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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)
HDVs	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	**P**ersistent **O**rganic **P**ollutant**s**
QA/QC	**Q**uality **A**ssurance/**Q**uality **C**ontrol
RM	**R**epublic of **M**acedonia
SNAP	**S**elected **N**omenclature for **A**ir **P**ollution
SSO	**S**tate **S**tatistical **O**ffice
UNECE/ CLRTAP	**U**nited **N**ations **E**conomic **C**ommission for **E**urope/**C**onvention on **L**ong-range **T**ransboundary **A**ir **P**ollution
UNFCCC	**U**nited **N**ations **F**ramework **C**onvention on **Cl**imate **C**hange
CORINAIR	**COR**e **IN**ventory **AIR** emissions
EAF	**E**lectric **A**rc **F**urnace
WWTP	**W**aste**w**ater **T**reatment **P**lants
CAA	**C**ivil **A**viation **A**gency
NEIT	**N**ational **E**mission **I**nventory **T**eam
MOD	**M**inistry **o**f **D**efense
PEMF	**P**ublic **e**Enterprise **M**acedonian **F**orests
MAFWS	**M**inistry **of** **A**griculture**, F**orestry **and W**ater **S**upply
2W	**Two Wheelers**
AS	**A**monium **S**ulfate
AN	**A**monium **N**itrate
CAN	**C**alcium **A**monium **N**itrate

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Republic of North Macedonia has an emission inventory reporting obligation towards the Convention on trans-boundary air pollution (CLRTAP) and its eight protocols as well as to the international organizations such as the European environmental agency (EEA). The reporting obligations to the relevant international organizations and to the Executive body (EB) of the LRTAP convention are set down in Article 27-d of the Law on ambient air quality (LAAQ)[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 (NOx), sulfur dioxide (SO_2), non-methane volatile organic compounds (NMVOC), ammonia (NH_3), 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/LTRAP convention and its protocols, which define the standards for the national emission inventory[2]. 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. Chapters on reporting LPS and gridded data are referring to preparation and reporting of LPS and gridded data. Sources used for the gathering of the activity data and information are presented in Reference chapter. The Appendix chapter has two Appendixes; the first one is on preliminary Energy balance for 2020 and the second one on 2020 emissions reported in the NFR categories. 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 1990-2020. 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.

[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, 151/21)

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

For the preparation of the 2016 and 2017 emission inventory submission and Informative Inventory Reports (IIRs) in those years, the Ministry of Environment and Physical Planning (MEPP) was supported by Austrian experts engaged within the framework of the EU funded Twinning Project "Further strengthening the capacities for effective implementation of the acquis in the field of air quality" (MK 12 IB EN 01) which was finalized in January 2017. Starting from 2018, the reporting has been conducted by an established national expert emission inventory team. 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 were calculated in new categories within waste sector, agriculture, and industry and solvents sector due to available data. In this reporting round recalculations were made mainly due to remarks received from the Stage 3 review report[3], final activity data from the Energy balance and revised activity data from the MAKSTAT database[4].The major improvement was carried out in the Transport sector due to the use of Tier 3 methodology – COPERT V model for calculation of 2005-2020 emissions. The implementation of this model was supported by several expert missions through TAEIX program.

The report presents trend analysis of the country's data for the period 1990 – 2020. 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 NOx and SOx emissions starting from 2011. The reduction of NOx is a result of the modernization of plants and extended working lifetime. Additionally, the reduced operating hours of the power plant REK Oslomej from twelve to few months per year, and the decrease in coal consumption including gasification of the heating plant Toplana Zapad has supported the reduction of NOx. 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 SOx emissions depend on the content and quantity of the consumed coal. The SOx emissions are reduced in 2020 due to the decreased amount of consumed coal in the power plant REK Bitola and higher production of electricity in 2020 compared to 2019. However, the increased emissions on national level did not affect on the SO_2 local measured concentrations in the city of Bitola, which remain under the limit values also during 2020.

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] https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020_s3/mk_s3_rr_2020_final.pdf

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

Table 1 Emission trends 1990 – 2020 for the main air pollutants and CO

Year	Emission in kt				
	NOx	NMVOC	SO_2	NH_3	CO
1990	45.47	47.59	112.19	15.80	132.40
1991	37.63	41.91	91.28	14.83	111.54
1992	39.46	44.24	88.47	14.94	123.46
1993	40.93	46.35	90.98	15.26	133.28
1994	36.74	41.30	90.26	15.20	120.87
1995	39.29	43.83	96.63	14.99	125.25
1996	38.57	43.52	90.51	13.95	123.17
1997	37.89	44.52	94.85	13.53	126.29
1998	43.18	44.37	109.38	13.23	128.72
1999	40.43	45.13	99.37	13.41	131.74
2000	43.76	47.13	106.28	13.49	144.14
2001	40.76	39.31	108.33	12.74	113.24
2002	40.81	38.28	96.25	12.12	115.03
2003	35.82	37.85	94.88	12.06	116.05
2004	37.14	38.11	96.17	12.16	121.20
2005	34.94	25.86	94.91	11.21	74.15
2006	34.83	27.10	93.27	11.49	69.74
2007	37.21	27.62	97.71	11.28	69.64
2008	33.56	27.35	75.65	11.23	64.09
2009	34.79	25.69	103.18	10.43	62.67
2010	36.26	26.80	85.76	10.63	61.65
2011	38.61	27.31	103.52	11.06	63.17
2012	36.14	27.02	90.41	10.26	64.75
2013	28.87	26.54	81.04	10.29	62.46
2014	26.27	26.46	82.72	10.32	61.40
2015	21.55	25.77	75.03	10.32	59.39
2016	24.72	25.33	63.70	10.42	62.56
2017	23.33	25.34	54.76	10.26	54.51
2018	22.55	24.55	59.83	9.79	53.97
2019	22.98	23.35	114.66	8.58	54.01
2020	19.94	22.34	93.42	8.47	49.51
Trend 1990-2020	*-56%*	*-53%*	*-17%*	*-46%*	*-63%*

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 2020 compared to 1990, is the reduced production of ferroalloys in the country. The calculated PM2.5 emissions in and PM10 emission in 2020 are reduced by around 2% compared to 2019.

Table 2 Emission trends for particulate matter 1990-2020

Year	Emissions			
	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]
1990	32.71	48.28.	59.88	3.03
1991	28.65	42.34	52.41	2.64
1992	34.99	50.63	61.54	3.30
1993	31.33	45.03	54.98	2.93
1994	29.30	42.63	52.41	2.67
1995	29.58	43.25	53.33	2.70
1996	32.45	47.21	58.02	3.02
1997	31.53	45.86	56.01	2.87
1998	35.94	52.36	64.27	3.30
1999	31.16	45.13	55.84	2.83
2000	30.05	43.62	56.09	2.73
2001	18.60	28.04	36.09	1.47
2002	19.11	28.41	35.99	1.63
2003	29.37	42.24	52.01	2.60
2004	31.81	45.82	56.55	2.87
2005	24.10	37.21	47.57	2.43
2006	21.71	33.80	43.14	2.16

Year	Emissions			
	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]
2007	17.31	27.51	35.60	1.74
2008	17.90	28.05	36.45	1.84
2009	12.84	22.17	31.01	1.24
2010	15.89	28.15	34.44	1.65
2011	21.74	35.31	46.76	2.15
2012	21.30	34.09	45.18	2.18
2013	23.63	36.91	49.31	2.44
2014	17.08	26.66	36.44	1.76
2015	14.73	22.16	27.09	1.47
2016	13.05	19.62	23.92	1.41
2017	8.96	14.08	17.41	1.02
2018	8.61	14.30	16.35	0.98
2019	8.86	13.70	16.87	1.02
2020	8.71	13.43	16.41	1.00
Trend 1990–2020	*-73%*	*-72%*	*-73%*	*-67%*

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

Table 3 Emission trends for heavy metals 1990-2020

Year	Emissions		
	Pb [Mg]	Cd [Mg]	Hg [Mg]
1990	232.48	1.60	0.65
1991	196.68	1.50	0.59
1992	227.56	1.46	0.55
1993	212.76	1.06	0.52
1994	203.76	1.01	0.44
1995	222.26	2.11	0.46
1996	229.64	2.32	0.52
1997	244.66	1.14	0.55
1998	259.95	1.39	0.62
1999	208.29	1.07	0.55
2000	195.45	0.93	0.56
2001	172.34	0.82	0.59
2002	170.74	0.80	0.61

Year	Emissions		
	Pb [Mg]	Cd [Mg]	Hg [Mg]
2003	131.95	0.60	0.46
2004	45.72	0.53	0.45
2005	6.41	0.28	0.32
2006	6.96	0.26	0.33
2007	7.31	0.25	0.35
2008	6.18	0.25	0.33
2009	5.70	0.25	0.30
2010	5.94	0.24	0.31
2011	6.46	0.26	0.35
2012	5.19	0.26	0.32
2013	4.02	0.24	0.27
2014	4.67	0.24	0.28
2015	4.40	0.24	0.28
2016	2.77	0.23	0.24
2017	2.57	0.22	0.22
2018	2.66	0.22	0.19
2019	2.83	0.23	0.21
2020	2.27	0.21	0.17
Trend 1990–2020	*-99%*	*-87%*	*-74%*

Regarding PAHs the trends are variable but still decreasing trend can be noticed from 2005 onwards. The largest source of emissions for these pollutants is the energy sector (mainly residential heating) with a share of 73%. Regarding PCB and HCB we can notice decreasing trend due to emission reduction coming from the metal production. The trend of PCDD/F depends mainly on combustion of fuels as well as waste incineration activities. Emissions are increased in 2000 due to introduction of medical waste incineration activity but reduced in 2018 due to installation of dust filter. High levels before 2000 are due to higher solid fuel consumption. The higher values of PCBs are due to introduction of the category 2.K in accordance with the Stage 3 review recommendations.

Table 4 Emission trends for POPs 1990-2020

Year	Emissions			
	PCDD/F [g – I TEQ]	PAHs [t]	HCB [kg]	PCB [kg]
1990	7.15	19.82	44.29	382.13
1991	6.40	17.63	39.22	383.55
1992	6.82	17.70	25.83	383.85
1993	7.28	17.29	24.18	370.81
1994	6.72	15.87	25.04	341.56
1995	6.82	18.92	18.63	356.74
1996	6.33	18.73	19.70	385.17

Year	Emissions			
	PCDD/F [g – I TEQ]	PAHs [t]	HCB [kg]	PCB [kg]
1997	6.57	16.00	27.89	397.21
1998	7.25	17.61	29.34	403.92
1999	7.25	17.18	53.97	367.45
2000	8.21	23.94	38.32	343.99
2001	6.61	25.41	34.15	333.26
2002	6.63	27.02	52.68	330.98
2003	7.30	28.02	42.98	288.38
2004	7.44	30.73	8.52	241.58
2005	4.89	26.88	7.54	207.53
2006	5.00	25.21	11.67	208.30
2007	5.03	26.37	8.87	208.90
2008	4.61	25.47	7.74	208.51
2009	4.25	27.35	8.28	208.55
2010	4.55	29.56	9.58	209.33
2011	4.75	35.78	10.50	209.73
2012	4.99	38.77	9.47	209.57
2013	4.69	39.88	6.35	209.38
2014	4.67	40.00	4.19	210.03
2015	4.73	49.52	0.96	216.91
2016	4.71	51.21	0.77	221.42
2017	3.96	51.54	2.06	229.16
2018	3.90	8.96	1.53	237.37
2019	4.09	9.31	4.43	238.45
2020	3.81	8.64	0.16	237.24
Trend 1990–2020	***-47%***	***-56%***	***-100%***	***-38%***

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

1.2. Priorities for improvement

Since emissions from the Transport sector for period 2005-2020 have been calculated using the Tier 3 method using Copert V model, this method would be used in the forthcoming year for calculation of historical emissions coming from this sector to secure consistency for the whole reporting period. This is important since the Transport sector is one of the key sources of CO and NOx national emissions.

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 is a critical pollutant in the country. However, use of Tier 2 may be possible after carrying out of the national census planned for 2021. The census data will be avalible in April this year which means after submission of the air emission inventory and the IIR, therefore improvement in this sector will be made in the upcoming years if detail data are avalible. We also plan to include the information of condensables in the future submissions after reciving training on the Workshop on condensables in Air Convention.

QA/QC procedures are continuously implemented but there is a need of further trainings, improvement of the implementation of these procedures, calculation of as well as the use of uncertainty analysis. For these types of thematic workshops support from EEA were required through the upcoming IPA III instrument. There is a need to use Tier 2 in most solvents and agriculture sectors but due to the need of expert trainings these improvements are planned to be carried out in the forthcoming project in the frame of IPA II program.

1.3. Information on recalculation – main reasons for recalculations

In the Energy sector, the emissions for the year 2019 were recalculated, using final activity data from the energy balance regarding fuel consumption. In Transport sector, recalculations have been made due to the final energy consumption and corrections made due to implementation of Stage 3 review recommendations, that were not implemented in the previous submission as well as introduction of COPERT V model for calculation of transport for the the period 2005-2020. Recommendations given in the stage 3 review were implemented in the sector Solvents and product use and Industry. No recalculations were carried out in 1.B sector.

1.4. Explanation of differences between reported national totals

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

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

As we are not a Member of the European Union, we are not obliged to report emissions under the EU's National Emissions Ceiling Directive (NECD). However, the NEC directive 2001/81/EC has been transposed in the national legislation and national emission ceilings for NOx, NMVOC, SOx and NH_3 have been defined. The new NEC Directive (2016/2284/EU) on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC will be transposed in the Law on ambient air quality and sub legislation as part of a technical project, which is programed in IPA 2 program "Support in implementation of the air quality directives", that is planned to start during 2023. However, based on the regular preparation of the emission inventory, the gridded data and LPS data starting from and the annual IIR, it can be as certained that several obligations coming from the new NEC directive are already implemented 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 Trans-Boundary Air Pollution (CLRTAP) is required to fulfill the obligations referring to the strategies and policies in compliance with the implementation of Protocols under the Convention. Parties should use the reporting procedures and are required to submit annual national emissions of SO_2, NO_X, NMVOC, CO and NH_3, particulate matter (PM), various HM and POPs.

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

- Convention on Long-Range Trans boundary Air Pollution (LRTAP) (Geneva, 1979). The Convention was ratified by means of the Law on Ratification („Official Gazette of the SFRY" No. 11/86). The Convention was taken over by the Republic of North Macedonia by means of succession with the date of effect of 30.12.1997.
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on long-term financing of the Cooperative Program for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) ("Official Gazette of the Republic of Macedonia" No.24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on reduction of sulfur emissions or their trans boundary transmission by at least 30 percentages ("Official Gazette of the Republic of Macedonia" No.24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on the control of nitrogen oxides or their trans boundary fluxes ("Official Gazette of the Republic of Macedonia" No. 24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution on the control of volatile organic compounds or their trans boundary fluxes ("Official Gazette of the Republic of Macedonia" No. 24/2010);
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Range trans boundary Air Pollution concerning further reduction of sulfur emissions ("Official Gazette of the Republic of Macedonia" No.24/2010).
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Rang trans boundary Air Pollution on heavy metals emissions ("Official Gazette of the Republic of Macedonia" No.135/2010).
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Rang trans boundary Air Pollution on persistent organic pollutants ("Official Gazette of the Republic of Macedonia" No.135/2010).
  - Law on Ratification of the Protocol to the 1979 Convention on Long-Rang trans boundary Air Pollution to abate acidification, eutrophication, and ground-level ozone ("Official Gazette of the Republic of Macedonia" No.135/2010).

- Regarding the Gothenburg Protocol, negotiations were ongoing in the period 2011-2014, on the proposed figures on the base year emission levels (1990 national emissions) and national emission ceilings (2010 national emissions). The Executive Body of the Convention on its 32nd

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

Status of ratification of the protocols under CLRTAP is presented in the table below.

Table 5 Status of ratification of the protocols under CLRTAP

Tools of UNECE Convention on Long-Range trans boundary Air Pollution (LRTAP)		Parties	entered into force	Signed (S) / Ratified (R) / Succession (d) / Accession (a) by North Macedonia
1979	Geneva Convention on Long-Range trans boundary Air Pollution		16.03.1983	30 Dec 1997 (d)[5]
1984	Geneva Protocol on Long-term Financing of the Cooperative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP)	47	28.01.1988	10 Mar 2010 (a)
1985	Helsinki Protocol on the Reduction of Sulfur Emissions or their trans boundary Fluxes by at least 30 per cent	25	02.09.1987	10 Mar 2010 (a)
1988	Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their trans boundary Fluxes	35	14.02.1991	10 Mar 2010 (a)
1991	Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their trans boundary Fluxes	24	29.09.1997	10 Mar 2010 (a)
1994	Oslo Protocol on Further Reduction of Sulfur Emissions	29	05.08.1998	5 Jun 2014 (a)
1998	Aarhus Protocol on Heavy Metals	31	29.12.2003	1 Nov 2010 (a)
	Aarhus Protocol on Heavy Metals, as amended on 13 December 2012			
1998	Aarhus Protocol on Persistent Organic Pollutants (POPs)	33	23.10.2003	1 Nov 2010 (a)
	Aarhus Protocol on Persistent Organic Pollutants, as amended on18 December 2009[6]			
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[7]			

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.

[5] https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-1&chapter=27&clang=_en

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

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

- Kyoto Protocol under the United Nations Framework Convention on Climate Change the Republic of North Macedonia. The Protocol was ratified by means of the Law on Ratification („Official Gazette of RM” No. 49/04).

– Stockholm Convention on Persistent Organic Pollutants. Republic of North Macedonia signed the Convention in Stockholm, Sweden, on 22.05.2001. The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.17/04).

– Vienna Convention for the Protection of the Ozone Layer (Vienna, March 1985). The Convention was ratified by means of the Law on Ratification („Official Gazette of SFRY No.1/90). Republic of North Macedonia has taken over by means of succession on 10.03.1994.
    - Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, September 1987). The Protocol was ratified by means of the Law on Ratification („Official Gazette of SFRY No.16/90). Republic of North Macedonia has taken over by means of succession on 10.03.1994.
        - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-London. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.25/98).
        - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-Copenhagen. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.25/98).
        - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-Montreal. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.51/99).
        - The Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer-Beijing, 1991. The Protocol was ratified by means of the Law on Ratification („Official Gazette of R.M. No.13/02).

– Convention on Environmental Impact Assessment in a trans boundary Context (Espoo, February 1991). The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.44/99).

– Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters (Aarhus Convention). The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.40/99).

– Basel Convention on the Control of trans-boundary Movements of Hazardous Wastes and Their Disposal. The Convention was ratified by means of the Law on Ratification („Official Gazette of R.M. No.49/97).

– Minamata convention on mercury. The convention has been signed on 24.07.2014.

At its thirty-second session[8] (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.

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:

[8] http://www.unece.org/index.php?id=33605#/

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 to fulfill the requirements toward the 1979 Convention on Long-Range trans-boundary Air Pollution and its amendments (hereinafter: LRTAP convention).

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

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

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

Amendments of these two rulebooks in compliance with the National Emissions Ceilings (NEC) Directive (2016/2284/EU) are envisaged in the forthcoming project in the frame of IPA II program that should start during next year.

Practical implementation and development of the inventory work

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

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

[10] 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)

[11] CLRTAP- Macedonia's Informative Inventory Report, 2004, MEPP, March 2006

[12] EMEP/CORINAIR Emission Inventory Guidebook - 2006

For the 2005, 2006, 2007, 2009 inventory years, according to the requirements of CLRTAP, MEPP has updated the air pollutant emission data only for the three main SNAP[13] 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 emissions[14].

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

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

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

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

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

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

The IIR submitted in 2016 covered information on anthropogenic emissions of air pollutants for 2014 for all pollutants, the entire time series starting from 1990, and it included documentation of methods, data sources, completeness of the Inventory, quality assurance and quality control

[13] SNAP Selected Nomenclature on Air Pollutants. https://en.eustat.eus/documentos/elem_13173/definicion.html

[14] CLRTAP- Macedonia's Informative Inventory Report, 2008, MEPP, March 2010

[15] http://www.ceip.at/fileadmin/inhalte/emep/pdf/2011/MK_Stage3_Review_Report_2011.pdf;

[16] EMEP/EEA air pollutant emission inventory guidebook - 2009

[17] EMEP/EEA air pollutant emission inventory guidebook - 2013

(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 2016[18] were used. For the previous reporting round additionally in most of the categories, EMEP/EEA Emission Inventory Guidebook 2019[19] and 2016 has been used, while older versions were rarely used due to limitation of activity data. The previous and present IIR submitted in 2022 contains improved and final activity data considered in the revised MAKSTAT database, as well as improvement and additional categories were added according to Stage 3 review recommendations [3]. 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	• 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			

[18] EMEP/EEA air pollutant emission inventory guidebook - 2016

[19] 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 to 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	• 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	• 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
2017	• Introduction of uncertainty trend analysis and key source analysis as well as QA/QC procedures implemented and improved, most of the	All + BC	1990-2015	EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016	MEPP Twinning			X	X

Year	Inventory	Pollutant	Time series	Based on	Implemented by	Submission			
						NFR07	NFR09	NFR 14	IIR
	Stage 3 review comments[20] implemented								
2018	• 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	• 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	• 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
2021	• Data quality improvement, Inclusion of Stage 3 Review report, Several NFR sectors added for the first time	Emission inventory experts	1990-2019	EMEP/EEA Emission Inventory Guidebook – 2019 (rarly older versions are used due to limitation of activity data)	MEPP			X	X
2022	• Data quality improvement, Inclusion of Stage 3 Review report, Introduction of Tier 2 and Tier 3 methodolody, in one NFR sector] added for the first time	Emission inventory experts	1990-2020	EMEP/EEA Emission Inventory Guidebook – 2019 (rearly older versions are used due to limitation of activity data)	MEPP			X	X

2.2. Institutional arrangements

According to the Article 40 of the Law on environment (LE)[21], 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.

[20] UNECE/CEIP/S3.RR/2016/Macedonia19/10/2016

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

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

Data needed for the preparation of the inventory are provided by either industrial operator, State statistical office (SSO), Ministry of Economy (MOE), Ministry of defense (MOD), Ministry of agriculture, forestry, and water supply (MAFWS), or Ministry of Interior (MOI) etc. MEPP has signed memorandum of understanding for data exchange with the SSO and starting from 2016 with MOI on detailed vehicles fleet data. MOI during 2021 has provided activity data per vehicle category for the period 2005-2020. Therefore, Tier 3 calculation methodology has been implemented for this period.

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

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

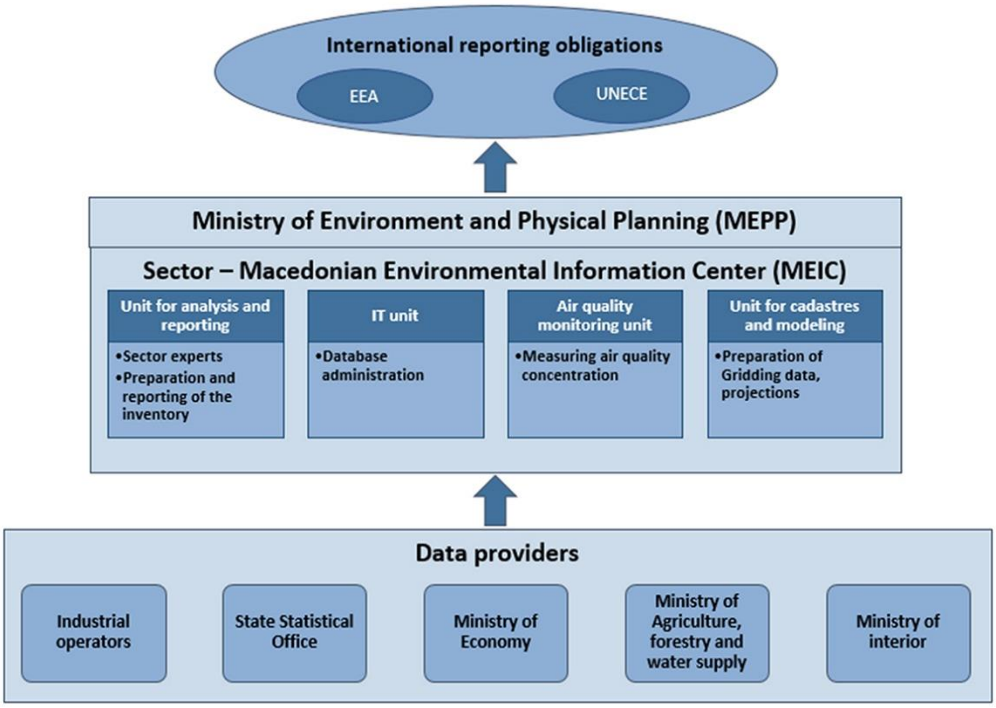


Figure 1 Institutional arrangements

2.3. Inventory preparation process

The preparation of the Inventory includes the following stages:

a) Planning

b) Preparation

c) Data management

d) Reporting

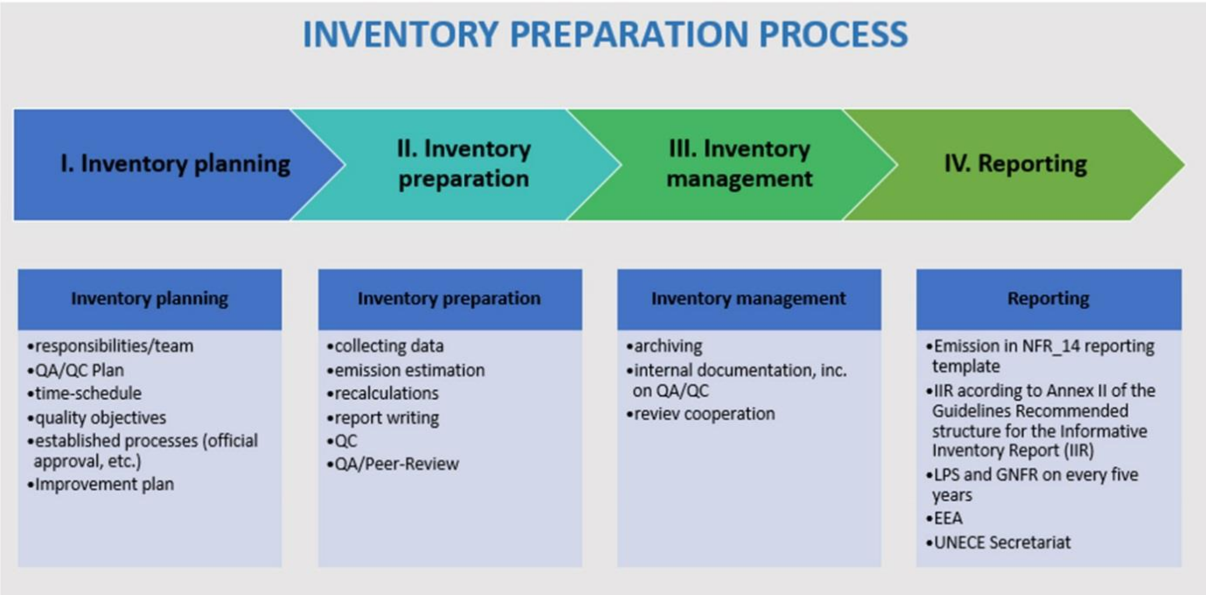


Figure 2 Scheme of inventory preparation process

a) Inventory planning

The planning of the Inventory includes organizational aspects, related to appointment of the team of key and deputy key experts within the department, description of specific tasks and responsibilities, development of operational procedures about data collection and data calculation on the activity rate and emission factors included in the database of the National Emission Inventory. Currently, 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 since preparation of the inventory is not their main task, they need further training to be independent in the preparation of the sector inventory, which is currently done with the support of Energy expert acting as emission inventory coordinator. The 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 has been prescribed and has been used by the experts within preparation of this inventory round.

b) Inventory preparation

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

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.

Starting from last year deputy experts per sectors have checked in more detail manner activity data and emissions calculations as well as links in the excel preparatory files prepared by the nominated key experts per sector according to the workflow matrix.

- **Identification of sources of pollution**

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

- **Data sources**

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

- Statistical Yearbooks of Republic of North Macedonia 1990-2020[22];(starting from 2000 data are available on web)
- MAKSTAT DATABASE from SSO
- Publications published by SSO in different areas (Transport, Industry in the Republic of North Macedonia, Industry and Energy, Livestock, Agriculture and Forestry);
- Energy Balance of the Republic of North Macedonia by Ministry of economy[23]
- Measurements data from the industrial operators and waste incineration plant
- International web page databases (FAO, Eurostat etc.).
- Data from relevant national ministries and agencies (MOD, PEMF, MAFWS and others)

c) Data management and processing

Emission factors and activity data for different source categories are collected and calculated in separate NFR excel tables, for the period from 1990 to 2020. NFR tables are categorized in separate folders (ENERGY, INDUSTRY and SOLVENT PRODUCT USE, AGICULTURE, 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

[22] http://www.stat.gov.mk/PublikaciiPoOblast.aspx?id=34&rbrObl=37
[23] http://www.stat.gov.mk/PrethodniSoopstenijaOblast.aspx?id=64&rbrObl=21

reporting round EF from GB 2019 were checked and excel calculations sheets and IIR tables were updated.

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

The basic approach in the selection of the methodology used in the calculation of emissions and selection of emission factors for each source is driven by availability of activity data. The availability of data and possible time series inconsistencies are described for each source category in the sectorial chapters, further below. Mainly the problem is coming from the fact that data coming from the Statistical publications are not detailed enough, 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. These effects in use of different methodology in the older statistical yearbook, and higher use of data gap filling methods that result with trend inconsistency in some sectors, as well as higher uncertainty. However lately with introduction of MAKSTAT database the activity data are revised, more detail and historical data are introduced, which enable us to improve in this field.

Considering such difficulties in the collection of data on activity rates, as well as the fact that Republic of North Macedonia does not yet have national emission factors with exception of those provided for the major industries, Tier 1 methodologies and the corresponding emission factors from GB 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.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. Emission factors from older Guidebooks GB 2009, GB 2013 or 2016 are used in cases when we availability of activity data is limited.

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), 5.A and 5.D.2, for the whole reporting period. Implied emission factors (IEFs) have been used in NFR categories 1.A.1.a (Public electricity and heat production), 2.A.1 (Cement production) 2.C.1 (Metal production) and 2.C.2 (Ferroalloy's production). Tier 2 has been also introduced in 2.C.5 (Lead production) and 2.C.6 (Zinc Production). Tier 3 method for calculation was used for calculation of NFR categories under 1.A.3.b for the period 2005-2020. Emission measurement data for NOx, CO, SOx and TSP considered as Tier 3 were used in the NFR category 1.A.1.a.

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

Detailed overview and explanation of activity data and emission factors for each of the NFR sectors are presented in Chapters 4.0 to 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 support of a NFR Reporting Tool, which was developed within the EU Twinning project and implemented by an IT expert from MEPP. The NFR Reporting Tool transposes columns to rows, includes data analysis, and provides emission trends. NFR Reporting tool is linked with the NFR_14 reporting template and reporting towards UNECE and EEA is carried out within the given deadline. For this year the air emission inventory was reported on 14.03.2022 and the resubmission was carried out on 7.03.2022.

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, 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 face 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 of from special studies, inquiries or e.g., from the literature. Default emission factors presented in the Guidebook have been used in the calculation of emissions. In the future there is a need to develop national emission factors in some key sectors that would more accurately correspond to the national conditions.

Data sources

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

Table 7 Activity data sources

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

Natural sources	State Statistical Office of the Republic of North Macedonia, Forestry, 2007–2014 [35] Data on fires (burned area, burned forests) reported by Macedonian forest fires 1990-2020	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 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 (NOx, NMVOC, SOx, NH_3 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 following the KCA table sent by CEIP through the REPDAP.

Table 8 Key categories for all air pollutants

Pollutant	Key categories 2020 (sorted from high to low contribution from left to right)											Total %
NOx	1A3biii	1A1a	1A2gviii	1A3bi	1A2a	1A3bii	1A3biii					81.2%
NMVOC	1A4bi	2D3d	2D3a	1B2av	2D3e	3B1a	3De	1B1a	3B1b	2D3f	2H2	82.2%
SO_2	1A1a											95.1%
NH_3	3B1a	3Da2a	3Da3	3Da1	3B3	3B1b						80.2%
PM2,5*	1A4bi	1A1a	1A2a									85.1%
PM10	1A4bi	1A1a	3Dc	1A2a								82.9%
TSP	1A4bi	1A1a	3Dc	2A5a	1A2a							82.6%
BC	1A4bi	1A3biii	1A2a	1A3bi	1A2gviii							80.7%
CO	1A4bi	1A2a	1A3bi	5A								84.3%
Pb	Pb	1A2a	1A1a	1A4bii	2C1	1A3bvi						82.6%

Pollutant	Key categories 2020 (sorted from high to low contribution from left to right)											Total %
Cd	1A4bi	1A1a	2C1									84.8%
Hg	1A1a	1A2a	2K									81.4%
As	1A1a											92.6%
Cr	1A1a	1A4bi	1A3bvi									81.6%
Cu	1A3bvi											86.7%
Ni	1A1a	1A4ai	1A4bi									82.4%
Se	1A1a											98.8%
Zn	1A4bi	1A2a	1A3bvi	2C1								84.8%
DIOX	1A4bi	1A2a										82.6%
PAH	1A4bi	1A2a										87.9%
HCB	5C1biii	1A4bi										94.7%
PCBs	2K											87.6%

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

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A3biii	R.T., Heavy duty vehicles	5.35	26.8%	26.8%
1A1a	Public electricity and heat production	4.33	21.7%	48.5%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	2.79	14.0%	62.6%
1A3bi	R.T., Passenger cars	1.53	7.7%	70.2%
1A2a	Iron and Steel	1.29	6.5%	76.7%
1A3bii	R.T., Light duty vehicles	0.89	4.5%	81.2%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
1A1a	Public electricity and heat production	23.77	4.33	0.697	37.5%	37.5%
1A3biii	R.T., Heavy duty vehicles	3.00	5.35	0.461	24.8%	62.3%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	2.00	2.79	0.219	11.8%	74.0%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	3.70	0.83	0.091	4.9%	78.9%
1A3bi	R.T., Passenger cars	5.28	1.53	0.089	4.8%	83.7%

Table 10 Key source categories for emissions of NMVOC in Gg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum

1A4bi	Residential: stationary	4.75	21.3%	21.3%
2D3d	Coating applications	2.52	11.3%	32.6%
2D3a	Domestic solvent use including fungicides	2.48	11.1%	43.7%
1B2av	Distribution of oil products	1.66	7.5%	51.1%
2D3e	Degreasing	1.62	7.3%	58.4%
3B1a	Dairy cattle	1.40	6.3%	64.7%
3De	Cultivated crops	1.09	4.9%	69.5%
1B1a	Coal Mining and Handling	0.91	4.1%	73.6%
3B1b	Non-dairy cattle	0.72	3.2%	76.8%
2D3f	Dry cleaning	0.62	2.8%	79.6%
2H2	Food and beverages industry	0.59	2.6%	82.2%

Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
1A3bi	R.T., Passenger cars	11.83	0.51	0.481	36.1%	36.1%
2D3a	Domestic solvent use including fungicides	2.43	2.48	0.128	9.6%	45.7%
1B2av	Distribution of oil products	1.18	1.66	0.106	7.9%	53.6%
2D3d	Coating applications	3.78	2.52	0.071	5.4%	59.0%
3B1a	Dairy cattle	1.59	1.40	0.062	4.7%	63.6%
3De	Cultivated crops	1.14	1.09	0.053	4.0%	67.6%
2D3e	Degreasing	2.43	1.62	0.046	3.5%	71.0%
1A3biv	R.T., Mopeds & Motorcycles	1.00	0.01	0.044	3.3%	74.3%
1A2a	Iron and Steel	0.20	0.52	0.041	3.1%	77.4%
2D3f	Dry cleaning	0.61	0.62	0.032	2.4%	79.8%
1A3bv	R.T., Gasoline evaporation	1.10	0.19	0.031	2.3%	82.1%

Table 11 Key source categories for emissions of SO_2 in Gg

Level Assessment 2020				
NFR Code	**NFR sector**	**2020**	**%**	**%cum**
1A1a	Public electricity and heat production	88.87	95.1%	95.1%

Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
1A1a	Public electricity and heat production	102.15	88.87	0.049	37.6%	37.6%
1A2a	Iron and Steel	1.40	3.36	0.028	21.6%	59.1%
1A2b	Non-ferrous Metals	2.10	0.00	0.022	17.2%	76.4%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	0.91	0.00	0.010	7.4%	83.8%

Table 12 Key source categories for emissions of NH_3 in Gg

Level Assessment 2020				
NFR Code	**NFR sector**	**2020**	**%**	**%cum**

Level Assessment 2020				
NFR Code	**NFR sector**	**2020**	**%**	**%cum**
3B1a	Dairy cattle	1.82	21.5%	21.5%
3Da2a	Animal manure	1.72	20.3%	41.8%
3Da3	Urine and dung deposited by grazing animals	1.04	12.3%	54.1%
3Da1	Inorganic N-fertilizers	0.75	8.9%	63.0%
3B1b	Non-dairy cattle	0.75	8.8%	71.8%
3B3	Swine	0.71	8.4%	80.2%

Trend Assessment 1990-2020						
NFR Code	NFR sector	**1990**	**2020**	**TA**	**%**	**%cum**
3B1a	Dairy cattle	2.07	1.82	0.157	22.8%	22.8%
3Da3	Urine and dung deposited by grazing animals	2.93	1.04	0.117	17.0%	39.9%
3B4gi	Laying Hens	1.76	0.47	0.104	15.1%	55.0%
3B3	Swine	0.84	0.75	0.066	9.6%	64.6%
3Da1	Inorganic N-fertilizers	0.91	0.75	0.059	8.6%	73.2%
3B2	Sheep	0.92	0.25	0.053	7.7%	80.9%

Table 13 Key source categories for emissions of CO in Gg

Level Assessment 2020				
NFR Code	**NFR sector**	**2020**	**%**	**%cum**
1A4bi	Residential: stationary	31.73	64.1%	64.1%
1A2a	Iron and Steel	3.79	7.7%	71.7%
1A3bi	R.T., Passenger cars	3.52	7.1%	78.9%
5A	Solid waste disposal on land	2.69	5.4%	84.3%

Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
1A3bi	R.T., Passenger cars	46.34	3.52	0.746	44.2%	44.2%
1A4bi	Residential: stationary	64.14	31.73	0.418	24.8%	68.9%
1A2a	Iron and Steel	1.50	3.79	0.175	10.3%	79.3%
5A	Solid waste disposal on land	1.22	2.69	0.121	7.1%	86.4%

Table 14 Key source categories for emissions of TSP in Gg

Level Assessment 2020				
NFR Code	**NFR sector**	**2020**	**%**	**%cum**
1A4bi	Residential: stationary	6.34	38.6%	38.6%
1A1a	Public electricity and heat production	3.90	23.8%	62.4%
3Dc	On-farm storage. handling and transport of agricultural products	1.97	12.0%	74.4%
2A5a	Quarrying and mining of minerals other than coal	0.79	4.8%	79.2%
1A2a	Iron and Steel	0.55	3.4%	82.6%

Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
2C2	Ferroalloys Production	24.52	0.08	1.476	46.5%	46.5%

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A4bi	Residential: stationary	12.74	6.34	0.633	19.9%	66.5%
3Dc	On-farm storage, handling and transport of agricultural products	2.06	1.97	0.312	9.8%	76.3%
2A5a	Quarrying and mining of minerals other than coal	0.62	0.79	0.139	4.4%	80.7%

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

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A4bi	Residential: stationary			5.86	67.3%	67.3%
1A1a	Public electricity and heat production			1.07	12.2%	79.5%
1A2a	Iron and Steel			0.49	5.6%	85.1%
Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum
2C2	Ferroalloys Production	14.71	0.05	1.668	49.2%	49.2%
1A4bi	Residential: stationary	11.78	5.86	1.174	34.6%	83.8%

Table 16 Key source categories for emissions of PM10 in Gg

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A4bi	Residential: stationary			6.02	44.8%	44.8%
1A1a	Public electricity and heat production			2.63	19.6%	64.4%
3Dc	On-farm storage. handling and transport of agricultural products			1.97	14.7%	79.0%
1A2a	Iron and Steel			0.52	3.9%	82.9%
Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum
2C2	Ferroalloys Production	20.84	0.07	1.533	48.4%	48.4%
1A4bi	Residential: stationary	12.10	6.02	0.710	22.4%	70.8%
3Dc	On-farm storage. handling and transport of agricultural products	2.06	1.97	0.373	11.8%	82.5%

Table 17 Key source categories for emissions of BC in Gg

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A4bi	Residential: stationary			0.59	58.4%	58.4%
1A3biii	R.T., Heavy duty vehicles			0.07	6.7%	65.0%
1A2a	Iron and Steel			0.06	5.7%	70.7%
1A3bi	R.T., Passenger cars			0.06	5.7%	76.4%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction			0.04	4.3%	80.7%
Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum

Level Assessment 2020

NFR Code	NFR sector			2020	%	%cum
2C2	Ferroalloys Production	1.47	0.00	1.451	58.0%	58.0%
1A4bi	Residential: stationary	1.18	0.59	0.590	23.6%	81.6%

Table 18 Key source categories for emissions of Pb in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A2a	Iron and Steel	0.50	22.3%	22.3%
1A1a	Public electricity and heat production	0.44	19.2%	41.5%
1A4bii	Residential: Household and gardening (mobile)	0.41	18.3%	59.8%
2C1	Iron and Steel Production	0.28	12.3%	72.1%
1A3bvi	R.T., Automobile tyre and break wear	0.24	10.5%	82.6%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
2C5	Lead Production	131.06	0.03	56.60	31.1%	31.1%
1A3bi	R.T., Passenger cars	89.09	0.00	39.29	21.6%	52.7%
1A2a	Iron and Steel	0.19	0,.50	22.76	12.5%	65.3%
1A1a	Public electricity and heat production	0.89	0,44	19.331	10.6%	75.9%
1A4bii	Residential: Household and gardening (mobile)	0.63	0.41	18.489	10.2%	86.1%

Table 19 Key source categories for emissions of Cd in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A4bi	Residential: stationary	0.10	49.1%	49.1%
1A1a	Public electricity and heat production	0.05	25.2%	74.3%
2C1	Iron and Steel Production	0.02	10.6%	84.8%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
1A4bi	Residential: stationary	0.21	0.10	2.754	37.6%	37.6%
2C5	Lead Production	0.35	0.00	1.647	22.5%	60.1%
1A1a	Public electricity and heat production	0.11	0.05	1.403	19.2%	79.3%
2C1	Iron and Steel Production	0.02	0.02	0.720	9.8%	89.1%

Table 20 Key source categories for emissions of Hg in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A1a	Public electricity and heat production	0.08	50.7%	50.7%
1A2a	Iron and Steel	0.03	18.1%	68.8%
2K	Consumption of POPs and heavy metals	0.02	12.6%	81.4%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
1A1a	Public electricity and heat production	0.17	0.08	0.950	39.5%	39.5%
1A2a	Iron and Steel	0.01	0.03	0.636	26.5%	66.0%

Level Assessment 2020

NFR Code	NFR sector			2020	%	%cum
2K	Consumption of POPs and heavy metals	0.02	0.02	0.369	15.3	81.3%

Table 21 Key source categories for emissions of As in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A1a	Public electricity and heat production	0.42	92.6%	92.6%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
1A1a	Public electricity and heat production	0.84	0.42	3.023	47.8%	47.8%
2C5	Lead Production	1.03	0.00	2.265	35.8%	83.5%

Table 22 Key source categories for emissions of Cr in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A1a	Public electricity and heat production	0.26	39.9%	39.9%
1A4bi	Residential: stationary	0.19	28.3%	68.3%
1A3bvi	R.T., Automobile tyre and break wear	0.09	13.4%	81.6%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
2C1	Iron and Steel Production	3.98	0.02	5.792	54.1%	54.1%
1A1a	Public electricity and heat production	0.54	0.26	2.225	20.8%	74.9%
1A4bi	Residential: stationary	0.37	0.19	1.595	14.9%	89.8%

Table 23 Key source categories for emissions of Cu in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A3bvi	R.T., Automobile tyre and break wear	1.94	86.7%	86.7%

Trend Assessment 1990-2020

NFR Code	NFR sector	1990	2020	TA	%	%cum
1A3bi	R.T., Passenger cars	0.30	0.00	0.132	28.0%	28.0%
1A2gviii	Other Stationary Combustion in Manufacturing	0.19	0.04	0.076	16.0%	44.0%
2G	Other product manufacture and use	0.14	0.04	0.055	11.6%	55.7%
1A3biii	R.T., Heavy duty vehicles	0.12	0.00	0.054	11.3%	67.0%
1A4bi	Residential: stationary	0.10	0.05	0.033	7.1%	74.1%
1A3bii	R.T., Light duty vehicles	0.06	0.00	0.027	5.8%	79.8%
2C1	Iron and Steel Production	0.06	0.00	0.027	5.7%	85.5%

Table 24 Key source categories for emissions of Ni in Mg

Level Assessment 2020

NFR Code	NFR sector	2020	%	%cum
1A1a	Public electricity and heat production	0.55	56.2%	56.2%
1A4ai	Commercial/Institutional: Stationary	0.15	15.7%	71.9%
1A4bi	Residential: stationary	0.10	10.5%	82.4%

Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum
1A1a	Public electricity and heat production	1.21	0.55	0.531	33.5%	33.5%
1A4ai	Commercial/Institutional: Stationary	0.05	0.15	0.441	27.9%	61.4%
1A4bi	Residential: stationary	0.13	0.10	0.198	12.5%	73.9%
1A2a	Iron and Steel	0.022	0.05	0.137	8.6%	82.5%

Table 25 Key source categories for emissions of Se in Mg

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A1a	Public electricity and heat production			1.30	98.8%	98.8%
Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum
1A1a	Public electricity and heat production	2.63	1.30	0.023	57.6%	57.6%
1A2a	Iron and Steel	0.00	0.01	0.009	21.9%	79.5%
1A2b	Non-ferrous Metals	0.00	0.00	0.003	7.9%	87.4%

Table 26 Key source categories for emissions of Zn in Mg

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A4bi	Residential: stationary			4.05	55.5%	55.5%
1A2a	Iron and Steel			1.02	14.0%	69.4%
1A3bvi	R.T., Automobile tyre and break wear			0.69	9.5%	78.9%
2C1	Iron and Steel Production			0.43	5.8%	84.8%
Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum
1A4bi	Residential: stationary	8.14	4.05	0.524	33.7%	33.7%
1A2a	Iron and Steel	0.37	1.02	0.363	23.3%	56.9%
2C1	Iron and Steel Production	3.54	0.43	0.312	20.0%	77.0%
1A2b	Non-ferrous Metals	0.48	0.00	0.065	4.2%	81.1%

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

Level Assessment 2020						
NFR Code	NFR sector			2020	%	%cum
1A4bi	Residential: stationary			6.34	73.4%	73.4%
1A2a	Iron and Steel			0.80	9.2%	82.6%
Trend Assessment 1990-2020						
NFR Code	NFR sector	1990	2020	TA	%	%cum
1A4bi	Residential: stationary	12.80	6.34	0.201	29.8%	29.8%
1A2a	Iron and Steel	0.29	0.80	0.178	26.4%	56.2%
2C1	Iron and Steel Production	2.66	0.56	0.160	23.7%	79.8%
1A2b	Non-ferrous Metals	0.47	0.00	0.054	8.0%	87.8%

Table 28 Key source categories for emissions of PAHs in Mg

Level Assessment 2020						
NFR Code	**NFR sector**			**2020**	**%**	**%cum**
1A4bi	Residential: stationary			2.77	72.8%	72.8%
1A2a	Iron and Steel			0.58	15.1%	87.9%
Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
1A4bi	Residential: stationary	5.63	2.77	0.214	29.0%	29.0%
1A2a	Iron and Steel	0.27	0.58	0.191	25.9%	54.9%
1A2gviii	Other Stationary Combustion in Manufacturing Industries and Construction	0.07	0.12	0.144	19.5%	74.4%
1A2b	Non-ferrous Metals	0.35	0.00	0.085	11.5%	86.0%

Table 29 Key source categories for emissions of HCB in kg

Level Assessment 2020						
NFR Code	**NFR sector**			**2020**	**%**	**%cum**
5C1biii	Clinical waste			0.11	69.22%	69.2%
1A4bi	Residential: stationary			0.04	25.5%	94.7%
Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
1A2b	Non-ferrous Metals	0.35	0.00	0.0 85	11.5%	86.0%

Table 30 Key source categories for emissions of PCB in kg

Level Assessment 2020						
NFR Code	**NFR sector**			**2020**	**%**	**%cum**
2K	Consumption of POPs and heavy metals			207.71	87.6%	87.6%
Trend Assessment 1990-2020						
NFR Code	**NFR sector**	**1990**	**2020**	**TA**	**%**	**%cum**
2K	Consumption of POPs and heavy metals	202.80	207.71	0.56	61.5%	61.5%
2C5	Lead Production	124.26	28.50	0.34	37.3%	98.8%

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).

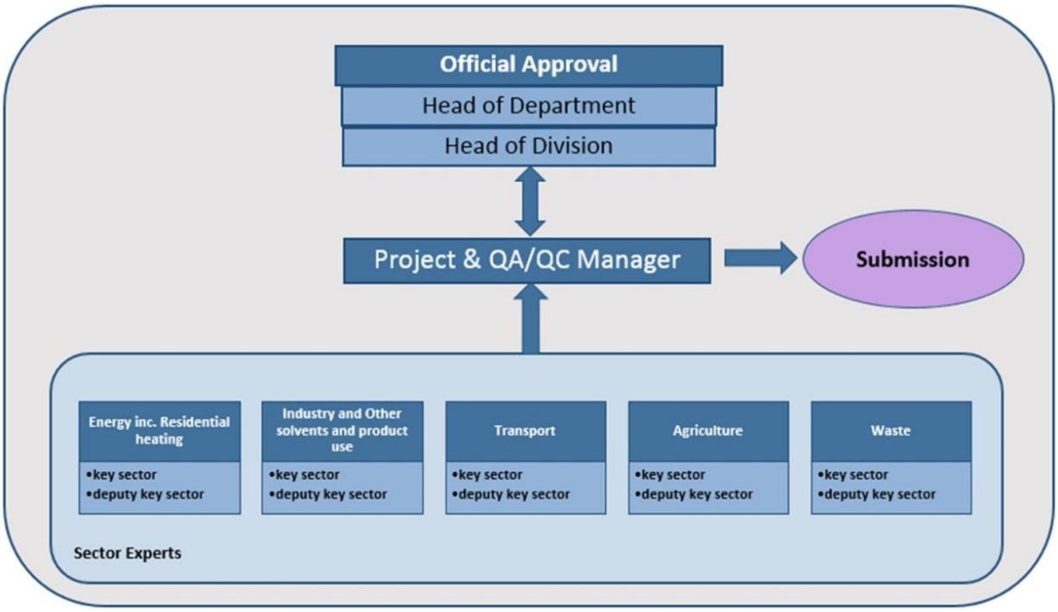


Figure 3 Roles in inventory preparation and submission

The sector experts are responsible for selection of methods. Collection of input data, emissions calculation as well as QC, are carried out at sector level. The project Manager oversees coordination of activities, timely preparation and completeness of IIR, as well as cross-cutting tasks such as basic QC of report, implementation and maintaining of a QA/QC plan, review coordination within the team, as well as for key category analysis and of Review communication. The update of uncertainty analysis, KCA, trend assessment and recalculations files are done by QA/QC Manager 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 2020 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, and resubmission was done on 7th March this year.

