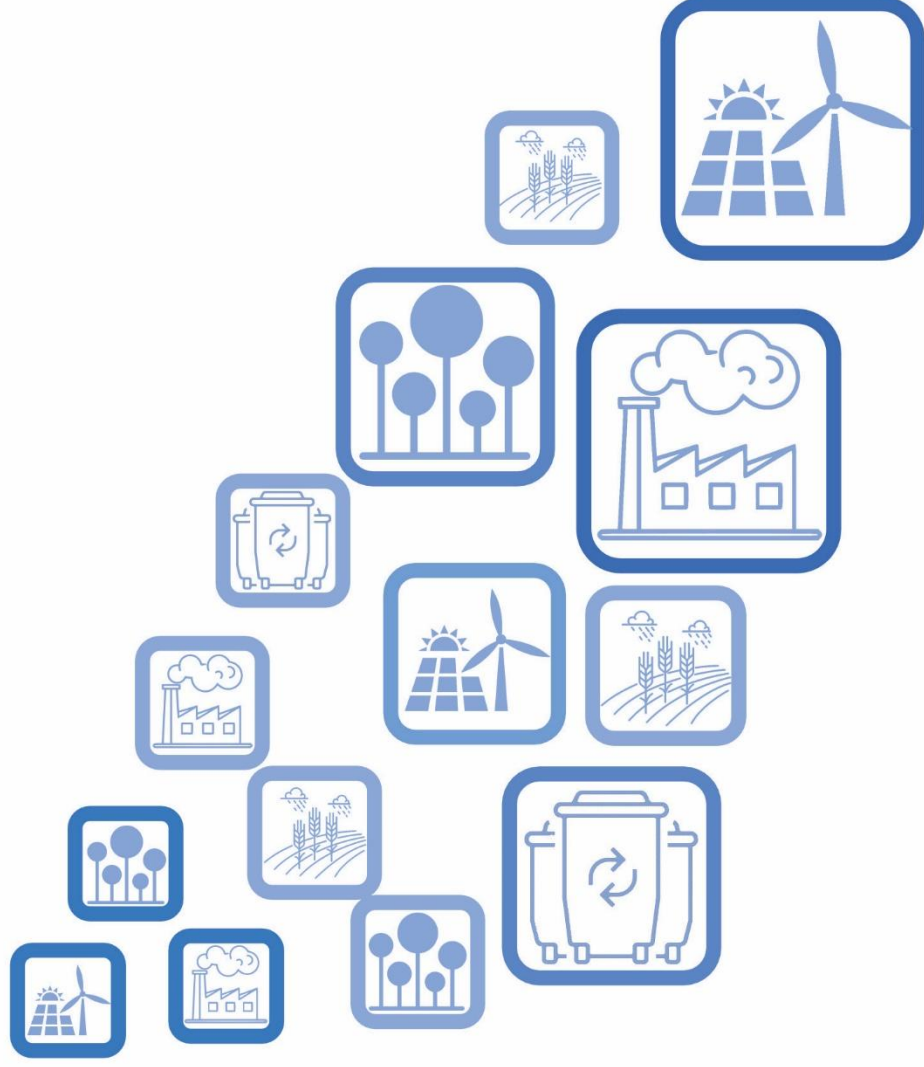


1990-2024



INFORMATIVE INVENTORY REPORT

Republic of North Macedonia

Republic of North Macedonia

INFORMATIVE INVENTORY REPORT

1990 – 2024

Submission under the

Convention on Long-Range Transboundary Air Pollution (CLRTAP)

April, 2026

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Acknowledgements

This report has been prepared by the Macedonian Environmental Information Center a department within the Ministry of Environment and Physical Planning. The authors of this report are: Aleksandra N. Krsteska. (Coordinator of Emission inventory and Energy expert), Pavle Malkov (Industry and Solvent expert) supported by Afrodita Stefanoska, Martina Spasovska and Onur Amet (Transport experts), Arminda Rushiti (Agriculture expert) and Margareta Cvetkovska (Waste expert). The data management and data transfer in the NFR reporting tables as well as NFR tool, KCA and trend analysis have been done by Aleksandra N.Krsteska.

Special thanks for the improvements made to the emission inventory and the preparation of the Informative Inventory Report (IIR), as well as for the calculation of projections and the detailed description of methodologies by sector in the frame of the IPA II project “Support in implementation of air quality directives”:

Without the dedicated work of all the experts involved, it would not have been possible to apply higher-tier methodologies across many sectors or to successfully prepare the projections. Estimation of projection has resolved the long-standing non-compliance in reporting following the ratification of the Gothenburg Protocol in 2014.

The editing and approval of the report was carried out by Katerina Nikolovska (Head of department).

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

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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 (NO_x), sulfur dioxide (SO₂), non-methane volatile organic compounds (NMVOC), ammonia (NH₃), persistent organic compounds (POPs) and heavy metals (HM). To be able to meet the obligations, Republic of North Macedonia compiles annually an emission inventory and reports the base year emissions (1980, 1987, 1988 and 1990) in accordance with the protocols' obligations.

This report is compiled according to the Annexes 2023 Reporting Guidelines under the UNECE/LTRAP convention and its protocols, which define the standards for the national emission inventory². The country has also used the latest emissions reporting template for this reporting round.

The report contains eleven chapters, five appendixes and references. The content was reconstructed to achieve compliance with Recommended structure for the Informative Inventory Report which was updated in 2021. The chapter introduction provides general information on the inventory preparation background, key source analysis, methodology and data sources used, QA/QC and completeness. The chapter Trend presents trends on different pollutants and discusses the main reasons for incline and decline of the values. Chapters 4-8 include detailed information on activity data emission factors used per Nomenclature for reporting (NFR) source category. This report contains subchapters on source-specific uncertainty analysis, QA/QC, recalculations, and planned improvements. The chapter Projections gives information on the calculated national projections for the first time as required in the current Gothenburg protocol. With submission of projections our country has no non-compliance issues with the CLRTAP protocols requirements.

The chapters on reporting LPS and gridded data refer to the preparation and submission of LPS datasets (2015, 2019, and 2023) and gridded data (2015 and 2019). An improved methodology for calculating gridded data for 2023 was developed within the framework of the IPA II project "Support in Implementation of Air Quality Directives" (hereinafter referred to as the IPA II Air Quality Project), however is still not finalized so gridded emissions for 2023 will be reported in May and updated version of IIR will be resubmitted.

Sources used for the gathering of the activity data and information are presented in Reference chapter. The Appendix chapter has 5 Appendixes; the first one is on Key category analysis, the second is on summary whether source sector use PM emission factor that include/exclude condensable component, then Appendix 3 which refers to further elaboration of completeness. Preliminary Energy balance for 2024 is presented in Appendix 4, while Appendix 5 refers to Additional information, here,

¹Law 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<https://www.ceip.at/reporting-instructions/annexes-to-the-2023-reporting-guidelines>

the emissions for 2024 which are reported in the NFR reporting format are presented. Appendices 6 and 7 from the Guidance are optional and are not part of the IIR.

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

This report contains emissions of the whole time series 1990-2024. The submissions prior to 2004 and some of the following years included data on emissions of the basic pollutants as the country was not in position to report for the whole reporting period.

For the preparation of the 2016 and 2017 emission inventory submission and Informative Inventory Reports (IIRs) in those years, the Ministry of Environment and Physical Planning (MEPP) was supported by Austrian experts engaged within the framework of the EU funded Twinning Project “Further strengthening the capacities for effective implementation of the acquis in the field of air quality” (MK 12 IB EN 01) which was finalized in January 2017. Starting from 2018, the reporting has been conducted by an established national expert emission inventory team. In this previous reporting round recalculations were made mainly due to remarks received from the Stage 3 review report in 2020 and sectorial Stage 3 review report for agriculture sector³, final activity data from the Energy balance and revised activity data from the MAKSTAT database⁴. The major recalculations in this submission, were done due to use of higher Tier methodology in the frame of the activities of the current IPA II air quality project. The current inventory has been significantly improved across all sectors through the application of more advanced methodologies, correction of data inconsistencies, and inclusion of previously missing data.

Overall, the inventory enhancements reflect a transition toward higher-tier methodologies, improved data quality, correction of previous inconsistencies, and better alignment with the latest EMEP/EEA Guidebook (2023).

Additionally, in the energy sector input data from the preliminary energy balances are replaced with final data for 2023.

The report presents trend analysis of the country’s data for the period 1990 – 2024. The evaluation of the status of the emission trends is based on emission inventories and key source analysis. Generally, the main reason for reduction of the main pollutants is reduced use of coal for electricity production, as well as closure of installations or reduced production in the sector industry. Furthermore, emission reduction is also due to the introduction of BAT in major installations as well as the increase of use of gas and pellets and decrease of solid fuels in the category 1.A.4.

A decreasing trend is noticed for NO_x and SO_x emissions starting from 2011. The reduction of NO_x is a result of the modernization of plants and extended working lifetime. Additionally, the reduced operating hours of the power plant REK Oslomej from twelve to few months per year, and the decrease in coal consumption including gasification of the heating plant Toplana Zapad has supported the reduction of NO_x. With regards to SO_x emissions, the trends vary and depend on the coal consumption considering that electricity production is the main source for SO_x emissions.

³https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020_s3/mk_s3_rr_2020_final.pdf/
https://webdab01.umweltbundesamt.at/download/review/MK/2023/MK_2023_Stage3RR_FINAL.pdf?cgiproxy_skip=1

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

Desulfurization units are still not in place in this installation, so mainly SO_x emissions depend on the content and quantity of the consumed coal. SO_x emissions were recalculated for the whole time period with use of EF from the EMEP/EEA Guidebook, since monthly measurements received by the operator were not representative and had high uncertainty as concluded by the Technical experts in the frame of the IPA II Air quality project.

The trend on NMVOC emissions is variable with stable decreasing trend from 2012. 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 (44% compared to 1990), which is related to decreasing livestock numbers due to the trend of moving of people from rural to urban areas and implementation of Best available techniques which refer to the bigger farms for swines and poultry.

Table 1 Emission trends 1990 – 2024 for the main air pollutants and CO

| Year | Emissions in kt | | | | |
|------|-----------------|-------|-----------------|-----------------|--------|
| | NO _x | NMVOC | SO ₂ | NH ₃ | CO |
| 1990 | 37.79 | 40.03 | 109.88 | 13.99 | 134.39 |
| 1991 | 27.27 | 33.29 | 87.57 | 13.34 | 98.71 |
| 1992 | 33.41 | 40.66 | 86.49 | 13.39 | 138.98 |
| 1993 | 34.54 | 40.40 | 88.57 | 13.47 | 140.75 |
| 1994 | 30.33 | 35.77 | 87.77 | 13.34 | 123.87 |
| 1995 | 31.88 | 35.70 | 93.09 | 13.15 | 131.81 |
| 1996 | 31.35 | 35.51 | 87.70 | 12.65 | 127.37 |
| 1997 | 29.42 | 34.56 | 91.18 | 12.26 | 118.86 |
| 1998 | 33.53 | 34.82 | 106.55 | 12.23 | 119.63 |
| 1999 | 30.96 | 34.55 | 96.46 | 12.43 | 114.84 |
| 2000 | 32.10 | 35.62 | 99.11 | 12.14 | 118.60 |
| 2001 | 29.12 | 32.11 | 103.87 | 11.65 | 96.70 |
| 2002 | 29.48 | 30.41 | 90.79 | 11.11 | 95.64 |
| 2003 | 26.99 | 29.50 | 91.62 | 11.05 | 92.47 |
| 2004 | 26.65 | 28.26 | 92.29 | 10.97 | 90.10 |
| 2005 | 28.43 | 23.92 | 91.09 | 10.69 | 79.56 |
| 2006 | 28.23 | 22.78 | 86.94 | 10.96 | 76.51 |
| 2007 | 30.85 | 23.38 | 90.55 | 11.21 | 76.01 |
| 2008 | 30.47 | 23.38 | 98.26 | 11.06 | 72.45 |
| 2009 | 28.81 | 21.31 | 91.79 | 10.37 | 67.70 |
| 2010 | 28.49 | 22.37 | 87.082 | 10.47 | 65.88 |
| 2011 | 29.39 | 23.04 | 97.13 | 10.64 | 67.02 |
| 2012 | 29.61 | 23.33 | 94.13 | 9.94 | 68.06 |
| 2013 | 27.64 | 22.51 | 80.57 | 9.81 | 66.17 |
| 2014 | 21.70 | 22.25 | 80.82 | 9.86 | 63.14 |

| | | | | | |
|------------------------|-------------|-------------|-------------|-------------|-------------|
| 2015 | 21.07 | 21.64 | 73.22 | 10.07 | 63.29 |
| 2016 | 20.60 | 20.59 | 62.63 | 9.99 | 62.82 |
| 2017 | 19.68 | 20.51 | 53.75 | 9.83 | 54.57 |
| 2018 | 20.23 | 19.72 | 58.95 | 9.81 | 53.84 |
| 2019 | 21.59 | 19.22 | 70.65 | 8.59 | 54.66 |
| 2020 | 19.10 | 18.56 | 53.15 | 8.92 | 49.46 |
| 2021 | 19.21 | 18.34 | 45.32 | 8.40 | 50.88 |
| 2022 | 19.72 | 17.65 | 55.01 | 7.93 | 48.34 |
| 2023 | 20.98 | 17.23 | 56.82 | 7.73 | 45.95 |
| 2024 | 18.97 | 15.71 | 45.81 | 7.89 | 40.97 |
| Trend 1990-2024 | -50% | -61% | -58% | -44% | -70% |

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 69-74% in total of the particulates in 2024 compared to 1990, is the reduced production of ferroalloys in the country. The calculated PM2.5, PM10 and TSP and BC emissions in 2024 are reduced compared to 2023, by 15, 13, 12 and 11 % respectively due to the higher use of clean fuels for heating.

Table 2 Emission trends for particulate matter 1990-2024

| Year | Emissions | | | |
|------|------------|-----------|----------|---------|
| | PM2.5 [kt] | PM10 [kt] | TSP [kt] | BC [kt] |
| 1990 | 27.90 | 41.14 | 51.96 | 2.88 |
| 1991 | 24.55 | 36.33 | 45.66 | 2.48 |
| 1992 | 30.83 | 44.67 | 54.93 | 3.23 |
| 1993 | 26.68 | 38.50 | 47.69 | 2.84 |
| 1994 | 24.54 | 35.88 | 44.90 | 2.48 |
| 1995 | 24.85 | 36.42 | 45.70 | 2.55 |
| 1996 | 27.83 | 41.00 | 51.73 | 2.87 |
| 1997 | 26.89 | 39.55 | 49.48 | 2.71 |
| 1998 | 31.32 | 45.90 | 57.50 | 3.14 |
| 1999 | 26.37 | 38.45 | 48.384 | 2.64 |
| 2000 | 24.40 | 35.84 | 47.401 | 2.45 |
| 2001 | 13.71 | 21.00 | 27.99 | 1.31 |
| 2002 | 14.44 | 21.87 | 28.61 | 1.49 |
| 2003 | 24.15 | 35.20 | 44.17 | 2.41 |
| 2004 | 26.48 | 38.62 | 48.54 | 2.65 |
| 2005 | 23.65 | 35.03 | 44.83 | 2.46 |

| Year | Emissions | | | |
|------------------------|-------------|-------------|-------------|-------------|
| | PM2.5 [kt] | PM10 [kt] | TSP [kt] | BC [kt] |
| 2006 | 21.41 | 31.87 | 40.72 | 2.19 |
| 2007 | 17.11 | 25.60 | 33.07 | 1.78 |
| 2008 | 18.15 | 27.33 | 35.78 | 1.87 |
| 2009 | 11.71 | 18.34 | 25.85 | 1.25 |
| 2010 | 15.84 | 24.29 | 33.27 | 1.66 |
| 2011 | 20.97 | 31.58 | 41.45 | 2.14 |
| 2012 | 20.68 | 31.07 | 40.91 | 2.17 |
| 2013 | 22.79 | 33.79 | 44.50 | 2.41 |
| 2014 | 17.26 | 26.31 | 36.24 | 1.82 |
| 2015 | 15.10 | 22.13 | 27.26 | 1.61 |
| 2016 | 13.16 | 19.35 | 23.98 | 1.47 |
| 2017 | 9.14 | 14.03 | 17.87 | 1.09 |
| 2018 | 9.09 | 14.13 | 18.09 | 1.04 |
| 2019 | 9.55 | 15.00 | 19.21 | 1.08 |
| 2020 | 9.12 | 14.06 | 17.83 | 1.04 |
| 2021 | 9.18 | 14.12 | 18.20 | 1.07 |
| 2022 | 9.16 | 14.65 | 19.10 | 1.03 |
| 2023 | 8.69 | 14.20 | 18.57 | 0.93 |
| 2024 | 7.35 | 12.31 | 16.27 | 0.83 |
| <i>Trend 1990–2024</i> | -74% | -70% | -69% | -71% |

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 1990-2024

| Year | Emissions | | |
|------|-----------|---------|---------|
| | Cd [Mg] | Hg [Mg] | Pb [Mg] |
| 1990 | 1.83 | 0.84 | 256.58 |
| 1991 | 1.75 | 0.80 | 193.50 |
| 1992 | 1.72 | 0.78 | 260.62 |
| 1993 | 1.37 | 0.81 | 245.35 |
| 1994 | 1.28 | 0.68 | 225.89 |
| 1995 | 2.36 | 0.70 | 235.04 |
| 1996 | 2.34 | 0.52 | 217.60 |
| 1997 | 1.29 | 0.67 | 219.62 |

| Year | Emissions | | |
|------------------------|-------------|-------------|-------------|
| | Cd [Mg] | Hg [Mg] | Pb [Mg] |
| 1998 | 1.69 | 0.89 | 230.88 |
| 1999 | 1.38 | 0.84 | 174.55 |
| 2000 | 1.44 | 0.56 | 185.46 |
| 2001 | 3.36 | 0.932 | 156.37 |
| 2002 | 2.58 | 0.666 | 98.65 |
| 2003 | 1.62 | 0.63 | 53.55 |
| 2004 | 2.27 | 0.47 | 35.08 |
| 2005 | 0.40 | 0.34 | 8.20 |
| 2006 | 0.37 | 0.35 | 8.83 |
| 2007 | 0.37 | 0.37 | 9.27 |
| 2008 | 0.36 | 0.36 | 7.77 |
| 2009 | 0.35 | 0.32 | 7.12 |
| 2010 | 0.34 | 0.33 | 8.28 |
| 2011 | 0.35 | 0.36 | 9.94 |
| 2012 | 0.35 | 0.34 | 8.68 |
| 2013 | 0.32 | 0.29 | 6.31 |
| 2014 | 0.32 | 0.30 | 7.82 |
| 2015 | 0.32 | 0.29 | 7.96 |
| 2016 | 0.31 | 0.25 | 5.33 |
| 2017 | 0.29 | 0.23 | 5.441 |
| 2018 | 0.29 | 0.20 | 5.66 |
| 2019 | 0.30 | 0.23 | 6.66 |
| 2020 | 0.28 | 0.18 | 6.42 |
| 2021 | 0.29 | 0.18 | 6.99 |
| 2022 | 0.30 | 0.20 | 7.39 |
| 2023 | 0.29 | 0.21 | 7.38 |
| 2024 | 0.27 | 0.18 | 7.14 |
| Trend 1990–2024 | -85% | -79% | -97% |

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

Table 4 Emission trends for POPs 1990-2024

| Year | Emissions | | | |
|------|-----------|------------------------|----------|----------|
| | PAHs [t] | PCDD/F [g – I TEQ] | HCB [kg] | PCB [kg] |
| 1990 | 4.91 | 14.98 | 44.26 | 418.35 |
| 1991 | 4.42 | 13.41 | 39.19 | 416.51 |
| 1992 | 4.67 | 13.18 | 25.80 | 421.08 |
| 1993 | 4.86 | 12.23 | 24.15 | 418.14 |
| 1994 | 4.40 | 11.00 | 25.01 | 381.12 |
| 1995 | 4.51 | 14.04 | 18.60 | 394.40 |
| 1996 | 4.01 | 13.63 | 19.67 | 381.38 |
| 1997 | 4.24 | 11.03 | 27.85 | 415.25 |
| 1998 | 5.03 | 13.04 | 29.31 | 448.78 |
| 1999 | 4.92 | 12.38 | 53.94 | 415.21 |
| 2000 | 5.45 | 19.19 | 38.28 | 382.55 |
| 2001 | 4.43 | 27.10 | 34.12 | 426.13 |
| 2002 | 4.48 | 27.29 | 52.65 | 338.05 |
| 2003 | 4.91 | 25.34 | 42.95 | 299.90 |
| 2004 | 4.97 | 30.34 | 8.48 | 241.22 |
| 2005 | 4.77 | 26.89 | 7.54 | 207.01 |
| 2006 | 4.87 | 25.22 | 11.67 | 207.78 |

| Year | Emissions | | | |
|------------------------|-------------|---------------------|--------------|-------------|
| | PAHs [t] | PCDD/F [g – I TEQ] | HCB [kg] | PCB [kg] |
| 2007 | 5.05 | 26.57 | 8.87 | 208.58 |
| 2008 | 4.73 | 25.88 | 7.74 | 208.28 |
| 2009 | 4.11 | 27.35 | 8.28 | 208.06 |
| 2010 | 4.42 | 29.55 | 9.58 | 208.85 |
| 2011 | 4.61 | 35.77 | 10.50 | 209.21 |
| 2012 | 5.06 | 38.96 | 9.47 | 209.19 |
| 2013 | 4.80 | 40.06 | 6.35 | 209.02 |
| 2014 | 4.63 | 40.06 | 4.19 | 209.48 |
| 2015 | 4.69 | 49.67 | 0.96 | 216.33 |
| 2016 | 4.59 | 51.18 | 0.77 | 220.79 |
| 2017 | 3.88 | 51.58 | 2.06 | 228.69 |
| 2018 | 3.79 | 8.93 | 1.53 | 236.92 |
| 2019 | 4.10 | 9.44 | 4.43 | 238.14 |
| 2020 | 3.73 | 8.62 | 0.16 | 236.77 |
| 2021 | 3.95 | 9.27 | 0.16 | 238.29 |
| 2022 | 3.46 | 8.35 | 0.15 | 242.34 |
| 2023 | 3.23 | 7.80 | 0.10 | 232.38 |
| 2024 | 2.72 | 6.80 | 0.05 | 240.29 |
| Trend 1990–2024 | -45% | -55% | -100% | -43% |

1.2. Priorities for improvement

Since emissions from the Transport sector for period 2005-2024 have been calculated using the Tier 3 method using Copert V model, this method was used in the calculation of historical emissions coming from this sector to secure consistency for the whole reporting period. This was important to be implemented since the Transport sector is one of the key sources for many pollutants, especially for CO and NO_x national emissions. The second national priority is the use of Tier 2 by using of N-fow tool in Agriculture sector which is key sector for ammonia emissions. Several Categories in solvent sector were also improved during current technical IPA II project for air quality.

1.3. Information on recalculation – main reasons for recalculations

In the energy sector, major updates include the implementation of Tier 2 and Tier 3 methodologies for both stationary and mobile sources. Residential combustion estimates were improved using updated models and national data, while issues such as double counting in cement production and fuel misallocation were corrected. Road transport emissions were recalculated using the COPERT model, with improved vehicle and fuel data. Fugitive emissions from fuel distribution were also refined using updated methodologies and corrected activity data.

For industrial processes and product use, improvements focused on applying higher-tier methodologies (Tier 2 and Tier 3), expanding time series coverage, and filling data gaps. Emission estimates were introduced or improved for several solvent use categories, including coatings, degreasing, dry cleaning, and chemical products. Missing historical data were incorporated, and methodologies were aligned with recent guidance and modeling tools.

In the agriculture sector, significant methodological upgrades were made through the introduction of Tier 2 approaches, particularly using the Nitrogen-flow tool. This enabled more accurate estimation of NH₃, NO_x, and NMVOC emissions across manure management and agricultural soils. Updates also include revised emission factors, improved activity data, and the introduction of new emission sources such as crop residues and field burning.

In the waste sector, new models and methodologies were applied for key categories, including solid waste disposal, biological treatment, and wastewater handling. These improvements include the use of Tier 1 and Tier 2 approaches and the introduction of emission estimates for pollutants such as NH₃, NMVOC, and particulate matter.

1.4. Explanation of differences between reported national totals

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

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

As we are not a Member of the European Union, we are not obliged to report emissions under the EU's National Emissions Ceiling Directive (NECD). However, the NEC directive 2001/81/EC has been transposed in the national legislation and national emission ceilings for NO_x, NMVOC, SO_x and NH₃ have been defined. The new NEC Directive (2016/2284/EU) on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC is currently being transposed in the new Law on ambient air quality and sub legislation as part of a IPA 2 Air quality project that started in November 2024 and will end in November 2026. However, based on the regular preparation and reporting of the emission inventory, the gridded data and LPS data and also the projections starting from year as well as the annual IIR, it can be ascertained that several obligations coming from the new NEC directive are already implemented by our country.

INTRODUCTION



2. INTRODUCTION

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 SO₂, NO_x, NMVOC, CO and NH₃, particulate matter (PM), various HM and POPs.

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

- Convention on Long-Range 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 | 28 | 08.02.2022 | / |
| 1998 | Aarhus Protocol on Persistent Organic Pollutants (POPs) | 33 | 23.10.2003 | 1 Nov 2010 (a) |
| | Aarhus Protocol on Persistent Organic Pollutants, as amended on 18 December 2009 ⁶ | 27 | 20.01.2022 | / |
| 1999 | Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone | 31 | 17.05.2005 | 5 Jun 2014 (a) |
| | Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, as amended on 4 May 2012 ⁷ | 31 | 7.10.2019 | Preparatory activities in progress |

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

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

⁵https://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>

⁷http://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 session⁸ (Geneva, 9–13 December 2013), the Executive Body (EB) for the LRTAP Convention adopted revised guidelines for reporting emissions and projections data under the Convention (ECE/EB.AIR/122/Add.1, decisions 2013/3 and 2013/4). Revised 2021 Reporting guidelines and the Annex for IIR content is followed in this report.

National legislation

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

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

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

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

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

The methodology for preparation of the inventory is prescribed in the Rulebook on the methodology for inventory and establishment of the levels of polluting substances emission into the atmosphere in tons per year concerning all types of activities, as well as other data to be submitted to the European Monitoring and Evaluation Program (EMEP), Official Gazette of the Republic of Macedonia No. 142/07⁹. Currently a new Rulebook in compliance with the EMEP Reporting Guidelines and the NEC Directive is under preparation and it is expected to be adopted in 2027.

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 level¹⁰, which will be merged with the defined National emission reduction commitments in a one joint Degree, which is currently under preparation and it is expected to be adopted in 2027.

Directive specific implementation plan for the National Emissions Ceilings (NEC) Directive (2016/2284/EU) with detail analysis of transposition and implementation and cost analysis is under preparation within the IPA II project for Air quality and is planned to be finalized by October 2026.

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 Guidebook¹² 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 SNAP¹³ 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 TEHNOLAB Ltd, a consulting company, for the second time, to prepare a complete Air pollutant emission inventory and IIR for year 2008 emissions¹⁴.

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 review¹⁵ 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 2009¹⁶. 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 PM_{2.5}, PM₁₀, dioxins and furans. Emissions for the baseline years 1980 (SO_x), 1987 (NO_x), 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 (SO_x), 1987 (NO_x), 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 2013¹⁷ for most of the source categories.

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

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

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

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

¹⁶EMEP/EEA air pollutant emission inventory guidebook - 2009

¹⁷EMEP/EEA air pollutant emission inventory guidebook - 2013

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 2016¹⁸ were used. For the previous reporting round additionally in most of the categories, EMEP/EEA Emission Inventory Guidebook 2019¹⁹ and 2016 has been used, while older versions were rarely used due to limitation of activity data. The previous submission and inventory submitted in 2022 were improved with final activity data considered in the revised MAKSTAT database, as well as several categories were improved and additional categories were added according to Stage 3 review recommendations [3]. The present IIR submitted during this year contains improvements made during expert missions in the IPA II air quality project regarding offroad emissions, emissions coming from combustion in households and solvent sector described in detail in chapter 1.3 and sectorial chapters below in this report. The overall view of the gradual improvement of the inventory work is presented in the following table.

Table 6 Development of the inventory work in North Macedonia

| Year of reporting | Inventory | Pollutant | Time series | Based on | Implemented by | Submission | | | |
|-------------------|---|-------------------------------------|-------------|---|--|------------|-------|--------|-----|
| | | | | | | NFR07 | NFR09 | NFR 14 | IIR |
| 2005 | <ul style="list-style-type: none"> 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 | MEPP | X | | | |
| 2006 | <ul style="list-style-type: none"> 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/ACC13F (EMEP Program) TEHNOLAB Ltd | X | | | X |
| 2007 | <ul style="list-style-type: none"> 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 of reporting | Inventory | Pollutant | Time series | Based on | Implemented by | Submission | | | |
|-------------------|---|--|--|---|---------------------|------------|-------|--------|-----|
| | | | | | | NFR07 | NFR09 | NFR 14 | IIR |
| 2008 and 2009 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> Air pollutant emission Inventory and IIR | Basic pollutants | 2008 | | TEHNOLAB Ltd | | X | | X |
| 2011 | <ul style="list-style-type: none"> Stage 3 in depth review Update | Basic pollutants SNAP sector 1, 2 and 3 | | EMEP/EEA GB 2009 | MEPP & TEHNOLAB Ltd | | X | | |
| 2012 | <ul style="list-style-type: none"> Inventory and preparation of the report | All including heavy metals (HM) | Full time series | | MEPP & TEHNOLAB Ltd | | X | | X |
| 2013 | <ul style="list-style-type: none"> Air pollutant emission Inventory Emissions for the baseline years 1980 (SO_x), 1987 (NO_x), 1988 (NMVOC) and 1990 (POPs) | All + HM including PM2.5, PM10, dioxins and furans | | EMEP/EEA GB 2009 | MEPP | | X | | |
| 2014 2015 | <ul style="list-style-type: none"> Recalculation including baseline years | All with exception of BC | Baseline years + 2012 and 2013 | EMEP/EEA Emission Inventory Guidebook - 2009, 2013 | MEPP | | | X | |
| 2016 | <ul style="list-style-type: none"> Recalculation of all pollutants, time series starting from 1990 documentation of methods, data sources, completeness of the Inventory, QA/QC, sectorial methodologies for emission estimations by category (NFR) | All with exception of BC | 1990 – 2014 | EMEP/EEA Emission Inventory Guidebook - 2009, 2013 | MEPP Twinning | | | X | X |
| 2017 | <ul style="list-style-type: none"> Introduction of uncertainty trend analysis and key source analysis as well as QA/QC procedures implemented and improved, most of the Stage 3 review comments^{14F20} implemented | All + BC | 1990-2015 | EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016 | MEPP Twinning | | | X | X |

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

| Year of reporting | Inventory | Pollutant | Time series | Based on | Implemented by | Submission | | | |
|-------------------|--|-----------|-------------|---|---|------------|-------|--------|-----|
| | | | | | | NFR07 | NFR09 | NFR 14 | IIR |
| 2018 | <ul style="list-style-type: none"> Data quality improvement, introduction of new QA/QC procedures | All + BC | 1990-2016 | EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016 | MEPP | | | X | X |
| 2019 | <ul style="list-style-type: none"> Data quality improvement, introduction of new QA/QC procedures | All + BC | 1990-2017 | EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016 | MEPP | | | X | X |
| 2020 | <ul style="list-style-type: none"> Data quality improvement, introduction of new QA/QC procedures, Several NFR sectors added for first time, use of Tier 2 methodology in several categories, use of EF from 2019 GB. | All + BC | 1990-2018 | EMEP/EEA Emission Inventory Guidebook - 2009, 2013 and 2016, 2019 | MEPP | | | X | X |
| 2021 | <ul style="list-style-type: none"> Data quality improvement, Inclusion of Stage 3 Review report, Several NFR sectors added for the first time | All + BC | 1990-2019 | EMEP/EEA Emission Inventory Guidebook – 2019 (early older versions are used due to limitation of activity data) | MEPP | | | X | X |
| 2022 | <ul style="list-style-type: none"> Data quality improvement | All + BC | 1990-2020 | EMEP/EEA Emission Inventory Guidebook – 2019 (early older versions are used due to limitation of activity data) | MEPP | | | X | X |
| 2023 | <ul style="list-style-type: none"> Data quality improvement | All + BC | 1990-2021 | EMEP/EEA Emission Inventory Guidebook – 2019 (early older versions are used due to limitation of activity data) | MEPP | | | X | X |
| 2024 | <ul style="list-style-type: none"> Data quality improvement | All + BC | 1990-2022 | EMEP/EEA Emission Inventory Guidebook – 2023 (early older versions are used due to limitation of activity data) | MEPP | | | X | X |
| 2025 | <ul style="list-style-type: none"> Tier 2 methodology introduced | All + BC | 1990-2023 | EMEP/EEA Emission Inventory Guidebook – 2023 (early older versions are used due to limitation of activity data) | MEPP together with KEY expert 2 from IPA II project “Support in implementation of air quality directives” | | | X | X |

| Year of reporting | Inventory | Pollutant | Time series | Based on | Implemented by | Submission | | | |
|-------------------|---|-----------|-------------|--|---|------------|-------|--------|-----|
| | | | | | | NFR07 | NFR09 | NFR 14 | IIR |
| 2026 | <ul style="list-style-type: none"> COPERT V model for whole time seral used N-flow management tool introduced | All | 1990-2024 | EMEP/EEA Emission Inventory Guidebook – 2023 | MEPP together Sector technical experts expert from IPA II project “Support in implementation of air quality directives” | | | 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. Within the MEIC, experts from four different departments are contributing, whereby experts from the division of Analysis and Reporting are compiling and reporting the inventory.

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

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

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

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](#)

a) Inventory planning

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

b) Inventory preparation

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

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

• Identification of sources of pollution

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

• Data sources

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

- Statistical Yearbooks of Republic of North Macedonia 1990-2023²²; (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 economy²³
- 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)

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

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

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 2024. 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 reporting round EF from GB 2019 were checked and excel calculations sheets and IIR tables were updated.

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

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

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

Calculation of emissions with use of Tier 2 method was carried out in the following sources: NFRs 1.B.1.a (Fugitive emission from solid fuels), 1B2.A.3 (Glass production), 2.D.3.a (Domestic solvent use including fungicides), 2.D.3.g (Chemical products), 2.D.3i and 2.G (Other solvents and product use) and 2.H.2 (Food and beverages industry), 5.A and 5.D.2, for the whole reporting period. Implied emission factors (IEFs) have been used in NFR categories in 2.A.1 (Cement production) 2.C.1 (Metal production) and 2.C.2 (Ferroalloy's production). Tier 2 has been also introduced in 2.C.5 (Lead production) and 2.C.6 (Zinc Production). The higher Tier 2 methodology was used from the last year in following categories: 1A4bii, 1A2gii, 1A4bii, 1A4cii, 2D3e and 2D3f. The activity data were improved and included in the categories 1Bav, 2G and 2D3g. Emission calculations in 2D3d, 5A and 5D1 were improved.

Changing to a Tier 2 method was implemented in 3Da2a, 3Da3 and 3B by using the N-flow tool. Tier 2 was also implemented in category 3De and 3F emissions were calculated for first time.

Tier 3 method – COPERT V model was used for calculation was used for calculation of NFR categories under 1.A.3.b for the period 2005-2024.

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

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

d) Reporting

For reporting of emissions, data from separated calculated sheets tables per NFR, containing EFs, activity data and calculated emissions per pollutant, were linked to the NFR table for reporting. This was carried out with the support of a NFR Reporting Tool, which was developed within the EU Twinning project and implemented by an IT expert from MEPP. The NFR Reporting Tool transposes columns to rows, includes data analysis, and provides emission trends. NFR Reporting tool is linked with the NFR_14 reporting template and reporting towards UNECE and EEA is carried out within the given deadline. For this year the air emission inventory was reported on 13.02.2026 and the resubmission was carried out on 16th March and 06.04.2026.

During the preparation of the current submission of Informative Inventory Report in 2026, the below listed guidelines were followed:

- Revised 2014 Reporting guidelines (ECE/EB.AIR.125);
- Annex II of the Guidelines Recommended structure for the Informative Inventory Report (IIR) - Documentation of methods, trends, recalculations, activity data and other information relevant for understanding the inventory.
- EMEP/EEA air pollutant emission inventory guidebook — 2009;
- EMEP/EEA air pollutant emission inventory guidebook — 2013;
- EMEP/EEA air pollutant emission inventory guidebook — 2016;
- EMEP/EEA air pollutant emission inventory guidebook — 2019;
- EMEP/EEA air pollutant emission inventory guidebook — 2023;

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

2.4. Methods and data sources

Methodology

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

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

Data sources

Activity data needed for emissions calculation are extracted from regular publications and databases of the State Statistical Office and other relevant governmental organizations and ministries, or also from the industry and inquiries carried out by MEIC. For sub-sectors and source categories, more detailed data are required than those published in official statistical reports, such as disaggregated energy balance, vehicle fleet etc. In the Table 7, the official activity data sources in relation to the NFR sectors are presented. The web pages for those data that are available are given in the chapter references. Data requested upon official letters or e-mails but are not available publicly are reported only here in the following table. In the frame of the new Law on ambient air quality which is under preparation in the frame of the ongoing IPA II Air quality project, new article is inserted that the Ministry shall prepare an annual program for collecting data on activities by sector, which shall be published on the website of the Ministry no later than March of the current year. The program shall include the data to be collected, as well as the entities referred to in table 7 below, that are required to submit the data.

Table 7 Activity data sources

| NFR Sector | Data source | Data provider |
|----------------------|---|---|
| Energy | Statistical Yearly reports 1990-2023 [22] Energy balance 2009-2024 [23] Energy statistics for 2000-2010 [24] MAKSTAT database-Energy [25] Questionares for petrol station for implementation phase II and IB | 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 2005-2024 | 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 1990-2024 [22] Questionnaire for emissions in environment 2014-2024 http://minerals.usgs.gov/minerals/pubs/country/europe.html#mk [30] Data recived by GHG inventory team | State statistical office MEPP MANU |

| NFR Sector | Data source | Data provider |
|-------------------------------|---|--|
| 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 1990-2024 [22] Questionnaire for emissions in environment -2014-2024 Data required from SSO for activity data through info email | State statistical office MEPP |
| Agriculture | State Statistical Office of the Republic of North Macedonia, Field crops, orchards and vineyards, 2007-2017 [32] Yearly Statistical reports 1990-2024 [22] State Statistical Office of the Republic of North Macedonia, Livestock, 2007-2015 [33] MAK STAT database agriculture [34] State Statistical Office of the Republic of North Macedonia, Forestry, 2000–2015 [35], Census of agriculture, 2007, Individual agricultural holdings grouped by total available land, by regions, 2008 [36] State agriculture inspectorate | State statistical office MAKSTAT database MAFWS FAO |
| Waste | Statistical Yearly reports 1990-2023 [22] Feasibility study on Drisla landfill, book 1of 2, General overview, Final report, August 2011 [37] “Drisla” landfill web page [38] Drisla, Yearly environmental reports, 2013, 2014, 2015, 2016,2017,2018, 2019,2020,2021,2022,2023,2024 Data on treated communal water 1990-2023 reported by wastewater treatment plants. PRTR database in MEPP [39] | State statistical office Public enterprise “Drisla” landfill EUROSTATE Wastewater treatment plants |
| Natural sources | State Statistical Office of the Republic of North Macedonia, Forestry, 2007–2014 [35] Data on fires (burned area, burned forests) reported by Macedonian forest fires 1990-2024 | State statistical office Public enterprise Macedonian forests |

2.5. Key Categories

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

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

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

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

The analysis of key sources in Republic of Macedonia includes all pollutants reported under CLRTAP: pollutants which cause acidification, eutrophication, and Ground-level ozone (NO_x, NMVOC, SO_x, NH₃ and CO), Particles (TSP) and heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn). Cumulative Table 8 presents the key sources for all reported pollutants.

The KCA table shows that the energy 1A1a (24.2%), 1A3bi (18.1%), 1A3biii (15.1%), 1A3bii (11.6%). 1A2f(7.4%). 1A3ai(i)(3.5%) and 3Da1 (2.8%) are main sources of NO_x. Energy sector emissions are mainly from power plants using lignite. 1A1a is key category for SO_x, contributing with 97.9%, because of high content of sulphur in the dosmesic lignite used for electricity production. This source is key category for many metals like Hg, As, Cr, Ni and Se.

Fugitive emissions from and Domestic heating 1A4bi (23.9%) is the main key sources for NMVOC followed by NFR categories from the solvent sector like 2D3d (20.8%) and 2D3a (16.2%).

Agriculture is main source for ammonia and the main NFR categories contributing to this pollutant are 3Da2a (21.4%), 3Da1 (17.5%), 3B3(13.8%), 3B1a(9.6%), 3Da3 and 5D1 with around 7% and 3B1b contributing with 6%.

Combustion in residential combustion plants is main sources for particulates (PM₁₀ (38.3%),PM_{2.5}(62.5%), TSP(30.5%), CO(62.3%) and HM (Zn and Cd) and POPs (PAHs(79.7%), DIOX(72.9%) pollutants. For HCB due to the closure of aluminium production installation, the in the last decade is the key category is 1A4bi with 72.2%, followed by clinical waste incineration 5C1biii, contributing with 20.5%.

The key categories for all air pollutants are presented in Table 8. Key categories for pollutants under CLRTAP for 2024 are in compliance with those calculated by CEIP as checked through the REPDAP system on CEIP webpage.

Table 8 Key categories for all air pollutants for 2024

| Component | Key categories (Sorted from high to low from left to right) | | | | | | | | Total (%) |
|-------------------------|---|--------|---------|--------|--------|----------|------|-------|-----------|
| NO_x | 1A1a | 1A3bi | 1A3biii | 1A3bii | 1A2f | 1A3ai(i) | 3Da1 | | 82.7% |
| NMVOC | 1A4bi | 2D3d | 2D3a | 3B1a | 1B1a | 2H2 | 2D3g | 3Da2a | 81.0% |
| SO₂ | 1A1a | | | | | | | | 97.9% |
| NH₃ | 3Da2a | 3Da1 | 3B3 | 3B1a | 5D1 | 3B1b | | | 83.1% |
| PM_{2.5} | 1A4bi | 1A1a | 2G | 2A5b | | | | | 81.6% |
| PM₁₀ | 1A4bi | 1A1a | 3Dc | 2G | | | | | 83.0% |
| TSP | 1A4bi | 1A1a | 3Dc | 2A5b | 2A5a | 2G | | | 83.4% |
| CO | 1A4bi | 3F | 1A3bi | | | | | | 81.4% |
| BC | 1A4bi | 1A3bi | 1A3biii | 3F | 1A3bii | | | | 82.1% |
| Pb | 2G | 1A3bvi | | | | | | | 83.0% |
| Cd | 1A4bi | 3F | 1A1a | 2C1 | | | | | 88.9% |
| Hg | 1A1a | 1A2f | 2C1 | 2K | | | | | 87.4% |
| As | 1A1a | | | | | | | | 87.9% |
| Cr | 1A3bvi | 1A1a | 1A4bi | 2G | | | | | 89.7% |
| Cu | 1A3bvi | 2G | | | | | | | 97.8% |
| Ni | 1A1a | 2C1 | 1A4ai | | | | | | 87.7% |
| Se | 1A4bi | 1A1a | | | | | | | 99.3% |
| Zn | 1A4bi | 1A3bvi | 2C1 | | | | | | 82.5% |
| DIOX | 1A4bi | 2C1 | | | | | | | 86.7% |
| PAH | 1A4bi | 5C2 | | | | | | | 85.6% |

| Component | Key categories (Sorted from high to low from left to right) | | | | | | | | Total (%) |
|-----------|---|---------|--|--|--|--|--|--|-----------|
| HCB | 1A4bi | 5C1biii | | | | | | | 92.7% |
| PCBs | 2K | | | | | | | | 88.5% |

2.6. QA/QC and Verification methods

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

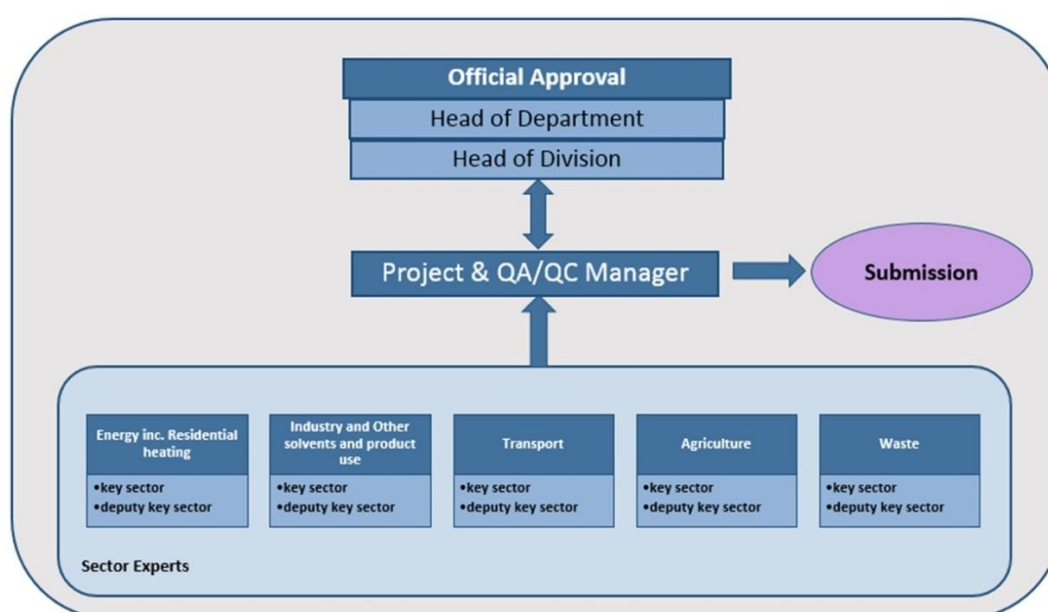


Figure 3 Roles in inventory preparation and submission

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

QA/QC Plan and quality objectives

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

- Transparency

- Accuracy
- Completeness
- Consistency
- Comparability
- Timeliness

Progress in transparency and completeness as well as timeliness is analyzed annually. The analysis is carried out by counting the total number of data records, as well as those reported as “not estimated” and “included elsewhere” (for all air pollutants). Then the share of “NE” and “IE” to total data records is determined. The results of this year’s analysis, and a comparison with the previous submission is shown in Table 9 below. As shown, completeness has been improved since last submission, since activity data for some sectors were made available.

The timeliness parameter of the IIR containing 2022 emission data was set to 95%, as the IIR report was submitted after the official deadline of 17th April defined in the CLRTAP Reporting Guidelines (ECE/EP.AIR/125), due to engagement of the experts in other work overload, especially with the IPA II air quality project. Submission of emission data, i.e. NFR Tables to CEIP was however done in time on 13th February, and resubmission was done on 16th March and 06th April this year.

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

Table 9 Completeness Analysis 2024

| Sector | Submission 2025 | | Submission 2026 | | | Plan Submission 2027 | | |
|-------------------------|-----------------|------|-----------------|------|------|----------------------|------|------|
| | 1990 | 2024 | 1990 | 2024 | 2025 | 1990 | 2024 | 2025 |
| Transparency (IE) | 98% | 98% | 98% | 98% | 98% | 98% | 98% | 98% |
| Completeness (NE) | 90% | 96% | 90% | 97% | 97% | 90% | 97% | 98% |
| Completeness (IIR) | ~ 360 pages | | ~ 470 pages | | | ~ 490 pages | | |
| Timeliness (Submission) | 96%* | | 97%* | | | 100% | | |

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

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

Table 10 Annual time schedule

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

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

2.6.1. Quality control procedures

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

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

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

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

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

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

2.6.2. Quality assurance procedures

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

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

The review consists of three stages, whereby stage 1 and 2 are carried out annually, and the third stage – the in-depth review – on an irregular basis. Findings in the Stage 1 and 2 review report are elaborated in the chapter's emission trends and recalculations. The Stage 3 review of the Macedonian Inventory was carried out in May – September 2023, for emissions coming from agriculture sector and in 2024 for Solvents and product use. In 2025 projections were reviewed, however no projections were provided. Projections are introduced for the first time in this submission. Most recommendations from previous reviews mainly on use of higher tier methodology for calculations were implemented in the frame of activity 2.9 of the ongoing IPA II Air quality project are incorporated in this report. Several 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.

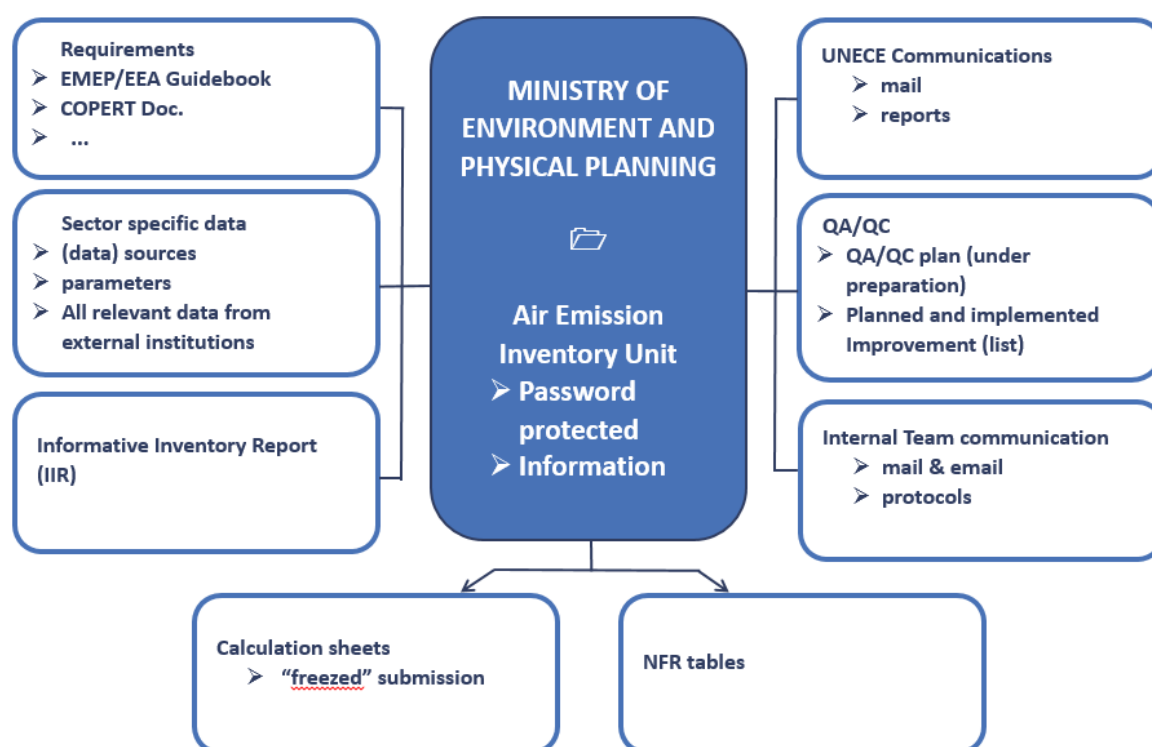


Figure 4 Archiving system

2.6.4. Continuous improvement

The Macedonian inventory is subject to continuous improvement.

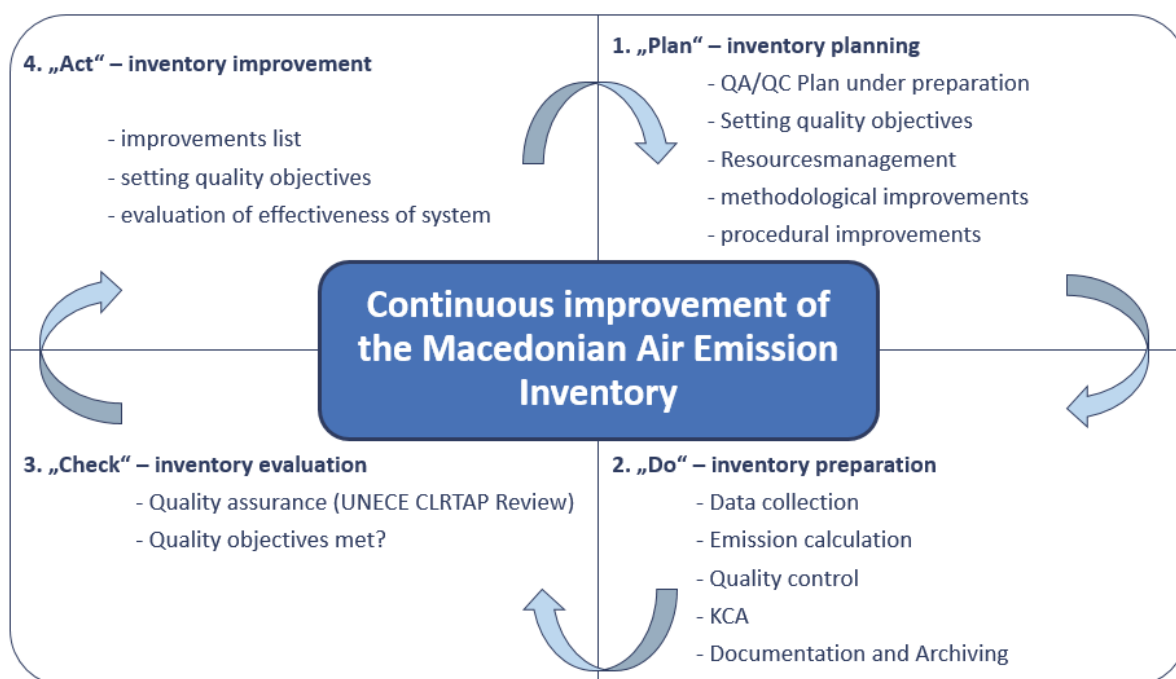


Figure 5 Improvement Cycle

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 their 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.

In the frame of the EU 4 Green project training for the improvement of the QA/QC activities will be carried out and QA/QC Plan will be prepared in the IPA II Air quality project.

2.7. General uncertainty evaluation

The uncertainty assessment of the main pollutants (SO_2 , NO_x , NMVOC, NH_3 and $\text{PM}_{2.5}$) has been carried out. The assessment was carried out for the base year 1990 and for the year 2023. An update of the uncertainty calculations for 2024 will be updated with new categories in the frame of EU 4 green project in June and included in the resubmitted IIR.

The method for the assessment of uncertainty is described in the “EMEP/EEA air pollutant emission inventory guidebook 2016” (EEA 2016)”. For the Macedonian uncertainty analysis, the Tier 1 method was implemented for the main pollutants. By using the error propagation method, the uncertainties for a specific source category can be estimated. By combining these uncertainties an overall uncertainty can be calculated. To estimate the overall uncertainty per pollutant, an uncertainty value for each activity data and emission factor in every sector had to be estimated. This assessment was based on guidance stated in Table 11 for activity and Table 12 for emission factors.

Table 11 Rating definitions for activity data

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

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

Table 12 Rating definitions for emission factors

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

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

2.7.1.

2.7.2. Results

The quantitative assessment was performed with the Tier 1 method for the pollutants SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}, for the year 2023 and the respective level and trend uncertainties. The results of the uncertainty analysis are presented in following tables. For the year 2024 uncertainties will be updated in the frame of the EU 4 Green project and updated values will be resubmitted in June this year.

Table 13 Result of overall uncertainty estimation for the main pollutants SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}

| Pollutants | Emissions 2023 | Level uncertainty 2023 | Trend uncertainty 1990 - 2023 |
|-----------------|----------------|------------------------|-------------------------------|
| SO ₂ | 105.1 kt | 20.0% | 6.6% |
| NOX | 20.1 kt | 20.1% | 6.2% |

| | | | |
|-----------------|---------|--------|--------|
| NM VOC | 21.3 kt | 0.4 kt | 0.1 kt |
| NH ₃ | 6.8 kt | 1.0 kt | 0.2 kt |
| PM2.5 | 7.6 kt | 86.8% | 16.1% |

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

Table 14 Uncertainty estimation of SO₂ emissions 1990 and 2023

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

Table 15 Uncertainty estimation of NO_x emissions 1990 and 2023

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

Table 16 Uncertainty estimation of NMVOC emissions 1990 and 2023

| Member State: | MK | | | | | | | | | | | |
|-----------------|------|--|--|--|--|--|--|--|--|--|--|--|
| Reporting year: | 2023 | | | | | | | | | | | |
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Table 17 Uncertainty estimation of NH₃ emissions 1990 and 2023

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

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

| Member State: | MK | | | | | | | | | | | |
|---------------------|----------|-------------------|----------------|-------------------------------|---------------------------------|-----------------------------------|--|---------------------|--------------------|---|--|--|
| Reporting year: | 2023 | | | | | | | | | | | |
| NRF sector | Pollutan | Base year emissio | Year t emissio | Activity data uncertainty (1) | Emission factor uncertainty (1) | Combined uncertainty | Contribution to variance by category in year x | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor / estimation parameter | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emission |
| | | Mg | Mg | % | % | % | % | % | % | % | % | % |
| | | Input data | Input data | input data Note A | input data Note A | $(E^2 + F^2)^{1/2}$ | $(G^2 D^2 + \text{Summe}(D)^2)^{1/2}$ | Note B | D/Summe(C) | I^F Note C | J^E sqrt(2) Note D | K^2 + L^2 |
| 1 A 1 a | NH3 | NA | NA | 5,0 | | | | | | | | |
| 1 A 1 b | NH3 | NE | NO | 5,0 | | | | | | | | |
| 1 A 1 c | NH3 | NO | NO | | | | | | | | | |
| 1 A 2 a | NH3 | NA | 0,0 | 10,0 | | | | | 0,00 | | 0,00 | |
| 1 A 2 b | NH3 | NA | 10,0 | | | | | | | | | |
| 1 A 2 c | NH3 | NA | NA | 10,0 | | | | | | | | |
| 1 A 2 d | NH3 | NA | 0,0 | 10,0 | | | | | 0,00 | | 0,00 | |
| 1 A 2 e | NH3 | NA | 0,0 | 10,0 | | | | | 0,00 | | 0,00 | |
| 1 A 2 f | NH3 | NO | NO | | | | | | | | | |
| 1 A 2 g 7 | NH3 | 0,0 | 0,0 | 10,0 | 125,0 | 125,40 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 1 A 2 g 8 | NH3 | 0,0 | 0,0 | 10,0 | | | | 0,00 | 0,00 | | 0,00 | |
| 1 A 3 a | NH3 | - | - | 10,0 | | | | 0,00 | 0,00 | | 0,00 | |
| 1 A 3 b | NH3 | - | 0,1 | 10,0 | 125,0 | 125,40 | 3,55 | 0,01 | 0,01 | 0,86 | 0,10 | 0,76 |
| 1 A 3 c | NH3 | 0,0 | 0,0 | 10,0 | 125,0 | 125,40 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 1 A 4 b | NH3 | 0,1 | 0,1 | 20,0 | 125,0 | 126,59 | 1,10 | 0,00 | 0,00 | 0,18 | 0,11 | 0,05 |
| 1 A 4 c | NH3 | 0,0 | 0,0 | 10,0 | 125,0 | 125,40 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 1 B 2 a | NH3 | 0,0 | - | 10,0 | 40,0 | 41,23 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 2 A 3 | NH3 | 0,0 | NO | 10,0 | 40,0 | 41,23 | | | | | | |
| 3 B 1 | NH3 | 2,9 | 1,6 | 5,3 | 125,0 | 125,11 | 837,36 | 0,02 | 0,11 | 1,90 | 0,80 | 4,25 |
| 3 B 2 | NH3 | 0,9 | 0,2 | 10,2 | 125,0 | 125,42 | 18,89 | -0,01 | 0,02 | -1,60 | 0,23 | 2,60 |
| 3 B 3 | NH3 | 0,9 | 0,9 | 6,1 | 125,0 | 125,15 | 279,95 | 0,03 | 0,06 | 4,28 | 0,53 | 18,57 |
| 3 B 4 | NH3 | 2,4 | 0,7 | 10,0 | 125,0 | 125,40 | 150,12 | -0,03 | 0,04 | -3,73 | 0,64 | 14,34 |
| 3 D a | NH3 | 7,4 | 3,1 | 50,0 | 200,0 | 206,16 | 9.025,60 | -0,02 | 0,21 | -3,99 | 15,00 | 240,84 |
| 3 D b | NH3 | NE | NE | | | | | | | | | |
| 3 D d | NH3 | NE | NE | | | | | | | | | |
| 3 D e | NH3 | NA | NA | | | | | | | | | |
| 3 F | NH3 | NE | NE | | | | | | | | | |
| 3 G | NH3 | | | | | | | | | | | |
| 3 H | NH3 | | | | | | | | | | | |
| 3 I | NH3 | NE | NE | | | | | | | | | |
| 5 A | NH3 | 0,0 | 0,0 | 50,0 | | | | 0,00 | 0,00 | | 0,01 | |
| 5 B | NH3 | - | 0,0 | | | | | 0,00 | 0,00 | | | |
| 5 C | NH3 | - | - | 10,0 | | | | 0,00 | 0,00 | | 0,00 | |
| 5 D | NH3 | - | - | | | | | 0,00 | 0,00 | | | |
| Total | | 14,7 | 6,8 | | | | 10.316,57 | | | | | 281,40 |
| Total Uncertainties | | | | | | Uncertainty in total inventory %: | 101,57 | Trend uncertainty % | | | | 16,78 |

2.7.3. 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 2024

The data for the whole year 2024 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 networks are taken from the Agency for State Roads, while the data on local road networks 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 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 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 2024 data are gathered from MAKSTAT database. There are no available data for uncertainty since these data are no longer published.

Table 19 Relative errors of livestock survey 2015

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

Waste

Municipal waste is waste collected by, or on behalf of municipal authorities. It consists of waste from the households, including the massive waste, similar waste from commercial and trade industries, official buildings, institutions and small businesses, 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 municipal waste collected, as well as data on the treatment of collected municipal waste, have been obtained based on the reports filled in by the reporting units. On the basis of the obtained data and the data on the number of populations, estimation has been made of the total generated municipal waste on the territory of the Republic of North Macedonia. The obtained indicator of the annual amount of municipal waste per person in kg is a ratio of the total annual amount of generated municipal waste and the total population estimated for the reference year (as at 01.01. in the reference year).

2.8. General assessment of completeness

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

Table 20 Notation keys used in the NFR

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

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

2.8.1. Sources not estimated (NE)

Table 21 Number of “not estimated” (NE) per sector and pollutant in 2024

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

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

2.8.2. Sources included elsewhere (IE)

Table 22 Number of “included elsewhere” (IE) per sector and pollutant in 2024

| Pollutant | Energy | Fugitives | IPPU | Agriculture | Waste | Other |
|--|--------|-----------|------|-------------|-------|-------|
| NO _x (as NO ₂) | 0 | 0 | 3 | 3 | 0 | 0 |
| NM VOC | 0 | 0 | 3 | 3 | 0 | 0 |
| SO _x (as SO ₂) | 0 | 0 | 3 | 1 | 0 | 0 |
| NH ₃ | 0 | 0 | 3 | 1 | 0 | 0 |
| PM _{2.5} | 0 | 0 | 3 | 1 | 0 | 0 |
| PM ₁₀ | 0 | 0 | 3 | 1 | 0 | 0 |
| TSP | 0 | 0 | 3 | 1 | 0 | 0 |
| BC | 0 | 0 | 3 | 0 | 0 | 0 |
| CO | 0 | 0 | 3 | 0 | 0 | 0 |
| Pb | 0 | 0 | 3 | 0 | 0 | 0 |
| Cd | 0 | 0 | 3 | 0 | 0 | 0 |
| Hg | 0 | 0 | 3 | 0 | 0 | 0 |
| As | 0 | 0 | 3 | 0 | 0 | 0 |
| Cr | 0 | 0 | 3 | 0 | 0 | 0 |
| Cu | 0 | 0 | 3 | 0 | 0 | 0 |
| Ni | 0 | 0 | 3 | 0 | 0 | 0 |
| Se | 0 | 0 | 3 | 0 | 0 | 0 |
| Zn | 0 | 0 | 3 | 0 | 0 | 0 |
| PCDD/ PCDF (dioxins/ furans) | 0 | 0 | 3 | 0 | 0 | 0 |
| PAHs (Total 1-4) | 0 | 0 | 3 | 0 | 0 | 0 |
| HCB | 0 | 0 | 3 | 0 | 0 | 0 |
| PCBs | 0 | 0 | 3 | 0 | 0 | 0 |

The notation key -“ included elsewhere” (IE) is used in those source categories for which activity data are not available in the required details in the statistical yearbooks but have been included in other source categories. For example, in case of category 1.A.5.b there are available data for the last three years, while emissions from the previous years are noted as IE as these emissions are accounted in offroad transport sector. For 2B10b emissions are included in 2B10a. Emissions from 3B4a are included in 3B1b. Abbreviation IE is used in cases where there is a lack of detail activity data.

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

Table 23 Number of “Not available” (NA) per sector and pollutant in 2024

| Pollutant | Energy | Fugitives | IPPU | Agriculture | Waste | Other |
|--|--------|-----------|------|-------------|-------|-------|
| NO _x (as NO ₂) | 3 | 3 | 20 | 6 | 8 | 0 |
| NMVOC | 2 | 1 | 11 | 7 | 5 | 0 |
| SO _x (as SO ₂) | 4 | 3 | 19 | 21 | 8 | 0 |
| NH ₃ | 9 | 2 | 22 | 6 | 3 | 0 |
| PM _{2.5} | 1 | 2 | 10 | 8 | 7 | 0 |
| PM ₁₀ | 1 | 2 | 10 | 8 | 7 | 0 |
| TSP | 3 | 2 | 8 | 8 | 6 | 0 |
| BC | 2 | 3 | 15 | 22 | 7 | 0 |
| CO | 3 | 3 | 20 | 21 | 7 | 0 |
| Pb | 8 | 3 | 18 | 22 | 7 | 0 |
| Cd | 3 | 3 | 17 | 22 | 7 | 0 |
| Hg | 10 | 2 | 18 | 22 | 8 | 0 |
| As | 9 | 2 | 18 | 22 | 7 | 0 |
| Cr | 3 | 3 | 20 | 22 | 7 | 0 |
| Cu | 3 | 3 | 20 | 22 | 7 | 0 |
| Ni | 3 | 3 | 19 | 22 | 8 | 0 |
| Se | 4 | 3 | 20 | 22 | 9 | 0 |
| Zn | 3 | 3 | 20 | 22 | 9 | 0 |
| PCDD/ PCDF (dioxins/ furans) | 9 | 3 | 17 | 22 | 7 | 0 |
| PAHs (Total 1- 4) | 5 | 3 | 19 | 16 | 7 | 0 |
| HCB | 9 | 3 | 19 | 16 | 7 | 0 |
| PCBs | 9 | 3 | 17 | 16 | 8 | 0 |

Table 24 Number of “Not occurring” (NO) per sector and pollutant in 2024

| Pollutant | Energy | Fugitives | IPPU | Agriculture | Waste | Other |
|--|--------|-----------|------|-------------|-------|-------|
| NO _x (as NO ₂) | 3 | 6 | 16 | 4 | 5 | 1 |
| NMVOC | 3 | 6 | 16 | 4 | 5 | 1 |
| SO _x (as SO ₂) | 3 | 6 | 16 | 4 | 5 | 1 |
| NH ₃ | 3 | 6 | 16 | 4 | 5 | 1 |
| PM _{2.5} | 3 | 6 | 16 | 4 | 5 | 1 |
| PM ₁₀ | 3 | 6 | 16 | 4 | 5 | 1 |
| TSP | 3 | 6 | 16 | 4 | 5 | 1 |
| BC | 3 | 6 | 15 | 4 | 5 | 1 |
| CO | 3 | 6 | 16 | 4 | 5 | 1 |
| Pb | 3 | 6 | 16 | 4 | 5 | 1 |
| Cd | 3 | 6 | 16 | 4 | 5 | 1 |
| Hg | 3 | 6 | 16 | 4 | 5 | 1 |

| Pollutant | Energy | Fugitives | IPPU | Agriculture | Waste | Other |
|------------------------------------|--------|-----------|------|-------------|-------|-------|
| As | 3 | 6 | 16 | 4 | 5 | 1 |
| Cr | 3 | 6 | 16 | 4 | 5 | 1 |
| Cu | 3 | 6 | 16 | 4 | 5 | 1 |
| Ni | 3 | 6 | 16 | 4 | 5 | 1 |
| Se | 3 | 6 | 16 | 4 | 5 | 1 |
| Zn | 3 | 6 | 16 | 4 | 5 | 1 |
| PCDD/ PCDF (dioxins/ furans) | 3 | 5 | 16 | 4 | 5 | 1 |
| PAHs | 3 | 6 | 17 | 10 | 6 | 1 |
| HCB | 3 | 6 | 17 | 10 | 6 | 1 |
| PCBs | 3 | 6 | 17 | 10 | 6 | 1 |

EXPLANATION OF KEY TRENDS



3. EXPLANATION OF KEY TRENDS

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

3.1. Emission Trends for the Main Air Pollutants and CO

National total emissions and trends for the main air pollutants (NO_x, NMVOC, SO₂ and NH₃) and CO, which are covered by the Gothenburg Protocol, from 1990-2024 are presented in the following table.

Table 25 Emission trends 1990 – 2024 for the main air pollutants and CO

| Year | Emission in kt | | | | |
|------|-----------------|--------|-----------------|-----------------|--------|
| | NO _x | NMVOC | SO ₂ | NH ₃ | CO |
| 1990 | 37.79 | 40.03 | 109.88 | 13.99 | 134.39 |
| 1991 | 27.27 | 33.29 | 87.57 | 13.34 | 98.71 |
| 1992 | 33.41 | 40.66 | 86.49 | 13.39 | 138.98 |
| 1993 | 34.54 | 40.40 | 88.57 | 13.47 | 140.75 |
| 1994 | 30.33 | 35.77 | 87.77 | 13.34 | 123.87 |
| 1995 | 31.88 | 35.70 | 93.09 | 13.15 | 131.81 |
| 1996 | 31.35 | 35.51 | 87.70 | 12.65 | 127.37 |
| 1997 | 29.42 | 34.56 | 91.18 | 12.26 | 118.86 |
| 1998 | 33.53 | 34.82 | 106.55 | 12.23 | 119.63 |
| 1999 | 30.96 | 34.55 | 96.46 | 12.43 | 114.84 |
| 2000 | 32.10 | 35.62 | 99.11 | 12.14 | 118.60 |
| 2001 | 29.12 | 32.11 | 103.87 | 11.65 | 96.70 |
| 2002 | 29.48 | 30.41 | 90.79 | 11.11 | 95.64 |
| 2003 | 26.99 | 29.50 | 91.62 | 11.05 | 92.47 |
| 2004 | 26.65 | 28.26 | 92.29 | 10.97 | 90.10 |
| 2005 | 28.43 | 23.92 | 91.09 | 10.69 | 79.56 |
| 2006 | 28.23 | 22.78 | 86.94 | 10.96 | 76.51 |
| 2007 | 30.85 | 23.38 | 90.55 | 11.21 | 76.01 |
| 2008 | 30.47 | 23.38 | 98.26 | 11.06 | 72.45 |
| 2009 | 28.81 | 21.31 | 91.79 | 10.37 | 67.70 |
| 2010 | 28.49 | 22.37 | 87.082 | 10.47 | 65.88 |
| 2011 | 29.39 | 23.04 | 97.13 | 10.64 | 67.02 |
| 2012 | 29.61 | 23.33 | 94.13 | 9.94 | 68.06 |
| 2013 | 27.64 | 22.51 | 80.57 | 9.81 | 66.17 |
| 2014 | 21.70 | 22.25 | 80.82 | 9.86 | 63.14 |
| 2015 | 21.07 | 21.64 | 73.22 | 10.07 | 63.29 |
| 2016 | 20.60 | 20.59 | 62.63 | 9.99 | 62.82 |
| 2017 | 19.68 | 20.51 | 53.75 | 9.83 | 54.57 |
| 2018 | 20.23 | 19.72 | 58.95 | 9.81 | 53.84 |
| 2019 | 21.59 | 19.222 | 70.65 | 8.59 | 54.66 |

| Year | Emission in kt | | | | |
|------------------------|-----------------|-------------------|-----------------|-----------------|-------------|
| | NO _x | NM _{VOC} | SO ₂ | NH ₃ | CO |
| 2020 | 19.10 | 18.56 | 53.15 | 8.92 | 49.46 |
| 2021 | 19.21 | 18.34 | 45.32 | 8.40 | 50.88 |
| 2022 | 19.72 | 17.65 | 55.01 | 7.93 | 48.34 |
| 2023 | 20.98 | 17.23 | 56.82 | 7.73 | 45.95 |
| 2024 | 18.97 | 15.71 | 45.81 | 7.89 | 40.97 |
| Trend 1990-2024 | -50% | -61% | -58% | -44% | -70% |

3.1.1. NO_x emissions

Emission trend

In 1990 national total NO_x emissions amounted to around 37.79 kt. Since then, the emissions decreased by 50%. In 2024 emissions were on the level of about 18.970 kt. The trend is variable but with minor pics and deeps until 2021. The sharp fall of emissions between 2012 and 2015 is owned to the lower consumption of coal in the major power plants and the modernization of boilers in the power plant REK Bitola. In the period 2016–2024, the emissions are stable without sharp deeps and jams. Compared to 2024, emissions in 2023 are lower for 10% owing to lower emissions in Transport, due to lower emissions in NFR category 1A3biii.

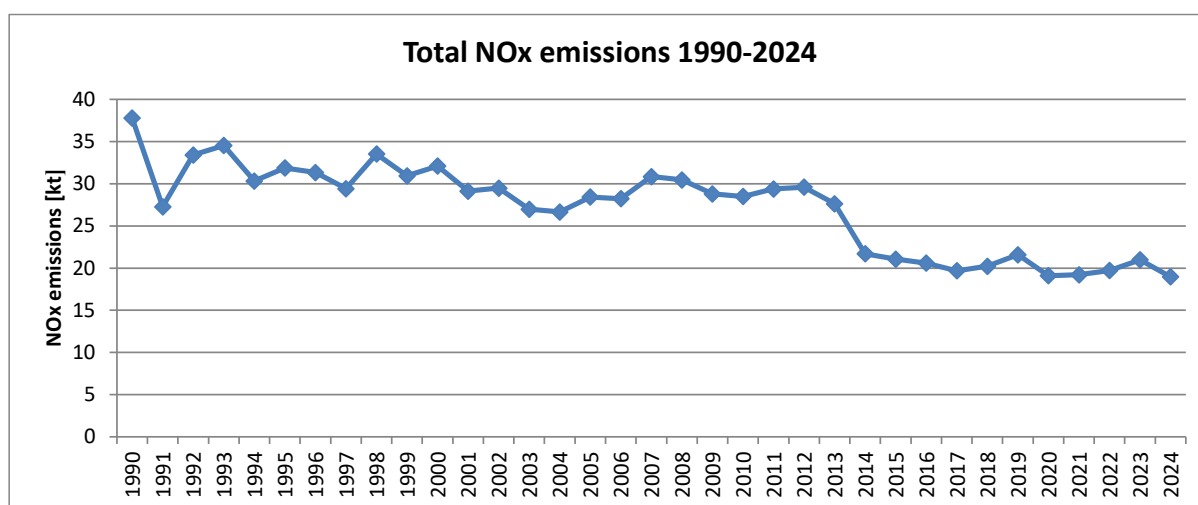


Figure 6 National total NO_x emissions 1990-2024

The target value for NO_x 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 NO_x emissions in 2024 are less than the NO_x 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 2024, which is accounting 8.422Gg.

Main emission sources in North Macedonia

Almost all NO_x emissions are coming from the sector Energy, Namely, the main emission sources in 2024 are NFR source categories: 1.A.3 Transport, 1.A.1 Energy Industries and 1.A.2 Manufacturing Industries and Construction which contributed with 49% (24% in 1990), 24% (40% in 1990) and 14% (23% in 1990) respectively, of the national total NO_x 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 2024 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 14 % and has not changed significantly in comparison to the value in 1990 of 23%. NFR sectors 1.A.4 Other sectors and 3.Agriculture contribute with 5% and 8% respectively, while 1.B Fugitive emissions, 2 Industrial Processes and Product Use and 5 Waste are minor sources of NO_x emissions.

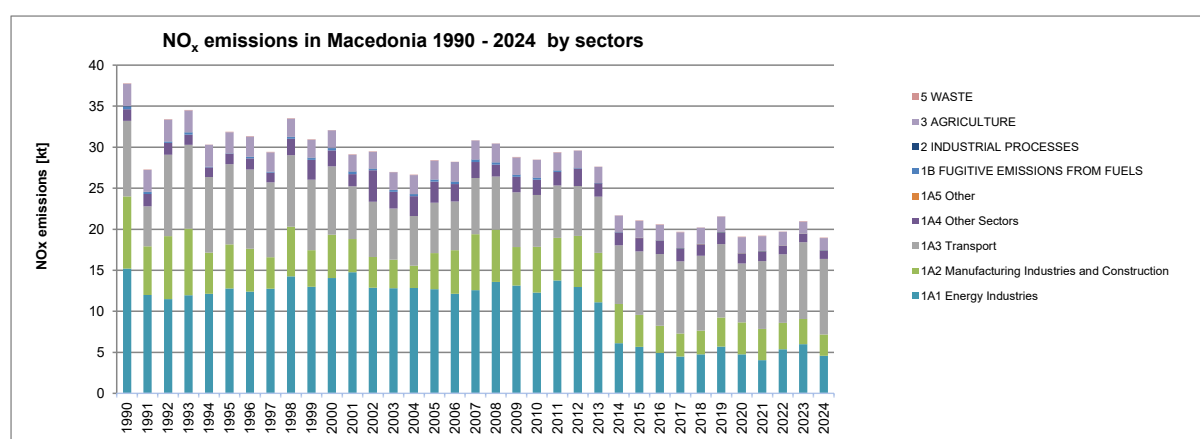


Figure 7 NO_x emissions in North Macedonia 1990-2024 by sectors

3.1.2. NMVOC emissions

Emission trend

In 1990, the total national NMVOC emissions amounted to about 40 kt. Compared to 2024, the emissions are down by 61% amounting to around 15.7 kt. Calculated emissions in 2024 compared to 2023 emissions decreased only by 9%.

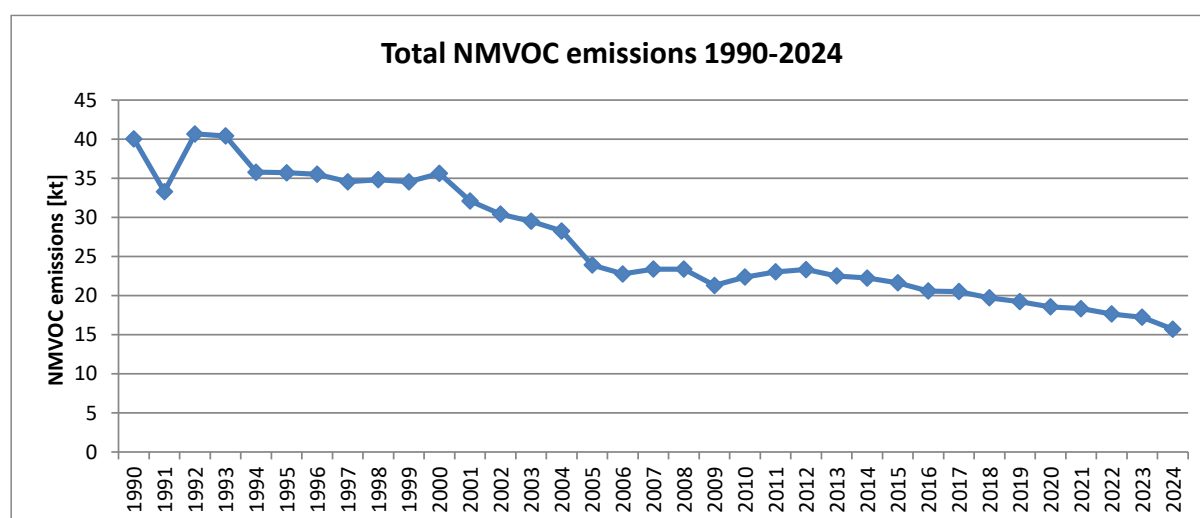


Figure 8 National total NMVOC emissions 1990-2024

Target value for NMVOC according to Gothenburg Protocol for year 2010 is 30 kt NMVOC. The emissions in 2024 are below the target value by 48%. The country is also in compliance with the Protocol on the control of volatile organic compounds or their Trans boundary fluxes since 1988, NMVOC emissions (48 kt) in 2024 in amount of 15.7 kt are reduced by 65% compared to 1988.

Main emission sources in North Macedonia

NMVOC emissions are emitted from different sources. The key category source in 2024 are NFR source categories is 2 Industrial pollution, contributing with 46% (37% in 1990) followed by 1.A.4 Other Sectors (mainly residential heating) and 3 Agriculture which contributed with 46 % and 25% (37% and 15% in 1990, respectively), to the national total NMVOC emissions. Agriculture is contributing with around 17%, while NFR source category 1.A.3 Transport and 1.A.2 contributed with 6% and 2% of total calculated national NMVOC emissions, respectively.

