North Macedonia. The installation has an IPPC environmental permit with adjustment plan, according to which the installation was supposed to install a filter facility for all electric furnaces until 01 April 2014. This deadline given by the Government of Republic of North Macedonia was postponed until October 2016. The second deadline has not been reached either, and that was the reason why the State Environmental Inspectorate closed the installation for a period of 6 months, in November 2016, with an approval of the Ministry of environment and physical planning. The installation remains closed until the requirement for installation of filter facility is not fulfilled. In the period 2017-2023, there was no ferroalloys production from this installation since the operator did not install the necessary filter.

FENI Industry is one of the biggest installations in the sector Ferroalloys Production (ferronickel production). In the period 2012-2013 this installation installed ESF (electrostatic filter) in 2 (two) biggest emission points (rotary kilns). The installation has scrubbers for reduction of emission gases from 2 electric furnaces, and thus fulfills the requirements given in the IPPC environmental permit. This installation worked with reduced capacity of around 40% compared to 2015. This installation was under bankruptcy proceedings from 2017. In 2018 this installation received a new owner changed the name in EURONICKEL Industry and started operations again during the reporting year.

This sector significantly contributed to the national total amount of emission of particulates until 2016.

#### 5.5.2.1. Methodological issue

Emissions coming from this sector have been calculated as a sum of ferrosilicon produced, multiplied with implied emission factors, and ferronickel and ferrosilicon manganese produced, multiplied with emission factors taken from GB 2019.

#### Activity Data

The activity data for ferrosilicon production has been taken from the Statistical yearbooks - chapter Industry, Energy and Construction for period 1990-2004[22], and publication Industry in the Republic of Macedonia for the period 2005–2015[28]. Emission measurements for TSP were considered for the following years 2012, 2013, 2014 and 2016.

Measurement data for TSP for the period 2005-2017 was reported by the operator FENI. Activity data for the period 2018-2023 for ferroalloys production are taken directly from the installation with new ownership EURONICKEL INDUSTRY.

**Table 120 Activity data for the source category 2.C.2 - Ferroalloy production**

Year	Total Alloy produced [t]	Year	Total Alloy produced [t]
1990	85 148	2007	175 719
1991	77 442	2008	170 252
1992	107 866	2009	60 458
1993	78 357	2010	133 347

Year	Total Alloy produced [t]	Year	Total Alloy produced [t]
1994	72 134	2011	184 310
1995	72 735	2012	146 970
1996	92 638	2013	165 803
1997	85 908	2014	163 489
1998	106 661	2015	130 970
1999	78 009	2016	69 455
2000	58 520	2017	34 558
2001	8 779	2018	51 831
2002	15 085	2019	78 959
2003	67 283	2020	82 870
2004	83 160	2021	73 884
2005	106 590	2022	38 651
2006	108 920	2023	11 819

The dips in the ferroalloys production activity data in 2001 of 85% and in 2009 of 64% and a jump in 2004 of 346% (approx. 4.5 times) and in 2010 of 121% (approx. 4.2 times), are due to several reasons for the fluctuation in the trend of ferroalloys production activity: the dip in 2001 was due to national war in Macedonia, in 2009 due to the economy crisis, and that also the two main companies have changed ownerships over the years and that this has influenced production.

### Emission factors

For calculation of PM2.5, PM10 and TSP from 1990 to 2011 as well as 2015 coming from ferronickel and ferrosilicon manganese production, GB 2023 emission factors have been used.

**Table 121 Emission factors for source category 2.C.2 - Ferroalloys production – production of ferronickel for historical data**

Pollutant	Value	Unit	References
PM10	850	g/Mg alloy produced	GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7
PM2.5	600	g/Mg alloy produced	GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7
TSP	1000	g/Mg alloy produced	GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7
BC	10	% PM2.5	GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7

For the estimation of emissions coming from the ferrosilicon production, due to the huge difference of the calculated emissions with the use of EF and emission measurements data, as well as no implementation of BAT in this installation, implied EF for TSP has been used, while EF for PM10 and PM2.5 have been calculated as 0.85 and 0.60 of TSP Emission factor value. These emission factors are presented in the following table.



**Table 122 Implied emission factors for 2.C.2 Ferroalloys production – production of ferrosilicon for historical data**

Pollutant	Value	Unit
PM10	244.8	kg/Mg alloy produced
PM2.5	172.8	kg/Mg alloy produced
TSP	288	kg/Mg alloy produced

#### **Emission measurements**

For the period 2012-2014, TSP emission measurements coming from ferrosilicon production were taken into account, while PM10 and PM2.5 emissions coming from this installation were calculated using the emission factors presented in the Table 128 above. For 2015, since no measurements were delivered by the company, TSP, PM10 and PM2.5 emissions coming from ferrosilicon production were calculated using the emission factors presented in Table 129. For 2016, measurement data for TSP emissions as well as, activity data for ferrosilicon produced was made available by the operator. The emissions of PM10 and PM2.5 were calculated using the values using proportions (0.85% and 0,60% of TSP emissions factor value). The installation did not operate since 2016 therefore there no measurements since that year. For ferronickel emission discontinuous measurements (four per year) for TSP were available for the period 2005-2023. These measurements were used to calculate the yearly emissions.

#### **5.5.2.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment. The inconsistency of the time-series may appear, considering that for the historical data implied emission factors was used, whereas for the period 2012-2014 measurement data was used.

#### **5.5.2.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR. The data received in form of an excel template aligned with the national legislation are checked for consistency by MEPP. Concerning jumps, dips or lack of emission data, the operator is contacted with official letter, and asked for the reasons behind the jumps and deeps of the measured emission or lack of required data. Mainly the jumps and deeps in this category are caused by the unstable operation of these installations and frequent change of ownership.

#### **5.5.2.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were carried out in this category.

#### **5.5.2.5. Source-specific planned improvements including those in response to the review process**

No improvements are planned in this category.

### **5.5.3. Aluminum production – NFR 2.C.3**

Primary aluminum is produced by means of electrolytic reduction of alumina. This chapter covers the complete process of primary aluminum production, from the production of alumina from bauxite to the shipment of the aluminum from the facilities. The secondary aluminum production covers the

whole process, starting from the melting of scrap. In Republic of North Macedonia, there is no primary aluminum production.

### 5.5.3.1. Methodological Issues

#### Activity Data

The activity data were taken from the Statistical Yearbooks 1990-2020 and for the period 2007-2019 from the installation for secondary aluminum production named RZ Institute Skopje. For the period 2020 and 2022 there is no activity data from RZ Institute Skopje because this installation has gone bankrupt. Type of activity data used for emission estimation is presented in the following list.

<b>1990 – 1998</b>	Pressed aluminum products and aluminum alloy products
<b>1999 – 2005</b>	Aluminum and aluminum alloys
<b>2005 – 2006</b>	Sum of unwrought aluminum, alloyed in ingot Aluminum alloyed bars, rods, profiles Aluminum tubes and pipes, non-alloyed
<b>2007-2019</b>	Aluminum alloys, in ingots, SSO RZ Institute secondary aluminum production
<b>2020</b>	Aluminum alloys, in ingots, SSO

**Table 123 Activity data for source category 2.C.3 - Aluminum production**

Year	Aluminum and aluminum products [t]	Year	Aluminum and aluminum products [t]
1990	8 841	2007	1 757
1991	7 829	2008	1 531
1992	5 150	2009	1 637
1993	4 819	2010	1 897
1994	4 991	2011	2 079
1995	3 709	2012	1 870
1996	3 924	2013	1 245
1997	5 561	2014	812
1998	5 850	2015	161
1999	10 777	2016	122
2000	7 641	2017	382
2001	6 809	2018	278
2002	10 516	2019	857
2003	8 573	2020	NE
2004	1 679	2021	NE
2005	1 489	2022	NE
2006	2 316	2023	NE

Noted jumps in the activity data of secondary aluminium production in 1999 of 84% and in 2002 of 54% and a dip in 2004 of 80%, by ERT are due to the changes in production capacity, and that the major company was closed in March 2004.

### **Emission factors**

The emission factors used in this source category are presented in the following table.

**Table 124 Emission factors for source category 2.C.3 - Secondary Aluminum production**

Pollutant	Value	Unit	References
TSP	2	kg/Mg aluminum	GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PM10	1.4	kg/Mg aluminum	GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PM2.5	0.55	kg/Mg aluminum	GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
BC	2.3	% of PM2.5	GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PCDD/F	35	µgI-TEQ/Mg aluminum	GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
HCB	5	g/Mg aluminum	GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15

#### **5.5.3.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 2%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

#### **5.5.3.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### **5.5.3.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were done in this sector.

#### **5.5.3.5. Source-specific planned improvements including those in response to the review process**

No planned improvements in this category.

### **5.5.4. Lead production – NFR 2.C.5**

This subchapter presents information on atmospheric emissions during primary and secondary lead production. The primary lead production in the country was conducted in the smelter company in the town of Veles, which ceased operations in 2003.

#### **5.5.4.1. Methodological issues**

To estimate (calculate) emissions from lead production, the general equation has been adopted:

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

where:

$E_{\text{pollutant}}$  = the emission of a specified pollutant

$AR_{\text{production}}$  = the annual lead production

$EF_{\text{pollutant}}$  = is the emission factor of this pollutant

### Activity data

Statistical data for production of crude lead were taken as primary lead production and the production of refined lead as secondary production.

**Table 125 Activity data for source category 2.C.5 - Lead production**

Year	Lead, Primary (t)	Lead, Secondary (t)	Year	Lead, Primary (t)	Lead, Secondary (t)
1990	28 585*	21 858*	2007	NO	18*****
1991	33 938*	19 265*	2008	NO	21*****
1992	27 860*	23 341*	2009	NO	39*****
1993	23 575*	21 881*	2010	NO	NE
1994	20 569*	20 965*	2011	NO	NE
1995	24 007*	22 490*	2012	NO	NE
1996	29 259*	23 584*	2013	NO	NE
1997	30 508*	26 046*	2014	NO	NE
1998	29 242*	28 415*	2015	NO	2 648
1999	27 086*	19 738*	2016	NO	4 472
2000	19 000**	17 137***	2017	NO	7 486
2001	19 000**	13 543***	2018	NO	10 576
2002	19 000**	11 934****	2019	NO	10 962
2003	19 000**	6 357****	2020	NO	10 339
2004	NO	3 591****	2021	NO	10 339
2005	NO	34*****	2022	NO	11 747
2006	NO	46*****	2023	NO	56 041

### List of data source:

\*Statistical yearbooks- Crude Lead (=Primary Lead) and Refined Lead (=Secondary Lead)\*\*[http://minerals.usgs.gov/minerals/pubs/commodity/lead/lead\\_myb03.pdf](http://minerals.usgs.gov/minerals/pubs/commodity/lead/lead_myb03.pdf)

\*\*\*\*<http://www.bgs.ac.uk/mineralsuk/statistics/europeanStatistics.html>

\*\*\*\*Statistical yearbooks - Regenerated secondary raw materials of lead and lead alloys

### Emission factors

Emission factors for primary lead production and secondary lead production are taken from GB 2023. These emission factors are presented in the following two tables.

**Table 126 Emission factors for source category 2.C.5 - Primary Lead production**

Pollutant	Value	Unit	References
TSP	560	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
PM10	450	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14

Pollutant	Value	Unit	References
PM2.5	225	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
Pb	150	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
Cd	0.8	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
Hg	1	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
As	0.18	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
PCDD/F	5	µg I-TEQ/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14
PCBs	1.9	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14

**Table 127 Emission factors for source category 2.C.5 – Secondary Lead production 1990-2009**

Pollutant	Value	Unit	References
TSP	14 800	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
PM10	11 800	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
PM2.5	8 800	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
Pb	5 800	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
Cd	15	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
As	47	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
Zn	35	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
PCDD/F	8	µg I-TEQ/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16
PCBs	3.2	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16

**Table 128 Emission factors for source category 2.C.5 - Secondary Lead production for 2010-2023**

Pollutant	Value	Unit	References
TSP	20	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
PM10	16	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
PM2.5	8	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17

Pollutant	Value	Unit	References
SOx	5000	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
Pb	1.1	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
Cd	0.05	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
As	0.3	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
Zn	0.05	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
PCBs	2.6	g/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17
PCDD/F	3.2	µg I-TEQ/Mg lead	GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17

#### 5.5.4.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

#### 5.5.4.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.5.4.4. Source-specific recalculations including changes made in response to the review process

No recalculations were carried out in this category.

#### 5.5.4.5. Source-specific planned improvements including those in response to the review process

Activity data for the whole reference period were received from the GHG emission inventory team and will be crosschecked with data used in this inventory in the frame of expert mission in the frame of IPA II air quality project.

#### 5.5.5. Zinc production—NFR 2.C.6

Zinc is produced from various primary and secondary raw materials. Primary zinc is produced from ores, which contain 85% zinc sulfide (by weight) and 8–10% iron sulfide, with the total zinc concentration about 50%. A secondary zinc smelter is defined as: any plant or factory in which zinc-bearing scrap or zinc-bearing materials, other than zinc-bearing concentrates (ores) derived from a mining operation, are processed. In practice, primary smelters often also use zinc scrap or recycled dust as input material. The primary zinc production in the country was conducted in the smelter company in town of Veles, which ceased operation in 2003.

### 5.5.5.1. Methodological Issues

#### Activity Data

The activity data has been taken from the Statistical yearbook – chapter Industry, energy and construction for the period 1990-2023\*, as well as from the following website [http://minerals.usgs.gov/minerals/pubs/commodity/zinc/zinc\\_myb05.pdf](http://minerals.usgs.gov/minerals/pubs/commodity/zinc/zinc_myb05.pdf)\*\*[30]. In the statistical publications, the activity data for the Primary Zinc production were defined as Crude Zinc and for Secondary Zinc production as Refined Zinc.

**Table 129 Activity data for source category 2.C.6 - Zinc production**

Year	Primary Zinc (t)	Secondary zinc (t)
1990	56 734*	17 383*
1991	56 081*	17 244*
1992	52 728*	14 526*
1993	51 931*	3 315*
1994	41 984*	4 532*
1995	44 081*	34 526*
1996	59 416*	37 853*
1997	59 693*	3 116*
1998	58 865*	8 594*
1999	53 304*	4 017*
2000	52000**	NO
2001	52 000**	NO
2002	56 000**	NO
2003	28 000**	NO
2004	25 000**	NO
2005	NO	NO
2006	NO	NO
2007	NO	NO
2008	NO	NO
2009	NO	NO
2010	NO	NO
2011	NO	NO
2012	NO	NO
2013	NO	NO
2014	NO	NO
2015	NO	NO
2016	NO	NO
2017	NO	NO
2018	NO	NO
2019	NO	NO
2020	NO	NO
2021	NO	NO
2022	NO	NO
2023	NO	NO

#### Emission factors

Emission factors for primary lead production and secondary zinc production were taken from GB 2023. These emission factors are presented in the following two tables.

**Table 130 Emission factors for source category 2.C.6 - Primary Zinc production**

Pollutant	Value	Unit	References
TSP	210	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
PM10	170	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
PM2.5	130	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
Pb	35	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
Cd	5	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
Hg	5	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
Zn	80	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
PCBs	0.9	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15
PCDD/F	5	µg I-TEQ/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15

**Table 131 Emission factors for source category 2.C.6 - Secondary Zinc production**

Pollutant	Value	Unit	References
TSP	425	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
PM10	340	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
PM2.5	255	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
Pb	65	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
Cd	35	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
Hg	0.006	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
As	5.9	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
Zn	150	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
PCBs	0.0031	g/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17
PCDD/F	100	µg I-TEQ/Mg zinc	GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17

**5.5.5.2. Source-specific uncertainties and time-series consistency**

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

**5.5.5.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

**5.5.5.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were carried out in this category.

**5.5.5.5. Source-specific planned improvements including those in response to the review process**

No improvements are planned in this category.

**5.5.6. Copper production –NFR 2.C.7 a**

Copper is produced from primary and secondary raw materials.



Primary copper is produced from concentrates produced from copper ores. The pyro-metallurgical copper production route entails a number of steps, depending on the concentrate used. The majority of concentrates are sulfides and the stages involved are roasting, smelting, converting, refining and electro-refining. Concentrates usually contain 20–30% Cu. In roasting, charge material of copper mixed with a siliceous flux is heated in air to about 650 °C, eliminating 20–50% of Sulfur and portions of volatile trace elements. The roasted product, calcine, serves as a dried and heated charge for the smelting furnace.

In Republic of North Macedonia there is a primary production of copper with pampering of copper ores for obtaining cathode copper.

A secondary copper smelter is defined as any plant or factory in which copper-bearing scrap or copper-bearing materials, other than copper-bearing concentrates (ores) derived from a mining operation, is processed by metallurgical or chemical process into refined copper and copper powder (a premium product).

In Republic of North Macedonia, it was a secondary production of copper in the factory RZ Institut Skopje in the period 2007-2019. In 2020 there is no activity data from this installation because it has gone bankrupt. The emissions are presented as NE because that company was working during 2020, however we could not gather the needed information due to their bankruptcy and lost of contact with the installation representatives.

#### 5.5.6.1. Methodological Issues

##### Activity Data

Activity data is available for secondary copper production (from the installation that has that production), for the period 2007-2019. No production is occurring during period 2020-2023.

**Table 132 Activity data for source category 2.C.7 a - Copper production**

Year	Primary copper (t)	Secondary copper (t)
1990	NO	NO
1991	NO	NO
1992	NO	NO
1993	NO	NO
1994	NO	NO
1995	NO	NO
1996	NO	NO
1997	NO	NO
1998	NO	NO
1999	NO	NO
2000	NO	NO
2001	NO	NO
2002	NO	NO
2003	NO	NO
2004	NO	NO
2005	NO	NO
2006	NO	NO
2007	NO	7
2008	NO	32
2009	NO	58

Year	Primary copper (t)	Secondary copper (t)
2010	NO	50
2011	NO	32
2012	NO	62
2013	NO	103
2014	NO	93
2015	NO	58
2016	NO	46
2017	NO	23
2018	NO	11
2019	NO	13
2020	NO	NE
2021	NO	NE
2022	NO	NE
2023	NO	NE

### Emission factors

Emission factors for secondary copper production are taken from GB 2023. These emission factors are presented in the following table.

**Table 133 Emission factors for source category 2.C.6 - Secondary Copper production**

Pollutant	Value	Unit	References
TSP	320	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PM10	250	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PM2.5	190	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
BC	0.1	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
SOx	1 320	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Pb	24	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Cd	2.3	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
As	2	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Cu	28	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Ni	0.13	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PCBs	3.7	g/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PCDD/F	50	µg I-TEQ/Mg copper	GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13

#### 5.5.6.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

#### 5.5.6.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.5.6.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done for this NFR category.

#### 5.5.6.5. Source-specific planned improvements including those in response to the review process

It is planned in this category to make control on the activity data from copper production in Republic of North Macedonia that is covered with primary or secondary copper production given in EMEP/EEA air pollutant emission inventory guidebook 2019, 2.C.7.a Copper production. This is planned to be carried out within the forthcoming technical project IPA II in the frame of activities which refer to improving of emission inventory.

#### 5.5.7. Other metal production – NFR 2.C.7.c

This category covers silver production in the reporting period 1990-1998.

##### 5.5.7.1. Methodological issues

Tier 1 method was used for calculation of emissions in this source category. This activity does not occur after the year 1998.

#### Activity Data

Activity data for this source category are taken from the Statistical yearbooks for the period 1990-1998.

**Table 134 Activity data for source category 2.C.7.c – Other Metals production**

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Silver produced [t]	15	19	16	9	13	13	21	28	32

#### Emission factors

The emission factor on TSP has been taken from GB 2013.

**Table 135 Emission factors for 2.C.7.c - Other Metals production**

Pollutant	Value	Unit	References
TSP	0.8	g/Mg metal produced	GB 2013 2.C.7.c Other metal production, Table 3.1, pg. 5

##### 5.5.7.2. Source-specific uncertainties and time-series consistency

This category includes TSP emissions only. Uncertainties have not yet been estimated for TSP emissions since this activity is not occurring since 1998.

##### 5.5.7.3. Source-specific QA/QC and verification

No QA/QC procedures were carried out for this source category since it is no longer occurring in the Republic of North Macedonia.

##### 5.5.7.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

##### 5.5.7.5. Source-specific planned improvements including those in response to the review process

Activity data for the whole reference period were received from GHG emission inventory team and will be crosschecked with data used in this inventory in the frame of expert mission in the frame of IPA II air quality project.

## 5.6. Other products and solvents used – NFR 2.D

In this source category activity data, emission factors and implemented methodology are presented for the following NFR source categories: 2.D.3, 2.D.3.b, 2.D.3.c, 2.D.3.d, 2.D.3.e, 2.D.3.f, 2.D.3.g, 2.D.3.h, 2.G, 2.H.1, 2.H.2 and 2.I.

### 5.6.1. Domestic solvent use including fungicides NFR 2.D.3.a

This category covers the use of fungicides in agriculture. The share of NMVOC emissions from this category of total NMVOC emissions in 2023 was 1.3%.

#### 5.6.1.1. Methodological issues

The Tier 1 method has been applied for period 1990-2004. This method assumes an averaged or typical technology and abatement implementation in the country and includes an integrated emission factor and emission factors for sub-processes within the source category. It is applied at a national level, using the population data. Tier 2 method was applied for the period 2005-2023 due to available activity data in the SSO publications. During the stage 3 review the ERT recommended the Party to move to the Tier 2 method for the next submission or as soon as possible or meanwhile to include this improvement into the improvement plan with clear steps and schedule and to report on progress of the work in the next submissions. Therefore, in this category according to the recommendation available data from production and import – export was gathered. Calculated activity data (production+import)-export were used for calculation of emissions coming from Cosmetics and toiletries (Perfume or room deodorizers, Toilet waters, Hair sprays) Shaving lotions, before shaving and after shaving, Other body care cosmetics - lotions, creams, including baby care products Soaps and other body cosmetics;) Car care products (antifriz); Households products (Washing and cleaning products for machine for hands wash, Pastes, powders and other cleaning preparations and Policies, creams and similar preparations for the maintenance of woodwork) and pesticides (Insecticides, rodenticides, fungicides, herbicides). In case of pharmaceutical products, the population was used as activity data.

#### Activity Data

**Table 136 Activity data for source category 2.D.3.a - Domestic solvent use including fungicides for different products and product types for period 1990-2004 using Tier 1 methodology**

Year	Population number
1990	2 028 000
1991	2 033 964
1992	2 056 000
1993	2 066 000
1994	1 957 265
1995	1 974 800
1996	1 991 398
1997	2 002 340
1998	2 012 705
1999	2 021 578
2000	2 038 651
2001	2 023 654
2002	2 029 892
2003	2 035 196
2004	2 038 514

**Table 137 Activity data for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types for period 2005-2023 using Tier 2 methodology**

Year	Cosmetics and toiletries (all)[kg]	Car care products (all) [kg]	Households' products (all) [kg]	Pesticides [kg]	Population
2005	2976576	NE	17540231	2285000	2038514
2006	7130576	NE	12664627	2285000	2041941
2007	8787562	33000	19415000	2318000	2045177
2008	7357406	7000	24636000	2768000	2048619
2009	6069440	34000	22674000	1522000	2052722
2010	11875502	204000	26796000	1648000	2057284
2011	10143673	18000	26796000	2378000	2059794
2012	7860433	1650553	31701757	1841549	2062294
2013	8016920	1415169	31357189	1867702	2065769
2014	8748658	1542853	32139836	1991441	2069172
2015	9294805	1720015	34439775	2053650	2071278
2016	9204934	1971099	35923836	1991441	2073702
2017	9508722	2283249	36668778	2146356	2075301
2018	10222125	2014718	39191712	1862376	2077132
2019	10377830	2527605	38717511	1969119	2076255
2020	10955857	2010092	40304000	2394361	2068808
2021	9861861	1873117	36845148	2372857	1837713
2022	8788029	1979074	36432703	1732368	1836714
2023	9453509	2259178	39994685	1799547	1826247

### Emission factors

The emission factors for calculation of NMVOC emissions for both methodologies coming from this sector are presented in the following table.

**Table 144 Emission factors for the source category 2.D.3.a - Domestic solvents use including fungicides**

Pollutant	Methodology	Value	Unit		References
NMVOC	Tier 2	127	g/kg product	Cosmetics and toiletries (all)	GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types p.16
NMVOC	Tier 2	180	g/kg product	Car care products (all)	GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16
NMVOC	Tier 2	48	g/person	Pharmaceutical	GB 2023 Table 3.5 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.17

Pollutant	Methodology	Value	Unit		References
NMVOC	Tier 2	16	g/kg product	Households products (all)	GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16
NMVOC	Tier 2	150	g/kg product	Pesticides	GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16
NMVOC	Tier 1	1.2	kg/person/year	Persons	GB 2023 3.D.2 Domestic solvent use including fungicides. Table 3.1, pg. 9

#### 5.6.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty for 2.D was estimated to be 20% according to expert judgment; the emission factor uncertainty was estimated to be 125% (rating C) for NMVOC and 40% (rating B) for PM2.5 based on EMEP Guidebook.

Population number is taken from statistical publications and MAKSTAT database, but there is uncertainty of these activity considering that the population census has been carried out only three times in 1991, 1994 and 2002, while for the other years estimated numbers were used. The use of disinfectants is higher during Covid pandemic, however due to the fact that populations instead of pharmaceutical products is used as activity data this pick is not recognized.

#### 5.6.1.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.6.1.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done during period 2021-2022 due to available activity data on import-export of households' products.

#### 5.6.1.5. Source-specific planned improvements including those in response to the review process

It is planned to replace Tier 1 with Tier 2 methodology also for historical emissions however due to limitation of data this activity will be considered in the frame of IPA II technical project, due to the need to use historical surrogate data since statistical data from that period are not so detailed activity data in the statistics.

### 5.6.2. Road paving with asphalt NFR 2.D.3.b

Asphalt is commonly referred to as bitumen, asphalt cement, asphalt concrete or road oil, and is mainly produced in petroleum refineries. In some countries, the laid mixed product is also referred to as 'asphalt'.

This section covers emissions from asphalt paving operations, as well as subsequent releases from the paved surfaces.

NMVOC emissions and particles are released to the air from this activity and the contribution of this sector in the total NMVOC in 2022 is 0.03% and in TSP is 0.42%. Due to the non-completeness of the

activity data, the emissions of these pollutants and the contribution of this sector in the national total may be underestimated.

#### 5.6.2.1. Methodological issues

To estimate emissions from road paving with asphalt, the following general equation has been applied:

$$E_{\text{pollutant}} = \sum AR_{\text{production}} \times EF_{\text{pollutnat}}$$

where:

$E_{\text{pollutant}}$  = the emission of the specified pollutant,

$AR_{\text{production}}$  = the activity rate (data) for the road paving with asphalt,

$EF_{\text{pollutant}}$  = the emission factor for this pollutant.

#### Activity data

The operators themselves have gathered activity data. Data from several asphalt production companies in 2016 delivered data on produced asphalt. For the period 2010-2023, activity data are taken from Statistical yearbook – Chapter Construction [22]. Summarized data on national asphalt using were used as activity data for estimation of emissions in this sector. The activity data for this sector may be underestimated, especially for the historical years, due to incomplete statistical data on asphalt production and using, as well as change of ownership and close of some of the asphalt production companies. The activity data are presented in the following table.

**Table 138 Activity data for source category 2.D.3.b - Road paving with asphalt**

Year	Asphalt produced (t)	Year	Asphalt produced or used (t)
1990	86 320	2007	101 508
1991	74 296	2008	170 049
1992	44 067	2009	232 001
1993	65 194	2010	286 728
1994	84 729	2011	230 107
1995	87 814	2012	259 388
1996	98 545	2013	317 300
1997	53 600	2014	372 099
1998	101 563	2015	386 451
1999	136 540	2016	342 672
2000	327 937	2017	461 664
2001	137 305	2018	527 798
2002	119 651	2019	522 926
2003	124 492	2020	565 780
2004	149 323	2021	563 440
2005	180 559	2022	540 391

Year	Asphalt produced (t)	Year	Asphalt produced or used (t)
2006	130 847	2023	560 991

ERT noted a jump in all emissions in 2000 of 145% (approx. by 2.4 times) in road paving with asphalt. To a question on the issue North Macedonia answered that in the statistics the length of roads is the highest in 2000.

### **Emission factors**

Emission factors for estimation of emissions in this source category are presented in the following table. Until 2015 the installations for asphalt production had A-permit with adjustment plan and from that year they build fabric filters with abatement efficiency of 99 %. Due to fact that these types of installations have installed abatement technology started from 2015, a new methodology for calculation of TSP, PM10 and PM2.5 emissions was used.

**Table 139 Emission factors for source category 2.D.3.b - Road paving with asphalt**

Pollutant	Value	Unit	References
NMVOC	16	g/Mg asphalt	GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
TSP	14 000	g/Mg asphalt	GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
PM10	3 000	g/Mg asphalt	GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
PM2.5	400	g/Mg asphalt	GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
BC	5.7	% PM2.5	GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9

### **5.6.2.2. Source-specific uncertainties and time-series consistency**

The inconsistency of the emissions in this sector comes from the fact that incomplete statistical data on asphalt production, as well as change of ownership and closedown of some of the asphalt production companies. No specific uncertainty analysis was done for this category.

### **5.6.2.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

### **5.6.2.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were made in this category for this category.

### **5.6.2.5. Source-specific planned improvements including those in response to the review process**

No planned improvements in this category.

## **5.6.3. Asphalt roofing NFR 2.D.3.c**

The source category covers emissions from the asphalt roofing industry. The industry manufactures saturated felt, roofing and siding shingles, and roll roofing and sidings. Most of these products are used in roofing and other building applications. Asphalt roofing contributes to NMVOC emissions by a share of 0.01% in 2023.

### **5.6.3.1. Methodological issues**

To estimate (calculate) emissions from the asphalt roofing, the following general equation has been adopted:



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

where:

$E_{pollutant}$  = the emission of the specified pollutant,

$AR_{production}$  = the activity rate (data) for the asphalt roofing,

$EF_{pollutant}$  = the emission factor for this pollutant.

### Activity Data

For the period 1990-1999 activity data have been taken from the Statistical Yearbooks – chapter Industry, Energy and Construction [22]. For the period 2005-2023, revised activity data for period 2007-2014, were taken from MAKSTAT database [29], while due to the lack of data for the period 2002-2004 the gap filling interpolation method has been used.

The activity data for this source category is presented in the following table.

**Table 140 Activity data for source category 2.D.3.c - Asphalt roofing**

Year	Asphalt roofing products (t)	Year	Asphalt roofing products (t)
1990	12 572	2007	12 164
1991	12 593	2008	14 401
1992	5 325	2009	18 783
1993	4 067	2010	14 908
1994	5 901	2011	25 145
1995	8 873	2012	17 727
1996	5 992	2013	13 676
1997	6 442	2014	6 814
1998	5 489	2015	10 146
1999	13 429	2016	14 402
2000*	13 075	2017	15 183
2001*	12 525	2018	17 114
2002*	12 104	2019	15 699
2003*	11 668	2020	15 175
2004*	12 458	2021	18 119
2005	11 305	2022	17 563
2006	9 773	2023	18 879

\*based on extrapolation

Due to a change of methodology in the collection of statistical data over the years, the list of different type of data collected in 1990-1999 and 2005-2023 are presented below. Data for the years 2000-2005 are not covered by the statistics but are calculated by use of interpolation.