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

Table 31 Completeness Analysis 2020

Sector	Submission 2021		Submission 2022			Plan Submission 2023		
	1990	2019	1990	2019	2020	1990	2020	2021
Transparency (IE)	98%	98%	98%	98%	98%	98%	98%	98%
Completeness (NE)	88%	93%	89%	94%	94%	90%	95%	95%
Completeness (IIR)	~ 273 pages		~ 310 pages			~ 340 pages		
Timeliness (Submission)	95%*		95%*			100%		

Accuracy, consistency, and comparability were checked during 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 the improvement plan below.

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

Table 32 Annual time schedule

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

*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 during May due limited capacities.

2.6.1. Quality control procedures

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

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

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

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

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

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

2.6.2. Quality assurance procedures

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

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

The review consists of three stages, whereby stage 1 and 2 are carried out annually, and the third stage – the in-depth review – on an irregular basis. Findings in the Stage 1 and 2 review report are elaborated in the chapter emission trends and recalculations. The Stage 3 review of the Macedonian Inventory was carried out in May – September 2020. Most of the recommendations were incorporated in 2021 report and some in this year report. Those recommendations that are planned to be implemented in the following submissions are listed in the chapter for planned improvements.

2.6.3. Archiving and documentation

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

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

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

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

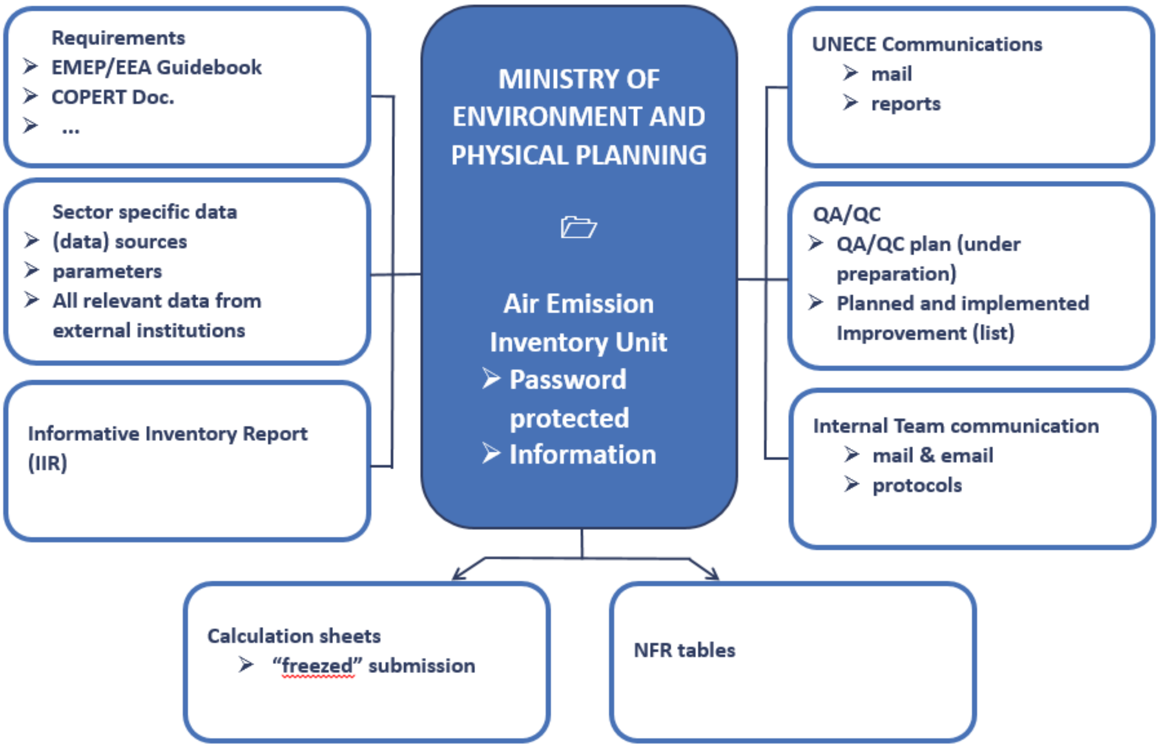


Figure 4 Archiving system

2.6.4. Continuous improvement

The Macedonian inventory is subject to continuous improvement.

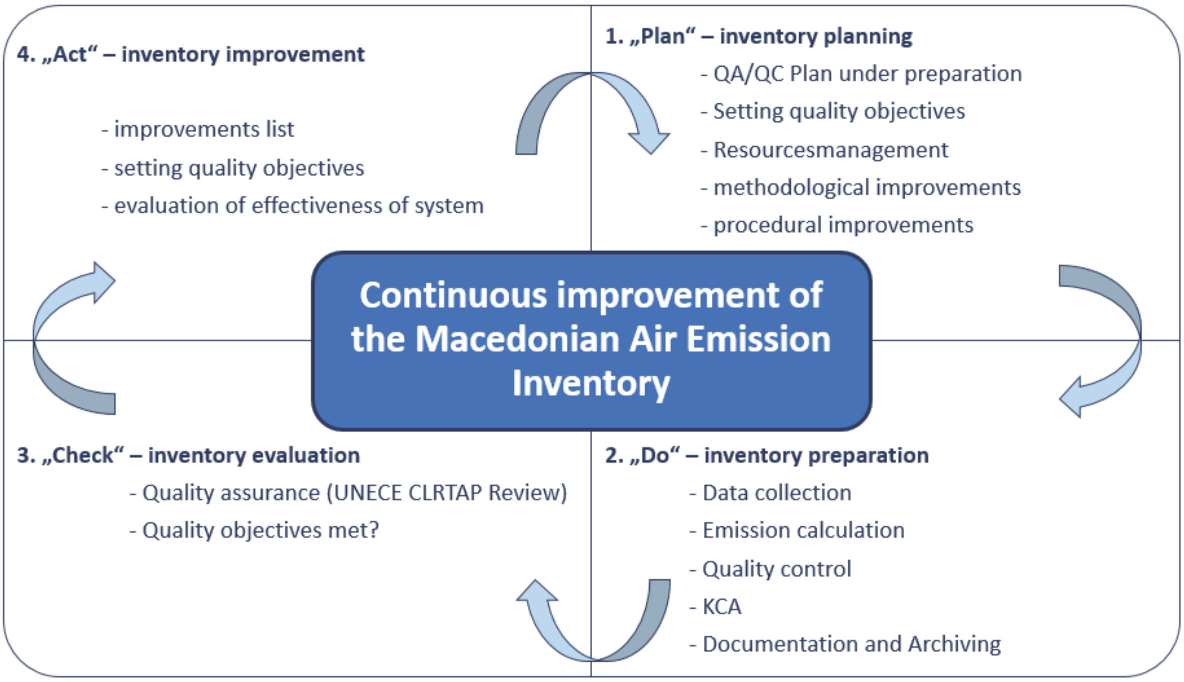


Figure 5 Improvement Cycle

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

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

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

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

2.7. General uncertainty evaluation

The uncertainty assessment of the main pollutants (SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$) has been carried out. The assessment was carried out for the base year 1990 and for the year 2020. 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. 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 judgment based on a number of relevant facts	50 to 200%
D	An estimate based on single measurements, or an engineering calculation derived from a number of relevant facts	100 to 300%
E	An estimate based on an engineering calculation derived from assumptions only	order of magnitude

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

2.7.1. Results

The quantitative assessment was performed with the Tier 1 method for the pollutants SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$, for the year 2020 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 SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$

Pollutants	Emissions 2020	Level uncertainty 200	Trend uncertainty 1990 - 2020
SO_2	93.4 kt	19.6%	5.7%
NOX	19.9 kt	18.2%	5.6%
NMVOC	22.3 kt	45.5%	10.7%
NH_3	8.3 kt	96.4%	18.9%
PM2.5	8.6 kt	87.4%	12.6%

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

Table 36 Uncertainty estimation of SO_2 emissions 1990 and 2020

Member State:	MK
Reporting year:	2022

NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertaint	Contribution to variance by category in year x	Type A sensitivi	Type B sensitivi	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 emissio	Comments (optional)
		Mg	Mg	%	%	%	%	%	%	%	%	%	
	SO2	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)	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2	
1 A 1 a	SO2	102,1	88,9	5,0	20,0	20,62	384,61	0,03	0,79	0,67	5,60	31,83	
1 A 1 b	SO2	0,8	NO	5,0	20,0	20,62							
1 A 2 a	SO2	1,4	3,4	10,0	20,0	22,36	0,65	0,02	0,03	0,39	0,42	0,33	
1 A 2 b	SO2	2,1	0,0	10,0	20,0	22,36	0,00	-0,02	0,00	-0,31	0,00	0,10	
1 A 2 c	SO2	0,0	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00	
1 A 2 d	SO2	0,3	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,04	0,00	0,00	
1 A 2 e	SO2	0,2	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,03	0,00	0,00	
1 A 2 g 8	SO2	0,4	0,7	10,0	20,0	22,36	0,03	0,00	0,01	0,07	0,09	0,01	
1 A 3 a	SO2	0,0	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00	
1 A 3 b	SO2	0,7	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,09	0,00	0,01	
1 A 3 d	SO2	0,0	0,0	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,00	0,00	
1 A 4 a	SO2	0,2	0,1	10,0	20,0	22,36	0,00	0,00	0,00	0,00	0,02	0,00	
1 A 4 b	SO2	0,4	0,2	20,0	20,0	28,28	0,00	0,00	0,00	-0,03	0,04	0,00	
1 A 4 c	SO2	0,2	0,0	10,0	20,0	22,36	0,00	0,00	0,00	-0,02	0,01	0,00	
1 B 2 a	SO2	0,8	-	10,0	20,0	22,36	0,00	-0,01	0,00	-0,11	0,00	0,01	
1 B 2 c	SO2	0,0	NO	20,0	20,0	28,28							
5 C	SO2	0,0	0,0	10,0	200,0	200,25	0,00	0,00	0,00	0,00	0,00	0,00	
Total Uncertainties						Uncertainty in total inventory %:	19,63				Trend uncertainty %:	5,68	

Table 37 Uncertainty estimation of NO_x emissions 1990 and 2020

Member State:	MK
Reporting year:	2022

NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertaint	Contribution to variance by category in year x	Type A sensitivi	Type B sensitivi	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 emissio	Comments (optional)
		Mg	Mg	%	%	%	%	%	%	%	%	%	
	NOX	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)	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2	
1 A 1 a	NOX	23,8	4,3	5,0	20,0	20,62	20,05	-0,13	0,10	-2,67	0,67	7,56	
1 A 1 b	NOX	0,3	NO	5,0	20,0	20,62							
1 A 2 a	NOX	1,8	1,3	10,0	40,0	41,23	7,15	0,01	0,03	0,43	0,40	0,35	
1 A 2 b	NOX	0,7	0,0	10,0	40,0	41,23	0,00	-0,01	0,00	-0,25	0,01	0,06	
1 A 2 c	NOX	0,1	0,0	10,0	40,0	41,23	0,01	0,00	0,00	0,01	0,01	0,00	
1 A 2 d	NOX	0,1	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,01	0,00	0,00	
1 A 2 e	NOX	0,9	0,4	10,0	40,0	41,23	0,62	0,00	0,01	0,01	0,12	0,01	
1 A 2 g 7	NOX	3,7	0,8	10,0	40,0	41,23	2,93	-0,02	0,02	-0,70	0,26	0,56	
1 A 2 g 8	NOX	2,0	2,8	10,0	40,0	41,23	33,34	0,04	0,06	1,68	0,87	3,59	
1 A 3 a	NOX	0,3	0,2	10,0	40,0	41,23	0,20	0,00	0,00	0,07	0,07	0,01	
1 A 3 b	NOX	8,9	7,8	10,0	40,0	41,23	258,17	0,09	0,17	3,40	2,42	17,42	
1 A 3 c	NOX	0,4	0,1	10,0	40,0	41,23	0,01	0,00	0,00	-0,10	0,02	0,01	
1 A 3 d	NOX	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00	
1 A 4 a	NOX	0,1	0,8	10,0	40,0	41,23	3,02	0,02	0,02	0,68	0,26	0,54	
1 A 4 b	NOX	0,8	0,4	20,0	40,0	44,72	0,88	0,00	0,01	0,05	0,26	0,07	
1 A 4 c	NOX	0,8	0,3	10,0	40,0	41,23	0,39	0,00	0,01	-0,03	0,09	0,01	
1 B 2 a	NOX	0,3	-	10,0	40,0	41,23	0,00	0,00	0,00	-0,11	0,00	0,01	
1 B 2 c	NOX	0,0	NO	20,0	40,0	44,72							
2 G	NOX	0,0	0,0	20,0	40,0	44,72	0,00	0,00	0,00	-0,01	0,01	0,00	
3 B 1	NOX	0,0	0,0	5,3	40,0	40,35	0,00	0,00	0,00	0,01	0,00	0,00	
3 B 2	NOX	0,0	0,0	10,2	40,0	41,28	0,00	0,00	0,00	0,00	0,00	0,00	
3 B 3	NOX	0,0	0,0	6,1	40,0	40,46	0,00	0,00	0,00	0,00	0,00	0,00	
3 B 4	NOX	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00	
3 D a	NOX	0,3	0,5	50,0	40,0	64,03	2,46	0,01	0,01	0,32	0,76	0,68	
5 C	NOX	0,1	0,0	10,0	200,0	200,25	0,18	0,00	0,00	0,09	0,01	0,01	
Total Uncertainties						Uncertainty in total inventory %:	18,15				Trend uncertainty %:	5,56	

Table 38 Uncertainty estimation of NMVOC emissions 1990 and 2020

Member State:	MK
Reporting year:	2022

NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertaint	Contribution to variance by category in year x	Type A sensitivi	Type B sensitivi	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 emissio	Comments (optional)
		Mg	Mg	%	%	%	%	%	%	%	%	%	
	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)	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2	
1 A 1 a	NMVOC	0,1	0,0	5,0	200,0	200,06	0,13	0,00	0,00	-0,01	0,01	0,00	
1 A 1 b	NMVOC	0,0	NO	5,0	200,0	200,06							
1 A 2 a	NMVOC	0,2	0,5	10,0	200,0	200,25	19,65	0,01	0,01	1,78	0,16	3,18	
1 A 2 b	NMVOC	0,2	0,0	10,0	200,0	200,25	0,00	0,00	0,00	-0,45	0,00	0,20	
1 A 2 c	NMVOC	0,0	0,0	10,0	200,0	200,25	0,00	0,00	0,00	0,01	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	-0,05	0,00	0,00	
1 A 2 e	NMVOC	0,1	0,1	10,0	200,0	200,25	0,33	0,00	0,00	0,17	0,02	0,03	
1 A 2 g 7	NMVOC	0,4	0,1	10,0	40,0	41,23	0,02	0,00	0,00	-0,09	0,03	0,01	
1 A 2 g 8	NMVOC	0,1	0,2	10,0	40,0	41,23	0,07	0,00	0,00	0,09	0,05	0,01	
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	2,3	10,0	40,0	41,23	15,86	-0,11	0,05	-4,23	0,68	18,35	
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	0,06	0,00	0,00	0,11	0,04	0,01	
1 A 4 b	NMVOC	10,5	5,3	20,0	40,0	44,72	102,39	0,00	0,11	0,12	3,17	10,09	
1 A 4 c	NMVOC	0,1	0,1	10,0	40,0	41,23	0,01	0,00	0,00	0,00	0,02	0,00	
1 B 1 a	NMVOC	1,3	0,9	10,0	20,0	22,36	0,74	0,01	0,02	0,10	0,27	0,08	
1 B 2 a	NMVOC	1,4	1,7	10,0	20,0	22,36	2,49	0,02	0,03	0,40	0,49	0,41	
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	0,00	0,00	0,00	-0,14	0,00	0,02	
2 D	NMVOC	10,5	7,7	20,0	125,0	126,59	1.710,31	0,05	0,16	6,52	4,58	63,55	
2 G	NMVOC	0,5	0,1	20,0	40,0	44,72	0,02	0,00	0,00	-0,15	0,05	0,02	
2 H	NMVOC	1,2	0,6	20,0	40,0	44,72	1,25	0,00	0,01	0,02	0,35	0,12	
3 B 1	NMVOC	2,6	2,1	5,3	40,0	40,35	13,07	0,02	0,04	0,68	0,33	0,57	
3 B 2	NMVOC	0,4	0,1	10,2	40,0	41,28	0,03	0,00	0,00	-0,07	0,03	0,01	
3 B 3	NMVOC	0,1	0,1	6,1	40,0	40,46	0,04	0,00	0,00	0,04	0,02	0,00	
3 B 4	NMVOC	1,6	0,4	10,0	40,0	41,23	0,51	-0,01	0,01	-0,34	0,12	0,13	
3 D a	NMVOC	-	-	50,0	40,0	64,03	0,00	0,00	0,00	0,00	0,00	0,00	
5 A	NMVOC	0,0	0,1	50,0	125,0	134,63	0,21	0,00	0,00	0,16	0,12	0,04	
5 C	NMVOC	0,0	0,0	10,0	125,0	125,40	0,01	0,00	0,00	0,02	0,00	0,00	
Total Uncertainties						Uncertainty in total inventory %:	**43,21**				Trend uncertainty %:	**9,84**	

Table 39 Uncertainty estimation of NH_3 emissions 1990 and 2020

Member State:	MK
Reporting year:	2022

NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertaint	Contribution to variance by category in year x	Type A sensitivi	Type B sensitivi	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 emissio	Comments (optional)
		Mg	Mg	%	%	%	%	%	%	%	%	%	
	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)	I*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	2,02	0,01	0,01	0,75	0,08	0,57	
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	0,6	20,0	125,0	126,59	70,49	0,00	0,04	-0,25	0,99	1,04	
1 A 4 c	NH3	0,0	0,0	10,0	125,0	125,40	0,00	0,00	0,00	0,02	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	2,5	5,3	125,0	125,11	1.439,34	0,06	0,16	7,06	1,20	51,24	
3 B 2	NH3	0,9	0,3	10,2	125,0	125,42	14,37	-0,01	0,02	-1,84	0,23	3,44	
3 B 3	NH3	0,8	0,7	6,1	125,0	125,15	125,95	0,02	0,05	2,43	0,41	6,07	
3 B 4	NH3	2,4	0,6	10,0	125,0	125,40	86,23	-0,04	0,04	-5,12	0,55	26,49	
3 D a	NH3	7,3	3,5	50,0	200,0	206,16	7.538,51	-0,02	0,22	-4,48	15,72	267,31	
Total Uncertainties						Uncertainty in total inventory %:	**96,32**				Trend uncertainty %:	**18,87**	

Table 40 Uncertainty estimation of PM2.5 emissions 1990 and 2020

Member State:	MK												
Reporting year:	2022												
NRF sector	Pollutan	Base year emissio	Year t emissio	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertaint	Contribution to variance by category in year x	Type A sensitivi	Type B sensitivi	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 emissio	Comments (optional)
		Mg	Mg	%	%	%	%	%	%	%	%	%	
	PM2.5	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)	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2	
1 A 1 a	PM2.5	3,5	1,1	5,0	125,0	125,10	238,02	0,00	0,03	0,53	0,23	0,34	
1 A 1 b	PM2.5	0,0	NO	5,0	40,0	40,31							
1 A 2 a	PM2.5	0,2	0,5	10,0	40,0	41,23	5,43	0,01	0,01	0,53	0,21	0,33	
1 A 2 b	PM2.5	0,3	0,0	10,0	40,0	41,23	0,00	0,00	0,00	-0,08	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	0,03	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	0,60	0,00	0,00	-0,04	0,02	0,00	
1 A 2 g 8	PM2.5	0,1	0,1	10,0	125,0	125,40	2,65	0,00	0,00	0,35	0,05	0,13	
1 A 3 a	PM2.5	0,0	0,0	10,0	40,0	41,23	0,00	0,00	0,00	0,00	0,00	0,00	
1 A 3 b	PM2.5	0,0	0,4	10,0	40,0	41,23	3,20	0,01	0,01	0,45	0,16	0,23	
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	1,53	0,00	0,00	0,30	0,04	0,09	
1 A 4 b	PM2.5	11,8	5,9	20,0	125,0	126,59	7.363,08	0,08	0,18	10,46	5,08	135,11	
1 A 4 c	PM2.5	0,0	0,0	10,0	125,0	125,40	0,18	0,00	0,00	0,07	0,01	0,00	
1 B 1 a	PM2.5	0,0	0,0	10,0	200,0	200,25	0,40	0,00	0,00	0,10	0,01	0,01	
1 B 2 a	PM2.5	0,0	-	10,0	200,0	200,25	0,00	0,00	0,00	-0,01	0,00	0,00	
2 A 1	PM2.5	0,1	0,0	2,0	200,0	200,01	0,51	0,00	0,00	0,09	0,00	0,01	
2 A 2	PM2.5	0,0	NO	5,0	200,0	200,06							
2 A 3	PM2.5	0,0	NO	10,0	200,0	200,25							
2 A 5	PM2.5	0,0	0,1	10,0	200,0	200,25	1,40	0,00	0,00	0,24	0,02	0,06	
2 C 1	PM2.5	0,1	0,0	2,0	40,0	40,05	0,00	0,00	0,00	-0,04	0,00	0,00	
2 C 2	PM2.5	14,7	0,0	5,0	40,0	40,31	0,05	-0,12	0,00	-4,70	0,01	22,06	
2 C 3	PM2.5	0,0	NE	2,0	40,0	40,05							
2 C 5	PM2.5	0,2	0,0	5,0	40,0	40,31	0,00	0,00	0,00	-0,06	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	0,2	20,0	40,0	44,72	0,92	0,00	0,01	-0,01	0,16	0,03	
3 B 1	PM2.5	0,1	0,1	5,3	200,0	200,07	2,25	0,00	0,00	0,27	0,01	0,07	
3 B 2	PM2.5	0,0	0,0	10,2	200,0	200,26	0,06	0,00	0,00	0,00	0,00	0,00	
3 B 3	PM2.5	0,0	0,0	6,1	200,0	200,09	0,06	0,00	0,00	0,05	0,00	0,00	
3 B 4	PM2.5	0,1	0,0	10,0	200,0	200,25	0,85	0,00	0,00	0,01	0,02	0,00	
3 D a	PM2.5	-	-	50,0	200,0	206,16	0,00	0,00	0,00	0,00	0,00	0,00	
5 A	PM2.5	0,0	0,0	50,0	200,0	206,16	0,00	0,00	0,00	0,00	0,00	0,00	
5 C	PM2.5	0,1	0,1	10,0	200,0	200,25	1,57	0,00	0,00	0,22	0,02	0,05	
Total Uncertainties						Uncertainty in total inventory %:	87,31				Trend uncertainty %:	12,59	

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 2020

The data for the whole year 2020 has been taken from the State Statistical Office (SSO).

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

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

Households

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

Transport

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

Industry

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

Agriculture

The estimates in the Livestock Survey are in the forms of totals and ratios. The domain of estimates is the whole country and the eight regions. Sample selection weights were used in the estimation procedures of the 2016 Livestock Survey, with certain adjustments made regarding the survey non-response rate. The errors are calculated as relative errors. All calculations were made with the SAS statistical software package. The non-response rate in the Livestock Survey 2016 was 5.3%. The following table shows the calculated relative errors of the main categories of livestock in the survey for 2016. For 2020 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 based on the reports filled in by the reporting units. On the basis of the obtained data and the data on the number of population, 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 2020

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

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

2.8.2. Sources included elsewhere (IE)

Table 44 Number of "included elsewhere" (IE) per sector and pollutant in 2020

Pollutant	Energy	Fugitives	IPPU	Agriculture	Waste	Other
NOx (as NO2)	0	0	3	3	0	0
NMVOC	0	0	3	3	0	0
SOx (as SO2)	0	0	3	1	0	0
NH3	0	0	3	1	0	0
PM2.5	0	0	3	1	0	0
PM10	0	0	3	1	0	0
TSP	0	0	3	1	0	0

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

The notation key -” included elsewhere” (IE) is used in those source categories for which activity data are not available in the required details in the statistical yearbooks but have been included in other source categories. For example, in case of category 1.A.5.b there are available data for the last three years, while emissions from the previous years are noted as IE. For category 1.A.4.aii, there are available data for the period 2005-2020 while for the previous years, emissions are noted as IE. Abbreviation IE is used in cases where there is a lack of activity data. According to recommendations given in the stage 3 review, notation key IE was used for the categories 2.C.7.d and 2.B.10.b.

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 (NOx, NMVOC, SO_2 and NH_3) and CO, which are covered by the Gothenburg Protocol, from 1990-2020 are presented in the following table.

Table 45 Emission trends 1990 – 2020 for the main air pollutants and CO

Year	Emission in kt				
	NOx	NMVOC	SO_2	NH_3	CO
1990	45.47	47.59	112.19	15.80	132.40
1991	37.63	41.91	91.28	14.83	111.54
1992	39.46	44.24	88.47	14.94	123.46
1993	40.93	46.35	90.98	15.26	133.28
1994	36.74	41.30	90.26	15.20	120.87
1995	39.29	43.83	96.63	14.99	125.25
1996	38.57	43.52	90.51	13.95	123.17
1997	37.89	44.52	94.85	13.53	126.29
1998	43.18	44.37	109.38	13.23	128.72
1999	40.43	45.13	99.37	13.41	131.74
2000	43.76	47.13	106.28	13.49	144.14
2001	40.76	39.31	108.33	12.74	113.24
2002	40.81	38.28	96.25	12.12	115.03
2003	35.82	37.85	94.88	12.06	116.05
2004	37.14	38.11	96.17	12.16	121.20
2005	34.94	25.86	94.91	11.21	74.15
2006	34.83	27.10	93.27	11.49	69.74
2007	37.21	27.62	97.71	11.28	69.64
2008	33.56	27.35	75.65	11.23	64.09
2009	34.79	25.69	103.18	10.43	62.67
2010	36.26	26.80	85.76	10.63	61.65
2011	38.61	27.31	103.52	11.06	63.17
2012	36.14	27.02	90.41	10.26	64.75
2013	28.87	26.54	81.04	10.29	62.46
2014	26.27	26.46	82.72	10.32	61.40
2015	21.55	25.77	75.03	10.32	59.39
2016	24.72	25.33	63.70	10.42	62.56
2017	23.33	25.34	54.76	10.26	54.51
2018	22.55	24.55	59.83	9.79	53.97
2019	22.98	23.35	114.66	8.58	54.01

Year	Emission in kt				
	NOx	NMVOC	SO_2	NH_3	CO
2020	19.94	22.34	93.42	8.47	49.51
Trend 1990-2020	***-56%***	***-53%***	***-17%***	***-46%***	***-63%***

3.1.1. NOx emissions

Emission trend

In 1990 national total NOx emissions amounted to around 45 kt. Since then, the emissions decreased by 56%. In 2020 emissions were on the level of about 20 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 2015 is owned to the lower consumption of coal in the major power plants and the modernization of boilers in the power plant REK Bitola. In the period 2016–2018, the emissions are stable. Compared to 2020, emissions in 2019 are lower for 13% due to lower fuel consumption in REK Bitola and lower consumption of low quality coal.

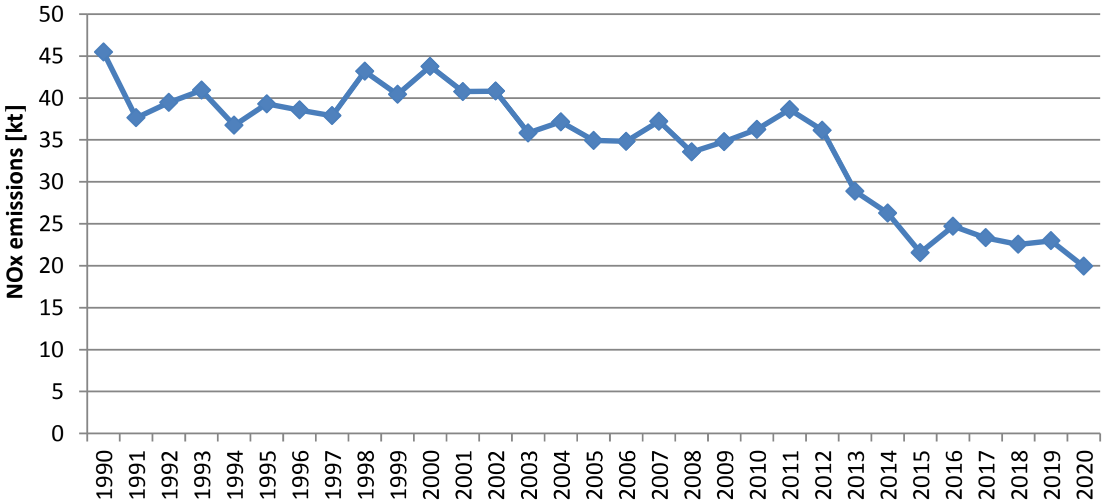


Figure 6 National total NOx emissions 1990-2020

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 2020 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 2020, which is 12.672 Gg.

Main emission sources in North Macedonia

Almost all NOx emissions are coming from the sector Energy. Namely, the main emission sources in 2020 are NFR source categories: 1.A.3 Transport, 1.A.1 Energy Industries and 1.A.2 Manufacturing Industries and Construction which contributed with 40% (21% in 1990), 22% (53% in 1990) and 27% (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 2020 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 27%, and has not changed significantly in comparison to the value in 1990 of 20%.NFR sectors 1.A.4 Other sectors and 3.Agriculture contribute with 8% and 3% respectively while 1.B Fugitive emissions, 2 Industrial Processes and Product Use and 5 Waste are minor sources of NOx emissions.

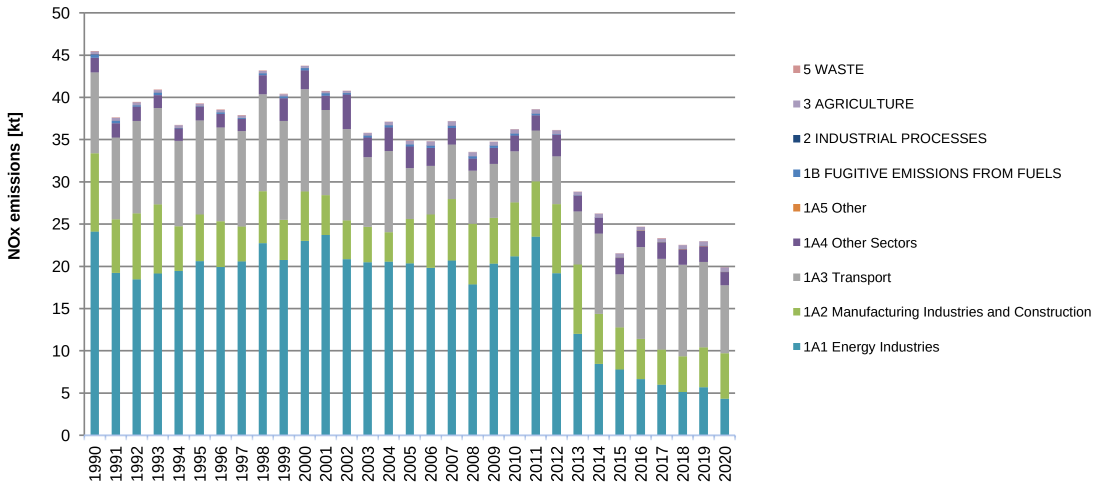


Figure 7 NOx emissions in North Macedonia 1990-2020 by sectors

3.1.2. NMVOC emissions

Emission trend

In 1990, the total national NMVOC emissions amounted to about 47 kt. Compared to 2020, the emissions are down by 53% amounting to around 22 kt. Starting from 2019 to 2020 emissions decreased by 5%, mainly due to the reduced emissions coming from 1.A.1 Energy industry and 1.A.3 Transport.

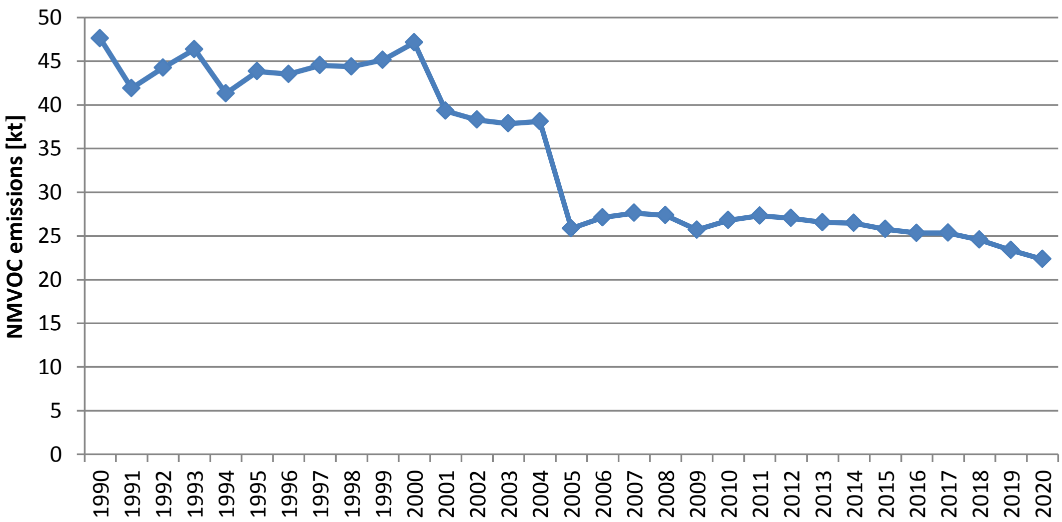


Figure 8 National total NMVOC emissions 1990-2020

Target value for NMVOC according to Gothenburg Protocol for year 2010 is 30 kt NMVOC. The emissions in 2020 are below the target value by 26%. The country is also in compliance with the

Protocol on the control of volatile organic compounds or their Trans boundary fluxes since 1988, NMVOC emissions (44 kt) in 2020 are reduced by 49% compared to 1988.

Main emission sources in North Macedonia

NMVOC emissions are emitted from different sources. The key category source in 2020 are NFR source categories is 2 Industrial pollution, contributing with 38% (26% in 1990) followed by 1.A.4 Other Sectors (mainly residential heating), which contributed with 22% (25% in 1990), to the national total NMVOC emissions. Agriculture is contributing with around 17%, while fugitive emissions are impacting the NMVOC emission with around 12%. NFR source category 1.A.3 Transport contributed with 5% of total calculated national NMVOC emissions and 1.A.2 with 4%.

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

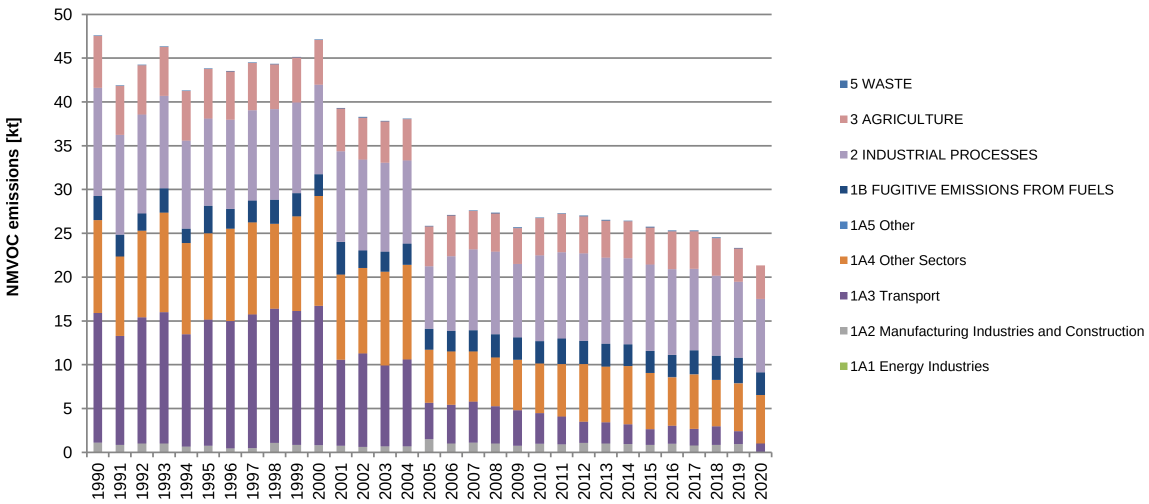


Figure 9 NMVOC emissions in North Macedonia 1990-2020 by sectors

3.1.3. SO_2 emissions

Emission trend

In 1990, the national total SO_2 emissions amounted to 112 kt. In the period 2011–2020 there was a decrease of emissions due to the decrease of coal consumption and lower capacity of work of the second largest (by capacity) power plant REK Oslomej (from 12 to 5 months), attributed to limited amounts of coal. In 2019 there is a sharp increase due to increased use of coal with higher sulfur content and higher production of electricity compared to 2018. But in 2020 the emissions are again decrease due to lower consumption of coal and heavy fuels, but not on the level of 2018. Compared to 2020, the emissions are down by 18%, and compare to 1990 emissions decreased by 16%.

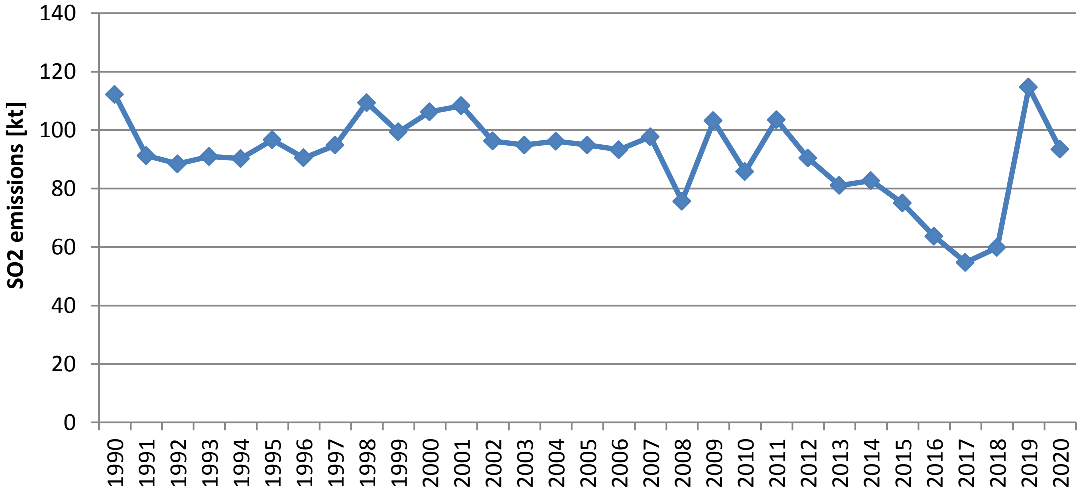


Figure 10 National total SO_2 emissions 1990-2020

North Macedonia is a party to the three protocols, under LRTAP convention, concerning sulfur. The emissions of sulfur dioxide in 2020 are below the base year 1990 emissions and the respective ceiling in 2010, which reflects compliance with the 1994 Protocol on further reduction on sulfur and the Gothenburg protocol.

The country is still in non-compliance with the 1985 Protocol on reduction of sulfur emissions or their trans-boundary transmission by at least 30 percent, because the emissions have not been reduced by the designated percentage between now and 1980. Because the major source of this pollutant is power production, compliance with the oldest protocol on sulfur is expected to be achieved with installation of a desulfurization unit in the Power plant REK Bitola. According to the agreement with the Energy community, the compliance with SOx emission limit values, which will also mean compliance with the protocol, should be reached with implementation of a desulfurization unit, that should be implemented in accordance with the time dynamics set in the revised National Plan for reduction of emissions from large combustion plants approved by the Government in April 2017. With regards to LCPs, the emissions in 2020 were not below national emission ceiling of 15.855 Gg, indicating that compliance with the set limit values was not reached. In 2020 SOx emissions have not reached values below the emission ceiling defined in the NERP since desulfurization unit is still not implemented in the major power plant.

Main emission sources in North Macedonia

Almost all SO_2 emissions are resulting from Energy sector. Consequently, the main emission source in 2020 is as expected NFR source category 1.A.1 Energy Industries (Public electricity and heat production), which contributed with 92% in 1990, and with 95% in 2020 of the national total SO_2 emissions. About 5% in both 1990 and 3.6% in 2020 of the total emissions are stemming from NFR source category 1.A.2 Manufacturing Industries.

Other NFR sectors produce minor SO_2 emissions.

Figure 11 SO_2 emissions in North Macedonia 1990–2020 by sectors

3.1.4. NH_3 emissions

Emission trend

In 1990 national total NH_3 emissions, amounted to about 15.8 kt. In 2020, the emissions were down by 46% compared to 1990, amounting to 8.5 kt. Main reasons for the decline are decreasing emissions from Agriculture (Manure Management) related to decreasing livestock numbers. From 2019 to 2020 emissions decreased by 1.2%.

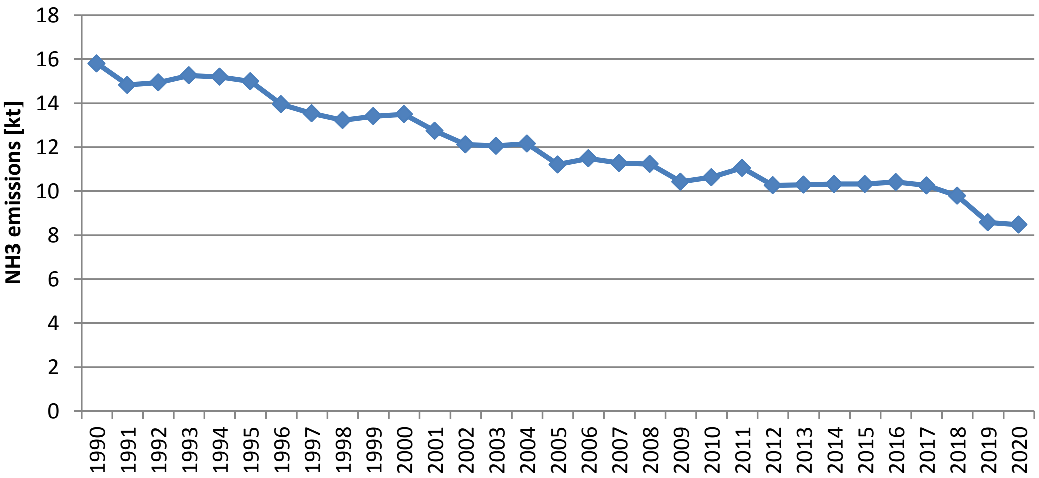


Figure 12 National total NH_3 emissions 1990-2020

Emissions of NH_3 are well below the respective ceiling. Emissions in 2020 were below national ceiling value (12 Gg NH_3) for 2010.

Main emission sources in North Macedonia

NH_3 emissions are mainly resulting from the agriculture sector contributing with 90% (92% in 1990) to national total NH_3 emissions. Within Agriculture sector, NH_3 is almost exclusively emitted by source category 3.B Manure Management (52% in 2020) and emissions from cattle (33%).

About 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 NH_3 emissions.

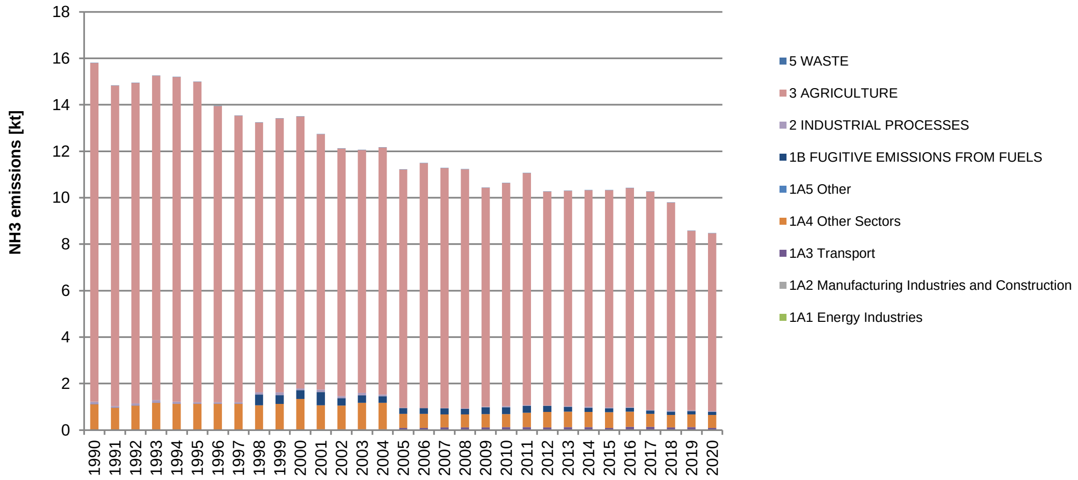


Figure 13 NH_3 emissions in North Macedonia 1990-2020 by sectors

3.1.5. CO emissions

Emission trend

In 1990 the national total CO emissions amounted to 132.40 kt. The decreasing trend started in 2000 and could be attributed to lower solid fuel consumption in 1.A.4 sector, but the trend is not stable. In 2020, the emissions decreased by 62% and amounted to 49.51 kt. From 2019 to 2020 emissions are decreased by 8%.

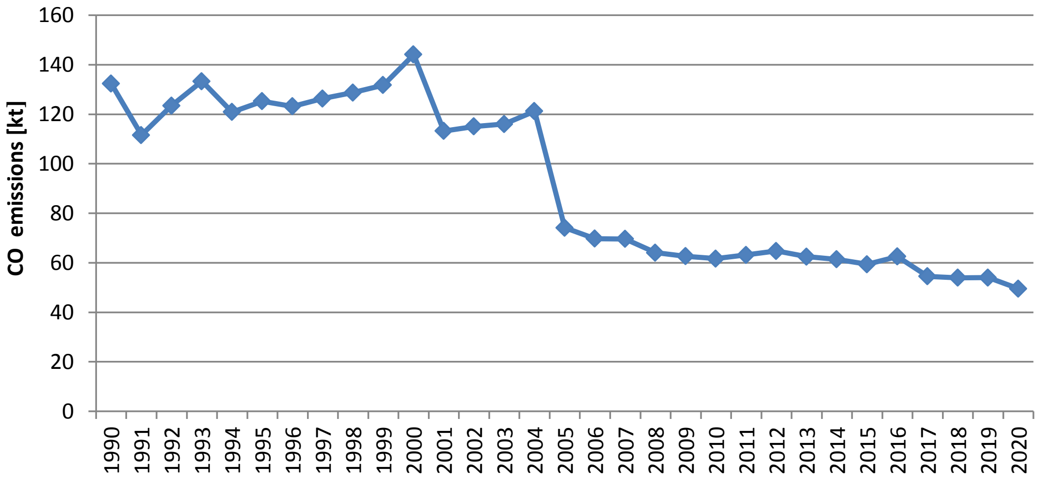


Figure 14 National total CO emissions 1990-2020

Main emission sources in North Macedonia

Almost all CO emissions are resulting from the Energy sector. As a Result, the main emission sources in 2020 are NFR sectors 1.A.4 Other Sectors (residential heating) and 1.A.3 Transport, contributing with 68% (51% in 1990) and 11% (39% in 1990) following by 1.A.2 Manufacturing Industries to the national total with 10% (4% in 1990). Further smaller emission sources in 2020 are 5 Waste and 1.A.1 Energy Industries with shares 7% 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.

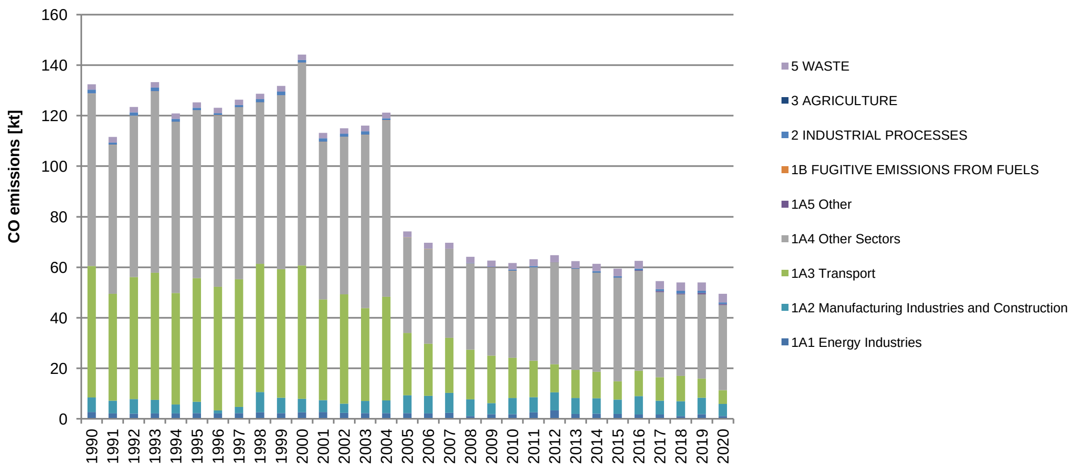


Figure 15 CO emissions in North Macedonia 1990-2020 by sectors

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 1990-2020

Year	Emissions			
	PM2.5 [kt]	PM10[kt]	TSP [kt]	BC [kt]
1990	32.71	48.28	59.88	3.03
1991	28.65	42.34	52.41	2.64
1992	34.99	50.63	61.54	3.30
1993	31.33	45.03	54.98	2.93
1994	29.30	42.63	52.41	2.67
1995	29.58	43.25	53.33	2.70
1996	32.45	47.21	58.02	3.02
1997	31.53	45.86	56.01	2.87
1998	35.94	52.36	64.27	3.30
1999	31.16	45.13	55.84	2.83
2000	30.05	43.62	56.09	2.73
2001	18.60	28.04	36.09	1.47
2002	19.11	28.41	35.99	1.63
2003	29.37	42.24	52.01	2.60
2004	31.81	45.82	56.55	2.87
2005	24.10	37.21	47.57	2.43
2006	21.71	33.80	43.14	2.16

Year	Emissions			
	PM2.5 [kt]	PM10[kt]	TSP [kt]	BC [kt]
2007	17.31	27.51	35.60	1.74
2008	17.90	28.05	36.45	1.84
2009	12.84	22.17	31.01	1.24
2010	15.89	28.15	34.44	1.65
2011	21.74	35.31	46.76	2.15
2012	21.30	34.09	45.18	2.18
2013	23.63	36.91	49.31	2.44
2014	17.08	26.66	36.44	1.76
2015	14.73	22.16	27.09	1.47
2016	13.05	19.62	23.92	1.41
2017	8.96	14.08	17. 41	1.02
2018	8.61	14.30	16.35	0.98
2019	8.86	13.70	16.87	1.02
2020	8.71	13.43	16.41	1.00
Trend 1990–2020	***-73%***	***-72%***	***-73%***	***-67%***

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 13.4kt in 2020 or a decrease of 72% compared to 1990. The main reason for the decrease is declining emissions from Industrial Processes (Ferroalloys Production), but also decreased use of solid fuels since 2013. Namely the deep presented in the period 2001-2002 is due to limited operation of Ferroalloys production industry. The Ferroalloys production has decreased because of a limited capacity of an installation producing ferrosilicon, between the end of 2014 and during 2015. This installation did not fulfill the obligation regulated in the IPPC license for installation of a filter for reduction of dust emissions. Additionally, this installation has been closed in November 2016 due to non-compliance with the activities for air quality protection set down in the IPPC permit referring to installation of dust filter.