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

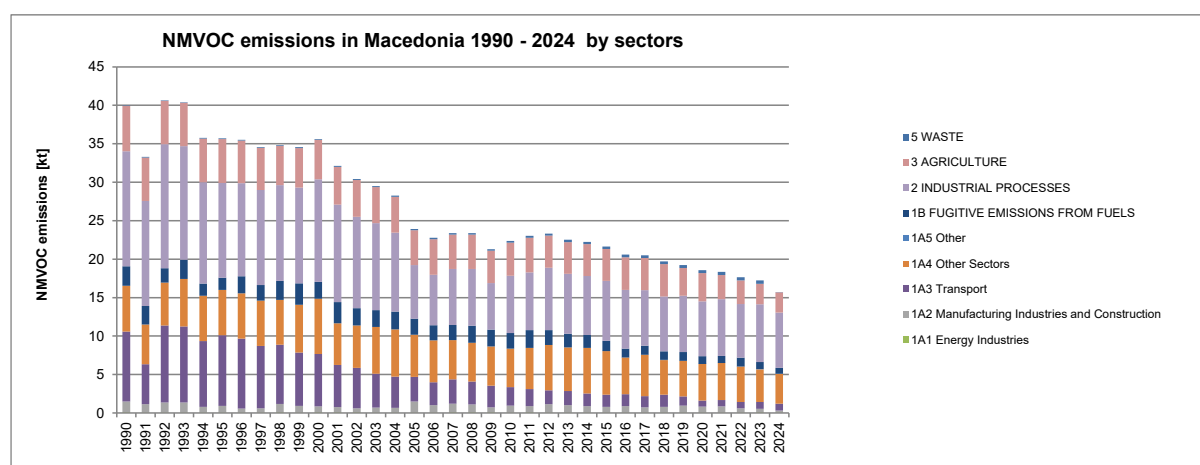


Figure 9 NMVOC emissions in North Macedonia 1990-2024 by sectors

3.1.3. SO₂ emissions

Emission trend

In 1990, the national total SO₂ emissions amounted to 109.9 kt. In the period 2011–2016 there was a decrease of emissions due to the decrease of coal consumption and lower capacity of work of the second largest (by capacity) power plant REK Oslomej (from 12 to 5 months), attributed to limited amounts of coal. In 2019 there is a sharp increase due to increased use of coal with higher sulfur content and higher production of electricity compared to 2018. But in 2020 the emissions are again decrease due to lower consumption of coal and heavy fuels, but not on the level of 2018. Compared to 2024 the emissions in 2023 are decreased by 19%, and compare to 1990 emissions are decreased by 58%.

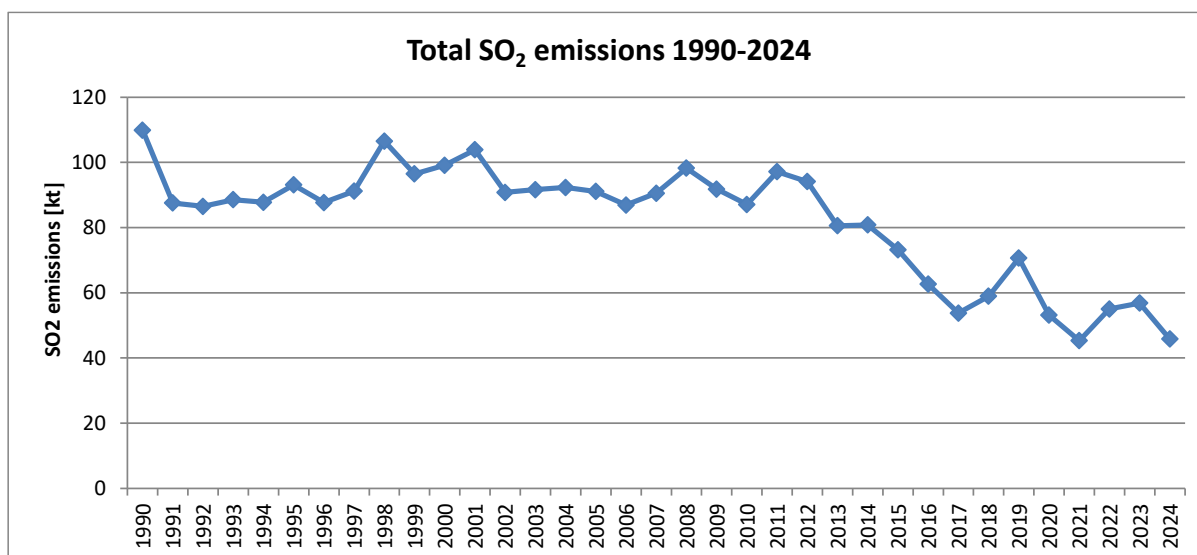


Figure 10 National total SO₂ emissions 1990-2024

North Macedonia is a party to the three protocols, under LRTAP convention, concerning sulfur. The emissions of sulfur dioxide in 2024 are below the base year 1990 emissions and the respective ceiling in 2010, which reflects compliance with the 1994 Protocol on further reduction on sulfur and the Gothenburg protocol.

The country is still in non-compliance with the 1985 Protocol on reduction of sulfur emissions or their trans-boundary transmission by at least 30 percent, because the emissions have not been reduced by the designated percentage between now and 1980. Because the major source of this pollutant is power production, compliance with the oldest protocol on sulfur is expected to be achieved with installation of a desulfurization unit in the Power plant REK Bitola. According to the agreement with the Energy community, the compliance with SO_x emission limit values, which will also mean compliance with the protocol, should be reached with implementation of a desulfurization unit, that should be implemented in accordance with the time dynamics set in the revised National Plan for reduction of emissions from large combustion plants approved by the Government in April 2017. With regards to LCPs, the emissions in 2024 as in the previous years were not below national emission ceiling of 15.855 Gg, indicating that compliance with the set limit values was not reached. In 2024, SO_x 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. However, steps forward have been taken to implement desulfurization. Namely, a working group has been established and tasked with the preparation of tender documentation for the development of a project, its revision, implementation, supervision of the works, and performance testing following completion, in relation to the reduction of SO₂ emissions in flue gases—specifically through primary desulphurisation. This activity constitutes a requirement under the Compliance Permit with an Operational Plan for the REK Bitola branch.

Main emission sources in North Macedonia

Almost all SO₂ emissions are resulting from Energy sector. Consequently, the main emission source in 2024 is as expected NFR source category 1.A.1 Energy Industries (Public electricity and heat production), which contributed with 91% in 1990, and with 98% in 2024 of the national total SO₂

emissions. About 5% in 1990 and 1% in 2024 of the total emissions are stemming from NFR source category 1.A.2 Manufacturing Industries.

Other NFR sectors produce minor SO₂ emissions.

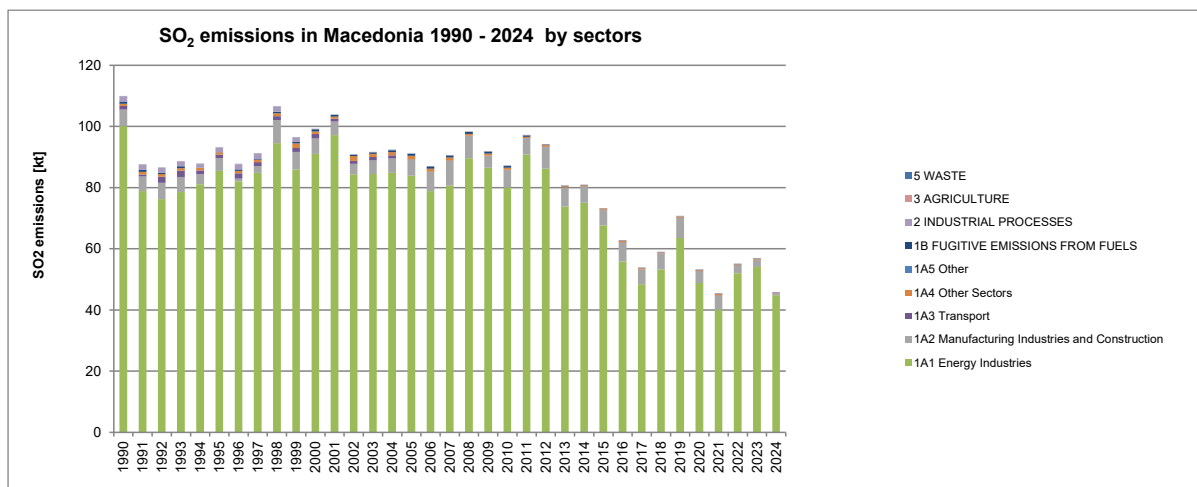


Figure 11 SO₂ emissions in North Macedonia 1990–2024 by sectors

3.1.4. NH₃ emissions

Emission trend

In 1990 national total NH₃ emissions, amounted to about 14 kt. In 2024, the emissions were down by 44% compared to 1990, amounting to 7.9 kt. Main reasons for the decline are decreasing emissions from Agriculture (Manure Management) related to decreasing livestock numbers. From 2023 to 2024 emissions increased by 2%.

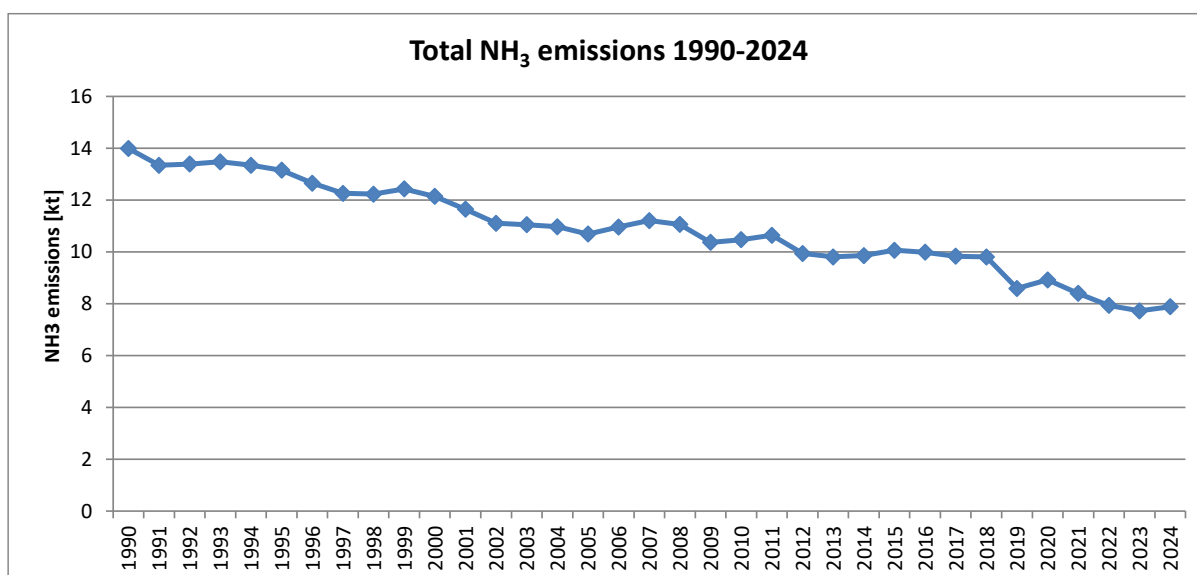


Figure 12 National total NH₃ emissions 1990-2024

Emissions of NH₃ are well below the respective ceiling. Emissions in 2024 were below national ceiling value (12 Gg NH₃) for 2010.

Main emission sources in North Macedonia

NH₃ emissions are mainly resulting from the agriculture sector contributing with 89% (95% in 1990) to national total NH₃ emissions. Within Agriculture sector, NH₃ is almost exclusively emitted by source category 3.B Manure Management (45% in 2024) and emissions from cattle (18%). The situation is similar in 1990, with the exception of much lower contribution of emissions from other livestock and poultry. NFR sectors 1.A.4 Other sectors 1.B Fugitive emissions. 1.A.3 Transport and 2 Industrial processes are minor sources of NH₃ emissions.

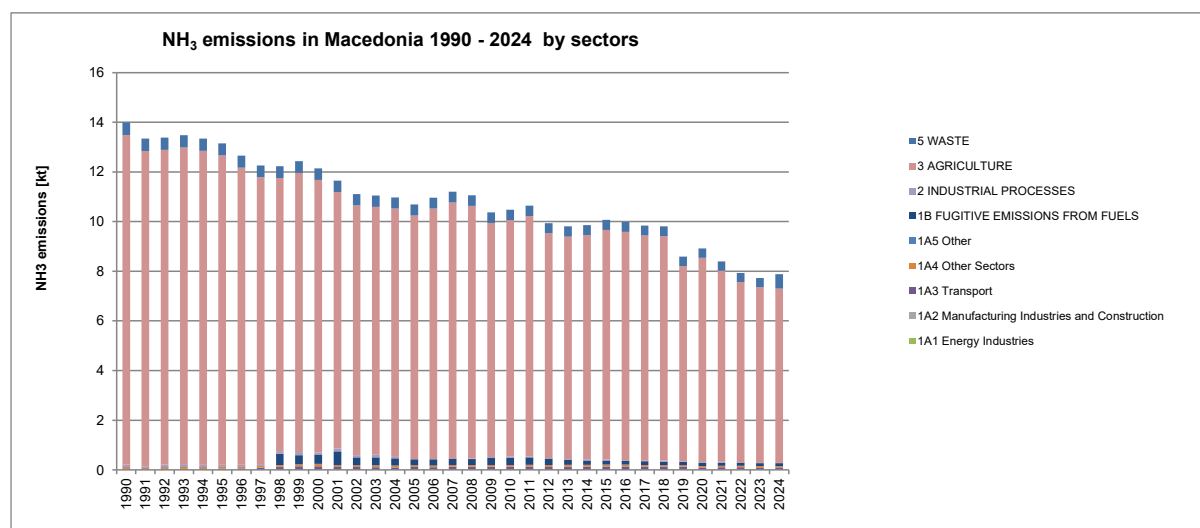


Figure 13 NH₃ emissions in North Macedonia 1990-2024 by sectors

3.1.5. CO emissions

Emission trend

In 1990 the national total CO emissions amounted to 134.39 kt. The trend is continuously decreasing and could be attributed to lower solid fuel consumption in 1.A.4 sector, but the trend is not stable. In 2024, the emissions amounted at 41 kt and decreased by 71%. From 2023 to 2024 emissions are decreased by 11% due to minor decrease of emission created coming for the category 1A2 and 1A4bii.

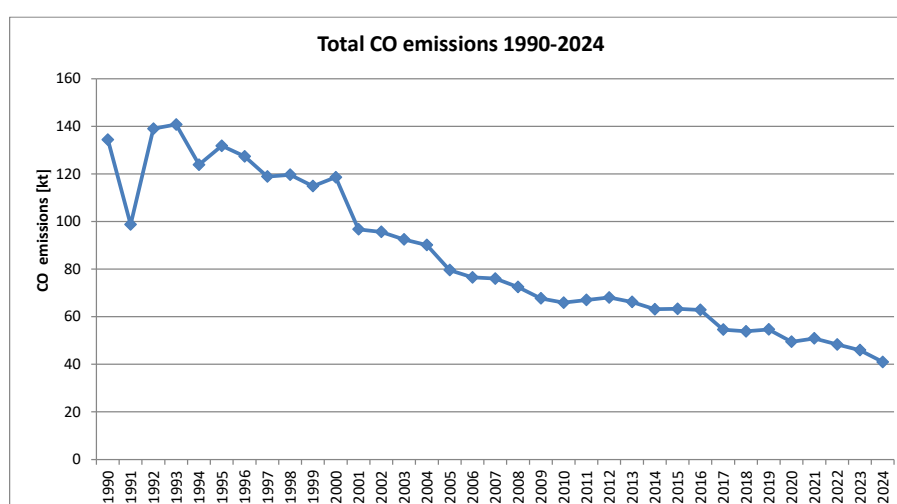


Figure 14 National total CO emissions 1990-2024

Main emission sources in North Macedonia

Almost all CO emissions are resulting from the Energy sector. As a Result, the main emission sources in 2024 are NFR sectors 1.A.4 Other Sectors (residential heating) and 1.A.3 Transport, contributing with 64% (30% in 1990) and 12% (53% in 1990) following by 3 Agriculture to the national total with 11% (7% in 1990). Further smaller emission sources in 2024 are 1.A.1 Energy Industries and 1.A.2 Manufacturing industries with share of 4%.

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.

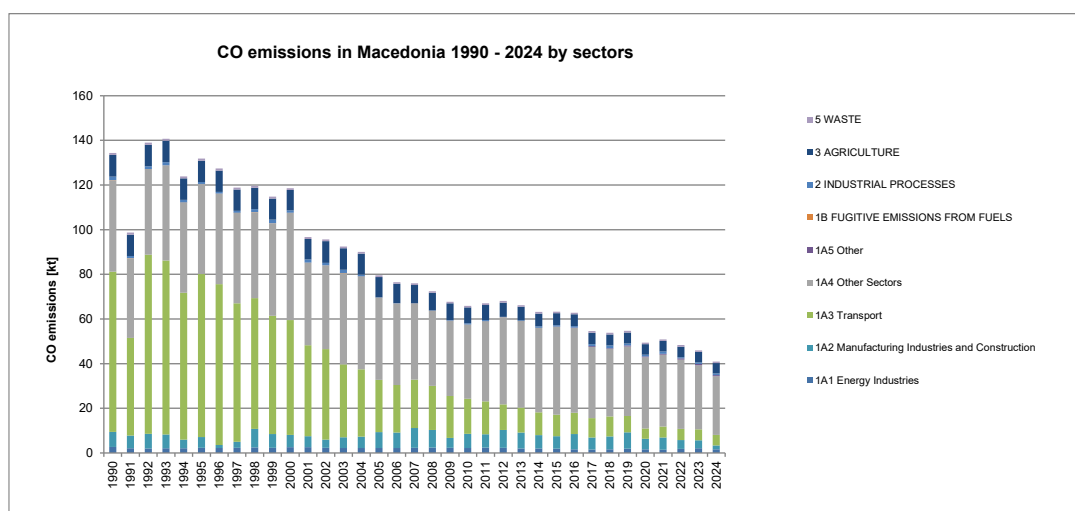


Figure 15 CO emissions in North Macedonia 1990-2024 by sectors

3.2. Emission Trends for Particulate Matter

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

Table 26 Emission trends for particulate matter 1990-2024

| Year | Emissions | | | |
|------|------------|-----------|----------|---------|
| | PM2.5 [kt] | PM10 [kt] | TSP [kt] | BC [kt] |
| 1990 | 27.90 | 41.14 | 51.96 | 2.88 |
| 1991 | 24.55 | 36.33 | 45.66 | 2.48 |
| 1992 | 30.83 | 44.67 | 54.93 | 3.23 |
| 1993 | 26.68 | 38.50 | 47.69 | 2.84 |
| 1994 | 24.54 | 35.88 | 44.90 | 2.48 |
| 1995 | 24.85 | 36.42 | 45.70 | 2.55 |
| 1996 | 27.83 | 41.00 | 51.73 | 2.87 |
| 1997 | 26.89 | 39.55 | 49.48 | 2.71 |
| 1998 | 31.32 | 45.90 | 57.50 | 3.14 |
| 1999 | 26.37 | 38.45 | 48.384 | 2.64 |
| 2000 | 24.40 | 35.84 | 47.401 | 2.45 |
| 2001 | 13.71 | 21.00 | 27.99 | 1.31 |
| 2002 | 14.44 | 21.87 | 28.61 | 1.49 |
| 2003 | 24.15 | 35.20 | 44.17 | 2.41 |
| 2004 | 26.48 | 38.62 | 48.54 | 2.65 |
| 2005 | 23.65 | 35.03 | 44.83 | 2.46 |
| 2006 | 21.41 | 31.87 | 40.72 | 2.19 |

| Year | Emissions | | | |
|-------------------------------|--------------------|--------------------|--------------------|--------------------|
| | PM2.5 [kt] | PM10 [kt] | TSP [kt] | BC [kt] |
| 2007 | 17.11 | 25.60 | 33.07 | 1.78 |
| 2008 | 18.15 | 27.33 | 35.78 | 1.87 |
| 2009 | 11.71 | 18.34 | 25.85 | 1.25 |
| 2010 | 15.84 | 24.29 | 33.27 | 1.66 |
| 2011 | 20.97 | 31.58 | 41.45 | 2.14 |
| 2012 | 20.68 | 31.07 | 40.91 | 2.17 |
| 2013 | 22.79 | 33.79 | 44.50 | 2.41 |
| 2014 | 17.26 | 26.31 | 36.24 | 1.82 |
| 2015 | 15.10 | 22.13 | 27.26 | 1.61 |
| 2016 | 13.16 | 19.35 | 23.98 | 1.47 |
| 2017 | 9.14 | 14.03 | 17.87 | 1.09 |
| 2018 | 9.09 | 14.13 | 18.09 | 1.04 |
| 2019 | 9.55 | 15.00 | 19.21 | 1.08 |
| 2020 | 9.12 | 14.06 | 17.83 | 1.04 |
| 2021 | 9.18 | 14.12 | 18.20 | 1.07 |
| 2022 | 9.16 | 14.65 | 19.10 | 1.03 |
| 2023 | 8.69 | 14.20 | 18.57 | 0.93 |
| 2024 | 7.35 | 12.31 | 16.27 | 0.83 |
| <i>Trend 1990–2024</i> | <i>-74%</i> | <i>-70%</i> | <i>-69%</i> | <i>-71%</i> |

3.2.1. PM10 emissions

Emission trend

In 1990, national total PM10 emissions amounted to 41 kt. Since then, the emissions are continuously decreasing, reaching a level of 12kt in 2024 or a decrease of 70% compared to 1990. The main reason for the decrease is declining emissions from Industrial Processes (Ferroalloys Production), but also decreased use of solid fuels since 2013. Namely the deep presented in the period 2001-2002 is due to limited operation of Ferroalloys production industry. The Ferroalloys production has decreased because of a limited capacity of an installation producing ferrosilicon, between the end of 2014 and during 2015. This installation did not fulfill the obligation regulated in the IPPC license for installation of a filter for reduction of dust emissions. Additionally, this installation has been closed in November 2016 due to non-compliance with the activities for air quality protection set down in the IPPC permit referring to installation of dust filter. After 2017 there is steady trend with minor decrease up to 2024. In 2024 there is decrease of 13% due to lower use of coal in 1A1a and lower biomass use in 1A4bi.

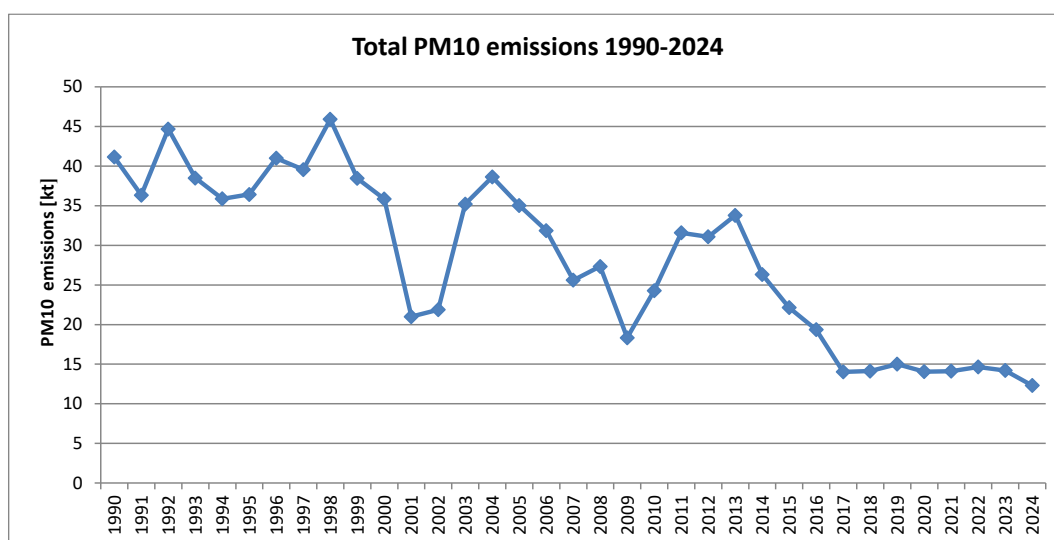


Figure 16 National total PM10 emissions 1990-2024

Main emission sources in North Macedonia

The main emission sources for PM10 in 2024 are NFR sectors 1.A.4 Other Sectors (residential and administrative heating), with a share of 39 % (18% in 1990) in total PM10 emissions 3 – Agriculture with 20% (8% in 1990) and 1.A.1 Energy Industries with 19% (% in 1990). With a share of 14% in 2024 (58% in 1990), the sector 2 Industrial processes is also contributing to the total PM10 emissions. As a result, a conclusion can be drawn that while in the past the major source for PM10 was the industry sector, mainly ferroalloys production, in the latest years that the major contributor is combustion of fuels in residential sector and administrative capacities – NFR 1.A.4 Other Sector. Transport sector as well as 1.A.2 manufacturing industries and construction are contributing with 5% and 1% in PM10 on national level. However, the transport sector has higher impact on local emissions and air quality according to PMF analysis.

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

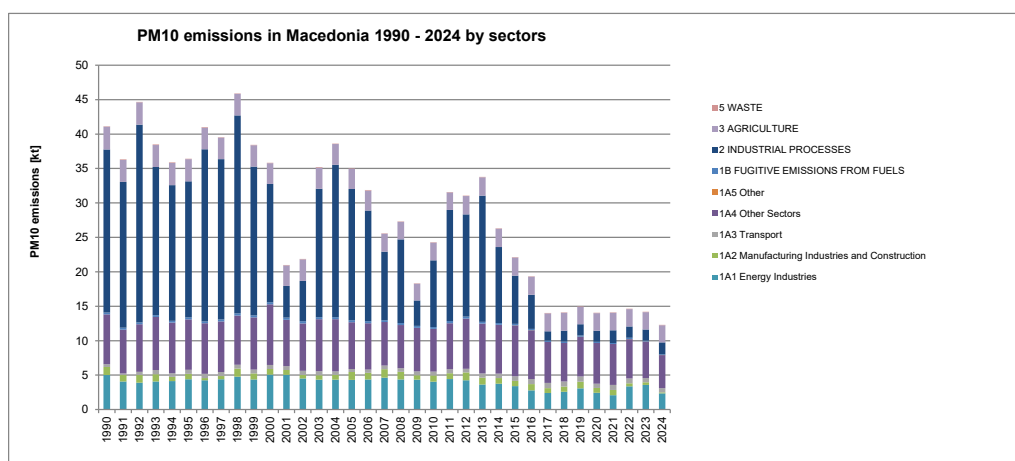


Figure 17 PM10 emissions in North Macedonia 1990-2024 by sectors

3.2.2. PM2.5 emissions

Emission trend

In 1990, national total PM2.5 emissions amounted to 28 kt. In 2024, compared to 1990 the emissions decreased by 74%, amounting to 7.3 kt. The main reason for the decrease is a decline of emissions from Industrial Processes (Ferroalloys Production) as well as from combustion of solid fuels from 1.A.4 due to increased use of clean fuels compared to solid fuels, like coal and biomass. For the years 2001, 2002 and 2009 emissions are very low compared to the other years. The reason is also due to low emissions from Ferroalloys Production, since in those years the company for production of ferrosilicon was operating with limited operating hours. The ferroalloys production has decreased because of the limited capacity of the installation producing ferrosilicon from the end of 2014 and during 2015, as this installation did not fulfill the obligation regulated in the IPPC license for installation of filter for reduction of dust emissions. Additionally, this installation has been closed in November 2016 due to non-compliance with the activities for air quality protection set down in the IPPC permit referring to installation of dust filter. Throughout the years, emissions from solid fuel combustion as well decreased affecting lower national emissions from particulates. After 2017, there is steady trend with slow decrease up to the last reporting year. In 2024 there is decrease of emissions up to 15%, due to same reasons explained for PM10.

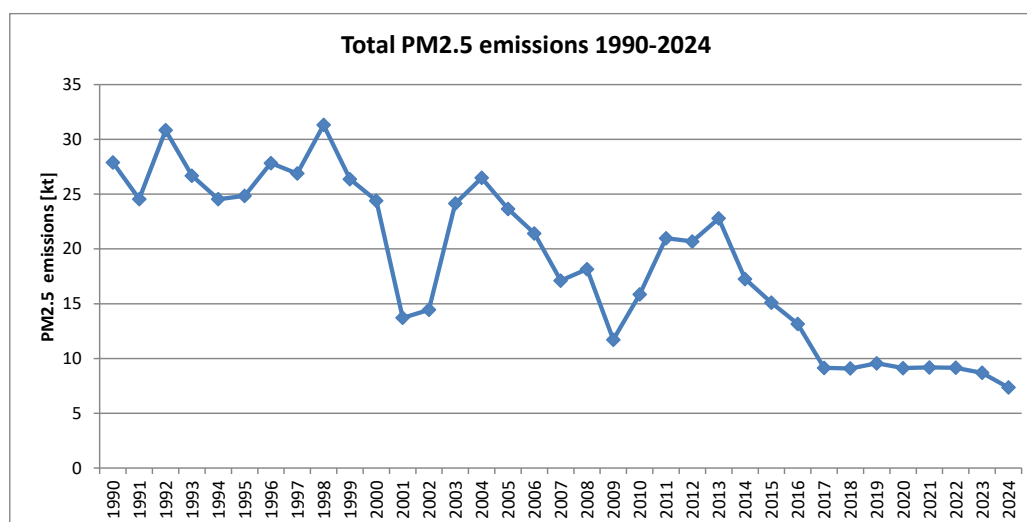


Figure 18 National total PM2.5 emissions 1990-2024

Main emission sources in North Macedonia

Like PM10, the main emission sources for PM2.5 in 2024 are NFR sectors 1.A.4 Other Sectors (residential heating) with a share of 64% (25% in 1990) in total PM2.5 emissions. The NFR category 1.A.1 Energy Industries with 14% (8% 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 7% (58% in 1990). Manufacturing industry and Constructions 1.A.2 are contributing with 2% in 2024. Transport is contributing with 6% and Agriculture with 7%. 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.

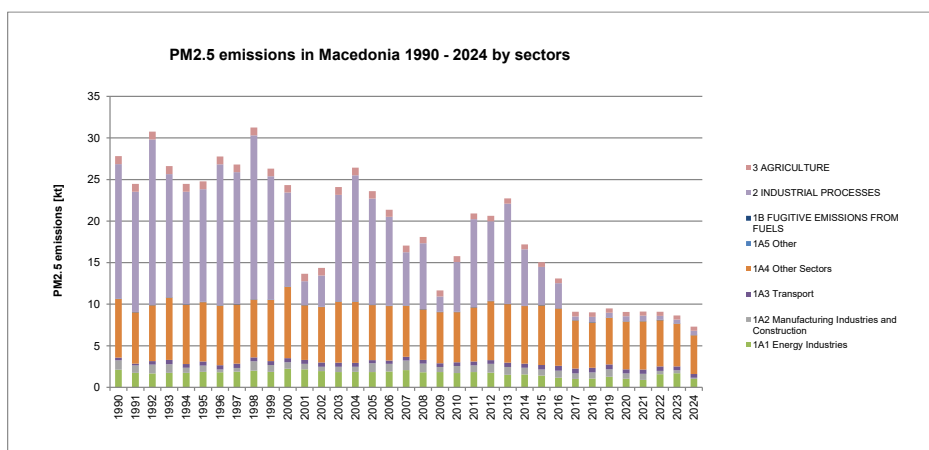


Figure 19 PM2.5 emissions in North Macedonia 1990-2024 by sectors

3.2.3. TSP emissions

Emission trend

In 1990, the national total TSP emissions amounted to about 52 kt. In 2024, the emissions decreased by 69% compared to 1990 amounting to about 16.3 kt. The main reason for the decrease is a decline of emissions from Industrial Processes (Ferroalloys Production), but also the decline of emissions coming from the 1.A.4 category due to reduced use of solid fuels. In 2024, the emissions are decreased by 12% compared to 2023 emissions due to same reasons elaborated for PM10.

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 2024, exceeded the national emission ceiling for TSP with a value of 1.738 Gg, and thus, not reaching compliance with this ceiling accordingly.

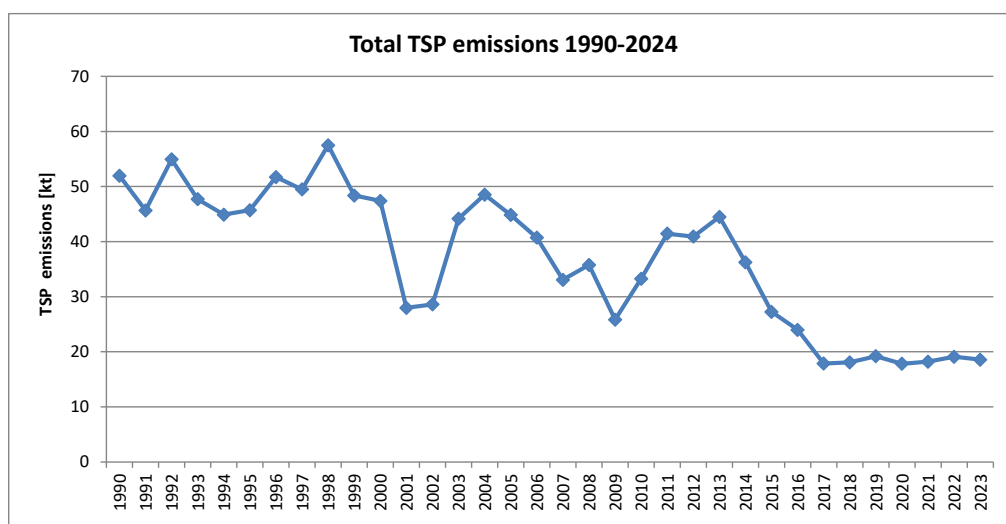


Figure 20 National total TSP emissions 1990-2024

Main emission sources in North Macedonia

The main emission sources for TSP in 2024 are 1.A.4 Other Sectors (residential heating) with 31% (15% in 1990) and 2 Industrial processes with 22 % in 2024 and 58% in 1990. 1.A.1 – Energy industries has a share of 21% in 2024 (14% in 1990) and 3 – Agriculture has a share of 18% in 2024 (9% 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. Transport is contributing with 5% in 2024 (1% in 1990). Other categories are minor sources of TSP.

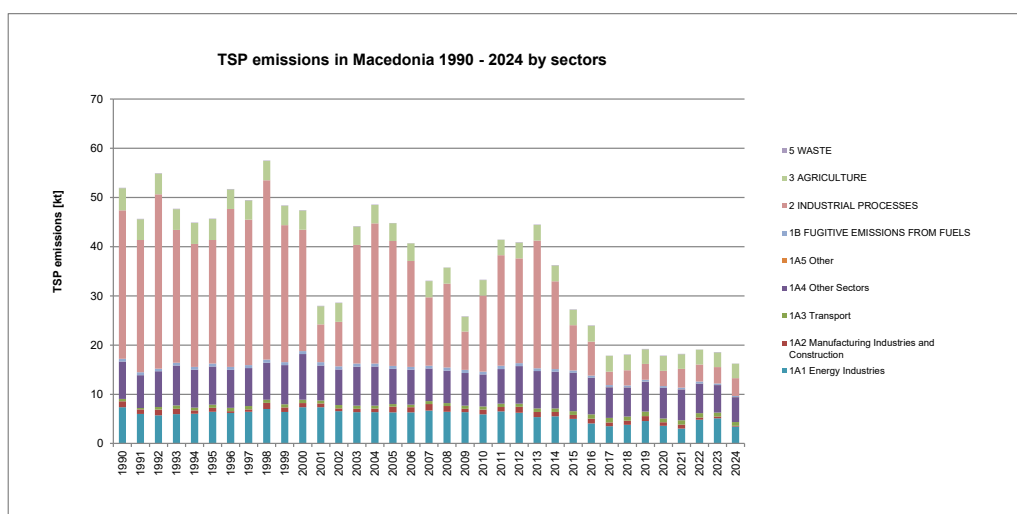


Figure 21 TSP emissions in North Macedonia 1990-2024 by sectors

3.2.4. BC emissions

Emission trend

In 1990, national total BC emissions amounted to about 3 kt. In 2024, the emissions decreased by 71% compared to 1990, amounting to about 1 kt. The main reason for the decrease is a decline of emissions of PM_{2.5}. The trend has similar pathway as that one for PM_{2.5} due the fact that for BC emissions are calculated as given contribution in PM_{2.5} expressed in %. Further explanation of the trend is given in PM_{2.5} chapter.

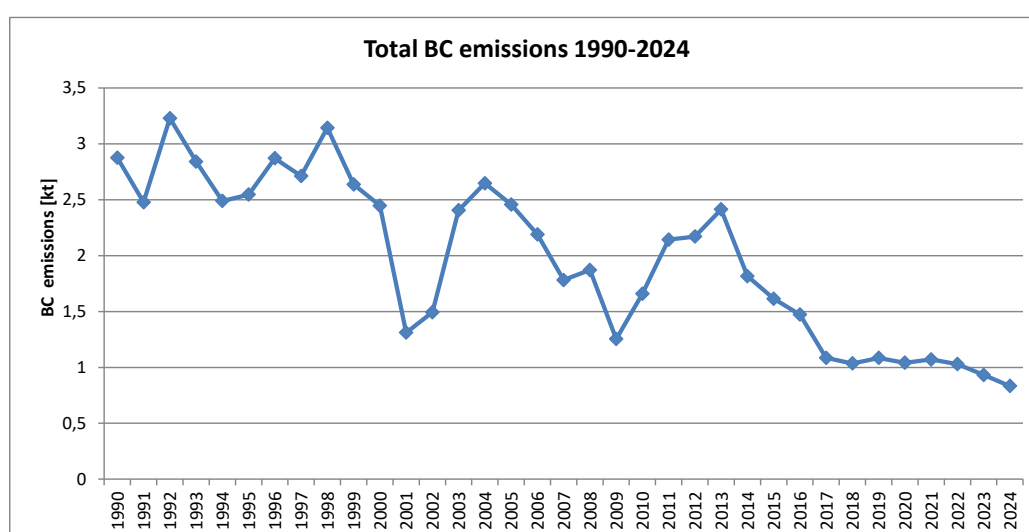


Figure 22 National total BC emissions 1990-2024

Main emission sources in North Macedonia

As expected, the main emission sources for BC are those for PM2.5. In 2024, the NFR sectors 1.A.4 Other Sectors (residential heating) contributed with a share of 58% (25% in 1990) in total BC emissions. Transport is contributing with 26%, while 1.A.2 Manufacturing industry and constructions contributed with 6% (14% in 1990) of the total BC emissions, whereas 2 Industrial Processes and Product Use (mainly 2.C.2 Ferroalloys Production) contributed with around 0.1% (55% in 1990), while Waste sector contributed with 3% in 2024 and 1%. in 1990. NFR sectors 3-Agriculture and 1.A.1 Energy industries are minor sources of PM2.5 emissions with shares of 4% and 2% respectively.

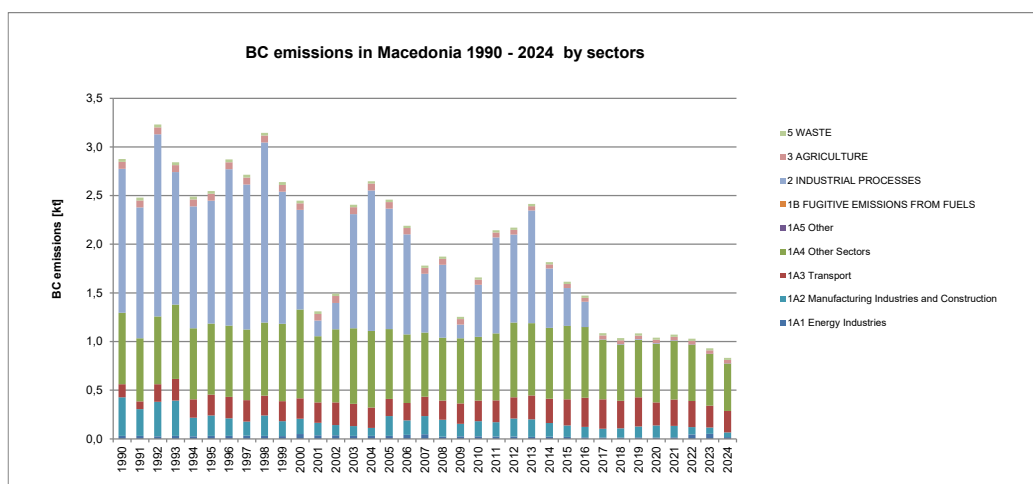


Figure 23 BC emissions in North Macedonia 1990-2024 by sectors

3.3. Emission trends for Heavy Metals

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

Table 27 Emission trends for heavy metals 1990-2024

| Year | Emissions | | |
|------|-----------|---------|---------|
| | Cd [Mg] | Hg [Mg] | Pb [Mg] |
| 1990 | 1.83 | 0.84 | 256.58 |
| 1991 | 1.75 | 0.80 | 193.50 |
| 1992 | 1.72 | 0.78 | 260.62 |
| 1993 | 1.37 | 0.81 | 245.35 |
| 1994 | 1.28 | 0.68 | 225.89 |
| 1995 | 2.36 | 0.70 | 235.04 |
| 1996 | 2.34 | 0.52 | 217.60 |
| 1997 | 1.29 | 0.67 | 219.62 |
| 1998 | 1.69 | 0.89 | 230.88 |
| 1999 | 1.38 | 0.84 | 174.55 |
| 2000 | 1.44 | 0.56 | 185.46 |
| 2001 | 3.36 | 0.932 | 156.37 |
| 2002 | 2.58 | 0.666 | 98.65 |
| 2003 | 1.62 | 0.63 | 53.55 |
| 2004 | 2.27 | 0.47 | 35.08 |
| 2005 | 0.40 | 0.34 | 8.20 |
| 2006 | 0.37 | 0.35 | 8.83 |
| 2007 | 0.37 | 0.37 | 9.27 |
| 2008 | 0.36 | 0.36 | 7.77 |
| 2009 | 0.35 | 0.32 | 7.12 |
| 2010 | 0.34 | 0.33 | 8.28 |
| 2011 | 0.35 | 0.36 | 9.94 |
| 2012 | 0.35 | 0.34 | 8.68 |
| 2013 | 0.32 | 0.29 | 6.31 |
| 2014 | 0.32 | 0.30 | 7.82 |
| 2015 | 0.32 | 0.29 | 7.96 |
| 2016 | 0.31 | 0.25 | 5.33 |
| 2017 | 0.29 | 0.23 | 5.441 |
| 2018 | 0.29 | 0.20 | 5.66 |
| 2019 | 0.30 | 0.23 | 6.66 |
| 2020 | 0.28 | 0.18 | 6.42 |
| 2021 | 0.29 | 0.18 | 6.99 |

| Year | Emissions | | |
|------------------------|-------------|-------------|-------------|
| | Cd [Mg] | Hg [Mg] | Pb [Mg] |
| 2022 | 0.30 | 0.20 | 7.39 |
| 2023 | 0.29 | 0.21 | 7.38 |
| 2024 | 0.27 | 0.18 | 7.14 |
| Trend 1990–2024 | -85% | -79% | -97% |

Republic of North Macedonia in 2024 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 257 t in 1990; emissions have decreased steadily, and in 2024 emissions were down to 7.14 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.

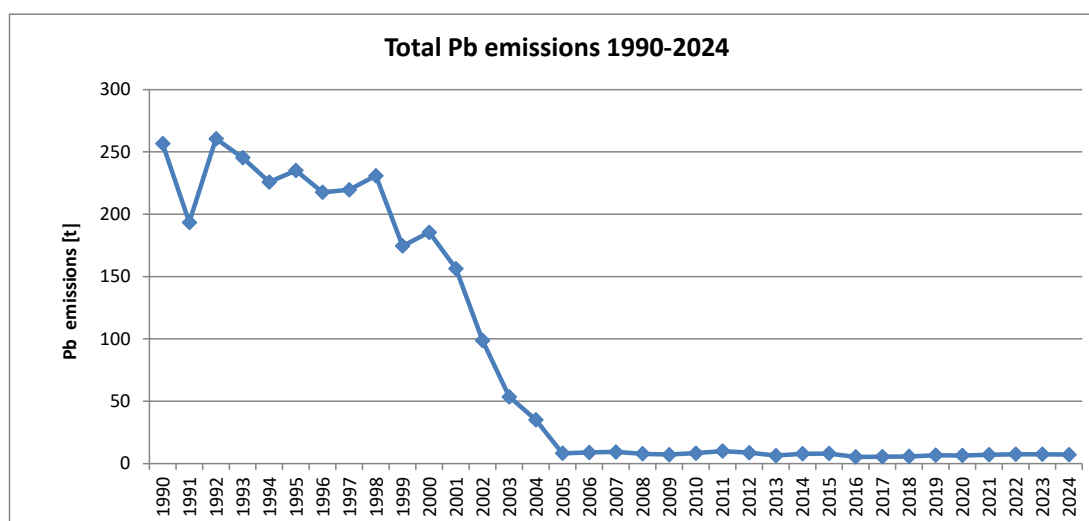


Figure 24 National total Pb emissions 1990-2024

Main emission sources in North Macedonia

The distribution of emissions sources is different in this submission, due to calculation of emissions coming from fireworks (2G), therefore, 2 Industrial process is key sector contributing with 76%, while in 1990 this percentage was lower accounting of 56%. While emissions from Transport due to use of leaded petrol were higher contributing with 43%. The other emission sources of Pb in 2024 are NFR sectors 1.A Energy with shares in national total emissions of 6 % from 1.A.2 in share of 1.5 %, 1.A.3 Transport is contributing with 14 % and other sectors 1.A.4 in share of 3%, and industrial process in share of 76%. The declined values are a result of the elimination of the use of leaded petrol in 2004.

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

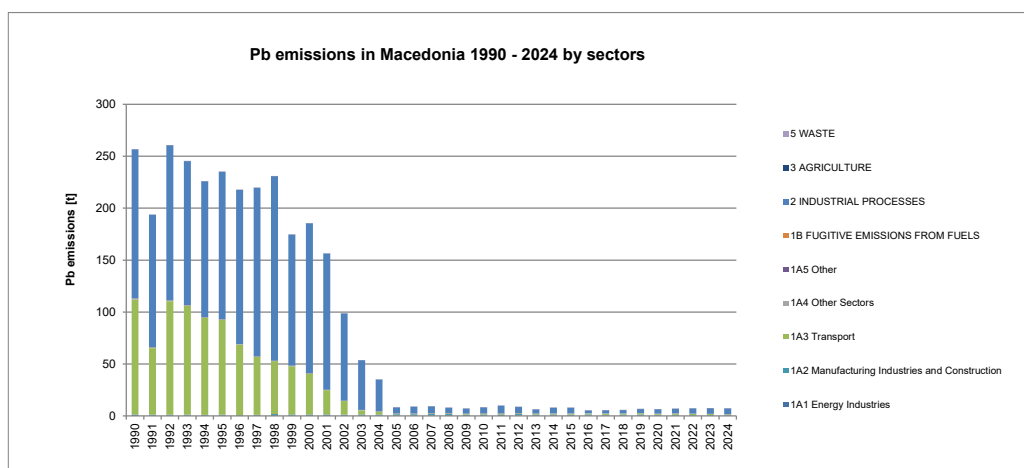


Figure 25 Pb emissions in North Macedonia 1990-2024 by sectors

3.3.2. Cadmium (Cd) emissions

Emission trend

National total Cd emissions amounted to 1.8 t in 1990; emissions have decreased steadily, and in the year 2024 emissions were estimated to be 0.27 t, which means they were down by 85% 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 2023 and 2024, cadmium emissions decreased by 10% due to lower emissions in the use of fossil fuels in power plants.

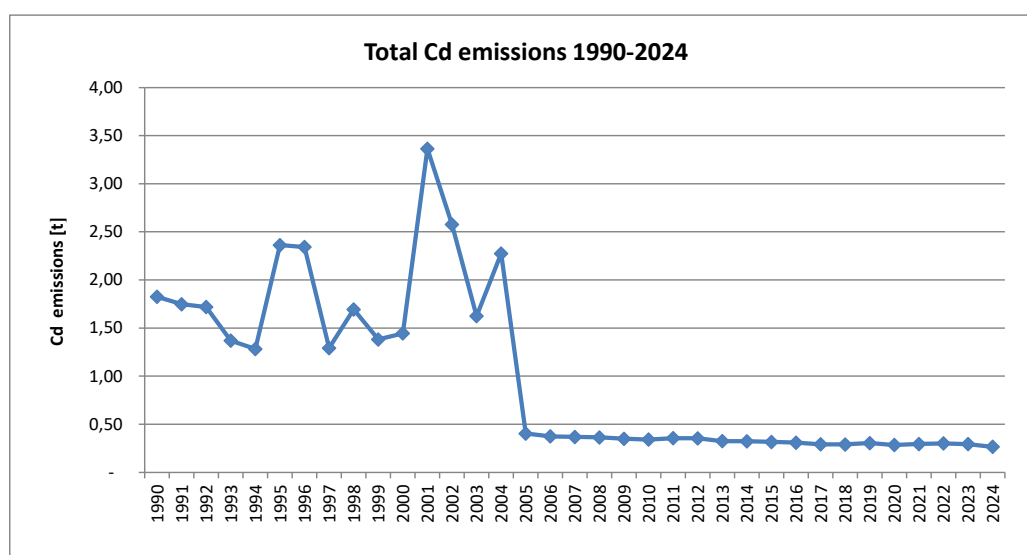


Figure 26 National total Cd emissions 1990-2024

Main emission sources in North Macedonia

The most important emission sources in 2024 of Cd are the following NFR categories: 1.A.4 Other Sectors Energy with 34% (7% in 1990), following by 3-Agriculture, with a share of 23% (7% in 1990), 1.A.1 Energy Industries, with a share of 19% (6% in 1990), and NFR category 2 Industrial Processes and

Product use contributing with 18% (79% in 1990). The 1.A.2 Manufacturing Industries is contributing with 4% (1%), while 5 Waste sector is contributing with 1%.

Cd emissions from NFR sector 1.B Fugitive Emissions are minor sources.

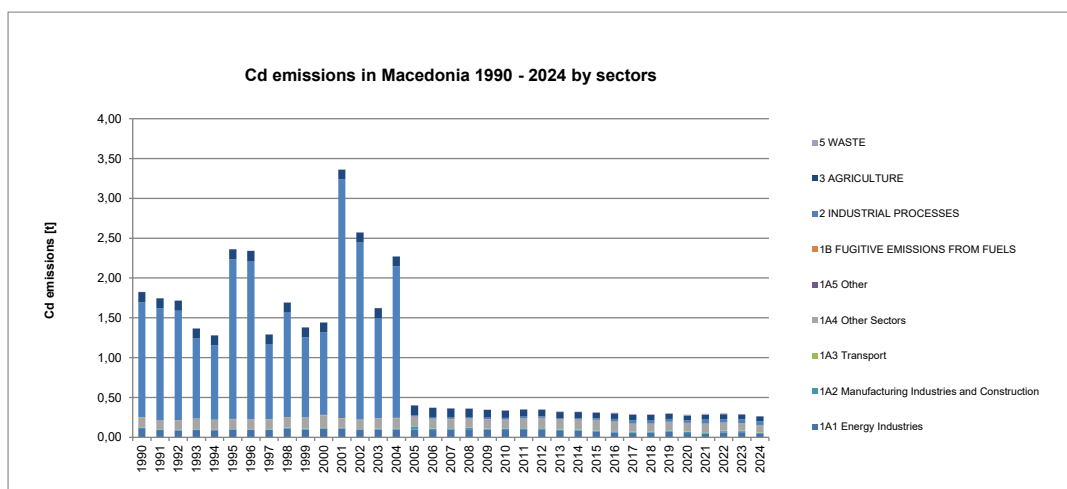


Figure 27 Cd emissions in North Macedonia 1990-2024 by sectors

3.3.3. Mercury (Hg) emissions

Emission trend

National total Hg emissions amounted to 0.84 t in 1990; in the year, 2024 emissions (0.18t) were down by 79% compared to 1990 emissions. The most important reductions could be observed in sector 2 Industrial Processes and Other Product Use (Metal Production), as Zinc production stopped in 2003. Also, fugitive emissions have been reduced significantly. Between 2023 and 2024 total Hg emissions decreased by 15%, due to lower emissions from 1A2 Manufacturing Industries and construction.

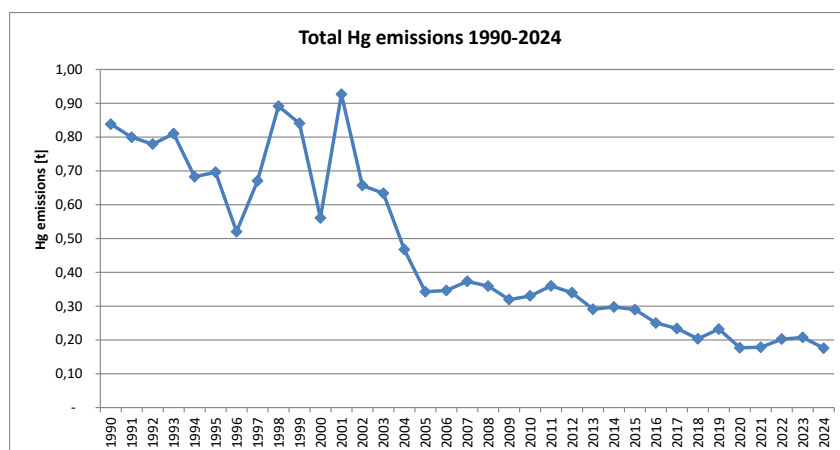


Figure 28 National total Hg emissions 1990-2024

Main emission sources in North Macedonia

The most important emission source in 2024 of Hg is NFR sector 1 - Energy. 1.A.1 Energy Industries with a share of 44% (20% in 1990) and 2 Industrial Processes, with a share of 24% (71% in 1990). 1.A.2 Manufacturing Industries and Construction contributes with 21% (4% in 1990) of the national total emissions. In 2024, also 6% of total mercury emissions are stemming from sector 3 Agriculture, while this sector has minor contribution in 1990, and 3% Hg emissions are coming from NFR sectors 1.A.4 - Other sectors and 2% from Transport. NFR sector 1.B Fugitive Emissions is a minor source.

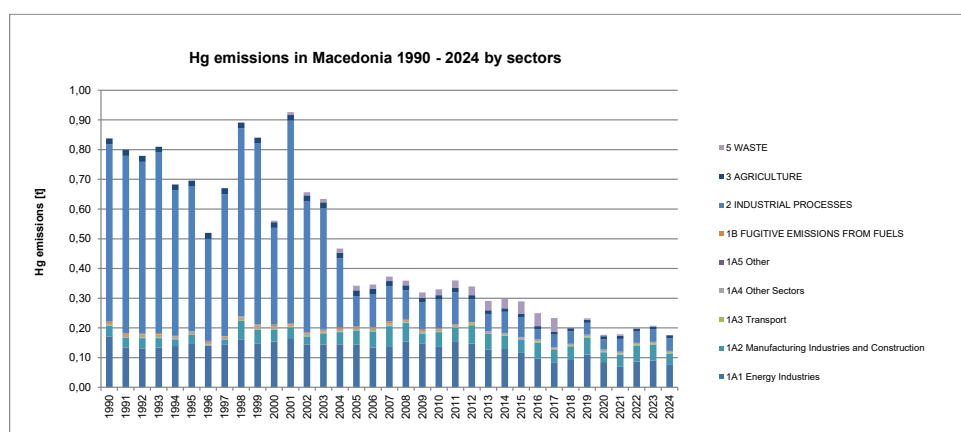


Figure 29 Hg emissions in North Macedonia 1990-2024 by sectors

3.4. Emission trends for POPs

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

Table 28 Emission trends for POPs 1990-2024

| Year | Emissions | | | |
|------|-----------|------------------------|----------|----------|
| | PAHs [t] | PCDD/F [g – I TEQ] | HCB [kg] | PCB [kg] |
| 1990 | 4.91 | 14.98 | 44.26 | 418.35 |
| 1991 | 4.42 | 13.41 | 39.19 | 416.51 |
| 1992 | 4.67 | 13.18 | 25.80 | 421.08 |
| 1993 | 4.86 | 12.23 | 24.15 | 418.14 |
| 1994 | 4.40 | 11.00 | 25.01 | 381.12 |
| 1995 | 4.51 | 14.04 | 18.60 | 394.40 |
| 1996 | 4.01 | 13.63 | 19.67 | 381.38 |
| 1997 | 4.24 | 11.03 | 27.85 | 415.25 |
| 1998 | 5.03 | 13.04 | 29.31 | 448.78 |
| 1999 | 4.92 | 12.38 | 53.94 | 415.21 |
| 2000 | 5.45 | 19.19 | 38.28 | 382.55 |
| 2001 | 4.43 | 27.10 | 34.12 | 426.13 |
| 2002 | 4.48 | 27.29 | 52.65 | 338.05 |
| 2003 | 4.91 | 25.34 | 42.95 | 299.90 |
| 2004 | 4.97 | 30.34 | 8.48 | 241.22 |
| 2005 | 4.77 | 26.89 | 7.54 | 207.01 |
| 2006 | 4.87 | 25.22 | 11.67 | 207.78 |

| Year | Emissions | | | |
|------------------------|-------------|---------------------|--------------|-------------|
| | PAHs [t] | PCDD/F [g – I TEQ] | HCB [kg] | PCB [kg] |
| 2007 | 5.05 | 26.57 | 8.87 | 208.58 |
| 2008 | 4.73 | 25.88 | 7.74 | 208.28 |
| 2009 | 4.11 | 27.35 | 8.28 | 208.06 |
| 2010 | 4.42 | 29.55 | 9.58 | 208.85 |
| 2011 | 4.61 | 35.77 | 10.50 | 209.21 |
| 2012 | 5.06 | 38.96 | 9.47 | 209.19 |
| 2013 | 4.80 | 40.06 | 6.35 | 209.02 |
| 2014 | 4.63 | 40.06 | 4.19 | 209.48 |
| 2015 | 4.69 | 49.67 | 0.96 | 216.33 |
| 2016 | 4.59 | 51.18 | 0.77 | 220.79 |
| 2017 | 3.88 | 51.58 | 2.06 | 228.69 |
| 2018 | 3.79 | 8.93 | 1.53 | 236.92 |
| 2019 | 4.10 | 9.44 | 4.43 | 238.14 |
| 2020 | 3.73 | 8.62 | 0.16 | 236.77 |
| 2021 | 3.95 | 9.27 | 0.16 | 238.29 |
| 2022 | 3.46 | 8.35 | 0.15 | 242.34 |
| 2023 | 3.23 | 7.80 | 0.10 | 232.38 |
| 2024 | 2.72 | 6.80 | 0.05 | 240.29 |
| Trend 1990–2024 | -45% | -55% | -100% | -43% |

From the figures presented in the previous table a conclusion can be drawn that Republic of North Macedonia in 2024 did not exceeded the emission levels set in POPs Protocol. In the case of HCB, the emissions are much lower than the values from the reference year 1990.

3.4.1. PAHs total emissions

Emission trend

National total PAHs total emissions in 1990 amounted to 4.91 t. Since then, the emissions have been quite stable and in the year 2024 emissions were at level of 2.72 t, reflecting a reduction of 45%. The most important reductions could be observed in the sector for residential heating. Between 2023 and 2024, total PAHs emissions decreased by 16%, because of decreased emissions from residential heating in the NFR 1.A.4 - Other sectors as well in combustion in industrial processes 1.A.2.

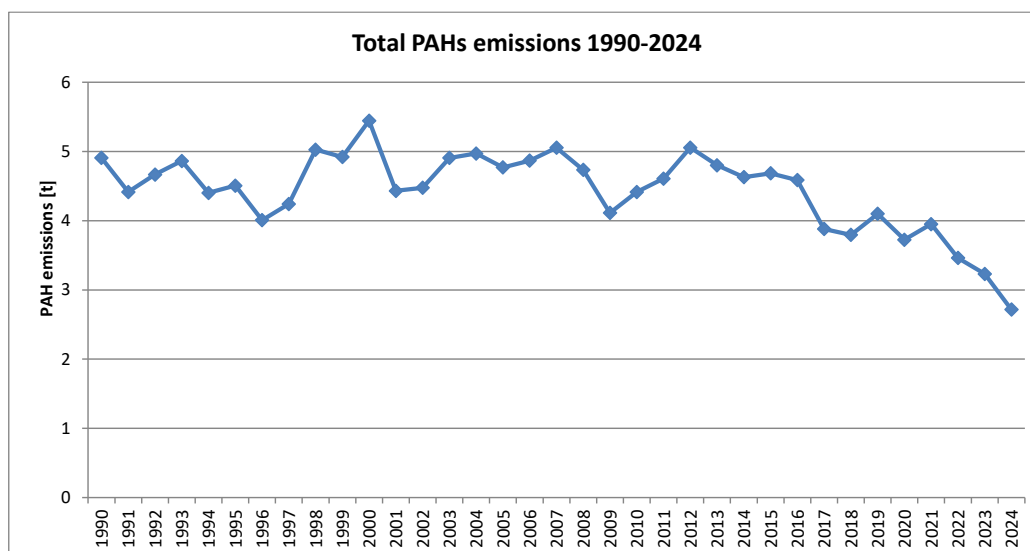


Figure 30 National total PAHs emissions 1990-2024

Main emission sources in North Macedonia

The most important emission source in 2024 of PAHs is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2024, as in the previous years is 1.A.4 Other Sectors (residential heating). With a share of 80%, while in 1990, this sector contributed with 69%, Furthermore, 1.A.2 Manufacturing Industries is contributing with a share of 6% (16% in 1990) of the national total emissions. Waste sector and 2 Industrial processes are also contributing with 6% in 2024. Other NFR sectors 1.A.1 Energy industries and 1B Fugitive emissions are minor sources.

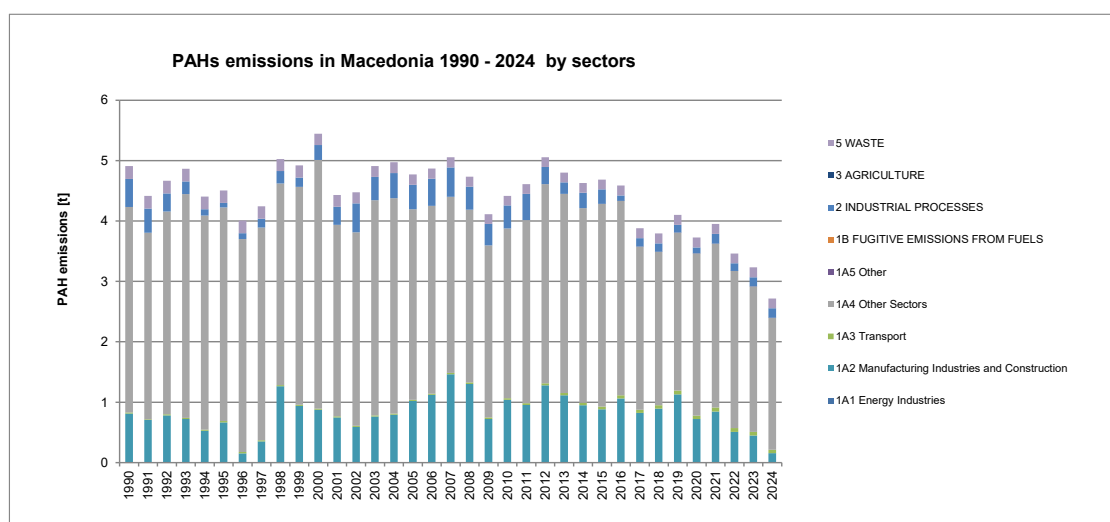


Figure 31 PAHs total emissions in North Macedonia 1990-2024 by sectors

3.4.2. Dioxin and Furan emissions (PCDD/F)

Emission trend

National total dioxin/furan emissions amounted to 14.98 g-I-TEQ in 1990; emissions have decreased then and, in the year, 2024 emissions were down to around 6.80 g-I-TEQ, decreasing by 55% compared to 1990.

The emissions have increased continuously since 2000 due to establishment of medical waste incineration. Emissions have been increasing until 2018, when dust filter has been established in the medical waste incineration plant. Between 2023 and 2024 total dioxin/furan emissions are decreased by 13% due to lower emissions in 5 Waste sector and 1A2 Manufacturing industries and construction.

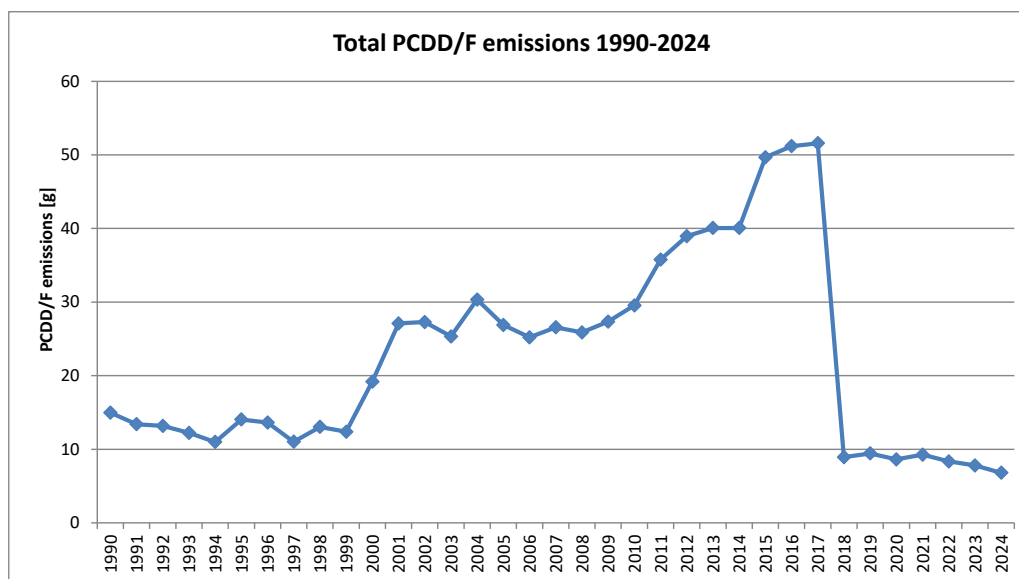


Figure 32 National total PCDD/F emissions 1990-2024

Main emission sources in North Macedonia

The most important emission source in 2024 of PCDD/F is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2024 is 1.A.4 Other Sectors (mainly residential heating), with a share of 51% in 1990 and with share 73% in 2024. The industry is contributing with 14% (37% in 1990), 1.A.2 Manufacturing Industries is contributing with a share of 1% (6% in 1990) in the national total emissions. NFR category Transport is also contributing with 5% of the national total PCDD/F emissions. In the period 2000-2017, Waste has been one of the key sectors as well.

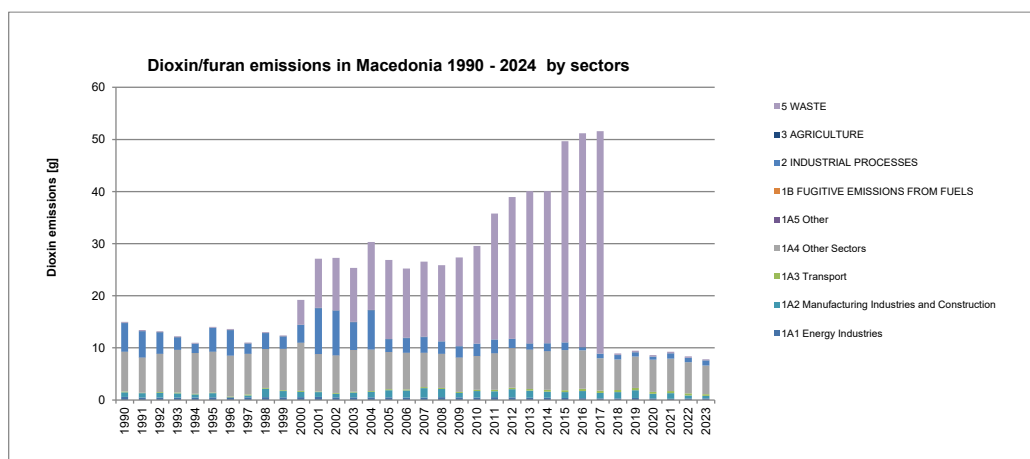


Figure 33 Dioxin/furan emissions in North Macedonia 1990-2024 by sectors

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 2024 emissions were down by 99.89%, compare to 2024 amounting to 0.05 kg. The emission peaks in 1999 and 2002 are due to higher activities of secondary aluminum production. The significant emission reduction between 2003 and 2004 is also caused by the aluminum production. From then onwards the emission level remained quite lower but still with mild fluctuations which depend on aluminum production. The most important reductions could be observed in the sector 2 Industrial Processes and Other Product Use (Aluminum Production). Due to higher activity data in aluminium production the emissions are higher in 2019 compared to 2018. But since 2020 since the emissions are sharply decreased due to the fact that the only installation for aluminum production went bankruptcy so no activity data were reported, and no emissions were calculated in this sector.

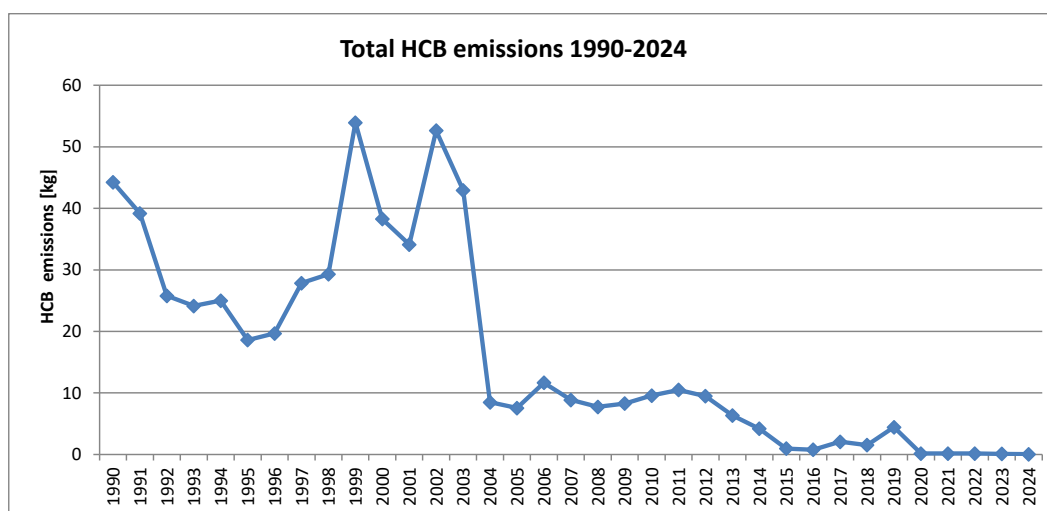


Figure 34 National total HCB emissions 1990-2024

Main emission sources in North Macedonia

During the period 1990-2024 the key emission source for HCB was NFR sector 2 Industrial Processes and Product Use. With a share of around 100% in 1990 of the national total emissions almost all HCB is emitted from this source and therefore dominating the trend. Within the category emissions are exclusively emitted from NFR sector 2.C.3 Aluminum Production. The most emissions are coming from 1.A.4. Other sectors in amount of 75%. Other sector is 5 Waste that contributes with a share of 21% in 2024, and it was the main source in the years 2020-2024.

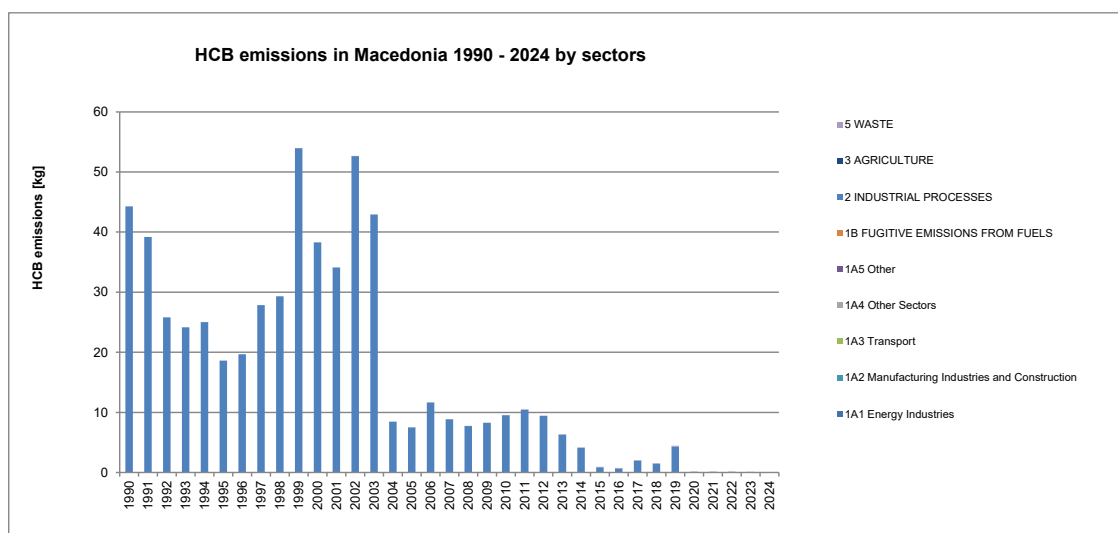


Figure 35 HCB emissions in North Macedonia 1990-2024 by sectors

3.4.4. Polychlorinated biphenyl (PCB) Emissions

Emission trend

National total PCB emissions amounted to 418 kg in 1990; emissions have decreased since then and, in the year, 2024 emissions were down by 43%. accounting to 240 kg. The trend emissions are not stable due to fluctuations in metal production – Lead and Zink production. This trend becomes stable in 2005 until 2014. In the last four years the emissions are continuously increased due to use of Tier 2 methodology in 2.C sector and increased emissions from lead production. Sharp pick of total emissions in 2024 is due to higher emissions coming from the lead production by 3% compare to 2023.

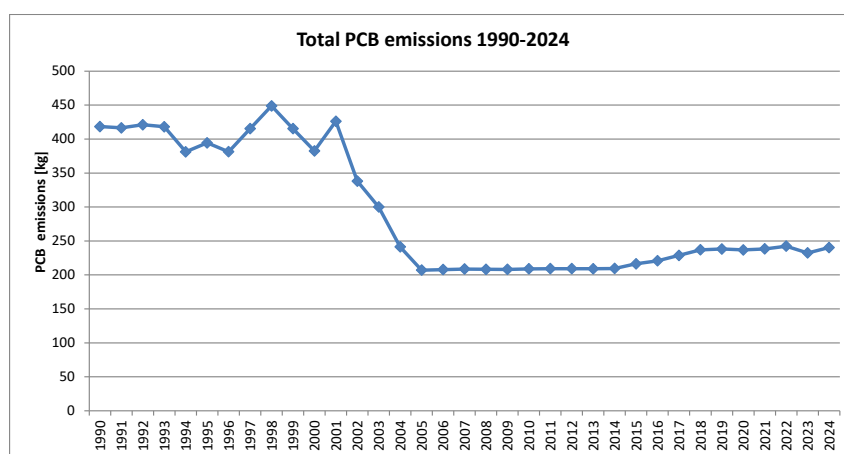


Figure 36 National total PCB emissions 1990-2024

Main emission sources in North Macedonia

The most important emission source in 2024 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 100% (around 100% in 1990) of the national total PCB emissions. PCB emissions from other NFR sectors are therefore minor. The additional key source in the nineties was the smelter company in Veles that has stopped production in 2003 and also has decline in production during the period 1998 until 2004 and 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 2014-2024. High peak in 2024 is due to high increase in lead production.

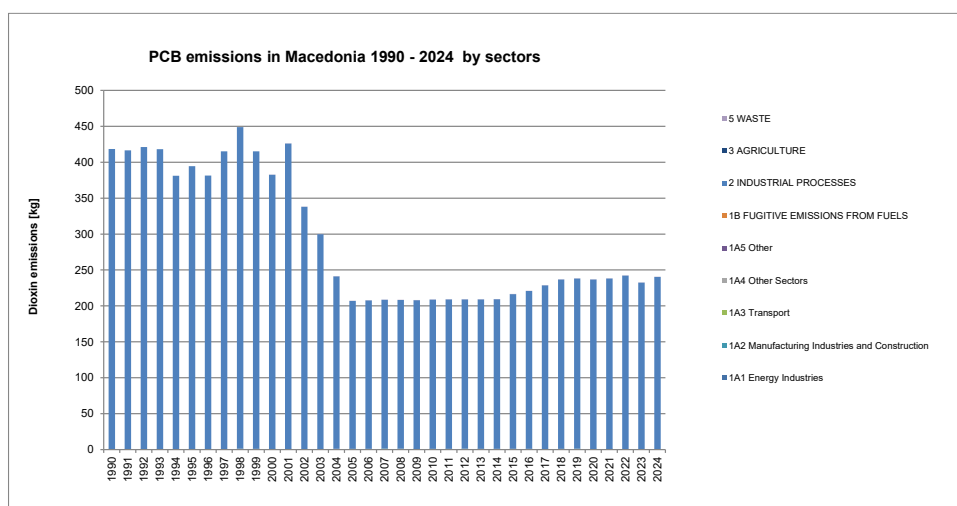
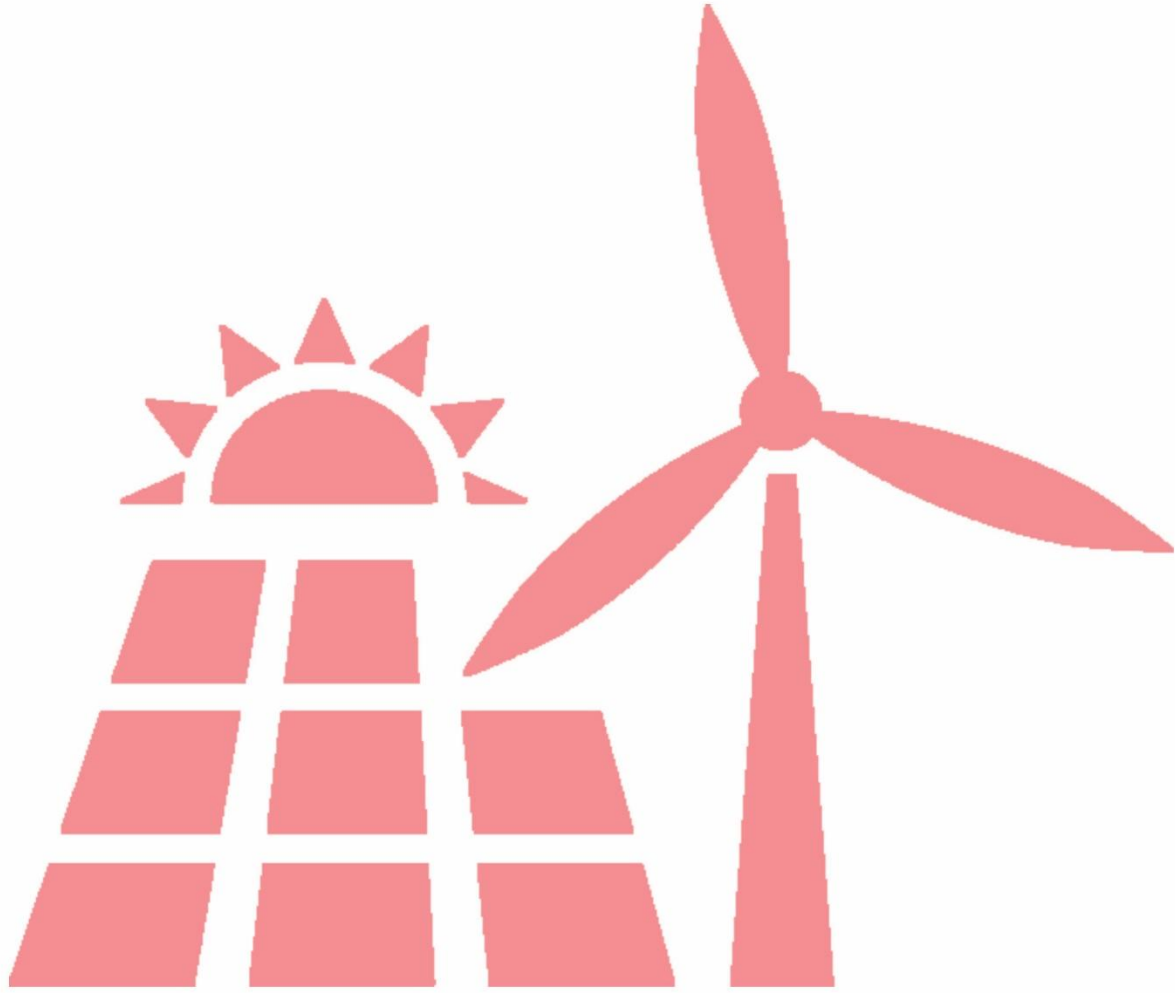


Figure 37 PCB emissions in North Macedonia 1990-2024 by sectors

ENERGY



4. ENERGY (NFR SECTOR 1)

4.1. Sector overview

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

Completeness

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

Table 29 NFR categories included in Energy sector for 2024

| 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 cruise(civil) | √ |
| 1 A 3 a ii (ii) Civil aviation LTO (Domestic, Cruise) | √ |
| 1A 3 Transport (fuel used) | √ |

Table 30 NFR categories not included in Energy sector for 2024

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

*Petrol refining activity is not occurring since 2014

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

Methodology

In general, the methodology is following the EMEP Tier 1 methodology, using default emission factors from the Guidebooks 2009/2013/2016/2019 and activity data from energy statistics. Plant specific emission data is considered for reporting of NO_x, SO₂, CO and TSP within the following sectors:

1.A.1.a - 9 power plants (one heating plant and two power plant were not operating in 2024)

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

1.A.2.f - 1 cement plant

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

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

With regards to LHV, these values have been taken from energy balance or operators reports if they were reported in the respective annual reports. For coal mines in the country LHV - 6.36 - 7.7 TJ/10³ t has been used. for imported coal – 8.29 TJ/10³t, for biomass this year separate LHV were used for fire wood – 6.7 TJ/10³ m³, 10.66 TJ/10³ m³ for fruit wood. for wood wastes, wood briquettes and pellets – 17.00 TJ/10³ t for heavy fuel – 40/40.19 TJ/10³t. for heating oil and other gasoil – 42.5 TJ/10³t, for diesel – 43/42.71 TJ/10³t for coke – 26.795 TJ/10³t. for other imported coal – 8.29 TJ/10³, for natural gas – 33.588/34.12 TJ/10⁶ Nm³, LPG – 46/46.05 TJ/10³t and petroleum coke – 31.82 TJ/10³t.