### Type of data available in the national statistics for 1990-1999 and 2005-2020 in tons

**1990 – 1999** Roof patch, Bitumen paper and jute;

**2005 – 2023**

Bituminous products for building;

Roofing or waterproofing felts of roofing cardboard based on bitumen in rolls;

Roofing or waterproofing felts of metal foil based on bitumen in rolls;

Bituminous paper in rolls;

Bituminous bands of glass wave in rolls;

Bituminous plastic bands in rolls;

Bituminous emulsions;

Tar or other bituminous materials;

Other bituminous mixtures based on natural asphalt, bitumen and other (ex. bitumen whale).

### **Emission factors**

Emission factors used for this source category are presented in the following table:

**Table 141 Emission factors for source category 2.D.3.c - Road paving with asphalt**

Pollutant	Value	Unit	References
CO	9.5	g/Mg shingle	GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
NMVOC	130	g/Mg shingle	GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
TSP	1 600	g/Mg shingle	GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
PM10	400	g/Mg shingle	GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
PM2.5	80	g/Mg shingle	GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
BC	0.013	% PM2.5	GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7

#### **5.6.3.2. Source-specific uncertainties and time-series consistency**

No specific uncertainty analysis was done for this category. The inconsistency in this sector is due to use of different sources for the activity data in different period.

#### **5.6.3.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### **5.6.3.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were done in this category.

#### **5.6.3.5. Source-specific planned improvements including those in response to the review process**

No planned improvements in this category.

#### **5.6.4. Coating application – NFR 2.D.3.d**

Coating applications in North Macedonia include emissions from quantity of paint applied in the industrial applications, other industrial applications and domestic application and this category is source of NMVOC emissions.

### Methodological Issues

The methodology of the estimation of emissions in this sector was done using Croatian methodology represented in The Republic of Croatia Informative Inventory Report, 2012 [42]. Namely, according to this methodology sectors Industrial application and Decorative application contribute in paints consumption with equal weighting as sector-Other industrial application. Considering the previously mentioned, the application of paint in the industry present about 33% of the paint produced in North Macedonia, and the same proportion was allocated the two other sectors. As a result, each sub-sector contributes with 33.3% to the total application of paint. At the end, the total amount of the paint produced in North Macedonia was distributed by the present methodology and resulting amounts of paint in each sub-sector were multiplied by the recommended FE (NMVOC) from the EMEP / EEA Guidebook – 2023.

### Activity data

The quantity of paint produced in the period 2005-2015 is taken from the publications Industry in the Republic of North Macedonia [28], for the period 2016-2023 data were taken from the MAKSTAT database [29], and the data for the imported-exported paints are taken from the publication External trade in the Republic of North Macedonia for the period 2006-2015 [31]. For the years 2016-2022, the data on the quantities of imported and exported paint was taken from MAKSTAT database [31].

**Table 142 Activity data for source category 2.D.3.d - Coating application**

Year	Industrial application	Decorative application	Other industrial application
	Paint [kg]	Paint [kg]	Paint [kg]
1990	5.039.128	5.039.128	5.039.128
1991	4.595.330	4.595.330	4.595.330
1992	4.309.611	4.309.611	4.309.611
1993	4.044.373	4.044.373	4.044.373
1994	3.671.095	3.671.095	3.671.095
1995	3.416.632	3.416.632	3.416.632
1996	3.608.965	3.608.965	3.608.965
1997	3.687.358	3.687.358	3.687.358
1998	3.771.334	3.771.334	3.771.334
1999	3.651.404	3.651.404	3.651.404
2000	3.739.061	3.739.061	3.739.061
2001	3.745.437	3.745.437	3.745.437
2002	3.728.881	3.728.881	3.728.881
2003	3.800.742	3.800.742	3.800.742
2004	3.683.217	3.683.217	3.683.217
2005	2.022.667	2.022.667	2.022.667
2006	3.388.000	3.388.000	3.388.000
2007	3.555.000	3.555.000	3.555.000
2008	3.669.667	3.669.667	3.669.667
2009	3.067.333	3.067.333	3.067.333

Year	Industrial application	Decorative application	Other industrial application
	Paint [kg]	Paint [kg]	Paint [kg]
2010	3.458.333	3.458.333	3.458.333
2011	3.797.247	3.797.247	3.797.247
2012	4.567.084	4.567.084	4.567.084
2013	4.419.688	4.419.688	4.419.688
2014	4.273.947	4.273.947	4.273.947
2015	4.411.483	4.411.483	4.411.483
2016	4.121.652	4.121.652	4.121.652
2017	3.577.271	3.577.271	3.577.271
2018	3.362.854	3.362.854	3.362.854
2019	3.503.141	3.503.141	3.503.141
2020	3.315.972	3.315.972	3.315.972
2021	3.512.100	3.512.100	3.512.100
2022	3.436.858	3.436.858	3.436.858
2023	3.727.874	3.727.874	3.727.874

### Emission factors

Emission factors for Tier 1 method from GB 2023 are presented in the following table:

**Table 143 Emission factors for source category 2.D.3.d - Coating application**

Pollutant	Value	Unit	References
NMVOC(Decorative coating application)	150	g/kg paint applied	GB 2023 Table 3-1 Tier 1 emission factors for source category 2.D.3.d Decorative coating application
NMVOC (Industrial coating application)	400	g/kg paint applied	GB 2023 Table 3-2 Tier 1 emission factors for source category 2.D.3.d Industrial coating application
NMVOC (Other coating application)	200	g/kg paint applied	GB 2023 Table 3-3 Tier 1 emission factors for source category 2.D.3.d other coating application

#### 5.6.4.1. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was done for this category.

#### 5.6.4.2. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.6.4.3. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 5.6.4.4. Source-specific planned improvements including those in response to the review process

The National emission inventory team has found activity data in the national statistics on of produced buses and application of paint in contruction. There are no activity data available on wood coating, coil coating, vehicle refinishing, or other non-industrial paint application). National emission inventory

team will make emission calculations with the continue to search available data and improve calculation in this category in 2025 with the support of technical experts from IPA II technical project during July 2025 and will report improvements in the next submission.

#### 5.6.5. Degreasing - NFR 2.D.3.e

Degreasing is a process of cleaning products from water-insoluble substances, such as grease, fats, oils, waxes, carbon deposits, fluxes and tars. In most cases, the process is applied to metal products, but also plastic, fiberglass, printed circuit boards and other products are treated by the same process. The metal-working industries are the major users of solvent degreasing. Industrial metal degreasing with organic solvents takes place in specially designed cleaning equipment. Emission limits required by the Solvents Emissions Directive 1999/13/EC can only be achieved by using hermetically sealed cleaning equipment. This leads to a significant reduction of emissions and increased workplace safety. Metal degreasing takes place in either open-top or closed tanks. The open-top tanks, however, have been phased out in the European Union due to the Solvents Emissions Directive 1999/13/EC. Only small facilities, using not more than 1 or 2 tonnes of solvent per year (depending on the risk profile of the solvent) are still allowed to use open-top tanks. The most common organic solvents for vapour cleaning are: methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL). Degreasing results in NMVOC emission.

##### 5.6.5.1. Methodological issues

or the calculation of NMVOC emissions, the consumption of the most common organic solvents for degreasing was used (according to GB2023). Data on quantities of the most common organic solvents (import / export) for the years 2012 – onward, were taken from the MAKSTAT database. Data on production is not available in the MAKSTAT database. Because the production data are currently unavailable, data on Import of the cleaning products were take as an activity data for the NMVOC calculation. If the data on the production will be available in the future that this data need to be include in the NMVOC emission estimations. The calculation does include the organic solvent Trichlorethylene, Xylol and Dichloromethane. In addition to data from the MAKSTAT database (2012-onward), for the NMVOC emission calculation from this source for the period 1990-2011, expert judgement for the quantities of degreasing products based on GDP were used.

#### Activity Data

The activity data – number of populations for this source category have been updated with revised numbers from MAKSTAT database for the period 1994-2023, while for the period 1990-1993, data from the hard copy publications form SSO was used.

**Table 144 Activity data for the source category 2.D.3.e Degreasing**

Year	Population number	Year	Population number
1990	106364	2007	58477
1991	80393	2008	55499
1992	94292	2009	53907
1993	84416	2010	59787
1994	68965	2011	61351
1995	68410	2012	59897
1996	67671	2013	74960

Year	Population number	Year	Population number
1997	80135	2014	42058
1998	78859	2015	71349
1999	75563	2016	94886
2000	60822	2017	85738
2001	58493	2018	91638
2002	55059	2019	84281
2003	63896	2020	82885
2004	59776	2021	91731
2005	57855	2022	109404
2006	61550	2023	132777

### Emission factors

Emission factor used for the calculation of NMVOC emissions coming from this category is presented below.

**Table 145 Emission factor for source category 2.D.3.e Degreasing**

Pollutant	Value	Unit	References
NMVOC	710	kg/cleaning products	GB 2023 Table 3-2 Tier 2 emission factors for source category 2.D.3.e Degreasing, Open-top degreaser page 10

### 5.6.5.2. Source-specific uncertainties and time-series consistency

An EF by population does not reflect country-specific circumstances, real conditions, and habits of use, and gives increasing emissions when the population grows. In case population is estimated, this brings additional uncertainty to the emission levels

### 5.6.5.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

### 5.6.5.4. Source-specific recalculations including changes made in response to the review process

Recalculations were done for the whole time period due to use of higher Tier 2 methodology.

### 5.6.5.5. Source-specific planned improvements including those in response to the review process

The National emission inventory team has found data of the named solvents for the period 2012-2023 in the MAKSTAT database. Historical data will be searched in the hard copy statistical yearsbook or suitable method for time consistency will be use. Calculation of emissions from available data will be reported in the next submission.

### 5.6.5.6. Dry cleaning – NFR 2.D.3.f

Dry cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres, using organic solvents. In general, dry-cleaning process can be divided into following steps: cleaning in a solvent bath, drying with hot air and recovery of solvent, deodorisation (final drying) and regeneration of used solvent. Dry cleaning results in NMVOC emission.

### Methodological issues

The calculation in this category is based on the volume of solvent use, including chlorinated organic solvents—in this case, tetrachloroethylene (also known as perchloroethylene or PER)—using the Tier 1/2 methodology. Data were obtained from the MAKSTAT database under the import–export section for the period 2012–2023.

For the historical period 1990–2011, where activity data (AD) were missing, a surrogate method was used. The surrogate data were based on the “Industry (including construction), value added (% of GDP)” indicator.

According to the EMEP/EEA Guidebook 2023 (GB2023), tetrachloroethylene is the most commonly used solvent in dry cleaning, accounting for approximately 90% of total solvent consumption. Since no production data are available in the MAKSTAT database, import data on dry cleaning products were used as the activity data for NMVOC emission calculations. If production data become available in the future, they should be incorporated into NMVOC emission estimates. In addition to MAKSTAT data from 2012 onwards, for the period 1990–2011, expert judgment and estimates based on GDP were used to approximate dry cleaning solvent consumption. The method assumes average technology use and abatement implementation at the national level. It includes both integrated emission factors and sub-process-specific factors, and is applied at the national level using population and economic indicators.

### Activity Data

Quantity of the Tetrachloroethylene 'perchloroethylene' for the period 1990-2023 is presented in table 153.

**Table 146 Emission factor for the source category 2.D.3.f- Dry Cleaning**

Year	Perchloroethylene	Year	Perchloroethylene
1990	111187	2007	61128
1991	84038	2008	58016
1992	98567	2009	56351
1993	88243	2010	62498
1994	72092	2011	64132
1995	71512	2012	62613
1996	70740	2013	43218
1997	83769	2014	51400
1998	82434	2015	45544
1999	78989	2016	50300
2000	63580	2017	45052
2001	61145	2018	58347
2002	57555	2019	42782
2003	66794	2020	54038
2004	62487	2021	62866
2005	60478	2022	58080
2006	64341	2023	60083

### Emission factors

The emission factor (EF) for NMVOC from dry cleaning, as presented in GB2023, is given in grams per kilogram of cleaned textiles. It is explained in Section 3.2.1 (Dry Cleaning) of GB2023 that solvent emissions from a closed-circuit dry-cleaning machine—currently the dominant technology—account for slightly more than 40% of solvent input. Open-circuit machines may still exist in small numbers but were largely phased out around the 1990s. Based on this, it is assumed that the EF for dry cleaning is 400 g NMVOC/kg of solvent for all years. This same methodology is also applied in the national inventories of Estonia and Croatia. In the previous submissions EF from Serbian IIR [40], has been used.

Emission factor for the calculation of NMVOC emissions is given below.

**Table 147 Emission factor for the source category 2.D.3.f- Dry Cleaning**

Pollutant	Value	Unit	References
NMVOC	400	kg/solvent/year	Informative Inventory Report for Croatia for 2025 [41]

#### 5.6.5.7. Source-specific uncertainties and time-series consistency

No specific uncertainties for this sector.

#### 5.6.5.8. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.6.5.9. Source-specific recalculations including changes made in response to the review process

Recalculations were done for the whole time series due to use of higher Tier 2 methodology.

#### 5.6.5.10. Source-specific planned improvements including those in response to the review process

No planned improvements.

### 5.6.6. Chemical products – NFR 2.D.3.g

This subchapter covers emissions from:

- polyurethane and polystyrene foam processing;
- asphalt blowing;
- tire production;
- specialty organic chemical industry;
- manufacture of paints, inks and glues;
- fat, edible and non-edible oil extraction;
- Industrial application of adhesives.

Emissions from manufacturing of chemical products include NMVOCs and NH<sub>3</sub>. The chemical production in the country is variable, because after the fall of ex-Yugoslavia, the economy in our country experienced several shocks that damaged the local economy. The economy began to recover in 1995 and recovered only after 2001. This situation influenced the trend series emissions coming from the chemicals production branch.

#### 5.6.6.1. Methodological issues

The following equation from Tier 2 approach has been used for calculating emissions from chemical products:



$$E_{pollutant} = \sum_{tehnologies} AR_{use,tehnology} \times EF_{tehnology,pollutant}$$

Where:

$AR_{use, tehnology}$  = the use of specific chemical products.

$EF_{tehnology, pollutants}$  = the emission factor for this technology and these pollutants.

### Activity Data

The activity data for this source category have been taken from the Statistical yearbook - chapter Industry, energy and construction for the period 1990-2004[22] and publication Industry in the Republic of North Macedonia for the period 2005-2015 [28] as well as MAKSTAT database for 2016-2023 [29]. For this submission historical data for leather tanning were calculated. Since there is no statistical data on raw hid used for the leather tanning in tonnes conversation factors for two period of time were aplide to convert m2 of skins (row hid) into tones. Convesation factor were prepared from the period 2009-2018 wher there is statistical data on leather of bovine animals in tonnes and in m2. For the period 1990-2021, conversion factors of 1,5 tonne/1000m2 was used, and fore the period 2011-2023 conversion factors of 1 tonne/1000m2 was used MAKSTAT for period 2007 – 2023 are the same. The activity data are presented in the following table.

**Table 148 Activity data for source category 2.D.3.g - Chemical products**

Year	Polyester/kg	Polyurethane /kg	Polystyrene /kg	Leather tanning/kg	Paints. Inks and glues/kg	Asphalt blowing/ tones	Rubber Processing/kg and Manufacturing of tyres
1990	16 450 000	NO	NO	11 997 000	NO	12 500	NO
1991	12 440 000	NO	NO	11 3970 00	NO	12 500	NO
1992	11 150 000	NO	364 000	10 797 000	NO	12 500	1 355 000
1993	4 466 000	NO	382 000	10 197 000	NO	12 500	1 145 000
1994	8 628 000	NO	455 000	9 177 000	NO	12 500	978 000
1995	9 904 000	NO	378 500*	10 119 500	NO	12 500	680 500*
1996	3 212 000	NO	302 000	11 062 000	NO	12 500	383 000
1997	3 820 000	NO	363 000	7 491 000	NO	12 500	371 000
1998	2 642 000	NO	547 000	4 908 000	NO	12 500	417 000
1999	NO	NO	NO	3 842 667	NO	12 500	NO
2000	NO	NO	NO	3 310 000	NO	12 500	NO
2001	NO	NO	NO	2 777 333	NO	5 500	NO
2002	NO	NO	NO	2 244 667	NO	5 500	NO
2003	NO	NO	NO	1 712 000	NO	5 500	NO
2004	NO	NO	NO	1 179 333	NO	5 500	NO
2005	NO	1 095 000	NO	646 667	6 068 000	5 500	NO
2006	NO	1 405 000	NO	114 000	5 252 000	5 500	NO
2007	NO	1 129 000	NO	111 000	4 982 000	5 500	NO

Year	Polyester/kg	Polyurethane/kg	Polystyrene/kg	Leather tanning/kg	Paints. Inks and glues/kg	Asphalt blowing/tones	Rubber Processing/kg and Manufacturing of tyres
2008	NO	1 239 000	NO	114 000	4 604 000	5 500	NO
2009	NO	1 132 000	NO	224 000	3 972 000	5 500	NO
2010	NO	1 033 000	NO	278 000	5 407 000	5 500	NO
2011	NO	1 059 000	NO	220 000	2 834 000	5 500	NO
2012	NO	1 221 000	NO	132 000	1 914 000	5 500	NO
2013	NO	1 166 000	NO	119 000	1 306 000	5 500	NO
2014	NO	697 000	NO	98 000	817 000	5 500	NO
2015	NO	NO	NO	112 000	991 000	5 500	NO
2016	NO	896 000	NO	94 000	891 000	2 000	NO
2017	NO	1 633 000	NO	99 000	768 000	2 000	NO
2018	NO	2 429 000	NO	110 000	867 000	2 000	NO
2019	NO	2 670 000	NO	86 000	1 319 000	2 000	NO
2020	NO	2 815 000	NO	73 000	933 000	2 000	NO
2021	NO	4 844 000	NO	107 000	1 077 000	2 000	NO
2022	NO	4 285 000	NO	99 000	787 000	2 000	NO
2023	NO	4 729 000	NO	80 000	729 000	2 000	NO

\*Data for chemical products in 1995 is based on Interpolation between the previous year and the next year. The value is the average of the previous year and the next year. For the other years, it is expected that no production occurs.

### Emission factors

The emission factors which were used for calculation of emissions taken from GB 2023 for different types of activities. The emission factors are presented in the following table.

**Table 149 Emission factors for source category 2.D.3.g - Chemical Products**

Pollutant	Value	Unit	References
NMVOC	50	g/kg polyester monomer used	GB 2023 2.D.3.g Chemical products. Table 3-2. pg. 17
NMVOC	120	g/kg polyurethane foam processed	GB 2023 2.D.3.g Chemical products. Table 3-3. pg. 17-18
NMVOC	60	g/kg polystyrene	GB 2023 2.D.3.g Chemical products. Table 3-4. pg. 18
NMVOC	8	g/kg rubber produced	GB 2023 2.D.3.g Chemical products. Table 3-5. pg. 18-19
NMVOC	1710	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
TSP	12000	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
Cd	0.0001	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
As	0.0005	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
Cr	0.006	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21

Pollutant	Value	Unit	References
			Bitumen blowing, coating
Ni	0.05	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
Se	0.0005	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
PAH	2.55	g/Mg asphalt	GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating
NMVOC	11	g/kg products (paints. inks. glues)	GB 2023 2.D.3.g Chemical products. Table 3-11. pg. 22
NMVOC	0.045	kg/pairs of shoes	GB 2023 2.D.3.g Chemical products. Table 3-13. pg. 23
NH <sub>3</sub>	0.68	g/kg raw hid (leather tanning)	GB 2023 2.D.3.g Chemical products. Table 3-14. pg. 24

#### 5.6.6.2. Source-specific uncertainties and time-series consistency

No source-specific uncertainties were done for the sector; the emissions vary due to the unstable economy over the years.

#### 5.6.6.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.6.6.4. Source-specific recalculations including changes made in response to the review process

Data for leather tanning were changed.

#### 5.6.6.5. Source-specific planned improvements including those in response to the review process

The national emission inventory team has started to gather data on the solvents used for pharmaceutical products manufacturing. However historical data before 2002 are missing and need to be gathered or method for time consistency will be used. Data on asphalt blowing are included. Manufacture of tires and adhesive tapes are not occurring. No data were found on the textile finishing. It is planned to improve this category in the next submission.

#### 5.6.7. Printing NFR – 2.D.3.h

Printing involves the use of inks, which may contain a proportion of organic solvents. Therefore, NMVOC emissions are expected from this process.

##### 5.6.7.1. Methodological issues

The simplified Tier 1 methodology for calculation of NMVOC emissions has been used. Namely, the quantity of ink used was multiplied with the appropriate emission factor.

#### Activity data

Data on ink consumption in the printing industry has been required from the SSO for the time series 1990-2023 since this data was not published in the statistical publications. Because the data has not been published so far, MEPP received a request by the SSO not to publish the activity data in the report. Therefore, this activity data is not presented in this report.

#### Emission factors

Emission factor for NMVOC has been taken from GB 2023 and is presented in table below.

**Table 157 Emission factors for source category 2.D.3.h Printing**

Pollutant	Value	Unit	References
NMVOC	500	g/kg ink	GB 2023 Table 3-1 Tier 1 emission factors for source category 2.D.3.h Printing

**5.6.7.2. Source-specific uncertainties and time-series consistency**

No source specific uncertainty was done for this sector.

**5.6.7.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

**5.6.7.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were done in the sector.

**5.6.7.5. Source-specific planned improvements including those in response to the review process**

No planned improvements in this sector.

**5.6.8. Other solvent and product use – NFR 2.D.3.i and 2.G**

NMVOC emissions are expected from this sector. Emissions from the following activities have been calculated in this source category:

- 060404 Fat, edible and non-edible oil extraction.
- 060406 Preservation of wood;
- 060602 Use of tobacco and
- 060603 Use of shoes
- 060604 Other solvent use and products - Aircraft de-icing; Use of fireworks)

Under the NFR category 2.G we have reported emissions from Tobacco use (tones) and Use of shoes calculated from produced, imported, and exported products, and under 2.D.3.i emissions from Fat, edible and non-edible oil extraction and Preservation of wood have been included.

**5.6.8.1. Methodological Issues**

To calculate activity data for these categories Use of shoes and Tobacco consumption the following formula have been used Use of shoes/tobacco = (produced product + imported product)-exported product. Consumption of creosote has been calculated with the formula 75 kg creosote/m<sup>3</sup> wood, where kg of wood preservative used was taken from the Statistical yearbooks. Regarding the activity Fat, edible and non-edible oil extraction statistics on different vegetable oil types have been used for estimation of seed quantity.

**Activity data**

The activity data on tobacco and pairs of shoes has been taken from the Statistical yearbooks - chapter Industry, energy and construction for the period 1990-2004 [22], and from the publication of the “Industry in the Republic of North Macedonia”, for the period 2005-2015 [28]. For 2016-2023 data from MAKSTAT database were used [29]. Data for deicing were gathered from both airports in Skopje and Ohrid. The deep that is visible in 2009 and jump in the 2012 are according to the produce parquet and wood packaging; the variable trend may be due to the economic reasons and not stable production in this sector. Data for the activity Use of fireworks and concrete additives which fall

under the scope of NFR 2G were gathered for the time period 2002-2023. For the calculation of missing AD for the period from 1990 to 2006 surrogat method is used. Surrogat data is Industry (including construction), value added (% of GDP).

The activity data are presented in the following table.

**Table 150 Activity data for the source category 2.D.3.i and 2.G - Other solvent and product use (Source Statistical yearbooks (1990-2004) and MAKSTAT/Industry in the Republic of North Macedonia (2005-2023)),**

Year	Tobacco [tones]	Creosote [kg]	Fat, edible and non-edible oil extraction-seed [kg]	Pairs of shoes	Use of fireworks [tonnes]	Concrete additive [tonnes]	Deicing
1990	26 481	261 440	38 303	6 638 000	4362	6701	NE
1991	16 576	209 583	39 190	4 049 000	3297	5065	NE
1992	22 297	241 980	32 975	3 667 000	3867	5940	NE
1993	25 964	197 934	30 218	2 308 000	3462	5318	NE
1994	21 143	163 377	47 598	1 529 000	2828	4345	NE
1995	16 152	123 016	30 990	1 122 000	2805	4310	NE
1996	13 980	82 013	54 763	1 231 000	2775	4263	NE
1997	14 904	55 388	52 515	1 509 000	3286	5048	NE
1998	23 297	47 551	47 063	1 790 000	3234	4968	NE
1999	29 005	43 522	28 165	2 488 000	3099	4760	NE
2000	18 991	38 073	39 048	2 129 000	2494	3832	58
2001	26 110	127 308	38 388	1 073 000	2399	3685	28
2002	20 547	100 054	71 910	1 521 000	2258	3469	85
2003	25 689	111 090	64 698	1 799 000	2620	4025	53
2004	15 317	158 732	61 148	1 785 000	2451	3766	48
2005	2 721	86 241	59 138	1 590 000	2372	3645	36
2006	1 859	78 125	63 578	1 892 504	2524	3878	45
2007	996	68 738	61 973	2 121 404	2398	3684	45
2008	3 854	53 457	76 303	2 320 371	1835	4334	28
2009	4 893	11 184	75 020	3 142 440	1828	2220	58
2010	10413	58 775	78 368	2 957 658	2976	1473	70
2011	10 138	54 654	82 848	3 408 829	4410	1600	71
2012	3 151	144 749	80 805	3 388 013	4224	1388	55
2013	6 365	113 177	77 008	1 599 026	2585	1596	27
2014	11 133	82 300	83 258	3 876 229	3852	1441	35
2015	9 040	106 723	102 678	4 381 143	4190	2547	45
2016	6 425	83 275	101 118	4 355 002	2987	3120	75
2017	6 113	78 150	65 370	3 876 436	3281	3371	90
2018	12 674	89 210	76 733	1 700 692	3452	3087	113

Year	Tobacco [tones]	Creosote [kg]	Fat, edible and non-edible oil extraction-seed [kg]	Pairs of shoes	Use of fireworks [tonnes]	Concrete additive [tonnes]	Deicing
2019	7 388	74 151	83 548	1 066 440	4268	2300	51
2020	7 956	88 288	74 978	926 875	4915	4765	1
2021	7 664	95 430	76 403	679 481	5123	4692	19
2022	1 009	87 228	75 215	780 253	5977	3306	65
2023	1 510	60 980	67 870	679 504	6069	4032	47

### Emission factors

The Emission factors have been taken from GB 2023 and are presented in the following table.

**Table 151 Emission factors for source category 2.D.3.i and 2.G - Other solvents and product use**

Pollutant	Activity	Value	Unit	References
NOx	Tobacco combustion	1.8	kg/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
NMVOC	Tobacco combustion	4.84	kg/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
NH3	Tobacco combustion	4.15	kg/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
PM2.5	Tobacco combustion	27	mg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
PM10	Tobacco combustion	27	mg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
TSP	Tobacco combustion	27	mg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
BC	Tobacco combustion	0.45	% of PM2.5	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
CO	Tobacco combustion	55.1	kg/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
Cd	Tobacco combustion	5.4	µg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
Ni	Tobacco combustion	2.7	µg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
Zn	Tobacco combustion	2.7	µg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23

Pollutant	Activity	Value	Unit	References
Cu	Tobacco combustion	5.4	µg/cigarette	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
PCDD/F	Tobacco combustion	0.1	µg I-TEQ/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
benzo(a) pyren	Tobacco combustion	0.111	g/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
benzo(b) fluoranthene	Tobacco combustion	0.045	g/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
benzo(k) fluoranthene	Tobacco combustion	0.045	g/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
Indeno (1.2.3-cd) pyren	Tobacco combustion	0.045	g/ton tobacco	GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23
NMVOC	Wood preservation. Creosote preservative type	105	g/kg creosote	GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17
benzo(a) pyren	Wood preservation. Creosote preservative type	1.05	mg/kg creosote	GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17
benzo(b) fluoranthene	Wood preservation. Creosote preservative type	0.53	mg/kg creosote	GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17
benzo(k) fluoranthene	Wood preservation. Creosote preservative type	0.53	mg/kg creosote	GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17
Indeno (1.2.3-cd) pyren	Wood preservation. Creosote preservative	0.53	mg/kg creosote	GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17
NMVOC	Manufacturing of shoes	0.06	kg/pair of shoes	GB 23 Table 3-16 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of Shoes, pg.24
NMVOC	Fat. edible and non-edible oil extraction	1.57	g/kg seed	GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16
PM2.5	Fat. edible and non-edible oil extraction	0.6	g/kg seed	GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16

Pollutant	Activity	Value	Unit	References
PM10	Fat. edible and non-edible oil extraction	0.9	g/kg seed	GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16
TSP	Fat. edible and non-edible oil extraction	1.1	g/kg seed	GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16
NOx	Use of fireworks	2060	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
SOx	Use of fireworks	3020	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
CO	Use of fireworks	7150	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
PM2.5	Use of fireworks	51.940	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
PM10	Use of fireworks	99.920	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
TSP	Use of fireworks	109.830	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
As	Use of fireworks	1.33	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
Cd	Use of fireworks	1.48	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
Cr	Use of fireworks	15.6	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
Cu	Use of fireworks	444	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
Hg	Use of fireworks	0.057	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
Ni	Use of fireworks	30	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
Pb	Use of fireworks	784	g/ t product	GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22
NMVOC	Concrete additive	260	g/ t product	GB 23 Table 3-17 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Other, pg.24



Pollutant	Activity	Value	Unit	References
NMVOC	Cooling lubricant	260	g/ t product	GB 23 Table 3-17 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Other, pg.24

#### 5.6.8.2. Source-specific uncertainties and time-series consistency

No specific source uncertainty is done for the sector.

#### 5.6.8.3. Source-specific recalculations including changes made in response to the review process

Recalculations were done in this category due to addition of activate data for use of fireworks and concrete adhesives.

#### 5.6.8.4. Source-specific planned improvements including those in response to the review process

#### 5.6.9. Additional investigation for needed activity data to calculate emissions from other activities like use of lubricants. Food and beverages industry - NFR 2.H.2

This source category addresses NMVOC emissions from food and beverages manufacturing, except emissions from vegetable oil extraction.

##### 5.6.9.1. Methodological issues

The Tier 2 approach has been applied. Both the activity data and the emission factors have been stratified according to the different techniques that occur in the country.

The following equation from Tier 2 approach has been used for calculating emissions from food and beverage industry:

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

Where:

$AR_{production, technology}$  = the production rate within this source category;

$EF_{technology, pollutants}$  = the emission factor for this technology and these pollutants.

#### Activity Data

The activity data for this source category has been taken from the Statistical yearbook - chapter Industry, energy and construction for the period 1990-2004 and publication Industry in the Republic of North Macedonia for the period 2005-2023. The data on wine production for the period 1990-2004 on wine and spirits was presented in total and therefore a proportion was used to divide this type of product. Additionally, data on wine production was officially required from the Ministry of agriculture, forestry, and water supply, but they responded that they do not have such data available. They are revised available activity data for period 2007-2009 MAKSTAT database. Due to revised available activity data for white wine produced since 2007 there are data for wine and white wine. The activity data for the period 1990-2006 for wine is for total wine produced (unspecified color). The animal feed is decreasing because of the decrease of the number of animals (see Agriculture chapter). The production of sugar varies during the reported period because there is only one major company dealing with sugar production. The company stopped with operation in 2015, so this process is not

occurring since. Also, for period 2007-2023 activity data for roasted coffee are included. The activity data is presented in the following table. There were no available data for the years before 2007.

