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INFORMATIVE INVENTORY REPORT

Republic of North Macedonia

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LIST OF ABBREVIATIONS

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

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

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EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

Republic of North Macedonia has an emission inventory reporting obligation towards the Convention on transboundary 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)¹.

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_x), sulfur dioxide (SO₂), non-methane volatile organic compounds (NMVOC), ammonia (NH₃), 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 Revised 2014 Reporting guidelines (ECE/EB.AIR.125) under the UNECE/CLTRAP convention and its protocols, which define the standards for the national emission inventory². The country has also used the latest emissions reporting template for this reporting round.

The report contains twelve chapters, two appendixes and references. 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. Two chapters on reporting LPS and gridded data and adjustment chapter are introduced for the first time. Sources used for the gathering of the activity data and information are presented in Reference chapter. The Appendix chapter has two Appendixes; the first one is on Energy balance for 2018 and the second one on 2018 reported NFR. Key category analysis and Analysis on completeness are incorporated in the IIR itself. The country uses mostly default emission factors. Summary information on condensable PM is not provided.

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

This report contains emissions of the whole time series 1990-2018. 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

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

²http://www.ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf

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. However, in comparison to the previous IIR, the quality control of the inventory has been improved in general. Additionally, the inventory has been improved since emissions’ new categories were introduced such as 1.A.4.a.ii and 5.D.2-Industrial wastewater treatment plants and additionally due to the available revised and activity data in MAKSTAT data³ base, as the population data and data in the energy sector and the industry sector. In some cases, recalculations were done due to clarification of the type of industrial processes and the available activity data from the industrial capacities. Additionally, EF from EMEP Guidebook 2019 were introduced in this submission.

1.2. Explanation of significant changes in the emission trends

The report presents trend analysis of the country’s data for the period 1990 – 2018. 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_x and SO_x emissions starting from 2011. The reduction of NO_x is a result of the modernization of plants and extended working lifetime. Additionally, the reduced operating hours of the power plant REK Oslomej from 12 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_x. With regards to SO_x emissions, the trends vary and depend on the coal consumption considering that electricity production is the main source for SO_x emissions. Desulfurization units are still not in place in this installation, so mainly SO_x emissions depend on the content and quantity of the consumed coal. The decreasing trend of SO_x emissions is due to the reduced amount of burnt coal in REK Bitola and reduced operation of REK Oslomej.

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, which is related to decreasing livestock numbers due to the trend of moving of people from rural to urban areas and implementation of BAT in the bigger farms.

³ MAKSTAT database - <http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>

Table 1 Emission trends 1990 – 2018 for the main air pollutants and CO

Year	Emission in kt				
	NO _x	NM _{VOC}	SO ₂	NH ₃	CO
1990	45.47	48.21	110.54	15.80	132.46
1991	37.63	42.39	89.54	14.83	111.59
1992	39.46	44.56	86.85	14.94	123.49
1993	40.93	46.55	89.47	15.26	133.33
1994	36.74	41.58	89.03	15.20	120.88
1995	39.29	44.25	95.22	14.99	125.25
1996	38.57	44.00	88.82	13.95	123.20
1997	37.89	45.07	93.07	13.53	126.31
1998	43.18	45.00	107.67	13.23	128.76
1999	40.43	45.86	97.88	13.41	131.78
2000	43.76	48.04	106.28	13.49	144.19
2001	40.76	40.35	108.33	12.74	113.29
2002	40.81	39.44	96.25	12.12	115.13
2003	35.82	39.14	94.89	12.06	116.22
2004	37.14	39.51	96.17	12.16	121.31
2005	39.52	37.86	96.56	11.57	114.75
2006	37.73	39.42	94.19	11.92	117.27
2007	40.54	39.66	99.23	11.57	112.52
2008	36.01	43.47	77.99	11.74	123.24
2009	39.40	44.02	104.53	11.06	132.95
2010	41.35	36.74	86.53	11.30	113.74
2011	43.65	39.17	106.15	11.61	120.25
2012	39.49	34.69	91.56	10.31	89.96
2013	33.37	33.55	82.68	10.33	90.03
2014	20.33	29.30	83.19	10.28	62.00
2015	20.29	29.91	76.79	10.34	64.58
2016	20.84	29.10	64.62	10.41	67.15
2017	19.54	30.07	55.92	10.21	56.66
2018	18.51	28.95	60.95	9.79	56.05
Trend 1990-2018	-59%	-40%	-45%	-38%	-58%

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% in total of the particulates in

2018 compared to 1990, is the reduced production of ferroalloys in the country. The calculated emissions in 2018 are similar to those in 2017.

Table 2 Emission trends for particulate matter 1990-2018

Year	Emissions			
	PM10 [kt]	PM2.5 [kt]	TSP [kt]	BC [kt]
1990	48.28	32.70	57.66	3.02
1991	42.34	28.65	50.23	2.63
1992	50.63	34.99	59.34	3.29
1993	45.03	31.33	52.81	2.92
1994	42.62	29.30	50.23	2.66
1995	43.25	29.58	51.17	2.69
1996	47.20	32.45	55.86	3.01
1997	45.86	31.53	53.86	2.86
1998	52.36	35.94	62.10	3.29
1999	45.13	31.16	53.68	2.82
2000	43.62	30.05	54.01	2.72
2001	27.69	18.25	34.08	1.46
2002	28.01	18.72	33.87	1.63
2003	41.87	29.00	49.91	2.60
2004	45.48	31.47	54.51	2.86
2005	41.25	28.03	50.24	2.59
2006	38.84	26.62	46.88	2.43
2007	31.14	20.84	38.14	1.85
2008	34.20	23.88	41.70	2.20
2009	29.49	19.97	37.72	1.71
2010	36.00	23.57	41.17	2.18
2011	42.29	28.53	52.86	2.59
2012	32.77	20.69	42.05	1.85
2013	37.70	24.40	48.74	2.23
2014	26.13	16.65	33.39	1.49
2015	22.26	13.29	25.11	1.32
2016	19.61	11.81	21.81	1.18
2017	13.66	8.60	14.85	0.76
2018	14.27	8.64	15.66	0.77
Trend 1990–2018	-70%	-74%	-73%	-74%

The concentrations of Pb have decreased significantly starting from 2003, mainly as a result 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 have been positively influenced with the introduction of unleaded petrol and BAT in the installations.

Table 3 Emission trends for heavy metals 1990-2018

Year	Emissions		
	Cd [Mg]	Pb [Mg]	Hg [Mg]
1990	1.60	232.48	0.62
1991	1.50	196.68	0.57
1992	1.45	227.56	0.53
1993	1.06	212.76	0.50
1994	1.01	203.76	0.42
1995	2.11	222.26	0.44
1996	2.31	229.64	0.50
1997	1.14	244.66	0.53
1998	1.39	259.95	0.60
1999	1.07	208.29	0.53
2000	0.93	195.45	0.54
2001	0.81	172.34	0.56
2002	0.80	170.77	0.59
2003	0.60	132.00	0.44
2004	0.53	45.74	0.43
2005	0.33	23.52	0.31
2006	0.35	8.61	0.31
2007	0.32	9.18	0.33
2008	0.37	6.51	0.32
2009	0.38	5.91	0.29
2010	0.39	6.23	0.30
2011	0.39	6.95	0.34
2012	0.29	5.29	0.30
2013	0.27	4.18	0.26
2014	0.24	4.54	0.26
2015	0.24	4.50	0.26
2016	0.48	2.64	0.22
2017	0.60	2.47	0.21
2018	0.60	2.59	0.22
Trend 1990–2018	-62%	-99%	-65%

With regard to PCDD/F and PAHs the trends are variable, but still decreasing trend can be noticed from 2011 onwards. The largest source of emissions for these pollutants is the energy sector (mainly

residential heating) with a share of 73% and 75% respectively. Regarding PCB and HCB we can notice decreasing trend due to emission reduction coming from the metal production.

Table 4 Emission trends for POPs 1990-2018

Year	Emissions			
	PCDD/F [g – I TEQ]	PAHs [t]	HCB [kg]	PCB [kg]
1990	19.82	6.54	44.29	179.33
1991	17.63	5.86	39.22	180.15
1992	17.70	6.27	25.83	178.25
1993	17.29	6.74	24.18	164.21
1994	15.87	6.20	25.04	145.84
1995	18.92	6.33	18.63	159.26
1996	18.73	6.06	19.70	186.03
1997	16.00	6.17	27.89	196.97
1998	17.61	6.69	29.34	202.65
1999	17.18	6.64	53.97	165.29
2000	19.35	7.65	38.32	140.88
2001	16.14	6.11	34.15	129.39
2002	17.08	6.22	52.68	128.61
2003	17.82	6.97	42.98	85.39
2004	17.83	7.13	8.51	38.07
2005	16.52	6.88	7.56	4.22
2006	17.74	7.34	11.70	4.60
2007	16.32	6.75	8.90	4.88
2008	17.90	7.48	7.78	4.44
2009	18.52	7.58	8.32	3.98
2010	19.57	8.17	9.63	4.41
2011	19.53	8.14	10.54	4.79
2012	13.28	5.63	9.47	3.68
2013	12.45	5.38	6.36	3.24
2014	10.66	4.35	4.18	3.10
2015	11.26	4.74	0.95	9.99
2016	10.19	4.52	0.84	13.63
2017	8.41	3.55	2.19	20.96
2018	8.65	3.77	1.66	29.02
Trend 1990–2018	-56%	-42%	-96%	-84%

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 1990-2013 and Tier 2 for the calculation of emissions in the period 2014-2018). A high level of uncertainty brought the used mileage data per vehicle category, for which there is no detailed scientific research evidence, and the different categorization over the years of the vehicles in the statistical publications and the MOI database. This issue is being resolved and eliminated with the introduction of the COPERT V model. Tier 2 results and COPERT V results for 2014-2016 showed minor differences in the results, but the emissions calculated with Tier 1, might be overestimated.

1.3. Priorities for improvement

Due to the fact that emissions from the Transport sector have been calculated using the Tier 2 method only for the last four years, the major priority is the establishment of Copert V model for calculation of emissions coming from this sector for the whole reporting period. This is important since the Transport sector is one of the key sources of CO and NO_x national emissions. National experts have participated in two trainings for use of COPERT V model.

The transport emissions were calculated for the period 2014-2018 for the purpose of GHG inventory but unfortunately, 2017 and 2018 emission calculations were finalized after the reporting deadline. These calculations will be reported in the next submission, and if necessary, will be available for the ERT during the stage 3 review. Therefore, in this submission emissions from transport are calculated by use of Tier 1 methodology for the period 1990-2013 and Tier 2 for the period 2014-2018. Reporting only 2014-2016 emissions with COPERT calculations and going back on Tier 2 for 2017-2018 seemed more complicated for the trend consistency. However, there is methodology inconsistency in this sector, but we have already applied for Taeix expert mission, to overcome the problem. The application has been improved by the European commission, but the missions will be carried out at the end of this year and the beginning of next. The aim of the mission is to acquire the means and know-how to incorporate COPERT V methodology for at least the period 2005-2018 for which there is an available car fleet data and possibly apply extrapolation method for the years up to 1990.

The second national priority is the use of Tier 2 in 1.A.4 sector. The combustion in households and administrative capacities is one of the major emission sources for several pollutants especially for particulate matter, which in itself is a critical pollutant in the country. However, use of Tier 2 will be possible after carrying out of the national census planned for 2021. We have discussed a possible national survey on this issue but still due to financial limitation nothing has been done up to now.

QA/QC procedures are continuously implemented but there is a need of further trainings, improvement of the implementation of these procedures as well as the use of uncertainty analysis.

1.4. Information on recalculation – main reasons for recalculations

- In the Energy sector, the emissions for the year 2018 (and even several years before) were recalculated, using final activity data from the energy balance and disaggregated activity data regarding fuel consumption. This recalculation did not result in some major changes. Additionally, revised activity data available in the MAKSTAT database were used. EF from GB 2019 were introduced. In Transport sector, recalculations have been made due to the final energy consumption.
- In the Solvent sectors, NFRs were recalculated in some cases up to 2006 in order to improve the consistency of the time serial and reduce overestimation; additionally, the population number used as activity data was replaced using revised data from the MAKSTAT database.
- In the Industry sector recalculations were done due to use of Tier 2 method for calculations of historical emissions and clarification of activity data. In this sector also calculations were done using available data from installations or revised data in the MAKSTAT database. Detailed information on the recalculations per category can be found in the sector chapters. In this sector also GB 2019 emission factors were used.

- In the Waste sector available activities were introduced and updated, while in the Agriculture sector only minor corrections were introduced in one NFR category. No recalculations were carried out in 1.B.

1.5. 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.

1.6. Clarification of the reason for differences in reported national totals for the entire territory with NECD reports

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_x, NMVOC, SO_x and NH₃ 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", planned to start at the end of 2020. However, on the basis of the regular preparation of the emission inventory, the gridded data starting from 2017, and the annual IIR, it can be ascertained that several obligations coming from the new NEC directive are already implemented in our by our country.

INTRODUCTION



2. INTRODUCTION

2.1. National Inventory background

International commitments

Reporting of emission data to the Executive Body (EB) of the Convention on Long-range Transboundary Air Pollution (CLRTAP) is required in order 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 SO₂, NO_x, NMVOC, CO and NH₃, 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 Transboundary 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 Transboundary 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 Transboundary Air Pollution on reduction of sulfur emissions or their transboundary 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 Transboundary Air Pollution on the control of nitrogen oxides or their transboundary fluxes (“Official Gazette of the Republic of Macedonia” No. 24/2010);
 - Law on Ratification of the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on the control of volatile organic compounds or their transboundary fluxes (“Official Gazette of the Republic of Macedonia” No. 24/2010);
 - Law on Ratification of the Protocol to the 1979 Convention on Long-Range Transboundary 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 Transboundary 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 Transboundary 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 Transboundary 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 are presented in the table below.

Table 5 Status of ratification of the protocols under CLRTAP

Tools of UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP)		Parties	entered into force	Signed (S) / Ratified (R) / Succession (d) / Accession (a) by North Macedonia
1979	Geneva Convention on Long-Range Transboundary Air Pollution		16.03.1983	30 Dec 1997 (d) 4
1984	Geneva Protocol on Long-term Financing of the Cooperative Programme 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 Transboundary 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 Transboundary Fluxes	35	14.02.1991	10 Mar 2010 (a)
1991	Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary 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			
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			
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 ⁶			

⁴https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-1&chapter=27&clang=en

⁵<http://www.unece.org/fileadmin/DAM/env/lrtap/full%20text/ece.eb.air.104.e.pdf>

⁶http://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE.EB.AIR.114_ENG.pdf

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.
 - 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 Transboundary 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 session⁷ (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 2014 Reporting guidelines (ECE/EB.AIR.125) are adopted for application in 2015 and subsequent years.

⁷<http://www.unece.org/index.php?id=33605#/>

This informative report has been prepared according to Annex II of the Revised 2014 Reporting guidelines.

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;
- 3) Preparation of report on implementation of emission reduction measures in order 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. 142/07⁸.

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 level⁹.

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 2004¹⁰ and has been based EMEP/EEA

⁸ [Rulebook on inventory making and establishment of the level of polluting substances emission in ambient air in tonnes per year for all types of activities, as well as other data to be delivered to the EMEP \(Official Gazette of RM no.142/2007\)](#)

⁹ [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 \(Official Gazette of RM No.2/2010,156/11\)](#)

¹⁰ [CLRTAP- Macedonia's Informative Inventory Report, 2004, MEPP, March 2006](#)

Guidebook¹¹ 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 SNAP¹² sectors (1, 2 and 3), without submitting an IIR Report.

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 emissions¹³.

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 review¹⁴ 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 2009¹⁵. Hence, recommendations from Stage 3 review were taken into account 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 particular 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 2013¹⁶ for most of the source categories.

¹¹ [EMEP/CORINAIR Emission Inventory Guidebook - 2006](#)

¹² [SNAP Selected Nomenclature on Air Pollutants](#)

¹³ [CLRTAP- Macedonia's Informative Inventory Report, 2008, MEPP, March 2010](#)

¹⁴ http://www.ceip.at/fileadmin/inhalte/emep/pdf/2011/MK_Stage3_Review_Report_2011.pdf

¹⁵ [EMEP/EEA air pollutant emission inventory guidebook - 2009](#)

¹⁶ [EMEP/EEA air pollutant emission inventory guidebook - 2013](#)

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.

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 2016¹⁷ were used. For this reporting round additionally in most of the categories, EMEP/EEA Emission Inventory Guidebook 2019¹⁸ and 2016 has been used, while older versions were rarely used due to limitation of activity data. The present IIR submitted in 2020 contains improved activity data and the editing has also been improved.

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	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2005	<ul style="list-style-type: none"> National Methodology for Air pollutants emission inventory Establishment of an emission inventory and reporting system 	Basic pollutants /SNAP sector 1,2,3	2003	EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition October 2002 UPDATE Emission measurements	MOEPP	X			
2006	First Air pollutant emission Inventory according CORINAIR methodology and Informative Inventory Report (IIR)	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
2007	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	Basic pollutants	2005		MEPP	X			

¹⁷ [EMEP/EEA air pollutant emission inventory guidebook - 2016](#)

¹⁸ [EMEP/EEA air pollutant emission inventory guidebook - 2019](#)

Year	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2008 and 2009	Update	Basic pollutants SNAP sector 1, 2 and 3	On yearly base according the rule n-2	EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition October 2002 UPDATE Emission measurements	MEPP		X		
2010	Air pollutant emission Inventory and IIR	Basic pollutants	2008		TEHNOLAB Ltd		X		X
2011	Stage 3 in depth review Update	Basic pollutants SNAP sector 1, 2 and 3		EMEP/EEA GB 2009	MEPP & TEHNOLAB Ltd		X		
2012	Inventory and preparation of the report	All including heavy metals (HM)	Full time series		MEPP & TEHNOLAB Ltd		X		X
2013	<ul style="list-style-type: none"> Air pollutant emission Inventory Emissions for the baseline years 1980 (SOx), 1987 (NOx), 1988 (NMVOC) and 1990 (POPs) 	All + HM including PM2.5, PM10, dioxins and furans		EMEP/EEA GB 2009	MOEPP		X		
2014 2015	Recalculation including baseline years	All with exception of BC	Baseline years + 2012 and 2013	EMEP/EEA Emission Inventory Guidebook - 2009, 2013	MEPP			X	
2016	<ul style="list-style-type: none"> Recalculation of all pollutants, time series starting from 1990 documentation of methods, data sources, completeness of the Inventory, QA/QC, sectorial methodologies for emission estimations by category (NFR) 	All with exception of BC	1990 - 2014	EMEP/EEA Emission Inventory Guidebook - 2009, 2013	MEPP Twinning			X	X

Year	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
2017	<ul style="list-style-type: none"> Introduction of uncertainty trend analysis and key source analysis as well as QA/QC procedures implemented and improved, most of the Stage 3 review comments¹⁹ implemented 	All + BC	1990-2015	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP Twinning			X	X
2018	<ul style="list-style-type: none"> Data quality improvement, introduction of new QA/QC procedures 	Emission inventory experts	1990-2016	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP			X	X
2019	<ul style="list-style-type: none"> Data quality improvement, introduction of new QA/QC procedures 	Emission inventory experts	1990-2017	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP			X	X
2020	<ul style="list-style-type: none"> 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 	Emission inventory experts	1990-2018	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016, 2019	MEPP			X	X

2.2. Institutional arrangements

According to the Article 40 of the Law on environment (LE)²⁰, 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. 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 operators, 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

¹⁹ [UNECE/CEIP/S3.RR/2016/Macedonia19/10/2016](#)

²⁰ [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](#)

fleet data. MOI during 2019 has provided activity data per vehicle category for the 2018. Therefore, Tier 2 calculation methodology has been implemented for the period 2014-2018 data.

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.

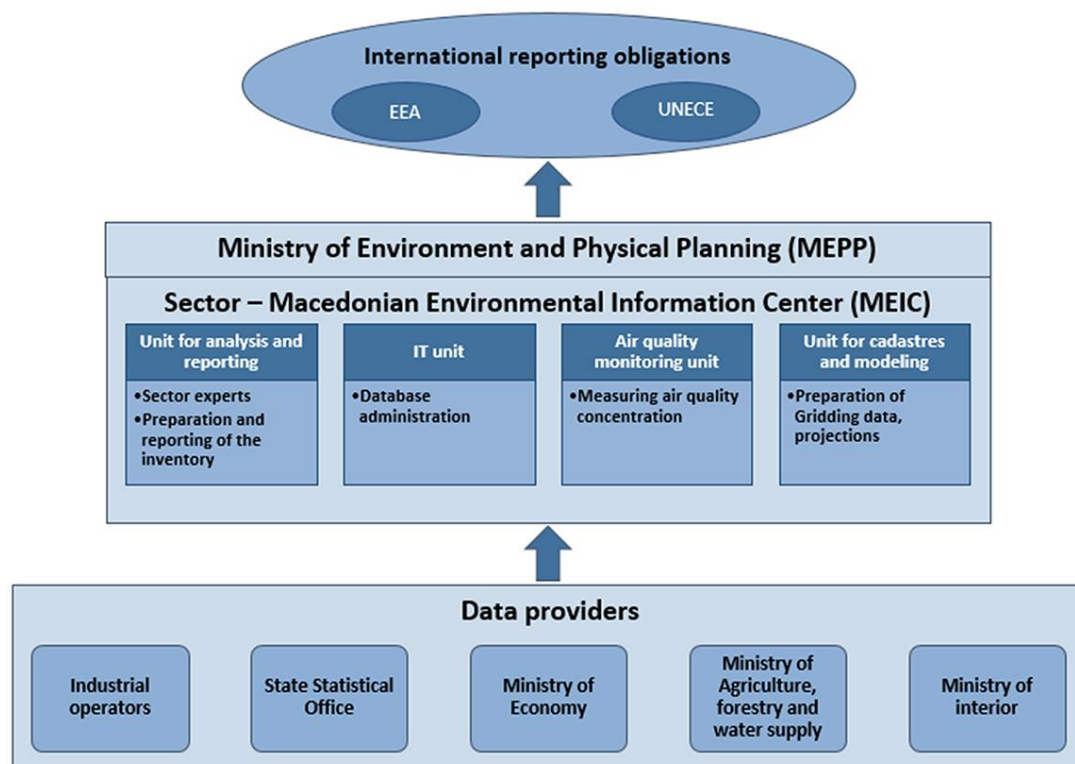


Figure 1 Institutional arrangements

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 with regard to data collection and data calculation on the activity rate and emission factors included in the database of the National Emission Inventory. Currently, seven 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 due to the fact that preparation of the inventory is not their main task, they need further training in order 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 IT expert is 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. A document for the timeline of the inventory preparation have 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 are 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.

During the Inventory preparation, recommendations given from Stage 3 review were followed and were of great use regarding the improvements made in the NFR, this IIR and improvements in general.

An expert mission on Improvement of the QA/QC procedures in the emission inventory process Within the project, "Capacity building on climate change mitigation and adaptation for western Balkan" Program for 2017, financed by the Austrian government, has been held in December 2017. During the mission a Workflow matrix for preparation of IIR and emission inventory has been developed and it is partially implemented.

In the last reporting round deputy experts per sectors have checked in more detail activity data and emissions calculations done by the nominated key experts per sector according the work flow 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 1990-2018;
- 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
- Measurements data from the industrial operators and waste incineration plant
- International web page databases (FAO, Eurostat and 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 2018. 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 sectoral chapters, further below. Mainly the problem is coming from the fact that data coming from the Statistical publications are not detailed enough, and the fact that the last Census was carried out in 2002. Additionally, compared to the other European countries, we have started with preparation of whole time series emission inventory for all pollutants only in 2014. This 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 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.

Taking into account 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 2009, GB 2013 in several categories and mainly GB 2016 and GB 2019 were used to estimate emissions from most sources in this Inventory. Only in 1.A.1.a 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. The factors are used in case when these plants do not report measured data, or the reported data are not approved by MEPP.

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.g (Chemical products) and 2.H.2 (Food and beverages industry). 1.A.3.b for 2014-2018 and in 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 (Ferroalloys production). Tier 2 has been also introduced in 2.C.5 (Lead production) and 2.C.6 (Zinc Production).

With regard to 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 8.0.

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 help 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.

During the preparation of the current submission of Informative Inventory Report in 2018, 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;

The structure of the above-mentioned guidelines was followed by the authors, in order 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 the beginning of May due to the expert's engagement in other duties. It is planned from the next submission 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.

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 2016 and now mainly 2019, targeting on transparency, completeness, consistency, comparability and accuracy of emissions data. In cases where we are limited with activity data, emission factors from EMEP/EEA Emission Inventory Guidebook 2013 and 2009 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 Macedonian 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 particular 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. Table 7 presents the official activity data sources in relation to the NFR sectors. 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 1990-2018 [21] Energy balance 2009-2018 [22] Energy statistics for 2000-2010 [23] MAKSTAT database-Energy [24]	Ministry of economy MEPP State statistical office
Transport	State Statistical Office of the Republic of North Macedonia, Transport and other communications, 2007-2015 [25], MAKSTAT database data on transport [26] MOI car fleet database 2014-2018	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 [27] MAKSTAT database industrial data [28] Statistical Yearly reports 1990-2018 [21] Questionnaire for emissions in environment 2014-2018 http://minerals.usgs.gov/minerals/pubs/country/europe.html#mk [29]	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 [30] 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 [27] MAK STAT database on solvent [28] Statistical Yearly reports 1990-2018 [21] Questionnaire for emissions in environment -2014-2018 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 [31] Statistical Yearly reports 1990-2018 [21] State Statistical Office of the Republic of North Macedonia, Livestock, 2007-2015 [32] 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 statistical office MAKSTAT database MAFWS FAO
Waste	Statistical Yearly reports 1990-2018 [21] 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 Data on treated communal water 1990-2017 reported by 7 waste water treatment plants PRTR database in MEPP [39]	State statistical office Public enterprise “Drisla” landfill EUROSTATE Waste water treatment plants
Natural sources	State Statistical Office of the Republic of North Macedonia, Forestry, 2007–2014 [32] Data on fires (burned area, burned forests) reported by Macedonian forest fires 1990-2018	State statistical office Public enterprise Macedonian forests

2.5. Key Categories

Following the encouragement from the last Stage 3 review, the update of the Key Category Analysis (KCA) was prepared on NFR subcategory basis for all pollutants and therefore is fully consistent with the analysis done by CEIP. The trend analysis was carried out as recommended in the Stage 3 review carried out last year for the first time and also carried out during this year.

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 pollutants under CLRTAP: pollutants which cause acidification, eutrophication and Ground-level ozone (NO_x, NMVOC, SO_x, NH₃ 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 key category analysis is in compliance with the KCA table sent by CEIP with exception with PM_{2.5}* due to the fact that for this pollutants KCA has been corrected in compliance with NFR reporting table version 2 which has been attached to CDR. Eionet web page in beginning of April. Corrections on the emissions of PM_{2.5} from 1.A.1a were made which effect on the KCA for this pollutant.

Table 8 Key categories for all air pollutants

Pollutant	Key categories 2018 (sorted from high to low contribution from left to right)											Total %
NO _x	1A1a	1A3biii	1A2gviii	1A3bi	1A2a	1A2gvi						81.3%
NMVOC	1A4bi	5A	2D3d	2D3a	2D3e	1B2av	3B1a	1A3bv	3Da1	1B1a	3B1b	80.4%
SO ₂	1A1a											88.4%
NH ₃	3B1a	3Da2a	3Da3	3B3	3Da1	3B1b						81.1%
PM _{2.5} *	1A4bi	1A1a	1A2a									82.1%
PM ₁₀	1A4bi	1A1a	3Da1	1A2a								81.7%
TSP	1A4bi	1A1a	2A5a	1A2a	1B1a							81.9%
CO	1A4bi	1A3bi	1A3biii	1A2a	5A							84.3%
Pb	1A1a	2C1	1A4bii	1A2a	1A2gvi							83.8%
Cd	2C1	1A4bi										85.0%
Hg	1A1a	5C1biii	2C1	1A2a								88.1%
As	1A1a											88.8%
Cr	1A3bi	1A3biii	1A1a	1A4bi								87.7%
Cu	5C1bii	1A4bi	2G	1A2a	1A2gvi	1A2gvi	1A1a					81.4%
Ni	1A4bi	1A1a	1A4ai									88.6%
Se	1A2gvi											98.8%
Zn	5C2	1A4bi	1A2a									84.4%

Pollutant	Key categories 2018 (sorted from high to low contribution from left to right)										Total %
DIOX	1A4bi	1A2a	2C1								87.1%
PAH	1A4bi	1A2a									88.7%
HCB	2C3										83.9%
PCBs	2C5										94.7%

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 9 Key source categories for emissions of NO_x in Gg

Table 3. Key sources categorized for emissions of HFCs, PFCs, SF₆ and NF₃

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A1a	Public electricity and heat production		5.12	27.7%	27.7%	
1A3biii	R.T., Heavy duty vehicles		4.38	23.6%	51.3%	
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction		1.98	10.7%	62.0%	
1A3bi	R.T., Passenger cars		1.63	8.8%	70.8%	
1A2a	Iron and Steel		1.12	6.0%	76.8%	
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction		0.83	4.5%	81.3%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A1a	Public electricity and heat production	23.77	5.12	0.605	36.2%	36.2%
1A3biii	R.T., Heavy duty vehicles	3.00	4.38	0.418	25.0%	61.2%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	2.00	1.98	0.154	9.2%	70.4%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	3.70	0.83	0.090	5.4%	75.8%
1A3bi	R.T., Passenger cars	5.28	1.63	0.069	4.1%	79.9%
1A4ai	Commercial/Institutional: Stationary	0.14	0.55	0.065	3.9%	83.8%

Table 10 Key source categories for emissions of NMVOC in Gg

Level Assessment 2018				
NFR Code	NFR sector	2018	%	%cum
1A1a	Public electricity and heat production	5.12	27.7%	27.7%
1A3biii	R.T., Heavy duty vehicles	4.38	23.6%	51.3%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	1.98	10.7%	62.0%
1A3bi	R.T., Passenger cars	1.63	8.8%	70.8%
1A2a	Iron and Steel	1.12	6.0%	76.8%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	0.83	4.5%	81.3%

Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A1a	Public electricity and heat production	23.77	5.12	0.605	36.2%	36.2%
1A3biii	R.T., Heavy duty vehicles	3.00	4.38	0.418	25.0%	61.2%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	2.00	1.98	0.154	9.2%	70.4%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	3.70	0.83	0.090	5.4%	75.8%
1A3bi	R.T., Passenger cars	5.28	1.63	0.069	4.1%	79.9%
1A4ai	Commercial/Institutional: Stationary	0.14	0.55	0.065	3.9%	83.8%

Table 11 Key source categories for emissions of SO₂ in Gg

Level Assessment 2018							
NFR Code	NFR sector				2018	%	%cum
1A1a	Public electricity and heat production				53.85	88.4%	88.4%
Trend Assessment 1990-2018							
NFR Code	NFR sector	1990	2018	TA	%	%cum	
1A1a	Public electricity and heat production	102.15	53.85	0.073	25.1%	25.1%	
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.41	2.60	0.071	24.2%	49.3%	
1A2a	Iron and Steel	1.40	3.03	0.067	23.0%	72.3%	
1A2b	Non-ferrous Metals	2.10	0.00	0.034	11.8%	84.0%	

Table 12 Key source categories for emissions of NH₃ in Gg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
3B1a	Dairy cattle			2.19	22.4%	22.4%
3Da2a	Animal manure			2.04	20.9%	43.2%
3Da3	Urine and dung deposited by grazing animals			1.21	12.4%	55.6%
3B3	Swine			0.90	9.2%	64.8%
3Da1	Inorganic N-fertilizers			0.81	8.3%	73.1%
3B1b	Non-dairy cattle			0.79	8.0%	81.1%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
3B1a	Dairy cattle	2.07	2.19	0.150	25.0%	25.0%
3Da3	Urine and dung deposited by grazing animals	2.93	1.21	0.099	16.6%	41.6%
3B4gi	Laying Hens	1.76	0.56	0.089	14.8%	56.3%
3B3	Swine	0.84	0.90	0.063	10.6%	66.9%
3B2	Sheep	0.92	0.29	0.046	7.7%	74.6%
3Da1	Inorganic N-fertilizers	0.91	0.81	0.041	6.9%	81.4%

Table 13 Key source categories for emissions of CO in Gg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A4bi	Residential: stationary		31.21	55.7%	55.7%	
1A3bi	R.T., Passenger cars		6.08	10.8%	66.5%	
1A3biii	R.T., Heavy duty vehicles		4.27	7.6%	74.1%	
1A2a	Iron and Steel		3.17	5.7%	79.8%	
5A	Solid waste disposal on land		2.53	4.5%	84.3%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A3bi	R.T., Passenger cars	46.34	6.08	0.571	42.9%	42.9%
1A4bi	Residential: stationary	64.14	31.21	0.171	12.9%	55.8%
1A3biii	R.T., Heavy duty vehicles	2.74	4.27	0.131	9.9%	65.7%
1A2a	Iron and Steel	1.50	3.17	0.107	8.0%	73.7%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.32	2.46	0.098	7.4%	81.1%

Table 14 Key source categories for emissions of TSP in Gg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A4bi	Residential: stationary		6.21	39.7%	39.7%	
1A1a	Public electricity and heat production		4.98	31.8%	71.4%	
2A5a	Quarrying and mining of minerals other than coal		0.80	5.1%	76.5%	
1A2a	Iron and Steel		0.43	2.7%	79.3%	
1B1a	Coal Mining and Handling		0.41	2.6%	81.9%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C2	Ferroalloys Production	24.52	0.05	1.554	46.6%	46.6%
1A4bi	Residential: stationary	12.74	6.21	0.647	19.4%	66.1%
1A1a	Public electricity and heat production	12.78	4.98	0.353	10.6%	76.7%
2A5a	Quarrying and mining of minerals other than coal	0.62	0.80	0.149	4.5%	81.1%

Table 15 Key source categories for emissions of PM2.5 in Gg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A4bi	Residential: stationary		5.74	66.5%	66.5%	
1A1a	Public electricity and heat production		0.97	11.2%	77.7%	
1A2a	Iron and Steel		0.38	4.4%	82.1%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C2	Ferroalloys Production	14.71	0.03	1.690	49.3%	49.3%
1A4bi	Residential: stationary	11.78	5.74	1.154	33.7%	82.9%

Table 16 Key source categories for emissions of PM10 in Gg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
1A4bi	Residential: stationary			5.90	41,3%	41.3%
1A1a	Public electricity and heat production			3.39	23.7%	65.0%
3Da1	Inorganic N-fertilizers			1.97	13.8%	78.9%
1A2a	Iron and Steel			0.41	2.9%	81.7%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C2	Ferroalloys Production	20.84	0.04	1.450	48.4%	48.4%
1A4bi	Residential: stationary	12.10	5.90	0.550	18.4%	66.7%
3Da1	Inorganic N-fertilizers	2.06	1.97	0.323	10.8%	77.5%
1A1a	Public electricity and heat production	8.63	3.39	0.197	6.6%	84.1%

Table 17 Key source categories for emissions of BC in Gg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
1A4bi	Residential: stationary			0.57	74.1%	74.1%
1A2a	Iron and Steel			0.03	4.3%	78.4%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction			0.03	4.2%	82.7%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C2	Ferroalloys Production	1.47	0.00	1.885	47.3%	47.3%
1A4bi	Residential: stationary	1.18	0.57	1.370	34.4%	81.7%

Table 18 Key source categories for emissions of Pb in Mg

Table 25 Key source categories for emissions of Pb in kg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
1A1a	Public electricity and heat production			0.48	18.4%	18.4%
2C1	Iron and Steel Production			0.46	17.9%	36.2%
1A4bii	Residential: Household and gardening (mobile)			0.45	17.3%	53.5%
1A2a	Iron and Steel			0.44	17.1%	70.7%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction			0.34	13.1%	83.8%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C5	Lead Production	131.06	0.03	49.65	29.9%	29.9%
1A3bi	R.T., Passenger cars	89.09	0.05	32.54	19.6%	49.6%
1A1a	Public electricity and heat production	0.89	0.48	16.13	9.7%	59.3%
1A2a	Iron and Steel	0.19	0.44	15.317	9.2%	68.5%
1A4bii	Residential: Household and gardening (mobile)	0.63	0.45	15.291	9.2%	77.7%
2C1	Iron and Steel Production	4.07	0.46	14.478	8.7%	86.5%

Table 19 Key source categories for emissions of Cd in Mg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
2C1	Iron and Steel Production		0.41	67.8%	67.8%	
1A4bi	Residential: stationary		0.10	17.2%	85.0%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C1	Iron and Steel Production	0.02	0.41	1.770	67.1%	67.1%
2C5	Lead Production	0.35	0.00	0.580	22.0%	89.0%

Table 20 Key source categories for emissions of Hg in Mg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A1a	Public electricity and heat production		0.09	42.6%	42.6%	
5C1biii	Clinical waste		0.04	18.1%	60.6%	
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction		0.03	15.1%	75.7%	
1A2a	Iron and Steel		0.03	12.4%	88.1%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2017	TA	%	%cum
1A1a	Public electricity and heat production	0.17	0.09	0.440	38.3%	38.3%
1A2a	Iron and Steel	0.01	0.03	0.304	26.4%	64.8%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.00	0.02	0.262	22.8%	87.6%

Table 21 Key source categories for emissions of As in Mg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A1a	Public electricity and heat production		0.45	88.8%	88.8%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A1a	Public electricity and heat production	0.84	0.45	2.474	47.1%	47.1%
2C5	Lead Production	1.03	0.00	1.991	37.9%	84.9%

Table 22 Key source categories for emissions of Cr in Mg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A3bi	R.T., Passenger cars		0.49	30.0%	30.0%	
1A3biii	R.T., Heavy duty vehicles		0.45	27.3%	57.3%	
1A1a	Public electricity and heat production		0.29	17.7%	74.9%	
1A4bi	Residential: stationary		0.21	12.8%	87.7%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C1	Iron and Steel Production	3,98	0,00	2,435	49,3%	49,3%
1A3bi	R.T., Passenger cars	0.01	0.49	0.917	18.6%	67.9%

1A3biii	R.T., Heavy duty vehicles	0.00	0.45	0.838	17.0%	84.9%
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Table 23 Key source categories for emissions of Cu in Mg

Table 25 Key source categories for emissions of burning

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
5C1biii	Clinical waste			0.09	18.4%	18.4%
1A4bi	Residential: stationary			0.06	12.9%	31.4%
2G	Other product manufacture and use			0.06	12.8%	44.2%
1A2a	Iron and Steel			0.06	12.0%	56.2%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction			0.04	9.2%	65.4%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction			0.04	8.9%	74.3%
1A1a	Public electricity and heat production			0.03	7.1%	81.4%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A3bi	R.T., Passenger cars	0.30	0.01	0.537	29.2%	29.2%
1A2a	Iron and Steel	0.03	0.06	0.248	13.5%	42.7%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.00	0.04	0.224	12.2%	54.9%
1A3biii	R.T., Heavy duty vehicles	0.12	0.01	0.182	9.9%	64.8%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	0.19	0.04	0.175	9.5%	74.3%
1A3bii	R.T., Light duty vehicles	0.06	0.00	0.114	6.2%	80.5%

Table 24 Key source categories for emissions of Ni in Mg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
1A4bi	Residential: stationary			0.49	38.1%	38.1%
1A1a	Public electricity and heat production			0.44	34.3%	72.4%
1A4ai	Commercial/Institutional: Stationary			0.21	16.2%	88.6%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A4bi	Residential: stationary	0.13	0.49	0.934	53.2%	53.2%
1A4ai	Commercial/Institutional: Stationary	0.05	0.21	0.400	22.8%	75.9%
1A4ci	Agriculture/Forestry/Fishing: Stationary	0.16	0.02	0.087	4.9%	80.9%

Table 25 Key source categories for emissions of Se in Mg

Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
1A1a	Public electricity and heat production		Se	1.42	90.2%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A1a	Public electricity and heat production	2.63	1.42	0.124	47.1%	47.1%
2C1	Iron and Steel Production	0.02	0.11	0.111	42.1%	89.2%

Table 26 Key source categories for emissions of Zn in Mg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
5C2	Open burning of waste			5.19	44.4%	44.4%
1A4bi	Residential: stationary			3.99	34.1%	78.5%
1A2a	Iron and Steel			0.69	5.9%	84.4%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
5C2	Open burning of waste	6.67	5.19	0.491	48.0%	48.0%
1A4bi	Residential: stationary	8.14	3.99	0.119	11.6%	59.6%
1A2a	Iron and Steel	0.37	0.69	0.110	10.7%	70.3%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.13	0.57	0.105	10.3%	80.6%

Table 27 Key source categories for emissions of DIOX in g I-TEQ

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
1A4bi	Residential: stationary			6.24	72.1%	72.1%
1A2a	Iron and Steel			0.67	7.8%	79.9%
2C1	Iron and Steel Production			0.63	7.2%	87.1%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A4bi	Residential: stationary	12.80	6.24	0.172	22.8%	22.8%
1A2a	Iron and Steel	0.29	0.67	0.145	19.3%	42.1%
2C1	Iron and Steel Production	2.66	0.63	0.141	18.7%	60.8%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.03	0.52	0.134	17.7%	78.6%
1A2b	Non-ferrous Metals	0.47	0.00	0.054	7.2%	85.7%

Table 28 Key source categories for emissions of PAHs in Mg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
1A4bi	Residential: stationary			2.84	75.3%	75.3%
1A2a	Iron and Steel			0.50	13.4%	88.7%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
1A4bi	Residential: stationary	5.63	2.84	0.187	35.0%	35.0%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.07	0.39	0.162	30.2%	65.2%
1A2a	Iron and Steel	0.27	0.50	0.161	30.1%	95.3%

Table 29 Key source categories for emissions of HCB in kg

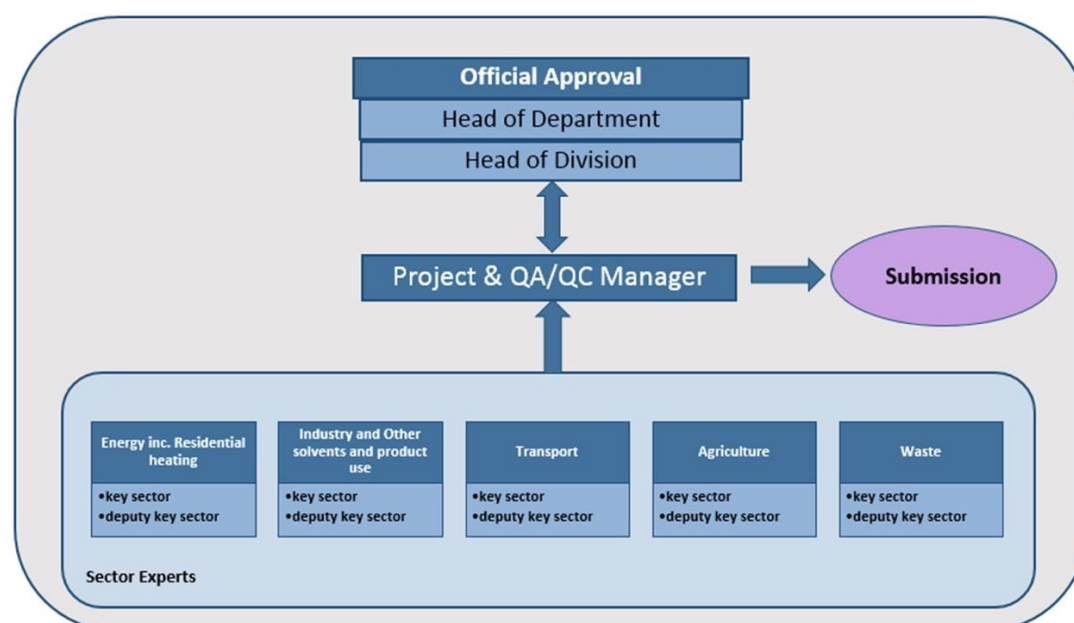
Level Assessment 2018						
NFR Code	NFR sector		2018	%	%cum	
2C3	Aluminum production		1.39	83.9%	83.9%	
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C3	Aluminum production	44.21	1.39	4.256	60.4%	60.4%
2C1	Iron and Steel Production	0.00	0.13	2.109	30.0%	90.4%

Table 30 Key source categories for emissions of PCB in kg

Level Assessment 2018						
NFR Code	NFR sector			2018	%	%cum
2C5	Lead Production			27.50	94.7%	94.7%
Trend Assessment 1990-2018						
NFR Code	NFR sector	1990	2018	TA	%	%cum
2C5	Lead Production	124.26	27.50	1.57	85.3%	85.3%

2.6. Quality assurance quality control

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 at sector level. The project Manager is in charge of 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 with support of the IT expert.

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 2018 emission data was set to 95%, as the IIR report was submitted after the official deadline of 15th March defined in the CLRTAP Reporting Guidelines (ECE/EP.AIR/125), due to engagement of the experts in other work overload. Submission of emission data, i.e. NFR Tables to CEIP was however done in time on 13th February.

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 31 Completeness Analysis 2019

Sector	Submission 2019		Submission 2020			Plan Submission 2021		
	1990	2017	1990	2017	2018	1990	2018	2019
Transparency (IE)	98%	98%	98%	98%	98%	98%	98%	98%
Completeness (NE)	88%	90%	88%	93%	93%	90%	95%	95%
Completeness (IIR)	~ 273 pages		~ 290 pages			~ 350 pages		
Timeliness (Submission)	95%*		95%*			100%		

Accuracy, consistency and comparability were checked in the course of the EMEP/EEA Reviews. Recommendations from the Stage 3 reviews (2011, 2016), have been almost fully implemented as can be seen from sectorial chapters. Those that have not been implemented and will be implemented in future submission are presented in 9.2.