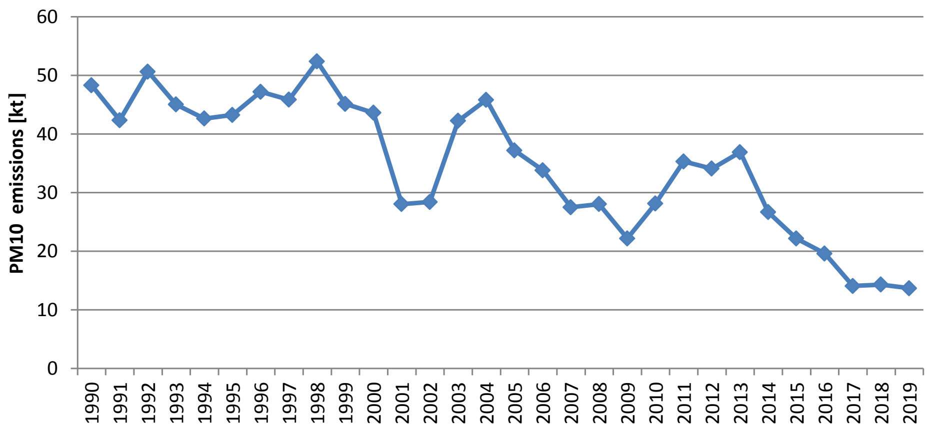


Figure 16 National total PM10 emissions 1990-2020

Main emission sources in North Macedonia

The main emission sources for PM10 in 2020 are NFR sectors 1.A.4 Other Sectors (residential and administrative heating), with a share of 45% (25% in 1990) in total PM10 emissions. 2 Industrial Processes and Product Use (mainly 2.C.2 Ferroalloys Production) with 6% (48% in 1990) and 1.A.1 Energy Industries with 19.6% (18% in 1990). With a share of 17% in 2020 (6% in 1990), the sector Agriculture is also contributing to the total PM10 emissions. As a result, a conclusion can be drawn that while in the past the major source for PM10 was the industry sector, mainly ferroalloys production, in the latest years that the major contributor is combustion of fuels in residential sector and administrative capacities – NFR 1.A.4 Other Sector. Transport sector is contributing with 3.6% in PM10 on national level but has higher impact on local emissions.

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

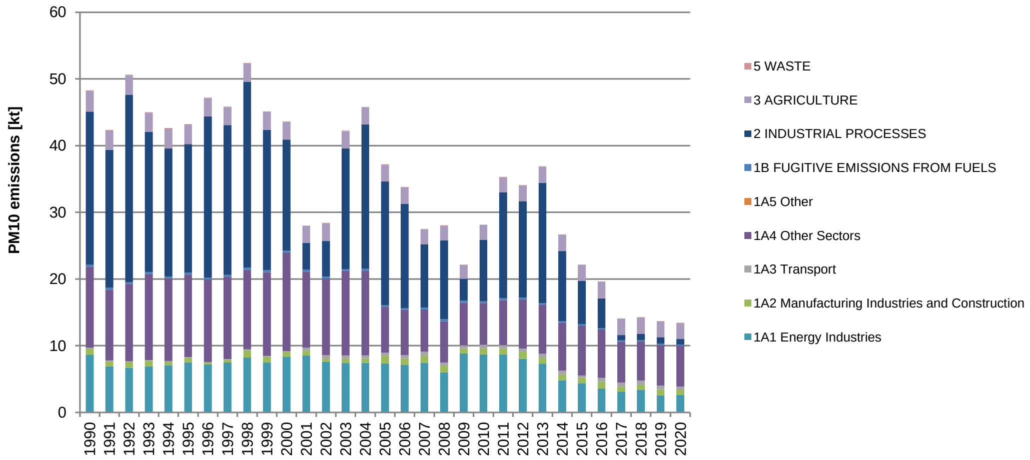


Figure 17 PM10 emissions in North Macedonia 1990-2020 by sectors

3.2.2. PM2.5 emissions

Emission trend

In 1990, national total PM2.5 emissions amounted to 33 kt. In 2020, compared to 1990 the emissions decreased by 68%, amounting to 8.7 kt. The main reason for the decrease is a decline of emissions from Industrial Processes (Ferroalloys Production) as well as from combustion of solid fuels from 1.A.4 due to increased use of clean fuels compared to solid fuels, like coal and biomass. For the years 2001, 2002 and 2009 emissions are very low compared to the other years. The reason is also due to low emissions from Ferroalloys Production, since in those years the company for production of ferrosilicon was operating with limited operating hours. The ferroalloys production has decreased because of the limited capacity of the installation producing ferrosilicon from the end of 2014 and during 2015, as this installation did not fulfill the obligation regulated in the IPPC license for installation of filter for reduction of dust emissions. Additionally, this installation has been closed in November 2016 due to non-compliance with the activities for air quality protection set down in the IPPC permit referring to installation of dust filter. Throughout the years, emissions from solid fuel combustion as well decreased affecting lower national emissions from particulates.

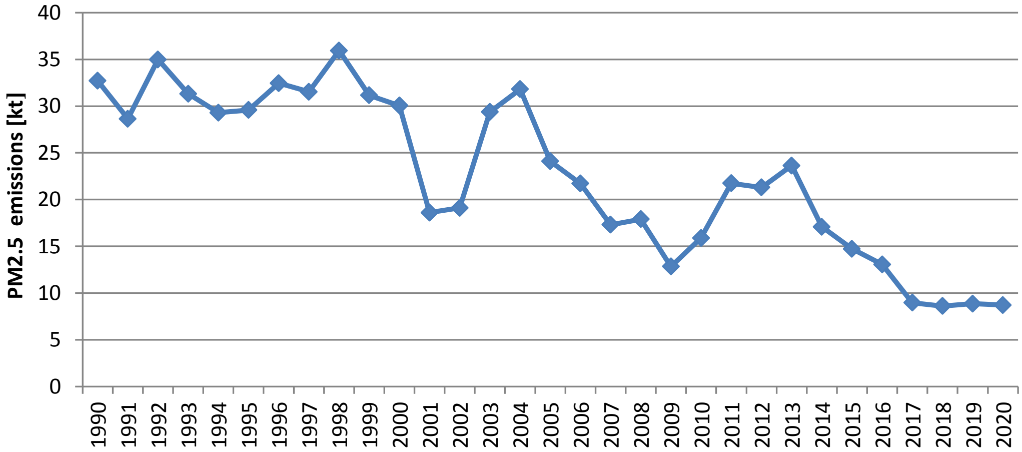


Figure 18 National total PM2.5 emissions 1990-2020

Main emission sources in North Macedonia

Like PM10, the main emission sources for PM2.5 in 2020 are NFR sectors 1.A.4 Other Sectors (residential heating) with a share of 68% (36% in 1990) in total PM2.5 emissions. The NFR category 1.A.1 Energy Industries with 12% (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 4% (49% in 1990). Manufacturing industry and Constructions 1.A.2 are contributing with 8% in 2020 while in 1990 the contribution was only 3%. Transport is contributing with 4% and Agriculture with 2.3%. Compared to PM10, the contribution of 1.A.4 and Energy industries is higher while the contribution from 1.A.1 Energy industries and Manufacturing industry and Constructions 1.A.2 is lower. NFR sectors 1B Fugitive emission and 5 Waste are minor sources of PM2.5 emissions.

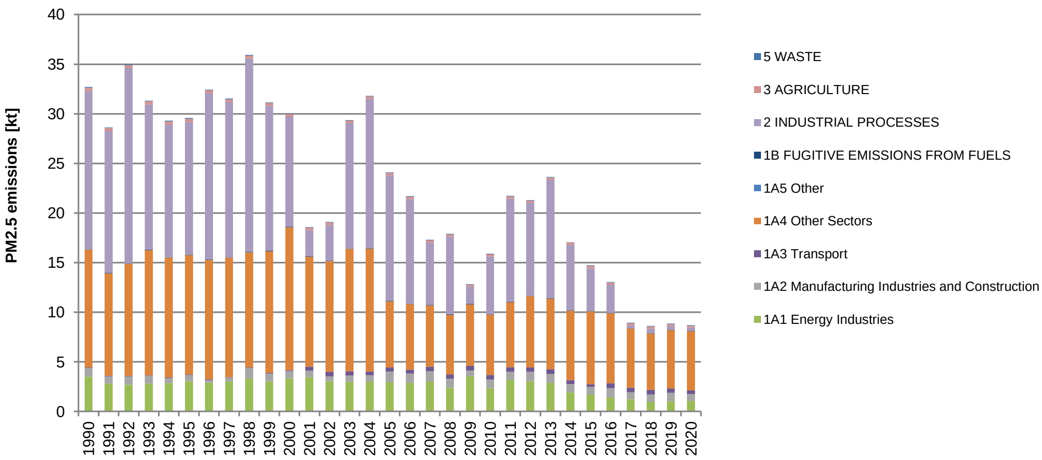


Figure 19 PM2.5 emissions in North Macedonia 1990-2020 by sectors

3.2.3. TSP emissions

Emission trend

In 1990, the national total TSP emissions amounted to about 59.8 kt. In 2020, 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 2020, exceeded the national emission celling for TSP with a value of 1.738 Gg, and thus not reaching compliance with this ceiling accordingly.

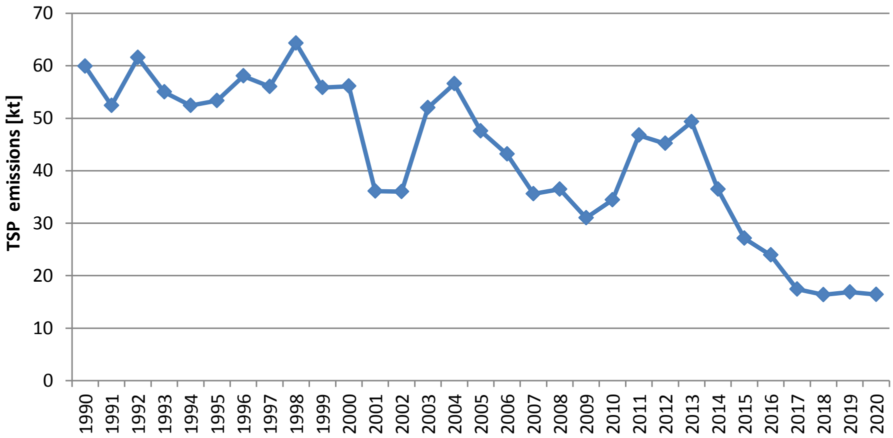


Figure 20 National total TSP emissions 1990-2020

Main emission sources in North Macedonia

The main emission sources for TSP in 2020 are 1.A.4 Other Sectors (residential heating) with 39% (21% in 1990) and 1.A.1 Energy Industries with 21% (23% in 1990). NFR sectors 2 Industrial Processes and Other Product Use (mainly NFR sector 2C2 Ferroalloys Production) with a share of 10% (48% in 1990) in total TSP emissions. Thus, it can be concluded that in the past the major source for TSP national emissions was the industry sector, mainly ferroalloys production, while in the latest years the major source is a consequence of the combustion of fuels in residential sector and administrative capacities – NFR 1.A.4. Agriculture is contributing with 16%, the category 1.A.2 is contributing with 5%, and Transport with 4%, while other categories are minor sources of this pollutant.

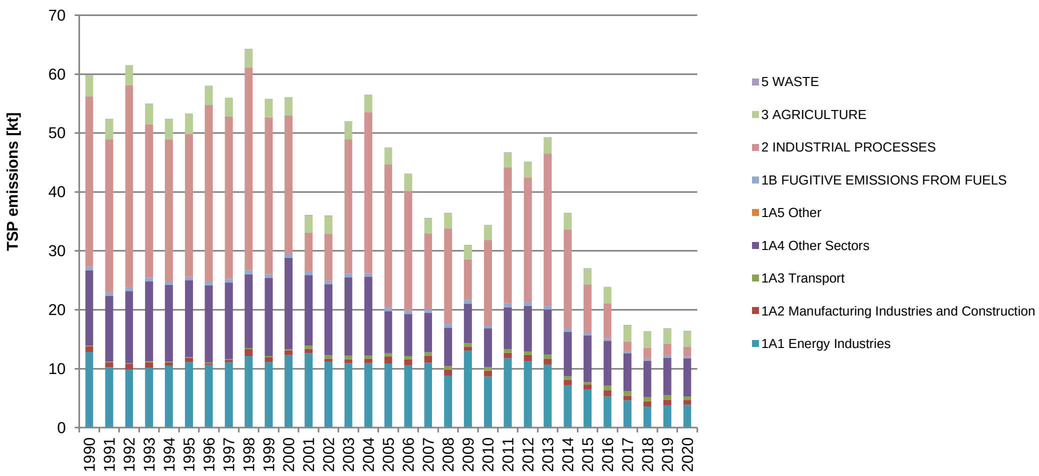


Figure 21 TSP emissions in North Macedonia 1990-2020 by sectors

3.2.4. BC emissions

Emission trend

In 1990, national total BC emissions amounted to about 3 kt. In 2020, the emissions decreased by 67% compared to 1990, amounting to about 1 kt. The main reason for the decrease is a decline of emissions of PM2.5. The trend has similar pathway as that one for PM2.5 due the fact that for BC emissions are calculated as given contribution in PM2.5 expressed in %. Further explanation of the trend is given in PM2.5 chapter.

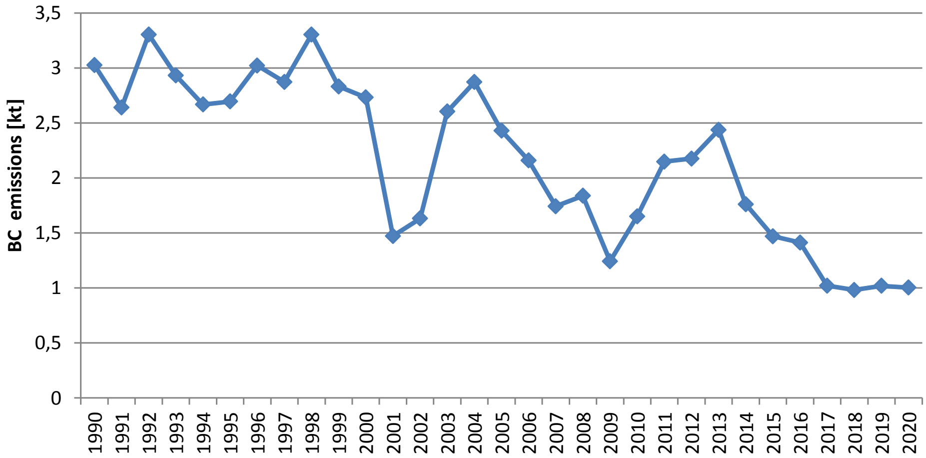


Figure 22 National total BC emissions 1990-2020

Main emission sources in North Macedonia

As expected, the main emission sources for BC are those for PM2.5. In 2020 the NFR sectors 1.A.4 Other Sectors (residential heating) contributed with a share of 63% (40% in 1990) in total BC emissions. Transport is contributing with 17%, while 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 around 1% (49% in 1990), while Waste sector contributed with 2% in 2020 and 1% in 1990.

NFR sectors 1.A.1 Energy industries and 1.B Fugitive emissions are minor sources of PM2.5 emissions.

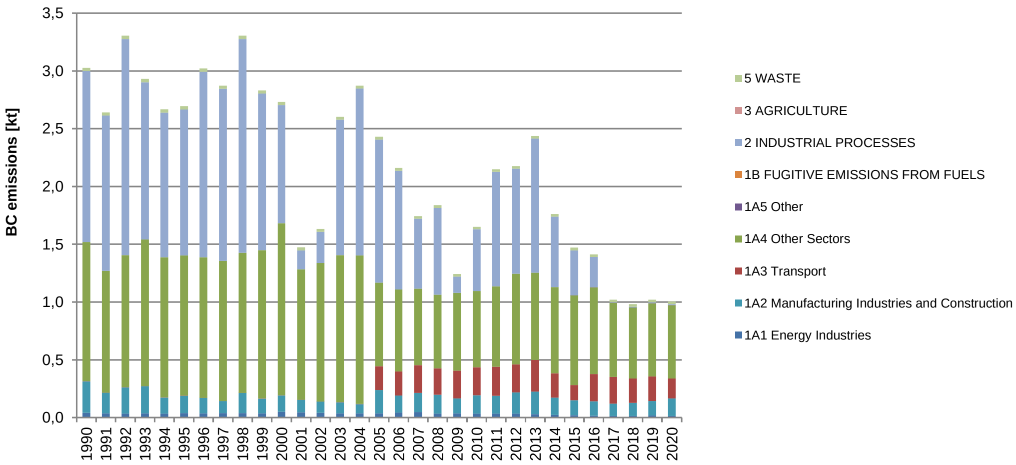


Figure 23 BC emissions in North Macedonia 1990-2020 by sectors

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 1990-2020

Year	Emissions		
	Pb [kt]	Cd [kt]	Hg [kt]
1990	232.48	1.60	0.65
1991	196.68	1.50	0.59
1992	227.56	1.46	0.55
1993	212.76	1.06	0.52
1994	203.76	1.01	0.44
1995	222.26	2.11	0.46
1996	229.64	2.32	0.52
1997	244.66	1.14	0.55
1998	259.95	1.39	0.62
1999	208.29	1.07	0.55
2000	195.45	0.93	0.56
2001	172.34	0.82	0.59
2002	170.74	0.80	0.61
2003	131.95	0.60	0.46
2004	45.72	0.53	0.45
2005	6.41	0.28	0.32
2006	6.96	0.26	0.33
2007	7.31	0.25	0.35
2008	6.18	0.25	0.33
2009	5.70	0.25	0.30
2010	5.94	0.24	0.31
2011	6.46	0.26	0.35
2012	5.19	0.26	0.32
2013	4.02	0.24	0.27
2014	4.67	0.24	0.28
2015	4.40	0.24	0.28
2016	2.77	0.23	0.24
2017	2.57	0.22	0.22
2018	2.66	0.22	0.19
2019	2.83	0.23	0.21
2020	2.27	0.21	0.17
Trend 1990–2020	***-99%***	***-87%***	***-74%***

Republic of North Macedonia in 2020 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 2020 emissions were down by 99% to 2.26 t. The most important reductions could be observed in sectors 1.A.3 Transport and 2 Industrial Processes and Other Product Use (mainly Lead Production). The big decline in the trend of Pb emissions from 2003 and 2004 is related to the main source of these emissions – Road transport and Lead production. From 2004 the content of Pb in the gasoline decreased from 0.0006 kg/l to 0.00015 kg/l. Also, in 2003 the Pb-Zn smelter "Zletovo" – Veles stopped the lead production, and zinc. From 2006 in North Macedonia, passenger cars can use only unleaded gasoline fuels which additionally reduced the Pb emissions.

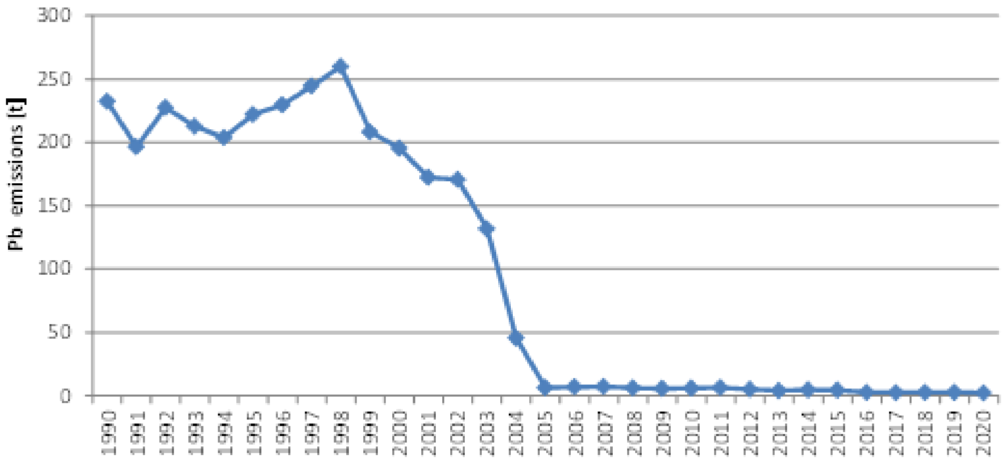


Figure 24 National total Pb emissions 1990-2020

Main emission sources in North Macedonia

The most important emission sources of Pb in 2020 are NFR sectors 1.A Energy with shares in national total emissions of 19% from 1.A.2 in share of 24 %, other sectors 1.A.4 in share of 29%, and industrial process in share of 13%. In 1990 the situation was different. The key factor contributing to the emissions was the industry with 59% and use of leaded petrol in transport sector which led to contribution of NFR 1.A.3 with 39%. 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 13% in 2020. The declined values are 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, since EF used for calculation of Pb emissions up to 2004 are not documented, there is a high uncertainty of estimation of lead emissions in 1.A.3 transport and these emissions should be recalculated with the use of COPERT model. Pb emissions from NFR sectors 1.B Fugitive Emissions, 3 Agriculture and 5 Waste are minor sources.

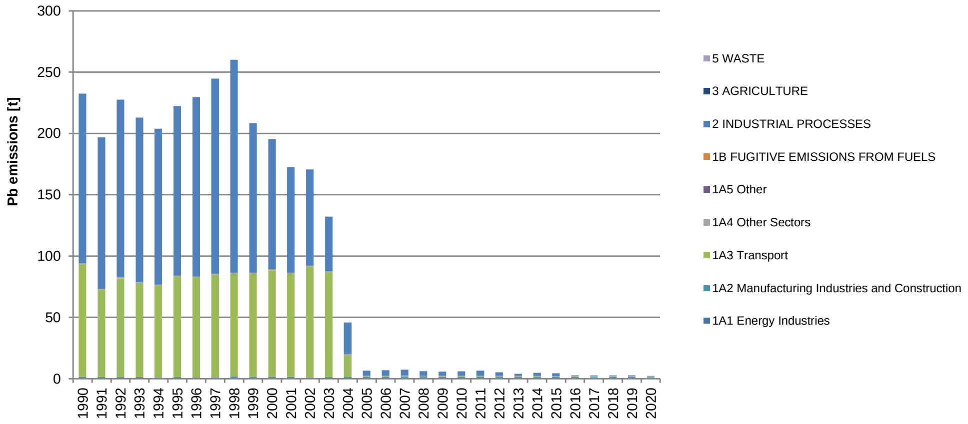


Figure 25 Pb emissions in North Macedonia 1990-2020 by sectors

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 2020 emissions were estimated to be 0.21 t, which means they were down by 86% compared to 1990. The most important reductions could be observed in sector 2 Industrial Processes and Other Product Use (Metal Production), as Zinc Production was stopped in 2003. Between 2019 and 2020, cadmium emissions decrased by 8.35%.

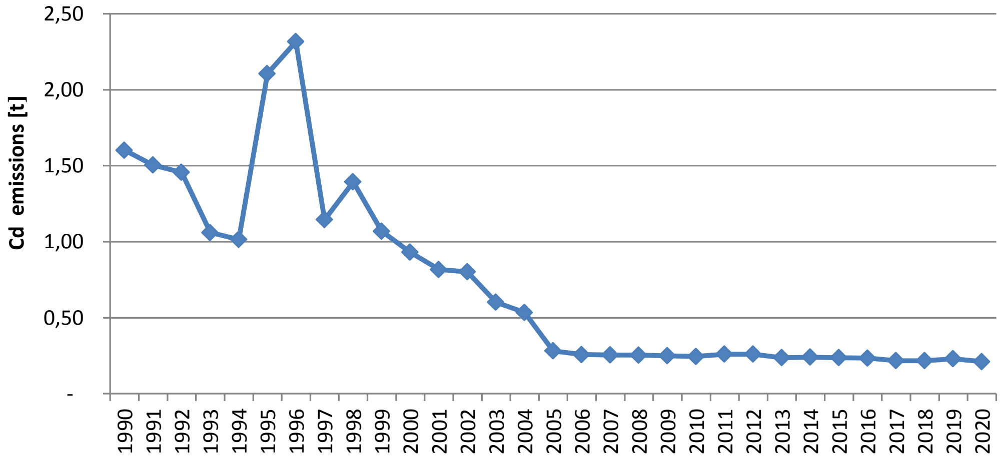


Figure 26 National total Cd emissions 1990-2020

Main emission sources in North Macedonia

The most important emission source in 2020 of Cd is in the national total emissions is NFR sector 1 Energy is contributing with the following NFR categories: 1.A.4 Other Sectors Energy with 51% (13% in 1990), following by 1.A.1 Energy Industries, with a share of 25% (7% in 1990), and NFR category 2 Industrial Processes and Product use contributing with 11% (79% in 1990). The 1.A.2 Manufacturing Industries is contributing with 8% (1%), while waste sector is contributing with 4.36%.

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

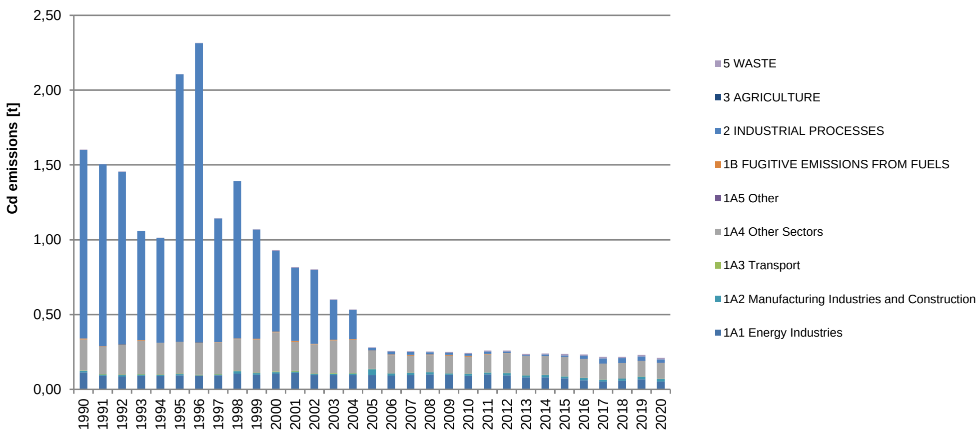


Figure 27 Cd emissions in North Macedonia 1990-2020 by sectors

3.3.3. Mercury (Hg) emissions

Emission trend

National total Hg emissions amounted to 0.65 t in 1990; emissions have decreased steadily and in the year 2020 emissions (0.16t) were down by 74% 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 2019 and 2020 total Hg emissions decreased by 23% due to lower emissions coming from 1.A.1a amd 1.A.2 categories.

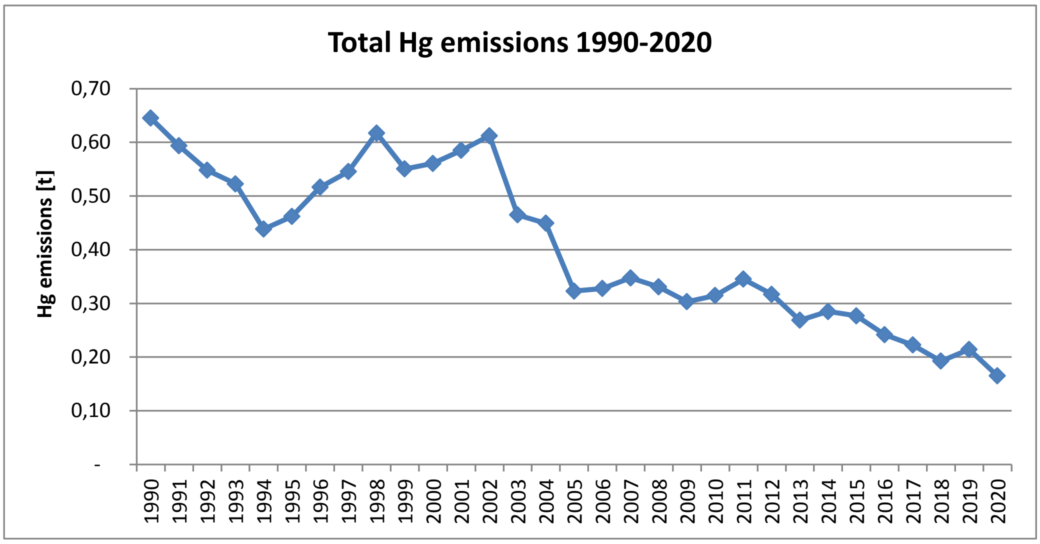


Figure 28 National total Hg emissions 1990-2020

Main emission sources in North Macedonia

The most important emission source in 2020 of Hg is NFR sector 1 - Energy. Within the Energy sector, the main contributors in 2020 are 1.A.1 Energy Industries with a share of 51% (27% in 1990) and 1.A.2 Manufacturing Industries and Construction with 20% (5% in 1990) of the national total emissions. NFR category 2 Industrial Processes and Product use is also one of the key sources with 19% (65% in 1990) of the national total mercury emissions. In 2020, also 3% of total mercury emissions are stemming from sector 5 Waste, while this sector has minor contribution in 1990, and 3% Hg emissions are coming from NFR sectors 1.A.4 - Other sectors. NFR sectors 1.B Fugitive Emissions and 3 Agriculture are minor sources in the whole trend period.

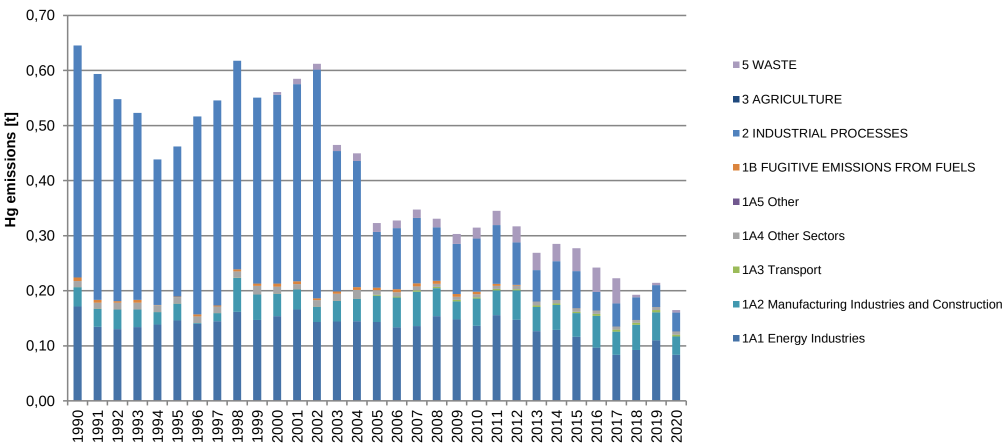


Figure 29 Hg emissions in North Macedonia 1990-2020 by sectors

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 1990-2020

Year	Emissions			
	PAH [t]	PCDD/F [g – I TEQ]	HCB [kg]	PCB [kg]
1990	7.15	19.82	44.29	382.13
1991	6.40	17.63	39.22	383.55
1992	6.82	17.70	25.83	383.85
1993	7.28	17.29	24.18	370.81
1994	6.72	15.87	25.04	341.56
1995	6.82	18.92	18.63	356.74
1996	6.33	18.73	19.70	385.17
1997	6.57	16.00	27.89	397.21
1998	7.25	17.61	29.34	403.92
1999	7.25	17.18	53.97	367.45
2000	8.21	23.94	38.32	343.99
2001	6.61	25.41	34.15	333.26
2002	6.63	27.02	52.68	330.98
2003	7.30	28.02	42.98	288.38
2004	7.44	30.73	8.52	241.58
2005	4.89	26.88	7.54	207.53
2006	5.00	25.21	11.67	208.30

Year	Emissions			
	PAH [t]	PCDD/F [g – I TEQ]	HCB [kg]	PCB [kg]
2007	5.03	26.37	8.87	208.90
2008	4.61	25.47	7.74	208.51
2009	4.25	27.35	8.28	208.55
2010	4.55	29.56	9.58	209.33
2011	4.75	35.78	10.50	209.73
2012	4.99	38.77	9.47	209.57
2013	4.69	39.88	6.35	209.38
2014	4.67	40.00	4.19	210.03
2015	4.73	49.52	0.96	216.91
2016	4.71	51.21	0.77	221.42
2017	3.96	51.54	2.06	229.16
2018	3.90	8.96	1.53	237.37
2019	4.09	9.31	4.43	238.45
2020	3.81	8.64	0.16	237.24
Trend 1990–2020	***-47%***	***-56%***	***-100%***	***-38%***

From the figures presented in the previous table a conclusion can be drawn that Republic of North Macedonia in 2020 did not exceeded the emission levels set in POPs Protocol. In the case of HCB, the emissions are much lower than the values from the reference year 1990.

3.4.1. PAH-4 emissions

Emission trend

National total PAH-4 emissions in 1990 amounted to 7.15 t. Since then, the emissions have been quite stable and in the year 2020 emissions were at level of 3.80 t, reflecting a reduction of 47%. The most important reductions could be observed in the sector for residential heating. Between 2019 and 2020, total PAH-4 emissions decreased by 7.17%, because of increased emissions from residential heating in the NFR 1.A.4 - Other sectors. Data from 2005 have been revised in MAKSTAT database which is one of the reasons for the sharp drop down.

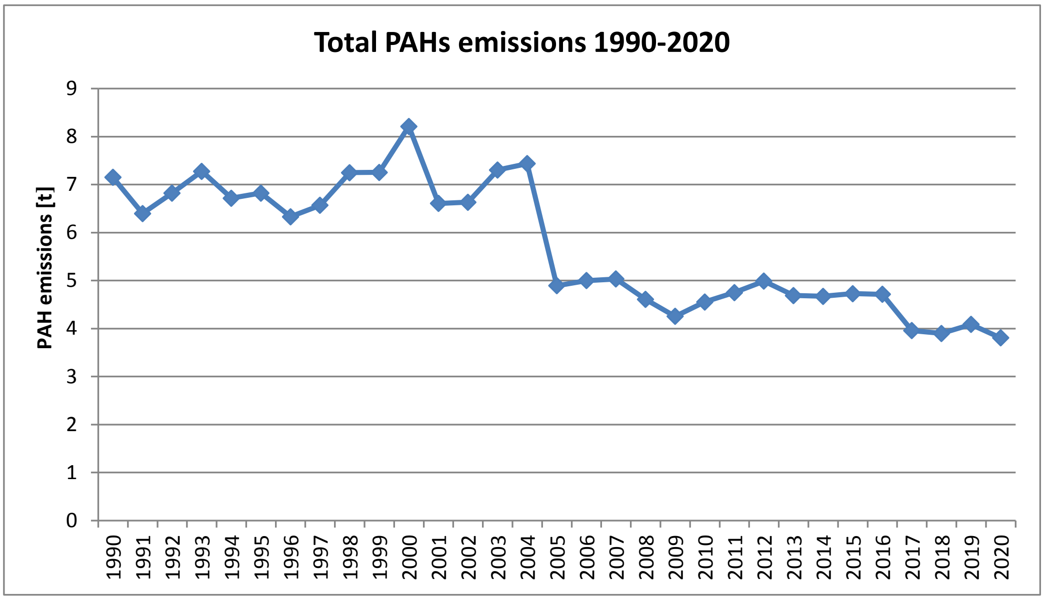


Figure 30 National total PAHs emissions 1990-2020

Main emission sources in North Macedonia

The most important emission source in 2020 of PAHs is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2020 is 1.A.4 Other Sectors (residential heating), with a share of 73%, while in 1990, this sector contributed with 79%. Furthermore, 1.A.2 Manufacturing Industries is contributing with a share of 18% (11% in 1990) of the national total emissions. PAHs emissions from NFR sectors 1.A.1 Energy industries and 2 - Industrial Processes and Product use are minor sources.

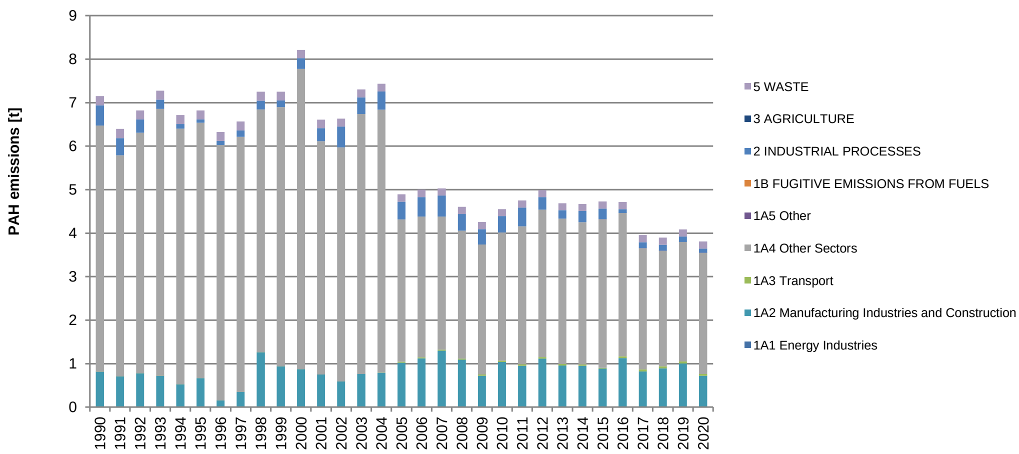


Figure 31 PAH-4 emissions in North Macedonia 1990-2020 by sectors

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 then and in the year 2020 emissions were down to around 8.6 g-I-TEQ, decreasing by 56% compared to 1990.

The emissions have increased since 2000 due to establishment of medical waste incineration. Emissions have been increasing until 2018, when dust filter has been established in the medical waste incineration plant.

Between 2019 and 2020 total dioxin/furan emissions are slightly decreased by 7%.

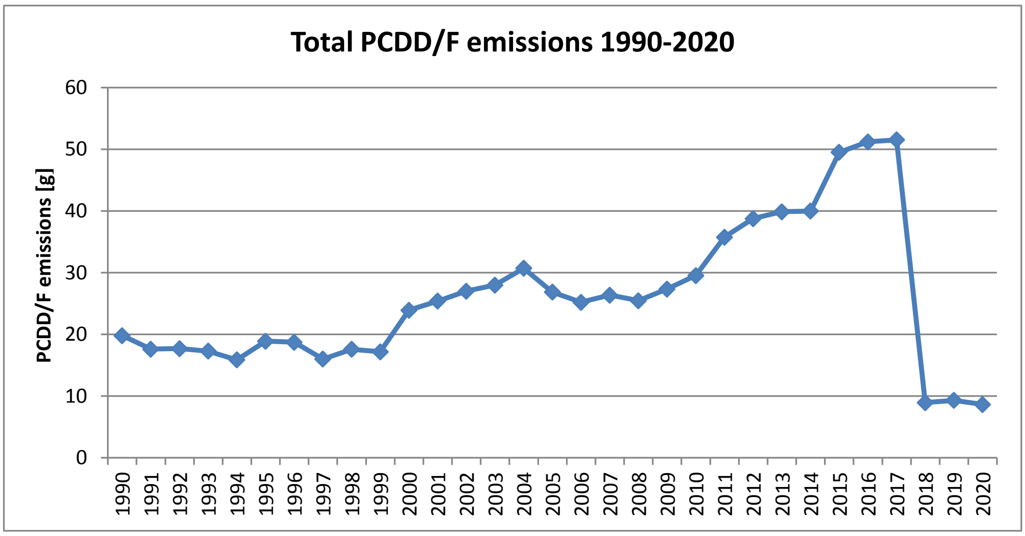


Figure 32 National total PCDD/F emissions 1990-2020

Main emission sources in North Macedonia

The most important emission source in 2020 of PCDD/F is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2020 is 1.A.4 Other Sectors (mainly residential heating), with a share of 65% in 1990 and with share 73% in 2020. Furthermore, 1.A.2 Manufacturing Industries is contributing with a share of 10% (5% in 1990) in the national total emissions. NFR category 2 Industrial Processes and Product use (Metal Production) is also contributing with 7% (27% in 1990) of the national total PCDD/F emissions. In the period 2000-2017, Waste has been one of the key sectors as well.

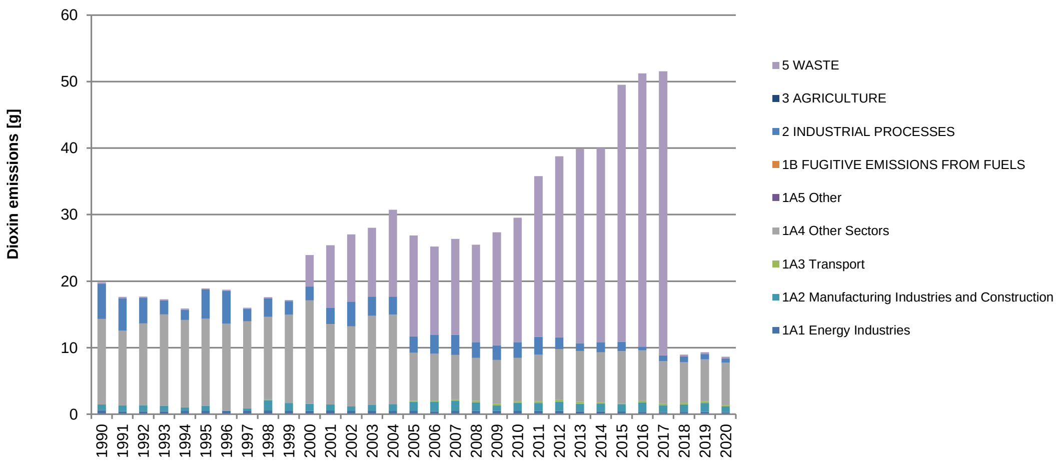


Figure 33 Dioxin/furan emissions in North Macedonia 1990-2020 by sectors

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 2020 emissions were down by 90%, amounting to 0.15 kg. The emission peaks in 1999 and 2002 are due to higher activities of secondary aluminum production. The significant emission reduction between 2003 and 2004, is also caused by the aluminum production. From then onwards the emission level remained quite lower but still with mild fluctuations which depend on aluminum production. The most important reductions could be observed in the sector 2 Industrial Processes and Other Product Use (Aluminum Production). Due to higher activity data in aluminium production the emissions are higher in 2019 compared to 2018. But for 2020 since the emissions for aluminum production went bankruptcy no activity data were reported, and no emissions were calculated in this sector.

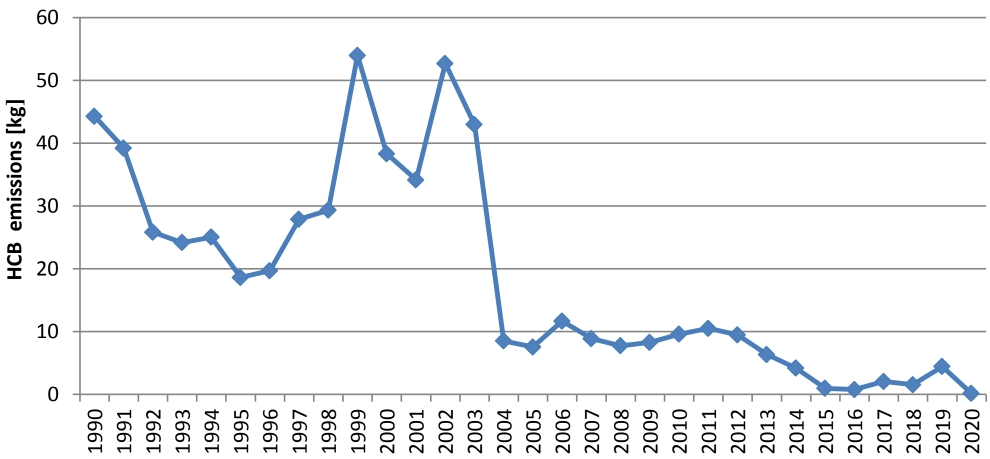


Figure 34 National total HCB emissions 1990-2020

Main emission sources in North Macedonia

During the period 1990-2020 the key emission source for HCB was NFR sector 2 Industrial Processes and Product Use. With a share of around 97% (100% in 1990) of the national total emissions almost all HCB is emitted from this source and therefore dominating the trend. Within the category emissions are exclusively emitted from NFR sector 2.C.3 Aluminum Production. However, due to bankruptcy the main contribution to the HCB emissions in 2020 is coming from 5 Waste in amount of 69%, 1.A.4 Other sectors is the second key source in 2020 contributing with 27% and 1.A.2 Manufacturing Industries is minor source contributing with 4%.

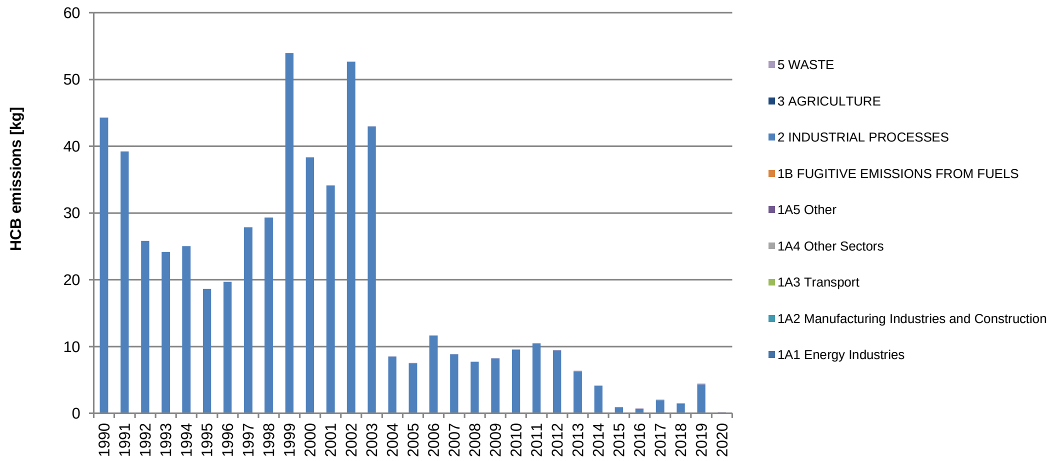


Figure 35 HCB emissions in North Macedonia 1990-2020 by sectors

3.4.4. Polychlorinated biphenyl (PCB) Emissions

Emission trend

National total PCB emissions amounted to 382kg in 1990; emissions have decreased since then and in the year 2020 emissions were down by 38%, accounting to 237 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 2.C sector and increased emissions from lead production.

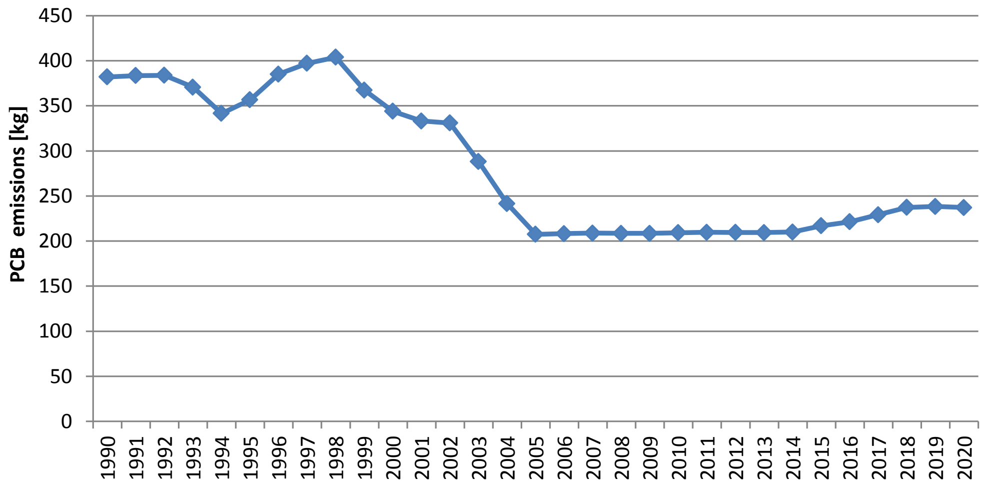


Figure 36 National total PCB emissions 1990-2020

Main emission sources in North Macedonia

The most important emission source in 2020 of PCB is NFR sector 2 Industrial Processes and Product Use. Within this sector, the main contributor is 2.C.5 Lead Production, with a share of around 99% (around 100% in 1990) of the national total PCB emissions. The main recalculations for this pollutant are emissions coming from NFR 2.K - Consumption of POPs and heavy metals (e.g., electrical, and scientific equipment), where population is taken as activity data. PCB emissions from other NFR sectors are therefore minor. The additional key source in the nineties was the smelter company in Veles that has stopped production in 2003, and mainly this is influencing the trend, decrease starting in 2002 until 2005 and rather stable trend until 2014. There is small increasing trend in the last several years due to increased lead production as well as due to use of Tier 2 methodology in 2C sector and calculation of PCB emissions from road transport with Tier 2 methodology for the period 2014-2020.