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

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

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

Table 31 TPP and DHP Installation technical properties and BAT

| Num. | Plant name | Technology | Thermal input [MW] | Fuel type 1 | Fuel type 2 | BAT | NERP | Comments |
|------|-----------------------------|--|--------------------|----------------|----------------|--|------|---|
| 1 | REK BITOLA | Production of electricity | 2025 | Lignite | Heavy fuel oil | Modernization of blocs in 2013-2014, reduction of NO _x , dust and CO electrostatic filter for dust $\eta=99,84\%$ | Yes | |
| 2 | REK OSLOMEJ | Production of electricity | 375 | Lignite | Heavy fuel oil | electrostatic filter for dust $\eta=98\%$ | Yes | Since 2015 limited operation only few mounts in the heating season due to limited coal reserves. |
| 3 | TEC NEGOTINO | Production of electricity | 630 | Heavy fuel oil | | | No | Not in operation since 2014 it is used as cold reserve; Due to the energy crisis the installation was put in operation in December 2021 -2023, not in operation in 2024 |
| 4 | Balkan Energy Toplana ISTOK | Heat production | 294 | Natural gas | | Burners for low NO _x insurance | Yes | |
| 5 | Balkan Energy Toplana ZAPAD | Heat production | 183 | Natural gas | | In 2013 Heavy fuel oil has been replaced with natural gas. Burners for low NO _x insurance | Yes | |
| 6 | Toplana Sever | Heat production | | Natural gas | | | No | Not in operation |
| 7 | TE-TO | Combined Electricity and heat production | 440 | Natural gas | | Ecological burners for low NO _x insurance and stable combustion mode | No | |
| 8 | ELEM | Heat production | 100 | Natural gas | | | No | |
| 9 | KOGEL | Combined Heat and electricity production | 90 | Natural gas | | | Yes | Started in October 2019, no data in this submission |

4.2.1. Methodological issues

A detail analysis of SO₂ emissions for the period 1990–2023, within the ongoing IPA project “Support in the implementation of air quality directives”, has identified significant fluctuations in reported concentrations and flue gas volumes. In certain cases, variations of several hundred percent were observed between months, raising concerns regarding the consistency and reliability of measurement data, particularly in recent years.

Furthermore, different methodologies were applied across reporting periods (e.g. use of measurement data versus implied emission factors (IEF) and Guidebook emission factors (EF) which contributed to inconsistencies. Two options were proposed by the key expert and the following has been chosen “use the default Tier 2 EFs from GB2023 (Table 3-12, 3-13, shown below) for the entire historical trend, until continuous measurement data for the REK Bitola power plant is available. This would avoid unexplained dips and spikes that are currently present in the IEFs and emissions. The use of implicit emission factors for NO_x, SO₂, TSP and CO cannot be considered reliable due to the highly

variable periodic measurement data (conducted once a month or even less frequently) such as e.g. mass flow, oxygen content and resulting in large fluctuations in the mass concentrations of pollutants in the waste gas), especially noticeable in the period 2019-2023. To avoid errors in the presentation of emission data, it is proposed to use the Tier 2 emission factor from GB2023 for source category 1.A.1.a, wet and dry bottom boilers using brown coal/lignite (Table 3-12) and the Tier 2 emission factor for source category 1.A.1.a, boilers using residual oil and heavy fuel oil (Table 3-13) for the entire historical trend. In the case of using the Tier 2 method from GB2023, for the assessment of and NO_x emissions, it is necessary to implement the emission reduction technique from the year of their application in REK Bitola”.

In addition, emissions for the base year 1980 were recalculated for category 1A1a using the same methodology described above and recalculated emissions for 1980 were submitted on April 6th, via the CDR (Eionet) platform as a second resubmission.

It was further agreed that measurement data will only be used for emission calculations once automated continuous emissions monitoring systems are fully established in major power plants. To the LCP reporting according to Energy community agreement, emission measurement data for 2024 were used for calculation of emissions coming from this sector.

Activity data

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

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

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

| 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 | 453 | 2602 |
| 1999 | 50091 | 424 | 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 |

| Year | Lignite (TJ) | Natural gas (TJ) | Residual fuel oil (TJ) |
|------|--------------|------------------|------------------------|
| 2006 | 45153 | 197 | 5152 |
| 2007 | 45697 | 895 | 6588 |
| 2008 | 52597 | 1627 | 1270 |
| 2009 | 50442 | 744 | 2267 |
| 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 |
| 2021 | 23445 | 9132 | 1462 |
| 2022 | 28794 | 7721 | 7223 |
| 2023 | 29770 | 11870 | 8132 |
| 2024 | 26123 | 10611 | 1890 |

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. Residual fuel oil and lignite are decreased in 2024 compare to 2023 due to lower consumption of fuels in REK Bitola and not operation of cold reserve TEC Negotino. The consumption of lignate is also increased due to reparation of the bloks in REK Bitola.

Data on fuel consumption is reported to MEPP by the installations in the format prescribed in the secondary legislation.

Emission factors

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

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

| Pollutant | Unit | Lignite | Natural gas | Heavy fuel oil |
|-----------------|--------|--------------------|-------------|----------------|
| NO _x | g/GJ | 247(140 from 2014) | 89 | 142 |
| NM VOC | g/GJ | 1.4 | 2.6 | 2.3 |
| SO ₂ | g/GJ | 1.678 | 0.281 | 495 |
| NH ₃ | g/GJ | NE | NE | NE |
| PM2.5 | g/GJ | 32 | 0.9 | 90 |
| PM10 | g/GJ | 79 | 0.9 | 150 |
| BC | %PM2.5 | 1 | 2.5 | 5.6 |

| Pollutant | Unit | Lignite | Natural gas | Heavy fuel oil |
|-----------------------------|--------------|---------|-------------|----------------|
| TSP | g/GJ | 117 | 0.89 | 200 |
| CO | g/GJ | 43 | 39 | 43 |
| Pb | mg/GJ | 15 | 0.0015 | 4.56 |
| Cd | mg/GJ | 1.8 | 0.00025 | 1.2 |
| Hg | mg/GJ | 2.9 | 0.1 | 0.341 |
| As | mg/GJ | 14.3 | 0.12 | 3.98 |
| Cr | mg/GJ | 9.1 | 0.00076 | 2.55 |
| Cu | mg/GJ | 1 | 0.000076 | 5.31 |
| Ni | mg/GJ | 9.7 | 0.00051 | 255 |
| Se | mg/GJ | 45 | 0.0112 | 2.06 |
| Zn | mg/GJ | 8.8 | 0.0015 | 87.8 |
| PCDD/ PCDF (dioxins/furans) | ng I-TEQ/GJ | 10 | 0.5 | 2.5 |
| benzo(a) pyren | µg/GJ | 1.3 | 0.56 | NE |
| benzo(b) fluoranthene | µg/GJ | 37 | 0.84 | 4.5 |
| benzo(k) fluoranthene | µg/GJ | 29 | 0.84 | 4.5 |
| Indeno (1.2.3-cd) pyren | µg/GJ | 2.1 | 0.84 | 6.92 |
| PCB | ng WHOTEG/GJ | 3.3 | NE | NE |
| HCB | µg/GJ | 6.7 | NE | NE |

4.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty for NO_x and SO_x was estimated to be 20% (rating A. cf. chapter 1.7), 200% for NMVOC (rating D) and 125% for PM_{2.5} (rating C). Updated uncertainty analysis due to change of methodology will be performed in the EU 4 Green project and included in the resubmitted IIR in June.

4.2.3. Source-specific QA/QC and verification

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

4.2.4. Source-specific recalculations

Recalculations were done due to lack of consistency of implied methodology for the whole trend for this category in IPA II air quality project.

4.2.5. Source-specific planned improvements

Measurement data will be used when secured from automated monitoring system as requirement for these installations according to the new Law on Industrial emissions.

4.3. Petroleum refining – NFR 1.A.1.b

This chapter presents the entire consumption of fuels in the oil industry. Main representative of this sector was only one company “OKTA AD – Skopje”. In 1982 with the commissioning of the processing plants OKTA AD – Skopje becomes the only crude oil refinery in the country. In January 2013 production in OKTA ended, after which the company entered a transformation process from an

inflexible and non-efficient heavy industry into a fast-growing client-oriented logistics services trade company. OKTA has developed a retail network of 25 petrol stations across the country, where it supplies high quality products and services to the end consumers.

4.3.1. Methodological issues

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

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

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

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

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

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

Activity data

Data on the consumption of fuels in this sector for the period 2000-2014 have been collected by the operator itself. No production was carried out from 2015 onwards. The company became customer-oriented. logistics and trading company. providing uninterrupted and reliable supply of fuel in the country. Request for providing data for the period 1990-1999 has been sent to the company. but these data have not been reported.

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

Table 34 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 |
| 2001 | 1425 | 1109 |
| 2002 | 912 | 870 |
| 2003 | 1103 | 1140 |
| 2004 | 1174 | 1181 |
| 2005 | 1373 | 1035 |

| Year | Refinery gas (TJ) | Residual fuel oil (TJ) |
|------|-------------------|------------------------|
| 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 |
| 2021 | NO | NO |
| 2022 | NO | NO |
| 2023 | NO | NO |
| 2024 | NO | NO |

Emission factors

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

Table 35 Emission factors for source category 1.A.1.b- Petroleum refining

| Pollutant | Unit | Refinery gas | Heavy fuel oil |
|-----------------|-------|--------------|----------------|
| NO _x | g/GJ | 63 | 142 |
| NM VOC | g/GJ | 2.58 | 2.3 |
| SO ₂ | g/GJ | 0.281 | 485 |
| PM2.5 | g/GJ | 0.89 | 9 |
| PM10 | g/GJ | 0.89 | 15 |
| TSP | g/GJ | 0.89 | 20 |
| CO | g/GJ | 12.2 | 6 |
| Pb | mg/GJ | 1.61 | 4.6 |
| Cd | mg/GJ | 2.19 | 1.2 |
| Hg | mg/GJ | 0.372 | 0.3 |
| As | mg/GJ | 0.352 | 3.98 |
| Cr | mg/GJ | 6.69 | 14.8 |
| Cu | mg/GJ | 3.29 | 11.9 |

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

4.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty for NO_x and SO_x was estimated to be 20% (rating A. cf. chapter 1.7), 200% for NMVOC (rating D) and 40% for PM_{2.5} (rating B).

4.3.3. Source-specific QA/QC and verification

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

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

No recalculations were made for this reporting period.

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

No planned improvements in this category.

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

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

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

4.4.1. Methodological issues

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

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

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

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

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

Activity data – stationary combustion

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

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

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

The activity data from the NFR category 1.A.2.g.vii - Mobile Combustion in manufacturing industries and construction: for diesel fuel are presented in Table 36.

Table 36 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 |
| 2006 | 69.59 | 1456 | 6308 | 2793 |
| 2007 | 31.66 | 1465 | 8337 | 3596 |
| 2008 | 9.13 | 1305 | 7373 | 3014 |

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] |
|------|--------------|------------------|--------------|------------------|
| 2009 | 0.98 | 1141 | 3761 | 2571 |
| 2010 | 52.51 | 1126 | 5842 | 3224 |
| 2011 | 3.42 | 754 | 5415 | 2002 |
| 2012 | 68.06 | 605 | 7455 | 3251 |
| 2013 | 4.00 | 754 | 6377 | 3000 |
| 2014 | 3.42 | 754 | 5410 | 2002 |
| 2015 | 4.01 | 658 | 4368 | 1399 |
| 2016 | 2.41 | 864 | 4082 | 1142 |
| 2017 | 1.51 | 1025 | 2522 | 806 |
| 2018 | 101.11 | 994 | 3071 | 926 |
| 2019 | 95.70 | 912 | 4800 | 998 |
| 2020 | 503.08 | 845 | 3712 | 1157 |
| 2021 | 337.77 | 946 | 3901 | 986 |
| 2022 | 257.966 | 959 | 2195 | 588 |
| 2023 | 61.997 | 926 | 1423 | 208 |
| 2024 | 7.820 | 952 | 165 | 3 |

Table 37 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 |

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] |
|------|--------------|------------------|--------------|------------------|
| 2009 | NA | NA | NA | 26 |
| 2010 | NA | NA | NA | 34 |
| 2011 | NA | NA | NA | 70 |
| 2012 | NA | NA | NA | 41 |
| 2013 | NA | NA | NA | 42 |
| 2014 | NA | NA | NA | 3 |
| 2015 | NA | NA | NA | 42 |
| 2016 | NA | NA | NA | 53 |
| 2017 | NA | NA | NA | 55 |
| 2018 | NA | NA | NA | 54 |
| 2019 | NA | NA | NA | 48 |
| 2020 | NA | NA | NA | 57 |
| 2021 | 0.187 | NA | NA | 70 |
| 2022 | 0.119 | NA | NA | 59 |
| 2023 | 0.068 | NA | NA | 57 |
| 2024 | 0.085 | NA | NA | 52 |

Table 38 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 | 0.85 | 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 |

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] |
|------|--------------|------------------|--------------|------------------|
| 2009 | NA | 37.596 | NA | 131 |
| 2010 | NA | 61.877 | NA | 89 |
| 2011 | NA | 52.170 | NA | 100 |
| 2012 | NA | 38.770 | NA | 75 |
| 2013 | 0.4165 | 36.942 | NA | 72 |
| 2014 | NA | 35.903 | NA | 65 |
| 2015 | NA | 36.439 | NA | 87 |
| 2016 | NA | 38.813 | NA | 74 |
| 2017 | 0.03 | 41.272 | NA | 83 |
| 2018 | 0.03 | 39.053 | NA | 75 |
| 2019 | 0.57 | 72.027 | NA | 83 |
| 2020 | 0.56 | 72.027 | NA | 41 |
| 2021 | 0.19 | 102.217 | NA | 23 |
| 2022 | 0.79 | 80.302 | NA | 20 |
| 2023 | 0.68 | 79.127 | NA | 25 |
| 2024 | 0.43 | 83.306 | NA | 18 |

Table 39 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 | 0.44376 | 16.88 |
| 1992 | NA | NA | 0.22188 | 12.40 |
| 1993 | NA | NA | NA | 7.92 |
| 1994 | NA | NA | NA | 7.76 |
| 1995 | NA | NA | NA | 7.60 |
| 1996 | NA | NA | 56.107072 | 196.99 |
| 1997 | NA | NA | 28.777036 | 169.95 |
| 1998 | 1.90 | NA | 1.447 | 142.91 |
| 1999 | 0.53 | NA | NA | 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 | 0.77926 | 52.94 |
| 2006 | 1.88 | 78.19 | 0.65491 | 55.17 |
| 2007 | 1.71 | 75.25 | 0.865476 | 56.71 |
| 2008 | 1.72 | 76.73 | 2.759885 | 129.93 |

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] |
|------|--------------|------------------|--------------|------------------|
| 2009 | 1.43 | 58.56 | 0.62175 | 62.99 |
| 2010 | 1.57 | 92.12 | 0.31502 | 38.51 |
| 2011 | 0.91 | 33.83 | 0.19067 | 27.53 |
| 2012 | 0.37 | 23.79 | 0.27357 | 17.27 |
| 2013 | 0.32 | 15.06 | 0.2487 | 16.01 |
| 2014 | 0.20 | 15.04 | 0.9593618 | 17.75 |
| 2015 | 0.18 | 15.04 | 0.226317 | 26.37 |
| 2016 | 2.02 | 14.02 | 0.20725 | 18.59 |
| 2017 | 2.85 | 15.94 | 0.2487 | 22.64 |
| 2018 | 2.74 | 16.24 | NA | 18.00 |
| 2019 | 3.30 | 19.32 | NA | 20.45 |
| 2020 | 3.42 | 22.384 | NA | 20.70 |
| 2021 | 4.63 | 23.468 | NA | 22.60 |
| 2022 | 3.51 | 19.727 | NA | 21.10 |
| 2023 | 2.70 | 18.784 | NA | 19.49 |
| 2024 | 2.53 | 20.830 | NA | 24.36 |

Table 40 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 |

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] |
|------|--------------|------------------|--------------|------------------|
| 2009 | 2.05 | 211.11 | 7.00 | 895 |
| 2010 | 9.33 | 238.05 | 9.24 | 862 |
| 2011 | 5.92 | 237.68 | 7.52 | 824 |
| 2012 | 74.28 | 218.77 | 6.78 | 812 |
| 2013 | 138.16 | 220.22 | 6.85 | 681 |
| 2014 | 188.88 | 204.67 | 4.42 | 660 |
| 2015 | 182.19 | 215.39 | NA | 701 |
| 2016 | 152.72 | 234.03 | NA | 687 |
| 2017 | 184.95 | 240.53 | NA | 666 |
| 2018 | 167.95 | 240.62 | NA | 345 |
| 2019 | 162.61 | 233.08 | 0.46 | 683 |
| 2020 | 137.88 | 247.68 | NA | 689 |
| 2021 | 161.04 | 280.78 | NA | 684 |
| 2022 | 152.85 | 180.879 | NA | 700 |
| 2023 | 165.55 | 262.100 | NA | 700 |
| 2024 | 196.40 | 287.046 | NA | 660 |

Table 41 Activity data for category source category 1.A.2.f

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] | Clinker [tones] |
|------|--------------|------------------|--------------|------------------|-----------------|
| 1990 | IE | IE | IE | IE | 491.902 |
| 1991 | IE | IE | IE | IE | 465.375 |
| 1992 | IE | IE | IE | IE | 396.496 |
| 1993 | IE | IE | IE | IE | 413.444 |
| 1994 | IE | IE | IE | IE | 375.914 |
| 1995 | IE | IE | IE | IE | 365.121 |
| 1996 | IE | IE | IE | IE | 396.015 |
| 1997 | IE | IE | IE | IE | 475.252 |
| 1998 | IE | IE | IE | IE | 346.867 |
| 1999 | IE | IE | IE | IE | 427.080 |
| 2000 | IE | IE | IE | IE | 614.162 |
| 2001 | IE | IE | IE | IE | 716.963 |
| 2002 | IE | IE | IE | IE | 739.492 |
| 2003 | IE | IE | IE | IE | 602.569 |
| 2004 | IE | IE | IE | IE | 643.258 |
| 2005 | IE | IE | IE | IE | 694.922 |
| 2006 | IE | IE | IE | IE | 801.302 |
| 2007 | IE | IE | IE | IE | 882.834 |
| 2008 | IE | IE | IE | IE | 843.765 |

| Year | Biomass [TJ] | Natural gas [TJ] | Lignite [TJ] | Heavy Fuels [TJ] | Clinker [tones] |
|------|--------------|------------------|--------------|------------------|-----------------|
| 2009 | IE | IE | IE | IE | 478.404 |
| 2010 | IE | IE | IE | IE | 588.978 |
| 2011 | IE | IE | IE | IE | 687.986 |
| 2012 | IE | IE | IE | IE | 645.482 |
| 2013 | IE | IE | IE | IE | 577.845 |
| 2014 | IE | IE | IE | IE | 518.198 |
| 2015 | IE | IE | IE | IE | 553.232 |
| 2016 | IE | IE | IE | IE | 739.807 |
| 2017 | IE | IE | IE | IE | 735.625 |
| 2018 | IE | IE | IE | IE | 748.287 |
| 2019 | IE | IE | IE | IE | 737.700 |
| 2020 | IE | IE | IE | IE | 770.599 |
| 2021 | IE | IE | IE | IE | 803.735 |
| 2022 | 2.34 | 38.82 | 229.96 | 1073 | 673.837 |
| 2023 | 2.15 | 691.50 | 691.50 | 1097 | 711.254 |
| 2024 | 1.26 | 105.25 | 24.29 | 1076 | 682.767 |

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

Activity data – mobile combustion

Activity data for category 1.A.2.gvii for diesel fuel is presented in Table 42.

Table 42 Activity data for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for diesel fuel

| Year | Heavy Fuels [TJ] | Year | Heavy Fuels [TJ] |
|------|------------------|------|------------------|
| 1990 | 4846 | 2008 | 554 |
| 1991 | 3496 | 2009 | 784 |
| 1992 | 4674 | 2010 | 1013 |
| 1993 | 4891 | 2011 | 1369 |
| 1994 | 2059 | 2012 | 1725 |
| 1995 | 2392 | 2013 | 2285 |
| 1996 | 2060 | 2014 | 1146 |
| 1997 | 1784 | 2015 | 1182 |
| 1998 | 1613 | 2016 | 1198 |
| 1999 | 1307 | 2017 | 1096 |
| 2000 | 1043 | 2018 | 1089 |
| 2001 | 1148 | 2019 | 1048 |
| 2002 | 675 | 2020 | 1127 |
| 2003 | 545 | 2021 | 1165 |
| 2004 | 504 | 2022 | 1136 |

| Year | Heavy Fuels [TJ] | Year | Heavy Fuels [TJ] |
|------|------------------|------|------------------|
| 2005 | 426 | 2023 | 1153 |
| 2006 | 456 | 2023 | 1242 |
| 2007 | 524 | 2024 | 1146 |

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 43-47.

Table 43 Emission factors for source category 1.A.2 - Stationary combustion in manufacturing industries and construction for biomass

| Pollutant | Value | Unit | References |
|-------------------------|-------|-------------|---|
| NOx | 91 | g/GJ | GB 2023 Table 3-5 emission factor for source category, 1.A.2. page 17 |
| NMVOC | 300 | g/GJ | GB 2023 Table 3-5 emission factor for source category. 1.A.2. page 17 |
| SOx | 11 | g/GJ | GB 2023 Table 3-5 emission factor for source category. 1.A.2. page 17 |
| NH3 | 1.2 | g/GJ | GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18 |
| PM2.5 | 140 | g/GJ | GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18 |
| PM10 | 143 | g/GJ | GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18 |
| BC | 28 | % of PM2.5 | GB 2023 Table 3-3 emission factor for source category, 1.A.2. page 18 |
| TSP | 150 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| CO | 570 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Pb | 27 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Cd | 13 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Hg | 0.56 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| As | 0.19 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Cr | 23 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Cu | 6 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Ni | 2 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Se | 0.5 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Zn | 512 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| PCDD/PCDF | 100 | ng I-Teq/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| benzo(a) pyren | 10 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| benzo(b) fluoranthene | 16 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| benzo(k) fluoranthene | 5 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| Indeno (1.2.3-cd) pyren | 4 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| HCB | 5 | µg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |
| PCBs | 0.06 | µg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 18 |

Table 44 Emission factors for source category 1.A.2 - Stationary combustion in manufacturing industries and construction for gaseous fuel

| Pollutant | Value | Unit | References |
|-----------|-------|------|--|
| NOx | 74 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |

| Pollutant | Value | Unit | References |
|-------------------------|--------|-----------------|--|
| NMVOC | 23 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| SOx | 0.67 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| PM2.5 | 0.78 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| PM10 | 0.78 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| TSP | 0.78 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| BC | 4 | % PM2.5 | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| CO | 29 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Pb | 0.011 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Cd | 0.0009 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Hg | 0.54 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| As | 0.1 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Cr | 0.013 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Cu | 0.0026 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Ni | 0.013 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Se | 0.058 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Zn | 0.73 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| PCDD/PCDF | 0.52 | ng I- Teq/GJ | GB2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| benzo(a) pyren | 0.72 | mg/GJ | GB2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| benzo(b) fluoranthen | 2.9 | mg/GJ | GB2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| benzo(k) fluoranthene | 1.1 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |
| Indeno (1.2.3-cd) pyren | 1.08 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 16 |

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

| Pollutant | Value | Unit | References |
|-----------|-------|------------|--|
| NOx | 173 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| NMVOC | 88.8 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| SOx | 900 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| PM2.5 | 108 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| PM10 | 117 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| TSP | 124 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| BC | 6.4 | % of PM2.5 | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| CO | 931 | g/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Pb | 134 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Cd | 1.8 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Hg | 7.9 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| As | 4 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Cr | 13.5 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |

| Pollutant | Value | Unit | References |
|-------------------------|-------|-------------|--|
| Cu | 17.5 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Ni | 13 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Se | 1.8 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Zn | 200 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| PCDD/PCDF | 203 | ng I-Teq/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| benzo(a) pyren | 45.5 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| benzo(b) fluoranthene | 58.9 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| benzo(k) fluoranthene | 23.7 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| Indeno (1.2.3-cd) pyren | 18.5 | mg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| HCB | 0.62 | µg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |
| PCBs | 170 | µg/GJ | GB 2023 Table 3-3 emission factor for source category 1.A.2. page 15 |

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

| Pollutant | Value | Unit | References |
|-----------------------|-------|-------------|--|
| NOx | 513 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| NM VOC | 25 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| SOx | 47 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| PM2.5 | 20 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| PM10 | 20 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| TSP | 20 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| BC | 56 | % of PM2.5 | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| CO | 66 | g/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Pb | 0.08 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Cd | 0.006 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Hg | 0.12 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| As | 0.03 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Cr | 0.2 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Cu | 0.22 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Ni | 0.008 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Se | 0.11 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| Zn | 29 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| PCDD/PCDF | 1.4 | ng I-Teq/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| benzo(a) pyren | 1.9 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| benzo(b) fluoranthene | 15 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |
| benzo(k) fluoranthene | 1.7 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |

| Pollutant | Value | Unit | References |
|-------------------------|-------|-------|--|
| Indeno (1.2.3-cd) pyren | 1.5 | mg/GJ | GB 2023 Table 3-4 emission factor for source category 1.A.2. page 17 |

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

Table 47 Emission factors for category 1.A.2 - Stationary combustion in manufacturing industries and construction: Other for clinker

| Pollutant | Value | Unit | References |
|-------------------------|--------------|--------------------|---|
| NOx | 1241 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| NMVOC | 18 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| SOx | 374 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| CO | 1455 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Pb | 0.098 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Cd | 0.008 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Hg | 0.049 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| As | 0.0265 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Cr | 0.041 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Cu | 0.0647 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Ni | 0.049 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Se | 0.0253 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Zn | 0.424 | g/tclinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| PCB | 103 | µg/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| PCDD/PCDF | 4.1 | ng I-TEQ/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| benzo(a) pyren | 0.00006 5 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| benzo(b) fluoranthen | 0.00028 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| benzo(k) fluoranthen | 0.00007 7 | g/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| Indeno (1.2.3-cd) pyren | 0.00004 3 | g/tclinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |
| HCB | 4.6 | µg/t clinker | GB 2023 Table 3-24 emission factor for source category 1.A.2.f. page 32 |

Emission factors – mobile combustion

Concerning the source category 1.A.2.gvii, the emission factors for diesel fuels are presented in Tables 48 and 49.

Table 48 Emission factors for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for HM and POPs from diesel fuel and gasoline

| Fuel | Pollutant | Units | Emission factor |
|--------|-----------|-------|-----------------|
| Diesel | Cadmium | mg/GJ | 0.234 |
| | Copper | mg/GJ | 39.808 |
| | Chromium | mg/GJ | 1.171 |

| Fuel | Pollutant | Units | Emission factor |
|----------|------------------------|-------|-----------------|
| | Nickel | mg/GJ | 1.639 |
| | Selenium | mg/GJ | 0.234 |
| | Zinc | mg/GJ | 23.416 |
| | Benz(a)anthracene | µg/GJ | 1873.301 |
| | Benzo(b)fluoranthene | µg/GJ | 1170.813 |
| | Dibenzo(a,h)anthracene | µg/GJ | 234.163 |
| | Benzo(a)pyrene | µg/GJ | 702.488 |
| | Chrysene | µg/GJ | 4683.253 |
| | Fluoranthene | µg/GJ | 10537.319 |
| | Phenanthrene | µg/GJ | 58540.661 |
| Gasoline | Cadmium | mg/GJ | 0.227 |
| | Copper | mg/GJ | 38.670 |
| | Chromium | mg/GJ | 1.137 |
| | Nickel | mg/GJ | 1.592 |
| | Selenium | mg/GJ | 0.227 |
| | Zinc | mg/GJ | 22.747 |
| | Benz(a)anthracene | µg/GJ | 1706.042 |
| | Benzo(b)fluoranthene | µg/GJ | 909.889 |
| | Dibenzo(a,h)anthracene | µg/GJ | 227.472 |
| | Benzo(a)pyrene | µg/GJ | 909.889 |
| | Chrysene | µg/GJ | 3412.084 |
| | Fluoranthene | µg/GJ | 10236.253 |
| | Phenanthrene | µg/GJ | 27296.674 |

Table 49 Emission factors for source category 1.A.2.gvii - Mobile Combustion in manufacturing industries and construction: for basic pollutants from diesel fuel and gasoline

| Fuel | Pollutant | Units | <1981 | 1981-1990 | 1991-Stage I | Stage I | Stage II | Stage IIIA | Stage IIIB | Stage IV | Stage V |
|--------|-----------|----------------|--------|-----------|--------------|---------|----------|------------|------------|----------|---------|
| Diesel | CH4 | g/tonnes fuel | 199 | 171 | 144 | 42 | 39 | 36 | 15 | 13 | 23 |
| | CO | g/tonnes fuel | 20690 | 18890 | 16258 | 6639 | 7135 | 6826 | 6445 | 6019 | 7352 |
| | CO2 | kg/tonnes fuel | 3159,8 | 3159,8 | 3159,8 | 3159,8 | 3159,8 | 3159,8 | 3159,8 | 3159,8 | 3159,8 |
| | N2O | g/tonnes fuel | 121 | 128 | 135 | 137 | 136 | 136 | 137 | 137 | 136 |

| | | | | | | | | | | | |
|-----------------------|-------|----------------|---------|--------|--------|--------|--------|-------|-------|------|--------|
| | NH3 | g/tonnes fuel | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| | NMVOC | g/tonnes fuel | 8077 | 6962 | 5851 | 1725 | 1587 | 1470 | 625 | 536 | 930 |
| | NOx | g/tonnes fuel | 26552 | 33942 | 43552 | 31077 | 22101 | 15653 | 11933 | 1570 | 7663 |
| | PM10 | g/tonnes fuel | 6207 | 4308 | 3642 | 1005 | 1034 | 950 | 98 | 98 | 116 |
| | PM2.5 | g/tonnes fuel | 6207 | 4308 | 3642 | 1005 | 1034 | 950 | 98 | 98 | 116 |
| | TSP | g/tonnes fuel | 6207 | 4308 | 3642 | 1005 | 1034 | 950 | 98 | 98 | 116 |
| | BC | g/tonnes fuel | 3414 | 2396 | 2001 | 800 | 825 | 758 | 78 | 78 | 56 |
| | f-BC | % PM2.5 | 0,55 | 0,56 | 0,55 | 0,80 | 0,80 | 0,80 | 0,80 | 0,80 | 0,48 |
| Gasoline: two-stroke | CH4 | g/tonnes fuel | 22483 | 19462 | 17284 | 16979 | 8517 | | | | 8539 |
| | CO | g/tonnes fuel | 754523 | 699494 | 621083 | 620519 | 695237 | | | | 694870 |
| | CO2 | kg/tonnes fuel | 3197 | 3197 | 3197 | 3197 | 3197 | | | | 3197 |
| | N2O | g/tonnes fuel | 12 | 16 | 16 | 18 | 20 | | | | 20 |
| | NH3 | g/tonnes fuel | 2 | 3 | 3 | 4 | 4 | | | | 4 |
| | NMVOC | g/tonnes fuel | 298703 | 258562 | 229630 | 225579 | 113157 | | | | 111450 |
| | NOx | g/tonnes fuel | 1050 | 1682 | 1852 | 3445 | 2495 | | | | 2490 |
| | PM10 | g/tonnes fuel | 7037 | 4786 | 3869 | 3683 | 4299 | | | | 4278 |
| | PM2.5 | g/tonnes fuel | 7037 | 4786 | 3869 | 3683 | 4299 | | | | 4278 |
| | TSP | g/tonnes fuel | 7037 | 4786 | 3869 | 3683 | 4299 | | | | 4278 |
| | BC | g/tonnes fuel | 352 | 239 | 193 | 184 | 215 | | | | 214 |
| | f-BC | % PM2.5 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | | | | 0,05 |
| Gasoline: four-stroke | CH4 | g/tonnes fuel | 710 | 910 | 672 | 650 | 568 | | | | 468 |
| | CO | g/tonnes fuel | 1214855 | 836966 | 768445 | 774457 | 804157 | | | | 778282 |
| | CO2 | kg/tonnes fuel | 3197 | 3197 | 3197 | 3197 | 3197 | | | | 3197 |
| | N2O | g/tonnes fuel | 56 | 55 | 59 | 59 | 60 | | | | 59 |
| | NH3 | g/tonnes fuel | 4 | 4 | 4 | 4 | 4 | | | | 4 |
| | NMVOC | g/tonnes fuel | 20182 | 25852 | 19082 | 18469 | 16126 | | | | 13293 |
| | NOx | g/tonnes fuel | 2429 | 5743 | 7129 | 7088 | 6676 | | | | 5354 |

| | | | | | | | | | | | |
|--|-------|---------------|------|------|------|------|------|--|--|--|------|
| | PM10 | g/tonnes fuel | 148 | 147 | 157 | 159 | 159 | | | | 159 |
| | PM2.5 | g/tonnes fuel | 148 | 147 | 157 | 159 | 159 | | | | 159 |
| | TSP | g/tonnes fuel | 148 | 147 | 157 | 159 | 159 | | | | 159 |
| | BC | g/tonnes fuel | 7 | 7 | 8 | 8 | 8 | | | | 8 |
| | f-BC | % PM2.5 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | | | | 0,05 |

4.4.3. Source-specific uncertainties and time-series consistency

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

4.4.4. Source-specific QA/QC and verification

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

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

Recalculations for 2023 were performed, due to the use of final data (from the energy balance) for fuel consumption.

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

Higher tier methodology will be performed in future submissions as soon as activity data is made available, through establishment of NEIS in 2027.

4.5. Transport

4.5.1. Road transport –NFR 1.A.3

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

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

The road transport inventory has been substantially improved through the application of the COPERT Tier 3 methodology and the update to COPERT 5.8.1. The revised approach supports a more consistent

and transparent time series and better reflects the actual structure and activity of the national vehicle fleet.

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

4.5.1.1.1. Methodology

For the recalculated period 1990–2024, emissions from road transport are estimated using the COPERT 5 model (version 5.8.1), in line with the EMEP/EEA air pollutant emission inventory guidebook 2023. This represents a methodological improvement compared with the previously reported time series, in which the period 1990–2004 was estimated using a simplified Tier 1 fuel-based approach and the period 2005–2024 using the previous COPERT version 5.5 calculations. The previous COPERT 5.5 calculations were maintained in two separate databases covering 2005–2014 and 2014–2022 respectively; these have now been replaced by a single unified COPERT 5.8.1 data time series database for the recalculated period. The latest available 2024 road transport activity data are reflected in this chapter, while the full recalculation of the period 2023–2025 will be completed in 2026 under the ongoing EU4Green project.

The COPERT methodology calculates total emissions from road transport as the sum of hot, cold-start and evaporative emissions:

$$E_{\text{total}} = E_{\text{hot}} + E_{\text{cold}} + E_{\text{evap}}$$

Where:

E_{total} = total emissions from road transport;

E_{hot} = emissions under stabilized engine operating conditions;

E_{cold} = excess emissions during engine warm-up (cold start);

E_{evap} = evaporative emissions from the fuel system of gasoline vehicles.

In addition, COPERT calculates emissions separately for the urban, rural and highway driving modes ($E_{\text{total}} = E_{\text{urban}} + E_{\text{rural}} + E_{\text{highway}}$), thereby reflecting differences in traffic conditions, vehicle speeds and trip patterns across the road network.

COPERT 5.8.1 has been used for the calculation of national emissions from road transport for the period 1990–2024. The methodology is fully integrated in the COPERT software and provides a standardized bottom-up framework for estimating fuel consumption and pollutant emissions from the national road fleet.

The COPERT methodology is part of the EMEP/EEA air pollutant emission inventory guidebook and is widely used for national reporting under the UNECE Convention on Long range Transboundary Air Pollution and EU reporting obligations.

The use of COPERT ensures a transparent, comparable and internally consistent estimation procedure. The model links fleet structure, mileage, fuel characteristics, meteorological conditions and driving patterns to technology-specific emission factors for both exhaust and non-exhaust emissions.

To calculate emissions using COPERT, the following input data are required: vehicle numbers; vehicle classification by category, class and Euro standard; annual mileage by vehicle category; mileage distribution by driving mode (urban, rural and highway); average speed by vehicle category and driving mode; fuel consumption by fuel type; fuel specifications, including sulphur and lead content, monthly minimum and maximum temperature; humidity; Reid vapor pressure; average trip length; β value; and the emission-factor functions embedded in COPERT.

COPERT 5.8.1 was used to calculate exhaust emissions, cold-start emissions, evaporative emissions, and non-exhaust emissions from tire and brake wear and road abrasion.

The model was applied to estimate emissions of NO_x, SO₂, NMVOC, NH₃, PM_{2.5}, PM₁₀, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, dioxins/furans, four indicator PAHs (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene), PCB and HCB, where relevant for the source category and technology represented in COPERT.

Emissions of particulate matter from tire and brake wear and road abrasion are also calculated in COPERT, together with the associated BC and selected heavy metal emissions where these are included in the model structure.

Compared with the previously reported methodology, the revised approach provides a more comprehensive and harmonized basis for the entire time series and reduces the inconsistency arising from the earlier combination of Tier 1 and Tier 3 methods.

Vehicle fleet

For the period 1990–2004, vehicle fleet composition was reconstructed from the Statistical Yearbooks of the Republic of North Macedonia. For 2005–2024, fleet composition was based on the COPERT database developed from the official vehicle database provided by the Ministry of Interior Affairs (MIA). Where detailed technology information was not directly available, the distribution by vehicle class and Euro standard was developed using year-of-production data and the implementation years of the European emission standards in Table 2-2 of the EMEP/EEA Guidebook 2023. For the historical period, assumptions on the distribution across vehicle classes and Euro standards were based on the distribution observed in Croatia and adapted to national circumstances. In the 1990–2004 reconstruction, buses and passenger carrying light commercial vehicles were redistributed where necessary to ensure consistency with COPERT vehicle definitions.

Fuel consumption and mileage data

Fuel consumption for road transport is based on the official national energy balance and is entered in COPERT as statistical consumption by fuel type. For 1990–2004, total fuel consumption was reconstructed from official national statistics and inventory data and disaggregated by fuel type using expert judgement, taking Croatia as the reference for the fuel shares and the gradual phase out of leaded gasoline. For 2005–2024, the statistical fuel consumption by fuel type was aligned with the official energy balance for road transport.

Initial mileage data by vehicle subcategory were based on COPERT default values. These data were used as the starting point for annual mileage by vehicle category and technology and, where nationally specific information was not available, also for related activity parameters needed by the model.

For years with incomplete information, annual mileage was interpolated or extrapolated using the best available time series evidence and then calibrated within COPERT. The model performs an automatic energy balance by adjusting mileage and, where relevant, blend shares, so that calculated fuel consumption is brought into line with the statistical energy consumption reported in the national energy balance.

The distribution of mileage between urban, rural and highway driving, together with the average speeds by driving condition, was based on COPERT defaults, previous national assumptions and expert assessment, and was checked for plausibility against national circumstances and the structure of the vehicle fleet.

Metdology

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

Extra emissions of NO_x, 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 profile. Monthly minimum and maximum temperature data, together with humidity, were compiled for the assessment period using the meteorological station in Skopje as the reference location. For 2005 and for 2015–2024, data from COPERT were used; for the intermediate period 2006–2014, temperature and humidity values were derived by linear extrapolation.

Annual mileage for the revised time series was derived from the best available national and model-based information and then adjusted through the COPERT energy balance procedure so that the final activity data is consistent with reported fuel consumption.

The COPERT 5.8.1 database was implemented in accordance with the national guidance. In practice, this involved the creation of a new Macedonia run, addition of the full annual series 1990–2024, entry of environmental information (monthly minimum and maximum temperature and humidity), entry of fuel specifications and statistical fuel consumption, activation of the automatic energy balance, definition of vehicle stock configuration by category and Euro standard, import of stock and activity data, use of COPERT default values for parameters not available nationally (including Reid vapour pressure, average trip length and β value), and export of the results to the NFR reporting format.

Sulfur dioxide emissions are calculated using the sulfur content of fuels entered in COPERT. For the period 1990–2004, sulfur and lead content in fuels were estimated based on expert judgement using values observed in Croatia as a reference, together with the national Regulation on quality standards for liquid petroleum fuels. For recent years, fuel specifications are defined by applicable national regulations.

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

Activity data

Fuel consumption data used in the calculations originates from the official national energy balance and related inventory datasets. For the historical period 1990–2004, activity data were reconstructed and disaggregated for COPERT application using official national statistics, expert judgement and the proxy fuel shares observed in Croatia. For 2005–2024, activity data were aligned with the statistical consumption reported for road transport and linked to the revised stock and mileage datasets described above. The resulting activity data are presented in Tables 50 and 51. The aggregated 2024 activity data available from the NFR submission have been added to Table 50, while the detailed disaggregated fuel-type table remains as in the latest fully tabulated recalculation.

Table 50 Activity data for source category 1.A.3.b - Road transport for period 1990-2024

| NFR | 1A3bi | 1A3bi | 1A3bii | 1A3biii | 1A3biv |
|------|--------------|----------|--------------|--------------|--------------|
| Year | Liquid fuels | Gas fuel | Liquid fuels | Liquid fuels | Liquid fuels |
| 1990 | 11135.15 | NA | 1428.32 | 1799.6 | 15.78 |
| 1991 | 5539.06 | NA | 846.51 | 1002.59 | 8.61 |
| 1992 | 12160.58 | NA | 1991.97 | 2253.16 | 21.29 |
| 1993 | 12166.09 | NA | 2278.11 | 2613.99 | 21.33 |
| 1994 | 10830.74 | NA | 1861.62 | 2389.46 | 10.32 |
| 1995 | 12086.37 | NA | 2109.12 | 2472.35 | 16.45 |
| 1996 | 12379.23 | NA | 2104.05 | 2477.39 | 19.4 |
| 1997 | 12468.01 | NA | 2101.37 | 2481.7 | 23.26 |
| 1998 | 12766.95 | NA | 1997.89 | 2292.6 | 24.51 |
| 1999 | 12851.23 | NA | 1951.75 | 2262.1 | 23.37 |
| 2000 | 13466 | NA | 1980.81 | 2229.57 | 23.96 |
| 2001 | 10750.51 | NA | 1624.73 | 1797.17 | 21.59 |
| 2002 | 11550.91 | NA | 1696.73 | 2011.97 | 14.85 |
| 2003 | 10779.41 | NA | 1590.03 | 2027.07 | 9.9 |
| 2004 | 10165.99 | NA | 1361.46 | 2241.27 | 17.62 |
| 2005 | 10187.96 | NA | 1526.51 | 2443.75 | 8.55 |
| 2006 | 10114.82 | NA | 1595.41 | 2408.07 | 14.89 |
| 2007 | 11220.19 | NA | 1825.12 | 3090.28 | 22.29 |
| 2008 | 11944.66 | NA | 2095.04 | 2571.91 | 25.49 |
| 2009 | 12692.26 | NA | 2474.92 | 2649.17 | 37.52 |
| 2010 | 13705.46 | NA | 2516.19 | 2258.8 | 33.33 |
| 2011 | 14814.96 | NA | 2547.71 | 2192.66 | 35.02 |
| 2012 | 14320.54 | NA | 2389.55 | 2047.31 | 31.57 |
| 2013 | 15984.17 | NA | 3048.68 | 2335.78 | 30.92 |
| 2014 | 17070.34 | NA | 2786.97 | 2478.62 | 29.8 |
| 2015 | 19255.82 | NA | 2985.18 | 2579.49 | 35.76 |
| 2016 | 21941.55 | NA | 3511.54 | 2808.36 | 41.94 |

| NFR | 1A3bi | 1A3bi | 1A3bii | 1A3biii | 1A3biv |
|------|--------------|----------|--------------|--------------|--------------|
| Year | Liquid fuels | Gas fuel | Liquid fuels | Liquid fuels | Liquid fuels |
| 2017 | 22709.57 | NA | 3899.57 | 2725.47 | 52.55 |
| 2018 | 22908.4 | NA | 3457.88 | 2944.13 | 46.16 |
| 2019 | 24775.01 | NA | 4225.26 | 2616.77 | 47.37 |
| 2020 | 21236.48 | 81.9 | 3875.24 | 1614.34 | 11.93 |
| 2021 | 24488.92 | 176.41 | 4556.76 | 1573.49 | 13.04 |
| 2022 | 24898.37 | 78.16 | 4591.55 | 1535.47 | 13.97 |
| 2023 | 21056.56 | NA | 7654.07 | 4465.35 | 37.78 |
| 2024 | 21110.58 | NA | 7645.42 | 4465.35 | 36.3 |

Table 51 Activity data for source category 1.A.3.b Road transport for 2024

| NFR code | Fuel | Fuel consumption [TJ] |
|----------|----------|-----------------------|
| 1A3bi | Gasoline | 4423.660684 |
| | Diesel | 14843.26366 |
| | LPG | 1843.66 |
| 1A3bii | Gasoline | 96.40977 |
| | Diesel | 7549.006351 |
| 1A3biii | Gasoline | 47.10638264 |
| | Diesel | 1788.525829 |
| 1A3biv | Gasoline | 36.30176868 |

4.5.1.1.2. Source-specific uncertainties and time-series consistency

The revised road transport time series is more consistent than the previously reported series because the COPERT Tier 3 methodology has been applied across the full period 1990–2024. Nevertheless, some uncertainty remains due to limitations in historical vehicle stock data, fuel disaggregation and the reconstruction of technology shares for earlier years.

For the years 2005–2024, detailed fleet data are available from the Ministry of Interior and were prepared for COPERT using dedicated data processing scripts. These scripts were used for quality control, assignment of vehicle technologies and preparation of the stock input files.

During the assessment of the vehicle database, several issues were identified, including inconsistencies in category allocation, implausible vehicle characteristics and incomplete technology information. These issues were reviewed and corrected where possible before the data were used in the model.

A particular issue concerned records that were not plausible from a technical perspective, such as heavy-duty vehicles classified as gasoline vehicles or unrealistic weight and payload entries. In addition, for the period 1990–2004, the number of vehicles in the bus category in the Statistical Yearbooks was found to be approximately 2.5 times higher than in the Ministry of Interior database for the overlapping year (2005), because the statistics include light duty vehicles carrying passengers as buses. These vehicles were reclassified to the LDV category in accordance with COPERT vehicle

definitions. Such records were checked and corrected using expert judgement and consistency rules before finalizing the COPERT inputs.

Uncertainty also remains in the estimation of annual mileage, especially for the historical period and for categories with limited direct activity information. However, the final mileage used in the model was constrained through the fuel balance procedure, which improves consistency with national fuel consumption statistics.

The activity data uncertainty is estimated at 10 % (rating C, cf. chapter 1.7). The emission factor uncertainty is estimated at 20 % for NO_x, NMVOC and PM_{2.5} (rating A), 40 % for SO₂ (rating B) and 125 % for NH₃ (rating C).

4.5.1.1.3. Source-specific QA/QC and verification

The road transport activity data was subject to QA/QC procedures. Fuel consumption data were checked against the national energy balance and compared across years. Incorrect fuel consumption values identified for 2000 and 2019 in the previously reported NFR tables were corrected. Fleet data, technology allocation and mileage assumptions were reviewed for plausibility and time series consistency.

The revised calculations were verified by comparing modelled fuel consumption with the statistical fuel consumption reported in the energy balance and by checking the consistency of the results across NFR categories. Additional checks were carried out on the emission outputs after updating the COPERT inputs and emission factors.

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

A recalculation has been carried out for this category. The previously reported estimates were based on a combination of Tier 1 calculations for 1990–2004 and two separate COPERT 5.5 databases for the period 2005–2024. These have been replaced by a single unified COPERT 5.8.1 database covering the recalculated period 1990–2024. The recalculation affects both activity data and emissions and improves the consistency and completeness of the reported series. For the activity data, a small difference was observed for the years 1990–1999 compared with the previous submission. For 2000 and 2019, the difference is larger due to incorrect reporting of fuel consumption in the previously submitted NFR tables. The fuel consumption for the series 2005–2024 now corresponds to the fuel consumption published in the official energy balances. The revised NO_x and NMVOC emissions for 1990–2004 are lower than previously reported, due to the use of the COPERT Tier 3 model instead of the Tier 1 method. The revised NO_x and NMVOC emissions for 2005–2024 are also lower, due to the use of the latest version of the COPERT model (5.8.1) in which the emission factors for NO_x and NMVOC have been revised. For particulate matter, emissions of PM_{2.5}, PM₁₀ and TSP for the period 1990–2000 were previously calculated only for tire and brake wear (1.A.3.b.vi) and road surface wear (1.A.3.b.vii). In the revised calculation, emissions are now calculated for all road transport subcategories (1.A.3.b.i to 1.A.3.b.iv) and recalculated for 1.A.3.b.vi and 1.A.3.b.vii. BC emissions were not estimated for the period 1990–2004 in the previous submission and are now included. For the period 2005–2024, PM and BC emissions are higher due to the revised emission factors in COPERT 5.8.1. The revised CO emissions for 1990–2004 are higher than previously reported, due to the use of the COPERT model instead of the Tier 1 method. The revised CO emissions for 2005–2024 are in line with previously reported values because no new CO emission factors were introduced between

COPERT 5.5 and 5.8.1. For heavy metals, Hg and As emissions were not estimated for the period 1990–2005 in the previous submission and are now included. Pb emissions for 1996–2004 were overestimated in the previous submission due to the Tier 1 calculation method. Zn emissions are higher due to revised emission factors in COPERT 5.8.1. A further recalculation covering the period 2023–2025 is planned for 2026 under the ongoing EU4Green project in order to integrate the 2024 and 2025 updates and address the remaining data and methodological gaps.

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

Further improvements are planned for road transport, with the following priorities: (1) Use the vehicle stock data from the Ministry of Interior vehicle database for the period 2000–2024. This remains a high priority improvement because the latest years are used for projection purposes and need to be determined as precisely as possible. (2) Compare the statistical data on buses and heavy-duty vehicles with the Ministry of Interior database for the period 2000–2003 and, if differences exist, revise the historical fleet data accordingly. (3) In 2026, carry out a recalculation for the period 2023–2025 under the ongoing EU4Green project, to integrate the 2024 and 2025 updates and resolve the remaining data and methodological gaps in the road transport time series.

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 calculations.

4.5.1.2.1. Methodological issues

For the revised inventory, evaporative emissions are estimated using COPERT 5.8.1 for the full period 1990–2024. This replaces the earlier split approach in which Tier 1 was used for 1990–2004 and COPERT for later years.

In COPERT, evaporate emissions are estimated as part of the overall road transport methodology using detailed information on vehicle stock, technology structure, ambient temperature and gasoline vehicle activity.

$E_{\text{evap}} = f(\text{vehicle stock, gasoline technology, temperature, trip characteristics})$

Where:

E_{evap} = evaporative NMVOC emissions from gasoline vehicles;

vehicle stock = number of gasoline vehicles by category and technology;

temperature = monthly minimum and maximum temperature conditions affecting evaporation;

trip characteristics = parameters influencing hot soak, diurnal and running losses, as represented in COPERT.

The use of a single COPERT-based methodology for the whole series improves consistency, completeness and comparability of the evaporative emission estimates.

Activity Data

Vehicle numbers for passenger cars, light-duty vehicles and two-wheel vehicles are based on the same stock datasets used for the road transport inventory. For 1990–2004, the historical vehicle stock was reconstructed from official statistics and distributed by technology in a form consistent with COPERT; for 2005–2018, the Ministry of Interior vehicle database processed in COPERT was used; and for 2019–2024 total vehicle numbers from the State Statistical Office were combined with the technology structure derived from year-of-production information and the Guidebook implementation years of the European emission standards. These inputs were combined with the meteorological and fuel data required by the model, including monthly temperature and humidity data and the gasoline-related parameters used by COPERT for evaporation calculations. The vehicle numbers used as input for the evaporative emission calculation for the historical period are shown in Table 52.

Table 52 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 | 190944 | 2438 | 1868 |
| 1991 | 206567 | 2582 | 1827 |
| 1992 | 231559 | 3026 | 2745 |
| 1993 | 239931 | 3152 | 3003 |
| 1994 | 217757 | 2723 | 1451 |
| 1995 | 233632 | 3022 | 2305 |
| 1996 | 229497 | 2985 | 2703 |
| 1997 | 231231 | 3045 | 3439 |
| 1998 | 229366 | 3086 | 3566 |
| 1999 | 228216 | 3078 | 3506 |
| 2000 | 233966 | 3184 | 3729 |
| 2001 | 240069 | 3331 | 4483 |
| 2002 | 236856 | 3109 | 2918 |
| 2003 | 229236 | 2947 | 2142 |
| 2004 | 183938 | 2158 | 3442 |

4.5.1.2.2. Source-specific uncertainties and time-series consistency

No separate quantitative uncertainty calculation has been developed specifically for evaporative emissions. The main uncertainties arise from the reconstruction of historical gasoline vehicle technologies and activity parameters for the early years of the time series.

4.5.1.2.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. Activity data were checked for plausibility and consistency with the broader road transport inventory, and the resulting emissions were checked against the exported COPERT outputs and NFR tables.

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

A recalculation has been carried out for this category through the implementation of COPERT 5.8.1 for the full period 1990–2023, replacing the earlier mixed approach and improving time series consistency.

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

Future improvements will focus on further refinement of the historical gasoline vehicle structure and on the continued use of updated fleet and meteorological data as these become available. In addition, the 2023–2025 period will be recalculated in 2026 including the integration of the 2024 update and the resolution of the remaining gaps relevant to this source category.

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 emissions of particulate matter and associated pollutants from road vehicle tire and brake wear (NFR 1.A.3.b.vi) and road surface wear (NFR 1.A.3.b.vii). These are non-exhaust emissions and are estimated separately from exhaust emissions from fuel combustion.

4.5.1.3.1. Methodological issues

For the revised inventory, non-exhaust emissions from tire and brake wear and road surface wear are estimated using COPERT 5.8.1 for the full period 1990–2024. This replaces the earlier approach in which Tier 1 was used for 1990–2004 and COPERT for later years.

COPERT estimates TSP, PM10 and PM2.5 from tire wear, brake wear and road abrasion using vehicle-category-specific activity data and technology-independent or process-specific functions integrated in the model.

$$E_i = \sum (vehicle\ activity_j \times EF_{i,j})$$

where:

E_i = total emissions of TSP, PM10 or PM2.5 for the defined period;

vehicle activity_j = annual mileage of vehicle category j;

$EF_{i,j}$ = emission factor for pollutant i and vehicle category j;

j = vehicle category represented in COPERT.

The categories considered include two-wheelers, passenger cars, light-duty vehicles, heavy-duty vehicles and buses.

The non-exhaust calculation is linked to the same annual mileage and fleet data used in the main road transport model, ensuring consistency between exhaust and non-exhaust activity data.

Passenger cars are represented as vehicles mainly used for carrying people, light-duty vehicles include vans and similar goods vehicles, and heavy-duty vehicles include trucks, coaches and buses.

The COPERT implementation also enables the estimation of BC and selected heavy metals from non-exhaust sources where these are represented in the model.

Applying COPERT across the full time series improves the consistency of the non-exhaust series and avoids the methodological break previously present between the historical and recent periods.

Activity Data

The activity data used for tire and brake wear and road abrasion are based on the same vehicle stock and annual mileage datasets used for the road transport fuel combustion calculations. For 1990–2004, vehicle numbers were reconstructed from official statistics, aligned with COPERT categories and combined with historical mileage assumptions derived from COPERT default values and expert judgement. For 2005–2024, detailed fleet data from the Ministry of Interior processed in COPERT were used. For earlier years with limited detail, additional assumptions were made to derive consistent activity by vehicle category, with the final mileage remaining consistent with the fuel-balance procedure applied in the main road transport calculation. The corresponding historical activity data used under the previous Tier 1 approach are shown in Table 53.

Table 53 Activity data for the source categories 1.A.3.b.vi - 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 | 4835274.834 | 1376284326 | 285036623 | 209717297.5 |
| 1991 | 4729085.241 | 1488871652 | 301837735.4 | 209717297.5 |
| 1992 | 7105231.549 | 1669036899 | 353952169.4 | 209717297.5 |
| 1993 | 7773080.677 | 1729357061 | 368587970.7 | 209717297.5 |
| 1994 | 3755910.313 | 1569553123 | 318315036.3 | 209717297.5 |
| 1995 | 5967733.309 | 1753415568 | 353507941.1 | 209717297.5 |
| 1996 | 6999413.721 | 1798765709 | 349185179.1 | 209717297.5 |
| 1997 | 8906346.852 | 1934667148 | 356091014.4 | 209717297.5 |
| 1998 | 9236266.671 | 2024125792 | 361007811.9 | 209717297.5 |
| 1999 | 9175265.098 | 2119742886 | 360029964.2 | 209717297.5 |
| 2000 | 9910003.825 | 2306669717 | 372350057.9 | 209717297.5 |
| 2001 | 12281827.12 | 2493797469 | 389700033.3 | 209717297.5 |
| 2002 | 8232449.668 | 2587501448 | 363546360.5 | 209717297.5 |
| 2003 | 6218090.091 | 2628976224 | 344504690.6 | 209717297.5 |
| 2004 | 10275435.96 | 2210896761 | 252348637.7 | 209717297.5 |

4.5.1.3.2. Source-specific uncertainties and time-series consistency

No separate quantitative uncertainty calculation has been performed specifically for this category. The main uncertainty is associated with historical vehicle activity and mileage estimates, particularly for the early years of the time series.

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

A recalculation has been carried out for this category by extending the COPERT 5.8.1 methodology to the entire period 1990–2024. This improves consistency of the non-exhaust emission series and ensures alignment with the revised road transport activity data.

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

Further improvement will focus on refining historical mileage and vehicle category data and on maintaining a single COPERT-based methodology across the whole time series. As more detailed traffic and fleet information becomes available, the non-exhaust estimates can be further improved. The 2023–2025 period will also be recalculated in 2026 under the ongoing EU4Green project, including the integration of the 2024 update and the resolution of the remaining gaps relevant to this source category.

Aviation

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

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

4.5.1.4.1. Methodological issues

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

Activity Data

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

Table 54 Activity data for source category 1.A.3.ai (i) - International aviation LTO civil (number of LTO)

| Year | Number of LTO | Year | Number of LTO | Year | Number of LTO |
|------|---------------|------|---------------|------|---------------|
| 1990 | 11 986 | 2002 | 12 767 | 2014 | 13 968 |
| 1991 | 11 297 | 2003 | 12 170 | 2015 | 15585 |
| 1992 | 10 539 | 2004 | 11 986 | 2016 | 16879 |
| 1993 | 14 581 | 2005 | 13 204 | 2017 | 18130 |
| 1994 | 14 351 | 2006 | 13 509 | 2018 | 19756 |
| 1995 | 14 305 | 2007 | 14 174 | 2019 | 21797 |
| 1996 | 12 307 | 2008 | 14 323 | 2020 | 9162 |
| 1997 | 11 067 | 2009 | 12 800 | 2021 | 14988 |
| 1998 | 13 249 | 2010 | 12 721 | 2022 | 19448 |
| 1999 | 24 156 | 2011 | 11 873 | 2023 | 23949 |
| 2000 | 23 168 | 2012 | 11 284 | 2024 | 25229 |
| 2001 | 11 664 | 2013 | 12 380 | | |

Emission factors

The calculation of emissions for emission parameters from 1990-2024 were used emission factors taken from GB 2013. The emission factors used are presented in Table 55.

Table 55 Emission factors for source category 1.A.3.ai (i) - International aviation LTO civil

| Pollutant | Value | Unit | References |
|-------------------|-------|--------|---|
| NO _x | 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)) |
| NM VOC | 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)) |
| SO _x | 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)) |
| PM _{2.5} | 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)) |

4.5.1.5. 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.

4.5.1.5.1. Methodological issues

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

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

Activity Data

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

Table 56 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 | 2002 | 46 844 | 2014 | 11 946 |
| 1991 | 19 461 | 2003 | 15 973 | 2015 | 13 371 |
| 1992 | 18 156 | 2004 | 8 882 | 2016 | 15 108 |
| 1993 | 25 118 | 2005 | 6 433 | 2017 | 19 810 |
| 1994 | 24 722 | 2006 | 4 670 | 2018 | 22 429 |
| 1995 | 24 643 | 2007 | 6 861 | 2019 | 26 473 |
| 1996 | 21 202 | 2008 | 6 121 | 2020 | 8637 |
| 1997 | 19 066 | 2009 | 2 772 | 2021 | 15 771 |
| 1998 | 22 824 | 2010 | 6 867 | 2022 | 25 913 |
| 1999 | 41 612 | 2011 | 3 652 | 2023 | 11 936 |
| 2000 | 28 266 | 2012 | 8 112 | 2024 | 7 248 |

| Year | Total fuel (t) | Year | Total fuel(t) | Year | Total fuel(t) |
|------|----------------|------|---------------|------|---------------|
| 2001 | 25 104 | 2013 | 10 144 | | |

Emission factors

Emission factors were taken from GB 2013 (Cruise (kg/t) — average fleet (B767)). These emission factors are given in Table 57 below.

Table 57 Emission factors for 1.A.3.ai(ii) - International aviation cruise (civil)

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

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

4.5.1.6.1. Methodological issues

The cruise fuel is calculated according to the following equation:

Cruise fuel = total fuel consumption — LTO fuel consumption

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

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

Activity Data

The activity data for calculation of total fuel consumption is taken from the Energy balance from the Statistical yearbooks 1990-1999[21], as well as from the publication Energy statistics 2000-2010[24]. Data on jet fuel and aviation gasoline consumption are available starting from 2005. For the period 1990-2004, surrogate methods have 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 62 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 58 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) |
|------|----------------------|------|----------------------|------|----------------------|
| 1990 | NO | 2002 | NO | 2014 | NO |
| 1991 | NO | 2003 | NO | 2015 | NO |
| 1992 | NO | 2004 | NO | 2016 | NO |
| 1993 | NO | 2005 | NO | 2017 | NO |
| 1994 | NO | 2006 | NO | 2018 | NO |
| 1995 | NO | 2007 | NO | 2019 | NO |
| 1996 | NO | 2008 | NO | 2020 | NO |
| 1997 | NO | 2009 | NO | 2021 | NO |
| 1998 | NO | 2010 | NO | 2022 | NO |

| Year | Fuel consumption (t) | Year | Fuel consumption (t) | Year | Fuel consumption (t) |
|------|----------------------|------|----------------------|------|----------------------|
| 1999 | NO | 2011 | NO | 2023 | NO |
| 2000 | NO | 2012 | NO | 2024 | NO |
| 2001 | NO | 2013 | NO | | |

Emission factors

Emission factors were taken from GB 2013 for all reporting period. These emission factors are given in Table 59 below.

Table 59 Emission factors for NFR - 1.A.3.iii (ii)

| Pollutant | Value | Unit | References |
|-------------------|-------|-----------|--|
| NO _x | 4 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |
| CO | 1200 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |
| NM VOC | 19 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |
| TSP | 0 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |
| PM ₁₀ | 0 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |
| PM _{2.5} | 0 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |
| SO ₂ | 1 | kg/t fuel | GB 2013 1.A.3.a. 1.A.5.b Aviation. Table 3-4. pg. 20 |

4.5.1.6.2. 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 NO_x, NM VOC and PM_{2.5} was estimated to be 40 % (rating B. cf. chapter 1.7) for SO₂ and was estimated to be 20% (rating A).

4.5.1.6.3. 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, Info sheet was inserted in the excel calculation files and data on fuel consumption were linked with energy balance. The consumption of kerosene in military has been deducted from consumption of kerosene in aviation in order not to report double consumption in two different NFR for the period 2015-2023 for which emissions in 1.A.5.b are estimated.

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

No recalculations were made in this category.

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

Check and change of used EF with EF from the GB 2013.

4.5.2. 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 frequent 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;

4.5.2.1. Methodology

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

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

where:

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

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

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

m = fuel type (diesel, gas oil);

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

Activity Data

The activity data for the diesel oil consumption for the period 1990, 1999-2022 was taken from the chapter Energy balance from the Statistical yearbooks for the related period. 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. Detailed set of activity data can be found on <https://www.ceip.at/status-of-reporting-and-review-results/2024-submission>

(North Macedonia).

For the period 1990–2019, data on the number of units and fuel consumption for locomotives and railcars separately were not available. Therefore, for the purpose of estimating the fuel consumption split between railcars and locomotives, the following definitions were applied:

- Line-haul locomotives – Long-distance, high-tonnage freight or intercity passenger trains, where power concentration and modularity are advantageous.
- Railcars (DMUs/EMUs) – Short-distance, high-frequency services, where quick acceleration, short dwell times, and operational flexibility are key.

According to these definitions, it was assumed that most of the domestic rail transport was carried out by railcars, while the majority of international rail freight transport was carried out by locomotives.

Data on national and international rail transport were extracted from Transport Statistics (<https://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/>).

For 2022, data on shares was available directly from the inventory. A QA/QC procedure was performed, and the difference between the original and assessed data was 2%, leading to the conclusion that the chosen assessment methodology is appropriate.

For the period 1990–2010, no statistical data were available, so it was assumed that the share corresponds to the average shares from the period 2011–2013.

Table 60 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 | 2002 | 2328 | 2014 | 2616 |
| 1991 | 5932 | 2003 | 2000 | 2015 | 1877 |
| 1992 | 3233 | 2004 | 2138 | 2016 | 2008 |
| 1993 | 1958 | 2005 | 2607 | 2017 | 2035 |
| 1994 | 1987 | 2006 | 3597 | 2018 | 2193 |
| 1995 | 1928 | 2007 | 3736 | 2019 | 2562 |
| 1996 | 3559 | 2008 | 3701 | 2020 | 1016 |
| 1997 | 4182 | 2009 | 3634 | 2021 | 1209 |
| 1998 | 4449 | 2010 | 3580 | 2022 | 1104 |
| 1999 | 3957 | 2011 | 3734 | 2023 | 794 |
| 2000 | 4212 | 2012 | 3169 | 2024 | 988 |
| 2001 | 3373 | 2013 | 2616 | | |

Table 61 Estimated shares for locomotives and rail cars for period 1990-2019

| Year | Locomotives | Railcars |
|-----------|-------------|---------------|
| 1990-2010 | 50.1% | 49.9% |
| 2011 | 50.1% | 49.9% |
| 2012 | 50.1% | 49.9% 50.3 |
| 2013 | 49.7% | 50.3% |
| 2014 | 50.3% | 49.7% |
| 2015 | 49.8% | 50.2% |
| 2016 | 49.6% | 50.4% |
| 2017 | 49.9% | 50.1% |
| 2018 | 50.1% | 49.9% |
| 2019 | 50.0% | 50.0% |

Table 62 Fuel consumption for period 1990-2019 by rail type and total fuel consumption

| Year | Fuel consumption t | | |
|------|--------------------|----------|-------|
| | Locomotives | Railcars | Total |
| 1990 | 3648 | 3652 | 7300 |
| 1991 | 2964 | 2968 | 5932 |
| 1992 | 1616 | 1617 | 3233 |
| 1993 | 978 | 979 | 1957 |
| 1994 | 993 | 994 | 1987 |
| 1995 | 963 | 964 | 1927 |
| 1996 | 1779 | 1781 | 3560 |
| 1997 | 2090 | 2092 | 4182 |
| 1998 | 2223 | 2226 | 4449 |
| 1999 | 1977 | 1979 | 3956 |
| 2000 | 2105 | 2107 | 4212 |
| 2001 | 1685 | 1687 | 3372 |
| 2002 | 1163 | 1165 | 2328 |
| 2003 | 999 | 1000 | 1999 |
| 2004 | 1068 | 1069 | 2137 |
| 2005 | 1303 | 1304 | 2607 |
| 2006 | 1797 | 1800 | 3597 |
| 2007 | 1867 | 1869 | 3736 |
| 2008 | 1849 | 1852 | 3701 |
| 2009 | 1816 | 1818 | 3634 |
| 2010 | 1789 | 1791 | 3580 |
| 2011 | 1872 | 1862 | 3734 |

| | | | |
|-------------|------|------|------|
| 2012 | 1587 | 1582 | 3169 |
| 2013 | 1257 | 1272 | 2529 |
| 2014 | 1310 | 1294 | 2604 |
| 2015 | 934 | 943 | 1877 |
| 2016 | 995 | 1013 | 2008 |
| 2017 | 991 | 993 | 1984 |
| 2018 | 1072 | 1066 | 2138 |
| 2019 | 1281 | 1280 | 2561 |

Table 63 Activity data for diesel fuel consumption in source category 1.A.3.c – Railways for 2020 – 2023 Tier 2

| Year | Category | Diesel fuel consumption [t] |
|-------------|-----------------------|------------------------------------|
| 2020 | Line-haul locomotives | 519 |
| | Rail cars | 497 |
| 2021 | Line-haul locomotives | 604 |
| | Rail cars | 605 |
| 2022 | Line-haul locomotives | 478 |
| | Rail cars | 626 |
| 2023 | Line-haul locomotives | 417 |
| | Rail cars | 377 |
| 2024 | Line-haul locomotives | 519 |
| | Rail cars | 469 |

Emission factors

Emission factors from GB 2023 are used in calculating the emissions for the period 1990-2023. Emission factors used are presented in Table 64 below.

Table 64 Emission factors for source category 1.A.3 - Railways

| Pollutant | Value | Unit | Tier | References |
|-------------------|--------------|-------------|-------------------------------|--|
| NO _x | 63 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| CO | 18 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| NM VOC | 4.8 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| NH ₃ | 10 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| TSP | 1.8 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| PM ₁₀ | 1.1 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| PM _{2.5} | 1.2 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |

| Pollutant | Value | Unit | Tier | References |
|-----------------------|-------|-----------|-------------------------------|---|
| Cd | 39.9 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| Cr | 10.8 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.10 |
| Cu | 4.7 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.10 |
| Ni | 10 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.10 |
| Se | 1 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.10 |
| Zn | 1.1 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.10 |
| Benzo(a)pyrene | 1.5 | kg/t fuel | Tier 2-Railcars | GB 2023, 1.A.3.c Railways, Table 3-2, pg.10 |
| Benzo(b)fluorant hene | 63 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |
| NOx | 18 | kg/t fuel | Tier 2 -Line haul locomotives | GB 2023, 1.A.3.c Railways, Table 3-2, pg.9 |

4.5.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for NO_x, NMVOC and PM_{2.5} was estimated to be 40% (rating B. cf. chapter 1.7), for NH₃ was estimated to be 125% (rating D).

4.5.2.3. 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, 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.

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

Under this improvement activity data stayed the same only was divided to Railcars and Locomotives.

The revised SO₂ emissions for the entire period remained unchanged, as the emission factor depends on the sulphur content in the fuel rather than on the type of locomotive. Regarding NO_x, the emission factors used in the Tier 2 methodology are very similar to those applied in the Tier 1 approach. For PM_{2.5}, PM₁₀, CO, and BC, the Tier 2 emission factors are lower than those used in the Tier 1 methodology, resulting in lower estimated emissions. Conversely, for NMVOC and TSP, the Tier 2 emission factors are higher than those applied in the Tier 1 approach, leading to higher estimated emissions under the Tier 2 methodology.

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

To improve the quality of the emission inventory, it is intended in future to make an effort to collect historical fuel consumption data disaggregated by locomotive type, going as far back as possible.

For the period 1990–2010, if fuel consumption data is not available, data on rail passenger transport by type of transport and by year should be obtained, as well as rail freight transport by type of transport and by year, in order to apply the methodology developed for the period 2011–2019.

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

Emissions from fuels used by vessels of all flags that depart and arrive in the same country (excludes fishing) includes small leisure boats. Republic of North Macedonia has three natural lakes, but only Ohrid Lake offers tourist boat transport. There were only six boats in 2023. Emissions from fuel consumption are calculated and presented below.

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

4.5.4. 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 65 Activity data for diesel consumption for source category 1.A.3.d.ii - National navigation - using diesel fuel oil 1990-2024

| Year | Diesel fuel consumption [t] | Year | Diesel fuel consumption [t] | Year | Diesel fuel consumption [t] |
|------|-----------------------------|------|-----------------------------|------|-----------------------------|
| 1990 | 87.93 | 2002 | 26.47 | 2014 | 50.43 |
| 1991 | 15.65 | 2003 | 12.93 | 2015 | 59.55 |
| 1992 | 10.96 | 2004 | 6.26 | 2016 | 61.11 |
| 1993 | 7.08 | 2005 | 19.06 | 2017 | 68.53 |
| 1994 | 10.00 | 2006 | 21.57 | 2018 | 73.63 |
| 1995 | 21.71 | 2007 | 72.34 | 2019 | 77.04 |
| 1996 | 8.71 | 2008 | 174.22 | 2020 | 25.59 |
| 1997 | 6.47 | 2009 | 164.28 | 2021 | 38.25 |
| 1998 | 25.52 | 2010 | 111.06 | 2022 | 60.09 |
| 1999 | 18.03 | 2011 | 57.85 | 2023 | 55.12 |
| 2000 | 21.85 | 2012 | 61.18 | 2024 | 56.83 |
| 2001 | 7.96 | 2013 | 41.38 | | |

Emission factors

For the calculation of emissions for emission parameters from 1990-2024 the used emission factors were taken from GB 2019 [19]. These emission factors are given in Table 66 below.

Table 66 Emission factors for source category 1.A.3.d.ii – National navigation

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

| Pollutant | Value | Unit | References |
|-----------|-------|------------|--|
| 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 67 National content of sulfur in diesel used for calculation of SO_x emissions 1.A.3.d.ii – 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 |
|-------------------|-------|------|--------------|

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

4.5.4.1. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis is done for this category.

4.5.4.2. 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.

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

No recalculations were made in this category

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

Change of emission factors with 2023 EMEP/EEA Guidebook.

4.5.5. 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.A.3biii and 1.A.3aii.

4.5.5.1. 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 2015-2024 are presented in the following table.

Table 68 Activity data for liquid fuel and aviation gasoline consumption for source category 1.A.5.b – Other, Mobile for 2015-2024

| Type of fuel [tons] | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---------------------|------|------|------|------|------|------|------|------|------|------|
| Liquefied fuels | 672 | 873 | 715 | 696 | 695 | 583 | 676 | 566 | 600 | 600 |
| Aviation gasoline | 22 | 166 | 364 | 284 | 460 | 310 | 372 | 459 | 479 | 479 |

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

Emission factors

See Table 59 for the EF used for aviation gasoline and for the diesel fuel Tier 1, Emission factors from Table 3-1 of GB 2023 has been used.

4.5.5.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis is done for this category.

4.5.5.3. Source-specific QA/QC and verification

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

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

No recalculations were made in this cycle.

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

Change of emission factors with 2023 EMEP/EEA Guidebook.

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

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

4.6.1. Methodological issues

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

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

where:

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

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

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

4.6.2. Source-specific uncertainties and time-series consistency

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

4.6.3. Source-specific QA/QC and verification

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

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

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

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

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

4.6.5.1. Methodological Issues

Activity data

Activity data for this sector has been taken from the Statistical yearbooks – chapter energy balance for the period 1990-2024. For the period 1990-1998, activity data were taken from the GHGs inventory.

Table 69 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 | 196 | NA | 2450 |
| 2005 | 209 | 193 | 120 | 5169 |
| 2006 | 351 | 178 | 112 | 4094 |
| 2007 | 334 | 207 | 103 | 3844 |
| 2008 | 436 | 27 | 95 | 2154 |
| 2009 | 610 | 16 | 77 | 3700 |
| 2010 | 528 | 20 | 79 | 3527 |
| 2011 | 220 | 4 | 83 | 1509 |

| Year | Biomass [TJ] | Coal [TJ] | Gaseous Fuels [TJ] | Liquid Fuels [TJ] |
|------|--------------|-----------|--------------------|-------------------|
| 2012 | 357 | 52 | 91 | 1821 |
| 2013 | 196 | 62 | 109 | 1780 |
| 2014 | 279 | 21 | 198 | 1558 |
| 2015 | 181 | 24 | 226 | 1896 |
| 2016 | 174 | 27 | 235 | 2046 |
| 2017 | 190 | 34 | 265 | 1831 |
| 2018 | 184 | 27 | 248 | 1645 |
| 2019 | 180 | 24 | 240 | 1591 |
| 2020 | 183 | 20 | 244 | 1255 |
| 2021 | 253 | 16 | 285 | 951 |
| 2022 | 246 | 9 | 190 | 808 |
| 2023 | 121 | 8 | 182 | 674 |
| 2024 | 167 | 6 | 212 | 664 |

Emission factors

Emission factors are taken from GB 2023. Emission factors for different type of fuels are presented in tables 70-73.

Table 70 Emission factors for biomass for source category 1.A.4.ai - Commercial/Institutional – stationary combustion

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

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

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

| Pollutant | Value | Unit | References |
|-------------------------|-------|-------------|--|
| NOx | 173 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| NMVOC | 88.8 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| SOx | 840 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| PM2.5 | 108 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| PM10 | 117 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| BC | 6.4 | %PM2.5 | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| TSP | 124 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| CO | 931 | g/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Pb | 134 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Cd | 1.8 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Hg | 7.9 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| As | 4 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Cr | 13.5 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Cu | 17.5 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Ni | 13 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Se | 1.8 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Zn | 200 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| PCB | 170 | µg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| PCDD/PCDF | 203 | ng I-TEQ/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| benzo(a) pyren | 45.5 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| benzo(b) fluoranthene | 58.9 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| benzo(k) fluoranthene | 23.7 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| Indeno (1.2.3-cd) pyren | 18.5 | mg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |
| HCB | 0.6 | µg/GJ | GB 2023 Table 3-7 emission factor for source category 1.A.4.a.i. page 36 |

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

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

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

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

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

4.6.5.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO₂ was estimated to be 20% (rating A. cf. chapter 1.7), for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} (125% rating C).

4.6.5.3. Source-specific QA/QC and verification

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

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

Recalculations were done for 2023 emissions within the category 1.A.4.ai due to use of final consumption data for this year only for biomass and liquid fuel.

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

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

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

Within the Commercial/Institutional sector, liquid fuel- diesel is used. The NFR sector is for the first time introduced in the inventory due to available activity data for the period 2011-2024. For the previous years the emissions were noted as IE in 1.A.4.ai, as it was recommended by previous stage 3 review.

4.6.6.1. Methodological Issues

Activity data

Activity data for this sector has been taken from the MAKSTAT database; activity data were available only for the period 2011-2024.

Table 74 Activity data for the source category 1.A.4.iii Commercial/Institutional: Mobile

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

| Year | Diesel [TJ] |
|------|-------------|
| 2023 | 815 |
| 2024 | 870 |

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

Table 75 Emission factors for and ratio of leaded to unleaded gasoline for the period 1990 – 2024

| Lead content | Gasoline Leaded | Gasoline Unleaded | Gasoline Leaded | Gasoline Unleaded | Gasoline Leaded | Gasoline Unleaded | Residential | Gasoline Leaded | Gasoline Unleaded |
|--------------|-----------------|-------------------|-----------------|-------------------|-----------------|-------------------|-------------|-----------------|-------------------|
| Unit | g/L = kg/t | g/L = kg/t | Share | Share | g/GJ | g/GJ | GJ | GJ | GJ |
| 1990 | 0,60 | 0,02 | 0,95 | 0,05 | 13,65 | 0,45 | 107309,78 | 101944,29 | 5365,489 |
| 1991 | 0,60 | 0,02 | 0,89 | 0,11 | 13,65 | 0,45 | 58292,816 | 51917,04 | 6375,777 |
| 1992 | 0,60 | 0,02 | 0,83 | 0,17 | 13,65 | 0,45 | 39960,913 | 33217,509 | 6743,404 |
| 1993 | 0,60 | 0,02 | 0,77 | 0,23 | 13,65 | 0,45 | 45983,624 | 35493,61 | 10490,01 |
| 1994 | 0,60 | 0,02 | 0,71 | 0,29 | 13,65 | 0,45 | 37015,499 | 26373,543 | 10641,96 |
| 1995 | 0,60 | 0,02 | 0,65 | 0,35 | 13,65 | 0,45 | 33938,201 | 22165,887 | 11772,31 |
| 1996 | 0,5 | 0,013 | 0,59 | 0,41 | 11,37 | 0,30 | 38861,878 | 23074,24 | 15787,64 |
| 1997 | 0,5 | 0,013 | 0,53 | 0,47 | 11,37 | 0,30 | 49676,382 | 26545,817 | 23130,57 |
| 1998 | 0,5 | 0,013 | 0,48 | 0,53 | 11,37 | 0,30 | 12924,652 | 6139,2095 | 6785,442 |
| 1999 | 0,5 | 0,013 | 0,42 | 0,58 | 11,37 | 0,30 | 30421,289 | 12643,848 | 17777,44 |
| 2000 | 0,5 | 0,013 | 0,36 | 0,64 | 11,37 | 0,30 | 43299,179 | 15425,332 | 27873,85 |
| 2001 | 0,5 | 0,013 | 0,30 | 0,70 | 11,37 | 0,30 | 35744,206 | 10611,561 | 25132,64 |
| 2002 | 0,3 | 0,013 | 0,24 | 0,76 | 6,82 | 0,30 | 19879,806 | 4721,4538 | 15158,35 |
| 2003 | 0,15 | 0,005 | 0,18 | 0,82 | 3,41 | 0,11 | 15903,01 | 2832,7236 | 13070,29 |
| 2004 | 0,15 | 0,005 | 0,12 | 0,88 | 3,41 | 0,11 | 52514,368 | 6236,0812 | 46278,29 |
| 2005 | 0,15 | 0,005 | 0,06 | 0,94 | 3,41 | 0,11 | 16462,841 | 977,48118 | 15485,36 |
| 2006 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 25983,385 | 0 | 25983,39 |
| 2007 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 14287,455 | 0 | 14287,46 |
| 2008 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 14199,532 | 0 | 14199,53 |
| 2009 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 14771,03 | 0 | 14771,03 |
| 2010 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 15430,451 | 0 | 15430,45 |
| 2011 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17320,792 | 0 | 17320,79 |
| 2012 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 16661,371 | 0 | 16661,37 |
| 2013 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 16177,795 | 0 | 16177,8 |
| 2014 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 16309,679 | 0 | 16309,68 |
| 2015 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17125,163 | 0 | 17125,16 |
| 2016 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17467,667 | 0 | 17467,67 |
| 2017 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17352,4 | 0 | 17352,4 |
| 2018 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17352,4 | 0 | 17352,4 |
| 2019 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17672,395 | 0 | 17672,39 |
| 2020 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 17318,929 | 0 | 17318,93 |

| Lead content | Gasoline Leaded | Gasoline Unleaded | Gasoline Leaded | Gasoline Unleaded | Gasoline Leaded | Gasoline Unleaded | Residential | Gasoline Leaded | Gasoline Unleaded |
|--------------|-----------------|-------------------|-----------------|-------------------|-----------------|-------------------|-------------|-----------------|-------------------|
| Unit | g/L = kg/t | g/L = kg/t | Share | Share | g/GJ | g/GJ | GJ | GJ | GJ |
| 2021 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 18233,184 | 0 | 18233,18 |
| 2022 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 18286,404 | 0 | 18286,4 |
| 2023 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 18286,404 | 0 | 18286,4 |
| 2024 | 0,15 | 0,005 | 0,0000 | 1,0000 | 3,41 | 0,11 | 18286,404 | 0 | 18286,4 |

4.6.6.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was calculated for this sector.