**Table 160 Activity data for source category 2.H.2 - Food and beverage industry (Source Statistical yearbook (year) (1990-2004) and Industry in the Republic of North Macedonia (2005-2023))**

Year	spirits/hL	beer/hL	wine/hL	Wine white / hL	Animal Feed/t	Margarine and solid cooking fat/t	Sugar/t	Meat. fish and poultry/t	Cakes. biscuits and breakfast cereals/t	Bread/t	Coffee /t
1990	13 100	958 224	1 296 900	NE	180 625	1 972	13 904	11 855	13 063	102 392	NE
1991	16 165	928 043	1 572 000	NE	167 137	1 972	8 624	10 921	13 328	86 892	NE
1992	21 708	860 843	2 111 000	NE	140 320	1 972	8 140	8 121	15 112	99 149	NE
1993	21 708	951 854	2 274 000	NE	143 034	1 972	6 677	7 128	12 602	85 379	NE
1994	23 710	724 974	2 347 290	NE	126 146	1 972	6 351	33 787	12 583	85 014	NE
1995	26 920	620 201	2 665 080	NE	126 583	1 972	7 205	29 375	12 308	84 901	NE
1996	40 040	622 223	3 963 960	NE	130 248	1 972	17 993	29 368	11 824	84 382	NE
1997	31 800	600 092	3 148 200	NE	105 754	1 972	35 183	27 800	11 426	83 817	NE
1998	24 790	578 212	2 454 210	NE	97 947	1 972	40 354	25 971	11 657	82 740	NE
1999	30 070	652 165	2 976 930	NE	97 946	1 972	43 039	26 512	12 296	81 184	NE
2000	27 820	659 829	2 754 180	NE	97 995	1 972	31 923	27 470	11 408	78 632	173
2001	43 900	622 181	4 346 100	NE	75 003	1 972	18 004	26 041	10 995	74 689	899
2002	37 960	637 894	3 758 040	NE	68 382	1 972	36 614	27 471	10 828	68 425	2686
2003	28 350	680 217	2 806 650	NE	61 474	1 972	33 334	29 835	10 454	58 606	2109
2004	12 424	717 496	516 000	NE	55 235	1 972	27 810	29 839	10 113	43 115	2600
2005	10 548	675 325	948 489	NE	77 025	1 734	36 815	28 264	8 051	45 654	3005
2006	11 831	669 648	703 005	NE	73 497	1 903	19 325	28 041	8 030	44 774	2931
2007	9 824	695 140	578 953	388 588	85 790	2 079	35 927	22 589	5 607	59 003	4 383
2008	7 608	702 382	707 271	436 981	81 198	2 240	43 731	26 156	6 938	65 124	4 365
2009	7 904	635 922	743 463	480 008	74 353	2 225	23 460	26 437	9 603	59 699	4 185
2010	11 284	631 371	661 793	401 546	72 434	2 387	37 998	28 644	25 419	62 492	4 338
2011	7 442	611 836	815 914	409 593	77 183	2 340	30 423	30 732	25 548	67 518	4 185
2012	10 341	633 621	591 291	457 824	62 695	2 228	21 414	35 473	30 144	68 723	4 214
2013	11 548	617 124	686 841	599 049	46 983	2 433	22 916	35 686	31 181	60 127	4 405
2014	9 847	640 948	396 630	399 351	47 553	2 339	12 085	32 155	31 150	62 919	3 894
2015	10 848	656 672	605 404	500 017	45 553	2 328	NO	31 278	39 532	63 808	4 160
2016	12 481	672 487	602 187	460 461	40 563	2 118	NO	32 125	36 303	64 751	4 609
2017	11 582	705 497	367 020	397 953	48 348	2 374	NO	30 706	36 374	59 968	4 239
2018	13 082	736 062	565 799	462 320	45 117	2 324	NO	34 916	37 656	57 528	4 306
2019	13 269	738 396	522 317	388 943	47 623	2 656	NO	26 947	37 495	56 670	4 344
2020	11 649	662 360	568 586	374 166	46 576	2 596	NO	25 421	38 144	47 119	4 100
2021	13 854	696 215	477 946	361 482	45 084	2 685	NO	27 310	36 269	45 266	4 258

Year	spirits/hL	beer/hL	wine/hL	Wine white / hL	Animal Feed/t	Margarine and solid cooking fat/t	Sugar/t	Meat. fish and poultry/t	Cakes. biscuits and breakfast cereals/t	Bread/t	Coffee /t
2022	14 574	667 352	404 842	439 903	37 286	2 922	NO	24 999	31 312	43 986	4 096
2023	15 014	683 507	324 576	277 786	37 809	3 053	NO	23009	34 391	39 782	4 102

### **Emission factors**

The emission factors for estimation of NMVOC emissions are presented in the following table.

**Table 152 Emission factors for source category 2.H.2 - Food and beverages industry**

Pollutant	Value	Unit	References
NMVOC	15	kg/hL alcohol(spirits)	GB 2023, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	35	g/hL beer	GB 2023, 2.H.2 Food and beverages industry, Table 3-27, pg. 22
NMVOC	80	g/hL wine	GB 2023, 2.H.2 Food and beverages industry, Table 3-24, pg. 21
NMVOC	35	g/hL white wine	GB 2023, 2.H.2 Food and beverages industry, Table 3-26, pg. 22
NMVOC	1	kg/Mg animal feed	GB 2023, 2.H.2 Food and beverages industry, Table 3-22, pg. 20
NMVOC	10	kg/Mg product (Margarine and solid cooking fats)	GB 2023, 2.H.2 Food and beverages industry, Table 3-21, pg. 19
NMVOC	10	kg/Mg sugar	GB 2023, 2.H.2 Food and beverages industry, Table 3-20, pg. 19
NMVOC	0.3	kg/Mg product (meat, fish and poultry)	GB 2023, 2.H.2 Food and beverages industry, Table 3-19, pg. 18
NMVOC	1	kg/Mg product (cakes, biscuits and breakfast cereals)	GB 2023, 2.H.2 Food and beverages industry, Table 3-18, pg. 18
NMVOC	4.5	kg/Mg bread	GB 2023, 2.H.2 Food and beverages industry, Table 3-14, pg. 16
NMVOC	0.55	kg/Mg beans (roasted coffee)	GB 2023, 2.H.2 Food and beverages industry, Table 3-23, pg. 20

### **5.6.9.2. Source-specific uncertainties and time-series consistency**

A quantitative uncertainty analysis has not yet been carried out to the Macedonian inventory, but it is scheduled for the future. Source category specific information on uncertainties will be added when the results are available. The trends of the food production are variable due to the change of the methodology in the statistics, as well as due to the unstable regime of the major food installations.

### **5.6.9.3. Source-specific QA/QC and verification**

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

### **5.6.9.4. Source-specific recalculations including changes made in response to the review process**

No recalculations were done in this category.

#### 5.6.9.5. Source-specific planned improvements including those in response to the review process

No planned improvements in this category.

#### 5.6.10. Wood processing – NFR 2.I

This source category is only important for particulate emissions. The emissions from this source category however are less than 1% of the national emissions for particulates.

##### 5.6.10.1. Methodological issues

The simplified Tier 1 methodology for emission calculation has been used. Namely, the quantity of activity data is multiplied with the appropriate emission factor.

##### Activity data

The input data for this source category is the quantity of different type of final products. These data have been taken from the Statistical Yearbooks of the Republic of North Macedonia for the period 1990-2020[22] and the publication Industry in the Republic of North Macedonia for the period 2005-2015[28], and data form MAKSTAT database for period 2016-2023 [29]. The quantity of processed data is lowest in 2023.

**Table 162 Activity data for source category 2.I - Wood processing**

Year	Wood processed [Mg]	Year	Wood processed [Mg]
1990	66 889	2007	15 173
1991	52 422	2008	12 863
1992	46 790	2009	4 429
1993	44 454	2010	14 225
1994	40 402	2011	11 986
1995	29 144	2012	19 251
1996	27 210	2013	14 211
1997	23 188	2014	14 414
1998	17 048	2015	11 496
1999	22 568	2016	10 098
2000	18 173	2017	10 660
2001	16 882	2018	7 698
2002	10 015	2019	10 102
2003	19 913	2020	9 701
2004	24 263	2021	9 816
2005	15 509	2022	10 136
2006	21 866	2023	6 641

##### Emission factors

Emission factor for estimation of TSP have been taken from GB 2023 and they are presented in the table below.

**Table 153 Emission factors for source category 2.I Wood processing**

Pollutant	Value	Unit	References
TSP	1	kg/Mg wood products	GB 2023 Table 3.1 Tier 1 emission factors for source category 2.I Wood processing

#### 5.6.10.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

#### 5.6.10.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e., activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.6.10.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 5.6.10.5. Source-specific planned improvements including those in response to the review process

No planned improvements in this sector

### 5.6.11. Consumption of POPs and heavy metals – NFR 2.K

This source category is only important for PCB and Hg. The emissions in this category were calculated due to ERT recommendation.

#### 5.6.11.1. Methodological issues

The simplified Tier 1 methodology for emission calculation has been used. Namely, the quantity of activity data – population is multiplied with the appropriate emission factor.

#### Activity data

The input data for this source category is population data. Population data for the source category 2.D.3.e – Degreasing, is presented in Table 160.

#### Emission factors

Emission factor for estimation of PCB and Hg have been taken from GB 2023 and they are presented in the table below.

**Table 154 Emission factors for source category 2.K- Consumption of POPs and heavy metals**

Pollutant	Value	Unit	References
PCB	0.1	g/capita	GB 2023 Table 3-1, Tier 1, 2.K- Consumption of POPs and heavy metals pg.6
Hg	0.01	g/capita	GB 2023 Table 3-1, Tier 1, 2.K- Consumption of POPs and heavy metals pg.6

#### 5.6.11.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

#### 5.6.11.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 5.6.11.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### **5.6.11.5. Source-specific planned improvements including those in response to the review process**

Due to high uncertainty of the Tier 1 methodology, possibility the use higher tier level will be investigated if data from the POPs inventory which is developed by the POPs office in MEPP can be use for this purpose.

# AGRICULTURE



## 6. AGRICULTURE (NFR 3)

### 6.1. Sector overview

The agriculture sector is a major source category for ammonia emissions. 90% of the total national emissions of NH<sub>3</sub> are emitted from the agricultural sector.

In the Macedonian national inventory emissions from emissions from several NFRs are not reported due to not available activity data, but more detail explanation is given below.

### 6.2. General description

#### Methodology

In general, a simple Tier 1 methodology is used, multiplying activity data for each source category with an applied emission factor. The methodology of selection of emission factors in the manure management source category is described in detail below. Emission factors from EMEP Guidebook 2023 were mostly used for calculation of emissions for 3B categories in this sector. Older versions of Guidebook are use for calculation of emissions in 3D categories.

#### Completeness

In the table below NFR categories covered in the Agriculture sector for 2023 are presented, which are not included in this sector and for which appropriate notation keys are used.

**Table 155 NFR categories covered in Agriculture sector for 1990-2023**

NFR category		Completeness
3B1a	Manure management - Dairy cattle	√
3B1b	Manure management - Non-dairy cattle	√
3B2	Manure management – Sheep	√
3B3	Manure management - Swine	√
3B4d	Manure management – Goats	√
3B4e	Manure management – Horses	√
3B4gi	Manure management - Laying hens	√
3B4gii	Manure management - Broilers	√
3B4giii	Manure management - Turkeys	√
3B4giv	Manure management - Other poultry	√
3Da1	Inorganic N-fertilizers (includes also urea application)	√
3B4f	Manure management - Mules and asses	NE
3B4a	Manure management – Buffalo	IE
3B4h	Manure management - Other animals (please specify in IIR)	NO
3Da2a	Animal manure applied to soils	√
3Da2b	Sewage sludge applied to soils	NE
3Da2c	Other organic fertilizers applied to soils (including compost)	NA
3Da3	Urine and dung deposited by grazing animals	√
3Da4	Crop residues applied to soils	NA



NFR category		Completeness
3Db	Indirect emissions from managed soils	NA
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	√
3Dd	Off-farm storage, handling and transport of bulk agricultural products	NA
3De	Cultivated crops	√
3Df	Use of pesticides	NO
3F	Field burning of agricultural residues	NO
3I	Agriculture other (please specify in the IIR)	NO
3B4h	Manure management - Other animals (please specify in IIR)	NO

**3.B.4.f:** Mules and asses: No data were received for number of mules and asses in the reporting period upon request sent to the state statistical office (NE).

**3.B.4.a:** Buffalos: only historic data are available. Buffalos are included in the Other cattle category (3.B.1.b), as buffalos are bovines and no data for buffalo is available from 2007 onwards (-> time series consistency). The NH<sub>3</sub> EF for buffalos and other cattle (solid) is very similar.

**3.B.4.h:** Other animals: The inventory includes all animals provided in the statistical review of North Macedonia. No additional animal categories are relevant for North Macedonia (NO).

**3.D.a.2.a:** Animal manure applied to soils: Emissions are included in sector 3.D, as calculations follow the tier 1 approach. Therefore, the notation key IE is used for this sector. NH<sub>3</sub> emissions of source category 3.D.a.2.a animal manure applied to soils have been reported from submission 2017 onwards.

**3.D.a.2.b:** Sewage sludge applied to soils: This source is not estimated (NE). Activities (tons of sewage sludge annually spread) are not available. According to our investigations there are available data on sewage sludge. In the SSO database there are available data. Wastewater treatment plants are also producing sewage sludge, but according to information that we have gained up to now sewage sludge has been used in Agriculture.

**3.D.a.2.c:** The EMEP/EEA Guidebook 2013 does not provide methodologies and emission factors for this source category. Thus, for other organic fertilizers applied to soils (including compost) the notation key NA is reported.

**3.D.a.3:** Urine and dung deposited by grazing animals: Emissions are included in sector 3.D as calculations follow the Tier 1 approach. Therefore, notation key IE is used. NH<sub>3</sub> emissions of source category 3.D.a.3 Urine and dung deposited by grazing animals have been reported from submission 2017 onwards.

**3.D.a.4:** The EMEP/EEA Guidebook 2023 provide methodologies and emission factors for this source category for ammonia. Thus, emissions from Crop residues applied to soils are reported as NA. It is planned to calculate these emissions for the next reporting round or use NE for NH<sub>3</sub> if calculations are not completed in the IPA II project for the next submission.

**3.D.b:** The EMEP/EEA Guidebook 2023 does not provide methodologies and emission factors for calculating emissions resulting from the deposition of N emitted from managed soils. Thus, for indirect emissions from managed soils NA is reported.

**3.D.d:** The EMEP/EEA Guidebook 2023 does not provide methodologies and emission factors for this source category. Thus, for Off-farm storage, handling and transport of bulk agricultural products NA is reported.

**3.F:** NO is reported for source category 3F - Field burning. The reason as required by the Stage 3 review for agriculture [3] is the following. According to the NATIONAL implementation plan of reduction and elimination of the persistent organic pollutants in the Republic of Macedonia, issued by the Ministry of environment and physical planning in 2004 – Table 1.3: The state of the production and use of POPs substances in the Republic of Macedonia, HCB is not used in the Republic of Macedonia. Moreover, according to National plan for ratification of the three lats protocols, it is stated HCB was widely used as a pesticide to protect the seeds of onions and sorghum, wheat, and other grains against fungus until 1965.

**3.I:** Agriculture other, does not occur (NO).

### 6.3. Manure management NFR 3.B

#### 6.3.1. Methodological issues

The Tier 1 default approach following the GB 2013 and the GB 2016 has been used.

Emission factors for NO<sub>x</sub>, NMVOC and PM have been obtained from EMEP/EEA Air Pollutant GB 2023. Separate default Tier 1 EFs are provided for slurry and litter-based manure management systems to be multiplied with the animal numbers of the appropriate livestock categories. The manner of data filing as well as analysis of provided information for the selection of proper emission factors for different substances is presented below.

##### 6.3.1.1. Activity data and background information on the activity data

The input data in this sub-sector is the number of registered heads of each domestic animal species. All activity data is derived from the Statistical Yearbooks for period 1990-2006 [22] and Publication Livestock prepared by the State Statistical Office for the period 2007-2015 [33] and MAKSTAT database for activity data for 2016-2023 [33]. The numbers per livestock category are presented in Table 166. The number of different categories of poultry is presented in Table 166.

**Table 156 Domestic livestock population and its trend 1990–2023**

Year	Dairy	Non-diary	Total Swine	Fattening pigs	Sows	Sheep	Goats	Horses
1990	122 318	166 458	178 537	154 359	24 178	2 297 115	252 904	66 282
1991	120 476	163 361	170 975	145 973	25 002	2 250 549	245 466	65 155
1992	121 097	165 001	173.006	147 479	25 527	2 351 408	238 027	64 576
1993	121 614	159 835	184 920	151 605	33 315	2 458 648	230 589	61 748
1994	122 006	160 351	171 571	138 809	32 762	2 466 099	223 151	61 797
1995	122 419	161 835	175 063	143 672	31 391	2 319 905	215 712	61 733
1996	129 223	166 403	192 396	161 365	31 031	1 813 895	208 274	66 479
1997	130 519	159 817	184 293	148 802	35 491	1 631 034	200 836	65 869

Year	Dairy	Non-diary	Total Swine	Fattening pigs	Sows	Sheep	Goats	Horses
1998	122 551	145 807	196 838	164 150	32 688	1 315 176	193 397	59 847
1999	126 536	144 336	226 047	190 933	35 114	1 288 733	185 959	57 152
2000	126 371	139 229	204 135	173 006	31 129	1 250 686	178 520	56 486
2001	128 218	137 653	189 293	160 794	28 499	1 285 099	171 082	45 638
2002	127 135	132 437	196 223	164 056	32 167	1 233 830	163 644	41 775
2003	118 325	142.217	179 050	143 557	35 493	1 239 330	156 205	42 883
2004	118 872	136 496	158 231	131 992	26 239	1 432 369	148 767	40 391
2005	115 485	133 174	155 753	128 940	26 813	1 244 000	141 329	39 651
2006	120 682	135 157	167 116	137 102	30 014	1 248 801	133 890	40 553
2007	121 005	132 761	255 146	209 641	45 505	817 536	126 452	31 065
2008	125 004	128 469	246 874	210 106	36 768	816 604	133 017	30 936
2009	109 858	142 662	193 840	164 796	29 044	755 356	94 017	29 418
2010	119 060	140 827	190 552	161 346	29 206	778 404	75 708	26 658
2011	136 926	128 373	196 570	171 412	25 158	766 631	72 777	25 415
2012	123 392	127 848	176 920	152 256	24 664	732 338	63 585	21 676
2013	128 677	109 656	167 492	140 768	26 724	731 828	75 028	20 682
2014	126 762	114 845	165 053	141 542	23 511	740 457	81 346	19 371
2015	124 194	129 248	195 443	174 586	20 857	733 510	88 064	18 784
2016	125 243	129 525	202 758	174 087	28 671	723 295	101 669	19 263
2017	122 604	132 432	202 197	175 623	26 574	724 555	107 466	17 951
2018	129 450	126 731	195 538	171 809	23 729	726 990	117 447	10 041
2019	111 147	106 643	135 770	118 814	16 956	684 558	87 581	8 952
2020	107 721	114 490	164 074	145 679	18 395	630 634	95 008	9 154
2021	98 217	79 441	186 146	165 815	20331	633281	75753	11140
2022	100 242	64 509	182 604	161 147	21 457	646 488	80 186	10 659
2023	69214	79479	193412	171778	21634	587073	85528	10104
<b>Trend 1990-2023</b>	<b>-43%</b>	<b>-52%</b>	<b>8,33%</b>	<b>11%</b>	<b>-11%</b>	<b>-74%</b>	<b>-66%</b>	<b>-85%</b>

**Table 157 Domestic poultry and its trend 1990–2023**

Year	Laying hens	Broilers	Livestock category – Population size [heads] *			
			Ducks	Geese	Turkeys	Total Poultry
1990	5 515 140	101 653	58 888	15 264	38 036	5 728 981
1991	4 392 197	80 955	46 898	12 156	30 291	4 562 497
1992	4 136 947	76 251	44 172	11 449	28 531	4 297 350

Year	Laying hens	Broilers	Livestock category – Population size [heads] *			
			Ducks	Geese	Turkeys	Total Poultry
1993	4 228 758	77 943	45 153	11 703	29 164	4 392 721
1994	4 510 147	83 129	48 157	12 482	31 105	4 685 021
1995	4 697 726	86 587	50 160	13 001	32 398	4 879 873
1996	3 235 355	59 633	34 546	8 954	22 313	3 360 801
1997	3 152 343	58 103	33 659	8 724	21 741	3 274 570
1998	3 214 141	59 242	34 319	8 895	22 167	3 338 764
1999	3 102 875	57 191	33 131	8 587	21 399	3 223 184
2000	3 574 763	65 889	38 170	9 893	24 654	3 713 369
2001	2 647 004	48 789	28 263	7 326	18 255	2 749 637
2002	2 407 615	44 376	25 707	6 663	16 604	2 500 966
2003	2 327 131	42 893	24 848	6 441	16 049	2 417 362
2004	2 623 573	48 357	28 013	7 261	18 094	2 725 298
2005	2 519 329	46 435	26 900	6 972	17 375	2 617 012
2006	2 488 827	45 873	26 575	6 888	17 165	2 585 327
2007	2 115 866	80 742	35 131	11 004	21 151	2 263 894
2008	2 173 346	9 717	22 656	4 082	16 254	2 226 055
2009	2 041 098	34 949	23 658	3 182	15 003	2 117 890
2010	1 951 276	27 235	6 982	4 652	4 707	1 994 852
2011	1 853 176	11 862	68 743	4 225	6 253	1 944 259
2012	1 715 180	30 698	15 670	4 495	10 254	1 776 297
2013	1 623 130	548 617	13 558	7 143	9 102	2 201 550
2014	1 884 289	26 492	13 790	5 687	9 621	1 939 879
2015	1 423 841	311 809	15 814	2 094	7 587	1 761 145
2016	1 705 948	97 322	25 416	10 829	26 254	1 865 769
2017	1 770 504	20 456	27 257	8 782	13 174	1 840 173
2018	1 736 208	25 641	40 222	8 956	17 260	1 828 287
2019	1 385 743	120 363	34 611	8 841	12 531	1 562 089
2020	1 482 348	101 268	31 900	14 306	13 640	1 643 462
2021	1 235 894	97 181	120 580	11 227	19 143	1 484 025
2022	1 367 092	124 332	46 036	10 971	13 502	1 561 933
2023	1508578	100119	112284	11997	13051	1 746 029
<b>Trend 1990–2023</b>	<b>-73%</b>	<b>-2%</b>	<b>91%</b>	<b>-21%</b>	<b>-66%</b>	<b>-61,73%</b>

Official data sets of the period 1990–2006 and from 2007 onwards are not fully consistent. In 2007, a new census on agriculture was introduced [36] leading to more accurate animal numbers. No census

for agriculture was conducted afterwards. Census was planned to be conducted during last year, however due to limited human and financial resources it was postponed with no define date.

The 2007 census was interview based (interviewers personally visited all farms) and provides a full coverage of the country.

The annual animal accountings in the years between are based on samples of about 5000 farms. The total farm number of North Macedonia is about 90000. In general, it is distinguished between individual farms (which reflect most farms) and business entities (less than 200 registered).

The annual accountings were made as of the 31<sup>st</sup> of December until the year 2014, but from 2015 onwards they are made as of the 20th of November.

A solution could not be found on how to improve inconsistency between these two datasets (1990-2006 and from 2007 onwards), especially for sheep, goats and pigs the time series shows significant inconsistencies.

The overall livestock population continuously decreased, especially for sheep, goats, and horses as well as poultry.

### **Cattle numbers**

For 1990-2006 national statistics include dairy, other cows and heifers in calve in one category “cows”. Activity data for dairy cows was not made available until this reporting period.

Regarding the relatively small number of calves and young cattle, compared to the cattle older than 2 years (including dairy cattle that the share dairy/non-dairy is in line with the data of neighboring countries of that region and that the marked is very volatile) – many calves are imported.

There is no specific tradition in animal breeding in North Macedonia. The quality of the genetic pool of the domestic livestock is not good enough for high yield and quality production. Thus, for the replacement of animals in milk, meat and pork production predominantly young animals are imported from abroad (no domestic breed is taken).

The small calve number in the official statistics is since (especially male calves) are slaughtered very early (between 2 and 12 months). In the veterinarian register, all born animals have to be registered within a period of 7 days. This is the reason why the livestock balances show a significant higher number of calves than outlined in the official statistics.

### **Dairy cattle**

Increased production of milk is responsible for the increased husbandry of dairy cattle 122% from 1990 to 2023).

### **Non-dairy cattle**

Reduced rent ability of beef production is responsible for the decrease of Non-dairy cattle numbers by 69% between 1990 and 2023 due to the reduced number of heifers in calf and other cattle.

### **Pig numbers**

Pig statistics from 1990-2006 are not fully consistent with the official numbers from 2007 onwards. A consistent time series had to be established. For the years 1990 to 2006, the fattening pig number has been derived from the difference of sow number (including boars) and total swine number 1990-2006.

In North Macedonia total swine production increased by 8,3% between 1990 and 2023, mainly due to increased production of fattening pigs.

### Sheep

Activity data for the whole time series are available in the official statistics. There are time series inconsistencies in animal numbers and milk production 1995-1996 and 2006-2007. No solution could be found. Inconsistencies are due to different methodologies of accounting. The main reason for the decline in sheep numbers (-74%) is that most of the sheep herds are owned by small individual businesses which are not profitable anymore.

### Goat numbers

No official goat numbers were published before 2007. Within a meeting with experts of the statistical office data for the period 2000-2007 from the MAKSTAT data base were provided. For the years before an official request has been made for the use of non-published data, and only 1999 data has been provided. For the derivation of consistent time series for 1990-1998 the average shares of the years 2007-2015 have been used. Goat numbers decreased by -66% between 1990 and 2023, because in the last century husbandry of goats was forbidden as it would curb the formation of karst. The number of goats has increased in period 2012-2018 but decreasing trend appears again due to fact higher migration from rural to urban places.

### Horses

Horse numbers show a decreasing trend since 1990 (-84%). In the past horses were used for means of locomotion in rural areas, but the purpose of horses changed, and more and more people are now living in the cities and less horses are needed.

### Mules and asses

Regarding information from the veterinary institute, horse category does not include mules and assess. No data on mules and assess were made available in the reporting period (NE).

### Poultry number

Before 2007, only total poultry number is available. An official request has been made for the use of non-published data of laying hens 1990-2006. Data were received by the statistical office and used in the calculations. For the derivation of consistent time series of broilers, geese, ducks and turkeys for 1990-2006 the average shares of the years 2007-2010 have been used. The time series of laying hens has been validated with annual total egg production and annual egg numbers per hen.

Total poultry number decreased by 61,73% from 1990 to 2023, mainly due to declining numbers of laying hens as a result of a reduced egg production in North Macedonia.

### Animal manure management system distribution

During the inventory preparation for submission in 2016, first investigations on management practices commonly applied in the Macedonian agriculture have been made. Based on expert judgments and information of big IPPC installations within pig and poultry husbandry a distinction between slurry and

solid systems could be made for each animal category. Since then, the same distinction between systems has been used.

The following expert judgment (REF) has been provided:

### Cattle husbandry

The cattle husbandry is mostly in traditional holdings – 97% of all farms in North Macedonia are small scale farms with up to 20 cows. In the past 25 years, the number of bigger holdings is decreasing and now there are only few farms with more than 100 dairy cows. The typical systems used in dairy cattle husbandry are small stalls with solid manure system, tied housing system with no outdoor loafing areas. Some of the bigger farms (more than 50 cattle) have changed from tied stall to free stall system, solid manure, and outdoor loafing areas. The milking system is mechanical with separate milking parlor in the bigger farms. The other category of cattle, which has a major part in the cattle husbandry in North Macedonia, is the cow-calf system (suckling cows). Where the cows are kept free on pasture and mountains and the breeders are using only the calves for meat production. This type of breeding is strictly traditional with the local breed Busha. In the milking sector, dominating breed is Holstein Friesian, with small percentage of Simmental breed and the rest of the cattle breeds are within negligible numbers. Although there are several attempts in the past decade for establishing bigger farms, there is no visible trend for creating dairy farms with large number of animals in North Macedonia. Based on this expert judgment we decided to use the EMEP/EEA default NH<sub>3</sub> and NO Tier 1 EFs for solid systems for all cattle categories.

### Pasturing of cattle

Pastured system is mostly present in the cow-calf system; explained above. The rest of the farmers are rarely using pasture for dairy cattle and dairy cattle are kept indoors during the whole year. There are some practices where the cows from the whole village are pastured on the same pasture during the summer months of the year. However, there are no exact numbers available for presenting the percentage of farms that are using pasture in their management.

Based on this expert judgment and discussions with agriculture experts it was decided to apply the solid NH<sub>3</sub> and NO EFs for all cattle.

### Swine

For IPPC installations (big pig farms), the national IPPC experts provided the following information: the number of animal places, the animal number produced per farm for 2014 and the number of days the animals are alive before being slaughtered for 2014.

Based on this data, it was possible to calculate the annual average animal population held in these seven big pig farms. The result was that about 30% of BC's pigs (mostly fattening pigs) were held in these farms in 2014. From the previous meeting we know that these farms use liquid systems. The situation in 2018 is similar so no changes to the distribution of type of system are changed.

Now it had to be clarified which kind of systems are usually applied for the rest of pigs held in smaller business entities and individual farms.

Additional information from the veterinary agency that also the small pig farms usually practice liquid manure systems; the manure is stored in septic tanks. Farmers have an agreement with someone else

that uses a tank truck to collect the manure or use the manure for fertilization of their own agricultural land.

National experts of the Ministry of Agriculture confirmed the assessment of the veterinary agency of North Macedonia. Based on this expert judgment we decided to use the EMEP/EEA default NH<sub>3</sub> and NO EFs for liquid systems for all swine categories.

### Poultry

In North Macedonia, only laying hens are kept in big poultry farms. Broilers are mainly imported from abroad. Data from IPPC investigations (big poultry farms) showed that the solid factor is the appropriate for all hens (conservative approach). The national experts of the Ministry of Agriculture within an expert meeting confirmed this approach during the mission.

EMEP/EEA Tier 1 NH<sub>3</sub> and NO<sub>x</sub> emission factors of all other animal categories do not distinguish between solid and liquid systems.

#### 6.3.1.2. Emission factors

Tables 168 and 169 provide emission factors taken from the EMEP EEA GB 2023 version and for NH<sub>3</sub> for each livestock category. These factors have been used for the estimation of NO<sub>x</sub> NMVOC and NH<sub>3</sub> emissions. For NMVOC and cattle, the average mean of both EFs (NMVOC EF with and EF without silage feeding) has been used (for details see description below).