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

Table 32 Annual time schedule

Task	Description	Responsibility	Deadline
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 sectoral 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 until mid-April-beginning of May due to the workload in the Ministry.

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 is 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 in order 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.

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, in order 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 2016. The next planned stage 3 review is during this year and its recommendations given will be included in future submissions.

Most of the findings were addressed in the IIR prepared last year but some findings have also been addressed in the current inventory to the extent possible. Those which were not implemented due to not available activity data or limited time are presented in the Table for future improvements.

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 in order to document the work, and keep an overview, which is especially essential when one person is responsible for numerous sectors and categories.

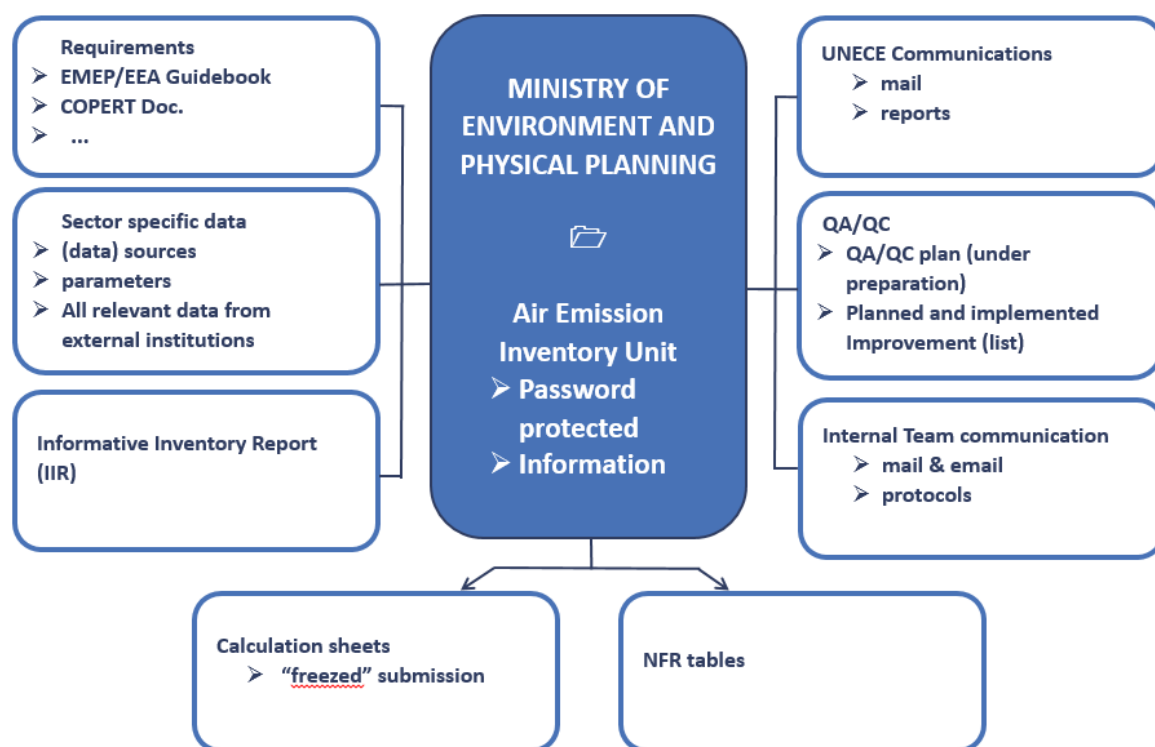


Figure 4 Archiving system

2.6.1. Continuous improvement

The Macedonian inventory is subject to continuous improvement.

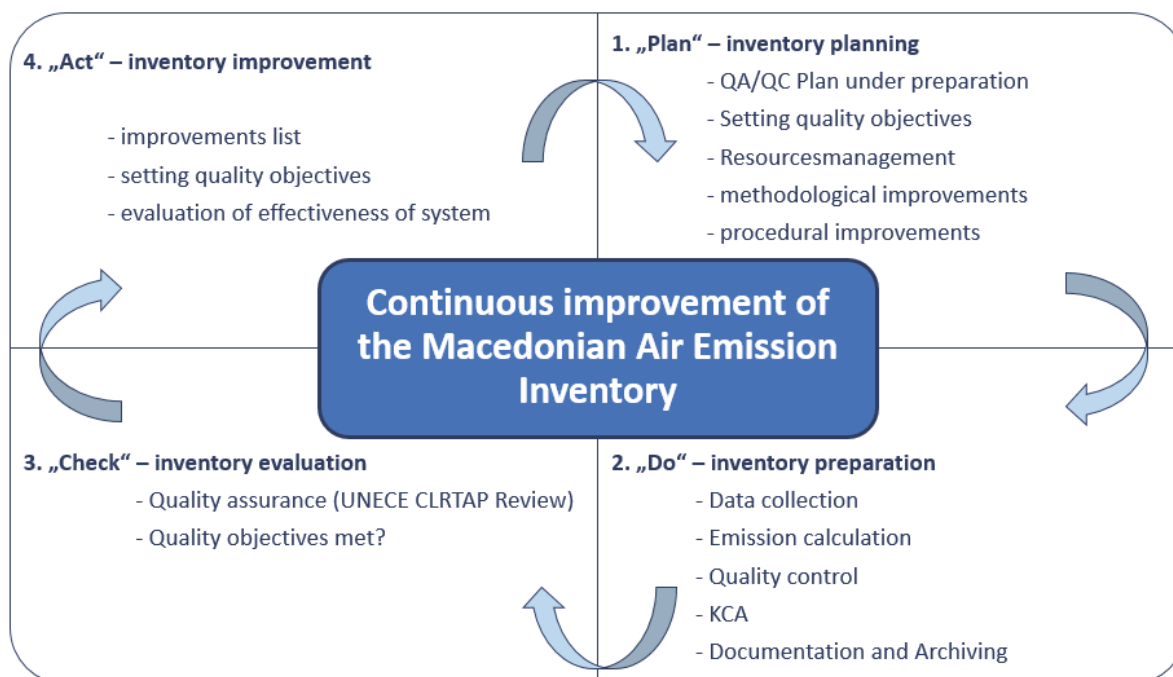


Figure 5 Improvement Cycle

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 (SO_2 , NO_x , NMVOC, 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 2018. There is a need of further trainings on this subject since now the knowledge is limited and excel files developed in the Twining project are updated on yearly base.

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. In order 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 33 for activity and Table 34 for emission factors.

Table 33 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 34 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 judgement 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 SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}, for the year 2018 and the respective level and trend uncertainties. The results of the uncertainty analysis are presented in following tables.

Table 35 Result of overall uncertainty estimation for the main pollutants SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}

Pollutants	Emissions 2018	Level uncertainty 2018	Trend uncertainty 1990 - 2018
SO ₂	57.9 kt	19.2%	3.5%
NOX	17.4 kt	17.8%	4.5%
NMVOC	28.6 kt	42.8%	14.5%
NH ₃	9.6 kt	96.6%	22.0%
PM2.5	7.4 kt	98.5%	13.7%

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

Table 36 Uncertainty estimation of SO₂ emissions 1990 and 2018

Member State: MK												
Reporting year: 2018												
NRF sector	Pollutant	Base year emissio Mg	Year t emissio Mg	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 (3) %	Uncertainty introduced into the trend in total national emission %
	SO ₂	Input data	Input data	input data Note A	input data Note A	$(E^2 + F^2)^{1/2}$	$(G^2 + D^2) / \text{Summe}$	Note B	D/Summe(C)	I/F Note C	J/E*sqrt(2) Note D	K^2 + L^2
1 A 1 a	SO ₂	102,1	53,9	5,0	20,0	20,62	367,43	0,00	0,49	-0,07	3,49	12,18
1 A 1 b	SO ₂	0,8	NO	5,0	20,0	20,62						
1 A 2 a	SO ₂	-	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 b	SO ₂	2,1	0,0	10,0	20,0	22,36	0,00	-0,01	0,00	-0,20	0,00	0,04
1 A 2 c	SO ₂	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	SO ₂	0,3	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,03	0,00	0,00
1 A 2 e	SO ₂	0,2	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,02	0,00	0,00
1 A 2 g 8	SO ₂	0,4	2,6	10,0	20,0	22,36	1,01	0,02	0,02	0,44	0,34	0,30
1 A 3 a	SO ₂	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	SO ₂	0,7	0,9	10,0	20,0	22,36	0,13	0,01	0,01	0,11	0,12	0,03
1 A 3 d	SO ₂	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	SO ₂	0,2	0,2	10,0	20,0	22,36	0,00	0,00	0,00	0,02	0,02	0,00
1 A 4 b	SO ₂	0,4	0,2	20,0	20,0	28,28	0,01	0,00	0,00	-0,01	0,05	0,00
1 A 4 c	SO ₂	0,2	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,01	0,00	0,00
1 B 2 a	SO ₂	0,8	-	10,0	20,0	22,36	0,00	0,00	0,00	-0,07	0,00	0,01
1 B 2 c	SO ₂	0,0	NO	20,0	20,0	28,28						
5 C	SO ₂	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 %:	19,20				Trend uncertainty %:	3,54

Table 37 Uncertainty estimation of NO_x emissions 1990 and 2018

Reporting year: 2018												
NRF sector	Pollutant	Base year emissio Mg	Year t emissio Mg	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 (3) %	Uncertainty introduced into the trend in total national emission %
	NO _x	Input data	Input data	input data Note A	input data Note A	$(E^2 + F^2)^{1/2}$	$(G^2 + D^2) / \text{Summe}$	Note B	D/Summe(C)	I/F Note C	J/E*sqrt(2) Note D	K^2 + L^2
1 A 1 a	NO _x	23,8	5,1	5,0	20,0	20,62	36,61	-0,10	0,12	-2,00	0,83	4,68
1 A 1 b	NO _x	0,3	NO	5,0	20,0	20,62						
1 A 2 a	NO _x	-	0,1	10,0	40,0	41,23	0,03	0,00	0,00	0,07	0,02	0,01
1 A 2 b	NO _x	0,7	0,0	10,0	40,0	41,23	0,00	-0,01	0,00	-0,24	0,01	0,06
1 A 2 c	NO _x	0,1	0,0	10,0	40,0	41,23	0,01	0,00	0,00	0,01	0,01	0,00
1 A 2 d	NO _x	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	NO _x	0,9	0,3	10,0	40,0	41,23	0,67	0,00	0,01	0,00	0,11	0,01
1 A 2 g 7	NO _x	3,7	0,8	10,0	40,0	41,23	3,87	-0,01	0,02	-0,59	0,27	0,43
1 A 2 g 8	NO _x	2,0	2,0	10,0	40,0	41,23	21,84	0,03	0,05	1,08	0,64	1,57
1 A 3 a	NO _x	0,3	0,5	10,0	40,0	41,23	1,27	0,01	0,01	0,32	0,15	0,13
1 A 3 b	NO _x	8,9	6,7	10,0	40,0	41,23	248,30	0,07	0,15	2,85	2,16	12,80
1 A 3 c	NO _x	0,4	0,1	10,0	40,0	41,23	0,07	0,00	0,00	-0,03	0,04	0,00
1 A 3 d	NO _x	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	NO _x	0,1	0,5	10,0	40,0	41,23	1,68	0,01	0,01	0,45	0,18	0,23
1 A 4 b	NO _x	0,8	0,4	20,0	40,0	44,72	1,14	0,00	0,01	0,08	0,27	0,08
1 A 4 c	NO _x	0,8	0,3	10,0	40,0	41,23	0,45	0,00	0,01	-0,02	0,09	0,01
1 B 2 a	NO _x	0,3	-	10,0	40,0	41,23	0,00	0,00	0,00	-0,11	0,00	0,01
1 B 2 c	NO _x	0,0	NO	20,0	40,0	44,72						
2 G	NO _x	0,0	0,0	20,0	40,0	44,72	0,00	0,00	0,00	0,00	0,01	0,00
3 B 1	NO _x	0,0	0,0	5,3	40,0	40,35	0,01	0,00	0,00	0,02	0,01	0,00
3 B 2	NO _x	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	NO _x	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	NO _x	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
3 D a	NO _x	0,3	0,4	50,0	40,0	64,03	1,81	0,01	0,01	0,24	0,59	0,41
5 C	NO _x	0,1	0,0	10,0	200,0	200,25	0,25	0,00	0,00	0,10	0,01	0,01
Total Uncertainties						Uncertainty in total inventory %:	17,83				Trend uncertainty %:	4,52

Table 38: Uncertainty estimation of NMVOC emissions 1990 and 2018

Member State: MK		Reporting year: 2018										
NRF sector	Pollutant	Base year emissio Mg	Year t emissio Mg	Activity data uncertainty (1) %	Emission factor uncertainty (1) %	Combined uncertainty (1) %	Contribution to variance by category in year x (G'D)*2/Summe (D)*2 %	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor / estimation paramete % F Note C	Uncertainty in trend in national emissions introduced by activity data uncertainty (3) % J'E*sqrt(2) Note D	Uncertainty introduced into the trend in total national emissio % K^2 + L^2
	NMVOC	Input data	Input data	input data Note A	input data Note A	(E^2+F^2)^(1/2)	(G'D)*2/Summe (D)*2	Note B	D/Summe(C)	F Note C	J'E*sqrt(2) Note D	K^2 + L^2
1 A 1 a	NMVOC	0,1	0,1	5,0	200,0	200,06	0,19	0,00	0,00	0,04	0,01	0,00
1 A 1 b	NMVOC	0,0	NO	5,0	200,0	200,06						
1 A 2 a	NMVOC	-	0,0	10,0	200,0	200,25	0,03	0,00	0,00	0,10	0,01	0,01
1 A 2 b	NMVOC	0,2	0,0	10,0	200,0	200,25	0,00	0,00	0,00	-0,54	0,00	0,29
1 A 2 c	NMVOC	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	NMVOC	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	NMVOC	0,1	0,1	10,0	200,0	200,25	0,30	0,00	0,00	0,19	0,02	0,04
1 A 2 g 7	NMVOC	0,4	0,1	10,0	40,0	41,23	0,02	0,00	0,00	-0,12	0,03	0,01
1 A 2 g 8	NMVOC	0,1	0,3	10,0	40,0	41,23	0,17	0,00	0,01	0,19	0,09	0,04
1 A 3 a	NMVOC	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	NMVOC	14,8	2,4	10,0	40,0	41,23	11,95	-0,13	0,05	-5,32	0,71	28,85
1 A 3 c	NMVOC	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	NMVOC	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	NMVOC	0,0	0,1	10,0	40,0	41,23	0,02	0,00	0,00	0,07	0,03	0,01
1 A 4 b	NMVOC	10,5	5,3	20,0	40,0	44,72	68,39	-0,02	0,11	-0,79	3,12	10,36
1 A 4 c	NMVOC	0,1	0,1	10,0	40,0	41,23	0,01	0,00	0,00	-0,01	0,02	0,00
1 B 1 a	NMVOC	1,3	1,0	10,0	20,0	22,36	0,61	0,00	0,02	0,09	0,29	0,09
1 B 2 a	NMVOC	1,4	1,7	10,0	20,0	22,36	1,86	0,02	0,04	0,37	0,51	0,40
1 B 2 c	NMVOC	0,0	NO	20,0	20,0	28,28						
2 A 3	NMVOC	0,0	NO	10,0	40,0	41,23						
2 C 1	NMVOC	0,1	0,0	2,0	125,0	125,02	0,02	0,00	0,00	-0,11	0,00	0,01
2 D	NMVOC	9,8	8,4	20,0	125,0	126,59	1,393,55	0,05	0,18	6,76	4,97	70,37
2 G	NMVOC	0,5	0,2	20,0	40,0	44,72	0,06	0,00	0,00	-0,13	0,09	0,03
2 H	NMVOC	1,2	0,7	20,0	40,0	44,72	1,06	0,00	0,01	-0,02	0,39	0,15
3 B 1	NMVOC	2,6	2,5	5,3	40,0	40,35	12,16	0,02	0,05	0,75	0,39	0,72
3 B 2	NMVOC	0,4	0,1	10,2	40,0	41,28	0,03	0,00	0,00	-0,09	0,04	0,01
3 B 3	NMVOC	0,1	0,1	6,1	40,0	40,46	0,04	0,00	0,00	0,05	0,02	0,00
3 B 4	NMVOC	1,6	0,5	10,0	40,0	41,23	0,45	-0,01	0,01	-0,42	0,14	0,20
3 Da	NMVOC	1,1	1,1	50,0	40,0	64,03	5,91	0,01	0,02	0,34	1,60	2,68
5 A	NMVOC	1,4	3,9	50,0	125,0	134,63	333,18	0,06	0,08	7,93	5,72	95,58
5 C	NMVOC	0,0	0,0	10,0	125,0	125,40	0,01	0,00	0,00	0,01	0,00	0,00
Total Uncertainties						Uncertainty in total inventory %:	42,78				Trend uncertainty %:	14,49

Table 39 Uncertainty estimation of NH₃ emissions 1990 and 2018

Member State: MK		Reporting year: 2018										
NRF sector	Pollutant	Base year emissio Mg	Year t emissio Mg	Activity data uncertainty (1) %	Emission factor uncertainty (1) %	Combined uncertainty (1) %	Contribution to variance by category in year x (G'D)*2/Summe (D)*2 %	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor / estimation paramete % F Note C	Uncertainty in trend in national emissions introduced by activity data uncertainty (3) % J'E*sqrt(2) Note D	Uncertainty introduced into the trend in total national emissio % K^2 + L^2
	NH3	Input data	Input data	input data Note A	input data Note A	(E^2+F^2)^(1/2)	(G'D)*2/Summe (D)*2	Note B	D/Summe(C)	F Note C	J'E*sqrt(2) Note D	K^2 + L^2
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 3 b	NH3	-	0,1	10,0	125,0	125,40	1,58	0,01	0,01	0,76	0,09	0,59
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	1,1	0,5	20,0	125,0	126,59	50,64	-0,01	0,03	-1,05	0,97	2,05
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	3,1	3,0	5,3	125,0	125,11	1,488,54	0,07	0,19	8,55	1,41	75,02
3 B 2	NH3	0,9	0,3	10,2	125,0	125,42	14,31	-0,02	0,02	-2,13	0,27	4,62
3 B 3	NH3	0,6	0,9	6,1	125,0	125,15	136,69	0,02	0,06	3,09	0,49	9,81
3 B 4	NH3	2,4	0,7	10,0	125,0	125,40	84,58	-0,05	0,04	-5,97	0,63	36,01
3 Da	NH3	7,3	4,1	50,0	200,0	206,16	7,556,77	-0,03	0,26	-5,12	18,19	357,09
Total Uncertainties						Uncertainty in total inventory %:	96,61				Trend uncertainty %:	22,03

Table 40 Uncertainty estimation of PM2.5 emissions 1990 and 2018

Member State:	MK											
Reporting year:	2018											
NRF sector	Pollutant	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 (3)	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	$(E^2 + F^2)^{1/2}$	$(G^2 + D^2)^{1/2}$	Note B	D/Summe(C)	I/F Note C	J/E*sqrt(2) Note D	K^2 + L^2
1 A 1 a	PM2.5	3,5	0,1	5,0	125,0	41,23	3,50	-0,02	0,00	-2,64	0,02	6,95
1 A 1 b	PM2.5	0,0	NO	5,0	40,0	40,31						
1 A 2 a	PM2.5	-	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 b	PM2.5	0,3	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,07	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	0,05	0,00	0,00	0,03	0,02	0,00
1 A 2 g 7	PM2.5	0,2	0,1	10,0	125,0	125,40	0,83	0,00	0,00	0,00	0,02	0,00
1 A 2 g 8	PM2.5	0,1	0,3	10,0	125,0	125,40	26,46	0,01	0,01	1,10	0,13	1,23
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	0,3	10,0	40,0	41,23	2,98	0,01	0,01	0,37	0,13	0,15
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	0,1	10,0	125,0	125,40	1,12	0,00	0,00	0,22	0,03	0,05
1 A 4 b	PM2.5	11,8	5,7	20,0	125,0	126,59	9,646,20	0,09	0,18	11,73	5,00	162,52
1 A 4 c	PM2.5	0,0	0,0	10,0	125,0	125,40	0,21	0,00	0,00	0,06	0,01	0,00
1 B 1 a	PM2.5	0,0	0,0	10,0	200,0	200,25	0,66	0,00	0,00	0,13	0,01	0,02
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	0,57	0,00	0,00	0,08	0,00	0,01
2 A 2	PM2.5	0,0	0,0	5,0	200,0	200,06	0,02	0,00	0,00	-0,01	0,00	0,00
2 A 3	PM2.5	0,0	NO	10,0	200,0	200,25						
2 A 5	PM2.5	0,0	0,1	10,0	200,0	200,25	2,13	0,00	0,00	0,27	0,02	0,07
2 C 1	PM2.5	0,1	NE	2,0	40,0	40,05						
2 C 2	PM2.5	14,7	0,0	5,0	40,0	40,31	0,03	-0,10	0,00	-4,07	0,01	16,56
2 C 3	PM2.5	0,0	0,0	2,0	40,0	40,05	0,00	0,00	0,00	0,00	0,00	0,00
2 C 5	PM2.5	0,2	0,0	5,0	40,0	40,31	0,00	0,00	0,00	-0,06	0,00	0,00
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	0,7	0,3	20,0	40,0	44,72	3,53	0,00	0,01	0,18	0,27	0,11
3 B 1	PM2.5	0,1	0,1	5,3	200,0	200,07	4,21	0,00	0,00	0,35	0,02	0,13
3 B 2	PM2.5	0,0	0,0	10,2	200,0	200,26	0,11	0,00	0,00	0,02	0,01	0,00
3 B 3	PM2.5	0,0	0,0	6,1	200,0	200,09	0,13	0,00	0,00	0,06	0,00	0,00
3 B 4	PM2.5	0,1	0,0	10,0	200,0	200,25	1,54	0,00	0,00	0,08	0,02	0,01
3 D a	PM2.5	0,1	0,1	50,0	200,0	206,16	4,46	0,00	0,00	0,36	0,17	0,15
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 C	PM2.5	0,1	0,1	10,0	200,0	200,25	2,16	0,00	0,00	0,24	0,02	0,06
Total Uncertainties						Uncertainty in total inventory %:	98,49				Trend uncertainty %:	13,71

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 2018

The data for the whole year 2018 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 effect 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 on the basis of 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 2018 data are gathered from MAKSTAT database. There are no available data for uncertainty since these data are no longer published.

Table 41 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 on the basis of the reports filled in by the reporting units. On the basis of the obtained data and the data on the number of population, an 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 2009/2013/2016/2019.

Table 42 Notation keys used in the NFR

Abbreviation	Meaning	Objective
NA	not applicable	is used for activities in a given 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;
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 43 Number of “not estimated” (NE) per sector and pollutant in 2018

	Energy	Fugitives	IPPU	Agriculture	Waste	Other
"NO _x						
(as NO ₂) "	3	2	8	4	6	0
NM VOC	2	0	4	5	4	0
"SO _x						
(as SO ₂)"	4	2	9	20	6	0
NH ₃	9	3	17	4	5	0
PM _{2.5}	1	2	6	6	6	0
PM ₁₀	3	2	8	6	6	0
TSP	3	2	7	7	5	0
BC	10	3	19	16	6	0
CO	3	2	8	20	5	0
Pb	8	3	14	20	7	0
Cd	5	3	11	21	7	0
Hg	15	3	20	21	7	0
As	13	3	19	21	7	0
Cr	5	3	11	21	7	0
Cu	5	3	11	21	7	0
Ni	5	3	11	21	7	0
Se	6	3	12	21	8	0
Zn	5	3	11	21	8	0
"PCDD/ PCDF						
(dioxins/ furans)"	12	3	18	21	7	0

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

2.8.2. Sources included elsewhere (IE)

Table 44 Number of “included elsewhere” (IE) per sector and pollutant in 2018

Pollutant	Energy	Fugitives	IPPU	Agriculture	Waste	Other
NO _x (as NO ₂)	0	0	1	3	0	0
NM VOC	0	0	1	3	0	0
SO _x (as SO ₂)	0	0	1	1	0	0
NH ₃	0	0	1	1	0	0
PM _{2.5}	0	0	1	1	0	0
PM ₁₀	0	0	1	1	0	0
TSP	0	0	1	1	0	0
BC	0	0	1	0	0	0
CO	0	0	1	0	0	0
Pb	0	0	1	0	0	0

Pollutant	Energy	Fugitives	IPPU	Agriculture	Waste	Other
Cd	0	0	1	0	0	0
Hg	0	0	1	0	0	0
As	0	0	1	0	0	0
Cr	0	0	1	0	0	0
Cu	0	0	1	0	0	0
Ni	0	0	1	0	0	0
Se	0	0	1	0	0	0
Zn	0	0	1	0	0	0
PCDD/ PCDF (dioxins/ furans)	0	0	1	0	0	0
PAHs (Total 1-4)	0	0	1	0	0	0
HCB	0	0	1	0	0	0
PCBs	0	0	1	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. For category 1.A.4.iii, there are available data for the period 2005-2018 while for the previous years emissions are noted as IE. Abbreviation IE is used in cases where there is a lack on historical activity data.

EMISSION TRENDS



3. EMISSION 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_x, NMVOC, SO₂ and NH₃) and CO, which are covered by the Gothenburg Protocol, from 1990-2018 are presented in the following table.

Table 45 Emission trends 1990 – 2018 for the main air pollutants and CO

Year	Emission in kt				
	NO _x	NMVOC	SO ₂	NH ₃	CO
1990	45.47	48.21	110.54	15.80	132.46
1991	37.63	42.39	89.54	14.83	111.59
1992	39.46	44.56	86.85	14.94	123.49
1993	40.93	46.55	89.47	15.26	133.33
1994	36.74	41.58	89.03	15.20	120.88
1995	39.29	44.25	95.22	14.99	125.25
1996	38.57	44.00	88.82	13.95	123.20
1997	37.89	45.07	93.07	13.53	126.31
1998	43.18	45.00	107.67	13.23	128.76
1999	40.43	45.86	97.88	13.41	131.78
2000	43.76	48.04	106.28	13.49	144.19
2001	40.76	40.35	108.33	12.74	113.29
2002	40.81	39.44	96.25	12.12	115.13
2003	35.82	39.14	94.89	12.06	116.22
2004	37.14	39.51	96.17	12.16	121.31
2005	39.52	37.86	96.56	11.57	114.75
2006	37.73	39.42	94.19	11.92	117.27
2007	40.54	39.66	99.23	11.57	112.52
2008	36.01	43.47	77.99	11.74	123.24
2009	39.40	44.02	104.53	11.06	132.95
2010	41.35	36.74	86.53	11.30	113.74
2011	43.65	39.17	106.15	11.61	120.25
2012	39.49	34.69	91.56	10.31	89.96
2013	33.37	33.55	82.68	10.33	90.03
2014	20.33	29.30	83.19	10.28	62.00
2015	20.29	29.91	76.79	10.34	64.58
2016	20.84	29.10	64.62	10.41	67.15
2017	19.54	30.07	55.92	10.21	56.66
2018	18.51	28.95	60.95	9.79	56.05
Trend 1990-2018	-59%	-40%	-45%	-38%	-58%

3.1.1. NOx emissions

Emission trend

In 1990 national total NOx emissions amounted to around 45 kt. Since then the emissions decreased by 59%. In 2018 emissions were on the level of about 18 kt. The reasons for the decrease are essentially to be found in the significantly declining emissions from the energy sector (Public electricity and heat production) and manufacturing industries. The sharp fall of emissions between 2012 and 2014 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 2016–2018, the decrease of emissions is due to shorter operation of the second power plant REK Oslomej and the decrease of coal consumption necessary for electricity production.

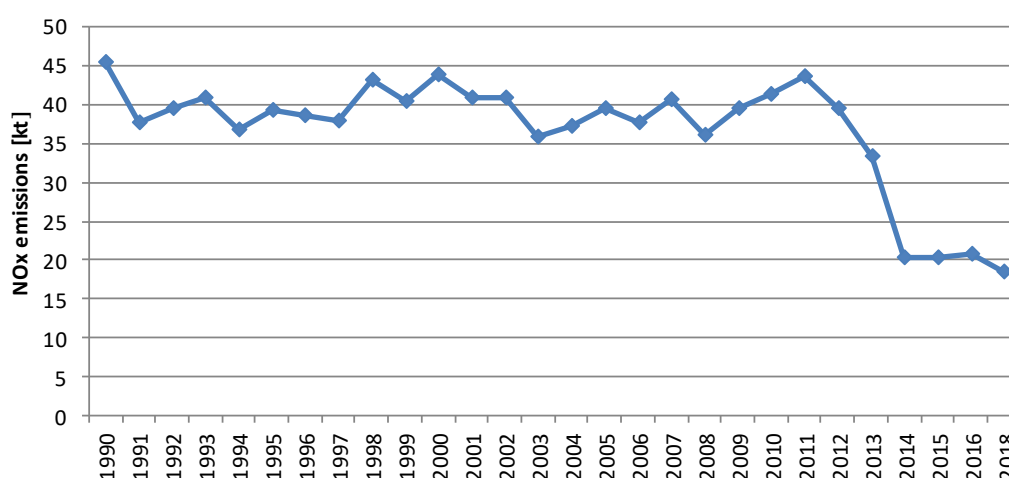


Figure 6 National total NOx emissions 1990-2018

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 2018 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 2018, which is 15,505 Gg.

Main emission sources in North Macedonia

Almost all NOx emissions are coming from the sector Energy. Namely, the main emission sources in 2018 are NFR source categories: 1.A.3 Transport, 1.A.1 Energy Industries and 1.A.2 Manufacturing Industries and Construction which contributed with 21% (39% in 1990), 28% (53% in 1990) and 24% (20% 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 2018 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 24%, and has not changed significantly in comparison to the value in 1990 of 20%. NFR sectors 1.B Fugitive emissions. 2 Industrial Processes and Product Use, 3 Agriculture and 5 Waste are minor sources of NOx emissions.

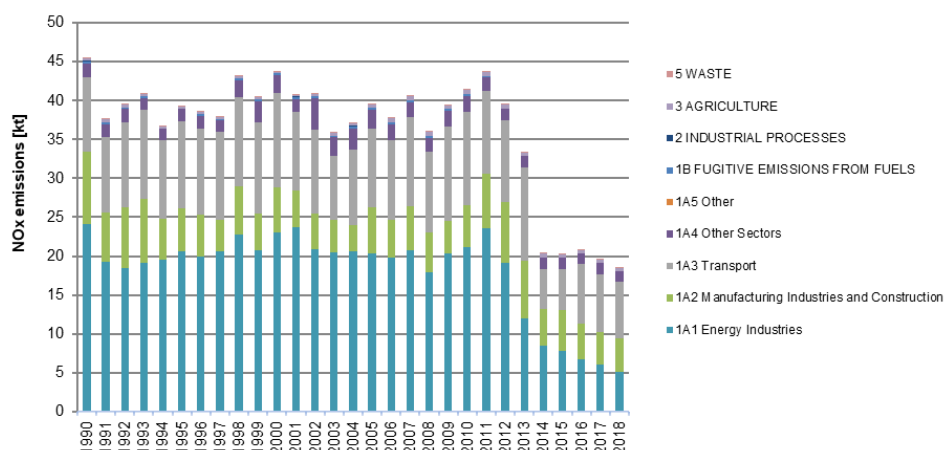


Figure 7 NOx emissions in North Macedonia 1990-2018 by sectors

3.1.2. NMVOC emissions

Emission trend

In 1990, the total national NMVOC emissions amounted to about 48 kt. Compared to 2018, the emissions are down by 40% amounting to around 28.95 kt. Main reasons for the decrease are the declining emissions from industrial processes. From 2017 to 2018 emissions decreased only by 4%, also due to the reduced emissions coming from 1.A.4 Other Sectors (mainly residential heating).

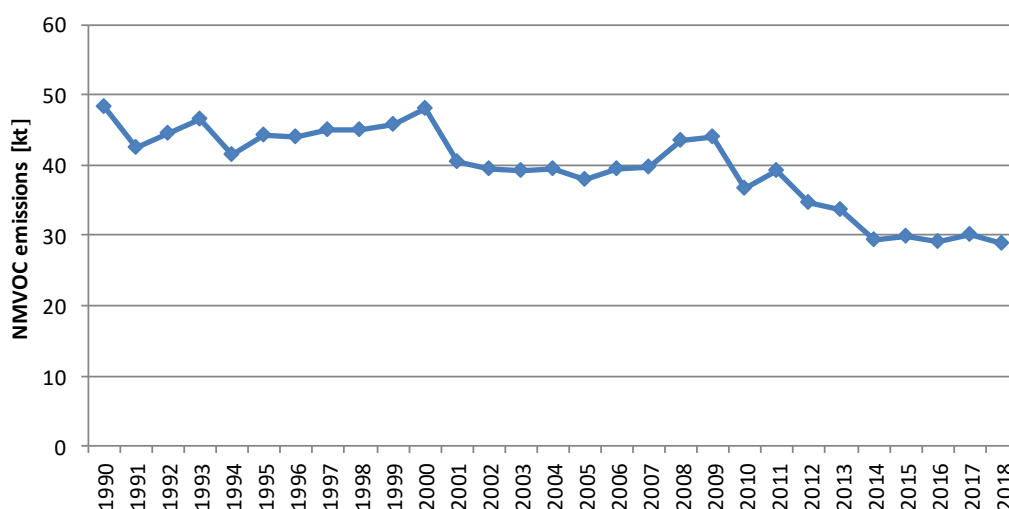


Figure 8 National total NMVOC emissions 1990-2018

Target value for NMVOC according to Gothenburg Protocol for year 2010 is 30 kt NMVOC. The emissions in 2018 are below the target value. The country is also in compliance with the Protocol on the control of volatile organic compounds or their transboundary fluxes since 1988, NMVOC emissions (44 kt) in 2018 are reduced by 40% compared to 1988.

Main emission sources in North Macedonia

NMVOC emissions are emitted from different sources. The key category source in 2018 are NFR source categories is 2 Industrial pollution, contributing with 32% (24% in 1990) followed by 1.A.4 Other Sectors (mainly residential heating), which contributed with 19% (22% in 1990), to the national total NMVOC emissions. NFR source category 1.A.3 Transport contributed with 8% in 2017 (31% in 1990) of total

calculated national NMVOC emissions. Agriculture is contributing with around 15%, while waste and fugitive emissions are impacting the NMVOC emission with around 13% and 9% respectively.

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

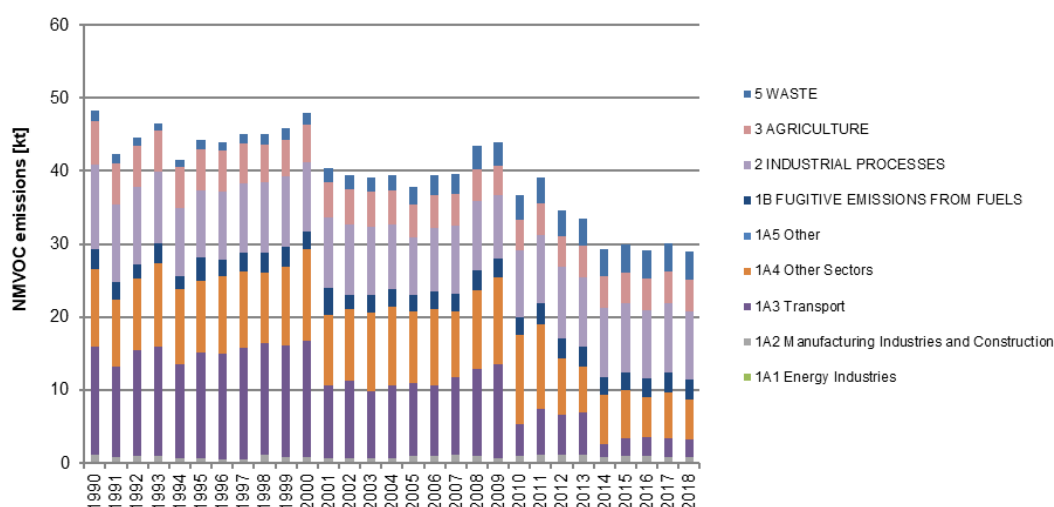


Figure 9 NMVOC emissions in North Macedonia 1990-2018 by sectors

3.1.3. SO₂ emissions

Emission trend

In 1990, the national total SO₂ emissions amounted to 110 kt. In the period 2011–2018 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 Osłomej (from 12 to 5 months), attributed to limited amounts of coal.

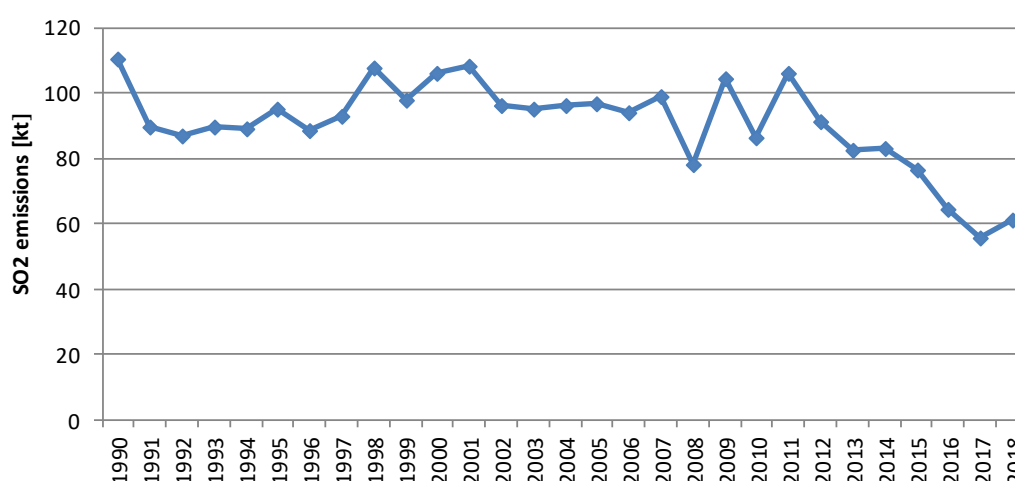


Figure 10 National total SO₂ emissions 1990-2018

North Macedonia is a party to the three protocols concerning sulfur. The emissions of sulfur dioxide 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 emissions in 2018 in the Republic of North Macedonia were around 40%(61 Gg SO_x) below the national ceiling value (110 Gg SO_x).

The country is in non-compliance with the 1985 Protocol on reduction of sulfur emissions or their transboundary transmission by at least 30 percent, because the emissions have not been reduced by the designated percentage between now and 1980. Due to the fact that 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_x 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. Unfortunately, SO_x emissions in 2018 have reached values above the emission ceiling defined in the NERP due to the fact that desulfurization unit is still not implemented in the major power plant. Namely, in 2018 our country did not reach compliance once more with the oldest Sulfur protocol. With regards to LCPs, the emissions in 2018 were not below national emission ceiling of 15,855 Gg, indicating that compliance with the set limit values was not reached.

Main emission sources in North Macedonia

Almost all SO₂ emissions are resulting from Energy sector. Consequently, the main emission source in 2018 is as expected NFR source category 1.A.1 Energy Industries (Public electricity and heat production), which contributed with 88% (93% in 1990) of the national total SO₂ emissions. About 9% (5% in 1990) of the total emissions are stemming from NFR source category 1.A.2 Manufacturing Industries.

Other NFR sectors produce minor SO₂ emissions.

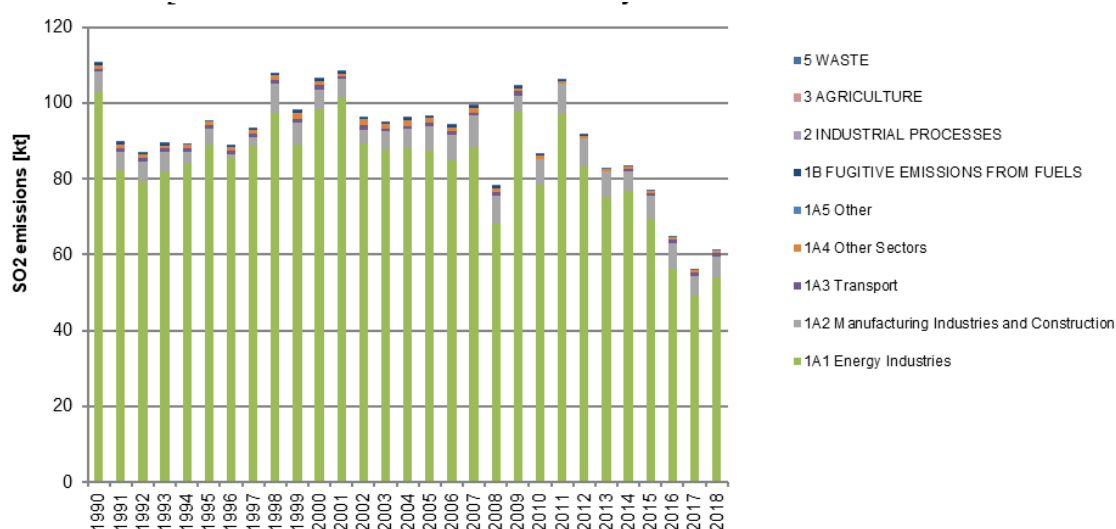


Figure 11 SO₂ emissions in North Macedonia 1990–2018 by sectors

3.1.4. NH₃ emissions

Emission trend

In 1990 national total NH₃ emissions, amounted to about 16 kt. In 2018, the emissions were down by 38% compared to 1990, amounting to 9.78 kt. Main reasons for the decline are decreasing emissions

from Agriculture (Manure Management) related to decreasing livestock numbers. From 2017 to 2018 emissions decreased by 4%.

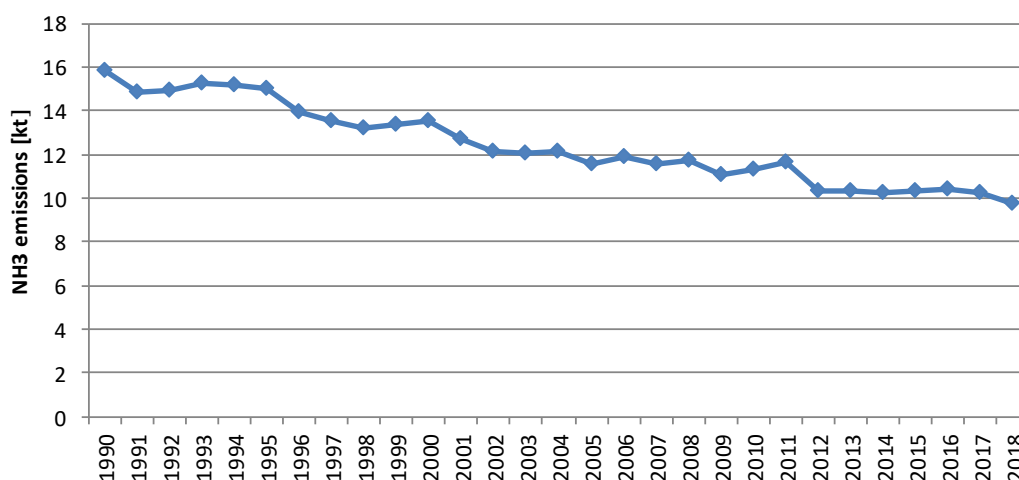


Figure 12 National total NH₃ emissions 1990-2018

Emissions of NH₃ are well below the respective ceiling. Emissions in 2018 were 18% below national ceiling value (12 Gg NH₃).

Main emission sources in North Macedonia

NH₃ emissions are mainly resulting from the Agriculture sector contributing with 91% (92% in 1990) to national total NH₃ emissions. Within Agriculture sector, NH₃ is almost exclusively emitted by source category 3.B Manure Management (55% in 2018) and emissions from cattle (33%).

About 6% (7% in 1990) of the total emissions are stemming from NFR source category 1.A.4 Other Sectors (residential heating).

NFR sectors 1.B Fugitive emissions, 1.A.3 Transport and 2. Industrial processes are minor sources of NH₃ emissions.

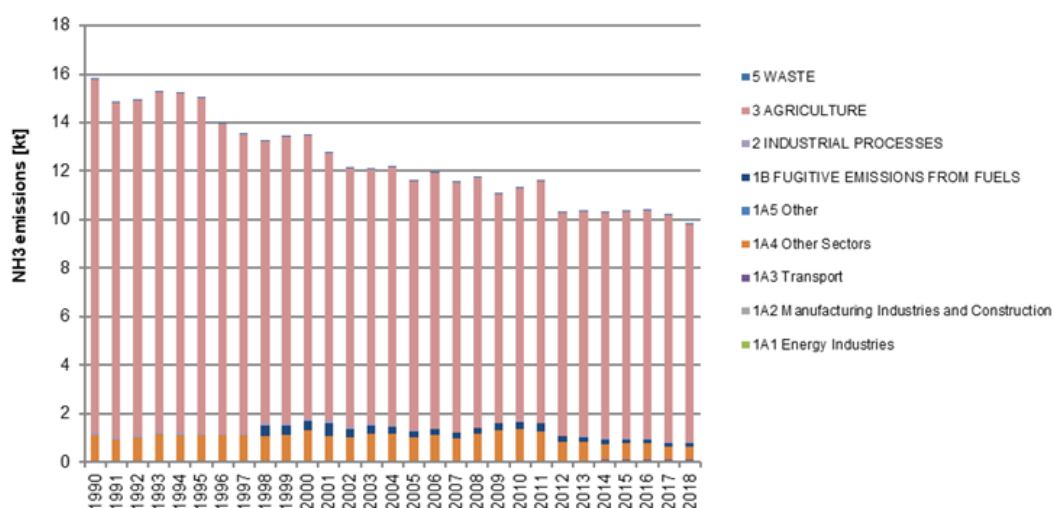


Figure 13 NH₃ emissions in North Macedonia 1990-2018 by sectors

3.1.5. CO emissions

Emission trend

In 1990 the national total CO emissions amounted to 132.46 kt. The decreasing trend started in 2010 and could be attributed to lower solid fuel consumption in 1.A.4 sector. In 2018, the emissions decreased by 58% and amounted to 56.05 kt. From 2017 to 2018 emissions decreased only by 1%.