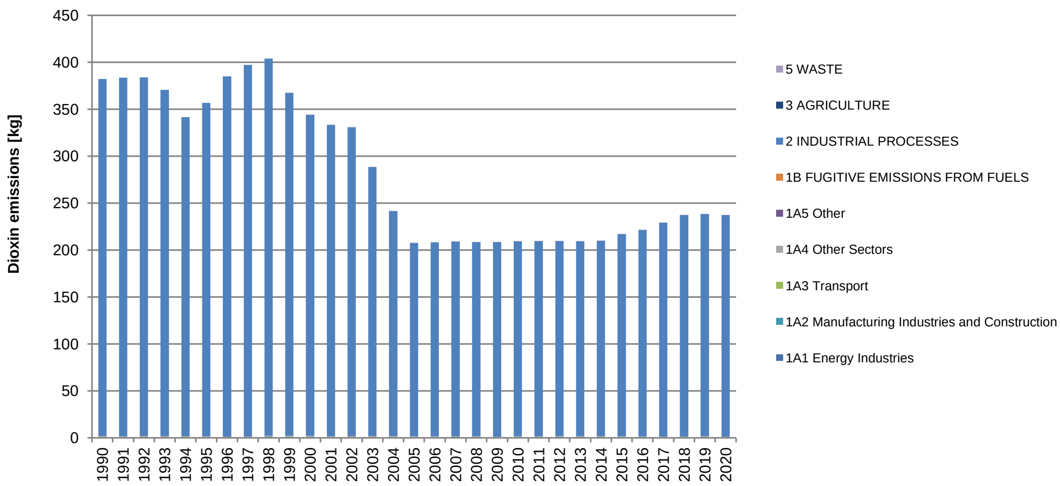
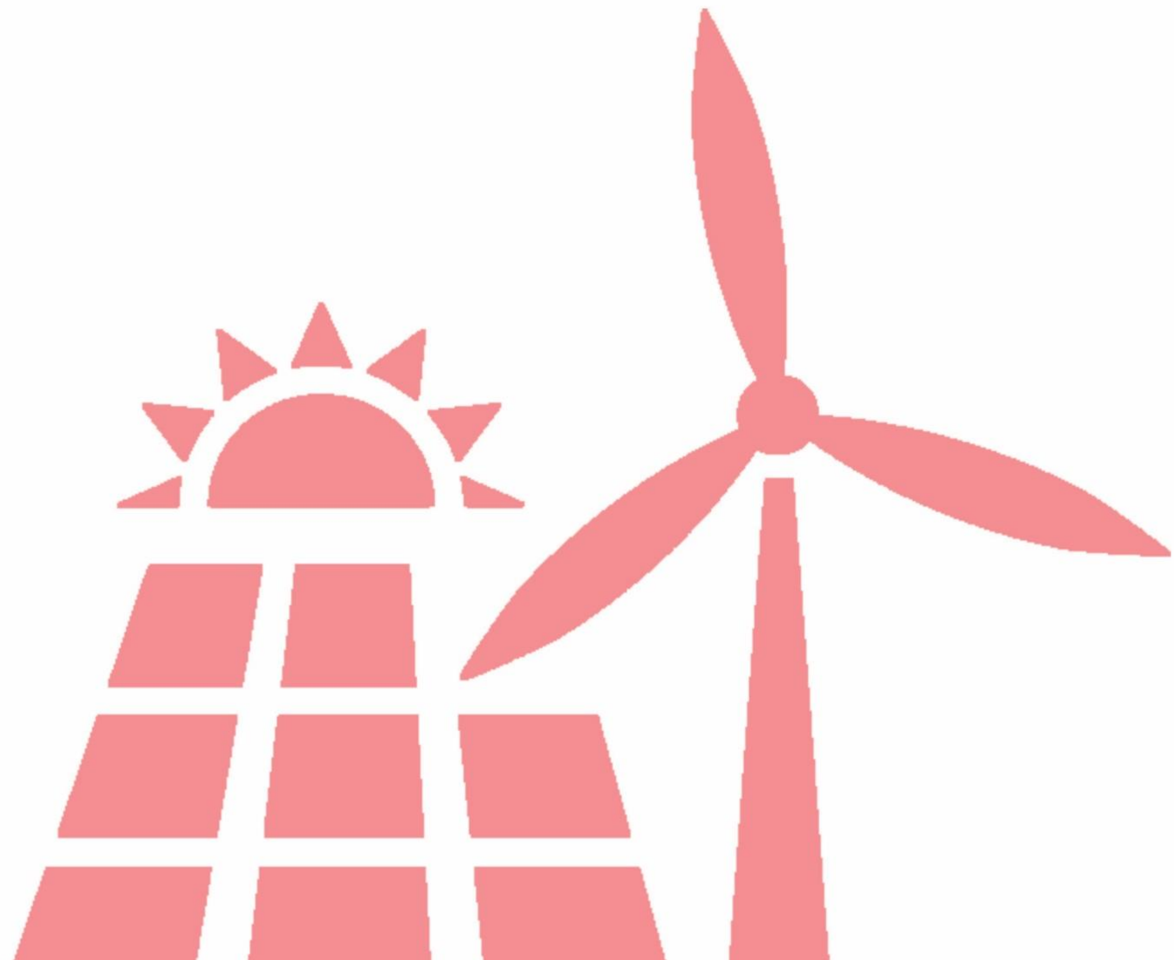


Figure 37 PCB emissions in North Macedonia 1990-2020 by sectors

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.aii 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 2020

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

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

Table 50 NFR categories not included in Energy sector for 2019

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 cruse (civil)	NO
1 A 3 d i (ii) International inland waterways	NO
1 A 3 e Pipeline compressors	NO
1A 4 c iii Agriculture/Forestry/Fishing: National fishing	NE
1 A 5 a Other stationary (including military)	NE
1 B 1 b Fugitive emission from solid fuels: Solid fuel transformation	NO
1 B 1 c Other fugitive emissions from solid fuels	NO
1 B 2 a i Exploration Production Transport	NO
1 B 2 b Natural gas	NO
Memo Items	
1 A 3 d i (i) International maritime navigation	NO
1 A 3 a ii (ii) Domestic aviation cruse (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, SO_2, CO and TSP within the following sectors:

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

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

1.A.2.f - 1 cement plant

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

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

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

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 2020, seven plants under this category were operating. Emissions from non-public district heat generation (industrial auto producers) are considered in the respective subcategories of 1.A.2 or 1.A.4.a.

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

Table 51 TPP and DHP Installation technical properties and BAT

Num.	Plant name	Technology	Thermal input [MW]	Fuel type 1	Fuel type 2	BAT	NERP	Comments
1	REK BITOLA	Production of electricity	2025	Lignite	Heavy fuel oil	Modernization of blocs in 2013-2014, reduction of NOx, dust and CO electrostatic filter for dust η=99,84 %	Yes	
2	REK OSLOMEJ	Production of electricity	375	Lignite	Heavy fuel oil	electrostatic filter for dust η=98 %	Yes	Since 2015 limited operation only few mountsin the heating season due to limited coal reservas.
3	TEC NEGOTINO	Production of electricity	630	Heavy fuel oil			No	Not in operation since 2014 it is used as cold reserve, Due to the energy crisis the installation was put in operation in December 2021 with half capacity but this do not influence the current 2020 emissions coming from this sector.
4	Balkan Energy Toplana ISTOK	Heat production	294	Natural gas		Burners for low NOx insurance	Yes	
5	Balkan Energy Toplana ZAPAD	Heat production	183	Natural gas		In 2013 Heavy fuel oil has been replaced with natural gas. Burners for low NOx insurance	Yes	
6	Toplana Sever	Heat production		Natural gas			No	Not in operation
7	TE-TO	Combined Electricity and heat production	440	Natural gas		Ecological burners for low NOx insurance and stable combustion mode	No	
8	ELEM	Heat production	100	Natural gas			No	
9	KOGEL	Combined Heat and electricity production	90	Natural gas			Yes	Started in October 2019

4.2.1. Methodological issues

For the years 2008 onwards, NO_X, SO_2, 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 SO_2 CO and TSP emissions from

1990 to 2007 are estimated by means of calculated implied emission factors which are derived from average 2009-2012 emissions and fuel consumption provided by plant operators. For natural gas emissions, from 1990 to 2007 the emissions are calculated with default Tier 1 emission factors as recommended in the Guidebook 2019.

Other pollutants (NH_3 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 NOx ana dust, implied emission factors were derived for NOx and dust for the period 2013-2014, and were used for calculation of NOX and TSP emissions for 2015-2017 while PM10 and PM2.5 emissions were calculated by applying the share of the Guidebook emissions factors. The share of PM10 in TSP is 68% and the share of PM2.5 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	58359	1000	2516
1991	45655	NO	3090
1992	44356	NO	2656
1993	45442	NO	3037
1994	47507	NO	2434
1995	49958	NO	2986
1996	47675	NO	3051
1997	49362	NO	3301
1998	55194	NO	2602
1999	50091	NO	2640
2000	51991	715	6345
2001	56387	673	3800
2002	48716	641	4286
2003	49091	345	2902
2004	49291	69	2936
2005	48711	52	3031
2006	45153	197	5152
2007	45697	895	6588
2008	52597	1627	1270
2009	50442	744	2267

Year	Lignite (TJ)	Natural gas (TJ)	Residual fuel oil (TJ)
2010	46386	1475	2330
2011	53111	1570	1431
2012	50549	974	1594
2013	43402	1522	1310
2014	44158	1633	1671
2015	39816	3258	1606
2016	32903	5653	1138
2017	28553	7456	933
2018	31523	6674	538
2019	37584	8290	687
2020	28740	9745	1073

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 (SOx, 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 are 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
NMVOC	g/GJ	1.4	2.6	2.3
SO_2	g/GJ	1.678	0281	1.678
NH_3	g/GJ	NE	NE	NE
PM2.5	g/GJ	57.4	0.9	57.4
PM10	g/GJ	141.8	0.9	141.8
BC	%PM2.5	1	2.5	5.6
TSP	g/GJ	210	0.89	210
CO	g/GJ	43	2.5	43
Pb	mg/GJ	15	0.0015	4.56
Cd	mg/GJ	1.8	0.00025	1.2
Hg	mg/GJ	2.9	0.1	0.341
As	mg/GJ	14.3	0.12	3.98
Cr	mg/GJ	9.1	0.00076	2.55

Pollutant	Unit	Lignite	Natural gas	Heavy fuel oil
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: NOx, SOx, 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 31th March each year. Installations are reporting on NOx, CO, TSP and SOx 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 2020 for these pollutants, the measurements received were converted to yearly emissions and presented in the NFR. The measured emissions for TSP are used for calculation of PM10 and PM2.5 as 68 and 27% fraction from TSP.

Implied emission factors

The following table shows NO_X, SO_2, TSP and CO implied emission factors for category 1.A.1.a. by type of fuel for the years 2009 to 2012, and the mean value which has been used to calculate emissions from lignite and fuel oil 1990 to 2007. These emission factors were calculated with the support of Austrian energy expert in the Twining project “Further strengthening the capacities for effective implementation of the acquis in the field of Air Quality” that has been carried out in the period 2015-2017 in our Ministry. As proposed by the expert the implied EF for both heavy fuel and coal are same for the basic pollutants taken into account emission measurement data. The IEF were developed with the Austrian experts in the Twining project.

The problem was that only for several years there was good coverage of measurements (there is still no automatic monitoring for coal power plants), so these measurements were used to develop IEF. Default emission factors from the guidebook are not suitable due to the fact that the coal is domestic. I the expert judgment to develop same emission factors from the measurements influence on less uncertainty than to use default emission factors for Guidebook."

Table 54 Implied Emission factors for source category Public electricity and heat production 1.A.1.a by using measurements data for period 2009 -2012

Year	NO_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 NOx 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 NOx and SOx 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.

Emissions from five out of nine plants in this NFR category are reported under LCP reporting obligation. Crosscheck of the data was between these two international obligations for reporting was carried out.

4.2.4. Source-specific recalculations

Recalculations were done due to due to final consumption data for 2020. HCB emisisons from this category are being estimated but calculation column has not been properly connected to total table and emissions are categorized as NE.

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 II air quality project that is planned to start in the end of this year.

4.3. Petroleum refining – NFR 1.A.1.b

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

4.3.1. Methodological issues

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

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

$E_{pollutant}$ annual emission of pollutant

$EF_{pollutant}$ emission factor of pollutant

$AR_{fuel\ consumption}$ 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
1996	980	961
1997	534	524
1998	1062	1042
1999	1077	1057
2000	1467	1071

Year	Refinery gas (TJ)	Residual fuel oil (TJ)
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	NO	NO
2019	NO	NO
2020	NO	NO

Emission factors

The emission factors for refinery gas have been taken from GB 2019. 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 2019. 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
NMVOC	g/GJ	2.58	2.3
SO_2	g/GJ	0.281	485
PM2.5	g/GJ	0.89	9
PM10	g/GJ	0.89	15
TSP	g/GJ	0.89	20
CO	g/GJ	12.2	6
Pb	mg/GJ	1.61	4.6
Cd	mg/GJ	2.19	1.2
Hg	mg/GJ	0.372	0.3
As	mg/GJ	0.352	3.98

Pollutant	Unit	Refinery gas	Heavy fuel oil
Cr	mg/GJ	6.69	14.8
Cu	mg/GJ	3.29	11.9
Ni	mg/GJ	7.37	773
Se	mg/GJ	1.56	2.1
Zn	mg/GJ	17	49.3
"PCDD/ PCDF (dioxins/furans)"	ng I-TEQ/GJ	-	2.5
benzo(a) pyren	µg/GJ	0.669	
benzo(b) fluoranthene	µg/GJ	1.14	3.7
benzo(k) fluoranthene	µg/GJ	0.631	-
Indeno (1.2.3-cd) pyren	µg/GJ	0.631	-

4.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty for NOx and SOx was estimated to be 20% (rating A. cf. chapter 1.7), 200% for NMVOC (rating D) and 40% for PM2.5 (rating B).

4.3.3. Source-specific QA/QC and verification

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

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

Recalulations were made for period 1990-2014 due to the use of GB 2019 EF as recommended by the last stage 3 Review report.

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

No planned improvements in this category.

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

This category includes emissions from manufacturing industries. Several industrial branches are contributing 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.gvii - 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	NA	NA	1396	3104
1991	NA	NA	2133	1184
1992	NA	NA	2451	1611
1993	NA	NA	1964	1291
1994	NA	NA	960	631
1995	NA	NA	2100	656
1996	NA	NA	NA	34
1997	NA	NA	272	179
1998	0.30	NA	5166	1793
1999	0.53	NA	3443	1414
2000	NA	27	2285	1699
2001	0.08	816	1912	780
2002	NA	960	1378	1076
2003	2.60	1119	2882	1196
2004	2.22	1226	3300	1041
2005	82.75	1413	5299	2029

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2006	69.59	1456	6308	2793
2007	9.13	1465	7373	2571
2008	9.13	1201	5931	2969
2009	0.98	1141	3761	2571
2010	52.51	1126	5842	3224
2011	3.42	754	5415	2002
2012	4.00	605	6377	3000
2013	4.00	610	5220	3366
2014	3.42	754	5410	2002
2015	4.01	658	4368	1399
2016	2.41	864	4521	1142
2017	1.51	1025	2522	806
2018	101.11	994	3071	926
2019	95.70	912	3926	998
2020	503.63	831	3666	1076

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	NA	NA	2298	631
1991	NA	NA	1827	278
1992	NA	NA	1830	591
1993	NA	NA	1834	905
1994	NA	NA	1686	862
1995	NA	NA	1537	819
1996	NA	NA	NA	26
1997	NA	NA	920	82
1998	NA	NA	1839	139
1999	NA	NA	1754	700
2000	NA	NA	2046	771
2001	NA	NA	1919	374
2002	NA	NA	1246	615
2003	NA	NA	596	9
2004	NA	NA	NA	13
2005	NA	NA	NA	22
2006	NA	NA	NA	32
2007	NA	NA	NA	42
2008	NA	NA	NA	266
2009	NA	NA	NA	26

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2010	NA	NA	NA	34
2011	NA	NA	NA	70
2012	NA	NA	NA	41
2013	NA	NA	NA	42
2014	NA	NA	NA	3
2015	NA	NA	NA	42
2016	NA	NA	NA	53
2017	NA	NA	NA	55
2018	NA	NA	NA	54
2019	NA	NA	NA	48
2020	NA	NA	NA	57

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	NA	NA	NA	169
1991	NA	NA	NA	166
1992	NA	NA	0.42527	613
1993	NA	NA	0.85054	1060
1994	NA	NA	0.746996	1136
1995	NA	NA	0.643452	1213
1996	NA	NA	2.540328	33
1997	NA	NA	2.256664	89
1998	0.84	NA	1.973	144
1999	NA	NA	NA	40
2000	NA	NA	NA	NA
2001	NA	37.518	NA	0.0838
2002	NA	40.373	NA	1.59
2003	NA	32.715	NA	0.712
2004	NA	25.964	NA	5.99
2005	NA	117.684	NA	187
2006	NA	68.480	NA	166
2007	NA	62.045	NA	158
2008	NA	57.061	NA	154
2009	NA	37.596	NA	131
2010	NA	61.877	NA	89
2011	NA	52.170	NA	100
2012	NA	38.770	NA	75
2013	0.4165	36.942	NA	72

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2014	NA	35.903	NA	65
2015	NA	36.439	NA	87
2016	NA	38.813	NA	74
2017	0.03	41.272	NA	83
2018	0.03	39.053	NA	75
2019	0.18	37.137	NA	83
2020	0.18	38.137	NA	84

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	NA	NA	337.1813	12.89
1991	NA	NA	337.18	16.88
1992	NA	NA	0.44	12.40
1993	NA	NA	0.22	7.92
1994	NA	NA	NA	7.76
1995	NA	NA	NA	7.60
1996	NA	NA	NA	196.99
1997	NA	NA	56.11	169.95
1998	1.90	NA	28.78	142.91
1999	0.53	NA	1.45	2.86
2000	0.50	NA	NA	0.38
2001	0.84	NA	NA	0.29
2002	0.67	NA	NA	1.93
2003	0.21	NA	NA	1.26
2004	1.00	NA	NA	1.13
2005	1.71	74.54	0.78	52.94
2006	1.88	78.19	0.65	55.17
2007	1.71	75.25	0.87	56.71
2008	1.72	76.73	2.76	129.93
2009	1.43	58.56	0.62	62.99
2010	1.57	92.12	0.32	38.51
2011	0.91	33.83	0.19	27.53
2012	0.37	23.79	0.27	17.27
2013	0.32	15.06	0.25	16.01
2014	0.20	15.04	0.96	17.75
2015	0.18	15.04	0.23	26.37
2016	2.02	14.02	0.21	18.59
2017	2.85	15.94	0.25	22.64

Year	Biomass [TJ]	Natural gas [TJ]	Lignite [TJ]	Heavy Fuels [TJ]
2018	2.74	16.24	NA	18.00
2019	3.30	19.32	NA	20.45
2020	4.35	22.384	NA	22.54

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	NA	NA	172	1611
1991	NA	NA	34	223
1992	NA	NA	32	414
1993	NA	NA	30	605
1994	NA	NA	22	589
1995	NA	NA	14	572
1996	NA	NA	3	137
1997	NA	NA	17	547
1998	15.54	NA	31	956
1999	18.41	NA	31	115
2000	13.19	NA	28	1614
2001	12.31	34	13	155
2002	9.67	59	18	172
2003	4.19	59	22	202
2004	5.86	51	16	155
2005	136.53	257.30	19.93	1057
2006	8.77	261.38	6.04	1002
2007	2.18	243.90	10.32	920
2008	7.38	246.31	8.76	891
2009	2.05	211.11	7.00	895
2010	9.33	238.05	9.24	862
2011	5.92	237.68	7.52	824
2012	74.28	218.77	6.78	812
2013	138.16	220.22	6.85	681
2014	188.88	204.67	4.42	660
2015	182.19	215.39	NA	701
2016	152.72	234.03	NA	687
2017	184.95	240.53	NA	666
2018	167.95	240.62	NA	345
2019	152.93	233.08	0.46	670
2020	151.60	234.50	0.46	683

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 [tones]
1990	67	NA	111	2666	491 902
1991	67	NA	111	2727	465 375
1992	67	NA	111	2606	396 496
1993	67	NA	110	2484	413 444
1994	67	NA	123	2117	375 914
1995	67	NA	135	1749	365 121
1996	66	NA	32	6040	396 015
1997	67	NA	593	2495	475 252
1998	66	NA	668	2991	346 867
1999	69	153	517	2000	427 080
2000	67	263	634	2540	614 162
2001	35	204	649	2744	716 963
2002	30	266	687	2922	739 492
2003	38	29	1084	2731	602 569
2004	29	NA	1706	1349	643 258
2005	2068	86	332	1974	694 922
2006	179	86	263	3073	801 302
2007	124	88	265	4603	882 834
2008	186	86	213	4359	843 765
2009	126	71	170	2980	478 404
2010	100	128	134	3184	588 978
2011	104	244	104	3520	687 986
2012	113	135	113	3441	645 482
2013	84	129	141	3335	577 845
2014	113	135	113	3441	518 198
2015	52	145	939	2345	553 232
2016	61	173	2662	1027	739 807
2017	63	213	2632	1017	735 625
2018	63	235	2548	1234	748 287
2019	92	254	2327	1668	730 700
2020	76	290	305	3421	770 559

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). Data for 2005-2018 have been revised and taken from MAKSTAT database, during previous submission.

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	**2006**	459
1991	3520	**2007**	528
1992	4707	**2008**	558
1993	4925	**2009**	789
1994	2074	**2010**	1020
1995	2408	**2011**	1378
1996	2074	**2012**	1737
1997	1796	**2013**	2300
1998	1624	**2014**	1154
1999	1316	**2015**	1190
2000	1050	**2016**	1207
2001	1156	**2017**	1104
2002	680	**2018**	1097
2003	549	**2019**	1056
2004	507	**2020**	1091
2005	429		

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

Pollutant	Value	Unit	References
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
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
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 2019 Table 3-4 emission factor for source category 1.A.2. page 17
SOx	47	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
PM2.5	20	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
PM10	20	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
TSP	20	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
BC	56	% of PM2.5	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
CO	66	g/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17

Pollutant	Value	Unit	References
Pb	0.08	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Cd	0.006	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Hg	0.12	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
As	0.03	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Cr	0.2	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Cu	0.22	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Ni	0.008	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Se	0.11	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Zn	29	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
PCDD/PCDF	1.4	ng I-Teq/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
benzo(a) pyren	1.9	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
benzo(b) fluoranthene	15	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
benzo(k) fluoranthene	1.7	mg/GJ	GB 2019 Table 3-4 emission factor for source category 1.A.2. page 17
Indeno (1.2.3-cd) pyren	1.5	mg/GJ	GB 2019 Table 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 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
SOx	374	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
CO	1455	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Pb	0.098	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Cd	0.008	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Hg	0.049	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
As	0.0265	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Cr	0.041	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f,page 31
Cu	0.0647	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Ni	0.049	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Se	0.0253	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Zn	0.424	g/tclinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
PCB	103	µg/t clinker	GB 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 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
benzo(a) pyren	0.000065	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
benzo(b) fluoranthen	0.00028	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
benzo(k) fluoranthen	0.000077	g/t clinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31
Indeno (1.2.3-cd)	0.000043	g/tclinker	GB 2019 Table 3-24 emission factor for source category 1.A.2.f, page 31

Pollutant	Value	Unit	References
pyren			
HCB	4.6	µg/t clinker	GB 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/tone	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
NH_3	8	g/ton	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
PM2.5	2104	g/tone	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
PM10	2104	g/ton	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
BC	1306	g/ton	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
TSP	2104	g/ton	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
CO	10 774	g/ton	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Cd	0.01	mg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
Cr	0.05	mg/kg	GB 2019 Table 3-1 Tier 1 emission factors for off-road machinery
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 SOx calculation for emissions coming from diesel is done using the sulfur content presented in Table 90.

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

4.4.3. 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 2019 were performed, due to the use of final data (from the energy balance) for fuel consumption.

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)

Road transport inventory has improved significantly, due to the implemented change of methodology in upgrading to Tier 3 method of emission calculation applied for the period 2005-2020. Activity data acquisition for the period 1990-2004 remains the same including estimated emissions, calculated with the highest uncertainty, due to the lack of details for the vehicle fleet data.

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

4.5.1.1.1. Methodology

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

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

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

Where:

E_i = emission of pollutant i [g].

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

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

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

The emission factors are available for CO, NH_3, NMVOC, NOx, 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 and PM25. The Tier 2 emission factors are stated in units of grams per vehicle-kilometer and for each vehicle technology are given in the table 3.17 of the EEA Guidebook 2013.

COPERT 5 (version 5.5.1) methodology has been used for calculation of the national emissions from road transport for the period 2005-2020. The methodology is fully incorporated in the computer software program COPERT 5 (version 5.5.1) which facilitates its application. The actual calculations have been therefore performed by using this computer software.

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

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

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

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

Exhaust emissions of NOx, SOx, NMVOC, NH3, PM2.5, PM10, TSP, Black carbon (BC), CO, Lead (Pb), Cadmium (Cd), Mercury (Hg), Arsenic (As), Chromium (Cr), Copper (Cu), Nickel (Ni), Selenium (Se), Zinc (Zn), dioxins/furans and four indicator PAHs (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene), PCB and HCB have been calculated using COPERT 5 (version 5.5.1).

Emissions of particulate matter (PM2.5, PM10, TSP, BC) from automobile tyre and brake wear and road abrasion have been calculated by COPERT 5 (version 5.5.1) as well.

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

Vehicle fleet

The fleet composition for the years 2005−2020 was taken from the official database of registered motor vehicles in North Macedonia, provided by the Ministry of Interior Affairs. Since no available database exists on motor and vehicles for the period 1990−2004, Tier 1 method of emission calculation was used.

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

Fuel consumption and mileage data

The fuel consumption and the consecutive energy consumption of the national vehicle fleet was taken from the official Energy statistic of the country / fuel consumption of the subsector road transportation. According to the national energy balance, the road transport sector mainly consumes diesel, petrol, LPG fuel, as well as small quantities of CNG. The national fuel balance is not containing any records for consumption of biodiesel, which should be further assessed and reconsidered by the State Statistical Office, due to the EU regulation of biofuels which is implemented in the country and the presence of the biofuels at the petrol stations in R. Macedonia.

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

On the basis of the mileage data for the period 2000 -2014, a linear interpolation of the mileage data has been done for the period 2015 - 2020. As a last step, the initial mileage data per category has been calibrated using the variables for the annual fuel consumption data and the specifics of the vehicles categories and classes. The detailed mileage matrix contains annual mileage per vehicle subcategory for new vehicles and for every vintage back in time, which determines the yearly mileage reduction percentages as a function of vehicle age. In a first step, the detailed mileage matrix is combined with corresponding fleet numbers in order to estimate intermediate total mileages for each year on a detailed fleet level. Next, each year's detailed (intermediate) mileage figures are scaled according to the difference between true and intermediate total mileage per vehicle subcategory.

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

Meteorology and climate data

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

Extra emissions of NOx, VOC, CH4, CO, PM, N2O, NH3 and fuel consumption from cold start are simulated separately. For SO2 and CO2, the extra emissions are derived from the cold start fuel consumption results.

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

The cold/hot ratios depend on the average trip length and the monthly ambient temperature distribution. The meteorological data for North Macedonia as minimum and maximum monthly temperature data and the average monthly humidity for the period 2005 -2020 have been provided by the National Hydrometeorological Service of North Macedonia. The City of Skopje is taken as a reference city for this assessment and the meteorological data provided in the COPERT assessment are referring to the meteorological conditions in the city of Skopje.

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

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.

Sulfur dioxide emissions are estimated by assuming that all sulfur in the fuel is transformed completely into SO_2, 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*

FCm = *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 1990-2020 [22]. Data on number of vehicles were taken from Statistical yearbook for the period 1990-2002 [22] and publication Transport and other communication for the period 2003-2004 [26]. For the period 2005-2020 data on number of vehicles were taken from MOI database.

Table 71 Activity data for source category 1.A.3.b - Road transport for period 1990-2020

NFR	1A3bi	1A3bi	1A3bii	1A3biii	1A3biv
Year	Liquid fuels	Gas fuel	Liquid fuels	Liquid fuels	Liquid fuels
1990	7647	2064	1553	3054	101
1991	6331	1396.6	2148.1	4293.3	121
1992	7097	1565.6	2544.1	5084.8	1818
1993	7353.6	1622.2	2652.8	5302.1	198.9
1994	6674	1472.3	2300.1	4597.1	96.1
1995	7250.3	1599.4	2579.2	5154.9	152.6
1996	7202.5	1588.8	2556.6	5109.8	179
1997	7333.9	1617.8	2614.7	5225.9	227.7
1998	7320.6	1614.9	2649	5294.4	236.2
1999	7350.6	1621.5	2640.6	5277.5	232.2
2000	7597.3	1675.9	2739.8	5475.9	246.9
2001	6115.9	1395.2	2198.5	4466.2	50.5
2002	6599	1395.2	2410.2	4819	76.6
2003	6.188	1.395.2	2.260.1	4.518.8	71.8
2004	6324.3	1395.2	2005.2	3991.3	91.5
2005	6034.5	1249.3	2229.9	4460	100.6
2006	5685.8	1489.4	1868.6	4982.6	135.1
2007	6150.6	1987.7	2156.3	5763.2	152.8
2008	5943	1.953	1.656.9	4.390.4	339.3
2009	6477.3	1987.7	2971.0	5972.4	342.1
2010	7456.4	2634	3980	8045	92.5
2011	7272.1	1599.6	3464.3	6986	93.7
2012	6300.4	1543.1	3553.6	7178.4	83.3
2013	6847.1	1693	4168.3	8433.1	87.4
2014	10 298	726.0	2122.0	6990.0	51.6
2015	10 873	717.0	2826.0	7877.0	60.4
2016	11446	734.0	2288.0	11568	70.0
2017	11902	737.0	1994.0	11723	84.0
2018	12411	742.0	2077	11788	79.0
2019	12981	722.4	2170.5	11910	68.2
2020	10491	NA	3342.5	12856	13.3

Table 72 Activity data for source category 1.A.3.b Road transport for 2020

NFR code	Fuel	Fuel consumption [TJ]
1A3bi	Gasoline	3044
	Diesel	5444
	LPG	2003

NFR code	Fuel	Fuel consumption [TJ]
1A3bii	Gasoline	225
	Diesel	3117
1A3biii	Gasoline	0.54
	Diesel	12324
1A3biv	Gasoline	13.3

Emission factors

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

Tier 3 approach used for the period 2005-2020 uses emission factors for calculating exhaust and non-exhaust emissions for NOx, SOx, NMVOC, NH3, PM2.5, PM10, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, dioxins/furans and PAHs (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene), HCB, PCB as default emission factors offered by the COPERT 5 (version 5.5.1).

Sulfur dioxide emissions are estimated by using the sulfur content in different periods as presented in Table 90.

Table 73 Emission factor for source category 1.A.3.b - Road Transport used for calculation of emissions in the period 1990-2004 by use of Tier 1 methodology

NFR code	Fuel	NOx	NMVOC	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	/

4.5.1.1.2. Source-specific uncertainties and time-series consistency

Tier 3 methodology has been used for calculation of the emissions for the period 2005-2020, while the calculation of the emissions for the previous years is done by use of Tier 1 method which presents a trend of inconsistency in this sector.

Acquired data for the fleet composition in Republic of North Macedonia is available for the years 2005-2020, and a TAIEX mission for establishment of Tier 3 method of emission calculation and use of COPERT 5 model was conducted. The data was preliminary quality checked by introducing a tool for automatic and manual data validation.

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

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

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

The activity data uncertainty was estimated to be 10 % (rating C. cf. chapter 1.7); the emission factor uncertainty for NOx. NMVOC and PM2.5 was estimated to be 20 % (rating A. cf. chapter 1.7), for SO_2 and was estimated to be 40% (rating B) and NH_3 for (125% rating C).

4.5.1.1.3. Source-specific QA/QC and verification

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

EF from GB 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

Recalculations were made for the period 2005-2019, since the Tier method was upgraded to Tier 3 by introducing COPERT 5 emission calculations.

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

New TAIEX follow-up mission is approved by the EC, related to improvement of the emission calculation in transport sector, by using COPERT 5 model. Moreover, the Ministry has obtained the VAT number of each vehicle entry in the vehicle database, that will allow the QA/QC procedure to be done once (within the TAIEX mission) for the whole vehicle fleet, and allow just a yearly QA/QC procedure for the newly registered vehicles each year. This will significantly improve the quality of the transport sector emission calculation.

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

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

Most evaporative emissions of VOCs emanate from the fuel systems (tanks, injection systems and fuel lines) of petrol vehicles. Evaporative emissions from diesel vehicles are considered negligible, due to the presence of heavier hydrocarbons and the relatively low vapor pressure of diesel fuel and can be neglected in the calculations.

4.5.1.2.1. Methodological issues

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

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

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

Where:

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

N_j =the number of vehicles in category j.

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

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

Tier 3 method is used to calculülate evaporative emissions for the period 2005-2020, using Copert 5 model

Activity Data

The number of vehicles in category PCs and TWs are taken directly from the statistical yearbooks for the period 1990-2004 [22] and MOI database for the period 2005 - 2020.

Table 74 Activity data for source category 1.A.3.v - Gasoline evaporation for Tier 1 calculation

Year	Passenger cars (PCs)	Light-duty vehicles (LDVs)	Two-wheel vehicles (TWVs)
1990	196 282	4 500	1 523
1991	212 340	4 729	1 489
1992	238 032	5 601	2 238

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

Emission factors used for Tier 1 methodology

For the calculation of emissions for emission parameters from 1990-2004, the used emission factors were taken from the GB 2009, NMVOC emission factors for gasoline fueled road vehicles, when daily temperature range is around 10 to 25°C, were 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 below.

Table 75 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.A3.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

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

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

$$\mathrm{TE} = \sum_{j} \mathrm{N_j} \times \mathrm{M_j} \times \mathrm{EF_{i.j}}$$

where:

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

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

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

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

The indices are:

i =TSP, PM10, PM2.5

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

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

Tier 3 method was used for the period 2004-2020, by using COPERT 5 model.

Activity Data

The activity data on the number of vehicles for the category Passenger cars and Motorcycles have been taken from the publication “Transport and communication” for the period 2003-2004 [26], and from the chapter Transport from the Statistical yearbook for the period 1990-2002 [22], and for the period 2005-2020, data from the MOI database was used.

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

Table 76 Activity data for the source categories 1.A.3.bvi - Road vehicle tire and brake wear and 1.A.3.b.vii Road surface wear

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

Emission factors

Tables 77 and 78 summarize the emission factors used for the calculation of particulate emissions for the period 1990-2004, for which Tier 1 method was applied. The emission factors for the period 2005-2020 are integrated in the COPERT 5 model.

Table 77 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 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Two-wheelers	0.0064	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear.

Pollutant	Vehicle type	Value	Unit	References
				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 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Passenger cars	0.0182	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Passenger cars	0.0138	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Passenger cars	0.0074	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Light duty trucks	0.0286	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Light duty trucks	0.0216	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Light duty trucks	0.0177	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
TSP	Heavy duty vehicles	0.0777	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM10	Heavy duty vehicles	0.0590	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14
PM2.5	Heavy duty vehicles	0.0316	g km-1 vehicle-1	GB 2019 1.A.3.b.vi Road vehicle tire and brake wear. 1.A.3.b.vii Road surface wear Table 3-1 pg 14

Table 78 Emission factors for the source category 1.A.3.bvii Road surface wear

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

Pollutant	Vehicle type	Value	Unit	References
	vehicles			1.A.3.b.vii Road surface wear Table 3-1 pg 14

4.5.1.3.2. Source-specific uncertainties and time-series consistency

No specific uncertainty calculations are performed in this category.

4.5.1.3.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

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.The emissions coming from this sector are significantly reduced due to COVID 19 restriction and ban and reduced number of flights in 2020.

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 was taken from the publication Transport and communications for the period 2005-2016[26]. 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 79 Activity data for source category 1.A.3.ai (i) - International aviation LTO civil (number of LTO)

Year	Number of LTO	Year	Number of LTO	Year	Number of LTO
1990	11 986	2000	23 168	2010	12 721
1991	11 297	2001	11 664	2011	11 873
1992	10 539	2002	12 767	2012	11 284

Year	Number of LTO	Year	Number of LTO	Year	Number of LTO
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	2019	20 281
				2020	8231

Emission factors

The calculation of emissions for emission parameters from 1990-2020 were used emission factors taken from GB 2013. The used emission factors are presented in Table 80.

Table 80 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 2011-2019 [22]. For the period 2000-2004 surrogate method has been used to calculate the consumption related to the passenger numbers. The data is available in the Statistical year books in the Transport chapter for the period 1990–2004, as for the period 2005-2015 data is taken from the special publication Transport and other services [26], while data after 2015 are taken from the MAKSTAT database[27].

Table 81 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

Year	Total fuel (t)	Year	Total fuel(t)	Year	Total fuel(t)
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	2019	26 473
				2020	8637

Emission factors

Emission factors were taken from GB 2013 (Cruise (kg/t) — average fleet (B767)). These emission factors are given in Table 82 below.

Table 82 Emission factors for 1.A.3.ai(ii) - International aviation cruise (civil)

Pollutant	Value	Unit	References
NOx	12.8	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
NMVOC	0.5	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
SOx	1	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
PM2.5	0.2	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))
CO	1.1	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-3. pg. 9 (Cruise (kg/t) — average fleet (B767))

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

4.5.2.3.1. Methodological issues

The cruse fuel is calculated according to the following equation:
Cruise fuel = total fuel consumption — LTO fuel consumption

The LTO fuel consumption is calculated according to the following equation:
LTO fuel = number of LTOs x fuel consumption per LTO (1617 kg/LTO)

Activity Data

The activity data for calculation of total fuel consumption is taken from the Energy balance from the Statistical yearbooks 1990-1999[21], as well as from the publication Energy statistics 2000-2010[24]. Data on jet fuel and aviation gasoline consumption are available starting from 2005. For the period 1990-2004, surrogate method has been used. The estimates of the activity data were related to the passenger numbers. The sources of number of LTO have been discussed in the previous chapter. Table 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 83 Activity data for source category 1.A.3.aii(ii) - Domestic aviation cruise (civil)

Year	Fuel consumption (t)	Year	Fuel consumption (t)	Year	Fuel consumption (t)

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	2019	NO
				2020	NO

Emission factors

Emission factors were taken from GB 2013 for all reporting period. These emission factors are given in Table 84 below.

Table 84 Emission factors for NFR - 1.A.3.aii (ii)

Pollutant	Value	Unit	References
NOx	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
NMVOC	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
PM10	0	kg/t fuel	GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20
PM2.5	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 NOx, NMVOC and PM2.5 was estimated to be 40 % (rating B. cf. chapter 1.7) for SO_2 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 2015-2020 for which emissions in 1.A.5.b are estimated.

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

No recalculations were done in this category.

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

Correction of data that contains jumps and deeps is planned to be implemented in future reporting rounds. The ERT noted that BC emissions from 1A3ai (i), and 1A3aii (i) were not calculated and these emissions will be calculated in the next submission. The National emission inventory team will check if EF from the latest version of the Guidebook could be used.

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:

$$\mathbf{E}_{\boldsymbol{i}} = \sum_{\boldsymbol{m}} \mathbf{FC}_{\boldsymbol{m}} \times \mathbf{EF}_{\boldsymbol{i.m}}$$

Where:

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

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

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

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

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

$$\mathbf{E}_{\boldsymbol{i}} = \sum_{m} \sum_{j} (FC_{j,m} \times EF_{i,j,m})$$

where:

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

$FC_{j,m}$= fuel consumption of fuel type mused by category jfor the period and areaconsidered (tonnes);

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

m = fuel type (diesel, gas oil);

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

Activity Data

The activity data for the diesel oil consumption for the period 1990, 1999-2020 was taken from the chapter Energy balance from the Statistical yearbooks for the related period [22]. For the period 1991-1998, an approach has been developed to complete lacking years in the time series by use of passenger km used as surrogate data.

Table 85 Activity data for diesel fuel consumption in source category 1.A.3.c – Railways – Tier 1

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1990	7300	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	2019	2562

For 2020 the Ministry of transport and communication has provided activity data needed for implementation of Tier 2 methodology.

Table 86 Activity data for diesel fuel consumption in source category 1.A.3.c – Railways for 2020 – Tier 2

Year	Category	Diesel fuel consumption [t]
2020	Line-houl locomotives	0.51
2020	Rail cars	497

The fuel consumption in 2020 is lower due to resticition and reduced railway transport due to COVID 19 situation.

Emission factors

The calculation of emissions for emission parameters from 1990-2019 were used emission factors taken from GB 2019. These emission factors are given in Table 87 below.

Table 87 Emission factors for source category 1.A.3 - Railways

Pollutant	Value	Unit	Tier	References
NOx	52.4	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
CO	10.7	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8

Pollutant	Value	Unit	Tier	References
NMVOC	4.65	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
NH_3	0.007	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
TSP	1.52	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
PM10	1.44	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
PM2.5	1.37	kg/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Cd	0.01	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Cr	0.05	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Cu	1.7	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Ni	0.07	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Se	0.01	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Zn	1	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Benzo(a)pyrene	0.03	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
Benzo(b)fluoranthene	0.05	g/t fuel	Tier 1	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 8
NOx	63	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
CO	18	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
NMVOC	4.8	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
NH3	10	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
TSP	1.8	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
PM10	1.1	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
PM2.5	1.2	kg/t fuel	Tier 2-Line houl locomotives	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
NOx	39.9	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-2, pg.9
CO	10.8	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 10
NMVOC	4.7	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 10
NH3	10	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 10
TSP	1	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 10
PM10	1.1	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-1, pg.10
PM2.5	1.5	kg/t fuel	Tier 2-Rail cars	GB 2019, 1.A.3.c Railways, Table 3-1, pg. 10

4.5.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for NOx, NMVOC and PM2.5 was estimated to be 40% (rating B. cf. chapter 1.7), for NH_3 was estimated to be 125% (rating D).

4.5.3.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

National inventory team has provided detail data from Macedonian railways, and conduct Tier 2 methodology for 2020 and will make effort to implement Tier 2 methodology on whole time seria in the future submissions.

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

Emissions from fuels used by vessels of all flags that depart and arrive in the same country (excludes fishing) includes small leisure boats. Republic of North Macedonia has three natural lakes, but 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. The emissions in 2020 are significantly reduced due to restriction implemented in this year taken into account COVID 19 situation that had major impact on turisam in this case on national navigation.

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

4.5.5. Methodological issues

See chapter 4.4.1

Activity Data

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

Table 88 Activity data for diesel consumption for source category 1.A.3.d.ii - National navigation - using diesel fuel oil 1990 -2020

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1990	87.93	2000	21.85	2010	111.06
1991	15.65	2001	7.96	2011	57.85
1992	10.96	2002	26.47	2012	61.18
1993	7.08	2003	12.93	2013	41.38
1994	10.00	2004	6.26	2014	50.43
1995	21.71	2005	19.06	2015	59.55
1996	8.71	2006	21.57	2016	61.11

Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]	Year	Diesel fuel consumption [t]
1997	6.47	2007	72.34	2017	68.53
1998	25.52	2008	174.22	2018	73.63
1999	18.03	2009	164.28	2019	77.04
				2020	25.59

Emission factors

For the calculation of emissions for emission parameters from 1990-2020 the used emission factors were taken from GB 2019 [19]. These emission factors are given in Table 89 below.

Table 89 Emission factors for source category 1.A.3.dii – 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
NMVOC	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
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 90 National content of sulfur in diesel used for calculation of SOx 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 category

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

No planned improvements for this category.

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

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

4.5.6.1. Methodological issues

See chapter 4.4.1

Activity Data

The activity data on diesel consumption were obtained from the Ministry of defense. Reported data for the years 2015-2020 are presented in the following table.

Table 91 Activity data for liquid fuel and aviation gasoline consumption for source category 1.A.5.b – Other, Mobile for 2015-2020

Type of fuel [tonnes]	2015	2016	2017	2018	2019	2020

Liquefied fuels	672	873	715	696	695	583
Aviation gasoline	22	166	364	284	460	310

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

Emission factors

See table 70 and 108.

4.5.6.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis is done for this category.

4.5.6.3. Source-specific QA/QC and verification

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

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

No recalucaltions were done in this category.

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

No planned improvements in this category.

4.6. Fugitive emission from fuels- NFR 1 B

Fugitive emission arises from coal mining, production, distribution, storage and distribution of oil products.

4.6.1. Coal mining and handling – NFR 1.B.1.a

4.6.1.1. Methodological issues

This is one of subcategories for which Tier 2 method was used.

$$E_{pollutants} = \sum_{tehnologies} AR_{production.tehnology} \times EF_{tehnology.pollutant}$$

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 92 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	2019	5 066 083
				2020	4 532 745

Emission factors

In this category calculations were done by use of Tier 2 methodology starting from 2015 due to the fact that all coal mines are categorized as open mines.

Table 93 Emission factors for1.B.1.a - Fugitive emission from solid fuels: Coal mining and handling

Pollutant	Value	Unit	References
NMVOC	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
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

4.6.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NOx was estimated to be 20% (rating A. cf. chapter 1.7) and 200% for PM2.5,(rating D).

4.6.1.3. 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.

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

No recalculations were performed in this category.

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

No further improvements are planned in this category.

4.6.2. 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.

4.6.2.1. Methodological issues

The Tier 1 approach for the refining industry uses the general equation:

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

This equation is applied at national level, using the total refined oil production as production statistics. It is also possible to use the crude oil throughput as production statistics.

Activity data

The activity data on crude oil input are taken from the energy balance within the Statistical Yearbook of the Republic of North Macedonia for the whole reporting period and are presented in the following table. Starting from 2015 onwards no crude oil input was reported. Therefore, emissions in this category did not occur.

Table 94 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
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	2019	NO
				2020	NO

Emission factors

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

Table 95 Emission factors for source category 1.B.2.aiv - Fugitive emissions oil: Refining/storage

Pollutant	Value	Unit	References
NOx	0.24	kg/Mg crude oil input	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
NMVOC	0.2	kg/Mg crude oil input	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
SOx	0.62	kg/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
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
PM2.5	0.0043	kg/Mg crude oil input	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
PM10	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
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

4.6.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NMVOC and SOx was estimated to be 20% (rating A. cf. chapter 1.7). and 40% for NO_x and NH_3 (rating B). and 200% for EF uncertainty for PM2.5 (rating D).

4.6.2.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this sector.

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

No planned improvements in this category.

4.6.3. Distribution of oil products – NFR 1.B.2.a.v

This chapter is dealing with the distribution of oil products, in particular (but not limited to) gasoline distribution.

4.6.3.1. Methodological issues

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

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

$E_{pollutant}$ = the emission of certain pollutant

$AR_{production}$ = activity rate by fuel gasoline sold

$EF_{pollutant}$ = 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 96 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
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	**2019**	942 879
				2020	832 130

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

Table 97 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

4.6.3.2. Source-specific uncertainties and time-series consistency

See chapter 3.7.2.1.

4.6.3.3. Source-specific QA/QC and verification

Comparison of data reported under this category with data reported under 1.B.a.iv.

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

No recalculations were performed in this category.

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

No planned improvements in this category.

4.6.4. Venting and flaring – 1.B.2.c

4.6.4.1. 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 98 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	2019	NO
				2020	NO

Emission factors

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

Table 99 Emission factors for source category 1B2c Venting and flaring

Pollutant	Value	Unit	References
NOx	100	g/GJ refinery feed	IIR 2010 Table 72 page 74
NMVOC	5	g/GJ refinery feed	IIR 2010 Table 72 page 74
SOx	15	g/GJ refinery feed	IIR 2010 Table 72 page 74
CO	24	g/GJ refinery feed	IIR 2010 Table 72 page 74

4.6.4.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 20%; the emission factor uncertainty for NMVOC was estimated to be 20% (rating A. cf. chapter 1.7) and 40% for NOx (rating B).

4.6.4.3. 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.

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

No recalculations were performed in this category.

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

No planned improvements in this category.

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

Emissions for NH_3, Hg and As were calculated for the period 2005-2020, where data on geothermal energy consumption were available.

Methodological issues

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

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

This equation is applied at the national level, using annual national statistics on the extraction of geothermal energy from the earth.

The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all different sub-processes within the geothermal energy extraction process.

Activity data

The activity data for this source category for the period 1998-2016 expressed in m^3 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 100 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	2019	64 362
				2020	64 985

Emission factors

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

Table 101 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 2019Table 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

4.6.5.1. Source-specific uncertainties and time-series consistency

No specific uncertainties were calculated for this category.

4.6.5.2. Source-specific QA/QC and verification

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

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

No recalculations were done in this sector. Only corrections for notation keys were included according to Stage 3 review recommendations given for this sector.

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

No planned improvements in this category.

4.7. 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.

4.7.1. 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:

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

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

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

4.7.2. 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. Moreover in this reporting round revised data for consumption of fuels used in administrative capacities and households are revised up to 2005 and taken from the MAKSTAT database.

4.7.3. 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.

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

The recalculations were minor due to use of final energy balance for 2019. Recalulations were done only in 1.A.4.bii when methodology for calculation was changed.

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

Use of higher Tier level will be implemented in future submissions.

4.7.6. 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.

4.7.6.1. Methodological Issues

Activity data

Activity data for this sector has been taken from the Statistical yearbooks – chapter energy balance for the period 1990-2020. For the period 1990-1998, activity data were taken from the GHGs inventory.

Table 102 Activity data for the source category 1.A.4.ai Commercial/Institutional – stationary combustion

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
1990	NA	144	NA	387
1991	NA	144	NA	NA
1992	NA	243	NA	NA
1993	NA	152	NA	NA
1994	NA	152	NA	NA
1995	NA	152	NA	NA
1996	NA	152	NA	NA
1997	NA	152	NA	NA
1998	712	152	NA	2640
1999	712	607	NA	3312
2000	848	58	NA	998
2001	NA	33	NA	705
2002	NA	196	NA	9337
2003	311	246	NA	3407
2004	325	656	NA	2450
2005	209	193	120	5169
2006	351	178	112	4094
2007	334	207	103	3844
2008	436	27	95	2154
2009	610	16	77	3700
2010	528	20	79	3527
2011	220	4	83	1509
2012	357	52	91	1821
2013	196	62	109	1780
2014	279	21	198	1558
2015	181	24	226	1896
2016	174	27	235	2046
2017	190	34	265	1831
2018	184	27	248	1645
2019	180	24	240	1591
2020	210	20	244	1231

Emission factors

Emission factors are taken from GB 2019. Emission factors for different type of fuels are presented in tables 103-107.

Table 103 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 104 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

Pollutant	Value	Unit	References
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 105 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
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

Pollutant	Value	Unit	References
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 106 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
NMVOC	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
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

4.7.6.2. 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 SO_2 was estimated to be 20% (rating A. cf. chapter 1.7), for SOx and NMVOC was estimated to be 40% (rating B) and for PM2.5.(125% rating C).

4.7.6.3. Source-specific QA/QC and verification

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

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

Recalculations were done for 2019 emissions within the category 1.A.4.ai due to use of final consumption data for this year.

4.7.6.5. 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. Namely, there is ongoing establishment of National environmental information system that will enable us to collect detail data from this sector in the future.

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

Within the Commercial/Institutional sector, liquid fuel- diesel is used. The NFR sector is for the first time introduced in the inventory due to available activity data for the period 2011-2020. For the previous years the emissions were noted as IE in 1.A.4.ai, as it was recommended by previous stage 3 review.

4.7.7.1. Methodological Issues

Activity data

Activity data for this sector has been taken from the MAKSTAT database; activity data were available only for the period 2011-2020.

Table 107 Activity data for the source category 1.A.4.aii Commercial/Institutional: Mobile

Year	Diesel [TJ]
1990	IE
1991	IE
1992	IE
1993	IE
1994	IE
1995	IE
1996	IE
1997	IE
1998	IE
1999	IE
2000	IE
2001	IE

Year	Diesel [TJ]
2002	IE
2003	IE
2004	IE
2005	IE
2006	IE
2007	IE
2008	IE
2009	IE
2010	IE
2011	722
2012	1486
2013	669
2014	684
2015	694
2016	694
2017	739
2018	741
2019	800
2020	554

Emission factors

Table 108 Emission factors for liquid fuels for source category 1.A.4.aii - 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
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

Pollutant	Value	Unit	References
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

4.7.7.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was calculated for this sector.

4.7.7.3. 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.

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

Recalculations were done for 2019 emissions within the category 1.A.4.ai due to use of final consumption data for this year.

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

No planned activities for this category.

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

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

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

The following table presents energy consumption of households in 2014.

Table 109 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
Wood mass consumed for other purposes (for food in winter. producing brandy. etc.)	149 366	N/A

4.7.8.1. 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 2005 were taken from MAKSTAT database. These numbers were more representative but still there may be some underestimation of the consumed biomass due to still existing illegal cut of woods, especially in the rural areas.