4.6.6.3. Source-specific QA/QC and verification

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

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

Recalculations were made for 2023 emissions within the category 1.A.4.ai due to use of final consumption data for this year.

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

No planned activities for this category.

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

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

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

The following table presents energy consumption of households in 2014.

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

| Type of energy | Consumption | Number of households using the type of energy |
|--|-----------------|---|
| Electricity | 3 118 365 (MWh) | 559 187 |
| Fuel wood | 1 328 979 (m3) | 345 658 |
| Wood of fruit trees and other plant residues | 32 243 (m3) | 27 242 |
| Wood residues. wood briquettes and pellets | 19 404 (t) | 8 078 |
| Coal | 4 462 (t) | 2 555 |
| LPG | 5 585 (t) | 87 739 |
| Natural gas | 49 460 (Nm3) | N/A |
| Heating oil | 4 822 (m3) | 3 633 |
| Derived heat | 327 082 (MWh) | 46 590 |

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

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

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

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

| Sector/Year | DOM_FPLACE | DOM_SHB_M | DOM_STOVE_H | Advanced / ecolabelled stoves and boilers | High-efficiency stoves | Pellets-since 2012* | TOTAL |
|-------------|------------|-----------|-------------|---|------------------------|---------------------|-------|
| 1990 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1991 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1992 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1993 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1994 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1995 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1996 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1997 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1998 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 1999 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2000 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2001 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2002 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2003 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2004 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2005 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2006 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2007 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2008 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2009 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2010 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2011 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2012 | 3% | 2% | 95% | 0% | 0% | 0% | 100% |
| 2013 | 3% | 2% | 94% | 0% | 0% | 1% | 100% |
| 2014 | 3% | 2% | 94% | 0% | 0% | 1% | 100% |
| 2015 | 3% | 2% | 93% | 0% | 0% | 1% | 100% |

| Sector/Year | DOM_FPLACE | DOM_SHB_M | DOM_STOVE_H | Advanced / ecolabelled stoves and boilers | High- efficiency stoves | Pellets- since 2012* | TOTAL |
|-------------|------------|-----------|-------------|--|-------------------------------|----------------------------|-------|
| 2016 | 3% | 2% | 93% | 0% | 0% | 2% | 100% |
| 2017 | 3% | 2% | 92% | 1% | 0% | 2% | 100% |
| 2018 | 3% | 2% | 91% | 1% | 0% | 2% | 100% |
| 2019 | 3% | 2% | 90% | 2% | 0% | 3% | 100% |
| 2020 | 3% | 2% | 90% | 2% | 0% | 3% | 100% |
| 2021 | 3% | 2% | 89% | 2% | 0% | 3% | 100% |
| 2022 | 3% | 2% | 88% | 3% | 1% | 3% | 100% |
| 2023 | 3% | 2% | 87% | 4% | 1% | 3% | 100% |
| 2024 | 3% | 2% | 87% | 4% | 1% | 3% | 100% |

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

Simplification 1: there is three solid fuels in MK:

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

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

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

| | DOM_SHB_M_Brown coal | DOM_STOVE_H_Brown coal | DOM_SHB_M_Derived coal | DOM_STOVE_H_Derived coal |
|------|-------------------------|------------------------|---------------------------|--------------------------|
| 1990 | 50% | 50% | 50% | 50% |
| 1991 | 50% | 50% | 50% | 50% |
| 1992 | 50% | 50% | 50% | 50% |
| 1993 | 50% | 50% | 50% | 50% |
| 1994 | 50% | 50% | 50% | 50% |
| 1995 | 50% | 50% | 50% | 50% |
| 1996 | 50% | 50% | 50% | 50% |
| 1997 | 50% | 50% | 50% | 50% |
| 1998 | 50% | 50% | 50% | 50% |
| 1999 | 50% | 50% | 50% | 50% |
| 2000 | 50% | 50% | 50% | 50% |
| 2001 | 50% | 50% | 50% | 50% |
| 2002 | 50% | 50% | 50% | 50% |
| 2003 | 50% | 50% | 50% | 50% |
| 2004 | 50% | 50% | 50% | 50% |
| 2005 | 50% | 50% | 50% | 50% |

| | | | | |
|-------------|-----|-----|-----|-----|
| 2006 | 51% | 49% | 50% | 50% |
| 2007 | 52% | 48% | 50% | 50% |
| 2008 | 53% | 47% | 50% | 50% |
| 2009 | 54% | 46% | 50% | 50% |
| 2010 | 55% | 45% | 50% | 50% |
| 2011 | 56% | 44% | 50% | 50% |
| 2012 | 57% | 43% | 50% | 50% |
| 2013 | 58% | 42% | 50% | 50% |
| 2014 | 59% | 41% | 50% | 50% |
| 2015 | 60% | 40% | 50% | 50% |
| 2016 | 60% | 40% | 50% | 50% |
| 2017 | 60% | 40% | 50% | 50% |
| 2018 | 60% | 40% | 50% | 50% |
| 2019 | 60% | 40% | 50% | 50% |
| 2020 | 60% | 40% | 50% | 50% |
| 2021 | 60% | 40% | 55% | 45% |
| 2022 | 60% | 40% | 60% | 40% |
| 2023 | 60% | 40% | 65% | 35% |
| 2024 | 60% | 40% | 65% | 35% |

4.6.7.1. Methodological Issues

Activity data

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

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

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

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

| Technology (TJ) / year | DOM_FPLACE | DOM_SHB_M | DOM_STOVE_H | Advanced / ecolabelled stoves and boilers | High-efficiency stoves | Pellets - since 2014* |
|------------------------|------------|-----------|-------------|---|------------------------|-----------------------|
| 1990 | 280 | 206 | 8862 | 0 | 0 | 0 |
| 1991 | 243 | 178 | 7671 | 0 | 0 | 0 |
| 1992 | 265 | 195 | 8384 | 0 | 0 | 0 |
| 1993 | 297 | 218 | 9400 | 0 | 0 | 0 |
| 1994 | 284 | 208 | 8980 | 0 | 0 | 0 |
| 1995 | 284 | 208 | 8980 | 0 | 0 | 0 |
| 1996 | 284 | 208 | 8980 | 0 | 0 | 0 |
| 1997 | 284 | 208 | 8980 | 0 | 0 | 0 |
| 1998 | 271 | 199 | 8559 | 0 | 0 | 0 |
| 1999 | 284 | 208 | 8982 | 0 | 0 | 0 |
| 2000 | 338 | 248 | 10670 | 0 | 0 | 0 |
| 2001 | 263 | 193 | 8300 | 0 | 0 | 0 |
| 2002 | 260 | 191 | 8212 | 0 | 0 | 0 |
| 2003 | 289 | 212 | 9143 | 0 | 0 | 0 |
| 2004 | 289 | 212 | 9118 | 0 | 0 | 0 |
| 2005 | 259 | 190 | 8198 | 0 | 0 | 0 |
| 2006 | 259 | 190 | 8169 | 0 | 0 | 0 |
| 2007 | 242 | 177 | 7636 | 0 | 0 | 0 |
| 2008 | 242 | 177 | 7636 | 0 | 0 | 0 |
| 2009 | 242 | 178 | 7649 | 0 | 0 | 0 |
| 2010 | 238 | 175 | 7532 | 0 | 0 | 0 |
| 2011 | 260 | 191 | 8214 | 0 | 0 | 0 |
| 2012 | 282 | 207 | 8898 | 0 | 0 | 28 |
| 2013 | 278 | 204 | 8722 | 0 | 0 | 59 |

| Technology (TJ) / year | DOM_FPLACE | DOM_SHB_M | DOM_STOVE_H | Advanced / ecolabelled stoves and boilers | High-efficiency stoves | Pellets - since 2014* |
|------------------------|------------|-----------|-------------|---|------------------------|-----------------------|
| 2014 | 291 | 213 | 9096 | 0 | 0 | 95 |
| 2015 | 280 | 205 | 8710 | 9 | 9 | 123 |
| 2016 | 236 | 173 | 7278 | 36 | 9 | 130 |
| 2017 | 270 | 198 | 8272 | 75 | 13 | 179 |
| 2018 | 225 | 165 | 6846 | 90 | 12 | 175 |
| 2019 | 233 | 171 | 7016 | 121 | 14 | 207 |
| 2020 | 242 | 177 | 7224 | 155 | 16 | 242 |
| 2021 | 245 | 179 | 7247 | 203 | 29 | 253 |
| 2022 | 237 | 174 | 6956 | 242 | 40 | 253 |
| 2023 | 221 | 162 | 6416 | 268 | 48 | 243 |
| 2024 | 202 | 148 | 5807 | 283 | 54 | 229 |

Table 80 Activity data for source category 1.A.4.bi - Residential: Stationary-liquid, gas and coal fuels

| Fuel | Coal | Coal | Total coal | Liquid | Gas |
|------------------------|-----------|-------------|------------|--------|-----|
| Technology (TJ) / year | DOM_SHB_M | DOM_STOVE_H | sum | | |
| 1990 | 93 | 93 | 186 | 397 | NA |
| 1991 | 166 | 166 | 333 | 863 | NA |
| 1992 | 162 | 162 | 323 | 921 | NA |
| 1993 | 157 | 157 | 313 | 980 | NA |
| 1994 | 152 | 152 | 304 | 1038 | NA |
| 1995 | 147 | 147 | 294 | 1097 | NA |
| 1996 | 142 | 142 | 284 | 1156 | NA |
| 1997 | 137 | 137 | 275 | 1214 | NA |
| 1998 | 107 | 107 | 213 | 1225 | NA |
| 1999 | 138 | 138 | 276 | 1316 | NA |
| 2000 | 118 | 118 | 235 | 1394 | NA |
| 2001 | 88 | 88 | 177 | 1435 | NA |
| 2002 | 113 | 113 | 227 | 1513 | NA |
| 2003 | 114 | 114 | 228 | 1577 | NA |
| 2004 | 124 | 124 | 248 | 1657 | NA |
| 2005 | 81 | 81 | 161 | 1687 | NA |
| 2006 | 59 | 56 | 115 | 1757 | NA |
| 2007 | 59 | 55 | 114 | 1890 | NA |
| 2008 | 38 | 34 | 72 | 1812 | NA |
| 2009 | 25 | 22 | 47 | 1895 | NA |
| 2010 | 29 | 24 | 53 | 1852 | NA |
| 2011 | 21 | 17 | 38 | 1896 | NA |
| 2012 | 23 | 17 | 40 | 1172 | NA |
| 2013 | 22 | 16 | 39 | 535 | 0 |
| 2014 | 16 | 11 | 27 | 431 | 2 |
| 2015 | 14 | 10 | 24 | 464 | 3 |

| Fuel | Coal | Coal | Total coal | Liquid | Gas |
|------------------------|-----------|-------------|------------|--------|-----|
| Technology (TJ) / year | DOM_SHB_M | DOM_STOVE_H | sum | | |
| 2016 | 15 | 10 | 25 | 476 | 4 |
| 2017 | 15 | 10 | 25 | 490 | 6 |
| 2018 | 12 | 8 | 19 | 456 | 8 |
| 2019 | 11 | 7 | 18 | 354 | 8 |
| 2020 | 10 | 7 | 17 | 354 | 10 |
| 2021 | 10 | 7 | 17 | 364 | 12 |
| 2022 | 3 | 2 | 5 | 316 | 6 |
| 2023 | 3 | 2 | 5 | 294 | 5 |
| 2024 | 3 | 2 | 5 | 221 | 8 |

Emission factors

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

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

| Pollutant | DOM_FPLACE | DOM_SHV_M_Biomass | DOM_STOVE_H_Biomass | Advanced eco labeled | High efficient stoves | Pellets | Unit |
|----------------|------------|-------------------|---------------------|----------------------|-----------------------|---------|-------------|
| NOx | 50 | 80 | 50 | 95 | 80 | 80 | g/GJ |
| NMVOC | 600 | 350 | 600 | 250 | 350 | 10 | g/GJ |
| SOx | 11 | 11 | 11 | 11 | 11 | 11 | g/GJ |
| NH3 | 8 | 8 | 8 | 4 | 8 | 1 | |
| PM2.5 | 820 | 470 | 740 | 93 | 370 | 60 | g/GJ |
| BC | 840 | 480 | 760 | 95 | 380 | 60 | % PM2.5 |
| PM10 | 880 | 500 | 800 | 100 | 400 | 62 | g/GJ |
| TSP | 7 | 16 | 10 | 28 | 16 | 15 | g/GJ |
| CO | 4000 | 4000 | 4000 | 2000 | 4000 | 300 | g/GJ |
| Pb | 27 | 27 | 27 | 27 | 27 | 27 | mg/GJ |
| Cd | 13 | 13 | 13 | 13 | 13 | 13 | mg/GJ |
| Hg | 0,56 | 0,56 | 0,56 | 0,56 | 0,56 | 0,56 | mg/GJ |
| As | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | mg/GJ |
| Cr | 23 | 23 | 23 | 23 | 23 | 23 | mg/GJ |
| Cu | 6 | 6 | 6 | 6 | 6 | 6 | mg/GJ |
| Ni | 2 | 2 | 2 | 2 | 2 | 2 | mg/GJ |
| Se | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | mg/GJ |
| Zn | 512 | 512 | 512 | 512 | 512 | 512 | mg/GJ |
| PCDD/ PCDF | 800 | 550 | 800 | 100 | 250 | 100 | ng I-TEQ/GJ |
| benzo(a) pyren | 121 | 121 | 121 | 10 | 121 | 10 | µg/GJ |

| Pollutant | DOM_FPLACE | DOM_SHV_M_Biomass | DOM_STOVE_H_Biomass | Advanced eco labeled | High efficient stoves | Pellets | Unit |
|-------------------------|------------|-------------------|---------------------|----------------------|-----------------------|---------|------|
| benzo(b) fluoranthene | 111 | 111 | 111 | 16 | 111 | 16 | g/GJ |
| benzo(k) fluoranthene | 42 | 42 | 42 | 5 | 42 | 5 | g/GJ |
| Indeno (1.2.3-cd) pyren | 71 | 71 | 71 | 4 | 71 | 4 | g/GJ |
| HCB | 5 | 5 | 5 | 5 | 5 | 5 | kg |
| PCB | 0.06 | 0.06 | 0.06 | 0,007 | 0.03 | 0,01 | kg |

Table 82 Emission factors for coal, for source category 1.A.4.bi - Residential: Stationary

| Pollutant | DOM_STOVE_H_Coal | DOM_SHB_M_Coal | Unit | References |
|-----------|------------------|----------------|---------|--|
| NOx | 100 | 158 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| NMVOC | 600 | 174 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| SOx | 900 | 900 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| PM2.5 | 450 | 201 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| BC | 6.4 | 225 | % PM2.5 | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| PM10 | 450 | 261 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| TSP | 500 | 6,4 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| CO | 5000 | 4787 | g/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Pb | 100 | 200 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Cd | 1 | 3 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Hg | 5 | 6 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| As | 1.5 | 5 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Cr | 10 | 15 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Cu | 20 | 30 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Ni | 10 | 20 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Se | 2 | 2 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Zn | 200 | 300 | mg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |

| Pollutant | DOM_STOVE_H_Coal | DOM_SHB_M_Coal | Unit | References |
|-------------------------|------------------|----------------|-------------|--|
| PCDD/ PCDF | 1000 | 500 | ng I-TEQ/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| benzo(a) pyren | 250 | 270 | µg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| benzo(b) fluoranthene | 400 | 250 | µg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| benzo(k) fluoranthene | 150 | 100 | µg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| Indeno (1.2.3-cd) pyren | 120 | 90 | µg/GJ | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| HCB | 0.62 | 0.62 | kg | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |
| PCB | 170 | 170 | kg | GB 2023. Table 3-4 emission factor for source category. 1.A.4.b.i. page 33 |

Table 83 Emission factors for natural gas for source category 1.A.4.bi - Residential: Stationary

| Pollutant | Value | Unit | References |
|-----------|----------|---------|--|
| NOx | 51 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| NMVOC | 1.9 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| SOx | 0.3 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| PM2.5 | 1.2 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| BC | 5.4 | % PM2.5 | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| PM10 | 1.2 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| TSP | 1.2 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| CO | 26 | g/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Pb | 0.0015 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Cd | 0.00025 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Hg | 0.1 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| As | 0.033 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Cr | 0.00076 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Cu | 0.000076 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |

| Pollutant | Value | Unit | References |
|-------------------------|---------|-------------|--|
| Ni | 0.00051 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Se | 0.011 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Zn | 0.0015 | mg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| PCDD/ PCDF | 0 | ng I-TEQ/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| benzo(a) pyren | 0 | µg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| benzo(b) fluoranthene | 0 | µg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| benzo(k) fluoranthene | 0 | µg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |
| Indeno (1.2.3-cd) pyren | 0 | µg/GJ | GB 2023, Table 3-4 emission factor for source category, 1.A.4.b.i, page 33 |

Table 84 Emission factors for liquid fuels for source category 1.A.4.bi - Residential: Stationary

| Pollutant | Value | Unit | References |
|-----------|-------|---------|--|
| NOx | 51 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| NMVOC | 0.69 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| SOx | 70 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| PM2.5 | 1.9 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| BC | 8.5 | % PM2.5 | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| PM10 | 1.9 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| TSP | 1.9 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| CO | 57 | g/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Pb | 0.012 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Cd | 0.001 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Hg | 0.12 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| As | 0.002 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Cr | 0.2 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Cu | 0.13 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |

| Pollutant | Value | Unit | References |
|-------------------------|-------|-------------|--|
| Ni | 0.005 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Se | 0.002 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Zn | 0.42 | mg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| PCDD/PCDF | 5.9 | ng I-TEQ/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| benzo(a) pyren | 80 | µg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| benzo(b) fluoranthene | 40 | µg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| benzo(k) fluoranthene | 70 | µg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |
| Indeno (1.2.3-cd) pyren | 160 | µg/GJ | GB 2023, Table 3-5 emission factor for source category, 1.A.4.b.i, page 34 |

4.6.7.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO₂ was estimated to be 20% (rating A. cf. chapter 1.7). for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} and NH₃ (125% rating C).

4.6.7.3. Source-specific QA/QC and verification

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

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

No recalculations were made in this category.

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

No planned improvements.

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

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

The species for which it is the more important are SO₂, NO_x, CO₂, PM, CO and non-methane volatile organic compounds (NMVOCs). The emissions of CO₂ and SO₂ are predominantly fuel-based and independent of engine technology/type of equipment.

4.6.8.1. Methodological Issues

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

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

Where:

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

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

Table 85 Activity data for source category 1.A.4.bii - Residential: Household and gardening (mobile)

| Year | Gasoline consumption [TJ] | Year | Gasoline consumption [TJ] |
|-------------|----------------------------------|-------------|----------------------------------|
| 1990 | 107.31 | 2008 | 14.20 |
| 1991 | 58.29 | 2009 | 14.77 |
| 1992 | 39.96 | 2010 | 15.43 |
| 1993 | 45.98 | 2011 | 17.32 |
| 1994 | 37.02 | 2012 | 16.66 |
| 1995 | 33.94 | 2013 | 16.18 |
| 1996 | 38.86 | 2014 | 16.31 |
| 1997 | 49.68 | 2015 | 17.13 |
| 1998 | 12.92 | 2016 | 17.47 |
| 1999 | 30.42 | 2017 | 17.35 |
| 2000 | 43.30 | 2018 | 17.35 |
| 2001 | 35.74 | 2019 | 17.67 |
| 2002 | 19.88 | 2020 | 17.32 |
| 2003 | 15.90 | 2021 | 18.23 |
| 2004 | 52.51 | 2022 | 18.29 |
| 2005 | 16.46 | 2023 | 17.92 |
| 2006 | 25.98 | 2024 | 18.25 |
| 2007 | 14.29 | | |

Emission factors

Emission factors for the basic pollutants and HM and POPs are presented in Table 48 and 49 respectively. Share of leaded and unleaded petrol is presented in table 75.

4.6.8.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was done for this sector.

4.6.8.3. Source-specific QA/QC and verification

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

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

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

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

No planned activities in this category.

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

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

4.6.9.1. Methodological Issues

Activity data

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

Table 86 Activity data for source category 1.A.4.ci - Agriculture/Forestry/Fishing: Stationary

| Year | Gaseous fuel [TJ] | Lignite [TJ] | Liquid Fuels [TJ] | Biomass [TJ] |
|------|-------------------|--------------|-------------------|--------------|
| 1990 | NA | 32.782 | 1302 | NA |
| 1991 | NA | 33.415 | 1545 | NA |
| 1992 | NA | 33.083 | 1322 | NA |
| 1993 | NA | 33.312 | 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 |
| 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 |

| Year | Gaseous fuel [TJ] | Lignite [TJ] | Lidued Fuels [TJ] | Biomass [TJ] |
|------|-------------------|--------------|-------------------|--------------|
| 2009 | NA | 0.124 | 351 | 47.688 |
| 2010 | NA | 0.124 | 363 | 47.048 |
| 2011 | NA | 0.124 | 323 | 51.119 |
| 2012 | NA | 0.091 | 349 | 55.681 |
| 2013 | NA | 36.393 | 230 | 56.675 |
| 2014 | NA | 36.393 | 230 | 56.675 |
| 2015 | NA | 35.572 | 251 | 56.679 |
| 2016 | NA | 32.555 | 248 | 51.220 |
| 2017 | NA | 25.765 | 207 | 55.943 |
| 2018 | NA | 21.761 | 211 | 57.621 |
| 2019 | NA | 86.485 | 197 | 57.909 |
| 2020 | NA | 33.427 | 123 | 56.751 |
| 2021 | NA | 96.525 | 126 | 60.709 |
| 2022 | NA | 61.700 | 95 | 58.811 |
| 2023 | NA | 115.202 | 68 | 55.414 |
| 2024 | NA | 64.465 | 126 | 53.39 |

Emission factors

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

4.6.9.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO₂ was estimated to be 20% (rating A. cf. chapter 1.7), for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} and NH₃ (125% rating C).

4.6.9.3. Source-specific QA/QC and verification

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

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

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

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

No planned improvements in this category.

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

4.6.10.1. Methodological Issues

Activity data

Non road mobile machinery related emissions for whole historic trend with use of 1.A.4 Non road mobile machinery Annex 2023 model for calculation of emissions from this sector for calculation

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

Table 87 Activity data for source category 1.A.4.cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

| Year | Diesel consumption [TJ] | Year | Diesel consumption [TJ] |
|------|-------------------------|------|-------------------------|
| 1990 | 408 | 2008 | 56 |
| 1991 | 552 | 2009 | 98 |
| 1992 | 482 | 2010 | 156 |
| 1993 | 327 | 2011 | 156 |
| 1994 | 315 | 2012 | 161 |
| 1995 | 355 | 2013 | 244 |
| 1996 | 405 | 2014 | 257 |
| 1997 | 296 | 2015 | 266 |
| 1998 | 314 | 2016 | 279 |
| 1999 | 348 | 2017 | 279 |
| 2000 | 495 | 2018 | 280 |
| 2001 | 409 | 2019 | 286 |
| 2002 | 227 | 2020 | 286 |
| 2003 | 182 | 2021 | 286 |
| 2004 | 601 | 2022 | 285 |
| 2005 | 80 | 2023 | 287 |
| 2006 | 30 | 2024 | 287 |
| 2007 | 41 | | |

Emission factors

Emission factors for the basic pollutants and HM and POPs are presented in Table 48 and 49 respectively. Share of leaded and unleaded petrol is presented in table 75.

4.6.10.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10% (rating C. cf. chapter 1.7); the emission factor uncertainty for SO₂ was estimated to be 20% (rating A. cf. chapter 1.7). for SO_x and NMVOC was estimated to be 40% (rating B) and for PM_{2.5} and NH₃ (125% rating C).

4.6.10.3. Source-specific QA/QC and verification

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

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

Recalculations was performed in this category due to use of higher tier methodology.

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

No planned improvements.

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

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

4.7. Fugitive emission from fuels- NFR 1 B

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

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

4.7.1.1. Methodological issues

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

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

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 88 Activity data for source category 1.B.1.a - Fugitive emission from solid fuels: Coal mining and handling

| Year | Coal mined [Mg] | Year | Coal mined [Mg] |
|------|-----------------|------|-----------------|
| 1990 | 6 643 409 | 2008 | 7 630 424 |
| 1991 | 6 978 171 | 2009 | 7 426 052 |
| 1992 | 6 472 920 | 2010 | 6 724 351 |
| 1993 | 6 917 774 | 2011 | 8 208 803 |
| 1994 | 6 859 762 | 2012 | 7 310 906 |
| 1995 | 7 249 237 | 2013 | 6 686 388 |

| Year | Coal mined [Mg] | Year | Coal mined [Mg] |
|------|-----------------|------|-----------------|
| 1996 | 7 145 667 | 2014 | 6 481 925 |
| 1997 | 7 442 876 | 2015 | 5 936 741 |
| 1998 | 8 144 653 | 2016 | 5 152 286 |
| 1999 | 7 277 623 | 2017 | 5 093 721 |
| 2000 | 7 513 998 | 2018 | 4 99 4843 |
| 2001 | 8 142 082 | 2019 | 5 066 083 |
| 2002 | 7 571 202 | 2020 | 4 532 745 |
| 2003 | 7 271 202 | 2021 | 4 118 936 |
| 2004 | 7 296 136 | 2022 | 5 079 495 |
| 2005 | 6 880 513 | 2023 | 3 993 792 |
| 2006 | 6 638 893 | 2024 | 3 227 018 |
| 2007 | 6 509 543 | | |

Emission factors

In this category calculations were done by use of Tier 2 methodology starting from 2015 since all coal mines are categorized as open mines.

Table 89 Emission factors for 1.B.1.a - Fugitive emission from solid fuels: Coal mining and handling

| Pollutant | Value | Unit | References |
|-----------|-------|-------|---|
| NMVOC | 0.2 | kg/Mg | GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10 |
| PM10 | 0.039 | kg/Mg | GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10 |
| PM2.5 | 0.006 | kg/Mg | GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10 |
| TSP | 0.082 | kg/Mg | GB 2023 Table 3-2 Tier 2 emission factors for source category 1.B.1.a Coal mining and handling. Open cast mining. page 10 |

4.7.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NO_x was estimated to be 20% (rating A. cf. chapter 1.7) and 200% for PM_{2.5}, (rating D).

4.7.1.3. Source-specific QA/QC and verification

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

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

No recalculations were performed in this category.

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

No further improvements are planned in this category.

4.7.2. Fugitive emissions oil: Refining/storage –NFR 1.B.2.aiv

Emissions of NMVOCs to the atmosphere occur in nearly every element of the oil products distribution chain. Most emissions occur due to the storage and handling of gasoline, because of the much higher volatility compared to other fuels such as gasoil, kerosene etc.

4.7.2.1. Methodological issues

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

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

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

| Year | Crude oil input [Mg] | Year | Crude oil input [Mg] |
|------|----------------------|------|----------------------|
| 1990 | 1 216 491 | 2008 | 1 061 736 |
| 1991 | 964 033 | 2009 | 972 532 |
| 1992 | 566 701 | 2010 | 853 000 |
| 1993 | 1 018 201 | 2011 | 705 144 |
| 1994 | 143 148 | 2012 | 259 606 |
| 1995 | 119 437 | 2013 | 59 676 |
| 1996 | 696 341 | 2014 | 7 274 |
| 1997 | 379 759 | 2015 | NO |
| 1998 | 754 775 | 2016 | NO |
| 1999 | 765 412 | 2017 | NO |
| 2000 | 1 043 104 | 2018 | NO |
| 2001 | 1 012 872 | 2019 | NO |
| 2002 | 648 137 | 2020 | NO |
| 2003 | 783 749 | 2021 | NO |
| 2004 | 975 262 | 2022 | NO |
| 2005 | 946 747 | 2023 | NO |
| 2006 | 1 067 096 | 2024 | NO |
| 2007 | 1 050 007 | | |

Emission factors

Emission factors for emission estimations in this sector are presented in the following table and are directly taken from GB 2023.

Table 91 Emission factors for source category 1.B.2.a.iv - Fugitive emissions oil: Refining/storage

| Pollutant | Value | Unit | References |
|-------------------|--------|-----------------------|---|
| NO _x | 0.24 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| NM VOC | 0.2 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| SO _x | 0.62 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| NH ₃ | 0.0011 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| PM _{2.5} | 0.0043 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| PM ₁₀ | 0.0099 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| TSP | 0.016 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| CO | 0.09 | kg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Pb | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Cd | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Hg | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| As | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Cr | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Cu | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Ni | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Se | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| Zn | 0.0051 | g/MG crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |
| PCDD/ PCDF | 0.0057 | µg/Mg crude oil input | GB 2023, Table 3-1 emission factor for source category, 1.B.2.a.iv, page 14 |

4.7.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty for NM VOC and SO_x was estimated to be 20% (rating A. cf. chapter 1.7). and 40% for NO_x and NH₃ (rating B). and 200% for EF uncertainty for PM_{2.5} (rating D).

4.7.2.3. Source-specific QA/QC and verification

No QA/QC procedure is performed due to the fact the activity is not occurring.

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

No recalculations were done in this sector.

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

No planned improvements in this category.

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

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

4.7.3.1. Methodological issues

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

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

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

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

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

The methodology for estimating NMVOC emissions from gasoline handling is based on Tier 1 emission factors that account for the level of implementation of Stage II vapor recovery systems at fuel stations. For the period 1990–2005, a default emission factor of 4.5 kg NMVOC per Mg of gasoline handled is applied. From 2018 onwards, the emission factor is adjusted to reflect the penetration of Stage II systems, using the relationship $EF = 2.2 - 1.5x$, where x represents the fraction of gasoline sold at sites equipped with Stage II controls. In the absence of Stage II installations ($x = 0$), the emission factor remains at 2.2 kg/Mg, while full implementation ($x = 1$) results in a reduced emission factor of 0.7 kg/Mg. This approach allows the estimation to capture variations in implementation rates across countries. It should be noted that emissions from gasoline storage at refineries are not included in this emission factor and are reported separately. Data for the status and year of implementation of implementation of a stage IB and II was gathered through questionnaires send by MEPP to petrol stations.

Activity data

The oil products considered in this source category are as follows: The activity data regarding distributed oil products are calculated as the difference between produced and imported products, reduced by the quantity of exported oil products. Activity data for the produced oil products were taken from the publication industry in the Republic of North Macedonia for the period 2005-2015 [27] and the chapter for industry within the Statistical yearbooks of the Republic of North Macedonia for the previous period [21]. Activity data on the imported and exported oil products are taken from External trade chapter, within the Statistical yearbooks of the Republic of North Macedonia for the whole reporting period. The quantity of distributed oil is presented in the following table.

Table 92 Activity data for source category 1.B.2.a.v - Distribution of oil products

| Year | Distributed oil (Mg) | Year | Distributed oil (Mg) |
|------|----------------------|------|----------------------|
| 1990 | 215 334 | 2008 | 118 237 |
| 1991 | 178 516 | 2009 | 123 809 |
| 1992 | 104 471 | 2010 | 123 578 |
| 1993 | 196 395 | 2011 | 130 191 |
| 1994 | 46 054 | 2012 | 105 948 |
| 1995 | 22 078 | 2013 | 111 055 |
| 1996 | 140 096 | 2014 | 100 920 |
| 1997 | 97 307 | 2015 | 103 210 |
| 1998 | 152 809 | 2016 | 103 743 |
| 1999 | 266 750 | 2017 | 103 082 |
| 2000 | 98 952 | 2018 | 101 145 |
| 2001 | 207 755 | 2019 | 103 425 |
| 2002 | 135 215 | 2020 | 75 525 |
| 2003 | 126 004 | 2021 | 84 832 |
| 2004 | 146 368 | 2022 | 93 853 |
| 2005 | 116 930 | 2023 | 104 613 |
| 2006 | 107 499 | 2024 | 111 966 |
| 2007 | 114 007 | | |

Emission factors

Table 93 Emission factors for source category 1.B.2.a.v - Distribution of oil products for NMVOC

| Pollutant | Year of implementation of a stage IB and II | Period for calculating the reduced emission factor | Number of stations with implementation of stage IB and II in place | X (coverage of sites with Stage II installed) | EF NMVOC (kg/Mg gasoline handled) | References |
|-----------|---|--|--|---|-----------------------------------|---|
| NMVOC | 1990-2005 | 1990 - 2005 | 0 | 0 | 4.5 | GB 2023 Table 3-1 emission factor for source category 1.B.2.a.v page 12 |
| | 2006 | 2006 - 2014 | 40 | 0,21 | 4,188 | Calculated |
| | 2015 | 2015 - 2015 | 166 | 0,86 | 3,203 | Calculated |
| | 2016 | 2016 - 2017 | 171 | 0,89 | 3,164 | Calculated |
| | 2018 | 2018 - 2023 | 172 | 0,90 | 3,156 | Calculated |
| | 2024 | 2024 - | 173 | 0,90 | 3,148 | Calculated |

4.7.3.2. Source-specific uncertainties and time-series consistency

No specific uncertainty was calculated for this category and consistency was insured during recalculations done in this reporting round.

4.7.3.3. Source-specific QA/QC and verification

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

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

Recalculations were done for the whole time in the frame of the ongoing Technical IPA II project for air quality improvements of this category were made by collecting information from all petrol stations in the country regarding implementation of phase II and IB.

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

No planned improvements in this category.

4.7.4. Venting and flaring – 1.B.2.c

4.7.4.1. Methodological issues

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

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

This equation is applied at national level. using annual totals for venting and flaring.

Activity data

The activity data for this source category for the years 2004, 2008 and 2010, has been taken from the previous informative reports, which were originally obtained from the refinery. For the period 1990-1999, the activity data were taken from the reported data in 2013 reporting round (there is no presented source where this data is coming from). For the other years, a gap filling method has been implemented by using data on quantity of crude oil processed as surrogate data. The consumption of refinery feed has been requested from the refinery, but the data was not reported. No production process was carried out from 2015 onwards so the emissions in this category are not occurring.

Table 94 Activity data for source category 1.B.2.c - Venting and flaring

| Year | Refinery feed [TJ] | Year | Refinery feed [TJ] | Year | Refinery feed [TJ] |
|------|--------------------|------|--------------------|------|--------------------|
| 1990 | 325 | 2002 | 129 | 2014 | 1 |
| 1991 | 186 | 2003 | 156 | 2015 | NO |
| 1992 | 109 | 2004 | 201 | 2016 | NO |
| 1993 | 196 | 2005 | 188 | 2017 | NO |
| 1994 | 28 | 2006 | 212 | 2018 | NO |
| 1995 | 23 | 2007 | 209 | 2019 | NO |
| 1996 | 134 | 2008 | 211 | 2020 | NO |
| 1997 | 73 | 2009 | 193 | 2021 | NO |
| 1998 | 146 | 2010 | 165 | 2022 | NO |
| 1999 | 148 | 2011 | 140 | 2023 | NO |
| 2000 | 188 | 2012 | 52 | 2024 | NO |
| 2001 | 201 | 2013 | 12 | | |

Emission factors

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

Table 95 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 |

4.7.4.2. 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).

4.7.4.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category. i.e. activity data were checked for plausibility and time-series consistency; emission data were checked for completeness and for consistency between the calculation files. NFR tables and the IIR. Data were crosschecked with activity data from the category 1.B.a.iv.

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

No recalculations were performed in this category.

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

No planned improvements in this category, since the activity does not occur anymore

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

Emissions for NH₃, Hg and As, were calculated for the period 1998-2023, where data on geothermal energy consumption were available.

Methodological issues

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

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

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

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

Activity data

The activity data for this source category for the period 1998-2016 expressed in m³ are taken from the Energy balance. Data are converted in Gcal which are expressed in GWh by use of conversion factor taken from the Energy balance for Republic of North Macedonia, where it is stated that 1 Gcal = 1.16 *10⁻³ GWh.

Table 96 Activity data for source category 1.B.2.d - Other fugitive emissions from energy production

| Year | Geothermal energy [MWh electricity produced] | Year | Geothermal energy [MWh electricity produced] | Year | Geothermal energy [MWh electricity produced] |
|------|---|------|---|------|---|
| 1990 | NE | 2003 | 153 373 | 2016 | 75 999 |
| 1991 | NE | 2004 | 136 983 | 2017 | 70 577 |
| 1992 | NE | 2005 | 115 561 | 2018 | 69 589 |
| 1993 | NE | 2006 | 116 846 | 2019 | 64 985 |
| 1994 | NE | 2007 | 124 244 | 2020 | 61 962 |
| 1995 | NE | 2008 | 115 379 | 2021 | 61 578 |
| 1996 | NE | 2009 | 141 326 | 2022 | 58 159 |
| 1997 | NE | 2010 | 141 326 | 2023 | 55 733 |
| 1998 | 217 375 | 2011 | 142 551 | 2024 | 58 159 |
| 1999 | 178 608 | 2012 | 122 982 | | |
| 2000 | 181 751 | 2013 | 98 741 | | |
| 2001 | 269 512 | 2014 | 84 884 | | |
| 2002 | 151 114 | 2015 | 78 217 | | |

Emission factors

Emission factors are taken from the GB 2023, expressed in MWh electricity produced.

Table 97 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 2023 Table 3-4 emission factor for source category 1.B.2.d page 5 |
| Hg | 0.44 | g/MWh electricity produced | GB 2023 Table 3-4 emission factor for source category 1.B.2.d page 5 |
| As | 0.025 | g/MWh electricity produced | GB 2023 Table 3-4 emission factor for source category 1.B.2.d page 5 |

4.7.5.1. Source-specific uncertainties and time-series consistency

No specific uncertainties were calculated for this category.

4.7.5.2. Source-specific QA/QC and verification

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

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

No recalculations were done in this sector.

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

No planned improvements in this category.

INDUSTRY



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

5.1. Sector overview

This chapter includes information on the estimation (calculation) of the emissions of NEC Directive gases, CO, particle matter (PM), heavy metals (HM) and persistent organic pollutants (POPs) as well as activity data and their references and emission factors reported under NFR category Industrial Processes taken from EMEP Guidebooks 2023 for the period from 1990-2023 with exception of those categories where due to limitation of activity data, emission factors from older version of the Guidebook are used.

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

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

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

5.2. General description

Completeness

Table 98 NFR categories covered in Industrial processes sector for 2024

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

| NFR sector | Completeness |
|---|--------------|
| 2.C.5 Lead production | √ |
| 2.C.6 Zinc production | NO |
| 2.C.7.a Copper production | NE |
| 2.C.7.b Nickel production | NO |
| 2.C.7.c Other metal production | √ |
| 2.C.7.d Storage, handling and transport of metal products | IE |
| 2.D.3.a Domestic solvent use including fungicides | √ |
| 2.D.3.b Road paving with asphalt | √ |
| 2.D.3.c Asphalt roofing | √ |
| 2.D.3.d Coating applications | √ |
| 2.D.3.e Degreasing | √ |
| 2.D.3.f Dry cleaning | √ |
| 2.D.3.g Chemical products | √ |
| 2.D.3.h Printing | √ |
| 2.G Other product use and 2.D.3.i Other solvent use | √ |
| 2.H.1 Pulp and paper industry | NO |
| 2.H.2 Food and beverage production industry | √ |
| 2.H.2 Other industrial processes | NE |
| 2.I Wood processing | √ |
| 2.J Production of POPs | NO |
| 2.K Consumption of POPs and HM | √ |
| 2.L Other production, consumption, storage, transportation or handling of bulk products | NE |

Methodology

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

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

where:

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

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

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

5.3. Mineral products – NFR 2.A

5.3.1. Cement production – 2.A.1

In the Republic of North Macedonia there is only one installation (factory) for cement production “Cementarnica TITAN USJE AD Skopje”. In this installation there are 2 (two) rotary kilns (furnace 3 and 4) where abatement (fabric filters) is used since 2001 (for furnace 3) and since 2003 (for furnace 4).

For these reasons for the period 2004-2015 we have made recalculation of the of PM2.5 emissions, PM10, TSP and BC, described below.

5.3.1.1. Methodological issues

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

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

where:

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

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

$EF_{\text{pollutant}}$ = is the emission factor of the relevant pollutant (in -g pollutant/Mg clinker produced)

Activity Data

The activity data for the whole reporting period was received from the operator itself.

Table 99 Activity data for source category 2.A.1 - Cement production

| Year | Clinker produced (t) | Year | Clinker produced (t) |
|------|----------------------|------|----------------------|
| 1990 | 491 900 | 2008 | 843 770 |
| 1991 | 465 380 | 2009 | 478 400 |
| 1992 | 396 500 | 2010 | 588 980 |
| 1993 | 413 440 | 2011 | 687 990 |
| 1994 | 375 910 | 2012 | 645 480 |
| 1995 | 365 120 | 2013 | 577 850 |
| 1996 | 396 020 | 2014 | 518 200 |
| 1997 | 475 250 | 2015 | 553 232 |
| 1998 | 346 870 | 2016 | 739 810 |
| 1999 | 427 080 | 2017 | 735 625 |
| 2000 | 614 160 | 2018 | 748 287 |
| 2001 | 716 960 | 2019 | 737 700 |
| 2002 | 739 490 | 2020 | 770 599 |
| 2003 | 602 570 | 2021 | 803 735 |
| 2004 | 643 260 | 2022 | 673 837 |
| 2005 | 694 920 | 2023 | 711 254 |
| 2006 | 801 300 | 2024 | 682 767 |
| 2007 | 882 830 | | |

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

Emission factors

For calculation (estimation) of emissions for PM2.5, PM10, TSP and BC for the period 1990-2003 emission factors were taken from GB 2023.

These emission factors are given in the table below:

Table 100 Emission factors for source category 2.A.1 cement production

| Pollutant | Value | Unit | References |
|-----------|-------|--------------|--|
| PM10 | 234 | g/Mg clinker | GB 2023 2.A.1 Cement production. Table 3-1. pg. 10 |
| PM2.5 | 130 | g/Mg clinker | GB 2023 2.A.1 Cement production. Table 3-1. pg. 10 |
| TSP | 260 | g/Mg clinker | GB 2023 2.A.1 Cement production. Table 3-1. pg. 10 |
| BC | 3 | % | GB 2023 2.A.1 Cement production. Table 3-1. pg. 10 |

For calculation (estimation) of emissions for PM2.5, PM10 and TSP for the period 2007-2024 the total emission TSP (measured with continuous monitoring) is taken into account: the emission factors from GB 2023 have been used (Tier 1, Table 102 above) as well as Tier 2, Table 103 (GB 2023) where the abatement efficiencies are considered (namely the proportion relation for calculation of abatement efficiencies for TSP, PM10 and PM2.5 is used for each particular year).

For the period 2004-2006 (when there was no continuous monitoring installed in the installation) the calculation of PM2.5, PM10 and TSP emissions are done by considering the mass of clinker produced and the emission factors from GB 2023 (Tier 1, Table 102 above) as well as Tier 2, Table 103 (GB 2023) where the abatement efficiencies are considered (namely the proportion relation for calculation of abatement efficiencies for TSP, PM10 and PM2.5 is used for each of these particular years).

For this calculation, the following equation was used:

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

Table 101 Abatement efficiencies ($\eta_{\text{abatement}}$) for source category 2.A.1 Cement production

| Abatement technology | Pollutant | Value | References |
|--|---|-------|---|
| Additional fabric filters on the oven stack; effective control of fugitive sources | particle > 10 μm | 98% | GB 2023 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12 |
| | 10 μm > particle > 2.5 μm | 80% | GB 2023 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12 |
| | 2.5 μm > particle | 73% | GB 2023 Tier 2 2.A.1 Cement production. Table 3-2. pg. 12 |

5.3.1.2. Source-specific uncertainties and time-series consistency

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

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

5.3.1.3. Source-specific QA/QC and verification

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

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

A new calculation was made to determine the mass of PM10 and PM2.5 particles for the period 2004-2024, because due to the definition of TSP, PM10 and PM2.5 it follows that $m(TSP) > m(PM_{10}) > m(PM_{2.5})$.

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 2014-2024 from the Statistical publication for Industry in the Republic of North Macedonia [29] was used as activity data. For the period 2020-2023 there is no lime production because the installation for this type of production was not working. There is production from this installation in 2024.

Table 102 Activity data for source category 2.A.2 - Lime production

| Year | Lime produced (t) | Year | Lime produced (t) |
|------|-------------------|------|-------------------|
| 1990 | 37 452 | 2008 | NE |
| 1991 | 29 194 | 2009 | 2 713 |
| 1992 | 33 872 | 2010 | 2 700 |
| 1993 | 24 904 | 2011 | 2 700 |
| 1994 | 14 097 | 2012 | 2 700 |
| 1995 | 12 538 | 2013 | 2 700 |
| 1996 | 9 707 | 2014 | 10 836 |
| 1997 | 4 344 | 2015 | 8 003 |
| 1998 | 964 | 2016 | 8 684 |
| 1999 | 4 264 | 2017 | 1 399 |
| 2000 | 1 000 | 2018 | 6 834 |
| 2001 | 500 | 2019 | 29 236 |
| 2002 | 500 | 2020 | NO |
| 2003 | 500 | 2021 | NO |

| Year | Lime produced (t) | Year | Lime produced (t) |
|------|-------------------|------|-------------------|
| 2004 | 500 | 2022 | NO |
| 2005 | 15 009 | 2023 | NO |
| 2006 | 12 704 | 2024 | 3593 |
| 2007 | 7 517 | | |

Emission factors

For the calculation (estimation) of emissions for PM2.5, PM10 and TSP for the period 1990-2024 emission factors were taken from GB 2023.

These emission factors are given in Table 103 below.

Table 103 Emission factors for source category 2.A.2 - Lime production

| Pollutant | Value | Unit | References |
|-----------|-------|------------|---|
| PM10 | 3500 | g/Mg lime | GB 2023 2.A.2 Lime production, Table 3-1, pg. 8 |
| PM2.5 | 700 | g/Mg lime | GB 2023 2.A.2 Lime production, Table 3-1, pg. 8 |
| TSP | 9000 | g/Mg lime | GB 2023 2.A.2 Lime production, Table 3-1, pg. 8 |
| BC | 0.46 | % of PM2.5 | GB 2023 2.A.2 Lime production, Table 3-1, pg. 8 |

5.3.2.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 5%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

5.3.2.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

Planned improvements in this category for next year is to correct activity data from inventory, by supplemented them with the data used for the estimation of greenhouse gas emissions with and to make recalculation transformation of the mass of slaked to quicklime in tons, followed by recalculation for emission parameters using new activity data

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

| Year | Flat glass produced [t] | Year | Flat glass produced [t] |
|------|-------------------------|------|-------------------------|
| 1990 | 448 | 2008 | NO |
| 1991 | 32 | 2009 | NO |
| 1992 | 179 | 2010 | NO |
| 1993 | NO | 2011 | NO |
| 1994 | NO | 2012 | NO |
| 1995 | NO | 2013 | NO |
| 1996 | NO | 2014 | NO |
| 1997 | NO | 2015 | NO |
| 1998 | NO | 2016 | NO |
| 1999 | NO | 2017 | NO |
| 2000 | NO | 2018 | NO |
| 2001 | NO | 2019 | NO |
| 2002 | NO | 2020 | NO |
| 2003 | NO | 2021 | NO |
| 2004 | NO | 2022 | NO |
| 2005 | NO | 2023 | NO |
| 2006 | NO | 2024 | NO |
| 2007 | NO | | |

Emission factors

For the estimation of emission parameters from 1990-1992, the used emission factors were taken from GB 2023. These emission factors are given in Table 105 below.

Table 105 Emission factors for source category 2.A.3 Flat glass production

| Pollutant | | Value | Unit | References |
|-----------|--|-------|------------|---|
| PM10 | | 120 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| PM2.5 | | 100 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| TSP | | 130 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |

| Pollutant | | Value | Unit | References |
|-----------|--|-------|------------|---|
| BC | | 0.062 | % of PM2.5 | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Pb | | 0.4 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Cd | | 0.068 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Hg | | 0.003 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| As | | 0.08 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Cr | | 0.08 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Cu | | 0.007 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Ni | | 0.74 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Se | | 0.15 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |
| Zn | | 0.37 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-2. Flat glass production pg. 16 |

Activity Data for source category 2.A.3 - Glass wool production

The activity data for glass wool production was taken from Statistical yearbooks - chapter industry for the period 1990-1998.

Table 106 Activity data for source category 2.A.3 - Glass wool production

| Year | Glass wool produced [t] | Year | Glass wool produced [t] |
|------|-------------------------|------|-------------------------|
| 1990 | 2739 | 2008 | NO |
| 1991 | 1 176 | 2009 | NO |
| 1992 | 1828 | 2010 | NO |
| 1993 | 444 | 2011 | NO |
| 1994 | 1332 | 2012 | NO |
| 1995 | 3043 | 2013 | NO |
| 1996 | 1454 | 2014 | NO |
| 1997 | 961 | 2015 | NO |
| 1998 | 960 | 2016 | NO |
| 1999 | NO | 2017 | NO |
| 2000 | NO | 2018 | NO |
| 2001 | NO | 2019 | NO |
| 2002 | NO | 2020 | NO |
| 2003 | NO | 2021 | NO |
| 2004 | NO | 2022 | NO |
| 2005 | NO | 2023 | NO |
| 2006 | NO | 2024 | NO |
| 2007 | NO | | |

Emission factors

For the estimation of emission parameters for the period 1990-1998 coming from this source category, the used emission factors were taken from GB 2023.

These emission factors are given in Table 105 below.

Table 107 Emission factors for Glass wool production

| Pollutant | Value | Unit | References |
|-----------------|-------|------------|---|
| NMVOC | 500 | g/Mg glass | GB 20232.A.3 Glass production. Table 3-5. Glass wool production pg. 19 |
| NH ₃ | 1400 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19 |
| PM2.5 | 520 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19 |
| PM10 | 590 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19 |
| TSP | 670 | g/Mg glass | GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19 |
| BC | 2 | % Of PM2.5 | GB 2023 2.A.3 Glass production. Table 3-5. Glass wool production pg. 19 |

5.3.3.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 40% for NMVOC and NH₃ 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 2007-2024 are taken from MAKSTAT database [29].

Table 108 Emission factors for minerals produced for source category 2.A.5.a Quarrying and mining the minerals other than coal

| Year | Mineral produced [t] | Year | Mineral produced [t] |
|------|----------------------|------|----------------------|
| 1990 | 6 117 811 | 2008 | 7 095 376 |
| 1991 | 5 730 999 | 2009 | 5 783 348 |
| 1992 | 5 299 552 | 2010 | 6 845 344 |

| Year | Mineral produced [t] | Year | Mineral produced [t] |
|------|----------------------|------|----------------------|
| 1993 | 5 246 466 | 2011 | 7 106 322 |
| 1994 | 4 817 372 | 2012 | 7 039 649 |
| 1995 | 5 215 134 | 2013 | 7 779 824 |
| 1996 | 5 233 110 | 2014 | 7 218 423 |
| 1997 | 5 528 418 | 2015 | 7 577 701 |
| 1998 | 5 158 798 | 2016 | 8 311 381 |
| 1999 | 4 658 946 | 2017 | 7 837 715 |
| 2000 | 4 917 560 | 2018 | 7 867 030 |
| 2001 | 3 488 792 | 2019 | 8 385 648 |
| 2002 | 2 855 005 | 2020 | 7 783 002 |
| 2003 | 739 786 | 2021 | 7 312 359 |
| 2004 | 347 795 | 2022 | 6 853 157 |
| 2005 | 2 827 908 | 2023 | 7707522 |
| 2006 | 4 605 478 | 2024 | 7364951 |
| 2007 | 6 955 426 | | |

Emission factors

For estimation of emissions for PM_{2.5}, PM₁₀ and TSP the used emission factors were taken from GB 2023. These emission factors are given in Table 109 below.

Table 109 Emission factors for minerals produced for 2.A.5.a source category - Quarrying and mining of minerals other than coal

| Pollutant | Value | Unit | References |
|-------------------|-------|--------------|--|
| TSP | 102 | g/Mg mineral | GB 2023 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5 |
| PM ₁₀ | 50 | g/Mg mineral | GB 2023 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5 |
| PM _{2.5} | 5.0 | g/Mg mineral | GB 2023 2.A.5.a Quarrying and mining of minerals other than coal. Table 3-1. pg. 5 |

5.3.4.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

5.3.4.3. Source-specific QA/QC and verification

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

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

Recalculation is made for 2023 due to updated data in the MAKSTAT database.

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 (m²) Average height of the hole/blast (m), Material density, Volume of production (m³) to be able to proceed with Tier 2 in this category. These types of required data will be included in the National environmental information system for gathering emission data which should be operational in 2025. After these data are gathered it will be possible to change the methodology of calculation.

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

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

5.3.5.1. Methodological issues

Tier 1 method has been applied for estimation of emissions coming from this source category where the activity data refer to floor area in m² of the building constructed or demolished.

Activity Data

Activity data on constructed (completed and unfinished) dwellings and demolished residential dwellings are taken from Statistical yearbooks - Chapter Construction for the period 1996-2024. There is only data for area in m² of constructed dwellings, as well as number of demolished dwellings. The area of demolished dwellings is calculated when the number of demolished dwellings per year is multiplied with an average dwelling area of 65 m². The activity data and EF are presented in the following tables:

Table 110 Activity data for constructed (completed and unfinished) individual dwellings for source category 2.A.5.b - Construction and demolition

| Year | m ² /year | Year | m ² /year |
|------|----------------------|------|----------------------|
| 1990 | 1241459 | 2008 | 809606 |
| 1991 | 960298 | 2009 | 824945 |
| 1992 | 1012393 | 2010 | 902234 |
| 1993 | 876103 | 2011 | 944630 |
| 1994 | 827450 | 2012 | 934773 |
| 1995 | 848494 | 2013 | 887697 |
| 1996 | 456408 | 2014 | 798891 |
| 1997 | 394471 | 2015 | 752207 |
| 1998 | 311088 | 2016 | 943400 |
| 1999 | 874951 | 2017 | 1130883 |
| 2000 | 841820 | 2018 | 1109077 |
| 2001 | 908906 | 2019 | 1028448 |
| 2002 | 771750 | 2020 | 1096693 |
| 2003 | 842519 | 2021 | 1814779 |
| 2004 | 962874 | 2022 | 1696994 |
| 2005 | 899876 | 2023 | 1466764 |

| Year | m ² /year | Year | m ² /year |
|------|----------------------|------|----------------------|
| 2006 | 958738 | 2024 | 1561922 |
| 2007 | 852971 | | |

Emission factors

Emission factors for the particulates PM2.5, PM10 and TSP are taken from GB 2023. These emission factors are given in Table 109 below.

Table 111 Emission factors for source category 2.A.5.b - Construction and demolition-Construction of apartment buildings

| Pollutant | Value | Unit | References |
|-----------|-------|-------------------------|---|
| TSP | 1 | kg/m ² /year | GB 2023 2.A.5.b Construction and demolition. Table 3-2. pg. 7 |
| PM10 | 0.3 | kg/m ² /year | GB 2023 2.A.5.b Construction and demolition. Table 3-2. pg. 7 |
| PM2.5 | 0.03 | kg/m ² /year | GB 2023 2.A.5.b Construction and demolition. Table 3-2. pg. 7 |

Table 112 Activity data for constructed public dwellings for source category 2.A.5.b - Construction and demolition

| Year | m ² /year | Year | m ² /year |
|------|----------------------|------|----------------------|
| 1990 | NE | 2008 | 7485 |
| 1991 | NE | 2009 | 33131 |
| 1992 | NE | 2010 | 17832 |
| 1993 | NE | 2011 | 14260 |
| 1994 | NE | 2012 | 33000 |
| 1995 | NE | 2013 | 37190 |
| 1996 | 471555 | 2014 | 4998 |
| 1997 | 449131 | 2015 | 8612 |
| 1998 | 482850 | 2016 | 6443 |
| 1999 | 65348 | 2017 | 8117 |
| 2000 | 56048 | 2018 | 19169 |
| 2001 | 48836 | 2019 | 18337 |
| 2002 | 100144 | 2020 | 32473 |
| 2003 | 110294 | 2021 | 34054 |
| 2004 | 58699 | 2022 | 19843 |
| 2005 | 61890 | 2023 | 30466 |
| 2006 | 57451 | 2024 | 50365 |
| 2007 | 39414 | | |

Emission factors

Emission factors for the particulates PM_{2.5}, PM₁₀ and TSP are taken from GB 2023. These emission factors are given in Table 113 below.

Table 113 Emission factors for source category 2.A.5.b - Construction and demolition-non-residential construction

| Pollutant | Value | Unit | References |
|-------------------|-------|-------------------------|---|
| TSP | 3.3 | kg/m ² /year | GB 2023 2.A.5.b Construction and demolition. Table 3-3. pg. 7/8 |
| PM ₁₀ | 1 | kg/m ² /year | GB 2023 2.A.5.b Construction and demolition. Table 3-3. pg. 7/8 |
| PM _{2.5} | 0.1 | kg/m ² /year | GB 2023 2.A.5.b Construction and demolition. Table 3-3. pg. 7/8 |

5.3.5.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

5.3.5.3. Source-specific QA/QC and verification

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

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

No recalculation was 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 2004-2024 (road transport) and the period 2011-2024 (railroad transport).

[27]. The historical data for the quantity of transported minerals in road transport were taken from the Statistical yearbook – chapter Transport for the period 1990-2008 [22], while regarding the railway transport the content of transported minerals in the transported goods in railway transport were estimated.

Table 114 Activity data for source category 2.A.5.c - Storage, handling, and transport of mineral products

| Year | Products transported [t] | Year | Products transported [t] |
|------|--------------------------|------|--------------------------|
| 1990 | 246 717 | 2008 | 1 965 897 |
| 1991 | 143 309 | 2009 | 7 058 289 |
| 1992 | 96 043 | 2010 | 2 820 746 |
| 1993 | 152 750 | 2011 | 3 330 100 |
| 1994 | 49 973 | 2012 | 3 499 387 |
| 1995 | 57 838 | 2013 | 3 407 267 |
| 1996 | 34 404 | 2014 | 5 564 332 |
| 1997 | 106 462 | 2015 | 4 142 405 |
| 1998 | 189 443 | 2016 | 5 034 346 |
| 1999 | 152 301 | 2017 | 4 717 295 |
| 2000 | 48 708 | 2018 | 8 410 139 |
| 2001 | 575 864 | 2019 | 6 405 305 |
| 2002 | 685 869 | 2020 | 5 498 961 |
| 2003 | 8 006 331 | 2021 | 9 594 126 |
| 2004 | 10 497 726 | 2022 | 8 482 780 |
| 2005 | 8 475 328 | 2023 | 6 555 998 |
| 2006 | 16 441 405 | 2024 | 10 097 000 |
| 2007 | 4 813 390 | | |

Emission factors

For estimation of emissions for particulates, PM_{2.5}, PM₁₀ and TSP, the emission factors were taken from GB 2023. Used emission factors are given in the table below.

Table 115 Emission factors for source category 2.A.5.c - Storage handling and transport of mineral products.

| Pollutant | Value | Unit | References |
|-------------------|-------|------|--|
| TSP | 12 | g/Mg | GB 2023 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7 |
| PM ₁₀ | 6 | g/Mg | GB 2023 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7 |
| PM _{2.5} | 0.6 | g/Mg | GB 2023 2.A.5.c Storage handling and transport of mineral products. Table 3-4. pg. 7 |

5.3.6.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 10%; the emission factor uncertainty was estimated to be 200% (rating D), based on expert judgment.

5.3.6.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

No improvements are planned in this category.

5.4. Chemical Industry – NFR 2B

The following NFR source categories:

- 2.B.1 - Ammonia production
- 2.B.2 - Nitric acid production
- 2.B.3 - Adipic acid production and
- 2.B.4 - Carbide production.
- 2.B.7 – Soda ash production

In the inventory, these are reported as NO since in North Macedonia this kind of production does not exist. Regarding Soda ash production this category is defined as NE since the process should be checked

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

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

5.4.1.1. Methodological issues

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

Activity data

The input data for this source category is the quantity of different type of final products. These data have been taken from the Statistical Yearbooks of the Republic of North Macedonia for the period 1990-2006 [22], and data form MAKSTAT database for period 2007-2024 [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 116 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 |

| Year | Chlorine production [Mg] | Phosphate Fertilizers [Mg] | Polyethylene High density [Mg] | Polyvinylchloride [Mg] | Sulfuric acid [Mg] | polyurethane [Mg] |
|------|--------------------------|----------------------------|--------------------------------|------------------------|--------------------|-------------------|
| 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 |
| 2020 | NO | NO | NO | 8178 | NO | 2815 |
| 2021 | NO | NO | NO | 8792 | NO | 4844 |
| 2022 | NO | NO | NO | 9354 | NO | 4285 |
| 2023 | NO | NO | NO | 10234 | NO | 4729 |
| 2024 | NO | NO | NO | 10167 | NO | 4628 |

Emission factors

Emission factors for estimation of pollutants have been taken from GB 2023 and they are presented in the table below.

Table 117 Emission factors for source category 2.B.10.a Other chemical industry

| Pollutant | Value | Unit | References |
|-----------|--------|---|--|
| SOx | 17 000 | g/Mg (100% H ₂ SO ₄) | GB 2023 Table 3.24 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, sulphuric acid production, wet contact process (98% and 78% sulphuric acid) |

| | | | |
|--------|------|-----------------|--|
| Hg | 4.8 | g/Mg | GB 2023 Table 3.32 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, chlorine production |
| TSP | 0.3 | kg/ton produced | GB 2023 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers |
| PM 10 | 0.24 | kg/ton produced | GB 2023 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers |
| PM 2.5 | 0.18 | kg/ton produced | GB 2023 Table 3.35 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, phosphate fertilizers |
| NMVOC | 2.3 | kg/ton produced | GB 2023 Table 3.40 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyethylene high density |
| TSP | 97 | kg/ton produced | GB 2023 Table 3.40 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyethylene high density |
| NMVOC | 96 | g/ton produced | GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC) |
| TSP | 263 | g/ton produced | GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC) |
| PM 10 | 100 | g/ton produced | GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC) |
| PM 2.5 | 5 | g/ton produced | GB 2023 Table 3.41 Tier 2 emission factors for source category 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC) |

5.4.1.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.4.1.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

No planned improvements

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 2016-2024 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 2008-2024 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 2016-2024 are taken directly from one installation mentioned above, Makstil AD Skopje, and the activity data for cold rolling mill from period 2016-2024 are taken from Makstat database, chapter Industry. Activity data for Dojran Stil are taken directly from the installation. The activity data have variable trend due to fluctuant as market prices as well as change of the ownerships of the companies.

Table 118 Activity data for source category 2.C.1 - Iron and steel production

| Year | Products [t] | Year | Products [t] |
|------|--------------|------|--------------|
| 1990 | 885 015 | 2008 | 862 779 |
| 1991 | 755 634 | 2009 | 781 053 |
| 1992 | 548 462 | 2010 | 823 012 |
| 1993 | 353 822 | 2011 | 927 150 |
| 1994 | 140 045 | 2012 | 623 642 |
| 1995 | 83 407 | 2013 | 407 027 |
| 1996 | 128 117 | 2014 | 543 608 |
| 1997 | 230 274 | 2015 | 512 568 |
| 1998 | 347 846 | 2016 | 670 386 |
| 1999 | 237 409 | 2017 | 798 429 |
| 2000 | 437 934 | 2018 | 834 408 |
| 2001 | 583 379 | 2019 | 774 692 |
| 2002 | 960 178 | 2020 | 670 459 |
| 2003 | 760 538 | 2021 | 870 224 |
| 2004 | 833 328 | 2022 | 792 329 |
| 2005 | 807 782 | 2023 | 823 759 |
| 2006 | 905 272 | 2024 | 821 691 |

| Year | Products [t] | Year | Products [t] |
|------|--------------|------|--------------|
| 2007 | 982 650 | | |

Table 119 Activity data for steel and hot and cold ingots production in the period of 2016-2024

| Year | Name of Products | [t] |
|-------------|-------------------|---------|
| 2016 | Liquid steel | 173 113 |
| | Hot rolled sheet | 274 721 |
| | Cold rolled sheet | 156 071 |
| | Dojran Stil | 56 907 |
| 2017 | Liquid steel | 277 599 |
| | Hot rolled sheet | 310 840 |
| | Cold rolled sheet | 157 756 |
| | Dojran Stil | 55 453 |
| 2018 | Liquid steel | 272 415 |
| | Hot rolled sheet | 309 504 |
| | Cold rolled sheet | 153 181 |
| | Dojran Stil | 97 086 |
| 2019 | Liquid steel | 247 017 |
| | Hot rolled sheet | 303 867 |
| | Cold rolled sheet | 142 714 |
| | Dojran Stil | 81 094 |
| 2020 | Liquid steel | 185 330 |
| | Hot rolled sheet | 271 463 |
| | Cold rolled sheet | 147 623 |
| | Dojran Stil | 67 350 |
| 2021 | Liquid steel | 321 453 |
| | Hot rolled sheet | 312 659 |
| | Cold rolled sheet | 154 549 |
| | Dojran Stil | 81 563 |
| 2022 | Liquid steel | 253 468 |
| | Hot rolled sheet | 344 311 |
| | Cold rolled sheet | 98 593 |
| | Dojran Stil | 95 957 |
| 2023 | Liquid steel | 303 979 |
| | Hot rolled sheet | 340 847 |
| | Cold rolled sheet | 86 858 |
| | Dojran Stil | 92 075 |
| 2024 | Liquid steel | 314 676 |
| | Hot rolled sheet | 330 716 |
| | Cold rolled sheet | 81625 |

| Year | Name of Products | [t] |
|------|------------------|--------|
| | Dojran Stil | 94 674 |

Emission factors

For the estimation of emissions for pollutants, emission factors were taken from GB 2023. Used emission factors are given in the table below.

Table 120 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 |
|-------------------|--------|------------------------|---|
| NO _x | 130 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| CO | 1.7 | kg/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| NM VOC | 46 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| SO ₂ | 60 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| TSP | 30 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| PM ₁₀ | 24 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| PM _{2.5} | 21 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| BC | 0.36 | % of PM _{2.5} | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Pb | 1.5 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Cd | 0.12 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Hg | 0.076 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| As | 0.0081 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Cr | 0.105 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Cu | 0.02 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Ni | 0.41 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| Zn | 2.3 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| PCDD/F | 3.0 | µgI-TEQ/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| PAHs (Total) | 0.48 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |
| PCBs | 2.5 | mg/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-19. pg. 44 |

Table 121 Emission factors for source category 2.C.1 - Iron and steel production, rolling mills, cold rolling mills

| Pollutant | Value | Unit | References |
|-----------|-------|------------|---|
| TSP | 96 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-21. pg. 46 |

Table 122 Emission factors for source category 2.C.1 - Iron and steel production, rolling mills, hot rolling mills

| Pollutant | Value | Unit | References |
|-----------|-------|------------|--|
| NM VOC | 7 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-22. pg. 46-47 |
| TSP | 9 | g/Mg steel | GB 2023 2.C.1 Iron and steel production. Table 3-22. pg. 46-47 |

5.5.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty was estimated to be 2%; the emission factor uncertainty was estimated to be 125% for NM VOC and 40% for PM_{2.5}, based on expert judgment.

5.5.1.3. Source-specific QA/QC and verification

Standard QA/QC procedures were carried out for this source category, i.e. activity data was checked for plausibility and time-series consistency; emission data was checked for completeness and for consistency between the calculation files, NFR tables and the IIR. Source-specific recalculations including changes were made in response to the review process.

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

No planned improvements.

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

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

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

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

"Jugohrom ALZAR DOOEL" is one of the biggest industrial polluters in Republic of North Macedonia. The installation has an IPPC environmental permit with adjustment plan, according to which the installation was supposed to install a filter facility for all electric furnaces until 01 April 2014. This deadline given by the Government of Republic of North Macedonia was postponed until October 2016. The second deadline has not been reached either, and that was the reason why the State Environmental Inspectorate closed the installation for a period of 6 months, in November 2016, with an approval of the Ministry of environment and physical planning. The installation remains closed until the requirement for installation of filter facility is not fulfilled. In the period 2017-2024, there was no ferroalloys production from this installation since the operator did not install the necessary filter.

Golden Eagle Nickel Kavadarci (ex 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. In 2024 there is no production from this installation.

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

5.5.2.1. Methodological issue

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

Activity Data

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

Measurement data for TSP for the period 2005-2017 was reported by the operator FENI. Activity data for the period 2018-2023 for ferroalloys production are taken directly from the installation with new ownership EURONICKEL INDUSTRY. From 2024 company has new owner and new brand name Golden Eagle Nickel Kavadarci. In the 2024 there is no production from this company.

Table 123 Activity data for the source category 2.C.2 - Ferroalloy production

| Year | Total Alloy produced [t] | Year | Total Alloy produced [t] |
|------|--------------------------|------|--------------------------|
| 1990 | 85 148 | 2008 | 170 252 |
| 1991 | 77 442 | 2009 | 60 458 |
| 1992 | 107 866 | 2010 | 133 347 |
| 1993 | 78 357 | 2011 | 184 310 |
| 1994 | 72 134 | 2012 | 146 970 |
| 1995 | 72 735 | 2013 | 165 803 |
| 1996 | 92 638 | 2014 | 163 489 |
| 1997 | 85 908 | 2015 | 130 970 |
| 1998 | 106 661 | 2016 | 69 455 |
| 1999 | 78 009 | 2017 | 34 558 |
| 2000 | 58 520 | 2018 | 51 831 |
| 2001 | 8 779 | 2019 | 78 959 |
| 2002 | 15 085 | 2020 | 82 870 |
| 2003 | 67 283 | 2021 | 73 884 |
| 2004 | 83 160 | 2022 | 38 651 |
| 2005 | 106 590 | 2023 | 11 819 |
| 2006 | 108 920 | 2024 | NO |
| 2007 | 175 719 | | |

The dips in the ferroalloys production activity data in 2001 of 85% and in 2009 of 64% and a jump in 2004 of 346% (approx. 4.5 times) and in 2010 of 121% (approx. 4.2 times), are due to several reasons for the fluctuation in the trend of ferroalloys production activity: the dip in 2001 was due to national war in Macedonia, in 2009 due to the economy crisis, and that also the two main companies have changed ownerships over the years and that this has influenced production.

Emission factors

For calculation of PM_{2.5}, PM₁₀ and TSP from 1990 to 2011 as well as 2015 coming from ferronickel and ferrosilicon manganese production, GB 2023 emission factors have been used.

Table 124 Emission factors for source category 2.C.2 - Ferroalloys production – production of ferronickel for historical data

| Pollutant | Value | Unit | References |
|-------------------|-------|---------------------|--|
| PM ₁₀ | 850 | g/Mg alloy produced | GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7 |
| PM _{2.5} | 600 | g/Mg alloy produced | GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7 |
| TSP | 1000 | g/Mg alloy produced | GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7 |
| BC | 10 | % PM _{2.5} | GB 2023 Table 3.1 Tier 1 emission factors for source category 2.C.2 Ferroalloys production pg. 7 |

For the estimation of emissions coming from the ferrosilicon production, due to the huge difference of the calculated emissions with the use of EF and emission measurements data, as well as no implementation of BAT in this installation, implied EF for TSP has been used, while EF for PM₁₀ and PM_{2.5} have been calculated as 0.85 and 0.60 of TSP Emission factor value. These emission factors are presented in the following table.

Table 125 Implied emission factors for 2.C.2 Ferroalloys production – production of ferrosilicon for historical data

| Pollutant | Value | Unit |
|-------------------|-------|----------------------|
| PM ₁₀ | 244.8 | kg/Mg alloy produced |
| PM _{2.5} | 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 PM_{2.5} emissions coming from this installation were calculated using the emission factors presented in the Table 128 above. For 2015, since no measurements were delivered by the company, TSP, PM₁₀ and PM_{2.5} emissions coming from ferrosilicon production were calculated using the emission factors presented in Table 129. For 2016, measurement data for TSP emissions as well as, activity data for ferrosilicon produced was made available by the operator. The emissions of PM₁₀ and PM_{2.5} 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 activity data for ferronickel production for the period 2005-2024 is used. 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.

5.5.2.2. 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. 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.

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

No recalculations were carried out in this category.

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

A calculation of emissions from ferronickel production from 2005 to 2023 is planned using emission factors from Table 127 due to the lack of continuous monitoring of TSP for its accurate calculation.

5.5.3. Aluminum production – NFR 2.C.3

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

5.5.3.1. Methodological Issues

Activity Data

The activity data were taken from the Statistical Yearbooks 1990-2020 and for the period 2007-2019 from the installation for secondary aluminum production named RZ Institute Skopje. For the period 2020 and 2022 there is no activity data from RZ Institute Skopje because this installation has gone bankrupt. Type of activity data used for emission estimation is presented in the following list.

| | |
|--------------------|---|
| 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 126 Activity data for source category 2.C.3 - Aluminum production

| Year | Aluminum and aluminum products [t] | Year | Aluminum and aluminum products [t] |
|-------------|------------------------------------|-------------|------------------------------------|
| 1990 | 8 841 | 2008 | 1 531 |
| 1991 | 7 829 | 2009 | 1 637 |
| 1992 | 5 150 | 2010 | 1 897 |

| Year | Aluminum and aluminum products [t] | Year | Aluminum and aluminum products [t] |
|------|------------------------------------|------|------------------------------------|
| 1993 | 4 819 | 2011 | 2 079 |
| 1994 | 4 991 | 2012 | 1 870 |
| 1995 | 3 709 | 2013 | 1 245 |
| 1996 | 3 924 | 2014 | 812 |
| 1997 | 5 561 | 2015 | 161 |
| 1998 | 5 850 | 2016 | 122 |
| 1999 | 10 777 | 2017 | 382 |
| 2000 | 7 641 | 2018 | 278 |
| 2001 | 6 809 | 2019 | 857 |
| 2002 | 10 516 | 2020 | NE |
| 2003 | 8 573 | 2021 | NE |
| 2004 | 1 679 | 2022 | NE |
| 2005 | 1 489 | 2023 | NE |
| 2006 | 2 316 | 2024 | NE |
| 2007 | 1 757 | | |

Noted jumps in the activity data of secondary aluminium production in 1999 of 84% and in 2002 of 54% and a dip in 2004 of 80%, by ERT are due to the changes in production capacity, and that the major company was closed in March 2004.

Emission factors

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

Table 127 Emission factors for source category 2.C.3 - Secondary Aluminum production

| Pollutant | Value | Unit | References |
|-----------|-------|---------------------|--|
| TSP | 2 | kg/Mg aluminum | GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15 |
| PM10 | 1.4 | kg/Mg aluminum | GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15 |
| PM2.5 | 0.55 | kg/Mg aluminum | GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15 |
| BC | 2.3 | % of PM2.5 | GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15 |
| PCDD/F | 35 | µgI-TEQ/Mg aluminum | GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15 |
| HCB | 5 | g/Mg aluminum | GB 2023 Tier 1, 2.C.3 Aluminum production. Secondary production. Table 3-4. pg. 15 |

5.5.3.2. Source-specific uncertainties and time-series consistency

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

5.5.3.3. Source-specific QA/QC and verification

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

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

No recalculations were made 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 128 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* | 2008 | NO | 21***** |
| 1991 | 33 938* | 19 265* | 2009 | NO | 39***** |
| 1992 | 27 860* | 23 341* | 2010 | NO | NE |
| 1993 | 23 575* | 21 881* | 2011 | NO | NE |
| 1994 | 20 569* | 20 965* | 2012 | NO | NE |
| 1995 | 24 007* | 22 490* | 2013 | NO | NE |
| 1996 | 29 259* | 23 584* | 2014 | NO | NE |
| 1997 | 30 508* | 26 046* | 2015 | NO | 2 648 |
| 1998 | 29 242* | 28 415* | 2016 | NO | 4 472 |
| 1999 | 27 086* | 19 738* | 2017 | NO | 7 486 |
| 2000 | 19 000** | 17 137*** | 2018 | NO | 10 576 |

| Year | Lead, Primary (t) | Lead, Secondary (t) | Year | Lead, Primary (t) | Lead, Secondary (t) |
|------|-------------------|---------------------|------|-------------------|---------------------|
| 2001 | 19 000** | 13 543*** | 2019 | NO | 10 962 |
| 2002 | 19 000** | 11 934**** | 2020 | NO | 10 339 |
| 2003 | 19 000** | 6 357**** | 2021 | NO | 10 339 |
| 2004 | NO | 3 591**** | 2022 | NO | 11 747 |
| 2005 | NO | 34***** | 2023 | NO | 7503 |
| 2006 | NO | 46***** | 2024 | NO | 10283 |
| 2007 | NO | 18***** | | | |

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 2023. These emission factors are presented in the following two tables.

Table 129 Emission factors for source category 2.C.5 - Primary Lead production

| Pollutant | Value | Unit | References |
|-----------|-------|------------------|---|
| TSP | 560 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| PM10 | 450 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| PM2.5 | 225 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| Pb | 150 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| Cd | 0.8 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| Hg | 1 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| As | 0.18 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| PCDD/F | 5 | µg I-TEQ/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |
| PCBs | 1.9 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, primary lead production, unabated, Table 3.2, pg. 14 |

Table 130 Emission factors for source category 2.C.5 – Secondary Lead production 1990-2009

| Pollutant | Value | Unit | References |
|-----------|--------|-----------|--|
| TSP | 14 800 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| PM10 | 11 800 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| PM2.5 | 8 800 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |

| Pollutant | Value | Unit | References |
|-----------|-------|------------------|--|
| Pb | 5 800 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| Cd | 15 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| As | 47 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| Zn | 35 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| PCDD/F | 8 | µg I-TEQ/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |
| PCBs | 3.2 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production, unabated, Table3-4, pg. 16 |

Table 131 Emission factors for source category 2.C.5 - Secondary Lead production for 2010-2024

| Pollutant | Value | Unit | References |
|-----------|-------|------------------|--|
| TSP | 20 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| PM10 | 16 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| PM2.5 | 8 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| SOx | 5000 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| Pb | 1.1 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| Cd | 0.05 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| As | 0.3 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| Zn | 0.05 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| PCBs | 2.6 | g/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |
| PCDD/F | 3.2 | µg I-TEQ/Mg lead | GB 2023 Tier 2 emission factors for source category 2.C.5 Lead production, secondary lead production assuming average technology in the EU-28, Table 3-5, pg. 17 |

5.5.4.2. Source-specific uncertainties and time-series consistency

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

5.5.4.3. Source-specific QA/QC and verification

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

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

Recalculations were carried out in this category for 2023 because of the new activity data for this year from the MAKSTAT database. Activity data for the whole reference period were received from the GHG emission inventory team and crosschecked with data used in this inventory in the frame of expert mission in the frame of IPA II air quality project.

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

No planned improvements in this category.

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 1990-2024*, 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 132 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 | 52 000** | NO |
| 2001 | 52 000** | NO |
| 2002 | 56 000** | NO |
| 2003 | 28 000** | NO |
| 2004 | 25 000** | NO |

| Year | Primary Zinc (t) | Secondary zinc (t) |
|------|------------------|--------------------|
| 2005 | NO | NO |
| 2006 | NO | NO |
| 2007 | NO | NO |
| 2008 | NO | NO |
| 2009 | NO | NO |
| 2010 | NO | NO |
| 2011 | NO | NO |
| 2012 | NO | NO |
| 2013 | NO | NO |
| 2014 | NO | NO |
| 2015 | NO | NO |
| 2016 | NO | NO |
| 2017 | NO | NO |
| 2018 | NO | NO |
| 2019 | NO | NO |
| 2020 | NO | NO |
| 2021 | NO | NO |
| 2022 | NO | NO |
| 2023 | NO | NO |
| 2024 | NO | NO |

Emission factors

Emission factors for primary lead production and secondary zinc production were taken from GB 2023. These emission factors are presented in the following two tables.

Table 133 Emission factors for source category 2.C.6 - Primary Zinc production

| Pollutant | Value | Unit | References |
|-----------|-------|------------------|--|
| TSP | 210 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| PM10 | 170 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| PM2.5 | 130 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| Pb | 35 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| Cd | 5 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| Hg | 5 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| Zn | 80 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| PCBs | 0.9 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |
| PCDD/F | 5 | µg I-TEQ/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.2. pg. 15 |

Table 134 Emission factors for source category 2.C.6 - Secondary Zinc production

| Pollutant | Value | Unit | References |
|-----------|-------|-----------|--|
| TSP | 425 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| PM10 | 340 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| PM2.5 | 255 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| Pb | 65 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| Cd | 35 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| Hg | 0.006 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |

| Pollutant | Value | Unit | References |
|-----------|--------|------------------|--|
| As | 5.9 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| Zn | 150 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| PCBs | 0.0031 | g/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |
| PCDD/F | 100 | µg I-TEQ/Mg zinc | GB 2023 2.C.6 Zinc production. Table 3.4. pg. 17 |

5.5.5.2. Source-specific uncertainties and time-series consistency

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

5.5.5.3. Source-specific QA/QC and verification

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

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

No recalculations were carried out in this category.

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

No improvements are planned in this category.

5.5.6. Copper production –NFR 2.C.7 a

Copper is produced from primary and secondary raw materials.

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

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

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

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

5.5.6.1. Methodological Issues

Activity Data

Activity data is available for secondary copper production (from the installation that has that production), for the period 2007-2019. No production is occurring during period 2020-2024.

Table 135 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 |
| 2021 | NO | NE |
| 2022 | NO | NE |
| 2023 | NO | NE |
| 2024 | NO | NE |

Emission factors

Emission factors for secondary copper production are taken from GB 2023. These emission factors are presented in the following table.

Table 136 Emission factors for source category 2.C.6 - Secondary Copper production

| Pollutant | Value | Unit | References |
|-----------|-------|-------------|--|
| TSP | 320 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |

| Pollutant | Value | Unit | References |
|-----------|-------|--------------------|--|
| PM10 | 250 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| PM2.5 | 190 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| BC | 0.1 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| SOx | 1 320 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| Pb | 24 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| Cd | 2.3 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| As | 2 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| Cu | 28 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| Ni | 0.13 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| PCBs | 3.7 | g/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |
| PCDD/F | 50 | µg I-TEQ/Mg copper | GB 2023 2.C.7.a Copper production. Tier 2. Table 3.3. pg. 13 |

5.5.6.2. Source-specific uncertainties and time-series consistency

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

5.5.6.3. Source-specific QA/QC and verification

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

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

No recalculations were done for this NFR category.