**Table 158 NH<sub>3</sub> emission factors for source categories 3.B - Manure management and 3.D - Agricultural Soils**

NFR code	NH <sub>3</sub>		
	Housing, storage, yard	Manure application*	Grazing**
	kg AAP-1 a-1	kg AAP-1 a-1	kg AAP-1 a-1
3B1a Dairy cattle	16.1	6.0	4.4
3B1b Non-dairy cattle	5.7	2.2	2.0
3B2 Sheep	0.4	0.2	0.8
3B3 Swine-fattening pigs	3.7	2.8	0.0
3B3 Swine-sows	12.5	5.2	0.0
3B4d Goats	0.4	0.2	0.8
3B4e Horses	7.0	2.7	6.1
3B4gi Laying hens	0.32	0.15	0.0
3B4gii Broilers	0.13	0.04	0.0
3B4giii Turkeys	0.56	0.34	0.0
3B4giv Other poultry (ducks)	0.45	0.20	0.0
3B4giv Other poultry (geese)	0.30	0.05	0.0
Reference	GB 2023 - Table 3.2 Default Tier 1 EF (EF NH <sub>3</sub> ) for calculation of NH <sub>3</sub> emissions from manure management		

\*reported under source category 3.D.a.2

\*\* reported under source category 3.D.a.3



**Table 159 NO<sub>x</sub> and NMVOC emission factors for source category 3B - Manure management**

NFR code	Pollutants	
	NO <sub>x</sub>	NMVOC
	kg AAP-1 a-1	kg AAP-1 a-1
3B1a Dairy cattle	0.752	13.4195
3B1b Non-dairy cattle	0.217	6.252
3B2 Sheep	0.012	0.169
3B3 Swine-fattening pigs	0.002	0.551
3B3 Swine-sows	0.005	1.704
3B4d Goats	0.012	0.542
3B4e Horses	0.250	7.781
3B4gi Laying hens	0.014	0.165
3B4gii Broilers	0.027	0.108
3B4giii Turkeys	0.027	0.489
3B4giv Other poultry (ducks)	0.002	0.489
3B4giv Other poultry (geese)	0.005	0.489
Reference	GB 2023 updated July 2015 - Table 3.3 Default Tier 1 EF for NO	GB 2023- Table 3-4 Default Tier 1 EF for NMVOC

Emissions of particulate matter (PM) occurring from animal husbandry were calculated with the EMEP/EEA Tier 1 methodology provided in the EMEP/EEA Guidebook 2023 (related 14 Sep 2023 Published 02 Oct 2023). The Tier 1 methodology multiplies average animal numbers with the particular default emission factors listed in the following table:

**Table 160 TSP, PM<sub>10</sub> and PM<sub>2.5</sub> emission factors for source category 3.B - Manure management**

NFR code	TSP	PM <sub>10</sub>	PM <sub>2.5</sub>	Reference
	kg/capita	kg/capita	kg/capita	
3B1a Dairy cattle	1.38	0.63	0.41	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B1b Non-dairy cattle	0.59	0.27	0.18	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B2 Sheep	0.14	0.06	0.02	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B3 Swine-fattening pigs	1.05	0.14	0.006	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B3 Swine- sows	0.62	0.17	0.01	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4d Goats	0.14	0.06	0.02	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4e Horses	0.48	0.22	0.14	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).

NFR code	TSP	PM10	PM2.5	Reference
	kg/capita	kg/capita	kg/capita	
3B4gi Laying hens	0.19	0.04	0.003	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4gii Broilers	0.04	0.02	0.002	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4giii Turkeys	0.11	0.11	0.02	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4giv Other poultry (ducks)	0.14	0,14	0.02	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4giv Other poultry (geese)	0.24	0.24	0.03	GB 2023 updated July 2015 - Table 3.5 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).

### NMVOC emission factors

Default Tier 1 emission factors distinguish between feeding with and without silage for dairy cows, other cattle, sheep, goats, horses and mules and asses (GB 2023, Table 3-4).

The following information from the Veterinary institute has been received on the feeding with silage.

“Feeding with silage is quite common in North Macedonia among farm animals. Especially during the winter period - to my knowledge (there is no exact data analysis for the time), at least half of the year the farmers are using silage as feed. The composition of silage is dominantly consisted of maize, alfalfa, clover and grains. This type of feed is especially used for cattle feeding.”

According to the information received, the following was decided:

- For cattle to use the average mean of both EF with, and EF without silage feeding
- For all other animals to use the EF without silage feeding

### 6.3.2. Source-specific uncertainties and time-series consistency

For the first time a quantitative uncertainty, analysis has been carried out for the Macedonian air pollutant emission inventory and was submitted in 2017. The 2015 Livestock Survey derived uncertainties of activity data, with certain adjustments made regarding the survey non-response rate. The errors are calculated as relative errors. All calculations were made with the SAS statistical software package. Uncertainties of emission factors were based on the GB 2013 and assumption of experts.

The following table presents combined uncertainties for emissions as well as uncertainties for activity data and the EFs for sector 3.B *Manure Management* according to GB 2013.

**Table 161 Uncertainties of activity data, emission factors and emissions for NFR 3.B**

Categories		NH3 Emissions	NOx Emissions	NMVOC Emissions	PM2.5 Emissions	EF NH3	EF NOx	EF NMVOC	EF PM2.5
3.B.1	Cattle	+/-125.1	+/-40.3	+/-40.3	+/-200.1	+/-125%	+/-40%	+/-40%	+/-200%
3.B.2	Sheep	+/-125.4	+/-41.3	+/-41.3	+/-200.3	+/-125%	+/-40%	+/-40%	+/-200%
3.B.3	Swine	+/-125.1	+/-40.5	+/-40.5	+/-200.1	+/-125%	+/-40%	+/-40%	+/-200%
3.B.4	Other Livestock	+/-125.4	+/-41.2	+/-41.2	+/-200.2	+/-125%	+/-40%	+/-40%	+/-200%
Activity Data					Relative errors				

Categories	NH3 Emissions	NOx Emissions	NMVOC Emissions	PM2.5 Emissions	EF NH3	EF NOx	EF NMVOC	EF PM2.5
Animal Population – Cattle								+/- 5.3%
Animal Population – Sheep								+/-10.2%
Animal Population – Swine								+/-6.1%
Animal Population – other Livestock								+/-10.0%

*\*Note: uncertainties of emissions are combined uncertainties*

A solution could not be found on how to improve inconsistency between these two datasets (1990-2006 and from 2007 onwards), especially for sheep, goats and pigs the time series shows significant inconsistencies. Statistical methods have been used for improvement of time consistency already described above.

Concerning the time series consistency, there is a dip in the number of broilers and jumps in between 2013 and 2015. According to the opinion of the Statistical office, the number of broilers in the business farm is variable while the number of broilers in the individual farms is mostly constant. The dips and jumps are due to the opening of new farms, which may be connected to the market prices. Concerning the jump in pig's number in 2007 and 2008, we have asked the MAFWS for the reason, but no explanation was provided. It is assumed that economic reasons-market prices are behind this jump too.

### 6.3.3. Source-specific QA/QC and verification

The following sector specific QA/QC procedures have been carried out:

#### Activity data

- Consistency of time series: plausibility checks of dips and jumps for which requests on reasons are send to relevant institutions;
- Comparison with time series of previous year. Explanation of revisions are done only if jumps or dips appeared;
- Consistency checks of sub-categories with totals like in case of poultry with sum of all subcategories.

#### Emission factors

- Default EFs were used

#### Results (emissions)

- Assessment of recalculation differences: plausibility checks, explanation
- Documentation in calculation sheets and IIR.
- Livestock emission excel sheet contains sheets for cross checking of animal number with production of milk, eggs and number of calves in the case of cattle numbers.

### 6.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were performed for this submission.

#### 6.3.5. Source-specific planned improvements including those in response to the review process

According to the Improvement plan prepared in the IPA II air quality project, NH<sub>3</sub> emissions from 3.B Manure Management can be calculated by Tier 2 methodology. Changing to a Tier 2 method can be facilitated using the N-flow tool. This improvement is already envisaged in expert mission during 2025.

### 6.4. Inorganic N-fertilizers (NFR 3.D.a.1)

#### 6.4.1.1. Methodological issues

Due to existing data gaps on fertilizer type level Tier 1 methodology has been used.

The approach to use a 3-years average for mineral fertilizers was confirmed by MAFWS, as fertilizers listed in the official imported/exported statistics are not applied on the fields accordingly. Wholesalers and big farmers buy fertilizers when the prices are good. Fertilizers are stored. There is no relevant fertilizer production in the country; therefore, the use of imported amounts is a good basis for emission calculation.

#### Activity data

From 2002 to 2010, activity data are based on FAO. Data from import/export statistics is available from 2009 onwards. These data were received from the Ministry of agriculture, forestry, and water supply. For the years before 2002, only an incomplete dataset is available.

There is no reporting obligation for wholesalers in the country. There are no numbers of sold fertilizer amounts available. Anyhow, all kind of fertilizers have to be registered for permission in the country; hardcopies are available for each type of fertilizer including the shares of fertilizer substances (but no amounts). As there are hundreds of different kinds of fertilizers registered, the manual evaluation would be very time consuming and there are no resources available. As a result, no information on N amounts could be obtained from this data source.

Based on a recommendation of the Stage 3 Review 2016 North Macedonia moved to Tier 2 methodology in submission by using the N contents for different types of fertilizer as provided in the Stage 3 Review Report 2016, category issue 2:

- AS - Ammonium sulfate, 0.21 kg N per kg fertilizer.
- AN - Ammonium nitrate, 0.34 kg N per kg fertilizer.
- CAN - Calcium ammonium nitrate, 0.27 kg N per kg fertilizer.
- U - Urea, 0.46 kg N per kg fertilizer.
- MAP, 0.11 kg N per kg fertilizer.
- DAP, 0.18 kg N per kg fertilizer.
- NPK > 10 kg, 0.15 kg N per kg fertilizer
- NPK < 10 kg, 0.15 kg N per kg fertilizer

For other fertilizers emissions are calculated by using average N content and average EF of all applied fertilizers.

Soil P<sub>h</sub> could be clarified. The European Soil Bureau, Research Report No. 9, outlines different soil types and complexes in ha (%). An evaluation of this information resulted in the assessment that all relevant soils have a low soil pH ≤ 7.0. The national experts of the Ministry of Agriculture confirmed this assessment.

According to the IPCC 2006 Guidelines, cool climates have an average temperature below 15°C. The average temperature in North Macedonia is 11.5 degrees.

In the following table the quantities of applied N fertilizers are shown. Since only data for import and export are available, the consumption of Inorganic N-fertilizers is calculated as three years average.

**Table 162 Activity data for source category NFR 3.D.a.1 - Inorganic N-fertilizers**

t N applied per year										
Year	Ammonium sulfate	Ammonium nitrate	Calcium ammonium nitrate	Urea	MAP	DAP	NPK > 10 kg	NPK < 10 kg	Other N-fertilizers	3 years average Total N/t
1990	412	3696	1007	5100	0	20	304	0	0	10 540
1991	412	3696	1.007	5000	0	20	304	0	0	10 440
1992	412	3696	1.007	4600	0	20	304	0	0	10 040
1993	412	3696	1.007	4117	0	20	304	0	0	9557
1994	412	3696	1.007	3804	0	20	304	0	0	9244
1995	429	3654	708	3168	0	20	304	0	0	8283
1996	431	4009	462	3025	0	20	304	0	0	8252
1997	434	4069	144	2657	0	20	304	0	0	7629
1998	420	3910	126	3097	0	20	304	0	0	7878
1999	420	3139	54	3266	0	20	304	0	0	7204
2000	420	2618	54	3220	0	20	304	0	0	6636
2001	420	1825	54	3005	0	20	304	0	0	5628
2002	607	3168	45	2260	0	20	304	0	0	6405
2003	751	4689	617	2410	0	22	555	0	0	9045
2004	630	6530	1657	2348	0	32	1540	0	0	12 737
2005	317	6476	3205	2610	1	40	3023	2	0	15 674
2006	46	6916	3515	2,520	61	31	3775	3	0	16 866
2007	42	7173	4190	2373	77	24	4159	3	0	18 041
2008	42	7248	3438	2628	77	13	3765	3	0	17 212
2009	30	4.516	4277	3291	35	27	3814	3	83	16 075
2010	27	4873	4811	3618	19	25	3586	4	128	17 092
2011	13	2693	6068	3708	18	22	4009	3	156	16 692
2012	13	2693	6296	3314	0	8	4742	1	144	17 211
2013	0	0	5731	3634	0	0	5673	0	98	15 137
2014	0	823	5641	3986	0	0	6119	0	180	16 749
2015	0	3090	4340	3858	0	0	4996	0	229	16 513
2016	0	3124	3381	3187	0	0	3531	0	234	13 457
2017	0	4561	2457	3034	17	0	3184	0	216	13 470
2018	0	4293	2266	3343	38	0	3990	0	153	14 082
2019	0	6524	1774	3784	58	0	5009	0	368	17 517
2020	0	7726	1373	3862	176	0	5166	0	496	18 798

t N applied per year										
Year	Ammonium sulfate	Ammonium nitrate	Calcium ammonium nitrate	Urea	MAP	DAP	NPK > 10 kg	NPK < 10 kg	Other N-fertilizers	3 years average Total N/t
2021	0	7482	1294	3516	195	0	4943	0	500	17 931
2022	0	5880	1224	2934	179	0	3683	0	307	14207
2023	0	3926	848	4063	44	0	2827	0	169	11876

### Emission factors

In the following tables the emission factors applied for source category 3.D.a.1 is shown. All emission factors are taken from the GB 2013 and the GB 2016.

**Table 163 NH<sub>3</sub> Emissions factors for source category NFR 3.D.a.1 - Inorganic fertilizers**

Fertilizer type	Value	Unit	References
AS	0.09	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
AN	0.015	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
CAN	0.008	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
U	0.155	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
MAP	0.05	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
DAP	0.05	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
NPK	0.05	kg NH <sub>3</sub> kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1

The emission factors for the respective N-fertilizers are taken for soils with normal pH and cool climate as described above.

**Table 164 NO<sub>x</sub> Emissions factors for source category NFR 3.D.a.1 - Inorganic fertilizers**

Pollutant	Value	Unit	References
NO <sub>x</sub>	0.026	kg kg-1 fertilizer-N applied	GB 2013 Table 3-1 emission factor for source category 3.D.a.1

### 6.4.2. Animal manure applied to soils (NFR 3.D.a.2)

This source category covers NH<sub>3</sub> emissions from animal manure applied to agricultural soils.

#### 6.4.2.1. Methodological issues

The Tier 1 methodology according the EMEP/EEA GB 2016 has been applied.

#### Activity data and background information on the activity data

The input data is the number of registered heads of each domestic animal species. All activity data is derived from the Statistical Yearbooks for period 1990-2006 [22] and Publication Livestock [33], prepared by the State Statistical Office for the period 2007-2015 [33] and MAKSTAT database for 2016-2023 [35]. The numbers per livestock category are presented in Table 166. Numbers of different

categories of poultry were presented in Table 167. For further information, please refer to chapter 3.B Manure Management.

### Emission factors

In the chapter 3.B Manure Management, for each livestock category the NH<sub>3</sub> emission factors for animal manure applied to soils, taken from EMEP/EEA GB 2023, are shown.

#### 6.4.3. Urine and dung deposited by grazing animals (NFR 3.D.a.3)

This source category covers NH<sub>3</sub> emissions from urine and dung deposited by grazing animals.

##### 6.4.3.1. Methodological issues

The Tier 1 default approach following the EMEP/EEA GB 2016 has been applied.

### Activity data and background information on the activity data

The input data is the number of registered heads of each domestic animal species. All activity data is derived from the Statistical Yearbooks for period 1990-2006, and Publication Livestock prepared by the State Statistical Office for the period 2007-2022. The numbers per livestock category are presented in Table 166. Number of different categories of poultry is presented in Table 167. For further information, please refer to chapter 3.B Manure Management.

In the chapter 3.B - Manure Management for each livestock category the NH<sub>3</sub> emission factors for grazing, taken from EMEP/EEA GB 2023, are shown.

##### 6.4.3.2. Source-specific uncertainties and time-series consistency

For the first time a quantitative uncertainty analysis has been carried out for the North Macedonian air pollutant emission inventory and was submitted in 2017. Uncertainties of activity data and emission factors were based on the EMEP/EEA GB 2013.

The following table presents uncertainties for emissions, as well as for activity data and the EFs for sector 3.D Agricultural Soils according to EMEP/EEA 2013.

**Table 165 Uncertainties of emissions, emission factors and activity data**

Categories		NH <sub>3</sub> Emissions	NO <sub>x</sub> Emissions	NM VOC Emissions	PM <sub>2.5</sub> Emissions	EF NH <sub>3</sub>	EF NO <sub>x</sub>	EF NM VOC	EF PM <sub>2.5</sub>
3.D.a	Inorganic N-fertilizers	+/- 206.2%	+/- 64.0%	+/- 64.0%	+/- 206.2%	+/- 200.0%	+/- 40.0%	+/- 40.0%	+/- 200.0%
Activity Data									
	Inorganic N-fertilizers - amount			+/- 50%					

\*Note: uncertainties of emissions are combined uncertainties

Emissions from the whole period have been calculated; however, the sources on activity data are different. Namely in the period 2009-2023, data are received from the State inspectorate under Ministry of agriculture, forestry, and water supply. For the period 1990-2008, data are taken from FAO; however, there are dips and jumps in the use of some fertilizers like ammonia nitrate for which MAFWS was contacted for further explanation of this inconsistency, however no explanation were provided.

#### 6.4.3.3. Source-specific QA/QC and verification

The following sector specific QA/QC procedures have been carried out:

##### Activity data

Activity data trend analysis for period 1990-2023 was performed. Major jumps and dips are noticed in use of ammonium nitrate, CAN and NPK >10 kg. The dip for ammonium nitrate is in 2013 when jumps are detected for CAN and NPK >10 kg. From 2019 the amount of ammonium nitrate is highly increasing while CAN amount is decreasing and the amount of NPK >10 kg is slightly increased. The others fertilizers do not show bigger dips and jumps.

##### Emission factors

Default Emission factors were used, but country specific parameters (e.g. N contents of fertilizers) were also compared with defaults and values reported by other countries (e.g. Serbia, Austria and Croatia).

##### Results (emissions)

Comparison of emissions calculated with Tier 1 and Tier 2 method was done. Use of tier 2 method result with lower emissions started from 2001 onwards.

#### 6.4.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 6.4.3.5. Source-specific planned improvements including those in response to the review process

No planned improvement in this category.

### 6.4.4. 3.D.e Cultivated crops

#### 6.4.4.1. Methodological issues

Calculation of particulates was carried out using EF given in the GB 2023 according to tier1 methodology.

##### Activity data

The activity data for source 3.D.c is derived from State Statistical Yearbooks for period 1990-2023 data and are presented in the following table:

**Table 166 Activity data for source category 3.D.c**

Year	Arable land [ha]	Year	Arable land [ha]
1990	1 320 000	2007	1 077 000
1991	1 295 000	2008	1 064 000
1992	1 308 000	2009	1 014 000
1993	1 299 000	2010	1 121 000
1994	1 298 000	2011	1 120 000
1995	1 289 000	2012	1 238 000
1996	1 291 000	2013	1 260 336
1997	1 285 000	2014	1 263 155
1998	1 293 000	2015	1 264 408
1999	1 284 000	2016	1 267 134
2000	1 236 000	2017	1 266 008



Year	Arable land [ha]	Year	Arable land [ha]
2001	1 244 000	2018	1 264 000
2002	1 316 000	2019	1 264 578
2003	1 303 000	2020	1 261 687
2004	1 265 000	2021	1 259 996
2005	1 229 000	2022	1 256 854
2006	1 225 000	2023	1250821

### Emission factors

**Table 167 Emission factors**

Pollutant	Value	Unit	References
PM2.5	0.06	Kg ha <sup>-1</sup>	GB 2023 Table 3-1 emission factor for source category 3.D.c
PM10	1.56	Kg ha <sup>-1</sup>	GB 2023Table 3-1 emission factor for source category 3.D.c
TSP	1.56	Kg ha <sup>-1</sup>	GB 2023 Table 3-1 emission factor for source category 3.D.c

#### 6.4.4.2. Source-specific recalculations including changes made in response to the review process

No recalculations were made in this category.

#### 6.4.4.3. Source-specific planned improvements including those in response to the review process

No planned improvements in this category.

### 6.4.5. 3.D.e Cultivated crops

#### 6.4.5.1. Methodological issues

Calculation of particulates was carried out using EF given in the GB 2019 according to Tier1 methodology.

### Activity data

The activity data for source 3.D.e is derived from State Statistical Yearbooks for period 1990-2022 data and are presented in the following table:

**Table 168 Activity data for source 3.D**

Year	kg/ha	Year	kg/ha
1990	1 320 000	2008	1 064 000
1991	1 295 000	2009	1 014 000
1992	1 308 000	2010	1 121 000
1993	1 299 000	2011	1 120 000
1994	1 298 000	2012	1 238 000
1995	1 289 000	2013	1 260 336
1996	1 291 000	2014	1 263 155
1997	1 285 000	2015	1 264 408
1998	1 293 000	2016	1 267 134
1999	1 284 000	2017	1 266 008
2000	1 236 000	2018	1 264 000
2001	1 244 000	2019	1 264 578
2002	1 316 000	2020	1 261 687
2003	1 303 000	2021	1 259 996

Year	kg/ha	Year	kg/ha
2004	1 265 000	2022	1 256 854
2005	1 229 000	2023	1250821
2006	1 225 000		
2007	1 077 000		

#### Emission factors

**Table 169 Emission factors for NMVOC**

Pollutant	Value	Unit	References
NMVOC	0.86	Kg ha <sup>-1</sup>	GB 2023 Table 3-1 emission factor for source category 3.D.e

#### 6.4.5.2. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 6.4.5.3. Source-specific planned improvements including those in response to the review process

The implementation of Tier 2 methodology is planned in the frame of the IPA II project.

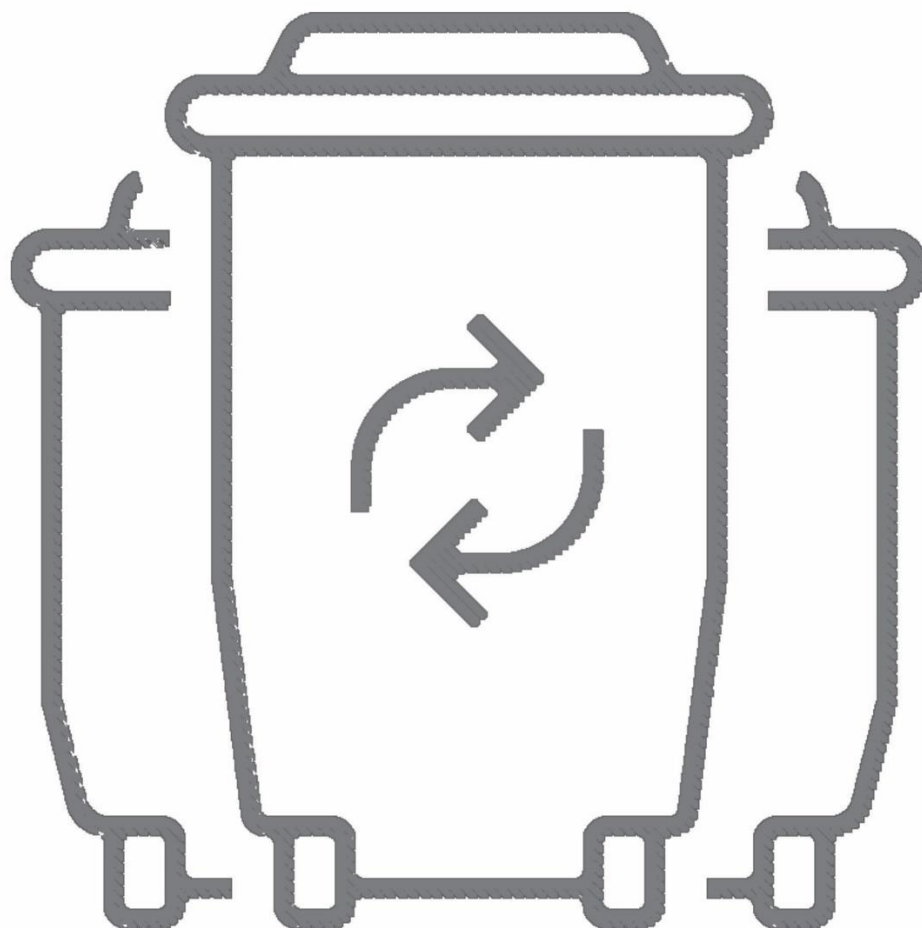
#### 6.4.6. Field burning of agricultural residues - NFR 3.F

Field burning activities were discussed with agriculture experts. Field burning is not permitted by law and there are no data on illegal field burning activities available.

Therefore, the source category 3.F “Field burning is reported as not occurring (“NO”). Anyhow, the current estimates for sector 5.C.2 “Open burning of waste” (average amount of waste burned for arable farmland of 25 kg/ha) should be kept as it is liable that open burning of small-scale (agricultural) waste happens in the country.

In the frame of the EU 4 Green project calculation for this sector were made for every five years for the period 1990-2040, by use of GAINS model and FINN remote sensing dataset. These data will be analyzed and submitted during next year.

# WASTE



## 7. WASTE (NFR 5)

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### 7.1. Sector overview

The chapter includes calculation of NO<sub>x</sub>, SO<sub>2</sub>, CO, NMVOC, Particulates, heavy metals and persistent organic compounds (POPs). Emissions addressed in this chapter include emissions from the next subcategories:

5.A - Solid waste disposal on land

5.B.1-Biological treatment of waste-Composting

5.C.1.biii - Clinical waste incineration

5.C.2 - Open burning of waste

5.D.1 - Domestic wastewater handling

5.D.2-Industrial wastewater handling

As during the stage 3 review in 2016, it was recommended to change to Tier 2 method for the category 5.A, this recommendation has been followed. Additionally, emissions for category 5.D.1, 5.D.2 and 5.B.1 have been calculated using a Tier 1 approach.

Explanations of the source of activity data, methodology used and emission factors are presented below. According to information from the statistical office, about 99% of municipal solid waste is landfilled and only less than 1% is composting or recycled. Generally, in the country there is only clinical waste incinerator operating from 2000. Other types of waste incineration, as well as cremation process do not occur. Open burning of waste covers the volume reduction by open burning of small-scale (agricultural) waste. It does not include stubble burning, or forest fires. The open burning of rubber tires or waste oil on farms has also not been included. Agricultural wastes that might be burned are crop residues (e.g., cereal crops, peas, beans, soya, sugar beet, oil seed rape, etc.), wood, pruning, slash, leaves, plastics, and other general wastes. Straw and wood are often used as the fuel for the open burning of agricultural wastes.

Regarding wastewater treatment, there are twenty-one Wastewater treatment plants (WWTP) operating in North Macedonia. For the plant in Ohrid and Dojran, activity data are available for the whole time series. Emissions have been estimated based on these activity data and the data from another wastewater treatment plants.

Emissions from 5.B.1-Biological treatment of waste (composting) have been calculated. Municipal waste incineration, industrial waste incineration, hazardous waste incineration, sewage sludge incineration and cremation do not occur in our country.

Regarding the Industrial wastewater handling, some installations subjected under the IPPC license system are obligated to install wastewater treatment. Emissions from this NFR category 5.D.2 have been calculated almost for the whole time series.

Emissions from 5.B.2 Biological treatment of waste - Anaerobic digestion at biogas facilities, 5.C.1 other waste incineration, 5.D.3-Other wastewater handling and 5.E. Other waste (Sludge spreading, car fire, detached and undetected house fires, apartment building fire, industrial building fire), have not been calculated.

#### 7.1.1. Methodology

Tier 1 approach was used, using the given default Emission factors from the GB 2023.

#### Completeness

The completeness in this sector is presented in the following table.

**Table 170 NFR categories included or not included in Waste sector for 2016**

NFR category		Completeness
5.A	Biological treatment of waste - Solid waste disposal on land	√
5.C.1.biii	Clinical waste incineration	√
5.C.2	Open burning of waste	√
5.B.1	Biological treatment of waste - Composting	√
5.B.2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NE
5.C.1.a	Municipal waste incineration	NO
5.C.1.bi	Industrial waste incineration	NO
5.C.1.bii	Hazardous waste incineration	NO
5.C.1.biv	Sewage sludge incineration	NO
5.C.1.bv	Cremation	NO
5.C.1.bvi	Other waste incineration (please specify in the IIR)	NE
5.D.1	Domestic wastewater handling	√
5.D.2	Industrial wastewater handling	√
5.D.3	Other wastewater handling	NE
5.E	Other waste (please specify in IIR)	NE

#### 7.1.2. Source-specific uncertainties and time-series consistency

Activity data for the whole time series and background information on these are hardly available, for which reason the uncertainty is expected to be rather high. Especially getting data on waste disposal is hard, as these data are required back to 1950, a time when Macedonia was still part of Yugoslavia. For further information, see the respective chapter below. Uncertainties of emissions, emission factors and activity data for 5.A and 5.C are presented below.

Time series consistency is ensured as recalculations are carried out for the whole time series and not only for specific years.

#### 7.1.3. Source-specific QA/QC and verification

The results of this year's calculations have been compared with last year, and the reasons for any major differences clarified. Calculation sheets were checked for any errors in formulas or links. Data or information received from third parties was reviewed and archived to ensure transparency.

The recommendations of the stage 3 review were taken in consideration and improvements made:

- request for country specific data to statistical office and installations
- change to Tier 2 approach for 5.A and 5C1biii
- calculation of emissions from 5.B.1
- estimation of emissions from 5.D.1
- calculation of emission from 5.D.2
- review of notation key use.
- correction of emissions in 5C1biii and 5C2

7.1.4. Source-specific recalculations including changes made in response to the review process

No recalculations were made in this category.

7.1.5. Source-specific planned improvements including those in response to the review process

Planned improvements refer to categories 5D1 and 5C2, also according to remarks and recommendations given in the Stage 3 review report conducted in 2020.

## **7.2. Solid waste disposal on land (NFR 5.A)**

Within this category the emissions arising from solid waste disposal shall be accounted for, whereby municipal and industrial waste shall be considered. However, it has to be taken into account that only waste which still undergoes biological or chemical degradation is relevant. Therefore, inert waste (like construction waste) shall not be included.

7.2.1. Methodological issues

NMVOC, CO and NH<sub>3</sub> was estimated using tier 2 methodology, and particulate emissions were estimated using Tier 1 method by multiplying amount of landfilled municipal solid waste and emission factors. NMVOC, CO and NH<sub>3</sub> have been calculated using Tier 2 emission factors following the guidance of 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

### **Activity Data**

As for Tier 2 methodology, since activity data on waste landfilled is required back to 1950, extrapolation was necessary based on population and GDP data. Data on municipal solid waste generation per person is available for the years 2003 until 2023 (source: Eurostat statistics and EEA report [43]). The hereby available information provided data on waste generation from 2003 to 2023. For the data from 1990-2003 the average annual change between 2003 and 2017 was applied, and then the value for 1990 (which is 97 kg per person), was kept constant until 1950.

Total municipal solid waste generation was calculated by multiplying with population data. Data on population is available in the Statistical Yearbooks of Macedonia, although before 1990 data were interpolated between decades. According to information from the statistical office about 99% of municipal solid waste is landfilled, for that reason it was assumed that 100% of municipal solid waste was deposited on uncategorized landfills.

In order to determine the waste fraction, information published in an EEA study “Municipal Waste Management in FYROM (2013), page 7-8” was used [43]. The shares are kept constant for the whole time series (1950 to 2020) due to a lack of better data, although, it can be assumed that in 1950 the waste composition was different.

**Table 171 Type of waste, percentage and considerations in FOD model**

Type of waste	Percentage	Consideration in FOD model as:
Biodegradable (organic) waste	26%	Food
Wood	2.7%	Wood
Paper and cardboard	11.9%	Paper
Plastics	9.6%	Plastics, other inert
Glass	3.5%	Plastics, other inert
Metals	2.6%	Plastics, other inert
Composite packaging	2.2%	Plastics, other inert
Other waste (complex products, inert materials, other categories)	7.5%	Plastics, other inert
Textiles	2.9%	Textile
Hazardous household waste	0.2%	Not considered
Fine mixed particle (<10mm)	30.9%	Plastics, other inert

It has been possible to collect data on industrial waste, but only for the year 2014. There are no available data in the latest year. The following table shows which waste types have been considered. In order to estimate industrial waste amounts back to 1950, GDP was used. National GDP data are available from 1994 to 2023 [44]. Before 1994, GDP for former Yugoslavia were found and used. The Industrial waste\*by category, in tons, from 2016 was used also for the latest years due to the fact that this data from SSO were considered reliable.