Table 110 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	1038
1995	16 024	294	NO	1097
1996	16 024	284	NO	1156
1997	16 024	275	NO	1214
1998	15 273	213	NO	1225
1999	16 028	276	NO	1316
2000	19 040	235	NO	1394
2001	14 811	177	NO	1435
2002	14 654	227	NO	1513
2003	16 315	228	NO	1577
2004	16 271	248	NO	1657
2005	8 648	161	NO	1687
2006	8 618	115	NO	1757
2007	8 055	114	NO	1890
2008	7 906	72	NO	1812
2009	8 069	47	NO	1895
2010	7 946	53	NO	1852
2011	8 664	38	NO	1896
2012	9 416	40	NO	1172
2013	9 262	39	0.3901	535
2014	9 694	27	2.6039	431

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
2015	9 336	24	2.6039	464
2016	7 862	25	3.8264	476
2017	9 006	25	6.2694	490
2018	7 513	19	7.7307	456
2019	7 761	18	8.2879	372
2020	7 906	19	10.3259	364

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

Pollutant	Value	Unit	References
NOx	50	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
NMVOC	600	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
SOx	11	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
NH_3	70	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
PM2.5	740	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
PM10	760	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
TSP	800	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
BC	10	%PM2.5	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
CO	4000	g/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Pb	27	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Cd	13	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Hg	0.56	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
As	0.19	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Cr	23	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Cu	6	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Ni	2	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Se	0.5	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
Zn	512	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
PCB	0.06	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
PCDD/PCDF	800	ng I-TEQ/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
benzo(a) pyren	121	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
benzo(b) fluoranthene	111	mg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35
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

Pollutant	Value	Unit	References
HCB	5	µg/GJ	GB 2019, Table 3-6 emission factor for source category, 1.A.4.b.i, page 35

Table 112 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 113 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
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

Pollutant	Value	Unit	References
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 114 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 2019, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34
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
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

Pollutant	Value	Unit	References
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

4.7.8.2. 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 SO_2 was estimated to be 20% (rating A. cf. chapter 1.7), for SOx and NMVOC was estimated to be 40% (rating B) and for PM2.5 and NH_3 (125% rating C).

4.7.8.3. 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.

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

Recalculations were done for 2019 emissions due to use of final consumption data for this year.

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

Furthermore, since this NFR is key sector for many pollutants, especially PM10 and PM2.5 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, as well as avalible survey on type of heating in South-East region that was conducted last year. Taken into account these avaliable data and Appliance type split according to IIASA GAINS model the National emission inventory team will try to use higher Tier methodology in future submissions regarding emissions coming from the residential sector and will include information on the condesales.

4.7.9. 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 SO_2, NOx, CO_2, PM, CO and non-methane volatile organic compounds (NMVOCs). The emissions of CO_2 and SO_2 are predominantly fuel-based and independent of engine technology/type of equipment.

4.7.9.1. 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 115 Activity data for source category 1.A.4.bii - Residential: Household and gardening (mobile)

Year	Gasoline consumption [TJ]
1990	48.62
1991	29.9
1992	56.1
1993	31.8
1994	31.8
1995	38.8
1996	38.4
1997	38.0
1998	38.2
1999	35.2
2000	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 is 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 the following table.

Table 116 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
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

Pollutant	Value	Unit	References
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

4.7.9.2. Source-specific uncertainties and time-series consistency

See chapter 3.6.7.1.

4.7.9.3. Source-specific QA/QC and verification

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

4.7.9.4. 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. The method for extrapolation using households as surogate data according to the formula Y0=Yt * (S0/St) was used to recalculate 2001-2019 emissions coming from this sector.

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

No planed activities in this category.

4.7.10. 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.

4.7.10.1. Methodological Issues

Activity data

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

Table 117 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	NA	32.782	1302	NA
1991	NA	33.415	1545	NA
1992	NA	33.083	1322	NA
1993	NA	33.312	944	NA
1994	NA	33.338	890	NA
1995	NA	33.570	985	NA
1996	NA	33.518	1125	NA
1997	NA	33.675	875	NA
1998	NA	0.022	829	NA
1999	NA	0.064	959	NA

Year	Biomass [TJ]	Coal [TJ]	Gaseous Fuels [TJ]	Liquid Fuels [TJ]
2000	NA	1.905	1261	NA
2001	NA	0.375	998	NA
2002	NA	0.008	571	NA
2003	NA	1.362	457	14.072
2004	NA	1,844	1508	18.075
2005	NA	2.802	1003	41.373
2006	NA	0.730	793	37.781
2007	NA	0.953	516	35.200
2008	NA	2.495	541	51.112
2009	NA	0.124	351	47.688
2010	NA	0.124	363	47.048
2011	NA	0.124	323	51.119
2012	NA	0.091	349	55.681
2013	NA	36.393	230	56.675
2014	NA	36.393	230	56.675
2015	NA	35.572	251	56.679
2016	NA	32.555	248	51.220
2017	NA	25.765	207	55.943
2018	NA	21.761	211	57.621
2019	NA	23.160	221	57.909
2020	NA	24.210	186	65.589

Emission factors

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

4.7.10.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO_2 was estimated to be 20% (rating A. cf. chapter 1.7), for SOx and NMVOC was estimated to be 40% (rating B) and for PM2.5 and NH_3 (125% rating C).

4.7.10.3. 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.

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

Furthermore, with regards to 2019 emission recalculations were done due to use of final fuel consumption data instead of preliminary consumption.

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

No planned improvements in this category.

4.7.11. Agriculture/Forestry/Fishing: Off-road vehicles and other machinery – NFR 1A4cii

4.7.11.1. 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 form the chapter agriculture in the statistical yearbook) has been used as surrogate data for estimation of the fuel consumption.

Table 118 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	NA	2441
1991	12917	NA	1326
1992	11276	NA	909
1993	7651	NA	1046
1994	7364	NA	842
1995	8305	NA	772
1996	9482	NA	884
1997	6932	NA	1130
1998	7346	NA	294
1999	8149	NA	692
2000	11598	NA	985
2001	9574	NA	813
2002	5325	NA	452
2003	4260	NA	362
2004	14066	NA	1195
2005	1865	NA	374
2006	711	NA	591
2007	964	NA	325
2008	1309	NA	323
2009	2306	NA	336
2010	3660	NA	351
2011	3659	NA	394
2012	3762	NA	379
2013	5710	NA	368
2014	6007	NA	371
2015	6223	NA	390
2016	6535	NA	397
2017	6537	NA	395
2018	6561	NA	395

Year	Diesel [TJ]	LPG [TJ]	Gasoline[TJ]
2019	6707	NA	402
2020	6692	NA	394

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 119 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 120 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 121 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

Pollutant	Value	Unit	References
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

4.7.11.2. 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 SO_2 was estimated to be 20% (rating A. cf. chapter 1.7), for SOx and NMVOC was estimated to be 40% (rating B) and for PM2.5 and NH_3 (125% rating C).

4.7.11.3. 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.

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

No recaluclations were performed in this category.

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

No planned improvements.

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

According to ERT recommends the Party was asked to include an explanation in the IIR on why emissions have not been estimated, we include the following explanation: For performing activity - fishing on natural and artificial lakes in our country are used boats equipped with outboard two-stroke and four-stroke engines with power of 4-10 KW. 30-40 boats are used in Lake Ohrid. Their utilization depends on the workload at different times of the year, which makes it difficult to determine fuel consumption.Therefore these emissions are not estimated.

4.8. Fugitive emission from fuels- NFR 1 B

Fugitive emission arises from coal mining, production, distribution, storage and distribution of oil products.

4.8.1. Coal mining and handling – NFR 1.B.1.a

4.8.1.1. Methodological issues

This is one of subcategories for which Tier 2 method was used.

$$E_{pollutants} = \sum_{tehnologies} AR_{production.tehnology} \times EF_{tehnology.pollutant}$$

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 122 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	2001	8 142 082	2012	7 309 546
1991	6 978 171	2002	7 571 202	2013	6 633 560
1992	6 472 920	2003	7 271 202	2014	6 681 752
1993	6 917 774	2004	7 296 136	2015	5 927 749
1994	6 859 762	2005	6 882 862	2016	5 101 758
1995	7 249 237	2006	6 653 474	2017	5 056 918
1996	7 145 667	2007	6 569 220	2018	4 994 843
1997	7 442 876	2008	7 669 103	2019	5 066 083
1998	8 144 653	2009	7 395 915	2020	4 532 745
1999	7 277 623	2010	6 583 074		
2000	7 513 998	2011	7 902 084		

Emission factors

In this category calculations were done by use of Tier 2 methodology starting from 2015 due to the fact that all coal mines are categorized as open mines.

Table 123 Emission factors for1.B.1.a - Fugitive emission from solid fuels: Coal mining and handling

Pollutant	Value	Unit	References
NMVOC	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
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

Pollutant	Value	Unit	References
			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

4.8.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NOx was estimated to be 20% (rating A. cf. chapter 1.7) and 200% for PM2.5,(rating D).

4.8.1.3. 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.

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

No recalculations were performed in this category.

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

No further improvements are planned in this category.

4.8.2. 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.

4.8.2.1. Methodological issues

The Tier 1 approach for the refining industry uses the general equation:

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

This equation is applied at national level, using the total refined oil production as production statistics. It is also possible to use the crude oil throughput as production statistics.

Activity data

The activity data on crude oil input are taken from the energy balance within the Statistical Yearbook of the Republic of North Macedonia for the whole reporting period and are presented in the following table. Starting from 2015 onwards no crude oil input was reported. Therefore, emissions in this category did not occur.

Table 124 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	2001	1 012 872	2012	259 606
1991	964 033	2002	648 137	2013	59 676
1992	566 701	2003	78 749	2014	7 274
1993	1 018 201	2004	975 262	2015	NO
1994	143 148	2005	946 747	2016	NO

Year	Crude oil input [Mg]	Year	Crude oil input [Mg]	Year	Crude oil input [Mg]
1995	119 437	2006	1 067 096	2017	NO
1996	696 341	2007	1 050 007	2018	NO
1997	379 759	2008	1 061 736	2019	NO
1998	754 775	2009	972 532	2020	NO
1999	765 412	2010	853 000		
2000	1 043 104	2011	705 144		

Emission factors

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

Table 125 Emission factors for source category 1.B.2.aiv - Fugitive emissions oil: Refining/storage

Pollutant	Value	Unit	References
NOx	0.24	kg/Mg crude oil input	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
NMVOC	0.2	kg/Mg crude oil input	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
SOx	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
PM2.5	0.0043	kg/Mg crude oil input	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14
PM10	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
Zn	0.0051	g/MG crude oil	GB 2019, Table 3-1 emission factor for source category, 1.B.2.a.iv, page

Pollutant	Value	Unit	References
		input	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

4.8.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NMVOC and SOx was estimated to be 20% (rating A. cf. chapter 1.7). and 40% for NO_x and NH_3 (rating B). and 200% for EF uncertainty for PM2.5 (rating D).

4.8.2.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this sector.

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

No planned improvements in this category.

4.8.3. Distribution of oil products – NFR 1.B.2.a.v

This chapter is dealing with the distribution of oil products, in particular (but not limited to) gasoline distribution.

4.8.3.1. Methodological issues

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

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

$E_{pollutant}$ = the emission of certain pollutant

$AR_{production}$ = activity rate by fuel gasoline sold

$EF_{pollutant}$ = 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 126 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	2001	959 035	**2012**	572 365
1991	457 295	2002	178 107	**2013**	626 447

Year	Distributed oil (Mg)	Year	Distributed oil (Mg)	Year	Distributed oil (Mg)
1992	278 185	2003	338 459	**2014**	598 267
1993	597 143	2004	383 553	**2015**	675 630
1994	117 255	2005	402 385	**2016**	745 722
1995	828 450	2006	409 568	**2017**	858 093
1996	334 711	2007	454 633	**2018**	872 279
1997	459 252	2008	456 165	**2019**	942 879
1998	484 508	2009	447 263	**2020**	832 130
1999	514 251	**2010**	516 450		
2000	394 487	**2011**	566 686		

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

Table 127 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

4.8.3.2. Source-specific uncertainties and time-series consistency

See chapter 3.7.2.1.

4.8.3.3. Source-specific QA/QC and verification

Comparison of data reported under this category with data reported under 1.B.a.iv.

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

No recalculations were performed in this category.

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

No planned improvements in this category.

4.8.4. Venting and flaring – 1.B.2.c

4.8.4.1. 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 128 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	2001	201	2012	52
1991	186	2002	129	2013	12
1992	109	2003	156	2014	1
1993	196	2004	201	2015	NO
1994	28	2005	188	2016	NO
1995	23	2006	212	2017	NO
1996	134	2007	209	2018	NO
1997	73	2008	211	2019	NO
1998	146	2009	193	2020	NO
1999	148	2010	165		
2000	188	2011	140		

Emission factors

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

Table 129 Emission factors for source category 1B2c Venting and flaring

Pollutant	Value	Unit	References
NOx	100	g/GJ refinery feed	IIR 2010 Table 72 page 74
NMVOC	5	g/GJ refinery feed	IIR 2010 Table 72 page 74
SOx	15	g/GJ refinery feed	IIR 2010 Table 72 page 74
CO	24	g/GJ refinery feed	IIR 2010 Table 72 page 74

4.8.4.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 20%; the emission factor uncertainty for NMVOC was estimated to be 20% (rating A. cf. chapter 1.7) and 40% for NOx (rating B).

4.8.4.3. 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.

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

No recalculations were performed in this category.

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

No planned improvements in this category.

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

Emissions for NH_3, Hg and As were calculated for the period 1998-2020, where data on geothermal energy consumption were available.

Methodological issues

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

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

This equation is applied at the national level, using annual national statistics on the extraction of geothermal energy from the earth.

The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all different sub-processes within the geothermal energy extraction process.

Activity data

The activity data for this source category for the period 1998-2016 expressed in m^3 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 130 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	2001	269 512	2012	122 982
1991	NE	2002	151 114	2013	98 741
1992	NE	2003	153 373	2014	84 884
1993	NE	2004	136 983	2015	78 217
1994	NE	2005	115 561	2016	75 999
1995	NE	2006	116 846	2017	71 177
1996	NE	2007	124 244	2018	69 589
1997	NE	2008	115 379	2019	64 362
1998	217 375	2009	141 326	2020	64 985
1999	178 608	2010	141 326		
2000	181 751	2011	142 551		

Emission factors

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

Table 131 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 2019Table 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

4.8.5.1. Source-specific uncertainties and time-series consistency

No specific uncertainties were calculated for this category.

4.8.5.2. Source-specific QA/QC and verification

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

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

No recalculations were done in this sector. Only corrections for notation keys were included according to Stage 3 review recommendations given for this sector.

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

No planned improvements in this category.

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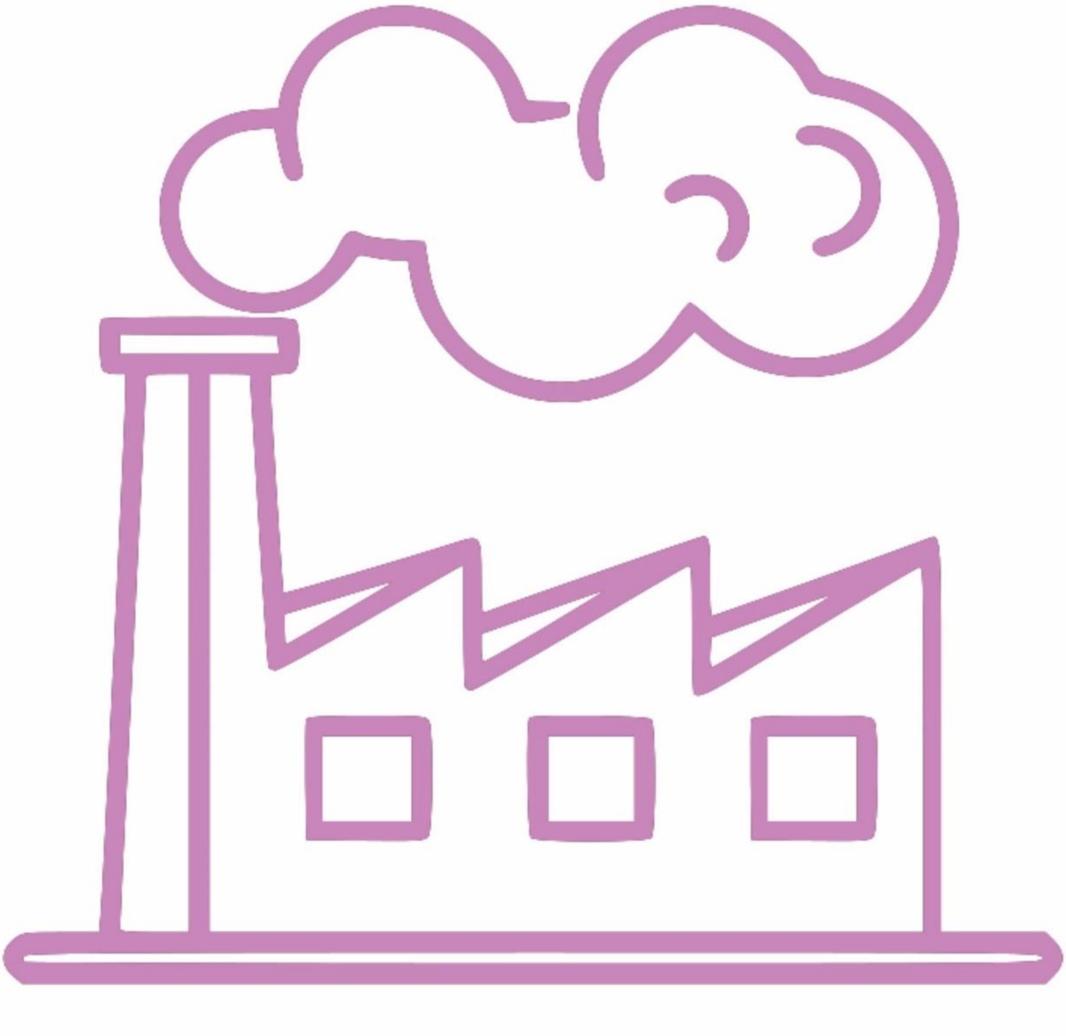


5. INDUSTRIAL PROCESSES AND PRODUCT USE (NFR SECTOR 2)

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 2016/2019) for the period from 1990-2020.

This category comprises emissions from the following subcategories: Mineral Products, Chemical Industry, Metal Production and Other products and solvents used.

Only process related emissions are considered in this Sector. Emissions due to fuel combustion in manufacturing industries are allocated in NFR Category 1.A.2 Fuel Combustion – Manufacturing Industries and Construction.

Some categories in this sector like those categorized as chemical production are not occurring (NO) in North Macedonia, as there is no such production. For some categories notation keys like not estimated (NE) or included elsewhere (IE) have been used.

5.2. General description

Completeness

Table 132 NFR categories covered in Industrial processes sector for 2020

NFR sector	Completeness
2.A.1 Cement production	√
2.A.2 Lime production	NO
2.A.3 Glass production	√
2.A.5.a Quarrying and mining of minerals other than coal	√
2.A.5.b Construction and demolition	√
2.A.5.c Storage. handling and transport of mineral products	√
2.B.1 Ammonia production	NO
2.B.2 Nitric acid production	NO
2.B.3 Adipic acid production	NO
2.B.4 Carbide production	NO
2.B.10.a Chemical industry: Other	√
2. B.10.b Storage. handling and transport of chemical products	IE
2.B.7 Soda ash production and use	NE
2.C.1 Iron and steel production	√
2.C.2 Ferroalloys production	√
2.C.3 Aluminum production	NE
2.C.4 Magnesium production	NO
2.C.5 Lead production	√
2.C.6 Zinc production	NO

NFR sector	Completeness
2.C.7.a Copper production	NE
2.C.7.b Nickel production	NO
2.C.7.c Other metal production	√
2.C.7.d Storage. handling and transport of metal products	IE
2.D.3.a Domestic solvent use including fungicides	√
2.D.3.b Road paving with asphalt	√
2.D.3.c Asphalt roofing	√
2.D.3.d Coating applications	√
2.D.3.e Degreasing	√
2.D.3.f Dry cleaning	√
2.D.3.g Chemical products	√
2.D.3.h Printing	√
2.G Other product use and 2.D.3.i Other solvent use	√
2.H.1 Pulp and paper industry	NO
2.H.2 Food and beverage production industry	√
2.H.2 Other industrial processes	NE
2.I Wood processing	√
2.J Production of POPs	NO
2.K Consumption of POPs and HM	√
2.L Other production, consumption, storage, transportation or handling of bulk products	NE

Methodology

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

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

where:

$E_{pollutant}$ = the emission of certain pollutant

$AR_{production}$ = the activity rate (data) for the production

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

5.3. Mineral products – NFR 2.A

5.3.1. Cement production – 2.A.1

In the Republic of North Macedonia there is only one installation (factory) for cement production "Cementarnica USJE AD Skopje". In this installation there are 2 (two) rotary kilns (furnace 3 and 4) where abatement (fabric filters) is used since 2001 (for furnace 3) and since 2003 (for furnace 4). For these reasons for the period 2004-2015 we have made recalculation of the of PM2.5 emissions, PM10, TSP and BC, described below.

5.3.1.1. Methodological issues

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

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

where:

$E_{pollutant}$ = the emission of a pollutant (kg),

$AR_{production}$ = the annual production of clinker (in Mg),

$EF_{pollutant}$ = 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 133 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	**2001**	716 960	**2012**	645 480
1991	465 380	**2002**	739 490	**2013**	577 850
1992	396 500	**2003**	602 570	**2014**	518 200
1993	413 440	**2004**	643 260	**2015**	553 232
1994	375 910	**2005**	694 920	**2016**	739 810
1995	365 120	**2006**	801 300	**2017**	735 625
1996	396 020	**2007**	882 830	**2018**	748 287
1997	475 250	**2008**	843 770	**2019**	737 700
1998	346 870	**2009**	478 400	**2020**	770 599
1999	427 080	**2010**	588 980		
2000	614 160	**2011**	687 990		

During the stage 3 Review, the ERT notes a jump in the clinker produced in 2000 for 44% and a dip in 2009 for 43%. And the reason behind is that the Cement Factory has been working since 2000 with a new owner who had previously made several modernizations in the production. In 2009, the decline in production was due to the economic crisis and data from then on are gradually increasing.

Emission factors

For calculation (estimation) of emissions for PM2.5, PM10, TSP and BC for the period 1990-2003 emission factors were taken from GB 2019.

These emission factors are given in the table below:

Table 134 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 2007-2020 the total emission TSP (measured with continuous monitoring) is taken into account: the emission factors from GB 2019 have been used (Tier 1, Table 134 above) as well as Tier 2, Table 135 (GB 2019) 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 PM2.5, PM10 and TSP emissions are done by considering the mass of clinker produced and the abatement efficiency, approximately 92% for TSP, 75 % for PM10 and 68,5 % for PM2.5.

For this calculation, the following equation was used:

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

Table 135 Abatement efficiencies ($\eta_{abatement}$) 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 2019 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12
	10 µm > particle > 2.5 µm	80%	GB 2019 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12
	2.5 µm > particle	73%	GB 2019 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12

5.3.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 2%; the emission factor uncertainty was estimated to be 200% (rating D, cf. chapter 2.7), based on expert judgment.

There has been one cement plant operating over the whole time series. Emissions follow the changes production.

5.3.1.3. Source-specific QA/QC and verification

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

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

The changes in the abatement technology have also been considered. No recalculations were carried out in this category.

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

No recalculations are planned in future.

5.3.2. Lime production – NFR 2.A.2

5.3.2.1. Methodological issues

For estimation of emission from lime production Tier 1 method is used, where lime produced was taken as activity data.

Activity Data

The activity data for the period 1990–1999, originates from the Statistical Yearbook - Chapter industry, while activity data for the period 2000-2013, was taken from the International Mineral yearbook [30]. No data was available for 2008 and 2014. According to the MS expert comments, data on hydraulic lime can be considered. Therefore, available data for the period 2014-2020 from the Statistical publication for Industry in the Republic of North Macedonia [29] was used as activity data. For 2020 there is no lime production because the installation for this type of production has gone bankrupt.

Table 136 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	**2001**	500	**2012**	2 700
1991	29 194	**2002**	500	**2013**	2 700
1992	33 872	**2003**	500	**2014**	10 836
1993	24 904	**2004**	500	**2015**	8 003
1994	14 097	**2005**	15 009	**2016**	8 684
1995	12 538	**2006**	12 704	**2017**	1 399
1996	9 707	**2007**	7 517	**2018**	6 834
1997	4 344	**2008**	NE	**2019**	29 236
1998	964	**2009**	2 713	**2020**	NO
1999	4 264	**2010**	2 700		
2000	1 000	**2011**	2 700		

Emission factors

For the calculation (estimation) of emissions for PM2.5, PM10 and TSP for the period 1990-2020 emission factors were taken from GB 2019.

These emission factors are given in Table 137 below.

Table 137 Emission factors for source category 2.A.2 - Lime production

Pollutant	Value	Unit	References
PM10	3500	g/Mg lime	GB 2019 2.A.2 Lime production, Table 3-1, pg. 8
PM2.5	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 PM2.5	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 judgment.

5.3.2.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e., activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Activity data was checked also in the MAKSTAT database [29].

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

No recalculations were carried out in this category.

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

No planned improvements in this category.

5.3.3. Glass production – NFR 2.A.3

The glass production in North Macedonia was ongoing in the installation "Staklara" during the nineties. Currently, there are small installations in which glass is only processed, but not produced.

5.3.3.1. Methodological issues

Tier 2 method, has been implemented for estimation of emissions coming from this source category bearing in mind data that were available for flat glass and glass wool produced.

$$E_{pollutants} = \sum_{tehnologies} AR_{production,tehnology} \times EF_{production,tehnology}$$

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 138 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	**2001**	NO	**2012**	NO
1991	32	**2002**	NO	**2013**	NO
1992	179	**2003**	NO	**2014**	NO
1993	NO	**2004**	NO	**2015**	NO
1994	NO	**2005**	NO	**2016**	NO
1995	NO	**2006**	NO	**2017**	NO
1996	NO	**2007**	NO	**2018**	NO
1997	NO	**2008**	NO	**2019**	NO
1998	NO	**2009**	NO	**2020**	NO
1999	NO	**2010**	NO		
2000	NO	**2011**	NO		

Emission factors

For the estimation of emission parameters from 1990-1992, the used emission factors were taken from GB 2019. These emission factors are given in Table 159 below.

Table 139 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
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 140 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	2001	NO	**2012**	NO
1991	1 176	2002	NO	**2013**	NO
1992	1828	2003	NO	**2014**	NO
1993	444	2004	NO	**2015**	NO
1994	1332	2005	NO	**2016**	NO
1995	3043	2006	NO	**2017**	NO
1996	1454	2007	NO	**2018**	NO
1997	961	2008	NO	**2019**	NO
1998	960	2009	NO	**2020**	NO
1999	NO	**2010**	NO		
2000	NO	**2011**	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 141 below.

Table 141 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

Pollutant	Value	Unit	References
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
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 NH_3 and 200% for PM2.5, based on expert judgment.

This time series ends in 1998, as the production of flat glass and glass wool ceased by that time.

5.3.3.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

No improvements are planned in this category.

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

This subchapter elaborates quarrying and mining of minerals other than coal and it does not include emissions from the combustion of fuels in the plant or transport machinery.

5.3.4.1. Methodological issues

Tier 1 method is used for calculation of emissions in this sector. The quantities of different minerals (like marble, talk, silica, gypsum, etc.) were summarized for calculation of activity data per reporting year.

Activity Data

The activity data for mineral produced were taken from the Statistical yearbook for the period 1990-2005[22], while activity data for the period 2005-2006 [28] were taken from the statistical publication for industry. Data for period 2007-2020 are taken from MAKSTAT database [29].

Table 142 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	**2001**	3 488 792	**2012**	7 039 649
1991	5 730 999	**2002**	2 855 005	**2013**	7 779 824
1992	5 299 552	**2003**	739 786	**2014**	7 218 423
1993	5 246 466	**2004**	347 795	**2015**	7 577 701
1994	4 817 372	**2005**	2 827 908	**2016**	8 311 381

Year	Mineral produced [t]	Year	Mineral produced [t)]	Year	Mineral produced [t)]
1995	5 215 134	**2006**	4 605 478	**2017**	7 837 715
1996	5 233 110	**2007**	6 955 426	**2018**	7 867 030
1997	5 528 418	**2008**	7 095 376	**2019**	8 385 648
1998	5 158 798	**2009**	5 783 348	**2020**	7 783 002
1999	4 658 946	**2010**	6 845 344		
2000	4 917 560	**2011**	7 106 322		

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 143 below.

Table 143 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

No recalculations were done in this category.

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

According to the recommendation given during the stage 3 revisions, the reason behind the deep in the quarrying and mining of minerals other than coal in 2003 for 74% and a jump in 2005 by 8 times (713%) is due to no mining activities in 2004. Furthermore, possibilities to use Tier 2 methodology in this category were investigated; however there are no detail activity data like Average area of the hole/blast (m^2) Average height of the hole/blast (m), Material density, Volume of production (m^3) to be able to proceed with Tier 2 in this category. These types of required data will be included in the database that is under preparation for gathering emission data. After these data are gathered it will be possible to change the methodology of calculation.

5.3.5. Construction and demolition – NFR 2.A.5.b

This subchapter elaborates emissions from construction and demolition works. This activity mainly results in emissions of particulates, but other pollutants may also be emitted, depending on the materials used in the work. At construction sites, construction materials are used to construct items including buildings and infrastructure. At demolition sites, a building, infrastructure, or other constructions are torn down, resulting in a lot of rubbish.

5.3.5.1. Methodological issues

Tier 1 method has been applied for estimation of emissions coming from this source category where the activity data refer to floor area in m^2 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 m^2. Summarized data are presented in the following table.

Table 144 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	**2001**	957 742	**2012**	934 773
1991	1 532 878	**2002**	871 894	**2013**	887 697
1992	1 375 918	**2003**	842 519	**2014**	798 891
1993	1 203 495	**2004**	962 874	**2015**	752 207
1994	1 017 799	**2005**	899 876	**2016**	943 400
1995	949 006	**2006**	958 738	**2017**	1 130 833
1996	927 963	**2007**	852 971	**2018**	1 109 077
1997	843 602	**2008**	809 606	**2019**	1 028 448
1998	793 938	**2009**	824 945	**2020**	1 027 683
1999	940 300	**2010**	902 234		
2000	897 868	**2011**	944 630		

Emission factors

Emission factors for the particulates PM2.5, PM10 and TSP are taken from GB 2019. These emission factors are given in Table 145 below.

Table 145 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
PM10	0.086	kg/m^2/year	GB 2019 2.A.5.b Construction and demolition. Table 3-1. pg. 6
PM2.5	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

No recalculations were done in this category.

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

Currently the emissions from the source category construction and demolition refer only to the area of constructed and demolished dwellings and are underestimated. It is planned for the reporting in future to gather activity data for other types of constructed and demolished buildings. This issue will be further discussed with SSO.

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

The source category refers to emissions from storage, handling and transport of mineral products

5.3.6.1. Methodological issue

In a Tier 2 approach, the emissions from storage, handling and transport of mineral products needs to be estimated separately. For this activity, only one 'technology' (the 'Tier 2 default') is available. Therefore, the equation describing the approach is the same as for Tier 1, where the activity data refer to the activity rate for the storage and handling of mineral products.

Activity data

Data on transported mineral by road and railway transport were taken from the statistical publication Transport and communications for the period 2009-2015 and MAKSTAT database for period 2016-2020 [27]. The historical data for the quantity of transported minerals in road transport were taken from the Statistical yearbook – chapter Transport for the period 1990-2008 [22], while regarding the railway transport the content of transported minerals in the transported goods in railway transport were estimated.

Table 146 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	**2001**	575 864	**2012**	3 499 387
1991	143 309	**2002**	685 869	**2013**	3 407 267
1992	96 043	**2003**	8 006 331	**2014**	5 564 332
1993	152 750	**2004**	10 497 726	**2015**	4 142 405
1994	49 973	**2005**	8 475 328	**2016**	5 034 346
1995	57 838	**2006**	16 441 405	**2017**	4 717 295
1996	34 404	**2007**	4 813 390	**2018**	8 410 139
1997	106 462	**2008**	1 965 897	**2019**	6 405 305
1998	189 443	**2009**	7 058 289	**2020**	5 498 961
1999	152 301	**2010**	2 820 746		
2000	48 708	**2011**	3 330 100		

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 147 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 since in North Macedonia this kind of production does not exist. Regarding Soda ash production this category is defined as NE since the process should be checked

5.4.1. Other chemical industry – NFR 2.B.10.a

This source category is important for several pollutants. It is introduced for the first time due to recommendation given by the ERT.

5.4.1.1. Methodological issues

The Tier 2 methodology for emission calculation has been used. Namely, the quantity of activity data is multiplied with the appropriate emission factor.

Activity data

The input data for this source category is the quantity of different type of final products. These data have been taken from the Statistical Yearbooks of the Republic of North Macedonia for the period 1990-2004 [22], and data form MAKSTAT database for period 2005-2020 [29]. As it can be seen from the table below the production of different product was unstable as it is usual in the countries in transition where factories were closed and change of ownership is frequent and, in those years, when production was stopped the notation key NO has been used.

Table 148 Activity data for source category 2.B.10 – Other chemical industry

Year	Chlorine production [Mg]	Phosphate Fertilizers [Mg]	Polyethylene High density [Mg]	Polyvinylchloride [Mg]	Sulfuric acid [Mg]	polyurethane [Mg]
1990	3167	2859	NO	44086	97 101	NO
1991	2439	2359	NO	24495	102 243	NO
1992	2325	1023	NO	9190	95 077	NO
1993	2358	498	NO	2120	88 814	NO
1994	2394	259	NO	NO	72 106	NO
1995	2368	NO	NO	NO	82 619	NO
1996	2562	NO	NO	3995	99 545	NO
1997	349	NO	NO	10344	105 034	NO
1998	772	NO	NO	15658	100 834	NO
1999	61	NO	NO	5134	87 770	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	NO	NO	812	1006	NO	1095
2006	NO	NO	614	NO	NO	1405
2007	NO	NO	360	645	NO	1129
2008	NO	NO	331	1975	NO	1239
2009	NO	NO	181	1731	NO	1132
2010	NO	NO	188	894	NO	1033
2011	NO	NO	319	1978	NO	1059
2012	NO	NO	89	1828	NO	1221
2013	NO	NO	NO	916	NO	1166
2014	NO	NO	NO	5531	NO	697
2015	NO	NO	NO	6662	NO	NO
2016	NO	NO	NO	7198	NO	896
2017	NO	NO	NO	7777	NO	1633
2018	NO	NO	NO	7970	NO	2429
2019	NO	NO	NO	9318	NO	2670

Year	Chlorine production [Mg]	Phosphate Fertilizers [Mg]	Polyethylene High density [Mg]	Polyvinylchloride [Mg]	Sulfuric acid [Mg]	polyurethane [Mg]
2020	NO	NO	NO	8178	NO	2815

Emission factors

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

Table 149 Emission factors for source category 2.B.10.a Other chemical industry

Pollutant	Value	Unit	References
Sox	17 000	g/Mg (100% H_2SO_4)	GB 2019 Table 3.24 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, sulphuric acid production, wet contact process (98% and 78% sulphuric acid)
Hg	4.8	g/Mg	GB 2019 Table 3.32 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, chlorine production
TSP	0.3	kg/ton produced	GB 2019 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers
PM 10	0.24	kg/ton produced	GB 2019 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers
PM 2.5	0.18	kg/ton produced	GB 2019 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers
NMVOC	2.3	kg/ton produced	GB 2019 Table 3.40 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyethylene high density
TSP	97	kg/ton produced	GB 2019 Table 3.40 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyethylene high density
NMVOC	96	g/ton produced	GB 2019 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)
TSP	263	g/ton produced	GB 2019 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)
PM 10	100	g/ton produced	GB 2019 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)
PM 2.5	5	g/ton produced	GB 2019 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC)

5.4.1.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.4.1.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

Deeper analysis of activity data will be conducted for the following submissions.

5.5. Metal Production – NFR 2.C

In this source category activity data, emission factors and implemented methodology is presented for the following NFR source categories: 2.C.1, 2.C.2, 2.C.3, 2.C.5, 2.C.6 and 2.C.7.c. According to Stage 3 review recommendation the NFR category 2C7d Storage, handling, and transport of metal products on p. 4, in the Tier 1 default approach, the dust emissions from storage, handling and transport of metal products are covered by the respective technical chapters. Consequently, the default emission factors are 'included elsewhere' (IE). The Notation key has been changed in accordance with the recommendation given.

5.5.1. Iron and steel production – NFR 2.C.1

In the nineties in Republic of North Macedonia there was one integrated steel plant for iron and steel where primary iron and steel was produced, as well as ingots using hot and cold rolling mills.

Due to the disintegration of Former Yugoslavia, and North Macedonia becoming an independent country, this factory has disintegrated over the years to several smaller installations with different ownership. Currently in Republic of North Macedonia, three installations have this type of production. The first one, Makstil AD Skopje, which has two units, first for steel production uses an electric arc furnace (EAF) with installed BAT (Best Available Techniques), namely fabric filter unit, since 2016, and second for producing ingots using hot rolling mills also with installed BAT and use of natural gas as a fuel. The second installation, ArcelorMittal – renamed Liberty from 2018 due to new ownership produces only ingots using cold rolling mill with BAT as well and uses natural gas as a fuel. The calculation for the period 1990-2015 is made using Tier 1, and for the period 2016-2020 using Tier 2 because since 2016 all units (electric arc furnace, hot rolling mills and cold rolling mills) in the installations are using BAT. The third one is Dojran Stil which have hot rolling mill with BAT in the period of 2008-2020 using Tier 2.

5.5.1.1. Methodological Issues

Activity Data

Activity data for the reporting period 1990-2004 have been taken from the statistical yearbooks chapter Industry [22], and for the period 2005-2015 from the publications Industry in the Republic of North Macedonia [28]. Activity data for the period of 2016-2020 are taken directly from the two installations mentioned above, Makstil AD Skopje and Liberty. Activity data for Dojran Stil are taken directly from the installation. The activity data have variable trend due to fluctuant as market prices as well as change of the ownerships of the companies.

Table 150 Activity data for source category 2.C.1 - Iron and steel production

Year	Products [t]	Year	Products [t]	Year	Products [t]
1990	885 015	**2001**	583 379	**2012**	623 642
1991	755 634	**2002**	960 178	**2013**	407 027
1992	548 462	**2003**	760 538	**2014**	543 608
1993	353 822	**2004**	833 328	**2015**	512 568
1994	140 045	**2005**	807 782	**2016**	670 386
1995	83 407	**2006**	905 272	**2017**	798 429
1996	128 117	**2007**	982 650	**2018**	834 408

Year	Products [t]	Year	Products [t]	Year	Products [t]
1997	230 274	**2008**	862 779	**2019**	774 692
1998	347 846	**2009**	781 053	**2020**	670 459
1999	237 409	**2010**	823 012		
2000	437 934	**2011**	927 150		

Table 151 Activity data for steel and hot and cold ingots production in the period of 2016-2020

Year	Name of Products	[t]
2016	Liquid steel	173 113
	Hot rolled sheet	274 721
	Cold rolled sheet	165 645
	Dojran Stil	56 907
2017	Liquid steel	277 599
	Hot rolled sheet	310 840
	Cold rolled sheet	154 537
	Dojran Stil	55 453
2018	Liquid steel	272 415
	Hot rolled sheet	309 504
	Cold rolled sheet	155 403
	Dojran Stil	97 086
2019	Liquid steel	247 017
	Hot rolled sheet	303 867
	Cold rolled sheet	142 714
	Dojran Stil	81 094
2020	Liquid steel	185 330
	Hot rolled sheet	271 463
	Cold rolled sheet	146 316
	Dojran Stil	67 350

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 152 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
NMVOC	46	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
SO2	60	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44

Pollutant	Value	Unit	References
TSP	30	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PM10	24	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
PM2.5	21	g/Mg steel	GB 2019 2.C.1 Iron and steel production. Table 3-19. pg. 44
BC	0.36	% of PM2.5	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 153 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 154 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 PM2.5, 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

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

No recalculations were carried out in this category.

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

ERT recommends a calculation of emissions from NFR 2.C.1 for the whole time series since 1990 by using the Guidebook Default Tier 2 methods for EAF steel production, for hot and for cold rolling. Inventory experts did not receive data for the whole time and there will be a need a of expert support for calculation of historical data, therefore this issue will be resolved during the upcoming IPA project in which one of the planned activities is improving of the air emission inventory.

5.5.2. Ferroalloy's production – NFR 2.C.2.

Ferroalloys are master alloys containing iron and one or more non-ferrous metals as alloying elements. The ferroalloys are usually classified in two groups: bulk ferroalloys and special ferroalloys. Bulk ferroalloys are used in steel production and steel, or iron foundries exclusively, while the use of special ferroalloys is far more versatile.

Depending on the raw material that is used (primary or secondary raw material), the production of ferroalloys can be carried out as a primary or secondary process.

In the Country, there are three major installations for production of ferroalloys: ferrosilicon, ferronickel and ferrosilicon manganese. The installation "Skopski Leguri" produces ferrosilicon manganese and was operational in the period 2007 – 2012. "Jugohrom ALZAR DOOEL" produces ferrosilicon and EURONIKEL (FENI) INDUSTRY produces ferronickel.

"Jugohrom ALZAR DOOEL" is one of the biggest industrial polluters in Republic of North Macedonia. The installation has an IPPC environmental permit with adjustment plan, according which the installation was supposed to install a filter facility for all electric furnaces until 01 April 2014. This deadline given by the Government of Republic of North Macedonia was postponed until October 2016. The second deadline has not been reached either, and that was the reason why the State Environmental Inspectorate closed the installation for a period of 6 months, in November 2016, with an approval of the Ministry of environment and physical planning. The installation remains closed until the requirement for installation of filter facility is not fulfilled. In the period 2017-2020, there was no ferroalloys production from this installation since the operator did not install the necessary filter.

FENI Industry is one of the biggest installations in the sector Ferroalloys Production (ferronickel production). In the period 2012-2013 this installation installed ESF (electrostatic filter) in 2 (two) biggest emission points (rotary kilns). The installation has scrubbers for reduction of emission gases from 2 electric furnaces, and thus fulfills the requirements given in the IPPC environmental permit. This installation worked with reduced capacity of around 40% compared to 2015. This installation was under bankruptcy proceedings from 2017. In 2018 this installation received a new owner changed the name in EURONICKEL Industry and started operations again during the reporting year.

This sector significantly contributed to the national total amount of emission of particulates until 2016.

5.5.2.1. Methodological issue

Emissions coming from this sector have been calculated as a sum of ferrosilicon produced, multiplied with implied emission factors, and ferronickel and ferrosilicon manganese produced, multiplied with emission factors taken from GB 2019.

Activity Data

The activity data for ferrosilicon production has been taken from the Statistical yearbooks - chapter Industry, Energy and Construction for period 1990-2004[22], and publication Industry in the Republic of Macedonia for the period 2005–2015[28]. Emission measurements for TSP were considered for the following years 2012, 2013, 2014 and 2016.

Measurement data for TSP for the period 2005-2017 was reported by the operator FENI. Activity data for the period 2018-2020 for ferroalloys production are taken directly from the installation with new ownership EURONICKEL INDUSTRY.

Table 155 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	**2001**	8 779	**2012**	146 970
1991	77 442	**2002**	15 085	**2013**	165 803
1992	107 866	**2003**	67 283	**2014**	163 489
1993	78 357	**2004**	83 160	**2015**	130 970
1994	72 134	**2005**	106 590	**2016**	69 455
1995	72 735	**2006**	108 920	**2017**	34 558
1996	92 638	**2007**	175 719	**2018**	51 831
1997	85 908	**2008**	170 252	**2019**	78 959
1998	106 661	**2009**	60 458	**2020**	82 870
1999	78 009	**2010**	133 347		
2000	58 520	**2011**	184 310		

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 156 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 157 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 176 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 177. For 2016, measurement data for TSP emissions as well as, activity data for ferrosilicon produced was made available by the operator. The emissions of PM10 and PM2.5 were calculated using the values using proportions (0.85% and 0,60% of TSP emissions factor value). The installation did not operate since 2016 therefore there no measurements since that year. For ferronickel emission discontinuous measurements (four per year) for TSP were available for the period 2005-2020. These measurements were used to calculate the yearly emissions.

5.5.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment. The inconsistency of the time-series may appear, considering that for the historical data implied emission factors was used, whereas for the period 2012-2014 measurement data was used.

5.5.2.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR. The data received in form of an excel template aligned with the national legislation are checked for consistency by MEPP. Concerning jumps, dips or lack of emission data, the operator is contacted with official letter, and asked for the reasons behind the jumps and deeps of the measured emission or lack of required data. Mainly the jumps and deeps in this category are caused by the unstable operation of these installations and frequent change of ownership.

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

No recalculations were carried out in this category.

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

No improvements are planned in this category.

5.5.3. Aluminum production – NFR 2.C.3

Primary aluminum is produced by means of electrolytic reduction of alumina. This chapter covers the complete process of primary aluminum production, from the production of alumina from bauxite to the shipment of the aluminum from the facilities. The secondary aluminum production covers the whole process, starting from the melting of scrap. In Republic of North Macedonia, there is no primary aluminum production.

5.5.3.1. Methodological Issues

Activity Data

The activity data were taken from the Statistical Yearbooks 1990-2020 and for the period 2007-2019 from the installation for secondary aluminum production named RZ Institute Skopje. For 2020 there is no activity data from RZ Institute Skopje because this installation has gone bankrupt. Type of activity data used for emission estimation is presented in the following list.

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
2007-2019	Aluminum alloys, in ingots, SSO
	RZ Institute secondary aluminum production
2020	Aluminum alloys, in ingots, SSO

Table 158 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	**2001**	6 809	**2012**	1 870
1991	7 829	**2002**	10 516	**2013**	1 245
1992	5 150	**2003**	8 573	**2014**	812
1993	4 819	**2004**	1 679	**2015**	161
1994	4 991	**2005**	1 489	**2016**	122
1995	3 709	**2006**	2 316	**2017**	382
1996	3 924	**2007**	1 757	**2018**	278
1997	5 561	**2008**	1 531	**2019**	857
1998	5 850	**2009**	1 637	**2020**	NE
1999	10 777	**2010**	1 897		
2000	7 641	**2011**	2 079		

The dip from 2002 to 2003 is due the fact that the major company for aluminum production has been closed in March 2004.

Emission factors

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

Table 159 Emission factors for source category 2.C.3 - Secondary Aluminum production

Pollutant	Value	Unit	References

Pollutant	Value	Unit	References
TSP	2	kg/Mg aluminum	GB 2019 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PM10	1.4	kg/Mg aluminum	GB 2019 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PM2.5	0.55	kg/Mg aluminum	GB 2019 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
BC	2.3	% of PM2.5	GB 2019 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
PCDD/F	35	μgI-TEQ/Mg aluminum	GB 2019 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15
HCB	5	g/Mg aluminum	GB 2019 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15

5.5.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 2%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

5.5.3.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this sector.

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

No planned improvements in this category.

5.5.4. Lead production – NFR 2.C.5

This subchapter presents information on atmospheric emissions during primary and secondary lead production. The primary lead production in the country was conducted in the smelter company in the town of Veles, which ceased operations in 2003.

5.5.4.1. Methodological issues

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

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

where:

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

$AR_{production}$ = the annual lead production

$EF_{pollutant}$ = 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 160 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*	**2006**	NO	46*****
1991	33 938*	19 265*	**2007**	NO	18*****
1992	27 860*	23 341*	**2008**	NO	21*****
1993	23 575*	21 881*	**2009**	NO	39*****
1994	20 569*	20 965*	**2010**	NO	NE
1995	24 007*	22 490*	**2011**	NO	NE
1996	29 259*	23 584*	**2012**	NO	NE
1997	30 508*	26 046*	**2013**	NO	NE
1998	29 242*	28 415*	**2014**	NO	NE
1999	27 086*	19 738*	**2015**	NO	2 648
2000	19 000**	17 137***	**2016**	NO	4 472
2001	19 000**	13 543***	**2017**	NO	7 486
2002	19 000**	11 934****	**2018**	NO	10 576
2003	19 000**	6 357****	**2019**	NO	10 962
2004	NO	3 591****	**2020**	NO	10 339
2005	NO	34*****			

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 161 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

Pollutant	Value	Unit	References
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
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 162 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 163 Emission factors for source category 2.C.5 - Secondary Lead production for 2010-2020

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
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

5.5.4.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

5.5.4.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

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).

5.5.5. Zinc production–NFR 2.C.6

Zinc is produced from various primary and secondary raw materials. Primary zinc is produced from ores, which contain 85% zinc sulfide (by weight) and 8–10% iron sulfide, with the total zinc concentration about 50%. A secondary zinc smelter is defined as: any plant or factory in which zinc-bearing scrap or zinc-bearing materials, other than zinc-bearing concentrates (ores) derived from a mining operation, are processed. In practice, primary smelters often also use zinc scrap or recycled dust as input material. The primary zinc production in the country was conducted in the smelter company in town of Veles, which ceased operation in 2003.

5.5.5.1. Methodological Issues

Activity Data

The activity data has been taken from the Statistical yearbook – chapter Industry, energy and construction for the period 1990-2018*, as well as from the following website http://minerals.usgs.gov/minerals/pubs/commodity/zinc/zinc_myb05.pdf**[30]. In the statistical publications, the activity data for the Primary Zinc production were defined as Crude Zinc and for Secondary Zinc production as Refined Zinc.

Table 164 Activity data for source category 2.C.6 - Zinc production

Year	Primary Zinc (t)	Secondary zinc (t)
1990	56 734*	17 383*
1991	56 081*	17 244*
1992	52 728*	14 526*
1993	51 931*	3 315*
1994	41 984*	4 532*
1995	44 081*	34 526*
1996	59 416*	37 853*
1997	59 693*	3 116*
1998	58 865*	8 594*
1999	53 304*	4 017*
2000	52000**	NO
2001	52 000**	NO
2002	56 000**	NO

Year	Primary Zinc (t)	Secondary zinc (t)
2003	28 000**	NO
2004	25 000**	NO
2005	NO	NO
2006	NO	NO
2007	NO	NO
2008	NO	NO
2009	NO	NO
2010	NO	NO
2011	NO	NO
2012	NO	NO
2013	NO	NO
2014	NO	NO
2015	NO	NO
2016	NO	NO
2017	NO	NO
2018	NO	NO
2019	NO	NO
2020	NO	NO

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 165 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 166 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

Pollutant	Value	Unit	References
			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

5.5.5.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

5.5.5.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

No improvements are planned in this category.

5.5.6. Copper production –NFR 2.C.7 a

Copper is produced from primary and secondary raw materials.

Primary cooper is produced from concentrates produced from copper ores. The pyro-metallurgical copper production route entails a number of steps, depending on the concentrate used. The majority of concentrates are sulfides and the stages involved are roasting, smelting, converting, refining and electro-refining. Concentrates usually contain 20–30% Cu. In roasting, charge material of copper mixed with a siliceous flux is heated in air to about 650 °C, eliminating 20–50% of Sulfur and portions of volatile trace elements. The roasted product, calcine, serves as a dried and heated charge for the smelting furnace.

In Republic of North Macedonia there is a primary production of copper with pampering of copper ores for obtaining cathode copper.

A secondary copper smelter is defined as any plant or factory in which copper-bearing scrap or copper-bearing materials, other than copper-bearing concentrates (ores) derived from a mining operation, is processed by metallurgical or chemical process into refined copper and copper powder (a premium product).