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

No planned activities in this category.

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 137 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 138 Emission factors for 2.C.7.c - Other Metals production

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

5.5.7.2. Source-specific uncertainties and time-series consistency

This category includes TSP emissions only. Uncertainties have not yet been estimated for TSP emissions since this activity is not occurring since 1998.

5.5.7.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

No planned improvements 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.

5.6.1.1. Methodological issues

The Tier 1 method has been applied for period 1990-2004. This method assumes an averaged or typical technology and abatement implementation in the country and includes an integrated emission factor and emission factors for sub-processes within the source category. It is applied at a national level, using the population data. Tier 2 method was applied for the period 2005-2023 due to available activity data in the SSO publications. During the stage 3 review the ERT recommended the Party to move to the Tier 2 method for the next submission or as soon as possible or meanwhile to include this improvement into the improvement plan with clear steps and schedule and to report on progress of the work in the next submissions. Therefore, in this category according to the recommendation available data from production and import – export was gathered. Calculated activity data (production+import)-export were used for calculation of emissions coming from Cosmetics and toiletries (Perfume or room deodorizers, Toilet waters, Hair sprays) Shaving lotions, before shaving and after shaving, Other body care cosmetics - lotions, creams, including baby care products Soaps and other body cosmetics;) Car care products (antifriz); Households products (Washing and cleaning products for machine for hands wash, Pastes, powders and other cleaning preparations and Policies, creams and similar preparations for the maintenance of woodwork) and pesticides (Insecticides, rodenticides, fungicides, herbicides). In case of pharmaceutical products, the population was used as activity data.

Activity Data

Table 139 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 140 Activity data for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types for period 2005-2024 using Tier 2 methodology

| Year | Cosmetics and toiletries (all)[kg] | Car care products (all) [kg] | Households' products (all) [kg] | Pesticides [kg] | Population |
|------|------------------------------------|------------------------------|---------------------------------|-----------------|------------|
| 2005 | 2976576 | NE | 17540231 | 2285000 | 2038514 |
| 2006 | 7130576 | NE | 12664627 | 2285000 | 2041941 |
| 2007 | 8787562 | 33000 | 19415000 | 2318000 | 2045177 |
| 2008 | 7357406 | 7000 | 24636000 | 2768000 | 2048619 |
| 2009 | 6069440 | 34000 | 22674000 | 1522000 | 2052722 |
| 2010 | 11875502 | 204000 | 26796000 | 1648000 | 2057284 |
| 2011 | 10143673 | 18000 | 26796000 | 2378000 | 2059794 |
| 2012 | 7860433 | 1650553 | 31701757 | 1841549 | 2062294 |
| 2013 | 8016920 | 1415169 | 31357189 | 1867702 | 2065769 |
| 2014 | 8748658 | 1542853 | 32139836 | 1991441 | 2069172 |
| 2015 | 9294805 | 1720015 | 34439775 | 2053650 | 2071278 |
| 2016 | 9204934 | 1971099 | 35923836 | 1991441 | 2073702 |
| 2017 | 9508722 | 2283249 | 36668778 | 2146356 | 2075301 |
| 2018 | 10222125 | 2014718 | 39191712 | 1862376 | 2077132 |
| 2019 | 10377830 | 2527605 | 38717511 | 1969119 | 2076255 |
| 2020 | 10955857 | 2010092 | 40304000 | 2394361 | 2068808 |
| 2021 | 9861861 | 1873117 | 36845148 | 2372857 | 1837713 |
| 2022 | 8788029 | 1979074 | 36432703 | 1732368 | 1836714 |
| 2023 | 9453509 | 2259178 | 39994685 | 1799547 | 1826247 |
| 2024 | 8764555 | 1990169 | 41560432 | 2309304 | 1822612 |

Emission factors

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

Table 141 Emission factors for the source category 2.D.3.a - Domestic solvents use including fungicides

| Pollutant | Methodology | Value | Unit | | References |
|-----------|-------------|-------|----------------|--------------------------------|---|
| NMVOC | Tier 2 | 127 | g/kg product | Cosmetics and toiletries (all) | GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types p.16 |
| NMVOC | Tier 2 | 180 | g/kg product | Car care products (all) | GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16 |
| NMVOC | Tier 2 | 48 | g/person | Pharmaceutical | GB 2023 Table 3.5 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.17 |
| NMVOC | Tier 2 | 16 | g/kg product | Households products (all) | GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16 |
| NMVOC | Tier 2 | 150 | g/kg product | Pesticides | GB 2023 Table 3.4 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use p.16 |
| NMVOC | Tier 1 | 1.2 | kg/person/year | Persons | GB 2023 3.D.2 Domestic solvent use including fungicides. Table 3.1, pg. 9 |

5.6.1.2. Source-specific uncertainties and time-series consistency

The activity data uncertainty for 2.D was estimated to be 20% according to expert judgment; the emission factor uncertainty was estimated to be 125% (rating C) for NMVOC and 40% (rating B) for PM2.5 based on EMEP Guidebook.

Population number is taken from statistical publications and MAKSTAT database as estimated data, but there is uncertainty of these activity considering that the population census has been carried out four times in 1991, 1994, 2002 and 2021, while for the other years estimated numbers were used. The use of disinfectants is higher during Covid pandemic, however due to the fact that populations instead of pharmaceutical products is used as activity data this pick is not recognized.

5.6.1.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

Recalculations for historical emissions in the period 1990-2004 for methodology consistency during the whole time period.

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.

Due to the non-completeness of the activity data, the emissions of these pollutants and the contribution of this sector in the national total may be underestimated.

5.6.2.1. Methodological issues

To estimate emissions from road paving with asphalt, the following general equation has been applied:

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

where:

$E_{\text{pollutant}}$ = the emission of the specified pollutant,

$AR_{\text{production}}$ = the activity rate (data) for the road paving with asphalt,

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

Activity data

The operators themselves have gathered activity data. Data from several asphalt production companies in 2016 delivered data on produced asphalt. For the period 2010-2024, activity data are taken from Statistical yearbook – Chapter Construction [22]. Summarized data on national asphalt using were used as activity data for estimation of emissions in this sector. The activity data for this sector may be underestimated, especially for the historical years, due to incomplete statistical data on asphalt production and using, as well as change of ownership and close of some of the asphalt production companies. The activity data are presented in the following table.

Table 142 Activity data for source category 2.D.3.b - Road paving with asphalt

| Year | Asphalt produced (t) | Year | Asphalt produced or used (t) |
|------|----------------------|------|------------------------------|
| 1990 | 86 320 | 2008 | 170 049 |
| 1991 | 74 296 | 2009 | 232 001 |
| 1992 | 44 067 | 2010 | 286 728 |
| 1993 | 65 194 | 2011 | 230 107 |
| 1994 | 84 729 | 2012 | 259 388 |
| 1995 | 87 814 | 2013 | 317 300 |

| Year | Asphalt produced (t) | Year | Asphalt produced or used (t) |
|------|----------------------|------|------------------------------|
| 1996 | 98 545 | 2014 | 372 099 |
| 1997 | 53 600 | 2015 | 386 451 |
| 1998 | 101 563 | 2016 | 342 672 |
| 1999 | 136 540 | 2017 | 461 664 |
| 2000 | 327 937 | 2018 | 527 798 |
| 2001 | 137 305 | 2019 | 522 926 |
| 2002 | 119 651 | 2020 | 565 780 |
| 2003 | 124 492 | 2021 | 563 440 |
| 2004 | 149 323 | 2022 | 540 391 |
| 2005 | 180 559 | 2023 | 560 991 |
| 2006 | 130 847 | 2024 | 845 354 |
| 2007 | 101 508 | | |

ERT noted a jump in all emissions in 2000 of 145% (approx. by 2.4 times) in road paving with asphalt. To a question on the issue North Macedonia answered that in the statistics the length of roads is the highest in 2000. The increased amount of asphalt in 2024 compared to previous years (more than 50%) is due to the increased volume of construction activities in civil engineering in the state (construction of highways and regional roads).

Emission factors

Emission factors for estimation of emissions in this source category are presented in the following table. Until 2015 the installations for asphalt production had A-permit with adjustment plan and from that year they build fabric filters with abatement efficiency of 99 %. Due to fact that these types of installations have installed abatement technology started from 2015, a new methodology for calculation of TSP, PM10 and PM2.5 emissions was used.

Table 143 Emission factors for source category 2.D.3.b - Road paving with asphalt

| Pollutant | Value | Unit | References |
|-----------|--------|--------------|--|
| NM VOC | 16 | g/Mg asphalt | GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9 |
| TSP | 14 000 | g/Mg asphalt | GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9 |
| PM10 | 3 000 | g/Mg asphalt | GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9 |
| PM2.5 | 400 | g/Mg asphalt | GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9 |
| BC | 5.7 | % PM2.5 | GB 2023 2.D.3.b Road paving with asphalt. Table 3.1. pg. 9 |

5.6.2.2. Source-specific uncertainties and time-series consistency

The inconsistency of the emissions in this sector comes from the fact that incomplete statistical data on asphalt production, as well as change of ownership and closedown of some of the asphalt production companies. No specific uncertainty analysis was done for this category.

5.6.2.3. Source-specific QA/QC and verification

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

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

No recalculations were made in this category for this category.

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

No planned improvements in this category.

5.6.3. Asphalt roofing NFR 2.D.3.c

The source category covers emissions from the asphalt roofing industry. The industry manufactures saturated felt, roofing and siding shingles, and roll roofing and sidings. Most of these products are used in roofing and other building applications.

5.6.3.1. Methodological issues

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

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

where:

$E_{\text{pollutant}}$ = the emission of the specified pollutant,

$AR_{\text{production}}$ = the activity rate (data) for the asphalt roofing,

$EF_{\text{pollutant}}$ = 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 2005-2024, 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 144 Activity data for source category 2.D.3.c - Asphalt roofing

| Year | Asphalt roofing products (t) | Year | Asphalt roofing products (t) |
|-------|------------------------------|------|------------------------------|
| 1990 | 12 572 | 2008 | 14 401 |
| 1991 | 12 593 | 2009 | 18.783 |
| 1992 | 5 325 | 2010 | 14 908 |
| 1993 | 4 067 | 2011 | 25 145 |
| 1994 | 5 901 | 2012 | 17 727 |
| 1995 | 8 873 | 2013 | 13 676 |
| 1996 | 5 992 | 2014 | 6 814 |
| 1997 | 6 442 | 2015 | 10 146 |
| 1998 | 5 489 | 2016 | 14 402 |
| 1999 | 13 429 | 2017 | 15 183 |
| 2000* | 13 075 | 2018 | 17 114 |

| Year | Asphalt roofing products (t) | Year | Asphalt roofing products (t) |
|-------|------------------------------|------|------------------------------|
| 2001* | 12 525 | 2019 | 15 699 |
| 2002* | 12 104 | 2020 | 15 175 |
| 2003* | 11 668 | 2021 | 18 119 |
| 2004* | 12 458 | 2022 | 17 563 |
| 2005 | 11 305 | 2023 | 18 879 |
| 2006 | 9 773 | 2024 | 22 949 |
| 2007 | 12 164 | | |

*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 2005-2024 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 2005-2024 in tons

| | |
|--------------------|--|
| 1990 – 1999 | Roof patch, Bitumen paper and jute; Bituminous products for building; |
| 2005 – 2024 | 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 145 Emission factors for source category 2.D.3.c - Road paving with asphalt

| Pollutant | Value | Unit | References |
|-----------|-------|--------------|---|
| CO | 9.5 | g/Mg shingle | GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7 |
| NMVOC | 130 | g/Mg shingle | GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7 |
| TSP | 1 600 | g/Mg shingle | GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7 |
| PM10 | 400 | g/Mg shingle | GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7 |
| PM2.5 | 80 | g/Mg shingle | GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7 |
| BC | 0.013 | % PM2.5 | GB 2023 2.D.3.c Asphalt roofing. Table 3.1. pg. 7 |

5.6.3.2. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was done for this category. The inconsistency in this sector is due to use of different sources for the activity data in different period.

5.6.3.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

No planned improvements in this category.

5.6.4. Coating application – NFR 2.D.3.d

Coating applications in North Macedonia include emissions from quantity of paint applied in the industrial applications, other industrial applications and domestic application and this category is source of NMVOC emissions.

Methodological Issues

Until previous year the methodology used for estimation of emissions in this sector was Croatian methodology represented in their national Informative Inventory Report, 2012 [42]. During this year in the frame of the IPA II Air quality project. NMVOC emissions are calculated by applying appropriate emission factors to the activity data, considering the type of paint, application technique, and level of emission control. Emission reductions are considered in line with the implementation of the European Solvents Directive (1999/13/EC), including measures such as reformulation of paints (low-solvent or powder coatings), improvements in application processes (e.g. electrostatic spraying), and the use of end-of-pipe abatement technologies (e.g. carbon adsorption, thermal and catalytic oxidation).

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 2016–2024 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 2016–2024, the data on the quantities of imported and exported paint was taken from MAKSTAT database [31]. The activity data for paint application are compiled using a combination of national statistics and international databases. For the period 2005–2015, data on paint production are derived from national publications on industry, while data for 2016–2022 are obtained from the MAKSTAT database. Import and export data for paints are taken from external trade statistics for the period 2006–2022. For earlier years (1990–2004), production data are sourced from the Statistical Yearbooks.

Due to missing data on imports and exports for the period 1990–2005, a gap-filling approach is applied following the EMEP/EEA methodology. Surrogate indicators are used, specifically the shares of imports and exports of goods and services as a percentage of GDP, obtained from international datasets (e.g.

World Development Indicators). These proxies are applied to estimate missing trade data and ensure time-series consistency.

Total paint consumption (applied paint) is calculated as the sum of domestic production and imports minus exports. Where inconsistencies or gaps are identified, adjustments are made to align the data with national trends and ensure a consistent time series.

The total paint applied is further disaggregated by technology and application type using GAINS model information. Four main categories are considered: decorative paints (DECO-P), industrial paints for general industry (IND_P_OT), vehicle refinishing (VEHR_P), and new vehicle painting (VEHR_P_NEW). The GAINS model provides technology splits at five-year intervals for the period 1990–2050; intermediate years are estimated using interpolation.

In cases where direct activity data for specific technologies are not available, the distribution of technologies is estimated using proxy indicators such as production capacity, number of employees, or other relevant structural data reflecting the relative importance of each technology.

Table 146 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 | 9.285 | 867 | 281 |
| 1991 | 8.453 | 789 | 262 |
| 1992 | 10.451 | 976 | 331 |
| 1993 | 9.423 | 880 | 305 |
| 1994 | 8.208 | 766 | 271 |
| 1995 | 7.441 | 695 | 251 |
| 1996 | 6.871 | 642 | 237 |
| 1997 | 7.094 | 662 | 250 |
| 1998 | 7.160 | 669 | 257 |
| 1999 | 6.987 | 652 | 256 |
| 2000 | 7.984 | 746 | 298 |
| 2001 | 7.169 | 717 | 293 |
| 2002 | 6.381 | 687 | 287 |
| 2003 | 6.055 | 706 | 302 |
| 2004 | 5.561 | 707 | 310 |
| 2005 | 3.675 | 515 | 231 |
| 2006 | 3.008 | 434 | 198 |
| 2007 | 3.160 | 470 | 218 |
| 2008 | 3.143 | 482 | 228 |
| 2009 | 2.528 | 401 | 193 |
| 2010 | 2.739 | 449 | 221 |
| 2011 | 2.984 | 493 | 235 |
| 2012 | 3.559 | 592 | 275 |

| Year | Industrial application | Decorative application | Other industrial application |
|------|------------------------|------------------------|------------------------------|
| | Paint [kg] | Paint [kg] | Paint [kg] |
| 2013 | 3.416 | 573 | 257 |
| 2014 | 3.276 | 553 | 241 |
| 2015 | 3.353 | 571 | 240 |
| 2016 | 3.133 | 533 | 222 |
| 2017 | 2.720 | 463 | 190 |
| 2018 | 2.558 | 435 | 176 |
| 2019 | 2.666 | 454 | 181 |
| 2020 | 2.524 | 430 | 169 |
| 2021 | 2.672 | 454 | 183 |
| 2022 | 2.613 | 443 | 184 |
| 2023 | 2.833 | 480 | 205 |
| 2024 | 2.625 | 444 | 194 |

Emission factors

Emission factors for Tier 1 method from GB 2023 are presented in the following table:

Table 147 Emission factors for source category 2.D.3.d - Coating application

| Pollutant | Value | Unit | References |
|---|-------|--------------------|--|
| NM VOC (Decorative coating application) | 150 | g/kg paint applied | GB 2023 Table 3-1 Tier 1 emission factors for source category 2.D.3.d Decorative coating application |
| NM VOC (Industrial coating application) | 400 | g/kg paint applied | GB 2023 Table 3-2 Tier 1 emission factors for source category 2.D.3.d Industrial coating application |
| NM VOC (Other coating application) | 200 | g/kg paint applied | GB 2023 Table 3-3 Tier 1 emission factors for source category 2.D.3.d other coating application |

5.6.4.1. Source-specific uncertainties and time-series consistency

No specific uncertainty analysis was carried out 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

Recalcualtions were done for the whole time due to change of methodology and use of Tier 2 model based on GAINS data.

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

No planned improvments.

5.6.5. Degreasing - NFR 2.D.3.e

Degreasing is a process of cleaning products from water-insoluble substances, such as grease, fats, oils, waxes, carbon deposits, fluxes and tars. In most cases, the process is applied to metal products, but also plastic, fiberglass, printed circuit boards and other products are treated by the same process. The metal-working industries are the major users of solvent decreasing. Industrial metal decreasing with organic solvents takes place in specially designed cleaning equipment. Emission limits required by the Solvents Emissions Directive 1999/13/EC can only be achieved by using hermetically sealed cleaning equipment. This leads to a significant reduction in emissions and increased workplace safety. Metal degreasing takes place in either open-top or closed tanks. The open-top tanks, however, have been phased out in the European Union due to the Solvents Emissions Directive 1999/13/EC. Only small facilities, using not more than 1 or 2 tonnes of solvent per year (depending on the risk profile of the solvent) are still allowed to use open-top tanks. The most common organic solvents for vapour cleaning are methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL). Degreasing results in NMVOC emission.

5.6.5.1. Methodological issues

For the calculation of NMVOC emissions, the consumption of the most common organic solvents for degreasing was used (according to GB2023). Data on quantities of the most common organic solvents (import / export) for the years 2012 – onward, were taken from the MAKSTAT database. Data on production is not available in the MAKSTAT database. Because the production data are currently unavailable, data on Import of the cleaning products were taken as activity data for the NMVOC calculation. If the data on the production will be available in the future, then this data needs to be include in the NMVOC emission estimations. The calculation does include the organic solvent Trichlorethylene, Xylol and Dichloromethane. In addition to data from the MAKSTAT database (2012-onward), for the NMVOC emission calculation from this source for the period 1990-2011, expert judgement for the quantities of degreasing products based on GDP were used.

Activity Data

The activity data – number of populations for this source category have been updated with revised numbers from MAKSTAT database for the period 1994-2024, while for the period 1990-1993, data from the hard copy publications form SSO was used.

Table 148 Activity data for the source category 2.D.3.e Degreasing

| Year | Population number | Year | Population number |
|------|-------------------|------|-------------------|
| 1990 | 106364 | 2008 | 55499 |
| 1991 | 80393 | 2009 | 53907 |
| 1992 | 94292 | 2010 | 59787 |
| 1993 | 84416 | 2011 | 61351 |
| 1994 | 68965 | 2012 | 59897 |
| 1995 | 68410 | 2013 | 74960 |
| 1996 | 67671 | 2014 | 42058 |
| 1997 | 80135 | 2015 | 71349 |
| 1998 | 78859 | 2016 | 94886 |
| 1999 | 75563 | 2017 | 85738 |

| Year | Population number | Year | Population number |
|------|-------------------|------|-------------------|
| 2000 | 60822 | 2018 | 91638 |
| 2001 | 58493 | 2019 | 84281 |
| 2002 | 55059 | 2020 | 82885 |
| 2003 | 63896 | 2021 | 91731 |
| 2004 | 59776 | 2022 | 109404 |
| 2005 | 57855 | 2023 | 132777 |
| 2006 | 61550 | 2024 | 121848 |
| 2007 | 58477 | | |

Emission factors

Emission factor used for the calculation of NMVOC emissions coming from this category is presented below.

Table 149 Emission factor for source category 2.D.3.e Degreasing

| Pollutant | Value | Unit | References |
|-----------|-------|----------------------|--|
| NMVOC | 710 | kg/cleaning products | GB 2023 Table 3-2 Tier 2 emission factors for source category 2.D.3.e Degreasing, Open-top degreaser page 10 |

5.6.5.2. Source-specific uncertainties and time-series consistency

An EF by population does not reflect country-specific circumstances, real conditions, and habits of use, and gives increasing emissions when the population grows. In case population is estimated, this brings additional uncertainty to the emission levels

5.6.5.3. Source-specific QA/QC and verification

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

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

Recalculations were made for the whole time period due to use of higher Tier 2 methodology in previous submission in the frame of IPA II Air quality project.

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

No planned improvements.

5.6.5.6. Dry cleaning – NFR 2.D.3.f

Dry cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibers, using organic solvents. In general, dry-cleaning process can be divided into following steps: cleaning in a solvent bath, drying with hot air and recovery of solvent, deodorization (final drying) and regeneration of used solvent. Dry cleaning results in NMVOC emission.

Methodological issues

Emission calculation for this activity includes methodology based on the amount of solvent used (import/export/production) for dry cleaning.

The EMEP/EEA GB2023 assumes that the most widespread solvent used in dry cleaning, accounting for about 90 % of the total consumption, is tetrachloroethene (also called tetrachloroethylene or perchloroethylene (PER)). Data for import / export are available from the MAKSTAT database for the period since 2012. The production data are not available in the MAKSTAT database. Because the production data are currently unavailable, data on Import of the cleaning products were taken as an activity data for the NMVOC calculation. If the data on the production will be available in the future that this data need to be include in the NMVOC emission estimations.

Activity Data

Quantity of the Tetrachloroethylene 'perchloroethylene' for the period 1990-2024 is presented in table 150.

Table 150 Emission factor for the source category 2.D.3.f- Dry Cleaning

| Year | Perchloroethylene | Year | Perchloroethylene |
|------|-------------------|------|-------------------|
| 1990 | 111187 | 2008 | 58016 |
| 1991 | 84038 | 2009 | 56351 |
| 1992 | 98567 | 2010 | 62498 |
| 1993 | 88243 | 2011 | 64132 |
| 1994 | 72092 | 2012 | 62613 |
| 1995 | 71512 | 2013 | 43218 |
| 1996 | 70740 | 2014 | 51400 |
| 1997 | 83769 | 2015 | 45544 |
| 1998 | 82434 | 2016 | 50300 |
| 1999 | 78989 | 2017 | 45052 |
| 2000 | 63580 | 2018 | 58347 |
| 2001 | 61145 | 2019 | 42782 |
| 2002 | 57555 | 2020 | 54038 |
| 2003 | 66794 | 2021 | 62866 |
| 2004 | 62487 | 2022 | 58080 |
| 2005 | 60478 | 2023 | 60083 |
| 2006 | 64341 | 2024 | 35140 |
| 2007 | 61128 | | |

Emission factors

Since EF (NMVOC) for dry cleaning is shown in GB2023 as grams per kilogram of cleaned textiles, it is proposed using the following NMVOC emission calculation method: the second paragraph of Section 3.2.1. Dry Cleaning in GB2023 explains that solvent emissions directly from the cleaning machine into the air represent little more than 40 % for a closed-circuit machine, which is most likely the main type of machines currently used for dry cleaning. Open-circuit equipment may be in use somewhere in small quantities, but it was basically removed from the use around the 1990s. According to the previous explanation, it should be assumed that the EF for dry cleaning can be 400 g of NMVOC/kg solvent (for all years). The same method is applied in the Estonian and Croatian Inventories. In addition to data from the MAKSTAT database (2012-onward), for the NMVOC emission calculation from this

source for the period 1990-2011, expert judgement and estimates for the quantities of dry cleaning products based on GDP were used.

Emission factor is expressed as the amount of NMVOC emissions per annual amount of solvent used for dry cleaning.

Table 151 Emission factor for the source category 2.D.3.f- Dry Cleaning

| Pollutant | Value | Unit | References |
|-----------|-------|-----------------|--|
| NMVOC | 400 | kg/solvent/year | Informative Inventory Report for Croatia for 2025 [41] |

5.6.5.7. Source-specific uncertainties and time-series consistency

No specific uncertainties for this sector.

5.6.5.8. Source-specific QA/QC and verification

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

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

Recalculations were done for the whole time series due to use of higher Tier 2 methodology in the previous submission in the frame of the IPA II Air quality project.

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

No planned improvements.

5.6.6. Chemical products – NFR 2.D.3.g

This subchapter covers emissions from:

- polyurethane and polystyrene foam processing;
- asphalt blowing;
- tire production;
- specialty organic chemical industry;
- manufacture of paints, inks and glues;
- fat, edible and non-edible oil extraction;
- Industrial application of adhesives.

Emissions from manufacturing of chemical products include NMVOCs and NH₃. The chemical production in the country is variable, because after the fall of ex-Yugoslavia, the economy in our country experienced several shocks that damaged the local economy. The economy began to recover in 1995 and recovered only after 2001. This situation influenced the trend series emissions coming from the chemicals production branch.

5.6.6.1. Methodological issues

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

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

Where:

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

EF_{technology, pollutants} = the emission factor for this technology and these pollutants.

Activity Data

The activity data for this source category have been taken from the Statistical yearbook - chapter Industry, energy and construction for the period 1990-2004[22] and publication Industry in the Republic of North Macedonia for the period 2005-2006 [28] as well as MAKSTAT database for 2007-2024 [29]. For previous year submission historical data for leather tanning were calculated. Since there is no statistical data on raw hid used for the leather tanning in tones conversation factors for two period of time were applied to convert m² of skins (row hid) into tones. Conversation factor were prepared from the period 2009-2018 where there is statistical data on leather of bovine animals in tones and in m². For the period 1990-2008, conversion factors of 1,5 ton/1000m² was used, and for the period 2009-2024 conversion factors of 1 ton/1000m² was used. The activity data are presented in the following table.

Table 152 Activity data for source category 2.D.3.g - Chemical products

| Year | Polyester/kg | Polyurethane /kg | Polystyrene /kg | Leather tanning/kg | Paints. Inks and glues/kg | Asphalt blowing/ tones | Rubber Processing/kg and Manufacturing of tyres |
|------|--------------|------------------|-----------------|--------------------|---------------------------|------------------------|---|
| 1990 | 16 450 000 | NO | NO | 11 997 000 | NO | 12 500 | NO |
| 1991 | 12 440 000 | NO | NO | 11 3970 00 | NO | 12 500 | NO |
| 1992 | 11 150 000 | NO | 364 000 | 10 797 000 | NO | 12 500 | 1 355 000 |
| 1993 | 4 466 000 | NO | 382 000 | 10 197 000 | NO | 12 500 | 1 145 000 |
| 1994 | 8 628 000 | NO | 455 000 | 9 177 000 | NO | 12 500 | 978 000 |
| 1995 | 9 904 000 | NO | 378 500* | 10 119 500 | NO | 12 500 | 680 500* |
| 1996 | 3 212 000 | NO | 302 000 | 11 062 000 | NO | 12 500 | 383 000 |
| 1997 | 3 820 000 | NO | 363 000 | 7 491 000 | NO | 12 500 | 371 000 |
| 1998 | 2 642 000 | NO | 547 000 | 4 908 000 | NO | 12 500 | 417 000 |
| 1999 | NO | NO | NO | 3 842 667 | NO | 12 500 | NO |
| 2000 | NO | NO | NO | 3 310 000 | NO | 12 500 | NO |
| 2001 | NO | NO | NO | 2 777 333 | NO | 5 500 | NO |
| 2002 | NO | NO | NO | 2 244 667 | NO | 5 500 | NO |
| 2003 | NO | NO | NO | 1 712 000 | NO | 5 500 | NO |
| 2004 | NO | NO | NO | 1 179 333 | NO | 5 500 | NO |
| 2005 | NO | 1 095 000 | NO | 646 667 | 6 068 000 | 5 500 | NO |
| 2006 | NO | 1 405 000 | NO | 114 000 | 5 252 000 | 5 500 | NO |
| 2007 | NO | 1 129 000 | NO | 111 000 | 4 982 000 | 5 500 | NO |
| 2008 | NO | 1 239 000 | NO | 114 000 | 4 604 000 | 5 500 | NO |
| 2009 | NO | 1 132 000 | NO | 224 000 | 3 972 000 | 5 500 | NO |
| 2010 | NO | 1 033 000 | NO | 278 000 | 5 407 000 | 5 500 | NO |
| 2011 | NO | 1 059 000 | NO | 220 000 | 2 834 000 | 5 500 | NO |

| Year | Polyester/kg | Polyurethane /kg | Polystyrene /kg | Leather tanning/kg | Paints. Inks and glues/kg | Asphalt blowing/ tones | Rubber Processing/kg and Manufacturing of tyres |
|------|--------------|------------------|-----------------|--------------------|---------------------------|------------------------|---|
| 2012 | NO | 1 221 000 | NO | 132 000 | 1 914 000 | 5 500 | NO |
| 2013 | NO | 1 166 000 | NO | 119 000 | 1 306 000 | 5 500 | NO |
| 2014 | NO | 697 000 | NO | 98 000 | 817 000 | 5 500 | NO |
| 2015 | NO | NO | NO | 112 000 | 991 000 | 5 500 | NO |
| 2016 | NO | 896 000 | NO | 94 000 | 891 000 | 2 000 | NO |
| 2017 | NO | 1 633 000 | NO | 99 000 | 768 000 | 2 000 | NO |
| 2018 | NO | 2 429 000 | NO | 110 000 | 867 000 | 2 000 | NO |
| 2019 | NO | 2 670 000 | NO | 86 000 | 1 319 000 | 2 000 | NO |
| 2020 | NO | 2 815 000 | NO | 73 000 | 933 000 | 2 000 | NO |
| 2021 | NO | 4 844 000 | NO | 107 000 | 1 077 000 | 2 000 | NO |
| 2022 | NO | 4 285 000 | NO | 99 000 | 787 000 | 2 000 | NO |
| 2023 | NO | 4 729 000 | NO | 80 000 | 729 000 | 2 000 | NO |
| 2024 | NO | 4 628 000 | NO | 90 000 | 1 379 000 | 2 000 | NO |

*Data for chemical products in 1995 is based on Interpolation between the previous year and the next year. The value is the average of the previous year and the next year. For the other years, it is expected that no production occurs.

Emission factors

The emission factors which were used for calculation of emissions taken from GB 2023 for different types of activities. The emission factors are presented in the following table.

Table 153 Emission factors for source category 2.D.3.g - Chemical Products

| Pollutant | Value | Unit | References |
|-----------|--------|----------------------------------|---|
| NMVOC | 50 | g/kg polyester monomer used | GB 2023 2.D.3.g Chemical products. Table 3-2. pg. 17 |
| NMVOC | 120 | g/kg polyurethane foam processed | GB 2023 2.D.3.g Chemical products. Table 3-3. pg. 17-18 |
| NMVOC | 60 | g/kg polystyrene | GB 2023 2.D.3.g Chemical products. Table 3-4. pg. 18 |
| NMVOC | 8 | g/kg rubber produced | GB 2023 2.D.3.g Chemical products. Table 3-5. pg. 18-19 |
| NMVOC | 1710 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| TSP | 12000 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| Cd | 0.0001 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| As | 0.0005 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| Cr | 0.006 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| Ni | 0.05 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| Se | 0.0005 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 |

| Pollutant | Value | Unit | References |
|-----------------|-------|-------------------------------------|---|
| | | | Bitumen blowing, coating |
| PAH | 2.55 | g/Mg asphalt | GB 2023 2.D.3.g Chemical products. Table 3-10. pg. 21 Bitumen blowing, coating |
| NMVOC | 11 | g/kg products (paints. inks. glues) | GB 2023 2.D.3.g Chemical products. Table 3-11. pg. 22 |
| NMVOC | 0.045 | kg/pairs of shoes | GB 2023 2.D.3.g Chemical products. Table 3-13. pg. 23 |
| NH ₃ | 0.68 | g/kg raw hid (leather tanning) | GB 2023 2.D.3.g Chemical products. Table 3-14. pg. 24 |

5.6.6.2. Source-specific uncertainties and time-series consistency

No source-specific uncertainties were done for the sector; the emissions vary due to the unstable economy over the years.

5.6.6.3. Source-specific QA/QC and verification

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

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

No recalculations were made for this category.

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

No planned improvements.

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 1990-2024 since this data was not published in the statistical publications. Because the data has not been published so far, MEPP received a request by the SSO not to publish the activity data in the report. Therefore, this activity data is not presented in this report.

Emission factors

Emission factor for NMVOC has been taken from GB 2023 and is presented in table below.

Table 154 Emission factors for source category 2.D.3.h Printing

| Pollutant | Value | Unit | References |
|-----------|-------|----------|--|
| NMVOC | 500 | g/kg ink | GB 2023 Table 3-1 Tier 1 emission factors for source category 2.D.3.h Printing |

5.6.7.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.7.3. Source-specific QA/QC and verification

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

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

No recalculations were done in the sector.

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

No planned improvements in this sector.

5.6.8. Other solvent and product use – NFR 2.D.3.i and 2.G

NM VOC emissions are expected from this sector. Emissions from the following activities have been calculated in this source category:

- 060404 Fat, edible and non-edible oil extraction.
- 060406 Preservation of wood;
- 060602 Use of tobacco and
- 060603 Use of shoes
- 060604 Other solvent use and products - Aircraft de-icing; Use of fireworks

Under the NFR category 2.G we have reported emissions from Tobacco use (tones) and Use of shoes calculated from produced, imported, and exported products, and under 2.D.3.i emissions from Fat, edible and non-edible oil extraction and Preservation of wood have been included.

5.6.8.1. Methodological Issues

To calculate activity data for these categories Use of shoes and Tobacco consumption the following formula have been used $\text{Use of shoes/tobacco} = (\text{produced product} + \text{imported product}) - \text{exported product}$. Consumption of creosote has been calculated with the formula $75 \text{ kg creosote/m}^3 \text{ wood}$, where kg of wood preservative used was taken from the Statistical yearbooks. Regarding the activity Fat, edible and non-edible oil extraction statistics on different vegetable oil types have been used for estimation of seed quantity.

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 2016-2024 data from MAKSTAT database were used [29]. Data for deicing were gathered from both airports in Skopje and Ohrid. The deep that is visible in 2009 and jump in the 2012 are according to the produce parquet and wood packaging; the variable trend may be due to the economic reasons and not stable production in this sector. Data for the activity Use of fireworks and concrete additives which fall under the scope of NFR 2G were gathered for the time period 2002-2024. For the calculation of missing AD for the period from 1990 to 2006 surrogate method is used. Surrogate data is Industry (including construction), value added (% of GDP).

The activity data are presented in the following table.

Table 155 Activity data for the source category 2.D.3.i and 2.G - Other solvent and product use

| Year | Tobacco [tones] | Creosote [kg] | Fat, edible and non-edible oil extraction-seed [kg] | Pairs of shoes | Use of fireworks [tones] | Concrete additive [tones] | Deicing |
|------|-----------------|---------------|---|----------------|--------------------------|---------------------------|---------|
| 1990 | 26 481 | 261 440 | 38 303 | 6 638 000 | 4362 | 6701 | NE |
| 1991 | 16 576 | 209 583 | 39 190 | 4 049 000 | 3297 | 5065 | NE |
| 1992 | 22 297 | 241 980 | 32 975 | 3 667 000 | 3867 | 5940 | NE |
| 1993 | 25 964 | 197 934 | 30 218 | 2 308 000 | 3462 | 5318 | NE |
| 1994 | 21 143 | 163 377 | 47 598 | 1 529 000 | 2828 | 4345 | NE |
| 1995 | 16 152 | 123 016 | 30 990 | 1 122 000 | 2805 | 4310 | NE |
| 1996 | 13 980 | 82 013 | 54 763 | 1 231 000 | 2775 | 4263 | NE |
| 1997 | 14 904 | 55 388 | 52 515 | 1 509 000 | 3286 | 5048 | NE |
| 1998 | 23 297 | 47 551 | 47 063 | 1 790 000 | 3234 | 4968 | NE |
| 1999 | 29 005 | 43 522 | 28 165 | 2 488 000 | 3099 | 4760 | NE |
| 2000 | 18 991 | 38 073 | 39 048 | 2 129 000 | 2494 | 3832 | 58 |
| 2001 | 26 110 | 127 308 | 38 388 | 1 073 000 | 2399 | 3685 | 28 |
| 2002 | 20 547 | 100 054 | 71 910 | 1 521 000 | 2258 | 3469 | 85 |
| 2003 | 25 689 | 111 090 | 64 698 | 1 799 000 | 2620 | 4025 | 53 |
| 2004 | 15 317 | 158 732 | 61 148 | 1 785 000 | 2451 | 3766 | 48 |
| 2005 | 2 721 | 86 241 | 59 138 | 1 590 000 | 2372 | 3645 | 36 |
| 2006 | 1 859 | 78 125 | 63 578 | 1 892 504 | 2524 | 3878 | 45 |
| 2007 | 996 | 68 738 | 61 973 | 2 121 404 | 2398 | 3684 | 45 |
| 2008 | 3 854 | 53 457 | 76 303 | 2 320 371 | 1835 | 4334 | 28 |
| 2009 | 4 893 | 11 184 | 75 020 | 3 142 440 | 1828 | 2220 | 58 |
| 2010 | 10413 | 58 775 | 78 368 | 2 957 658 | 2976 | 1473 | 70 |
| 2011 | 10 138 | 54 654 | 82 848 | 3 408 829 | 4410 | 1600 | 71 |
| 2012 | 3 151 | 144 749 | 80 805 | 3 388 013 | 4224 | 1388 | 55 |
| 2013 | 6 365 | 113 177 | 77 008 | 1 599 026 | 2585 | 1596 | 27 |
| 2014 | 11 133 | 82 300 | 83 258 | 3 876 229 | 3852 | 1441 | 35 |
| 2015 | 9 040 | 106 723 | 102 678 | 4 381 143 | 4190 | 2547 | 45 |
| 2016 | 6 425 | 83 275 | 101 118 | 4 355 002 | 2987 | 3120 | 75 |
| 2017 | 6 113 | 78 150 | 65 370 | 3 876 436 | 3281 | 3371 | 90 |
| 2018 | 12 674 | 89 210 | 76 733 | 1 700 692 | 3452 | 3087 | 113 |
| 2019 | 7 388 | 74 151 | 83 548 | 1 066 440 | 4268 | 2300 | 51 |
| 2020 | 7 956 | 88 288 | 74 978 | 926 875 | 4915 | 4765 | 1 |
| 2021 | 7 664 | 95 430 | 76 403 | 679 481 | 5123 | 4692 | 19 |
| 2022 | 1 009 | 87 228 | 75 215 | 780 253 | 5977 | 3306 | 65 |
| 2023 | 1 510 | 60 980 | 67 870 | 679 504 | 6069 | 4032 | 47 |
| 2024 | 2223 | 191 129 | 88 850 | 380 963 | 6264 | 4776 | 47 |

Emission factors

The Emission factors have been taken from GB 2023 and are presented in the following table.

Table 156 Emission factors for source category 2.D.3.i and 2.G - Other solvents and product use

| Pollutant | Activity | Value | Unit | References |
|-----------------------|--------------------|-------|------------------------|---|
| NO _x | Tobacco combustion | 1.8 | kg/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| NM VOC | Tobacco combustion | 4.84 | kg/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| NH ₃ | Tobacco combustion | 4.15 | kg/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| PM _{2.5} | Tobacco combustion | 27 | mg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| PM ₁₀ | Tobacco combustion | 27 | mg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| TSP | Tobacco combustion | 27 | mg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| BC | Tobacco combustion | 0.45 | % of PM _{2.5} | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| CO | Tobacco combustion | 55.1 | kg/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| Cd | Tobacco combustion | 5.4 | µg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| Ni | Tobacco combustion | 2.7 | µg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| Zn | Tobacco combustion | 2.7 | µg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| Cu | Tobacco combustion | 5.4 | µg/cigarette | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| PCDD/F | Tobacco combustion | 0.1 | µg I-TEQ/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| benzo(a) pyren | Tobacco combustion | 0.111 | g/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| benzo(b) fluoranthene | Tobacco combustion | 0.045 | g/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |

| Pollutant | Activity | Value | Unit | References |
|-------------------------|---|-------|------------------|---|
| benzo(k) fluoranthene | Tobacco combustion | 0.045 | g/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| Indeno (1.2.3-cd) pyren | Tobacco combustion | 0.045 | g/ton tobacco | GB 23 Table 3-15 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Tobacco combustion, pg.22,23 |
| NMVOC | Wood preservation. Creosote preservative type | 105 | g/kg creosote | GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17 |
| benzo(a) pyren | Wood preservation. Creosote preservative type | 1.05 | mg/kg creosote | GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17 |
| benzo(b) fluoranthene | Wood preservation. Creosote preservative type | 0.53 | mg/kg creosote | GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17 |
| benzo(k) fluoranthene | Wood preservation. Creosote preservative type | 0.53 | mg/kg creosote | GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17 |
| Indeno (1.2.3-cd) pyren | Wood preservation. Creosote preservative | 0.53 | mg/kg creosote | GB 23 Table 3-5 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Preservation of wood, Creosote preservative type, pg.17 |
| NMVOC | Manufacturing of shoes | 0.06 | kg/pair of shoes | GB 23 Table 3-16 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of Shoes, pg.24 |
| NMVOC | Fat. edible and non-edible oil extraction | 1.57 | g/kg seed | GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16 |
| PM2.5 | Fat. edible and non-edible oil extraction | 0.6 | g/kg seed | GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16 |
| PM10 | Fat. edible and non-edible oil extraction | 0.9 | g/kg seed | GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16 |
| TSP | Fat. edible and non-edible oil extraction | 1.1 | g/kg seed | GB 23 Table 3-4 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Fat, edible and non-edible oil extraction, pg.16 |
| NOx | Use of fireworks | 2060 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |

| Pollutant | Activity | Value | Unit | References |
|-----------|--------------------|---------|--------------|---|
| SOx | Use of fireworks | 3020 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| CO | Use of fireworks | 7150 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| PM2.5 | Use of fireworks | 51.940 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| PM10 | Use of fireworks | 99.920 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| TSP | Use of fireworks | 109.830 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| As | Use of fireworks | 1.33 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| Cd | Use of fireworks | 1.48 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| Cr | Use of fireworks | 15.6 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| Cu | Use of fireworks | 444 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| Hg | Use of fireworks | 0.057 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| Ni | Use of fireworks | 30 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| Pb | Use of fireworks | 784 | g/ t product | GB 23 Table 3-14 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of fireworks, pg.22 |
| NMVOC | Concreate additive | 260 | g/ t product | GB 23 Table 3-17 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Other, pg.24 |
| NMVOC | Cooling lubricant | 260 | g/ t product | GB 23 Table 3-17 Tier 2 emission factors for source category 2.D.3.i, 2.G Other solvent and product use, Other, Other, pg.24 |

5.6.8.2. Source-specific uncertainties and time-series consistency

No specific source uncertainty is done for the sector.

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

Recalculations were made in this category due to addition of activate data for use of fireworks and concrete adhesives in previous submission in the frame of IPA II Air quality project.

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

Additional investigation for needed activity data to calculate emissions from other activities like use of lubricants.

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 from Tier 2 approach has been used for calculating emissions from food and beverage industry:

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

Where:

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

$EF_{\text{technology, pollutants}}$ = the emission factor for this technology and these pollutants.

Activity Data

The activity data for this source category has been taken from the Statistical yearbook - chapter Industry, energy and construction for the period 1990-2004 and publication Industry in the Republic of North Macedonia for the period 2005-2023. The data on wine production for the period 1990-2004 on wine and spirits was presented in total and therefore a proportion was used to divide this type of product. Additionally, data on wine production was officially required from the Ministry of agriculture, forestry, and water supply, but they responded that they do not have such data available. They are revised available activity data for period 2007-2009 MAKSTAT database. Due to revised available activity data for white wine produced since 2007 there are data for wine and white wine. The activity data for the period 1990-2006 for wine is for total wine produced (unspecified color). The animal feed is decreasing because of the decrease of the number of animals (see Agriculture chapter). The production of sugar varies during the reported period because there is only one major company dealing with sugar production. The company stopped with operation in 2015, so this process is not occurring since. Also, for period 2007-2024 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 157 Activity data for source category 2.H.2 - Food and beverage industry

| 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 |

| 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 |
|------|------------|---------|-----------|-----------------|---------------|-----------------------------------|---------|--------------------------|---|---------|-----------|
| 1993 | 21 708 | 951 854 | 2 274 000 | NE | 143 034 | 1 972 | 6 677 | 7 128 | 12 602 | 85 379 | NE |
| 1994 | 23 710 | 724 974 | 2 347 290 | NE | 126 146 | 1 972 | 6 351 | 33 787 | 12 583 | 85 014 | NE |
| 1995 | 26 920 | 620 201 | 2 665 080 | NE | 126 583 | 1 972 | 7 205 | 29 375 | 12 308 | 84 901 | NE |
| 1996 | 40 040 | 622 223 | 3 963 960 | NE | 130 248 | 1 972 | 17 993 | 29 368 | 11 824 | 84 382 | NE |
| 1997 | 31 800 | 600 092 | 3 148 200 | NE | 105 754 | 1 972 | 35 183 | 27 800 | 11 426 | 83 817 | NE |
| 1998 | 24 790 | 578 212 | 2 454 210 | NE | 97 947 | 1 972 | 40 354 | 25 971 | 11 657 | 82 740 | NE |
| 1999 | 30 070 | 652 165 | 2 976 930 | NE | 97 946 | 1 972 | 43 039 | 26 512 | 12 296 | 81 184 | NE |
| 2000 | 27 820 | 659 829 | 2 754 180 | NE | 97 995 | 1 972 | 31 923 | 27 470 | 11 408 | 78 632 | 173 |
| 2001 | 43 900 | 622 181 | 4 346 100 | NE | 75 003 | 1 972 | 18 004 | 26 041 | 10 995 | 74 689 | 899 |
| 2002 | 37 960 | 637 894 | 3 758 040 | NE | 68 382 | 1 972 | 36 614 | 27 471 | 10 828 | 68 425 | 2686 |
| 2003 | 28 350 | 680 217 | 2 806 650 | NE | 61 474 | 1 972 | 33 334 | 29 835 | 10 454 | 58 606 | 2109 |
| 2004 | 12 424 | 717 496 | 516 000 | NE | 55 235 | 1 972 | 27 810 | 29 839 | 10 113 | 43 115 | 2600 |
| 2005 | 10 548 | 675 325 | 948 489 | NE | 77 025 | 1 734 | 36 815 | 28 264 | 8 051 | 45 654 | 3005 |
| 2006 | 11 831 | 669 648 | 703 005 | NE | 73 497 | 1 903 | 19 325 | 28 041 | 8 030 | 44 774 | 2931 |
| 2007 | 9 824 | 695 140 | 578 953 | 388 588 | 85 790 | 2 079 | 35 927 | 22 589 | 5 607 | 59 003 | 4 383 |
| 2008 | 7 608 | 702 382 | 707 271 | 436 981 | 81 198 | 2 240 | 43 731 | 26 156 | 6 938 | 65 124 | 4 365 |
| 2009 | 7 904 | 635 922 | 743 463 | 480 008 | 74 353 | 2 225 | 23 460 | 26 437 | 9 603 | 59 699 | 4 185 |
| 2010 | 11 284 | 631 371 | 661 793 | 401 546 | 72 434 | 2 387 | 37 998 | 28 644 | 25 419 | 62 492 | 4 338 |
| 2011 | 7 442 | 611 836 | 815 914 | 409 593 | 77 183 | 2 340 | 30 423 | 30 732 | 25 548 | 67 518 | 4 185 |
| 2012 | 10 341 | 633 621 | 591 291 | 457 824 | 62 695 | 2 228 | 21 414 | 35 473 | 30 144 | 68 723 | 4 214 |
| 2013 | 11 548 | 617 124 | 686 841 | 599 049 | 46 983 | 2 433 | 22 916 | 35 686 | 31 181 | 60 127 | 4 405 |
| 2014 | 9 847 | 640 948 | 396 630 | 399 351 | 47 553 | 2 339 | 12 085 | 32 155 | 31 150 | 62 919 | 3 894 |
| 2015 | 10 848 | 656 672 | 605 404 | 500 017 | 45 553 | 2 328 | NO | 31 278 | 39 532 | 63 808 | 4 160 |
| 2016 | 12 481 | 672 487 | 602 187 | 460 461 | 40 563 | 2 118 | NO | 32 125 | 36 303 | 64 751 | 4 609 |
| 2017 | 11 582 | 705 497 | 367 020 | 397 953 | 48 348 | 2 374 | NO | 30 706 | 36 374 | 59 968 | 4 239 |
| 2018 | 13 082 | 736 062 | 565 799 | 462 320 | 45 117 | 2 324 | NO | 34 916 | 37 656 | 57 528 | 4 306 |
| 2019 | 13 269 | 738 396 | 522 317 | 388 943 | 47 623 | 2 656 | NO | 26 947 | 37 495 | 56 670 | 4 344 |
| 2020 | 11 649 | 662 360 | 568 586 | 374 166 | 46 576 | 2 596 | NO | 25 421 | 38 144 | 47 119 | 4 100 |
| 2021 | 13 854 | 696 215 | 477 946 | 361 482 | 45 084 | 2 685 | NO | 27 310 | 36 269 | 45 266 | 4 258 |
| 2022 | 14 574 | 667 352 | 404 842 | 439 903 | 37 286 | 2 922 | NO | 24 999 | 31 312 | 43 986 | 4 096 |
| 2023 | 15 014 | 683 507 | 324 576 | 277 786 | 37 809 | 3 053 | NO | 23 009 | 34 391 | 39 782 | 4 102 |
| 2024 | 16 031 | 700 025 | 343 406 | 317 263 | 38 241 | 2 831 | NO | 23 973 | 33 573 | 38 570 | 3 920 |

Emission factors

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

Table 158 Emission factors for source category 2.H.2 - Food and beverages industry

| Pollutant | Value | Unit | References |
|-----------|-------|---|--|
| NMVOC | 15 | kg/hL alcohol(spirits) | GB 2023, 2.H.2 Food and beverages industry, Table 3-28, pg. 23 |
| NMVOC | 35 | g/hL beer | GB 2023, 2.H.2 Food and beverages industry, Table 3-27, pg. 22 |
| NMVOC | 80 | g/hL wine | GB 2023, 2.H.2 Food and beverages industry, Table 3-24, pg. 21 |
| NMVOC | 35 | g/hL white wine | GB 2023, 2.H.2 Food and beverages industry, Table 3-26, pg. 22 |
| NMVOC | 1 | kg/Mg animal feed | GB 2023, 2.H.2 Food and beverages industry, Table 3-22, pg. 20 |
| NMVOC | 10 | kg/Mg product (Margarine and solid cooking fats) | GB 2023, 2.H.2 Food and beverages industry, Table 3-21, pg. 19 |
| NMVOC | 10 | kg/Mg sugar | GB 2023, 2.H.2 Food and beverages industry, Table 3-20, pg. 19 |
| NMVOC | 0.3 | kg/Mg product (meat, fish and poultry) | GB 2023, 2.H.2 Food and beverages industry, Table 3-19, pg. 18 |
| NMVOC | 1 | kg/Mg product (cakes, biscuits and breakfast cereals) | GB 2023, 2.H.2 Food and beverages industry, Table 3-18, pg. 18 |
| NMVOC | 4.5 | kg/Mg bread | GB 2023, 2.H.2 Food and beverages industry, Table 3-14, pg. 16 |
| NMVOC | 0.55 | kg/Mg beans (roasted coffee) | GB 2023, 2.H.2 Food and beverages industry, Table 3-23, pg. 20 |

5.6.9.2. Source-specific uncertainties and time-series consistency

A quantitative uncertainty analysis has not yet been carried out to the Macedonian inventory, but it is scheduled for the future. Source category specific information on uncertainties will be added when the results are available. The trends of the food production are variable due to the change of the methodology in the statistics, as well as due to the unstable regime of the major food installations.

5.6.9.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

No planned improvements in this category.

5.6.10. Wood processing – NFR 2.I

This source category is only important for particulate emissions. The emissions from this source category however are less than 1% of the national emissions for particulates.

5.6.10.1. Methodological issues

The simplified Tier 1 methodology for emission calculation has been used. Namely, the quantity of activity data is multiplied with the appropriate emission factor.

Activity data

The input data for this source category is the quantity of different type of final products. These data have been taken from the Statistical Yearbooks of the Republic of North Macedonia for the period 1990-2020[22] and the publication Industry in the Republic of North Macedonia for the period 2005-2015[28], and data form MAKSTAT database for period 2016-2023 [29]. The quantity of processed data is lowest in 2023.

Table 159 Activity data for source category 2.I - Wood processing

| Year | Wood processed [Mg] | Year | Wood processed [Mg] |
|------|---------------------|------|---------------------|
| 1990 | 66 889 | 2008 | 12 863 |
| 1991 | 52 422 | 2009 | 4 429 |
| 1992 | 46 790 | 2010 | 14 225 |
| 1993 | 44 454 | 2011 | 11 986 |
| 1994 | 40 402 | 2012 | 19 251 |
| 1995 | 29 144 | 2013 | 14 211 |
| 1996 | 27 210 | 2014 | 14 414 |
| 1997 | 23 188 | 2015 | 11 496 |
| 1998 | 17 048 | 2016 | 10 098 |
| 1999 | 22 568 | 2017 | 10 660 |
| 2000 | 18 173 | 2018 | 7 698 |
| 2001 | 16 882 | 2019 | 10 102 |
| 2002 | 10 015 | 2020 | 9 701 |
| 2003 | 19 913 | 2021 | 9 816 |
| 2004 | 24 263 | 2022 | 10 136 |
| 2005 | 15 509 | 2023 | 6 641 |
| 2006 | 21 866 | 2024 | 127 |
| 2007 | 15 173 | | |

Emission factors

Emission factor for estimation of TSP have been taken from GB 2023 and they are presented in the table below.

Table 160 Emission factors for source category 2.I Wood processing

| Pollutant | Value | Unit | References |
|-----------|-------|---------------------|---|
| TSP | 1 | kg/Mg wood products | GB 2023 Table 3.1 Tier 1 emission factors for source category 2.I Wood processing |

5.6.10.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.10.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

Activity data for 2024 need to be revised.

5.6.11. Consumption of POPs and heavy metals – NFR 2.K

This source category is only important for PCB and Hg. The emissions in this category were calculated due to ERT recommendation.

5.6.11.1. Methodological issues

The simplified Tier 1 methodology for emission calculation has been used. Namely, the quantity of activity data – population is multiplied with the appropriate emission factor.

Activity data

The input data for this source category is population data. Population data for the source category 2.D.3.e – Degreasing, is presented in Table 160.

Emission factors

Emission factor for estimation of PCB and Hg have been taken from GB 2023 and they are presented in the table below.

Table 161 Emission factors for source category 2.K- Consumption of POPs and heavy metals

| Pollutant | Value | Unit | References |
|-----------|-------|----------|---|
| PCB | 0.1 | g/capita | GB 2023 Table 3-1, Tier 1, 2.K- Consumption of POPs and heavy metals pg.6 |
| Hg | 0.01 | g/capita | GB 2023 Table 3-1, Tier 1, 2.K- Consumption of POPs and heavy metals pg.6 |

5.6.11.2. Source-specific uncertainties and time-series consistency

No source specific uncertainty was done for this sector.

5.6.11.3. Source-specific QA/QC and verification

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

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

No recalculations were done in this category.

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

Due to high uncertainty of the Tier 1 methodology, possibility the use higher tier level will be investigated if data from the POPs inventory which is developed by the POPs office in MEPP can be use for this purpose.

AGRICULTURE



6. AGRICULTURE (NFR 3)

6.1. Sector overview

The agriculture sector is a major source category for ammonia emissions. Around 90% of the total national emissions of NH₃ are emitted from the agricultural sector.

In the Macedonian national inventory emissions from emissions from several NFRs are not reported due to not available activity data, but more detail explanation is given below.

6.2. General description

Methodology

In 2025, under the project “Support in the Implementation of Air Quality Directives, Strengthening the administrative capacities for emission inventories, modelling, monitoring and air quality assessment”, new expert judgements from the Ministry of Agriculture have been collected to implement the EMEP/EEA Tier 2 methodology, based on the Nitrogen mass-flow approach. The methodology of selection of emission factors in the manure management source category is described in detail below. Emission factors from EMEP Guidebook 2023 were mostly used for calculation of emissions for 3B and 3D categories in this sector.

Completeness

In the table below NFR categories covered in the agriculture sector for 2024 are presented, which are not included in this sector and for which appropriate notation keys are used.

Table 162 NFR categories covered in Agriculture sector

| 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 |

| NFR category | | Completeness |
|--------------|---|--------------|
| 3Da3 | Urine and dung deposited by grazing animals | √ |
| 3Da4 | Crop residues applied to soils | √ |
| 3Db | Indirect emissions from managed soils | NA |
| 3Dc | Farm-level agricultural operations including storage, handling and transport of agricultural products | √ |
| 3Dd | Off-farm storage, handling and transport of bulk agricultural products | NA |
| 3De | Cultivated crops | √ |
| 3Df | Use of pesticides | NO |
| 3F | Field burning of agricultural residues | √ |
| 3I | Agriculture other (please specify in the IIR) | NO |
| 3B4h | Manure management - Other animals (please specify in IIR) | NO |

3.B.4.f: Mules and asses: No data were received for number of mules and asses in the reporting period upon request sent to the state statistical office (NE).

3.B.4.a: Buffalos: only historic data are available. Buffalos are included in the Other cattle category (3.B.1.b), as buffalos are bovines and no data for buffalo is available from 2007 onwards (-> time series consistency). The NH₃ EF for buffalos and other cattle (solid) is very similar.

3.B.4.h: Other animals: The inventory includes all animals provided in the statistical review of North Macedonia. No additional animal categories are relevant for North Macedonia (NO).

3.D.a.2.a: Animal manure applied to soils: Emissions are included in sector 3.D, as calculations follow the tier 1 approach. Therefore, the notation key IE is used for this sector. NH₃ emissions of source category 3.D.a.2.a animal manure applied to soils have been reported from submission 2017 onwards.

3.D.a.2.b: Sewage sludge applied to soils: This source is not estimated (NE). Activities (tons of sewage sludge annually spread) are not available. According to our investigations there are available data on sewage sludge. In the SSO database there are available data. Wastewater treatment plants are also producing sewage sludge, but according to information that we have gained up to now sewage sludge has been used in Agriculture.

3.D.a.2.c: The EMEP/EEA Guidebook 2013 does not provide methodologies and emission factors for this source category. Thus, for other organic fertilizers applied to soils (including compost) the notation key NA is reported.

3.D.a.3: Urine and dung deposited by grazing animals: Emissions are included in sector 3.D as calculations follow the Tier 1 approach. Therefore, notation key IE is used. NH₃ emissions of source category 3.D.a.3 Urine and dung deposited by grazing animals have been reported from submission 2017 onwards.

3.D.a.4: This emission source is new as the associated methodology was first included in the 2023 EMEP/EEA Guidebook.

Crop residues are defined as those parts of the crop left on the soil surface following harvest or after another management action such as cutting grass for silage or hay or trimming pasture to stimulate fresh growth. Volunteer crops killed using herbicides, potato haulms desiccated by acid application and green manures that die after frost are also to be included in the calculation. Ammonia emissions from crop residues are related to the amount and N content of the residue left on the soil surface.

3.D.b: The EMEP/EEA Guidebook 2023 does not provide methodologies and emission factors for calculating emissions resulting from the deposition of N emitted from managed soils. Thus, for indirect emissions from managed soils NA is reported.

3.D.d: The EMEP/EEA Guidebook 2023 does not provide methodologies and emission factors for this source category. Thus, for Off-farm storage, handling and transport of bulk agricultural products NA is reported.

3.D.e: The main crops mentioned in EMEP for calculation are the following: wheat, rye, rape, grass. In North Macedonia statistics, there is no information on rape, thus, only wheat, rye and grass (pasture and meadows) are considered.

3.F: Source category 3F - Field burning. of agricultural residues releases multiple pollutants into the atmosphere, the activity is illegal in the country, so no official data exists for its occurrence. Emissions are estimated using Tier 1 methodology from the 2023 EMEP/EEA Guidebook. GAINS model and FINN remote sensing data are used to estimate biomass burnt for certain years (2005, 2010, 2015, 2020). For missing years, interpolation or assumptions are applied, e.g., average biomass of 4 t/ha.

3.I: Agriculture other, does not occur (NO).

6.3. Manure management NFR 3.B

6.3.1. Methodological issues on distribution of manure: housing, yards, grazing

In 2025, under the project “Support in the Implementation of Air Quality Directives, Strengthening the administrative capacities for emission inventories, modelling, monitoring and air quality assessment”, new expert judgements from the Ministry of Agriculture have been collected to implement the EMEP/EEA Tier 2 methodology, based on the Nitrogen mass-flow approach. Expert judgements have been mobilized to estimate the share of manure that is deposited within buildings in which livestock are housed, on uncovered yards and during grazing.

Dairy cattle

About one third of dairy cattle remain housed in buildings throughout the year. The remaining two thirds split their time equally between housing—where their manure is collected—and grazing in the fields. In North Macedonia, there are no areas equivalent to “yards” as defined in the EMEP/EEA Guidebook 2023. Thus, on average, dairy cattle spend around two thirds of their time in housing, and one third grazing.

Non-dairy cattle, sheep, goats, horses

Animals split their time equally between housing—where their manure is collected—and grazing in the fields. In North Macedonia, there are no areas equivalent to “yards” as defined in the EMEP/EEA Guidebook 2023.

Swine and poultry

Animals remain housed in buildings throughout the year. In North Macedonia, there are no areas equivalent to “yards” as defined in the EMEP/EEA Guidebook 2023.

The following table summarizes the assumption made regarding the distribution of manure between housing, yards and grazing per animal category:

Table 163 Share of housing, yards and grazing per animal category

| Animal category | Share of housing | Share of yards | Share of grazing |
|--|------------------|----------------|------------------|
| Dairy cattle | 2/3 | 0 | 1/3 |
| Non-dairy cattle, sheep, goats, horses | 50% | 0% | 50% |
| Swine, poultry | 100% | 0% | 0% |

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.

6.3.2. 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.

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 has been 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 stalls to free stall system, solid manure, and outdoor loafing areas. The milking system is mechanical with separate milking parlors 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). In this system 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, it was concluded that in housing cattle are managed in solid systems. For dairy cattle, values are taken from tied housing systems.

Pasturing of cattle

Pastured system is mostly present in the cow-calf system; explained above. The rest of the farmers rarely use 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 in the same pasture during the summer months of the year. However, there are no exact numbers available for presenting the percentage of farms that are using pasture in their management.

Based on this expert judgment and discussions with agriculture experts it was decided to apply the solid NH₃ and NO EFs for all cattle.

Based on this expert judgment, it was concluded that in housing cattle are managed in solid systems. For dairy cattle, values are taken from tied housing systems.

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 on these farms in 2014. From the information received from the meeting held within the project, it is known that these farms use liquid systems. The situation in 2018 is similar, so there are no changes in the distribution of system types.

It was then necessary to clarify which type of systems are usually applied for the rest of pigs held in smaller business entities and individual farms.

Additional information was gathered from the veterinary agency that also small pig farms usually practice liquid manure systems; the manure is stored in septic tanks. Farmers have an agreement with someone who 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, it was concluded that in housing, swine are managed in liquid systems.

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 appropriate for all hens (conservative approach). The national experts of the Ministry of Agriculture within an expert meeting confirmed this approach during the mission. Based on this expert judgment, it was concluded that in housing, poultry is managed in solid systems.

6.3.3. Nitrogen excretion rates

Nitrogen excretion rates are based on default animal weight and average nitrogen excretion by masses of animals. The following table presents values and associated sources per animal category:

Table 164 Values and associated sources to estimate N excretion (weight, N rate)

| NFR Code | Weight | | Nitrogen excretion by mass of animal | |
|---------------------------------|-----------------|---|--|--|
| | Value (kg/head) | Source | Value (kg N/1000 kg animal mass day-1) | Source |
| 3B1a Dairy cattle | 550 | Volume 4, Chapter 10, Table 10A.1, IPCC 2019 | 0.42 | Volume 4, Chapter 10, Table 10.19, IPCC 2019 – Eastern Europe |
| 3B1b non-dairy cattle | 340 | Table A1.5, 3B, EMEP/EEA Guidebook 2023 | 0.47 | |
| 3B2 Sheep | 50 | | 0.36 | |
| 3B3 Swine-fattening pigs | 65 | | 0.77 | |
| 3B3 Swine-sows | 225 | | 0.36 | |
| 3B4d Goats | 50 | | 0.44 | |
| 3B4e Horses | 500 | | 0.3 | |
| 3B4gi Laying hens | 2.2 | | 0.81 | |
| 3B4gii Broilers | 1 | | 1.12 | |
| 3B4giii Turkeys | 6.8 | | 0.74 | |
| 3B4giv Other poultry (ducks) | 2 | | 0.83 | |
| 3B4giv Other poultry (geese) | 3.5 | | 0.83 | |

The following equation is then applied to estimate the N excretion:

$$\text{N excretion (kgN/head)} = [\text{Weight (kg)} / 1000] * \text{Nitrogen excretion by mass of animal (kg N/1000 kg animal mass day-1)} * 365$$

The following table presents the nitrogen excretion obtained per animal category:

Table 165 N excretion per animal category (kg N/head)

| NFR Code | Value (kg N/head) |
|--------------------------|-------------------|
| 3B1a Dairy cattle | 84.32 |
| 3B1b non-dairy cattle | 58.33 |
| 3B2 Sheep | 6.57 |
| 3B3 Swine-fattening pigs | 18.27 |
| 3B3 Swine-sows | 29.57 |
| 3B4d Goats | 8.03 |

| NFR Code | Value (kg N/head) |
|------------------------------|-------------------|
| 3B4e Horses | 54.75 |
| 3B4gi Laying hens | 0.65 |
| 3B4gii Broilers | 0.41 |
| 3B4giii Turkeys | 1.84 |
| 3B4giv Other poultry (ducks) | 0.61 |
| 3B4giv Other poultry (geese) | 1.06 |

Additional information has been received regarding weight data:

- Data from the GHG inventory;
- Data on national weight

The national data sent have been compared to the default values currently used in the inventory, and the two set of data looks quite consistent on the following figure:

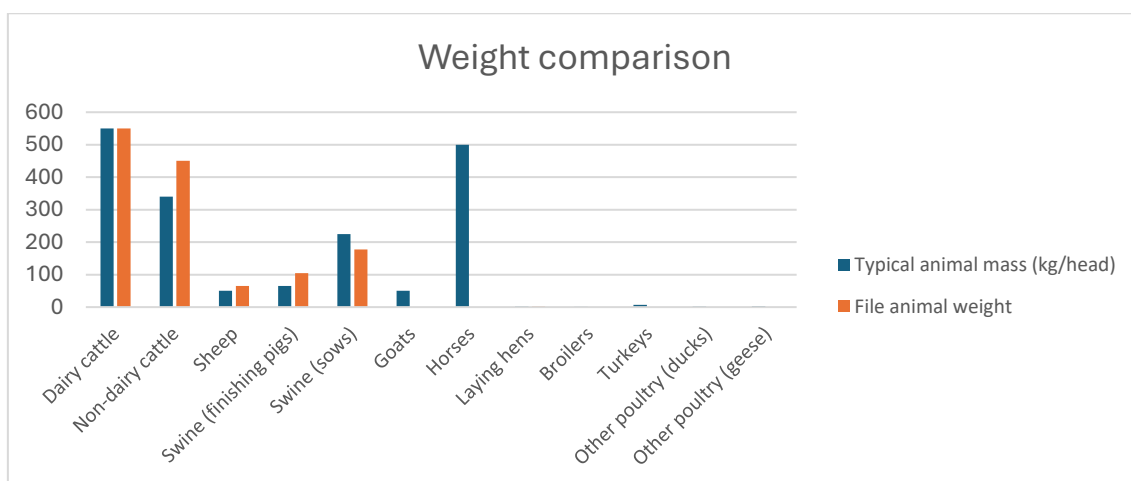


Figure 38 Weight animal comparasions

However, national data does not cover all the categories used in the inventory, thus default values are maintained. For the GHG inventory, for common categories, values can differ. As there is no specific information on the data source used for the GHG inventory, default values as currently used are maintained in the inventory.

Feed intake (MJ/day/head)

The Feed intake parameter is used to estimate NMVOC emissions from 3B according to a Tier 2 methodology. The Tier 2 methodology is only applied for dairy cattle (3B1a) and non-dairy cattle (3B1b). Thus, feed intake has only been estimated for cattle.

Currently, the information on feed intake for cattle (MJ) from the GHG inventory is not available. Therefore, to estimate NMVOC emissions based on a Tier 2 method, the default values given in the IPCC 2019 Refinement were used.

For Eastern Europe, the following data are suggested:

- Dairy cattle: 217.69 MJ/day/head (rounded value)

- Non-dairy cattle: 140.72 MJ/day/head (rounded value)

To be noted: in GAINS calculation, the following values have been considered:

- Dairy cattle: 174.07 MJ/day/head (rounded value)
- Non-dairy cattle: 147.90 MJ/day/head (rounded value)

6.3.3.1. 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 2016-2024 [33]. The numbers per livestock category are presented in Table 166. The number of different categories of poultry is presented in Table 167.

Table 166 Domestic livestock population and its trend 1990–2024

| 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 |
| 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 |

| Year | Dairy | Non-diary | Total Swine | Fattening pigs | Sows | Sheep | Goats | Horses |
|------------------------|-------------|-------------|-------------|----------------|-------------|-------------|-------------|-------------|
| 2018 | 129 450 | 126 731 | 195 538 | 171 809 | 23 729 | 726 990 | 117 447 | 10 041 |
| 2019 | 111 147 | 106 643 | 135 770 | 118 814 | 16 956 | 684 558 | 87 581 | 8 952 |
| 2020 | 107 721 | 114 490 | 164 074 | 145 679 | 18 395 | 630 634 | 95 008 | 9 154 |
| 2021 | 98 217 | 79 441 | 186 146 | 165 815 | 20331 | 633281 | 75753 | 11140 |
| 2022 | 100 242 | 64 509 | 182 604 | 161 147 | 21 457 | 646 488 | 80 186 | 10 659 |
| 2023 | 69214 | 79479 | 193412 | 171778 | 21634 | 587073 | 85528 | 10104 |
| 2024 | 73522 | 70431 | 179682 | 160866 | 18816 | 517128 | 97918 | 7815 |
| <i>Trend 1990-2024</i> | -40% | -58% | 5% | 4% | -22% | -77% | -61% | -88% |

Table 167 Domestic poultry and its trend 1990–2024

| 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 |
| 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 |

| Year | Laying hens | Broilers | Livestock category – Population size [heads] * | | | |
|------------------------|-------------|-------------|--|-------------|-------------|----------------|
| | | | Ducks | Geese | Turkeys | Total Poultry |
| 2015 | 1 423 841 | 311 809 | 15 814 | 2 094 | 7 587 | 1 761 145 |
| 2016 | 1 705 948 | 97 322 | 25 416 | 10 829 | 26 254 | 1 865 769 |
| 2017 | 1 770 504 | 20 456 | 27 257 | 8 782 | 13 174 | 1 840 173 |
| 2018 | 1 736 208 | 25 641 | 40 222 | 8 956 | 17 260 | 1 828 287 |
| 2019 | 1 385 743 | 120 363 | 34 611 | 8 841 | 12 531 | 1 562 089 |
| 2020 | 1 482 348 | 101 268 | 31 900 | 14 306 | 13 640 | 1 643 462 |
| 2021 | 1 235 894 | 97 181 | 120 580 | 11 227 | 19 143 | 1 484 025 |
| 2022 | 1 367 092 | 124 332 | 46 036 | 10 971 | 13 502 | 1 561 933 |
| 2023 | 1 508 578 | 100 119 | 112 284 | 11 997 | 13 051 | 1 746 029 |
| 2024 | 1 255 780 | 74 655 | 220 929 | 9 978 | 57 115 | 1 573 294 |
| Trend 1990–2024 | -77% | -27% | 275% | -35% | -50% | -63,38% |

Official data sets of the period 1990–2006 and from 2007 onwards are not fully consistent. In 2007, a new census on agriculture was introduced [36] leading to more accurate animal numbers. No census for agriculture was conducted afterwards. Census was planned to be conducted during last year, however due to limited human and financial resources it was postponed with no define date.

The 2007 census was interview based (interviewers personally visited all farms) and provides full coverage of the country.

The annual animal accountings in the years between are based on samples of about 5000 farms. The total farm number of North Macedonia is about 90000. In general, it is distinguished between individual farms (which reflect most farms) and business entities (less than 200 registered).

The annual accountings were made from 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.

The overall livestock population continuously decreased, especially for sheep, goats, and horses as well as poultry.

Cattle numbers

For 1990-2006 national statistics include dairy, other cows and heifers in calf in one category “cows”. Activity data for dairy cows was not made available until this reporting period.

Regarding the relatively small number of calves and young cattle, compared to the cattle older than 2 years (including dairy cattle that the share dairy/non-dairy is in line with the data of neighboring countries of that region and that the market 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 domestic livestock is not good enough for high yield and quality production. Thus, for the replacement of animals in milk, meat and pork production predominantly young animals are imported from abroad (no domestic breed is taken).

The small calf number in the official statistics is since (especially male calves) are slaughtered very early (between 2 and 12 months). In the veterinarian register, all born animals must be registered within a period of 7 days. This is the reason why the livestock balances show a significantly 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 170% from 1990 to 2024.

Non-dairy cattle

Reduced rent ability of beef production is responsible for the decrease of non-dairy cattle numbers by 58% between 1990 and 2024 due to the reduced number of heifers in calves and other cattle.

Pig numbers

Pig statistics from 1990-2006 are not fully consistent with the official numbers from 2007 onwards. A consistent time series had to be established. For the years 1990 to 2006, the fattening pig number has been derived from the difference of sow number (including boars) and total swine number 1990-2006.

In North Macedonia total swine production increased by 5% between 1990 and 2024, mainly due to increased production of fattening pigs.

Sheep

Activity data for the whole series is 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 (-77%) 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 database were provided. For years before an official request has been made for the use of non-published data, and only 1999 data have 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 -61% between 1990 and 2024, because in the last century husbandry of goats was forbidden as it would curb the formation of karst. The number

of goats has increased in period 2012-2018 but decreasing trend appears again due to fact higher migration from rural to urban places.

Horses

Horse numbers show a decreasing trend since 1990 (-88%). In the past horses were used for means of locomotion in rural areas, but the purpose of horses changed, 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 for laying hens 1990-2006. Data was 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 63,38% from 1990 to 2024, mainly due to declining numbers of laying hens because of a reduced egg production in North Macedonia.

6.3.3.2. Emission factors

NH₃ and NO_x emissions

For NH₃ and NO_x emission, the Tier 2 methodology from the 2023 EMEP Guidebook has been implemented, using the N-flow tool.

The following updates have been made on the tool to consider the latest versions of the different guidebooks (2023 EMEP Guidebook, IPCC 2019 Refinement):

- Update of N₂O EF for solid based on the IPCC 2019 Refinement
- Update of N rate based on the IPCC 2019 Refinement

Different impacting parameters are involved through calculation. Their definition and associated reference are presented in the table below.

Table 168 Definition and references used for impacting parameters

| Parameter | Unit | Definition | Source |
|----------------|----------|--|---|
| x housing | Fraction | proportion of manure deposited in buildings | National estimates based on expert judgement (see section Error! Reference source not found.) |
| housed period | Days | multiplication of 365 by x housing | / |
| x yards | Fraction | proportion of manure deposited in yards | National estimates based on expert judgement (see section Error! Reference source not found.) |
| x house slurry | Fraction | proportion of manure deposited in houses which is "slurry" | National estimates based on expert judgement (see section Error! Reference source not found.) |

| Parameter | Unit | Definition | Source |
|--|-------------|--|---|
| x store_slurry | | proportion of slurry that is stored (not entering biogas plant or directly spread) | All manure is stored before spreading. Anaerobic digestion is not estimated currently as activity data is missing. |
| x biogas_slurry | Fraction | proportion of slurry that is going to anaerobic digestion | Anaerobic digestion is not estimated currently as activity data is missing. |
| x store_solid | Fraction | proportion of solid that is stored (not entering biogas plant or directly spread) | All manure is stored before spreading. Anaerobic digestion is not estimated currently as activity data is missing. |
| x biogas_solid | Fraction | proportion of solid manure that is going to anaerobic digestion | Anaerobic digestion is not estimated currently as activity data is missing. |
| animal weight | Kg | Weight per animal category | Default value from EMEP 2023 (Table A1.5, Chapter 3B) and 2019 IPCC Refinement (Volume 4, Chapter 10, Table 10A.1) |
| annual straw use in litter-based manure management systems | Kg and Kg N | | Default value from EMEP 2023 (Table 3.7, Chapter 3B), adapted based on housed period. |

The following table presents the values entered for different impacting parameters per animal category:

Table 169 Values of impacting parameters per animal category

| NFR Code | x housing | housed period | x yards | x house slurry | x store slurry | x biogas slurry |
|------------------------------|-----------|---------------|---------|----------------|----------------|-----------------|
| 3B1a Dairy cattle | 2/3 | 243.33 | 0 | 0 | 1 | 0 |
| 3B1b non-dairy cattle | 0.5 | 182.5 | 0 | 0 | 1 | 0 |
| 3B2 Sheep | 0.5 | 182.5 | 0 | 0 | 1 | 0 |
| 3B3 Swine-fattening pigs | 1 | 365 | 0 | 1 | 1 | 0 |
| 3B3 Swine-sows | 1 | 365 | 0 | 1 | 1 | 0 |
| 3B4d Goats | 0.5 | 182.5 | 0 | 0 | 1 | 0 |
| 3B4e Horses | 0.5 | 182.5 | 0 | 0 | 1 | 0 |
| 3B4gi Laying hens | 1 | 365 | 0 | 0 | 1 | 0 |
| 3B4gii Broilers | 1 | 365 | 0 | 0 | 1 | 0 |
| 3B4giii Turkeys | 1 | 365 | 0 | 0 | 1 | 0 |
| 3B4giv Other poultry (ducks) | 1 | 365 | 0 | 0 | 1 | 0 |
| 3B4giv Other poultry (geese) | 1 | 365 | 0 | 0 | 1 | 0 |

Table 170 Values of impacting parameters per animal category (continued)

| NFR code | x store_solid | x biogas_solid | Animal weight | Annual straw use in litter-based manure management systems (kg/head) | Annual straw use in litter-based manure management systems (kg N/head) |
|------------------------------|---------------|----------------|---------------|--|--|
| 3B1a Dairy cattle | 1 | 0 | 550 | 2028 | 8.11 |
| 3B1b Non-dairy cattle | 1 | 0 | 340 | 507 | 2.03 |
| 3B2 Sheep | 1 | 0 | 50 | 122 | 0.49 |
| 3B3 Swine-fattening pigs | 1 | 0 | 65 | 200 | 0.8 |
| 3B3 Swine-sows | 1 | 0 | 225 | 600 | 2.4 |
| 3B4d Goats | 1 | 0 | 50 | 122 | 0.49 |
| 3B4e Horses | 1 | 0 | 500 | 507 | 2.03 |
| 3B4gi Laying hens | 1 | 0 | 2.2 | 0 | 0 |
| 3B4gii Broilers | 1 | 0 | 1 | 0 | 0 |
| 3B4giii Turkeys | 1 | 0 | 6.8 | 0 | 0 |
| 3B4giv Other poultry (ducks) | 1 | 0 | 2 | 0 | 0 |
| 3B4giv Other poultry (geese) | 1 | 0 | 3.5 | 0 | 0 |

The following figure presents the N mass flow approach as described in the 2023 EMEP Guidebook, simplified and adapted for North Macedonia (no yards):

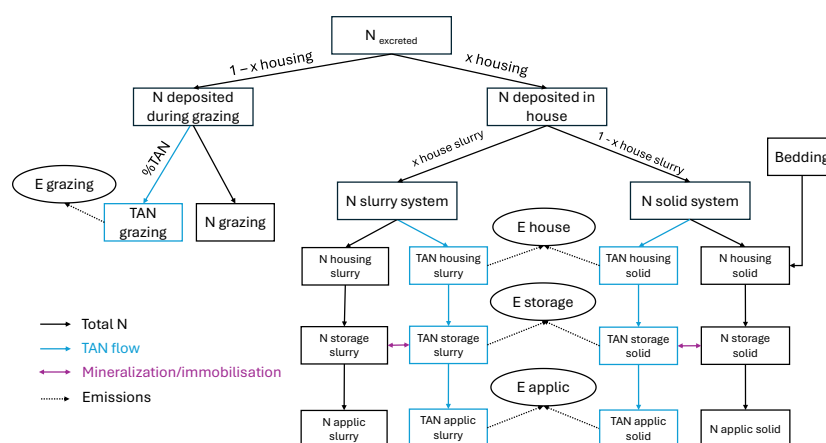


Figure 39 Mass flow approach

According to the Tier 2 methodology from EMEP, emissions of NH_3 and NO_x are estimated based on Total Ammoniacal Nitrogen (TAN – in blue in the figure above). It is also important to follow the total nitrogen, as immobilization and mineralization process can occur (at storage), involving transition between ammoniacal nitrogen and organic nitrogen.

Emissions presented in the figure above are attributed to different NFR codes:

- E house: 3B Manure management
- E storage: 3B Manure management
- E applic: 3Da2a Animal manure
- E grazing: 3Da3 Urine and dung deposited by grazing animals

The different parameters presented on the figure are described below.