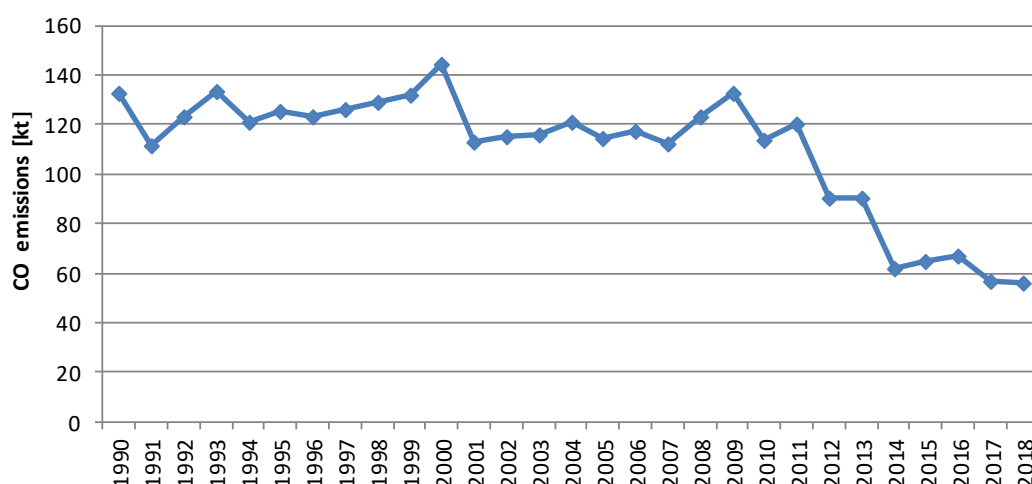


Figure 14 National total CO emissions 1990-2018

Main emission sources in North Macedonia

Almost all CO emissions are resulting from the Energy sector. As a Result, the main emission sources in 2018 are NFR sectors 1.A.4 Other Sectors (residential heating) and 1.A.3 Transport, contributing with 59% (51% in 1990) and 21% (39% in 1990) following by 1.A.2 Manufacturing Industries to the national total with 11% (4% in 1990). Further smaller emission sources in 2018 are 5 Waste and 1.A.1 Energy Industries with shares 6% and 2% 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.

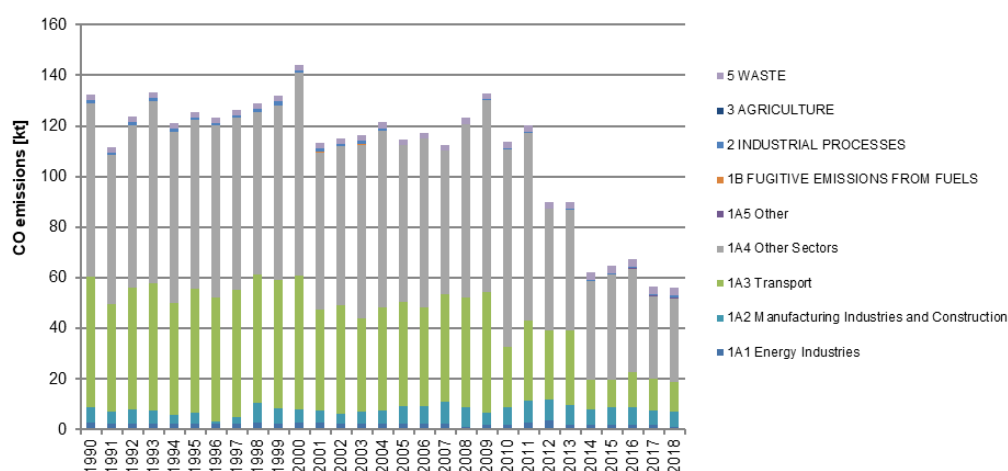


Figure 15 CO emissions in North Macedonia 1990-2018 by sectors

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 46 Emission trends for particulate matter 1990-2018

Year	Emissions			
	PM10 [kt]	PM2.5[kt]	TSP [kt]	BC [kt]
1990	48.28	32.70	57.66	3.02
1991	42.34	28.65	50.23	2.63
1992	50.63	34.99	59.34	3.29
1993	45.03	31.33	52.81	2.92
1994	42.62	29.30	50.23	2.66
1995	43.25	29.58	51.17	2.69
1996	47.20	32.45	55.86	3.01
1997	45.86	31.53	53.86	2.86
1998	52.36	35.94	62.10	3.29
1999	45.13	31.16	53.68	2.82
2000	43.62	30.05	54.01	2.72
2001	27.69	18.25	34.08	1.46
2002	28.01	18.72	33.87	1.63
2003	41.87	29.00	49.91	2.60
2004	45.48	31.47	54.51	2.86
2005	41.25	28.03	50.24	2.59
2006	38.84	26.62	46.88	2.43
2007	31.14	20.84	38.14	1.85
2008	34.20	23.88	41.70	2.20
2009	29.49	19.97	37.72	1.71
2010	36.00	23.57	41.17	2.18
2011	42.29	28.53	52.86	2.59
2012	32.77	20.69	42.05	1.85
2013	37.70	24.40	48.74	2.23
2014	26.13	16.65	33.39	1.49
2015	22.26	13.29	25.11	1.32
2016	19.61	11.81	21.81	1.18
2017	13.66	8.60	14.85	0.76
2018	14.27	8.64	15.66	0.77
Trend 1990–2018	-70%	-74%	-73%	-74%

3.2.1. PM10 emissions

Emission trend

In 1990, national total PM10 emissions amounted to 48 kt. Since then, the emissions are continuously decreasing, reaching a level of 14,27kt in 2018 or a decrease of 70% compared to 1990. The main reason for the decrease are 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 as a consequence 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.

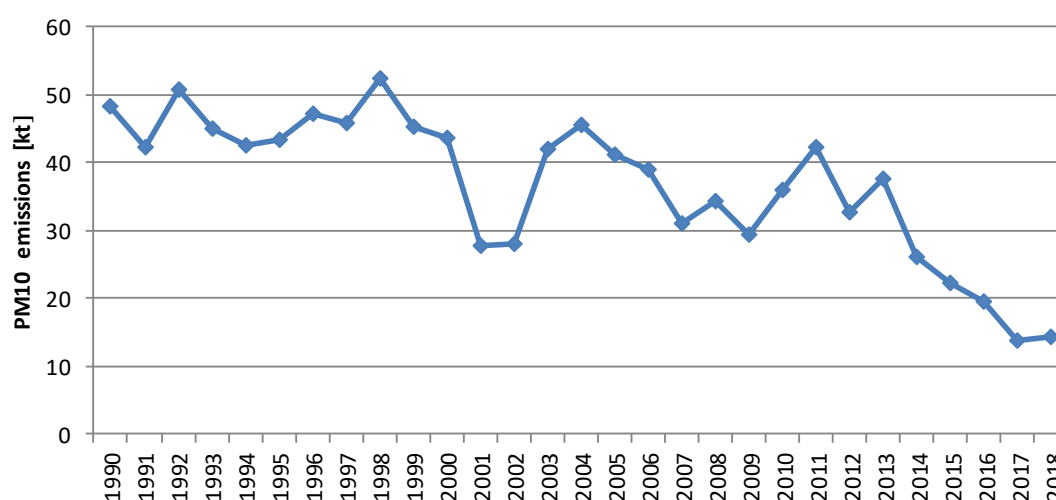


Figure 16 National total PM10 emissions 1990-2018

Main emission sources in North Macedonia

The main emission sources for PM10 in 2018 are NFR sectors 1.A.4 Other Sectors (residential heating) with a share of 42% (25% in 1990) in total PM10 emissions. 2 Industrial Processes and Product Use (mainly 2C2 Ferroalloys Production) with 7% (47% in 1990) and 1.A.1 Energy Industries with 24% (18% in 1990). With a share of 17% in 2017 (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 combustion of fuels in residential sector and administrative capacities – NFR 1.A.4 Other Sector.

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

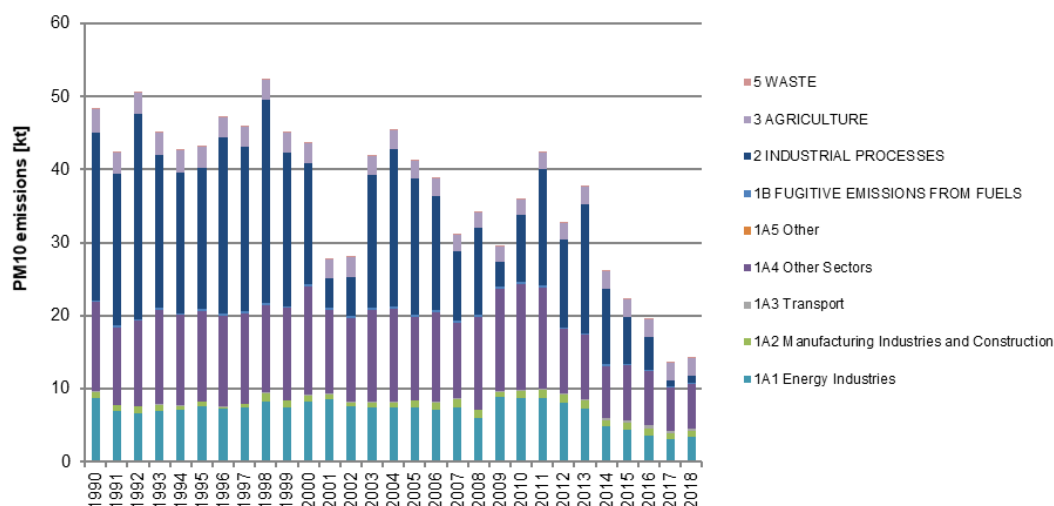


Figure 17 PM10 emissions in North Macedonia 1990-2018 by sectors

3.2.2. PM2.5 emissions

Emission trend

In 1990, national total PM2.5 emissions amounted to 33 kt. In 2018, compared to 1990 the emissions decreased by 74%, amounting to 8.6 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 as a result 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.

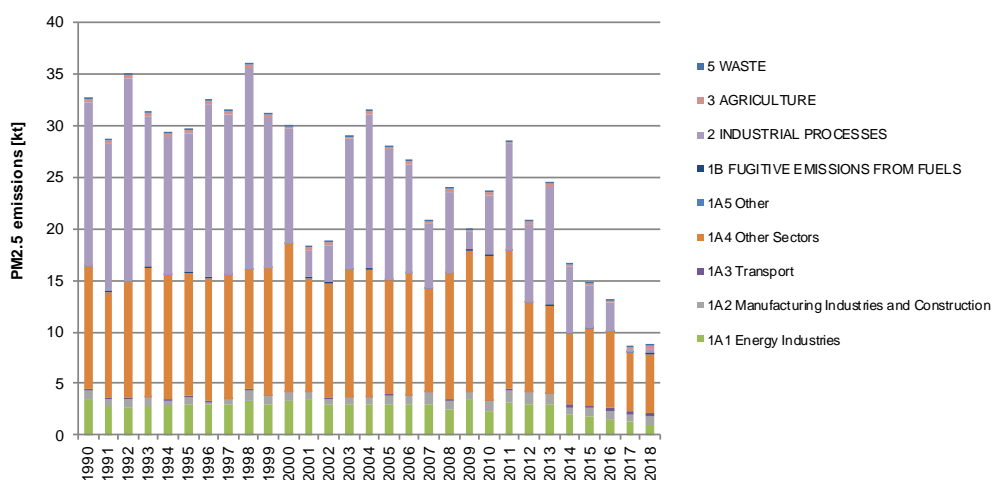


Figure 18 National total PM2.5 emissions 1990-2018

Main emission sources in North Macedonia

Similar to PM10, the main emission sources for PM2.5 in 2018 are NFR sectors 1.A.4 Other Sectors (residential heating) with a share of 68% (36% in 1990) in total PM2.5 emissions. 1.A.1 Energy Industries with 11% (11% 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 5% (49% in 1990). Manufacturing industry and Constructions 1.A.2 are contributing with 8% in 2018 while in 1990 the contribution was only 3%. Transport is contributing with 4% and Agriculture with 2.6%. Compared to PM10, the contribution of 1.A.4 is higher while the contribution from Energy industries is lower. NFR sectors 1B Fugitive emission and 5 Waste are minor sources of PM2.5 emissions.

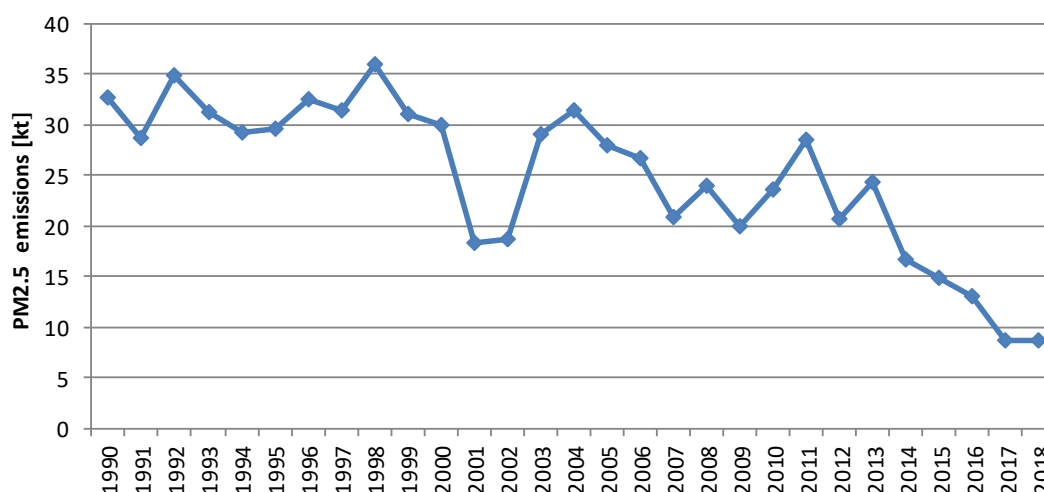


Figure 19 PM2.5 emissions in North Macedonia 1990-2018 by sectors

3.2.3. TSP emissions

Emission trend

In 1990, the national total TSP emissions amounted to about 58 kt. In 2018, the emissions decreased by 73% compared to 1990 amounting to about 16 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.

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 2018, exceeded the national emission ceiling for TSP with a value of 1,738 Gg. and thus not reaching compliance with this ceiling accordingly.

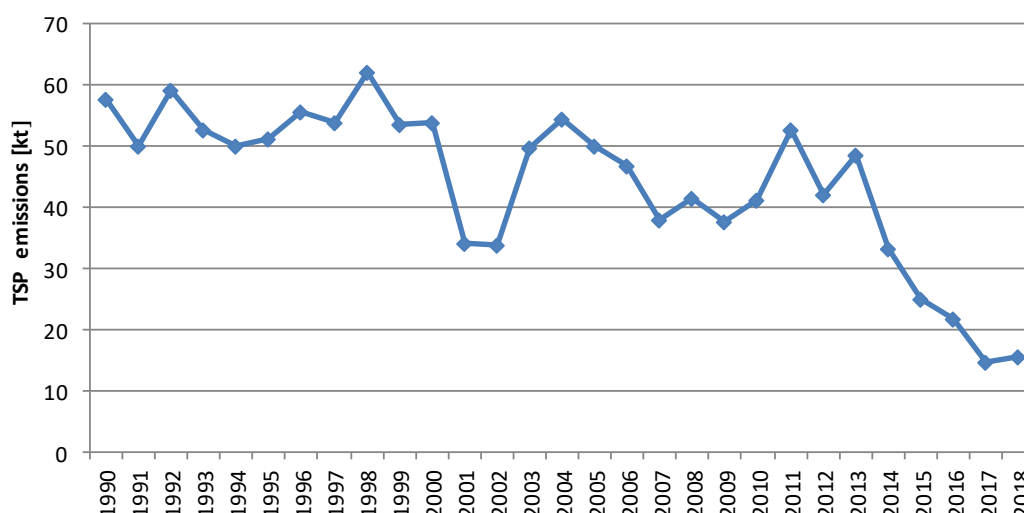


Figure 20 National total TSP emissions 1990-2018

Main emission sources in North Macedonia

The main emission sources for TSP in 2018 are 1.A.4 Other Sectors (residential heating) with 40% (22% in 1990) and 1.A.1 Energy Industries with 32% (22% in 1990). NFR sectors 2 Industrial Processes and Other Product Use (mainly NFR sector 2C2 Ferroalloys Production) with a share of 11% (50% 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 Other Sector. NFR sectors 1.B Fugitive emissions. 3 Agriculture and 1.A.3 Transport and 1.A.2 Manufacturing Industries and Construction are minor sources of PM_{2.5} emissions.

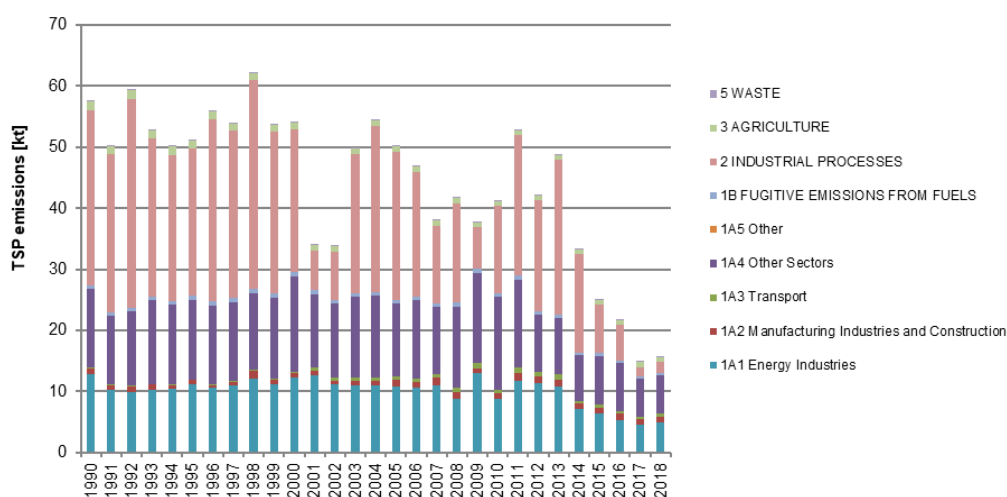


Figure 21 TSP emissions in North Macedonia 1990-2018 by sectors

3.2.4. BC emissions

Emission trend

In 1990, national total BC emissions amounted to about 3 kt. In 2018, the emissions decreased by 74% compared to 1990, amounting to about 0.774 kt. The main reason for the decrease is a decline of

emissions of PM_{2.5}. The trend has similar pathway as that one for PM_{2.5} due the fact that for BC emissions are calculated as given contribution in PM_{2.5} expressed in %. Further explanation of the trend is given in PM_{2.5} chapter.

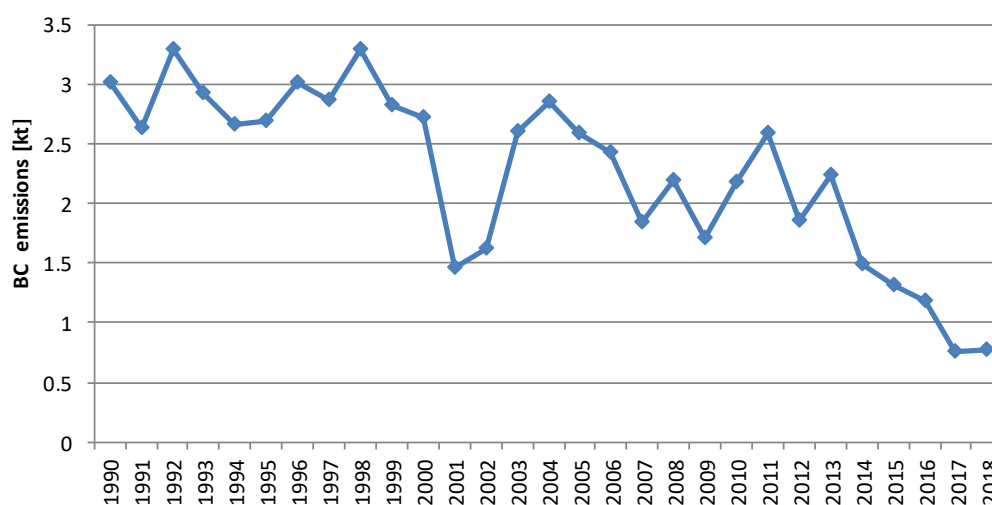


Figure 22 National total BC emissions 1990-2018

Main emission sources in North Macedonia

As expected, the main emission sources for BC are those for PM_{2.5}. In 2018 the NFR sectors 1.A.4 Other Sectors (residential heating) contributed with a share of 78% (40% in 1990) in total BC emissions. 1.A.2 Manufacturing industry and constructions contributed with 15% (9% in 1990) of the total BC emissions, whereas 2 Industrial Processes and Product Use (mainly 2.C.2 Ferroalloys Production) contributed with 4% (49% in 1990).

NFR sectors 1.A.1 Energy industries, 1.B Fugitive emissions and 5 Waste are minor sources of PM_{2.5} emissions.

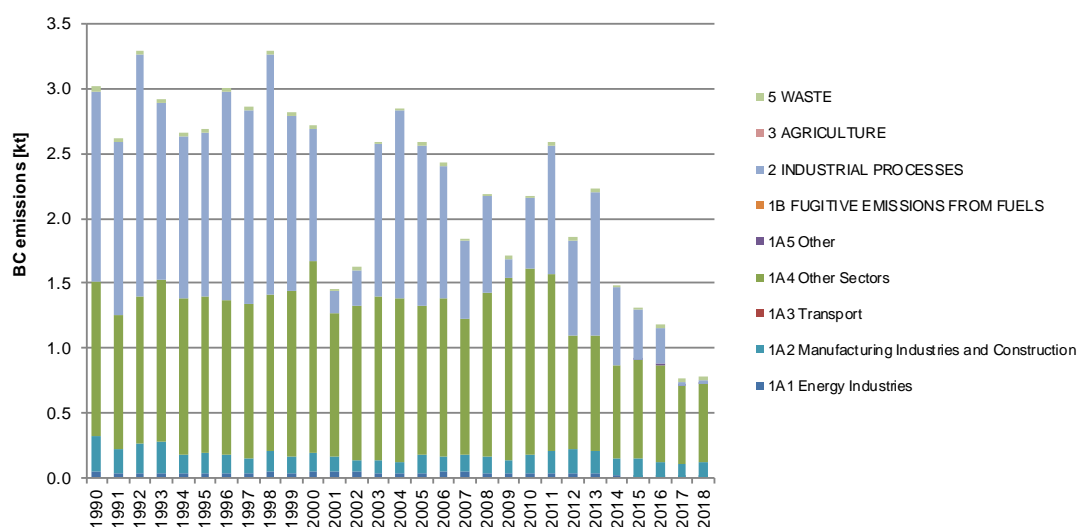


Figure 23 BC emissions in North Macedonia 1990-2018 by sectors

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 47 Emission trends for heavy metals 1990-2018

Year	Emissions		
	Cd [kt]	Pb [kt]	Hg [kt]
1990	1.60	232.48	0.62
1991	1.50	196.68	0.57
1992	1.45	227.56	0.53
1993	1.06	212.76	0.50
1994	1.01	203.76	0.42
1995	2.11	222.26	0.44
1996	2.31	229.64	0.50
1997	1.14	244.66	0.53
1998	1.39	259.95	0.60
1999	1.07	208.29	0.53
2000	0.93	195.45	0.54
2001	0.81	172.34	0.56
2002	0.80	170.77	0.59
2003	0.60	132.00	0.44
2004	0.53	45.74	0.43
2005	0.33	23.52	0.31
2006	0.35	8.61	0.31
2007	0.32	9.18	0.33
2008	0.37	6.51	0.32
2009	0.38	5.91	0.29
2010	0.39	6.23	0.30
2011	0.39	6.95	0.34
2012	0.29	5.29	0.30
2013	0.27	4.18	0.26
2014	0.24	4.54	0.26
2015	0.24	4.50	0.26
2016	0.48	2.64	0.22
2017	0.60	2.47	0.21
2018	0.60	2.59	0.22
Trend 1990–2018	-62%	-99%	-65%

Republic of North Macedonia in 2018 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 232t in 1990; emissions have decreased steadily and in the year 2018 emissions were down by 99% to 2.59 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 production of lead and zinc. From 2006 in North Macedonia, passenger cars can use only unleaded gasoline fuels which additionally reduced the Pb emissions.

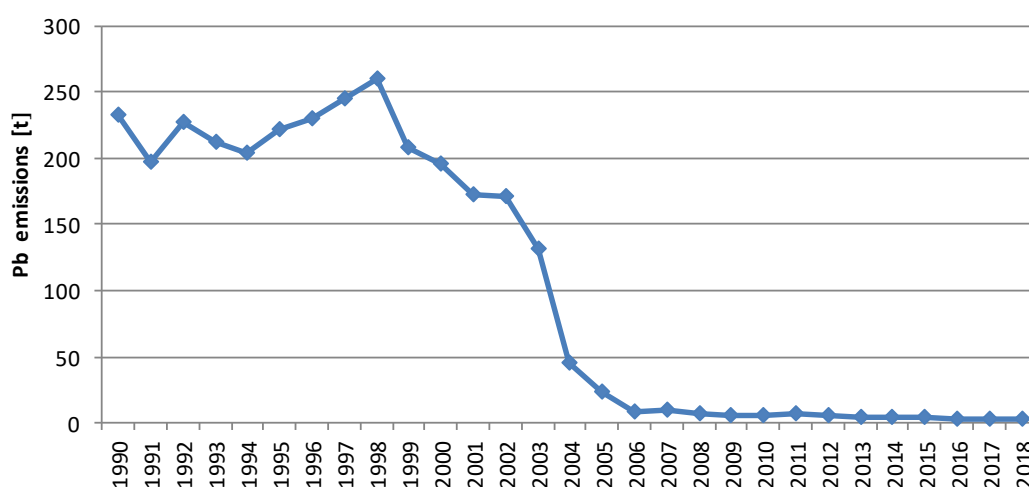


Figure 24 National total Pb emissions 1990-2018

Main emission sources in North Macedonia

The most important emission sources of Pb in 2018 are NFR sectors 1 Energy with shares in national total emissions of 18% from 1.A.2 and 3 % in 1.A.4, 1.A.1.a with share of 18% and Industrial Processes and Product Use with share of 19%. In 1990 the situation was different. The key factor contributing to the emissions was the use of leaded petrol in transport sector which led to contribution of NFR 1.A.3 with 39%. The Industrial Processes and Product Use contributed with a share of 59%. Back then, the energy sector, meaning 1.A.1, 1.A.2 and 1.A.4 were minor sources. Within NFR sector 2 Industrial Processes and Product Use, all Pb emissions result from 2.C Metal Production (2.C.1 Iron and Steel Production) with a share of 59% in 1990 and 19% in 2018. The declined values is a result of the elimination of the use of leaded petrol in 2004. The reduction of 99% compared to 1990 is due to the elimination of the use of leaded petrol and reduction of lead emissions from lead production. However, due to the fact that 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 model.

Pb emissions from NFR sectors 1.B Fugitive Emissions. 3 Agriculture and 5 Waste are minor sources.

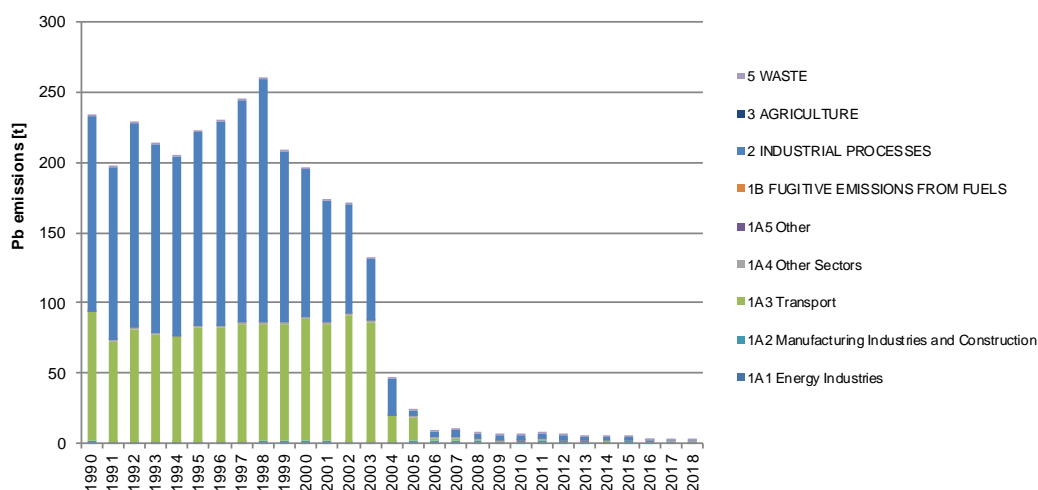


Figure 25 Pb emissions in North Macedonia 1990-2018 by sectors

3.3.2. Cadmium (Cd) emissions

Emission trend

National total Cd emissions amounted to 1.6 t in 1990; emissions have decreased steadily and in the year 2018 emissions were estimated to be 0.6 t, which means they were down by 62% 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 2017 and 2018, emissions slightly increased by 0.3%.

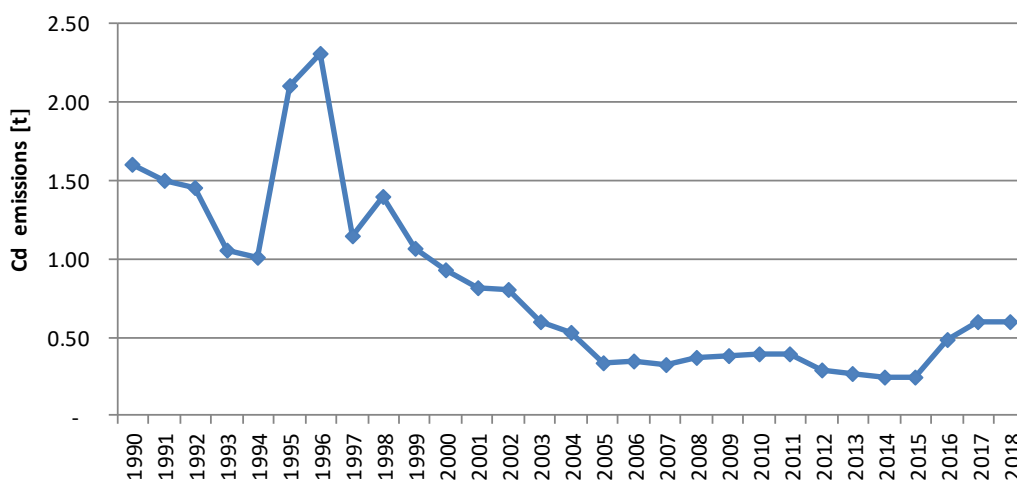


Figure 26 National total Cd emissions 1990-2018

Main emission sources in North Macedonia

The most important emission source in 2018 of Cd is in the national total emissions is NFR category 2 Industrial Processes and Product use contributing with 68% (79% in 1990). The NFR sector 1 Energy is contributing with the following NFR categories: 1.A.4 Other Sectors Energy with 18% (13% in 1990), 1.A.1 Energy Industries, with a share of 10% (7% in 1990), 1.A.2 Manufacturing Industries with 2% (1%).

Cd emissions from NFR sectors 1.B Fugitive Emissions, 3 Agriculture and 5 Waste sector are minor sources.

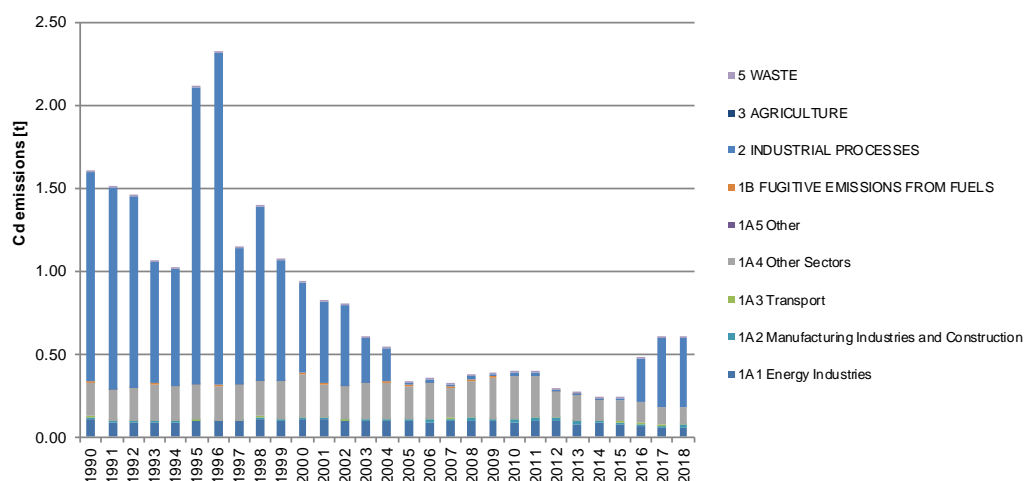


Figure 27 Cd emissions in North Macedonia 1990-2018 by sectors

3.3.3. Mercury (Hg) emissions

Emission trend

National total Hg emissions amounted to 0.62 t in 1990; emissions have decreased steadily and in the year 2018 emissions (0.22t) were down by 69% 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 2017 and 2018 total Hg emissions increased by 3%.

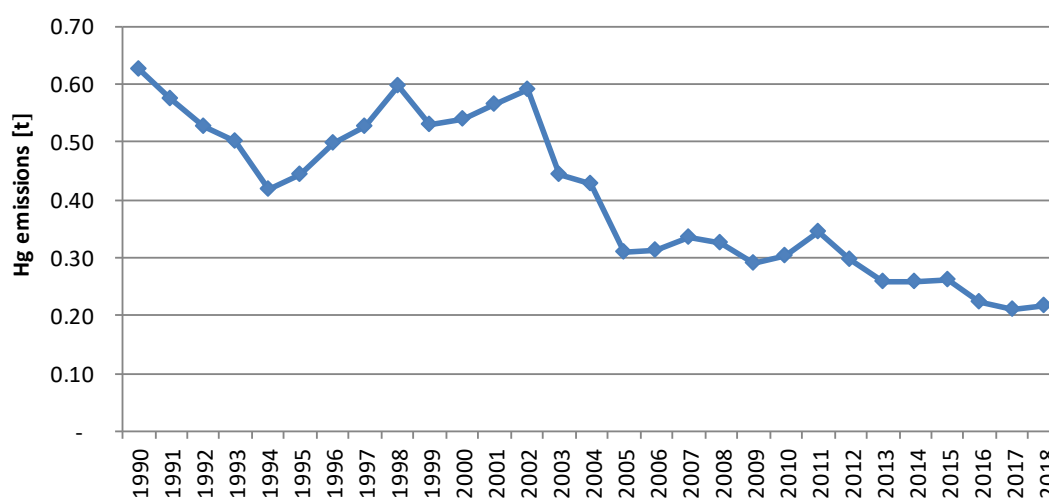


Figure 28 National total Hg emissions 1990-2018

Main emission sources in North Macedonia

The most important emission source in 2018 of Hg is NFR sector 1 - Energy. Within the Energy sector, the main contributors in 2018 are 1.A.1 Energy Industries with a share of 43% (27% in 1990) and 1.A.2. Manufacturing Industries and Construction with 22% (6% in 1990) of the national total emissions. NFR category 2 Industrial Processes and Product use is also one of the key sources with 15% (64% in 1990) of the national total mercury emissions. In 2018, also 18% of total mercury emissions are stemming from sector 5 Waste while this sector has minor contribution in 1990, Hg emissions from NFR sectors

1.A.4 Other sectors, 1.B Fugitive Emissions and 3 Agriculture are minor sources in the whole trend period.

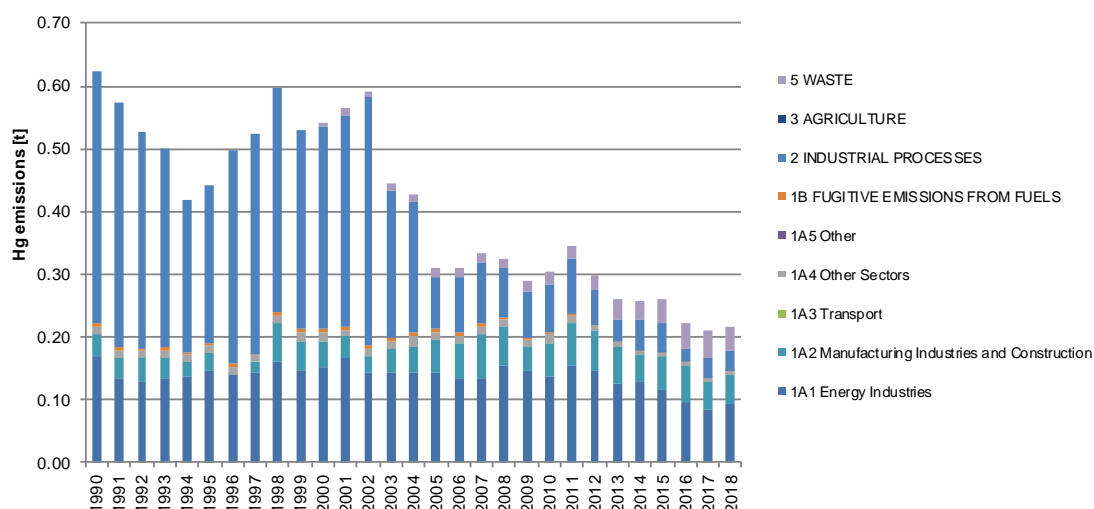


Figure 29 Hg emissions in North Macedonia 1990-2018 by sectors

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 48 Emission trends for POPs 1990-2018

Year	Emissions			
	PCDD/F [g – I TEQ]	PAH [t]	HCB [kg]	PCB [kg]
1990	19.82	6.54	44.29	179.33
1991	17.63	5.86	39.22	180.15
1992	17.70	6.27	25.83	178.25
1993	17.29	6.74	24.18	164.21
1994	15.87	6.20	25.04	145.84
1995	18.92	6.33	18.63	159.26
1996	18.73	6.06	19.70	186.03
1997	16.00	6.17	27.89	196.97
1998	17.61	6.69	29.34	202.65
1999	17.18	6.64	53.97	165.29
2000	19.35	7.65	38.32	140.88
2001	16.14	6.11	34.15	129.39
2002	17.08	6.22	52.68	128.61
2003	17.82	6.97	42.98	85.39
2004	17.83	7.13	8.51	38.07
2005	16.52	6.88	7.56	4.22
2006	17.74	7.34	11.70	4.60

Year	Emissions			
	PCDD/F [g – I TEQ]	PAH [t]	HCB [kg]	PCB [kg]
2007	16.32	6.75	8.90	4.88
2008	17.90	7.48	7.78	4.44
2009	18.52	7.58	8.32	3.98
2010	19.57	8.17	9.63	4.41
2011	19.53	8.14	10.54	4.79
2012	13.28	5.63	9.47	3.68
2013	12.45	5.38	6.36	3.24
2014	10.66	4.35	4.18	3.10
2015	11.26	4.74	0.95	9.99
2016	10.19	4.52	0.84	13.63
2017	8.41	3.55	2.19	20.96
2018	8.65	3.77	1.66	29.02
Trend 1990–2018	-56%	-42%	-96%	-84%

From the figures presented in the previous table a conclusion can be drawn that Republic of North Macedonia in 2018 did not exceeded the emission levels set in POPs Protocols. In the case of HCB and PCBs, the emissions are much lower the values from the reference year 1990.

3.4.1. PAH-4 emissions

Emission trend

National total PAH-4 emissions in 1990 amounted to 6.54 t. Since then, the emissions have been quite stable and in the year 2018 emissions were at level of 3.8 t, reflecting a reduction of 42%. The most important reductions could be observed in the sector for residential heating. Between 2017 and 2018, total PAH-4 emissions increased by 6%, because of increased emissions from residential heating in the NFR 1.A.4 Other sectors.

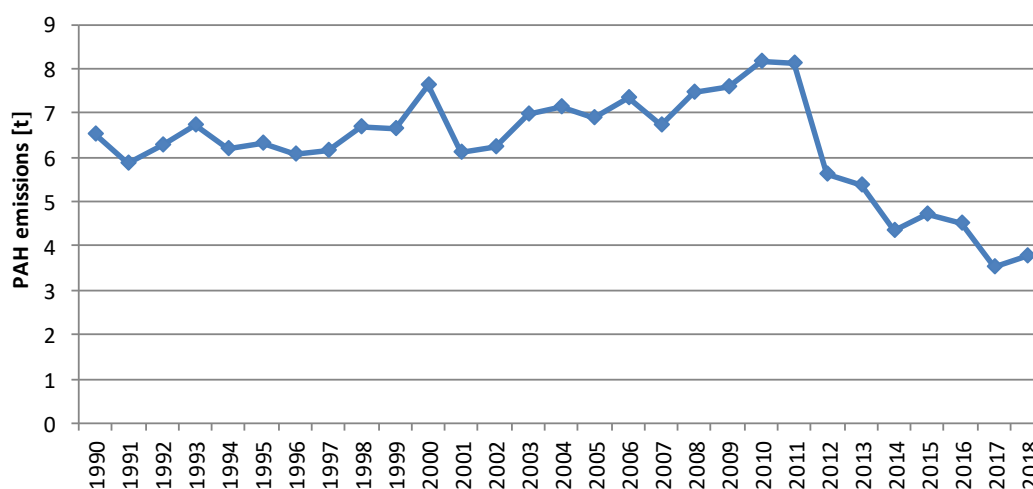


Figure 30 National total PAH emissions 1990-2018

Main emission sources in North Macedonia

The most important emission source in 2018 of PAH is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2018 is 1.A.4 Other Sectors (residential heating), with a share of 75%, while in 1990, this sector contributed with 86%. Furthermore, 1.A.2 Manufacturing Industries is contributing with a share of 24% (7% in 1990) of the national total emissions. PAH emissions from NFR sectors 1.A.1 Energy industries and 2 - Industrial Processes and Product use are minor sources.

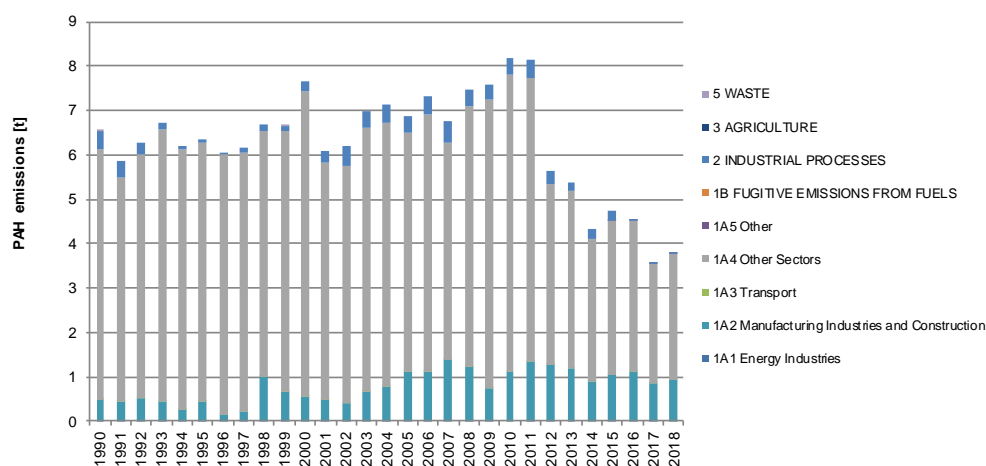


Figure 31 PAH-4 emissions in North Macedonia 1990-2018 by sectors

3.4.2. Dioxin and Furan emissions (PCDD/F)

Emission trend

National total dioxin/furan emissions amounted to 19.8 g-I-TEQ in 1990; emissions have decreased since then and in the year 2018 emissions were down to around 8.6 g-I-TEQ, decreasing by 56% compared to 1990. The most important reductions could be observed in the sector 2 Industrial Processes and Other Product Use (Metal Production), especially in iron and steel production. This production has not been stable due to variations of the price of steel and due to a significant reduction of fugitive emissions. Between 2017 and 2018 total dioxin/furan emissions increased slightly by 3%.

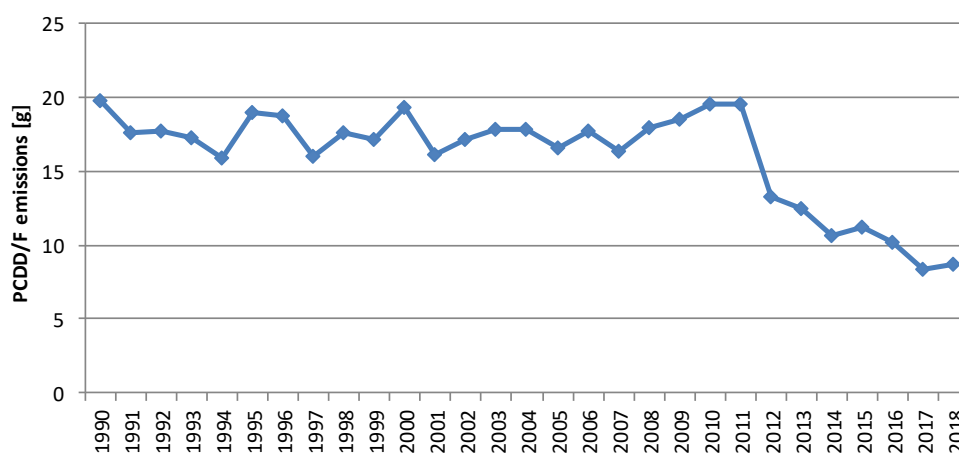


Figure 32 National total PCDD/F emissions 1990-2018

Main emission sources in North Macedonia

The most important emission source in 2018 of PCDD/F is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2018 is 1.A.4 Other Sectors (mainly residential heating), with a share of 65% in 1990 and 73% in 2017. Furthermore, 1.A.2 Manufacturing Industries is contributing with a share of 14% (5% in 1990) in the national total emissions. NFR category 2 Industrial Processes and Product use (Metal Production) is also contributing with 27% (8%) of the national total PCDD/F emissions.