**Table 172 Type of waste, and quantity in tons**

Type of waste	Quantity [t]
Waste from households and similar waste – non-hazardous	5.131,38
Mixed and undifferentiated materials – nonhazardous	9.643,95
Waste from sorting materials – non-hazardous	167,65
Deposition	729,54
Waste from combustion	3.005,33
Soil waste	9.827,26
Waste from excavation	71.027,10
Industrial waste disposition	945.761,30
Paper and cardboard waste	483.859,40
Rubber waste	1.650,89
Plastics waste	8.792,21
Wood waste	1.398,89
Textile waste	721,05
Animal waste and mixed food waste	2.408,00
Agricultural waste	3.427,89
Animal manure and urine	86.099,50
<b>TOTAL</b>	<b>1.633.651,33</b>

**Table 173 Activity data for source category 5.A – Solid waste disposal on land for the period 1990-2023**

<b>Year</b>	<b>Municipal Waste in Gg</b>	<b>Industrial Waste in Gg</b>	<b>Total Waste in Gg</b>	<b>Methane Emission in m<sup>3</sup></b>
1990	198	197	956.970	55.880.395
1991	209	208	866.923	56.799.402
1992	221	222	762.066	57.288.296
1993	233	236	692.189	57.303.851
1994	246	235	711.155	57.013.027
1995	260	250	802.077	56.816.648
1996	274	267	840.913	56.979.209
1997	289	283	885.602	57.269.171
1998	305	301	935.614	57.703.436
1999	321	319	999.662	58.295.947
2000	339	339	1.108.203	59.095.131
2001	358	359	1.180.774	60.271.499
2002	378	377	1.218.358	61.657.934
2003	399	875	1.273.595	63.105.610
2004	463	914	1.376.957	64.676.555
2005	572	1004	1.575.993	66.499.410
2006	589	1090	1.678.902	68.886.318
2007	606	1214	1.819.752	71.554.400
2008	714	1350	2.064.464	74.645.308
2009	726	1350	2.075.591	78.427.384
2010	721	1423	2.144.393	82.054.979
2011	735	1511	2.245.923	85.797.193
2012	787	1519	2.306.024	89.753.957
2013	793	1634	2.426.435	93.688.590
2014	765	1634	2.398.807	97.918.081
2015	786	1634	2.419.833	100.560.449
2016	797	1634	2.430.236	104.436.069
2017	787	1634	2.420.537	108.152.584
2018	855	1634	2.488.516	111.664.029
2019	916	1634	2.549.594	115.213.404
2020	913	1634	2.546.684	118.723.324
2021	896	1634	2.529.717	122.057.830
2022	856	1634	2.490.417	125.190.410
2023	878	1634	2.414.954	128.076.663



### Emission Factors

As for the emission calculations the IPCC waste model was applied, the default parameters and factors were used as set in the excel calculation sheet for Southern European Countries with dry temperature.

**Table 174 Parameter used for methane calculation of different waste types for source category 5.A. -Biological treatment of waste**

Parameter	Food	Garden	Paper	Wood	Textiles	Industrial
DOC	0.15	0.2	0.4	0.43	0.24	0.150
DOCf	0.500	0.500	0.500	0.500	0.500	0.500
Methane generation rate constant (k)	0.060	0.050	0.040	0.020	0.040	0.050
Half-life time (t1/2. years):	11.6	13.9	17.3	34.7	17.3	13.9
$\exp(-k)$	0.94	0.95	0.96	0.98	0.96	0.95
Process start in deposition year. Month M	13.00	13.00	13.00	13.00	13.00	13.00
$\exp(-k*((13-M)/12))$	1.00	1.00	1.00	1.00	1.00	1.00
Fraction to CH <sub>4</sub>	0.500	0.500	0.500	0.500	0.500	0.500

The methane correct factor is set to 0.6, as the landfills are treated as uncategorized. All municipal and industrial waste is landfilled, other treatments are not relevant. No methane recovery occurs.

NM VOC, CO and NH<sub>3</sub> were estimated based on the landfill gas emitted. Therefore, methane emission has been converted to landfill gas in m<sup>3</sup> by consideration of the CH<sub>4</sub> concentration in the landfill gas and by taking into account the absolute density of CH<sub>4</sub>. Based on those emissions for NM VOC, CO and NH<sub>3</sub> were calculated. However due to recommendation given by Stage 3 review in 2020, NM VOC emissions are taken from the GHG inventory. Since the last year for which inventory has been prepared is 2019 the same emissions are presented for the period 2020-2023. GHG inventory which will consider emissions in the period 2020-2023 will be prepared during this year and updated values will be submitted during next year.

**Table 175 Data for conversion of methane emissions to NM VOC, CO and NH<sub>3</sub> emissions for category 5A - Biological treatment of waste**

Parameter	CH <sub>4</sub>	NM VOC	CO	NH <sub>3</sub>
Relative density	0.555	0.555	0.967	-
Absolute density [kg/Nm <sup>3</sup> ] bei 30°C	0.650	0.72	1.13	-
Concentration in landfill gas [%] (Cd, Hg, Pb, NM VOC, NH <sub>3</sub> in mg/m <sup>3</sup> )	55	300	2	10

The emission factors used to calculate emission from particulate matter are as outlined in the GB 2023 for source category 5.A.

**Table 176 Emission factors for source category 5.A- Biological treatment of waste**

Pollutant	Value	Unit	Reference
NM VOC	1.56	kg/Mg	GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land

TSP	0.463	g/Mg	GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land
PM10	0.219	g/Mg	GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land
PM2.5	0.33	g/Mg	GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land

For NO<sub>x</sub> and SO<sub>x</sub>, heavy metals except Hg and POPs the notation key NA was used. For NH<sub>3</sub>, Hg and CO the notation key NE was used – as outlined in the GB 2016/2023.

#### 7.2.2. Source-specific uncertainties and time-series consistency

Uncertainties of activity data and emission factors have been estimated by using Tier 1 methodology of the EMEP/EEA GB 2013.

**Table 177 Uncertainties of emissions, emission factors and activity data for 5.A**

Categories	NMVOC Emissions	PM2.5 Emissions	EF NMVOC	EF PM2.5
5.A Solid waste disposal on land	+/- 134.6%	+/- 206.2%	+/- 125.0%	+/- 200.0%
<b>Activity data</b>				
Amount of landfilled waste		+/- 50,0%		

#### 7.2.3. Source-specific QA/QC and verification

The calculation has been checked by waste management experts and the used parameters and factors have been discussed. Therefore, the 4-eye principle was applied. Internal documentation was written to allow for transparency and reproduction in the following years.

The results have been compared to emission estimates from other countries, to check if the range of magnitude is right.

#### 7.2.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this category.

#### 7.2.5. Source-specific planned improvements including those in response to the review process

Improvement of the category is planned in the IPA II Air quality project. Additionally, activity data for this category for period 2019-2023 will be available for the next submission.

### 7.3. Biological treatment of waste-Composting-NFR 5.B.1

#### 7.3.1.1. Methodological issues

Small amount of organic domestic waste is gathered separately. Composting the organic waste produces a reusable product. Emissions to air from this source category include odors; also, small amounts of ammonia are produced. We use the Tier 2 method, to calculate the emission of NH<sub>3</sub> since it is expected that it is easier to obtain the necessary input data for this approach. Emissions from this category arise according to recommendation of the stage 3 review process.

### Activity data

The activity data for source category-5.B.1 is part of organic municipal waste in (kt) which is composted. The data are gathered from Annual reports from the Major of the municipalities which are submitted to the Ministry of Environment and Physical Planning each year.

**Table 178 Activity data for source category 5.B.1 – Waste composted 1990-2023**

Year	Waste composted in kt	Year	Waste composted in kt
1990	NO	2007	NO
1991	NO	2008	NO
1992	NO	2009	0.45
1993	NO	2010	0.31
1994	NO	2012	0.73
1995	NO	2013	0.44
1996	NO	2014	1.94
1997	NO	2015	2.81
1998	NO	2016	2.24
1999	NO	2017	1.11
2000	NO	2018	0.74
2001	NO	2019	0.55
2002	NO	2020	0.44
2003	NO	2021	0.17
2004	NO	2022	0.12
2005	NO	2023	0,09
2006	NO		

### Emission Factors

Tier 2 emission factors for source category 5.B.1 Biological treatment of waste - composting, compost production is 0.24 for the emission of NH<sub>3</sub>.

#### 7.3.2. Source-specific uncertainties and time-series consistency

Time series consistency is ensured by applying the same methodology for the whole time series.

#### 7.3.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 7.3.4. Source-specific recalculations including changes made in response to the review process

Emissions coming from the category 5.B.1, category was calculated for the period from 2009 till 2022. Waste composted started from 2009. From 1990 till 2008 waste composting didn't occur in our country. No recalculation was performed in this category.

#### 7.3.5. Source-specific planned improvements including those in response to the review process

Activity data were received from several out of 84 municipalities. Emissions are underestimated in this sector. We intend to improve the process of collection the data and information about the biological

treatment of waste-composting. The information and data currently are underestimated. With the establishment of National environmental information system, which is in phase of testing this year, it is expected to have more complete data gathering starting from next reporting round.

## 7.4. Clinical Waste incineration - NFR 5.C

### 7.4.1. Methodological issues

Emissions from this source category are estimated according to GB-2023. The guideline outlines simple methodology where the amount of clinical waste incinerated is multiplied with Tier 1 emission factors.

#### Activity data

The activity data for source category 5.C - Clinical waste originates from the annual report of company “Drisla” where clinical waste incineration is operating. The company started with operation in 2000. Data for the period 2000-2023 were taken from the “Drisla” landfill website [38]. Value for 2023 is taken from report submitted to MEPP.

**Table 179 Quantity of clinical waste incinerated in the period 2000–2023**

Year	Clinical waste [Gg]	Year	Clinical waste [Gg]
2000	0.115	2012	0.677
2001	0.232	2013	0.727
2002	0.249	2014	0.726
2003	0.255	2015	0.962
2004	0.323	2016	1.023
2005	0.376	2017	1.064
2006	0.329	2018	0.971
2007	0.357	2019	0.996
2008	0.362	2020	1.073
2009	0.416	2021	1.154
2010	0.465	2022	1.055
2011	0.600	2023	0.55487

#### Emission Factors

The emission factors used are as outlined in the GB 2023 and presented in the following table. Due to installation of filter for the period 2018-2020 the EF from the 2009 Guidebook were used. This Guidebook has EF for this type of reduction technics- Type 2 plant: larger on-site facilities equipped with de-dusting systems, while in the GB 2019/2023, only EF for BAT is provided.

**Table 180 Emission factors for source category 5.c.1.dii - Clinical waste incineration**

Pollutant	Value	Unit	References
SO <sub>2</sub>	1.1	kg/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
NO <sub>x</sub>	2.3	kg/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8

Pollutant	Value	Unit	References
NM VOC	0.7	kg/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
TSP	17	kg/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
BC	2.3	% of TSP	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
CO	0.19	g/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Pb	62	g/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Cd	8	g/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Cr	2	g/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Cu	98	g/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Hg	5.4	g/Mg waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
As	0.1	kg/g waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Ni	0.4	kg/g waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
PCB	0.02	g/Mg waste	GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
PCDD/PCDF (dioxins/furans)	40	mg I-Teq/Mg waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Total 4 PAHs	0.04	mg/Mg waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
HCB	0.1	g/Mg waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
NOx	1.4	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
CO	2.8	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
NM VOC	0.7	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
SOx	1.4	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
TSP	0.5	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Pb	63.2	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Cd	7.35	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13

Pollutant	Value	Unit	References
Hg	4.47	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
As	1.3	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Cr	4.7	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Cu	2.6	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Ni	0.4	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
PCB	0.02	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
PCDD/PCDF	0.141	mg I-Teq/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Total 4 PAHs	0.04	mg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
HCB	0.1	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13

#### 7.4.2. Source-specific uncertainties and time-series consistency

In the NFR sector 5.C the activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment for SO<sub>x</sub>, NO<sub>x</sub> 125% (rating C) for NMVOC. No uncertainty analysis was done for the other pollutants.

#### 7.4.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

#### 7.4.4. Source-specific recalculations including changes made in response to the review process

No recalculation was performed in this category.

#### 7.4.5. Source-specific planned improvements including those in response to the review process

No recalculations in this category.

### 7.5. Open burning of waste- NFR 5.C.2

#### 7.5.1. Methodological issues

The simpler methodology involves the use of a single emission factor for each pollutant representing the emission per mass of waste burned, combined with activity statistics:

$$E_{\text{pollutant}} = A R_{\text{production}} \times EF_{\text{pollutant}}$$

This requires a prior knowledge of the weight of agricultural waste produced per hectare of forestry, orchard, and farmland. It is assumed that open burning of agricultural waste (except stubble burning)

is mainly practiced in forestry, orchard, and arable farming; emissions from open burning for other types of farming are likely to be less significant and are assumed to be negligible. The average amount of waste burned for arable farmland is therefore 5.C.2 Open burning of waste GB 2013/2009 estimated to be 25 kg/hectare. This approach has been used for estimation of activity data. The activity data were calculated when the agriculture area expressed in hectares was multiplied with the factor 25 and divided by 1000 which equals to the waste burned in kg. For example, for 2018 the burning waste was calculated in this manner  $518.740 \times 25 / 1000 = 12.969$ .

#### **Activity data**

Data on arable farmland taken from the statistical office and calculated waste burned are presented in the following table. Data on arable farmland are taken from State Statistical Office of the Republic of North Macedonia, Field crops, orchards, and vineyards, 2007-2017 and MAKSTAT database [32].

**Table 181 Activity data for source category 5.C.2 - Open burning of waste**

Year	Arable farmland [hectare]	Waste [Mg]	Year	Arable farmland [hectare]	Waste [Mg]
1990	667 000	16 675	2007	529 000	13 225
1991	664 000	16 600	2008	521 000	13 025
1992	662 000	16 550	2009	513 000	12 825
1993	663 000	16 575	2010	504 000	12 600
1994	661 000	16 525	2011	511 000	12 775
1995	656 000	16 400	2012	510 000	12 750
1996	658 000	16 450	2013	509 000	12 725
1997	647 000	16 175	2014	511 579	12 789
1998	635 000	15 875	2015	513 564	12 839
1999	633 000	15 825	2016	516 644	12 916
2000	598 000	14 950	2017	516 870	12 922
2001	612 000	15 300	2018	518 740	12 969
2002	577 000	14 425	2019	519 848	12 996
2003	569 000	14 225	2020	517 039	12 926
2004	560 000	14 000	2021	516 733	12 918
2005	546 000	13 650	2022	514 436	12 861
2006	537 000	13 425	2023	514 375	12 859

#### **Emission Factors**

The emission factors used are as outlined in the GB 2023 for source category 5.C.2.

**Table 182 Emission factors for source category 5.C.2 - Open burning of waste**

Pollutant	Value	Unit	References
NOx	3.18	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
NMVOC	1.23	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
SOx	0.11	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6

Pollutant	Value	Unit	References
PM2.5	4.19	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
PM10	4.51	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
TSP	4.64	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
BC	42	% of PM2.5	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
CO	55.83	kg/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
Pb	0.49	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
Cd	0.1	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
Cr	0.01	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
Cu	0.2	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
Se	0.07	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
"PCDD/PCDF (dioxins/furans)"	10	mg I- Teq/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
benzo(a) pyren	2.33	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
benzo(b) fluoranthene	4.63	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6
benzo(k) fluoranthene	5.68	g/Mg	GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6

#### 7.5.2. Source-specific uncertainties and time-series consistency

See chapter 7.4.2.

#### 7.5.3. Source-specific QA/QC and verification

See chapter 7.4.3.

#### 7.5.4. Standard QA/QC procedures

These procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR

#### 7.5.5. Source-specific recalculations including changes made in response to the review process

No recalculations were made in this category.

#### 7.5.6. Source-specific planned improvements including those in response to the review process

No planned improvements.



## 7.6. Wastewater treatment - NFR 5.D.1 and 5.D.2

### 7.6.1. Methodological issues

In Macedonia there are seventeen municipal wastewater treatment plants. The data and information related with specific plants and especially the amount of domestic municipal wastewater treated in the plants has been gathered from State statistical offices. Based on the gathered data, emission was calculated based on a Tier 1 approach.

It was also attempted to gain data on how much people are connected to wastewater treatment. The data from Eurostat provide values for several years, in the range of 5-7%. Another information was found in the SOER country profile for Macedonia (see below), mentioning that “Sixty percent of dwellings are connected to a public sewage system, 21% have septic tanks and another 19% have only a system of uncontrolled wastewater discharge “. According to the BC experts, this number seems right concerning the connection to the sewage system, but when it comes to the connection to waste water treatment plants, the percentages provided by EUROSTAT seem reliable. Still, this information is not sufficient to decide on how many people are using latrines or septic tanks, which serve as activity data for NH<sub>3</sub> emissions. For this reason, NH<sub>3</sub> emissions from 5.D. cannot be calculated with the available data. However, to also report on NMVOC emissions from 5.D., the amount of wastewater from households and industries is needed.

With regards to the 5.D.2, Industrial facilities send the information about their wastewater treated in their wastewater treatment plants through questionnaires send to them by the State Statistical Office. The results for the quantity of wastewater treated and emissions calculated based on a Tier 1 approach of NMVOC are underestimated.

#### Activity data

Activity data on wastewater handled in treatment plants are presented in the following table:

**Table 183 Activity data for source category 5.D.1 - Wastewater treatment-(1990-2023)**

Year	Water treated [m <sup>3</sup> ]	Year	Water treated [m <sup>3</sup> ]
1990	14 690 160	2007	15.304.820
1991	15 320 880	2008	16.093.220
1992	14.374.800	2009	21.187.840
1993	15.636.240	2010	21.698.560
1994	15.320.880	2011	21.113.200
1995	14.374.800	2012	22.836.899
1996	14.847.840	2013	21.079.644
1997	15.163.200	2014	24.709.351
1998	15.793.920	2015	25.322.341
1999	15.951.600	2016	12.675.451
2000	14.532.480	2017	9.639.664
2001	15.478.560	2018	21.395.408
2002	14.374.800	2019	36.126.117
2003	15.163.200	2020	47.746.743

<b>2004</b>	15.462.500	<b>2021</b>	39.301.456
<b>2005</b>	16 408 580	<b>2022</b>	29.861.372
<b>2006</b>	16 250 900	<b>2023</b>	35.195.445

**Table 184 Activity data for source category 5.D.2 – Industrial Wastewater treatment-(1990-2023)**

<b>Year</b>	<b>Water treated [m<sup>3</sup>]</b>	<b>Year</b>	<b>Water treated [m<sup>3</sup>]</b>
<b>1990</b>	NO	<b>2007</b>	349.927.000
<b>1991</b>	NO	<b>2008</b>	94.786.000
<b>1992</b>	7.449.000	<b>2009</b>	49.593.000
<b>1993</b>	24.469.000	<b>2010</b>	20.131.000
<b>1994</b>	35.479.000	<b>2011</b>	77.573.000
<b>1995</b>	46.489.000	<b>2012</b>	92.492.000
<b>1996</b>	19.298.000	<b>2013</b>	230.053.000
<b>1997</b>	33.157.000	<b>2014</b>	12.161.000
<b>1998</b>	47.016.000	<b>2015</b>	16.188.000
<b>1999</b>	22.002.000	<b>2016</b>	12.620.000
<b>2000</b>	15.197.000	<b>2017</b>	242.036.000
<b>2001</b>	3.728.000	<b>2018</b>	351.131.000
<b>2002</b>	41.461.000	<b>2019</b>	6.823.420
<b>2003</b>	45.879.000	<b>2020</b>	220.391.000
<b>2004</b>	NE	<b>2021</b>	219.714.000
<b>2005</b>	132.976.000	<b>2022</b>	332.125.000
<b>2006</b>	132.976.000	<b>2023</b>	331.867.000

The emission factors applied are the given ones in the EMEP 2023 guidebook, which allowed the calculation of NMVOC emission from domestic wastewater handling. The emission factor used is 15mg NMVOC per m<sup>3</sup> wastewater. There is an available emission factor on ammonia but it has not been used for calculation of ammonia emissions, because until now there is no available data on number of people connected to latrines.

#### 7.6.2. Source-specific uncertainties and time-series consistency

In the NFR sector 5.D the activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 125% (rating C) for NMVOC. Time series consistency is ensured by applying the same methodology for the whole time series.

#### 7.6.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files, NFR tables and the IIR.

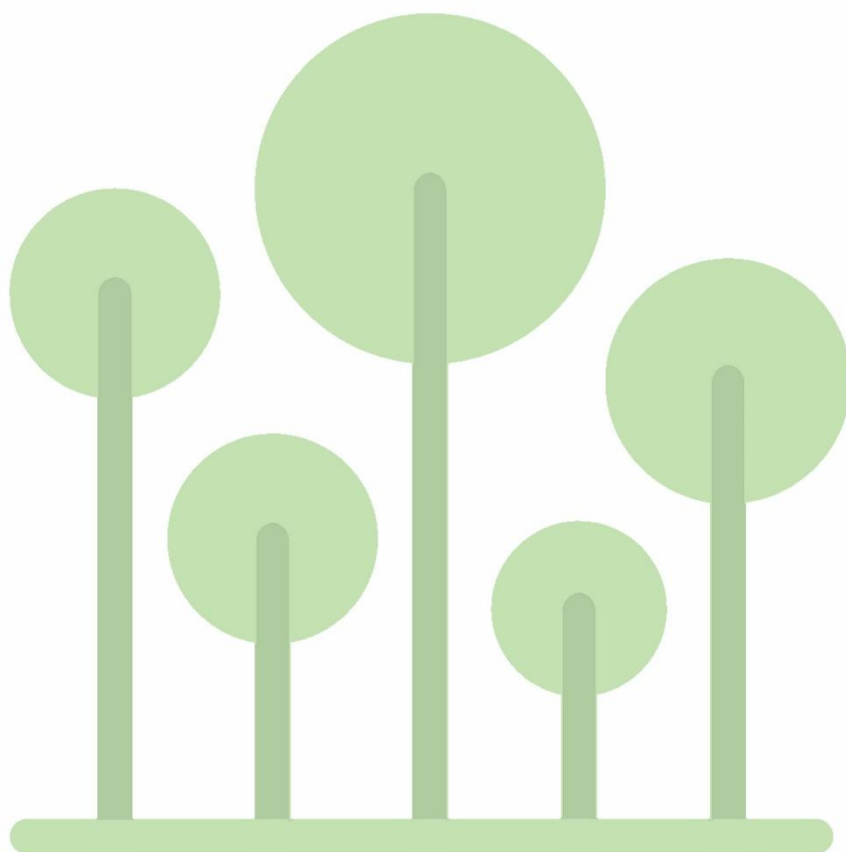
7.6.4. Source-specific recalculations including changes made in response to the review process

No recalculations were made in this category.

7.6.5. Source-specific planned improvements including those in response to the review process

Activity data were received from Annual reports from State statistical office. Data on number of people connected to latrines will be required from the relevant institution. The information and data currently are underestimated regarding the unavailability of data for number of latrines. No data were available in the Census conducted in 2021. EIT will search possibility for estimation of these emissions. Improvement in this category is expected in the frame of the IPA II project.

# OTHER AND NATURAL SOURCES



## 8. NATURAL SOURCES

### 8.1. Sector overview

This chapter describes emissions from (naturally or man-induced) burning of non-managed and managed forests and other vegetation, excluding agricultural burning of stubble, etc. This includes domestic fires (fuel wood, crop residue, dung and charcoal burning), as well as open vegetation fires (forest, shrub, grass and cropland burning).

In this Inventory Report, this chapter shows emissions, which originated from open vegetation forest fires.

This sector includes information and description of the methodologies applied for estimating emissions for NMVOC, NH<sub>3</sub>, NO<sub>x</sub>, SO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, TSP CO and BC as well as references to activity data and emission factors concerning emissions coming from the forest fires for the period 1990-2023.

### 8.1. General description

#### Methodology

Tier 1 approach was used, using the given default Emission factors from the GB2019.

#### Completeness

The information on the completeness in this sector is presented in the following table.

**Table 185 Completed/Not completed NFRs in sector Natural sources**

NFR category	Completeness
11.B Forest fires	√
11.A Volcanoes	NO
11.C Other Natural Sources	NE

### 8.2. Forest fires – NFR 11.B

#### 8.2.1. Methodological issues

The Tier 1 approach for emissions from forest fires uses the general equation:

$$E_{pollutant} = \sum AR_{burned} \times EF_{pollutnat}$$

Where:

$E_{pollutant}$  = is the emission of a certain pollutant.

$AR_{burned}$  = is the total area that has been burned/wood burned

$EF_{pollutant}$  = is the emission factor for this pollutant.

##### 8.2.1.1. Activity Data

The activity data for this sector are taken from the publication Forestry, 2000–2014[35], published by the Statistical office, as well on data received on the requirement sent to the Public enterprise Macedonian forests on our request.

**Table 186 Activity data for source category 11.B Forest fires**

<b>Year</b>	<b>Area burned [ha]</b>	<b>Wood burned [m3]</b>	<b>Wood burned [kg]</b>
1990	NE	1 131	870 870
1991	NE	3 729	2 871 330
1992	NE	2	1 540
1993	NE	4 213	3 244 010
1994	NE	96 612	74 391 240
1995	NE	54 228	41 755 560
1996	NE	636	489 720
1997	NE	4 084	3 144 680
1998	NE	4 214	3 244 780
1999	NE	3 856	2 969 120
2000	4 807	711 782	548 072 140
2001	5 255	88 260	67 960 200
2002	5 482	24 661	18 989 186
2003	1 922	10 987	8 459 990
2004	1 798	4 322	3 328 171
2005	3 093	1 063	8 185 510
2006	3 594	12 978	9 993 060
2007	34 443	617 678	475 612 060
2008	15 046	35 652	27 452 425
2009	1 030	1 551	1 194 270
2010	4 725	2 033	1 565 410
2011	8 702	55 743	42 922 341
2012	19 312	102 160	78 663 200
2013	2 844	15 268	11 756 090
2014	1 150	19 152	14 747 040
2015	3 165	32 494	25 020 380
2016	2 166	17 573	13 531 749
2017	13 405	82 981	63 895 455
2018	2 823	5786	4 455 205
2019	15 675	95 940	73 872 414
2020	1 234	8138	62 66 260
2021	12 315	49 0023	377 318 080
2022	1 956	12 477	9 607 444
2023	5772,48	18940,50	14584185

#### 8.2.1.2. Emission factors

Calculation of emission parameters was used, and emission factors were taken from the GB 2023.

**Table 187 Emission factors for source category 11.B Forest fires**

Pollutant	Value	Unit	References
NO <sub>x</sub>	100	kg/ha area burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
CO	3000	kg/ha area burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
NMVOC	300	kg/ha area burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
SO <sub>x</sub>	20	kg/ha area burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
NH <sub>3</sub>	20	kg/ha area burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
PM <sub>10</sub>	11	g/kg wood burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
PM <sub>2.5</sub>	9	g/kg wood burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
TSP	17	g/kg wood burned	GB 2023, 11B Forest fires, Table 3-1, pg. 9
BC	9	%PM <sub>2.5</sub>	GB 2023, 11B Forest fires, Table 3-1, pg. 9

In the Statistical Yearbooks from 2000-2016 [22] there is data for wood burned in m<sup>3</sup>. Calculation is made for wood burned in kg using the equation: average density 0.77 kg/m<sup>3</sup> \*1000.

#### 8.2.2. Source-specific uncertainties and time-series consistency

No data available for burned area for the period 1990-1999.

#### 8.2.3. Source-specific QA/QC and verification

Macedonian Forests Company provided the data that was crosschecked with the data published in the SSO publication Forestry.

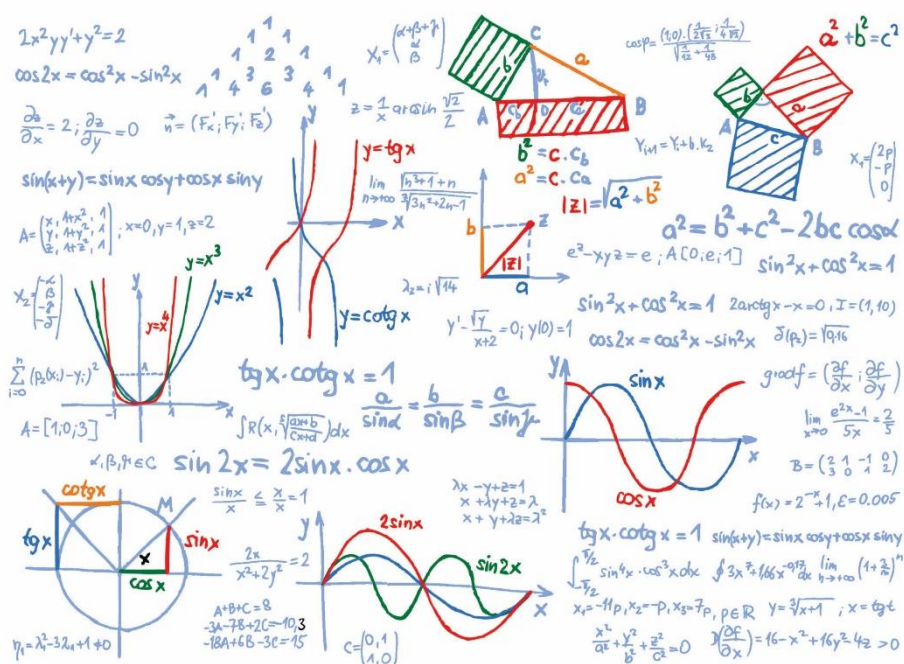
#### 8.2.4. Source-specific recalculations including changes made in response to the review process

**No recalculations were done in this sector.**

#### 8.2.5. Source-specific planned improvements including those in response to the review process

It is possible to investigate other natural sources but emissions coming from this category are not calculated in national totals and the rate of importance is considered low compared to other categories.

# RECALCULATIONS





## 9. RECALCULATIONS AND IMPROVEMENTS

### 9.1. Recalculations

The following section summarizes the changes made since the previous submission for each sector (e.g. methodological changes, update of activity data, new emission sources). Detailed information per category can be found in the chapters per sector, above.

#### 9.1.1. Explanation of recalculations per sector

The recalculation was based on the availability and correction of activity data due to use of final energy balances for 2022 as well as due to change of methodology and detail activity data.

Explanations for recalculation per sector are given in the respective chapters. The tables indicating recalculations per pollutant can be found in tables 199-213.

#### Energy (NFR 1)

In the NFR sectors 1.A.2 - Combustion in manufacturing industries and 1.A.4 - Small combustion, final fuel consumption data has been used for 2022 instead of preliminary data. Also, Tier 2 methodology was performed for 1A4bi.

#### Transport (NFR 1.A.3)

Emissions from offroad transport were calculated with higher tier methodology in the following categories: 1A2gvii, 1A4a, 1A4bii and 1A4cii.

#### Industrial processes and product use (NFR 2)

Recalculations were performed due to use of higher tier methodology for categories 2D3e and 2D3f and more detail available activity data for categories 2D3g and 2G.

#### Agriculture (NFR 3)

Recalculations were performed only in category 1A4bi due to omission of added value in the excel calculation file.

#### Waste (NFR 5)

No recalculations were done in this sector.

#### Recalculations per pollutant

The following tables present the changes of emissions for all air pollutants (reported mandatory by North Macedonia), compared to the previous submission for 1990 and 2022 national totals.