N excreted

The total nitrogen excreted for an animal category is estimated according to the following equation:

$$\text{N excreted (kg N)} = \text{N excreted (kg N/head)} * \text{Population (number of animals)}$$

N deposited in house

The nitrogen deposited in house is estimated according to the following equation:

$$\text{N deposited in house (kg N)} = \text{N excreted (kg N)} * x \text{ housing (fraction)}$$

The parameter “x housing” represents the proportion of manure deposited in buildings. Assumptions made to estimate this parameter are presented in section **Error! Reference source not found..** Values used are presented in **Error! Reference source not found..**

N slurry system & N solid system

The nitrogen deposited in house as slurry (liquid) is estimated according to the following equation:

$$\text{N slurry system (kg N)} = \text{N deposited in house (kg N)} * x \text{ house slurry (fraction)}$$

The nitrogen deposited in house as solid is estimated according to the following equation:

$$\text{N solid system (kg N)} = \text{N deposited in house (kg N)} * (1 - x \text{ house slurry (fraction)})$$

The parameter “x house slurry” represents the proportion of manure deposited in houses which is "slurry". Assumptions made to estimate this parameter are presented in section 6.3.3.2 Emission factors which are presented in **Error! Reference source not found..**

TAN housing slurry & TAN housing solid

The TAN deposited in house is estimated according to the following equation:

$$\text{TAN housing slurry (kg TAN)} = \text{N slurry system (kg N)} * \% \text{TAN (kg TAN/kg N)}$$

$$\text{TAN housing solid (kg TAN)} = \text{N solid system (kg N)} * \% \text{TAN (kg TAN/kg N)}$$

The parameter “%TAN” represents the proportion of TAN in manure. Values used are default values from the 2023 EMEP Guidebook, Chapter 3B, Table 3-9. The following table presents those values per animal category:

Table 171 Proportion of TAN per animal category

| NFR Code | % TAN |
|-------------------|-------|
| 3B1a Dairy cattle | 0.6 |

| | |
|------------------------------|-----|
| 3B1b non-dairy cattle | 0.6 |
| 3B2 Sheep | 0.5 |
| 3B3 Swine-fattening pigs | 0.7 |
| 3B3 Swine-sows | 0.7 |
| 3B4d Goats | 0.5 |
| 3B4e Horses | 0.6 |
| 3B4gi Laying hens | 0.7 |
| 3B4gii Broilers | 0.7 |
| 3B4giii Turkeys | 0.7 |
| 3B4giv Other poultry (ducks) | 0.7 |
| 3B4giv Other poultry (geese) | 0.7 |

N housing slurry & N housing solid

The N org deposited in house is estimated according to the following equation:

$$\begin{aligned} \text{N housing slurry (kg N)} &= \text{N slurry system (kg N)} \\ \text{N housing solid (kg N)} &= \text{N solid system (kg N)} + \text{N bedding (kg N)} \end{aligned}$$

The amount of N bedding is estimated according to the following equation:

$$\text{N bedding (kg N)} = \text{Population (number of animals)} * \text{Annual straw use in litter-based manure management systems (kg N/head)} * (1 - x \text{ house slurry (fraction)})$$

The total amount of bedding (kg) will also be useful later, and is estimated according to the following equation:

$$\text{Total bedding (kg)} = \text{Population (number of animals)} * \text{Annual straw use in litter-based manure management systems (kg/head)} * (1 - x \text{ house slurry (fraction)})$$

The assumptions taken to estimate the annual straw use in litter-based manure management systems and resulting values are presented in Table 168 and Table 169.

E house

This parameter corresponds to emissions from manure deposited in house. Only NH₃ emissions are estimated at this stage, according to the following equation:

$$\begin{aligned} \text{E N-NH}_3 \text{ house slurry (kg N-NH}_3\text{)} &= \text{TAN housing slurry (kg TAN)} * \text{EF NH}_3 \text{ housing slurry (kg N-NH}_3\text{/kg TAN)} \\ \text{E N-NH}_3 \text{ house solid (kg N-NH}_3\text{)} &= \text{TAN housing solid (kg TAN)} * \text{EF NH}_3 \text{ housing solid (kg N-NH}_3\text{/kg TAN)} \end{aligned}$$

Emission factors are taken from the 2023 EMEP Guidebook, Chapter 3B, Table 3-9. Different values are suggested per animal category and manure management system (slurry/solid). As mentioned in section **Error! Reference source not found.**, tied housing systems are considered for dairy cattle.

The following table presents the values used per animal category:

Table 172 NH₃ Emission factor (kg N-NH₃/kg TAN) from housing per animal category and system

| NFR Code | EF NH ₃ housing slurry (kg N-NH ₃ /kg TAN) | EF NH ₃ housing solid (kg N-NH ₃ /kg TAN) |
|------------------------------|---|--|
| 3B1a Dairy cattle | 0.09 | 0.09 |
| 3B1b Non-dairy cattle | 0.24 | 0.08 |
| 3B2 Sheep | No default available | 0.22 |
| 3B3 Swine-fattening pigs | 0.27 | 0.23 |
| 3B3 Swine-sows | 0.35 | 0.24 |
| 3B4d Goats | No default available | 0.22 |
| 3B4e Horses | No default available | 0.22 |
| 3B4gi Laying hens | 0.41 | 0.2 |
| 3B4gii Broilers | No default available | 0.21 |
| 3B4giii Turkeys | No default available | 0.35 |
| 3B4giv Other poultry (ducks) | No default available | 0.24 |
| 3B4giv Other poultry (geese) | No default available | 0.57 |

To be noted: slurry systems are only considered for swine, but values have been provided for all animal categories when available in case those systems appear in future years.

Emissions are reported in 3B Manure management as NH₃, according to the following conversion:

$$E_{\text{NH}_3 \text{ house}} (\text{kg NH}_3) = [E_{\text{N-NH}_3 \text{ house slurry}} (\text{kg N-NH}_3) + E_{\text{N-NH}_3 \text{ house solid}} (\text{kg N-NH}_3)] * 17/14$$

TAN storage solid & N storage solid

In solid systems, the addition of animal bedding will bring nitrogen to the system (N from bedding) but it will also allow the immobilization of part of the TAN, which will become organic nitrogen, not emitting anymore.

As described in Step 7 of the 2023 EMEP Guidebook, Chapter 3B, the following equations are applied:

$$\begin{aligned} \text{TAN storage solid (kg TAN)} &= [\text{TAN housing solid (kg TAN)} - [E_{\text{N-NH}_3 \text{ house solid}} (\text{kg N-NH}_3) + (\text{Total bedding (kg)} * f_{\text{imm}} (\text{kg N/ kg}))]] * x_{\text{store solid}} \\ \text{N storage solid (kg N)} &= [\text{N housing solid (kg N)} + \text{N bedding (kg N)} - E_{\text{N-NH}_3 \text{ house solid}} (\text{kg N-NH}_3)] * x_{\text{store solid}} \end{aligned}$$

The parameter “ f_{imm} ” represents the fraction of TAN that is immobilized in organic matter. The value used is the default value from the 2023 EMEP Guidebook, Chapter 3B: 0.0067 kg N/kg straw.

The parameter “ $x_{\text{store solid}}$ ” represents the proportion of solid that is stored (not entering biogas plant or directly spread). Assumptions made to estimate this parameter and resulting values are presented in **Error! Reference source not found.** and Table 169.

TAN storage liquid & N storage solid

In liquid systems, a fraction of the organic N is mineralized to TAN before the gaseous emissions are calculated.

The following equation is applied to estimate N storage slurry (kg N):

$$\text{N storage slurry (kg N)} = [\text{N housing slurry (kg N)} - \text{E N-NH}_3 \text{ house slurry (kg N-NH}_3)] * x \text{ store slurry}$$

The parameter “x store slurry” represents the proportion of slurry that is stored (not entering biogas plant or directly spread). Assumptions made to estimate this parameter and resulting values are presented in **Error! Reference source not found.** and **Error! Reference source not found.**

The following equation is applied to estimate TAN storage slurry (kg N):

$$\begin{aligned} \text{TAN storage slurry (kg TAN)} = & [\text{TAN housing slurry (kg TAN)} - \text{E N-NH}_3 \text{ house slurry (kg N-NH}_3)] * x \text{ store liquid} \\ & + [\text{N storage slurry (kg N)} - ([\text{TAN housing slurry (kg TAN)} - \text{E N-NH}_3 \text{ house slurry (kg N-NH}_3)] * x \text{ store liquid})] * f_{\min} \end{aligned}$$

The parameter “ f_{\min} ” represents the fraction of the organic N which is mineralised to TAN. The value used is the default value from the 2023 EMEP Guidebook, Chapter 3B: 0.1.

E storage

This parameter corresponds to emissions from manure at storage. At this stage, emissions of NH₃, N₂O, NO_x and N₂ are estimated.

NH₃ emissions

The following equations are applied for NH₃ emissions:

$$\begin{aligned} \text{E N-NH}_3 \text{ storage slurry (kg N-NH}_3) &= \text{TAN storage slurry (kg TAN)} * \text{EF NH}_3 \text{ storage slurry (kg N-NH}_3/\text{kg TAN)} \\ \text{E N-NH}_3 \text{ storage solid (kg N-NH}_3) &= \text{TAN storage solid (kg TAN)} * \text{EF NH}_3 \text{ storage solid (kg N-NH}_3/\text{kg TAN)} \end{aligned}$$

Emission factors are taken from the 2023 EMEP Guidebook, Chapter 3B, Table 3-9. Different values are suggested per animal category and manure management system (slurry/solid). As mentioned in section **Error! Reference source not found.**, tied housing systems are considered for dairy cattle.

The following table presents the values used per animal category:

Table 076 NH₃ Emission factor (kg N-NH₃/kg TAN) from storage per animal category and system

| NFR Code | EF NH ₃ storage slurry (kg N-NH ₃ /kg TAN) | EF NH ₃ storage solid (kg N-NH ₃ /kg TAN) |
|-----------------------|---|--|
| 3B1a Dairy cattle | 0.25 | 0.32 |
| 3B1b non-dairy cattle | 0.25 | 0.32 |
| 3B2 Sheep | No default available | 0.32 |

| | | |
|------------------------------|----------------------|------|
| 3B3 Swine-fattening pigs | 0.11 | 0.29 |
| 3B3 Swine-sows | 0.11 | 0.29 |
| 3B4d Goats | No default available | 0.28 |
| 3B4e Horses | No default available | 0.35 |
| 3B4gi Laying hens | 0.14 | 0.08 |
| 3B4gii Broilers | No default available | 0.3 |
| 3B4giii Turkeys | No default available | 0.24 |
| 3B4giv Other poultry (ducks) | No default available | 0.24 |
| 3B4giv Other poultry (geese) | No default available | 0.16 |

To be noted: slurry systems are only considered for swine, but values have been provided for all animal categories when available in case those systems appear in future years.

Emissions are reported in 3B Manure management as NH₃, according to the following conversion:

$$E_{\text{NH}_3 \text{ storage}} (\text{kg NH}_3) = [E_{\text{N-NH}_3 \text{ storage slurry}} (\text{kg N-NH}_3) + E_{\text{N-NH}_3 \text{ storage solid}} (\text{kg N-NH}_3)] * 17/14$$

NO_x emissions

The following equations are applied for NO emissions:

$$E_{\text{N-NO storage slurry}} (\text{kg N-NO}) = \text{TAN storage slurry} (\text{kg TAN}) * \text{EF NO storage slurry} (\text{kg N-NO/kg TAN})$$

$$E_{\text{N-NO storage solid}} (\text{kg N-NO}) = \text{TAN storage solid} (\text{kg TAN}) * \text{EF NO storage solid} (\text{kg N-NO/kg TAN})$$

Emission factors are taken from the 2023 EMEP Guidebook, Chapter 3B, Table 3-10. Different values are suggested per manure management system:

- 0.0001 kg N-NO/kg TAN for slurry
- 0.01 kg N-NO/kg TAN for solid

Emissions are reported in 3B Manure management as NO₂, according to the following conversion:

$$E_{\text{NO}_2 \text{ storage}} (\text{kg NO}_2) = [E_{\text{N-NO storage slurry}} (\text{kg N- NO}) + E_{\text{N-NO storage solid}} (\text{kg N-NO})] * 46/14$$

To be noted: slurry systems are only considered for swine, but values have been provided for all animal categories when available in case those systems appear in future years. The following assumptions have been made: slurry for cattle is with natural crust, while slurry from swine and laying hens is without natural crust.

Total emissions at storage (for N flow)

To ensure a consistent N flow, all losses as N emissions are accounted for:

$$E_{\text{storage slurry}} (\text{kg N}) = E_{\text{N-NH}_3 \text{ storage slurry}} (\text{kg N-NH}_3) + E_{\text{N-NO storage slurry}} (\text{kg N-NO}) + E_{\text{N-N}_2 \text{ storage slurry}} (\text{kg N-N}_2) + E_{\text{N-N}_2\text{O storage slurry}}$$

$$E \text{ storage solid (kg N)} = E \text{ N-NH}_3 \text{ storage solid (kg N-NH}_3) + E \text{ N-NO storage solid (kg N-NO)} + E \text{ N-N}_2 \text{ storage solid (kg N-N}_2) + E \text{ N-N}_2\text{O storage solid}$$

TAN applic slurry, TAN applic solid, N applic slurry & N applic solid

To estimate the amount of TAN and N available at spreading, all losses should be deducted from the pool of nitrogen at storage, as presented in the following equations:

$$\text{TAN applic slurry (kg TAN)} = \text{TAN storage slurry (kg TAN)} - E \text{ storage slurry (kg N)}$$

$$\text{N applic slurry (kg N)} = \text{N storage slurry (kg N)} - E \text{ storage slurry (kg N)}$$

$$\text{TAN applic solid (kg TAN)} = \text{TAN storage solid (kg TAN)} - E \text{ storage solid (kg N)}$$

$$\text{N applic solid (kg N)} = \text{N storage solid (kg N)} - E \text{ storage solid (kg N)}$$

E applic

This parameter corresponds to emissions from manure at spreading. At this stage, emissions of NH₃ and NO_x are estimated.

NH₃ emissions

The following equations are applied for NH₃ emissions:

$$E \text{ N-NH}_3 \text{ applic slurry (kg N-NH}_3) = \text{TAN applic slurry (kg TAN)} * EF \text{ NH}_3 \text{ applic slurry (kg N-NH}_3/\text{kg TAN)}$$

$$E \text{ N-NH}_3 \text{ applic solid (kg N-NH}_3) = \text{TAN applic solid (kg TAN)} * EF \text{ NH}_3 \text{ applic solid (kg N-NH}_3/\text{kg TAN)}$$

Emission factors are taken from the 2023 EMEP Guidebook, Chapter 3B, Table 3-9. Different values are suggested per animal category and manure management system (slurry/solid). As mentioned in section **Error! Reference source not found.**, tied housing systems are considered for dairy cattle.

The following table presents the values used per animal category:

Table 173 NH₃ Emission factor (kg N-NH₃/kg TAN) from spreading per animal category and system

| NFR Code | EF NH₃ applic slurry (kg N-NH₃/kg TAN) | EF NH₃ applic solid (kg N-NH₃/kg TAN) |
|--------------------------|---|--|
| 3B1a Dairy cattle | 0.55 | 0.68 |
| 3B1b non-dairy cattle | 0.55 | 0.68 |
| 3B2 Sheep | <i>No default available</i> | 0.9 |
| 3B3 Swine-fattening pigs | 0.4 | 0.45 |
| 3B3 Swine-sows | 0.29 | 0.45 |
| 3B4d Goats | <i>No default available</i> | 0.9 |
| 3B4e Horses | <i>No default available</i> | 0.9 |
| 3B4gi Laying hens | 0.69 | 0.45 |
| 3B4gii Broilers | <i>No default available</i> | 0.38 |

| | | |
|------------------------------|----------------------|------|
| 3B4giii Turkeys | No default available | 0.54 |
| 3B4giv Other poultry (ducks) | No default available | 0.54 |
| 3B4giv Other poultry (geese) | No default available | 0.45 |

To be noted: slurry systems are only considered for swine, but values have been provided for all animal categories when available in case those systems appear in future years.

Emissions are reported in **3Da2a Animal manure** as NH₃, according to the following conversion:

$$E_{\text{NH}_3 \text{ applic}} (\text{kg NH}_3) = [E_{\text{N-NH}_3 \text{ applic slurry}} (\text{kg N-NH}_3) + E_{\text{N-NH}_3 \text{ applic solid}} (\text{kg N-NH}_3)] * 17/14$$

NOx emissions

The following equations are applied for NOx emissions:

$$E_{\text{NO}_2 \text{ applic slurry}} (\text{kg NO}_2) = N_{\text{applic slurry}} (\text{kg N}) * EF_{\text{NO}_2 \text{ applic slurry}} (\text{kg NO}_2/\text{kg N})$$

$$E_{\text{NO}_2 \text{ applic solid}} (\text{kg NO}_2) = N_{\text{applic solid}} (\text{kg N}) * EF_{\text{NO}_2 \text{ applic solid}} (\text{kg NO}_2/\text{kg N})$$

One unique emission factor is suggested in the 2023 EMEP Guidebook, Chapter 3D, Table 3-1: 0.04 kg NO₂/kg N.

Emissions are reported in **3Da2a Animal manure** as NO₂:

$$E_{\text{NO}_2 \text{ applic}} (\text{kg NO}_2) = [E_{\text{NO}_2 \text{ applic slurry}} (\text{kg NO}_2) + E_{\text{NO}_2 \text{ applic solid}} (\text{kg NO}_2)]$$

All relevant emissions from the N flow approach related to housed animals (3B and 3Da2a) have been described above. Now, calculations of grazing animals' emissions are detailed below.

N deposited during grazing

The nitrogen deposited during grazing is estimated according to the following equation:

$$N_{\text{deposited during grazing}} (\text{kg N}) = N_{\text{excreted}} (\text{kg N}) * [1 - x_{\text{housing}} (\text{fraction})]$$

The parameter “x housing” represents the proportion of manure deposited in buildings. Assumptions made to estimate this parameter are presented in section **Error! Reference source not found.**. Values used are presented in **Error! Reference source not found.**.

TAN grazing

The TAN deposited during grazing is estimated according to the following equation:

$$\text{TAN grazing} (\text{kg TAN}) = N_{\text{deposited during grazing}} (\text{kg N}) * \% \text{TAN} (\text{kg TAN/kg N})$$

The parameter “%TAN” represents the proportion of TAN in manure. Values used are default values from the 2023 EMEP Guidebook, Chapter 3B, Table 3-9. See **Error! Reference source not found.** above.

E grazing

This parameter corresponds to emissions from manure deposited in house. At this stage, emissions of NH₃ and NO_x are estimated.

Amonia (NH₃) emissions

The following equation is applied for NH₃ emissions:

$$E \text{ N-NH}_3 \text{ grazing (kg N-NH}_3\text{)} = \text{TAN grazing (kg TAN)} * \text{EF NH}_3 \text{ grazing (kg N-NH}_3\text{/kg TAN)}$$

Emission factors are taken from the 2023 EMEP Guidebook, Chapter 3B, Table 3-9. Different values are suggested per animal category.

The following table presents the values used per animal category:

Table 174 NH₃ Emission factor (kg N-NH₃/kg TAN) from grazing per animal category

| NFR Code | EF NH₃ grazing (kg N-NH₃/kg TAN) |
|------------------------------|---|
| 3B1a Dairy cattle | 0.14 |
| 3B1b Non-dairy cattle | 0.14 |
| 3B2 Sheep | 0.09 |
| 3B3 Swine-fattening pigs | <i>No default value available</i> |
| 3B3 Swine-sows | 0.31 |
| 3B4d Goats | 0.09 |
| 3B4e Horses | 0.35 |
| 3B4gi Laying hens | <i>No default value available</i> |
| 3B4gii Broilers | <i>No default value available</i> |
| 3B4giii Turkeys | <i>No default value available</i> |
| 3B4giv Other poultry (ducks) | <i>No default value available</i> |
| 3B4giv Other poultry (geese) | <i>No default value available</i> |

Emissions are reported in **3Da3 Urine and dung deposited by grazing animals** as NH₃, according to the following conversion:

$$E \text{ NH}_3 \text{ grazing (kg NH}_3\text{)} = E \text{ N-NH}_3 \text{ grazing (kg N-NH}_3\text{)} * 17/14$$

NO_x emissions

The following equation is applied for NO_x emissions:

$$E \text{ NO}_2 \text{ grazing (kg NO}_2\text{)} = \text{N deposited during grazing (kg N)} * \text{EF NO}_2 \text{ grazing (kg NO}_2\text{/kg N)}$$

One unique emission factor is suggested in the 2023 EMEP Guidebook, Chapter 3D, Table 3-1: 0.04 kg NO₂/kg N. Emissions are reported under NFR category **3Da3 Urine and dung deposited by grazing animals**.

Particulate mater (PM) emissions

According to the 2023 EMEP Guidebook, Chapter 3B, p.18:

Emissions of PM occur from both housed and free-range or grazing livestock. However, emission measurements have focused on housed livestock, and a general lack of available information in the scientific literature means that EFs that are specific to free-range or grazing livestock are not available. The processes that give rise to emissions from housed poultry are similar to those for free-range poultry. So, when calculating PM emissions using the Tier 1 default EFs, it is good practice to use the housed livestock EFs for estimating emissions from both housed and free-range poultry. For other livestock types, grazing animals are not considered to be subject to the same processes for PM emissions as those within livestock housing. So, it is good practice to apply the Tier 1 EFs to housed livestock only.

As mentioned in the guidebook, emissions of particulate matter are estimated only for housed animals. Thus, the following equation is applied:

$$E_{PM} \text{ (kg PM)} = \text{Population (number of animals)} * x_{\text{housing (fraction)}} * EF_{PM} \text{ (kg PM/head)}$$

The parameter “x housing” represents the proportion of manure deposited in buildings. Assumptions made to estimate this parameter are presented in section 6.3.3.2 **Error! Reference source not found..** Values used are presented in **Error! Reference source not found..** Default emission factors from the 2023 EMEP Guidebook, Chapter 3B, Table 3-5 have been used, as listed in the following table:

Table 175 Particle emission factors (kg particle/head) from housed animals per category

| NFR Code | EF TSP (kg TSP/head) | EF PM10 (kg PM10/head) | EF PM2.5 (kg PM2.5/head) |
|---------------------------------|---------------------------------|-----------------------------------|-------------------------------------|
| 3B1a Dairy cattle | 1.38 | 0.63 | 0.41 |
| 3B1b Non-dairy cattle | 0.59 | 0.27 | 0.18 |
| 3B2 Sheep | 0.14 | 0.06 | 0.02 |
| 3B3 Swine-fattening pigs | 1.05 | 0.14 | 0.006 |
| 3B3 Swine-sows | 0.62 | 0.17 | 0.01 |
| 3B4d Goats | 0.14 | 0.06 | 0.02 |
| 3B4e Horses | 0.48 | 0.22 | 0.14 |
| 3B4gi Laying hens | 0.19 | 0.04 | 0.003 |
| 3B4gii Broilers | 0.04 | 0.02 | 0.002 |
| 3B4giii Turkeys | 0.11 | 0.11 | 0.02 |
| 3B4giv Other poultry (ducks) | 0.14 | 0.14 | 0.02 |
| 3B4giv Other poultry (geese) | 0.24 | 0.24 | 0.03 |

NMVOC emissions

Emissions of NMVOCs occur from silage, manure in livestock housing, outside manure stores, field application of manure and from grazing animals.

In 2023, the review recommended that North Macedonia uses a Tier 2 or higher method for the calculation of NMVOC emissions from 3B1a Dairy and 3B1b Non-dairy cattle.

As stated in the 2023 EMEP Guidebook:

Values of feed intake in MJ should, if possible, be country specific (refer to the format for annual reporting of greenhouse gases to the UNFCCC, Table 4.A). If the data from the UNFCCC are used they should be multiplied by 365 to obtain intake in MJ per year. If no country-specific data on feed intake in MJ are available, the default data given in the IPPC 2006 Guidelines should be used.

As previously mentioned in section Feed intake (MJ/day/head), since no national value from the GHG inventory is available, thus default values from the 2019 IPCC Refinement are used.

According to the 2023 EMEP/EEA Guidebook, NMVOC emissions arise from six different sources:

- silage stores
- the feeding table if silage is used for feeding
- livestock housing
- outdoor manure stores
- manure application
- grazing animals

The following six equations are applied:

$$E \text{ NMVOC silage store (kg NMVOC)} = \text{Population (number of animals)} * MJ * x \text{ housing} * (EF \text{ NMVOC silage feeding} * \text{Frac of max silage}) * \text{Frac silage store}$$
$$E \text{ NMVOC silage feeding (kg NMVOC)} = \text{Population (number of animals)} * MJ * x \text{ housing} * (EF \text{ NMVOC silage feeding} * \text{Frac of max silage})$$
$$E \text{ NMVOC house (kg NMVOC)} = \text{Population (number of animals)} * MJ * x \text{ housing} * EF \text{ NMVOC housing}$$
$$E \text{ NMVOC manure store (kg NMVOC)} = E \text{ NMVOC house} * (E \text{ NH}_3 \text{ storage} / E \text{ NH}_3 \text{ house})$$
$$E \text{ NMVOC applic (kg NMVOC)} = E \text{ NMVOC house} * (E \text{ NH}_3 \text{ applic} / E \text{ NH}_3 \text{ house})$$
$$E \text{ NMVOC grazing (kg NMVOC)} = \text{Population (number of animals)} * MJ * (1 - x \text{ housing}) * EF \text{ NMVOC grazing}$$

The parameter “MJ” represents the value of feed intake in MJ/year, which is estimated based on the values presented in section Feed intake (MJ/day/head) multiplied by 365.

The parameter “x housing” represents the proportion of manure deposited in buildings. Assumptions made to estimate this parameter are presented in section 6.3.3.2, Emission factors used are presented in **Error! Reference source not found.**

The parameter “Frac of max silage” is the feed in dry matter during housing that is silage, expressed as a fraction of the maximum proportion of silage possible in the feed composition. If silage feeding is dominant, Frac of max silage should be 1.0. A value of 0.5 may be used by default for the maximum proportion of silage possible in the feed composition, but this is a guide value only and use of country

specific data is preferable to determine Frac of max silage. In the previous inventory, averaged EF between with and without silage were considered. Thus, we maintain this assumption here and use a value of 0.5.

The Frac silage store is the proportion of the emissions from the silage store compared with the emissions from the feeding table in the building. The default value suggested in the 2023 EMEP/EEA Guidebook (0.25) is used.

Default emission factors from the 2023 EMEP Guidebook, Chapter 3B, Table 3-11 have been used, as listed in the following table:

Table 176 Default NMVOC emission factors

| NFR Code | EF NMVOC silage feeding kg NMVOC/MJ feed intake | EF NMVOC housing kg NMVOC/MJ feed intake | EF NMVOC grazing kg NMVOC/MJ feed intake |
|-----------------------|--|---|---|
| 3B1a Dairy cattle | 0.0002002 | 0.0000353 | 0.0000069 |
| 3B1b Non-dairy cattle | 0.0002002 | 0.0000353 | 0.0000069 |

Emission factors obtained for 2023 have been compared to EF provided by GAINS and present in following figures:

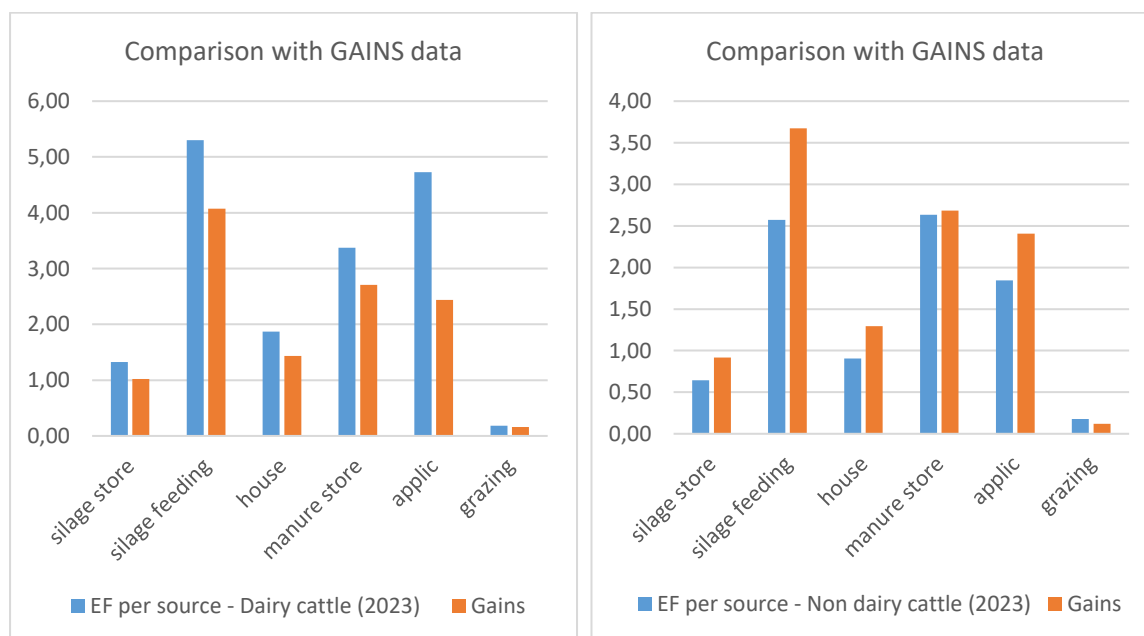


Figure 40 Comparison of NOx estimates with EF and GAINS for dairy and non-dairy cattle

The main difference is found on the parameter MJ (higher for dairy cows here than in Gains, lower for non-dairy cattle here than in Gains). There is also more housing time in Gains for non-dairy cattle.

For all other animals than cattle, the Tier 1 methodology from the EMEP/EEA Guidebook is applied. The following equation is used for NMVOC emission estimation:

$$E \text{ NMVOC (kg NMVOC)} = \text{Population (number of animals)} * EF \text{ NMVOC (kg NMVOC/head)}$$

Default emission factors from the 2023 EMEP Guidebook, Chapter 3B, Table 3-4 have been used. These default emission factors distinguish feeding with and without silage. The following assumptions have been made:

Table 177 Particle emission factors (kg particle/head) from housed animals per category (2023 EMEP Guidebook, Chapter 3B, Table 3-5)

| NFR Code | Assumption on silage | EF NMVOC (kg NMVOC/head) |
|------------------------------|----------------------|-----------------------------|
| 3B2 Sheep | without silage | 0.169 |
| 3B3 Swine-fattening pigs | without silage | 0.551 |
| 3B3 Swine-sows | without silage | 1.704 |
| 3B4d Goats | without silage | 0.542 |
| 3B4e Horses | with silage | 7.781 |
| 3B4gi Laying hens | without silage | 0.165 |
| 3B4gii Broilers | without silage | 0.108 |
| 3B4giii Turkeys | without silage | 0.489 |
| 3B4giv Other poultry (ducks) | without silage | 0.489 |
| 3B4giv Other poultry (geese) | without silage | 0.489 |

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 178 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% |

| Categories | NH3 Emissions | NOx Emissions | NMVOC Emissions | PM2.5 Emissions | EF NH3 | EF NOx | EF NMVOC | EF PM2.5 |
|------------|-------------------------------------|---------------|-----------------|-----------------|-----------------|--------|----------|----------|
| | 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 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:

- Consistency of time series: plausibility checks of dips and jumps for which requests on reasons are sent to relevant institutions;
- Comparison with time series of previous year. Explanation of revisions are done only if jumps or dips appear;
- Consistency checks of sub-categories with totals like in case of poultry with sum of all subcategories.
- Assessment of recalculation differences: plausibility checks, explanation
- Documentation in calculation sheets and IIR.
- Livestock emission excel 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

The main reasons for recalculations are listed below:

- Implementation of a Tier 2 method for the calculation of NH₃ emissions from 3B, using the Nitrogen-flow tool;
- Separate estimation and reporting of NOx emissions from 3B following the implementation of a Tier 2 method using the Nitrogen-flow tool;
- Revised estimates for particles (only housing) ;
- Implementation of a Tier 2 method for the calculation of NMVOC emissions from 3B1a and 3B1b.

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

Currently, there are around 10 biogas plant in North Macedonia, using animal manure as feedstock. Unfortunately, data are missing to approximate the amount of manure concerned. For future submission, it would be interesting to further explore this to include data on anaerobic digestion. First estimates have been conducted based on a survey completed by one biogas plant. We assume that the biogas plan produces 3MW. It uses 13 778.53 t of liquid manure-pigs, cows, whey. If we assume that 1/3 of the manure comes from pigs, the rest from cows, having a pig producing around 1 ton of manure per year and a cow around 15 tons of manure per year, that will lead to 69 214 dairy cattle and 171 778 fattening pigs. If we consider that the total number should be multiplied by 3 (around 10MW in total), that will mean, compared to the 2023 population, that around 2.7% of dairy cattle and 8% of fattening pigs have their manure collected to produce biogas. This first estimate has not been used but may serve as a basis for reflection for future improvement.

Regarding the nitrogen excretion rates:

During the project “EU4Green”, specific nitrogen excretion rates have been estimated based on the data from the Rulebook CGAP North Macedonia (2015). However, as consultation of this document was not possible, default values have been used.

It would be interesting to further explore the Rulebook CGAP North Macedonia (2015) and/or update weight information with national estimates to refine the nitrogen excretion rates.

6.4. Inorganic N-fertilizers (NFR 3.D.a.1) includes urea application also)

6.4.1. Methodological issues

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 kinds of fertilizers must 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. Since only data for import and export are available, the consumption of Inorganic N-fertilizers is calculated as three years average.

Table 179 Activity data for source category NFR 3.D.a.1 - Inorganic N-fertilizers

| t N applied per year | | | | | | | | | | |
|----------------------|------------------|------------------|--------------------------|-------|-----|-----|-------------|-------------|---------------------|---------------------------|
| Year | Ammonium sulfate | Ammonium nitrate | Calcium ammonium nitrate | Urea | MAP | DAP | NPK > 10 kg | NPK < 10 kg | Other N-fertilizers | 3 years average Total N/t |
| 1990 | 412 | 3696 | 1007 | 5100 | 0 | 20 | 304 | 0 | 0 | 10 540 |
| 1991 | 412 | 3696 | 1.007 | 5000 | 0 | 20 | 304 | 0 | 0 | 10 440 |
| 1992 | 412 | 3696 | 1.007 | 4600 | 0 | 20 | 304 | 0 | 0 | 10 040 |
| 1993 | 412 | 3696 | 1.007 | 4117 | 0 | 20 | 304 | 0 | 0 | 9557 |
| 1994 | 412 | 3696 | 1.007 | 3804 | 0 | 20 | 304 | 0 | 0 | 9244 |
| 1995 | 429 | 3654 | 708 | 3168 | 0 | 20 | 304 | 0 | 0 | 8283 |
| 1996 | 431 | 4009 | 462 | 3025 | 0 | 20 | 304 | 0 | 0 | 8252 |
| 1997 | 434 | 4069 | 144 | 2657 | 0 | 20 | 304 | 0 | 0 | 7629 |
| 1998 | 420 | 3910 | 126 | 3097 | 0 | 20 | 304 | 0 | 0 | 7878 |
| 1999 | 420 | 3139 | 54 | 3266 | 0 | 20 | 304 | 0 | 0 | 7204 |
| 2000 | 420 | 2618 | 54 | 3220 | 0 | 20 | 304 | 0 | 0 | 6636 |
| 2001 | 420 | 1825 | 54 | 3005 | 0 | 20 | 304 | 0 | 0 | 5628 |
| 2002 | 607 | 3168 | 45 | 2260 | 0 | 20 | 304 | 0 | 0 | 6405 |
| 2003 | 751 | 4689 | 617 | 2410 | 0 | 22 | 555 | 0 | 0 | 9045 |
| 2004 | 630 | 6530 | 1657 | 2348 | 0 | 32 | 1540 | 0 | 0 | 12 737 |
| 2005 | 317 | 6476 | 3205 | 2610 | 1 | 40 | 3023 | 2 | 0 | 15 674 |
| 2006 | 46 | 6916 | 3515 | 2,520 | 61 | 31 | 3775 | 3 | 0 | 16 866 |
| 2007 | 42 | 7173 | 4190 | 2373 | 77 | 24 | 4159 | 3 | 0 | 18 041 |

| 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 |
| 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 |
| 2021 | 0 | 7482 | 1294 | 3516 | 195 | 0 | 4943 | 0 | 500 | 17 931 |
| 2022 | 0 | 5880 | 1224 | 2934 | 179 | 0 | 3683 | 0 | 307 | 14207 |
| 2023 | 0 | 3926 | 848 | 4063 | 44 | 0 | 2827 | 0 | 169 | 11876 |
| 2024 | 0 | 4423 | 914 | 5081 | 4 | 0 | 3071 | 0 | 200 | 13693 |

Emissions factors

NH₃ emissions

NH₃ emissions have been estimated based on the Tier 2 methodology from the 2023 EMEP Guidebook. The following equation is applied, summing all mineral fertilizers forms spread in North Macedonia:

$$E_{\text{NH}_3} (\text{kg NH}_3) = \sum \text{Amount of Nitrogen per form (kg N)} * \text{EF NH}_3 \text{ per form (g NH}_3/\text{kg N)} / 1000$$

Default emission factors from the 2023 EMEP Guidebook, Chapter 3D, Table 3-2 have been used. To identify the appropriate EF, soil pH 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.

Thus, the following values per form have been used:

Table 180 NH₃ Emission factors (gNH₃/kg N) from mineral fertilizers per form

| Fertilizer form | EF NH ₃ (g NH ₃ /kg N) |
|--------------------------|--|
| Ammonium sulphate | 84 |
| Ammonium nitrate | 24 |
| Calcium ammonium nitrate | 24 |

| Fertilizer form | EF NH ₃ (g NH ₃ /kg N) |
|--------------------------|--|
| Urea | 195 |
| MAP | 84 |
| DAP | 84 |
| NPK > 10 kg | 84 |
| NPK < 10 kg | 84 |
| Other N-fertilizers | 24 |
| Ammonium sulphate | 84 |
| Ammonium nitrate | 24 |
| Calcium ammonium nitrate | 24 |

NO_x emissions

NO_x emissions have been estimated based on the Tier 1 methodology from the 2023 EMEP Guidebook. The following equation is applied:

$$E \text{ NO}_2 \text{ (kg NO}_2\text{)} = \text{Total amount of nitrogen from mineral fertilizers (kg N)} * \text{EF NO}_2 \text{ (kg NO}_2\text{/kg N)}$$

Default emission factor from the 2023 EMEP Guidebook, Chapter 3D, Table 3-1 has been used. One unique value is given and used here: 0.04 kg NO₂/kg N.

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

The main improvements implemented are listed below:

- Update of Tier 2 NH₃ EFs with values from the 2023 EMEP Guidebook;
- Update of Tier 1 NO₂ EF with value from the 2023 EMEP Guidebook.

6.4.2. Animal manure applied to soils (NFR 3.D.a.2)

6.4.2.1. Methodological issues

6.4.2.2. This source category covers NH₃ emissions from animal manure applied to agricultural soils.

6.4.2.3. Activity data

As the N-flow approach has been implemented, activity data for animal manure has been updated to reflect the total amount of nitrogen from animal manure spread, in tons of N/year.

The total amount of nitrogen from animal manure spread corresponds to the sum of the parameters “N applic slurry” and “N applic solid” presented in section **Emission factors**

NH₃ and NO_x emissions.

6.4.2.4. Emission factor

NH₃ emissions

Calculation of NH₃ emissions has been presented in section **Emission factors**

NH₃ and NO_x emissions and corresponds to the parameter E NH₃ applic.

NO_x emissions

NO_x emissions have been estimated based on the Tier 1 methodology from the 2023 EMEP Guidebook. The following equation is applied:

| |
|---|
| $E \text{ NO}_2 \text{ (kg NO}_2\text{)} = [\text{N applic slurry (kg N)} + \text{N applic solid (kg N)}] * \text{EF NO}_2 \text{ (kg NO}_2\text{/kg N)}$ |
|---|

Default emission factor from the 2023 EMEP Guidebook, Chapter 3D, Table 3-1 has been used. One unique value is given and used here: 0.04 kg NO₂/kg N.

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

The main improvement implemented are listed below:

- Implementation of a Tier 2 method for the calculation of NH₃ emissions from 3Da2a, using the Nitrogen-flow tool ;
- Separate estimation and reporting of NO_x emissions from NFR 3Da2a following the implementation of a Tier 2 method using the Nitrogen-flow tool.

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

6.4.3.1. Methodological issue

As the N-flow approach has been implemented, activity data for urine and dung deposited by grazing animal has been updated to reflect the total amount of nitrogen deposited by grazing animals, in tons of N/year.

The total amount of nitrogen deposited by grazing animals corresponds to the parameter “N deposited during grazing” presented in section **Emission factors**

NH₃ and NO_x emissions.

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 2007-2024. The numbers per livestock category are presented in Table 166. Number of different categories of poultry is presented in Table 167. For further information, please refer to chapter 3.B Manure Management.

6.4.3.2. Emission factors

In chapter 3.B - Manure Management for each livestock category the NH₃ emission factors for grazing, taken from EMEP/EEA GB 2023, are shown.

NH₃ emissions

Calculation of NH₃ emissions has been presented in section **Emission factors**

NH₃ and NO_x emissions and corresponds to the parameter E NH₃ grazing.

NO_x emissions

NO_x emissions have been estimated based on the Tier 1 methodology from the 2023 EMEP Guidebook. The following equation is applied:

$$E \text{ NO}_2 \text{ (kg NO}_2\text{)} = N \text{ deposited during grazing (kg N)} * EF \text{ NO}_2 \text{ (kg NO}_2\text{/kg N)}$$

Default emission factor from the 2023 EMEP Guidebook, Chapter 3D, Table 3-1 has been used. One unique value is given and used here: 0.04 kg NO₂/kg N.

6.4.3.3. 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 181 Uncertainties of emissions, emission factors and activity data

| Categories | | NH ₃ Emissions | NO _x Emissions | NM VOC Emissions | PM _{2.5} Emissions | EF NH ₃ | EF NO _x | EF NM VOC | EF PM _{2.5} |
|---------------|----------------------------------|------------------------------|------------------------------|---------------------|--------------------------------|--------------------|--------------------|-----------|----------------------|
| 3.D. a | Inorganic N-fertilizers | +/- 206.2% | +/- 64.0% | +/- 64.0% | +/- 206.2% | +/- 200.0% | +/- 40.0% | +/- 40.0% | +/- 200.0% |
| Activity Data | | | | | | | | | |
| | Inorganic N-fertilizers - amount | | | +/- 50% | | | | | |

*Note: uncertainties of emissions are combined uncertainties

Emissions for the whole period have been calculated; however, the sources on activity data are different. Namely in the period 2009-2023, data are received from the State inspectorate under Ministry of agriculture, forestry, and water supply. For the period 1990-2008, data are taken from FAO; however, there are dips and jumps in the use of some fertilizers like ammonia nitrate for which MAFWS was contacted for further explanation of this inconsistency, however no explanation was provided.

6.4.3.4. Source-specific QA/QC and verification

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

Activity data trend analysis for period 1990-2024 was performed. Major jumps and deeps are noticed in use of ammonium nitrate, CAN and NPK >10 kg. The deep for ammonium nitrate is in 2013 when jumps are detected for CAN and NPK >10 kg. From 2019 the amount of ammonium nitrate is highly increasing while CAN amount is decreasing and the amount of NPK >10 kg is slightly increased. The other fertilizers do not show bigger dips and jumps.

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

The main improvement implemented are listed below:

- Implementation of a Tier 2 method for the calculation of NH₃ emissions from 3Da3, using the Nitrogen-flow tool;
- Separate estimation and reporting of NO_x emissions from NFR 3Da3 following the implementation of a Tier 2 method using the Nitrogen-flow tool.

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

No planned improvement in this category.

6.4.4. Cultivated crops (3.D.c)

6.4.4.1. Methodological issues

Calculation of particulates was carried out using EF given in the GB 2023 according to tier1 methodology.

Activity data

The activity data for source 3.D.c is derived from State Statistical Yearbooks for period 1990-2024 data and are presented in the following table:

Table 182 Activity data for source category 3.D.c

| Year | Arable land [ha] | Year | Arable land [ha] |
|------|------------------|------|------------------|
| 1990 | 1 320 000 | 2008 | 1 064 000 |
| 1991 | 1 295 000 | 2009 | 1 014 000 |
| 1992 | 1 308 000 | 2010 | 1 121 000 |
| 1993 | 1 299 000 | 2011 | 1 120 000 |
| 1994 | 1 298 000 | 2012 | 1 238 000 |
| 1995 | 1 289 000 | 2013 | 1 260 336 |
| 1996 | 1 291 000 | 2014 | 1 263 155 |
| 1997 | 1 285 000 | 2015 | 1 264 408 |
| 1998 | 1 293 000 | 2016 | 1 267 134 |
| 1999 | 1 284 000 | 2017 | 1 266 008 |
| 2000 | 1 236 000 | 2018 | 1 264 000 |
| 2001 | 1 244 000 | 2019 | 1 264 578 |
| 2002 | 1 316 000 | 2020 | 1 261 687 |
| 2003 | 1 303 000 | 2021 | 1 259 996 |
| 2004 | 1 265 000 | 2022 | 1 256 854 |
| 2005 | 1 229 000 | 2023 | 1 250 821 |
| 2006 | 1 225 000 | 2024 | 1 241 316 |
| 2007 | 1 077 000 | | |

Emission factors

Table 183 Emission factors

| Pollutant | Value | Unit | References |
|-----------|-------|---------------------|---|
| PM2.5 | 0.06 | Kg ha ⁻¹ | GB 2023 Table 3-1 emission factor for source category 3.D.c |
| PM10 | 1.56 | Kg ha ⁻¹ | GB 2023Table 3-1 emission factor for source category 3.D.c |
| TSP | 1.56 | Kg ha ⁻¹ | GB 2023 Table 3-1 emission factor for source category 3.D.c |

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

No recalculations were made in this category.

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

No planned improvements in this category.

6.4.5. Crop residues applied to soils (3Da4)

This emission source is new as the associated methodology was first included in the 2023 EMEP/EEA Guidebook.

Crop residues are defined as those parts of the crop left on the soil surface following harvest or after another management action such as cutting grass for silage or hay or trimming pasture to stimulate fresh growth. Volunteer crops killed using herbicides, potato haulms desiccated by acid application and green manures that die after frost are also to be included in the calculation. Ammonia emissions from crop residues are related to the amount and N content of the residue left on the soil surface.

6.4.5.1. Methodological issues

The methodology applied is the Tier 2 methodology from the 2023 EMEP/EEA Guidebook. NH₃ emissions are calculated from the amount of N in crop residues on the soil surface from which NH₃ may be emitted, and an emission factor. The equation applied is as follows:

$$\text{NH}_3 \text{ crop residues} = (17/14) * \sum (A * \text{N Load} * F) * \text{EF crop residues}$$

The parameter A corresponds to the area of the crop (ha). The parameters N Load and F have been presented in the activity data section.

Activity data and background information on the activity data

Different activity data are mobilized to estimate NH₃ emissions from crop residues left on fields more than 3 days:

- Harvested area (ha)
- Production (tons)
- Dry matter content (%)
- Above-ground dry matter residue (equation from the 2019 IPCC Refinement)
- N content of above-ground residues for crop
- Fraction of residues burnt, removed, left on fields for more than 3 days.

Crops considered for the calculation are summarized in the table below:

Table 184 Crops considered for NH₃ residues calculation

| Crop | EMEP aggregated category |
|-----------------------|--------------------------|
| Wheat | Generic Grains |
| Rye | Generic Grains |
| Barley | Generic Grains |
| Oats | Generic Grains |
| Maize | Generic Grains |
| Rice | Generic Grains |
| Sunflower | Generic Grains |
| Potatoes | Potatoes and Tubers |
| Beans-single maincrop | Beans and Pulses |

| Crop | EMEP aggregated category |
|-----------------|--------------------------|
| Peas-grain | Beans and Pulses |
| Lentil | Beans and Pulses |
| Clover | N-fixing forages |
| Alfafa | Alfalfa |
| Vetches-hay | N-fixing forages |
| Fodder peas-hay | N-fixing forages |
| Fodder maize | Non-N-fixing forages |
| Fodder beet | Non-N-fixing forages |
| Meadows | Grass-Clover Mixtures |
| Pastures | Perennial Grasses |

Part of these activity data are used to estimate the parameter N load, which corresponds to the above-ground production of N from crop residues:

$$\text{N load (kg N/ha/an)} = \text{AGDM (kg DM/ha/an)} * \text{NAG (kg N/kg DM)}$$

The parameter NAG corresponds to the N content of the above-ground residues for the crop (kg N/kg DM). The values taken are default values from the 2019 IPCC Refinement, Table 11.1a. Values are also presented in the table 185 below.

The parameter AGDM is estimated according to the following equation:

$$\text{AGDM (kg DM/ha/an)} = \text{Yield Fresh} * \text{DRY} * \text{RAG}$$

The parameter DRY corresponds to the dry matter fraction of the harvested crop (kg DM/kg fresh weight). The values taken are default values from the 2019 IPCC Refinement, Table 11.1a. Values are also presented in the table 185 below.

The parameter RAG corresponds to the ratio of above-ground residue dry matter to harvested yield. The values taken are default values from the 2019 IPCC Refinement, Table 11.1a. Values are also presented in the table 185 below.

The parameter Yield Fresh corresponds to the harvested fresh yield of the crop (kg fresh weight/ha). It is estimated based on harvested area and production data from MAKSTAT database. Values are varying through time.

Table 185 Parameters used to estimate N load (kgN/ha/an)

| EMEP aggregated category | NAG (kgN/kg DM) | DRY (kg DM/kg fresh weight) | RAG (dimensionless) | Cf |
|--------------------------|--------------------|--------------------------------|------------------------|------|
| Generic Grains | 0.006 | 88% | 1.3 | 0.85 |

| | | | | |
|-----------------------|-------|-----|-----|------|
| Grass-Clover Mixtures | 0.025 | 90% | 0.3 | 0.85 |
| N-fixing forages | 0.027 | 90% | 0.3 | 0.85 |
| Alfalfa | 0.027 | 90% | 0.3 | 0.85 |
| Non-N-fixing forages | 0.015 | 90% | 0.3 | 0.85 |
| Soybeans | 0.008 | 91% | 2.1 | 0.85 |
| Perennial Grasses | 0.015 | 90% | 0.3 | 0.85 |
| Beans and Pulses | 0.008 | 91% | 2.1 | 0.85 |
| Potatoes and Tubers | 0.019 | 22% | 0.4 | 0.85 |

Another activity data is necessary to calculate those emissions: the fraction of the crop residues that produce NH₃ emissions, i.e. the fraction that remains on the soil surface for longer than 3 days after harvesting (called F).

The parameter F is calculated as follow:

$$F = 1 - (\text{Frac Incorp} + \text{Frac Remove} + \text{Frac Burnt} * \text{Cf})$$

The parameter Frac Incorp corresponds to the fraction of residues incorporated within 3 days of harvesting: as no national value is available, it is assumed that there was no incorporation.

The parameter Frac Remove corresponds to the fraction of residues removed within 3 days of harvesting: as no national value is available, it is assumed that there was no removal.

The parameter Frac Burnt corresponds to the fraction of annual harvested area burnt within 3 days of harvesting: it is assumed that burning estimated within the category 3F happens within 3 days. We apply the average share of burnt area presented in section **Error! Reference source not found.** to all the crops considered here.

The parameter Cf corresponds to the combustion factor. Values are taken from the 2019 IPCC Refinement (Chapter 2, Table 2.6) and presented in the table above.

Emission factors

The EF crop residues are taken from the 2023 EMEP/EEA Guidebook and depends on the N concentration in crop residues (see parameter NAG).

- If the NAG ≤ 0.0132 kg N/kg DM, EF crop residues = 0;
- Otherwise: EF crop residues = (410 * NAG - 5.42)/100

The EFs obtained are presented in the table below:

Table 186 EFs estimated NH₃ emissions from crop residues left on fields more than 3 days

| EMEP aggregated category | EF - NH ₃ from crop residues |
|--------------------------|---|
| Generic Grains | 0 |

| | |
|-----------------------|--------|
| Grass-Clover Mixtures | 0.0483 |
| N-fixing forages | 0.0565 |
| Alfalfa | 0.0565 |
| Non-N-fixing forages | 0.0073 |
| Soybeans | 0 |
| Perennial Grasses | 0.0073 |
| Beans and Pulses | 0 |
| Potatoes and Tubers | 0.0237 |

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

The improvement consisted in establishing first estimates for this emission source.

The first estimates obtained for Category “3Da4 Crop residues” have been compared to national total of NH₃ emission in 2023. NH₃ emissions from this source would represent 1.8% of the national total in 2023.

6.4.5.3. Source-specific planned improvements

For future submissions, information and assumptions on practices for residues management should be examined by national experts, to be confirmed or further refined.

6.4.6. Cultivated crops (3.D.e)

6.4.6.1. Methodological issues

Only NMVOC emissions are estimated for 3De.

The method for determining Tier 2 EFs in the 2023 EMEP Guidebook consists in adapting some parameters – such as yield, dry matter content, crop areas by crop type - used to generate the Tier 1 EF with national values and assumptions from the country. Those parameters and associated values have been presented in the “activity data” section above.

Activity data

To estimate NMVOC emissions from cultivated crops, the following activity data are needed to adapt the default factor suggested:

- Mean yield of crop (kg dry matter/ha)
- Crop distribution

The main crops mentioned in EMEP are the following: wheat, rye, rape, grass. In North Macedonia statistics, there is no information on rape, thus, only wheat, rye and grass (pasture and meadows) are considered.

The following table presents activity data on area from the national statistical database (MAKSTAT database). Activity data are available from 2014:

Table 187 Area of agricultural land, wheat, rye, meadows and pasture (MAKSTAT database) in hectares

| Year | Agricultural area | Wheat* | Rye* | Meadows | Pasture |
|------|-------------------|--------|-------|---------|---------|
| 2014 | 1 263 155 | 76 861 | 4 380 | 59 960 | 751 086 |
| 2015 | 1 264 408 | 73 979 | 3 760 | 59 464 | 750 359 |
| 2016 | 1 267 134 | 79 898 | 4 490 | 59 437 | 749 772 |
| 2017 | 1 266 008 | 72 965 | 4 071 | 59 912 | 748 413 |
| 2018 | 1 264 139 | 73 072 | 3 838 | 59 685 | 744 667 |
| 2019 | 1 264 578 | 68 959 | 3 834 | 59 773 | 743 991 |
| 2020 | 1 261 687 | 69 902 | 3 936 | 59 898 | 743 911 |
| 2021 | 1 259 996 | 70 515 | 3 794 | 59 301 | 742 760 |
| 2022 | 1 256 854 | 70 222 | 3 807 | 58 511 | 741 698 |
| 2023 | 1 250 821 | 69 689 | 3 416 | 59 299 | 735 694 |
| 2024 | 1 241 613 | 67 321 | 3 193 | 59 613 | 734 304 |

*For wheat and rye, sown area has been considered

The following table presents activity data on production yield from the national statistical database (MAKSTAT database). Activity data are available from 2014:

Table 188 Production yield of wheat, rye, meadows and pasture (MAKSTAT database) in kg/ha

| Year | Wheat | Rye | Meadows | Pasture |
|------|-------|------|---------|---------|
| 2014 | 3755 | 2736 | 1969 | 682 |
| 2015 | 2754 | 2061 | 1796 | 686 |
| 2016 | 3838 | 2277 | 1894 | 658 |
| 2017 | 2746 | 2070 | 1613 | 685 |
| 2018 | 3396 | 2445 | 1799 | 688 |
| 2019 | 3485 | 2265 | 1647 | 678 |
| 2020 | 3527 | 2409 | 1692 | 685 |
| 2021 | 3463 | 2248 | 1482 | 673 |
| 2022 | 3204 | 2261 | 1545 | 674 |
| 2023 | 3095 | 1548 | 1402 | 685 |
| 2024 | 3411 | 1535 | 1441 | 692 |

We consider that those data are expressed as fresh yield. To estimate the production yield in dry matter, the default dry matter fractions given in the 2019 IPCC Refinement, Volume 4, Chapter 11, Table 11.1a have been used, as listed in the table below:

Table 189 Dry matter fraction considered for wheat, rye, meadows and pasture

| | Wheat | Rye | Meadows | Pasture |
|---------------------|-------|------|---------|---------|
| Dry matter fraction | 0.89 | 0.88 | 0.9 | 0.9 |

To estimate the crop distribution, the following steps have been implemented:

- Meadows proportion (fraction) = Meadow's area (ha) / Agricultural area (ha)
- Pasture proportion (fraction) = Pasture area (ha) / Agricultural area (ha)
- Wheat proportion (fraction) = [Agricultural area (ha) – (Meadow's area (ha) + Pasture area (ha))] * [Wheat area (ha) / (Wheat area (ha) + Rye area (ha))]
- Rye proportion (fraction) = [Agricultural area (ha) – (Meadows's area (ha) + Pasture area (ha))] * [Rye area (ha) / (Wheat area (ha) + Rye area (ha))]

We obtain the following distribution:

Table 190 Crop distribution estimated based on MAKSTAT database

| Year | Wheat | Rye | Meadows | Pasture |
|------|-------|------|---------|---------|
| 2014 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2015 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2016 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2017 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2018 | 0.35 | 0.02 | 0.05 | 0.59 |
| 2019 | 0.35 | 0.02 | 0.05 | 0.59 |
| 2020 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2021 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2022 | 0.34 | 0.02 | 0.05 | 0.59 |
| 2023 | 0.35 | 0.02 | 0.05 | 0.59 |
| 2024 | 0.34 | 0.02 | 0.05 | 0.59 |

Emission factors

To estimate the average weighted emission factor, the following equation is applied:

$$EF_{NMVOC} \text{ (kg NMVOC/ha)} = EF_{\text{weighted Wheat}} \text{ (kg NMVOC/ha)} + EF_{\text{weighted Rye}} \text{ (kg NMVOC/ha)} + EF_{\text{weighted Meadows}} \text{ (kg NMVOC/ha)} + EF_{\text{weighted Pasture}} \text{ (kg NMVOC/ha)}.$$

The following equation is applied to estimate the weighted EF for each category:

$$EF_{\text{weighted Category1}} \text{ (kg NMVOC/ha)} = NMVOC_{\text{Category1}} \text{ (kg NMVOC/kgDM/hour)} * \text{Fraction of year Category1 is emitting (fraction)} * 365 * 24 * \text{Yield Category1 (kg/ha)} * \text{Dry matter fraction Category1} * \text{Category1 distribution}$$

The value of NMVOC Category1 (kg NMVOC/kgDM/hour) and Fraction of year Category1 is emitting, are taken from the 2023 EMEP Guidebook, Chapter 3D, Table 3-4, and presented in the table below. For meadows and pasture, the average value for Grass <15°C and Grass >15°C has been considered.

Table 191 Default parameters considered for NMVOC emissions estimates from 3De

| | Wheat | Rye | Meadows | Pasture |
|-----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| NMVOC (kg NMVOC/kg DM/hour) | 2.60×10^{-8} | 1.41×10^{-7} | 2.85×10^{-8} | 2.85×10^{-8} |
| Fraction of year emitting | 0.3 | 0.3 | 0.5 | 0.5 |

Other parameters (Yield Category1 (kg/ha); Dry matter fraction Category1; Category1 distribution) have been presented in the Activity data section above.

The resulting emission factor varies slightly through time due to change in crop distribution and production yields. As data are not available before 2014, the average EF for 2014 is used from 1990 to 2014. The following table presents the average value obtained from 2014:

Table 192 Average NMVOC EF (kg NMVOC/ha)

| Year | Average NMVOC EF (kg NMVOC/ha) |
|------|--------------------------------|
| 2014 | 0.151 |
| 2015 | 0.124 |
| 2016 | 0.148 |
| 2017 | 0.124 |
| 2018 | 0.141 |
| 2019 | 0.141 |
| 2020 | 0.143 |
| 2021 | 0.139 |
| 2022 | 0.134 |
| 2023 | 0.127 |
| 2024 | 0.133 |

The average EF obtained is much lower than the default T1 EF provided in the 2023 EMEP Guidebook used in previous submission (0.86 kg NMVOC/ha). This difference is mainly explained by the strong difference in production yield for pasture (default: 9000 kg DM/ha, national estimate: around 600 kg DM/ha).

To estimate total NMVOC emissions from 3De, the following equation is applied:

$$E \text{ NMVOC (kg NMVOC)} = EF \text{ NMVOC (kg NMVOC/ha)} \times \text{Agricultural area (ha)}$$

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

The main improvement implemented are listed below:

- Implementation of a Tier 2 method, adjusting default parameters used in the Tier 1 EF calculation with national estimates.

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

The data from 2007 until 2013 were identified in a separate publication in the state statistical office web and NMVOC emissions coming from this category for this period will be submitted in the future submissions.

6.4.7. Field burning of agricultural residues - NFR 3.F

6.4.7.1. Methodological issues

Many pollutants are emitted during burning. Emissions have been estimated based on the Tier 1 methodology from the 2023 EMEP/EEA Guidebook. The following equation is applied:

$$E \text{ Pollutant (kg pollutant)} = \text{Amount of biomass burnt (kg of dry matter)} * EF \text{ pollutant (kg pollutant/kg biomass burnt)}$$

Activity data and background information on the activity data

Field burning activities were discussed with agriculture experts. Field burning is not permitted by law and there is no data on illegal field burning activities available.

Therefore, the source category 3.F “Field burning is reported as not occurring (“NO”). Anyhow, the current estimates for sector 5.C.2 “Open burning of waste” (average amount of waste burned for arable farmland of 25 kg/ha) should be kept as it is liable that open burning of small-scale (agricultural) waste happens in the country.

In the frame of the EU 4 Green project calculations for this sector were made for every five years for the period 1990-2040, by use of GAINS model and FINN remote sensing dataset. This data will be analyzed and submitted during next year. Data regarding biomass burnt from agricultural residues has been provided by GAINS. The table below presents those data:

Table 193 Estimation of biomass burnt from agricultural residues (million tons of dry matter)

| | 2005 | 2010 | 2015 | 2020 | 2025* | 2030* | 2035* | 2040* |
|--------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Biomass burnt (Mt) | 0.136 | 0.106 | 0.081 | 0.071 | 0.075 | 0.072 | 0.068 | 0.065 |

**Projected data not considered for the historical inventory*

Data from GAINS is only available for certain years (2005, 2010, 2015, 2020). Data is used as follow through time:

- For 1990 to 2004: application of the rate of burning estimated for 2005 (biomass burnt/total agricultural area = 110.7 kg MS/ ha of total agricultural area) to the total agricultural area
- For 2005: use of GAINS data
- For 2006 to 2009: interpolation of data between 2005 and 2010
- For 2010: use of GAINS data
- For 2011 to 2014: interpolation of data between 2010 and 2015
- From 2016 and onward: application of the rate of burning estimated for 2015 (biomass burnt/total agricultural area = 56.3 kg MS/ ha of total agricultural area) to the total agricultural area

The NFR tables require the amount of “Area burnt” to be reported as an activity data. Thus, an assumption is made on the average biomass available per hectare. The average biomass available per hectare considered is taken from the 2006 IPCC Guidebook, Volume 4, Chapter 2, Table 2.4, for wheat.

The value is 4 tons of dry matter/ha (corresponding to the parameter Mb x Cf). Applying this assumption, we obtain the following data for the Area burnt:

Table 194 Estimation of the agriculture area burnt (ha) and associated share burnt compared to the total agricultural area (%)

| Year | Agriculture Area burnt (ha) | Share of burned area (%) | Year | Agriculture Area burnt (ha) | Share of burned area (%) |
|------|-----------------------------|--------------------------|------|-----------------------------|--------------------------|
| 1990 | 36 517 | 2.8% | 2008 | 29 500 | 2.8% |
| 1991 | 35 826 | 2.8% | 2009 | 28 000 | 2.8% |
| 1992 | 36 186 | 2.8% | 2010 | 26 500 | 2.4% |
| 1993 | 35 937 | 2.8% | 2011 | 25 250 | 2.3% |
| 1994 | 35 909 | 2.8% | 2012 | 24 000 | 1.9% |
| 1995 | 35 660 | 2.8% | 2013 | 22 750 | 1.8% |
| 1996 | 35 715 | 2.8% | 2014 | 21 500 | 1.7% |
| 1997 | 35 549 | 2.8% | 2015 | 20 250 | 1.6% |
| 1998 | 35 771 | 2.8% | 2016 | 19 750 | 1.6% |
| 1999 | 35 522 | 2.8% | 2017 | 19 250 | 1.5% |
| 2000 | 34 194 | 2.8% | 2018 | 18 750 | 1.5% |
| 2001 | 34 415 | 2.8% | 2019 | 18 250 | 1.4% |
| 2002 | 36 407 | 2.8% | 2020 | 17 750 | 1.4% |
| 2003 | 36 047 | 2.8% | 2021 | 17 726 | 1.4% |
| 2004 | 34 996 | 2.8% | 2022 | 17 682 | 1.4% |
| 2005 | 34 000 | 2.8% | 2023 | 17 597 | 1.4% |
| 2006 | 32 500 | 2.7% | 2024 | 17 468 | 1.4% |
| 2007 | 31 000 | 2.9% | | | |

The rate of burned area estimated combining GAINS data and IPCC data varies between 2.8% and 1.4% of the total agricultural area through time.

Emission factors

The following table presents the EF applied, which are default emission factors from the 2023 EMEP Guidebook, Chapter 3F, Table 3-1:

Table 195 Default Tier 1 emission factors from 2023 EMEP Guidebook for agricultural burning

| Pollutants | Value | unit |
|------------|--------|-----------------------|
| NOx | 0.0023 | kg/kg dry matter (DM) |
| CO | 0.0667 | kg/kg dry matter (DM) |
| NM VOC | 0.0005 | kg/kg dry matter (DM) |
| Sox | 0.0005 | kg/kg dry matter (DM) |
| NH3 | 0.0024 | kg/kg dry matter (DM) |
| TSP | 0.0058 | kg/kg dry matter (DM) |
| PM10 | 0.0057 | kg/kg dry matter (DM) |
| PM2.5 | 0.0054 | kg/kg dry matter (DM) |
| BC | 500 | mg/kg dry matter (DM) |
| Pb | 0.11 | mg/kg dry matter (DM) |
| Cd | 0.88 | mg/kg dry matter (DM) |
| Hg | 0.14 | mg/kg dry matter (DM) |
| As | 0.0064 | mg/kg dry matter (DM) |
| Cr | 0.08 | mg/kg dry matter (DM) |
| Cu | 0.073 | mg/kg dry matter (DM) |

| | | |
|--------|-------|-----------------------|
| Ni | 0.052 | mg/kg dry matter (DM) |
| Se | 0.02 | mg/kg dry matter (DM) |
| Zn | 0.56 | mg/kg dry matter (DM) |
| PCDD/F | 0.5 | µg I TEQ/t |
| BaP | 0.393 | mg/kg dry matter (DM) |
| BbF | 1.097 | mg/kg dry matter (DM) |
| BkF | 0.468 | mg/kg dry matter (DM) |
| IndPy | 0.336 | mg/kg dry matter (DM) |

To be noted: some EF are expressed in mg/kg DM or in µg I TEQ/t, requiring additional conversion when applying the previous equation to consider the different unit.

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

The improvement consisted in establishing first estimates for this emission source. The first estimates obtained for the Category “3F Field burning of agricultural residues” were compared with the national emission totals for 2023. The following graph presents the share that this new emission category would represent compared to the national totals. An important contribution is observed, especially for Cd emissions.

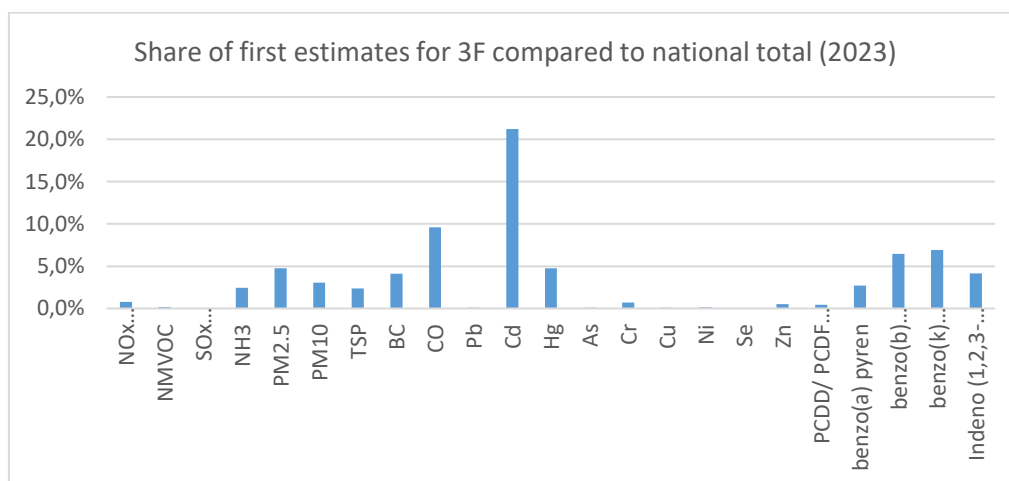


Figure 41 Share of estimates for 3F to national total emission for 2023 per pollutant

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

Different improvements have been identified:

- The EF applied (from the 2023 EMEP/EEA Guidebook) are different from those that appear to have been used for the GAINS estimates. It would be interesting to understand the EF used in the GAINS methodology
- The estimates of area burnt are based on GAINS data (for biomass burnt) and on an assumption on the average biomass available (for activity data). These assumptions should be validated by national experts before any inclusion in the inventory.

7. WASTE (NFR 5)

7.1. Sector overview

The chapter includes calculation of NO_x, SO₂, CO, NMVOC, Particulates, heavy metals and persistent organic compounds (POPs). Emissions addressed in this chapter include emissions from the next subcategories:

5.A - Solid waste disposal on land

5.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

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 composted 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. For Biological treatment of waste, recalculations of NMVOC emissions were necessary due to inconsistencies in the applied emission factors and the reported inventory results. Although the IIR_MK_2024_Final document used an emission factor of 1.56 kg/Mg in line with earlier guidance, the EMEP/EEA Guidebook 2023 also provides an alternative factor of 3.6 kg/Mg CH₄ based on a different methodological approach. In addition, the NMVOC emissions reported for the period 1990–2023 in the national dataset were not consistent with calculations based on the 1.56 kg/Mg factor. Therefore, recalculations were undertaken to ensure methodological consistency, transparency, and alignment with the latest EMEP/EEA guidance.

Regarding wastewater treatment, there are twenty-one Wastewater treatment plants (WWTP) operating in North Macedonia. For the plant in Ohrid and Dojran, activity data are available for the whole time series. Emissions have been estimated based on these activity data and the data from another wastewater treatment plants. For category 5.D.1, NH₃ emissions were not estimated (NE) for the entire period 1990–2023. Within the IPA 2 project for Air quality these emissions were calculated and included in the national totals.

Emissions from 5.B.1-Biological treatment of waste (composting) have been calculated. Municipal waste incineration, industrial waste incineration, hazardous waste incineration, sewage sludge incineration and cremation do not occur in our country.

Regarding the Industrial wastewater handling, some installations subjected under the IPPC license system are obligated to install wastewater treatment.

Emissions from 5.C.1 other waste incineration, 5.D.3-Other wastewater handling and 5.E. Other waste (Sludge spreading, car fire, detached and undetected house fires, apartment building fire, industrial building fire), have not been calculated. Regarding the category 5.B.2 Biological treatment of waste - Anaerobic digestion at biogas facilities, during the IPA II Air quality project, calculation documentation was developed, particularly for estimating NH₃ emissions in upcoming years.

7.1.1. Methodology

Tier 1 approach was used, using the given default Emission factors from the GB 2023.

Completeness

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

Table 196 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

During the inventory improvement process, the correctness of all data and parameters in the estimate files was checked. Plausibility of the results of estimations and their trends were checked and documented. All assumptions and expert judgements were explained and documented in the corresponding Excel files.

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 of methodology for 5.A
- developed new methodology for future calculation of emissions from 5.B.1
- estimation of NH₃ emissions from 5.D.1

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

Recalculations were made for the categories 5.A, 5.B.1 and 5.D.1 and 5.D.2 in the frame of the IPA II Air quality ongoing project.

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

Planned improvements refer to category 5.B.1 as methodology for calculation of emissions coming from this category was established in the frame of the IPA II project.

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

Non methanic volatile organic compounds (NMVOC) emissions

The country-specific (CS) methodology used to estimate a NMVOC emission factors for all years in reporting period (1990 - 2023), based on the CH₄ emissions which are estimated using the kinetic model (IPCC FOD model) in the framework of the greenhouse gas emissions report. The CH₄ emission ratio per ton of disposed waste was used, converted into a volume of CH₄ per tons of disposed waste (using the molecular volume of CH₄) and then into a volume of biogas per tons of disposed waste (applying the fraction of CH₄ in biogas $F = 50\%$) and then the fraction of NMVOC in biogas (5.65 g/m³ of landfill gas), as presented in the note at the bottom of Table 3-1, Chapter 5.A of the EMEP/EEA GB2023, was applied. In 2006 IPCC Guidelines, Vol. 5, Table 3.2, default values for OX are defined as:

OX = 0.1 for managed SWDS covered with CH₄ oxidizing material, which can refer to soil.

OX = 0.0 for unmanaged (not covered with aerated material), unmanaged and uncategorized SWDS.

This is an important difference for entering OX parameters for these two models.

A comprehensive kinetic model (IPCC FOD model) was developed for CH₄ emission calculation. Two separate IPCC FOD models were prepared: one for unmanaged landfills and one for managed landfills as is the case with most countries that have both managed and unmanaged landfills. Emissions from both models were summed to obtain total emissions.

Methane (CH₄) emissions

A method used to calculate CH₄ emissions according to the 2006 IPCC Guidelines is First Order Decay (FOD) method. A calculation of CH₄ emissions was performed using the Tier 2 method and the IPCC FOD model, with a combination of country-specific data and default parameters. The Decision Tree (Figure 3.1 in the 2006 IPCC Guidelines, Volume 5) indicates that the NMK approach results in a Tier 2 estimate. The inventory improvement generated country-specific activity data on historical and current waste disposal.

According to the 2006 IPCC Guidelines, section 3.2.1.1, the IPCC FOD model provides two options for CH₄ emission estimation that can be used depending on the level of available data: single-phase model based on bulk waste and multi-phase model based on waste composition data, which is currently used in the NMK. The inventory improvement defined the amounts of components (food, garden, paper, wood, textile, nappies, plastics and other inert waste) of deposited municipal solid waste (MSW), required for multi-phase models.

The NMK included CH₄ emissions for category 5.A Solid waste disposal from MSW and industrial waste (IW) deposited at Solid Waste Disposal Sites (SWDS) for the complete time series. The quantity of deposited MSW and IW is considered from 1950 onwards. Data on deposited sludge from wastewater treatment are missing, which should also be included in the model along with MSW and IW, and this gap needs to be filled in further improvement of the inventory.

The mass fraction of the waste deposited on each type of SWDS (unmanaged shallow, unmanaged deep and managed) in the total mass of deposited waste was calculated by dividing the mass of deposited waste at each type of SWDS (unmanaged shallow, unmanaged deep and managed) by the total mass of deposited waste. These calculated mass fractions have been multiplied by corresponding default MCF proposed by the 2006 IPCC Guidelines.

mass fraction for unmanaged shallow SWDS * 0.4;

mass fraction for unmanaged deep SWDS * 0.8;

mass fraction for managed SWDS * 1.0.

In this way, a weighted average MCF was calculated for each type of SWDS (unmanaged shallow, unmanaged deep and managed). The total weighted average MCF was obtained by summing the weighted average MCF for each type of SWDS (unmanaged shallow, unmanaged deep and managed), for each year in the reporting period.

The total weighted average MCF for MSW and IW for managed and unmanaged is obtained by summing the values for managed and unmanaged SWDS.

For the Methane Correction Factor (MCF) for MSW, it has been estimated that The Drisla landfill (the biggest landfill in NMK) meets the requirements for managed solid waste disposal sites (SWDS), according to 2006 IPCC Guidelines. SWDS classification and methane correction factors (MCF). Anaerobic managed solid waste disposal sites: These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.

The share of landfilled MSW at Drisla landfill into total landfilled Waste in NMK is included in IPCC FOD model for managed SWDS (for the entire operating time of Drisla landfill).

For unmanaged waste, the difference of up to 100 percent has been included in the IPCC FOD model. For deep unmanaged SWDS, an expert judgement was used, i.e. extrapolation method for the period 1950 - 1993, using calculated trend for unmanaged SWDS from data for managed Drisla landfill for the period 1994 - 2023 (the share of unmanaged SWDS was calculated as the difference of up to 100 percent) and is included into IPCC FOD model. For unmanaged shallow SWDS, the difference of up to 100 percent for total unmanaged SWDS is included in IPCC FOD model.

Due to insufficient data for assessment MCF for IW, values for uncategorised SWDS are included in IPCC FOD model.

Activity Data

Due to the lack of data on population covered by organized MSW collection, data on the total population in NMK are included in the IPCC FOD model.

MSW per capita based on existing statistical data for the period 2008 - 2023, is included in the IPCC FOD model. As part of this improvement, data on MSW per capita for the period 2008 - 2023 are calculated based on Total generated MSW (statistical data are available for the period 2008 - 2023) and population data.

The composition of MSW going to SWDS for the entire period 1950 - 2023, based on existing statistical data for the period 2014 - 2023, is included in the IPCC FOD model. A part of this improvement, historical data on the composition of MSW going to SWDS (1950 - 2013) were assessed using the extrapolation method, using the trend 2014 - 2019.

The extrapolation method does not provide accurate results for a longer period; therefore, expert judgment was applied for Food, mixed waste; Garden; Paper and Textile, in such a way that the extrapolated values were estimated by adjusting. Therefore, for the period 1950 - 2007, a correction factor was included in the extrapolation formula, which was calculated by evenly distributing the "surplus" across these waste categories, with the aim of making the sum of all waste types correspond to 100%. For Wood, rubber, extrapolation method was used for the period 1950 - 2013. For Nappies, extrapolation method was used for the period 2008 - 2013, and for the period back to 1950, the same value, as for 2008, was estimated. For Plastics, other inert waste extrapolation method was used for the period 1963 - 2013, and for the period back to 1950, the same value, as for 1963, was estimated.

Data on GDP, waste generation rate, percentage of disposed IW at SWDS for the entire period 1950 - 2023 are included in the IPCC FOD model.

Data on GDP for the entire period 1950 - 2023, based on existing statistical data for the period 2000 - 2023, are included in the IPCC FOD model. Historical data on GDP (1950 - 1999) were assessed by expert judgement and extrapolation method. The expert judgement was used for the period 1950 - 1988, from

1988 to 1950 back assessment of the annual decrease of GDP by 1 percent. The extrapolation method was used for the period 1989 - 1999, using the trend from 2000 to 2005.

The comparison was made with Croatian GDP as well as NMK one of the countries of the former Yugoslavia. During the period of Yugoslavia and immediately after the separation and independence of the Republic of Croatia, the differences between the NMK and Croatian GDP ranged in the following interval: NMK GDP amount 10 - 28% of Croatian GDP, depending on the year. The largest differences were during the Croatian Homeland War, which explains the fluctuations in GDP. In the period 2000 – 2023, for which there are official data for NMK GDP, the differences are somewhat milder, the differences between the NMK and Croatian GDP ranged in the following interval: NMK GDP amount 11 - 22% of Croatian GDP, depending on the year. This can be explained by the development of the NMK and the Croatian economy, which went in a different direction, since Croatia has been a member of the EU since 2013.

Particulate matter (PM) emissions

The Tier 1 EMEP/EEA methodology from GB2023 is used for emissions calculation of TSP, PM10 and PM2.5. Tier 2 is not available for this source. The amount of landfilled waste is used for activity data. The recommended Tier 1 emission factors from EMEP/EEA GB2023, which are expressed as the amount of pollutant per amount of landfilled waste, are used.

Table 197 Type of waste, percentage and considerations in FOD model

| Type of waste | Percentage | Consideration in FOD model as: |
|--------------------------|------------|--------------------------------|
| Food mix | 85,42% | Food |
| Wood and rubber | 0,21% | Wood |
| Paper and cardboard | 1,76% | Paper |
| Plastics and other inert | 3,24% | Plastics, other inert |
| Textiles | 1,08% | Textile |
| Nappies | 1,92% | Nappies |
| Garden | 6,38% | Garden |

It has been possible to collect data on industrial waste, but only for the year 2014. There are no available data in the latest year. The following table shows which waste types have been considered. In order to estimate industrial waste amounts back to 1950, GDP was used. According to expert judgment only small percentage of industrial waste has been taken into consideration for calculation, the fraction that goes to the landfill. That percentage of industrial waste that has been considered is presented in Table 198.