Dioxin/furan emissions from NFR sectors 1.A.1 Energy industries and 5 Waste are minor sources.

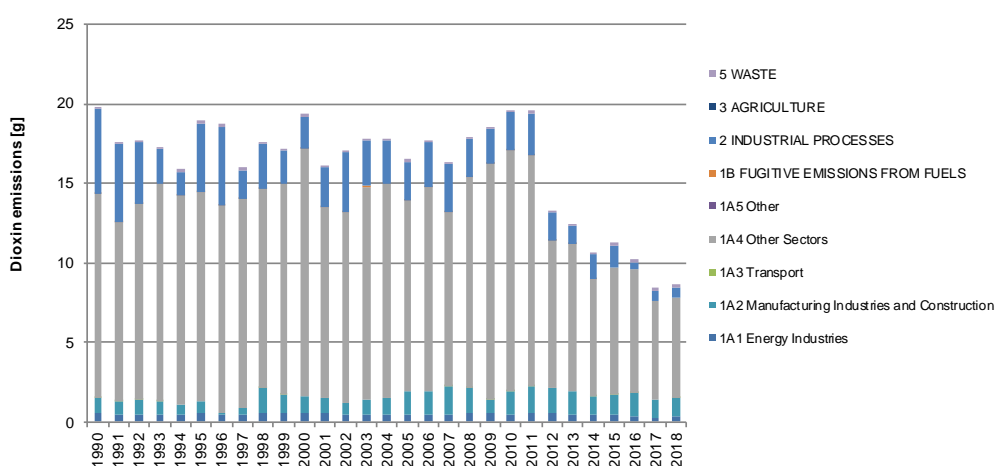


Figure 33 Dioxin/furan emissions in North Macedonia 1990-2018 by sectors

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 2018 emissions were down by 96%, amounting to 1.66 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 stable. The most important reductions could be observed in the sector 2 Industrial Processes and Other Product Use (Aluminum Production). Between 2017 and 2018 total HCB emissions decreased by 24% mainly due to decrease in aluminum production sector.

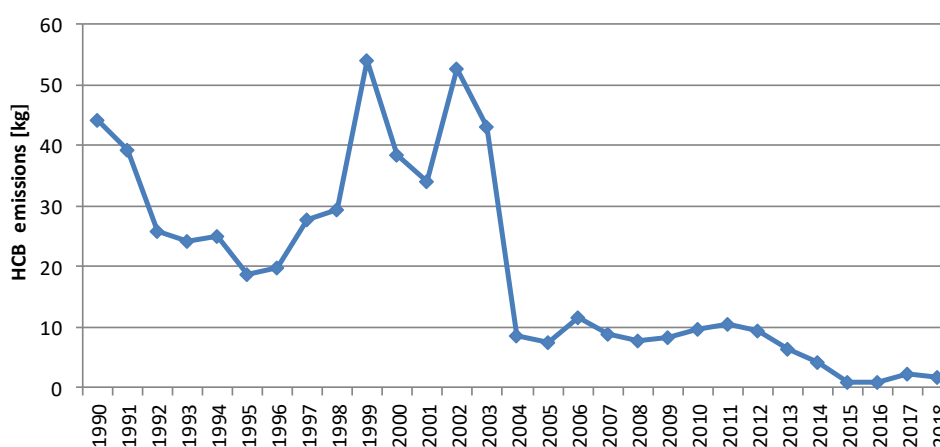


Figure 34 National total HCB emissions 1990-2018

Main emission sources in North Macedonia

The most important emission source in 2018 of HCB is NFR sector 2 Industrial Processes and Product Use. With a share of 92% (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. The contribution to the HCB emissions from 5 Waste, 1.A.4 Other sectors and 1.A.2 Manufacturing Industries and Construction is 5.5%, 2.4% and 0.3% respectively.

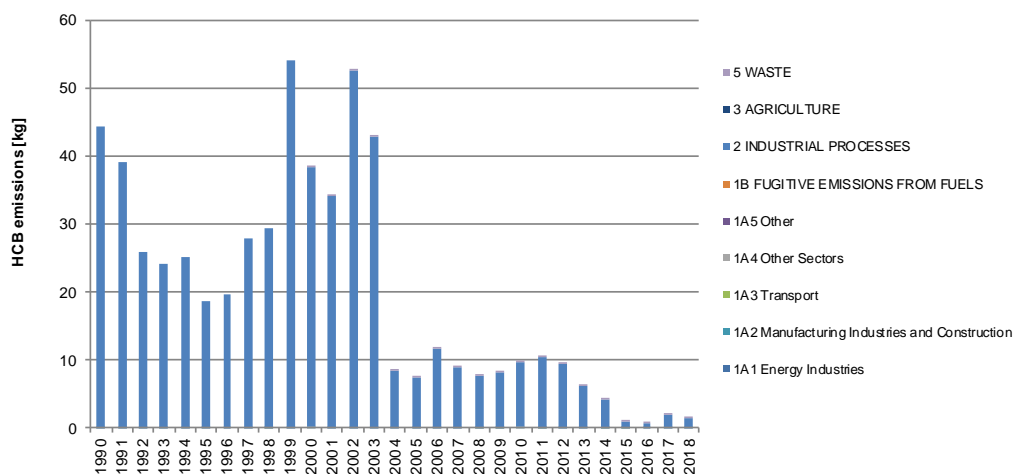


Figure 35 HCB emissions in North Macedonia 1990-2018 by sectors

3.4.4. Polychlorinated biphenyl (PCB) Emissions

Emission trend

National total PCB emissions amounted to 179.3 kg in 1990; emissions have decreased steadily since then and in the year 2018 emissions were down by 84%, accounting to 29.2 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 increased due to use of Tier 2 methodology in 2C sector.

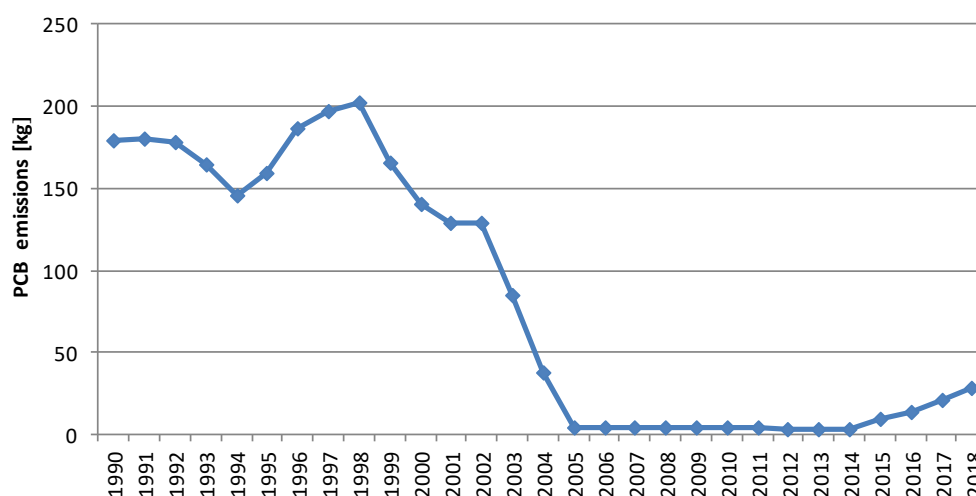


Figure 36 National total PCB emissions 1990-2018

Main emission sources in North Macedonia

The most important emission source in 2018 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 95% (99% in 1990) of the national total PCB emissions. The main source in the nineties was the smelter company in Veles that has stopped production in 2003. Further emission sources in 2018 are NFR sectors 1.A.2 Manufacturing Industries (Iron and Steel Production) and 1.A.4 Other Sectors (mainly residential heating) with share of 3% and 2% respectively.

PCB emissions from NFR sector 5 - Waste is a minor source.

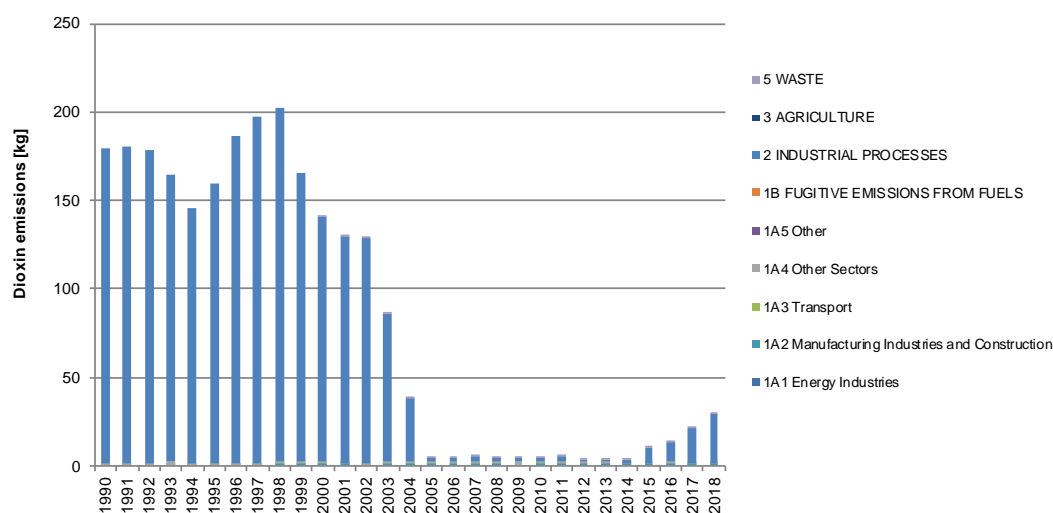
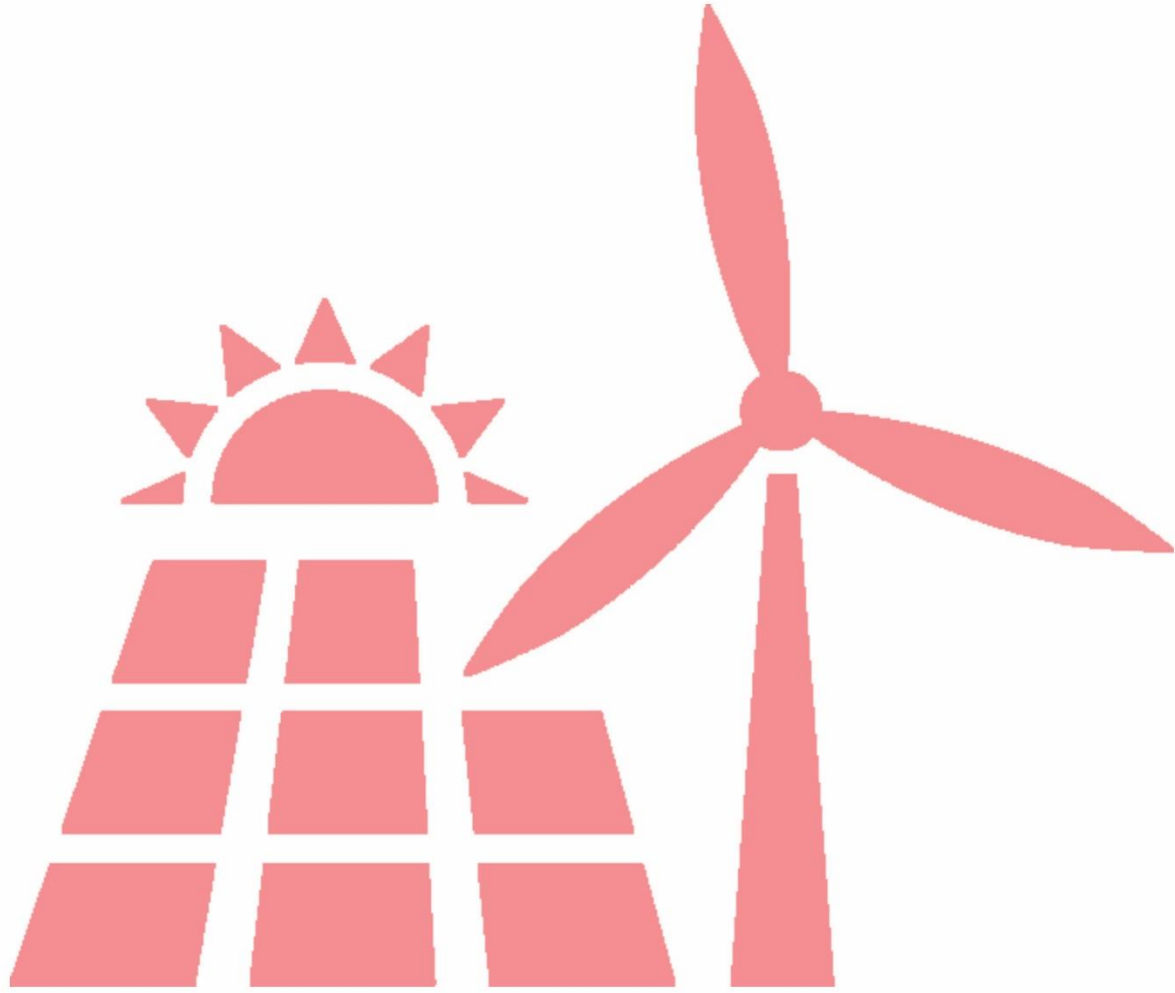


Figure 37 PCB emissions in North Macedonia 1990-2018 by sectors

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 change 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 49 NFR categories included in Energy sector for 2018

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	√
A 3 d ii National navigation (Shipping)	√
Memo Items	
1 A 3 a i (ii) International aviation cruise(civil)	√
1 A 3 a ii (ii) Civil aviation LTO (Domestic. Cruise)	√
1A3 Transport (fuel used)	√

Table 50 NFR categories not included in Energy sector for 2018

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	NE
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
1 B 3 Other fugitive emission from geothermal energy production. peat and other energy extraction not included in 1 B 2	NE
Memo Items	
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 1.A..3.e , 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_x, SO₂, 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 2018 and one have started in 2019)

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 are updated with EF from the latest available Guidebook version 2019. 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.

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/10³ t has been used, for imported coal – 8.29 TJ/10³t, for biomass this year separate LHV were used for fire wood – 6.7 TJ/10³ m³, 10.66 TJ/10³ m³ for fruit wood, for wood wastes, wood briquettes and pellets – 17.00 TJ/10³ t for heavy fuel – 40/40.19 TJ/10³t, for heating oil and other gasoil – 42.5 TJ/10³t, for diesel – 43/42.71 TJ/10³t for coke – 26.795 TJ/10³t, for other imported coal – 8.29 TJ/10³, for natural gas –33.588/34.12 TJ/10⁶ Nm³. LPG – 46/46.05 TJ/10³t and petroleum coke – 31.82 TJ/10³t.

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 mainly operated using natural gas. At current, biofuels are not used for power or district heat generation. In 2018, only six 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 51 TPP and DHP Installation technical properties and BAT

Plant name	Technology	Thermal input [MW]	Fuel type 1	Fuel type 2	BAT	NERP	Comments
REK BITOLA	Production of electricity	2025	Lignite	Heavy fuel oil	Modernization of blocs in 2013-2014, reduction of NOx, dust and CO electrostatic filter for dust $\eta=99,84\%$	Yes	
REK OSLOMEJ	Production of electricity	375	Lignite	Heavy fuel oil	electrostatic filter for dust $\eta=98\%$	Yes	Since 2015 limited operation due to limited coal
TEC NEGOTINO	Production of electricity	630	Heavy fuel oil			No	Not in operation since 2014 it is used as cold reserve
Balkan Energy Toplana ISTOK	Heat production	294	Natural gas		Burners for low NOx insurance	Yes	
Balkan Energy Toplana ZAPAD	Heat production	183	Natural gas		In 2013 Heavy fuel oil has been replaced with natural gas. Burners for low NOx insurance	Yes	
Toplana Sever	Heat production		Natural gas			No	Not in operation
TE-TO	Combined Electricity and heat production	440	Natural gas		Ecological burners for low NOx insurance and stable combustion mode	No	
ELEM	Heat production	100	Natural gas			No	
KOGEL	Combined Heat and electricity production	90	Natural gas			No	Started in October 2019

4.2.1. Methodological issues

For the years 2008 onwards, NO_x, SO₂, 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_x SO₂ 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 (NH₃ 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_x and dust, implied emission factors were derived for NO_x and dust for the period 2013-2014, and were used for calculation of NO_x and TSP emissions for 2015-2017 while PM₁₀ and PM_{2.5} emissions were calculated by applying the share of the Guidebook emissions factors. The share of PM₁₀ in TSP is 68% and the share of PM_{2.5} 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 52 Activity data for source category 1.A.1.a Public electricity and heat production by type of fuel

Year	Lignite (TJ)	Natural gas (TJ)	Residual fuel oil (TJ)
1990	58 359	1 000	2 516
1991	45655	NO	3 090
1992	44 356	NO	2 656
1993	45 442	NO	3 037
1994	47 507	NO	2 434
1995	49 958	NO	2 986
1996	47 675	NO	3 051
1997	49 362	NO	3 301
1998	55 194	NO	2 602
1999	50 091	NO	2 640
2000	51 991	715	6 345
2001	56 387	673	3 800
2002	48 716	641	4 286
2003	49 091	345	2 902

Year	Lignite (TJ)	Natural gas (TJ)	Residual fuel oil (TJ)
2004	49 291	69	2 936
2005	48 711	52	3 031
2006	45 153	197	5 152
2007	45 697	895	6 588
2008	52 597	1 627	1 270
2009	50 442	744	2 267
2010	46 386	1 475	2 330
2011	53 111	1 570	1 431
2012	50 549	974	1 594
2013	43 402	1 522	1 310
2014	44 158	1 633	1 671
2015	39 816	3 258	1 606
2016	32 903	5 653	1 138
2017	28 553	7 456	933
2018	31 523	6 674	538

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. 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_x, 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 on the basis of 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 is presented in the following table:

Table 53 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 _x	g/GJ	389	89	389
NM VOC	g/GJ	1.4	2.6	2.3
SO ₂	g/GJ	1.678	0281	1.678
NH ₃	g/GJ	NE	NE	NE
PM _{2.5}	g/GJ	57.4	0.9	57.4
PM ₁₀	g/GJ	141.8	0.9	141.8
BC	%PM _{2.5}	1	2.5	5.6
TSP	g/GJ	210	0.89	210

Pollutant	Unit	Lignite	Natural gas	Heavy fuel oil
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
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_x, SO_x, 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 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 15th March each year. Installations are reporting on NO_x, CO, TSP and SO_x 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 2018 for these pollutants, the measurements received were converted to yearly emissions and presented in the NFR.

Implied emission factors

The following table shows NO_x, SO₂, 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.

Table 54 Implied Emission factors for source category Public electricity and heat production 1.A.1.a by type of fuel for 2009 -2013

Year	NO _x (g/GJ)	SO ₂ (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_x and TSP values were recalculated due to lower figures of monthly measurements which is infected by the modernization boilers in the power plants.

Table 55 Implied Emission factors for source category Public electricity and heat production 1.A.1.a by type of fuel for 2014-2017

Year	NO_x (g/GJ)	TSP (g/GJ)
2013	261.03	239.74
2014	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.

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_x and SO_x was estimated to be 20% (rating A. cf. chapter 1.7). 200% for NMVOC (rating D) and 125% for PM2.5 (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. An improved quality checks for the use of 2014-2017, EF was done. The EF were corrected due to reduction of NO_x and TSP in the last several years due to modernization of power plant REK Bitola. Data on fuel consumption are crosschecked with SSO reports and starting from 2018 data on SO_x, NO_x and dust are cross checked with LCP reporting [40].

Namely, emissions data for NO_x, SO_x and dust 2018 that were reported under the obligation LCP - article 72 IED (Large Combustion Plant – Industrial Emission Directive article 72) towards the Energy community agreement, were cross checked with emissions coming from this sector. Emissions from four out of six plants in this NFR category are reported under LCP reporting obligation.

4.2.4. Source-specific recalculations

Recalculations were done due to introduction of Implied emission factors for dust, PM10, PM2.5 and NO_x for plants using coal and heavy fuel for period 2014-2017, as well due to final consumption data for 2017.

4.2.5. Source-specific planned improvements

Calculation of the national emission factors for power production plants will improve the quality of data in this key category. These planned improvements will be part of the activity for improving of national air emission inventory in IPA 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 56 Activity data for source category 1.A.1.b- Petroleum refining by type of fuel

Year	Refinery gas (TJ)	Residual fuel oil (TJ)
1990	1711	1680
1991	1356	1331
1992	797	782
1993	1432	1406
1994	201	198
1995	168	165

Year	Refinery gas (TJ)	Residual fuel oil (TJ)
1996	980	961
1997	534	524
1998	1062	1042
1999	1077	1057
2000	1467	1071
2001	1425	1109
2002	912	870
2003	1103	1140
2004	1174	1181
2005	1373	1035
2006	1522	1002
2007	1551	1228
2008	1483	1304
2009	1368	1339
2010	1294	1921
2011	723	1815
2012	236	990
2013	68	384
2014	NO	107
2015	NO	NO
2016	NO	NO
2017	NO	NO
2018	1711	NO

Emission factors

The emission factors for refinery gas has been taken from GB 2013. 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 2013. Table 4-4 Tier 2 emission factors for source category 1.A.1.b. process furnaces using residual oil.

Table 57 Emission factors for source category 1.A.1.b- Petroleum refining

Pollutant	Unit	Refinery gas	Heavy fuel oil
NO _x	g/GJ	63	142
NM VOC	g/GJ	2.58	2.3
SO ₂	g/GJ	0.281	485
PM _{2.5}	g/GJ	0.89	9
PM ₁₀	g/GJ	0.89	15
TSP	g/GJ	0.89	20
CO	g/GJ	39.3	15
Pb	mg/GJ	1.79	4.6
Cd	mg/GJ	0.712	1.2

Pollutant	Unit	Refinery gas	Heavy fuel oil
Hg	mg/GJ	0.086	0.3
As	mg/GJ	0.343	3.98
Cr	mg/GJ	2.74	14.8
Cu	mg/GJ	2.22	11.9
Ni	mg/GJ	3.6	1.030
Se	mg/GJ	0.42	2.1
Zn	mg/GJ	25.2	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_x and SO_x was estimated to be 20% (rating A. cf. chapter 1.7), 200% for NMVOC (rating D) and 40% for PM_{2.5} (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 in this category.

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

Update of EF from the latest 2019 Guidebook.

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

This category includes emissions from manufacturing industries. Several industrial branches are contributing in 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 the Tables 58-63:

- 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 58.

Table 58 Activity data for source category 1.A.2.a – Stationary combustion in manufacturing industries and construction: Iron and steel

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
1990	NO	NO	1396	3104
1991	NO	NO	2133	1184
1992	NO	NO	2451	1611
1993	NO	NO	1964	1291
1994	NO	NO	960	631
1995	NO	NO	2100	656
1996	NO	NO	NO	34
1997	NO	NO	272	179
1998	0.30	NO	5166	1793
1999	0.53	NO	3443	1414
2000	NO	27	2285	1699
2001	0.08	816	1912	780
2002	NO	960	1378	1076
2003	2.60	1119	2882	1196
2004	2.22	1226	3300	1041
2005	130.42	1272	4852	1963

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2006	111.20	1310	5060	2739
2007	50.74	1322	6820	3588
2008	14.57	1201	5931	2969
2009	1.55	1094	2636	2530
2010	83.74	1079	4446	2977
2011	47.29	1598	6163	4014
2012	110.70	437	5847	3543
2013	6.49	610	5220	3366
2014	5.53	754	5410	1981
2015	4.01	658	5516	1399
2016	2.41	878	4521	1142
2017	1.51	1044	2808	841
2018	0.13	994	3313	918

Table 59 Activity data for source category 1.A.2.b - Stationary combustion in manufacturing industries and construction: Iron and steel

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
1990	NO	NO	2298	631
1991	NO	NO	1827	278
1992	NO	NO	1830	591
1993	NO	NO	1834	905
1994	NO	NO	1686	862
1995	NO	NO	1537	819
1996	NO	NO	NO	26
1997	NO	NO	920	82
1998	NO	NO	1839	139
1999	NO	NO	1754	700
2000	NO	NO	2046	771
2001	NO	NO	1919	374
2002	NO	NO	1246	615
2003	NO	NO	596	9
2004	NO	NO	NO	13
2005	NO	NO	NO	22
2006	NO	NO	NO	32
2007	NO	NO	NO	42
2008	NO	NO	NO	32
2009	NO	NO	NO	26
2010	NO	NO	NO	35
2011	NO	NO	NO	39

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2012	NO	NO	NO	42
2013	6.00	NO	NO	43
2014	4.00	37.95	NO	3
2015	NO	NO	NO	41
2016	NO	NO	NO	52
2017	NO	NO	NO	55
2018	NO	NO	NO	58

Table 60 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	NO	NO	NO	169
1991	NO	NO	NO	166
1992	NO	NO	0.43	613
1993	NO	NO	0.85	1060
1994	NO	NO	0.75	1136
1995	NO	NO	0.64	1213
1996	NO	NO	2.54	33
1997	NO	NO	2.26	89
1998	NO	NO	1.97	144
1999	NO	NO	NO	40
2000	NO	NO	NO	NO
2001	NO	38	NO	0.1
2002	NO	40	NO	1.6
2003	NO	33	NO	0.7
2004	NO	26	NO	6.0
2005	NO	23	NO	5.4
2006	NO	14	NO	7.6
2007	NO	10	NO	5.4
2008	NO	9	NO	3.6
2009	NO	6	NO	4.4
2010	NO	5	NO	8.5
2011	NO	2	NO	43
2012	NO	NO	NO	77
2013	0.38	NO	NO	73
2014	NO	36	NO	65
2015	NO	36	NO	86
2016	NO	39	NO	74
2017	NO	42	NO	83

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2018	NO	40	NO	83

Table 61 Activity data for source category 1.A.2.d - Stationary combustion in manufacturing industries and construction: Pulp, paper and print

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
1990	NO	NO	337.1813	12.89
1991	NO	NO	337.18	16.88
1992	NO	NO	0.44	12.40
1993	NO	NO	0.22	7.92
1994	NO	NO	NO	7.76
1995	NO	NO	NO	7.60
1996	NO	NO	NO	196.99
1997	NO	NO	56.11	169.95
1998	1.90	NO	28.78	142.91
1999	0.53	NO	1.45	2.86
2000	0.50	NO	NO	0.38
2001	0.84	NO	NO	0.29
2002	0.67	NO	NO	1.93
2003	0.21	NO	NO	1.26
2004	1.00	NO	NO	1.13
2005	1.30	NO	NO	0.25
2006	0.88	NO	NO	0.29
2007	0.84	NO	NO	0.13
2008	0.92	NO	NO	0.21
2009	0.75	NO	NO	0.38
2010	1.84	6.58	NO	0.25
2011	1.21	15.29	NO	8.92
2012	0.59	23.99	0.15	17.58
2013	0.46	15.16	0.29	16.37
2014	0.20	15.04	0.21	17.75
2015	0.18	15.24	0.90	26.39
2016	2.02	14.25	0.22	18.64
2017	1.01	16.23	0.21	22.73
2018	2.87	16.55	0.25	18.07

Table 62 Activity data for source category 1.A.2.e - Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
1990	NO	NO	172	1611
1991	NO	NO	34	223

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
1992	NO	NO	32	414
1993	NO	NO	30	605
1994	NO	NO	22	589
1995	NO	NO	14	572
1996	NO	NO	3	137
1997	NO	NO	17	547
1998	15.54	NO	31	956
1999	18.41	NO	31	115
2000	13.19	NO	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	12.39	43	16	137
2006	7.54	56	4	161
2007	3.18	53	9	117
2008	5.57	60	8	124
2009	2.47	57	6	147
2010	7.41	62	1	191
2011	28.64	139	3	511
2012	49.86	216	6	830
2013	116.98	218	6	706
2014	184.35	201	4	656
2015	81.73	211	NO	701
2016	75.53	233	NO	689
2017	184.95	241	NO	669
2018	194.00	241	NO	605

Table 63 Activity data for category source category 1.A.2. gviii - Stationary combustion in manufacturing industries and construction: Other

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]	Clinker [tonnes]
1990	67	NO	111	2666	491 902
1991	67	NO	111	2727	465 375
1992	67	NO	111	2606	396 496
1993	67	NO	110	2484	413 444
1994	67	NO	123	2117	375 914
1995	67	NO	135	1749	365 121
1996	66	NO	32	6040	396 015
1997	67	NO	593	2495	475 252

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]	Clinker [tonnes]
1998	66	NO	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	NO	1706	1349	643 258
2005	29	NO	1781	4628	694 922
2006	5	NO	1885	1349	801 302
2007	29	NO	1751	1451	882 834
2008	23	NO	1822	1349	843 765
2009	17	10	1752	1489	478 404
2010	22	127	2386	1926	588 978
2011	111	242	2130	1829	687 986
2012	136	133	1930	1645	645 482
2013	98	127	2009	1061	577 845
2014	112	137	73	1016	518 198
2015	55	143	928	2468	553 232
2016	59	169	2658	1023	739 807
2017	63	210	2593	1012	735 625
2018	63	231	2514	1152	748 287

Activity data – mobile combustion

Activity data for category 1.A.2.gvii for diesel fuel is presented in Table 64. The activity data for the period 1990-2002 were calculated using surrogate data (off-road vehicles in industry). Activity data for the years 2004, 2008 and 2010 were taken from the IIR reported for those years. Data for 2013 and 2014 is available from the energy balance, when the source category diesel for transport has been introduced. For 2015-2018 data from the category diesel for transport has been used. Activity data for 2016 has been recalculated due to correction in the excel sheet conversion.

Table 64 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	4879	2004	507
1991	3520	2005	429
1992	4707	2006	459
1993	4925	2007	528
1994	2074	2008	558
1995	2408	2009	789
1996	2074	2010	1020

Year	Heavy Fuels [TJ]	Year	Heavy Fuels [TJ]
1997	1796	2011	1378
1998	1624	2012	1737
1999	1316	2013	2300
2000	1050	2014	1254
2001	1156	2015	1182
2002	680	2016	1165
2003	549	2017	1096
		2018	1089

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 65-68.

Table 65 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 2019 Table 3-5 emission factor for source category, 1.A.2. page 17
NMVOC	300	g/GJ	GB 2019 Table 3-5 emission factor for source category, 1.A.2. page 17
SOx	11	g/GJ	GB 2019 Table 3-5 emission factor for source category, 1.A.2. page 17
NH3	1.2	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
PM2.5	140	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
PM10	143	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
BC	28	% of PM2.5	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
TSP	150	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
CO	570	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Pb	27	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Cd	13	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Hg	0.56	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
As	0.19	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Cr	23	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Cu	6	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Ni	2	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Se	0.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Zn	512	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
PCDD/PCDF	100	ng I-Teq/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
benzo(a) pyren	10	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
benzo(b) fluoranthene	16	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
benzo(k) fluoranthene	5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
Indeno (1.2.3-cd) pyren	4	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18
HCB	5	µg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18

Pollutant	Value	Unit	References
PCBs	0.06	µg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 18

Table 66 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 2019 Table 3-3 emission factor for source category 1.A.2. page 16
NMVOC	23	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
SOx	0.67	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
PM2.5	0.78	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
PM10	0.78	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
TSP	0.78	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
BC	4	% PM2.5	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
CO	29	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Pb	0.011	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Cd	0.0009	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Hg	0.54	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
As	0.1	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Cr	0.013	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Cu	0.0026	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Ni	0.013	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Se	0.058	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Zn	0.73	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
PCDD/PCDF	0.52	ng I- Teq/GJ	GB2019 Table 3-3 emission factor for source category 1.A.2. page 16
benzo(a) pyren	0.72	mg/GJ	GB2019 Table 3-3 emission factor for source category 1.A.2. page 16
benzo(b) fluoranthen	2.9	mg/GJ	GB2019 Table 3-3 emission factor for source category 1.A.2. page 16
benzo(k) fluoranthene	1.1	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16
Indeno (1.2.3-cd) pyren	1.08	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 16

Table 67 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 2019 Table 3-3 emission factor for source category 1.A.2. page 15
NMVOC	88.8	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
SOx	900	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
PM2.5	108	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
PM10	117	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
TSP	124	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
BC	6.4	% of PM2.5	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
CO	931	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Pb	134	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15

Pollutant	Value	Unit	References
Cd	1.8	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Hg	7.9	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
As	4	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Cr	13.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Cu	17.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Ni	13	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Se	1.8	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Zn	200	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
PCDD/PCDF	203	ng I-Teq/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
benzo(a) pyren	45.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
benzo(b) fluoranthene	58.9	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
benzo(k) fluoranthene	23.7	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
Indeno (1.2.3-cd) pyren	18.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
HCB	0.62	µg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15
PCBs	170	µg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.2. page 15

Table 68 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 2019 Table 3-4 emission factor for source category 1.A.2. page 17
NMVOC	25	g/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
SOx	47	g/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
PM2.5	20	g/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
PM10	20	g/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
TSP	20	g/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
BC	56	% of PM2.5	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
CO	66	g/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Pb	0.08	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Cd	0.006	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Hg	0.12	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
As	0.03	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17

Pollutant	Value	Unit	References
Cr	0.2	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Cu	0.22	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Ni	0.008	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Se	0.11	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Zn	29	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
PCDD/PCDF	1.4	ng I- Teq/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
benzo(a) pyren	1.9	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
benzo(b) fluoranthene	15	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
benzo(k) fluoranthene	1.7	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17
Indeno (1.2.3-cd) pyren	1.5	mg/GJ	GB 2016 2019 Table 3-3 4 emission factor for source category 1.A.2. page 17

The emission factors for clinker production are presented in Table 69.

Table 69 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 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
NMVOC	18	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
SOx	374	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
CO	1455	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Pb	0.098	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Cd	0.008	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Hg	0.049	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
As	0.0265	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Cr	0.041	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Cu	0.0647	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31

Pollutant	Value	Unit	References
Ni	0.049	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Se	0.0253	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Zn	0.424	g/tclinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
PCB	103	µg/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
PCDD/PCDF	4.1	ng I-TEQ/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
benzo(a) pyren	0.000065	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
benzo(b) fluoranthen	0.00028	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
benzo(k) fluoranthen	0.000077	g/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
Indeno (1.2.3-cd) pyren	0.000043	g/tclinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31
HCB	4.6	µg/t clinker	GB 2016 2019 Table 3-24 emission factor for source category 1.A.2.f.. page 31

Emission factors – mobile combustion

Concerning the source category 1.A.2.gvii, the emission factors for diesel fuels are presented in table 70.

Table 70 Emission factors for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for diesel fuel

Pollutant	Value	Unit	References
NOx	32 629	g/ton	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
NMVOC	3777	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
NH ₃	8	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
PM2.5	2104	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
PM10	2104	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
BC	1306	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
TSP	2104	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
CO	10 774	g/ton	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Cd	0.01	mg/kg	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Cr	0.05	mg/kg	GB 2013 2019 Table 3-1 Tier 1 emission factors for off-road machinery

Pollutant	Value	Unit	References
Cu	1.7	mg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Ni	0.07	mg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Se	0.01	mg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Zn	1	mg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
benzo(a) pyrene	30	µg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
benzo(b) fluoranthene	50	µg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery

With regards to SO_x calculation for emissions coming from diesel is done using the sulfur content presented in Table 94.

4.4.2. 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 SO_x was estimated to be 20% (rating A. cf. chapter 1.7). For NO_x, 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 PM_{2.5}, 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).

4.4.3. 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.

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

Recalculations for 2017 were performed, due to the use of final data (from the energy balance) for fuel consumption. Additionally EF for ammonia from the newest version of the Guidebook for 1.A.2 coming from biomass were implemented and EF for several substances for NFR 1.A.2.gvii for clinker production and EF for 1.A.2.c were corrected in the excel sheets.

4.4.5. 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.

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)

The preparation of the road transport inventory was the most difficult part of the emission calculation, compared to other sectors due to the lack of activity data, as well as the weak support of the existent scientific institutions in the country. The estimated emissions from this category are calculated with the highest uncertainty, due to the lack of details on vehicles fleet data for the period 1990-2013 during the inventory preparation.

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 1990-2013 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 Tier 2 methodology or emissions calculation included in the EEA Guidebook 2013, has been used for calculation of the emission from road transport for the years 2014-2018. The Tier 2 approach allows to estimate the emission for a given vehicles fleet, when the information concerning the number of vehicles classified by categories, fuel and emission standards is known. The calculation includes emissions from passenger cars, light duty vehicles, heavy-duty vehicles and busses, motorcycles and gasoline evaporation from vehicles.

The Tier 2 approach considers the fuel used by different vehicle categories and their emission standards that are 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 2 approach for exhaust emissions uses the following general equation:

The emission E for a certain pollutant i and a vehicles category j is calculated as following:

$$E_{i,j} = \sum_k (N_{j,k} \cdot M_{j,k} \cdot EF_{i,j,k})$$

where:

$N_{j,k}$ = number of vehicles in the fleet of category j and technology k .

$M_{j,k}$ = average annual distance driven per vehicle of category j and technology k .

$EF_{i,j,k}$ = technology-specific emission factor of pollutant i for vehicle category j and technology k .

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).

The data of the vehicle stock has been delivered from the official National Car Registry of North Macedonia managed by the Ministry of interior (MOI). The data for the driven kilometer per type of vehicle has been calculated.

The emission factors are available for CO, NH₃, NMVOC, NO_x, 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 PM₁₀. 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.

Sulfur dioxide emissions are estimated by assuming that all sulfur in the fuel is transformed completely into SO₂, using the formula:

$$E_{SO_2,m} = (2 \cdot k_{S,m} \cdot FC_m)$$

where:

$k_{S,m}$ = weight related sulfur content in fuel of type m

FC_m = *fuel consumption of fuel m*

The typical sulfur content of fuel was retrieved from the table 3.13 of the EEA Guidebook 2013. Road Transport.

Activity data

Fuel consumption data were taken from Statistical yearbook – chapter Energy balance 1990-2018 [21]. Data on number of vehicles were taken from Statistical yearbook for the period 1990-2002 [21] and publication Transport and other communication for the period 2003-2013 [25]. For the period 2014-2018 data on number of vehicles were taken from MOI database. The data on mileage was received from the Faculty for Mechanical Engineering in Skopje.

Table 71 Activity data for source category 1.A.3.b - Road transport for period 1990-2018

NFR	1A3bi	1A3bi	1A3bii	1A3biii	1A3biv
Year	Liquified fuels	Gas fuel	Liquified fuels	Liquified fuels	Liquified 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
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	11 446	734.0	2288.0	11 568	70.0
2017	11 902	737.0	1994.0	11 723	84.0
2018	12 411	742.0	2077	11 788	79.0

Table 72 Activity data for source category 1.A.3.b Road transport for 2018

NFR code	Fuel	Fuel consumption [TJ]
1A3bi	Gasoline	4 034
	Diesel	8 377
	LPG	742.0
1A3bii	Gasoline	36.43
	Diesel	2 041

NFR code	Fuel	Fuel consumption [TJ]
1A3biii	Gasoline	
	Diesel	11 788
1A3biv	Gasoline	79.0

Emission factors

Default emission factors for the basic pollutants, lead and particulates were taken from GB 2009 –Tier 1 emission factors. Emission factors for HM were taken from IIR 2010. In the Tables 73 -78. Emission factors used for estimation of emissions grouped by sub-sectors are presented. Emission factor for lead was used for calculation of emissions starting from 2008 onwards.

Compared to the previous IIR the EF for SOx emissions has been revised as recommended in the last Stage 3 Review Report. For SOx emissions the country specific sulfur content of diesel in road transport is being used now.

Sulfur dioxide emissions are estimated by using the sulfur content in different periods as presented in Table 94

Table 73 Emission factor for source category 1.A.3.b - Road Transport used for calculation of emissions in the period 1990-2013 by use of Tier 1 methodology

NFR code	Fuel	NOx	NM VOC	NH ₃	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	/

Table 74 Emission factor for source category 1.A.3.bi Road Transport: Passenger cars used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodologies

Fuel type	g/km	CO	NH ₃	NM VOC	NO _x	Pb	PM2.5	B(a)P
gasoline	EURO 0	24.60	0.002	2.16	2.66	0.0000182	0.0022	0.00000048
gasoline	EURO 1	4.07	0.0922	0.48	0.46	0.0000182	0.0022	0.0000003
gasoline	EURO 2	2.04	0.1043	0.22	0.24	0.0000182	0.0022	0.00000032
gasoline	EURO 3	1.80	0.0342	0.10	0.09	0.0000182	0.0011	0.00000032
gasoline	EURO 4	0.63	0.0342	0.05	0.06	0.0000182	0.0011	0.00000032
gasoline	EURO 5	0.63	0.0123	0.05	0.06	0.0000182	0.0014	0.00000032
gasoline	EURO 6	0.63	0.0123	0.05	0.06	0.0000182	0.0014	0.00000032
diesel	EURO 0	0.69	0.001	0.16	0.71	0.0000182	0.2209	0.00000174
diesel	EURO 1	0.41	0.001	0.06	0.69	0.0000182	0.0842	0.00000174
diesel	EURO 2	0.30	0.001	0.07	0.72	0.0000182	0.0548	0.00000174

Fuel type	g/km	CO	NH ₃	NMVOC	NO _x	Pb	PM2.5	B(a)P
diesel	EURO 3	0.09	0.001	0.03	0.77	0.0000182	0.0391	0.00000174
diesel	EURO 4	0.09	0.001	0.01	0.58	0.0000182	0.0314	0.00000174
diesel	EURO 5	0.04	0.0019	0.01	0.61	0.0000182	0.0021	0.00000174
diesel	EURO 6	0.05	0.00	0.01	0.50	0.0000182	0.0015	0.00000174
other	EURO 0	6.83	0.002	1.05	2.36	1.82E-05	0.0022	1.00E-08
other	EURO 1	3.57	0.088	0.72	0.41	1.82E-05	0.0022	1.00E-08
other	EURO 2	2.48	0.1007	0.34	0.18	0.0000182	0.0022	0.00000001
other	EURO 3	1.79	0.0338	0.12	0.09	0.0000182	0.0011	0.00000001
other	EURO 4	0.62	0.0338	0.10	0.06	1.82E-05	0.0011	1.00E-08
other	EURO 5	0.62	0.0338	0.10	0.06	1.82E-05	n.a.	n.a.
other	EURO 6	0.62	0.0338	0.10	0.06	1.82E-05	n.a.	n.a.