**Table 188 Recalculation difference of NO<sub>x</sub> emissions [kt] compared to submission in 2025**

NO <sub>x</sub> emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	-0.07	-1%
1A3	Transport	0.00	0%	0.00	0%
1A4	Other Sectors	-0.31	-18%	0.01	0%
1B	Fugitive Emissions	0.00	0%	0.00	-

NO <sub>x</sub> emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
2	Industrial Processes and Product Use	0.00	2%	0.00	4%
3	Agriculture	0.00	0%	0.00	0%
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-0.31</b>	<b>-1%</b>	<b>-0.06</b>	<b>0%</b>

**Table 199 Recalculation difference of NMVOC emissions [kt] compared to submission in 2022**

NMVOC emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0%	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0%	0%
1A3	Transport	0.00	0%	0%	0%
1A4	Other Sectors	-3.95	0%	-37%	-1%
1B	Fugitive Emissions	0.00	-35%	0%	-44%
2	Industrial Processes and Product Use	-3.33	0%	-29%	-22%
3	Agriculture	0.23	3%	4%	0%
5	Waste	0.00	0%	0%	0%
6	Other	0.00	-	-	-
<b>Total</b>	<b>Total emissions</b>	<b>-7.05</b>	<b>-3%</b>	<b>-15%</b>	<b>-17%</b>

**Table 189 Recalculation difference of SO<sub>2</sub> emissions [kt] compared to submission in 2022**

SO <sub>2</sub> emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.23	9%
1A3	Transport	0.00	0%	0.00	0%
1A4	Other Sectors	-0.07	-10%	-0.01	-6%
1B	Fugitive Emissions	0.00	0%	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-0.07</b>	<b>0%</b>	<b>0.22</b>	<b>0%</b>

**Table 190 Recalculation difference of NH<sub>3</sub> emissions [kt] compared to submission in 2022**

NH <sub>3</sub> emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	-
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	-
1A3	Transport	0.00	0%	0.00	0%

NH <sub>3</sub> emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A4	Other Sectors	-0.05	-41%	-1.00	-94%
1B	Fugitive Emissions	0.00	-	0.00	0%
2	Industrial Processes and Product Use	0.00	0%	0.00	-
3	Agriculture	0.10	1%	-0.04	-1%
5	Waste	0.00	-	0.00	-
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	0.04	0%	-1.05	-13%

**Table 191 Recalculation difference of PM2.5 emissions [kt] compared to submission in 2022**

PM2.5 emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0.00	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0.02	0.00	5%
1A3	Transport	0.00	0.00	-0.02	0%
1A4	Other Sectors	-4.83	-0.37	0.00	-6%
1B	Fugitive Emissions	0.00	0.00	-0.09	0%
2	Industrial Processes and Product Use	0.23	0.31	0.04	167%
3	Agriculture	0.00	0.00	0.00	0%
5	Waste	0.00	0.00	0.00	0%
6	Other	0.00	0.00	-0.07	-
<b>Total</b>	<b>Total emissions</b>	<b>-4.60</b>	<b>-0.04</b>	<b>0.00</b>	<b>0%</b>

**Table 192 Recalculation difference of PM10 emissions [kt] compared to submission 2022**

PM10 emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	-	0.03	6%
1A3	Transport	0.00	-	0.00	0%
1A4	Other Sectors	-4.96	-	-0.39	-6%
1B	Fugitive Emissions	0.00	-	0.00	0%
2	Industrial Processes and Product Use	0.44	-	0.60	23%
3	Agriculture	0.00	-	0.00	0%
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-4.53</b>	<b>0%</b>	<b>0.24</b>	<b>2%</b>

**Table 193 Recalculation difference of TSP emissions [kt] compared to submission in 2022**

TSP emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	0%

TSP emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A2	Manufacturing Industries & Construction	0.00	-	0.00	0%
1A3	Transport	0.00	-	0.00	0%
1A4	Other Sectors	0.00	-	-0.02	0%
1B	Fugitive Emissions	0.00	-	0.05	16%
2	Industrial Processes and Product Use	0.00	-	-1.25	-38%
3	Agriculture	-0.40	-	-0.11	-4%
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-0.40</b>	<b>0%</b>	<b>-1.33</b>	<b>-8%</b>

**Table 194 Recalculation difference of CO emissions [kt] compared to submission in 2022**

CO emissions [kt]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0.00	0%	0%
1A2	Manufacturing Industries & Construction	0.00	0.23	0%	6%
1A3	Transport	0.00	0.00	0%	0%
1A4	Other Sectors	-25.81	-1.43	-38%	-4%
1B	Fugitive Emissions	0.00	0.00	0%	-
2	Industrial Processes and Product Use	0.03	0.04	2%	8%
3	Agriculture	0.00	0.00	-	-
5	Waste	0.00	0.00	0%	0%
6	Other	0.00	0.00	-	-
<b>Total</b>	<b>Total emissions</b>	<b>-25.78</b>	<b>-1.16</b>	<b>-19%</b>	<b>-2%</b>

**Table 195 Recalculation difference of Pb emissions [t] compared to submission in 2022**

Pb emissions [t]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.04	9%
1A3	Transport	0.00	0%	0.00	0%
1A4	Other Sectors	-0.17	-15%	0.00	0%
1B	Fugitive Emissions	0.00	-	0.00	#DIV/0!
2	Industrial Processes and Product Use	3.42	2%	4.69	1192%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>3.25</b>	<b>1%</b>	<b>4.72</b>	<b>213%</b>

**Table 196 Recalculation difference of Cd emissions [t] compared to submission in 2022**

Cd emissions [t]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0,00	0%	0,00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	4%
1A3	Transport	0.00	0%	0.00	0%
1A4	Other Sectors	-0.08	-41%	0.00	0%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.01	1%	0.01	29%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-0.08</b>	<b>-5%</b>	<b>0.01</b>	<b>4%</b>

**Table 197 Recalculation difference of Hg emissions [t] compared to submission in 2022**

Hg emissions [t]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	4%
1A3	Transport	0.00	0%	0.00	0%
1A4	Other Sectors	0.00	0%	0.00	-1%
1B	Fugitive Emissions	0.00	0%	0.00	0%
2	Industrial Processes and Product Use	0.00	0%	0.00	1%
3	Agriculture	0.00	0%	0.00	-
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	0%	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>0.00</b>	<b>0%</b>	<b>0.00</b>	<b>1%</b>

**Table 198 Recalculation difference of PCDD/ PCDF emissions [t] compared to submission in 2022**

PCDD/ PCDF emissions [t]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.05	11%
1A3	Transport	0.00	-	0.00	-
1A4	Other Sectors	-5.23	-41%	-0.41	-7%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-5.23</b>	<b>-26%</b>	<b>-0.36</b>	<b>-4%</b>

**Table 199 Recalculation difference of PAHs emissions [t] compared to submission in 2022**

PAHs emissions [t]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.04	9%
1A3	Transport	0.00	-	0.00	0%
1A4	Other Sectors	-2.23	-40%	-0.15	-6%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	-1%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	-
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-2,23</b>	<b>-31%</b>	<b>-0,12</b>	<b>-5%</b>

**Table 200 Recalculation difference of HCB emissions [kg] compared to submission in 2022**

HCB emissions [kg]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	-
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	5%
1A3	Transport	0.00	-	0.00	-
1A4	Other Sectors	-0.03	-41%	0.00	0%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	-
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-
<b>Total</b>	<b>Total emissions</b>	<b>-0.03</b>	<b>0%</b>	<b>0.00</b>	<b>0%</b>

**Table 201 Recalculation difference of PCB emissions [kg] compared to submission in 2022**

PCB emissions [kg]		1990		2022	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	-
1A2	Manufacturing Industries & Construction	0.00	0%	0.04	12%
1A3	Transport	0.00	-	0.00	-
1A4	Other Sectors	0.00	-1%	0.00	-9%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-

<b>Total</b>	<b>Total emissions</b>	0.00	0%	0.04	0%
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## 9.2. Planned Improvements

In the following table the planned improvements that are listed were recommended but were not implemented up to now and are planned to be implemented in the future. The improvements are structured as general issues and summaries sector improvements, while detail sector improvements are given in Chapters 3-7.

**Table 202 Planned improvements**

Subject	Source	Rating	Improvement planned	Timeline/Comments
Recalculations to be quantified for the whole time series, currently (i.e. Submission 2017) only for 1990 and last reporting year	NEIT	Medium	Depends on possibility to make it due to limited capacities, but it will be done for future submissions.	Planned to be implemented in the following submissions – it is planned to prepare whole time recalculation in IPA technical project during 2025-2026
Preparation of QA/QC plan	NEIT	Medium	There are a lot of QA/QC procedures and Matrix flow has been prepared but due to limited capacities QA/QC plan has not been yet prepared, it is considered to be preparing in the forthcoming IPA project.	2025-2026
Implement higher Tier method for all the key categories.	NEIT	High	Tier 2 method is implemented for several categories and Tier 3 is implemented in Transport and Energy production. However, there are still many categories for which we use Tier 1 method	Higher Tier method was implemented for agriculture sector 3B by IIASA in EU 4 Green project but the results should be analysed and will be implemented for
Submission of projections data is planned for the following submissions.	NEIT	High		IPA technical project during 2025-2026 and to submit data in 2027
Improvement of the information on gridded data	NEIT	Medium		Text will be improved with next submission of gridded data in 2025

### 9.3. Status of implementation of ERTs in-depth review recommendations (CLRTAP stage 3 review and if applicable NECD review)

#### 9.3.1. Status of implementation of last and previous reviews

**Table 214 Status of implementation of last and previous reviews**

Category	Notes	Source	Rating	Status
General	North Macedonia does not provide information on the condensable component of PM in the IIR. To the question on the issue North Macedonia answered that they will consider the issue and include it in a forthcoming project during 2021. The ERT recommends North Macedonia to include this project in the improvement plan in the next submission and to report the results of the project regarding condensable component in IIR Table A6.1 as requested in Reporting Guidelines Annex II.	CEIP/S3.RR/2020/North Macedonia	Medium	Implemented. Status on condensables is included in the IIR submitted in 2021 as Appendix 2
1A2gvii 1A4aaii 1A4bii 1A4cii	Improvement of Non road mobile machinery related emissions for whole historic trend with use of 1.A.4 Non road mobile machinery Annex 2023 model for calculation of emissions from this sector with Tier 2 methodology  Improvement of activity data used from national energy balances.  Use of the assumptions from neighbouring country.	CEIP/S3.RR/2016/North Macedonia	High	Tier 2 Methodology implemented in this reporting cycle
1.A.3.b	ERT noticed the inconsistency of data in road transport. There is a need to use the same methodology	CEIP/S3.RR/2016/North Macedonia	High	COPERT V model was used for emission calculations for period 2005-2022
1.A.3.b	ERT noted that the EF used for passenger cars gasoline fuel for Euro 0 vehicles in IIR Table 74 (Emission factor for source category 1A3bi Road Transport: Passenger cars used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodologies) differs from the EF in Guidebook 2019. The ERT recommends that the Party adds an explanation for the use of this EF and documents the calculation of Euro 0 passenger cars' gasoline emissions in the IIR.	CEIP/S3.RR/2020/North Macedonia	Low	Explanation included in IIR
1.A..3.b	The ERT identified some errors in the reported values such as CO from NFR 1A3b in the 2019 submission and in the 2020 submission. In the 2019 submission the value of CO emissions for 1991 was 35.295 kt. and in the 2020 submission the value of CO emission was 56.323 kt. During the review the Party explained that there was a mistake in the 2019	CEIP/S3.RR/2020/North Macedonia	Low	Value was corrected.



	submission and that in the 2020 submission the value was correct.			
1.A.2.gvii 1.A.4aii 1.A.3a 1.A.3b 1.A.3cii and 1.A.3ciii	Inconsistency in notation keys and explanation of the reasons for the use of the notation keys	CEIP/S3.RR/ 2020/North Macedonia	Low	Notation keys changed and explanation included in the IIR according to the recommendations given by Stage 3 review
1.A.3.a and 1.A.3.b	The ERT noted that BC emissions from 1A3ai (i). and 1A3aii (i). 1A3c. 1A3b emissions are not reported	CEIP/S3.RR/ 2016/North Macedonia § 20	Low	Black carbon emissions were calculated for these categories
1.A.3.c	The ERT recommended use of higher tier methodology	CEIP/S3.RR/ 2020/North Macedonia	Low	Tier 2 was implemented for 2020-2021 emissions due to available data
1.A.3.ei	The ERT recommends that the party contacts the gas supplier to find out if compressor stations are used in the FYROM and which technologies they use to maintain the pressure in the pipelines.	CEIP/S3.RR/ 2016/North Macedonia	Low	The National inventory team has contacted the gas supplier and receive information that stations are on electricity. therefore the notation key NO-Not occurring is inserted for the whole series and this is explained in the IIR.
1A4bi	Shift from Tier 1 methods to Tier 2 given this is key category	CEIP/S3.RR/ 2020/North Macedonia	High	Collection of activity data for the burning of wood, and on use of pellets systems in the country and moving from Tier 1 to Tier 2 methodology for solid biomass and coal combustion according to different appliance types on a per country basis.  Prepare a mathematical model for emission calculation for the whole historic period of time.  Provide information on assumptions used. Combine GAINS and national data. Link prepared mathematical model with NFR calculation tool at DMS. Tier 2 Implemented and data reported in this submission
1.A.4.bi				
General	The ERT would like to point out that a Tier 2 or 3 methodology should be applied to all sources identified as key categories and thus would apply to all sources listed in tables 2 to 7.	CEIP/S3.RR/ 2016/		Currently Tier 2 methodologies are implemented only on limited NFR sectors but few more sectors in this submission. However, for most of the sectors, T1 calculations are possible due to data constraints, but further methodological improvements will be investigated. Tier 3

				COPERT methodology for 2014-2018 has been implemented but data were not submitted in the reporting round. The submission at least for the period 2014-2018 will be done in the next submission. The NERT has already prepared TAEIX expert mission application for calculation of historical emissions up to 2013 which has been approved by EU commission and is expecting that the mission will be carried out In period 2020-2022
General	The ERT wants to point out that where the older versions of Guidebook are used for emission calculations reasoning for that should be provided in the IIR because it is generally recommended to use the latest version of the Guidebook.	CEIP/S3.RR/2016/		The NIT has used 2023 EMEP Guidebook for a lot of sector. however due to limited activity data for some sectors EF from older Guidebooks are used.
General	During the review. the ERT pointed out that Tier 2 or higher tier methods should be used for key categories instead of Tier 1 methods that are currently used for most categories.	CEIP/S3.RR/2016/		The NIT has started to use Tier 2 for several sector in Transport. Industry and Agriculture.
General	In the inventory improvement plan. the FYROM indicated to carry out a trend assessment within the KCA in future years	CEIP/S3.RR/2016/		Trend assessment analysis was included in the IIR the following year after the stage 3 review was done.
General	The ERT recommends actual value of emissions instead of a plain zeroor replacement of the value with an appropriate notation key.	CEIP/S3.RR/2016/		This recommendation has been implemented.
General	The 2016 submission included LPS data for 2014 but no gridded emissions	CEIP/S3.RR/2016/		Gridded data for 2015 were reported in 2017 but information was not included in the IIR due to limited capacities.
1.A.3.b	For 2014. 2015 and 2016 data. Tier 2 methodology was applied. MEPP is planning to start with the use COPERT V model for calculating transport emissions in future.	CEIP/S3.RR/2016/Macedonia	High	COPERT V model was used for emission calculations for period 2005-2022
1.A.5.a	In the IIR it is stated that this sector is not estimated due to lack of activity data and that it seems not to have a major impact on the national emissions and will be calculated or categorized as IE when activity data or information are made available in the future submissions. The ERT recommends that North Macedonia includes this issue in their planned improvements and follows up on them.	CEIP/S3.RR/2016/North Macedonia	High	Emission from this sector are IE and information is included in the IIR
2.B.10.a	To the question on if it is assumed that any of the activities falling under the scope of NFR 2B10a exist in the territory of North Macedonia and in case they exist. can the Party estimate emissions be using the guidance given by the ERT North Macedonia responded that the	CEIP/S3.RR/2020/Macedonia	High	Emissions are estimated for period 1990-2005

	following activities existed in earlier years or existed also currently: sulfuric acid (040401). Fertilizer do not know which one. Chlorine production - mercury cell (040413). Phosphate fertilisers (040414). Polyethylene low density (040506) and polyethylene high density (040507). Polyvinylchloride (040508).			
2.C.1	During the review, the ERT noted that according to the IIR (page 54, Table 8) NFR 2C1 is one of the Key categories for Hg emissions, and that on page 59 in Table 20, where the results of the level and trend assessment for Hg are presented, key Hg category 2C1, is missing	CEIP/S3.RR/2020/Macedonia	Medium	KCA was corrected
2.C.2 2.C.3 2.D.3.b	The ERT noted dips in the ferroalloys production activity data in 2001 of 85% and in 2009 of 64% and a jumps in 2004 of 346% (approx. 4.5 times) and in 2010 of 121% (approx. 4.2 times). The ERT noted jumps in the activity data of secondary aluminium production in 1999 of 84% and in 2002 of 54% and a dip in 2004 of 80%. The ERT noted a jump in all emissions in 1999 of 145% (approx. by 2.4 times) in road paving with asphalt. To a question on the issue North Macedonia answered that in the statistics the length of roads is the highest in 1999. The ERT recommends North Macedonia to include this information in the next submission	CEIP/S3.RR/2020/Macedonia	Low	Explanation incorporated in the report
2.C.7.c	the ERT asked North Macedonia to provide revised estimates for SO2 and TSP during the review	CEIP/S3.RR/2020/Macedonia	Low	Estimation provided and included in 2022 submission
2.D.3 g	During the review the ERT looked through the activities that are included in the inventory under the category 2D3g and noted that some of the activities that are covered in the Guidebook 2019 version are not included in the inventory of North Macedonia, such as: Asphalt blowing, Adhesive tape manufacturing, Pharmaceutical products manufacturing, Textile finishing and Manufacture of tires. In the IIR on p. 213, there is information about the plan to check the availability of data on Textile finishing and pharmaceutical products manufacturing and to report the related emissions in the following submissions. However, there is no information on why activities like Asphalt blowing, Adhesive tape manufacturing and Manufacture of tires are not included.	CEIP/S3.RR/2020/North Macedonia	High	Information is included in the IIR
2.K	The ERT noted that the notation key "NE" is reported for emissions of Hg and PCB from category 2K. The ERT noted that an EF based on population is given in the Guidebook.	CEIP/S3.RR/2020/Macedonia	High	Estimation provided and included in 2022 submission

2.D.3.a	The ERT also notes that the national statistical office, wholesale businesses or industry associations may have the statistics on the consumption of different products that are part of domestic use and required for calculation of NMVOC emissions with the Tier 2b of the Guidebook. Alternatively, as presented on p.18 of Ch. 2D3a in Guidebook 2019, product consumption may be calculated from statistics on the production of these products, provided that import and export data are available to recalculate from production to consumption	CEIP/S3.RR/2020/Macedonia	High	Estimation for this category provided and included in 2022 submission
2.D.3.a	The NFR tables that NMVOC emissions from 2D3a domestic solvent use including fungicides do not show a peak during the COVID-19 pandemic	CEIP/S3.RR/2024/North Macedonia	Medium	Explanation included
2.D.3.e	Shift from Tier 1 methods to Tier 2 given this is key category	CEIP/S3.RR/2020/Macedonia	High	NMVOC emissions were calculated using solvents statistics on the sales of cleaning products and the Tier 2 method according to GB2023. According to the Guidebook the most common organic solvents for vapour cleaning are methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL) that normally require a closed cleaning machine while for batch cold cleaners the primary solvents used are mineral spirits, Stoddard solvents (white spirit) and alcohols like propylene glycol.
2.D.3.i 2G	NMKs inventory does not include emissions estimates from activities that probably exist on the territory of NMK like Use of fireworks, Other product use (concrete additive, cooling lubricant, lubricant), and other industrial application of solvents in products) and Barbeque, which fall under the scope of NFR 2G, Application of glues and adhesives, Other (preservation of seeds), which fall in the scope of NFR 2D3i.	CEIP/S3.RR/2020/Macedonia	Medium	Data on fireworks included
2.D.3.f	Shift from Tier 1 methods to Tier 2 as recommended by the ERT	CEIP/S3.RR/2020/North Macedonia	High	Tier 2 methodology implemented
3.B.4.g.ii	No explanation was received for the high broiler number in 2013. The ERT recommends that the Party further investigates the deviation for 2013 and encourages to complete the documentation of the statistics in the IIR with this information.	CEIP/S3.RR/2020/North Macedonia	Low	Implemented

3.D.a.2.a and 3.D.a.3	The ERT recommends that the Party estimate and report NH3 emissions from NFRs 3.D.a.2.a and 3.D.a.3 separately even if those emissions are still calculated using Tier 1.	CEIP/S3.RR/2020/North Macedonia	High	Implemented
3	However, while EFs are provided in Table 149 of the IIR, the methodology is not elaborated. The ERT encourages the Party to provide a more detailed description of the methodology for calculating particle emissions in the IIR	CEIP/S3.RR/2016/North Macedonia	Low	Implemented
3.D.1	Based on the data set provided by the Party the ERT concludes that the N contents of the fertilizers equal those of Guidebook and recommends that the Party moves to Tier 2 methodology using the proposed N contents	CEIP/S3.RR/2016/North Macedonia	High	Implemented
3.B	The ERT recommends that the FYROM estimate emissions from key categories by using at least the Tier 2 method provided in Chapter 3B of the Guidebook.	CEIP/S3.RR/2020/North Macedonia	Low	Implemented
3.B.3. 3.B4.gi. 3.B4.giii	Party has reported emissions for Black carbon (BC) as notation key "NE". Emissions of these pollutants are not expected from these categories as no methods are provided in the Guidebook. The ERT recommends using notation key "NA".	CEIP/S3.RR/2020/North Macedonia	Low	Implemented
3.B.3	Pb is reported as notation key "NE". Emission of this pollutant is not expected from this category as no methods are provided in the Guidebook, and "NA" is recommended.	CEIP/S3.RR/2020/North Macedonia	Low	Implemented
3.B.1.b	For 3B1b emissions of CO is reported as "NE". Emission of this pollutant is not expected from this category as no methods are provided in the Guidebook, and notation key "NA" is recommended	CEIP/S3.RR/2020/North Macedonia	Low	Implemented
3Da2a	The NH3 emissions from manure application to land (3Da2a) and from excreta deposited during grazing (3Da3) is wrongly described in the IIR to be included elsewhere "IE" under NFR 3B. In the NFR reporting tables the emission figures are reported under 3D. The ERT encourages North Macedonia to correct the information in the future IIR.	CEIP/S3.RR/2020/North Macedonia	Low	Implemented
3.Da.2a and 3.Da.3	the Party has reported emissions for Black carbon (BC) with the notation key "NE". Emissions of these pollutants are not expected from these categories and no methods are provided in the Guidebook. The ERT recommends using notation key "NA".	CEIP/S3.RR/2020/North Macedonia	Low	Implemented
3.D.1	The ERT notes that North Macedonia reports emissions NMVOC, PM2.5 and PM10 emissions from inorganic fertilizers under NFR 3D1. According to the 2016/2019 versions of the Guidebook	CEIP/S3.RR/2020/North Macedonia	Low	Implemented

	there is no method for calculating these emissions. The ERT therefore recommends the Party to report the notation key "NA" instead of emission values.			
3.Da.1	The ERT also notes the for use of emission factors in NFR 3Da1 that in the 2016/2019 Guidebook versions refer to NFR 3De. Cultivated crops (NMVOC) and NFR 3Dc. Farm-level agricultural operations (PM2.5 and PM10). When no methods are given in the 2016/2019 Guidebook. the ERT recommend the use of "NA" in NFR 3Da1 for NMVOC. PM2.5 and PM10. In addition. the Party should estimate the currently missing NMVOC emissions from NFR 3De and PM2.5 and PM10 emissions from NFR 3Dc using the 2019 Guidebook version Table 3.1. For 3D1 the ERT recommends the Party to replace the emission values with the notation key "NA".	CEIP/S3.RR/2020/North Macedonia	High	Implemented
3.D.1	The Party is using emission factor for NOx emissions from inorganic fertilizer from the 2013 version of the Guidebook. but the IIR is referring to EF from the 2016 Guidebook. Due to consistency the ERT recommend the Party to always use updated EFs from the same and the latest Guidebook version and to recalculate the emissions for the time series to the next submission. During the review North Macedonia provided a revised estimate for NOx emissions from NFR 3D1 using updated emission factor as presented in Annex I to this review report.	CEIP/S3.RR/2020/North Macedonia	High	Implemented
3.D.f	The ERT recommends North Macedonia to provide a transparent description of the use of the notation key "NO". providing all relevant documentation in the 2024 submission of the IIR. Macedonia	CEIP/S3.RR/2022/North Macedonia	Medium	The required information is inserted in the IIR
3.Da.1	The ERT recommends that the Party clearly document the procedure used to calculate emissions from NFR 3Da1. Inorganic Nfertilisers.	CEIP/S3.RR/2022/North Macedonia	High	The required information is inserted in the IIR and source of EF for NOx is changed
5.A	The ERT sent technical correction and the Party accepted to include it in the next submission. The ERT recommends North Macedonia to correct the emission factor for PM2.5 in line with the revised estimate sent to the ERT during the review in the next submission. The ERT recommends the Party to provide detailed explanation of the methodology used for calculation of emissions in the IIR of the next submission.	CEIP/S3.RR/2020/North Macedonia	High	EF was corrected and detailed explanation of the methodology used for calculation of emissions in the IIR.
5.C1.biii	The ERT recommends North Macedonia to correct these PCDD/F emissions in the next submission according to the revised estimate sent to the ERT. The ERT	CEIP/S3.RR/2020/North Macedonia	High	The revised estimates were included and reference for the source of SOx. Hg. As and Ni. Was provided in the IIR.

	noted that no information is provided in the IIR regarding the reference to the source of emission factors of SOx, Hg, As and Ni. asked North Macedonia if it possible to use a higher tier method to estimate emissions from this category.			Higher method was implemented.
5.D.1	The ERT noted that emissions of PAHs were calculated using other emission factors than listed in the IIR.	CEIP/S3.RR/2020/North Macedonia	Medium	Calculations for PAHs were corrected
5.D.1	NH3 emissions should be reported under NFR 5D1. and that under NFR 5D2 both SNAPs are listed for domestic and industrial wastewater treatment. and that they can reallocate the emissions from domestic wastewater treatment to the category 5D1 if necessary	CEIP/S3.RR/2020/North Macedonia	Low	Emissions were reallocated as suggested by the ERT
5.D.2	The ERT noted significant decrease and subsequent increase of emissions of NMVOC in the category 5D2. but that no explanation was provided in the IIR. The ERT recommends the Party to report data on domestic and industrial wastewater handling separately and to explain in the IIR the decrease of NMVOC emissions from industrial wastewater handling in 2017	CEIP/S3.RR/2020/North Macedonia	Low	Emissions from 5D1 and 5D2 were reported separately and explanation of the variations of the trend in the IIR was included.
5.E	The ERT noted that emissions under the category 5E were reported as NO although this category includes accidental fires of cars. of detached/undetached houses and administrative. industrial buildings.	CEIP/S3.RR/2020/North Macedonia	Low	Notation key was changed

### 9.3.2. Progress a schedule for implementation

Those recommendations given by the stage 3 review that have not implemented by now are listed in the table 215 below.

**Table 203 Sectorial improvements planned**

No	Key Category	Category Code and Name	Issue	Improvement Option	Priority of Improvement	Timing of Improvement
1	Yes	1.A.3.b (i-vii) Road transport	Missing coherent emission trends due to different methodology use.	Develop a mathematical model which will enable emission calculation for the whole historic trend with the use of COPERT 5 model to receive coherent emission trends. Collection of activity data needed for reproduce the historic trend which than can be used in the COPERT 5 or if detail data is not available, use of surrogate data (e.g. neighbouring country).	High	Inventory cycle in 2026
2	No	1.A.3.c Railways	Missing coherent emission trends due to different methodology use.	Improvement of historic railways transport related emissions with collection of detail activity data or if detail data is not available, use of surrogate data or other suitable method according to GB2023.	Low	Inventory cycle in 2026
3	No	2.C.5 Lead production: primary and secondary production	Possible uncompleted activity data.	Review of activity data in use for the emission calculations and edited as appropriate.	Low	Inventory cycle in 2026
4	Yes	2.D.3.d Coating applications	Shift from Tier 1 methods to Tier 2 given this is key category	<p>Improvement of calculation of NMVOC emissions from the solvent and product use sector. This includes data collection and processing (production + import – export).</p> <p>The relevant activity statistics include: the number of painted buses/cars/trucks to calculate the emissions for vehicle coatings; the mass of wire coated to calculate the emissions for wire coating; the mass of leather coated to calculate the emissions for leather finishing; the use of paint to calculate the emissions for all other sources like paint application- construction and buildings, paint application- domestic use (except SNAP 060107), wood coating, coil coating, vehicle refinishing, or</p>	High	Inventory cycle in 2026



No	Key Category	Category Code and Name	Issue	Improvement Option	Priority of Improvement	Timing of Improvement
				<p>other non-industrial paint application).</p> <p>Prepare a mathematical model for emission calculation for the whole historic period of time.</p> <p>Provide information on assumptions used.</p> <p>Provide and information on approximation and surrogate data used.</p>		
5	Yes	3.D.a.2.a Livestock manure applied to soils and 3.D.a.3 Urine and dung deposited by grazing livestock	NOx emissions from NFRs 3Da2a and 3Da3 are reported as "IE" instead of reporting emissions with values.	<p>The Tier 2 method can be facilitated using the N-flow tool available at <a href="https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture">https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture</a></p> <p>This includes national data collection and processing.</p>	High	Next inventory cycle in 2026
7	Yes	3.B Manure Management	Shift from Tier 1 methods to Tier 2 given this is key category	<p>Update agriculture NH3 emissions for 3.B Manure Management to Tier 2 methodology.</p> <p>Changing to a Tier 2 method can be facilitated using the N-flow tool available at <a href="https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture">https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture</a></p> <p>This includes national data collection and processing.</p>	High	Next inventory cycle in 2026
8	Yes	3.D.a.1 Inorganic N fertilisers (includes urea)	<p>The method used for the emission collection is not from the latest the EMEP/EEA Guidebook 2023 and there is the possibility of over/under-estimation of emissions.</p> <p>Shift from Tier 1 methods to Tier 2 given this is key category</p>	The NMK should use a Tier 2 method from the latest version of the EMEP/EEA Guidebook, which provides more accurate emission factors based on best practices for estimating emissions for a sector which is a key category.	High	Next inventory cycle in 2026

No	Key Category	Category Code and Name	Issue	Improvement Option	Priority of Improvement	Timing of Improvement
9	Yes	3.D.e Cultivated crops	The ERT recommends North Macedonia to use a Tier 2 or higher method for the calculation of NMVOC emissions from 3De, Cultivated crops	Provided the transparent description of the methodology in North Macedonia IIR by the 2025 submission. This includes national data collection and processing.	Medium	Next inventory cycle in 2026
10	No	5.D.1 Domestic wastewater handling (Latrines)	Possible under/over-estimation of emissions	This includes review of activity data in use for the emission calculation for Latrines and possible recalculation of emission.	Low	Next inventory cycle in 2026
11	No	5.B.2 Biological treatment of waste - Anaerobic digestion at biogas facilities	This activity exists at the territory of NMK, and the emission calculation is currently missing in the inventory	This includes data collection for the activity data from the biogas facilities in NMK and emission calculations.	High	Next inventory cycle in 2026
12	/	Cross-cutting (DSM: recalculation tool)	Only recalculations for the base year and the previous historic year have been reported.	The improvement of the Recalculation tool will include the provision of recalculated emission data for the entire time series.	High	Next inventory cycle in 2026
13	/	Cross-cutting (DSM: uncertainty tool)	When shift from Tier 1 methods to Tier 2 the Uncertainty tool need to be updated.	The improvement of the Uncertainty tool will include the update of the uncertainty calculation for the NFR categories with improved Tier 2 methodology with the updated uncertainty for higher-tier emission factors, and updated uncertainty for activity data.	High	Next inventory cycle in 2026

# PROJECTIONS



## 10. PROJECTIONS

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The requirement for preparation of national emission projections comes from the:

- Obligation under the Gothenburg protocol (Republic of North Macedonia is a party to the protocol starting from 2014) projections data for 2020, 2025 and 2030 under the Gothenburg Protocol are requirement under the Article 7 of the Gothenburg Protocol and as outlined in the Guidelines for Reporting Emissions and Projections Data under the Convention. ECE/EB.AIR/125; Emission projections need to be sent by 15 March 2017 and every two years thereafter
- Need to prepare National air pollution control program under NEC directive 2016/2284/EU
- Transposition of the revised NEC directive 2016/2284/EU in the national legislation.