Table 198 Industrial waste generation and % to SWDS from 2000 untill 2024

| Year | GDP | Waste generation rate | Total industrial waste | % to SWDS | Total to SWDS |
|-------------|-------------|-----------------------|------------------------|-----------|---------------|
| / | \$ millions | Gg/\$m GDP/yr | Gg | % | Gg |
| 2000 | 4,723.66 | 0.067 | 318.207 | 4.82% | 15.342 |
| 2001 | 4,794.85 | 0.068 | 326.470 | 4.88% | 15.932 |

| Year | GDP | Waste generation rate | Total industrial waste | % to SWDS | Total to SWDS |
|------|-------------|-----------------------|------------------------|-----------|---------------|
| / | \$ millions | Gg/\$m GDP/yr | Gg | % | Gg |
| 2002 | 4,912.40 | 0.069 | 338.027 | 4.94% | 16.694 |
| 2003 | 5,104.52 | 0.070 | 354.939 | 5.00% | 17.738 |
| 2004 | 5,334.24 | 0.070 | 374.771 | 5.06% | 18.949 |
| 2005 | 5,859.73 | 0.071 | 415.929 | 5.11% | 21.273 |
| 2006 | 6,361.14 | 0.072 | 456.120 | 5.17% | 23.596 |
| 2007 | 7,083.97 | 0.072 | 513.074 | 5.23% | 26.844 |
| 2008 | 7,881.89 | 0.073 | 576.566 | 5.29% | 30.503 |
| 2009 | 7,876.80 | 0.074 | 581.890 | 5.35% | 31.126 |
| 2010 | 8,307.55 | 0.075 | 619.720 | 5.41% | 33.513 |
| 2011 | 8,818.41 | 0.075 | 664.207 | 5.47% | 36.308 |
| 2012 | 8,866.21 | 0.076 | 674.220 | 5.53% | 37.251 |
| 2013 | 9,534.69 | 0.077 | 731.951 | 5.58% | 40.870 |
| 2014 | 10,023.71 | 0.077 | 776.741 | 5.64% | 43.826 |
| 2015 | 10,618.75 | 0.078 | 830.532 | 5.70% | 47.348 |
| 2016 | 11,299.64 | 0.079 | 891.960 | 5.76% | 51.373 |
| 2017 | 11,742.49 | 0.080 | 935.410 | 5.82% | 54.424 |
| 2018 | 12,555.05 | 0.080 | 1,009.220 | 5.88% | 59.310 |
| 2019 | 13,159.27 | 0.081 | 1,067.307 | 5.94% | 63.350 |
| 2020 | 12,714.67 | 0.082 | 1,040.443 | 5.99% | 62.365 |
| 2021 | 13,857.66 | 0.083 | 1,143.997 | 6.05% | 69.243 |
| 2022 | 15,503.59 | 0.083 | 1,291.088 | 6.11% | 78.903 |
| 2023 | 17,053.98 | 0.084 | 1,432.534 | 6.17% | 88.387 |
| 2024 | 17,053.98 | 0.084 | 1,432.534 | 6.17% | 88.387 |

Table 199 Activity data for source category 5.A – Solid waste disposal on land for the period 1990-2024

| Year | Municipal Waste in Gg | Industrial Waste in Gg | Total Waste in Gg | Methane Emission in Gg |
|------|-----------------------|------------------------|-------------------|------------------------|
| 1990 | 138 | 6 | 145 | 3.522 |
| 1991 | 151 | 6 | 158 | 3.606 |
| 1992 | 165 | 7 | 173 | 3.710 |
| 1993 | 180 | 8 | 189 | 3.839 |
| 1994 | 184 | 9 | 193 | 3.991 |
| 1995 | 202 | 10 | 212 | 4.224 |
| 1996 | 221 | 11 | 232 | 4.494 |
| 1997 | 241 | 11 | 253 | 4.803 |
| 1998 | 263 | 12 | 276 | 5.172 |
| 1999 | 286 | 13 | 300 | 5.570 |

| Year | Municipal Waste in Gg | Industrial Waste in Gg | Total Waste in Gg | Methane Emission in Gg |
|------|-----------------------|------------------------|-------------------|------------------------|
| 2000 | 312 | 15 | 328 | 6.006 |
| 2001 | 340 | 15 | 356 | 6.485 |
| 2002 | 367 | 16 | 383 | 6.996 |
| 2003 | 399 | 17 | 416 | 7.547 |
| 2004 | 463 | 18 | 481 | 8.140 |
| 2005 | 572 | 21 | 593 | 8.855 |
| 2006 | 589 | 23 | 612 | 9.790 |
| 2007 | 606 | 26 | 632 | 10.713 |
| 2008 | 713 | 30 | 744 | 11.626 |
| 2009 | 725 | 31 | 757 | 12.747 |
| 2010 | 721 | 33 | 755 | 13.837 |
| 2011 | 735 | 36 | 771 | 14.856 |
| 2012 | 786 | 37 | 824 | 15.852 |
| 2013 | 792 | 40 | 833 | 16.919 |
| 2014 | 760 | 43 | 804 | 17.946 |
| 2015 | 781 | 47 | 828 | 18.851 |
| 2016 | 791 | 51 | 843 | 19.764 |
| 2017 | 782 | 54 | 836 | 20.642 |
| 2018 | 850 | 59 | 909 | 21.466 |
| 2019 | 913 | 63 | 976 | 22.423 |
| 2020 | 911 | 62 | 973 | 23.479 |
| 2021 | 894 | 69 | 963 | 24.470 |
| 2022 | 855 | 78 | 933 | 25.384 |
| 2023 | 876 | 88 | 964 | 26.161 |
| 2024 | 789 | 88 | 877 | 26.936 |

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 200 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 CH ₄ | 0.500 | 0.500 | 0.500 | 0.500 | 0.500 | 0.500 |

NMVOC was estimated based on the landfill gas emitted. Therefore, methane emission has been converted to landfill gas in m³ by consideration of the CH₄ concentration in the landfill gas and by considering the absolute density of CH₄. Based on those emissions for NMVOC, was calculated.

Table 201 Data for conversion of methane emissions to NMVOC, CO and NH₃ emissions for category 5A - Biological treatment of waste

| Parameter | CH ₄ | NMVOC |
|--|-----------------|-------|
| Relative density | 0.555 | 0.555 |
| Absolute density [kg/Nm ³] bei 30°C | 0.650 | 0.72 |
| Concentration in landfill gas [%] (Cd, Hg, Pb, NMVOC, NH ₃ in mg/m ³) | 55 | 300 |

The emission factors used to calculate emission from particulate matter are as outlined in the GB 2023 for source category 5.A.

Table 202 Emission factors for source category 5.A- Biological treatment of waste

| Pollutant | Value | Unit | Reference |
|-------------------|-------|-------|--|
| NMVOC | 1.56 | kg/Mg | GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land |
| TSP | 0.463 | g/Mg | GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land |
| PM ₁₀ | 0.219 | g/Mg | GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land |
| PM _{2.5} | 0.33 | g/Mg | GB 2023 Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste – Solid waste disposal on land |

For NO_x and SO_x, heavy metals except Hg and POPs the notation key NA was used. For NH₃, Hg and CO the notation key NE was used – as outlined in the GB 2016/2023.

7.2.2. Source-specific uncertainties and time-series consistency

Uncertainties of activity data and emission factors have been estimated by using Tier 1 methodology of the EMEP/EEA GB 2013.

Table 203 Uncertainties of emissions, emission factors and activity data for 5.A

| Categories | NMVOC Emissions | PM _{2.5} Emissions | EF NMVOC | EF PM _{2.5} |
|----------------------------------|-----------------|-----------------------------|------------|----------------------|
| 5.A Solid waste disposal on land | +/- 134.6% | +/- 206.2% | +/- 125.0% | +/- 200.0% |
| Activity data | | | | |
| Amount of landfilled waste | | +/- 50,0% | | |

The applied recalculations are associated with relatively high uncertainty due to the lack of historical and activity-specific data. Many key parameters were estimated using extrapolation methods and expert judgment, particularly for earlier years (1950–1990), which increases the overall uncertainty of the results. In addition, assumptions based on proxy data (e.g. comparison with other countries)

further contribute to uncertainty. Therefore, additional data collection and future refinements are needed to improve accuracy and reduce uncertainty in the inventory.

7.2.3. Source-specific QA/QC and verification

The calculation has been checked by waste management experts and the parameters and factors used 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 magnitudes is right.

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

In the frame of IPA II project for Air quality recalculation was implemented for all years in reporting period 1990 - 2023.

The CS methodology used to estimate the NMVOC emission factors was based on CH₄ emissions which have been estimated using the kinetic model (IPCC FOD model) in the framework of the greenhouse gas emissions report.

The method used to calculate CH₄ emissions according to the 2006 IPCC Guidelines is the First Order Decay (FOD) method. The calculation of CH₄ emissions was carried out using the Tier 2 method and the IPCC FOD model, with a combination of country-specific data and default parameters. The improvement generated more accurate and reliable country-specific activity data and parameters for historical and current waste disposal. The improvement defined the amounts of components (food, garden, paper, wood, textile, nappies, plastics and other inert waste) of deposited MSW and IW required for multi-phase model based on waste composition data.

CH₄ emissions for category 5.A Biological treatment of waste - solid waste disposal on land include emissions from MSW and IW. Data on deposited sludge are missing and need to be included in the IPCC FOD model to complete the time series. The quantity of deposited MSW and IW is considered from 1950 onwards.

Two separate IPCC FOD models were prepared: one for unmanaged landfills and one for managed landfills, like the most countries that have both managed and unmanaged landfills. Both emissions are summed up to obtain total emissions. This assumption improves the comparability of the NMK inventory.

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

In order to further improve the inventory in future submission, it is necessary to include data on the population covered by organized MSW collection in the IPCC FOD model for the entire reporting period 1950 - 2023.

Data on sludge is missing, which should also be included in the model along with MSW and IW, and this gap should be filled in the further improvement of the inventory. For this category it would be desirable to prepare and implement a comprehensive improvement project that would further improve the GHG and air pollutant emission calculations. It is necessary to strengthen cooperation with experts in statistics,

to collect/evaluate the necessary data in future inventories using appropriate expert judgment methods to assessment accurate and reliable data.

7.3. Biological treatment of waste-Composting-NFR 5.B.1

7.3.1. 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 204 Activity data for source category 5.B.1 – Waste composted 1990-2024

| Year | Waste composted in kt | Year | Waste composted in kt |
|------|-----------------------|------|-----------------------|
| 1990 | NO | 2007 | NO |
| 1991 | NO | 2008 | NO |
| 1992 | NO | 2009 | 0.45 |
| 1993 | NO | 2010 | 0.31 |
| 1994 | NO | 2012 | 0.73 |
| 1995 | NO | 2013 | 0.44 |
| 1996 | NO | 2014 | 1.94 |
| 1997 | NO | 2015 | 2.81 |
| 1998 | NO | 2016 | 2.24 |
| 1999 | NO | 2017 | 1.11 |
| 2000 | NO | 2018 | 0.74 |
| 2001 | NO | 2019 | 0.55 |
| 2002 | NO | 2020 | 0.44 |
| 2003 | NO | 2021 | 0.17 |
| 2004 | NO | 2022 | 0.12 |
| 2005 | NO | 2023 | 0.09 |
| 2006 | NO | 2024 | 0.159 |

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 NH₃.

7.3.2. Source-specific uncertainties and time-series consistency

Time series consistency is ensured by applying the same methodology for the whole series.

7.3.3. Source-specific QA/QC and verification

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

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

Emissions coming from the category 5.B.1, category was calculated for the period from 2009 till 2022. Waste composted started in 2009. From 1990 till 2008 waste composting didn't occur in our country. No recalculation was performed in this category.

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

Activity data was received from several out of 84 municipalities. Emissions are underestimated in this sector. We intend to improve the process of collecting the data and information about the biological treatment of waste-composting. The information and data currently are underestimated. With the establishment of National environmental information system, which is in phase of testing this year, it is expected to have more complete data gathering starting from next reporting round.

7.4. Clinical Waste incineration - NFR 5.C

7.4.1. Methodological issues

Emissions from this source category are estimated according to GB-2023. The guideline outlines simple methodology where the amount of clinical waste incinerated is multiplied with Tier 1 emission factors.

Activity data

The activity data for source category 5.C - Clinical waste originates from the annual report of company "Drisla" where clinical waste incineration is operating. The company started with operation in 2000. Data for the period 2000-2024 were taken from the "Drisla" landfill website [38]. Values for 2023 and 2024 are taken from report submitted to MEPP since these data are not updated on the company web side.

Table 205 Quantity of clinical waste incinerated in the period 2000–2024

| Year | Clinical waste [Gg] | Year | Clinical waste [Gg] |
|------|---------------------|------|---------------------|
| 2000 | 0.115 | 2013 | 0.727 |
| 2001 | 0.232 | 2014 | 0.726 |
| 2002 | 0.249 | 2015 | 0.962 |
| 2003 | 0.255 | 2016 | 1.023 |
| 2004 | 0.323 | 2017 | 1.064 |
| 2005 | 0.376 | 2018 | 0.971 |
| 2006 | 0.329 | 2019 | 0.996 |
| 2007 | 0.357 | 2020 | 1.073 |
| 2008 | 0.362 | 2021 | 1.154 |
| 2009 | 0.416 | 2022 | 1.055 |

| Year | Clinical waste [Gg] | Year | Clinical waste [Gg] |
|------|---------------------|------|---------------------|
| 2010 | 0.465 | 2023 | 0.55487 |
| 2011 | 0.600 | 2024 | 0.9561 |
| 2012 | 0.677 | | |

Emission Factors

The emission factors used are as outlined in the GB 2023 and presented in the following table. Due to installation of filter for the period 2018-2020 the EF from the 2009 Guidebook were used. This Guidebook has EF for this type of reduction technics- Type 2 plant: larger on-site facilities equipped with de-dusting systems, while in the GB 2019/2023, only EF for BAT is provided.

Table 206 Emission factors for source category 5.c.1.dii - Clinical waste incineration

| Pollutant | Value | Unit | References |
|----------------------------|-------|-------------------|---|
| SO ₂ | 1.1 | kg/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| NO _x | 2.3 | kg/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| NM VOC | 0.7 | kg/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| TSP | 17 | kg/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| BC | 2.3 | % of TSP | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| CO | 0.19 | g/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| Pb | 62 | g/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| Cd | 8 | g/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| Cr | 2 | g/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| Cu | 98 | g/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| Hg | 5.4 | g/Mg waste | GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| As | 0.1 | kg/g waste | GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| Ni | 0.4 | kg/g waste | GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| PCB | 0.02 | g/Mg waste | GB 2023, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |
| PCDD/PCDF (dioxins/furans) | 40 | mg I-Teq/Mg waste | GB 2019, Table 3-1 Tier 1 emission factors for source category, 5.C.1.b.iii Clinical waste incineration. uncontrolled rotary kiln incinerator, page 8 |

| Pollutant | Value | Unit | References |
|-----------------|-------|-------------------|---|
| 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 |
| NO _x | 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 |
| SO _x | 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

No recalculation was performed in this category.

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

No recalculations in this category.

7.5. Open burning of waste- NFR 5.C.2

7.5.1. Methodological issues

The simpler methodology involves the use of a single emission factor for each pollutant representing the emission per mass of waste burned, combined with activity statistics:

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

This requires a prior knowledge of the weight of agricultural waste produced per hectare of forestry, orchard, and farmland. It is assumed that open burning of agricultural waste (except stubble burning) is mainly practiced in forestry, orchard, and arable farming; emissions from open burning for other types of farming are likely to be less significant and are assumed to be negligible. The average amount of waste burned for arable farmland is therefore 5.C.2 Open burning of waste GB 2013/2009 estimated to be 25 kg/hectare. This approach has been used for estimation of activity data. The activity data were calculated when the agriculture area expressed in hectares was multiplied with the factor 25 and divided by 1000 which equals to the waste burned in kg. For example, for 2018 the burning waste was calculated in this manner $518.740 \times 25 / 1000 = 12.969$.

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 207 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 | 2008 | 521 000 | 13 025 |
| 1991 | 664 000 | 16 600 | 2009 | 513 000 | 12 825 |
| 1992 | 662 000 | 16 550 | 2010 | 504 000 | 12 600 |
| 1993 | 663 000 | 16 575 | 2011 | 511 000 | 12 775 |
| 1994 | 661 000 | 16 525 | 2012 | 510 000 | 12 750 |
| 1995 | 656 000 | 16 400 | 2013 | 509 000 | 12 725 |
| 1996 | 658 000 | 16 450 | 2014 | 511 579 | 12 789 |
| 1997 | 647 000 | 16 175 | 2015 | 513 564 | 12 839 |
| 1998 | 635 000 | 15 875 | 2016 | 516 644 | 12 916 |
| 1999 | 633 000 | 15 825 | 2017 | 516 870 | 12 922 |
| 2000 | 598 000 | 14 950 | 2018 | 518 740 | 12 969 |

| Year | Arable farmland [hectare] | Waste [Mg] | Year | Arable farmland [hectare] | Waste [Mg] |
|------|------------------------------|------------|------|------------------------------|------------|
| 2001 | 612 000 | 15 300 | 2019 | 519 848 | 12 996 |
| 2002 | 577 000 | 14 425 | 2020 | 517 039 | 12 926 |
| 2003 | 569 000 | 14 225 | 2021 | 516 733 | 12 918 |
| 2004 | 560 000 | 14 000 | 2022 | 514 436 | 12 861 |
| 2005 | 546 000 | 13 650 | 2023 | 514 375 | 12 859 |
| 2006 | 537 000 | 13 425 | 2024 | 506 586 | 12 665 |
| 2007 | 529 000 | 13 225 | | | |

Emission Factors

The emission factors used are as outlined in the GB 2023 for source category 5.C.2.

Table 208 Emission factors for source category 5.C.2 - Open burning of waste

| Pollutant | Value | Unit | References |
|------------------------------|-------|------------------------|---|
| NO _x | 3.18 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| NM VOC | 1.23 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| SO _x | 0.11 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| PM _{2.5} | 4.19 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| PM ₁₀ | 4.51 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| TSP | 4.64 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| BC | 42 | % of PM _{2.5} | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| CO | 55.83 | kg/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| Pb | 0.49 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| Cd | 0.1 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| Cr | 0.01 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| Cu | 0.2 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| Se | 0.07 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| "PCDD/PCDF (dioxins/furans)" | 10 | mg I- Teq/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| benzo(a) pyren | 2.33 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |
| benzo(b) fluoranthene | 4.63 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |

| Pollutant | Value | Unit | References |
|-----------------------|-------|------|---|
| benzo(k) fluoranthene | 5.68 | g/Mg | GB 2023, Table 3-1 Tier 1, emission factors for source category 5.C.2 Small-scale waste burning, page 6 |

7.5.2. Source-specific uncertainties and time-series consistency

See chapter 7.4.2.

7.5.3. Source-specific QA/QC and verification

See chapter 7.4.3.

7.5.4. Standard QA/QC procedures

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

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

No recalculations were made in this category.

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

No planned improvements.

7.6. Wastewater treatment - NFR 5.D.1 and 5.D.2

7.6.1. Methodological issues

In Macedonia there are several municipal wastewater treatment plants. The data and information related with specific plants and especially the amount of domestic municipal wastewater treated in the plants has been gathered from State statistical offices. Based on the data gathered, emission was calculated based on a Tier 1 approach.

It was also attempted to gain data on how much people are connected to wastewater treatment. The data from Eurostat provide values for several years, in the range of 5-7%. Another information was found in the SOER country profile for Macedonia (see below), mentioning that "Sixty percent of dwellings are connected to a public sewage system, 21% have septic tanks and another 19% have only a system of uncontrolled wastewater discharge ". According to the BC experts, this number seems right concerning the connection to the sewage system, but when it comes to the connection to waste water treatment plants, the percentages provided by EUROSTAT seem reliable.

A latrine is a simple "dry" toilet built outside the house, usually in a backyard without water flushing. A storage tank under the latrine can be a hole dug in the ground, or a concrete reservoir. Latrines are sources of NH₃ emissions.

The Tier 2 EMEP/EEA methodology and recommended Tier 2 emission factor from GB 2023 are used for NH₃ emission calculation from latrine.

Table 209 The Tier 2 EMEO/EEA methodology NH₃ emission factor for source category 5.D.1 Domestic wastewater handling, sub-category latrine

| Pollutant | Value | Unit | References |
|-----------------|-------|----------------|--|
| NH ₃ | 1.6 | kg/person/year | GB 2023 Tier 2 emission factors for source category 5.D Wastewater handling, latrines Table 2-5 pg 8 |

$$E_{NH_3} = AD \times EF_{NH_3}$$

where:

E_{NH_3} = NH₃ emission,

AD = activity data

EF_{NH_3} = NH₃ emission factor,

With regard to category 5.D.2, industrial facilities report data on wastewater treated in their on-site wastewater treatment plants through questionnaires distributed by the State Statistical Office. The resulting estimates of treated wastewater quantities, as well as NMVOC emissions calculated using a Tier 1 approach, are considered to be underestimated.

Activity data

Activity data on wastewater handled in treatment plants are presented in the following table:

Table 210 Activity data for source category 5.D.1 - Wastewater treatment-(1990-2024)

| Year | Water treated [m ³] | Year | Water treated [m ³] |
|------|---------------------------------|------|---------------------------------|
| 1990 | 14 690 160 | 2008 | 16.093.220 |
| 1991 | 15 320 880 | 2009 | 21.187.840 |
| 1992 | 14.374.800 | 2010 | 21.698.560 |
| 1993 | 15.636.240 | 2011 | 21.113.200 |
| 1994 | 15.320.880 | 2012 | 22.836.899 |
| 1995 | 14.374.800 | 2013 | 21.079.644 |
| 1996 | 14.847.840 | 2014 | 24.709.351 |
| 1997 | 15.163.200 | 2015 | 25.322.341 |
| 1998 | 15.793.920 | 2016 | 12.675.451 |
| 1999 | 15.951.600 | 2017 | 9.639.664 |
| 2000 | 14.532.480 | 2018 | 21.395.408 |
| 2001 | 15.478.560 | 2019 | 36.126.117 |
| 2002 | 14.374.800 | 2020 | 47.746.743 |
| 2003 | 15.163.200 | 2021 | 39.301.456 |
| 2004 | 15.462.500 | 2022 | 29.861.372 |
| 2005 | 16 408 580 | 2023 | 35.195.445 |
| 2006 | 16 250 900 | 2024 | 33.082.153 |
| 2007 | 15.304.820 | | |

The relevant activity data for latrines is the number of residents who use latrines. The source of activity data is MAKSTAT. Statistical data on the Total population, households and dwellings in the Republic of North Macedonia, are available from the Population Census 2021, and have been used in the calculation of activity data.

Data on the Total population and statistical and assessed data for the population with Toilet outside the dwelling; No toilet and Unknown, for the years 2002 and 2021. The extrapolation method for the periods 1990 - 2001 and 2022 - 2023, according to the trend 2002- 2021, was carried out to estimate data for the entire reporting period.

Table 211 Activity data for source category 5.D.1 - Wastewater treatment - Latrine

| Year | Total population | Population with toilet outside the dwelling, no toilet, unknown | Share of Population who use latrine in the Total population |
|------|------------------|---|---|
| 1990 | 2028000 | 316595 | 15.6% |
| 1991 | 2033964 | 313965 | 15.4% |
| 1992 | 2056000 | 311335 | 15.1% |
| 1993 | 2066000 | 308705 | 14.9% |
| 1994 | 1945932 | 306075 | 15.7% |
| 1995 | 1966000 | 303444 | 15.4% |
| 1996 | 1983000 | 300814 | 15.2% |
| 1997 | 1996869 | 298184 | 14.9% |
| 1998 | 2007523 | 295554 | 14.7% |
| 1999 | 2017142 | 292924 | 14.5% |
| 2000 | 2026350 | 290294 | 14.3% |
| 2001 | 2034882 | 287664 | 14.1% |
| 2002 | 2022547 | 285034 | 14.1% |
| 2003 | 2026773 | 282403 | 13.9% |
| 2004 | 2032544 | 279773 | 13.8% |
| 2005 | 2036855 | 277143 | 13.6% |
| 2006 | 2040228 | 274513 | 13.5% |
| 2007 | 2043559 | 271883 | 13.3% |
| 2008 | 2046898 | 269253 | 13.2% |
| 2009 | 2050671 | 266623 | 13.0% |
| 2010 | 2055044 | 263993 | 12.8% |
| 2011 | 2058539 | 261363 | 12.7% |
| 2012 | 2061044 | 258732 | 12.6% |
| 2013 | 2064032 | 256102 | 12.4% |
| 2014 | 2069172 | 253472 | 12.2% |
| 2015 | 2070226 | 250842 | 12.1% |
| 2016 | 2073702 | 248212 | 12.0% |
| 2017 | 2073702 | 245582 | 11.8% |
| 2018 | 2077132 | 242952 | 11.7% |

| Year | Total population | Population with toilet outside the dwelling, no toilet, unknown | Share of Population who use latrine in the Total population |
|------|------------------|---|---|
| 2019 | 2076255 | 240322 | 11.6% |
| 2020 | 2068808 | 237692 | 11.5% |
| 2021 | 1836713 | 235061 | 12.8% |
| 2022 | 1829954 | 232431 | 12.7% |
| 2023 | 1826247 | 229801 | 12.6% |
| 2024 | 1822612 | 227171 | 12.50% |

Table 212 Activity data for source category 5.D.2 – Industrial Wastewater treatment

| Year | Water treated [m ³] | Year | Water treated [m ³] |
|------|---------------------------------|------|---------------------------------|
| 1990 | NO | 2008 | 94.786.000 |
| 1991 | NO | 2009 | 49.593.000 |
| 1992 | 7.449.000 | 2010 | 20.131.000 |
| 1993 | 24.469.000 | 2011 | 77.573.000 |
| 1994 | 35.479.000 | 2012 | 92.492.000 |
| 1995 | 46.489.000 | 2013 | 230.053.000 |
| 1996 | 19.298.000 | 2014 | 12.161.000 |
| 1997 | 33.157.000 | 2015 | 16.188.000 |
| 1998 | 47.016.000 | 2016 | 12.620.000 |
| 1999 | 22.002.000 | 2017 | 242.036.000 |
| 2000 | 15.197.000 | 2018 | 351.131.000 |
| 2001 | 3.728.000 | 2019 | 6.823.420 |
| 2002 | 41.461.000 | 2020 | 220.391.000 |
| 2003 | 45.879.000 | 2021 | 219.714.000 |
| 2004 | NE | 2022 | 332.125.000 |
| 2005 | 132.976.000 | 2023 | 331.867.000 |
| 2006 | 132.976.000 | 2024 | 749.605.000 |
| 2007 | 349.927.000 | | |

The emission factors applied are the given ones in the EMEP 2023 guidebook, which allowed the calculation of NMVOC emission from domestic wastewater handling. The emission factor used is 15mg NMVOC per m³ wastewater. There is an available emission factor on ammonia, and it has been used for calculation of ammonia emissions, because there is 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

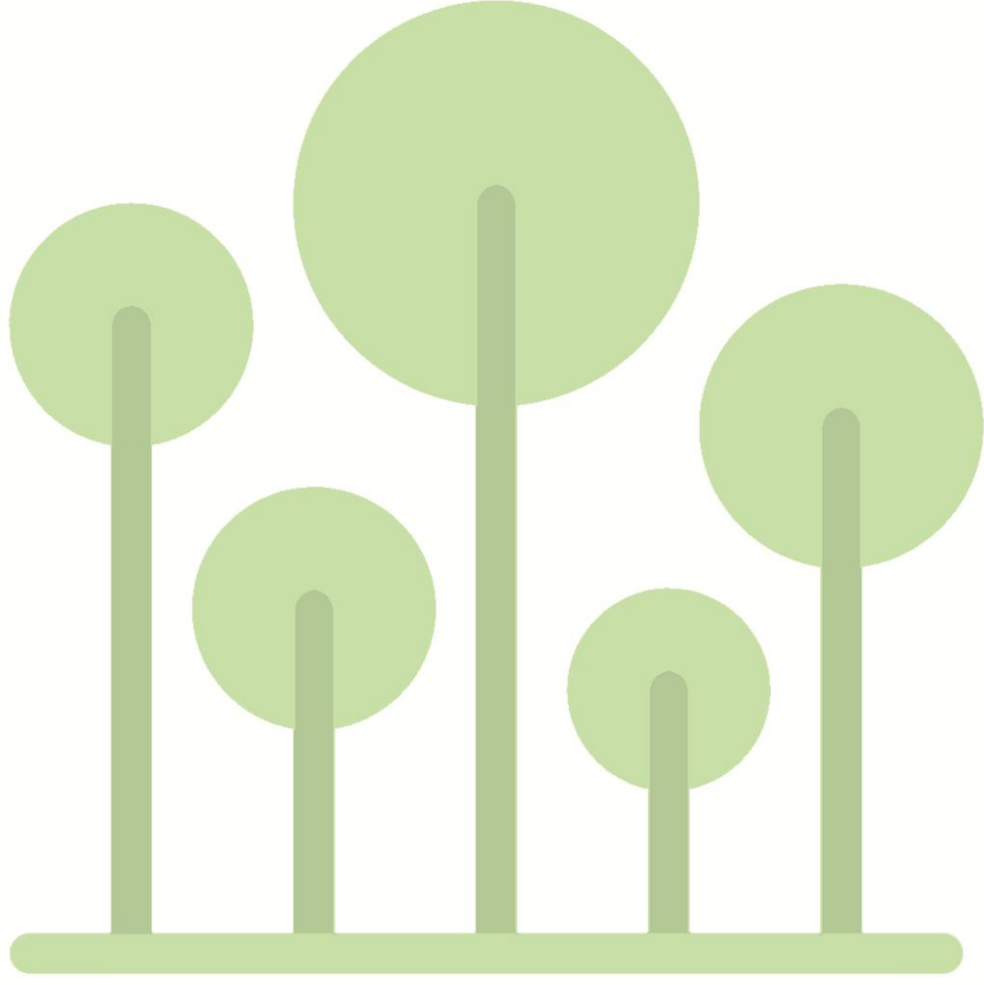
NH₃ emissions from latrine were calculated using Tier 2 methodology.

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

It is necessary to strengthen cooperation with experts in statistics, to collect/evaluate the necessary data in the future inventories using the appropriate expert judgment methods to assessment accurate, transparent and comparable activity data for historical series.

OTHER AND NATURAL SOURCES

ES



8. NATURAL SOURCES

8.1. Sector overview

This chapter describes emissions from (naturally or man-induced) burning of non-managed and managed forests and other vegetation, excluding agricultural burning of stubble, etc. This includes domestic fires (fuel wood, crop residue, dung and charcoal burning), as well as open vegetation fires (forest, shrub, grass and cropland burning).

In this Inventory Report, this chapter shows emissions, which originated from open vegetation forest fires.

This sector includes information and description of the methodologies applied for estimating emissions for NMVOC, NH₃, NO_x, SO_x, PM₁₀, PM_{2.5}, TSP CO and BC as well as references to activity data and emission factors concerning emissions coming from the forest fires for the period 1990-2024.

8.1. General description

Methodology

Tier 1 approach was used, using the given default Emission factors from the GB2019.

Completeness

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

Table 213 Completed/Not completed NFRs in sector Natural sources

| NFR category | Completeness |
|----------------------------|--------------|
| 11.B Forest fires | ✓ |
| 11.A Volcanoes | NO |
| 11.C Other Natural Sources | NE |

8.2. Forest fires – NFR 11.B

8.2.1. Methodological issues

The Tier 1 approach for emissions from forest fires uses the general equation:

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

Where:

$E_{pollutant}$ = is the emission of a certain pollutant.

AR_{burned} = is the total area that has been burned/wood burned

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

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 214 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 | 1 234 | 8138 | 62 66 260 |
| 2021 | 12 315 | 49 0023 | 377 318 080 |
| 2022 | 1 956 | 12 477 | 9 607 444 |
| 2023 | 5772,48 | 18940,50 | 14584185 |
| 2024 | 61061 | 635005,15 | 488953965,5 |

Emission factors

Calculation of emission parameters was used, and emission factors were taken from the GB 2023.

Table 215 Emission factors for source category 11.B Forest fires

| Pollutant | Value | Unit | References |
|-------------------|-------|--------------------|---|
| NO _x | 100 | kg/ha area burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| CO | 3000 | kg/ha area burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| NM VOC | 300 | kg/ha area burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| SO _x | 20 | kg/ha area burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| NH ₃ | 20 | kg/ha area burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| PM ₁₀ | 11 | g/kg wood burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| PM _{2.5} | 9 | g/kg wood burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| TSP | 17 | g/kg wood burned | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |
| BC | 9 | %PM _{2.5} | GB 2023, 11B Forest fires, Table 3-1, pg. 9 |

In the Statistical Yearbooks from 2000-2016 [22] there is data for wood burned in m³. Calculation is made for wood burned in kg using the equation: average density 0.77 kg/m³ *1000.

8.2.2. Source-specific uncertainties and time-series consistency

No data available for burned area for the period 1990-1999.

8.2.3. Source-specific QA/QC and verification

Macedonian Forests Company provided the data that was crosschecked with the data published in the SSO publication Forestry.

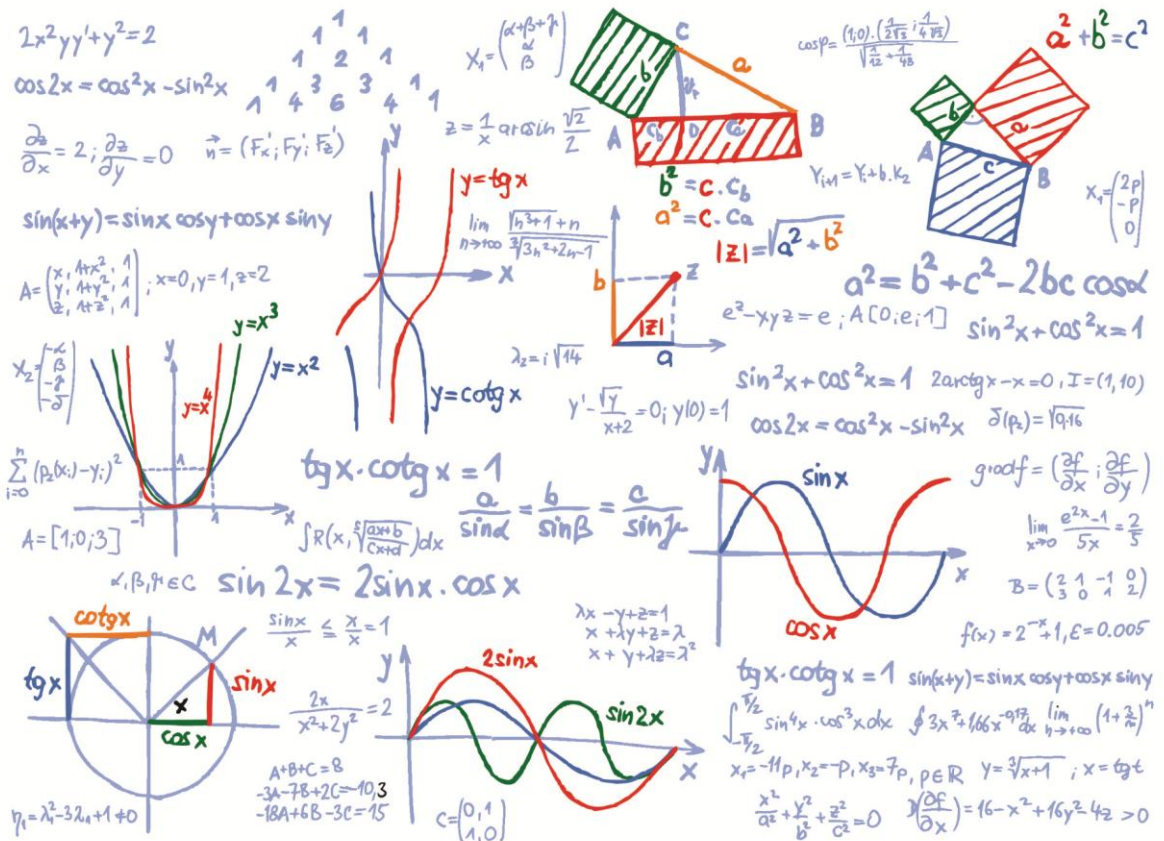
8.2.4. Source-specific recalculations including changes made in response to the review process

No recalculations were made in this sector.

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

It is possible to investigate other natural sources but emissions coming from this category are not calculated in national totals and the rate of importance is considered low compared to other categories.

RECALCULATIONS



9. RECALCULATIONS AND IMPROVEMENTS

9.1. Recalculations

The following section summarizes the changes made since the previous submission for each sector (e.g. methodological changes, update of activity data, new emission sources). Detailed information per category can be found in the chapters per sector, above.

9.1.1. Explanation of recalculations per sector

The recalculation was based on the availability and correction of activity data due to use of final energy balans for 2023 as well as due to change of methodology and detail activity data.

Explanations for recalculation per sector are given in the respective chapters. The tables indicating recalculations per pollutant can be found in tables 214-230.

The current inventory has been significantly improved across all sectors through the application of more advanced methodologies, correction of data inconsistencies, and inclusion of previously missing data.

In the energy sector, major updates include the implementation of Tier 2 and Tier 3 methodologies for both stationary and mobile sources. Residential combustion estimates were improved using updated models and national data, while issues such as double counting in cement production and fuel misallocation were corrected. Road transport emissions were recalculated using the COPERT model, with improved vehicle and fuel data. Fugitive emissions from fuel distribution were also refined using updated methodologies and corrected activity data. Regarding energy production sector, measurement data were replaced with use of GB emissions factors due to high uncertainty of measurement and inconsistency of use of different methodologies during the whole time series.

For industrial processes and product use, improvements focused on applying higher-tier methodologies (Tier 2), expanding time series coverage, and filling data gaps. Emission estimates were introduced or improved for several solvent use categories, including coatings, degreasing, dry cleaning, and chemical products. Missing historical data was incorporated, and methodologies were aligned with recent guidance and modeling tools.

In the agriculture sector, significant methodological upgrades were made through the introduction of Tier 2 approaches, particularly using the Nitrogen-flow tool. This enabled more accurate estimation of NH_3 , NO_x , and NMVOC emissions across manure management and agricultural soils. Updates also include revised emission factors, improved activity data, and the introduction of new emission sources such as crop residues and field burning.

In the waste sector, new models and methodologies were applied for key categories, including solid waste disposal, biological treatment, and wastewater handling. These improvements include the use of Tier 2 approaches and the introduction of emission estimates for pollutants such as NH_3 , NMVOC, and particulate matter.

Overall, the inventory enhancements reflect a transition toward higher-tier methodologies, improved data quality, correction of previous inconsistencies, and better alignment with the latest EMEP/EEA Guidebook (2023).

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 2023 national totals.

Table 216 Recalculation difference of NO_x emissions [kt] compared to submission in 2025

| NO _x emissions [kt] | | 1990 | | 2023 | |
|--------------------------------|---|-------------|------------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 8.91 | 59% | -0.56 | -9% |
| 1A2 | Manufacturing Industries & Construction | 0.61 | 7% | 0.74 | 24% |
| 1A3 | Transport | 0.41 | 4% | 0.26 | 3% |
| 1A4 | Other Sectors | 0.00 | 0% | -0.19 | -20% |
| 1B | Fugitive Emissions | 0.00 | 0% | 0.00 | - |
| 2 | Industrial Processes and Product Use | 0.00 | 0% | 0.00 | 0% |
| 3 | Agriculture | -1.86 | -78% | -1.04 | -71% |
| 5 | Waste | 0.00 | 0% | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 8.06 | 22% | -0.79 | -4% |

Table 217 Recalculation difference of NMVOC emissions [kt] compared to submission in 2025

| NMVOC emissions [kt] | | 1990 | | 2023 | |
|----------------------|---|-------------|-----------|-------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | 0% | 0.00 | 0% |
| 1A2 | Manufacturing Industries & Construction | 0.01 | 1% | 0.01 | 2% |
| 1A3 | Transport | 5.73 | 63% | 0.03 | 3% |
| 1A4 | Other Sectors | 0 | 0% | -0.03 | -1% |
| 1B | Fugitive Emissions | 1.70 | 67% | 4.62 | 497% |
| 2 | Industrial Processes and Product Use | -6.65 | -44% | -0.72 | -10% |
| 3 | Agriculture | 0.11 | 2% | 0.45 | 17% |
| 5 | Waste | -0.01 | -18% | -0.33 | -77% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 0.87 | 2% | 4.02 | 23% |

Table 218 Recalculation difference of SO₂ emissions [kt] compared to submission in 2025

| SO ₂ emissions [kt] | | 1990 | | 2023 | |
|--------------------------------|---|-------|------|-------|------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 2.86 | 3% | 48.14 | 89% |
| 1A2 | Manufacturing Industries & Construction | 0.18 | 3% | 0.01 | 1% |
| 1A3 | Transport | -0.45 | -38% | -0.01 | -10% |
| 1A4 | Other Sectors | 0.00 | 0% | -0.06 | -20% |
| 1B | Fugitive Emissions | 0.00 | 0% | 0.00 | - |
| 2 | Industrial Processes and Product Use | 0.00 | 0% | 0.24 | 435% |

| SO ₂ emissions [kt] | | 1990 | | 2023 | |
|--------------------------------|------------------------|-------------|-----------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 3 | Agriculture | 0.00 | - | -0.04 | - |
| 5 | Waste | 0.00 | 0% | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 2.59 | 2% | 48.30 | 85% |

Table 219 Recalculation difference of NH₃ emissions [kt] compared to submission in 2025

| NH ₃ emissions [kt] | | 1990 | | 2023 | |
|--------------------------------|---|-------------|-----------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | - | 0.00 | - |
| 1A2 | Manufacturing Industries & Construction | 0.00 | 0% | 0.00 | - |
| 1A3 | Transport | -0.04 | -100% | 0.01 | 11% |
| 1A4 | Other Sectors | 0.00 | 0% | 0.00 | -2% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | 0% |
| 2 | Industrial Processes and Product Use | 0.00 | 0% | 0.00 | - |
| 3 | Agriculture | 1.79 | 14% | -0.28 | -4% |
| 5 | Waste | -0.51 | - | -0.37 | - |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 1.25 | 9% | -0.64 | -9% |

Table 220 Recalculation difference of PM_{2.5} emissions [kt] compared to submission in 2025

| PM _{2.5} emissions [kt] | | 1990 | | 2023 | |
|----------------------------------|---|-------------|----------|--------------|-------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 1.40 | - | -0.63 | -37% |
| 1A2 | Manufacturing Industries & Construction | 0.00 | - | 0.01 | 4% |
| 1A3 | Transport | -0.28 | - | -0.10 | -21% |
| 1A4 | Other Sectors | 0.00 | - | -0.08 | -1% |
| 1B | Fugitive Emissions | 0.00 | -- | 0.00 | 0% |
| 2 | Industrial Processes and Product Use | -0.01 | - | 0.02 | 4% |
| 3 | Agriculture | 0.06 | - | -0.36 | -72% |
| 5 | Waste | 0.00 | - | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 1.17 | 0 | -1.12 | -13% |

Table 221 Recalculation difference of PM₁₀ emissions [kt] compared to submission 2025

| PM ₁₀ emissions [kt] | | 1990 | | 2023 | |
|---------------------------------|---|-------|-----|-------|------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 3.64 | - | -0.95 | -24% |
| 1A2 | Manufacturing Industries & Construction | 0.00 | - | 0.01 | 3% |
| 1A3 | Transport | -0.32 | - | -0.11 | -11% |
| 1A4 | Other Sectors | 0.00 | - | -0.08 | -1% |

| PM10 emissions [kt] | | 1990 | | 2023 | |
|---------------------|--------------------------------------|-------------|-----------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | 0% |
| 2 | Industrial Processes and Product Use | -0.01 | - | 0.03 | 0% |
| 3 | Agriculture | 0.13 | - | -0.35 | -10% |
| 5 | Waste | 0.00 | - | 0.00 | 1% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 3.45 | 0% | -1.45 | -9% |

Table 222 Recalculation difference of TSP emissions [kt] compared to submission in 2025

| TSP emissions [kt] | | 1990 | | 2023 | |
|--------------------|---|-------------|-----------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 5.45 | - | -1.22 | -24% |
| 1A2 | Manufacturing Industries & Construction | 0.00 | - | 0.01 | 3% |
| 1A3 | Transport | -0.34 | - | -0.09 | -11% |
| 1A4 | Other Sectors | 0.00 | - | -0.08 | -1% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | 0% |
| 2 | Industrial Processes and Product Use | -0.01 | - | 0.00 | 0% |
| 3 | Agriculture | 0.30 | - | -0.30 | -10% |
| 5 | Waste | 0.00 | - | 0.00 | 1% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 5.41 | 0% | -1.68 | -9% |

Table 223 Recalculation difference of CO emissions [kt] compared to submission in 2025

| CO emissions [kt] | | 1990 | | 2023 | |
|-------------------|---|---------------|-------------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | 0.00 | -0.91 | -44% |
| 1A2 | Manufacturing Industries & Construction | 0.72 | 11 | 0.00 | 0% |
| 1A3 | Transport | -19.82 | -28 | 1.00 | 21% |
| 1A4 | Other Sectors | 0.00 | 0.00 | -0.50 | -2% |
| 1B | Fugitive Emissions | 0.00 | 0.00 | 0.00 | - |
| 2 | Industrial Processes and Product Use | 0.00 | 0.00 | 0.00 | 0.00% |
| 3 | Agriculture | 0.00 | - | -4.96 | - |
| 5 | Waste | 1.22 | 131 | 2.90 | 403% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | -17.89 | -14% | -2.21 | -5% |

Table 224 Recalculation difference of Pb emissions [t] compared to submission in 2025

| Pb emissions [t] | | 1990 | | 2023 | |
|------------------|---|------|-------|-------|-----|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | 0.00% | 0.00 | 0% |
| 1A2 | Manufacturing Industries & Construction | 0.05 | 8% | -0.01 | -3% |

| | | | | | |
|--------------|--------------------------------------|---------------|------------|--------------|------------|
| 1A3 | Transport | -18.72 | -17% | -0.72 | -70% |
| 1A4 | Other Sectors | 0.00 | 0.00% | -0.01 | -2% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | - |
| 2 | Industrial Processes and Product Use | -1.70 | -1% | 0.05 | 1% |
| 3 | Agriculture | 0.00 | - | -0.01 | - |
| 5 | Waste | 0.00 | 0% | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | -20.38 | -8% | -0.69 | -9% |

Table 225 Recalculation difference of Cd emissions [t] compared to submission in 2025

| Cd emissions [t] | | 1990 | | 2023 | |
|------------------|---|--------------|-------------|--------------|-------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0,00 | 0% | 0,00 | 0% |
| 1A2 | Manufacturing Industries & Construction | 0.00 | 40% | 0.00 | -5% |
| 1A3 | Transport | 0.00 | 51% | 0.00 | -67% |
| 1A4 | Other Sectors | 0.00 | 0% | 0.00 | 0% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | - |
| 2 | Industrial Processes and Product Use | -0.17 | -12% | 0.00 | 5% |
| 3 | Agriculture | 0.00 | - | -0.06 | - |
| 5 | Waste | 0.00 | 0% | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | -0.17 | -10% | -0.06 | -22% |

Table 226 Recalculation difference of Hg emissions [t] compared to submission in 2025

| Hg emissions [t] | | 1990 | | 2023 | |
|------------------|---|--------------|-------------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | 0% | 0.00 | 0% |
| 1A2 | Manufacturing Industries & Construction | 0.02 | 2% | 0.00 | -1% |
| 1A3 | Transport | 0.00 | 0% | 0.00 | -1% |
| 1A4 | Other Sectors | 0.00 | 0% | 0.00 | -1% |
| 1B | Fugitive Emissions | 0.00 | 0% | 0.00 | 0% |
| 2 | Industrial Processes and Product Use | -0.17 | -17% | 0.00 | 0% |
| 3 | Agriculture | 0.00 | 0% | -0.01 | - |
| 5 | Waste | 0.00 | 0% | 0.00 | 0% |
| 6 | Other | 0.00 | 0% | 0.00 | - |
| Total | Total emissions | -0.15 | -15% | -0.01 | -5% |

Table 227 Recalculation difference of PCDD/ PCDF emissions [t] compared to submission in 2025

| PCDD/ PCDF emissions [t] | | 1990 | | 2023 | |
|--------------------------|---|--------------|------------|--------------|-----------|
| | | 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 | -0.14 | - | -0.10 | - |
| 1A4 | Other Sectors | 0.00 | 0% | -0.04 | -1% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | - |
| 2 | Industrial Processes and Product Use | -0.19 | -3% | 0.16 | 17% |
| 3 | Agriculture | 0.00 | - | -0.04 | - |
| 5 | Waste | 0.00 | 0% | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | -0.33 | -2% | -0.03 | 0% |

Table 228 Recalculation difference of PAHs emissions [t] compared to submission in 2025

| PAHs emissions [t] | | 1990 | | 2023 | |
|--------------------|---|-------------|-----------|--------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | 0% | 0.00 | 0% |
| 1A2 | Manufacturing Industries & Construction | 0.05 | 6% | 0.02 | 2% |
| 1A3 | Transport | -0.02 | - | 0.00 | -30% |
| 1A4 | Other Sectors | 0.00 | 0% | -0.07 | -3% |
| 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 | 0.03 | 1% | -0,05 | -7% |

Table 229 Recalculation difference of HCB emissions [kg] compared to submission in 2025

| HCB emissions [kg] | | 1990 | | 2023 | |
|--------------------|---|-------------|-----------|-------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | - | 0.00 | - |
| 1A2 | Manufacturing Industries & Construction | 0.00 | 0% | 0.00 | -9% |
| 1A3 | Transport | 0.00 | - | 0.00 | - |
| 1A4 | Other Sectors | 0.00 | 0% | 0.00 | 0% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | - |
| 2 | Industrial Processes and Product Use | 0.00 | 0% | 0.00 | - |
| 3 | Agriculture | 0.00 | - | 0.00 | - |
| 5 | Waste | 0.00 | - | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | 0.00 | 0% | 0.00 | -1% |

Table 230 Recalculation difference of PCB emissions [kg] compared to submission in 2025

| PCB emissions [kg] | | 1990 | | 2023 | |
|--------------------|---|---------------|------------|---------------|------------|
| | | Δ kt | Δ % | Δ kt | Δ % |
| 1A1 | Energy Industries | 0.00 | - | 0.00 | - |
| 1A2 | Manufacturing Industries & Construction | 0.00 | 0% | -0.01 | -3% |
| 1A3 | Transport | 0.00 | - | 0.00 | - |
| 1A4 | Other Sectors | 0.00 | 0% | 0.00 | 0% |
| 1B | Fugitive Emissions | 0.00 | - | 0.00 | - |
| 2 | Industrial Processes and Product Use | -37.17 | -9% | 126.20 | 54% |
| 3 | Agriculture | 0.00 | - | 0.00 | - |
| 5 | Waste | 0.00 | - | 0.00 | 0% |
| 6 | Other | 0.00 | - | 0.00 | - |
| Total | Total emissions | -37.17 | -9% | 126.19 | 54% |

9.2. Planned Improvements

In the following table the planned improvements that are listed were recommended but were not implemented up to now and are planned to be implemented in the future. The improvements are structured as general issues and summaries sector improvements, while detail sector improvements are given in Chapters 3-7.

Table 231 Planned improvements

| Subject | Source | Rating | Improvement planned | Timeline/Comments |
|---|--------|--------|--|--|
| Recalculations to be quantified for the whole time series, currently (i.e. Submission 2017) only for 1990 and last reporting year | NEIT | Medium | The improvement of the Recalculation tool will include the provision of recalculated emission data for the entire time series. | Planned to be implemented in the following submissions |
| Preparation of QA/QC plan | NEIT | Medium | There are a lot of QA/QC procedures and Matrix flow has been prepared but due to limited capacities QA/QC plan has not been yet prepared. It is concdered to be prepared in the forthcoming IPA project. | 2026 (In the frame of EU 4 green and IPA II Air quality project) to be finalized by the end of the year. |
| Preparation of Program for gathering of activity data for preparation on inventort | NEIT | High | Article on requirement for preparation on the program is defined in the new law on ambient air quality. It is concdered to be preparedi n the forthcoming IPA project. | 2026 (In the frame of PA II Air quality project) to be finalized by the end of the year, and implemented from 2027 |
| Implement higher Tier method for all the key categories. | NEIT | High | Tier 2 method is implemented for several categories and Tier 3 is implemented in Transport. However, there are stil many categories for which we use Tier 1 method | Plan to recived more detailed measurement data from the operators when NEIS is established |
| Cross-cutting (DSM: uncertainty tool) | NEIT | High | When shift from Tier 1 methods to Tier 2 the Uncertainty tool need to be updated. The improvement of the Uncertainty tool will include the update of the uncertainty calculation for the NFR categories with improved Tier 2 methodology with the updated uncertainty for higher-tier emission | 2026 (In the frame of EU 4 green) to be finalized by the end of May |

| Subject | Source | Rating | Improvement planned | Timeline/Comments |
|---------|--------|--------|---|-------------------|
| | | | factors, and updated uncertainty for activity data. | |

9.3. Status of implementation of ERTs in-depth review recommendations (CLRTAP stage 3 review and if applicable NECD review)

9.3.1. Status of implementation of last and previous reviews

Table 232 Status of implementation of last and previous reviews

| Category | Notes | Source | Rating | Status |
|---------------------------------------|--|--|--------|--|
| General | North Macedonia does not provide information on the condensable component of PM in the IIR. To the question on the issue North Macedonia answered that they will consider the issue and include it in a forthcoming project during 2021. The ERT recommends North Macedonia to include this project in the improvement plan in the next submission and to report the results of the project regarding condensable component in IIR Table A6.1 as requested in Reporting Guidelines Annex II. | CEIP/S3.RR/2020/North Macedonia | Medium | Implemented. Status on condensables is included in the IIR submitted in 2021 as Appendix 2 |
| General | The ERT would like to point out that a Tier 2 or 3 methodology should be applied to all sources identified as key categories and thus would apply to all sources listed in tables 2 to 7. | CEIP/S3.RR/2016/ IPA II Air quality improvement plan | High | For many categories TIER 2 methodology was implemented in the last submission with support of technical experts in |
| General | The ERT wants to point out that the older versions of Guidebook are used for emission calculations, reasoning for that should be provided in the IIR because it is generally recommended to use the latest version of the Guidebook. | CEIP/S3.RR/2016/ | High | The NIT has used 2023 EMEP Guidebook for a lot of sectors. However, due to limited activity data for some sectors EF from older Guidebooks are still used. |
| General | In the inventory improvement plan. the FYROM indicated to carry out a trend assessment within the KCA in future years | CEIP/S3.RR/2016/ | High | Trend assessment analysis was included in the IIR the following year after stage 3 review was done. |
| 1A2gvii 1A4aii 1A4bii 1A4cii | Improvement of Non-Road mobile machinery related emissions for whole historic trend with use of 1.A.4 Non Road mobile machinery Annex 2023 model for calculation of emissions from this sector with Tier 2 methodology Improvement of activity data used from national energy balances. Use of the assumptions from neighbouring country. | CEIP/S3.RR/2016/North Macedonia | High | Tier 2 Methodology implemented in previous reporting cycle |
| 1.A.3.b | ERT noted that the EF used for passenger cars gasoline fuel for Euro 0 vehicles in IIR Table 74 (Emission factor for source category 1A3bi Road Transport: Passenger cars used for calculation of emissions in the period 2014-2018 by use of Tier 2 methodologies) differs from the EF in Guidebook 2019. The ERT recommends that the Party adds an explanation for the use of this EF and documents the calculation of Euro 0 passenger cars' gasoline emissions in the IIR. | CEIP/S3.RR/2020/North Macedonia | Low | Explanation included in IIR |
| 1.A.3.b | The ERT identified some errors in the reported values such as CO from NFR 1A3b in the 2019 submission and in the 2020 submission. In the 2019 submission the value of CO emissions for 1991 was 35.295 kt. and in the 2020 submission the value of CO emission was 56.323 kt. During the review the Party explained that there was a mistake in the 2019 submission and that in the 2020 submission the value was correct. | CEIP/S3.RR/2020/North Macedonia | Low | Value was corrected. |

| Category | Notes | Source | Rating | Status |
|--|---|---|--------|---|
| 1.A.3.b | Missing coherent emission trends due to different methodology use. Emission calculation for the whole historic trend with the use of COPERT 5 model to receive coherent emission trends. Collection of activity data needed for reproduce the historic trend which than can be used in the COPERT 5 or if detail data is not available, use of surrogate data (e.g. neighbouring country). | IPA II Air quality improvement plan | High | Implemented in 2026 inventory submission COPERT V model was used for emission calculations for period 1990-2024 |
| 1.A.2.gvii 1.A.4aii 1.A.3a 1.A.3b 1.A.3cii and 1.A.3ciii | Inconsistency in notationkeys and expelnation of the reasons for the use of the notation keys. | CEIP/S3.RR/2 020/North Macedonia | Low | Notation keys changed and explanation included in the IIR according to the recommendations given by Stage 3 review |
| 1A2gvii 1A4aii 1A4bii 1A4ciii | Improvement of Non-road mobile machinery related emissions for whole historic trend with use of 1.A.4 Non road mobile machinery Annex 2023 model for calculation of emissions from this sector with Tier 2 methodology Improvement of activity data used from national energy balances. Use of the assumptions from neighbouring country. | IPA II Air quality improvement plan | High | Implemented in 2025 inventory submission |
| 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/2 016/North Macedonia § 20 | Low | Black carbon emissions were calculated for these categories |
| 1.A.3.c | The ERT recommended use of higher tier methodology Missing coherent emission trends due to different methodology use. | CEIP/S3.RR/2 020/North Macedonia IPA II Air quality improvement plan | Low | Tier 2 was implemented for 1990-2024 emissions in 2026 inventory submission |
| 1.A.3.ei | The ERT recommends that the party contacts the gas supplier to find out if compressor stations are used in the FYROM and which technologies they use to maintain the pressure in the pipelines. | CEIP/S3.RR/2 016/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. |
| 1A4bi | Shift from Tier 1 methods to Tier 2 given this is key category. Collection of activity data for the burning of wood, and on use of pellets systems in the country and moving from Tier 1 to Tier 2 methodology for solid biomass and coal combustion according to different appliance types on a per country basis. Prepare a mathematical model for emission calculation for the whole historic period of time. Provide information on assumptions used. Combine GAINS and national data. Link prepared mathematical model with NFR calculation tool at DMS. Tier 2 Implemented and data reported in this submission | CEIP/S3.RR/2 020/North Macedonia IPA II Air quality improvement plan | High | Tier 2 was implemented for 1990-2024 emissions in 2025 inventory submission |
| 1.A.5.a | In the IIR it is stated that this sector is not estimated due to lack of activity data and that it seems not to have a major impact on the national emissions and will be calculated or categorized as IE when activity data or information are made available in the future submissions. The ERT recommends that North Macedonia includes this issue in their planned improvements and follows up on them. | CEIP/S3.RR/2 016/North Macedonia | High | Emission from this sector are IE and information is included in the IIR |
| 2.B.10.a | To the question on if it is assumed that any of the activities falling under the scope of NFR 2B10a exist in the territory of North Macedonia and in case they exist. can the Party | CEIP/S3.RR/2 020/Macedonia | High | Emissions are estimated for period 1990-2005 |

| Category | Notes | Source | Rating | Status |
|---------------------------|---|-------------------------------------|--------|---|
| | estimate emissions be using the guidance given by the ERT North Macedonia responded that the following activities existed in earlier years or existed also currently: sulfuric acid (040401). Fertilizer do not know which one. Chlorine production - mercury cell (040413). Phosphate fertilisers (040414). Polyethylene low density (040506) and polyethylene high density (040507). Polyvinylchloride (040508). | | | |
| 2.C.1 | During the review, the ERT noted that according to the IIR (page 54. Table 8) NFR 2C1 is one of the Key categories for Hg emissions. and that on page 59 in Table 20. where the results of the level and trend assessment for Hg are presented. key Hg category 2C1. is missing | CEIP/S3.RR/2 020/Macedonia | Medium | KCA was corrected |
| 2.C.2 2.C.3 2.D.3.b | The ERT noted dips in the ferroalloys production activity data in 2001 of 85% and in 2009 of 64% and a jumps in 2004 of 346% (approx. 4.5 times) and in 2010 of 121% (approx. 4.2 times). The ERT noted jumps in the activity data of secondary aluminium production in 1999 of 84% and in 2002 of 54% and a dip in 2004 of 80%. The ERT noted a jump in all emissions in 1999 of 145% (approx. by 2.4 times) in road paving with asphalt. To a question on the issue North Macedonia answered that in the statistics the length of roads is the highest in 1999. The ERT recommends North Macedonia to include this information in the next submission | CEIP/S3.RR/2 020/Macedonia | Low | Explanation incorporated in the report |
| 2.C.5 | Possible uncompleted activity data | NIT | Low | |
| 2.D.3.d | Improvement of calculation of NMVOC emissions from the solvent and product use sector. This includes data collection and processing (production + import – export). The relevant activity statistics include: the number of painted buses/cars/trucks to calculate the emissions for vehicle coatings; the mass of wire coated to calculate the emissions for wire coating; the mass of leather coated to calculate the emissions for leather finishing; the use of paint to calculate the emissions for all other sources like paint application-construction and buildings, paint application-domestic use (except SNAP 060107), wood coating, coil coating, vehicle refinishing, or other non-industrial paint application). Prepare a mathematical model for emission calculation for the whole historic period of time. Provide information on assumptions used. Provide and information on approximation and surrogate data used. | IPA II Air quality improvement plan | High | Implemented in 2026 submission |
| 2.C.7.c | the ERT asked North Macedonia to provide revised estimates for SO2 and TSP during the review | CEIP/S3.RR/2 020/Macedonia | Low | Estimation provided and included in 2022 submission |
| 2.D.3 g | During the review the ERT looked through the activities that are included in the inventory under the category 2D3g and noted that some of the activities that are covered in the Guidebook 2019 version are not included in the inventory of North Macedonia. such as: Asphalt blowing. Adhesive tape manufacturing. Pharmaceutical products manufacturing. Textile finishing and Manufacture of tires. In the IIR on p. 213. there is information about the plan to check the availability of data on Textile finishing and pharmaceutical products manufacturing and to report the related emissions in the following submissions. However, there is no information on why activities like Asphalt blowing. Adhesive tape manufacturing and Manufacture of tires are not included. | CEIP/S3.RR/2 020/North Macedonia | High | Information is included in the IIR |
| 2.K | The ERT noted that the notation key "NE" is reported for emissions of Hg and PCB from category 2K. The ERT noted that an EF based on population is given in the Guidebook. | CEIP/S3.RR/2 020/Macedonia | High | Estimation provided and included in 2022 submission |

| Category | Notes | Source | Rating | Status |
|-----------------------|---|---|--------|--|
| 2.D.3.a | The ERT also notes that the national statistical office. wholesale businesses or industry associations may have the statistics on the consumption of different products that are part of domestic use and required for calculation of NMVOC emissions with the Tier 2b of the Guidebook. Alternatively, as presented on p.18 of Ch. 2D3a in Guidebook 2019, product consumption may be calculated from statistics on the production of these products, provided that import and export data are available to recalculate from production to consumption | CEIP/S3.RR/2 020/Macedonia | High | Estimation for this category provided and included in 2022 submission |
| | The NFR tables that NMVOC emissions from 2D3a domestic solvent use including fungicides do not show a peak during the COVID-19 pandemic | CEIP/S3.RR/2 024/North Macedonia | Medium | Explanation included |
| 2.D.3.e | Shift from Tier 1 methods to Tier 2 given this is key category | IPA II Air quality improvement plan | High | Implemented in 2026 submission NMVOC emissions were calculated using solvents statistics on the sales of cleaning products and the Tier 2 method according to GB2023. According to the Guidebook the most common organic solvents for vapour cleaning are methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL) that normally require a closed cleaning machine while for batch cold cleaners the primary solvents used are mineral spirits, Stoddard solvents (white spirit) and alcohols like propylene glycol. |
| 2.D.3.i 2G | NMKs inventory does not include emissions estimates from activities that probably exist on the territory of NMK like Use of fireworks, Other product use (concrete additive, cooling lubricant, lubricant), and other industrial application of solvents in products) and Barbeque, which fall under the scope of NFR 2G, Application of glues and adhesives, Other (preservation of seeds), which fall in the scope of NFR 2D3i. | CEIP/S3.RR/2 020/Macedonia IPA II Air quality improvement plan | Medium | Implemented in 2025 submission Data on fireworks included |
| 2.D.3.g | Missing emission estimation for leather tanning. | IPA II Air quality improvement plan | Low | Implemented in 2025 submission |
| 2.D.3.f | Shift from Tier 1 methods to Tier 2 as recommended by the ERT Improvement of calculation of NMVOC emissions from the solvent and product use sector. This includes data collection and processing. | CEIP/S3.RR/2 020/North Macedonia | High | Tier 2 methodology implemented Implemented in 2025 submission |
| 3.B.4.g.ii | No explanation was received for the high broiler number in 2013. The ERT recommends that the Party further investigates the deviation for 2013 and encourages to complete the documentation of the statistics in the IIR with this information. | CEIP/S3.RR/2 020/North Macedonia | Low | Implemented |
| 3.D.a.2.a and 3.D.a.3 | The ERT recommends that the Party estimate and report NH3 emissions from NFRs 3.D.a.2.a and 3.D.a.3 separately even if those emissions are still calculated using Tier 1. NOx emissions from NFRs 3Da2a and 3Da3 are reported as "IE" instead of reporting emissions with values. | CEIP/S3.RR/2 020/North Macedonia IPA II Air quality improvement plan | High | Implemented in 2026 submission |
| 3.D.a.1 | Based on the data set provided by the Party the ERT concludes that the N contents of the fertilizers equal those of Guidebook and recommends that the Party | CEIP/S3.RR/2 016/North Macedonia | High | Implemented in 2026 submission |

| Category | Notes | Source | Rating | Status |
|---------------------------------|---|---|--------|--|
| | moves to Tier 2 methodology using the proposed N contents. The method used for the emission collection is not from the latest the EMEP/EEA Guidebook 2023 and there is the possibility of over/under-estimation of emissions. | IPA II Air quality improvement plan | | |
| 3.B | <p>The ERT recommends that the FYROM estimate emissions from key categories by using at least the Tier 2 method provided in Chapter 3B of the Guidebook. Update agriculture NH3 emissions for 3.B Manure Management to Tier 2 methodology.</p> <p>Changing to a Tier 2 method can be facilitated using the N-flow tool available at https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture</p> <p>This includes national data collection and processing.</p> | CEIP/S3.RR/2 020/North Macedonia | High | Implemented in 2026 inventory submission |
| 3.B.3. 3.B4.gi. 3.B4.giii | Party has reported emissions for Black carbon (BC) as notation key "NE". Emissions of these pollutants are not expected from these categories as no methods are provided in the Guidebook. The ERT recommends using notation key "NA". | CEIP/S3.RR/2 020/North Macedonia | Low | Implemented |
| 3.B.3 | Pb is reported as notation key "NE". Emission of this pollutant is not expected from this category as no methods are provided in the Guidebook. and "NA" is recommended. | CEIP/S3.RR/2 020/North Macedonia | Low | Implemented |
| 3.B.1.b | For 3B1b emissions of CO is reported as "NE". Emission of this pollutant is not expected from this category as no methods are provided in the Guidebook. and notation key "NA" is recommended | CEIP/S3.RR/2 020/North Macedonia | Low | Implemented |
| 3.Da.2a and 3.Da.3 | <p>The NH3 emissions from manure application to land (3Da2a) and from excreta deposited during grazing (3Da3) is wrongly described in the IIR to be included elsewhere "IE" under NFR 3B. In the NFR reporting tables the emission figures are reported under 3D. The ERT encourages North Macedonia to correct the information in the future IIR.</p> <p>NOx emissions from NFRs 3Da2a and 3Da3 are reported as "IE" instead of reporting emissions with values. The Party has reported emissions for Black carbon (BC) with the notation key "NE". Emissions of these pollutants are not expected from these categories and no methods are provided in the Guidebook. The ERT recommends using notation key "NA".</p> | CEIP/S3.RR/2 020/North Macedonia | Low | Implemented |
| | <p>Tier 2 method can be facilitated using the N-flow tool available at https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture</p> <p>This includes national data collection and processing.</p> | IPA II Air quality improvement plan | Low | Implemented in 2026 inventory submission |
| 3.D.1 | The ERT notes that North Macedonia reports emissions NMVOC. PM2.5 and PM10 emissions from inorganic fertilizers under NFR 3D1. According to the 2016/2019 versions of the Guidebook there is no method for calculating these emissions. The ERT therefore recommends the Party to report the notation key "NA" instead of emission values. | CEIP/S3.RR/2 020/North Macedonia | Low | Implemented |
| 3.D.a.1 | The ERT also notes the for use of emission factors in NFR 3Da1 that in the 2016/2019 Guidebook versions refer to NFR 3De. Cultivated crops (NMVOC) and NFR 3Dc. Farm-level agricultural operations (PM2.5 and PM10). When no methods are given in the 2016/2019 Guidebook. the ERT recommend the use of "NA" in NFR 3Da1 for NMVOC. PM2.5 and PM10. In addition, the Party should estimate the currently missing NMVOC emissions from NFR 3De and PM2.5 and PM10 emissions from NFR 3Dc using the 2019 Guidebook version Table 3.1. For 3D1 the ERT recommends the Party to replace the emission values with the notation key "NA". | CEIP/S3.RR/2 020/North Macedonia IPA II Air quality improvement plan | High | Implemented |

| Category | Notes | Source | Rating | Status |
|------------------------|---|---|--------|---|
| | Shift from Tier 1 methods to Tier 2 given this is key category | | | |
| 3.D.1 | The Party is using emission factor for NOx emissions from inorganic fertilizer from the 2013 version of the Guidebook. but the IIR is referring to EF from the 2016 Guidebook. Due to consistency the ERT recommend the Party to always use updated EFs from the same and the latest Guidebook version and to recalculate the emissions for the time series to the next submission. During the review North Macedonia provided a revised estimate for NOx emissions from NFR 3D1 using updated emission factor as presented in Annex I to this review report. | CEIP/S3.RR/2 020/North Macedonia | High | Implemented |
| 3.D.e Cultivated crops | The ERT recommends North Macedonia to use a Tier 2 or higher method for the calculation of NMVOC emissions from 3De, Cultivated crops | IPA II Air quality improvement plan | Medium | Implemented in 2026 reporting submission |
| 3.D.f | The ERT recommends North Macedonia to provide a transparent description of the use of the notation key "NO". providing all relevant documentation in the 2024 submission of the IIR. | CEIP/S3.RR/2 022/North | Medium | The required information is inserted in the IIR |
| 3.D.a.1 | The ERT recommends that the Party clearly document the procedure used to calculate emissions from NFR 3Da1. Inorganic N fertilisers. | CEIP/S3.RR/2 022/North Macedonia | High | The required information is inserted in the IIR and source of EF for NOx is changed |
| 3F | Source category 3F - Field burning. of agricultural residues releases multiple pollutants into the atmosphere, the activity is illegal in the country, so no official data exists for its occurrence. Emissions are estimated using Tier 1 methodology from the 2023 EMEP/EEA Guidebook. GAINS model and FINN remote sensing data are used to estimate biomass burnt for certain years (2005, 2010, 2015, 2020). For missing years, interpolation or assumptions are applied, e.g., average biomass of 4 t/ha. | IPA II Air quality improvement plan | Low | Implemented in the 2026 submission |
| 5.A | Improved methodology for calculation of emissions from this category was develop. Recalculations for 1990–2023 used the IPCC FOD model (Tier 2), with NMVOC factors derived from CH ₄ . Improved data and separate models for managed and unmanaged landfills increased accuracy | IPA II Air quality improvement plan | High | Implemented in the 2026 submission |
| 5.C1.biii | The ERT recommends North Macedonia to correct these PCDD/F emissions in the next submission according to the revised estimate sent to the ERT. The ERT noted that no information is provided in the IIR regarding the reference to the source of emission factors of SOx. Hg. As and Ni. asked North Macedonia if it possible to use a higher tier method to estimate emissions from this category. | CEIP/S3.RR/2 020/North Macedonia | High | The revised estimates were included and reference for the source of SOx. Hg. As and Ni. Was provided in the IIR. Higher method was implemented. |
| 5.D.1 | The ERT noted that emissions of PAHs were calculated using other emission factors than listed in the IIR. | CEIP/S3.RR/2 020/North Macedonia | Medium | Calculations for PAHs were corrected |
| | NH3 emissions should be reported under NFR 5D1. and that under NFR 5D2 both SNAPs are listed for domestic and industrial wastewater treatment. and that they can reallocate the emissions from domestic wastewater treatment to the category 5D1. NH3 emissions from latrines were not calculated | CEIP/S3.RR/2 020/North Macedonia IPA II project improvement plan | Low | Emissions were reallocated as suggested by the ERT. Ammonia emission from latrines were calculated for the whole time seria |
| 5.D.2 | The ERT noted significant decrease and subsequent increase of emissions of NMVOC in the category 5D2. but that no explanation was provided in the IIR. The ERT recommends the Party to report data on domestic and industrial wastewater handling separately and to explain in the IIR the decrease of NMVOC emissions from industrial wastewater handling in 2017 | CEIP/S3.RR/2 020/North Macedonia | Low | Emissions from 5D1 and 5D2 were reported separatly abd explanation of the variations of the trend in the IIR was included. |
| 5.E | The ERT noted that emissions under the category 5E were reported as NO although this category includes accidental fires of cars. of detached/undetached houses and administrative. industrial buildings. | CEIP/S3.RR/2 020/North Macedonia | Low | Notation key was changed |

9.3.2. Progress a schedule for implementation

Those recommendations given by experts in the frame of the IPA II Air quality project that have not been implemented by now are listed in table 233 below.

Table 233 Sectorial improvements planned

| No | Key Category | Issue | Improvement Option | Priority of Improvement | Timing of Improvement |
|----|--------------|--|---|-------------------------|-----------------------|
| 1 | 1A2 | Use of Tier 1 methodology | Shift to Tier 2 methodology | Medium | 2028 |
| 2 | 1A4ai | Use of Tier 1 methodology | Use established NEIS to use data from all operators instead of STAT database and shift from Tier 1 to Tier 2 methodology. | Medium | 2028 |
| 3 | 1A4bi | Use of IIASA model for type of stove use in country | Use of national data from surveys when available | High | Fututre submissions |
| 4 | 1A3 | Use of Tier 1 method (1) Use the vehicle stock data from the Ministry of Interior vehicle database for the period 2000–2024. This remains a high priority improvement because the latest years are used for projection purposes and need to be determined as precisely as possible. (2) Compare the statistical data on buses and heavy-duty vehicles with the Ministry of Interior database for the period 2000–2003 and, if differences exist, revise the historical fleet data accordingly. (3) In 2026, carry out a recalculation for the period 2023–2025 under the ongoing EU4Green project, in order to integrate the 2024 and 2025 updates and resolve the remaining data and methodological gaps in the road transport time series. | Future improvements will focus on further refinement of the historical gasoline vehicle structure and on the continued use of updated fleet and meteorological data as these become available. In addition, the 2023–2025 period will be recalculated in 2026 including the integration of the 2024 update and the resolution of the remaining gaps relevant to this source category. | Хигх | 2026 |

| No | Key Category | Issue | Improvement Option | Priority of Improvement | Timing of Improvement |
|----|-----------------|--|--|-------------------------|-----------------------|
| 5 | 1A3c | Missing detail historical data | To improve the quality of the emission inventory, it is intended in future to make an effort to collect historical fuel consumption data disaggregated by locomotive type, going as far back as possible. For the period 1990–2010, if fuel consumption data is not available, data on rail passenger transport by type of transport and by year should be obtained, as well as rail freight transport by type of transport and by year, in order to apply the methodology developed for the period 2011–2019. | Low | 2027 |
| 6 | 2.D.3.i and 2.G | Additional investigation for needed activity data to calculate emissions from other activities like use of lubricants. | Complete NFR categories with all subsectors | Low | 2028 |
| 7 | 2.A.5.b - | 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. | Medium | 2027 |
| 8 | 3B | Further explore the Rulebook CGAP North Macedonia (2015) to check weight animal information | Update weight information with national estimates to refine the nitrogen excretion rates. | Low | Future submissions |
| 9 | 3De | The data from 2007 until 2013 were identified in a separate publication in the state statistical office web and NMVOC emissions coming from this category for this period will be submitted in the future submissions. | Recalculate emissions in 2007-2013 | Medium | Next submission |

| No | Key Category | Issue | Improvement Option | Priority of Improvement | Timing of Improvement |
|----|--------------|---|---|-------------------------|------------------------------|
| 10 | 5A | <p>To further improve the inventory in future submission, it is necessary to include data on the population covered by organized MSW collection in the IPCC FOD model for the entire reporting period 1950 - 2023.</p> <p>Data on sludge is missing, which should also be included in the model along with MSW and IW, and this gap should be filled in the further improvement of the inventory.</p> | For this category it would be desirable to prepare and implement a comprehensive improvement project that would further improve the GHG and air pollutant emission calculations. It is necessary to strengthen cooperation with experts in statistics, to collect/evaluate the necessary data in future inventories using appropriate expert judgment methods to assessment accurate and reliable data. | Low | Future submissions |
| 11 | 5.B.2 | <p>This activity exists in the territory of NMK, and the emission calculation is currently missing in the inventory.</p> <p>Methodology has been established in the frame of the IPA II Air quality project</p> | This includes data collection for the activity data from the biogas facilities in NMK and emission calculations. | High | Next inventory cycle in 2027 |

10. PROJECTIONS

For the 2026 submission, North Macedonia has prepared emission projections for the following air pollutants: SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}, covering the projection years 2025, 2030, 2035 and 2040.

In line with the requirements under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), emission projections are prepared and reported every four years starting from 2015. The year 2025 represents the latest mandatory reporting year under the current reporting cycle, while the next mandatory submission is expected in 2029, with a reporting deadline of 15 March.

As an EU candidate country, North Macedonia reports emission projections in accordance with Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NECD), covering SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}, and, where available, black carbon. These requirements are aligned with the amended Gothenburg Protocol under the UNECE LRTAP Convention. However, North Macedonia has so far ratified only the original 1999 Gothenburg Protocol. Emission projections are nevertheless prepared to ensure comparability with European emission reduction commitments and policy frameworks.

The projections are developed using methodologies established under the LRTAP Convention, in particular the 2023 EMEP Reporting Guidelines and the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 (GB2023, Section A.8 – Projections).

Only the “With Measures” (WM), also referred to as “With Existing Measures” (WEM), scenario is reported in this submission. The WM scenario reflects the expected evolution of emissions under currently implemented and formally adopted policies and measures, including those resulting from the transposition of relevant EU acquis.

Emission projections are reported in accordance with Annex IV: Projections reporting template of 2023 Reporting Guidelines. The base year for projections is 2023, corresponding to the latest officially submitted national emission inventory (1990–2023), ensuring full consistency between historical data and projections.

The WM scenario for North Macedonia includes all measures implemented up to 31 December 2024, reflecting the application of existing national legislation as well as relevant EU acquis, particularly in the energy and transport sectors. Future energy consumption is based on the WM scenario from the National Energy and Climate Plan (NECP), while activity data for non-energy sectors are developed using the best available national statistics and sectoral trends, ensuring consistency with historical data and macroeconomic assumptions.

10.1. Methodology and basic tool for emission projections work

10.1.1. Methodology

Projections of air pollutant emissions for the Republic of North Macedonia have been prepared in accordance with the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023. The starting point

for the projections is the most recent officially reported emission inventory time series (1990–2023), with 2023 used as the base year, as submitted to the EEA on 29 December 2025. This ensures full consistency between historical data and projected emissions.

Emission projections have been developed for the years 2025, 2030, 2035 and 2040. All projections include all source categories contributing to national total emissions (corresponding to row 141 of the reporting format) and exclude memo items. This approach ensures consistency when comparing projected emissions with both the latest historical year (2023) and the reference year 2005.

One scenario has been developed: “With Measures” (WM) scenario.

The WM scenario reflects the combined effect of implemented and formally adopted policies and measures, including those resulting from the transposition and implementation of relevant EU acquis. It represents the expected development of emissions under existing legislation and currently committed policy instruments.

Key policies and measures are defined within the national energy and climate policy framework, primarily the National Energy and Climate Plan (NECP) of the Republic of North Macedonia.

The NECP is based on a comprehensive review of national strategic, regulatory and technical documentation across key sectors, including energy, transport, agriculture, waste and cross-sectoral climate policy.

10.1.2. Sectoral policy basis and key references

Energy sector projections are based on national energy strategies, regulatory reports and the National Energy and Climate Plan (NECP), including long-term decarbonisation and transition policies. Transport projections are aligned with national transport strategies and intelligent transport system planning documents. Agricultural projections are based on national agriculture and rural development strategies and EU pre-accession programmes. Waste sector projections are derived from national waste management and waste prevention plans, including circular economy policies. Cross-sectoral assumptions are consistent with national climate policy documents, including national communications, biennial update reports and the Long-Term Climate Strategy to 2050, as well as European Commission progress reports and reform agendas.

It should be noted however that the projections presented in this chapter, for the WEM scenario, are based on the WEM energy-climate scenario from the NECP.

The main policy and planning documents used as the basis for activity projections and assumptions are summarised in table below.

Table 234 Key strategies, plans and data sources

| Sector / Policy area | Key strategies, plans and data sources |
|----------------------|---|
| Energy | <ul style="list-style-type: none"> Annual Report of the Energy and Water Services Regulatory Commission for 2024, Energy and Water Services Regulatory Commission of the Republic of North Macedonia, 2025 National Energy and Climate Plan, Government of the Republic of North Macedonia, 2022 Strategy for Development of the Energy Sector until 2040, Government of the Republic of North Macedonia, 2019 Just Transition Roadmap & Action Plan, Government of the Republic of North Macedonia, 2023 |

| Sector / Policy area | Key strategies, plans and data sources |
|--------------------------|--|
| Transport | <ul style="list-style-type: none"> National Strategy for Intelligent Transport Systems 2023–2032, Government of the Republic of North Macedonia, 2023 National Transport Strategy 2018 – 2030, Government of the Republic of North Macedonia, 2018 |
| Agriculture | <ul style="list-style-type: none"> National Strategy for Agriculture and Rural Development 2021–2027, Government of the Republic of North Macedonia, 2021 Program for Rural Development (IPARD III) 2021–2027, Government of the Republic of North Macedonia, adopted in 2021 |
| Waste | <ul style="list-style-type: none"> National Waste Management Plan 2021–2031, Ministry of Environment and Physical Planning, 2021 National Waste Prevention Plan 2022–2028, Ministry of Environment and Physical Planning, 2022 Draft Strategy for Waste Management 2025 – 2036, Ministry of Environment and Physical Planning Plan for Closure of Non-Compliant Landfills, Ministry of Environment and Physical Planning, 2012 The Circular Economy Roadmap for North Macedonia 2024–2044, 2024 |
| General & Cross-sectoral | <ul style="list-style-type: none"> North Macedonia 2024 Report, European Commission, 2024 Reform Agenda for North Macedonia, European Commission, 2024 3rd Biennial Update Report on Climate Change, Government of the Republic of North Macedonia, 2020 4th National Communications on Climate Change, Government of the Republic of North Macedonia, 2023 Long Term Strategy on Climate Action until 2050 and Action Plan, Government of the Republic of North Macedonia, 2021 |

10.1.3. Methods and tools

Air pollutant emission projections are aligned with the assumptions and parameters used in greenhouse gas projections prepared under Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, ensuring methodological and scenario consistency across air pollutant and climate reporting.