Table 75 Emission factor for source category 1.A.3.bii - Road Transport: Light duty vehicles. used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodology

Type	Technology	CO	NH ₃	NMVOC	NO _x	Pb	PM2.5	B(a)P
Gasoline <3.5t	Conventional	25.5	0.0025	3.44	3.09	2.82E-06	0.0023	4.80E-07
Gasoline <3.5t	Euro1	8.82	0.0758	0.614	0.563	3.31E-06	0.0023	3.20E-07
Gasoline <3.5t	Euro2	5.89	0.091	0.304	0.23	3.31E-06	0.0023	3.20E-07
Gasoline <3.5t	Euro3	5.05	0.0302	0.189	0.129	3.31E-06	0.0011	3.20E-07
Gasoline <3.5t	Euro4	2.01	0.0302	0.128	0.064	3.31E-06	0.0011	3.20E-07
Gasoline <3.5t	Euro5	1.3	0.0123	0.096	0.064	3.31E-06	0.0014	3.20E-07
Gasoline <3.5t	Euro6	1.3	0.0123	0.096	0.064	3.31E-06	0.0012	3.20E-07
Diesel <3.5 t	Conventional	1.34	0.0012	0.133	1.66	4.65E-06	0.356	2.85E-06
Diesel <3.5 t	Euro1	0.577	0.0012	0.141	1.22	4.17E-06	0.117	6.30E-07
Diesel <3.5 t	Euro2	0.577	0.0012	0.149	1.22	4.17E-06	0.117	6.30E-07
Diesel <3.5 t	Euro3	0.473	0.0012	0.094	1.03	4.17E-06	0.0783	6.30E-07
Diesel <3.5 t	Euro4	0.375	0.0012	0.035	0.831	4.17E-06	0.0409	6.30E-07
Diesel <3.5 t	Euro5	0.075	0.0019	0.035	1.18	4.17E-06	0.001	6.30E-07
Diesel <3.5 t	Euro6	0.075	0.0019	0.035	0.953	4.17E-06	0.0009	6.30E-07

Table 76 Emission factor for source category 1.A.3.biii - Road Transport: Heavy duty vehicles used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodology

Type	Technology	CO	NH ₃	NMVOC	NO _x	Pb	PM2.5	B(a)P
		g/km	g/km	g/km	g/km	g/km	g/km	g/km
Gasoline >3.5 t	Conventional	59.5	0.0019	5.25	6.6	5.84E-06	0.057	4.80E-07
Diesel <=7.5 t	Conventional	1.85	0.0029	1.07	4.7	6.47E-06	0.333	9.00E-07
Diesel <=7.5 t	HD Euro I - 91/542/EEC I	0.657	0.0029	0.193	3.37	5.43E-06	0.129	9.00E-07

Type	Technology	CO	NH ₃	NM VOC	NO _x	Pb	PM2.5	B(a)P
		g/km	g/km	g/km	g/km	g/km	g/km	g/km
Diesel <=7.5 t	HD Euro II - 91/542/EEC II	0.537	0.0029	0.123	3.49	5.22E-06	0.061	9.00E-07
Diesel <=7.5 t	HD Euro III - 2000	0.584	0.0029	0.115	2.63	5.47E-06	0.0566	9.00E-07
Diesel <=7.5 t	HD Euro IV - 2005	0.047	0.0029	0.005	1.64	5.17E-06	0.0106	9.00E-07
Diesel <=7.5 t	HD Euro V - 2008	0.047	0.011	0.005	0.933	5.17E-06	0.0106	9.00E-07
Diesel <=7.5 t	HD Euro VI	0.047	0.011	0.005	0.18	5.17E-06	0.0005	9.00E-07
Diesel 7.5 - 16 t	Conventional	2.13	0.0029	0.776	8.92	9.48E-06	0.3344	9.00E-07
Diesel 7.5 - 16 t	HD Euro I - 91/542/EEC I	1.02	0.0029	0.326	5.31	8.36E-06	0.201	9.00E-07
Diesel 7.5 - 16 t	HD Euro II - 91/542/EEC II	0.902	0.0029	0.207	5.5	8.05E-06	0.104	9.00E-07
Diesel 7.5 - 16 t	HD Euro III - 2000	0.972	0.0029	0.189	4.3	8.39E-06	0.0881	9.00E-07
Diesel 7.5 - 16 t	HD Euro IV - 2005	0.071	0.0029	0.008	2.65	7.85E-06	0.0161	9.00E-07
Diesel 7.5 - 16 t	HD Euro V - 2008	0.071	0.011	0.008	1.51	7.85E-06	0.0161	9.00E-07
Diesel 7.5 - 16 t	HD Euro VI	0.071	0.011	0.008	0.291	7.85E-06	0.0005	9.00E-07
Diesel 16 - 32 t	Conventional	1.93	0.0029	0.486	10.7	1.31E-05	0.418	9.00E-07
Diesel 16 - 32 t	HD Euro I - 91/542/EEC I	1.55	0.0029	0.449	7.52	1.14E-05	0.297	9.00E-07
Diesel 16 - 32 t	HD Euro II - 91/542/EEC II	1.38	0.0029	0.29	7.91	1.11E-05	0.155	9.00E-07
Diesel 16 - 32 t	HD Euro III - 2000	1.49	0.0029	0.278	6.27	1.13E-05	0.13	9.00E-07
Diesel 16 - 32 t	HD Euro IV - 2005	0.105	0.0029	0.01	3.83	1.06E-05	0.0239	9.00E-07
Diesel 16 - 32 t	HD Euro V - 2008	0.105	0.011	0.01	2.18	1.06E-05	0.0239	9.00E-07
Diesel 16 - 32 t	HD Euro VI	0.105	0.011	0.01	0.422	1.06E-05	0.0012	9.00E-07
Diesel >32 t	Conventional	2.25	0.0029	0.534	12.8	1.54E-05	0.491	9.00E-07
Diesel >32 t	HD Euro I - 91/542/EEC I	1.9	0.0029	0.51	9.04	1.36E-05	0.358	9.00E-07
Diesel >32 t	HD Euro II - 91/542/EEC II	1.69	0.0029	0.326	9.36	1.33E-05	0.194	9.00E-07
Diesel >32 t	HD Euro III - 2000	1.79	0.0029	0.308	7.43	1.36E-05	0.151	9.00E-07
Diesel >32 t	HD Euro IV - 2005	0.121	0.0029	0.012	4.61	1.26E-05	0.0268	9.00E-07
Diesel >32 t	HD Euro V - 2008	0.121	0.011	0.012	2.63	1.26E-05	0.0268	9.00E-07
Diesel >32 t	HD Euro VI	0.121	0.011	0.012	0.507	1.26E-05	0.0013	9.00E-07

Table 77 Emission factor for source category 1.A.3.biii - Buses used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodology

Type	EURO class	CO	NH ₃	NMVOC	NO _x	Pb	PM2.5	B(a)P
		g/km	g/km	g/km	g/km	g/km	g/km	g/km
Urban Buses Standard	Conventional	5.71	0.0029	1.99	16.5	1.90E-05	0.909	9.00E-07
Urban Buses Standard	HD Euro I - 91/542/EEC I	2.71	0.0029	0.706	10.1	1.61E-05	0.479	9.00E-07
Urban Buses Standard	HD Euro II - 91/542/EEC II	2.44	0.0029	0.463	10.7	1.55E-05	0.22	9.00E-07
+ Urban Buses Standard	HD Euro III - 2000	2.67	0.0029	0.409	9.38	1.62E-05	0.207	9.00E-07
Urban Buses Standard	HD Euro IV - 2005	0.223	0.0029	0.022	5.42	1.54E-05	0.0462	9.00E-07
Urban Buses Standard	HD Euro V - 2008	0.223	0.0029	0.022	3.09	1.54E-05	0.0462	9.00E-07
Urban Buses Standard	HD Euro VI	0.223	0.0029	0.022	0.597	1.54E-05	0.0023	9.00E-07

Table 78 Emission factor for source category 1A3biv - Road Transport: Mopeds & motorcycles used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodology

Capacity	EURO class	CO	NH ₃	NMVOC	NO _x	Pb	PM2.5	B(a)P
		g/km	g/km	g/km	g/km	g/km	g/km	g/km
<50	Conventional	14.7	0.001	8.28	0.056	0.000011	0.176	9.6E-08
<50	Mop - Euro 1	5.65	0.001	1.96	0.2	0.000011	0.0425	6.4E-08
<50	Mop - Euro 2	3.5	0.001	1.665	0.17	0.000011	0.0165	6.4E-08
<50	Mop - Euro 3	2.25	0.001	1.15	0.17	0.000011	0.011	6.4E-08
<250	Conventional	28.55	0.0019	6.015	0.146	1.08E-06	0.087	3.2E-07
<250	Mop - Euro 1	14.95	0.0019	3.45	0.2365	1.01E-06	0.039	3.2E-07
<250	Mop - Euro 2	9.185	0.0019	1.3395	0.2105	9.7E-07	0.01775	3.2E-07
<250	Mop - Euro 3	2.88	0.0019	0.6355	0.237	8.82E-07	0.00655	3.2E-07
<750	Conventional	25.7	0.0019	1.68	0.233	1.23E-06	0.014	3.2E-07
<750	Mop - Euro 1	13.8	0.0019	1.19	0.477	1.19E-06	0.014	3.2E-07
<750	Mop - Euro 2	7.17	0.0019	0.918	0.317	1.19E-06	0.0035	3.2E-07
<750	Mop - Euro 3	3.03	0.0019	0.541	0.194	1.19E-06	0.0035	3.2E-07
>750	Conventional	21.1	0.0019	2.75	0.247	1.48E-06	0.014	3.2E-07
>750	Mop - Euro 1	10.1	0.0019	1.5	0.579	1.53E-06	0.014	3.2E-07
>750	Mop - Euro 2	7.17	0.0019	0.994	0.317	1.53E-06	0.0035	3.2E-07
>750	Mop - Euro 3	3.03	0.0019	0.587	0.194	1.53E-06	0.0035	3.2E-07

4.5.1.1.2. Source-specific uncertainties and time-series consistency

Tier 2 approach upgrade has been used to calculate the emissions of the transport sector for the years 2014-2018, while the calculation of the emissions for previous years is done by use of Tier 1 method which brings trend inconsistency in this sector.

Acquired data for the fleet composition in Republic of North Macedonia is available for the years 2005-2018, but the TAEIX expert support that was required has not been provided yet to make calculations with COPERT V model for this period as well as to apply method of extrapolation for the historical years before 2005. The data need to be quality checked and controlled. Further analysis and calculations are necessary. The National Car Registry of North Macedonia database is obsolete and does not quite meet the quality standards. There are many gaps and inconsistencies.

Since the calculation method of the traffic emissions has been upgraded from Tier 1 to Tier 2 for 2014-2018, there is a difference in the emissions in the sector 1.A.3.bii and 1.A.3.biii. This discrepancy is a result of the different classification of the vehicle categories in the data gained from the National Statistical Office and the data acquired from the National Car Registry of North Macedonia. The statistical methodology of the vehicle fleet used by the two different data holders is not in compliance. Nevertheless, this does not affect the total emissions.

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_x, NMVOC and PM_{2.5} was estimated to be 20 % (rating A. cf. chapter 1.7). for SO₂ and was estimated to be 40% (rating B) and NH₃ 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 2 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.

Calculation excel sheets were developed within the Twinning project for calculations of emissions in 1.A.3bi, bii, biii and biv NFR categories by use of Tier 2 methodology for the period 2014 - 2018. EF from GB 2016 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

Corrections for Sulfur emissions from 1.A.bi were carried out.

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

Compared to the previous IIR, also POPs (benzo(a) pyrene) emissions have been calculated with Tier 2 method, as recommended in the last Stage 3 Review Report. Furthermore, PM_{2.5} and PM₁₀ have been calculated for the period 2014-2018. The emission calculation software COPERT V for 1.A.3.b Road Transport is planned to be used within the Inventory System in the following submissions. There were several trainings carried out for the inventory experts and calculations were made with the use of COPERT V model for the period 2014-2018 but the figures were available after submission of the inventory. Experts from the National emission inventory team are working to overcome this problem. Beside the cooperation with GHG team they also applied for TAEIX expert missions two years ago but due to administrative problems (change of staff responsible for carrying out procedures for TAEIX applications) the application has been approved only few months ago. Within these three missions it is planned to check calculate emissions with COPERT V model for the period 2014-2018, calculate 2005-2013 emissions and use methods for extrapolation to calculate emissions from sector transport up to 1990 in order to improve the present methodology and have consistent methodology through whole reporting period. The results of the applied COPERT V model will be used in both GHG and National air emission inventory.

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

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])

Activity Data

The number of vehicles in category PCs and TWs are taken directly from the statistical yearbooks for the period 1990-2004 [21] and Publication transport and communication for the period 2005-2013

[25] and MOI database for 2014 - 2018. The LDVs were calculated gathering subcategories (freight cars, special vehicles).

Table 79 Activity data for source category 1.A.3.v - Gasoline evaporation

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
2005	198 088	4 139	1 484
2006	186 812	3 804	3 132
2007	207 218	3 962	4 396
2008	203 234	4 212	8 319
2009	216 380	4 674	8 684
2010	227 184	4 663	7 457
2011	217 016	4 363	7 510
2012	199 329	4 096	7 965
2013	213 808	4 311	7 681
2014	215 175	4 128	8 180
2015	209 231	7 069	10 077
2016	202 608	5 859	11 810
2017	197 787	5 751	14 193
2018	194 475	5 649	13 395

Emission factors

For the calculation of emissions for emission parameters from 1990-2018, 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 taken into account. 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 80 below.

Table 80 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 check of the applied emission factors was done for this category bearing in mind the latest EMEP Guidebook. However, this is planned before next submission.

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 as a result of the wear of surfaces — and not those resulting from the re-suspension of previously deposited material.

4.5.1.3.1. Methodological issues

In order to calculate emissions of TSP, PM₁₀ or PM_{2.5} 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.

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 2003-2013 [25], and from the chapter Transport from the Statistical yearbook for the period 1990-2002 [21], and for the latest years 2014 – 2018, data from the MOI database were used. The number of Heavy-duty (HDV) vehicles have 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 81 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

Year	2W x Mileage [km]	PCs x Mileage [km]	LDTs x Mileage [km]	HDVs x Mileage [km]
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
2005	5 169 000	1 800 211 000	346 780 000	675 610 000
2006	10 323 000	1 724 960 000	319 505 000	706 385 000
2007	14 118 000	1 915 348 000	327 040 000	821 205 000
2008	25 875 000	1 874 564 000	329 716 982	813 077 500
2009	27 282 000	2 009 790 000	367 222 156	896 444 016
2010	23 277 000	2 205 249 000	381 681 101	946 292 282
2011	25 119 000	2 223 648 000	370 832 622	936 272 203
2012	25 416 000	2 141 113 000	352 826 216	892 923 288
2013	24 270 000	2 458 887 000	402 735 024	1 028 991 603
2014	25 887 000	2 633 300 000	431 162 836	1 107 184 651
2015	30 231 000	2 727 403 000	795 305 000	567 040 000
2016	35 430 000	2 806 809 000	643 330 000	873 605 000
2017	42 579 000	2 870 567 000	677 195 000	719 510 000
2018	401 850 000	2 949 227 000	698 655 000	725 260 000

Emission factors

Tables 82 and 83 summarizes the emission factors used for the calculation of particulate emissions in the complete reporting period.

Table 82 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 ⁻¹ vehicle ⁻¹	GB 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 ⁻¹ vehicle ⁻¹	GB 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 ⁻¹ vehicle ⁻¹	GB 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 ⁻¹ vehicle ⁻¹	GB 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 ⁻¹ vehicle ⁻¹	GB 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 ⁻¹ vehicle ⁻¹	GB 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 ⁻¹ vehicle ⁻¹	GB 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	Light duty trucks	0.0216	g km-1 vehicle-1	GB 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-1 vehicle-1	GB 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-1 vehicle-1	GB 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	0.0590	g km-1 vehicle-1	GB 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 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 83 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 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM10	Two-wheelers	0.003	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM2.5	Two-wheelers	0.0016	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
TSP	Passenger cars	0.015	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM10	Passenger cars	0.0075	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM2.5	Passenger cars	0.0041	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
TSP	Light duty trucks	0.015	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM10	Light duty trucks	0.0075	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM2.5	Light duty trucks	0.0041	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
TSP	Heavy duty vehicles	0.076	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM10	Heavy duty vehicles	0.038	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 pg 14
PM2.5	Heavy duty vehicles	0.0205	g km-1 vehicle-1	GB 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-2 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

No check of the applied emission factors was done for these categories bearing in mind the latest EMEP Guidebook. However, this is planned before next submission.

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 are divided into "international LTOs" (regular + charter) and "other operations". "Other operations" have a share of 9% of total LTOs in 2016 and it is assumed that private jets running internationally on kerosene operate these flights.

Activity Data

The Number of LTO were taken from the publication Transport and communications for the period 2005-2016[25]. For the previous years, the surrogate method has been used. The estimates of the activity data were related to the passenger numbers. MEPP has send official request to the TAV airport in Skopje and the Civil aviation agency (CAA) of Republic of North Macedonia regarding jumps in 1999 and 2000 on LTO, but did not receive answer.

Table 84 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	Total fuel(t)
1990	11 986	2000	23 168	2010	12 721
1991	11 297	2001	11 664	2011	11 873
1992	10 539	2002	12 767	2012	11 284
1993	14 581	2003	12 170	2013	12 380
1994	14 351	2004	11 986	2014	13 968
1995	14 305	2005	13 204	2015	15 585
1996	12 307	2006	13 509	2016	15 719
1997	11 067	2007	14 174	2017	16 796
1998	13 249	2008	14 323	2018	18 295
1999	24 156	2009	12 800		

Emission factors

The calculation of emissions for emission parameters from 1990-2018 were used emission factors taken from GB 2013. The used emission factors are presented in Table 85.

Table 85 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 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 2011-2018 [21]. 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 [25], while data after 2015 are taken from the MAKSTAT database[26].

Table 86 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	2000	28 266	2010	6 867
1991	19 461	2001	25 104	2011	3 652
1992	18 156	2002	46 844	2012	8 112
1993	25 118	2003	15 973	2013	10 144
1994	24 722	2004	8 882	2014	11 946
1995	24 643	2005	6 433	2015	13 371
1996	21 202	2006	4 670	2016	15 108
1997	19 066	2007	6 861	2017	19 810
1998	22 824	2008	6 121	2018	22 429
1999	41 612	2009	2 772		

Emission factors

Emission factors taken from GB 2013 (Cruise (kg/t) — average fleet (B767)). These emission factors are given in Table 87 below.

Table 87 Emission factors for 1.A.3.ai(ii) - International aviation cruise (civil)

Pollutant	Value	Unit	References
NO _x	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))
SO _x	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))
PM _{2.5}	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.a.ii(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[23]. 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 88 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 88 Activity data for source category 1.A.3.a.ii(ii) - Domestic aviation cruise (civil)

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

Emission factors

Emission factors were taken from GB 2013 for all reporting period. These emission factors are given in Table 89 below.

Table 89 Emission factors for NFR - 1.A.3.aii (ii)

Pollutant	Value	Unit	References
NO _x	4	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
CO	1200	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
NM VOC	19	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
TSP	0	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
PM ₁₀	0	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
PM _{2.5}	0	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
SO ₂	1	kg/t fuel	GB 2013 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_x, NMVOC and PM_{2.5} was estimated to be 40 % (rating B. cf. chapter 1.7). for SO₂ 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 2015-2018 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

Correction of the labelling of the NFR codes for international vs domestic aviation that has been used in the spread sheets and in the IIR was carried out due to remarks given by ERT. Minor recalculations were done due to revised activity data for kerosene and aviation gasoline consumption in 1A3ai(i).

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

Correction of data that contains jumps and deeps is planned to be implemented in future reporting rounds.

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].

Activity Data

The activity data for the diesel oil consumption for the period 1990, 1999-2018 was taken from the chapter Energy balance from the Statistical yearbooks for the related period [21]. 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 90 Activity data for diesel fuel consumption in source category 1.A.3.c - Railways

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1990	7300	2000	4212	2010	3580
1991	5932	2001	3373	2011	3734
1992	3233	2002	2328	2012	3169
1993	1958	2003	2000	2013	2616
1994	1987	2004	2138	2014	2616
1995	1928	2005	2607	2015	1877
1996	3559	2006	3597	2016	2008
1997	4182	2007	3736	2017	2035
1998	4449	2008	3701	2018	2193
1999	3957	2009	3634		

Emission factors

The calculation of emissions for emission parameters from 1990-2018 were used emission factors taken from GB 2019. These emission factors are given in Table 91 below.

Table 91 Emission factors for source category 1.A.3 - Railways

Pollutant	Value	Unit	References
NOx	52.4	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
CO	10.7	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
NM VOC	4.65	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
NH ₃	0.007	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
TSP	1.52	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8

Pollutant	Value	Unit	References
PM10	1.44	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
PM2.5	1.37	kg/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Cd	0.01	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Cr	0.05	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Cu	1.7	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Ni	0.07	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Se	0.01	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Zn	1	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Benzo(a)pyrene	0.03	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8
Benzo(b)fluoranthene	0.05	g/t fuel	GB 2019. 1.A.3.c Railways. Table 3-1. pg. 8

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 NO_x, NMVOC and PM_{2.5} was estimated to be 40% (rating B. cf. chapter 1.7), for NH₃ 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

As it was recommended by ERT, SO_x emissions from diesel were calculated using the national Sulfur content for different periods presented in Table 94. Emissions for 2017 were recalculated due to final figures for consumption from energy balance.

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

National inventory team will require additional detail data from Macedonian railways in order to conduct Tier 2 methodology in the future.

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 the lake tourist boat transport is made on Ohrid lake with four boats starting from 2011. Emissions from fuel consumption are calculated and presented below.

There is no international/maritime navigation (bunkers fuels) – so the source category International maritime bunkers is 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 92 Activity data for diesel consumption for source category 1.A.3.d.ii - National navigation - using diesel fuel oil 1990 -2018

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

Emission factors

For the calculation of emissions for emission parameters from 1990-2018 the used emission factors were taken from GB 2019 [16] These emission factors are given in Table 93 below.

Table 93 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
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

Pollutant	Value	Unit	References
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 94 National content of sulfur in diesel used for calculation of SO_x 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
Calculations			
	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

Data on the content of Sulfur were received from 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 sector.

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

The table on the content of sulfur in diesel was included in the IIR as it was asked by the ERT in the previous stage 3 review. The inventory team will update the EF factors from 2019 EMEP Guidebook for next submission.

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

Emissions from fuels used in the Military has 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.A.3biii 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 2015-2018 are presented in the following table.

Table 95 Activity data for liquid fuel and aviation gasoline consumption for source category 1.A.5.b – Other, Mobile for 2015-2018

Type of fuel [TJ]	2015	2016	2017	2018
Liquified fuels	672	873	715	696
Aviation gasoline	22	166	364	284

Diesel fuel consumption has been reported in L and converted in tons by use of diesel density of 0.837kg/m³.

Emission factors

See table 70 and 89.

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

Emissions for 2017 were recalculated due to available activity data.

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, taken into account 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

Info sheets were added in the excel calculation files. Data on fuel consumption were linked with the activity data from excel file - energy balance. Furthermore, trend graphs on fuel consumption were created in order to locate jumps and deeps in the trend period.

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

Recalculations of the emissions were carried out due to the use of final energy consumption data for 2017 and updated EF from 2019 EMEP Guidebook. According to the recommendations given in previous stage 3 review emissions in the category 1.A.b.ii were calculated for the whole time series, and updated EF from GB 2019 were used. Additionally, due to available activity data in MAKSTAT database emissions for the category 1.A.4.a.ii were calculated for the period 2011-2018, while for the previous years were noted as IE.

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

Use of higher Tier level when detail activity data for the type of stoves are available from surveys or State statistical offices.

4.6.6. 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.

4.6.6.1. Methodological Issues

Activity data

Activity data for this sector has been taken from the Statistical yearbooks – chapter energy balance for the period 1990-2018. For the period 1990-1998, activity data were taken from the GHGs inventory.

Table 96 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	NO	144	NO	387
1991	NO	144	NO	NO
1992	NO	243	NO	NO
1993	NO	152	NO	NO
1994	NO	152	NO	NO
1995	NO	152	NO	NO
1996	NO	152	NO	NO
1997	NO	152	NO	NO
1998	712	152	NO	2 640
1999	712	607	NO	5 649
2000	848	58	NO	1 702
2001	NO	33	NO	1 202
2002	NO	196	NO	15 928
2003	311	246	NO	5 812
2004	325	656	NO	4 180
2005	209	203	22	5 141
2006	436	63	26	3 016
2007	334	223	30	3 811
2008	562	53	29	3 338
2009	592	53	33	3 650
2010	562	53	79	3 189
2011	253	47	83	2 144
2012	448	88	91	2 501
2013	196	62	109	2 476
2014	279	12	198	2 275
2015	269	24	222	1 896
2016	273	27	235	2 022

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
2017	190	42	265	1 953
2018	184	27	248	1 662

Emission factors

Emission factors are taken from GB 2019. Emission factors for different type of fuels are presented in tables 96-99.

Table 97 Emission factors for biomass for source category 1.A.4.ai - Commercial/Institutional – stationary combustion

Pollutant	Value	Unit	References
NOx	91	g/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
NMVOC	300	g/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
SOx	11	g/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PM2.5	160	g/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PM10	163	g/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
TSP	170	g/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
BC	28	% PM2.5	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
CO	570	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Pb	27	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Cd	13	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Hg	0.56	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
As	0.19	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Cr	23	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Cu	6	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Ni	2	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Se	0.5	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
Zn	512	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PCDD/ PCDF	100	ng I-TEQ/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
benzo(a) pyren	10	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
benzo(b) fluoranthene	16	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
benzo(k) fluoranthene	5	mg/GJ	GB 2019 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 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
HCB	5	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39
PCB	0.06	mg/GJ	GB 2019 Table 3-10 emission factor for source category 1.A.4.a.i. page 39

Table 98 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 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
NMVOC	88.8	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
SOx	900	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PM2.5	108	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PM10	117	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
BC	6.4	%PM2.5	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
TSP	124	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
CO	931	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Pb	134	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Cd	1.8	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Hg	7.9	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
As	4	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Cr	13.5	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Cu	17.5	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Ni	13	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Se	1.8	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
Zn	200	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PCB	170	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
PCDD/PCDF	203	ng I-TEQ/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
benzo(a) pyren	45.5	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
benzo(b) fluoranthene	58.9	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
benzo(k) fluoranthene	23.7	mg/GJ	GB 2019 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 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36
HCB	0.62	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 36

Table 99 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 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
NMVOC	23	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
SOx	0.67	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
PM2.5	0.78	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
PM10	0.78	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
TSP	0.78	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
BC	4	% PM2.5	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
CO	29	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Pb	0.011	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Cd	0.00009	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37

Pollutant	Value	Unit	References
Hg	0.1	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
As	0.1	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Cr	0.013	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Cu	0.0026	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Ni	0.013	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Se	0.058	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
Zn	0.73	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
PCDD/ PCDF	0.52	ng I-TEQ/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
benzo(a) pyren	0.72	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
benzo(b) fluoranthene	2.9	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37
benzo(k) fluoranthene	1.1	µg/GJ	GB 2019 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 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 37

Table 100 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 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
NM VOC	20	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
SOx	94	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PM2.5	18	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PM10	21	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
TSP	21	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
BC	56	%PM2.5	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
CO	93	g/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Pb	8	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Cd	0.15	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Hg	0.1	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
As	0.5	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Cr	10	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Cu	3	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Ni	125	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Se	0.1	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
Zn	18	mg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PCDD/ PCDF	6	ng I-TEQ/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
benzo(a) pyren	1.9	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
benzo(b) fluoranthene	15	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38

Pollutant	Value	Unit	References
benzo(k) fluoranthene	1.7	µg/GJ	GB 2019 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 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
HCB	0.22	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38
PCB	0.13	µg/GJ	GB 2019 Table 3-7 emission factor for source category 1.A.4.a.i. page 38

4.6.6.2. 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 SO₂ was estimated to be 20% (rating A. cf. chapter 1.7). for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5}.(125% rating C).

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 2017 emissions within the category 1.A.4.ai due to use of final consumption data for this year. Updated EF from EMEP Guidebook were used.

4.6.6.5. 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.

4.6.7. Commercial/Institutional – stationary combustion – NFR 1.A.4.a.ii

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 2011-2018. For the previous years the emissions were noted as IE in 1.A.4.ai, as it was recommended by previous stage 3 review.

4.6.7.1. Methodological Issues

Activity data

Activity data for this sector has been taken from the MAKSTAT database, activity data were available only for the period 2011-2018.

Table 101 Activity data for the source category 1.A.4.a.ii Commercial/Institutional: Mobile

Year	Diesel [TJ]
1990	IE
1991	IE
1992	IE
1993	IE
1994	IE
1995	IE
1996	IE

Year	Diesel [TJ]
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	31
2012	63
2013	29
2014	29
2015	30
2016	30
2017	32
2018	32

Emission factors

Table 102 Emission factors for liquid fuels for source category 1.A.4.a.ii - Commercial/Institutional – mobile

Pollutant	Value	Unit	References
NOx	32629	g/t	GB 2019 Table 3-1 emission factor for source category, 1.A.4.a.ii. page 23
NMVOC	3377	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
NH3	8	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
PM2.5	2104	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
PM10	2104	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
TSP	2104	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
BC	1306	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
CO	10774	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
Cd	0.01	mg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
Cr	0.05	mg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
Cu	1.7	mg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
Ni	0.07	mg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23

Pollutant	Value	Unit	References
Se	0.01	mg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
Zn	1	mg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
benzo(a) pyren	30	µg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23
benzo(b) fluoranthene	60	µg/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.a.ii. page 23

4.6.7.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was calculated for this sector.

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

The NFR sector was introduced for the first time, therefore no recalculations were done.

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

The national experts will try by use of gap filling method to calculate emissions for the period before 2011, for which there are no available activity data.

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

A 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 103 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	31 243 (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
Heating oil	4 822 (m3)	3 633
Derived heat	317 082 (MWh)	46 590

Type of energy	Consumption	Number of households using the type of energy
Wood mass consumed for other purposes (for food in winter. producing brandy. etc.)	149 366	N/A

4.6.8.1. 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 2014 were taken from MAKSTAT database. These number 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.

Table 104 Activity data for source category 1.A.4.bi - Residential: Stationary

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
1990	15 814	186	NO	397
1991	13 688	333	NO	863
1992	14 961	323	NO	921
1993	16 774	313	NO	980
1994	16 024	304	NO	1 038
1995	16 024	294	NO	1 097
1996	16 024	284	NO	1 156
1997	16 024	275	NO	1 214
1998	15 273	213	NO	1 225
1999	16 028	276	NO	1 316
2000	19 040	235	NO	1 394
2001	14 811	177	NO	1 435
2002	14 654	227	NO	1 513
2003	16 315	228	NO	1 577
2004	16 271	248	NO	1 657
2005	14 629	249	NO	1 700
2006	15 688	305	NO	1 775
2007	13 280	228	NO	1 907
2008	16 335	128	NO	1 828
2009	18 250	85	NO	1 912

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
2010	18 759	95	NO	1 872
2011	17 953	44	NO	1 828
2012	11 380	47	NO	1 445
2013	9 115	55	0.39	535
2014	9 835	37	2.60	431
2015	9 168	33	2.60	449
2016	7 584	34	3.83	476
2017	9 218	34	6.27	497
2018	7 743	27	7.73	498

Emission factors

For biomass, the default emission factors were updated and taken for this submission from Guidebook 2019. Emission factors for different type of fuels are presented in the four following tables.

Table 105 Emission factors for biomass for source category 1.A.4.bi - Residential: Stationary

Pollutant	Value	Unit	References
NO _x	50	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
NM VOC	600	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
SO _x	11	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
NH ₃	70	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
PM _{2.5}	740	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
PM ₁₀	760	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
TSP	800	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
BC	10	%PM _{2.5}	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
CO	4000	g/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Pb	27	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Cd	13	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Hg	0.56	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
As	0.19	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Cr	23	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Cu	6	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Ni	2	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Se	0.5	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
Zn	512	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
PCB	0.06	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
PCDD/PCDF	800	ng I-TEQ/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
benzo(a) pyren	121	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35
benzo(b) fluoranthene	111	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.bi. page 35

Pollutant	Value	Unit	References
benzo(k) fluoranthene	42	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.b.i. page 35
Indeno (1.2.3-cd) pyren	71	mg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.b.i. page 35
HCB	5	µg/GJ	GB 2019 Table 3-6 emission factor for source category 1.A.4.b.i. page 35

Table 106 Emission factors for coal for source category 1.A.4.bi - Residential: Stationary

Pollutant	Value	Unit	References
NOx	110	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
NMVOC	484	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
SOx	900	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
NH ₃	0.3		GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
PM2.5	398	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
BC	6.4	% PM2.5	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
PM10	404	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
TSP	444	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
CO	4600	g/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
BC	6.4	% of PM2.5	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Pb	130	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Cd	1.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Hg	5.1	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
As	2.5	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Cr	11.2	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Cu	22.3	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Ni	12.7	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Se	1	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Zn	220	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
PCB	170	µg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
PCDD/PCDF	800	ng I-TEQ/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
benzo(a) pyren	230	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
benzo(b) fluoranthene	330	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
benzo(k) fluoranthene	130	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
Indeno (1.2.3-cd) pyren	110	mg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32
HCB	0.62	µg/GJ	GB 2019 Table 3-3 emission factor for source category 1.A.4.b.i. page 32

Table 107 Emission factors for natural gas for source category 1.A.4.bi - Residential: Stationary

Pollutant	Value	Unit	References
NOx	51	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i. page 33
NMVOC	1.9	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i. page 33
SOx	0.3	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i. page 33

Pollutant	Value	Unit	References
PM2.5	1.2	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
BC	5.4	% PM2.5	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
PM10	1.2	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
TSP	1.2	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
CO	26	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Pb	0.0015	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Cd	0.00025	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Hg	0.1	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
As	0.12	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Cr	0.00076	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Cu	0.000076	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Ni	0.00051	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Se	0.011	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
Zn	0.0015	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
PCDD/ PCDF	1.5	ng I-TEQ/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
benzo(a) pyren	0.56	µg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
benzo(b) fluoranthene	0.84	µg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33
benzo(k) fluoranthene	0.84	µg/GJ	GB 2019 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 2019 Table 3-4 emission factor for source category 1.A.4.b.i.page 33

Table 108 Emission factors for liquid fuels for source category 1.A.4.bi - Residential: Stationary

Pollutant	Value	Unit	References
NOx	51	g/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
NMVOC	0.69	g/GJ	GB 2009 Table 3-5 emission factor for source category 1.A.4.b.i. page 23
SOx	140	g/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
PM2.5	3.7	g/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
BC	8.5	% PM2.5	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
PM10	3.7	g/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
TSP	6	g/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
CO	57	g/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Pb	15.5	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Cd	1.5	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Hg	0.03	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
As	0.9	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Cr	15.5	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Cu	7.9	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Ni	240	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Zn	8.5	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34

Pollutant	Value	Unit	References
PCDD/PCDF	10	ng I-TEQ/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
benzo(a) pyren	22	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
benzo(b) fluoranthene	25.7	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
benzo(k) fluoranthene	12.5	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34
Indeno (1.2.3-cd) pyren	14.8	mg/GJ	GB 2019 Table 3-5 emission factor for source category 1.A.4.b.i. page 34

4.6.8.2. 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 SO₂ was estimated to be 20% (rating A. cf. chapter 1.7), for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} and NH₃ (125% rating C).

4.6.8.3. 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.

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

Recalculations were done for 2017 emissions due to use of final consumption data for this year, as well as use of updated emissions factors and fuels from 2019 EMEP Guidebook. Additionally, activity data for the period 2014-2016 for gas consumption were updated with recalculated data from the MAKSTAT database. With regards to biomass activity data, there are available data on different biomass fuels as well as separate EF that were used to recalculate activity data for biomass for the period 2012-2016.

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

The inventory team will also recalculate activity data for biomass consumption for the period 2005-2011 for the next submission round.

Furthermore, since this NFR is key sector for many pollutants, especially PM₁₀ and PM_{2.5} which are critical pollutants in our country it is planned to use Tier 2 in the future when data from National census which is expected to be conducted in 2021, or other surveys, for which discussions with SSO already started.

4.6.9. 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 SO₂, NO_x, CO₂, PM, CO and non-methane volatile organic compounds (NMVOCs). The emissions of CO₂ and SO₂ are predominantly fuel-based and independent of engine technology/type of equipment.

4.6.9.1. Methodological Issues

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

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

Where:

Epollutant = the emission of the specified pollutant.

FCfuel type = the fuel consumption for each fuel (diesel. LPG. four-stroke gasoline and two-stroke gasoline) for the source category

EFpollutant = the emission factor for this pollutant for each fuel type.

Activity data

Activity data for this source have been taken from the NFR tables reported in 2013. Regarding the source of activity data, in the IIR 2010 it was emphasized that all activity data were taken from the energy balances. Considering that the energy balances for the period 1990-2000 contain only data on total petroleum products, an expert judgment has been used for determination of gasoline consumed in this category.

Table 109 Activity data for source category 1.A.4.bii - Residential: Household and gardening (mobile)

Year	Gasoline consumption [TJ]	Year	Gasoline consumption [TJ]	Year	Gasoline consumption [TJ]
1990	48.62	2000	34.4	2010	34
1991	29.9	2001	34.4	2011	34
1992	56.1	2002	34.4	2012	34
1993	31.8	2003	34	2013	34
1994	31.8	2004	34	2014	34
1995	38.8	2005	34	2015	34
1996	38.4	2006	34	2016	34
1997	38.0	2007	34	2017	34
1998	38.2	2008	34	2018	34
1999	35.2	2009	34		

Emission factors

Emission factors are taken from EB 2009. For the HM default emissions, factors from the guidebook have been used. With regards to other pollutants, EF are calculated as averages between EF for gasoline: two strike and gasoline: four strike engines. Emission factors used in calculation of emissions coming from this sector are presented in table 110.

Table 110 Emission factors for source category 1.A.4.bii - Residential: Household and gardening (mobile)

Pollutant	Value	Unit	References
NOx	4941	g/ton fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
NMVOc	129 899.5	g/ton fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
SOx	40.0	ppm	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
NH3	3.5	g/ton fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
TSP	1959.5	g/ton fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19

Pollutant	Value	Unit	References
CO	695 580.5	g/ton fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Pb	0.00013	kg/l fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Cd	0.01	mg/kg fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Cr	0.05	mg/kg fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Cu	1.70	mg/kg fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Ni	0.07	mg/kg fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Se	0.01	mg/kg fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19
Zn	1	mg/kg fuel	GB 2009 1A4bii Table 3-1 Tier 1 emission factors for off-road machinery. pg.19

4.6.9.2. Source-specific uncertainties and time-series consistency

See chapter 3.6.7.1.

4.6.9.3. Source-specific QA/QC and verification

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

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

During the 2016 stage 3 review, the ERT pointed out that emissions from NFR 1.A.4.b.ii are currently estimated only for the period 1991-2000. The ERT recognized the challenge faced by the Party, and the difficulty to derive a full time series of emissions due to insufficient information available from the earlier inventories. During the review, the ERT provided suggestions on how to proceed (use of emissions calculated in 2000 for the upcoming years or use household number as surrogate data) to provide emission. We have agreed to use the suggestion with surrogate data, however due to the lack of reliable households' data and time constraints, we have kept same emissions from 2000 for the period 2001-2018.

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

The calculation of emissions in this category will be performed with the use of households' numbers as surrogate data for future submissions, when household data are available in future submissions.

4.6.10. 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.

4.6.10.1. Methodological Issues

Activity data

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

Table 111 Activity data for source category 1.A.4.ci - Agriculture/Forestry/Fishing: Stationary

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
1990	NO	32.78	NO	1302
1991	NO	33.41	NO	1545
1992	NO	33.08	NO	1322

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
1993	NO	33.31	NO	944
1994	NO	33.34	NO	890
1995	NO	33.57	NO	985
1996	NO	33.52	NO	1125
1997	NO	33.67	NO	875
1998	NO	0.02	NO	829
1999	NO	0.06	NO	959
2000	NO	1.90	NO	1261
2001	NO	0.37	NO	998
2002	NO	0.01	NO	571
2003	14.07	1.36	NO	457
2004	18.07	1.84	NO	1508
2005	22.03	0.80	NO	991
2006	20.39	0.25	NO	832
2007	19.06	0.25	NO	542
2008	27.56	0.59	NO	569
2009	41.20	0.11	NO	413
2010	42.09	0.11	NO	752
2011	49.10	0.11	NO	652
2012	51.47	0.08	32.64	622
2013	86.92	36.31	48.87	526
2014	77.82	33.58	NO	508
2015	56.68	35.57	NO	251
2016	51.22	32.55	NO	248
2017	55.94	25.77	NO	207
2018	57.62	21.76	NO	149

Emission factors

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

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 SO₂ was estimated to be 20% (rating A. cf. chapter 1.7). for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} and NH₃ (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 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.

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

Recalculations were performed for some pollutants due to use of EF from 2019 EMEP Guidebook. Furthermore, recalculation of activity data from MAKSTAT database were updated for biomass for 2016 and activity data for final consumption instead of preliminary consumption were used.

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 1A4cii

4.6.11.1. Methodological Issues

Activity data

The activity data for the period have been taken from the energy balance within the Statistical yearbooks for the reporting period. Regarding the missing activity data, the number of off-road vehicles used in agriculture sector (taken from the chapter agriculture in the statistical yearbook) has been used as surrogate data for estimation of the fuel consumption.

Table 112 Activity data for source category 1.A.4.cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

Year	Diesel [TJ]	LPG [TJ]	Gasoline[TJ]
1990	9558	NO	2441
1991	12 917	NO	1326
1992	11 276	NO	909
1993	7651	NO	1046
1994	7364	NO	842
1995	8305	NO	772
1996	9482	NO	884
1997	6932	NO	1130
1998	7346	NO	294
1999	8149	NO	692
2000	11 598	NO	985
2001	9574	NO	813
2002	5325	NO	452
2003	4260	NO	362
2004	14 066	NO	1195
2005	1865	NO	393
2006	711	NO	620
2007	964	NO	339
2008	140	NO	341
2009	610	NO	336
2010	540	NO	351
2011	564	NO	394

Year	Diesel [TJ]	LPG [TJ]	Gasoline[TJ]
2012	3762	NO	379
2013	5710	NO	368
2014	6007	NO	390
2015	6223	NO	390
2016	6535	NO	397
2017	6537	NO	395
2018	6561	NO	395

Emission factors

Emission factors for calculation of emissions in this sector have been taken from the GB 2019 and are presented in the following table.

Table 113 Emission for source category 1.A.4.cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery for diesel

Pollutant	Value	Unit	References
NOx	34 457	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
NMVOC	3542	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
NH3	8	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
PM2.5	1913	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
PM10	1913	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
TSP	1913	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
CO	11 469	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
Cd	0.01	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
Cr	0.05	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
Cu	1.70	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
Ni	0.07	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
Zn	1	mg/GJ	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
benzo(a) pyren	30	µg/GJ	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23
benzo(b) fluoranthene	50	µg/GJ	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 22-23

Table 114 Emission factors for LPG source category 1.A.4.cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

Pollutant	Value	Unit	References
NOx	28 571	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 23
NMVOC	6720	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 23
PM2.5	225	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 23
PM10	225	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 23
TSP	225	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 23
CO	4823	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 23

Table 115 Emission factors for gasoline for source category 1.A.4.cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

Pollutant	Value	Unit	References
NOx	7117	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
NMVOC	18 893	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
PM2.5	157	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
PM10	157	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
TSP	157	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
CO	770 368	g/t	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
Cd	0.01	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
Cr	0.05	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
Cu	1.70	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
Ni	0.07	mg/kg	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
Zn	1	mg/GJ	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
benzo(a) pyren	40	µg/GJ	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24
benzo(b) fluoranthene	40	µg/GJ	GB 2019 Table 3-1 emission factor for source category 1.A.4.c.ii-Agriculture. page 24

4.6.11.2. 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 SO₂ was estimated to be 20% (rating A. cf. chapter 1.7), for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} and NH₃ (125% rating C).

4.6.11.3. 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.

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

Recalculations were performed for some pollutants due to use of EF from 2019 EMEP Guidebook. Furthermore, recalculation of activity data from MAKSTAT database were updated for diesel for the years 2007, 2015-2017 and for gasoline for 2015. Other available data for this category was checked, but the figures remained unchanged.

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

No planned improvements.

4.6.12. Agriculture/Forestry/Fishing: Off-road vehicles and other machinery – NFR 1.A.4.ciii

As there is no commercial fishing industry in North Macedonia, emissions from 1.A.4.ciii (national fishing) are not occurring (NO). It is assumed that the fuel consumption of the few private working boats used for fishing are included in 1.A.3.d domestic navigation.

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 116 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]	Year	Coal mined[Mg]
1990	6 643 409	2000	7 513 998	2010	6 583 074
1991	6 978 171	2001	8 142 082	2011	7 902 084
1992	6 472 920	2002	7 571 202	2012	7 309 546
1993	6 917 774	2003	7 271 202	2013	6 633 560
1994	6 859 762	2004	7 296 136	2014	6 681 752
1995	7 249 237	2005	6 882 862	2015	5 927 749
1996	7 145 667	2006	6 653 474	2016	5 101 758
1997	7 442 876	2007	6 569 220	2017	5 056 918
1998	8 144 653	2008	7 669 103	2018	4 994 843
1999	7 277 623	2009	7 395 915		

Emission factors

Tier 2 emission factors has been used in the calculations starting from 2015 due to the fact that all coal mines are categorized as open mines.

Table 117 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 2019 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10

Pollutant	Value	Unit	References
PM10	0.039	kg/Mg	GB 2019 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	0.06	kg/Mg	GB 2019 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 2019 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_x was estimated to be 20% (rating A. cf. chapter 1.7) and 200% for PM_{2.5}. (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. The vast majority of emissions occur due to the storage and handling of gasoline, as a consequence 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:

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

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 118 Activity data for source category 1.B.2.aiv - Fugitive emissions oil: Refining/storage

Year	Crude oil input [Mg]	Year	Crude oil input [Mg]	Year	Crude oil input [Mg]
1990	1 216 491	2000	1 043 104	2010	853 000
1991	964 033	2001	1 012 872	2011	705 144
1992	566 701	2002	648 137	2012	259 606

Year	Crude oil input [Mg]	Year	Crude oil input [Mg]	Year	Crude oil input [Mg]
1993	1 018 201	2003	78 749	2013	59 676
1994	143 148	2004	975 262	2014	7 274
1995	119 437	2005	946 747	2015	NO
1996	696 341	2006	1 067 096	2016	NO
1997	379 759	2007	1 050 007	2017	NO
1998	754 775	2008	1 061 736	2018	NO
1999	765 412	2009	972 532		

Emission factors

Emission factors for emission estimations in this sector are presented in the following table and are directly taken from GB 2019.

Table 119 Emission factors for source category 1.B.2.a.iv - Fugitive emissions oil: Refining/storage

Pollutant	Value	Unit	References
NO _x	0.24	kg/Mg crude oil input	GB 2019 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 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
SO _x	0.62	kg/Mg crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
NH ₃	0.0011	kg/Mg crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
PM _{2.5}	0.0043	kg/Mg crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
PM ₁₀	0.0099	kg/Mg crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
TSP	0.016	kg/Mg crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
CO	0.09	kg/Mg crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Pb	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Cd	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Hg	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
As	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Cr	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Cu	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Ni	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
Se	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14

Pollutant	Value	Unit	References
Zn	0.0051	g/MG crude oil input	GB 2019 Table 3-1 emission factor for source category 1.B.2.a.iv page 14
PCDD/PCDF	0.0057	µg/Mg crude oil input	GB 2019 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_x was estimated to be 20% (rating A. cf. chapter 1.7). and 40% for NO_x and NH₃ (rating B). and 200% for EF uncertainty for PM_{2.5} (rating D).

4.7.2.3. Source-specific QA/QC and verification

Crosschecking of data reported by the operator and data reported in Energy balance is carried out.

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.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 taken into account 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 Industry chapter 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 120 Activity data for source category 1.B.2.a.v - Distribution of oil products

Year	Distributed oil (Mg)	Year	Distributed oil (Mg)	Year	Distributed oil (Mg)
1990	592 133	2000	394 487	2010	516 450

Year	Distributed oil (Mg)	Year	Distributed oil (Mg)	Year	Distributed oil (Mg)
1991	457 295	2001	959 035	2011	566 686
1992	278 185	2002	178 107	2012	572 365
1993	597 143	2003	338 459	2013	626 447
1994	117 255	2004	383 553	2014	598 267
1995	828 450	2005	402 385	2015	675 630
1996	334 711	2006	409 568	2016	745 722
1997	459 252	2007	454 633	2017	858 093
1998	484 508	2008	456 165	2018	872 279
1999	514 251	2009	447 263		

The emission factor from GB 2019 has been used for calculations.