### Current situation

Projections for the main pollutants SO<sub>x</sub>, NO<sub>x</sub>, NMVOC and NH<sub>3</sub> have been calculated within the National Program for Progressive Reduction of Emission for the period 2012-2020 [45] which has been prepared within the framework of Western Balkan project “Ratification and implementation of the three last protocols under CLRTAP”. This program has been officially published in 2012.

Within this program two scenarios have been developed: The basic scenario, which relies on policies and measures, planned by the year selected as baseline year. For the development of this scenario an official document, applicable legislation, and year of fulfillment of individual emission reduction measures have been used. Mainly, energy strategic documents were considered. No serious analyses were made on the strategic documents in the industrial, waste and agriculture sector.

A second scenario with measures has been developed based on the Strategy for Energy Development in the Republic of North Macedonia by 2030, The Energy Balance of the Republic of North Macedonia for the period 2012 to 2016, the Environmental Assessment of Strategy, the Strategy for Energy Efficiency Promotion in the Republic of North Macedonia by 2021, the Baseline Study on Renewable Energy Sources in the Republic of North Macedonia and the National Strategy for Transport and others. These Scenarios were compared with the model scenario developed by CEIP (Centre on Emission Inventories and Projections). No scenario with additional measurements has been developed.

Total emission projections with measures have been reported in 2013. However, there is a need of recalculation of SO<sub>x</sub>, NMVOC and NH<sub>3</sub> emission projections.

In accordance with the international agreement with Energy community and Decision D/2013/05/MC-EnC, the Ministerial Council provided the possibility for Contracting Parties to use the option for national emission reduction plan (NERP) as an alternative to setting the emission limit values of Directive 2001/80/EC for each combustion plant individually from 01.01.2018 until 31 December 2027, as well as to define national emission ceilings for LCPs. This approach has been chosen by Republic of North Macedonia and NERP has been prepared within two TAEIX expert missions in the period October 2014-November 2015. The plan includes emission ceilings for eight plants (Three power plants, two heating plants and one oil refinery, which is currently out of work). The Government in December in 2015 has officially adopted this draft plan. This plan contains emission ceilings for the period 2018-2027 for the following pollutants NO<sub>x</sub>, SO<sub>x</sub> and dust. The plan was sent in January 2016 to be checked by Energy Community experts. After the revision the comments were incorporated by

the national working group, responsible for monitoring the implementation of the plan. The revised plan has been approved by the Government in April 2017. The MoEPP is actively monitoring the implementation of the National Emissions Reduction Plan from large combustion plants in the energy sector. According to this Plan, the country is compliant with the national ceiling for nitrogen oxides for 2022, but not for dust and sulfur oxides. Furthermore, defined measures for reduction of projections for the GHG pollutants for 2025, 2030 and 2035 (Basic scenario, Scenario with measures and additional measures) set in the National plan for energy and climate for North Macedonia will also be taken into account when projections for NEC pollutants are prepared [46].

This plan will have impact on the current national emission projections for NO<sub>x</sub>, SO<sub>x</sub> and dust in this plan will also be considered in the process of calculation of 2030 projections for SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>2.5</sub>.

Regarding the inventory within the Twinning project “Further strengthening the capacities for effective implementation of the acquis in the field of air quality”, 6 expert missions have been used for preparation of the framework for future calculation of projections in the following sectors: energy production, energy used in households, transport, industry, waste, and agriculture. The recommendations from all experts were summarized in a Guidance document for preparation of the projections.

One of the planned activities of the project technical project under IPA 2 program “Support for implementation of air quality directives”, is further improvement of the national air emission inventory and preparation of National emission projections under NEC directive 2016/2248/EC. The project was evaluated during 2021 and then canceled by the EU delegation in April 2022. The project was renaunched and the second phase of evaluation expected to begin during April/May 2024. If the project evaluation is finished successfully it is planned that the agreement with the chosen Contractor to be signed at the end of the year, and the activities which include improvement of emission inventory in different sector and preparation of projections for 2030 will start in 2025.

Moreover, in the working package 1-10 in the frame of Regional EU4 Green Project an activity is planned for preparation of the reduction commitments under the amended Gothenburg protocol and Annex 2 of NEC directive. The project is in phase of implementation. The calculated data were based on regional approach but as requested were made available to us. In the frame of IPA II project for air experts were engaged for preparation of projection for 2030 per sector and it is expected that prepared projections are reported until end of this year.

## 11. REPORTING OF GRIDDED EMISSIONS AND LPS

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Republic of North Macedonia is regularly reporting data to fulfill the reporting obligation for gridded emissions and LPS. Last reported data was submitted in 2021 for the 2019 reporting year.

Following, a short description of the methodology for calculation of gridded emissions is presented.

Within a Twinning project, two expert missions on calculations of gridded emissions were carried out. It was decided to prepare gridded emissions for the new EMEP grid resolution (0.1°x0.1° long/lat). Within these missions several proxy tools were developed:

- DISTRIBUTE\_MUNICIPAL\_VALUES\_via\_PROXY\_GRID.xlsm
- DISTRIBUTE\_REGIONAL\_VALUES\_via\_PROXY\_GRID.xlsm

- DISTRIBUTE\_TOTAL\_VALUES\_via\_PROXY\_GRID.xlsm
- LPS\_to\_GRID.xlsm
- Road\_proxy\_calculation.xlsm
- Farm\_and\_farmland\_proxy\_calculation.xlsm

A proxy map to distribute road transport emissions was derived from a road network map for Macedonia from “MapCruzin.com”. Therefore, the road network was intersected with the EMEP grid (by using “ArcGis”) to get the road share per cell. The length of these road fractions was then calculated within the GIS application.

The attribute table was exported from “ArcGis” and imported to Excel to proceed with the further steps. With the road type, which is an attribute of the road network map, an additional weighting was implemented (e.g. motorways were weighted double in comparison with other roads and residential streets were weighted only half). Then these fractions of proxy values, based on the road length and the type weighting, were aggregated to the 315 EMEP grid cells and multiplied with a population density proxy grid which was derived from SEDAC/CIESIN. The result is a proxy grid which considers the road network (including different road types) and the population density to distribute road transport emissions.

In addition, the population grid from SEDAC/CIESIN was adjusted regarding newer municipal population data from Macedonia.

A proxy map to distribute emissions from the agricultural sector was derived from a land use map for Macedonia from “MapCruzin”, Therefore the areas with the types “farm”, “farmland” and “farmyard” were intersected with the EMEP grid (by using “ArcGis”) to get the area share per cell. The attribute table was then exported from “ArcGis” and imported to Excel where these area fractions were aggregated to the 315 EMEP grid cells to get a distribution grid for agricultural emissions.

In addition, a tool was programmed, which was able to sum up the emissions from a list of large point sources to the allocated EMEP grid cells.

These tools were used by national experts to calculate emissions per grids. Furthermore, emissions from major installations for production of heat electricity and industry for production of cement were taken into account. Ferro metals and Incineration of medical waste as well as big swine and poultry farms were allocated in the grids according to their coordinates. Fugitive emissions were distributed using land cover and petrol and mines network.

Additionally, data for small emission was distributed using the population proxy calculations excluding households connected to district heating. Emissions originating from administrative capacities were included from the National cadaster database.

Population data was used to distribute emissions originating from the use of solvents and municipal waste. Emissions from aviation and national navigation are minor and were distributed according to the location of airports and boat ports. For this year reporting calculation of emissions per grid from 2.K were added.

Currently, reporting for 2023 gridded emission data is under preparation, using the same methodology. Data report will be submitted with a certain delay, due to the time alignment with dedicated expert mission that is expected to provide assessment and improvement of the gridded

emission reporting methodology. Provided expert mission assistance is part of current implementation of an IPA3 project related to support in the Implementation of Air Quality Directives. Expected improvement should involve assessment of the reporting methodology calculation, updating the proxy data used for emission distribution and improvement of the data acquisition.

The LPS report comprehensively details the methodologies for calculating emissions from ten distinct installations, encompassing both energy production and industrial processes.

Within the energy sector, there are five large combustion plants. REK Bitola and REK Oslomej, both major electricity producers utilizing lignite, employ different approaches. REK Bitola calculates SO<sub>2</sub>, NO<sub>x</sub>, CO, and TSP using implied Emission Factors (EFs) derived from historical measurements (2020-2022 data), and then estimates PM<sub>10</sub> and PM<sub>2.5</sub> based on a proportion of TSP and Tier 1 EFs from the Guidebook 2023 for NFR category 1.A.1 Energy Industries (Tables 3-3 and 3-6). REK Oslomej, on the other hand, directly uses 2023 measurement data for these pollutants, similarly determining PM<sub>10</sub> and PM<sub>2.5</sub> from measured TSP with proportionality and the same Guidebook Tier 1 EFs. Three natural gas-fired heat production plants—ESM-Energetika and ESM-Toplana Zapad—consistently apply Tier 1 EFs from the Guidebook 2023, NFR category 1.A.1 Energy Industries (Table 3-4) for all parameters. ESM-Toplana Istok is an exception, using 2023 measurement data for NO<sub>x</sub>, while all other parameters follow the same Guidebook Tier 1 EFs. Lastly, TE-TO AD Skopje, a cogeneration plant, relies on 2023 measurement data for SO<sub>2</sub>, NO<sub>x</sub>, and CO, but utilizes Tier 2 EFs from the Guidebook 2023, NFR category 1.A.1 Energy Industries (Table 3-19) for NMVOC, PM<sub>10</sub>, and PM<sub>2.5</sub>, and Tier 1 EFs from the same category (Table 3-4) for heavy metals like Pb, Cd, and Hg.

The report also covers four manufacturing industries. Cementarnica USJE Skopje (cement production) primarily uses 2023 measurement data for SO<sub>2</sub>, NO<sub>x</sub>, CO, and TSP. PM<sub>10</sub> and PM<sub>2.5</sub> are then derived from the measured TSP value using proportionality and EFs from the Guidebook 2023 for NFR category 2.A.1 Cement production (Tier 1, Table 3-1 and Tier 2, Table 3-2), while other parameters use Tier 2 EFs from NFR category 1.A.2 Manufacturing industries and construction (combustion), Table 3-25. Euronickel Industry Kavadarci (ferronickel production) and Makstil Skopje (steel production) both utilize 2023 measurement data for SO<sub>2</sub>, NO<sub>x</sub>, CO, and TSP. For PM<sub>10</sub> and PM<sub>2.5</sub>, they apply proportionality to the measured TSP and Tier 1 EFs from the Guidebook 2023, NFR category 1.A.2 Manufacturing industries and construction (combustion), (Tables 3-2, 3-4, and 3-5), with Makstil additionally incorporating Tier 2 EFs from NFR category 2.C.1 Iron and steel production (Tables 3-19 and 3-22) for these particles and other parameters. Finally, Liberty Skopje (cold mill products) consistently uses Tier 1 EFs from the Guidebook 2023, NFR category 1.A.2 Manufacturing industries and construction (combustion), (Table 3-4) for all its parameters. This comprehensive approach, combining direct measurements with specific Guidebook EFs, ensures a robust calculation of emissions across the diverse industrial landscape.

## 12. ADJUSTMENTS

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Executive Body decisions 2012/3 and 2012/12 concern adjustments to emission reduction commitments or to inventories under the 2012 amended Gothenburg Protocol. The decisions include the detailed lists of supporting information which must be provided in an IIR or in a separate report. Until now, Republic of North Macedonia did not apply for adjustment procedure.

## IIR APPENDEXIS

Appendix 1: Key category analysis

Appendix 2: Summary of whether source sectors use PM emission factors that include/exclude the condensable component

Appendix 3: Further elaboration of completeness. uses of NE & IE and (potential) sources of air pollutant emissions excluded

Appendix 4: National energy balance for 2023

Appendix 5: National totals and NFR sector emissions for 2023



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## APPENDIX 1: Key category analysis

In the process of key categories identification each pollutant was analyzed separately. The results of the level and trend assessment for each pollutant are presented in the following tables.

**Table 204 Key source categories for emissions of NO<sub>x</sub> in Gg**

Level Assessment 2023						
NFR Code	NFR sector		2023		%	%cum
1A3biii	R.T., Heavy duty vehicles		6.18		30.7%	30.7%
1A1a	Public electricity and heat production		5.43		26.9%	57.6%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction		2.61		13.0%	70.6%
1A3bi	R.T., Passenger cars		1.89		9.4%	80.0%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A3biii	R.T., Heavy duty vehicles	3.00	6.18	6.181	30.7%	30.7%
1A1a	Public electricity and heat production	23.77	5.43	5.426	26.9%	57.6%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	2.00	2.61	2.613	13.0%	70.6%
1A3bi	R.T., Passenger cars	5.28	1.89	1.894	9.4%	80.0%
1A3bii	R.T.. Light duty vehicles	0.59	0.96	0.958	4.8%	84.7%

**Table 205 Key source categories for emissions of NMVOC in Gg**

Level Assessment 2023				
NFR Code	NFR sector	2023	%	%cum
1B2av	Distribution of oil products	4.75	22.3%	22.3%
1A4bi	Residential: stationary	4.13	19.4%	41.7%
2D3d	Coating applications	2.80	13.2%	54.9%
2D3a	Domestic solvent use including fungicides	2.60	12.3%	67.2%

3De	Cultivated crops			1.08	5.1%	72.2%
3B1a	Dairy cattle			0.93	4.4%	76.6%
1B1a	Coal Mining and Handling			0.80	3.8%	80.3%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1B2av	Distribution of oil products	2.66	4.75	4.746	22.3%	22.3%
1A4bi	Residential: stationary	5.63	4.13	4.127	19.4%	41.7%
2D3d	Coating applications	3.78	2.80	2.796	13.2%	54.9%
2D3a	Domestic solvent use including fungicides	2.43	2.60	2.605	12.3%	67.2%
3De	Cultivated crops	1.14	1.08	1.076	5.1%	72.2%
3B1a	Dairy cattle	1.64	0.93	0.929	4.4%	76.6%
1B1a	Coal Mining and Handling	1.33	0.80	0.799	3.8%	80.3%

**Table 206 Key source categories for emissions of SO<sub>2</sub> in Gg**

Level Assessment 202						
NFR Code	NFR sector			2023	%	%cum
1A1a	Public electricity and heat production			102.19	97.2%	97.2%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A1a	Public electricity and heat production	102.15	102.19	102.187	97.2%	97.2%

**Table 207 Key source categories for emissions of NH<sub>3</sub> in Gg**

<b>Level Assessment 2023</b>					
<b>NFR Code</b>	<b>NFR sector</b>	<b>2023</b>	<b>%</b>	<b>%cum</b>	
3Da2a	Animal manure	1.21	17.8%	17.8%	
3B1a	Dairy cattle	1.11	16.4%	34.3%	
3Da3	Urine and dung deposited by grazing animals	1.06	15.7%	49.9%	
3B3	Swine	0.91	13.3%	63.3%	

Level Assessment 2023							
NFR Code	NFR sector				2023	%	%cum
3Da1	Inorganic N-fertilizers				0.85	12.5%	75.8%
3B4gi	Laying Hens				0.48	7.1%	82.9%
Trend Assessment 1990-2022							
NFR Code	NFR sector	1990	2023	TA	%	%cum	
3Da2a	Animal manure	3.20	1.21	1.211	17.8%	17.8%	
3B1a	Dairy cattle	1.97	1.11	1.114	16.4%	34.3%	
3Da3	Urine and dung deposited by grazing animals	3.32	1.06	1.063	15.7%	49.9%	
3B3	Swine	0.87	0.91	0.906	13.3%	63.3%	
3Da1	Inorganic N-fertilizers	0.91	0.85	0.849	12.5%	75.8%	
3B4gi	Laying Hens	1.76	0.48	0.483	7.1%	82.9%	
3Da2a	Animal manure	3.20	1.21	1.211	17.8%	17.8%	

**Table 208 Key source categories for emissions of CO in Gg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
1A4bi	Residential: stationary			28.04	63.5%	63.5%
1A3bi	R.T., Passenger cars			3.77	8.5%	72.0%
5A	Solid waste disposal on land			2.90	6.6%	78.6%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction			1.91	4.3%	82.9%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	38.33	28.04	28.037	63.5%	63.5%
1A3bi	R.T., Passenger cars	46.34	3.77	3.773	8.5%	72.0%
5A	Solid waste disposal on land	1.22	2.90	2.900	6.6%	78.6%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	1.03	1.91	1.907	4.3%	82.9%

**Table 209 Key source categories for emissions of TSP in Gg**

<b>Level Assessment 2023</b>						
<b>NFR Code</b>	<b>NFR sector</b>		<b>2022</b>	<b>%</b>	<b>%cum</b>	
1A4bi	Residential: stationary		5.47	32.3%	32.3%	
1A1a	Public electricity and heat production		3.90	23.0%	55.3%	
3Dc	On-farm storage, handling and transport of agricultural products		1.95	11.5%	66.8%	
2A5b	Construction and demolition		1.57	9.3%	76.1%	
2A5a	Quarrying and mining of minerals other than coal		0.78	4.6%	80.7%	
<b>Trend Assessment 1990-2023</b>						
<b>NFR Code</b>	<b>NFR sector</b>	<b>1990</b>	<b>2023</b>	<b>TA</b>	<b>%</b>	<b>%cum</b>
1A4bi	Residential: stationary	7.51	5.47	5.472	32.3%	32.3%
1A1a	Public electricity and heat production	12.78	3.90	3.897	23.0%	55.3%
3Dc	On-farm storage, handling and transport of agricultural products	2.06	1.95	1.951	11.5%	66.8%
2A5b	Construction and demolition	1.24	1.57	1.567	9.3%	76.1%
2A5a	Quarrying and mining of minerals other than coal	0.62	0.78	0.777	4.6%	80.7%

**Table 210 Key source categories for emissions of PM2.5 in Gg**

<b>Level Assessment 2023</b>						
<b>NFR Code</b>	<b>NFR sector</b>		<b>2023</b>	<b>%</b>	<b>%cum</b>	
1A4bi	Residential: stationary		5.06	66.4%	66.4%	
1A1a	Public electricity and heat production		1.07	14.0%	80.3%	
<b>Trend Assessment 1990-2023</b>						
<b>NFR Code</b>	<b>NFR sector</b>	<b>1990</b>	<b>2023</b>	<b>TA</b>	<b>%</b>	<b>%cum</b>
1A4bi	Residential: stationary	6.95	5.06	5.064	66.4%	66.4%
1A1a	Public electricity and heat production	3.50	1.07	1.066	14.0%	80.3%

**Table 211 Key source categories for emissions of PM10 in Gg**

Level Assessment 2023						
NFR Code	NFR sector			2022	%	%cum
1A4bi	Residential: stationary			5.20	40.6%	40.6%
1A1a	Public electricity and heat production			2.63	20.5%	61.2%
3Dc	On-farm storage, handling and transport of agricultural products			1.95	15.2%	76.4%
2G	Other product manufacture and use			0.65	5.1%	81.5%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2022	TA	%	%cum
1A4bi	Residential: stationary	7.13	5.20	5.200	40.6%	40.6%
1A1a	Public electricity and heat production	8.63	2.63	2.631	20.5%	61.2%
3Dc	On-farm storage, handling and transport of agricultural products	2.06	1.95	1.951	15.2%	76.4%
2G	Other product manufacture and use	1.15	0.65	0.647	5.1%	81.5%

**Table 212 Key source categories for emissions of BC in Gg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
1A4bi	Residential: stationary			0.55	67.0%	67.0%
1A3biii	R.T.. Heavy duty vehicles			0.06	7.9%	75.0%
1A3bi	R.T.. Passenger cars			0.06	7.5%	82.5%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	0.69	0.51	0.507	62.0%	62.0%
1A3biii	R.T., Heavy duty vehicles	NE	0.06	0.060	7.3%	69.3%
1A3bi	R.T., Passenger cars	NE	0.06	0.059	7.2%	76.5%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.03	0.04	0.042	5.2%	81.7%

**Table 213 Key source categories for emissions of Pb in Mg**



Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
2G	Other product manufacture and use			4.76	71.1%	71.1%
1A1a	Public electricity and heat production			0.48	7.2%	78.3%
2C1	Iron and Steel Production			0.46	6.8%	85.1%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
2G	Other product manufacture and use	3.42	4.02	4.76	71.1%	71.1%
1A1a	Public electricity and heat production	0.89	0.36	0.48	7.2%	78.3%
2C1	Iron and Steel Production	4.07	0.48	0.46	6.8%	85.1%

**Table 214 Key source categories for emissions of Cd in Mg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
1A4bi	Residential: stationary			0.10	41.6%	41.6%
1A1a	Public electricity and heat production			0.06	27.5%	69.1%
2C1	Iron and Steel Production			0.04	15.8%	84.9%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	0.12	0.10	0.096	41.6%	41.6%
1A1a	Public electricity and heat production	0.11	0.06	0.063	27.5%	69.1%
2C1	Iron and Steel Production	0.02	0.04	0.036	15.8%	84.9%

**Table 215 Key source categories for emissions of Hg in Mg**

Level Assessment 2023				
NFR Code	NFR sector	2023	%	%cum
1A1a	Public electricity and heat production	0.09	45.9%	45.9%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.04	20.7%	66.6%
2C1	Iron and Steel Production	0.02	11.7%	78.3%

Level Assessment 2023						
NFR Code	NFR sector		2023	%	%cum	
2K	"Consumption of POPs and heavy metals		0.02	9.3%	87.6%	
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A1a	Public electricity and heat production	0.17	0.09	0.090	45.9%	45.9%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.03	0.04	0.041	20.7%	66.6%
2C1	Iron and Steel Production	0.09	0.02	0.023	11.7%	78.3%
2K	"Consumption of POPs and heavy metals	0.02	0.02	0.018	9.3%	87.6%

**Table 216 Key source categories for emissions of As in Mg**

Level Assessment 2023						
NFR Code	NFR sector		2023	%	%cum	
1A1a	Public electricity and heat production		0.46	87.4%	87.4%	
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A1a	Public electricity and heat production	0.84	0.34	0.460	87.4%	87.4%

**Table 217 Key source categories for emissions of Cr in Mg**

Level Assessment 2023						
NFR Code	NFR sector		2023	%	%cum	
1A1a	Public electricity and heat production		0.22	27.7%	27.7%	
1A4bi	Residential: stationary		0.19	23.9%	51.6%	
1A3bvi	R.T., Automobile tyre and break wear		0.10	12.1%	63.7%	
2G	Other product manufacture and use		0.08	10.2%	73.9%	
1A2a	Iron and Steel		0.06	7.9%	81.8%	
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A1a	Public electricity and heat production	0.54	0.22	0.292	37.2%	37.2%
1A4bi	Residential: stationary	0.22	0.19	0.169	21.6%	58.7%

1A3bvi	R.T., Automobile tyre and break wear	NA	0.10	0.116	14.8%	73.5%
2G	Other product manufacture and use	0.07	0.08	0.095	12.1%	85.6%

**Table 218 Key source categories for emissions of Cu in Mg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
2G	Other product manufacture and use			2,66	47,7%	47,7%
1A3bvi	R.T., Automobile tyre and break wear			2,40	43,2%	90,9%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
		2,08	2.70	2.703	48.5%	48.5%
		NA	2.55	2.551	45.8%	94.3%

**Table 219 Key source categories for emissions of Ni in Mg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
1A1a	Public electricity and heat production			2.36	90.7%	90.7%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A1a	Public electricity and heat production	1.21	0.64	0.637	83.4%	83.4%

**Table 220 Key source categories for emissions of Se in Mg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
1A1a	Public electricity and heat production			1.31	56.0%	56.0%
1A4bi	Residential: stationary			1.00	42.9%	98.9%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	0.03	0.49	0.487	50.4%	50.4%
1A1a	Public electricity and heat production	2.63	0.47	0.471	48.8%	99.2%

**Table 221 Key source categories for emissions of Zn in Mg**

Level Assessment 2023						
NFR Code	NFR sector		2023	%	%cum	
1A4bi	Residential: stationary		3.77	48.7%	48.7%	
1A1a	Public electricity and heat production		0.98	12.6%	61.3%	
1A3bvi	R.T.. Automobile tyre and break wear		0.90	11.6%	72.9%	
1A2a	Iron and Steel		0.70	9.0%	82.0%	
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	4.83	3.77	3.769	48.7%	48.7%
2C1	Iron and Steel Production	0.73	0.98	0.976	12.6%	61.3%
1A1a	Public electricity and heat production	NA	0.90	0.901	11.6%	72.9%
1A2a	Iron and Steel	3.54	0.70	0.699	9.0%	82.0%

**Table 222 Key source categories for emissions of DIOX in g I-TEQ**

Level Assessment 2023						
NFR Code	NFR sector		2023	%	%cum	
1A4bi	Residential: stationary		5.47	70.1%	70.1%	
2C1	Iron and Steel Production		0.91	11.7%	81.8%	
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	7.57	5.47	5.467	70.1%	70.1%
2C1	Iron and Steel Production	2.66	0.91	0.912	11.7%	81.8%

**Table 223 Key source categories for emissions of PAHs in Mg**

Level Assessment 2023				
NFR Code	NFR sector	2022	%	%cum
1A4bi	Residential: stationary	2.38	73.4%	73.4%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.23	7.1%	80.5%

Level Assessment 2023						
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
1A4bi	Residential: stationary	3.38	2.69	2.384	73.4%	73.4%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.12	0.30	0.232	7.1%	80.5%

**Table 224 Key source categories for emissions of HCB in kg**

Level Assessment 2023						
NFR Code	NFR sector			2023	%	%cum
5C1biii	Clinical waste			0.06	57.6%	57.6%
1A4bi	Residential: stationary			0.04	38.2%	95.8%
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
5C1biii	Clinical waste	NO	0.06	0.055	57.6%	57.6%
1A4bi	Residential: stationary	0.05	0.,04	0.037	38.2%	95.8%

**Table 225 Key source categories for emissions of PCB in kg**

Level Assessment 2023						
NFR Code	NFR sector	2023		%	%cum	
2K	Consumption of POPs and heavy metals	211.71		59.0%	59.0%	
2C5	Lead Production	145.71		40.6%	99.7%	
Trend Assessment 1990-2023						
NFR Code	NFR sector	1990	2023	TA	%	%cum
2K	Consumption of POPs and heavy metals	202.80	211.71	211.71	59.0%	59.0%
2C5	Lead Production	124.26	145.71	145.71	40.6%	99.7%

## APPENDIX 2: Summary source sectors use PM emission factors that include/exclude the condensable component (see below)

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A1a	Public electricity and heat production	no	yes	The emission factors used for TSP, PM10 and PM2.5, that are calculating from direct emission for large point sources (LPS) and yearly taken from the EPR database. exclude the condensable component. Method used for PM10 emission measurement is gravimetric method and samples for it, need to be dry. Gravimetric method is in North Macedonian law. reference method for determination of mass concentration of floating particles. described with HRN EN 12341 standard for PM10 fraction. For non LCP sources. the emission factors used for TSP, PM10 and PM2.5 are default ones from

				GB2019 and these PM factors represent filterable PM emissions and are based on an defined ash content.
1A1b	Petroleum refining	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction)
1A1c	Manufacture of solid fuels and other energy industries	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and the basis of these emission factors could not be determined in the reference.
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.

1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2e	Stationary combustion in manufacturing industries and	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from



	construction: Food processing, beverages and tobacco			GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors represent total PM emissions (filterable and condensable fractions).
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and

				condensable) emissions.
1A3ai(i)	International aviation LTO (civil)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2013 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3aii(i)	Domestic aviation LTO (civil)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2013 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3bi	Road transport: Passenger cars	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from COPERT IV that is Tier 3 approach according to GB2019. According to GB2019, PM mass emission factors are considered to include both filterable and condensable material. The mass of particles collected on a filter kept below 52°C during diluted exhaust sampling. This corresponds to total (filterable and
1A3bii	Road transport: Light duty vehicles	yes	no	
1A3biii	Road transport: Heavy duty vehicles and buses	yes	no	
1A3biv	Road transport: Mopeds & motorcycles	yes	no	

				condensable) PM2.5. Coarse exhaust PM (i.e. >2.5µm diameter) is considered to be negligible. hence PM=PM2.5.
1A3bv	Road transport: Gasoline evaporation	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
1A3bvi	Road transport: Automobile tyre and brake wear	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3bvii	Road transport: Automobile road abrasion	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3c	Railways	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

1A3di(ii)	International inland waterways	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3dii	National navigation (shipping)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3ei	Pipeline transport	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1A3eii	Other (please specify in the IIR)	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1A4ai	Commercial/institutional: Stationary	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A4aii	Commercial/institutional: Mobile	IE	IE	IE: 1A4aii

1A4bi	Residential: Stationary	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A4bii	Residential: Household and gardening (mobile)	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors represent total PM emissions (filterable and condensable fractions).
1A4ci	Agriculture/Forestry/ Fishing: Stationary	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors represent total PM

				emissions (filterable and condensable fractions).
1A4ciii	Agriculture/Forestry/ Fishing: National fishing	IE	IE	IE: 1A3dii
1A5a	Other stationary (including military)	IE	IE	IE: 1A4a
1A5b	Other. Mobile (including military. land based and recreational boats)	IE	IE	IE: 1A4a. 1A3b(i-iv)
1B1a	Fugitive emission from solid fuels: Coal mining and handling	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B1c	Other fugitive emissions from solid fuels	NO	NO	This activity does not exist in North Macedonia.
1B2ai	Fugitive emissions oil: Exploration. production. transport	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable

				component in PM emission factors.
1B2aiv	Fugitive emissions oil: Refining / storage	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B2av	Distribution of oil products	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1B2c	Venting and flaring (oil, gas, combined oil and gas)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B2d	Other fugitive emissions from energy production	NO	NO	This activity does not exist in North Macedonia.
2A1	Cement production	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is

				no information on inclusion or exclusion of the condensable component in PM emission factors.
2A2	Lime production	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A3	Glass production	NO	NO	This activity does not exist in North Macedonia.
2A5a	Quarrying and mining of minerals other than coal	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A5b	Construction and demolition	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A5c	Storage, handling and transport of mineral products	IE	IE	IE: 2A1, 2A2, 2A3, 2A5a, 2A5b



2A6	Other mineral products (please specify in the IIR)	NO	NO	This activity does not exist in North Macedonia.
2B1	Ammonia production	NO	NO	This activity does not exist in North Macedonia.
2B2	Nitric acid production	NO	NO	This activity does not exist in North Macedonia.
2B3	Adipic acid production	NO	NO	This activity does not exist in North Macedonia.
2B5	Carbide production	NO	NO	This activity does not exist in North Macedonia.
2B6	Titanium dioxide production	NO	NO	This activity does not exist in North Macedonia.
2B7	Soda ash production	NO	NO	This activity does not exist in North Macedonia.
2B10a	Chemical industry: Other (please specify in the IIR)	NE	NE	There is no emission factor for TSP, PM10 and PM2.5 in the GB2019.
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)	IE	IE	IE: 2B10a
2C1	Iron and steel production	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction (European Commission, 2001)).