In Republic of North Macedonia it was a secondary production of copper in the factory RZ Institut Skopje in the period 2007-2019. In 2020 there is no activity data from this installatrion because it has gone bankrupt. The emission are presented as NE because that company was working during 2020, however we could not gather the needed information due to their bankruptcy and lost of contact with the installation reperesentatives.

5.5.6.1. Methodological Issues

Activity Data

Activity data is available for secondary copper production (from the installation that has that production), for the period 2007-2019. No activity data were avalible for 2020.

Table 167 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
2019	NO	13
2020	NO	NE

Emission factors

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

Table 168 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

Pollutant	Value	Unit	References
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

5.5.6.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 40% (rating B), based on expert judgment.

5.5.6.3. Source-specific QA/QC and verification

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

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

No recalculations were done for this NFR category.

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

It is planned in this category to make control on the activity data from copper production in Republic of North Macedonia that is covered with primary or secondary copper production given in EMEP/EEA air pollutant emission inventory guidebook 2019, 2.C.7.a Copper production. This is planned to be carried out within the forthcoming technical project in the frame of activities which refer to improving of emission inventory.

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

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

5.5.7.1. Methodological issues

Tier 1 method was used for calculation of emissions in this source category. This activity does not occur after the year 1998.

Activity Data

Activity data for this source category are taken from the Statistical yearbooks for the period 1990-1998.

Table 169 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 170 Emission factors for 2.C.7.c - Other Metals production

Pollutant	Value	Unit	References
TSP	0.8	g/Mg metal produced	GB 2013 2.C.7.c Other metal production, Table 3.1, pg. 5

5.5.7.2. Source-specific uncertainties and time-series consistency

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

5.5.7.3. Source-specific QA/QC and verification

No QA/QC procedures were carried out for this source category, since it is no longer occurring in the Republic of North Macedonia.

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

No recalculations were done in this category.

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

No planned improvments in this category.

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 2020 was 11%.

5.6.1.1. Methodological issues

The Tier 1 method has been applied for period 1990-2004. This method assumes an averaged or typical technology and abatement implementation in the country and includes an integrated emission factor and emission factors for sub-processes within the source category. It is applied at a national level, using the population data. Tier 2 method was applied for the period 2005-2020 due to avalible activity data in the SSO publications. During the stage 3 review the ERT recommended the Party to move to the Tier 2 method for the next submission or as soon as possible or meanwhile to include this improvement into the improvement plan with clear steps and schedule and to report on progress of the work in the next submissions. Therefore in this category according to the recommendation avalible data from procution and import – export were gathered. Calculated activity data (production+import)-export were used for calculation of emissions coming from Cosmetics and toiletries (Perfume or room deodorizers, Toalet waters, Hair sprays) Shaving lotions, before shaving and after shaving, Other body care cosmetics - lotions, creams, including baby care products Soaps and other body cosmetics;) Car care products (antifriz); Households products (Washing and cleaning products for mashine for hands wash, Pastes, powders and other cleaning preparations and Policies, creams and similar preparations for the maintenance of woodwor) and pesticides (Insecticides, rodenticides, fungicides, herbicides). In case of pharmaceutical product the population was used as activity data.

Activity Data

Table 171 Activity data for source category 2.D.3.a - Domestic solvent use including fungicides for different products and product types for period 1990-2004 using Tier 1 methodology

Year	Population number
1990	2 028 000
1991	2 033 964
1992	2 056 000
1993	2 066 000
1994	1 957 265
1995	1 974 800
1996	1 991 398
1997	2 002 340
1998	2 012 705
1999	2 021 578
2000	2 038 651
2001	2 023 654
2002	2 029 892
2003	2 035 196
2004	2 038 514

Table 172 Activity data for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types for period 2005-2020 using Tier 2 methodology

Year	Cosmetics and toiletries (all)[kg]	Car care products (all) [kg]	Households products (all) [kg]	Pesticides [kg]	Population
2005	2976576	33000	17540231	2285000	2038514
2006	7130576	7000	12664627	2285000	2041941
2007	8787562	34000	19415000	2318000	2045177
2008	7357406	204000	24636000	2768000	2048619
2009	6069440	18000	22674000	1522000	2052722
2010	11875502	18000	26796000	1648000	2057284
2011	10143673	17030	26796000	2378000	2059794
2012	7860433	7000	31701757	1841549	2062294
2013	8016920	12000	31357189	1867702	2065769
2014	8748658	6988	32139836	1991441	2069172
2015	9294805	12995	34439775	2053650	2071278
2016	9204934	10857	35923836	1991441	2073702
2017	4216648	9920	36668778	2146356	2075301
2018	4589282	5893	39191712	1862376	2077132
2019	4412393	33000	38717511	1969119	2076255
2020	4093706	7000	40304000	2394361	2068808

Emission factors

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

Table 173 Emission factors for the source category 2.D.3.a - Domestic solvents use including fungicides

Pollutant	Methodology	Value	Unit		References
NMVOC	Tier 2	127	g/kg product	Cosmetics and toiletries (all)	GB 2019 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types p.16
NMVOC	Tier 2	180	g/kg product	Car care products (all)	GB 2019 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16
NMVOC	Tier 2	48	g/person	Pharmaceutical	GB 2019 Table 3.5 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.17
NMVOC	Tier 2	16	g/kg product	Households products (all)	GB 2019 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16
NMVOC	Tier 2	150	g/kg product	Pesticides	GB 2019 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16
NMVOC	Tier 1	1.2	kg/person/year	Persons	GB 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 judgment; the emission factor uncertainty was estimated to be 125% (rating C) for NMVOC and 40% (rating B) for PM2.5 based on EMEP Guidebook.

Population number is taken from statistical publications and MAKSTAT database, but there is uncertainty of these activity considering that the population census has been carried out only three times in 1991, 1994 and 2002, while for the other years estimated numbers were used.

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

The Tier 2 methodology was introduced for the period 2005-2020, therefore recalualtions were done for the period 2005-2019.

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

It is planned to replace Tier 1 with Tier 2 methodology also for historical emissions however due to limitation of data this activity will be planned in the forthcoming IPA II technical project.

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 2020 is 0.04% and in TSP is 0.48%. 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:

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

where:

$E_{\text{pollutant}}$ = the emission of the specified pollutant,

$AR_{\text{prodution}}$ = the activity rate (data) for the road paving with asphalt,

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

Activity data

The operators themselves have gathered activity data. Data from several asphalt production companies in 2016 delivered data on produced asphalt. For the period 2017-2020, activity data are taken from Statistical yearbook – Chapter Construction [22]. 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 174 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	**2001**	137 305	**2012**	336 725
1991	74 296	**2002**	119 651	**2013**	389 163
1992	44 067	**2003**	124 492	**2014**	336 545

Year	Asphalt produced (t)	Year	Asphalt produced (t)	Year	Asphalt produced (t)
1993	65 194	**2004**	149 323	**2015**	500 943
1994	84 729	**2005**	180 559	**2016**	366 536
1995	87 814	**2006**	130 847	**2017**	461 664
1996	98 545	**2007**	101 508	**2018**	527 798
1997	53 600	**2008**	170 049	**2019**	522 926
1998	101 563	**2009**	232 001	**2020**	565 780
1999	136 540	**2010**	274 654		
2000	327 937	**2011**	356 596		

Emission factors

Emission factors for estimation of emissions in this source category are presented in the following table. Until 2015 the installations for asphalt production had A-permit with adjustment plan and from that year they build fabric filters with abatement efficiency of 99 %. Due to fact that these type of installations have installed abatement technology started from 2015, a new methodology for calculation of TSP, PM10 and PM2.5 emissions was used.

Table 175 Emission factors for source category 2.D.3.b - Road paving with asphalt

Pollutant	Value	Unit	References
NMVOC	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

No recalculations were carried out in this category.

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 0.009% in 2020.

5.6.3.1. Methodological issues

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

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

where:

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

$AR_{prodution}$ = the activity rate (data) for the asphalt roofing,

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

Activity Data

For the period 1990-1999 activity data have been taken from the Statistical Yearbooks – chapter Industry, Energy and Construction [22]. For the period 2005-2020, revised activity data for period 2007-2014, were taken from MAKSTAT database [29], while due to the lack of data for the period 2002-2004 the gap filling interpolation method has been used.

The activity data for this source category is presented in the following table.

Table 176 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	**2001***	12 525	**2012**	17 727
1991	12 593	**2002***	12 104	**2013**	13 676
1992	5 325	**2003***	11 668	**2014**	6 814
1993	4 067	**2004***	12 458	**2015**	10 146
1994	5 901	**2005**	11 305	**2016**	14 402
1995	8 873	**2006**	9 773	**2017**	15 183
1996	5 992	**2007**	12 164	**2018**	17 114
1997	6 442	**2008**	14 401	**2019**	15 699
1998	5 489	**2009**	18.783	**2020**	15 175
1999	13 429	**2010**	14 908		
2000*	13 075	**2011**	25 145		

*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 2005-2020 are presented below. Data for the years 2000-2005 are not covered by the statistics but are calculated by use of interpolation.

Type of data available in the national statistics for 1990-1999 and 2005-2020 in tons

1990 – 1999 Roof patch, Bitumen paper and jute;

	Bituminous products for building;
2005 – 2020	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 177 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

No recalculations were done in this category.

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

Notation key for HCB was changed to NE as it was recommended by the ERT.

5.6.4. Coating application – NFR 2.D.3.d

Coating applications in North Macedonia include emissions from quantity of paint applied in the industrial applications, other industrial applications and domestic application and this category is source of NMVOC emissions.

Methodological Issues

The methodology of the estimation of emissions in this sector was done using Croatian methodology represented in The Republic of Croatia Informative Inventory Report, 2012 [42]. Namely, according to this methodology sectors Industrial application and Decorative application contribute in paints consumption with equal weighting as sector-Other industrial application. 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 – 2019.

Activity data

The quantity of paint produced in the period 2005-2015 is taken from the publications Industry in the Republic of North Macedonia [28], for the period 2016-2020 data were taken from the MAKSTAT database [29], and the data for the imported-exported paints are taken from the publication External trade in the Republic of North Macedonia for the period 2006-2015 [31]. For the years 2016-2020, the data on the quantities of imported and exported paint was taken from MAKSTAT database [31].

Table 178 Activity data for source category 2.D.3.d - Coating application

Year	Industrial application	Decorative application	Other industrial application
	Paint [kg]	Paint [kg]	Paint [kg]
1990	5.039.128	5.039.128	5.039.128
1991	4.595.330	4.595.330	4.595.330
1992	4.309.611	4.309.611	4.309.611
1993	4.044.373	4.044.373	4.044.373
1994	3.671.095	3.671.095	3.671.095
1995	3.416.632	3.416.632	3.416.632
1996	3.608.965	3.608.965	3.608.965
1997	3.687.358	3.687.358	3.687.358
1998	3.771.334	3.771.334	3.771.334
1999	3.651.404	3.651.404	3.651.404
2000	3.739.061	3.739.061	3.739.061
2001	3.745.437	3.745.437	3.745.437
2002	3.728.881	3.728.881	3.728.881
2003	3.800.742	3.800.742	3.800.742
2004	3.683.217	3.683.217	3.683.217
2005	2.022.667	2.022.667	2.022.667
2006	3.388.000	3.388.000	3.388.000
2007	3.555.000	3.555.000	3.555.000
2008	3.669.667	3.669.667	3.669.667

Year	Industrial application	Decorative application	Other industrial application
	Paint [kg]	Paint [kg]	Paint [kg]
2009	3.067.333	3.067.333	3.067.333
2010	3.458.333	3.458.333	3.458.333
2011	3.797.247	3.797.247	3.797.247
2012	4.567.084	4.567.084	4.567.084
2013	4.419.688	4.419.688	4.419.688
2014	4.273.947	4.273.947	4.273.947
2015	4.411.483	4.411.483	4.411.483
2016	4.121.652	4.121.652	4.121.652
2017	3.577.271	3.577.271	3.577.271
2018	3.362.854	3.362.854	3.362.854
2019	3.503.141	3.503.141	3.503.141
2020	3.315.972	3.315.972	3.315.972

Emission factors

Emission factors for Tier 1 method from GB 2019 are presented in the following table:

Table 179 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

Reclaculations were done for the period 2016-2019 due to revised activity data for production.

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..

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

The activity data – number of population for this source category have been updated with revised numbers from MAKSTAT database for the period 1994-2020, 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 2003-2020 are estimated population numbers.

Table 180 Activity data for the source category 2.D.3.e Degreasing

Year	Population number	Year	Population number	Year	Population number
1990	2 028 000	**2001**	2 023 654	**2012**	2 062 294
1991	2 033 964	**2002**	2 029 892	**2013**	2 065 769
1992	2 056 000	**2003**	2 035 196	**2014**	2 069 172
1993	2 066 000	**2004**	2 038 514	**2015**	2 071 278
1994	1 957 265	**2005**	2 041 941	**2016**	2 073 702
1995	1 974 800	**2006**	2 045 177	**2017**	2 075 301
1996	1 991 398	**2007**	2 048 619	**2018**	2 077 132
1997	2 002 340	**2008**	2 052 722	**2019**	2 076 255
1998	2 012 705	**2009**	2 038 651	**2020**	2 068 808
1999	2 021 578	**2010**	2 057 284		
2000	2 038 651	**2011**	2 059 794		

Emission factors

Emission factor used for the calculation of NMVOC emissions coming form this category are presented below.

Table 181 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

No recalculations were done in this category.

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

Improvments in this category are planned to be carried out within the activities for the improvement of the emission inventory of the forthcoming IPA II project.

5.6.5.6. 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.

5.6.5.7. 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 180.

Emission factors

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

Table 182 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

5.6.5.8. 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.

5.6.5.9. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

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 during next year in order to gather representative quantity of treated wear.

5.6.6. Chemical products – NFR 2.D.3.g

This subchapter covers emissions from:

- polyurethane and polystyrene foam processing;
- asphalt blowing;
- tire production;
- specialty organic chemical industry;
- manufacture of paints, inks and glues;
- fat, edible and non-edible oil extraction;
- Industrial application of adhesives.

Emissions from manufacturing of chemical products include NMVOCs and NH_3. The chemical production in the country is variable, because after the fall of ex-Yugoslavia, the economy in our country experienced several shocks that damaged the local economy. The economy began to recover in 1995 and recovered only after 2001. This situation influenced the trend series emissions coming from the chemicals production branch.

5.6.6.1. Methodological issues

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

$$E_{pollutant} = \sum_{tehnologies} AR_{use,tehnology} \times EF_{tehnology,pollutant}$$

Where:

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

$EF_{tehnology,\ pollutants}$ = the emission factor for this technology and this pollutants.

<u>**Activity Data**</u>

The activity data for this source category have been taken from the Statistical yearbook - chapter Industry, energy and construction for the period 1990-2004[22] and publication Industry in the Republic of North Macedonia for the period 2005-2015 [28] as well as MAKSTAT database for 2016-2020 [29]. The activity data are presented in the following table.

Table 183 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	Asphalt blowing/ tones	Rubber Processing/kg
1990	16 450 000	NO	NO	6 638 000	NO	NO	12 500	NO

Year	Polyester/kg	Polyurethane /kg	Polystyrene /kg	Shoos/pairs	Leather tanning/kg	Paints. Inks and glues/kg	Asphalt blowing/ tones	Rubber Processing/kg
1991	12 440 000	NO	NO	4 049 000	NO	NO	12 500	NO
1992	11 150 000	NO	364 000	3 667 000	10 797 000	NO	12 500	1 355 000
1993	4 466 000	NO	382 000	2 308 000	10 197 000	NO	12 500	1 145 000
1994	8 628 000	NO	455 000	1 529 000	9 177 000	NO	12 500	978 000
1995	9 904 000	NO	378 500*	1 122 000	10 119 500*	NO	12 500	680 500*
1996	3 212 000	NO	302 000	1 231 000	11 062 000	NO	12 500	383 000
1997	3 820 000	NO	363 000	1 509 000	7 491 000	NO	12 500	371 000
1998	2 642 000	NO	547 000	1 790 000	4 908 000	NO	12 500	417 000
1999	NO	NO	NO	2 488 000	NE	NO	12 500	NO
2000	NO	NO	NO	2 129 000	NE	NO	12 500	NO
2001	NO	NO	NO	1 073 000	NE	NO	5 500	NO
2002	NO	NO	NO	1 521 000	NE	NO	5 500	NO
2003	NO	NO	NO	1 799 000	NE	NO	5 500	NO
2004	NO	NO	NO	1 785 000	NE	NO	5 500	NO
2005	NO	1 095 000	NO	1 540 000	NE	6 068 000	5 500	NO
2006	NO	1 405 000	NO	1 739 000	NE	5 252 000	5 500	NO
2007	NO	1 129 000	NO	2 860 000	114 000	4 982 000	5 500	NO
2008	NO	1 239 000	NO	2 853 000	111 000	4 604 000	5 500	NO
2009	NO	1 132 000	NO	3 036 000	143 000	3 972 000	5 500	NO
2010	NO	1 033 000	NO	3 290 000	141 000	5 407 000	5 500	NO
2011	NO	1 059 000	NO	3 148 000	160 000	2 834 000	5 500	NO
2012	NO	1 221 000	NO	3 047 000	93 000	1 914 000	5 500	NO
2013	NO	1 166 000	NO	4 631 000	94 000	1 306 000	5 500	NO
2014	NO	697 000	NO	5 128 000	81 000	817 000	5 500	NO
2015	NO	NO	NO	4 195 000	94 000	991 000	5 500	NO
2016	NO	896 000	NO	4 286 000	81 000	891 000	2 000	NO
2017	NO	1 633 000	NO	3 815 000	87 000	768 000	2 000	NO
2018	NO	2 429 000	NO	3 550 000	98 000	867 000	2 000	NO
2019	NO	2 670 000	NO	2 910 000	80 000	1 319 000	2 000	NO
2020	NO	2 815 000	NO	1 583 000	67 000	933 000	2 000	NO

*data for chemical products in 1995 is based on Interpolation between the previous year and the next year. The value is the average of the previous year and the next year. For the other years, it is expected that no production occur.

Emission factors

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

Table 184 Emission factors for source category 2.D.3.g - Chemical Products

Pollutant	Value	Unit	References

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	1710	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
TSP	12000	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
Cd	0.0001	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
As	0.0005	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
Cr	0.006	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
Ni	0.05	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
Se	0.0005	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
PAH	2.55	g/Mg asphalt	GB 2019 2.D.3.g Chemical products. Table 3-10. pg. 21 Asphalt blowing, coating
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

5.6.6.2. Source-specific uncertainties and time-series consistency

No source-specific uncertainties were done for the sector; the emissions vary due to the unstable economy over the years.

5.6.6.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

5.6.6.5. 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.

5.6.7. Printing NFR – 2.D.3.h

Printing involves the use of inks, which may contain a proportion of organic solvents. Therefore, NMVOC emissions are expected from this process.

5.6.7.1. Methodological issues

The simplified Tier 1 methodology for calculation of NMVOC emissions has been used. Namely, the quantity of ink used was multiplied with the appropriate emission factor.

Activity data

Data on ink consumption in the printing industry has been required from the SSO for the time series 1990-2020, 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 185 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

5.6.7.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.7.3. Source-specific QA/QC and verification

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

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

No recalculations were done in the sector.

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

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

5.6.8. Other solvent and product use – NFR 2.D.3.i and 2.G

NMVOC emissions are expected from this sector. Emissions from the following activities have been calculated in this source category:

- 060404 Fat, edible and non-edible oil extraction;
- 060406 Preservation of wood;
- 060602 Use of tobacco and
- 060603 Use of shoes

Under the NFR category 2G we have reported emissions from Tobacco use (tones) and Use of shoes calculated from produced, imported and exported products, and under 2D3i emissions from Fat, edible and non-edible oil extraction and Preservation of wood have been included.

5.6.8.1. Methodological Issues

In order to calculate activity data for these categories Use of shoes and Tobacco consumption the following formula have been used Use of shoes/tobacco = (produced product + imported product)-exported product. Consumption of creosote has been calculated with the formula 75 kg creosote/m3 wood, where kg of wood preservative used was taken from the Statistical yearbooks. Regarding the activity Fat, edible and non-edible oil extraction statistics on different vegetable oil types have been used for estimation of seed quantity.

Activity data

The activity data on tobacco and pairs of shoes has been taken from the Statistical yearbooks - chapter Industry, energy and construction for the period 1990-2004 [22], and from the publication of the "Industry in the Republic of North Macedonia", for the period 2005-2015 [28]. For 2016-2020 data from MAKSTAT database were used [29]. The deep that is visible in 2009 and jump in the 2012 are according to the produce parquet and wood packaging; the variable trend may be due to the economic reasons and not stable production in this sector.

The activity data are presented in the following table.

Table 186 Activity data for the source category 2.D.3.i and 2.G - Other solvent and product use (Source Statistical yearbooks (1990-2004) and MAKSTAT/Industry in the Republic of North Macedonia (2005-2020),

Year	Tobacco [tones]	Creosote [kg]	Fat, edible and non-edible oil extraction-seed [kg]	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	1 785 000
2005	2 721	86 241	59 138	1 590 000
2006	1 881	78 125	63 578	1 892 504
2007	1 040	68 738	61 973	2 121 404
2008	4 366	53 457	76 303	2 320 371
2009	4 893	11 184	75 020	3 142 440
2010	10413	58 775	78 368	2 957 658
2011	10 138	54 654	82 848	3 408 829
2012	3 151	144 749	80 805	3 388 013
2013	6 365	113 177	77 008	1 599 026

Year	Tobacco [tones]	Creosote [kg]	Fat, edible and non-edible oil extraction-seed [kg]	Pairs of shoes
2014	11 133	82 300	83 258	3 876 229
2015	9 904	106 723	102 678	4 381 143
2016	6 425	83 275	101 118	4 355 002
2017	6 054	78 150	65 370	3 876 436
2018	10 385	89 210	76 733	1 700 692
2019	7 714	74 151	83 548	1 066 440
2020	6 853	88 288	74 978	833 000

Emission factors

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

Table 187 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 19 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.22,23
NMVOC	Tobacco combustion	4.84	kg/ton tobacco	GB 19 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.22,23
NH3	Tobacco combustion	4.15	kg/ton tobacco	GB 19 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.22,23
PM2.5	Tobacco combustion	27	kg/ton tobacco	GB 19 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.22,23
PM10	Tobacco combustion	27	kg/ton tobacco	GB 19 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.22,23
TSP	Tobacco combustion	27	kg/ton tobacco	GB 19 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.22,23
BC	Tobacco combustion	0.45	% of PM2.5	GB 19 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.22,23
CO	Tobacco combustion	55.1	kg/ton tobacco	GB 19 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.22,23
Cd	Tobacco combustion	5.4	g/ton tobacco	GB 19 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.22,23
Ni	Tobacco combustion	2.7	g/ton tobacco	GB 19 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.22,23
Zn	Tobacco combustion	2.7	g/ton tobacco	GB 19 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.22,23
Cu	Tobacco	5.4	g/ton tobacco	GB 19 Table 3-4 Tier 2 emission factors for source

Pollutant	Activity	Value	Unit	References
	combustion			category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.22,23
PCDD/F	Tobacco combustion	0.1	µg I-TEQ/ton tobacco	GB 19 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.22,23
benzo(a) pyren	Tobacco combustion	0.111	g/ton tobacco	GB 19 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.22,23
benzo(b) fluoranthene	Tobacco combustion	0.045	g/ton tobacco	GB 19 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.22,23
benzo(k) fluoranthene	Tobacco combustion	0.045	g/ton tobacco	GB 19 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.22,23
Indeno (1.2.3-cd) pyren	Tobacco combustion	0.045	g/ton tobacco	GB 19 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.22,23
NMVOC	Wood preservation. Creosote preservative type	105	g/kg creosote	GB 19 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.22,23
benzo(a) pyren	Wood preservation. Creosote preservative type	1.05	mg/kg creosote	GB 19 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.22,23
benzo(b) fluoranthene	Wood preservation. Creosote preservative type	0.53	mg/kg creosote	GB 19 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.22,23
benzo(k) fluoranthene	Wood preservation. Creosote preservative type	0.53	mg/kg creosote	GB 19 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.22,23
Indeno (1.2.3-cd) pyren	Wood preservation. Creosote preservative	0.53	mg/kg creosote	GB 19 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.22,23
NMVOC	Manufacturing of shoes	0.06	kg/pair of shoes	GB 19 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.22,23
NMVOC	Fat. edible and non-edible oil extraction	1.57	g/kg seed	GB 19 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.22,23
PM2.5	Fat. edible and non-edible oil extraction	0.6	g/kg seed	GB 19 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.22,23
PM10	Fat. edible and non-edible oil extraction	0.9	g/kg seed	GB 19 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.22,23
TSP	Fat. edible and non-edible oil extraction	1.1	g/kg seed	GB 19 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.22,23

5.6.8.2. Source-specific uncertainties and time-series consistency

No specific source uncertainty is done for the sector.

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

No recalculations were done in this category.

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

The ERT recommended to include emissions estimates in the inventory from activities like Use of fireworks, Other product use (concrete additive, cooling lubricant, lubricant, pesticide and other industrial application of solvents in products) and Barbeque, which fall under the scope of NFR 2G and Glass wool enduction, Mineral wool enduction, Application of glues and adhesives, Underseal treatment and conservation of vehicles, Vehicles dewaxing and Other (preservation of seeds,...), which fall in the scope of NFR 2D3i. The national inventory team has searched data on firewoks and did not find these types of data. The improvement of this category is expected to happen in the forthcoming Technical IPA project on implementation on air quality directives.

5.6.9. Food and beverages industry - NFR 2.H.2

This source category addresses NMVOC emissions from food and beverages manufacturing, except emissions from vegetable oil extraction.

5.6.9.1. Methodological issues

The Tier 2 approach has been applied. Both the activity data and the emission factors have been stratified according to the different techniques that occur in the country.

The following equation form Tier 2 approach has been used for calculating emissions from food and beverage industry:

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

Where:

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

$EF_{tehnology,\ pollutants}$ = 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 2005-2020. 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 2007-2020 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 188 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 (2005-2020)

Year	spirits/hL	beer/hL	wine/hL	Wine white / hL	Animal Feed/t	Margarine and solid cooking fat/t	Sugar/t	Meat. fish and poultry/t	Cakes. biscuits and breakfast cereals/t	Bread/t	Coffee /t
1990	13 100	958 224	1 296 900	NE	180 625	1 972	13 904	11 855	13 063	102 392	NE
1991	16 165	928 043	1 572 000	NE	167 137	1 972	8 624	10 921	13 328	86 892	NE
1992	21 708	860 843	2 111 000	NE	140 320	1 972	8 140	8 121	15 112	99 149	NE
1993	21 708	951 854	2 274 000	NE	143 034	1 972	6 677	7 128	12 602	85 379	NE
1994	23 710	724 974	2 347 290	NE	126 146	1 972	6 351	33 787	12 583	85 014	NE
1995	26 920	620 201	2 665 080	NE	126 583	1 972	7 205	29 375	12 308	84 901	NE
1996	40 040	622 223	3 963 960	NE	130 248	1 972	17 993	29 368	11 824	84 382	NE
1997	31 800	600 092	3 148 200	NE	105 754	1 972	35 183	27 800	11 426	83 817	NE
1998	24 790	578 212	2 454 210	NE	97 947	1 972	40 354	25 971	11 657	82 740	NE
1999	30 070	652 165	2 976 930	NE	97 946	1 972	43 039	26 512	12 296	81 184	NE
2000	27 820	659 829	2 754 180	NE	97 995	1 972	31 923	27 470	11 408	78 632	173
2001	43 900	622 181	4 346 100	NE	75 003	1 972	18 004	26 041	10 995	74 689	899
2002	37 960	637 894	3 758 040	NE	68 382	1 972	36 614	27 471	10 828	68 425	2686
2003	28 350	680 217	2 806 650	NE	61 474	1 972	33 334	29 835	10 454	58 606	2109
2004	12 424	717 496	516 000	NE	55 235	1 972	27 810	29 839	10 113	43 115	2600
2005	10 548	675 325	948 489	NE	77 025	1 734	36 815	28 264	8 051	45 654	3005
2006	11 831	669 648	703 005	NE	73 497	1 903	19 325	28 041	8 030	44 774	2931
2007	9 824	695 140	578 953	388 588	85 790	2 079	35 927	22 589	5 607	59 003	4 383
2008	7 608	702 382	707 271	436 981	81 198	2 240	43 731	26 156	6 938	65 124	4 365
2009	7 904	635 922	743 463	480 008	74 353	2 225	23 460	26 437	9 603	59 699	4 185
2010	11 284	631 371	661 793	401 546	72 434	2 387	37 998	28 644	25 419	62 492	4 338
2011	7 442	611 836	815 914	409 593	77 183	2 340	30 423	30 732	25 548	67 518	4 185
2012	10 341	633 621	591 291	457 824	62 695	2 228	21 414	35 473	30 144	68 723	4 214
2013	11 548	617 124	686 841	599 049	46 983	2 433	22 916	35 686	31 181	60 127	4 405
2014	9 847	640 948	396 630	399 351	47 553	2 339	12 085	32 155	31 150	62 919	3 894
2015	10 848	656 672	605 404	500 017	45 553	2 328	NO	31 278	39 532	63 808	4 160
2016	12 481	672 487	602 187	460 461	40 563	2 118	NO	32 125	36 303	64 751	4 609
2017	11 582	705 497	367 020	397 953	48 348	2 374	NO	30 706	36 374	59 968	4 239
2018	13 082	736 062	565 799	462 320	45 117	2 324	NO	34 916	37 656	57 528	4 306
2019	13 269	738 396	522 317	388 943	47 623	2 656	NO	26 947	37 495	56 670	4 344

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
2020	11 649	662 360	568 586	374 166	46 576	2 596	NO	25 421	38 144	47 119	4 100

Emission factors

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

Table 189 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 3-28, pg. 23
NMVOC	80	g/hL wine	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	35	g/hL white wine	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	1	kg/Mg animal feed	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	10	kg/Mg product (Margarine and solid cooking fats)	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	10	kg/Mg sugar	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	0.3	kg/Mg product (meat, fish and poultry)	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	1	kg/Mg product (cakes, biscuits and breakfast cereals)	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	4.5	kg/Mg bread	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23
NMVOC	0.55	kg/Mg beans (roasted coffee)	GB 2019, 2.H.2 Food and beverages industry, Table 3-28, pg. 23

5.6.9.2. Source-specific uncertainties and time-series consistency

A quantitative uncertainty analysis has not yet been carried out to the Macedonian inventory, but it is scheduled for the future. Source category specific information on uncertainties will be added when the results are available. The trends of the food production are variable due to the change of the methodology in the statistics, as well as due to the unstable regime of the major food installations.

5.6.9.3. Source-specific QA/QC and verification

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

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

Recalculations were done in this sector for the period 2000-2006, due to avalible activity data on coffee roasting.

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

No recalculations were performed in this category.

5.6.10. Wood processing – NFR 2.I

This source category is only important for particulate emissions. The emissions from this source category however are less than 1% of the national emissions for particulates.

5.6.10.1. Methodological issues

The simplified Tier 1 methodology for emission calculation has been used. Namely, the quantity of activity data is multiplied with the appropriate emission factor.

Activity data

The input data for this source category is the quantity of different type of final products. These data have been taken from the Statistical Yearbooks of the Republic of North Macedonia for the period 1990-2020[22] and the publication Industry in the Republic of North Macedonia for the period 2005-2015[28], and data form MAKSTAT database for period 2016-2020 [29].

Table 190 Activity data for source category 2.I - Wood processing

Year	Wood processed [Mg]	Year	Wood processed [Mg]	Year	Wood processed [Mg]
1990	66 889	**2001**	16 882	**2012**	19 251
1991	52 422	**2002**	10 015	**2013**	14 211
1992	46 790	**2003**	19 913	**2014**	14 414
1993	44 454	**2004**	24 263	**2015**	11 496
1994	40 402	**2005**	15 509	**2016**	10 098
1995	29 144	**2006**	21 866	**2017**	10 660
1996	27 210	**2007**	15 173	**2018**	7 698
1997	23 188	**2008**	12 863	**2019**	10 102
1998	17 048	**2009**	4 429	**2020**	9 701
1999	22 568	**2010**	14 225		
2000	18 173	**2011**	11 986		

Emission factors

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

Table 191 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

5.6.10.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.10.3. Source-specific QA/QC and verification

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

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

No recaluclations were done in this category.

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

The National emission team is planning to check historical activity data in this category and make recalculations ig necessary.

5.6.11. Consumption of POPs and heavy metals – NFR 2.K

This source category is only important for PCB and Hg. The emissions in this category were calculated due to ERT recommendation.

5.6.11.1. Methodological issues

The simplified Tier 1 methodology for emission calculation has been used. Namely, the quantity of activity data – population is multiplied with the appropriate emission factor.

Activity data

The input data for this source category is population data. Population data for the source category 2.D.3.e – Degreasing, is presented in Table 180.

Emission factors

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

Table 192 Emission factors for source category 2.K- Consumption of POPs and heavy metals

Pollutant	Value	Unit	References
PCB	0.1	g/capita	GB 2019 Table 3-1, Tier 1, 2.K- Consumption of POPs and heavy metals pg.6
Hg	0.01	g/capita	GB 2019 Table 3-1, Tier 1, 2.K- Consumption of POPs and heavy metals pg.6

5.6.11.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.11.3. Source-specific QA/QC and verification

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

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

No recaluclations were done in this category.

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

Due to high uncertainty of the Tier 1 methodology, possibility the use higher tier level will be investigated.

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 NH_3 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 2020 are presented, which are not included in this sector and for which appropriate notation keys are used.

Table 193 NFR categories covered in Agriculture sector for 1990-2020

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	√
3Dd Off-farm storage. handling and transport of bulk agricultural products	NA
3De Cultivated crops	√
3Df Use of pesticides	NO
3F Field burning of agricultural residues	NO
3I Agriculture other (please specify in the IIR)	NO
3B4h Manure management - Other animals (please specify in IIR)	NO

3.B.4.f: Mules and asses: No data were received for number of mules and asses in the reporting period upon request sent to the state statistical office (NE).

3.B.4.a: Buffalos: only historic data are available. Buffalos are included in the Other cattle category (3.B.1.b), as buffalos are bovines and no data for buffalo is available from 2007 onwards (-> time series consistency). The NH_3 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. NH_3 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. NH_3 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.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.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 NOx, 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 NH_3 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 [22] and Publication Livestock prepared by the State Statistical Office for the period 2007-2015 [33] and MAKSTAT database for activity data for 2016-2020 [33]. The numbers per livestock category are presented in Table 194. The number of different categories of poultry is presented in Table 195.

Table 194 Domestic livestock population and its trend 1990–2020

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
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

Year	Dairy	Non-diary	Total Swine	Fattening pigs	Sows	Sheep	Goats	Horses
2002	127 135	132 437	196 223	164 056	32 167	1 233 830	163 644	41 775
2003	118 325	142.217	179 050	143 557	35 493	1 239 330	156 205	42 883
2004	118 872	136 496	158 231	131 992	26 239	1 432 369	148 767	40 391
2005	115 485	133 174	155 753	128 940	26 813	1 244 000	141 329	39 651
2006	120 682	135 157	167 116	137 102	30 014	1 248 801	133 890	40 553
2007	121 005	132 761	255 146	209 641	45 505	817 536	126 452	31 065
2008	125 004	128 469	246 874	210 106	36 768	816 604	133 017	30 936
2009	109 858	142 662	193 840	164 796	29 044	755 356	94 017	29 418
2010	119 060	140 827	190 552	161 346	29 206	778 404	75 708	26 658
2011	136 926	128 373	196 570	171 412	25 158	766 631	72 777	25 415
2012	123 392	127 848	176 920	152 256	24 664	732 338	63 585	21 676
2013	128 677	109 656	167 492	140 768	26 724	731 828	75 028	20 682
2014	126 762	114 845	165 053	141 542	23 511	740 457	81 346	19 371
2015	124 194	129 248	195 443	174 586	20 857	733 510	88 064	18 784
2016	125 243	129 525	202 758	174 087	28 671	723 295	101 669	19 263
2017	122 604	132 432	202 197	175 623	26 574	724 555	107 466	17 951
2018	129 450	126 731	195 538	171 809	23 729	726 990	117 447	10 041
2019	111 147	106 643	135 770	118 814	16 956	684 558	87 581	8 952
2020	107 721	114 490	164 074	145 679	18 395	630 634	95 008	9 154
Trend 1990-2020	***-12%***	***-31%***	***-8%***	***-6%***	***-24%***	***-73%***	***-62%***	***-86%***

Table 195 Domestic poultry and its trend 1990–2020

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
2001	2 647 004	48 789	28 263	7 326	18 255	2 749 637

Year	Laying hens	Broilers	Livestock category – Population size [heads] *			
			Ducks	Geese	Turkeys	Total Poultry
2002	2 407 615	44 376	25 707	6 663	16 604	2 500 966
2003	2 327 131	42 893	24 848	6 441	16 049	2 417 362
2004	2 623 573	48 357	28 013	7 261	18 094	2 725 298
2005	2 519 329	46 435	26 900	6 972	17 375	2 617 012
2006	2 488 827	45 873	26 575	6 888	17 165	2 585 327
2007	2 115 866	80 742	35 131	11 004	21 151	2 263 894
2008	2 173 346	9 717	22 656	4 082	16 254	2 226 055
2009	2 041 098	34 949	23 658	3 182	15 003	2 117 890
2010	1 951 276	27 235	6 982	4 652	4 707	1 994 852
2011	1 853 176	11 862	68 743	4 225	6 253	1 944 259
2012	1 715 180	30 698	15 670	4 495	10 254	1 776 297
2013	1 623 130	548 617	13 558	7 143	9 102	2 201 550
2014	1 884 289	26 492	13 790	5 687	9 621	1 939 879
2015	1 423 841	311 809	15 814	2 094	7 587	1 761 145
2016	1 705 948	97 322	25 416	10 829	26 254	1 865 769
2017	1 770 504	20 456	27 257	8 782	13 174	1 840 173
2018	1 736 208	25 641	40 222	8 956	17 260	1 828 287
2019	1 385 743	120 363	34 611	8 841	12 531	1 562 089
2020	1 482 348	101 268	31 900	14 306	13 640	1 643 462
Trend 1990–2020	***-73%***	***0%***	***-46%***	***-6%***	***-64%***	***-62%***

Official data sets of the period 1990–2006 and from 2007 onwards are not fully consistent. In 2007, a new census on agriculture was introduced [36] leading to more accurate animal numbers. No census for agriculture was conducted afterwards.

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 calve in one category "cows". Activity data for dairy cows was not made available until this reporting period.

Regarding the relatively small number of calves and young cattle, compared to the cattle older than 2 years (including dairy cattle that the share dairy/non-dairy is in line with the data of neighboring countries of that region and that the marked is very volatile) – many calves are imported.

There is no specific tradition in animal breeding in North Macedonia. The quality of the genetic pool of the domestic livestock is not good enough for high yield and quality production. Thus, for the replacement of animals in milk, meat and pork production predominantly young animals are imported from abroad (no domestic breed is taken).

The small calve number in the official statistics is 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 2020).

Non-dairy cattle

Reduced rent ability of beef production is responsible for the decrease of Non-dairy cattle numbers by 31% between 1990 and 2020 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 decrease by 8% between 1990 and 2020, mainly due to decreased 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 (-73%) 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 -62% between 1990 and 2020, because in the last century husbandry of goats was forbidden as it would curb the formation of karst.

Horses

Horse numbers show a decreasing trend since 1990 (-86%). In the past horses were used for means of locomotion in rural areas, but the purpose of horses changed and more and more people are now living in the cities and less horses are needed.

Mules and asses

Regarding information from the veterinary institute, horse category does not include mules and assess. No data on mules and assess were made available in the reporting period (NE).

Poultry number

Before 2007, only total poultry number is available. An official request has been made for the use of non-published data of laying hens 1990-2006. Data were received by the statistical office and used in the calculations. For the derivation of consistent time series of broilers, geese, ducks and turkeys for 1990-2006 the average shares of the years 2007-2010 have been used. The time series of laying hens has been validated with annual total egg production and annual egg numbers per hen.

Total poultry number decreased by 62% from 1990 to 2020, mainly due to declining numbers of laying hens as a result of a reduced egg production in North Macedonia.

Animal manure management system distribution

During the inventory preparation for submission in 2016, first investigations on management practices commonly applied in the Macedonian agriculture have been made. Based on expert judgments and information of big IPPC installations within pig and poultry husbandry a distinction between slurry and solid systems could be made for each animal category. Since then the same distinction between systems has been used.

The following expert judgment (REF) has been provided:

Cattle husbandry

The cattle husbandry is mostly in traditional holdings – 97% of all farms in North Macedonia are small scale farms with up to 20 cows. In the past 25 years, the number of bigger holdings is decreasing and now there are only few farms with more than 100 dairy cows. The typical systems used in dairy cattle husbandry are small stalls with solid manure system, tied housing system with no outdoor loafing areas. Some of the bigger farms (more than 50 cattle) have changed from tied stall to free stall system, solid manure and outdoor loafing areas. The milking system is mechanical with separate milking parlor in the bigger farms. The other category of cattle, which has a major part in the cattle husbandry in North Macedonia, is the cow-calf system (suckling cows). Where the cows are kept free on pasture and mountains and the breeders are using only the calves for meat production. This type of breeding is strictly traditional with the local breed Busha. In the milking sector, dominating breed is Holstein Friesian, with small percentage of Simmental breed and the rest of the cattle breeds are within negligible numbers. Although there are several attempts in the past decade for establishing bigger farms, there is no visible trend for creating dairy farms with large number of animals in North Macedonia. Based on this expert judgment we decided to use the EMEP/EEA default NH_3 and NO Tier 1 EFs for solid systems for all cattle categories.

Pasturing of cattle

Pastured system is mostly present in the cow-calf system; explained above. The rest of the farmers are rarely using pasture for dairy cattle and dairy cattle are kept indoors during the whole year. There are some practices where the cows from the whole village are pastured on the same pasture during the summer months of the year. However, there are no exact numbers available for presenting the percentage of farms that are using pasture in their management.

Based on this expert judgment and discussions with agriculture experts it was decided to apply the solid NH_3 and NO EFs for all cattle.

Swine

For IPPC installations (big pig farms), the national IPPC experts provided the following information: the number of animal places, the animal number produced per farm for 2014 and the number of days the animals are alive before being slaughtered for 2014.

Based on this data, it was possible to calculate the annual average animal population held in these seven big pig farms. The result was that about 30% of BC's pigs (mostly fattening pigs) were held in these farms in 2014. From the previous meeting we know that these farms use liquid systems. The situation in 2018 is similar so no changes to the distribution of type of system are changed.

Now it had to be clarified which kind of systems are usually applied for the rest of pigs held in smaller business entities and individual farms.

Additional information from the veterinary agency that also the small pig farms usually practice liquid manure systems; the manure is stored in septic tanks. Farmers have an agreement with someone else that uses a tank truck to collect the manure or use the manure for fertilization of their own agricultural land.

National experts of the Ministry of Agriculture confirmed the assessment of the veterinary agency of North Macedonia. Based on this expert judgment we decided to use the EMEP/EEA default NH_3 and NO EFs for liquid systems for all swine categories.

Poultry

In North Macedonia, only laying hens are kept in big poultry farms. Broilers are mainly imported from abroad. Data from IPPC investigations (big poultry farms) showed that the solid factor is the appropriate for all hens (conservative approach). The national experts of the Ministry of Agriculture within an expert meeting confirmed this approach during the mission.

EMEP/EEA Tier 1 NH_3 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 196 and 197 provide emission factors taken from the EMEP EEA GB 2013 (updated July 2015 version) and for NH_3 from EMEP EEA GB 2016, for each livestock category. These factors have been used for the estimation of NO_X NMVOC and NH_3 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 is same in EMEP EEA GB 2013 and 2016.

Table 196 NH_3 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 197 NOx and NMVOC emission factors for source category 3B - Manure management

NFR code	Pollutants	
	NOx	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

NFR code	Pollutants	
	NOx	NMVOC
	kg AAP-1 a-1	kg AAP-1 a-1
3B4giii Turkeys	0.005	0.489
3B4giv Other poultry (ducks)	0.004	0.489
3B4giv Other poultry (geese)	0.001	0.489
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 NMVOC

Emissions of particulate matter (PM) occurring from animal husbandry were calculated with the EMEP/EEA Tier 1 methodology provided in the EMEP/EEA Guidebook 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 198 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	0009	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	052	007	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).

NMVOC emission factors

Default Tier 1 emission factors distinguish between feeding with and without silage for dairy cows, other cattle, sheep, goats, horses and mules and asses (GB 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 199 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 send to relevant institutions;
- Comparison with time series of previous year. Explanation of revisions are done only if jumps or dips appeared;
- Consistency checks of sub-categories with totals like in case of poultry with sum of all subcategories.

Emission factors

- Default EFs were used

Results (emissions)

- Assessment of recalculation differences: plausibility checks, explanation
- Documentation in calculation sheets and IIR.
- Livestock emission excel sheet contains sheets for cross checking of animal number with production of milk, eggs and number of calves in the case of cattle numbers.

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

No recalculations 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 2016 and recommendation given in the last stage 3 Review conducted in 2020.

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 sulfate, 0.21 kg N per kg fertilizer.
- AN - Ammonium nitrate, 0.34 kg N per kg fertilizer.
- CAN - Calcium ammonium nitrate, 0.27 kg N per kg fertilizer.
- U - Urea, 0.46 kg N per kg fertilizer.
- MAP, 0.11 kg N per kg fertilizer.
- DAP, 0.18 kg N per kg fertilizer.
- NPK > 10 kg, 0,15 kg N per kg fertilizer
- NPK< 10 kg, 0,15 kg N per kg fertilizer

For other fertilizers emissions are calculated by using average N content and average EF of all applied fertilizers.

Soil P_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 200 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

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
1995	429	3654	708	3168	0	20	304	0	0	8283
1996	431	4009	462	3025	0	20	304	0	0	8252
1997	434	4069	144	2657	0	20	304	0	0	7629
1998	420	3910	126	3097	0	20	304	0	0	7878
1999	420	3139	54	3266	0	20	304	0	0	7204
2000	420	2618	54	3220	0	20	304	0	0	6636
2001	420	1825	54	3005	0	20	304	0	0	5628
2002	607	3168	45	2260	0	20	304	0	0	6405
2003	751	4689	617	2410	0	22	555	0	0	9045
2004	630	6530	1657	2348	0	32	1540	0	0	12 737
2005	317	6476	3205	2610	1	40	3023	2	0	15 674
2006	46	6916	3515	2,520	61	31	3775	3	0	16 866
2007	42	7173	4190	2373	77	24	4159	3	0	18 041
2008	42	7248	3438	2628	77	13	3765	3	0	17 212
2009	30	4.516	4277	3291	35	27	3814	3	83	16 075
2010	27	4873	4811	3618	19	25	3586	4	128	17 092
2011	13	2693	6068	3708	18	22	4009	3	156	16 692
2012	13	2693	6296	3314	0	8	4742	1	144	17 211
2013	0	0	5731	3634	0	0	5673	0	98	15 137
2014	0	823	5641	3986	0	0	6119	0	180	16 749
2015	0	3090	4340	3858	0	0	4996	0	229	16 513
2016	0	3124	3381	3187	0	0	3531	0	234	13 457
2017	0	4561	2457	3034	17	0	3184	0	216	13 470
2018	0	4293	2266	3343	38	0	3990	0	153	14 082
2019	0	6524	1774	3784	58	0	5009	0	368	17 517
2020	0	7726	1373	3862	176	0	5166	0	496	18 798

*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 201 NH_3 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 NH3 kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1

Fertilizer type	Value	Unit	References
CAN	0.008	kg NH3 kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
U	0.155	kg NH3 kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
MAP	0.05	kg NH3 kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
DAP	0.05	kg NH3 kg-1 fertilizer-N applied	GB 2016 Table 3-2 emission factor for source category 3.D.a.1
NPK	0.05	kg NH3 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 202 NOx Emissions factors for source category NFR 3.D.a.1 - Inorganic fertilizers

Pollutant	Value	Unit	References
NOx	0.026	kg kg-1 fertilizer-N applied	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 NH_3 emissions from animal manure applied to agricultural soils.

6.4.2.1. Methodological issues

The Tier 1 methodology according the EMEP/EEA GB 2016 has been applied.

Activity data and background information on the activity data

The input data is the number of registered heads of each domestic animal species. All activity data is derived from the Statistical Yearbooks for period 1990-2006 [22] and Publication Livestock [33], prepared by the State Statistical Office for the period 2007-2015 [33] and MAKSTAT database for 2016-2020 [35]. The numbers per livestock category are presented in Table 194. Numbers of different categories of poultry were presented in Table 195. For further information, please refer to chapter 3.B Manure Management.

Emission factors

In the chapter 3.B Manure Management, for each livestock category the NH_3 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 NH_3 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 2007-2020. The numbers per livestock category are presented in Table 194. Number of different categories of poultry is presented in Table 195. For further information, please refer to chapter 3.B Manure Management.

Emission factors

In the chapter 3.B - Manure Management for each livestock category the NH_3 emission factors for grazing, taken from EMEP/EEA GB 2016, are shown.

6.4.3.2. Source-specific uncertainties and time-series consistency

For the first time a quantitative uncertainty analysis has been carried out for the North Macedonian air pollutant emission inventory and was submitted in 2017. Uncertainties of activity data and emission factors were based on the EMEP/EEA GB 2013.

The following table presents uncertainties for emissions, as well as for activity data and the EFs for sector *3.D Agricultural Soils* according to EMEP/EEA 2013.

Table 203 Uncertainties of emissions, emission factors and activity data

Categories		NH3 Emissions	NOx Emissions	NMVOC Emissions	PM2.5 Emissions	EF NH3	EF NOx	EF NMVOC	EF PM2.5
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 2009-2020, 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.

6.4.3.3. 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.

Excel sheets 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. For example the activity data showed in the last years mostly stedy trend for all fertilizers exept for MAP which quantity is tripled in 2020 and no import of ammonium nitrate conducted in 2013. For the other fertlizers no biger jums and deeps are shown in the last decade.

Emission factors

Default Emission factors were used, but country specific parameters (e.g. N contents of fertilizers) were also compared with defaults and values reported by other countries (e.g. Serbia, Austria and Croatia).

Results (emissions)

Comparison of emissions calculated with Tier 1 and Tier 2 method was done. Use of tier 2 method result with lower emissions started from 2001 onwards.

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

No recalculations were done in this category.

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

No planned improvments in this category.

6.4.4. 3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products

6.4.4.1. Methodological issues

Calculation of particulates was carried out using EF given in the GB 2019 according to tier1 methodology.