Table 121 Emission factors for source category 1.B.2.a.v - Distribution of oil products for NMVOC

Pollutant	Value	Unit	References
NMVOC	2	kg/Mg oil	GB 2019 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 3.7.2.1.

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

No recalculations were performed in this category.

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

No planned improvements in this category.

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 122 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	2000	188	2010	165
1991	186	2001	201	2011	140
1992	109	2002	129	2012	52
1993	196	2003	156	2013	12
1994	28	2004	201	2014	1
1995	23	2005	188	2015	NO
1996	134	2006	212	2016	NO
1997	73	2007	209	2017	NO
1998	146	2008	211	2018	NO
1999	148	2009	193		

Emission factors

Emission factors are taken from the IIR 2010 expressed in TJ.

Table 123 Emission factors for source category 1B2c Venting and flaring

Pollutant	Value	Unit	References
NO _x	100	g/GJ refinery feed	IIR 2010 Table 72 page 74
NM VOC	5	g/GJ refinery feed	IIR 2010 Table 72 page 74
SO _x	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 NO_x (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.

4.7.5. Other fugitive emissions from energy production – 1.B.2.d

Emissions for NH₃, Hg and As were calculated for the period 2005-2018, 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 m³ 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 *10⁻³ GWh.

Table 124 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	2000	181 751	2010	141 326
1991	NE	2001	269 512	2011	142 551
1992	NE	2002	151 114	2012	122 982
1993	NE	2003	153 373	2013	98 741
1994	NE	2004	136 983	2014	84 884
1995	NE	2005	115 561	2015	78 217
1996	NE	2006	116 846	2016	75 999
1997	NE	2007	124 244	2017	71 177
1998	217 375	2008	115 379	2018	69 589
1999	178 608	2009	141 326		

Emission factors

Emission factors are taken from the GB 2019, expressed in MWh electricity produced.

Table 125 Emission factors for source category 1.B.2.d -Other fugitive emissions from energy

Pollutant	Value	Unit	References
NH ₃	2100	g/MWh electricity produced	GB 2019 Table 3-4 emission factor for source category 1.B.2.d page 5
Hg	0.44	g/MWh electricity produced	GB 2019 Table 3-4 emission factor for source category 1.B.2.d page 5
As	0.025	g/MWh electricity produced	GB 2019 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

Info sheet was added to the calculation sheet and consumption data from energy balance were linked.

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

Emissions in the category 1.B.2.d for the period 2011-2013 were recalculated due to available revised energy consumption data in the MAKSTAT database.

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 2009/2013/2016/2019) for the period from 1990-2018.

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 emissions have not been estimated (NE) or are included elsewhere (IE).

5.2. General description

Completeness

Table 126 NFR categories covered in Industrial processes sector for 2017

NFR sector	Completeness
2.A.1 Cement production	✓
2.A.2 Lime production	✓
2.A.3 Glass production	✓
2.A.5.a Quarrying and mining of minerals other than coal	✓
2.A.5.b Construction and demolition	✓
2.A.5.c Storage, handling and transport of mineral products	✓
2.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.5.a Other chemical industry	NO
2. B.5.b Storage, handling and transport of chemical products	NO
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	✓
2.C.4 Magnesium production	NO
2.C.5 Lead production	✓
2.C.6 Zinc production	NO

NFR sector	Completeness
2.C.7.a Copper production	✓
2.C.7.b Nickel production	NO
2.C.7.c Other metal production	✓
2.C.5.d Storage, handling and transport of metal products	NE
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	NE
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) are 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 PM_{2.5} 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:

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

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 127 Activity data for source category 2.A.1 - Cement production

Year	Clinker produced (t)	Year	Clinker produced (t)	Year	Clinker produced (t)
1990	491 900	2000	614 160	2010	588 980
1991	465 380	2001	716 960	2011	687 990
1992	396 500	2002	739 490	2012	645 480
1993	413 440	2003	602 570	2013	577 850
1994	375 910	2004	643 260	2014	518 200
1995	365 120	2005	694 920	2015	553 232
1996	396 020	2006	801 300	2016	739 810
1997	475 250	2007	882 830	2017	735 625
1998	346 870	2008	843 770	2018	748 287
1999	427 080	2009	478 400		

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 2019.

These emission factors are given in the table below:

Table 128 Emission factors for source category 2.A.1 cement production

Pollutant	Value	Unit	References
PM10	234	g/Mg clinker	GB 2019 2.A.1 Cement production. Table 3-1. pg. 10
PM2.5	130	g/Mg clinker	GB 2019 2.A.1 Cement production. Table 3-1. pg. 10
TSP	260	g/Mg clinker	GB 2019 2.A.1 Cement production. Table 3-1. pg. 10

For calculation (estimation) of emissions for PM2.5, PM10 and TSP for the period 2007-2018 the total emission TSP (measured with continuous monitoring) is taken into account: the emission factors from GB 2019 have been used (Tier 1, Table 128 above) as well as Tier 2, Table 129 (GB 2016) were 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 PM_{2.5}, PM₁₀ and TSP emissions are done by taking into account the mass of clinker produced and the abatement efficiency, approximately 92% for TSP, 75 % for PM₁₀ and 68,5 % for PM_{2.5}.

For this calculation, the following equation was used:

$$EF_{\text{technology/abated}} = (1 - \eta(\text{abatement})) \times EF_{\text{technology/unabated}}$$

Table 129 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 μm	98%	GB 2016 2.A.1 Cement production. Table 3-2. pg. 12
	10 μm > particle > 2.5 μm	80%	GB 2016 2.A.1 Cement production. Table 3-2. pg. 12
	2.5 μm > particle	73%	GB 2016 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 taken into account. 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 [25]. 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 2014-2018 from the Statistical publication for Industry in the Republic of North Macedonia [27] was used as activity data.

Table 130 Activity data for source category 2.A.2 - Lime production

Year	Lime produced (t)	Year	Lime produced (t)	Year	Lime produced (t)
1990	37 452	2000	1 000	2010	2 700
1991	29 194	2001	500	2011	2 700
1992	33 872	2002	500	2012	2 700
1993	24 904	2003	500	2013	2 700
1994	14 097	2004	500	2014	10 836
1995	12 538	2005	15 009	2015	8 003
1996	9 707	2006	12 704	2016	8 684
1997	4 344	2007	7 517	2017	1 399
1998	964	2008	NE	2018	6 834
1999	4 264	2009	2 713		

Emission factors

For the calculation (estimation) of emissions for PM_{2.5}, PM₁₀ and TSP for the period 1990-2018 emission factors were taken from GB 2019.

These emission factors are given in Table 131 below.

Table 131 Emission factors for source category 2.A.2 - Lime production

Pollutant	Value	Unit	References
PM ₁₀	3500	g/Mg lime	GB 2019 2.A.2 Lime production, Table 3-1, pg. 8
PM _{2.5}	700	g/Mg lime	GB 2019 2.A.2 Lime production, Table 3-1, pg. 8
TSP	9000	g/Mg lime	GB 2019 2.A.2 Lime production, Table 3-1, pg. 8
BC	0.46	% of PM _{2.5}	GB 2019 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 judgement.

The activity data time series, as taken from the statistical yearbook, shows some inconsistencies; data is not available for 2008.

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 [28]. For the year 2007 as well as the years 2014-2018 the data was unchanged, but there is no available data for the years 2008-2012. There was difference in the activity data for 2013. This will be adequately replaced in the next submission.

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

No recalculations were carried out in this category. Hydraulic lime data for 2014-2018 was used as activity data, following the recommendation given by the MS solvent and industry expert within the last Twining project.

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 132 Activity data for 2.A.3 - Flat glass production

Year	Flat glass produced [t]	Year	Flat glass produced [t]	Year	Flat glass produced [t]
1990	448	2000	NO	2010	NO
1991	32	2001	NO	2011	NO
1992	179	2002	NO	2012	NO
1993	NO	2003	NO	2013	NO
1994	NO	2004	NO	2014	NO
1995	NO	2005	NO	2015	NO
1996	NO	2006	NO	2016	NO
1997	NO	2007	NO	2017	NO
1998	NO	2008	NO	2018	NO
1999	NO	2009	NO		

Emission factors

For the estimation of emission parameters from 1990-1992, the used emission factors were taken from GB 2016. These emission factors are given in Table 133 below.

Table 133 Emission factors for source category 2.A.3 Flat glass production

Pollutant	Value	Unit	References
PM10	120	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2.Flat glass production pg. 16
PM2.5	100	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16

Pollutant	Value	Unit	References
TSP	130	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Pb	0.4	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Cd	0.068	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Hg	0.003	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
As	0.08	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Cr	0.08	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Cu	0.007	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Ni	0.74	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Se	0.15	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16
Zn	0.37	g/Mg glass	GB 2019 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 134 Activity data for source category 2.A.3 - Glass wool production

Year	Glass wool produced [t]	Year	Glass wool produced [t]	Year	Glass wool produced [t]
1990	2739	2000	NO	2010	NO
1991	1 176	2001	NO	2011	NO
1992	1828	2002	NO	2012	NO
1993	444	2003	NO	2013	NO
1994	1332	2004	NO	2014	NO
1995	3043	2005	NO	2015	NO
1996	1454	2006	NO	2016	NO
1997	961	2007	NO	2017	NO
1998	960	2008	NO	2018	NO
1999	NO	2009	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 2019.

These emission factors are given in Table 135 below.

Table 135 Emission factors for Glass wool production

Pollutant	Value	Unit	References
NMVOC	500	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
NH ₃	1400	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
PM2.5	520	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
PM10	590	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19
TSP	670	g/Mg glass	GB 2019 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19

Pollutant	Value	Unit	References
BC	2	% of PM2.5	GB 2019 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 NH₃ and 200% for PM2.5, based on expert judgement.

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[21], while activity data for the period 2005-2015 [27] were taken from the statistical publication for industry. Data for period 2016-2018 are taken from MAKSTAT database [28].

Table 136 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]	Year	Mineral produced [t]
1990	6 117 811	2000	4 917 560	2010	6 845 344
1991	5 730 999	2001	3 488 792	2011	7 106 322
1992	5 299 552	2002	2 855 005	2012	7 039 649
1993	5 246 466	2003	739 786	2013	7 779 824
1994	4 817 372	2004	347 795	2014	7 218 423
1995	5 215 134	2005	2 827 908	2015	7 577 533
1996	5 233 110	2006	4 605 478	2016	8 311 381
1997	5 528 418	2007	6 955 302	2017	7 837 577
1998	5 158 798	2008	7 095 376	2018	7 866 875

Year	Mineral produced [t]	Year	Mineral produced [t]	Year	Mineral produced [t]
1999	4 658 946	2009	5 783 348		

Emission factors

For estimation of emissions for PM2.5, PM10 and TSP the used emission factors were taken from GB 2019. These emission factors are given in Table 137 below.

Table 137 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 2019 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5
PM10	50	g/Mg mineral	GB 2019 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5
PM2.5	5.0	g/Mg mineral	GB 2019 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

Recalculations were done in this category due to revised available statistical activity data in the MAKSTAT database.

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

No improvements are planned in this category.

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 m² of the building constructed or demolished.

Activity Data

Activity data on constructed dwellings and number of demolished dwellings are taken from Statistical yearbooks - Chapter Industry, Energy and Construction. There is only data for area of constructed dwellings, as well as number of demolished dwellings. The area of demolished dwellings is calculated when the number of constructed dwellings per year is multiplied with an average dwelling area of 65 m². Summarized data are presented in the following table.

Table 138 Activity data for constructed and demolished area for source category 2.A.5.b - Construction and demolition

Year	m ² /year	Year	m ² /year	Year	m ² /year
1990	1 810 252	2000	897 868	2010	902 234
1991	1 532 878	2001	957 742	2011	944 630
1992	1 375 918	2002	871 894	2012	934 773
1993	1 203 495	2003	842 519	2013	887 697
1994	1 017 799	2004	962 874	2014	798 891
1995	949 006	2005	899 876	2015	752 207
1996	927 963	2006	958 738	2016	943 400
1997	843 602	2007	852 971	2017	1 130 833
1998	793 938	2008	809 606	2018	1 109 077
1999	940 300	2009	824 945		

Emission factors

Emission factors for the particulates PM_{2.5}, PM₁₀ and TSP are taken from GB 2019. These emission factors are given in Table 139 below.

Table 139 Emission factors for source category 2.A.5.b - Construction and demolition

Pollutant	Value	Unit	References
TSP	0.29	kg/m ² /year	GB 2019 2.A.5.b Construction and demolition. Table 3-1. pg. 6
PM ₁₀	0.086	kg/m ² /year	GB 2019 2.A.5.b Construction and demolition. Table 3-1. pg. 6
PM _{2.5}	0.0086	kg/m ² /year	GB 2019 2.A.5.b Construction and demolition. Table 3-1. pg. 6

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

Recalculation for the period 2003-2018 was performed, considering the revised available statistical activity data in the MAKSTAT database.

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.

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 [26]. 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[21], while regarding the railway transport the content of transported minerals in the transported goods in railway transport were estimated.

Table 140 Activity data for source category 2.A.5.c - Storage, handling and transport of mineral products

Year	Products transported [t]	Year	Products transported [t]	Year	Products transported [t]
1990	246 717	2000	48 708	2010	2 820 746
1991	143 309	2001	575 864	2011	3 330 100
1992	96 043	2002	685 869	2012	3 499 387
1993	152 750	2003	8 006 331	2013	3 407 267
1994	49 973	2004	10 497 726	2014	5 564 332
1995	57 838	2005	8 475 328	2015	4 142 405
1996	34 404	2006	16 441 405	2016	5 034 346
1997	106 462	2007	4 813 390	2017	4 717 295
1998	189 443	2008	1 965 897	2018	8 410 139
1999	152 301	2009	7 058 289		

Emission factors

For estimation of emissions for particulates, PM2.5, PM10 and TSP, the emission factors were taken from GB 2019. Used emission factors are given in the table below.

Table 141 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 2019 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7
PM10	6	g/Mg	GB 2019 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7
PM2.5	0.6	g/Mg -	GB 2019 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 due to the fact that 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

The NFR categories: 2.B.5.a - Other chemical industry and 2.B.5.b - Storage handling and transport of chemical products in national inventory are reported as NE due to the lack of official activity data.

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.

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 a number of smaller installations with different ownership. Currently in Republic of North Macedonia, two 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 2016-2018 using Tier 2 because since 2016 all units (electric arc furnace, hot rolling mills and cold rolling mills) in the installations are using BAT.

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 [21], and for the period 2005-2015 from the publications Industry in the Republic of North Macedonia [27]. Activity data for the period of 2016-2018 are taken directly from the two installations mentioned above. The activity data have variable trend due to fluctuant as market prices as well as change of the ownerships of the companies.

Table 142 Activity data for source category 2.C.1 - Iron and steel production

Year	Products [t]	Year	Products [t]	Year	Products [t]
1990	885 015	2000	437 934	2010	759 924
1991	755 634	2001	583 379	2011	862 827
1992	548 462	2002	960 178	2012	564 054
1993	353 822	2003	760 538	2013	363 887
1994	140 045	2004	833 328	2014	498 459
1995	83 407	2005	807 782	2015	466 847
1996	128 117	2006	905 272	2016	613 479
1997	230 274	2007	982 650	2017	742 976
1998	347 846	2008	766 310	2018	737 322
1999	237 409	2009	705 567		

Table 143 Activity data for steel and hot and cold ingots production in the period of 2016-2018

Year	Name of Products	[t]
2016	Liquid steel	173 113
	Hot rolled sheet	274 721
	Cold rolled sheet	165 645
2017	Liquid steel	277 599
	Hot rolled sheet	310 840
	Cold rolled sheet	154 537
2018	Liquid steel	272 415
	Hot rolled sheet	309 504
	Cold rolled sheet	155 403

Emission factors

For the estimation of emissions for pollutants, emission factors were taken from GB 2019. Used emission factors are given in the table below.

Table 144 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 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
CO	1.7	kg/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44

Pollutant	Value	Unit	References
NMVOC	46	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
SO ₂	60	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
TSP	30	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PM ₁₀	24	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PM _{2.5}	21	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
BC	0.36	% of PM _{2.5}	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Pb	1.5	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Cd	0.12	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Hg	0.076	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
As	0.0081	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Cr	0,105	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Cu	0.02	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Ni	0.41	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Se	2.3	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
Zn	3	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PCDD/F	0.48	µgI-TEQ/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PAHs (Total)	2.5	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
HCB	130	mg/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PCBs	30	mg/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44

Table 145 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 2019 2.C.1 Iron and steel production. Table 3-21. pg. 46

Table 146 Emission factors for source category 2.C.1 - Iron and steel production, rolling mills, hot rolling mills

Pollutant	Value	Unit	References
NMVOC	7	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-22. pg. 46-47
TSP	9	g/Mg steel	GB 2019 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 NMVOC and 40% for PM_{2.5}, 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

No recalculations were carried out in this category.

5.5.1.4. 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 period and there will be a need of expert support for calculation of historical data, therefore this issue will be resolved during the upcoming IPA project in which one of the planned activities is improving of the air emission inventory of Ferroalloys 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 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 2018, same as in 2017 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 fulfill 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.

5.5.1.5. 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[21], and publication Industry in the Republic of Macedonia for the period 2005–2015[27]. 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 year 2018 for ferroalloys production are taken directly from the installation with new ownership EURONICKEL INDUSTRY.

Table 147 Activity data for the source category 2.C.2 - Ferroalloy production

Year	Total Alloy produced [t]	Year	Total Alloy produced [t]	Year	Total Alloy produced [t]
1990	85 148	2000	58 520	2010	133 347
1991	77 442	2001	8 779	2011	184 310
1992	107 866	2002	15 085	2012	146 970
1993	78 357	2003	67 283	2013	165 803
1994	72 134	2004	83 160	2014	163 489
1995	72 735	2005	106 590	2015	130 970
1996	92 638	2006	108 920	2016	69 455
1997	85 908	2007	175 719	2017	34 558
1998	106 661	2008	170 252	2018	51 831
1999	78 009	2009	60 458		

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 2019 emission factors have been used.

Table 148 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 2019 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 2019 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7
TSP	1000	g/Mg alloy produced	GB 2019 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7
BC	10	% PM2.5	GB 2019 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 149 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 149 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 148. 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 measurements for TSP were available for the period 2005-2018.

5.5.1.6. 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 judgement. 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

5.5.1.7. 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.

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

No recalculations were carried out in this category.

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

No improvements are planned in this category.

5.5.2. 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.

5.5.2.1. Methodological Issues

Activity Data

The activity data were taken from the Statistical Yearbooks 1990-2018 and for the period 2007-2018 from the installation for secondary aluminum production named RZ Institut Skopje. Type of activity data used for emission estimation are presented in the following list.

1990 – 1998	Pressed aluminum products and aluminum alloy products
1999 – 2005	Aluminum and aluminum alloys
2005 – 2006	Sum of unwrought aluminum, alloyed in ingot Aluminum alloyed bars, rods, profiles Aluminum tubes and pipes, non-alloyed
2007-2018	Aluminum alloys, in ingots, SSO RZ Institute secondary aluminum production

Table 150 Activity data for source category 2.C.3 - Aluminum production

Year	Aluminum and aluminum products [t]	Year	Aluminum and aluminum products [t]	Year	Aluminum and aluminum products [t]
1990	8 841	2000	7 641	2010	1 897
1991	7 829	2001	6 809	2011	2 079
1992	5 150	2002	10 516	2012	1 870
1993	4 819	2003	8 573	2013	1 245
1994	4 991	2004	1 679	2014	812
1995	3 709	2005	1 489	2015	161
1996	3 924	2006	2 316	2016	122
1997	5 561	2007	1 757	2017	382
1998	5 850	2008	1 531	2018	278
1999	10 777	2009	1 637		

Emission factors

The emission factors used in this source category are presented in the following table.

Table 151 Emission factors for source category 2.C.3 - Secondary Aluminum production

Pollutant	Value	Unit	References
TSP	2	kg/Mg aluminum	GB 2019 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PM10	1.4	kg/Mg aluminum	GB 2019 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PM2.5	0.55	kg/Mg aluminum	GB 2019 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
BC	2.3	% of PM2.5	GB 2019 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15

Pollutant	Value	Unit	References
PCDD/F	35	µgI-TEQ/Mg aluminum	GB 2019 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
HCB	5	g/Mg aluminum	GB 2019 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15

5.5.2.2. 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 judgement.

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 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.

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

Recalculations were carried out in this category for the period 2007-2017 as a result of revised activity data in the MAKSAT database, and data received from the installation RZ Institute.

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

It is planned MEPP to discuss with The State Statistical Office the possibility for this institution to start collecting data on the quantity of secondary aluminum produced.

5.5.3. 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.

5.5.3.1. Methodological issues

To estimate (calculate) emissions from lead production, the general equation has been adopted:

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

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 152 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*	2004	NO	3 591****
1991	33 938*	19 265*	2005	NO	34*****
1992	27 860*	23 341*	2006	NO	46*****
1993	23 575*	21 881*	2007	NO	18*****
1994	20 569*	20 965*	2008	NO	21*****
1995	24 007*	22 490*	2009	NO	39*****
1996	29 259*	23 584*	2010	NO	NE
1997	30 508*	26 046*	2011	NO	NE
1998	29 242*	28 415*	2012	NO	NE
1999	27 086*	19 738*	2013	NO	NE
2000	19 000**	17 137***	2014	NO	NE
2001	19 000**	13 543***	2015	NO	2648
2002	19 000**	11 934****	2016	NO	4472
2003	19 000**	6 357****	2017	NO	7486
			2018	NO	10 576

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://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 2019. These emission factors are presented in the following two tables.

Table 153 Emission factors for source category 2.C.5 - Primary Lead production

Pollutant	Value	Unit	References
TSP	560	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
PM10	450	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
PM2.5	225	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
Pb	150	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
Cd	0.8	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
Hg	1	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
As	0.18	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14
PCDD/F	5	µg I-TEQ/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14

Pollutant	Value	Unit	References
PCBs	1.9	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated pg. 14

Table 154 Emission factors for source category 2.C.5 – Secondary Lead production 1990-2009

Pollutant	Value	Unit	References
TSP	14 800	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
PM10	11 800	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
PM2.5	8 800	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
Pb	5 800	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
Cd	15	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
As	47	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
Zn	35	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
PCDD/F	5	µg I-TEQ/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16
PCBs	1.9	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated pg. 16

Table 155 Emission factors for source category 2.C.5 - Secondary Lead production for 2010-2018

Pollutant	Value	Unit	References
TSP	20	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
PM10	16	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
PM2.5	8	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
Pb	2.6	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
Cd	0.05	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
As	0.3	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
Zn	0.05	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17

Pollutant	Value	Unit	References
PCBs	2.6	g/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17
PCDD/F	3.2	µg I-TEQ/Mg lead	GB 2019 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28 pg. 17

5.5.3.2. 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 judgement.

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 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.

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

Recalculations were carried out in this category due to the use of Tier 2 emission factors from GB 2019 for unabated production

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

MEPP will further discuss with the State Statistical Office the possibility for this institution to start collecting data on the quantity of secondary lead produced (before 2015)

5.5.4. 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.

5.5.4.1. Methodological Issues

Activity Data

The activity data has been taken from the Statistical yearbook – chapter Industry, energy and construction for the period 1990-2018*, as well as from the following website http://minerals.usgs.gov/minerals/pubs/commodity/zinc/zinc_myb05.pdf**[25]. 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 156 Activity data for source category 2.C.6 - Zinc production

Year	Primary Zinc (t)	Secondary zinc (t)
1990	56 734*	17 383*

Year	Primary Zinc (t)	Secondary zinc (t)
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

Emission factors

Emission factors for primary lead production and secondary zinc production were taken from GB 2019. These emission factors are presented in the following two tables.

Table 157 Emission factors for source category 2.C.6 - Primary Zinc production

Pollutant	Value	Unit	References
TSP	210	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
PM10	170	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
PM2.5	130	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
Pb	35	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
Cd	5	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
Hg	5	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
Zn	80	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
PCBs	0.9	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11
PCDD/F	5	µg I-TEQ/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.1. pg. 11

Table 158 Emission factors for source category 2.C.6 - Secondary Zinc production

Pollutant	Value	Unit	References
TSP	425	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.2. pg. 12
PM10	340	g/Mg zinc	GB 2013 2.C.6 Zinc production. Table 3.2. pg. 12
PM2.5	255	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
Pb	65	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
Cd	35	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
Hg	0.006	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
As	5.9	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
Zn	150	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
PCBs	0.0031	g/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15
PCDD/F	100	µg I-TEQ/Mg zinc	GB 2019 Table 3.2 Tier 2 emission factors for source category 2.C.6 Zinc production, primary zinc production, unabated. pg. 15

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

Recalculations were carried out in this category due to the use of Tier 2 emission factors from GB 2019 for unabated production.

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

No improvements are planned in this category.

5.5.5. 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 sulfidic 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 Sulphur 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 there is a secondary production of copper.

5.5.5.1. Methodological Issues

Activity Data

Activity data is available for secondary copper production (from the installation that has that production), for the period 2007-2018.

Table 159 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
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

Emission factors

Emission factors for secondary copper production are taken from GB 2019. These emission factors are presented in the following table.

Table 160 Emission factors for source category 2.C.6 - Secondary Copper production

Pollutant	Value	Unit	References
TSP	320	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PM10	250	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PM2.5	190	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
BC	0.1	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
SOx	1 320	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Pb	24	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Cd	2.3	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
As	2	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Cu	28	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
Ni	0.13	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PCBs	3.7	g/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13
PCDD/F	50	µg I-TEQ/Mg copper	GB 2019 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13

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

Recalculation were carried out in this category due to revised activity data for secondary copper production in the period 2007-2017. Also the calculation for primary copper production for the period 2012-2017 was deleted because it was concluded that the installation for pampering of copper ores for obtaining cathode copper doesn't include primary copper production according to GB for Copper Production.

5.5.5.5. 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.

5.5.6. Other metal production – NFR 2.C.7.c

This category covers silver production in the reporting period 1990-1998.

5.5.6.1. 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 161 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 162 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

5.5.6.2. Source-specific uncertainties and time-series consistency

This category includes TSP emissions only. Uncertainties have not yet been estimated for TSP emissions.

5.5.6.3. 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.

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

No recalculations were carried out in this category.

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

Updated emission factors for TSP and EF for SO_x from the latest 2019 GB will be used in the next reporting round.

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 2018 was 8.6%.

5.6.1.1. Methodological issues

The Tier 1 method has been applied. 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.

Activity Data

The activity data – number of population for this source category have been updated with revised numbers from MAKSTAT database for the period 1998-2017, while for the period 1990-1993, data from the hard copy publications form SSO was used. It should be emphasized that the last census in the country was carried out in 2002, and therefore the data for the period 2003-2018 are estimated population numbers.

Table 163 Activity data for the source category 2.D.3.a - Domestic solvents use including fungicides

Year	Population number	Year	Population number	Year	Population number
1990	2 028 000	2000	2 038 651	2010	2 057 284
1991	2 033 964	2001	2 023 654	2011	2 059 794
1992	2 056 000	2002	2 029 892	2012	2 062 294
1993	2 066 000	2003	2 035 196	2013	2 065 769
1994	1 957 265	2004	2 038 514	2014	2 069 172
1995	1 974 800	2005	2 041 941	2015	2 071 278
1996	1 991 398	2006	2 045 177	2016	2 073 702
1997	2 002 340	2007	2 048 619	2017	2 075 301
1998	2 012 705	2008	2 052 722	2018	2 077 132
1999	2 021 578	2009	2 038 651		

Emission factors

The emission factor for calculation of NMVOC emissions coming from this sector are presented in the following table.

Table 164 Emission factors for the source category 2.D.3.a - Domestic solvents use including fungicides

Pollutant	Value	Unit	References
NMVOC	1.2	kg/person/year	GB 2019 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 judgement; 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.

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 carried out due to revised population numbers in the MAKSTAT data base. Emissions in the period 1994-2013 were recalculated, and for the other years they were the same numbers. Furthermore, as recommended by the stage 3 review Guidebook 2009 NMVOC EF of 1 kg/person/year has been replaced with EF of 1.2 kg/person/year.

The historical data on the population number was reviewed due to the comments given by the MS solvent expert within the last Twining project, considering the existence of different data on population numbers.

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 2018 is 0.11% and in TSP is 0.05%. 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 2017 and 2018, activity data are taken from Statistical yearbook – Chapter Construction [21]. Summarized data on national asphalt produced 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, as well as change of ownership and close down of some of the asphalt production companies. The activity data are presented in the following table.

Table 165 Activity data for source category 2.D.3.b - Road paving with asphalt

Year	Asphalt produced (t)	Year	Asphalt produced (t)	Year	Asphalt produced (t)
1990	86 320	2000	327 937	2010	274 654
1991	74 296	2001	137 305	2011	356 596
1992	44 067	2002	119 651	2012	336 725
1993	65 194	2003	124 492	2013	389 163
1994	84 729	2004	149 323	2014	336 545
1995	87 814	2005	180 559	2015	500 943

Year	Asphalt produced (t)	Year	Asphalt produced (t)	Year	Asphalt produced (t)
1996	98 545	2006	130 847	2016	366 536
1997	53 600	2007	101 508	2017	461 664
1998	101 563	2008	170 049	2018	527 798
1999	136 540	2009	232 001		

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 this installation of abatement technology from 2015 a new methodology for calculation of TSP, PM10 and PM2.5 emissions was used.

Table 166 Emission factors for source category 2.D.3.b - Road paving with asphalt

Pollutant	Value	Unit	References
NM VOC	16	g/Mg asphalt	GB 2019 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
TSP	14 000	g/Mg asphalt	GB 2019 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
PM10	3 000	g/Mg asphalt	GB 2019 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
PM2.5	400	g/Mg asphalt	GB 2019 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9
BC	5.7	% PM2.5	GB 2019 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

Recalculations were carried out in this category for the period 2015-2018 due to additionally received information for improvement of these installations for asphalt production by building of fabric filters with abatement efficiency of 99 % a fact that taken into account in the recalculation.

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

It is planned that in cooperation with SSO to gather more reliable historical activity data for 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 0.008% in 2018.

5.6.3.1. Methodological issues

To estimate (calculate) emissions from the asphalt roofing, the following general equation has been adopted:

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

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 [21]. For the period 2005-2018, revised activity data for period 2007-2014, were taken from MAKSTAT database [28], 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 167 Activity data for source category 2.D.3.c - Asphalt roofing

Year	Asphalt roofing products (t)	Year	Asphalt roofing products (t)	Year	Asphalt roofing products (t)
1990	12 572	2000*	13 075	2010	14 908
1991	12 593	2001*	12 525	2011	25 145
1992	5 325	2002*	12 104	2012	17 727
1993	4 067	2003*	11 668	2013	13 676
1994	5 901	2004*	12 458	2014	6 814
1995	8 873	2005	11 305	2015	10 146
1996	5 992	2006	9 773	2016	14 402
1997	6 442	2007	12 164	2017	15 183
1998	5 489	2008	14 401	2018	17 114
1999	13 429	2009	18.783		

*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 2005-2018 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 2005-2018 in tons

1990 – 1999 Roof patch, Bitumen paper and jute;

Bituminous products for building;

2005 – 2018 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 168 Emission factors for source category 2.D.3.c - Road paving with asphalt

Pollutant	Value	Unit	References
CO	9.5	g/Mg shingle	GB 2019 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
NMVOC	130	g/Mg shingle	GB 2019 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
TSP	1 600	g/Mg shingle	GB 2019 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
PM10	400	g/Mg shingle	GB 2019 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
PM2.5	80	g/Mg shingle	GB 2019 2.D.3.c Asphalt roofing. Table 3.1. pg. 7
BC	0.013	% PM2.5	GB 2019 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

Notation keys were corrected according to ERT recommendations with exception of HCB. Additionally, the information on unit I type of bitumen products was added to the report. Recalculations were done in this sector for the period 2007-2014 due to revised available activity data.

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

Notation key for HCB remain as NA even it was recommended by the ERT to be changed in NE due to the fact it was omitted.

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 with contribution of around 10% in 2018.

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 [41]. Namely, according to this methodology sectors Industrial application and Decorative application contribute in paints consumption with equal weighting as sector Other industrial application. Taking into account 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 – 2016.

Activity data

The quantity of paint produced in the period 2005-2015 is taken from the publications Industry in the Republic of North Macedonia [27], for the period 2016-2018 data were taken from the MAKSTAT database [28], 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 [30]. For the years 2016-2018, the data on the quantities of imported and exported paint was taken from MAKSTAT database [30].

Table 169 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	3 828 333	3 828 333	3 828 333
2008	3 926 667	3 926 667	3 926 667
2009	2 998 667	2 998 667	2 998 667

Year	Industrial application	Decorative application	Other industrial application
	Paint [kg]	Paint [kg]	Paint [kg]
2010	3 287 000	3 287 000	3 287 000
2011	3 750 580	3 750 580	3 750 580
2012	4 516 084	4 516 084	4 516 084
2013	4 365 688	4 365 688	4 365 688
2014	4 273 947	4 273 947	4 273 947
2015	4 372 150	4 372 150	4 372 150
2016	4 077 318	4 077 318	4 077 318
2017	3 571 937	3 571 937	3 571 937
2018	3 356 187	3 356 187	3 356 187

Emission factors

Emission factors for Tier 1 method from GB 2016 are presented in the following table:

Table 170 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 2019 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 2019 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 2019 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. However, the recommendations given in the previous stage 3 review were implemented; In the previous submissions EF were already corrected in the excel files and data on import and export of paints in the MAKSTAT database are available for the reporting year, which was not the case with publications on trade. Therefore, it can be concluded that the emissions are not underestimated for the last reporting year. now.

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

No planned improvements in this category in the next submission There is a need for development of own methodology for this category but there are no available capacities or budget. It may be possible to gather some data for decorative paint application with the upcoming census.

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.

5.6.5.1. Methodological issues

The Tier 1 method has been applied. 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.

Activity Data

See subchapter on activity data in 2.D.3.a category, table 163.

Emission factors

Emission factor for the calculation of NMVOC emissions is presented below.

Table 171 Emission factor for source category 2.D.3.e - Degreasing

Pollutant	Value	Unit	References
NMVOC	0.85	kg/inhabitant/year	Informative Inventory Report of Republic of Serbia for 2013 [42] which refers to GB 2006

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

See explanation in 2.D.3.a.

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

See explanation in 2.D.3.a.

5.6.6. Dry cleaning – NFR 2.D.3.f

Dry cleaning refers to any process of removal of contamination from furs, leather, down leathers, textiles or other objects made of fibers using organic solvents. The most significant pollutants from dry cleaning are non-methane volatile organic compounds.

5.6.6.1. Methodological issues

The calculation in this category is based on the volume of solvents, including chlorinated organic chlorinated solvents using Tier 1 method. 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.

Activity Data

Due to the lack of data on textile treatment, the activity data considered in this source category is population. Population data for the source category 2.D.3.e – Degreasing, is presented in Table 163.

Emission factors

Emission factor for the calculation of NMVOC emissions is given below.

Table 172 Emission factor for the source category 2.D.3.f- Dry Cleaning

Pollutant	Value	Unit	References
NMVOC	0.3	kg/inhabitant/year	GB 2013 2.D.3.f Dry cleaning. pg. 6

5.6.6.2. 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.

5.6.6.3. 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.

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

See explanation in 2.D.3.a.

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

See explanation given in 2.D.3.a chapter. The emission factor was corrected on the recommendation of the ERT. Additionally, MEPP already sent questionnaires on amount of treated textile in dry cleaning shops but received only limited number of responses. The procedures will be reported earlier next year in order to gather representative quantity of treated wear.

5.6.7. 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 NH₃. 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.

5.6.7.1. Methodological issues

The following equation from Tier 2 approach has been used for calculating emissions from chemical products:

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

Where:

$AR_{use,technology}$ = the use of specific chemical products;

$EF_{technology,pollutants}$ = the emission factor for this technology and this 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[21] and publication Industry in the Republic of North Macedonia for the period 2005-2015 [27] as well as MAKSTAT database for 2016-2018 [28]. The activity data are presented in the following table.

Table 173 Activity data for source category 2.D.3.g - Chemical products

Year	Polyester/kg	Polyurethane /kg	Polystyrene /kg	Shoos/pairs	Leather tanning/kg	Paints. Inks and glues/kg	Rubber Processing/kg
1990	16 450 000	NO	NO	6 638 000	NO	NO	NO
1991	12 440 000	NO	NO	4 049 000	NO	NO	NO
1992	11 150 000	NO	364 000	3 667 000	10 797 000	NO	1 355 000
1993	4 466 000	NO	382 000	2 308 000	10 197 000	NO	1 145 000
1994	8 628 000	NO	455 000	1 529 000	9 177 000	NO	978 000
1995	9 904 000	NO	378 500*	1 122 000	10 119 500*	NO	680 500*
1996	3 212 000	NO	302 000	1 231 000	11 062 000	NO	383 000
1997	3 820 000	NO	363 000	1 509 000	7 491 000	NO	371 000
1998	2 642 000	NO	547 000	1 790 000	4 908 000	NO	417 000
1999	NO	NO	NO	2 488 000	NE	NO	NO
2000	NO	NO	NO	2 129 000	NE	NO	NO
2001	NO	NO	NO	1 073 000	NE	NO	NO
2002	NO	NO	NO	1 521 000	NE	NO	NO
2003	NO	NO	NO	1 799 000	NE	NO	NO
2004	NO	NO	NO	1 785 000	NE	NO	NO
2005	NO	1 095 000	NO	1 540 000	NE	6 068 000	NO
2006	NO	1 405 000	NO	1 739 000	NE	5 252 000	NO
2007	NO	1 129 000	NO	2 860 000	114 000	4 982 000	NO
2008	NO	1 239 000	NO	2 853 000	111 000	4 604 000	NO
2009	NO	1 132 000	NO	3 036 000	143 000	3 972 000	NO

Year	Polyester/kg	Polyurethane /kg	Polystyrene /kg	Shoos/pairs	Leather tanning/kg	Paints. Inks and glues/kg	Rubber Processing/kg
2010	NO	1 033 000	NO	3 290 000	141 000	5 407 000	NO
2011	NO	1 059 000	NO	3 148 000	160 000	2 834 000	NO
2012	NO	1 221 000	NO	3 047 000	93 000	1 914 000	NO
2013	NO	1 166 000	NO	4 631 000	94 000	1 306 000	NO
2014	NO	697 000	NO	5 128 000	81 000	817 000	NO
2015	NO	NO	NO	4 195 000	94 000	991 000	NO
2016	NO	896 000	NO	4 286 000	81 000	891 000	NO
2017	NO	1 633 000	NO	3 815 000	87 000	768 000	NO
2018	NO	2 429 000	NO	3 550 000	98 000	867 000	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 occur.

Emission factors

The emission factors used for calculation of emissions taken from GB 2019 for different types of activities. The emission factors are presented in the following table.

Table 174 Emission factors for source category 2.D.3.g - Chemical Products

Pollutant	Value	Unit	References
NMVOC	50	g/kg polyester monomer used	GB 2019 2.D.3.g Chemical products. Table 3-2. pg. 17
NMVOC	120	g/kg polyurethane foam processed	GB 2019 2.D.3.g Chemical products. Table 3-3. pg. 17-18
NMVOC	60	g/kg polystyrene	GB 2019 2.D.3.g Chemical products. Table 3-4. pg. 18
NMVOC	8	g/kg rubber produced	GB 2019 2.D.3.g Chemical products. Table 3-5. pg. 18-19
NMVOC	11	g/kg products (paints. inks. glues)	GB 2019 2.D.3.g Chemical products. Table 3-11. pg. 22
NMVOC	0.045	kg/pairs of shoes	GB 2019 2.D.3.g Chemical products. Table 3-13. pg. 23
NH ₃	0.68	g/kg raw hid (leather tanning)	GB 2019 2.D.3.g Chemical products. Table 3-14. pg. 24

5.6.7.2. 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.

5.6.7.3. 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

Recalculations were done in this sector for the period 2007-2017 due to revised activity data (polyurethane foam processing for 2009, shoes manufacturing and leather tanning).

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

It is planned to check the availability of data on other chemical products for future reporting (Textile finishing and Pharmaceutical products manufacturing) and report emissions in the following submissions.

5.6.8. 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.

5.6.8.1. 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 1990-2018, 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 2019 and is presented in table below.

Table 175 Emission factors for source category 2.D.3.h Printing

Pollutant	Value	Unit	References
NMVOC	500	g/kg ink	GB 2019 Table 3-1 Tier 1 emission factors for source category 2.D.3.h Printing

5.6.8.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.8.3. 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.

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

No recalculations were done in the sector.

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

The confidentiality of activity data was included in the IIR as recommended by ERT. No planned improvements in this sector.

5.6.9. 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

The calculated emissions have been reported in the NFR 2.G while for the NFR category 2.D.3.i, the notation key IE has been used.

5.6.9.1. Methodological Issues

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[21], and from the publication of the “Industry in the Republic of North Macedonia”, for the period 2005-2015 [27]. For 2016-2018 data from MAKSTAT database were used [28]. The deep that 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. Consumption of creosote has been calculated with the formula $75 \text{ kg creosote/m}^3 \text{ wood}$, 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.

The activity data are presented in the following table.

Table 176 Activity data for the source category 2.D.3.i and 2.G - Other solvent and product use (Source Statistical yearbooks (1990-2004) and Industry in the Republic of North Macedonia (2005-2018))

Year	Tobacco	Creosote	Fat, edible and non-edible oil extraction-seed	Pairs of shoes
1990	26 481	261 440	38 303	6 638 000
1991	16 576	209 583	39 190	4 049 000
1992	22 297	241 980	32 975	3 667 000
1993	25 964	197 934	30 218	2 308 000
1994	21 143	163 377	47 598	1 529 000
1995	16 152	123 016	30 990	1 122 000
1996	13 980	82 013	54 763	1 231 000
1997	14 904	55 388	52 515	1 509 000
1998	23 297	47 551	47 063	1 790 000
1999	29 005	43 522	28 165	2 488 000
2000	18 991	38 073	39 048	2 129 000
2001	26 110	127 308	38 388	1 073 000
2002	20 547	100 054	71 910	1 521 000
2003	25 689	111 090	64 698	1 799 000
2004	15 317	158 732	61 148	1 590 000
2005	2 721	86 241	59 138	1 892 504
2006	1 881	78 125	63 578	2 121 404
2007	1 040	68 738	61 973	2 320 371
2008	4 366	53 457	76 303	3 142 440
2009	4 893	11 184	75 020	2 957 658

Year	Tobacco	Creosote	Fat, edible and non-edible oil extraction-seed	Pairs of shoes
2010	10413	58 775	78 368	3 408 829
2011	10 138	54 654	82 848	3 388 013
2012	3 151	144 749	80 805	1 599 026
2013	6 365	113 177	77 008	3 876 229
2014	11 133	82 300	83 258	4 381 143
2015	9 904	106 723	102 678	4 355 002
2016	6 425	83 275	101 118	3 876 436
2017	6 054	78 150	65 370	1 599 026
2018	11 512	89 210	76 733	1 700 692

Emission factors

The Emission factors have been taken from GB 2016 and are presented in the following table.

Table 177 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 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
NMVOC	Tobacco combustion	4.84	kg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
NH3	Tobacco combustion	4.15	kg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
PM2.5	Tobacco combustion	27	kg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
PM10	Tobacco combustion	27	kg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
TSP	Tobacco combustion	27	kg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
BC	Tobacco combustion	0.45	% of PM2.5	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
CO	Tobacco combustion	55.1	kg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
Cd	Tobacco combustion	5.4	mg/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
Ni	Tobacco combustion	2.7	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
Zn	Tobacco combustion	2.7	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20

Pollutant	Activity	Value	Unit	References
Cu	Tobacco combustion	5.4	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
PCDD/F	Tobacco combustion	0.1	Mg I-TEQ/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
benzo(a) pyren	Tobacco combustion	0.111	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
benzo(b) fluoranthene	Tobacco combustion	0.045	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
benzo(k) fluoranthene	Tobacco combustion	0.045	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
Indeno (1.2.3-cd) pyren	Tobacco combustion	0.045	g/ton tobacco	GB 16 Table 3-14 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Tobacco combustion pg.20
NMVOC	Wood preservation. Creosote preservative type	105	g/kg creosote	GB 16 Table 3-5 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Wood preservation. Creosote preservative type pg 15
benzo(a) pyren	Wood preservation. Creosote preservative type	1.05	mg/kg creosote	GB 16 Table 3-5 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Wood preservation. Creosote preservative type
benzo(b) fluoranthene	Wood preservation. Creosote preservative type	0.53	mg/kg creosote	GB 16 Table 3-5 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Wood preservation. Creosote preservative type
benzo(k) fluoranthene	Wood preservation. Creosote preservative type	0.53	mg/kg creosote	GB 16 Table 3-5 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Wood preservation. Creosote preservative type
Indeno (1.2.3-cd) pyren	Wood preservation. Creosote preservative	0.53	mg/kg creosote	GB 16 Table 3-5 Tier 2 emission factors for source category 2.D.3.i. 2.G Other solvent and product use. Wood preservation. Creosote preservative type
NMVOC	Manufacturing of shoes	0.06	kg/pair of shoes	GB 16 Table 3-15 Tier 2 emission factor for source category 2.D.3.i. 2.G Other solvent and product use. Other. Use of Shoes pg 21
NMVOC	Fat. edible and non-edible oil extraction	1.57	g/kg seed	GB 16 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 16 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 16 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 16 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

5.6.9.2. Source-specific uncertainties and time-series consistency

No specific source uncertainty is done for the sector. Time series minor inconsistency is expected because recalculation of the activity data on tobacco combustion and manufacturing of shoes was done only for the last two reporting years.