2C2	Ferroalloys production	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction).
2C3	Aluminium production	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction).
2C4	Magnesium production	NO	NO	This activity does not exist in North Macedonia.
2C5	Lead production	NO	NO	This activity does not exist in North Macedonia.
2C6	Zinc production	NO	NO	This activity does not exist in North Macedonia.
2C7a	Copper production	NO	NO	This activity does not exist in North Macedonia.
2C7b	Nickel production	NO	NO	This activity does not exist in North Macedonia.
2C7c	Other metal production (please specify in the IIR)	NO	NO	This activity does not exist in North Macedonia.
2C7d	Storage, handling and transport of metal	NO	NO	This activity does not exist in North Macedonia.

	products (please specify in the IIR)			
2D3a	Domestic solvent use including fungicides	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
2D3b	Road paving with asphalt	yes	no	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions with Nnote that US EPA (2004) includes condensable PM emission factors and factors for controlled plant.
2D3c	Asphalt roofing	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2D3d	Coating applications	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
2D3e	Degreasing	NE	NE	There is no emission factor for PM2.5 in the GB2019.
2D3f	Dry cleaning	NE	NE	There is no emission factor for PM2.5 in the GB2019.
2D3g	Chemical products	NA	NA	This activity does not result with TSP.

				PM10 and PM2.5 emissions.
2D3h	Printing	NE	NE	There is no emission factor for PM2.5 in the GB2019.
2D3i	Other solvent use (please specify in the IIR)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2G	Other product use (please specify in the IIR)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2H1	Pulp and paper industry	NO	NO	This activity does not exist in North Macedonia.
2H2	Food and beverages industry	NE	NE	There is no emission factor for TSP, PM10 and PM2.5 in the GB2019.
2H3	Other industrial processes (please specify in the IIR)	NO	NO	This activity does not exist in North Macedonia.
2I	Wood processing			There is no emission factor for PM10 and PM2.5 in the GB2019.
2J	Production of POPs	NO	NO	This activity does not exist in North Macedonia.

2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
2L	Other production. consumption. storage. transportation or handling of bulk products (please specify in the IIR)	NO	NO	This activity does not exist in North Macedonia.
3B1a	Manure management - Dairy cattle	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B1b	Manure management - Non-dairy cattle	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B2	Manure management - Sheep	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

3B3	Manure management - Swine	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4a	Manure management - Buffalo	NO	NO	This activity does not exist in North Macedonia.
3B4d	Manure management - Goats	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4e	Manure management - Horses	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4f	Manure management - Mules and asses	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

3B4gi	Manure mangement - Laying hens	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4gii	Manure mangement - Broilers	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4giii	Manure mangement - Turkeys	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4giv	Manure management - Other poultry	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4h	Manure management - Other animals (please specify in IIR)	NO	NO	This activity does not exist in North Macedonia.

3Da1	Inorganic N-fertilizers (includes also urea application)	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Da2a	Animal manure applied to soils	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Da2b	Sewage sludge applied to soils	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Da2c	Other organic fertilisers applied to soils (including compost)	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Da3	Urine and dung deposited by grazing animals	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Da4	Crop residues applied to soils	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Db	Indirect emissions from managed soils	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information that the processes which result in particulate emissions are largely low-temperature mechanical activities, and emissions are unlikely to include substantial quantities



				of condensable particulate material.
3Dd	Off-farm storage, handling and transport of bulk agricultural products	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2019.
3De	Cultivated crops	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Df	Use of pesticides	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3F	Field burning of agricultural residues	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3I	Agriculture other (please specify in the IIR)	NO	NO	This activity does not exist in North Macedonia.
5A	Biological treatment of waste - solid waste disposal on land	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5B1	Biological treatment of waste - composting	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2019.

5B2	Biological treatment of waste - anaerobic digestion at biogas facilities	NA	NA	This activity does not result with TSP. PM10 and PM2.5 emissions.
5C1a	Municipal waste incineration	NO	NO	This activity does not exist in North Macedonia.
5C1bi	Industrial waste incineration	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5C1bii	Hazardous waste incineration	NO	NO	This activity does not exist in North Macedonia.
5C1biii	Clinical waste incineration	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5C1biv	Sewage sludge incineration	NO	NO	This activity does not exist in North Macedonia.
5C1bv	Cremation	NO	NO	This activity does not exist in North Macedonia.
5C1bvi	Other waste incineration (please specify in the IIR)	NO	NO	This activity does not exist in North Macedonia.
5C2	Open burning of waste	unclear	unclear	The emission factors used for TSP. PM10 and PM2.5 are default ones from

				GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5D1	Domestic wastewater handling	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2019.
5D2	Industrial wastewater handling	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2019.
5D3	Other wastewater handling (please specify in IIR)	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2019.
5E	Other waste (please specify in IIR)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
6A	Other (included in national total for entire territory) (please specify in IIR)	NO	NO	This activity does not exist in North Macedonia.

## APPENDIX 3 Further elaboration of completeness

No further info on this subject

# APPENDIX 4 National energy balance 2023

## Part 1

		Hard coal ['000 tonnes]	Coke ['000 tonnes]	Sub-bituminous coal ['000]	Lignite ['000 tonnes]	Total petroleum products ['000 tonnes]	Refinery gas ['000 tonnes]	LPG ['000 tonnes]	Motor spirit ['000 tonnes]	Kerosenes, jet fuels ['000 tonnes]	Road diesel ['000]	Heating and other gasoil ['000]	Residual fuel oil ['000 tonnes]	Petroleum coke ['000]	Other petroleum products ['000 tonnes]
Total primary production	-	-	-	3994,33176	-	-	-	-	-	-	-	-	-	-	-
Recovered products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Imports	22,867366	0,70453	5,28882	1335,73666	-	1255,703707	-	65,054819	-	110,854561	32,410683	750,208866	22,582994	141,376546	
Stock change	0,015015	0,161009	21,15162	16,428584	-	31,375502	-	-0,280883	-	0,432563	0,542985	-6,208302	0,964727	22,01714	
Exports	-	-	-	58,47335	-	117,638436	-	1,501826	-	6,673958	20,52228	65,241038	-	1,761454	
Gross inland consumption	22,882381	0,865539	26,44044	5288,023654	-	1169,440773	-	63,27211	-	104,613166	12,431388	678,759526	23,547721	161,632232	
Transformation input	-	-	-	5275,007	-	134,948	-	-	-	-	-	-	-	-	134,948
.. Public thermal power stations	-	-	-	5275,007	-	134,948	-	-	-	-	-	-	-	-	134,948
.. Autoprod. thermal power stations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. CHP plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Briquetting plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Biogas plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Main activity producer heat plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transformation output	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Public thermal power stations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Autoprod. thermal power stations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. CHP plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Briquetting plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Biogas plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Main activity producer heat plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Exchanges and transfers, returns	-	-	-	-	-	0,234	-	-	-	-	-	-	0,234	-	-
Consumption of the energy branch	-	-	-	-	-	1,644042	-	-	-	-	-	-	1,546308	-	0,097734
Distribution losses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Available for final consumption	22,882381	0,865539	26,44044	13,016654	-	1033,082731	-	63,27211	-	104,613166	12,431388	677,447218	23,547721	26,586498	
Final non-energy consumption	-	-	-	-	-	46,086837	-	-	-	-	-	-	-	-	-
Final energy consumption	22,882381	0,865539	26,44044	13,016654	-	986,995894	-	63,27211	-	104,613166	12,431388	677,447218	23,547721	26,586498	
...Industry	22,860381	0,410539	26,44044	10,4289	-	154,92591	-	15,706837	-	-	-	27,010272	10,160427	24,379581	
...Iron and steel industry	0,859678	0,410539	26,44044	2,01	-	16,078189	-	0,167636	-	-	-	1,466712	0,024	4,873952	
...Non-ferrous metal industry	-	-	-	-	-	1,38471	-	1,35861	-	-	-	0,0181	0,008	-	
...Chemical industry	-	-	-	-	-	0,586912	-	0,01453	-	0,0977	-	0,397682	0,077	-	
...Glass, pottery and building mat. industry	22,000703	-	-	5,6819	-	87,033728	-	7,861003	-	-	-	1,962562	1,323382	7,763877	
...Ore-extraction industry	-	-	-	0,07	-	12,67762	-	0,065278	-	-	-	12,436342	0,176	-	
...Food, drink and tobacco industry	-	-	-	-	-	16,780474	-	3,96682	-	-	-	0,372484	4,777606	7,663564	
...Textile, leather and clothing industry	-	-	-	2,665	-	2,800773	-	0,151493	-	-	-	-	0,745092	1,904188	
...Paper and printing	-	-	-	-	-	0,479225	-	0,102935	-	-	-	0,0139	0,10339	0,259	
...Engineering and other metal industry	-	-	-	-	-	2,75893	-	1,647263	-	-	-	0,310331	0,795336	0,006	
...Other industries	-	-	-	0,002	-	14,345349	-	0,371269	-	-	-	10,332141	1,809939	1,832	
..Transport	-	-	-	-	-	780,622652	-	39,397199	-	104,20552	12,395652	624,624281	-	-	
...Railways	-	-	-	-	-	1,104	-	-	-	-	-	1,104	-	-	
...Road transport	-	-	-	-	-	767,092486	-	39,397199	-	104,175006	-	623,520281	-	-	
...Air transport	-	-	-	-	-	12,426166	-	-	-	0,030514	12,395652	-	-	-	
..Households, commerce, pub. auth., etc.	0,022	0,455	-	2,587754	-	51,447332	-	8,168075	-	0,407646	0,035736	25,812665	13,387294	2,206917	
...Households	-	-	-	0,769463	-	6,644974	-	3,163305	-	-	-	-	3,481669	-	
...Agriculture	0,022	0,455	-	0,850375	-	10,248318	-	0,048769	-	0,407646	0,035736	6,717167	0,55254	1,057459	
...Other	-	-	-	0,967916	-	34,55404	-	4,956	-	-	-	19,095497	9,353084	1,149458	
Statistical difference	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

## Part 2

	Natural gas [ '000 mn3]	Geothermal heat [ '000 m3]	Fuelwood [ '000 m3]	Wood of fruit trees and oth.	Wood wastes, wood briquettes	Hydro energy [GWh]	Solar electricity [GWh]	Solar thermal [TJ]	Wind electricity [GWh]	Biogas [GJ]	Biodiesel [ '000 tonnes]	Derived heat [TJ]	Electrical energy [GWh]	Derived heat [TJ]	Electrical energy [GWh]
Total primary production	-	-	-	1334,611825	861,395451	22,950672	22,410285	1622,93355	355,474034	129,194931	157,647978	939,558761	-	-	-
Recovered products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Imports	79,210717	54,004521	356333,6594	-	4,539616	-	63,726369	-	-	-	-	-	-	-	1469,777403
Stock change	13,971917	-0,064644	97,989	-	46,99	-	3,737833	-	-	-	-	-	0,234	-	-
Exports	14,08484	7,85304	-	-	0,007	-	0,57474	-	-	-	-	-	-	-	1319,303403
Gross inland consumption	79,097794	46,086837	356431,6484	1334,611825	912,918066	22,950672	89,299747	1622,93355	355,474034	129,194931	157,647978	939,558761	0,234	-	150,474
Transformation input	-	-	298644,679	-	-	-	-	-	-	-	-	939,558761	-	-	-
.. Public thermal power stations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Autoprod. thermal power stations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. CHP plants	-	-	272738,492	-	-	-	-	-	-	-	-	-	-	-	-
.. Briquetting plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Biogas plants	-	-	-	-	-	-	-	-	-	-	-	939,558761	-	-	-
.. Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Main activity producer heat plants	-	-	25906,187	-	-	-	-	-	-	-	-	-	-	-	-
Transformation output	-	-	-	-	-	-	-	-	-100,749424	-	-	-	-	2076,175788	4839,886024
.. Public thermal power stations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3291,076633
.. Autoprod. thermal power stations	-	-	-	-	-	-	-	-	-100,749424	-	-	-	-	-	100,749424
.. CHP plants	-	-	-	-	-	-	-	-	-	-	-	-	-	1182,85968	1382,81283
.. Briquetting plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Biogas plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65,247136
.. Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.. Main activity producer heat plants	-	-	-	-	-	-	-	-	-	-	-	-	-	893,316108	-
Exchanges and transfers, returns	-	-	-	-	-	-	-	-1622,93355	-254,72461	-	-157,647978	-	-0,234	-	2035,306138
Consumption of the energy branch	-	-	-	-	0,051	-	-	-	-	-	-	-	-	1,052389	483,61668
Distribution losses	-	-	2635,602	97,806134	-	-	-	-	-	-	-	-	-	208,337534	956,438746
Available for final consumption	79,097794	46,086837	55151,3674	1236,805691	912,867066	22,950672	89,299747	-	-	129,194931	-	-	-	1866,785866	5585,610736
Final non-energy consumption	-	46,086837	-	-	-	-	-	-	-	-	-	-	-	-	-
Final energy consumption	79,097794	-	55151,36734	1236,805691	912,867066	22,950672	89,299747	-	-	129,194931	-	-	-	1866,785866	5585,610736
..Industry	77,668794	-	46350,55131	-	11,18063	-	11,463617	-	-	-	-	-	-	20,184	1335,373322
...Iron and steel industry	9,54589	-	27558,73817	-	0,011	-	3,642524	-	-	-	-	-	-	20,184	383,356554
...Non-ferrous metal industry	-	-	-	-	-	-	0,004	-	-	-	-	-	-	-	15,136206
...Chemical industry	-	-	2355,824589	-	-	-	0,04	-	-	-	-	-	-	-	85,168685
...Glass, pottery and building mat. industry	68,122904	-	2837,753401	-	0,076	-	0,09658	-	-	-	-	-	-	-	137,460211
...Ore-extraction industry	-	-	-	-	0,022	-	0,0073	-	-	-	-	-	-	-	144,790169
...Food, drink and tobacco industry	-	-	7661,098353	-	7,27335	-	4,416867	-	-	-	-	-	-	-	180,706813
...Textile, leather and clothing industry	-	-	115,519561	-	1,8404	-	0,264876	-	-	-	-	-	-	-	48,133177
...Paper and printing	-	-	559,259333	-	0,239	-	0,08805	-	-	-	-	-	-	-	15,503725
...Engineering and other metal industry	-	-	4572,678809	-	0,4346	-	0,25244	-	-	-	-	-	-	-	221,44592
...Other industries	-	-	689,679093	-	1,28428	-	2,65098	-	-	-	-	-	-	-	103,671862
..Transport	-	-	3323,338	-	-	-	-	-	-	-	-	-	-	-	0,000008
...Railways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,000008
...Road transport	-	-	3323,338	-	-	-	-	-	-	-	-	-	-	-	-
...Air transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
..Households, commerce, pub. auth., etc.	1,429	-	5477,478028	1236,805691	901,686436	22,950672	77,83613	-	-	129,194931	-	-	-	1846,601866	4250,237406
...Households	-	-	137,2	-	875,496121	22,950672	71,364571	-	-	129,194931	-	-	-	1441,408288	2995,530875
...Agriculture	1,429	-	-	651,619175	8,22227	-	-	-	-	-	-	-	-	-	39,481555
...Other	-	-	5340,278028	585,186516	17,968045	-	6,471559	-	-	-	-	-	-	405,193578	1215,224976
Statistical difference	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

<sup>1)</sup> Претходни податоци/Preliminary data

## APPENDIX 5 Useful information- Nomenclature for reporting format (NFR)- Format for reporting under the UNECE/LRTAP convention for 2023

[illegible]

[illegible]

MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)				Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
				NO <sub>x</sub> (as N <sub>2</sub> O <sub>2</sub> )	NMVOC	SO <sub>x</sub> (as SO <sub>2</sub> )	NH <sub>3</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	TSP	BC		CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/PCDF (dioxins/furans)	PAHs						Total-4									HCB	PCBs																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
																								benzo(a)pyrene	benzo(b)fluoranthene	benzo(k)fluoranthene	Indeno(1,2,3-cd)pyrene																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
L_Offroad	1A3ei	Other (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO





MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)				Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)										Activity Data (from 1990)											
				NO <sub>x</sub> (as N <sub>2</sub> O <sub>2</sub> )	NMVOC	SO <sub>x</sub> (as SO <sub>2</sub> )	NH <sub>3</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	TSP	BC		CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/PCDF (dioxins / furans)	PAHs					Total-4	HCB	PCBs													
																								benzo(a)pyrene	benzo(b)fluoranthene	benzo(k)fluoranthene	Indeno(1,2,3-cd)pyrene																	
B_Industry	2B2	Nitric acid production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Nitric acid produced [kt]
B_Industry	2B3	Adipic acid production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Adipic acid produced [kt]	
B_Industry	2B5	Carbide production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Carbide produced [kt]	
B_Industry	2B6	Titanium dioxide production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Titanium dioxide produced [kt]	
B_Industry	2B7	Soda ash production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Soda ash produced [kt]	
B_Industry	2B10a	Chemical industry: Other (please specify in the IIR)		NA	0.00038	1.63227	NA	2E-05	0.0004	0.00105	NA	NA	NA	1.2E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR	
B_Industry	2B10b	Storage, handling and transport of chemical products (please specify in the IIR)		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	Please specify and/or provide details in the IIR
B_Industry	2C1	Iron and steel production		NE	0.01922	NE	NE	0.01794	0.02306	0.03844	6.5E-05	NE	0.58934	0.00256	0.01281	0.05125	0.57653	0.00897	0.01794	0.00256	0.51247	0.38435	NE	NE	NE	NE	0.0615	3.8E-06	0.32629														Steel produced [kt]	
B_Industry	2C2	Ferroalloys production		NA	NA	NA	NA	16,0078	22,6778	26,6797	1.60078	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Ferroalloys produced [kt]	
B_Industry	2C3	Aluminium production		NA	NA	NA	NA	0.00216	0.00549	0.00785	5E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.13734	NA	NA	NA	NA	NA	19.62	NA														Aluminium produced [kt]	
B_Industry	2C4	Magnesium production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Magnesium produced [kt]
B_Industry	2C5	Lead production		NA	NA	NA	NA	0.21412	0.29146	0.36543	NA	NA	141.176	0.37717	0.02926	1.11371	NA	NA	NA	NA	NA	0.33497	NA	NA	NA	NA	NA	NA	131.061													Lead produced [kt]		
B_Industry	2C6	Zinc production		NA	NA	NA	NA	0.01738	0.02297	0.02857	NA	NA	4.5404	1.62215	0.29731	0.22337	NA	NA	NA	NA	10,4321	4.08298	NA	NA	NA	NA	NA	NA	NA	53,5918												Zinc produced [kt]		
B_Industry	2C7a	Copper production		NA	NA	NE	NA	NE	NE	NE	NE	NA	NE	NE	NA	NE	NA	NE	NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NE													Copper produced [kt]	

MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Ot he r (fr om 19 90 )	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)									
				N O <sub>x</sub> (as N O <sub>2</sub> )	NM VO C	SO x (as SO <sub>2</sub> )	NH <sub>3</sub>	P M <sub>2.5</sub>	P M <sub>10</sub>	TS P	BC		C O	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PC DD/ PC DF (dio xins / fura ns)	ben zo(a ) pyre ne	PAHs			Ind eno (1, 2,3 - cd) pyr ene	To tal 1- 4									H CB	PC Bs
B_Industry	2C7b	Nickel production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Nickel produced [kg]
B_Industry	2C7c	Other metal production (please specify in the IR)		NA	NA	0.0003	NA	NA	NA	0.0003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IR	
B_Industry	2C7d	Storage, handling and transport of metal products (please specify in the IR)		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	Amount (kg)		
E_Solvents	2D3a	Domestic solvent use including fungicides		NA	2,389.68	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Solvents used [kg]		
B_Industry	2D3b	Road paving with asphalt		NA	0.00158	NA	NA	0.0003942	0.29564	1.37963	0.00225	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	98,545	Please specify and/or provide details in the IR			
B_Industry	2D3c	Asphalt roofing		NE	0.00078	NA	NA	0.000048	0.00024	0.000995	6.2E-08	5.7E-05	NE	NE	NE	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NA		NA	NA	NA	NA	5,992	Please specify and/or provide details in the IR			
E_Solvents	2D3d	Coating applications		NA	2,706.72	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10,826.9	Paint applied [kg]		
E_Solvents	2D3e	Degreasing		NA	0.04857	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.06767	Solvents used [kg]			
E_Solvents	2D3f	Dry cleaning		NA	0.0283	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	70.74	Solvents used [kg]			
E_Solvents	2D3g	Chemical products		NA	0.04256	NA	0.000752	NA	NA	0.15	NA	NA	NA	1.3E-06	NA	6.3E-06	7.5E-05	NA	0.00063	6.3E-06	NA	NA	NA	NA	NA	NA	0.003188	NA	NA		NA	NA	NA	NA	NA	Please specify and/or provide details in the IR			
E_Solvents	2D3h	Printing		NA	0.008	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IR			
E_Solvents	2D3i	Other solvent use (please specify in the IR)		NE	0.0087	NE	NE	3.3E-05	4.9E-05	6E-05	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	4.3E-05	4.34667E-05	4.3E-05	0.00022	0.00035	NE	NE		NA	NA	NA	NA	NA	Please specify and/or provide details in the IR			
E_Solvents	2G	Other product use (please specify in the IR)		0.000269	0.14152	NE	0.000802	0.52159	0.65474	0.69224	0.0017	0.789014	2.1756	0.00048	0.00016	0.000369	0.0004329	1.30759	NE	NE	NE	1.4E-06	0.00155	0.0006291	0.00063	0.00044	NE	NE		NA	NA	NA	NA	NA	Please specify and/or provide details in the IR				
B_Industry	2H1	Pulp and paper industry		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Pulp production [kg]			

MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)				Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)								
				N O <sub>x</sub> (as N O <sub>2</sub> )	NM VOC	SO <sub>x</sub> (as SO <sub>2</sub> )	NH <sub>3</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	TSP	BC		CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/PCDF (dioxins / furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4	HCB	PCBs									
B_Industry	2H2	Food and beverages industry		NA	1,669.74	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Bread, Wine, Beer, Spirits production [t]
B_Industry	2H3	Other industrial processes (please specify in the IIR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Please specify and/or provide details in the IIR	
B_Industry	2I	Wood processing		NA	NA	NA	NA	NA	NA	0.02741	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	27,406.8	Please specify and/or provide details in the IIR			
B_Industry	2J	Production of POPs		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR		
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	0.01991	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NE	199.14		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR		
B_Industry	2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Please specify and/or provide details in the IIR			
K_AgriLivestock	3B1a	Manure management - Dairy cattle		0.09718	1,734.11	NA	2.08049	0.05298	0.08141	0.17833	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	129.223	Population size (1000 head)			
K_AgriLivestock	3B1b	Manure management - Non-dairy cattle		0.03611	1,040.35	NA	0.9485	0.02995	0.04493	0.09818	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	166.403	Population size (1000 head)				
K_AgriLivestock	3B2	Manure management - Sheep		0.02177	0,306.55	NA	0.72556	0.03628	0.10883	0.20395	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1813.9	Population size (1000 head)				
K_AgriLivestock	3B3	Manure management - Swine		0.0048	0,141.79	NA	0.98494	0.00128	0.02787	0.18867	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	192.396	Population size (1000 head)				
K_AgriLivestock	3B4a	Manure management - Buffalo		IE	IE	IE	IE	IE	IE	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	IE	Population size (1000 head)					
K_AgriLivestock	3B4d	Manure management - Goats		0.0025	0,112.88	NA	0.08331	0.00042	0.0125	0.02916	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	208.274	Population size (1000 head)				
K_AgriLivestock	3B4e	Manure management - Horses		0.01662	0,517.27	NA	0.46535	0.000931	0.01463	0.03191	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	66.479	Population size (1000 head)				

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				N Ox (as N O <sub>2</sub> )	NM VO C	SO x (as SO <sub>2</sub> )	NH <sub>3</sub>	P M <sub>2.5</sub>	P M <sub>10</sub>	TS P	BC		C O	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PC DD/ PC DF (dioxins / furans)	PAHs				H CB	PC Bs																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
																								benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno(1,2,3-cd) pyrene			Total-4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
K_AgrLivestock	3B4f	Manure management - Mules and asses		NE	NE	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Ot he r (fr om 19 90 )	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)							POPs (from 1990)										Activity Data (from 1990)									
				N O <sub>x</sub> (as N O <sub>2</sub> )	NM VO C	SO x (as SO <sub>2</sub> )	NH 3	P M <sub>2.5</sub>	P M <sub>10</sub>	TS P	BC		C O	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PC DD/ PC DF (dio xins / fura ns)	ben zo(a ) pyre ne	PAHs				To tal 1- 4	H CB	PC Bs											
																									benzo (b) fluora nthen e	benzo (k) fluora nthen e	Ind eno (1, 2,3 - cd) pyr ene															
L_AgriOther	3Dd	Off-farm storage, handling and transport of bulk agricultural products		NA	NA	NA	NA	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IR
L_AgriOther	3De	Cultivated crops		NA	1,110.26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IR	
L_AgriOther	3Di	Use of pesticides		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IR	
L_AgriOther	3F	Field burning of agricultural residues		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Area burned [ha]	
L_AgriOther	3I	Agriculture other (please specify in the IR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IR	
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land		NA	0.04557	NA	0.00055	2.6E-05	0.00017	0.00037	NA	1.23594	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.79543	Deposition [kg]		
J_Waste	5B1	Biological treatment of waste - Composting		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Organic domestic waste [kg]	
J_Waste	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities		NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N in feedstock [kg]		
J_Waste	5C1a	Municipal waste incineration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kg]	
J_Waste	5C1bi	Industrial waste incineration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kg]	
J_Waste	5C1bii	Hazardous waste incineration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kg]	
J_Waste	5C1biii	Clinical waste incineration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kg]	
J_Waste	5C1biv	Sewage sludge incineration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Sludge incinerated [kg]	
J_Waste	5C1bv	Cremation		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Corpses [Number]	

MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Ot he r (fr om 19 90 )	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)								
				N O <sub>x</sub> (as N O <sub>2</sub> )	NM VO C	SO x (as SO <sub>2</sub> )	NH <sub>3</sub>	P M <sub>2.5</sub>	P M <sub>10</sub>	TS P	BC		C O	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PC DD/ PC DF (dioxins / furans)	PAHs				To tal 1- 4	H CB									PC Bs
																								benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno(1,2,3-cd) pyrene											
J_Waste	5C1bvi	Other waste incineration (please specify in the IR)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IR	
J_Waste	5C2	Open burning of waste		0.05231	0.02023	0.00181	NE	0.06893	0.07419	0.07633	0.02895	0.9184	0.00806	0.00165	NE	0.00674	0.00016	0.00329	NE	0.00115	0.28837	0.1645	0.03833	0.0761635	0.09344	NE	0.20793	NE	NA		NA	NA	NA	NA	NA	Please specify and/or provide details in the IR		
J_Waste	5D1	Domestic wastewater handling		NA	0.00022	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	14847.8	Total organic product [kt DC]			
J_Waste	5D2	Industrial wastewater handling		NA	0.00029	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	19298	Total organic product [kt DC]			
J_Waste	5D3	Other wastewater handling		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	Total organic product [kt DC]			
J_Waste	5E	Other waste (please specify in the IR)		NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NE	NA	NE	NE	NE	NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	Please specify and/or provide details in the IR			
M_Other	6A	Other (included in national total for entire territory) (please specify in the IR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	Please specify and/or provide details in the IR		
	NATIONAL TOTAL	National total (based on fuel sold)	(a)	38.79	36.78	90.54	12.86	27.77	42.77	55.11	25.9	96.61	231.37	2.24	0.53	2.12	1.36	2.20	2.23	2.19	17.78	13.42	1.29	1.38	0.55	0.72	4.03	19.67	384.21									
	1A3bi(fu)	Road transport: Passenger cars (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	TJ NCV		
	1A3bi(fu)	Road transport: Light duty vehicles (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	TJ NCV		
	1A3bi(fu)	Road transport: Heavy duty vehicles and buses (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	TJ NCV		
	1A3bi(fu)	Road transport: Mopeds & motorcycles (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	TJ NCV		
	1A3bi(fu)	Road transport: Gasoline evaporation (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	TJ NCV		

MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Ot he r (fr om 19 90 )	Priority Heavy Metals (from 1990)				Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)							
				N O <sub>x</sub> (as N O <sub>2</sub> )	NM VO C	SO x (as SO <sub>2</sub> )	NH 3	P M <sub>2.5</sub>	P M <sub>10</sub>	TS P	BC		C O	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PC DD/ PC DF (dioxins / fura ns)	PAHs				To tal 1- 4	H CB	PC Bs								
																								ben zo(a ) pyre ne	benzo (b) fluora nthen e	benzo (k) fluora nthen e	Ind eno (1, 2,3 - cd) pyr ene											
	1A3bvi(f u)	Road transport: Automobile tyre and brake wear (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Mileage [10*6 km]
	1A3bvi(f u)	Road transport: Automobile road abrasion (fuel used)	(b)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	Mileage [10*6 km]	
	ADJUST MENTS	Sum of approved adjustments (negative value) from Annex VII (CLRTAP)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA
	COMPLI ANCE TOTAL (CLRTA P)	National total for compliance calculations and checks (CLRTAP)	(c)	36, 79	36,78	90, 54	12, 86	27, 77	42, 77	55, 11	25, 9	96, 61	231, 37	2,2 4	0,5 3	2,1 2	1,3 6	2,2 0	2,2 3	2,1 9	17, 78	13,42	1,29	1,38	0,55	0,72	4,0 3	19, 67	384, 21									
	ADJUST MENTS AND FLEXIBI LITIES	Sum of approved adjustments from Annex VII and other flexibilities (negative value) (NECD)	(d)																																			
	COMPLI ANCE TOTAL (NECD)	National total for compliance calculations and checks (NECD)	(e)	36, 79	36,78	90, 54	12, 86	27, 77	42, 77	55, 11	25, 9	96, 61	231, 37	2,2 4	0,5 3	2,1 2	1,3 6	2,2 0	2,2 3	2,1 9	17, 78	13,42	1,29	1,38	0,55	0,72	4,0 3	19, 67	384, 21									
MEMO ITEMS – NOT TO BE INCLUDED IN NATIONAL TOTALS																																						
O_AviCruise	1A3ai(i)	International aviation cruise (civil)		0,0 848 1	0,402 83	0,0 212	NA	NA	NA	NA	NA	25, 442 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NA	NA	NE	NA	911,67 4	TJ NCV		
O_AviCruise	1A3ai(ii)	Domestic aviation cruise (civil)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NA	NA	NE	NA	NO	TJ NCV		
P_IntShippin g	1A3di(i)	International maritime navigation		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	TJ NCV		
z_Memo	1A5c	Multilateral operations		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NO	NO	NO	NO	NO	NA	TJ NCV		
z_Memo	6B	Other not included in national total of the entire territory (please specify in the IR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IR		



MK: 25/04/20 25: 1996	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)				Additional Heavy Metals (from 1990, voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)							
				N Ox (as N <sub>2</sub> O <sub>5</sub> )	NM VOC	SO <sub>x</sub> (as SO <sub>2</sub> )	NH <sub>3</sub>	P <sub>M<sub>2.5</sub></sub>	P <sub>M<sub>10</sub></sub>	TSP	BC		CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/PCDF (dioxins/furans)	benzo(a)pyrene	benzo(b)fluoranthene	benzo(k)fluoranthene	Indeno(1,2,3-cd)pyrene	Total-4	HCB	PCBs								
N_Natural	11A	Volcanoes		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR			
N_Natural	11B	Forest fires		NE	NE	NE	NE	0.00441	0.00539	0.00833	0.0004	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NE	Area of forest burned [ha]				
N_Natural	11C	Other natural emissions (please specify in the IIR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NA	NA	NA	NA	NE	Please specify and/or provide details in the IIR					