Activity data

The activity data for source 3.D.c is derived from State Statistical Yearbooks for period 1990-2020 data and are presented in the following table:

Table 204 Activity data for source category 3.D.c

Year	Arable land [ha]
1990	1 320 000
1991	1 295 000
1992	1 308 000
1993	1 299 000
1994	1 298 000
1995	1 289 000
1996	1 291 000
1997	1 285 000
1998	1 293 000
1999	1 284 000
2000	1 236 000
2001	1 244 000
2002	1 316 000
2003	1 303 000
2004	1 265 000
2005	1 229 000
2006	1 225 000
2007	1 077 000
2008	1 064 000
2009	1 014 000

Year	Arable land [ha]
2010	1 121 000
2011	1 120 000
2012	1 238 000
2013	1 260 336
2014	1 263 155
2015	1 264 408
2016	1 267 134
2017	1 266 008
2018	1 264 000
2019	1 264 578
2020	1 261 687

Emission factors

Table 205 Emission factors

Pollutant	Value	Unit	References
PM2.5	0.06	Kg ha^{-1}	GB 2019 Table 3-1 emission factor for source category 3.D.c
PM10	1.56	Kg ha^{-1}	GB 2019 Table 3-1 emission factor for source category 3.D.c
TSP	1.56	Kg ha^{-1}	GB 2019 Table 3-1 emission factor for source category 3.D.c

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

This category was introduced for the first time according Stage 3 review, recommendations for QC procedures there have been create a new NFR and have been made changes of notation key directly in the NFR category: 3Dc for $NH_{3,}$ BC, CO, Heavy metals, POPs, NO_X, SO_2 MNVOC, PM2,5 and PM10 and TSP emissions.

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

No planned improvements in this category.

6.4.5. 3.D.e Cultivated crops

6.4.5.1. Methodological issues

Calculation of particulates was carried out using EF given in the GB 2019 according to Tier1 methodology.

Activity data

The activity data for source 3.D.e is derived from State Statistical Yearbooks for period 1990-2020 data and are presented in the following table:

Table 206 Activity data for source 3.D

Year	kg/ha
1990	1 320 000
1991	1 295 000
1992	1 308 000
1993	1 299 000
1994	1 298 000
1995	1 289 000

Year	kg/ha
1996	1 291 000
1997	1 285 000
1998	1 293 000
1999	1 284 000
2000	1 236 000
2001	1 244 000
2002	1 316 000
2003	1 303 000
2004	1 265 000
2005	1 229 000
2006	1 225 000
2007	1 077 000
2008	1 064 000
2009	1 014 000
2010	1 121 000
2011	1 120 000
2012	1 238 000
2013	1 260 336
2014	1 263 155
2015	1 264 408
2016	1 267 134
2017	1 266 008
2018	1 264 000
2019	1 264 578
2020	1 261 687

Emission factors

Table 207 Emission factors for NMVOC

Pollutant	Value	Unit	References
NMVOC	0.86	Kg ha^{-1}	GB 2019 Table 3-1 emission factor for source category 3.D.e

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

No recalculations were done in this category.

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

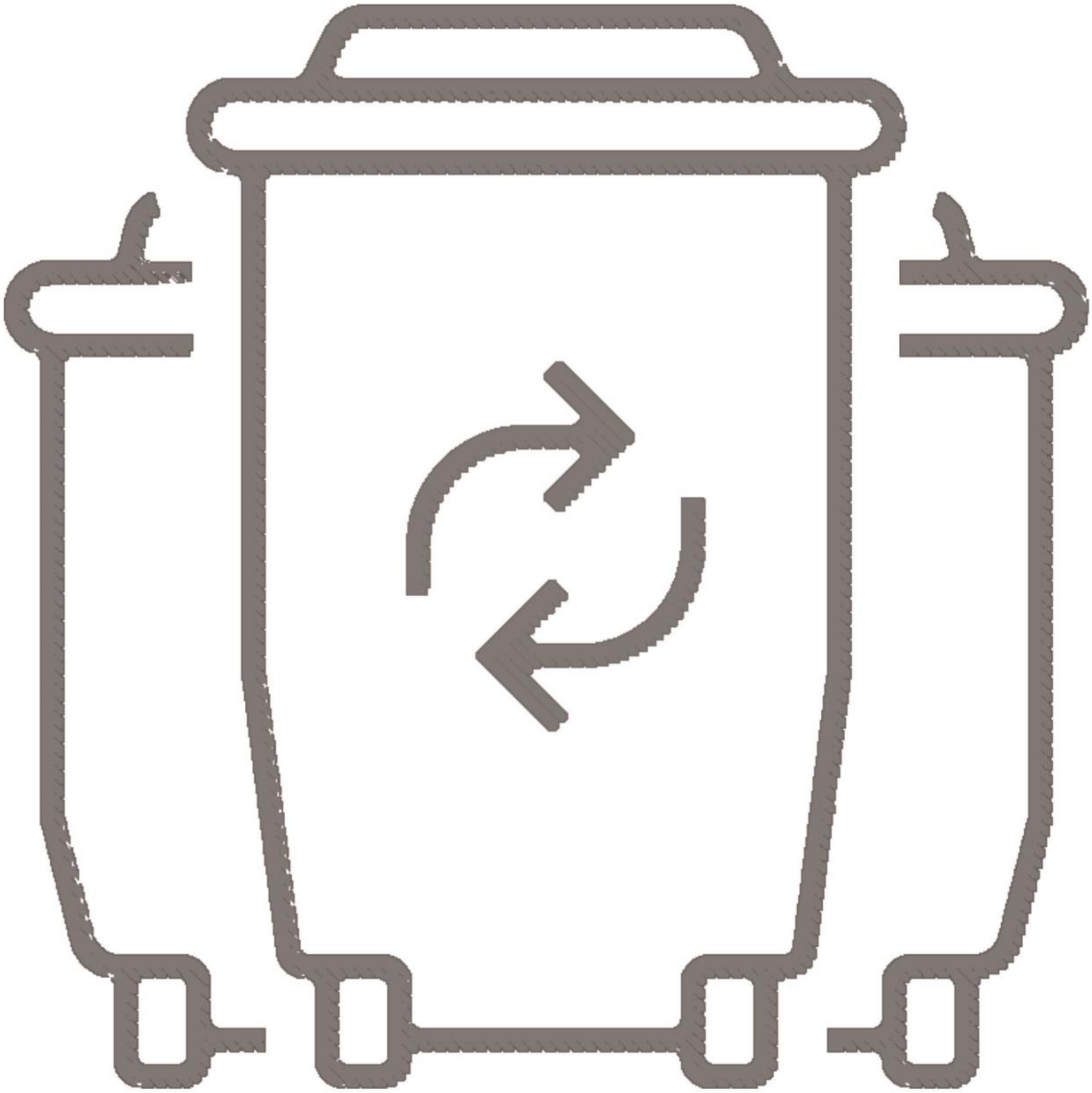
No planned improvements in this category.

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 NOx, SO_2, CO, NMVOC, Particulates, heavy metals and persistent organic compounds (POPs). Emissions addressed in this chapter include emissions from the next subcategories:

5.A - Solid waste disposal on land

5.B.1-Biological treatment of waste-Composting

5.C.1.biii - Clinical waste incineration

5.C.2 - Open burning of waste

5.D.1 - Domestic wastewater handling

5.D.2-Industrial wastewater handling

As during the stage 3 review in 2016, it was recommended to change to Tier 2 method for the category 5.A, this recommendation has been followed. Additionally, emissions for category 5.D.1, 5.D.2 and 5.B.1 have been calculated using a Tier 1 approach.
Explanations of the source of activity data, methodology used and emission factors are presented below. According to information from the statistical office, about 99% of municipal solid waste is landfilled and only less than 1% is composting or recycled. Generally, in the country there is only clinical waste incinerator operating from 2000. Other types of waste incineration, as well as cremation process do not occur. Open burning of waste covers the volume reduction by open burning of small-scale (agricultural) waste. It does not include stubble burning, or forest fires. The open burning of rubber tires or waste oil on farms has also not been included. Agricultural wastes that might be burned are crop residues (e.g., cereal crops, peas, beans, soya, sugar beet, oil seed rape, etc.), wood, pruning, slash, leaves, plastics and other general wastes. Straw and wood are often used as the fuel for the open burning of agricultural wastes.

Regarding waste water treatment, there are fifteen Waste Water treatment plants (WWTP) operating in North Macedonia. For the plant in Ohrid and Dojran, activity data are available for the whole time series. Emissions have been estimated based on these activity data and the data from another twelve waste water treatment plants. However, as data for the two plants are currently not available, the emissions are underestimated.

For the first time, emissions from 5.B.1-Biological treatment of waste (composting) have been calculated. Municipal waste incineration, industrial waste incineration, hazardous waste incineration, sewage sludge incineration and cremation do not occur in our country.

Regarding the Industrial wastewater handling, some installations subjected under the IPPC license system are obligated to install waste water treatment. Emissions from this NFR category 5.D.2 have been calculated almost for the whole time series.

Emissions from 5.B.2 Biological treatment of waste - Anaerobic digestion at biogas facilities, 5.C.1 other waste incineration, 5.D.3-Other wastewater handling and 5.E. Other waste (Sludge spreading, car fire, detached and undetached house fires, apartment building fire, industrial building fire), have not been calculated.

7.1.1. Methodology

Tier 1 approach was used, using the given default Emission factors from the GB2016.

Completeness

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

Table 208 NFR categories included or not included in Waste sector for 2016

NFR category		Completeness
5.A	Biological treatment of waste - Solid waste disposal on land	√
5.C.1.biii	Clinical waste incineration	√
5.C.2	Open burning of waste	√
5.B.1	Biological treatment of waste - Composting	√
5.B.2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NE
5.C.1.a	Municipal waste incineration	NO
5.C.1.bi	Industrial waste incineration	NO
5.C.1.bii	Hazardous waste incineration	NO
5.C.1.biv	Sewage sludge incineration	NO
5.C.1.bv	Cremation	NO
5.C.1.bvi	Other waste incineration (please specify in the IIR)	NE
5.D.1	Domestic wastewater handling	√
5.D.2	Industrial wastewater handling	√
5.D.3	Other wastewater handling	NE
5.E	Other waste (please specify in IIR)	NE

7.1.2. Source-specific uncertainties and time-series consistency

Activity data for the whole time series and background information on these are hardly available, for which reason the uncertainty is expected to be rather high. Especially getting data on waste disposal is hard, as these data are required back to 1950, a time when Macedonia was still part of Yugoslavia. For further information, see the respective chapter below. Uncertainties of emissions, emission factors and activity data for 5.A and 5.C are presented below.

Time series consistency is ensured as recalculations are carried out for the whole time series and not only for specific years.

7.1.3. Source-specific QA/QC and verification

The results of this year’s calculations have been compared with last year, and the reasons for any major differences clarified. Calculation sheets were checked for any errors in formulas or links. Data or information received from third parties was reviewed and archived to ensure transparency.

The recommendations of the stage 3 review were taken in consideration and improvements made:

- request for country specific data to statistical office and installations
- change to Tier 2 approach for 5.A and 5C1biii
- calculation of emissions from 5.B.1
- estimation of emissions from 5.D.1
- calculation of emission from 5.D.2
- review of notation key use.
- correction of emissions in 5C1biii and 5C2

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

No recalculations were made in this category.

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

Planned improvements refer to categories 5D1 and 5C2, also according to remarks and recommendations given in the Stage 3 review report conducted in 2020.

7.2. Solid waste disposal on land (NFR 5.A)

Within this category the emissions arising from solid waste disposal shall be accounted for, whereby municipal and industrial waste shall be considered. However, it has to be taken into account that only waste which still undergoes biological or chemical degradation is relevant. Therefore, inert waste (like construction waste) shall not be included.

7.2.1. Methodological issues

NMVOC, CO and NH_3 was estimated using tier 2 methodology, and particulate emissions were estimated using Tier 1 method by multiplying amount of landfilled municipal solid waste and emission factors. For the fourth time, these emissions have been calculated using Tier 2 emission factors following the guidance of 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Activity Data

As for Tier 2 methodology, since activity data on waste landfilled is required back to 1950, extrapolation was necessary based on population and GDP data. Data on municipal solid waste generation per person is available for the years 2003 until 2020 (source: Eurostat statistics and EEA report [43]). The hereby available information provided data on waste generation from 2003 to 2020. For the data from 1990-2003 the average annual change between 2003 and 2017 was applied, and then the value for 1990 (which is 97 kg per person), was kept constant until 1950.

Total municipal solid waste generation was calculated by multiplying with population data. Data on population is available in the Statistical Yearbooks of Macedonia, although before 1990 data were interpolated between decades. According to information from the statistical office about 99% of municipal solid waste is landfilled, for that reason it was assumed that 100% of municipal solid waste was deposited on uncategorized landfills.

In order to determine the waste fraction, information published in an EEA study “Municipal Waste Management in FYROM (2013), page 7-8” was used [43]. The shares are kept constant for the whole time series (1950 to 2020) due to a lack of better data, although, it can be assumed that in 1950 the waste composition was different.

Table 209 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 2020 [44]. Before 1994, GDP for former Yugoslavia were found and used. The Industrial waste*by category, in tons, from 2016 was used also for the latest years due to the fact that this data from SSO are considered realiable.

Table 210 Type of waste, and quantity in tons

Type of waste	Quantity [t]
Waste from households and similar waste – non-hazardous	5.131,38
Mixed and undifferentiated materials – nonhazardous	9.643,95
Waste from sorting materials – non-hazardous	167,65
Deposition	729,54
Waste from combustion	3.005,33
Soil waste	9.827,26
Waste from excavation	71.027,10
Industrial waste disposition	945.761,30
Paper and cardboard waste	483.859,40
Rubber waste	1.650,89
Plastics waste	8.792,21
Wood waste	1.398,89
Textile waste	721,05
Animal waste and mixed food waste	2.408,00
Agricultural waste	3.427,89
Animal manure and urine	86.099,50
TOTAL	**1.633.651,33**

Table 211 Activity data for source category 5.A - Solid waste disposal on land for the period 1990-2020

Year	Municipal Waste in Gg	Industrial Waste in Gg	Total Waste in Gg	Methane Emission in m³
1990	198	197	956.970	55.880.395
1991	209	208	866.923	56.799.402
1992	221	222	762.066	57.288.296
1993	233	236	692.189	57.303.851
1994	246	235	711.155	57.013.027
1995	260	250	802.077	56.816.648
1996	274	267	840.913	56.979.209
1997	289	283	885.602	57.269.171
1998	305	301	935.614	57.703.436
1999	321	319	999.662	58.295.947
2000	339	339	1.108.203	59.095.131
2001	358	359	1.180.774	60.271.499
2002	378	377	1.218.358	61.657.934
2003	399	875	1.273.595	63.105.610
2004	463	914	1.376.957	64.676.555
2005	572	1004	1.575.993	66.499.410
2006	589	1090	1.678.902	68.886.318
2007	606	1214	1.819.752	71.554.400
2008	714	1350	2.064.464	74.645.308
2009	726	1350	2.075.591	78.427.384
2010	721	1423	2.144.393	82.054.979
2011	735	1511	2.245.923	85.797.193
2012	787	1519	2.306.024	89.753.957
2013	793	1634	2.426.435	93.688.590
2014	765	1634	2.398.807	97.918.081
2015	786	1634	2.419.833	100.560.449
2016	797	1634	2.430.236	104.436.069
2017	787	1634	2.420.537	108.152.584
2018	855	1634	2.488.516	111.664.029
2019	916	1634	2.549.594	115.213.404
2020	913	1634	2.546.684	118.723.324

Emission Factors

As for the emission calculations the IPCC waste model was applied, the default parameters and factors were used as set in the excel calculation sheet for Southern European Countries with dry temperature.

Table 212 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
exp1 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 CH4	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.

NMVOC, CO and NH_3 were estimated based on the landfill gas emitted. Therefore methane emission have been converted to landfill gas in m³ by consideration of the CH_4 concentration in the landfill gas and by taking into account the absolute density of CH_4. Based on that emissions for NMVOC, CO and NH_3 were calculated.

Table 213 Data for conversion of methane emissions to NMVOC, CO and NH_3 emissions for category 5A - Biological treatment of waste

Parameter	CH_4	NMVOC	CO	NH_3
Relative density	0.555	0.555	0.967	-
Absolute density [kg/Nm3] bei 30°C	0.650	0.72	1.13	-
Concentration in landfill gas [%] (Cd, Hg, Pb, NMVOC, NH3 in mg/m3)	55	300	2	10

The emission factors used to calculate emission from particulate matter are as outlined in the GB 2016 for source category 5.A.

Table 214 Emission factors for source category 5.A- Biological treatment of waste

Pollutant	Value	Unit	Reference
NMVOC	1.56	kg/Mg	GB 2016 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land
TSP	0.463	g/Mg	GB 2016 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land
PM10	0.219	g/Mg	GB 2016 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land
PM2.5	0.33	g/Mg	GB 2016 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land

For NO_x and SO_x, heavy metals except Hg and POPs the notation key NA was used. For NH_3,Hg and CO the notation key NE was used – as outlined in the GB 2016.

7.2.2. Source-specific uncertainties and time-series consistency

Uncertainties of activity data and emission factors have been estimated by using Tier 1 methodology of the EMEP/EEA GB 2013.

Table 215 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%		

7.2.3. Source-specific QA/QC and verification

The calculation has been checked by waste management experts and the used parameters and factors have been discussed. Therefore, the 4-eye principle was applied. Internal documentation was written to allow for transparency and reproduction in the following years.

The results have been compared to emission estimates from other countries, to check if the range of magnitude is right.

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

No recalculations were done in this category.

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

No plans improvement for the next reporting.

7.3. Biological treatment of waste-Composting-NFR 5.B.1

7.3.1.1. Methodological issues

Small amount of organic domestic waste is gathered separately. Composting the organic waste produces a reusable product. Emissions to air from this source category include odors; also, small amounts of ammonia are produced. We use the Tier 2 method, to calculate the emission of NH3 since it is expected that it is easier to obtain the necessary input data for this approach. Emissions from this category arise according to recommendation of the stage 3 review process.

Activity data

The activity data for source category-5.B.1 is part of organic municipal waste in (kt) which is composted. The data are gathered from Annual reports from the Major of the municipalities which are submitted to the Ministry of Environment and Physical Planning each year.

Table 216 Activity data for source category 5.B.1 – Waste composted 1990-2020

Year	Waste composted in kt	Year	Waste composted in kt
1990	NO	**2005**	NO
1991	NO	**2006**	NO
1992	NO	**2007**	NO
1993	NO	**2008**	NO
1994	NO	**2009**	0.4984
1995	NO	**2010**	0.3106

Year	Waste composted in kt	Year	Waste composted in kt
1996	NO	**2011**	0.947
1997	NO	**2012**	0.73872
1998	NO	**2013**	0.4378
1999	NO	**2014**	1.94515
2000	NO	**2015**	2.80664
2001	NO	**2016**	2.23885
2002	NO	**2017**	1.11532
2003	NO	**2018**	0.7455
2004	NO	**2019**	0.55
		2020	0.44

Emission Factors

Tier 2 emission factors for source category 5.B.1 Biological treatment of waste - composting, compost production is 0.24 for the emission of NH_3.

7.3.2. Source-specific uncertainties and time-series consistency

Time series consistency is ensured by applying the same methodology for the whole time series.

7.3.3. Source-specific QA/QC and verification

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

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

Emissions coming from the category 5.B.1, category was calculated for the period from 2009 till 2020. Waste composted started from 2009. From 1990 till 2008 waste composting didn't occur in our country.

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

Activity data were received from several out of 84 municipalities. Emissions are underestimated in this sector. We intend to improve the process of collection the data and information about the biological treatment of waste-composting. The information and data currently are underestimated.

7.4. Clinical Waste incineration - NFR 5.C

7.4.1. 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.

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 2000-2020 were taken from the "Drisla" landfill website [38].

Table 217 Quantity of clinical waste incinerated in the period 2000–2020

Year	Clinical waste[Gg]	Year	Clinical waste [Gg]
2000	0.115	**2010**	0.465
2001	0.232	**2011**	0.600
2002	0.249	**2012**	0.677
2003	0.255	**2013**	0.727
2004	0.323	**2014**	0.726
2005	0.376	**2015**	0.962
2006	0.329	**2016**	1.023
2007	0.357	**2017**	1.064
2008	0.362	**2018**	0.971
2009	0.416	**2019**	0.996
		2020	1.073

Emission Factors

The emission factors used are as outlined in the GB 2019 and presented in the following table. Due to installation of filter for the period 2018-2020 the EF from the 2009 Guidebook were used. This Guidebook has EF for this type of reduction technics- Type 2 plant: larger on-site facilities equipped with de-dusting systems, while in the GB 2019, only EF for BAT are provided.

Table 218 Emission factors for source category 5.c.1.dii - Clinical waste incineration

Pollutant	Value	Unit	References
SO_2	1.1	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
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
Hg	5.4	g/Mg	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii

Pollutant	Value	Unit	References
		waste	Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
As	0.1	kg/g waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
Ni	0.4	kg/g waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
PCB	0.02	g/Mg waste	GB 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	mg/Mg waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
HCB	0.1	g/Mg waste	GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8
NOx	1.4	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
CO	2.8	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
NMVOC	0.7	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
SOx	1.4	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
TSP	0.5	kg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Pb	63.2	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Cd	7.35	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Hg	4.47	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
As	1.3	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Cr	4.7	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Cu	2.6	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Ni	0.4	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
PCB	0.02	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
PCDD/PCDF	0.141	mg I-Teq/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
Total 4 PAHs	0.04	mg/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13
HCB	0.1	g/Mg waste	GB 2009, Table 3-5, Tier 2 emission factors for source category, 6.c.a, Clinical waste incineration, Type 2 plants, page 13

7.4.2. Source-specific uncertainties and time-series consistency

In the NFR sector 5.C the activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment for SO_x, NO_x 125% (rating C) for NMVOC. No uncertainty analysis was done for the other pollutants.

7.4.3. Source-specific QA/QC and verification

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

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

Recalculation were implemented in this category due to recalculated activity data announced by the company on their official web page for period 2011-2019.

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

The ERT recommends North Macedonia to develop a higher Tier method, as in line with Reporting Guidelines paragraph 21 for key categories Parties should make every effort to use a Tier 2 or higher (detailed) methodology, including country-specific information. Higher Tier method will be used in the future submission.

7.5. Open burning of waste- NFR 5.C.2

7.5.1. Methodological issues

The simpler methodology involves the use of a single emission factor for each pollutant representing the emission per mass of waste burned, combined with activity statistics:

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

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*25/1000=12.969

Activity data

Data on arable farmland taken from the statistical office and calculated waste burned are presented in the following table. Data on arable farmland are taken from State Statistical Office of the Republic of North Macedonia, Field crops, orchards and vineyards, 2007-2017 and MAKSTAT database [32].

Table 219 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	**2005**	546 000	13 650
1991	664 000	16 600	**2006**	537 000	13 425
1992	662 000	16 550	**2007**	529 000	13 225
1993	663 000	16 575	**2008**	521 000	13 025
1994	661 000	16 525	**2009**	513 000	12 825
1995	656 000	16 400	**2010**	504 000	12 600
1996	658 000	16 450	**2011**	511 000	12 775
1997	647 000	16 175	**2012**	510 000	12 750
1998	635 000	15 875	**2013**	509 000	12 725
1999	633 000	15 825	**2014**	511 579	12 789
2000	598 000	14 950	**2015**	513 564	12 839
2001	612 000	15 300	**2016**	516 644	12 916
2002	577 000	14 425	**2017**	516 870	12 922
2003	569 000	14 225	**2018**	518 740	12 969
2004	560 000	14 000	**2019**	519 848	12 996
			2020	517 039	12 926

<u>Emission Factors</u>

The emission factors used are as outlined in the GB 2019 for source category 5.C.2.

Table 220 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

Pollutant	Value	Unit	References
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
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

7.5.2. Source-specific uncertainties and time-series consistency

See chapter 5.3.2.

7.5.3. Source-specific QA/QC and verification

See chapter 5.3.3.

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

No recalculations were made in this category.

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

No planned improvements.

7.6. Waste water treatment - NFR 5.D.1 and 5.D.2

7.6.1. Methodological issues

In Macedonia there are seventeen wastewater treatment plants, they have been contacted to get data plant specific data and especially the amount of domestic wastewater treated in the plants. Based on the data received by the plants, emission was calculated based on a Tier 1 approach.

It was also attempted to gain data on how much people are connected to waste water treatment. The data from Eurostat provide values for several years, in the range of 5-7%. Another information was found in the SOER country profile for Macedonia (see below), mentioning that “Sixty percent of dwellings are connected to a public sewage system, 21% have septic tanks and another 19% have only a system of uncontrolled wastewater discharge “. According to the BC experts, this number seems right concerning the connection to the sewage system, but when it comes to the connection to waste water treatment plants, the percentages provided by EUROSTAT seem reliable. Still, this information is not sufficient to decide on how many people are using latrines or skeptic tanks, which serve as activity data for NH3 emissions. For this reason, NH_3 emissions from 5.D cannot be calculated with the available data. However, in order to also report on NMVOC emissions from 5.D, the amount of wastewater from households and industries is needed.

With regards to the 5.D.2, Industrial facilities send the information about their waste water treated in their waste water treatment plants through questionnaires send to them by the State Statistical Office. The results for the quantity of wastewater treated and emissions calculated based on a Tier 1 approach of NMVOC are underestimated.

Activity data

Activity data on wastewater handled in treatment plants are presented in the following table:

Table 221 Activity data for source category 5.D.1 - Wastewater treatment-(1990-2020)

Year	Water treated [m^3]	Year	Water treated [m^3]
1990	14 690 160	**2006**	16 250 900
1991	15 320 880	**2007**	15.304.820
1992	14.374.800	**2008**	16.093.220
1993	15.636.240	**2009**	21.187.840
1994	15.320.880	**2010**	21.698.560
1995	14.374.800	**2011**	21.113.200
1996	14.847.840	**2012**	22.836.899
1997	15.163.200	**2013**	21.079.644
1998	15.793.920	**2014**	24.709.351
1999	15.951.600	**2015**	25.322.341
2000	14.532.480	**2016**	12.675.451
2001	15.478.560	**2017**	9.639.664
2002	14.374.800	**2018**	21.395.408
2003	15.163.200	**2019**	36.126.117
2004	15.462.500	**2020**	47.746.743
2005	16 408 580		

Table 222 Activity data for source category 5.D.2 – Industrial Wastewater treatment-(1990-2020)

Year	Water treated [m^3]	Year	Water treated [m^3]
1990	NO	**2006**	132.976.000
1991	NO	**2007**	349.927.000
1992	7.449.000	**2008**	94.786.000
1993	24.469.000	**2009**	49.593.000
1994	35.479.000	**2010**	20.131.000
1995	46.489.000	**2011**	77.573.000
1996	19.298.000	**2012**	92.492.000
1997	33.157.000	**2013**	230.053.000
1998	47.016.000	**2014**	12.161.000
1999	22.002.000	**2015**	16.188.000
2000	15.197.000	**2016**	12.620.000
2001	3.728.000	**2017**	242.036.000

Year	Water treated [m^3]	Year	Water treated [m^3]
2002	41.461.000	**2018**	351.131.000
2003	45.879.000	**2019**	6.823.420
2004	NE	**2020**	220.391.000
2005	132.976.000		

The emission factors applied are the given ones in the EMEP 2019 guidebook, which allowed the calculation of NMVOC emission from domestic wastewater handling. The emission factor used is 15mg NMVOC per m^3 wastewater. There is an available emission factor on ammonia but it has not been used for calculation of ammonia emissions, because until now there is no available data on number of people connected to latrines.

7.6.2. Source-specific uncertainties and time-series consistency

In the NFR sector 5.D the activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 125% (rating C) for NMVOC. Time series consistency is ensured by applying the same methodology for the whole time series.

7.6.3. Source-specific QA/QC and verification

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

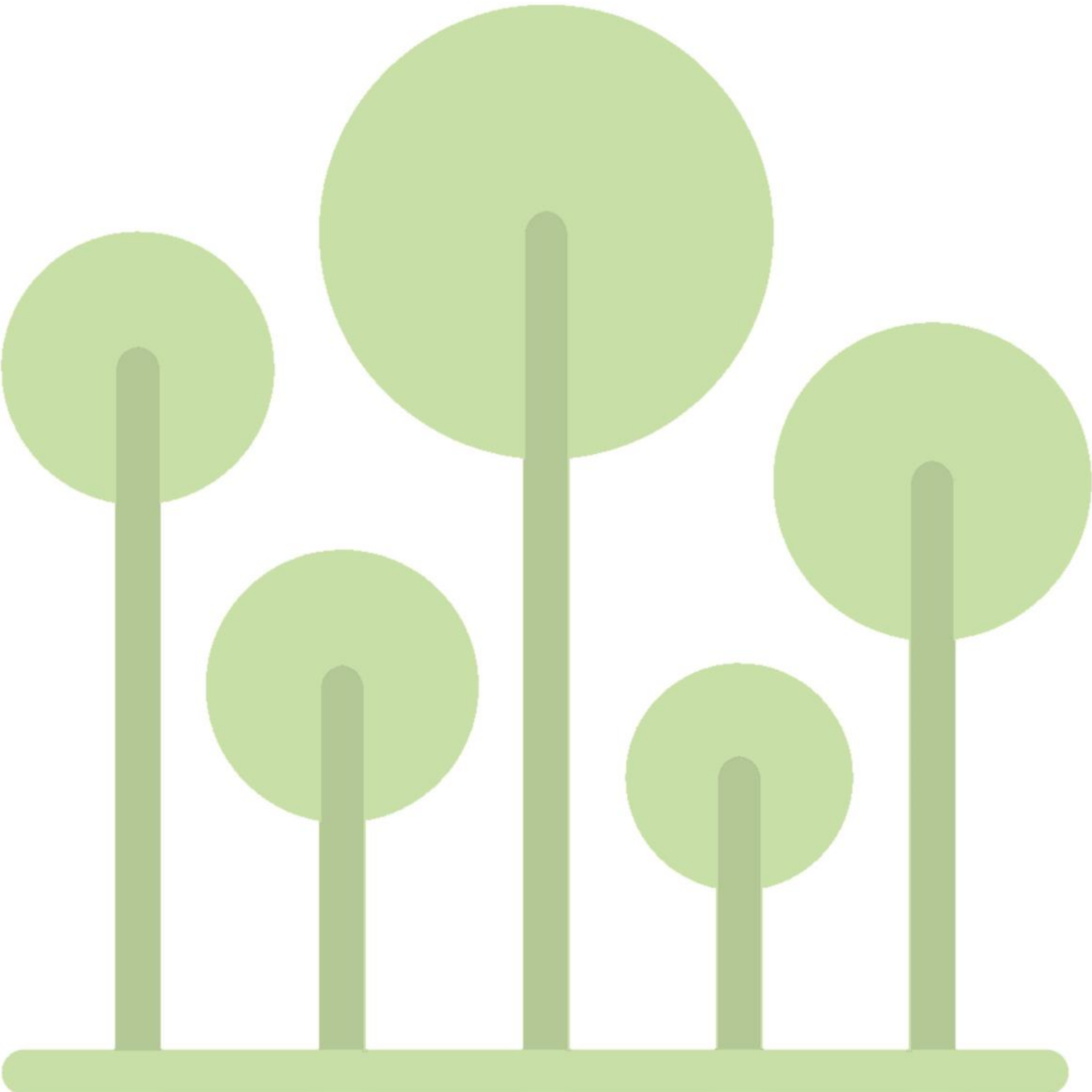
7.6.4. Source-specific recalculations including changes made in response to the review process

No recalculations were made in this category.

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

Activity data were received from sixteen out ofseventeen wastewater treatment public plants. It is expected that all data will be collected for the next submission, because emissions are underestimated in this sector. Data on number of people connected to latrines will be required from the relevant institution. We intend to improve the process of collection the data and information about industrial wastewater treatment plants and quantity of treated wastewater. The information and data currently are underestimated regarding the industrial wastewater treated. The information about latrine will be available in the next census in our country which is planned to be held this year.

NATURAL SOURCES



8. NATURAL SOURCES

8.1. Sector overview

This chapter describes emissions from (naturally or man-induced) burning of non-managed and managed forests and other vegetation, excluding agricultural burning of stubble, etc. This includes domestic fires (fuel wood, crop residue, dung and charcoal burning), as well as open vegetation fires (forest, shrub, grass and cropland burning).

In this Inventory Report, this chapter shows emissions, which originated from open vegetation forest fires.

This sector includes information and description of the methodologies applied for estimating emissions for NMVOC, NH_3, NOx, SOx, PM10, PM2.5, TSP CO and BC as well as references to activity data and emission factors concerning emissions coming from the forest fires for the period 1990-2020.

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 223 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 224 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	4 807	711 782	548 072 140
2001	5 255	88 260	67 960 200
2002	5 482	24 661	18 989 186
2003	1 922	10 987	8 459 990
2004	1 798	4 322	3 328 171
2005	3 093	1 063	8 185 510
2006	3 594	12 978	9 993 060
2007	34 443	617 678	475 612 060
2008	15 046	35 652	27 452 425
2009	1 030	1 551	1 194 270
2010	4 725	2 033	1 565 410
2011	8 702	55 743	42 922 341
2012	19 312	102 160	78 663 200
2013	2 844	15 268	11 756 090
2014	1 150	19 152	14 747 040
2015	3 165	32 494	25 020 380
2016	2 166	17 573	13 531 749
2017	13 405	82 981	63 895 455
2018	2 823	5786	4 455 205
2019	15 675	95 940	73 872 414
2020	1234	8138	6266260

8.3.1.2. Emission factors

Calculation of emission parameters was used, and emission factors were taken from the GB 2019.

Table 225 Emission factors for source category 11.B Forest fires

Pollutant	Value	Unit	References
NOx	100	kg/ha area burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
CO	3000	kg/ha area burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
NMVOC	300	kg/ha area burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
SOx	20	kg/ha area burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
NH_3	20	kg/ha area burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
PM10	11	g/kg wood burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
PM2.5	9	g/kg wood burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
TSP	17	g/kg wood burned	GB 2019, 11B Forest fires, Table 3-1, pg. 9
BC	9	%PM2.5	GB 2019, 11B Forest fires, Table 3-1, pg. 9

In the Statistical Yearbooks from 2000-2016 [22] there is data for wood burned in m^3. Calculation is made for wood burned in kg using the equation: average density 0.77 kg/m^3 *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.

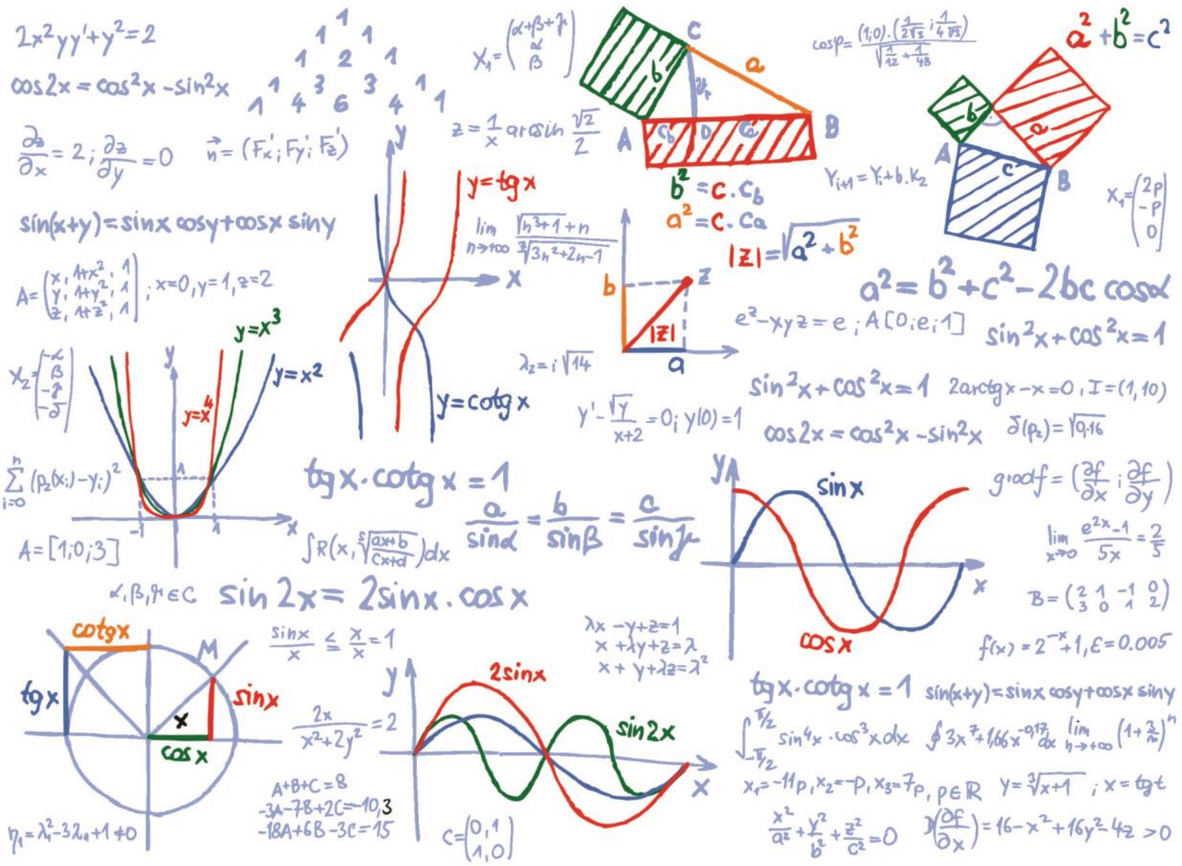
8.3.4. Source-specific recalculations including changes made in response to the review process

No recalculations were done in this sector.

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

It is possible to investigate other natural sources but emissions coming from this category are not calculated in national totals and the rate of importance is considered low compare to other categories.

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 due to use of final energy balans for 2019 as well as due to implementation of several remarks given in the Stage 3 review report that have not been implemented in the previous cycle, use of Tier 2 and Tier 3 methodology and recalculation in several categories like 1A3b and 2D3g. Explanations for recalculation per sector are given in the respective chapters. The tables indicating recalculations per pollutant can be found in tables 226-240.

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 2019 in stead of preliminary data. Additional corrections were done in the NFR categories 1.A.1.a and 1.A.b.a in compliance with Stage 3 review remarks.

Transport (NFR 1.A.3)

In this sector major recalculations were done due remarks given in the Stage 3 review report – sector Transport.. The major impact is for emission data coming from transport due to implementation of COPERT V model for calculation of emission data for the period 2005-2020. Moreover BC emissions were calculated from following categories: 1.A.3.ai (i), and 1.A.3.aii (i), 1.A.3.c, 1.A.3.b. Additionally, minor recalculations were done due to change of activity data for 2019 from preliminary fuel consumption data to final consumption data.

Industrial processes and product use (NFR 2)

Tier 2 method was implemented for calculation of emissions coming from category 2.D.3.a. Moreover historical emissions coming from coffiee roasting for period 2000-2006 were estimated due to availability of activity data.

Agriculture (NFR 3)

No recalculations were done in this sector.

Waste (NFR 5)

Recaluations were done for NH_3 emissions coming from 5.A due to omitted formula linkage in the excel calculation sheet.

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 2019 national totals.

Table 226 Recalculation difference of NOx emissions [kt] compared to submission in 2020

NOx emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	0%	0.01	0%
1A2	Manufacturing Industries & Construction	0.00	0%	-0.22	-5%
1A3	Transport	0.00	0%	-1.84	-18%
1A4	Other Sectors	0.00	0%	-0.03	-2%
1B	Fugitive Emissions	0.00	0%	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	0%	0.00	0%
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-2.09***	***-9%***

Table 227 Recalculation difference of NMVOC emissions [kt] compared to submission in 2020

NMVOC emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.01	2%
1A3	Transport	0.00	0%	0.82	56%
1A4	Other Sectors	0.00	0%	-0.32	-6%
1B	Fugitive Emissions	0.00	0%	0.00	0%
2	Industrial Processes and Product Use	-0.71	-6%	0.17	2%
3	Agriculture	0.00	0%	0.00	0%
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***-0.71***	***-2%***	***0.68***	***3%***

Table 228 Recalculation difference of SO_2 emissions [kt] compared to submission in 2020

SO_2 emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.19	3%
1A3	Transport	0.00	0%	0.91	1760%
1A4	Other Sectors	0.00	0%	-0.05	-11%
1B	Fugitive Emissions	0.00	0%	0.00	-
2	Industrial Processes and Product Use	-1.65	-100%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	-3%
6	Other	0.00	-	0.00	-
Total	***Total emissions***	***-1.65***	***-1%***	***1.05***	1%

Table 229 Recalculation difference of NH_3 emissions [kt] compared to submission in 2020

NH_3 emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	-	0.00	-
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	-
1A3	Transport	0.00	0%	-0.04	-28%
1A4	Other Sectors	0.00	0%	-0.04	-8%
1B	Fugitive Emissions	0.00	-	0.00	-1%
2	Industrial Processes and Product Use	0.00	0%	0.00	-
3	Agriculture	0.00	0%	0.00	0%
5	Waste	0.00	-	0.00	-
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-0.08***	***-1%***

Table 230 Recalculation difference of PM2.5 emissions [kt] compared to submission in 2020

PM2.5 emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	-	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	-	0.02	2%
1A3	Transport	0.00	-	-0.07	-15%
1A4	Other Sectors	0.00	-	-0.46	-8%
1B	Fugitive Emissions	0.00	-	0.00	0%
2	Industrial Processes and Product Use	0.00	-	0.00	0%
3	Agriculture	0.00	-	0.00	0%
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-0.51***	***-6%***

Table 231 Recalculation difference of PM10 emissions [kt] compared to submission 2020

PM10 emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	-	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	-	0.02	2%
1A3	Transport	0.00	-	-0.14	-28%
1A4	Other Sectors	0.00	-	-0.47	-8%
1B	Fugitive Emissions	0.00	-	0.00	0%
2	Industrial Processes and Product Use	-0.01	-	0.00	0%
3	Agriculture	0.00	-	0.00	0%
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	-0.01	***0%***	-0.59	-4%

Table 232 Recalculation difference of TSP emissions [kt] compared to submission in 2020

TSP emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	-	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	-	0.02	2%
1A3	Transport	0.00	-	-0.21	-28%
1A4	Other Sectors	0.00	-	-0.49	-8%
1B	Fugitive Emissions	0.00	-	0.00	0%
2	Industrial Processes and Product Use	-0.01	-	0.00	0%
3	Agriculture	0.00	-	0.00	0%
5	Waste	0.00	-	0.00	0%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***-0.01***	***0%***	***-0.68***	***-4%***

Table 233 Recalculation difference of CO emissions [kt] compared to submission in 2020

CO emissions [kt]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.06	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.19	3%
1A3	Transport	0.00	0%	2.90	38%
1A4	Other Sectors	0.00	0%	-2.40	-7%
1B	Fugitive Emissions	0.00	0%	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	0%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.06***	***0%***	***0.70***	***1%***

Table 234 Recalculation difference of Pb emissions [t] compared to submission in 2020

Pb emissions [t]		1990		2019	
		Δ019	Δ01	Δ019	Δ01
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.03	4%
1A3	Transport	0.00	0%	-0.19	-69%
1A4	Other Sectors	0.00	0%	0.01	2%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	-6%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-0.15***	***-5%***

Table 235 Recalculation difference of Cd emissions [t] compared to submission in 2020

Cd emissions [t]		1990		2019	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-2%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	4%
1A3	Transport	0.00	0%	0.01	372%
1A4	Other Sectors	0.00	0%	-0.01	-8%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	-5%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***0.00***	***-1%***

Table 236 Recalculation difference of Hg emissions [t] compared to submission in 2020

Hg emissions [t]		1990		2019	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	4%
1A3	Transport	0.00	0%	0.00	-100%
1A4	Other Sectors	0.00	0%	0.00	-14%
1B	Fugitive Emissions	0.00	0%	0.00	-1%
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	0%	0.00	-
5	Waste	0.00	0%	0.00	-6%
6	Other	0.00	0%	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***0.00***	***-1%***

Table 237 Recalculation difference of PCDD/ PCDF emissions [t] compared to submission in 2020

PCDD/ PCDF emissions [t]		1990		2019	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.05	4%
1A3	Transport	0.00	-	0.00	-
1A4	Other Sectors	0.00	0%	-0.50	-8%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	-0.01	-3%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-0.46***	***-5%***

Table 238 Recalculation difference of PAHs emissions [t] compared to submission in 2020

PCDD/ PCDF emissions [t]		1990		2019	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	0%	0.00	0%
1A2	Manufacturing Industries & Construction	0.00	0%	0.02	3%
1A3	Transport	0.00	-	-0.01	0%
1A4	Other Sectors	0.00	0%	-0.22	-8%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	0%	0.00	-
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-0.20***	***-6%***

Table 239 Recalculation difference of HCB emissions [kg] compared to submission in 2020

HCB emissions [kg]		1990		2019	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	-
1A2	Manufacturing Industries & Construction	0.00	0%	0.00	4%
1A3	Transport	0.00	-	0.00	-
1A4	Other Sectors	0.00	0%	0.00	-8%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	-	-0.01	-6%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	***0.00***	***0%***	***-0,01***	***0%***

Table 240 Recalculation difference of PCB emissions [kg] compared to submission in 2020

PCB emissions [kg]		1990		2019	
		Δ kt	Δ %	Δ kt	Δ %
1A1	Energy Industries	0.00	-	0.00	-
1A2	Manufacturing Industries & Construction	0.00	0%	0.04	4%
1A3	Transport	0.00	-	0.00	-
1A4	Other Sectors	0.00	0%	-0.05	-10%
1B	Fugitive Emissions	0.00	-	0.00	-
2	Industrial Processes and Product Use	0.00	0%	0.00	0%
3	Agriculture	0.00	-	0.00	-
5	Waste	0.00	-	0.00	-6%
6	Other	0.00	-	0.00	-
Total	**Total emissions**	0.00	0%	-0.01	0%

9.2. Improvements

Improvements made

The following table presents issues flagged by the CLRTAP stage 3 in 2020 that were not implemented in the previous round as well as well as findings by the sectorial experts. Planned improvements at sector level are described in the respective sector chapters.

Table 241 Findings from step 3 Reviews 2020 and National emission inventory team (NEIT) and improvements made

Category	Subject	Source	rating	Improvement made
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	NEIT	Medium	The HCB emissions were properly calculated and reported
1.A.1.b	Use of GB 2019 Emission factors	NEIT	Medium	The 2019 GB emission were used in calculations
1.A.3.b	ERT noticed the inconsistency of data in road transport. There is a need to use the same methodology	CEIP/S3.RR/ 2016/North Macedonia	High	COPERT V model was used for emission calculations for period 2005-2020
1.A.3.a and 1.A.3.b	The ERT noted that BC emissions from 1A3ai (i), and 1A3aii (i), 1A3c, 1A3b emissions are not reported	CEIP/S3.RR/ 2016/North Macedonia § 20	Low	Black carbon emissions were calculated for these categories
1.A.3.c	The ERT recommended use of higher tier methodology	CEIP/S3.RR/ 2020/North Macedonia	Low	Tier 2 was implemented for 2020 emissions due to avalible data
1.A.3.ei	The ERT recommends that the party contacts the gas supplier in order to find out if compressor stations are used in the FYROM and which technologies they use to maintain the pressure in the pipelines.	CEIP/S3.RR/ 2016/North Macedonia	Low	The National inventory team has contacted the gas supplier and recive information that stations are on electricity, therefore the notation key NO-Not occurring is inserted for the whole seria and this is explain in the IIR.
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 household’s maybe used ad surrogate data.	CEIP/S3.RR/ 2016/North Macedonia	Low	Recalculation was made in this sector using households data as surrogate data
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.	CEIP/S3.RR/ 2016/North Macedonia		Information on reason why these emissions are not estimated is included in this IIR
1.A.5.a	In the IIR it is stated that this sector is not estimated due to lack of activity data and that it seems not to have a major impact on the national emissions and will be calculated or categorized as IE when activity data or information are made available in the future submissions. The ERT recommends that North Macedonia	CEIP/S3.RR/ 2016/North Macedonia	1.A.5.a	Emission from this sector are IE and information is included in the IIR

	includes this issue in their planned improvements and follows up on them.			
2H	Check quality of historical data for wine production	Twinning mission report No. 24/2016	Low	Information on different methodology for gathering statictical activity data is explained in the IIR.
2.D.3c	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.	NEIT	Low	Notation key has been changed.
2.D.3 g	During the review the ERT looked through the activities that are included in the inventory under the category 2D3g and noted that some of the activities that are covered in the Guidebook 2019 version are not included in the inventory of North Macedonia, such as: Asphalt blowing. Adhesive tape manufacturing. Pharmaceutical products manufacturing. Textile finishing and Manufacture of tires. In the IIR on p. 213, there is information about the plan to check the availability of data on Textile finishing and Pharmaceutical products manufacturing and to report the related emissions in the following submissions. However, there is no information on why activities like Asphalt blowing. Adhesive tape manufacturing and Manufacture of tires are not included.	CEIP/S3.RR/ 2020/North Macedonia	High	Informamation is included in the IIR

Planned improvements

In the following table the planned improvements that are listed were recommended during the CLRTAP stage 3 reviews 2020 but were not implemented up to now and are planned to be implemented in the future. The improvements are structured as general issues (Table 242) and sector improvements (Table 243). In accordance with the recommendations given in the stage 3 Review report improvements are prioritized in accordance with the KCA and the uncertainty analysis.