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

The reasons behind the dips and jumps in creosote usage are given in the chapter up as recommended by ERT and the EF for tobacco factor were corrected previously. The ERT implemented the recommendations to correct the EF and perform PAHs emissions recalculations. Furthermore, based on the recommendation given by the MS solvent expert stipulated in the Twining mission report 24/2016, expert activity data on use of shoes and use of tobacco has been recalculated for the period 2004-2015, bearing in mind that the import and export data should be taken into account. Data on shoes used were recalculated up to 2013. Additionally, emissions from creosote were recalculated up to 2007 due to the recommendations given in the same report. These activity data were available and recalculate in the previous two years.

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

This report does not include emissions from the following activities in the inventory: SNAP 060401 Glass wool induction, 060402 Mineral wool induction, 060405 Application of glues and adhesives, 060409 Vehicle de-waxing. Therefore, NMVOC emissions from NFR 2.D.3.i might be underestimated. A meeting with SSO was held in the beginning of this year to discuss the needed missing data and the possibility to collect this type of data will be investigated, also historical data maybe a little overestimated and will be recalculated in the upcoming submission. This requires more time because these data are available in hard copy only. The experts did not find any data on fireworks and this remain recommendation that has not been implemented.

5.6.9.5. 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.

5.6.9.6. 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 form 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:

$AR_{\text{production,technology}}$ = the production rate within this source category;

$EF_{\text{technology,pollutants}}$ = the emission factor for this technology and this 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 2005-2018. 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 2007-2018 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 178 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 (2005-2017))

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	NE
2001	43 900	622 181	4 346 100	NE	75 003	1 972	18 004	26 041	10 995	74 689	NE
2002	37 960	637 894	3 758 040	NE	68 382	1 972	36 614	27 471	10 828	68 425	NE
2003	28 350	680 217	2 806 650	NE	61 474	1 972	33 334	29 835	10 454	58 606	NE
2004	12 424	717 496	516 000	NE	55 235	1 972	27 810	29 839	10 113	43 115	NE
2005	10 548	675 325	948 489	NE	77 025	1 734	36 815	28 264	8 051	45 654	NE

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
2006	11 831	669 648	703 005	NE	73 497	1 903	19 325	28 041	8 030	44 774	NE
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	30 259	25 548	67 518	4 185
2012	10 341	633 621	591 291	457 824	62 695	2 228	21 414	34 999	30 144	68 723	4 214
2013	11 548	617 124	686 841	599 049	46 983	2 433	22 916	35 439	31 181	60 127	4 405
2014	9 847	640 948	396 630	399 351	47 553	2 339	12 085	31 331	31 150	62 919	3 894
2015	10 848	656 672	605 404	500 017	45 553	2 328	NO	30 466	39 532	63 808	4 160
2016	12 481	672 487	602 187	460 461	40 563	2 118	NO	30 769	36 303	64 751	4 609
2017	11 582	705 497	367 020	397 953	48 348	2 374	NO	29 438	36 374	59 968	4 239
2018	13 082	736 062	565 799	462 320	45 117	2 324	NO	33 457	37 656	57 528	4 306

Emission factors

The emission factors for estimation of NMVOC emissions are presented in the following table.

Table 179 Emission factors for source category 2.H.2 - Food and beverages industry

Pollutant	Value	Unit	References
NMVOC	15	kg/hL alcohol(spirits)	GB 2019 2.H.2 Food and beverages industry. Table 3-28. pg. 23
NMVOC	35	g/hL beer	GB 2019 2.H.2 Food and beverages industry. Table 3-27. pg. 22
NMVOC	80	g/hL wine	GB 2019 2.H.2 Food and beverages industry. Table 3-24. pg. 21
NMVOC	35	g/hL white wine	GB 2019 2.H.2 Food and beverages industry. Table 3-26. pg. 22
NMVOC	1	kg/Mg animal feed	GB 2019 2.H.2 Food and beverages industry. Table 3-22. pg. 20
NMVOC	10	kg/Mg product (Margarine and solid cooking fats)	GB 2019 2.H.2 Food and beverages industry. Table 3-21. pg. 19
NMVOC	10	kg/Mg sugar	GB 2019 2.H.2 Food and beverages industry. Table 3-20. pg. 19
NMVOC	0.3	kg/Mg product (meat, fish and poultry)	GB 2019 2.H.2 Food and beverages industry. Table 3-19. pg. 18
NMVOC	1	kg/Mg product (cakes, biscuits and breakfast cereals)	GB 2019 2.H.2 Food and beverages industry. Table 3-18. pg. 18
NMVOC	4.5	kg/Mg bread	GB 2019 2.H.2 Food and beverages industry. Table 3-10. pg. 14
NMVOC	0.55	kg/Mg beans (roasted coffee)	GB 2019 2.H.2 Food and beverages industry. Table 3-23. pg. 20

5.6.9.7. 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.

5.6.9.8. 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.

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

Recalculations were done in this sector for the period 2007-2017, due to revised available statistical activity data.

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

It is planned to make recalculation for historical data using the available activity data on coffee roasting and on wine production maybe by use of extrapolation method in future submissions.

5.6.9.11. 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.

5.6.9.12. 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 1990-2018[21] and the publication Industry in the Republic of North Macedonia for the period 2005-2015[27], and data form MAKSTAT database for period 2016-2018 [29].

Table 180 Activity data for source category 2.I - Wood processing

Year	Wood processed [Mg]	Year	Wood processed [Mg]	Year	Wood processed [Mg]
1990	66 889	2000	18 173	2010	14 225
1991	52 422	2001	16 882	2011	11 986
1992	46 790	2002	10 015	2012	19 251
1993	44 454	2003	19 913	2013	14 211
1994	40 402	2004	24 263	2014	14 414
1995	29 144	2005	15 509	2015	11 496
1996	27 210	2006	21 866	2016	10 098
1997	23 188	2007	15 173	2017	10 660
1998	17 048	2008	12 863	2018	7 698
1999	22 568	2009	4 429		

Emission factors

Emission factor for estimation of TSP have been taken from GB 2019 and they are presented in the table below.

Table 181 Emission factors for source category 2.I Wood processing

Pollutant	Value	Unit	References
TSP	1	kg/Mg wood products	GB 2019 Table 3.1 Tier 1 emission factors for source category 2.I Wood processing

5.6.9.13. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.9.14. 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.

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

Activity data in the sector Wood production – 2.I has been recalculated for the period 2007-2015, because unprocessed wood has been also taken into account in the previous submission. This correction was made due to the comments given by the MS expert within the last Twining project.

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

In response to the comments given by the MS industry expert, correction of the historical data for period 1990-2006 will be carried out because currently the emissions in this sector are overestimated.

AGRICULTURE



6. AGRICULTURE (NFR 3)

6.1. Sector overview

The Agriculture sector is a major source category for ammonia emissions. 91% of the total national emissions of NH₃ 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 2013 and 2016 were used for calculation of emissions in this sector.

Completeness

In the table below NFR categories covered in the Agriculture sector for 2018 are presented, which are not included in this sector and for which appropriate notation keys are used.

Table 182 NFR categories covered in Agriculture sector for 1990-2018

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
3Db	Indirect emissions from managed soils	NA

NFR category		Completeness
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	NE
3Dd	Off-farm storage, handling and transport of bulk agricultural products	NA
3De	Cultivated crops	NE
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 NH₃ 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.B, as calculations follow the tier 1 approach. Therefore, the notation key IE is used for this sector. NH₃ 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. The possibilities to estimate emissions in this sector will be discussed with national experts for the next reporting.

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.B as calculations follow the Tier 1 approach. Therefore, notation key IE is used. NH₃ 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 2013 does not provide methodologies and emission factors for this source category. Thus, emissions from Crop residues applied to soils are reported as NA.

3.D.b: The EMEP/EEA Guidebook 2013 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.c: Farm-level agricultural operations including storage, handling and transport of agricultural products: In this category PM and TSP emissions from soil cultivation and crop harvesting should be reported. Data are not available (NE).

3.D.d: The EMEP/EEA Guidebook 2013 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.D.e: Cultivated crops is not estimated

3.D.f: Use of pesticides: Only if HCB is used as pesticide. HCB is forbidden under the Stockholm Convention on Persistent Organic Pollutants, so this NFR does not occur

3.F: Field burning is permitted by law and there are no data on illegal field burning activities available. NO is reported for source category 3F - Field burning.

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_x, NMVOC and PM have been obtained from EMEP/EEA Air Pollutant GB 2013. 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. Based on a recommendation of the Stage 3 CLRTAP Review 2016, North Macedonia applied the new Tier 1 methodology for calculating NH₃ emissions based on the EMEP/EEA GB 2016. Separate emission factors for housing, storage and yard (reported under 3.B), animal manure application and grazing (reported under 3.D) are now available in the latest GB version. 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[21] and Publication Livestock prepared by the State Statistical Office for the period 2007-2015[32] and MAKSTAT database for activity data for 2016-2018[34]. The numbers per livestock category are presented in Table 183. Number of different categories of poultry are presented in Table 184.

Table 183 Domestic livestock population and its trend 1990–2017

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
Trend 1990-2018	6%	-24%	10%	14%	-16%	-68%	-58%	-85%

Table 184 Domestic poultry and its trend 1990–2018

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
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

Year	Laying hens	Broilers	Livestock category – Population size [heads] *			
			Ducks	Geese	Turkeys	Total Poultry
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
Trend 1990–2018	-68%	-74%	-32%	-41%	-54%	-68%

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 [26] leading to more accurate animal numbers.

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 the vast majority of farms) and business entities (less than 200 registered).

The annual accountings were made as of the 31st 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.

Actually, the Ministry of Agriculture and the Statistics Office have an ongoing project with the aim of improving the livestock statistics by using animal data (cattle, swine) of the Veterinarian Register.

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 calf 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 calf number in the official statistics is due to the fact that (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 (+3.5% from 1990 to 2018).

Non-dairy cattle

Reduced rent ability of beef production is responsible for the decrease of Non-dairy cattle numbers by 20% between 1990 and 2018 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 16.5% between 1990 and 2018, 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 (-69%) 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 -53% between 1990 and 2018, because in the last century husbandry of goats was forbidden as it would curb the formation of karst. In the MAKSTAT database revised goat numbers were provided for the period 2000-2018. Revised numbers for period 2000-2007 will be used in the next submission.

Horses

Horse numbers show a decreasing trend since 1990 (-85%). 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 asses. No data on mules and asses 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 68% from 1990 to 2018 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 NH₃ 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 is 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 NH₃ 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 is 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 NH₃ 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 NH₃ and NO_x emission factors of all other animal categories do not distinguish between solid and liquid systems.

6.3.1.2. Emission factors

Tables 174 and 175 provide emission factors taken from the EMEP EEA GB 2013 (updated July 2015 version) and for NH₃ from EMEP EEA GB 2016, for each livestock category. These factors have been

used for the estimation of NO_x NMVOC and NH₃ 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). EF for NMVOC are same in EMEP EEA GB 2013 and 2016.

Table 185 NH₃ emission factors for source categories 3.B - Manure management and 3.D - Agricultural Soils

NFR code	NH ₃		
	Housing, storage, yard	Manure application*	Grazing**
	kg AAP-1 a-1	kg AAP-1 a-1	kg AAP-1 a-1
3B1a Dairy cattle	16.9	8.8	2.9
3B1b Non-dairy cattle	6.2	2.2	0.8
3B2 Sheep	0.4	0.2	0.8
3B3 Swine-fattening pigs	4.0	2.7	0.0
3B3 Swine-sows	9.0	6.0	0.0
3B4d Goats	0.4	0.2	0.8
3B4e Horses	7.0	1.7	6.1
3B4gi Laying hens	0.32	0.15	0.0
3B4gii Broilers	0.15	0.07	0.0
3B4giii Turkeys	0.56	0.39	0.0
3B4giv Other poultry (ducks)	0.45	0.23	0.0
3B4giv Other poultry (geese)	0.30	0.05	0.0
Reference	GB 2016 - Table 3.2 Default Tier 1 EF (EF NH ₃) for calculation of NH ₃ emissions from manure management		

*reported under source category 3.D.a.2

** reported under source category 3.D.a.3

Table 186 NO_x and NMVOC emission factors for source category 3B - Manure management

NFR code	Pollutants	
	NO _x	NMVOC
	kg AAP-1 a-1	kg AAP-1 a-1
3B1a Dairy cattle	0.154	12.992
3B1b Non-dairy cattle	0.094	6.252
3B2 Sheep	0.005	0.169
3B3 Swine-fattening pigs	0.001	0.551
3B3 Swine-sows	0.004	1.704
3B4d Goats	0.005	0.542
3B4e Horses	0.131	7.781
3B4gi Laying hens	0.003	0.165
3B4gii Broilers	0.001	0.108
3B4giii Turkeys	0.005	0.489
3B4giv Other poultry (ducks)	0.004	0.489
3B4giv Other poultry (geese)	0.001	0.489

NFR code	Pollutants	
	NOx	NM VOC
	kg AAP-1 a-1	kg AAP-1 a-1
Reference	GB 2013 updated July 2015 - Table 3.2 Default Tier 1 EF for NO	GB 2016- Table 3-3 Default Tier 1 EF for NM VOC

Emissions of particulate matter (PM) occurring from animal husbandry were calculated with the EMEP/EEA Tier 1 methodology provided in the EMEP/EEA Guidebook 2013 (updated version July 2015). The Tier 1 methodology multiplies average animal numbers with the particular default emission factors listed in the following table:

Table 187 TSP, PM10 and PM2.5 emission factors for source category 3.B - Manure management

NFR code	TSP	PM10	PM2.5	Reference
	kg/capita	kg/capita	kg/capita	
3B1a Dairy cattle	1.38	0.63	0.41	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B1b Non-dairy cattle	0.59	0.27	0.18	GB 2013 updated July 2015 - Table 3,3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B2 Sheep	0.139	0.0556	0.0167	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B3 Swine-fattening pigs	0.75	0.34	0.06	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B3 Swine- sows	1.53	0.69	0.12	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4d Goats	0.139	0.0556	0.0167	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4e Horses	0.48	0.22	0.14	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4gi Laying hens	0.119	0.119	0.023	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4gii Broilers	0.069	0.069	0.009	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4giii Turkeys	0.52	0.52	0.07	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4giv Other poultry (ducks)	0.14	0.14	0.02	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).
3B4giv Other poultry (geese)	0.24	0.24	0.03	GB 2013 updated July 2015 - Table 3.3 Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).

NM VOC 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 2013. Table 3-3).

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 188 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				
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 sent 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 helpers and calves in the case of cattle numbers.

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

No recalculations have been carried out in this sector.

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

The main issue of use of higher Tier methodology for this sector remains. It is planned to make improvement in the upcoming IPA project due to limitation of expertise to proceed with Tier 2 methodology. According to the recommendation given in the stage 3 Review “The ERT encourages the Party to provide a more detailed description of the methodology for calculating particle emissions in the IIR” it was explained that Tier 1 methodology is used to calculate particulate emissions coming from this sector. Due to the limited time Emission factors from the latest Guidebook were not checked and it is planned to check latest EF for the next submission. Additionally, there are revised number of livestock in the MAKSTAT database data need to be compared with the used activity data and updated if needed. For example, there are update numbers of goats for period 2000-2018, while the numbers for period 2007-2018 remain the same, the numbers for period 2000-2006 need to be updated.

6.4. Crop production and Agricultural Soils - NFR 3.D

6.4.1. 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 sulphate, 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_h 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.

Table 189 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

*the 3-years average is used for all fertilizer types

Emission factors

In the following tables the emission factors applied for source category 3.D.a.1 are shown. All emission factors are taken from the GB 2013 and the GB 2016.

Table 190 NH₃ Emissions factors for source category NFR 3.D.a.1 - Inorganic fertilizers

Fertilizer type	Value	Unit	References
AS	0.09	kg NH ₃ kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
AN	0.015	kg NH ₃ kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
CAN	0.008	kg NH ₃ kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
U	0.155	kg NH ₃ kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
MAP	0.05	kg NH ₃ kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
DAP	0.05	kg NH ₃ kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
NPK	0.05	kg NH ₃ 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 191 NO_x, NMVOC and PM Emissions factors for source category NFR 3.D.a.1 - Inorganic fertilizers

Pollutant	Value	Unit	References
NO _x	0.026	kg kg-1 fertilizer-N applied	GB 2016 Table 3-1 emission factor for source category 3.D.a.1
NMVOC	0.86	kg/ha	GB 2016 Table 3-1 emission factor for source category 3.D.a.1
PM ₁₀	1.56	kg/ha	GB 2016 Table 3-1 emission factor for source category 3.D.a.1
PM _{2.5}	0.06	kg/ha	GB 2016 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 NH₃ 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[21] and Publication Livestock [32], prepared by the State Statistical Office f period 2007-2015 [32] and MAKSTAT database for 2016-2018 [34]. The numbers per livestock category are presented in Table 183. Numbers of different categories of poultry were presented in Table 184. 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 NH₃ emission factors for animal manure applied to soils, taken from EMEP/EEA GB 2016, are shown.

6.4.3. Urine and dung deposited by grazing animals (NFR 3.D.a.3)

This source category covers NH₃ 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 2007-2018. The numbers per livestock category are presented in Table 183. Number of different categories of poultry are presented in Table 184. 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 NH₃ emission factors for grazing, taken from EMEP/EEA GB 2016, are shown.

6.4.4. 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 192 Uncertainties of emissions, emission factors and activity data

Categories		NH ₃ Emissions	NO _x Emissions	NM ₂ VOC Emissions	PM _{2.5} Emissions	EF NH ₃	EF NO _x	EF NM ₂ VOC	EF PM _{2.5}
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 2009-2018, 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 will be contact for further explanation of this inconsistency.

6.4.5. Source-specific QA/QC and verification

The following sector specific QA/QC procedures have been carried out:

Activity data

Activity data from different sources like (FAO and MAFWS) for the period 2009-2011 was performed. Last year data were compared with 2015 data.

An Excel sheet called Fertilizers_final.xls was prepared by the MS expert in which graphs for different type of fertilizers are shown are checked for dips and jumps. Furthermore, comparison with time series of previous year is done and the data providers are asked on dips or jumps, that was not the case in this year.

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 starting from 2001 onwards.

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

Minor recalculations were done but due to correction of excel formula for the three years average of the used fertilizers.

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

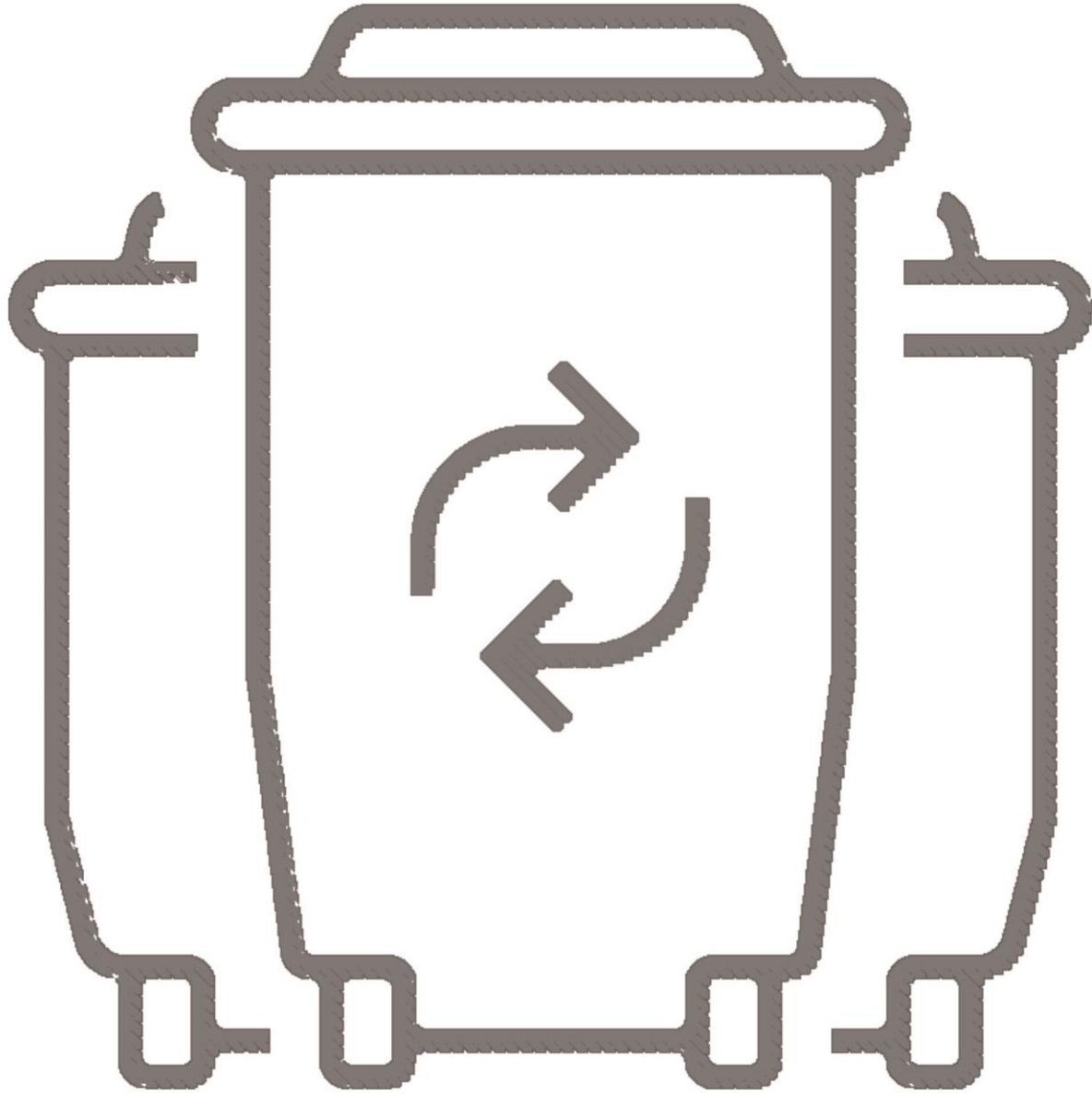
Questions on the dips and jumps in the use of some fertilizers will be sent to Ministry of agriculture.

6.5. 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.

WASTE



7. WASTE (NFR 5)

7.1. Sector overview

The chapter includes calculation of NO_x, SO₂, 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.C.1.biii - Clinical waste incineration

5.C.2 - Open burning of waste

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 have been followed. Additionally, emissions for category 5.D.2 have been calculated using a Tier 2 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. Generally, in the country there is only clinical waste incinerator operating from 2000. Other type 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 fifteen Waste-Water treatment plants (WWTP) operating in North Macedonia. For the plant in Dojran, activity data are available for the whole time series. Emissions have been estimated based on these activity data and the data from the another thirteen wastewater treatment plants. However, as data for the biggest plant in Ohrid is currently not available, the emissions are underestimated.

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.

With regards to 5.D.1 Domestic wastewater handling latrines, there are no available activity data to calculate these emissions. The tier 1 approach for this submission was replaced with tier 2 approach and category 5.D.1 was categorized as NE.

7.1.1. Methodology

Tier 1 and Tier 2 approach were used, using the given default Emission factors from the GB2016.

Completeness

The completeness in this sector is presented in the following table.

Table 193 NFR categories 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	NE
5.B.2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NA
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)	NA
5.D.1	Domestic wastewater handling	NE
5.D.2	Industrial wastewater handling	√
5.D.3	Other wastewater handling	NA
5.E	Other waste (please specify in IIR)	NO

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
- calculation of emission from 5.D.2
- review of notation key use.

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

Recalculation were made for the following sectors, the resulting differences and justifications are described in the respective sub-chapters.

5.D.1 - Domestic Waste Water Handling

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

The stage 3 review recommended establishing a national data reporting system for waste amounts in coordination with the National Statistical Office. This recommendation is taken seriously but takes some time to be set up and implemented.

In addition, wastewater treatment plants shall be asked again to send whole time series activity data to be able to calculate emissions from category 5.D.1, since currently the emissions in this sector are underestimated. The activity data concerning industrial wastewater treated are available from the PRTR software BUBE that is operational starting from this year onwards.

A TAEIX study visit to an EU country Austria has been held during this year on strengthening the capacities for future establishment of a national data reporting system for waste amounts in coordination with the National Statistical Office. Key sector expert, deputy expert and representative from the National Statistical Office participated in this planned TAEIX mission.

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 NH₃ were estimated using Tier 2 method, and particulate emissions were estimated using Tier 1 method by multiplying amount of landfilled municipal solid waste and emission factors. These emissions have been calculated using Tier 2 emission factors following the guidance of 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

7.2.2. Activity Data

As for Tier 2 method, 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 2018 (source: Eurostat statistics and EEA report). The hereby available information provided data on waste generation from 2003 to 2018. 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” [43] was used. The shares are kept constant for the whole time series (1950 to 2018) due to a lack of better data, although, it can be assumed that in 1950 the waste composition was different.

Table 194 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. 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 2018. Before 1994, GDP for former Yugoslavia were found and used [44]. Industrial waste * by category, tons.

Table 195 Type of waste, and quantity in tons

Type of waste	Quantity [t]
Waste from households and similar waste – non-hazardous	5131,38
Mixed and undifferentiated materials – nonhazardous	9643,95
Waste from sorting materials – non-hazardous	167,65
Deposition	729,54
Waste from combustion	3005,33
Soil waste	9827,26
Waste from excavation	71 027,10
Industrial waste disposition	945 761,30
Paper and cardboard waste	483 859,40
Rubber waste	1650,89
Plastics waste	8792,21
Wood waste	1398,89
Textile waste	721,05
Animal waste and mixed food waste	2408,00
Agricultural waste	3427,89
Animal manure and urine	86 099,50
TOTAL	1 633 651,33

Table 196 Activity data for source category 5.A - Solid waste disposal on land for the period 1990-2018

Year	Municipal Waste in Gg	Industrial Waste in Gg	Total Waste in Gg	Methane Emission in m ³
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

7.2.2.1. 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 for Southern European Countries with dry temperature.

Table 197 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 ₄	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 NH₃ were estimated based on the landfill gas emitted. Therefore, methane emission has been converted to landfill gas in m³ by consideration of the CH₄ concentration in the landfill gas and by taking into account the absolute density of CH₄. Based on that NM VOC, CO and NH₃ were calculated.

Table 198 Data for conversion of methane emissions to NM VOC, CO and NH₃ emissions for category 5A - Biological treatment of waste

Parameter	CH ₄	NM VOC	CO	NH ₃
Relative density	0.555	0.555	0.967	-
Absolute density [kg/Nm ³] by 30°C	0.650	0.72	1.13	-
Concentration in landfill gas [%] (Cd, Hg, Pb, NM VOC, NH ₃ in mg/m ³)	55	300	2	10

The emission factors used to calculate emission from particulate matter are as outlined in the GB 2019 for source category 5.A.

Table 199 Emission factors for source category 5.A- Biological treatment of waste

Pollutant	Value	Unit	Reference
NM VOC	1.56	kg/Mg	GB 2019 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land Table 3-1 page 5
TSP	0.463	g/Mg	GB 2019 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land Table 3-1 page 5
PM ₁₀	0.219	g/Mg	GB 2019 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land Table 3-1 page 5
PM _{2.5}	0.33	g/Mg	GB 2019 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land Table 3-1 page 5

For NO_x, CO, SO_x, heavy metals except and POPs the notation key NA was used. For NH₃, particulates, BC, Heavy metals the notation key NE was used – as outlined in the GB 2019.

7.2.3. 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 200 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%
Activity data				
Amount of landfilled waste		+/- 50,0%		

7.2.4. 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.

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

The activity data for the period 1990-2000 were recalculated, as revised population data was used in the calculations. These revised population data was used also in 2 D categories, in order to have consistency. Source-specific improvements are planned, as well as a categorization of the waste types for the next reporting.

7.3. Clinical Waste incineration - NFR 5.C

7.3.1. Methodological issues

Emissions from this source category are estimated according to GB-2019. The guideline outlines simple methodology where the amount of clinical waste incinerated is multiplied with Tier 1 emission factors.

7.3.1.1. 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 2000-2018 were taken from the Drisla landfill website [38].

Table 201 Quantity of clinical waste incinerated in the period 2000–2018

Year	Clinical waste[Gg]	Year	Clinical waste [Gg]
2000	0.115	2010	0.465
2001	0.232	2011	0.479
2002	0.249	2012	0.511
2003	0.255	2013	0.684
2004	0.323	2014	0.676
2005	0.376	2015	0.903
2006	0.329	2016	0.969

Year	Clinical waste[Gg]	Year	Clinical waste [Gg]
2007	0.357	2017	1.007
2008	0.362	2018	0.912
2009	0.416		

7.3.1.2. Emission Factors

The emission factors used are as outlined in the GB 2019 and presented in the following table.

Table 202 Emission factors for source category 5.c.1.dii - Clinical waste incineration

Pollutant	Value	Unit	References
NOx	2.3	kg/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
NMVOC	0.7	kg/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
TSP	17	kg/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
BC	2.3	% of TSP	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
CO	0.19	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
Pb	62	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
Cd	8	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
Cr	2	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
Cu	98	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
PCB	0.02	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
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	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
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

7.3.2. 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_x, NO_x 125% (rating C) for NMVOC. No uncertainty analysis was done for the other pollutants.

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

Recalculations were done for the period considering that updated data was presented. Previously the enterprise reported only the medical waste carried that was transported only with their own transport, but not with other transport. Additionally, they report the amounts of medical waste in boxes and bags, while previously only number of boxes were provided.

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

No planned improvements in this category.

7.4. Open burning of waste- NFR 5.C.2

7.4.1. 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:

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

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 $518.740 \times 25 / 1000 = 12.969$

7.4.1.1. 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, 2007-2018 [31].

Table 203 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	2004	560 000	14 000
1991	664 000	16 600	2005	546 000	13 650
1992	662 000	16 550	2006	537 000	13 425
1993	663 000	16 575	2007	529 000	13 225

Year	Arable farmland [hectare]	Waste [Mg]	Year	Arable farmland [hectare]	Waste [Mg]
1994	661 000	16 525	2008	521 000	13 025
1995	656 000	16 400	2009	513 000	12 825
1996	658 000	16 450	2010	504 000	12 600
1997	647 000	16 175	2011	511 000	12 775
1998	635 000	15 875	2012	510 000	12 750
1999	633 000	15 825	2013	509 000	12 725
2000	598 000	14 950	2014	511 579	12 789
2001	612 000	15 300	2015	513 564	12 839
2002	577 000	14 425	2016	516 644	12 916
2003	569 000	14 225	2017	516 870	12 922
			2018	518 740	12 969

7.4.1.2. Emission Factors

The emission factors used are as outlined in the GB 2019 for source category 5.C.2.

Table 204 Emission factors for source category 5.C.2 - Open burning of waste

Pollutant	Value	Unit	References
NOx	3.18	kg/Mg	GB 2019 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 2019 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 2019 Table 3-1 Tier 1 emission factors for source category 5.C.2 Small-scale waste burning, page 6
PM2.5	4.19	kg/Mg	GB 2019 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 2019 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 2019 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 2019 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 2019 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 2019 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 2019 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 2019 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 2019 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 2019 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 2019 Table 3-1 Tier 1 emission factors for source category 5.C.2 Small-scale waste burning, page 6

Pollutant	Value	Unit	References
benzo(a) pyren	2.33	g/Mg	GB 2019 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 2019 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 2019 Table 3-1 Tier 1 emission factors for source category 5.C.2 Small-scale waste burning, page 6

7.4.2. Source-specific uncertainties and time-series consistency

See chapter 5.3.2.

7.4.3. Source-specific QA/QC and verification

See chapter 5.3.3.

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

No recalculations were made in this sector.

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

No planned improvements.

7.5. Waste water treatment - NFR 5.D

7.5.1. Methodological issues

In the Republic of North Macedonia there are fifteen wastewater treatment plants that have been contacted to submit plant specific data and particularly provide the amount of domestic wastewater treated in the plants. Based on the data received by the plants, emissions were calculated based on a Tier 2 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”. This number seems to be correct when analyzing the connection to the sewage system, but when it comes to the connection to wastewater treatment plants, the percentages provided by EUROSTAT seem reliable. Nevertheless, this information is not sufficient to decide on how many people are using latrines or septic tanks, which serves as activity data for NH₃ emissions. For this reason, NH₃ emissions from 5.D.1 cannot be calculated with the available data. However, in order to also report on NMVOC emissions from 5.D.2, the amount of wastewater from households and industries is needed.

Regarding the 5.D.2. several industrial facilities submitted data on the wastewater treated in their wastewater treatment plants. The information was collected through questionnaires. The results for the quantity of wastewater treated and emissions calculated was based on a Tier 2 approach of NMVOC improved for 2018.

7.5.1.1. Activity data

Activity data on wastewater handled in treatment plants are presented in the following table:

Table 205 Activity data for source category 5.D2 - Wastewater treatment in residential/commercial sector, SNAP 091001

Year	Water treated [m3]	Year	Water treated [m3]
1990	14 690 160	2004	15 462 500
1991	15 320 880	2005	16 408 580
1992	14 374 800	2006	16 250 900
1993	15 636 240	2007	15 304 820
1994	15 320 880	2008	16 093 220
1995	14 374 800	2009	21 187 840
1996	14 847 840	2010	21 698 560
1997	15 163 200	2011	21 113 200
1998	15 793 920	2012	22 836 899
1999	15 951 600	2013	21 079 644
2000	14 532 480	2014	24 709 351
2001	15 478 560	2015	25 322 341
2002	14 374 800	2016	12 675 451
2003	15 163 200	2017	9 639 664
		2018	18 566 614

Table 206 Activity data for source category 5.D.2 – Industrial Wastewater treatment in industry sector

Year	Water treated [m ³]
2018	12 927 585

1.5.1.2. Emission Factors

The emission factors applied are given in the EMEP 2019 guidebook, Table 3-3, Tier 2 emission factors for source category 5.D Wastewater handling, latrines on page 9, which allowed the calculation of NMVOC emission from domestic and industry wastewater handling. The emission factor used is 15mg NMVOC per m³ 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.

7.5.2. 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.

7.5.3. Source-specific QA/QC and verification

A waste expert checked the calculation, so a 4-eye principle was applied.

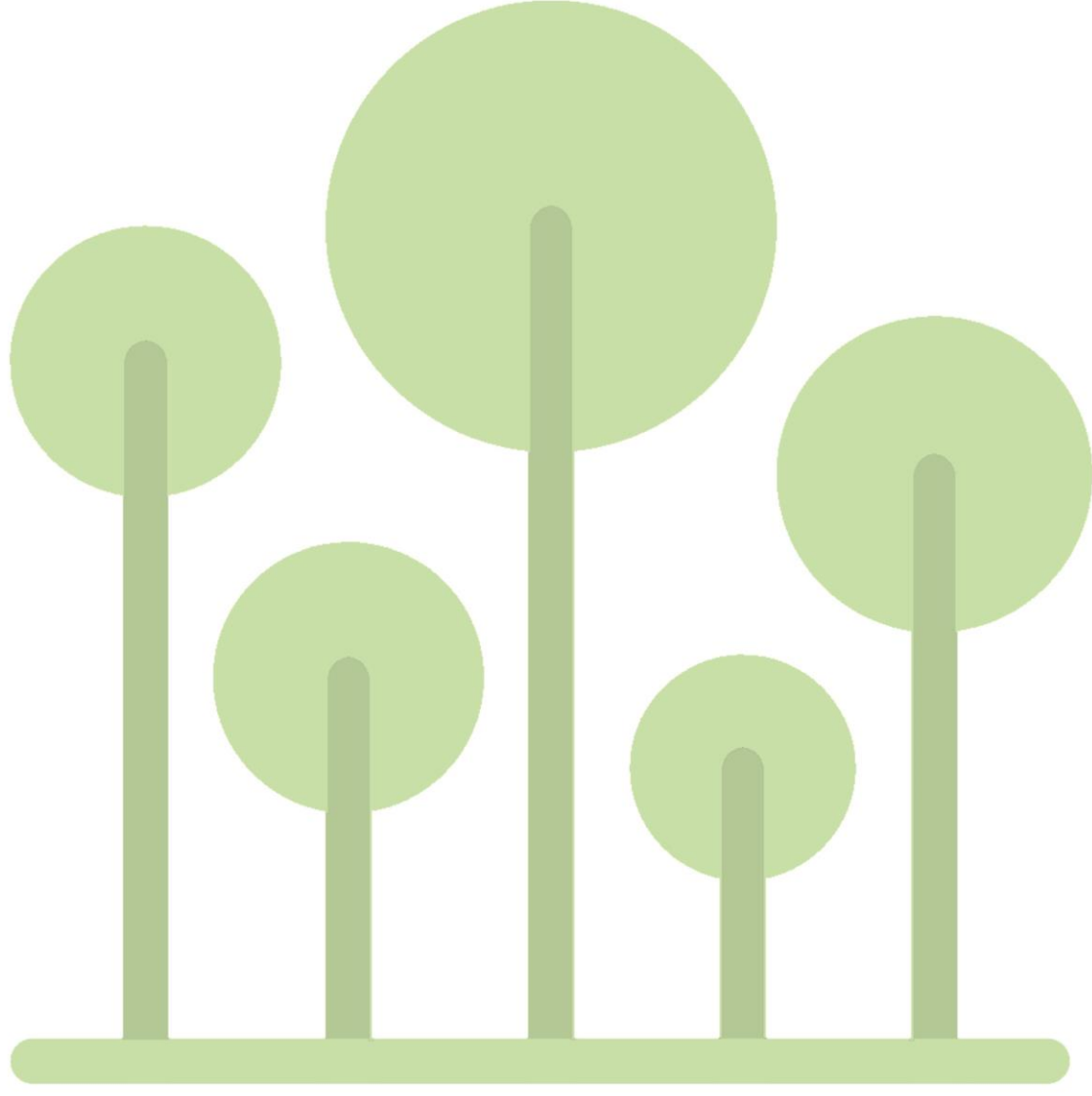
7.5.4. Source-specific recalculations including changes made in response to the review process

No recalculation was done in this category. Category 5.D.1 was categorized as not estimated and emissions were reported as 5.D.2 for 2018 taken into account also emissions coming from industrial waste water treatment plants.

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

Activity data was received from thirteen out of fifteen wastewater treatment public plants. It is expected that all data will be collected for the next submission. Data on number of people connected to latrines should be available with the upcoming National census. It is intended to improve the process of collection the data and information about industrial wastewater treatment plants and quantity of treated wastewater and to make calculation of NMVOC emissions coming from industrial wastewater treatment plants for the years before 2018.

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, NH₃, NO_x, SO_x, PM₁₀, PM_{2.5}, TSP CO and BC as well as references to activity data and emission factors concerning emissions coming from the forest fires for the period 1990-2018.

8.2. 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 207 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

8.3. Forest fires – NFR 11.B

8.3.1. 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.

8.3.1.1. 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 208 Activity data for source category 11.B Forest fires

Year	Area burned [ha]	Wood burned [m3]	Wood burned [kg]
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	4807	711 782	548 072 140
2001	5255	88 260	67 960 200
2002	5482	24 661	18 989 186
2003	1922	10 987	8 459 990
2004	1798	4 322	3 328 171
2005	3093	1 063	8 185 510
2006	3594	12 978	9 993 060
2007	34443	617 678	475 612 060
2008	15046	35 652	27 452 425
2009	1030	1 551	1 194 270
2010	4725	2 033	1 565 410
2011	8702	55 743	42 922 341
2012	19312	102 160	78 663 200
2013	2844	15 268	11 756 090
2014	1150	19 152	14 747 040
2015	3165	32 494	25 020 380
2016	2166	17 573	13 531 749
2017	13405	82 981,11	63 895 454,7
2018	2823	5 785,98	4 455 204,6

8.3.1.2. Emission factors

Calculation of emission parameters was used, and emission factors were taken from the GB 2019.

Table 209 Emission factors for source category 11.B Forest fires

Pollutant	Value	Unit	References
NO _x	100	kg/ha area burned	GB 2019 11B Forest fires. Table 3-1. pg. 9
CO	3000	kg/ha area burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
NM VOC	300	kg/ha area burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
SO _x	20	kg/ha area burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
NH ₃	20	kg/ha area burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
PM ₁₀	11	g/kg wood burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
PM _{2.5}	9	g/kg wood burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
TSP	17	g/kg wood burned	GB 2019 11.B Forest fires. Table 3-1. pg. 9
BC	9	% of PM _{2.5}	GB 2019 11.B Forest fires. Table 3-1. pg. 9

In the Statistical Yearbooks from 2000-2016 [21] there is data for wood burned in m³. Calculation is made for wood burned in kg using the equation: average density 0.77 kg/m³ *1000.

8.3.2. Source-specific uncertainties and time-series consistency

No data available for burned area for the period 1990-1999.

8.3.3. Source-specific QA/QC and verification

Macedonian Forests Company provided the data that was crosschecked with the data published in the SSO publication Forestry.

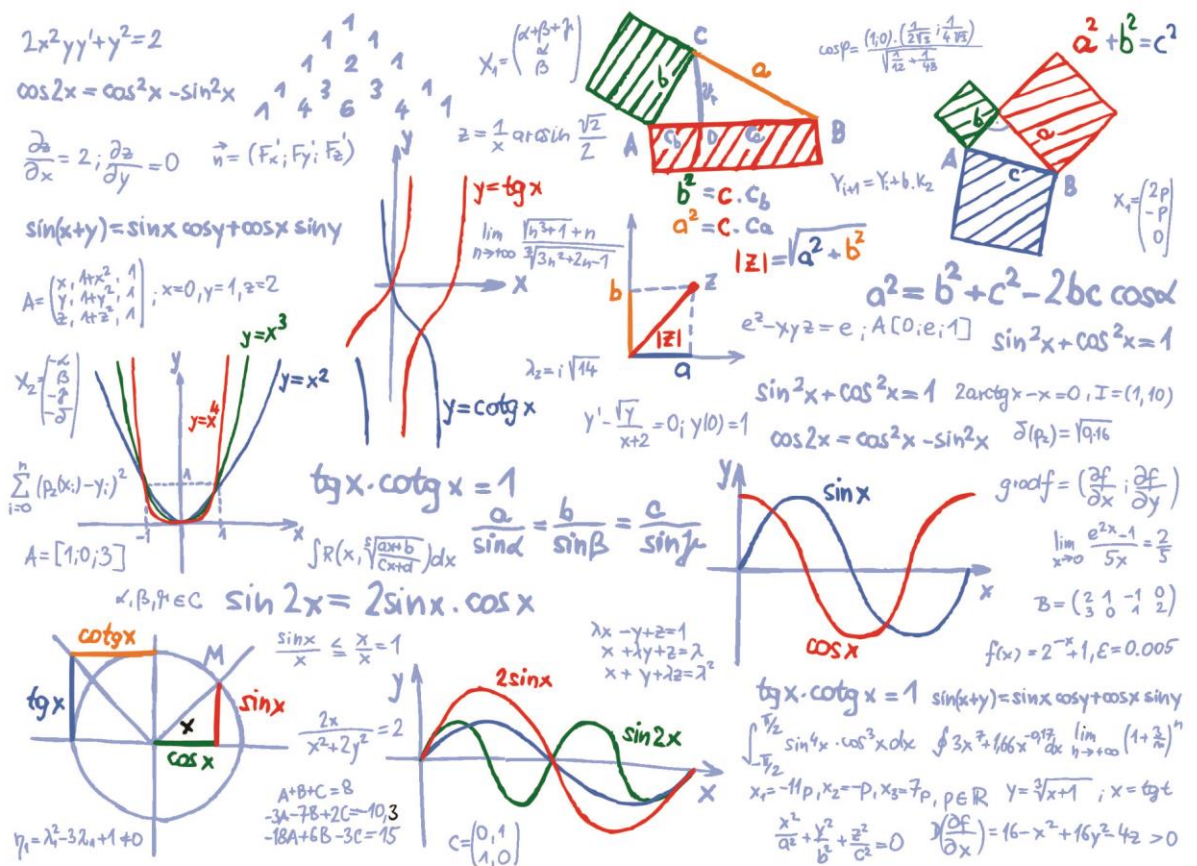
8.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this sector.

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

No planned improvements in this sector for the future submission. During the future IPA project possible other natural sources may be investigated, but during the period 2021-2022.

RECALCULATIONS



9. RECALCULATIONS AND IMPROVEMENTS

9.1. Recalculations

To ensure time series consistency when improving the Macedonian emission inventory, recalculations have been carried out for the historical years.

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 and use of updated emission factors from the GB 2019. Explanations for recalculation per sector are given in the respective chapters. The tables indicating recalculations per pollutant can be found in tables 210-224.

Energy (NFR 1)

In the NFR sectors 1.A.2 - Combustion in manufacturing industries and 1.A.4 - Small combustion, instead of preliminary activity data, final fuel consumption data has been used for 2017. Furthermore, we have recalculated implied EF for 1.A.1.a for certain period taken into account technological issues, updated the emission factors for 1.A.4 using EF from 2019 Guidebook, and updated activity data in 1.A.4 on solid fuels.

Transport (NFR 1.A.3)

In this sector the recalculations were done by using the final data instead of preliminary data for fuel use for 2017.

Industrial processes and product use (NFR 2)

The recalculations in this sector were made due to the comments given by the MS solvent expert in the frame of the Twinning project, as well as by the ERT engaged in stage III review of the previous IIR.

There was an overestimation of the estimated emissions in the sectors 2.G - Other product use and in 2.I – Wood production. This was because produced instead of used products data were taken into account as activity data in the NFR 2.G - Other product use. and in 2.I – Wood production, all wooden products instead only those that are covered with creosote. The recalculations were done up to 2006 and 2011 respectively because of available activity data from the SSO.

Recalculations were also done due to replacement of EF in 2.D.3.c after gathering information of major use of BAT in this sector, and EF in NFRs sector 2.C.5 and 2.C.6 were updated with EF used for unabated technologies due to the fact that these processes were ongoing during the time when no BAT were implemented.

In sectors like 2.D.3.a, e, f, where population is used as activity data, data on populations was updated as recommended by Twining expert, using only data from SSO.

Agriculture (NFR 3)

No major recalculations were performed in this sector, only minor correction in category 3.D.a.1.

Waste (NFR 5)

Major recalculation occurred for this sector in NFR category 5.C.dii due to updated activity data by the company for waste incineration.

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 2017 national totals.

Table 210 Recalculation difference of NOx emissions [kt] compared to submission in 2019

NOx emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	5.73	0%	95%
1A2	Manufacturing Industries & Construction	-4.72	-0.34	-51%	-8%
1A3	Transport	0.00	-0.04	0%	-1%
1A4	Other Sectors	-0.34	-0.50	-19%	-34%
1B	Fugitive Emissions	0.00	0.00	0%	-
2	Industrial Processes and Product Use	0.00	0.04	0%	331%
3	Agriculture	0.00	0.06	0%	14%
5	Waste	0.00	0.00	0%	-1%
6	Other	0.00	0.00	-	-
Total emissions		-5.05	4.93	-11%	25%

Table 211 Recalculation difference of NMVOC emissions [kt] compared to submission in 2019

NMVOC emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0.00	0%	0%
1A2	Manufacturing Industries & Construction	-0.40	-0.01	-40%	-2%
1A3	Transport	0.00	0.00	0%	0%
1A4	Other Sectors	-0.01	-1.03	0%	-16%
1B	Fugitive Emissions	0.00	-0.01	0%	0%
2	Industrial Processes and Product Use	-0.41	-0.42	-3%	-4%
3	Agriculture	0.00	0.00	0%	0%
5	Waste	0.09	0.00	7%	0%
6	Other	0.00	0.00	-	-
Total emissions		-0.72	-1.48	-1%	-5%

Table 212 Recalculation difference of SO₂ emissions [kt] compared to submission in 2019

SO ₂ emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0.00	0%	0%
1.A.2	Manufacturing Industries & Construction	-0.64	0.09	-12%	2%
1.A.3*	Transport	0.00	-0.09	0%	-9%
1.A.4	Other Sectors	0.08	0.14	11%	31%
1.B	Fugitive Emissions	0.00	0.00	0%	-
2	Industrial Processes and Product Use	0.00	0.00	-	6%
3	Agriculture	0.00	0.00	-	-
5	Waste	0.00	0.00	0%	-3%
6	Other	0.00	0.00	-	-
Total emissions		-0.56	0.14	-1%	0%

Table 213 Recalculation difference of NH₃ emissions [kt] compared to submission in 2019

NH ₃ emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0.00	-	-
1.A.2*	Manufacturing Industries & Construction	0.00	0.00	-100%	-
1.A.3	Transport	0.00	0.00	0%	0%
1.A.4	Other Sectors	0.00	0.00	0%	0%
1.B	Fugitive Emissions	0.00	0.00	-	1%
2	Industrial Processes and Product Use	0.00	-0.02	0%	-
3	Agriculture	0.00	0.00	0%	0%
5	Waste	0.00	0.00	-	-
6	Other	0.00	0.00	-	-
Total emissions		0.00	-0.02	0%	0%

Table 214 Recalculation difference of PM_{2.5} emissions [kt] compared to submission in 2019

PM _{2.5} emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0.71	-	73%
1.A.2	Manufacturing Industries & Construction	-0.22	-0.03	-	-3%
1.A.3	Transport	0.00	0.00	-	0%
1.A.4	Other Sectors	0.00	-0.01	-	0%
1.B	Fugitive Emissions	0.00	0.00	-	-1%
2	Industrial Processes and Product Use	-0.20	0.19	-	70%
3	Agriculture	0.00	0.00	-	0%
5	Waste	0.00	0.00	-	0%
6	Other	0.00	0.00	-	-
Total emissions		-0.42	0.87	0%	10%

Table 215 Recalculation difference of PM10 emissions [kt] compared to submission 2017

PM10 emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	1.12	-	36%
1.A.2	Manufacturing Industries & Construction	-0.10	-0.02	-	-2%
1.A.3	Transport	0.00	0.00	-	0%
1.A.4	Other Sectors	0.00	0.00	-	32%
1.B	Fugitive Emissions	0.00	0.00	-	-1%
2	Industrial Processes and Product Use	-0.26	1.37	-	423%
3	Agriculture	0.00	0.00	-	0%
5	Waste	0.00	0.00	-	-3%
6	Other	0.00	0.00	-	-
	Total emissions	-0.36	2.46	0%	68%

Table 216 Recalculation difference of TSP emissions [kt] compared to submission in 2019

TSP emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	-	1.64	36%
1.A.2	Manufacturing Industries & Construction	0.12	-	-0.02	-2%
1.A.3	Transport	0.00	-	0.00	0%
1.A.4	Other Sectors	0.01	-	2.01	32%
1.B	Fugitive Emissions	0.00	-	0.00	-1%
2	Industrial Processes and Product Use	-0.33	-	6.42	423%
3	Agriculture	0.00	-	0.00	0%
5	Waste	0.00	-	0.00	-3%
6	Other	0.00	-	0.00	-
	Total emissions	-0.20	0%	10.05	68%

Table 217 Recalculation difference of CO emissions [kt] compared to submission in 2019

CO emissions [kt]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0%	0.00	0%
1.A.2	Manufacturing Industries & Construction	-1.23	-21%	-0.04	-1%
1.A.3	Transport	0.00	0%	-0.01	0%
1.A.4	Other	-0.10	0%	0.10	0%
1.B	Fugitive Emissions	0.00	0%	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.47	141%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.05	2%	0.11	4%
6	Other	0.00	-	0.00	-
	Total emissions	-1.28	-1%	0.64	1%

Table 218 Recalculation difference of Pb emissions [t] compared to submission in 2019

Pb emissions [t]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0.00	0%	0%
1.A.2	Manufacturing Industries & Construction	0.04	0.01	8%	2%
1.A.3	Transport	0.00	0.00	0%	0%
1.A.4	Other Sectors	0.21	-0.24	19%	-34%
1.B	Fugitive Emissions	0.00	0.00	-	-
2	Industrial Processes and Product Use	-123.35	-0.03	-89%	-7%
3	Agriculture	0.00	0.00	-	-
5	Waste	0.00	-0.01	0%	-10%
6	Other	0.00	0.00	-	-
	Total emissions	-123.09	-0.26	-53%	-11%

Table 219 Recalculation difference of Cd emissions [t] compared to submission in 2019

Cd emissions [t]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0.00	0%	0%
1.A.2	Manufacturing Industries & Construction	0.00	0.00	1%	-15%
1.A.3	Transport	0.00	0.00	0%	0%
1.A.4	Other Sectors	-0.18	-0.09	-88%	-88%
1.B	Fugitive Emissions	0.00	0.00	-	-
2	Industrial Processes and Product Use	-1.03	-0.38	-82%	-91%
3	Agriculture	0.00	0.00	-	-
5	Waste	0.00	0.00	0%	-10%
6	Other	0.00	0.00	-	-
	Total emissions	-1.21	-0.47	-76%	-79%

Table 220 Recalculation difference of Hg emissions [t] compared to submission in 2019

Hg emissions [t]		1990		2018	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0%	0.00	0%
1.A.2	Manufacturing Industries & Construction	0.00	0%	0.00	-5%
1.A.3	Transport	0.00	0%	0.00	0%
1.A.4	Other Sectors	0.00	0%	0.00	27%
1.B	Fugitive Emissions	0.00	0%	0.00	0%
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	0%	0.00	-
5	Waste	0.00	0%	0.01	18%
6	Other	0.00	0%	0.00	-
	Total emissions	0.00	0%	0.01	2%

Table 221 Recalculation difference of PCDD/ PCDF emissions [t] compared to submission in 2019

PCDD/ PCDF emissions [t]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0%	0.00	0%
1.A.2	Manufacturing Industries & Construction	0.00	0%	-0.07	-5%
1.A.3	Transport	0.00	-	0.00	-
1.A.4	Other Sectors	0.00	0%	1.90	29%
1.B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	-0.01	-2%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.01	4%
6	Other	0.00	-	0.00	-
Total emissions		0.00	0%	1.82	20%

Table 222 Recalculation difference of PAHs emissions [t] compared to submission in 2019

PAH emissions [t]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	0%	0.00	0%
1.A.2	Manufacturing Industries & Construction	0.05	10%	0.02	21%
1.A.3	Transport	0.00	-	0.00	-
1.A.4	Other Sectors	5.63	100%	2.67	95%
1.B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.13	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	-
6	Other	0.00	-	0.00	-
Total emissions		5.68	87%	2.82	83%

Table 223 Recalculation difference of HCB emissions [kg] compared to submission in 2019

HCB emissions [kg]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	-	0.00	-
1.A.2	Manufacturing Industries & Construction	0.00	2%	0.00	-11%
1.A.3	Transport	0.00	-	0.00	-
1.A.4	Other Sectors	0.02	20%	0.01	16%
1.B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	4.49	220%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	-	-0.01	-12%
6	Other	0.00	-	0.00	-
Total emissions		0.02	0%	4.48	205%

Table 224 Recalculation difference of PCB emissions [kg] compared to submission in 2019

PCB emissions [kg]		1990		2017	
		Δ kt	Δ %	Δ kt	Δ %
1.A.1	Energy Industries	0.00	-	0.00	-
1.A.2	Manufacturing Industries & Construction	0.00	0%	0.00	0%
1.A.3	Transport	0.00	-	0.00	-
1.A.4	Other Sectors	-0.01	-1%	0.01	3%
1.B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	8.21	5%	4.15	21%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	-	0.00	-12%
6	Other	0.00	-	0.00	-
	Total emissions	8.21	5%	4.16	20%

9.2. Improvements

Improvements made

The following table presents issues flagged by the CLRTAP stage 3 in 2016, as well as gaps in the emission inventory discovered by the MS experts that participated Twining project (which has not been already implemented in the previous submissions), as well as findings by the sectorial experts. Planned improvements at sector level are described in the respective sector chapters.

Table 225 Findings from step 3 Reviews (2011 and 2016) and improvements made (general issues)

Subject	Source	rating	Improvement made
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/2 016/	High	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 2020-2021
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/2 016/	High	The NIT has used 2019 EMEP Guidebook for a lot of sector, however due to limited activity data for some sectors EF from older Guidebooks are used.
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/2 016/	High	The NIT has started to use Tier 2 for several sector in Transport, Industry and Agriculture.

Subject	Source	rating	Improvement made
In the inventory improvement plan, the FYROM indicated to carry out a trend assessment within the KCA in future years.	CEIP/S3.RR/2016/	High	Trend assessment analysis was included in the IIR the following year after the stage 3 review was done.
The ERT noted an inconsistent use of notation keys between pollutants and years from some sources as indicated in the sector chapters below. The ERT recommends that the FYROM analyses the whole inventory on the correct use of notation keys as defined in the Reporting Guidelines.	CEIP/S3.RR/2016/	High	All recommendation on inconsistent notations key were implemented.
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/	High	This recommendation has been implemented.
The 2016 submission included LPS data for 2014 but no gridded emissions	CEIP/S3.RR/2016/	High	Gridded data for 2015 were reported in 2017 but information was not included in the IIR due to limited capacities.
QA/QC procedures improved	Peer-Review 2016	High	QA/QC procedures were improved due to the fact that all experts followed the QA/QC procedures and the QA/QC Matrix flow has been partially implemented.

Planned improvements

In the following table the planned improvements that are listed were recommended during the CLRTAP stage 3 reviews in 2011 and 2016 but were not implemented up to now and are planned to be implemented in the future. The improvements are structured as general issues (Table 226) and sector improvements (Table 227). Planned improvements which originate from a peer review in the course of the Twinning project in 2016, as well as improvements planned according to the observations of the gaps by the national emission inventory team (NEIT).

Table 226 Planned improvements (general issues)

Subject	Source	Rating	Improvement planned	Timeline
The ERT notes that the country does not submit emission estimates for projections. The ERT encourages the party to submit projected emissions for the 'With measures' and 'With additional measures' scenarios together with the associated social economic data for 2010 and 2020 to 2050 if possible.	CEIP/S3.RR/2010/ North Macedonia	High	Submission of projections data is planned for future submissions (see chapter 7)	Planned to be implemented in the following submissions
Verification - According to the review, a comparison with emission data submitted under NEC and UNFCCC has to be done. NEC currently not relevant. But UNFCCC data available. Issue raised during Stage 3 CLRTAP Review 2011.	CEIP/S3.RR/2010/ North Macedonia	Medium	Both teams have improved cooperation. Teams exchanged data on industry and energy sector. Statistical data have been used in both cases. Copert V model and same activity data will be used for future submission for both inventories.	Planned to be fully implemented in the following submissions
Recalculations to be quantified for the whole time series. currently (i.e. Submission 2017) only for 1990 and 2016	Peer-Review 2016	Low	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

Subject	Source	Rating	Improvement planned	Timeline
Preparation of QA/QC plan	Peer-Review 2016	Medium	There are a lot of QA/QC procedures and also Matrix flow has been prepared but due to limited capacities QA/QC plan has not been yet prepared	2021-2022
Use of higher Tier methodology for key sectors	CEIP/S3.RR/2010/ North Macedonia	High	It is planned to use Tier 3 for Transport, We have already started using Tier 2 in Industry sector and plan to use Tier 2 for 1A4 and 3B when activity data are available.	Planned to be implemented in the following submissions and started for some sectors in the upcoming IPA project
Inclusion of Gridded and LPS data in the IIE	CEIP/S3.RR/2010/ North Macedonia		These reporting obligations were fulfilled but due to time and capacity limitations were not included in the IIR	Planned to be implemented in the submission of the IIR in 2021 when LPS and Gridded data will be submitted
Inclusion of other Appendixes in the IIR		Medium	This obligation is time consuming and depends on capacities and time	Planned to be implemented in future submissions.

Table 227 Sectoral improvements planned

NFR Category	Subject	Source	rating	Timeline
1.A.1.a	HCB from this category are being estimated but calculation column has not been properly connected to total table and emissions are categorized as NE. This will be corrected in next submission.	National emission inventory team	Medium	2020
1.A.1.b	Use of GB 2019 Emission factors	National emission inventory team	Medium	2020
1.A.3.b	For 2014-2018 data, Tier 2 methodology was applied. MEPP is planning to start with the use COPERT V model for calculating transport emissions in following submissions. This model was installed, and calculations were made for the period 2014-2018. Several trainings under UNDP project on GHG inventory on use of Copert model were held for the Emission inventory team. TAEIX expert missions has been approved to make trend calculations of transport emissions for period 1990-2013. For the NFR categories 1.A.3.v,vi,vii, emission factors will be rechecked.	CEIP/S3.RR/2016/North Macedonia § 16	High	2020-2021
1.A.4.bi	Recalculate activity data for biomass due to available revised data in Makstat data base	National emission inventory team	Medium	2020-2021
1.A.3.ei	The ERT recommends that the FYROM contacts the gas supplier in order to find	CEIP/S3.RR/2016/North Macedonia	Low	2021

NFR Category	Subject	Source	rating	Timeline
	out if compressor stations are used in the FYROM and which technologies they use to maintain the pressure in the pipelines. National experts will try to get this information	§ 16		
1.A.4.bii	Due to not available activity data for Residential: Household and gardening (mobile) same activity data are used for the last year. According to the last stage 3 review report number of households maybe used as surrogate data.	CEIP/S3.RR/2016/North Macedonia § 16	Low	2020-2021
1.A.4.c.iii	The ERT recommends the Party to estimate and report the missing emissions, or, encourages the Party to include an explanation in the IIR on why emissions have not been estimated. The activity data are missing, Experts will try to calculate or investigate if these emissions are calculated elsewhere.	CEIP/S3.RR/2016/North Macedonia § 16	Low	2022-2023
2.A.1	For 2016 and 2017 Tier 2 method has been applied. It is planned to use higher 2 methodology also for the previous years (2015 and before)	National emission inventory team	Medium	2019-2020
2.C.3	There is a lack of available data on secondary aluminum production. MEPP will try to collect these data for future submissions.	National emission inventory team	Medium	2020-2021
2.C.5	There is a lack of available data on secondary lead production. MEPP will try to collect these data for future submissions.	National emission inventory team	Medium	2020-2021
2H	Historical data for wine production (No data are available within MAFWS. MEPP will try to recalculate data with method of extrapolation)	Twinning mission report No. 24/2016	Low	2021-2022
2.C.7.c	Updated emission factors for TSP and EF for SO _x from the latest 2019 GB will be used in the next reporting round.	National emission inventory team	Medium	2020
2.D.3 g	It is planned to check the availability of data on other chemical products for future reporting (Textile finishing and Pharmaceutical products manufacturing) and report emissions in the following submissions.	National emission inventory team	Medium	2022
2.D.3.i and 2.G	This report does not include emissions from the following activities in the inventory: SNAP 060401 Glass wool induction, 060402 Mineral wool induction, 060405 Application of glues and adhesives, 060409 Vehicle de-waxing. Therefore, it is planned to gather data to estimate emissions from these process	National emission inventory team	Medium	2022
2.D.3.b	It is planned that in cooperation with SSO to gather more reliable historical activity data for this category.	National emission inventory team	Medium	2021
2.D.3c	Notation key for HCB remain as NA even it was recommended by the ERT to be	National emission inventory team	Low	2020

NFR Category	Subject	Source	rating	Timeline
	changed in NE due to the fact it was omitted.			
2.D.3f	Additionally, MEPP already sent questionnaires on amount of treated textile in dry cleaning shops but received only limited number of responses. The procedures will be repeated earlier next year in order to gather representative quantity of treated wear and recalculate emissions coming from this category.	National emission inventory team	Low	2020
3B and 3D	Check and if possible use updated EF from the latest Guidebook	National emission inventory team	Medium	2020-2021
3.B.4.d	Use revised activity data form MAKSTAT database	National emission inventory team	Medium	2020
5.D.1	The experts will review the categorizations and type of waste that influence activity data in this sector	National emission inventory team	Medium	2020-2021
5.D.2	The emissions are underestimated due to not complete activity data, activity data for 2018 arrived after the inventory submission, the NEIT will extend the period for data gathering	National emission inventory team	Medium	2020-2021
5.B.1	During the TAEIX expert mission in Vienna in 2020, experts were trained on preparation of waste inventory. The experts will try to gather data and report emissions from this sector in following submissions	National emission inventory team	Medium	2020-2022
11.C	Investigate and gather information for other natural sources	National emission inventory team	Low	2022

PROJECTIONS



10. PROJECTIONS

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 programme 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_x, NO_x, NMVOC and NH₃ 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 taken into account. No serious analyses were made on the strategic documents in the industrial, waste and agriculture sector.

A second scenario with measures has been developed on the basis of 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 2020, 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_x, NMVOC and NH₃ 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_x, SO_x 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 2018, but not for dust and sulfur oxides. The Joint Stock Company Electrical Power Supply of Macedonia (ESM) is undertaking activities to reduce the emissions of the pollutants listed in the Plan, as well as activities for the initiation of Phase I - Dust Reduction, through reconstruction of an electrostatic precipitator and the replacement of ID ventilators and ducts for exhaust fumes. At the same time, ESM and "Girisim Electric" from Turkey signed an Agreement in November 2019 for construction of a photovoltaic power plant "Oslomej" with an installed capacity of 10 MW, worth seven million euros, out of which 5.9 million euros are loan from the European Bank for Reconstruction and Development and 1.1 million euros are own funds from ESM. Under the Agreement, the photovoltaic power plant should be built within 10 months and it is expected to start production during next fall.

This plan will have impact on the current national emission projections for NO_x and SO_x for 2020, which implies that these projections will be revised. The projections of NO_x, SO_x and dust in this plan will also be taken into account in the process of calculation of 2030 projections for SO_x, NO_x and PM_{2.5}.

Regarding the inventory within the Twining 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. This document has been taken into account within current preparation of a TOR for a Technical project under IPA 2 program support for implementation (OIS has already been accepted). One of the planned activities of the project is preparation of National emission projections under NEC directive 2016/2248/EC. The project was envisaged to start in the last quarter of 2020, giving an opportunity to report projections in 2022 at earliest stage.

11. REPORTING OF GRIDDED EMISSIONS AND LPS

Republic of North Macedonia has reported gridded and LPS data in 2017 for 2015 reporting year and they are available on CDR Eionet web page. In this IIR a short description on the methodology of calculation of these emissions are presented. However, it is intended to calculate and report LPS and gridded data as obligation during next reporting round in 2021, when proper and comprehensive description in the IIR will be included.

Within the last Twining project in 2015 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 this 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

Aproxy 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 were 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, metals and Ferro metals and Incineration of medical waste as well as big swine and poultry farms were allocated in the grids according their coordinates. Fugitive emissions were distributed using land cover and petrol and mines network.

Additionally, data for small emission were distributed using the population proxy calculations exclude households connected to district heating and for emissions coming from administrative capacities emissions from National cadaster were used.

Population data were used to distribute emissions coming from use of solvents and municipal waste. Emissions from aviation and national navigation are minor and were distributed according the location of airports and boat ports.

With regards to LPS in 2017, emissions from 13 LPS were reported, mainly coming from the category 1.A.1a for electricity and heat production, one in category 2.A.1, two in 2.C.1, two in 2.C.2. Data on CO, NO_x, SO_x emissions were calculated mainly by the installations taken into account monthly emissions measurements while emissions from other pollutants are calculated by using EF from the Guidebooks. Implied emission factors were used for calculations of TSP emissions from the installation for production of ferroalloys and for one power plant. IEF for NO_x and SO_x emissions were used for calculations of emissions from one power plant. Three of LPS are currently not in operation. For installations for production of cement, steel and ferronickel Tier 2 methodology for calculation was used. For other installations Tier 1 methodology was used for the other pollutants.

The same methodology is planned to be used for calculation of emissions coming from LPSs as well for gridded emissions in 2021.

12. ADJUSTMENTS

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.

13. IIR APPENDIX Error! Bookmark not defined.

Appendix 1: National energy balance 2018

Appendix 2: NFR 2018

REFERENCES

- [1] 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)
- [2] http://www.ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf
- [3] MAKSTAT database - <http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>
- [4] https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-1&chapter=27&clang=_en
- [5] <http://www.unece.org/fileadmin/DAM/env/lrtap/full%20text/ece.eb.air.104.e.pdf>
- [6] http://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE.EB.AIR.114_ENG.pdf
- [7] <http://www.unece.org/index.php?id=33605#/>
- [8] 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 Programme (EMEP), Official Gazette of the Republic of Macedonia No. 142/07
- [9] 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)
- [10] CLRTAP-Macedonia's Informative Inventory Report, 2004, MEPP, March 2006
- [11] EMEP/CORINAIR Emission Inventory Guidebook–2006
- [12] SNAP Selected Nomenclature on Air Pollutants
- [13] CLRTAP-Macedonia's Informative Inventory Report, 2008, MEPP, March 2010
- [14] http://www.ceip.at/fileadmin/inhalte/emep/pdf/2011/MK_Stage3_Review_Report_2011.pdf
- [15] EMEP/EEA air pollutant emission inventory guidebook – 2009
- [16] EMEP/EEA air pollutant emission inventory guidebook – 2013
- [17] EMEP/EEA air pollutant emission inventory guidebook – 2016
- [18] EMEP/EEA air pollutant emission inventory guidebook – 2019
- [19] UNECE/CEIP/S3.RR/2016/Macedonia19/10/2016
- [20] Law on environment Official Gazzette 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
- [21] Statistical Yearly book of Republic of North Macedonia, 2000-2019, SSO, Skopje
<http://www.stat.gov.mk/PublikaciiPoOblast.aspx?id=34&rbrObl=37>
- [22] Energy balance 2009-2018,
<http://www.stat.gov.mk/PrethodniSooopstenijaOblast.aspx?id=64&rbrObl=21>
- [23] Energy statistics 2000-2010 - <http://www.stat.gov.mk/PrikaziPoslednaPublikacija.aspx?id=61>

- [24] MAKSTAT database- Energy data
<http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>
- [25] State Statistical Office of the Republic of North Macedonia, Transport and other communications. 2007-2015
<http://www.stat.gov.mk/PublikaciiPoOblast.aspx?id=15&rbrObl=24>
- [26] MAK STAT database for transport
<http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>
- [27] State Statistical Office of the Republic of North Macedonia. Industry in the Republic of North Macedonia. 2002-2015) <http://www.stat.gov.mk/PublikaciiPoOblast.aspx?id=8&rbrObl=19>. Makstat database <http://makstat.stat.gov.mk/PXWeb/pxweb/mk/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>
- [28] MAKSTAT DATABASE on industry
http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/MakStat__Industrija__Bazna2015/525_Proizvodstvo_na_ind_proizv_po_godini_ml.px/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef
- [29] <http://minerals.usgs.gov/minerals/pubs/country/europe.html#mk>
- [30] State Statistical Office of the Republic of North Macedonia. Commodity international exchange in the Republic of North Macedonia, 2006-2014.
<http://www.stat.gov.mk/PublikaciiPoOblast.aspx?id=14&rbrObl=23>
- [31] State Statistical Office of the Republic of North Macedonia, Field crops, orchards and vineyards, 2007-2018 [32]
<http://www.stat.gov.mk/PrikaziPoslednaPublikacija.aspx?id=5>
- [32] State Statistical Office of the Republic of North Macedonia, Livestock, 2007-2015.
<http://www.stat.gov.mk/PrikaziPoslednaPublikacija.aspx?id=6>.
<http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>;
- [34] MAKSTAT agriculture data <http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef>
- [35] State Statistical Office of the Republic of North Macedonia, Forestry, 2000-2015
- [36] Census of agriculture, 2007, Individual agricultural holdings grouped by total available land, by regions. 2008. Skopje
- [37] Feasibility study on drisla landfill, book 1 of 2, General overview, Final report, August, 2011
- [38] "Drisla" landfill web page - http://drisla.mk/page_detail.asp?IID=3&ID=25
- [39] PRTR database in MEPP - ripz.moepp.gov.mk/
- [40] The Republic of Serbia Informative Inventory Report to LRTAP Convention, Belgrade, 2012
- [41] The Republic of Croatia Informative Inventory Report to LRTAP Convention, Zagreb, 2012
- [42] LCP data on CDR eionet database https://cdr.eionet.europa.eu/mk/eu/lcp_ied/envxlw8hq/
- [43] EEA, Municipal Waste Management in FYROM (2013), page 7-8

- [44] GDP per capita of Former Yugoslavia by Angus Maddison
(https://www.quandl.com/data/MADDISON/GDPPC_YUG_NEW-GDP-Per-Capita-of-Former-Yugoslavia-New-Estimate) accessed 28.11.2016
- [45] National program for the gradual reduction of the quantities of emissions of the certain pollutants at the level of the Republic of North Macedonia for the period 2012 to 2020 (Official gazette of RM no.107/2012)

APPENDIX 1 National energy balance 2018

Part 1

Снабдување и потрошувачка			Камен јаглен	Кокс	Суббитуми- нозен јаглен	Лигнит	Вкупно нафтни продукти	ТНГ	Моторен бензин	Керозини, млазни горива	Дизел за транспорт	Нафта за ложење (екстралесна)	Мазут	Нафтен (петролејски) кокс	Supply and consumption
			Hard coal	Coke	Sub- bituminous coal	Lignite	Total petroleum products	LPG	Motor spirit	Kerosenes, jet fuels	Road diesel	Heating and other gasoil	Residual fuel oil	Petroleum coke	
			000тони / '000 tonnes				000тони / '000 tonnes				000тони / '000 tonnes				
	Бруто-примарно производство		-	-	-	4994.843	-	-	-	-	-	-	-	-	Total primary production
	Увоз		101.220	0.328	91.686	20.569	1095.422	80.396	103.804	37.575	623.630	43.016	67.277	84.853	Imports
	Салдо на залихи		-9.736	0.100	-9.121	-277.716	8.104	-0.855	-0.819	-0.246	4.686	2.777	3.348	-0.800	Stock change
	Извоз		0.838	-	0.055	-	126.559	1.872	4.061	14.561	53.326	-	3.250	47.826	Exports
Вкупно потребна енергија			90.646	0.229	82.510	4737.696	976.968	77.669	98.925	22.769	574.990	45.793	67.376	36.226	Gross inland consumption
Енергија за енергетски трансформации			-	-	-	4689.356	13.567	-	-	-	-	-	13.567	-	Transformation input
	Термоцентрали		-	-	-	4689.356	13.567	-	-	-	-	-	13.567	-	Public thermal power stations
	Комбинирани електрани		-	-	-	-	-	-	-	-	-	-	-	-	CHP plants
	Биогасни центри		-	-	-	-	-	-	-	-	-	-	-	-	Biogas plants
	Јавни котларници		-	-	-	-	-	-	-	-	-	-	-	-	Main activity producer heat plants
Производство на трансформирана енергија			-	-	-	-	-	-	-	-	-	-	-	-	Transformation output
	Термоцентрали		-	-	-	-	-	-	-	-	-	-	-	-	Public thermal power stations
	Комбинирани електрани		-	-	-	-	-	-	-	-	-	-	-	-	CHP plants
	Биогасни центри		-	-	-	-	-	-	-	-	-	-	-	-	Biogas plants
	Јавни котларници		-	-	-	-	-	-	-	-	-	-	-	-	Main activity producer heat plants
Размена			-	-	-	-	0.099	-	-	-	0.099	-	-	-	Exchanges and transfers, returns
Потрошувачка во енергетскиот сектор			-	-	-	-	1.936	-	-	-	1.869	0.020	0.047	-	Consumption of the energy branch
Загуби при пренос и дистрибуција			-	-	-	-	-	-	-	-	-	-	-	-	Distribution losses
Расположливо за финална потрошувачка			90.646	0.229	82.510	48.340	961.564	77.669	98.925	22.769	573.220	45.773	53.762	36.226	Available for final consumption
Финална неенергетска потрошувачка			-	-	-	-	53.219	-	-	-	-	-	-	-	Final non-energy consumption
Финална енергетска потрошувачка			90.646	0.229	82.510	48.340	908.344	77.669	98.925	22.769	573.220	45.773	53.762	36.226	Final energy consumption
	Индустрија		90.646	0.229	82.510	39.201	132.443	10.925	-	-	25.501	15.234	44.557	36.226	Industry
		Индустрија за железо и челик	7.699	0.229	76.982	17.824	52.892	0.175	-	-	1.886	0.067	22.779	27.985	Iron & steel industry
		Обоена металургија	-	-	-	-	1.277	1.239	-	-	0.010	0.029	-	-	Non-ferrous metal industry
		Хемиска индустрија	-	-	-	-	2.053	0.001	-	-	0.019	0.374	1.659	-	Chemical industry
		Индустрија за градежен материјал стакло и керамика	82.947	-	5.528	18.051	26.315	5.985	-	-	0.997	1.898	9.358	8.077	Glass, pottery & building mat. industry
		Индустрија за експлоатација на руди	-	-	-	-	13.602	0.056	-	-	12.908	0.475	-	0.164	Ore-extraction industry
		Прехранбена индустрија, пијалаци и тутун	-	-	-	-	14.588	2.089	-	-	0.219	6.081	6.199	-	Food, drink & tobacco industry
		Текстилна индустрија и кожарство	-	-	-	3.318	4.686	0.058	-	-	-	2.388	2.241	-	Textile, leather & clothing industry
		Индустрија за хартија и печатење	-	-	-	-	0.438	0.097	-	-	0.010	0.118	0.213	-	Paper and printing

Снабдување и потрошувачка			Камен јаглен	Кокс	Суббитуминозен јаглен	Лигнит	Вкупно нафтени продукти	ТНГ	Моторен бензин	Керозини, млазни горива	Дизел за транспорт	Нафта за ложење (екстралесна)	Мазут	Нафтен (петролејски) кокс	Supply and consumption	
			Hard coal	Coke	Sub-bituminous coal	Lignite	Total petroleum products	LPG	Motor spirit	Kerosenes, jet fuels	Road diesel	Heating and other gasoil	Residual fuel oil	Petroleum coke		
			000тони / '000 tonnes				000тони / '000 tonnes				000тони / '000 tonnes					
		Инженерство и друга метална индустрија	-	-	-	0.002	3.188	1.183	-	-	0.272	0.920	0.813	-		Engineering & other metal industry
		Останати индустрии	-	-	-	0.006	13.403	0.042	-	-	9.179	2.887	1.295	-		Other industries
		Сообраќај	-	-	-	-	698.969	53.889	98.530	22.743	523.807	-	-	-		Transport
		Железнички сообраќај	-	-	-	-	2.138	-	-	-	2.138	-	-	-		Railways
		Патен сообраќај	-	-	-	-	674.039	53.889	98.482	-	521.669	-	-	-		Road transport
		Воздушен сообраќај	-	-	-	-	22.791	-	0.048	22.743	-	-	-	-		Air transport
		Останата потрошувачка	-	-	-	9.139	76.932	12.855	0.395	0.026	23.913	30.539	9.205	-		Households, commerce, pub. auth., etc.
		Домаќинства	-	-	-	3.220	10.170	6.410	-	-	-	3.760	-	-		Households
		Земјоделство	-	-	-	2.625	10.645	0.035	0.395	0.026	6.561	0.538	3.090	-		Agriculture
		Други сектори	-	-	-	3.294	56.118	6.410	-	-	17.352	26.241	6.115	-		Other
		Статистичка разлика	-	-	-	-	-	-	-	-	-	-	-	-		Statistical difference

³¹ Претходни податоци/Preliminary data

Part 2

Снабдување и потрошувачка			Други нафтени продукти	Природен гас	Геотермална топлина	Биомаса	Брикети, пелети и дрвени отпадоци	Хидро електрична енергија	Соларна електрична енергија	Ветерна електрична енергија	Биогас	Биодизел	Топлинска енергија	Вкупно електрична енергија	Supply and consumption	
			Other petroleum products	Natural gas	Geothermal heat	Biomass	Briquettes, pellets and wood residues	Hydro electricity	Solar electricity	Wind electricity	Biogases	Blodiesel	Derived heat	Electrical energy		
				'000 m ³	'000 m ³		'000 тони/tonnes	GWh			TJ	'000 тони/tonnes	TJ	GWh		
		Бруто-примарно производство	-	-	1666.405	973.765	10.151	1791.366	22.788	97.338	200.416	-	-	-		Total primary production
		Увоз	255376.698	255376.698	-	32.028	68.241	-	-	-	-	0.151	-	2297.169		Imports
		Салдо на залихи	-150.625	0.013	-150.625	-	4.223	0.323	-	-	-	-0.052	-	-		Stock change
		Извоз	-	-	-	0.069	0.935	-	-	-	-	-	-	377.423		Exports
		Вкупно потребна енергија	53.219	255226.073	1666.405	1009.948	77.780	1791.366	22.788	97.338	200.416	0.099	-	1919.746		Gross inland consumption
		Енергија за енергетски трансформации	-	201553.176	-	-	-	-	-	-	200.416	-	-	-		Transformation input
		Термоцентрали	-	-	-	-	-	-	-	-	-	-	-	-		Public thermal power stations
		Комбинирани електрани	172277.153	172277.153	-	-	-	-	-	-	-	-	-	-		CHP plants
		Биогасни централи	-	-	-	-	-	-	-	-	200.416	-	-	-		Biogas plants
		Јавни котларници	29276.023	29276.023	-	-	-	-	-	-	-	-	-	-		Main activity producer heat plants
		Производство на трансформирана енергија	-	-	-	-	-	-	-	-	-	-	2244.880	3695.678		Transformation output
		Термоцентрали	-	-	-	-	-	-	-	-	-	-	-	2895.752		Public thermal power stations

Снабдување и потрошувачка		Други нафтени продукти	Природен гас	Геотермална топлина	Биомаса	Брикети, пелети и дрвени отпадоци	Хидро електрична енерија	Соларна електрична енерија	Ветерна електрична енерија	Биогас	Биодизел	Топлинска енерија	Вкупно електрична енерија	Supply and consumption	
		Other petroleum products	Natural gas	Geothermal heat	Biomass	Briquettes, pellets and wood residues	Hydro electricity	Solar electricity	Wind electricity	Biogases	Biodiesel	Derived heat	Electrical energy		
			'000 m ³	'000 m ³		'000 тони/tonnes	GWh			TJ	'000 тони/tonnes	TJ	GWh		
	Комбинирани електрани	-	-	-	-	-	-	-	-	-	-	1261.649	745.876		CHP plants
	Биогасни центри	-	-	-	-	-	-	-	-	-	-	-	54.050		Biogas plants
	Јавни котларници	-	-	-	-	-	-	-	-	-	-	983.231	-		Main activity producer heat plants
	Размена	-	-	-	-	-	-1791.366	-22.788	-97.338	-	-0.099	-	1911.493		Exchanges and transfers, returns
	Потрошувачка во енергетскиот сектор	-	-	-	0.079	-	-	-	-	-	-	19.480	426.642		Consumption of the energy branch
	Загуби при пренос и дистрибуција	-	713.720	176.086	-	-	-	-	-	-	-	277.295	994.814		Distribution losses
	Расположливо за финална потрошувачка	53.219	52959.177	1490.319	1009.869	77.780	-	-	-	-	-	1948.105	6105.461		Available for final consumption
	Финална неенергетска потрошувачка	53.219	-	-	0.000	0	-	-	-	-	-	-	-		Final non-energy consumption
	Финална енергетска потрошувачка	-	52959.177	1490.319	1009.869	77.780	-	-	-	-	-	1948.105	6105.461		Final energy consumption
	Индустрија	44605.869	44605.869	-	13.049	10.133	-	-	-	-	-	20.838	1545.715		Industry
	29051.679	-	29051.679	-	0.019	0	-	-	-	-	-	20.838	709.330		Iron & steel industry
	-	-	-	-	0.000	0	-	-	-	-	-	-	13.321		Non-ferrous metal industry
	1162.713	-	1162.713	-	0.005	0	-	-	-	-	-	-	75.339		Chemical industry
	1946.471	-	1946.471	-	0.020	0.025	-	-	-	-	-	-	137.744		Glass, pottery & building mat. industry
	-	-	-	-	0.007	0.019	-	-	-	-	-	-	154.823		Ore-extraction industry
	7033.299	-	7033.299	-	8.745	7.946	-	-	-	-	-	-	149.929		Food, drink & tobacco industry
	100.433	-	100.433	-	2.090	0.221	-	-	-	-	-	-	62.602		Textile, leather & clothing industry
	483.635	-	483.635	-	0.145	0.112	-	-	-	-	-	-	11.481		Paper and printing
	4593.609	-	4593.609	-	0.770	0.280	-	-	-	-	-	-	152.542		Engineering & other metal industry
	234.030	-	234.030	-	1.249	1.530	-	-	-	-	-	-	78.604		Other industries
	Сообраќај	862.036	862.036	-	-	0	-	-	-	-	-	-	11.764		Transport
	-	-	-	-	-	0	-	-	-	-	-	-	11.764		Railways
	862.036	-	862.036	-	-	0	-	-	-	-	-	-	-		Road transport
	-	-	-	-	-	0	-	-	-	-	-	-	-		Air transport
	Останата потрошувачка	7491.272	7491.272	1490.319	996.819	67.648	-	-	-	-	-	1927.267	4547.982		Households, commerce, pub. auth., etc.
	225.978	-	225.978	-	965.678	65.779	-	-	-	-	-	1417.546	2998.774		Households
	-	-	-	829.947	8.550	0	-	-	-	-	-	-	38.858		Agriculture
	7265.294	-	7265.294	660.372	22.592	1.868	-	-	-	-	-	509.720	1510.350		Other
	Статистичка разлика	-	-	-	-	-	-	-	-	-	-	-	-		Statistical difference

¹⁾ Претходни податоци/Preliminary data

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MRC 15.02.2018: 2016	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 ¹⁾ (from 1990)										Activity Data (from 1990)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
				NOx (as NO ₂)	NMVOC	SOx (as SO ₂)	NH ₃	PM ₁₀	PM _{2.5}	TSP	BC		CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	PAHs						HCB	PCBs																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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NFR Aggregation for Gridding and LRS (GNFR)	NFR Code	Longname	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t	t	g-t-TEQ	t	t	t	t	t	kg	kg																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

MRC 15.02.2016: 2016	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other r (from 1990)	Priority Heavy Metals (from 1990)			Additional/Heavy Metals (from 1990: voluntary reporting)						POPs ⁽¹⁾ (from 1990)										Activity Data (from 1990)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
				NOx (asNO ₂)	NMVOC	SOx (as SO ₂)	NH ₃	PM ₁₀	PM _{2.5}	TSP	BC		CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxin/ furan)	PAHs						HCB	PCBs																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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B_Industry	2A3	Glass 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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2A6a	Quarrying and mining of minerals other than coal		NA	NA	NA	NA	0.03933 4375	0.39334 375	0.90242 125	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2A6b	Construction and demolition		NA	NA	NA	NA	0.00953 802	0.09538 802	0.32163 233	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2A6c	Storage, handling and transport of mineral products		NA	NA	NA	NA	0.00504 6083	0.05046 6084	0.10092 1668	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2A6	Other mineral products (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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2B1	Ammonia 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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2B10a	Chemical industry: Other (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	NE	NE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2B10b	Storage, handling and transport of chemical products (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	NE	NE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2C1	Iron and steel production		NE	0.03541 395	0.01469 7618	0.01634 49	NE	0.00572 0715	0.00653 796	0.025 8766 74	2.05 9466 05	0.46930 55	0.40862 25	0.03268 98	0.02070 354	0.00230 6562	0.02860 3575	0.00544 83	0.11169 015	0	0.62655 45	0.81724 5	NE	NE	NE	NE	NE	0.130 7592	NE	NE	NE	NE	NE	NE	NE	NE	NE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
B_Industry	2C2	Ferrous production		NA	NA	NA	NA	0.03109 86	0.04405 635	0.05183 1	0.003 1098 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2C3	Aluminium production		NA	NA	NA	NA	0.00015 29	0.00038 92	0.00055 6	3.536 7656	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00973	NA	NA	NA	NA	NA	1.39	NA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
B_Industry	2C5	Lead production		NA	NA	0.05288	NA	0.00008 4608	0.00016 926	0.00021 152	NA	NA	0.02749 76	0.00052 88	NE	0.00317 28	NA	NA	NA	NA	0.00052 88	0.03984 32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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				NOx (asNO ₂)	NMVOC	SOx (as SO ₂)	NH ₃	PM ₁₀	PM _{2.5}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxin/ furans)	PAHs					HCB	PCBs										
																							benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3- cd) pyrene	Total 1- 4												
NFR Aggregation for Gridding and LRS (GNFR)	NFR Code	Longname	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t	g-tEQ	t	t	t	t	t	kg	kg											
E_Solvents	2D3a	Domestic solvent use including turpentine		NA	2.49255 84	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
E_Solvents	2D3b	Road paving with asphalt		NA	0.00844 4768	NA	NA	0.00211 1102	0.01583 394	0.07389 172	0.000 1203 38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
B_Industry	2D3c	Asphalt roofing		NE	0.00222 482	NA	NA	0.00126 912	0.00684 56	0.02728 24	1.779 866- 07	0.00 0162 583	NE	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NA	NA	NA											
B_Industry	2D3d	Coating applications		NA	3.05798 875	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
E_Solvents	2D3e	Degreasing		NA	1.76556 22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
E_Solvents	2D3f	Dry cleaning		NA	0.02313 96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
E_Solvents	2D3g	Chemical products		NA	0.46076 7	NA	0.00006 664	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
E_Solvents	2D3h	Printing		NA	0.02343 15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
E_Solvents	2D3i	Other solvent use (please specify in the IR)		NE	0.00948 7483	NE	NE	4.60395 E-05	6.90593 E-05	8.44058 E-05	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	9.36701 E-05	4.72811 E-05	4.72811 E-05	4.72811 E-05	0.000 2351 3	NE	NE										
E_Solvents	2G	Other product use (please specify in the IR)		0.00072 2417	0.15776 1788	NE	0.04777 6684	0.31083 6258	0.31083 6258	0.31083 6258	0.002 3987 63	0.63 436 215	NE	6.21673 E-05	1.15125 E-06	1.84199 E-06	4.02936 E-06	0.06216 7252	NE	NE	NE	NE	1.15125 E-06	1.15125 E-06	1.15125 E-06	1.15125 E-06	0.00051 806	0.000 5215 4	NE	NE									
B_Industry	2H1	Pulp and paper industry		NO	NO	NO	NA	NO	NO	NO	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO										
B_Industry	2H2	Food and beverages industry		NA	0.05836 339	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA										
B_Industry	2H3	Other industrial processes (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	NE	NE	NE										
B_Industry	2I	Wood processing		NA	NA	NA	NA	NA	NA	0.00769 8463	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA										
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										
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE										
B_Industry	2L	Other production, consumption, storage, transportation or handling of bulk products (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	NE	NE	NE										
K_Agriculture Livestock	3B1a	Manure management - Dairy cattle		0.00993 53	1.86181 44	NA	2.38770 5	0.05407 45	0.08155 35	0.17864 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA										
K_Agriculture Livestock	3B1b	Manure management - Non-dairy cattle		0.01191 2714	0.79232 2212	NA	0.78573 22	0.02281 158	0.03421 737	0.07477 129	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA										

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	benzo(a) pyrene	benzo(b) fluoranth- ene	benzo(k) fluoranth- ene									Indeno (1,2,3- cd) pyrene												Total 1- 4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
NFR Aggregation for Griding and LRS (GNFR)	NFR Code	Longname	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t	g t-TEQ	t	t	t	t	t	kg	kg	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
	ADJUST- MENTS (Net- tkt)	Sum of adjustments (negative value from Annex VII)		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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