Table 242 Planned improvements (general issues)

Subject	Source	Rating	Improvement planned	Timeline/Comments
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 – it is planned to prepare projections in IPA technical project during 2023-2024.
Recalculations to be quantified for the	Peer-Review 2016	Low	Depends on possibility to	Planned to be

Subject	Source	Rating	Improvement planned	Timeline/Comments
whole time series. currently (i.e. Submission 2017) only for 1990 and 2019			make it due to limited capacities, but it will be done for future submissions.	implemented in the following submissions – it is planned to prepare projections in IPA technical project during 2023-2024
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. it is concedered to be preparing in the forthcoming IPA project.	2023-2024

Table 243 Sectorial improvements planned

NFR Category	Subject	Source	rating	Timeline/Comments
1.A.3.b	The Tier 3 COPERT V method needs to be implemented for calculations for period 1990-2004. Due to limitation of reliable activity data this activtity needs to be implemented with technical support.	CEIP/S3.RR/2020/North Macedonia	High	It is considered to use Tier 3 method for the historical data during expert missions in the forthcoming IPA II project (2023-2024) within the activities for improvement of emission inventory
1.A.3.c	Tier 2 method was used only for 2020 if data are gathered the Tier 2 method will be implemented for previous years	CEIP/S3.RR/2020/North Macedonia	Low	2022-2023
1.A.4.bi	The ERT notes that Tier 1 methodology is still applied for key categories in the following sectors: 1A4bi: NMVOC, PM2.5, PM10, TSP, CO, BC, Cd, Cu, Ni, Zn, PCDD/F, PAHs	CEIP/S3.RR/2020/North Macedonia	High	2022-2023 Data from the census implemented in 2021 will be avalible for the next reporting round. It is expeted to move on higher Tier level.
2.C.3	There is a lack of available data on secondary aluminum production.	NEIT	Medium	It is considered to use Tier 2 method during expert missions in the forthcoming IPA II project (2023-2024) within the activities for improvement of emission inventory
2.C.5	There is a lack of available data on secondary lead production.	NEIT	Medium	Request for these data has been sent to SSO but data are still no
2.C.3 2.C.5	There is some uncertainty of activity data for, so there is a need of deeper analysis	NEIT	Medium	These analysis will be performed within the

NFR Category	Subject	Source	rating	Timeline/Comments
2.C.7.a	of the technological process.			forthcoming IPA II project (2023-2024) within the activities for improvement of emission inventory
2D3i and 2G	During the review, the ERT looked through the activities that are included in the inventory under the category 2D3g and noted that some of the activities that are covered in the Guidebook 2019 version are not included in the inventory of North Macedonia, such as: Asphalt blowing. Adhesive tape manufacturing. Pharmaceutical products manufacturing. Textile finishing and Manufacture of tires. In the IIR on p. 213, there is information about the plan to check the availability of data on Textile finishing and Pharmaceutical products manufacturing and to report the related emissions in the following submissions, however, there is no information on why activities like Asphalt blowing. Adhesive tape manufacturing and Manufacture of tires are not included.	CEIP/S3.RR/2020/North Macedonia	High	It is considered to use Tier 2 method during expert missions in the forthcoming IPA II project (2023-2024) within the activities for improvement of emission inventory
2.D.3.a. 2.D.3.e	ERT recommends the Party to move to the Tier 2 method for the next submission or as soon as possible or meanwhile to include this improvement into the improvement plan with clear steps and schedule and to report on progress of the work in the next submissions	CEIP/S3.RR/2020/North Macedonia § 20	High	It is considered to use Tier 2 method during expert missions in the forthcoming IPA II project (2023-2024) within the activities for improvement of emission inventory
2.D.3f	Use of population as activity data is uncertain. MEPP already sent questionnaires on amount of treated textile in dry cleaning shops but received only limited number of responses.	NEIT	Low	The procedures will be repeated during this year in order to gather representative quantity of treated wear but the questionare will be previously reviewed and if we receive good respond we will recalculate emissions coming from this category.
2A5a	According to IIR p. 183 North Macedonia doesn´t have a plan for improvement in category 2A5a. However, according to page 54 Table 8. 2A5a is a Key category for TSP in 2018. Since this is a key category. The ERT notes that using a Tier 1 method is not best practice, and could result in an over and/or underestimate of emissions.	CEIP/S3.RR/2010/North Macedonia	High	No activity data are avalibale currently. The NEIS system for data gathering is currently under establishement it is expected to recive more avalible data

NFR Category	Subject	Source	rating	Timeline/Comments
	The ERT is of the view that the use of a Tier 2 method could be possible for North Macedonia if activity data can be stratified according to the different techniques.			through it. 2023
11.C	Investigate and gather information for other natural sources	NEIT	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 program under NEC directive 2016/2284/EU
- Transposition of the revised NEC directive 2016/2284/EU in the national legislation.

Current situation

Projections for the main pollutants SO_x, NO_x, NMVOC and NH_3 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 SOx, NMVOC and NH_3 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 NOx, SOx 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 2020, but not for dust and sulfur oxides.

This plan will have impact on the current national emission projections for NOx, SOx and dust in this plan will also be taken into account in the process of calculation of 2030 projections for SOx, NOx and PM2.5.

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.

One of the planned activities of the project Technical project under IPA 2 program "Support for implementation of air quality directives", is further improvement of the national air emission inventory and preparation of National emission projections under NEC directive 2016/2248/EC. The second stage of evaluation of the project was finalized and the project was canceled by the EU delegation. The project need to be reanaunced and it is expected to start next year giving an opportunity to report projections in 2024 at earliest stage.

11. REPORTING OF GRIDDED EMISSIONS AND LPS

Republic of North Macedonia has reported gridded and LPS data in 2021 for 2019 reporting year and they are available on CDR Eionet web page as well gridded data for 2019 but reported with delay after the deadline of 1 May. In this IIR a short description on the methodology of calculation of these emissions are presented.

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 these missions several proxy tools were developed:

- DISTRIBUTE_MUNICIPAL_VALUES_via_PROXY_GRID.xlsm
- DISTRIBUTE_REGIONAL_VALUES_via_PROXY_GRID.xlsm
- DISTRIBUTE_TOTAL_VALUES_via_PROXY_GRID.xlsm
- LPS_to_GRID.xlsm
- Road_proxy_calculation.xlsm
- Farm_and_farmland_proxy_calculation.xlsm

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 were taken into account. Ferro metals and Incineration of medical waste as well as big swine and poultry farms were allocated in the grids according 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. For this year reporting calculation of emissions per grid from 2.K were added.

With regards to LPS reporting in 2019, emissions from 10 LPS were reported, six coming from the category 1.A.1a for electricity and heat production, one in category 2.A.1, two in 2.C.1, and one in 2.C.2. Data on CO, NOx, SOx 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 NOx and SOx 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 has been used for calculation of emissions coming for gridded emissions in 2021.

12. ADJUSMENTS

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 APPENDEXIS

Appendix 1: National energy balance 2020
Appendix 2: NFR 2020

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APPENDIX 1 National energy balance 2020

Part 1

Снабдување и потрошувачка	Камен јаглен / Hard coal	Кокс / Coke	Суб-битуми-нозен јаглен / Sub-bituminous coal	Лигнит / Lignite	Вкупно нафтени продукти / Total petroleum products	ТНГ / LPG	Моторен бензин / Motor spirit	Керозини, млазни горива / Kerosenes, jet fuels	Дизел за транспорт / Road diesel	Нафта за ложење (екстра лесно) / Heating and other gasoil	Мазут / Residual fuel oil	Нафтен (петролејски) кокс / Petroleum coke	Supply and consumption
	000 тони/'000 tonnes												
Бруто-примарно производство	-	-	-	5028,737	-	-	-	-	-	-	-	-	Total primary production
Увоз	1,011	0,536	140,232	32,418	1149,500	67,310	85,189	18,425	619,177	36,554	80,803	182,324	Imports
Салдо на залихи	6,894	0,108	-36,472	38,318	-33,829	0,254	-0,885	-0,239	-19,132	0,986	5,181	-19,950	Stock change
Извоз	0,050	-	0,537	-	103,364	1,741	8,834	9,202	51,299	-	1,730	28,652	Exports
Вкупно потребна енергија	7,855	0,644	103,223	5099,473	1012,307	65,823	75,470	8,983	**548,745**	**37,540**	**84,254**	**133,722**	**Gross inland consumption**
Енергија за енергетски трансформации	-	-	-	5051,375	26,829	-	-	-	-	-	26,829	-	Transformation input
Термоцентрали	-	-	-	5051,375	26,829	-	-	-	-	-	26,829	-	Public thermal power stations
Комбинирани електрани	-	-	-	-	-	-	-	-	-	-	-	-	Autoprod. thermal power stations and CHP plants
Биогасни централи	-	-	-	-	-	-	-	-	-	-	-	-	Biogas plants
Јавни котларници	-	-	-	-	-	-	-	-	-	-	-	-	Main activity producer heat plants
Производство на трансформирана енергија	-	-	-	-	-	-	-	-	-	-	-	-	Transformation output
Термоцентрали	-	-	-	-	-	-	-	-	-	-	-	-	Public thermal power stations
Комбинирани електрани	-	-	-	-	-	-	-	-	-	-	-	-	Autoprod. thermal power stations and CHP plants
Биогасни централи	-	-	-	-	-	-	-	-	-	-	-	-	Biogas plants
Јавни котларници	-	-	-	-	-	-	-	-	-	-	-	-	Main activity producer heat plants
Размена	-	-	-	-	0,068	-	-	-	0,068	-	-	-	Exchanges and transfers, returns
Потрошувачка во енергетскиот сектор	-	-	-	-	1,856	-	-	-	1,025	-	0,831	-	Consumption of the energy branch
Загуби при пренос и дистрибуција	-	-	-	-	-	-	-	-	-	-	-	-	Distribution losses
Расположливо за финална потрошувачка	7,855	0,644	103,223	48,098	983,690	65,823	75,470	8,983	**547,788**	**37,540**	**56,594**	**133,722**	**Available for final consumption**
Финална неенергетска потрошувачка	-	-	-	-	57,771	-	-	-	-	-	-	-	Final non-energy consumption
Финална енергетска потрошувачка	7,855	0,644	103,223	48,098	925,919	65,823	75,470	8,983	**547,788**	**37,540**	**56,594**	**133,722**	**Final energy consumption**
Индустрија	7,257	0,644	103,223	41,463	234,218	12,292	-	-	25,376	13,205	49,621	133,722	**Industry**
Индустрија за железо и челик	0,838	0,644	103,223	25,409	84,799	0,190	-	-	2,060	0,042	26,511	55,995	Iron & steel industry
Обоена металургија	-	-	-	-	1,254	1,207	-	-	0,022	0,025	-	-	Non-ferrous metal industry
Хемиска индустрија	-	-	-	-	1,108	0,004	-	-	0,093	0,375	0,635	-	Chemical industry
Индустрија за градежен материјал, стакло и керамика	6,419	-	-	13,250	94,189	6,710	-	-	1,023	1,811	6,919	77,727	Glass, pottery & building mat. industry
Индустрија за експлоатација на руди	-	-	-	-	11,968	0,020	-	-	11,685	0,263	-	-	Ore-extraction industry
Прехранбена индустрија, пијалаци и тутун	-	-	-	0,055	16,611	2,771	-	-	0,313	5,654	7,873	-	Food, drink & tobacco industry
Текстилна индустрија и кожарство	-	-	-	2,749	3,569	0,042	-	-	-	1,543	1,984	-	Textile, leather & clothing industry
Индустрија за хартија и печатење	-	-	-	-	0,542	0,081	-	-	-	0,158	0,302	-	Paper and printing
Инженерство и друга метална индустрија	-	-	-	-	6,305	1,145	-	-	0,263	1,054	3,842	-	Engineering & other metal industry
Останати индустрии	-	-	-	-	13,873	0,122	-	-	9,916	2,280	1,554	-	Other industries
Сообраќај	-	-	-	-	630,290	43,512	75,076	8,960	502,743	-	-	-	**Transport**
Железнички сообраќај	-	-	-	-	1,203	-	-	-	1,203	-	-	-	Railways
Патен сообраќај	-	-	-	-	620,083	43,512	75,031	-	501,540	-	-	-	Road transport
Воздушен сообраќај	-	-	-	-	9,004	-	0,044	8,960	-	-	-	-	Air transport
Останата потрошувачка	0,598	-	-	6,635	61,412	10,019	0,394	0,023	19,669	24,335	6,973	-	**Households, commerce, pub. auth., etc.**
Домаќинства	-	-	-	3,120	8,192	4,134	-	-	-	4,058	-	-	Households
Земјоделство	0,598	-	-	1,118	11,694	0,035	0,394	0,023	6,692	0,589	3,962	-	Agriculture
Други сектори	-	-	-	2,398	41,525	5,849	-	-	12,977	19,688	3,011	-	Other
Статистичка разлика	-	-	-	-	-	-	-	-	-	-	-	-	**Statistical difference**

[1)] Претходни податоци/Preliminary data

Part 2

Снабдување и потрошувачка	Други нафтени продукти / Other petroleum products	Природен гас / Natural gas	Геотермална топлина / Geothermal heat	Биомаса / Biomass	Брикети, пелети и дрвени отпадоци / Briquettes, pellets and wood residues	Хидро електрична енергија / Hydro electricity	Соларна електрична енергија / Solar electricity	Ветерна електрична енергија / Wind electricity	Биогас / Biogases	Биодизел / Biodiesel	Топлинска енергија / Derived heat	Вкупно електрична енергија / Electrical energy	Supply and consumption
		'000 m_n^3	'000 m^3		'000 тони/tonnes	GWh			TJ	'000 тони/tonnes	TJ	GWh	
Бруто-примарно производство	-	-	1556,158	991,317	11,969	1277,144	23,536	116,884	212,458	1,349	-	-	Total primary production
Увоз	59,718	339462,031	-	32,859	129,366	-	-	-	-	-	-	2965,204	Imports
Салдо на залихи	-0,042	35,184	-	11,176	-17,769	-	-	-	-	-1,281	-	-	Stock change
Извоз	1,905	-	-	0,069	0,363	-	-	-	-	-	-	638,598	Exports
Вкупно потребна енергија	**57,771**	**339497,215**	**1556,158**	**1035,283**	**123,203**	**1277,144**	**23,536**	**116,884**	**212,458**	**0,068**	**-**	**2326,606**	**Gross inland consumption**
Енергија за енергетски трансформации	-	285665,391	-	-	-	-	-	-	212,458	-	-	-	Transformation input
Термоцентрали	-	-	-	-	-	-	-	-	-	-	-	-	Public thermal power stations
Комбинирани електрани	-	253111,815	-	-	-	-	-	-	-	-	-	-	Autoprod. thermal power stations and CHP plants
Биогасни централи	-	-	-	-	-	-	-	-	212,458	-	-	-	Biogas plants
Јавни котларници	-	32553,576	-	-	-	-	-	-	-	-	-	-	Main activity producer heat plants
Производство на трансформирана енергија	-	-	-	-	-	-	-	-	-	-	2533,269	3928,909	Transformation output
Термоцентрали	-	-	-	-	-	-	-	-	-	-	-	2726,987	Public thermal power stations
Комбинирани електрани	-	-	-	-	-	-	-	-	-	-	1420,953	1144,625	Autoprod. thermal power stations and CHP plants
Биогасни централи	-	-	-	-	-	-	-	-	-	-	-	57,297	Biogas plants
Јавни котларници	-	-	-	-	-	-	-	-	-	-	1112,316	-	Main activity producer heat plants
Размена	-	-	-	-	-	-1277,144	-23,536	-116,884	-	-0,068	-	1417,564	Exchanges and transfers, returns
Потрошувачка во енергетскиот сектор	-	-	-	0,040	-	-	-	-	-	-	17,866	421,898	Consumption of the energy branch
Загуби при пренос и дистрибуција	-	1144,132	92,370	-	-	-	-	-	-	-	585,518	1026,748	Distribution losses
Расположливо за финална потрошувачка	**57,771**	**52687,692**	**1463,788**	**1035,243**	**123,203**	**-**	**-**	**-**	**-**	**-**	**1929,885**	**6224,431**	**Available for final consumption**
Финална неенергетска потрошувачка	57,771	-	-	0,000	0	-	-	-	-	-	-	-	Final non-energy consumption
Финална енергетска потрошувачка	**-**	**52687,692**	**1463,788**	**1035,243**	**123,203**	**-**	**-**	**-**	**-**	**-**	**1929,885**	**6224,431**	**Final energy consumption**
Индустрија	-	42861,053	-	10,755	39,687	-	-	-	-	-	23,612	1639,830	**Industry**
Индустрија за железо и челик	-	24745,225	-	0,102	29,585	-	-	-	-	-	23,612	748,683	Iron & steel industry
Обоена металургија	-	-	-	0,000	0,005	-	-	-	-	-	-	12,993	Non-ferrous metal industry
Хемиска индустрија	-	2144,416	-	0,005	0,031	-	-	-	-	-	-	84,385	Chemical industry
Индустрија за градежен материјал стакло и керамика	-	4026,963	-	0,020	0,108	-	-	-	-	-	-	145,741	Glass, pottery & building mat. industry
Индустрија за експлоатација на руди	-	-	-	0,047	0,013	-	-	-	-	-	-	146,269	Ore-extraction industry
Прехранбена индустрија, пијалаци и тутун	-	6812,757	-	6,585	6,956	-	-	-	-	-	-	163,076	Food, drink & tobacco industry
Текстилна индустрија и кожарство	-	76,248	-	1,816	0,864	-	-	-	-	-	-	65,236	Textile, leather & clothing industry
Индустрија за хартија и печатење	-	666,428	-	0,196	0,178	-	-	-	-	-	-	11,582	Paper and printing
Инженерство и друга метална индустрија	-	2555,108	-	0,687	0,345	-	-	-	-	-	-	180,220	Engineering & other metal industry
Останати индустрии	-	1833,908	-	1,297	1,602	-	-	-	-	-	-	81,646	Other industries
Сообраќај	-	2382,191	-	-	-	-	-	-	-	-	-	12,698	**Transport**
Железнички сообраќај	-	-	-	-	-	-	-	-	-	-	-	12,698	Railways
Патен сообраќај	-	2382,191	-	-	-	-	-	-	-	-	-	-	Road transport
Воздушен сообраќај	-	-	-	-	-	-	-	-	-	-	-	-	Air transport
Останата потрошувачка	-	7444,448	1463,788	1024,489	83,516	-	-	-	-	-	1906,273	4571,903	**Households, commerce, pub. auth., etc.**
Домаќинства	-	301,822	-	994,024	78,475	-	-	-	-	-	1531,212	3191,109	Households
Земјоделство	-	-	818,984	8,593	0,520	-	-	-	-	-	-	39,260	Agriculture
Други сектори	-	7142,626	644,804	21,872	4,521	-	-	-	-	-	375,061	1341,535	Other
Статистичка разлика	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Statistical difference**

[1] Претходни податоци/Preliminary data

APPENDIX 2 Nomenclature for reporting format (NFR) - Format for reporting under the UNECE/LRTAP convention for 2020

MK:08/03/2021:2019	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)					
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Long name	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t	t
A_PublicPower	1A1a	Public electricity and heat production		4,3307135	0,043126868	88,868004	NA	1,065958974	2,631586218	3,8974125	0,014545832	1,094925	0,435986984	0,053018906	0,083726994	0,415266233	0,264266548	0,034437247	0,552389793	1,295493753	0,347118272
B_Industry	1A1b	Petroleum refining		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B_Industry	1A1c	Manufacture of solid fuels and other energy industries		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		1,293478339	0,522610356	3,355701128	0,000604357	0,488560706	0,523061914	0,552246464	0,057156199	3,794854606	0,5048824	0,013152467	0,029818138	0,014873447	0,061294989	0,067408505	0,048679353	0,007016447	1,022788273
B_Industry	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		0,029027849	0,001414613	0,002659472	NA	0,00113169	0,00113169	0,00113169	0,000633746	0,003734577	4,52676E-06	3,39507E-07	6,79014E-06	1,69754E-06	1,13169E-05	1,24486E-05	4,52676E-07	6,2243E-06	0,001640951
B_Industry	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		0,046014833	0,003330678	0,003985915	NA	0,001874614	0,001878152	0,001886408	0,005565386	0,007321428	3,89843E-05	1,58714E-05	3,13331E-05	6,55745E-06	4,44211E-05	2,56531E-05	3,52663E-06	1,20403E-05	0,003067355
B_Industry	1A2d	Stationary combustion in manufacturing industries and construction: Pulp. Paper and Print		0,013617771	0,002384933	0,001122468	5,22601E-06	0,00107804	0,001091105	0,00112159	0,000423907	0,004619391	0,000119635	5,67705E-05	1,72314E-05	3,74217E-06	0,000104965	3,11479E-05	9,18136E-06	5,95561E-06	0,002899879
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco		0,381452203	0,067980919	0,034322233	0,000181918	0,035109921	0,035568822	0,036633203	0,013599354	0,138694377	0,004211487	0,001975904	0,000297053	7,45596E-05	0,003632506	0,001068377	0,000317638	0,000165318	0,097678981
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
I_Offroad	1A2gvii	Mobile combustion in manufacturing industries and construction (please specify in the IIR)		0,828004517	0,085695892	0,001015054	0,000203011	0,053391814	0,053391814	0,053391814	0,029899416	0,273404661	NA	0,000253763	NA	NA	0,001268817	0,043139774	0,001776344	0,000253763	0,025376338
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		2,792255203	0,155889784	0,724184009	9,10658E-05	0,112166686	0,115136114	0,117799813	0,043401714	0,561069979	0,043147641	0,001555684	0,003016532	0,001364655	0,006545995	0,006539851	0,004143244	0,000979428	0,199196021
H_Aviation	1A3ai(i)	International aviation LTO (civil)		0,214006	0,0016462	0,0131696	NA	0,00123465	0,00123465	NA	0,000592632	0,0502091	NA	NA	NA	NA	NA	NA	NA	NA	NA
H_Aviation	1A3aii(i)	Domestic aviation LTO (civil)		0,000737568	2,88113E-05	5,76225E-05	NA	1,15245E-05	1,15245E-05	NA	5,53176E-06	6,33848E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA

MK:08/03/2021:2019	NFR sectors to be reported	POPs (from 1990)								Activity Data (from 1990)						
			PAHs													
		PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1.2. 3-cd) pyrene	Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	g I-TEQ	t	t	t	t	t	kg	kg	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV		
A_PublicPower	1A1a	0,29008655	3,79382E-05	0,00106833	0,000838413	6,79152E-05	0,002012597	0,000192555	9,48406E-05	1073,0027	28739,58986	9745,281912	NA	NA	NA	TJ NCV
B_Industry	1A1b	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	TJ NCV
B_Industry	1A1c	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	TJ NCV
B_Industry	1A2a	0,796416591	0,17386571	0,240104031	0,091222793	0,071442871	0,576635406	0,00479082	0,623180626	1076,015996	3665,590636	831,1426173	503,6307583	NA	NA	TJ NCV
B_Industry	1A2b	7,92183E-05	0,000107511	0,000848768	9,61937E-05	8,48768E-05	0,001137348	NA	NA	56,5845	NA	NA	NA	NA	NA	TJ NCV
B_Industry	1A2c	0,000255361	0,000171398	0,001278787	0,000148717	0,00013074	0,00168836	5,89738E-06	7,07685E-08	83,987002	NA	38,1374119	1,179475	NA	NA	TJ NCV
B_Industry	1A2d	0,000478702	8,63997E-05	0,000407904	6,01244E-05	5,12601E-05	0,000605689	2,1775E-05	2,613E-07	22,543959	NA	22,38398366	4,355007417	NA	NA	TJ NCV
B_Industry	1A2e	0,016330158	0,002834041	0,012693621	0,001929652	0,001639137	0,01909645	0,000758274	8,66638E-05	682,6997	0,4562816	234,4984997	151,5981436	NA	NA	TJ NCV
B_Industry	1A2f	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	TJ NCV
I_Offroad	1A2gvii	NA	0,00076129	0,001268817	NA	NA	0,002030107	NA	NA	1091,182514	NO	NO	NO	NO	NO	TJ NCV
B_Industry	1A2gviii	0,074370904	0,021119611	0,070469297	0,013414975	0,011070806	0,116217854	0,000568318	0,051793413	3420,728522	304,6403502	290,5339167	75,88815216	NO	0,770599	TJ NCV
H_Aviation	1A3ai(i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8231	TJ NCV
H_Aviation	1A3aii(i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TJ NCV

MK:08/03/ 2021:2019	NFR sectors to be reported		Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)									Activity Data (from 1990)						
																						PAHs													
			NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1.2.3-cd) pyrene	Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
F_RoadTransport	1A3bi	Road transport: Passenger cars	1,531775466	0,51288647	0,008243935	0,074905471	0,069880368	0,069880368	0,069880368	0,056748471	3,520210566	0,000175013	2,02917E-05	0,001280749	3,36118E-05	0,001521904	0,001041211	0,000185501	2,66668E-05	0,004590698	0,1151767	0,003338396	0,003745449	0,002911864	0,003215964	0,013211674	0,000115176	2,30552E-05	10491	NA	NA	NA	NA	NA	TJ NCV
F_RoadTransport	1A3bii	Road transport: Light duty vehicles	0,888232095	0,056868323	0,001563143	0,003183444	0,050242807	0,050242807	0,050242807	0,038201939	0,460757451	4,47494E-05	4,68115E-06	0,000431761	8,84678E-06	0,000652994	0,000439309	2,64576E-05	8,33125E-06	0,001484158	0,0346981	0,001559227	0,001751441	0,001368652	0,001462661	0,006141982	3,46978E-05	6,9942E-06	3342	NA	NE	NA	NA	NA	TJ NCV
F_RoadTransport	1A3biii	Road transport: Heavy duty vehicles and buses	5,34841924	0,245331957	0,006022171	0,008933507	0,108709266	0,108709266	0,108709266	0,066757722	1,35315278	0,000150568	1,50573E-05	0,001595917	3,01133E-05	0,002559396	0,001716304	6,02477E-05	3,01121E-05	0,00542014	0,0574965	0,001347629	0,008160642	0,009118956	0,002096312	0,020723538	4,58862E-05	1,01169E-05	12856	NA	NA	NA	NA	NA	TJ NCV
F_RoadTransport	1A3biv	Road transport: Mopeds & motorcycles	0,001355538	0,006115	6,08574E-06	1,96389E-05	8,63565E-05	8,63565E-05	8,63565E-05	1,79282E-05	0,027017242	5,00098E-07	1,8792E-06	2,6473E-06	9,12861E-08	9,57318E-06	0,000311604	1,34163E-05	1,87122E-06	0,000189563	0,0001052	2,99362E-06	3,48659E-06	2,40087E-06	3,80392E-06	1,2685E-05	1,048E-07	2,94E-08	13	NA	NE	NA	NA	NA	TJ NCV
F_RoadTransport	1A3bv	Road transport: Gasoline evaporation	NA	0,191435473	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TJ NCV
F_RoadTransport	1A3bvi	Road transport: Automobile tyre and brake wear	NA	NA	NA	NA	0,087110219	0,165421618	0,214327318	0,008531765	NA	0,238166664	0,001078377	NA	0,002738517	0,088516374	1,940323855	0,013833286	0,001742204	0,694517901	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5894,862304	Mileage [10^6 km]
F_RoadTransport	1A3bvii	Road transport: Automobile road abrasion	NA	NA	NA	NA	0,048509531	0,089832464	0,179664928	0,001904448	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5894,862304	Mileage [10^6 km]
I_Offroad	1A3c	Railways	0,052522515	0,007858966	4,0638E-05	1,01595E-05	0,001119725	0,001117544	0,001679588	7,27821E-06	0,014708192	NA	1,01595E-05	NA	NA	5,07975E-05	0,001727113	7,11164E-05	1,01595E-05	0,001015949	NA	3,04785E-05	5,07975E-05	NA	NA	8,12759E-05	NA	NA	43,68581143	NA	NA	NA	NA	NA	TJ NCV
G_Shipping	1A3di(ii)	International inland waterways	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	TJ NCV
G_Shipping	1A3dii	National navigation (shipping)	0,002008675	7,1647E-05	3,08147E-06	NA	3,58235E-05	3,58235E-05	3,83823E-05	NA	0,000189353	3,32647E-06	2,55882E-07	7,67647E-07	1,02353E-06	1,27941E-06	2,25176E-05	2,55882E-05	2,55882E-06	1,27941E-05	3,32647E-06	NA	NA	NA	NA	NA	2,04706E-06	9,72352E-07	1,100293347	NA	NA	NA	NA	NA	TJ NCV
I_Offroad	1A3ei	Pipeline transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	TJ NCV
I_Offroad	1A3eii	Other (please specify in the IIR)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	TJ NCV
C_OtherStationaryComb	1A4ai	Commercial/ Institutional: Stationary	0,417303276	0,094846918	0,136097572	NA	0,058020363	0,062521565	0,064127249	0,021941874	0,259499542	0,018173198	0,002944046	0,000421866	0,000759323	0,017402715	0,005299322	0,154587877	0,000277796	0,13358251	0,032500204	0,003002069	0,004542138	0,001521024	0,001207896	0,010273127	0,001330722	0,003392232	1231,258149	19,87942	243,7064022	209,5040506	NO	NO	TJ NCV
I_Offroad	1A4aii	Commercial/ Institutional: Mobile	0,423422748	0,043822937	0,000519075	0,000103815	0,027303364	0,027303364	0,027303364	0,015289884	0,139812948	NA	0,000129769	NA	NA	0,000648844	0,022060703	0,000908382	0,000129769	0,012976884	NA	0,000389307	0,000648844	NA	NA	0,001038151	NA	NA	IE	554,2427156	IE	IE	NA	NA	TJ NCV
C_OtherStationaryComb	1A4bi	Residential: Stationary	0,416412001	4,752742001	0,15464389	0,553409111	5,859035147	6,017262167	6,335062392	0,585883758	31,72971542	0,221513799	0,103348428	0,00453414	0,001877219	0,187678539	0,050723089	0,103336599	0,003971617	4,054939638	6,343161155	0,968887624	0,893040684	0,33901782	0,568749087	2,769695214	0,039540368	0,477511476	363,7024007	18,62116101	10,32585784	7905,764642	NA	NA	TJ NCV
I_Offroad	1A4bii	Residential: Household and gardening (mobile)	0,001440794	0,588421161	0,0005796	3,18461E-06	NE	NE	0,003391614	NE	1,137767106	0,41490341	7,23776E-06	NA	NA	3,61888E-05	0,001230419	5,06643E-05	7,23776E-06	0,000723776	NA	NE	NE	NE	NA	NA	NA	NA	IE	NA	NA	IE	NA	NA	TJ NCV
C_OtherStationaryComb	1A4ci	Agriculture/Forestry/Fishing: Stationary	0,067061573	0,025545892	0,039990624	0,002426808	0,016456273	0,017428817	0,018057409	0,004980249	0,077219635	0,006502701	0,000924134	0,000246582	0,000202282	0,003695016	0,001375093	0,023691279	9,49682E-05	0,041771025	0,012589262	0,001757783	0,002478164	0,00090203	0,000710514	0,005848491	0,000383869	0,004119587	185,9630078	24,209575	NA	65,58940576	NA	NA	TJ NCV
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,233378569	0,031144933	NA	5,51092E-05	0,01286301	0,01286301	0,01286301	0,007331916	0,380239365	NA	7,08563E-05	NA	NA	0,000354281	0,012045563	0,000495994	NA	0,007085625	NA	0,000216508	0,000350342	NA	NA	0,00056685	NA	NA	305,0600747	NA	NA	NA	NA	NA	TJ NCV
I_Offroad	1A4ciii	Agriculture/Forestry/Fishing: National fishing	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	TJ NCV
C_OtherStationaryComb	1A5a	Other stationary (including military)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	TJ NCV
I_Offroad	1A5b	Other. Mobile (including military. land based and recreational boats)	0,02038148	0,007865441	0,000309998	NA	0,001217655	0,001217655	0,001217655	0,000681887	0,378228679	NA	5,83727E-06	NA	NA	2,91864E-05	0,000992336	4,08609E-05	5,83727E-06	0,000583727	NA	2,91864E-05	NA	NA	NA	2,91864E-05	NA	NA	38,72676678	NA	NA	NA	NA	NA	TJ NCV
D_Fugitive	1B1a	Fugitive emission from solid fuels: Coal mining and handling	NA	0,906549	NA	NA	0,02719647	0,176777055	0,37168509	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,532745	Coal produced [Mt]
D_Fugitive	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Coal used for transformation [Mt]
D_Fugitive	1B1c	Other fugitive emissions from solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide

MK:08/03/2021:2019	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)									Activity Data (from 1990)						
																							PAHs														
				NOx (as NO$_2$)	NMVOC	SOx (as SO$_2$)	NH$_3$	PM$_{2.5}$	PM$_{10}$	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1.2.3-cd) pyrene	Total 1-4	HCB	PCBs		Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
																																					details in the IIR
D_Fugitive	1B2ai	Fugitive emissions oil: Exploration. production. transport		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Crude oil produced [Mt]
D_Fugitive	1B2aiv	Fugitive emissions oil: Refining and storage		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Crude oil refined [Mt]
D_Fugitive	1B2av	Distribution of oil products		NA	1,664 2604 8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	0,832 1302 4	Oil consumed [Mt]
D_Fugitive	1B2b	Fugitive emissions from natural gas (exploration. production. processing. transmission . storage. distribution and other)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Gas throughput [TJ]
D_Fugitive	1B2c	Venting and flaring (oil. gas. combined oil and gas)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Gas vented flared [TJ]
D_Fugitive	1B2d	Other fugitive emissions from energy production		NA	NA	NA	0,136 4688 15	NA	NA	NA	NA	NA	NA	NA	2,859 35E-05	1,624 63E-06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	6498 5,150 02	Please specify and/or provide details in the IIR
B_Industry	2A1	Cement production		NA	NA	NA	NA	0,030 9	0,043 7	0,014 3	0,000 927	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	770,5 99	Clinker produced [kt]
B_Industry	2A2	Lime production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Lime produced [kt]
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	NO		NO	NO	NO	NO	NO	NO	Glass produced [kt]
B_Industry	2A5a	Quarrying and mining of minerals other than coal		NA	NA	NA	NA	0,038 9150 1	0,389 1501	0,793 8662 04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	7,783 002	Material quarried [kt]
B_Industry	2A5b	Construction and demolition		NA	NA	NA	NA	0,008 8380 74	0,088 3807 38	0,298 0280 7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	1027 683	Floor space constructed/demolished [m2]
B_Industry	2A5c	Storage. handling and transport of mineral products		NA	NA	NA	NA	0,003 2993 77	0,032 9937 66	0,065 9875 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	5,498 961	Amount [kt]
B_Industry	2A6	Other mineral products (please specify in the IIR)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
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	NO		NO	NO	NO	NO	NO	NO	Ammonia produced [kt]
B_Industry	2B2	Nitric acid production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Nitric acid produced [kt]
B_Industry	2B3	Adipic acid production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Adipic acid produced [kt]
B_Industry	2B5	Carbide production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Carbide produced [kt]
B_Industry	2B6	Titanium dioxide production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Titanium dioxide produced [kt]
B_Industry	2B7	Soda ash production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Soda ash produced [kt]
B_Industry	2B10a	Chemical industry: Other (please specify in the IIR)		NA	0,000 7850 88	NA	NA	0,000 0408 9	0,000 8178	0,002 1508 14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
B_Industry	2B10b	Storage. handling and transport of chemical products (please specify in the IIR)		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE		IE	IE	IE	IE	IE	IE	Please specify and/or provide details in the IIR
B_Industry	2C1	Iron and steel production		0,024 0929	0,010 8968 71	0,011 1198	NE	0,003 8919 3	0,004 4479 2	0,022 6555 53	1,401 09E-05	0,315 061	0,277 995	0,022 2396	0,014 0850 8	0,001 5011 73	0,019 4596 5	0,003 7066	0,075 9853	NE	0,426 259	0,555 99	NE	NE	NE	NE	0,088 9584	NE	0,463 325		NA	NA	NA	NA	NA	670,4 59	Steel produced [kt]

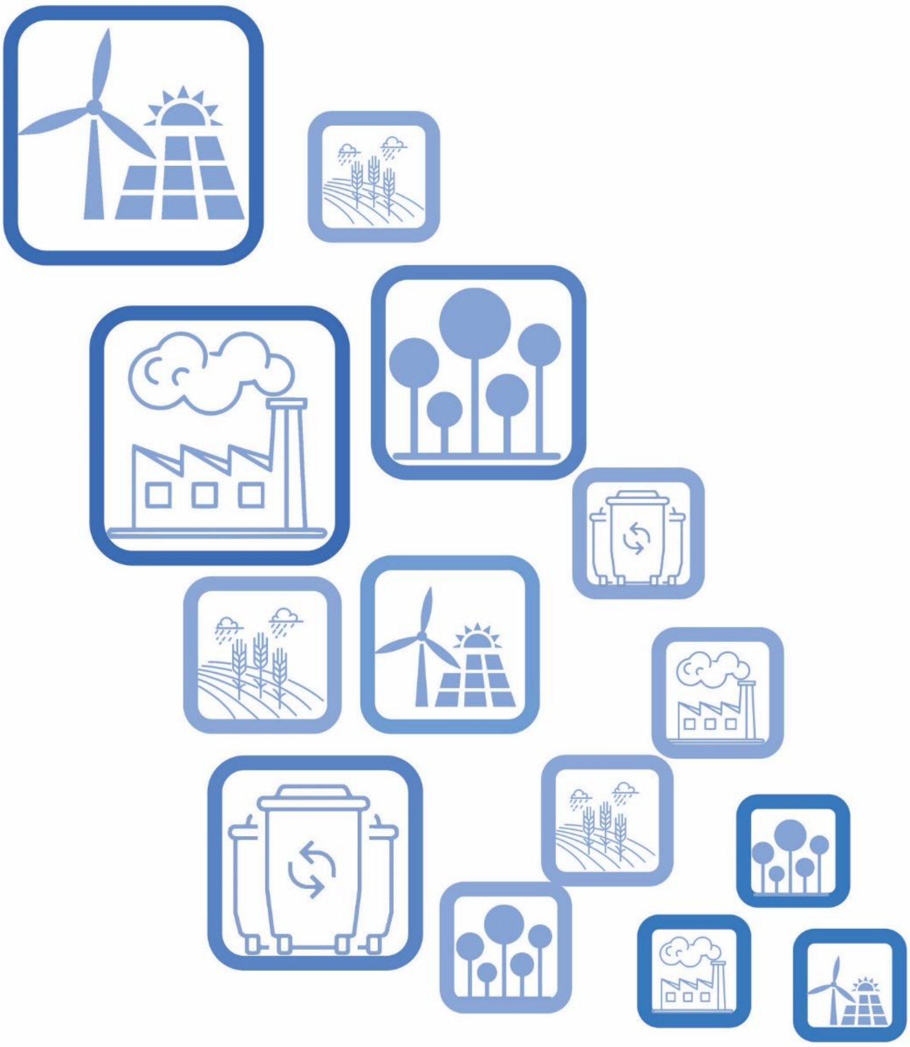
MK:08/03/ 2021:2019	NFR sectors to be reported		Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)						
																						PAHs													
			NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1.2.3-cd) pyrene	Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
B_Industry	2C2	Ferroalloys production	NA	NA	NA	NA	0,049722	0,0704395	0,08287	0,0049722	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	82,87	Ferroalloys produced [kt]
B_Industry	2C3	Aluminium production	NA	NA	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NA	NA	NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NE	Aluminium produced [kt]
B_Industry	2C4	Magnesium production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Magnesium produced [kt]
B_Industry	2C5	Lead production	NA	NA	0,051695	NA	0,000082712	0,000165424	0,00020678	NA	NA	0,0268814	0,00051695	NE	0,0031017	NA	NA	NA	NA	0,00051695	0,0330848	NA	NA	NA	NA	NA	NA	26,8814	NA	NA	NA	NA	NA	10339	Lead produced [kt]
B_Industry	2C6	Zinc production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Zinc produced [kt]
B_Industry	2C7a	Copper production	NA	NA	NE	NA	NE	NE	NE	NE	NA	NE	NE	NA	NE	NA	NE	NE	NA	NA	NE	NA	NA	NA	NA	NA	NA	NE	NA	NA	NA	NA	NA	NE	Copper produced [kt]
B_Industry	2C7b	Nickel production	NO	NO	NO	NO	NO	NO	NO	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Nickel produced [kt]
B_Industry	2C7c	Other metal production (please specify in the IIR)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
B_Industry	2C7d	Storage. handling and transport of metal products (please specify in the IIR)	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	Amount (kt)
E_Solvents	2D3a	Domestic solvent use including fungicides	NA	2,4825696	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2068,808	Solvents used [kt]
B_Industry	2D3b	Road paving with asphalt	NA	0,00905248	NA	NA	0,0026312	0,0169734	0,0792092	0,000128998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	565,78	Please specify and/or provide details in the IIR
B_Industry	2D3c	Asphalt roofing	NE	0,00197275	NA	NA	0,001214	0,00607	0,02428	1,5782E-07	0,000144163	NE	NE	NE	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NA	NA	NA	NA	NA	NA	15,175	Please specify and/or provide details in the IIR
E_Solvents	2D3d	Coating applications	NA	2,52214025	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9,947917	Paint applied [kt]
E_Solvents	2D3e	Degreasing	NA	1,62482328	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Solvents used [kt]
E_Solvents	2D3f	Dry cleaning	NA	0,6206424	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2068,808	Solvents used [kt]
E_Solvents	2D3g	Chemical products	NA	0,422718	NA	0,00004556	NA	NA	0,024	NA	NA	NA	0,0000002	NA	0,000001	0,000012	NA	0,0001	0,000001	NA	NA	NA	NA	NA	NA	0,0051	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
E_Solvents	2D3h	Printing	NA	0,019183	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
E_Solvents	2D3i	Other solvent use (please specify in the IIR)	NE	0,00938796	NE	NE	4,49865E-05	6,74798E-05	8,24753E-05	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	4,67927E-05	4,67927E-05	4,67927E-05	0,00023308	0,000373458	NE	NE	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
E_Solvents	2G	Other product use (please specify in the IIR)	0,0123335774	0,083149527	NE	0,028440813	0,185036616	0,185036616	0,185036616	0,000832665	0,377611761	3,4266E-07	3,70073E-05	6,85321E-07	1,09651E-06	2,39862E-06	0,037007323	NE	NE	NE	6,85321E-07	0,000760706	0,000308394	0,000308394	0,000308394	0,001685889	NE	NE	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
B_Industry	2H1	Pulp and paper industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Pulp production [kt]
B_Industry	2H2	Food and beverages industry	NA	0,589097558	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Bread, Wine, Beer, Spirits production [kt]
B_Industry	2H3	Other industrial processes (please specify in the IIR)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
B_Industry	2I	Wood processing	NA	NA	NA	NA	NA	NA	0,00970055	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9,70055048	Please specify and/or provide details in the IIR
B_Industry	2J	Production of POPs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or

MK:08/03/ 2021:2019	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)									Activity Data (from 1990)						
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	PAHs: benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1.2.3-cd) pyrene	Total 1-4	HCB	PCBs		Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
																																					provide details in the IIR
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,0208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	208,7132		NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
B_Industry	2L	Other production. consumption . storage. transportation or handling of bulk products (please specify in the IIR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	Please specify and/or provide details in the IIR
K_AgriLivestock	3B1a	Manure management - Dairy cattle		0,016589034	1,399511232	NA	1,8204849	0,04416561	0,06786423	0,14865498	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NO	NO	NO	NO	NO	107,721	Population size (1000 head)
K_AgriLivestock	3B1b	Manure management - Non-dairy cattle		0,01076206	0,71579148	NA	0,709838	0,0206082	0,0309123	0,0675491	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NO	NO	NO	NO	NO	114,49	Population size (1000 head)
K_AgriLivestock	3B2	Manure management - Sheep		0,00315317	0,106577146	NA	0,2522536	0,010531588	0,03506325	0,087658126	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NO	NO	NO	NO	NO	630,634	Population size (1000 head)
K_AgriLivestock	3B3	Manure management - Swine		0,000219259	0,111614209	NA	0,748271	0,01094814	0,06222341	0,1374036	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NO	NO	NO	NO	NO	164,074	Population size (1000 head)
K_AgriLivestock	3B4a	Manure management - Buffalo		IE	IE	IE	IE	IE	IE	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	IE	Population size (1000 head)
K_AgriLivestock	3B4d	Manure management - Goats		0,00047504	0,051494336	NA	0,0380032	0,001586634	0,005282445	0,013206112	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	95,008	Population size (1000 head)
K_AgriLivestock	3B4e	Manure management - Horses		0,001199174	0,071227274	NA	0,064078	0,00128156	0,00201388	0,00439392	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	9,154	Population size (1000 head)
K_AgriLivestock	3B4f	Manure management - Mules and asses		NE	NE	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO		NA	NA	NA	NA	NA	NE	Population size (1000 head)
K_AgriLivestock	3B4gi	Manure management - Laying hens		0,004447044	0,24458742	NA	0,47435136	0,034094004	0,176399412	0,176399412	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	1482,348	Population size (1000 head)
K_AgriLivestock	3B4gii	Manure management - Broilers		0,000101268	0,010936944	NA	0,0151902	0,00091141 2	0,006987492	0,006987492	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	101,268	Population size (1000 head)
K_AgriLivestock	3B4giii	Manure management - Turkeys		0,0000682	0,00666996	NA	0,0076384	0,0009548	0,0070928	0,0070928	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	13,64	Population size (1000 head)
K_AgriLivestock	3B4giv	Manure management - Other poultry		0,000141906	0,022594734	NA	0,0186468	0,00106718	0,00789944	0,00789944	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	46,206	Population size (1000 head)
K_AgriLivestock	3B4h	Manure management - Other animals (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Population size (1000 head)
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)		0,488750184	NA	NA	0,754903993	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	18798084	Use of inorganic fertilizers (kg N)
L_AgriOther	3Da2a	Animal manure applied to soils		IE	IE	NA	1,7190879	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
L_AgriOther	3Da2b	Sewage sludge applied to soils		NE	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
L_AgriOther	3Da2c	Other organic fertilisers applied to soils (including compost)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
L_AgriOther	3Da3	Urine and dung deposited by grazing animals		IE	IE	NA	1,0403359	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
L_AgriOther	3Da4	Crop residues applied to soils		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO		NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR

MK:08/03/ 2021:2019	NFR sectors to be reported		Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)								Activity Data (from 1990)						
																						PAHs													
			NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1.2.3-cd) pyrene	Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
L_AgriOther	3Db	Indirect emissions from managed soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
L_AgriOther	3Dc	Farm-level agricultural operations including storage. handling and transport of agricultural products	NA	NA	NA	NA	0,07570122	1,96823172	1,96823172	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1261687	Please specify and/or provide details in the IIR
L_AgriOther	3Dd	Off-farm storage. handling and transport of bulk agricultural products	NA	NA	NA	NA	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NO	Please specify and/or provide details in the IIR
L_AgriOther	3De	Cultivated crops	NA	1,08505082	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1261687	Please specify and/or provide details in the IIR
L_AgriOther	3Df	Use of pesticides	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
L_AgriOther	3F	Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Area burned [ha]
L_AgriOther	3I	Agriculture other (please specify in the IIR)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land	NA	0,080062227	NA	0,001187233	8,40406E-05	0,000557724	0,001179115	NA	2,689136773	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,546684	Deposition [kt]
J_Waste	5B1	Biological treatment of waste - Composting	NA	NA	NA	0,0001056	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	0,44	Organic domestic waste [kt]
J_Waste	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	N in feedstock [kt]
J_Waste	5C1a	Municipal waste incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kt]
J_Waste	5C1bi	Industrial waste incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kt]
J_Waste	5C1bii	Hazardous waste incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Waste incinerated [kt]
J_Waste	5C1biii	Clinical waste incineration	0,001502217	0,000751108	0,001502217	NA	NA	NA	0,000536506	1,23396E-05	0,003004434	0,067814358	0,007886638	0,004796364	0,001394916	0,002146024	0,002789831	0,002146024	NA	NA	0,151294692	NA	NA	NA	NA	4,29205E-08	0,1073012	0,02146024	NA	NA	NA	NA	NA	1,073012	Waste incinerated [kt]
J_Waste	5C1biv	Sewage sludge incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Sludge incinerated [kt]
J_Waste	5C1bv	Cremation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Corpses [Number]
J_Waste	5C1bvi	Other waste incineration (please specify in the IIR)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
J_Waste	5C2	Open burning of waste	0,041104601	0,015898949	0,001421857	NE	0,054159835	0,058296147	0,059976524	0,022747131	0,721657184	0,006333728	0,001292598	NE	0,00529965	0,00012926	0,002585195	NE	0,000904818	0,226592342	0,12925975	0,030117522	0,059847264	0,073419538	NE	0,163384324	NE	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR
J_Waste	5D1	Domestic wastewater handling	NA	0,000716201	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	47746,743	Total organic product [kt DC]
J_Waste	5D2	Industrial wastewater handling	NA	0,000082005	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5467	Total organic product [kt DC]
J_Waste	5D3	Other wastewater handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	Total organic product [kt DC]
J_Waste	5E	Other waste (please specify in the IIR)	NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NE	NA	NE	NE	NE	NA	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Please specify and/or provide details in the IIR

MK:08/03/2021:2019	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)									Activity Data (from 1990)						
																							PAHs														
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/PCDF (dioxins/furans)	benzo(a)pyrene	benzo(b)fluoranthene	benzo(k)fluoranthene	Indeno(1.2.3-cd)pyrene	Total 1-4	HCB	PCBs		Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
M_Other	6A	Other (included in national total for entire territory) (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
	NATIONAL TOTAL	National total (based on fuel sold)	(a)	19,94	22,34	93,42	8,47	8,71	13,43	16,41	1,00	49,51	2,27	0,21	0,17	0,45	0,66	2,24	0,98	1,31	7,31	8,64	1,21	1,30	0,54	0,66	3,81	0,16	237,24								
	1A3bi(fu)	Road transport: Passenger cars (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	TJ NCV	NE
	1A3bii(fu)	Road transport: Light duty vehicles (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	TJ NCV	NE
	1A3biii(fu)	Road transport: Heavy duty vehicles and buses (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	TJ NCV	NE
	1A3biv(fu)	Road transport: Mopeds & motorcycles (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	TJ NCV	NE
	1A3bv(fu)	Road transport: Gasoline evaporation (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	TJ NCV	NE
	1A3bvi (fu)	Road transport: Automobile tyre and brake wear (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	Mileage [10^6 km]	NE
	1A3bvii (fu)	Road transport: Automobile road abrasion (fuel used)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	Mileage [10^6 km]	NE
	ADJUSTMENTS	Sum of approved adjustments (negative value) from Annex VII (CLRTAP)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NO		NE
	COMPLIANCE TOTAL (CLRTAP)	National total for compliance calculations and checks (CLRTAP)	19,94	22,34	93,42	8,47	8,71	13,43	16,41	1,00	49,51	2,27	0,21	0,17	0,45	0,66	2,24	0,98	1,31	7,31	8,64	1,21	1,30	0,54	0,66	3,81	0,16	237,24									19,94
	ADJUSTMENTS AND FLEXIBILITIES	Sum of approved adjustments from Annex VII and other flexibilities (negative value) (NECD)																																			
	COMPLIANCE TOTAL (NECD)	National total for compliance calculations and checks (NECD)	19,94	22,34	93,42	8,47	8,71	13,43	16,41	1,00	49,51	2,27	0,21	0,17	0,45	0,66	2,24	0,98	1,31	7,31	8,64	1,21	1,30	0,54	0,66	3,81	0,16	237,24									19,94
MEMO ITEMS - NOT TO BE INCLUDED IN NATIONAL TOTALS																																					
O_AviCruise	1A3ai(ii)	International aviation cruise (civil)	0,034549182	0,164108615	0,008637296	NA	NA	NA	NA	NA	10,36475461	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NE	NO	NO	NE	NO	372,4401823	TJ NCV	0,034549182
O_AviCruise	1A3aii(i)	Domestic aviation cruise (civil)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NE	NO	NO	NE	NO	NO	TJ NCV	NO
P_IntShipping	1A3di(i)	International maritime navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	TJ NCV	NO
z_Memo	1A5c	Multilateral operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NO	NO	NO		NO	NO	NO	NO	NO	NO	TJ NCV	NE
z_Memo	6B	Other not included in national total of the entire territory (please specify in the IIR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NO	NO	NO		NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
N_Natural	11A	Volcanoes		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	Please specify and/or provide details in the IIR
N_Natural	11B	Forest fires		0,123392	0,370176	0,0246784	0,0246784	0,0563963 4	0,0689288 6	0,1065264 2	0,0050756 71	3,70176	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NO	NO	NO	NO	NO	1233,92	Area of forest burned [ha]
N_Natural	11C	Other natural emissions (please		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NO	NO	NO	NO	NO	NE	Please specify and/or

MK:08/03/ 2021:2019	NFR sectors to be reported	Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990. voluntary reporting)						POPs (from 1990)									Activity Data (from 1990)						
																					PAHs														
		NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/PCDF (dioxins/furans)	benzo(a)pyrene	benzo(b)fluoranthene	benzo(k)fluoranthene	Indeno (1.2.3-cd) pyrene	Total 1-4	HCB	PCBs		Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	Other activity (specified)	Other Activity Units
	specify in the IIR)																																		provide details in the IIR



Republic of North Macedonia
Ministry of Environment and Physical Planning
Macedonian Environmental Information Center
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