The data structure and modelling approach are fully aligned with the national air pollutant emission inventory submitted in December 2025 for the period 1990–2023. The inventory and projections are based on the NFR (Nomenclature for Reporting) classification.

Energy-related emissions (NFR Sector 1) are calculated using energy balance data for the base year 2023, combined with projected energy balances developed within the NECP. For non-energy sectors, projections are based on sector-specific activity data derived from national statistics and policy assumptions which are integrated in the energy-climate strategy developed within the NECP.

Emission projections are developed using Tier 1 and Tier 2 methodologies in accordance with the EMEP/EEA Guidebook 2023. Tier 2 methods are applied where more detailed activity data and emission factors are available, allowing further disaggregation of NFR categories into sub-categories or large point sources. This enables the use of more specific emission factors and improves the accuracy of projections.

The modelling system is implemented through Excel-based tools linked to a centralised Microsoft Access database. The database serves as the main compilation platform, while Excel sheets are used for calculations, scenario development and analysis. The system produces outputs in the required NFR format, including emission totals, trends, key source contributions and reporting tables.

10.1.4. Quality assurance and quality control (QA/QC)

QA/QC procedures applied to the projection system follow the same principles as those used for the national emission inventory (1990–2023), to ensure consistency, transparency and reliability of results.

Key QA/QC activities include verification of the consistency between the projection base year and the last reported historical inventory year (2023), including mandatory calibration of the base year within the modelling tool. This ensures a seamless transition between historical data and future projections.

Cross-sectoral consistency checks are performed to ensure harmonisation of key macroeconomic and sectoral assumptions, including GDP growth, population development and energy demand trends across all emission modules.

Trend analysis is used to identify and justify any significant deviations from historical emission pathways, ensuring that all changes are supported by documented policy or activity drivers. In addition, all input data sources, assumptions, calculation versions and modelling iterations are systematically documented and archived to ensure full transparency, reproducibility and traceability of the projection process.

10.1.5. Uncertainties

Key uncertainties in projection work relate to the future implementation of energy and environmental policies, particularly as delays in adoption may alter expected outcomes, the pace of technological change and fuel switching, and the availability and quality of detailed sectoral data; additional uncertainty arises from macroeconomic trends, changes in energy demand, and unexpected external factors such as geopolitical developments or extreme events.

10.2. Energy sector

10.2.1. Methods and models

For the Energy sector, the same methodologies as those used in the 2026 Informative Inventory Report (IIR), based on the EMEP/EEA Guidebook 2023, are applied across all sectors.

In line with good practice, projections were developed for activity data and emission factors. Activity data were estimated using Tier 1–3 methods, including projections of macroeconomic and population trends and the effects of policies and measures, supported by sectoral analyses. Emission factors were estimated using Tier 1–2 methods, based on historical averages, policies and measures, and sectoral studies.

The Energy sector includes Energy Industries (NFR 1A1), Combustion in Manufacturing Industries (NFR 1A2), Other Sectors (NFR 1A4), and Fugitive Emissions (NFR 1B).

Where operator measurements were available but not yet included in the inventory due to data constraints, these were used in projections to improve accuracy, effectively applying a Tier 2 approach for the relevant sources. Compared to the December 2025 inventory, this applied to NFR 1A1a (NO_x from thermal power plants) and NFR 1A2f (SO₂ from clinker production).

Where Tier 2 methodologies were already used in inventory, the same approach was maintained for projections. Additional disaggregation or assumptions were applied where required by regulation,

particularly for combustion installations with emission limit values by capacity range. Detailed methodologies are provided in the relevant subchapters by NFR category.

10.2.2. Measures (WM scenario)

The “with existing measures” (WEM) scenario reflects the combined effect of policies and measures already implemented or adopted, including those arising from the transposition of the EU acquis. Measures for the Energy sector are aligned with those described in the NECP and are presented in Annex 1.

10.2.3. Assumptions

Assumptions for the Energy sector are based on the National Energy and Climate Plan and are summarized below.

10.2.3.1. Electricity Supply Sector

Installed capacities in the power system in 2024 are based on the Annual Report of the Energy and Water Services Regulatory Commission of North Macedonia and are presented in the table below.

Additional capacities expected to be commissioned until 2040 are included in the model assumptions. The model selects least-cost generation options among PV (up to 10 MW units), wind power (up to 2 MW units), biogas (up to 1 MW, up to 10 units per year), and biomass (up to 10 MW, one unit per year). The maximum number of PV and wind plants is set to 10.

Lignite power plants are assumed to remain in operation throughout the projection period under a “must-run” assumption, reflecting system operation conditions under carbon pricing.

Investment cost assumptions for electricity generation technologies are based on IEA WEO 2022 (EU region). Lithium-ion battery storage is also included, assuming a 1:4 power-to-capacity ratio (4-hour storage cycle). Cost assumptions include battery components, management systems, and operational costs, with declining cost trends over time.

Fuel price projections are based on the European Commission DG CLIMA recommended parameters (2023). Neighbouring electricity system development and cross-border transmission capacities are aligned with the ENTSO-E TYNDP 2024 “National Trends” scenario.

10.2.3.2. Building Sector

The building sector is divided into households and services (public and commercial).

Household projections are based on demographic trends, with average household size decreasing from 3.06 persons in 2021 to approximately 2.7 in 2050.

Energy consumption in public buildings is based on the draft National Energy Efficiency Programme for Public Buildings, while commercial sector consumption is derived from the national energy balance. Target specific energy use after renovation is assumed at 95 kWh/m² for all service buildings, including new constructions.

A renovation rate of 3% by 2030 is assumed across all building segments. Investment costs range from 250 EUR/m² (rural households) to 600 EUR/m² (non-residential buildings), while new construction costs are assumed at 1,500 EUR/m².

10.2.3.3. Industry Sector

Energy use in industry is based on the 2022 national energy balance. Future activity growth follows the National Industrial Development Strategy until 2027, with gradual alignment to long-term GDP growth (3.3%) by 2030 and beyond., given in the table below.

Table 235 Annual GDP growth rate

| Annual GDP growth rate | 2025 | 2026 | 2029 | 2030 |
|-----------------------------|------|------|------|------|
| Iron and Steel | 3.7 | 3.9 | 3.5 | 3.3 |
| Non-ferrous metals | 3.7 | 3.9 | 3.5 | 3.3 |
| Chemical | 3.7 | 3.9 | 3.5 | 3.3 |
| Glass and building material | 1 | 1 | 2 | 3 |
| Ore extraction | 3.7 | 3.9 | 3.5 | 3.3 |
| Food, beverages and tobacco | 3.7 | 3.9 | 3.5 | 3.3 |
| Paper | 3.7 | 3.9 | 3.5 | 3.3 |
| Other | 3.7 | 3.9 | 3.5 | 3.3 |

After 2030, all industrial branches are assumed to grow at the GDP growth rate. Improvements in energy efficiency and fuel switching are included in both WEM and WAM scenarios, with more ambitious decarbonisation in WAM, including hydrogen use for industrial heat.

By 2040, energy intensity is assumed to converge towards EU-average levels (2020).

10.2.4. Parameters

The parameters applied in the WEM (“with existing measures”) scenario are reported in Annex IV (Projection Reporting Format). Emission factors are based on the EMEP/EEA Guidebook 2023.

A detailed description of methodologies and assumptions by sector is provided below.

A – Public electricity and heat production (NFR 1A1a)

Projected activity data are based on the WEM scenario of the NECP and include fuel consumption projections for electricity and heat production. Electricity generation gradually shifts towards natural gas and renewable energy sources, while lignite consumption remains broadly stable over the projection period (see table below).

Table 236 Consumptions NFR 1A1a (TJ)

| | Consumptions NFR 1A1a (TJ) | | | | |
|------|----------------------------|-------------|----------|---------|--------|
| | Lignite | Natural gas | Fuel oil | Biomass | Biogas |
| 2023 | 29 770 | 11 870 | 8 132 | - | - |
| 2025 | 31 707 | 17 541 | - | 391 | 110 |
| 2030 | 31 707 | 26 645 | - | 927 | 378 |
| 2035 | 31 751 | 28 058 | - | 928 | 648 |
| 2040 | 31 794 | 29 470 | - | 929 | 917 |

Fuel distribution across installation types and capacity ranges is based on national reporting and expert judgment, due to limited disaggregated data availability. Large combustion plants are assumed to operate under current national regulatory emission limit values, applied from 2025 onwards where applicable, except for SO₂ and dust from coal thermal power plants where information was collected from operators to assess this could not be done for 2025.

B – Stationary combustion in manufacturing industries (NFR 1A2, except clinker)

Activity data are based on NECP projections and national industrial growth rates by sector as presented in the following tables. Fuel consumption generally increases in line with industrial output growth across all subsectors.

Table 237 Consumptions NFR 1A2a – Iron and steel

| | Consumptions NFR 1A2a – Iron and steel (TJ) | | | | |
|------|---|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 1 408 | 927 | 463 | 62 | - |
| 2025 | 1 439 | 1 103 | 1 466 | 278 | - |
| 2030 | 1 737 | 1 332 | 1 770 | 336 | - |
| 2035 | 2 113 | 1 620 | 2 153 | 409 | - |
| 2040 | 2 571 | 1 971 | 2 619 | 497 | - |

Table 238 Consumptions NFR 1A2b – Non-ferrous metals

| | Consumptions NFR 1A2b – Non-ferrous metals (TJ) | | | | |
|------|---|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | - | - | 63 | 0.1 | - |
| 2025 | - | - | 65 | 0.1 | - |
| 2030 | - | - | 77 | 0.2 | - |
| 2035 | - | - | 88 | 0.2 | - |
| 2040 | - | - | 100 | 0.2 | - |

Table 239 Consumptions NFR 1A2c – Chemical

| | Consumptions NFR 1A2c – Chemical (TJ) | | | | |
|------|---------------------------------------|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | - | 80 | 20.7 | 0.7 | - |
| 2025 | - | 90 | 3.4 | 0.9 | - |
| 2030 | - | 108 | 4.1 | 1.0 | - |
| 2035 | - | 125 | 4.7 | 1.2 | - |
| 2040 | - | 145 | 5.5 | 1.4 | - |

Table 240 Consumptions NFR 1A2d – Pulp and paper

| | Consumptions NFR 1A2d – Pulp and paper (TJ) | | | | |
|------|---|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | - | 19 | 20 | 3 | - |
| 2025 | - | 22 | 20 | 5 | - |
| 2030 | - | 26 | 24 | 6 | - |
| 2035 | - | 31 | 28 | 8 | - |
| 2040 | - | 35 | 32 | 9 | - |

Table 241 Consumptions NFR 1A2e – Food and beverages

| | Consumptions NFR 1A2e – Food and beverages (TJ) | | | | |
|------|---|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | - | 263 | 514 | 124 | - |
| 2025 | - | 196 | 743 | 162 | - |
| 2030 | - | 234 | 889 | 194 | - |
| 2035 | - | 272 | 1 031 | 225 | - |
| 2040 | - | 315 | 1 195 | 261 | - |

Table 242 Consumptions NFR 1A2f –Non-metallic minerals except clinker production

| | Consumptions NFR 1A2f – Non-metallic minerals except clinker production (TJ) | | | | |
|------|--|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 692 | 66 | 1 098 | 2 | - |
| 2025 | 3 | 36 | 1 239 | 2 | - |
| 2030 | 3 | 37 | 1 302 | 3 | - |
| 2035 | 3 | 39 | 1 369 | 3 | - |
| 2040 | 3 | 41 | 1 439 | 3 | - |

Table 243 Consumptions NFR 1A2f –Non-metallic minerals except clinker production

| | Consumptions NFR 1A2gvi – Other industries (TJ) | | | | |
|------|---|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 23 | 184 | 404 | 78 | - |
| 2025 | 39 | 191 | 428 | 107 | - |
| 2030 | 46 | 215 | 502 | 127 | - |
| 2035 | 53 | 240 | 575 | 146 | - |
| 2040 | 61 | 268 | 659 | 169 | - |

Which gives in total for the whole stationary combustion in the industry:

Table 244 Consumptions NFR 1A2 – Total stationary combustion except clinker

| | Consumptions NFR 1A2 – Total stationary combustion except clinker (TJ) | | | | |
|------|--|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 2 122 | 1 567 | 4 467 | 270 | - |
| 2025 | 1 483 | 1 683 | 7 611 | 559 | - |
| 2030 | 1 789 | 2 000 | 8 400 | 670 | - |
| 2035 | 2 172 | 2 376 | 9 276 | 794 | - |
| 2040 | 2 639 | 2 828 | 10 283 | 943 | - |

For medium and small combustion plants, fuel use is allocated across installation size categories using sector-specific assumptions, due to the absence of detailed installation-level data. Compliance with emission limit values is assumed to increase progressively over time.

C – Clinker production (NFR 1A2fi & 2A1)

Clinker production projections are based on data provided by the sole national cement producer, reflecting expected market development. Emissions are calculated using plant-specific information and measured data where available.

Table 245 Clinker production

| | 2022 | 2023 | 2025 | 2030 | 2035 | 2040 |
|-------------------------|------|------|------|------|------|------|
| Clinker production (kt) | 674 | 711 | 780 | 795 | 810 | 830 |

D – Residential sector (NFR 1A4bi)

The residential sector is the main driver of biomass consumption, which increases progressively over the projection period in line with expected energy demand patterns as modelled in the NECP.

Table 246 Consumptions NFR 1A4bi – Residential

| | Consumptions NFR 1A4bi – Residential (TJ) | | | | |
|------|---|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 5 | 5 | 294 | 7 358 | - |
| 2025 | 10 | 9 | 318 | 7 861 | - |
| 2030 | 10 | 9 | 318 | 8 067 | - |
| 2035 | 10 | 9 | 318 | 8 274 | - |
| 2040 | 10 | 9 | 318 | 8 480 | - |

No specific national emission control regulation is currently implemented for domestic combustion sources. Emission developments therefore mainly reflect changes in fuel use and the gradual replacement of older heating devices with more efficient technologies. The EU Ecodesign framework (Directive 2009/125/EC), including Commission Regulations (EU) 2015/1185 for solid fuel local space heaters and 2015/1189 for solid fuel boilers, is considered a relevant long-term driver for the evolution of the appliance stock, although its impact is gradual due to slow stock turnover and delayed market penetration of compliant devices.

For biomass combustion, emission factors are modelled based on the distribution of appliance types (fireplaces, single-house boilers, conventional stoves, high-efficiency stoves, eco-labelled stoves, and pellet stoves/boilers). The methodology is based on the GAINS model Baseline scenario developed by IIASA under the EU4Green project, complemented by the national data on pellets sold in the country and national expert judgement.

Fireplaces and single-house boilers are assumed to remain constant over the projection period, while structural changes occur within the stove category, with a shift from conventional to more efficient and eco-labelled technologies. This results in progressive changes in emission factors for biomass combustion, while emission factors for fossil fuels remain unchanged over the projection period. The evolution of the shares of the different appliances for solid biomass consumption is as follows:

Table 247 Shares of the different appliances for solid biomass consumption

| Biomass | | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
|----------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|
| Fireplaces | | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% |
| Single-house boilers | | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% |
| Stoves | Conventional | 93.3% | 89.7% | 87.2% | 85.6% | 82.3% | 79.5% | 76.7% |
| | High efficiency | 0.1% | 1.9% | 3.6% | 4.8% | 7.1% | 9.5% | 11.8% |
| | Eco-labelled | 0.1% | 0.2% | 0.7% | 1.0% | 1.4% | 1.8% | 2.3% |

| Biomass | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
|-----------------------|------|------|------|------|------|------|------|
| Pellet stoves/boilers | 1,3% | 3.0% | 3.0% | 3.5% | 4.0% | 4.0% | 4.0% |

E – Commercial and agriculture/forestry (NFR 1A4ai & 1A4ci)

Activity data is based on NECP projections and shows moderate growth in energy use across both sectors, driven mainly by liquid fuels and biomass consumption.

Table 248 Consumptions NFR 1A4ai – Tertiary

| | Consumptions NFR 1A4ai – Tertiary (TJ) | | | | |
|------|--|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 8 | 182 | 46 | 121 | - |
| 2025 | 19 | 199 | 846 | 252 | - |
| 2030 | 19 | 208 | 865 | 263 | - |
| 2035 | 19 | 216 | 870 | 274 | - |
| 2040 | 18 | 225 | 860 | 285 | - |

Table 249 Consumptions NFR 1A4ci – Agriculture and forestry

| | Consumptions NFR 1A4ci – Agriculture and forestry (TJ) | | | | |
|------|--|-------------|--------------|---------|----------|
| | Solid fuels | Natural gas | Liquid fuels | Biomass | Hydrogen |
| 2023 | 115 | - | 68 | 55 | - |
| 2025 | 11 | - | 189 | 63 | - |
| 2030 | 13 | - | 228 | 76 | - |
| 2035 | 15 | - | 270 | 91 | - |
| 2040 | 18 | - | 321 | 108 | - |

Due to the lack of detailed installation-level information, fuel use is distributed between medium and small combustion plants using sector-specific assumptions. Emission reductions are driven mainly by assumed gradual compliance with applicable emission standards for combustion equipment.

F – Non-road mobile machinery (NRMM)

The EU “Regulation 2016/1628 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery” has not yet been transposed in the national legislation. However, in practice, the currently applied methodology in the inventory, based on the Tier 2 methodology from the EMEP/EEA guidebook 2023, considers that this regulation is in place as the machines used come from markets which must be compliant with the regulation. The Stage V from the EU Regulation 2016/1628 is applied from 2019 or 2020 onwards, depending on the engine type, and the former Stages are applied according to the other amended directives, as is the case in the EU situation. The methodology developed in the historical years of the emission inventory is therefore extrapolated based on the renewal of the fleet and the new Stages coming onto the market.

Fuel consumption projections are based on NECP activity data and show steady growth in industry, agriculture, and forestry sectors.

From the WEM scenario of the NECP, the diesel and gasoline consumptions over the national territory are provided for the mobile combustion, per subsector, and evolve as follows:

Table 250 Fuel consumptions for NRMM - WEM

| | Fuel consumptions for NRMM - WEM | | | | |
|----------------------------|----------------------------------|--------|--------|--------|--------|
| | 2023 | 2025 | 2030 | 2035 | 2040 |
| Industry – diesel (t) | 27 010 | 29 476 | 34 884 | 40 268 | 46 519 |
| Tertiary – diesel (t) | 19 095 | 19 632 | 20 149 | 20 362 | 20 270 |
| Residential – gasoline (t) | 408 | 451 | 542 | 644 | 764 |
| Agriculture – diesel (t) | 5 374 | 5 783 | 6 948 | 8 252 | 9 801 |
| Forestry – diesel (t) | 1 343 | 1 446 | 1 737 | 2 063 | 2 450 |

Emission developments reflect fleet turnover and the gradual penetration of newer engine standards, assuming continued replacement of older machinery with Stage V compliant equipment over time.

G – Gasoline distribution (NFR 1B2av)

Gasoline distribution projections are based on NECP energy data. Emissions are assumed to follow activity trends, as emission factors remain constant due to full implementation of vapour recovery requirements under existing legislation.

Table 251 Gasoline distribution projections

| | 2023 | 2025 | 2030 | 2035 | 2040 |
|----------------------------|-------|------|------|------|------|
| Gasoline distribution (kt) | 104.6 | 94.4 | 95.9 | 97.4 | 98.9 |

The “Directive on the promulgation of the law on control of emissions of volatile organic compounds when using gasoline”, issued in the Official Gazette of the Republic of Macedonia n°38 has been adopted in February 2014, and transposed the requirements of EU Directives Directive 94/63/EC and 2009/126/EC. For the gasoline distribution, based on the emission inventory, 90% of the installations have already implemented the requirements from the MK regulation between 2006 and 2024.

As some specific rules exist to meet the requirements, for example on the amount of gasoline flowing through the installation annually (> 500 m³/year), it has been assumed that the share of installations compliant with the regulation would remain constant.

H – Coal mining and handling (NFR 1B1a)

Lignite production is assumed to follow lignite consumption in the power sector, reflecting continued domestic supply under existing system operation conditions. Emissions are therefore driven primarily by changes in demand rather than changes in emission factors, as no specific regulation is in place for this source.

Table 252 Lignite produced

| | 2023 | 2025 | 2030 | 2035 | 2040 |
|-----------------------|-------|------|------|------|------|
| Lignite produced (kt) | 3 994 | 4223 | 4223 | 4229 | 4235 |

10.3. Transport sector

10.3.1. Methods and models

Emission projections for the Transport sector are developed in accordance with the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023, using methodologies consistent with the 2026 Informative Inventory Report.

Road transport emissions are calculated using the COPERT model, which is the standard tool for estimating emissions from road transport and is fully consistent with the EMEP/EEA Guidebook methodology. The model applies a bottom-up approach, based on detailed vehicle categories, fuel types and EURO emission standards.

Projections are developed up to 2040 (in five-year intervals), using disaggregated activity data and fleet composition. For non-road transport (aviation, railways and other mobile sources), Tier 1 and Tier 2 methodologies are applied, depending on data availability.

10.3.2. Measures

The “with existing measures” (WEM) scenario reflects the impact of policies and measures already implemented or adopted, primarily driven by the transposition of EU acquis. Measures relevant to the Transport sector are described in Annex 1 and originate from the National Energy and Climate Plan (NECP).

10.3.3. Assumptions

Key assumptions used in the WEM scenario include:

Number of passenger vehicles in 2022 amounts to 260 vehicles per 1,000 inhabitants and increases to about 300 vehicles per 1,000 inhabitants in 2030.

The average number of kilometers traveled for electric passenger vehicles is 8,000 km/year in the period until 2030, with a gradual increase after 2030. The average number of kilometers travelled for light commercial vehicles is 18,000 km/year, and for heavy duty vehicles 35,000 km/year in the period until 2030, with a gradual increase after 2030.

The trajectory of achieving the target share of RES in traffic by 2030 and the structure of renewable energy is defined in accordance with the RED II directive.

In terms of modal shift, the most important is the assumed growth of rail transport, growing at 1.23 until 2030 and 2% beyond 2030.

10.3.4. Parameters

The parameters applied in the WEM (“with existing measures”) scenario are reported in Annex IV (Projection Reporting Format).

A detailed description of the methodologies and assumptions by transport sub-sector is provided below.

[A – International and Domestic aviation \(NFR 1A3a\)](#)

For aviation, the WEM scenario reflects a business-as-usual trend based on fuel consumption data from the NECP.

For international aviation (NFR 1A3ai(i)), kerosene is the only fuel considered, while aviation gasoline is assumed to be zero. Since projected LTO cycles are not available, they are estimated based on the ratio between kerosene consumption and LTO cycles in the base year (2022). The resulting number of LTO cycles (flights) applied in the calculations is presented in table below. Emissions are calculated using default emission factors from the EMEP/EEA Guidebook 2023, expressed per LTO cycle.

Table 253 Activity data for civil aviation

| Activity data | | | 2022 | 2025 | 2030 | 2035 | 2040 |
|---------------|------------------------------------|---------|--------|--------|--------|--------|--------|
| 1A3a | Civil Aviation - LTO | flights | 19,448 | 20,792 | 22,070 | 23,426 | 24,866 |
| 1A3ai | Civil Aviation - International LTO | flights | 19,448 | 20,792 | 22,070 | 23,426 | 24,866 |

For domestic aviation (NFR 1A3aii), kerosene use is not reported and related emissions are assumed to be zero. Emissions are estimated based on aviation gasoline consumption using default emission factors from the EMEP/EEA Guidebook 2023.

B – Road transport (NFR 1A3b)

Road transport projections are based on fuel consumption data from the NECP. Total fuel use is distributed across vehicle categories (passenger cars, light-duty vehicles, heavy-duty vehicles, buses and two-wheelers) using the 2023 structure, which is assumed to be constant over time. From the WEM scenario of the National Energy Climate Plan (NECP), the projected activity data for the road transport, which are the fuel consumptions, are as follows:

Table 254 Road transport total AD_WEM

| Road transport total AD_WEM | | | | | |
|-----------------------------|---------|---------|---------|---------|---------|
| Fuel, TJ | 2022 | 2025 | 2030 | 2035 | 2040 |
| Electricity | 87.3 | 90.6 | 96.4 | 102.6 | 109.2 |
| Natural Gas | 4604.0 | 4638.3 | 4712.1 | 4786.1 | 4860.3 |
| Gasoline | 26819.3 | 27517.6 | 28740.0 | 30040.4 | 31424.0 |
| Diesel | 2196.1 | 2283.3 | 2436.4 | 2600.0 | 2774.6 |
| LPG | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hydrogen | 107.9 | 446.6 | 1064.2 | 1755.0 | 2527.7 |
| Biofuels I | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Biofuels UCO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Advanced biofuels | 33814.7 | 34976.4 | 37049.2 | 39284.0 | 41695.7 |
| Total | 87.3 | 90.6 | 96.4 | 102.6 | 109.2 |

To allocate the total fuel consumption reported in the NECP across vehicle categories (passenger cars, light-duty vehicles, heavy-duty vehicles and buses, and mopeds and motorcycles), the distribution observed in 2023 was applied. It is assumed that the share of fuel consumption by vehicle category remains constant over the entire projection period.

Emission factors are derived from COPERT for each vehicle category, fuel type and EURO standard. The fleet composition evolves over time, with a decreasing share of pre-EURO 4 vehicles and increasing shares of EURO 4–6 vehicles, reflecting gradual fleet renewal.

Emission factors are kept constant, while emission reductions are driven by changes in fleet composition and fuel consumption.

C – Railways (NFR 1A3c)

Railway emissions are estimated using a fuel-based Tier 2 methodology consistent with the EMEP/EEA Guidebook. Only diesel-powered rail transport is included, while electric rail is excluded.

Total diesel consumption is projected based on NECP data and split between locomotives and railcars using average shares from the period 2020–2022, which are assumed constant in future years. Fuel consumption by locomotive types is presented in following table.

Table 255 Rail transport projection

| Rail transport projection | Unit | 2025 | 2030 | 2035 | 2040 |
|----------------------------------|-------------|-------------|-------------|-------------|-------------|
| Total Diesel | t | 1143.63 | 1213.91 | 1288.52 | 1367.71 |
| Locomotives | t | 600.65 | 637.57 | 676.75 | 718.34 |
| Railcars | t | 542.98 | 576.35 | 611.77 | 649.37 |

Emission factors are taken from the EMEP/EEA Guidebook 2023.

D – National navigation (NFR 1A3dii)

Emission projections for national navigation are not developed due to the absence of activity data in the NECP. This sector is considered negligible in the emission inventory.

10.4. 3. Industrial Processes and Product Use

10.4.1. Methods and models

Emission projections for the IPPU sector are based on methodologies consistent with the 2026 Informative Inventory Report (IIR) and the EMEP/EEA Guidebook 2023. Projections are developed for both activity data and emission factors following Tier 1–3 approaches, depending on data availability. Activity data are projected using macroeconomic indicators (GDP, population), sectoral trends, and relevant studies, while emission factors are derived from historical averages and adjusted where relevant to reflect regulatory requirements or technological changes.

Where available, measured data reported by operators are used to improve accuracy, resulting in a shift from Tier 1 to Tier 2 methodologies for specific sources (e.g. TSP emissions from electric arc furnaces). For categories where detailed regulatory requirements apply, additional assumptions and disaggregation are introduced.

10.4.2. Measures

The “with existing measures” (WEM) scenario reflects currently implemented policies and measures as defined in national strategic and sectoral documents, including the National Energy and Climate Plan (NECP). These measures are primarily driven by regulatory requirements, market conditions, and the application of best available techniques (BAT). No additional measures beyond those already adopted are considered.

Measures for the IPPU sector are presented in Annex 1 and are originally contained in the document National Energy and Climate Plan.

10.4.3. Assumptions

Projections are based on expected industrial development up to 2040. Key assumptions include:

- Activity drivers are linked to industrial GDP growth and population trends.
- Industrial growth follows national strategies until 2027, gradually aligning with a long-term annual GDP growth rate of 3.3% after 2030.

Table 256 Rail transport projection

| Annual GDP growth rate | 2025 | 2026 | 2029 | 2030 |
|-----------------------------|------|------|------|------|
| Iron and Steel | 3.7 | 3.9 | 3.5 | 3.3 |
| Non-ferrous metals | 3.7 | 3.9 | 3.5 | 3.3 |
| Chemical | 3.7 | 3.9 | 3.5 | 3.3 |
| Glass and building material | 1 | 1 | 2 | 3 |
| Ore extraction | 3.7 | 3.9 | 3.5 | 3.3 |
| Food, beverages and tobacco | 3.7 | 3.9 | 3.5 | 3.3 |
| Paper | 3.7 | 3.9 | 3.5 | 3.3 |
| Other | 3.7 | 3.9 | 3.5 | 3.3 |

Population decline influences demand-driven activities (e.g. solvent use)

Table 257 Population projected data

| | 2023 | 2025 | 2030 | 2035 | 2040 |
|------------|-----------|-----------|-----------|-----------|-----------|
| Population | 1 811 980 | 1 771 351 | 1 643 450 | 1 518 843 | 1 436 152 |

- Energy efficiency improvements and partial fuel switching are assumed.
- In 2040, energy intensity approaches EU average levels (2020).
- Where sector-specific data is lacking, trends are extrapolated or supplemented with external sources (e.g. GAINS/EU4Green).

10.4.4. Parameters

The parameters used for the WM scenario "with existing measures" are presented in Annex IV Projection Reporting Format.

A detailed description of the methodologies and assumptions by IPPU sub-sector is provided below.

A – Clinker production (2A1)

Methodology for clinker production is fully consistent with the energy sector approach (NFR 1A2fi & 2A1) and no additional assumptions have been applied. The implementation period is assumed to be continuous, with full application of existing regulatory requirements throughout the entire projection period.

B – Quarrying and mining (2A5a)

Activity for quarrying and mining is linked to clinker production using a stable historical ratio derived from the period 2020–2023. Emission factors for dust are assumed to remain constant due to the absence of specific regulation.

C – Construction and demolition (2A5b)

Construction activity is modelled separately for residential and non-residential buildings, where residential construction follows population trends adjusted for a slower decline, while non-residential

construction is assumed to remain constant; the resulting activity data are presented in table below. No specific regulation is in place, and emission factors remain unchanged.

Table 258 Population projected data

| Built surfaces | 2023 | 2025 | 2030 | 2035 | 2040 |
|-----------------------------------|-----------|-----------|-----------|-----------|-----------|
| Apartments (m ²) | 1 466 764 | 1 564 144 | 1 508 315 | 1 453 923 | 1 417 828 |
| Non-residential (m ²) | 30 466 | 28 121 | 28 121 | 28 121 | 28 121 |

D – Storage and transport of mineral products (2A5c)

Activity is assumed to evolve proportionally to clinker production based on stable historical ratios. No regulatory framework exists and emission factors are kept constant.

E – Other chemical production (2B10a)

Production of other chemical products is assumed to remain stable based on recent historical trends, resulting in constant emissions over time.

F – Iron and steel production (2C1)

Activity is linked to sectoral GDP growth, while emission factors are derived from a combination of operator measurements, regulatory ELVs, and inventory values, with the lowest value applied. The implementation period assumes compliance with national ELVs from 2025 onwards and their continued application throughout the projection period.

G – Domestic solvent use (2D3a)

Activity is linked to population trends, with a reduction applied at half the population decline rate, and the resulting trend is presented in table below. Emission factors are constant. The implementation period assumes no additional regulatory or technological changes over the projection period.

Table 259 Population projected data

| | 2025 | 2030 | 2035 | 2040 |
|--|-------|-------|-------|--------|
| Evolution compared to 2023 consumption level | -1.6% | -5.1% | -8.5% | -10.8% |

H – Road paving and asphalt roofing (2D3b, 2D3c)

Activity is linked to half of industrial GDP growth, with results presented in table below. Emission factors remain constant. The implementation period assumes no changes in construction practices or emission control measures during the projection period.

Table 260 Population projected data

| | 2025 | 2030 | 2035 | 2040 |
|--|------|-------|-------|-------|
| Evolution compared to 2023 activity levels | 2.9% | 11.6% | 19.9% | 28.1% |

I – Coating application (2D3d)

Activity data are based on GAINS/EU4Green projections, while emission factors reflect abatement technologies and regulatory requirements, with stable technology shares assumed after 2025 and presented in table below.

Table 261 Population projected data

| | 2023 | 2025 | 2030 | 2035 | 2040 |
|------------------|------|------|------|------|------|
| Decorative paint | 32% | 32% | 32% | 33% | 33% |
| Industrial paint | 65% | 65% | 65% | 65% | 65% |
| Other paint | 3% | 3% | 3% | 2% | 2% |

VOC emissions are regulated through the transposition of the VOC Solvents Directive (1999/13/EC) and Chapter V of the Industrial Emissions Directive (2010/75/EU), implemented in national legislation via secondary legislation, including the Rulebook on emission limit values for stationary sources (Official Gazette No. 141/10), the Law on Ambient Air Quality, and the new Law on Industrial Emissions Control (2024/2025), which further aligns the framework with the IED through integrated permitting (IPPC permits). Full compliance is achieved progressively through permitting requirements and installation-level upgrades.

In addition, the GAINS EU4Green baseline is considered overly optimistic after 2025; therefore, abatement rates from 2025 are assumed to remain constant throughout the projection period.

The implementation period assumes no further changes in regulatory stringency or abatement levels beyond 2025.

J – Degreasing (2D3e)

Activity is linked to half of industrial GDP growth and is presented in table below, while emission factors remain constant. The implementation period assumes no changes in solvent use practices or control measures.

Table 262 Population projected data

| | 2025 | 2030 | 2035 | 2040 |
|--|------|-------|-------|-------|
| Evolution compared to 2023 activity levels | 2.9% | 11.6% | 19.9% | 28.1% |

K – Dry cleaning and printing (2D3f, 2D3h)

Activity is assumed constant based on recent historical averages and is presented in table below. Emission factors are constant due to the absence of regulatory requirements. The implementation period assumes no changes in activity levels or technology.

Table 263 Projected activity data for NFR categories Dry cleaning and printing (2D3f, 2D3h)

| | 2023 | 2025 | 2030 | 2035 | 2040 |
|---|--------|--------|--------|--------|--------|
| Dry cleaning – solvent consumption (kt) | 60 083 | 58 767 | 58 767 | 58 767 | 58 767 |
| Printing – ink consumption (t) | 38 | 39 | 39 | 39 | 39 |

L – Chemical products (2D3g)

Activity varies by product type, with some processes remaining constant and others following GDP-linked or stable trends; results are presented in table below. Emission factors remain constant. The implementation period assumes no structural changes in production technologies.

Table 264 Production type projections

| Product type | 2023 | 2025 | 2030 | 2035 | 2040 |
|-------------------|-------|-------|-------|-------|-------|
| Polyurethane foam | 4 729 | 4 866 | 5 278 | 5 668 | 6 058 |
| Leather tanning | 0,080 | 0,080 | 0,080 | 0,080 | 0,080 |

| Product type | 2023 | 2025 | 2030 | 2035 | 2040 |
|---------------------|-------|-------|-------|-------|-------|
| Paints, inks, glues | 729 | 729 | 729 | 729 | 729 |
| Asphalt blowing | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 |

M – Other solvent use (2D3i)

Activity is assumed stable based on historical averages and is presented in table below. Emission factors remain constant. The implementation period assumes no changes in consumption patterns or control measures.

Table 265 Projected activity data for NFR category 2D3i

| | 2023 | 2025 | 2030 | 2035 | 2040 |
|--------------------------|--------|--------|--------|--------|--------|
| Creosote (kg) | 60 980 | 60 980 | 60 980 | 60 980 | 60 980 |
| Oil extraction (kg seed) | 67 870 | 73 616 | 73 616 | 73 616 | 73 616 |

N – Other product use (2G)

Activity is either constant or linked to population trends depending on product type, with results presented in table below. Emission factors are constant. The implementation period assumes no additional policy or technological developments affecting emissions.

Table 266 Projected activity data for NFR category 2G

| Product type | 2023 | 2025 | 2030 | 2035 | 2040 |
|-------------------|-------|-------|-------|-------|-------|
| Fireworks | 6 069 | 6 069 | 6 069 | 6 069 | 6 069 |
| Concrete additive | 4 032 | 4 032 | 4 032 | 4 032 | 4 032 |
| Tobacco | 1 510 | 1 485 | 1 432 | 1 381 | 1 347 |
| Use of shoes | 680 | 668 | 645 | 621 | 606 |

O – Food and beverages (2H2)

Activity is modelled by product type, reflecting a combination of GDP-driven, constant, or population-related trends, with detailed results presented in table below. Emission factors are constant. The implementation period assumes that current production structures and trends continue without major technological changes.

Table 267 Projected activity data for NFR category 2G

| Product type | 2023 | 2025 | 2030 | 2035 | 2040 |
|---------------------|---------|---------|---------|---------|---------|
| Spirits | 15 014 | 15 449 | 16 756 | 17 994 | 19 233 |
| Beer | 683 507 | 677 359 | 677 359 | 677 359 | 677 359 |
| Wine | 324 576 | 319 228 | 307 896 | 296 856 | 289 530 |
| White wine | 277 786 | 273 209 | 263 511 | 254 062 | 247 792 |
| Animal feed | 37 809 | 37 186 | 35 866 | 34 580 | 33 727 |
| Margarine | 3 053 | 2 814 | 2 814 | 2 814 | 2 814 |
| Meat, fish, poultry | 23 009 | 22 630 | 21 827 | 21 044 | 20 525 |
| Cake, biscuits etc. | 34 391 | 35 029 | 35 029 | 35 029 | 35 029 |

| Product type | 2023 | 2025 | 2030 | 2035 | 2040 |
|--------------|--------|--------|--------|--------|--------|
| Bread | 39 782 | 39 127 | 37 738 | 36 384 | 35 487 |
| Coffee | 4 102 | 4 139 | 4 139 | 4 139 | 4 139 |

P – Wood processing (2I)

Activity remains stable with marginal emissions, and emission factors are constant. The implementation period assumes no changes in production technology or regulatory framework.

10.5. Agriculture

10.5.1. Methods and models

Projection calculations for the agriculture sector are consistent with the methodologies applied in the 2026 Informative Inventory Report (IIR) and based on the EMEP/EEA Guidebook 2023. Emission projections are developed using Tier 1–3 approaches for activity data and Tier 1–2 approaches for emission factors, depending on data availability and sector specificity. Activity data are derived from historical trends, policy effects, and sectoral studies, while emission factors are based on historical averages and expert judgement. A tabular calculation model consistent with the national inventory system is used to ensure consistency between historical and projected data.

10.5.2. Measures

The “with existing measures” (WEM) scenario reflects currently implemented policies and measures as defined in national strategic and sectoral documents, including the National Energy and Climate Plan (NECP). Measures for Agriculture sector, presented in Annex 1 and are originally contained in the document National Energy and Climate Plan, have negligible quantified impact on emissions.

10.5.3. Assumptions

Projections are based on NECP and EU4Green input data and are consistent with expected long-term agricultural development. Livestock trends, fertiliser use, and land use are projected based on historical developments and expert judgement. No structural changes in agricultural practices are assumed beyond those already reflected in historical trends.

For livestock-related categories, no changes in animal management practices are assumed. For crop- and land-based categories, agricultural areas are assumed to remain stable over the projection period unless otherwise specified.

10.5.4. Parameters

The parameters used for the WM scenario “with existing measures” are presented in Annex IV Projection Reporting Format. Key parameters include livestock population trends, fertiliser consumption, agricultural area, nitrogen excretion rates, manure management distribution, and emission factors from the EMEP/EEA Guidebook 2023. All parameters are consistent with those used in the national inventory system and are harmonised with NECP assumptions where applicable.

A detailed description of the methodologies and assumptions by agriculture NFR categories is provided below.

A – Manure management (3B)

Activity is driven by livestock population. Most categories follow NECP trends (average +0.2% annually), while cattle categories decline based on historical trends. Results are shown in table below. Emission factors remain constant due to unchanged management practices. The implementation period assumes no change in animal husbandry systems over the projection horizon.

Table 268 Projected activity data for NFR category 3B

| Number of heads | 2023 | 2025 | 2030 | 2035 | 2040 |
|------------------------|-----------|-----------|-----------|-----------|-----------|
| Dairy cattle | 69 214 | 66 397 | 59 845 | 53 940 | 48 617 |
| Non-dairy cattle | 79 479 | 74 524 | 63 446 | 54 015 | 45 986 |
| Sheep | 587 073 | 589 424 | 595 342 | 601 319 | 607 356 |
| Swine (finishing pigs) | 171 778 | 172 466 | 174 197 | 175 946 | 177 713 |
| Swine (sows) | 21 634 | 21 721 | 21 939 | 22 159 | 22 381 |
| Goats | 85 528 | 85 870 | 86 733 | 87 603 | 88 483 |
| Horses | 10 104 | 10 144 | 10 246 | 10 349 | 10 453 |
| Laying hens | 1 508 578 | 1 514 618 | 1 529 825 | 1 545 185 | 1 560 699 |
| Broilers | 100 119 | 100 520 | 101 529 | 102 548 | 103 578 |
| Turkeys | 13 051 | 13 103 | 13 235 | 13 368 | 13 502 |
| Other poultry (ducks) | 112 284 | 112 734 | 113 865 | 115 009 | 116 163 |
| Other poultry (geese) | 11 997 | 12 045 | 12 166 | 12 288 | 12 411 |

B – Inorganic N-fertilisers (3Da1)

Activity is driven by total fertiliser use (+0.1% annually), with constant fertiliser type distribution (table below). Emission factors remain unchanged. The implementation period assumes no changes in fertiliser application practices or mitigation measures.

Table 269 Projected activity data for NFR category 3Da1

| Tons of N | 2023 | 2025 | 2030 | 2035 | 2040 |
|--------------------------|-------|-------|-------|-------|-------|
| Ammonium sulphate | 0 | 0 | 0 | 0 | 0 |
| Ammonium nitrate | 3 926 | 3 934 | 3 953 | 3 973 | 3 993 |
| Calcium ammonium nitrate | 848 | 850 | 854 | 859 | 863 |
| Urea | 4 063 | 4 071 | 4 091 | 4 112 | 4 132 |
| MAP | 44 | 44 | 44 | 44 | 45 |
| DAP | 0 | 0 | 0 | 0 | 0 |
| NPK > 10 kg | 2 827 | 2 832 | 2 846 | 2 861 | 2 875 |
| NPK < 10 kg | 0 | 0 | 0 | 0 | 0 |
| Other N-fertilizers | 169 | 169 | 170 | 171 | 172 |

| Tons of N | 2023 | 2025 | 2030 | 2035 | 2040 |
|-----------|--------|--------|--------|--------|--------|
| Total | 11 876 | 11 900 | 11 960 | 12 020 | 12 080 |

C – Manure applied to soils (3Da2a)

Activity is derived from nitrogen flow calculations and follows livestock trends (table below). No changes in manure management are assumed. Emission factors remain constant. The implementation period assumes continuation of current spreading practices.

Table 270 Projected activity data for NFR category 3Da2a

| Tons of N from animal manure spread in fields | 2023 | 2025 | 2030 | 2035 | 2040 |
|---|----------|----------|----------|---------|---------|
| Dairy cattle | 3 448.6 | 3 308.3 | 2 981.8 | 2 687.6 | 2 422.4 |
| Non-dairy cattle | 1 691.4 | 1 586.0 | 1 350.2 | 1 149.5 | 978.6 |
| Sheep | 1 818.8 | 1 826.1 | 1 844.4 | 1 863.0 | 1 881.7 |
| Swine (finishing pigs) | 2 353.0 | 2 362.4 | 2 386.1 | 2 410.1 | 2 434.3 |
| Swine (sows) | 447.8 | 449.6 | 454.1 | 458.7 | 463.3 |
| Goats | 306.8 | 308.0 | 311.1 | 314.2 | 317.4 |
| Horses | 194.0 | 194.8 | 196.7 | 198.7 | 200.7 |
| Laying hens | 628.5 | 631.0 | 637.3 | 643.7 | 650.2 |
| Broilers | 21.1 | 21.1 | 21.4 | 21.6 | 21.8 |
| Turkeys | 12.1 | 12.1 | 12.2 | 12.4 | 12.5 |
| Other poultry (ducks) | 36.6 | 36.8 | 37.1 | 37.5 | 37.9 |
| Other poultry (geese) | 5.8 | 5.9 | 5.9 | 6.0 | 6.0 |
| Total | 10 964.5 | 10 742.0 | 10 238.5 | 9 802.9 | 9 426.7 |

D – Grazing animals (3Da3)

Activity reflects nitrogen excretion during grazing, based on livestock numbers and housing times (table below). No changes in management are assumed. Emission factors remain constant. The implementation period assumes stable grazing practices throughout the projection period.

Table 271 Projected activity data for NFR category 3Da3

| Tons of N from grazing animals | 2005 | 2023 | 2025 | 2030 | 2035 | 2040 |
|--------------------------------|---------|---------|---------|---------|---------|---------|
| Dairy cattle | 3 245.7 | 1 945.3 | 1 866.1 | 1 681.9 | 1 516.0 | 1 366.4 |
| Non-dairy cattle | 3 883.8 | 2 317.9 | 2 173.4 | 1 850.3 | 1 575.3 | 1 341.1 |
| Sheep | 4 086.5 | 1 928.5 | 1 936.3 | 1 955.7 | 1 975.3 | 1 995.2 |
| Swine (finishing pigs) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Swine (sows) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Goats | 567.4 | 343.4 | 344.8 | 348.2 | 351.7 | 355.3 |
| Horses | 1 085.4 | 276.6 | 277.7 | 280.5 | 283.3 | 286.2 |
| Laying hens | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Broilers | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Tons of N from grazing animals | 2005 | 2023 | 2025 | 2030 | 2035 | 2040 |
|--------------------------------|----------|---------|---------|---------|---------|---------|
| Turkeys | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other poultry (ducks) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other poultry (geese) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 12 868.9 | 6 811.7 | 6 598.2 | 6 116.7 | 5 701.6 | 5 344.1 |

E – Crop residues (3Da4)

Activity is based on constant agricultural area (table below). Emission factors remain unchanged. The implementation period assumes no changes in residue management practices.

Table 272 Projected activity data for NFR category 3Da3

| ha | 2005 | 2023 | 2025 | 2030 | 2035 | 2040 |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Agricultural area | 1 229 000 | 1 250 821 | 1 250 821 | 1 250 821 | 1 250 821 | 1 250 821 |

F – Farm-level operations (3Dc)

Activity is based on constant agricultural area (table above). Emission factors remain constant. The implementation period assumes unchanged agricultural practices.

G – Cultivated crops (3De)

Activity is based on constant agricultural area (table above). Emission factors remain constant. The implementation period assumes no changes in crop production practices.

H – Field burning of residues (3F)

Activity is based on EU4Green projections of biomass burning (table below), despite national prohibition of burning. Emission factors remain constant. The implementation period assumes residual burning practices persist at low levels throughout the projection period.

Table 273 Projected activity data for NFR category 3F

| ktons of dry matter | 2005 | 2023 | 2025 | 2030 | 2035 | 2040 |
|---------------------|---------|--------|--------|--------|--------|--------|
| Biomass burnt | 136 000 | 70 389 | 71 923 | 69 046 | 65 210 | 62 333 |

10.6. Waste

10.6.1. Methods and models

Emission projections for the Waste sector cover the following categories: 5A solid waste disposal on land, 5B1 composting, 5C1biii clinical waste incineration, 5C2 open burning of waste, 5D1 domestic wastewater handling, and 5D2 industrial wastewater handling.

Activity data used for waste sector is based on NECP macro drivers (GDP and population), while emission factors are kept constant and based on the latest inventory year (2022), unless otherwise specified. For 5A, country-specific methodologies based on the IPCC FOD model are applied, consistent with the national GHG inventory system.

10.6.2. Measures

The WEM scenario includes measures defined in the National Energy and Climate Plan (NECP), including reduction of municipal solid waste generation, improved landfill management, and

development of mechanical and biological treatment (MBT) with composting. These measures are described in Annex I of the report.

10.6.3. Assumptions

Projections are based on NECP macroeconomic drivers (GDP and population) and assume no additional infrastructure beyond currently planned developments. The scenario includes measures related to waste prevention, improved separate collection, recycling, and reduction of biodegradable waste disposed of at landfills. Emission factors are assumed to be constant and based on the latest inventory year (2022), except for category 5A where IPCC FOD-based country-specific methods are applied.

10.6.4. Parameters

Key parameters are provided in Annex IV and include GDP and population projections, waste generation rates, landfill allocation factors, IPCC FOD model parameters, and emission factors from the EMEP/EEA Guidebook 2023 and national inventory methodologies.

A detailed description of the methodologies and assumptions for Agriculture sector categories is provided below.

A – Solid waste disposal on land (5A)

Emissions are calculated using two IPCC FOD models (managed and unmanaged landfills), consistent with the national greenhouse gas inventory methodology. Activity data and model parameters are based on the National Waste Management Plan 2021–2031. The implementation period assumes gradual transition towards improved landfill management practices over the projection horizon.

B – Composting (5B1)

Activity is driven by GDP and population trends. Only green and garden waste is considered for composting, in line with national planning assumptions. The implementation period assumes gradual development of composting capacities as part of MBT systems.

C – Clinical waste incineration (5C1biii)

Activity is driven by GDP and population trends. No additional changes in treatment technology are assumed. The implementation period assumes continuation of existing incineration practices.

D – Open burning of waste (5C2)

Activity is based on GDP and population trends, despite regulatory prohibition of open burning. Residual activity is included in line with historical observations. The implementation period assumes persistence of low-level residual burning.

E – Domestic wastewater (5D1)

Activity is driven by population trends. Emission estimation follows historical methodologies and trends. The implementation period assumes continuation of current wastewater treatment practices without structural changes.

F – Industrial wastewater (5D2)

Activity is driven by GDP growth. Emission projections follow historical methodologies with constant emission factors. The implementation period assumes gradual improvement in industrial wastewater treatment efficiency consistent with existing policies.

10.7. Main results for WEM scenario

Total projected emissions in kt for all pollutants considered for 2025, 2030, 2035 and are shown for the WM scenario “with existing measures” in table below and for the WAM scenario “with additional measures” in table below together with historical emissions for 2005 and 2023 (as reported in 2024) compared to the base year 2005 in % for the WEM scenario “with existing measures”.

Table 274 Projected activity data for NFR category 3Da3

| Pollutant | Unit | Historic emission | | WEM scenario | | | |
|----------------------|------|-------------------|-------|--------------|-------|-------|-------|
| | | 2005 | 2023 | 2025 | 2030 | 2035 | 2040 |
| NOx | kt | 28.42 | 20.66 | 20.27 | 19.46 | 19.53 | 20.12 |
| Comparison with 2005 | % | - | -27% | -29% | -32% | -31% | -29% |
| SO2 | kt | 91.09 | 56.99 | 55.40 | 7.07 | 7.31 | 7.70 |
| Comparison with 2005 | % | - | -37% | -39% | -92% | -92% | -92% |
| NMVOC | kt | 24.78 | 17.33 | 17.33 | 17.33 | 17.35 | 17.29 |
| Comparison with 2005 | % | - | -30% | -30% | -30% | -30% | -30% |
| NH3 | kt | 10.69 | 7.73 | 7.54 | 7.30 | 7.10 | 6.90 |
| Comparison with 2005 | % | - | -28% | -29% | -32% | -34% | -35% |
| PM2.5 | kt | 23.65 | 8.74 | 8.36 | 7.57 | 7.58 | 7.65 |
| Comparison with 2005 | % | - | -63% | -65% | -68% | -68% | -68% |

10.8. Results for WEM scenario per pollutant

10.8.1. Nitrogen oxides (NOx) emissions

10.8.1.1. National trend

The following figure and table present the historical trend and projections of NOx emissions in North Macedonia under the WEM (With Existing Measures) scenario.

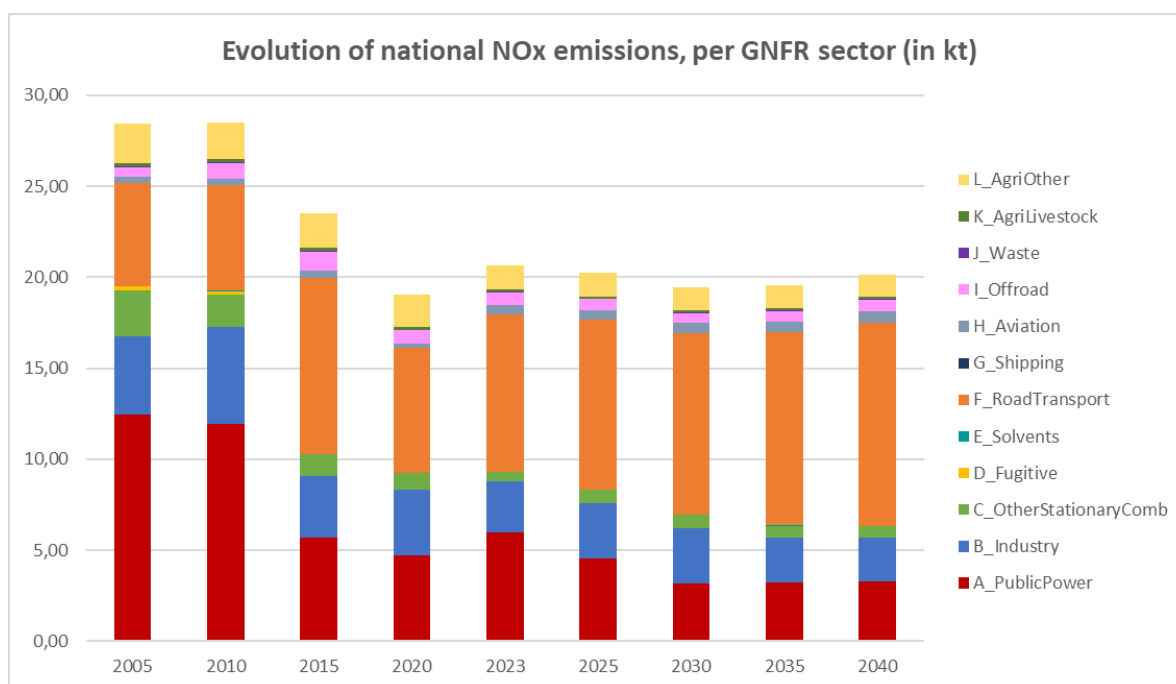


Figure 42 Trend of total emissions and projection of NOx emissions for WEM scenario

Table 275 Total NOx emissions (historical and projected) in kt, for WEM scenario

| Sector | | Historic emissions (kt) | | | | | Projected emissions (kt) | | | |
|--------------|-----------------------------|-------------------------|--------------|--------------|--------------|--------------|--------------------------|--------------|--------------|--------------|
| GNFR | Name | 2005 | 2010 | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
| GNFR A | Public Power | 12.47 | 11.92 | 5.67 | 4.74 | 5.98 | 4.54 | 3.17 | 3.23 | 3.29 |
| GNFR B | Industry | 4.29 | 5.34 | 3.38 | 3.57 | 2.80 | 3.02 | 3.03 | 2.44 | 2.38 |
| GNFR C | Other Stationary Combustion | 2.50 | 1.76 | 1.21 | 0.91 | 0.49 | 0.75 | 0.75 | 0.67 | 0.66 |
| GNFR D | Fugitive | 0.25 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR E | Solvents | 0.01 | 0.02 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR F | Road Transport | 5.64 | 5.79 | 9.67 | 6.89 | 8.66 | 9.34 | 9.94 | 10.60 | 11.16 |
| GNFR G | Shipping | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR H | Aviation | 0.34 | 0.33 | 0.41 | 0.24 | 0.51 | 0.54 | 0.57 | 0.61 | 0.65 |
| GNFR I | Offroad | 0.55 | 0.89 | 1.04 | 0.69 | 0.71 | 0.59 | 0.55 | 0.57 | 0.62 |
| GNFR J | Waste | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 |
| GNFR K | Agriculture Livestock | 0.19 | 0.17 | 0.16 | 0.14 | 0.11 | 0.10 | 0.10 | 0.09 | 0.08 |
| GNFR L | Agriculture Other | 2.14 | 2.00 | 1.88 | 1.81 | 1.35 | 1.34 | 1.29 | 1.25 | 1.22 |
| TOTAL | | 28.42 | 28.49 | 23.49 | 19.06 | 20.66 | 20.27 | 19.46 | 19.53 | 20.12 |

Total NOx emissions show an overall decreasing trend compared to 2005, although with some fluctuations in the projection period due to opposing sectoral developments. In 2005, total emissions amounted to 28.42 kt, decreasing to 19.06 kt in 2020. A temporary increase is observed in the reference year 2023, when emissions reach 20.66 kt. In the projection period, emissions slightly decrease to 19.46 kt in 2030, before increasing again to 20.12 kt in 2040. Overall, this corresponds to a reduction of approximately 29% compared to 2005 levels.

The main driver of emission reductions is the significant decline in emissions from the public power sector (GNFR A), which reflects improvements in combustion efficiency and implementation of emission control measures. However, this reduction is partially offset by increasing emissions from road transport, which becomes the dominant source in the long term.

10.8.1.2. National contributions

The following figure presents the contributions of the different GNFR categories in the national totals, in the WEM scenario, for the reference year and the projected years 2030 and 2040.

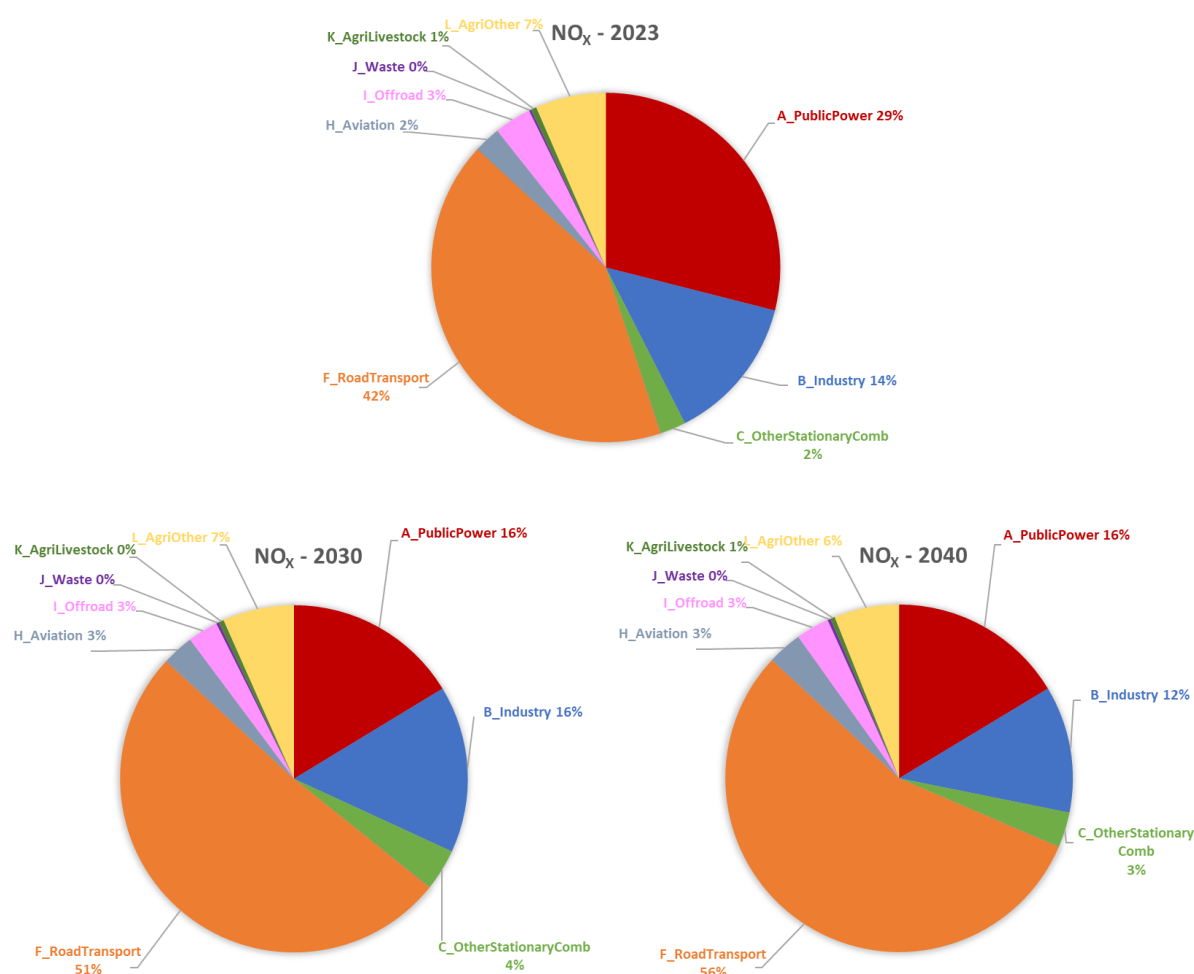


Figure 43 Pie charts with the national contributions of GNFR categories for NO_x emissions, for the years 2023, 2030 and 2040, for the WEM scenario

The sectoral structure of NO_x emissions changes significantly over the modelling period, indicating a clear shift in dominant sources (see tables below about key category analysis).

In 2023, the public power sector (NFR 1A1a) is still the largest contributor, accounting for 29.0% of total emissions. It is followed by road transport categories (NFR 1A3bi, 1A3biii, and 1A3bii), which aggregated together represent a substantial share of total emissions. Industrial combustion (NFR 1A2f and 1A2a) contributes a smaller but still relevant share.

By 2030, a structural shift becomes evident. The public power sector decreases its contribution to 16.3%, while road transport becomes the dominant source. NFR 1A3bi contributes 20.7%, followed by

NFR 1A3biii (17.1%) and NFR 1A3bii (13.2%). Together, transport-related categories account for more than half of total NO_x emissions, clearly indicating the increasing importance of road transport in the national emission profile.

In 2040, this trend is further strengthened. Road transport categories dominate the emission structure, with NFR 1A3bi (22.0%), NFR 1A3biii (18.9%), and NFR 1A3bii (14.6%) together contributing more than 55% of total emissions. The public power sector stabilises at a reduced level (16.4%), while industrial combustion categories maintain a relatively stable but secondary role.

In terms of NFR sectors, the key categories for North Macedonia in the reference year and the projected years 2030 and 2040, for the WEM scenario, are as follows:

Table 276 Total NO_x emissions (historical and projected) in kt, for WEM scenario

| NFR | 2023 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|---------|---------------------|------------------|-------------------------|------|
| 1A1a | 5.984 | 29.0% | 29.0% | 1 |
| 1A3bi | 3.503 | 17.0% | 45.9% | 2 |
| 1A3biii | 2.923 | 14.1% | 60.1% | 3 |
| 1A3bii | 2.233 | 10.8% | 70.9% | 4 |
| 1A2f | 1.617 | 7.8% | 78.7% | 5 |
| 1A2a | 0.555 | 2.7% | 81.4% | 6 |

Table 277 Total NO_x emissions (historical and projected) in kt, for WEM scenario

| NFR | 2030 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|---------|---------------------|------------------|-------------------------|------|
| 1A3bi | 4.031 | 20.7% | 20.7% | 1 |
| 1A3biii | 3.336 | 17.1% | 37.9% | 2 |
| 1A1a | 3.174 | 16.3% | 54.2% | 3 |
| 1A3bii | 2.573 | 13.2% | 67.4% | 4 |
| 1A2f | 1.414 | 7.3% | 74.6% | 5 |
| 1A2a | 1.003 | 5.2% | 79.8% | 6 |

Table 278 Total NO_x emissions (historical and projected) in kt, for WEM scenario

| NFR | 2040 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|---------|---------------------|------------------|-------------------------|------|
| 1A3bi | 4.427 | 22.0% | 22.0% | 1 |
| 1A3biii | 3.800 | 18.9% | 40.9% | 2 |
| 1A1a | 3.293 | 16.4% | 57.2% | 3 |
| 1A3bii | 2.931 | 14.6% | 71.8% | 4 |
| 1A2f | 1.169 | 5.8% | 77.6% | 5 |
| 1A2a | 0.865 | 4.3% | 81.9% | 6 |

Overall, the analysis highlights a transition from a power-sector-dominated emission structure in 2023 to a transport-dominated structure by 2030 and 2040. This is primarily driven by increasing fuel consumptions in road transport, coupled with a slow replacement of the vehicle fleet, which offset reductions achieved in the energy sector and makes transport the key priority for future NO_x mitigation efforts.

10.8.1.3. Conclusion

Overall, NO_x emissions in North Macedonia under the WEM scenario show a moderate long-term decreasing trend compared to 2005, but with a clear structural shift in emission sources over time. While total emissions declined by approximately 29% in 2040 compared to 2005, the trend is not linear due to increasing emissions from road transport.

The emission profile transitions from a system where the public power sector is the dominant source in 2023 to a transport-dominated structure by 2030 and 2040. This shift is driven by significant reductions in emissions from energy production, related to implementation of abatement technologies on thermal power plants, combined with increasing fuel consumptions in the transport sector.

Despite continued improvements in stationary combustion sources, rising emissions from passenger cars and light-duty vehicles increasingly offset these reductions, making road transport the key driver of NO_x emissions in the long term. As a result, further mitigation efforts targeting transport activity and vehicle emissions will be essential to achieve more substantial NO_x reductions beyond 2030.

10.8.2. Sulphur oxides (SO₂) emissions

10.8.2.1. National trend

The following figure and table present the historical trend and projections of SO₂ emissions in North Macedonia under the WEM (With Existing Measures) scenario.

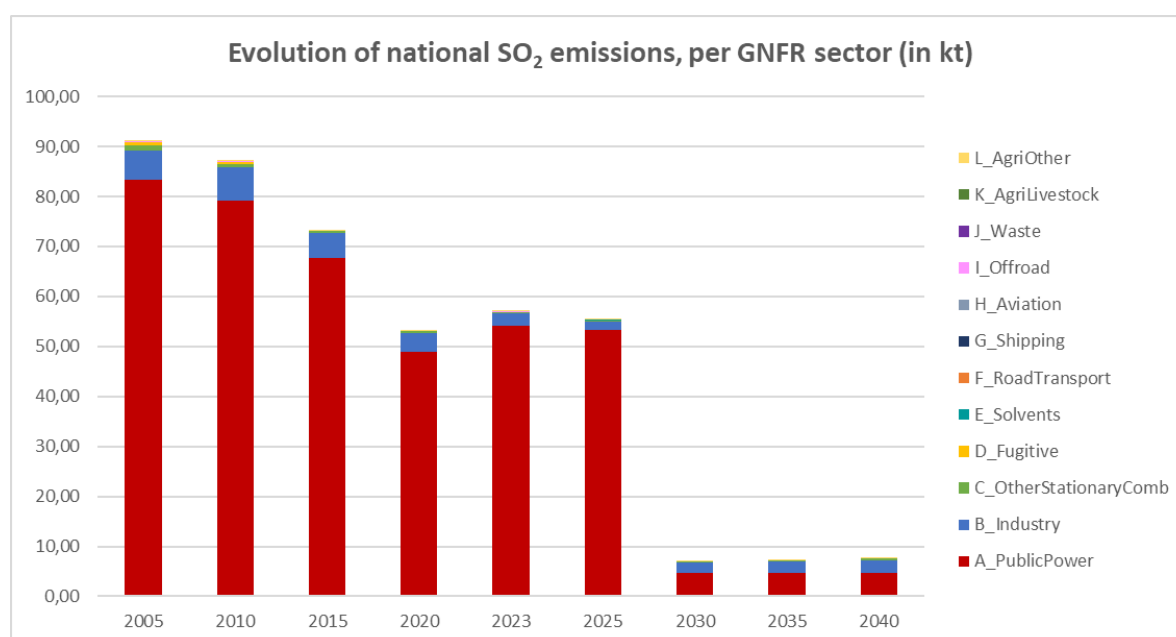


Figure 44 Trend of total emissions and projection of SO₂ emissions for WEM scenario

Table 279 Total SO₂ emissions (historical and projected) in kt, for WEM scenario

| Sector | | Historic emissions (kt) | | | | | Projected emissions (kt) | | | |
|--------|--------------|-------------------------|-------|-------|-------|-------|--------------------------|------|------|------|
| GNFR | Name | 2005 | 2010 | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
| GNFR A | Public Power | 83.34 | 79.08 | 67.69 | 48.82 | 54.04 | 53.28 | 4.68 | 4.69 | 4.70 |
| GNFR B | Industry | 5.87 | 6.67 | 5.01 | 3.93 | 2.60 | 1.74 | 1.99 | 2.21 | 2.57 |

| | | | | | | | | | | |
|--------------|-----------------------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|-------------|
| GNFR C | Other Stationary Combustion | 1.11 | 0.65 | 0.42 | 0.31 | 0.23 | 0.24 | 0.25 | 0.26 | 0.27 |
| GNFR D | Fugitive | 0.59 | 0.53 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR E | Solvents | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 |
| GNFR F | Road Transport | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| GNFR G | Shipping | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR H | Aviation | 0.02 | 0.02 | 0.03 | 0.01 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 |
| GNFR I | Offroad | 0.09 | 0.06 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 |
| GNFR J | Waste | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR K | Agriculture Livestock | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR L | Agriculture Other | 0.07 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 |
| TOTAL | | 91.09 | 87.08 | 73.22 | 53.15 | 56.99 | 55.40 | 7.07 | 7.31 | 7.70 |

Total SO₂ emissions show a strong long-term declining trend compared to 2005 levels, primarily driven by substantial reductions in the energy sector. In 2005, total emissions amounted to 91.09 kt, decreasing to 56.99 kt in 2023, which represents a reduction of approximately 37%. A further marked decrease is projected by 2030, when emissions fall sharply to 7.07 kt in 2030 (–92% compared to 2005). Emissions remain at a similarly low level in 2035 and 2040, reaching 7.70 kt, corresponding to an overall reduction of about 92% compared to the base year.

The dominant driver of this downward trend is the public power sector (GNFR A), which shows a very significant reduction over time. Emissions from this sector declined from 83.34 kt in 2005 to 54.04 kt in 2023 (–35%) and further drop to 4.68 kt in 2030 (–94%), before remaining stable around this level until 2040. This reflects the strong impact of desulphurisation measures and compliance with existing environmental regulations in the energy sector.

Industry (GNFR B) also contributes to the overall decline, decreasing from 5.87 kt in 2005 to 2.60 kt in 2023 (–56%), with a further reduction to 1.74 kt in 2025. However, a slight rebound is projected in the longer term, reaching 2.57 kt by 2040, mainly due to the increasing fuel consumptions in the iron and steel industry (NFR 1A2a), although remaining well below historical levels.

Other stationary combustion (GNFR C) shows a gradual and consistent decrease, while all remaining sectors (transport, waste, agriculture, shipping, and solvents) contribute only marginally to total SO₂ emissions throughout the entire period.

10.8.2.2. National contributions

The following figure presents the contributions of the different GNFR categories in the national totals, in the WEM scenario, for the reference year and the projected years 2030 and 2040.

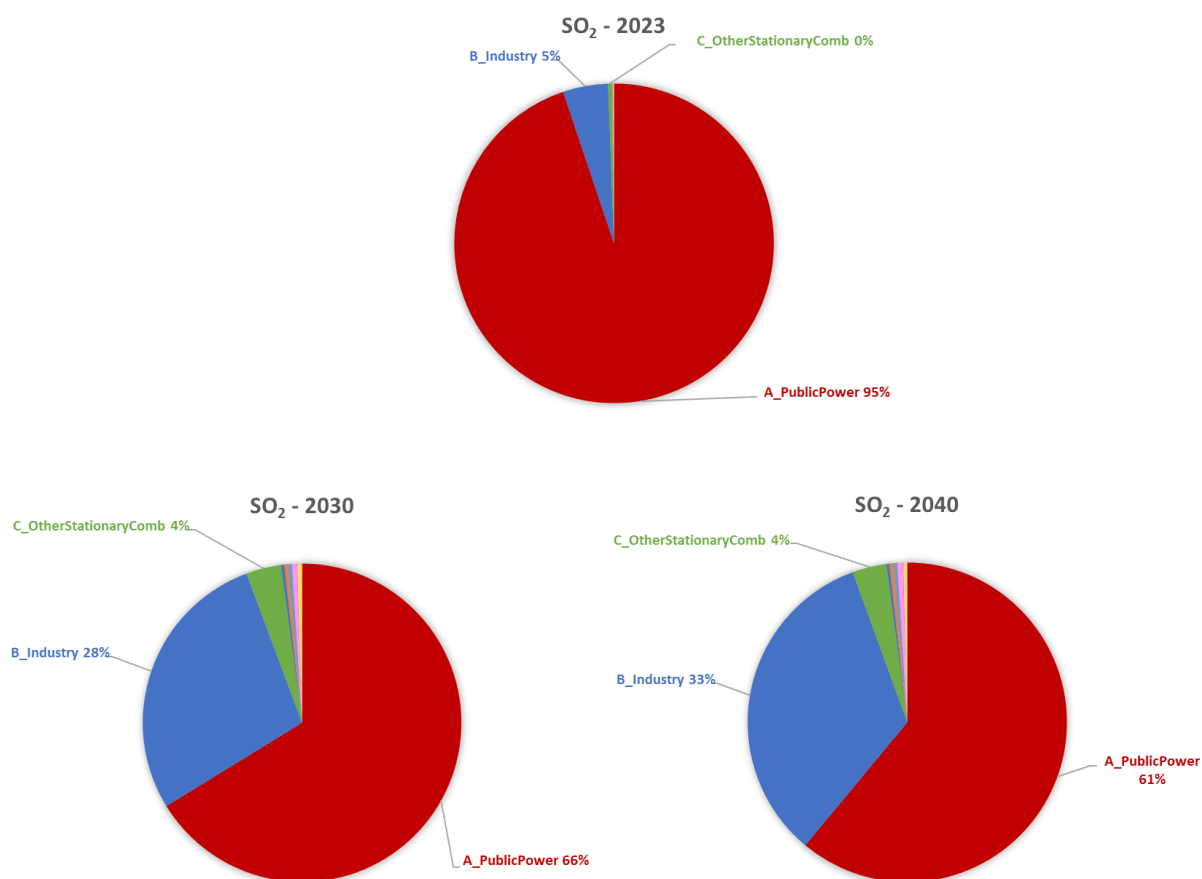


Figure 45 Pie charts with the national contributions of GNFR categories for the emissions of SO₂, for the years 2023, 2030 and 2040, for the WEM scenario

The contribution structure of SO₂ emissions is highly concentrated in a single dominant source throughout the entire modelling period.

In 2023, the public power sector (GNFR A) overwhelmingly dominates the emission profile, accounting for 94.8% of total SO₂ emissions and being the only key category (see Table below). All other sectors have negligible contributions, reflecting the strong dominance of large combustion plants in national SO₂ emissions.

By 2030, the sectoral structure changes significantly due to the sharp reduction in emissions from public power. GNFR A decreases its share to 66.2%, while industrial combustion (1A2a / GNFR B-related contribution) becomes the second most important source, accounting for 21.2%. This indicates that, once emission controls are fully implemented in the energy sector, industry becomes a relatively more relevant contributor to remaining emissions.

In 2040, the dominance of public power remains, but at a reduced level of 61.0%. Industry further increases its relative contribution to 26.0%, confirming its growing importance in the residual SO₂ emission profile. All other sectors remain marginal and collectively account for less than 13% of total emissions.

In terms of NFR sectors, the key categories for North Macedonia in the reference year and the projected years 2030 and 2040, for the WEM scenario, are as follows:

Table 280 Key categories for North Macedonia in the reference year 2023

| NFR | 2023 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|------|---------------------|------------------|-------------------------|----------|
| 1A1a | 54.042 | 94.8% | 94.8% | 1 |

Table 281 Key categories for North Macedonia in the 2030

| NFR | 2030 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|------|---------------------|------------------|-------------------------|----------|
| 1A1a | 4.682 | 66.2% | 66.2% | 1 |
| 1A2a | 1.501 | 21.2% | 87.5% | 2 |

Table 282 Key categories for North Macedonia in the 2040

| NFR | 2040 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|------|---------------------|------------------|-------------------------|----------|
| 1A1a | 4.701 | 61.0% | 61.0% | 1 |
| 1A2a | 2.000 | 26.0% | 87.0% | 2 |

10.8.2.3. Conclusion

Overall, SO₂ emissions in North Macedonia under the WEM scenario are characterised by a very strong and sustained downward trend, driven almost exclusively by emission reductions in the public power sector, due to the implementation of national regulations and in particular desulphurization on coal thermal power plants. The sector's rapid decline leads to a near-complete structural transformation of the national SO₂ emission profile, shifting from a highly concentrated energy-based system in 2005 to a significantly reduced and more balanced structure by 2030 and 2040. Industry becomes relatively more important in the long term, but absolute emission levels remain low across all sectors, confirming the high effectiveness of existing measures in controlling SO₂ emissions.

10.8.3. Non-methane volatile organic compounds (NMVOC) emissions

10.8.3.1. National trend

The following figure and table present the historical trend and projections of NMVOC emissions in North Macedonia under the WEM (With Existing Measures) scenario.

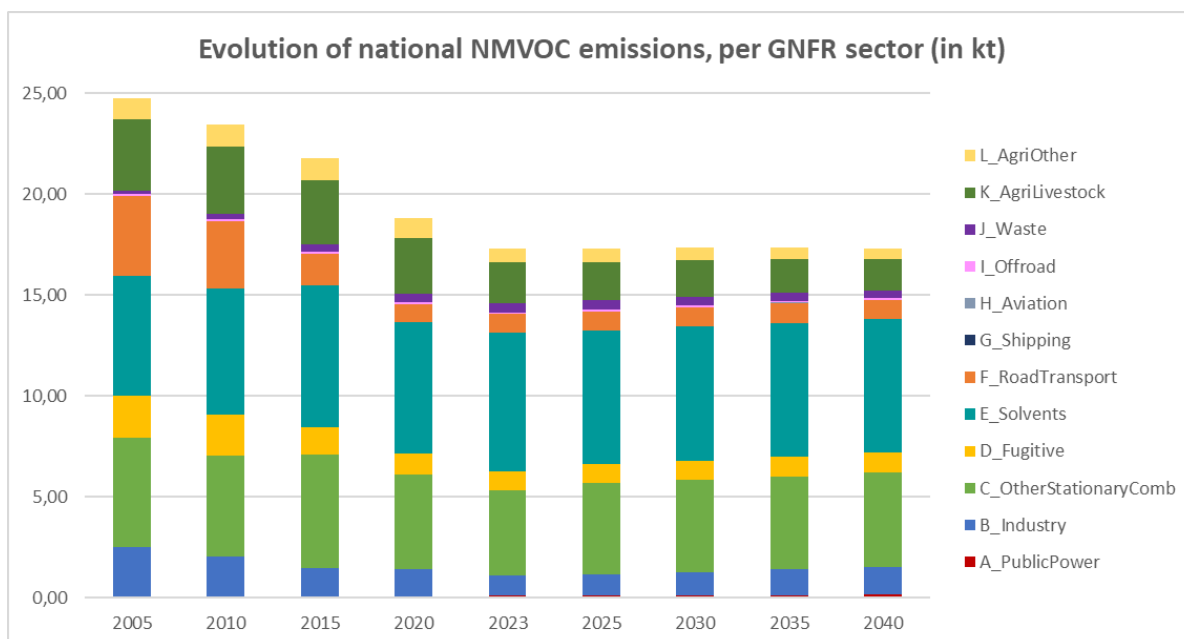


Figure 46 Trend of total emissions and projection of NMVOC emissions for WEM scenario

Table 283 Total NMVOC emissions (historical and projected) in kt, for WEM scenario

| Sector | | Historic emissions (kt) | | | | | Projected emissions (kt) | | | |
|--------|-----------------------------|-------------------------|-------|-------|-------|-------|--------------------------|-------|-------|-------|
| GNFR | Name | 2005 | 2010 | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
| GNFR A | Public Power | 0.08 | 0.07 | 0.07 | 0.07 | 0.09 | 0.09 | 0.12 | 0.13 | 0.14 |
| GNFR B | Industry | 2.44 | 1.99 | 1.42 | 1.34 | 1.00 | 1.06 | 1.15 | 1.26 | 1.39 |
| GNFR C | Other Stationary Combustion | 5.42 | 5.00 | 5.61 | 4.72 | 4.22 | 4.52 | 4.56 | 4.62 | 4.68 |
| GNFR D | Fugitive | 2.09 | 2.01 | 1.33 | 1.00 | 0.93 | 0.96 | 0.96 | 0.96 | 0.97 |
| GNFR E | Solvents | 5.91 | 6.27 | 7.04 | 6.53 | 6.88 | 6.64 | 6.63 | 6.62 | 6.64 |
| GNFR F | Road Transport | 3.95 | 3.33 | 1.59 | 0.90 | 0.94 | 0.93 | 0.97 | 1.02 | 0.94 |
| GNFR G | Shipping | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR H | Aviation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GNFR I | Offroad | 0.08 | 0.10 | 0.11 | 0.08 | 0.08 | 0.07 | 0.08 | 0.09 | 0.11 |
| GNFR J | Waste | 0.16 | 0.24 | 0.32 | 0.39 | 0.44 | 0.45 | 0.44 | 0.41 | 0.35 |
| GNFR K | Agriculture Livestock | 3.54 | 3.33 | 3.21 | 2.79 | 2.05 | 1.92 | 1.78 | 1.65 | 1.54 |
| GNFR L | Agriculture Other | 1.09 | 1.09 | 1.07 | 0.98 | 0.69 | 0.68 | 0.62 | 0.57 | 0.53 |
| TOTAL | | 24.78 | 23.43 | 21.76 | 18.80 | 17.33 | 17.33 | 17.33 | 17.35 | 17.29 |

Total NMVOC emissions show a gradual decreasing trend over the entire period. In 2005, emissions amounted to 24.78 kt, decreasing to 17.33 kt in 2023, which represents a reduction of approximately 30% compared to the base year. A stabilisation of emissions is observed in the projection period, with total emissions remaining almost constant at around 17.3 kt in 2030 and 2040. Overall, this indicates a long-term reduction trend followed by a plateau in emission levels.

The observed decline is mainly driven by reductions in agricultural and transport-related emissions, while solvent use and stationary combustion sources remain relatively stable over time and partially limit further overall reductions.

10.8.3.2. National contributions

The following figure presents the contributions of the different GNFR categories in the national totals, in the WEM scenario, for the reference year and the projected years 2030 and 2040.

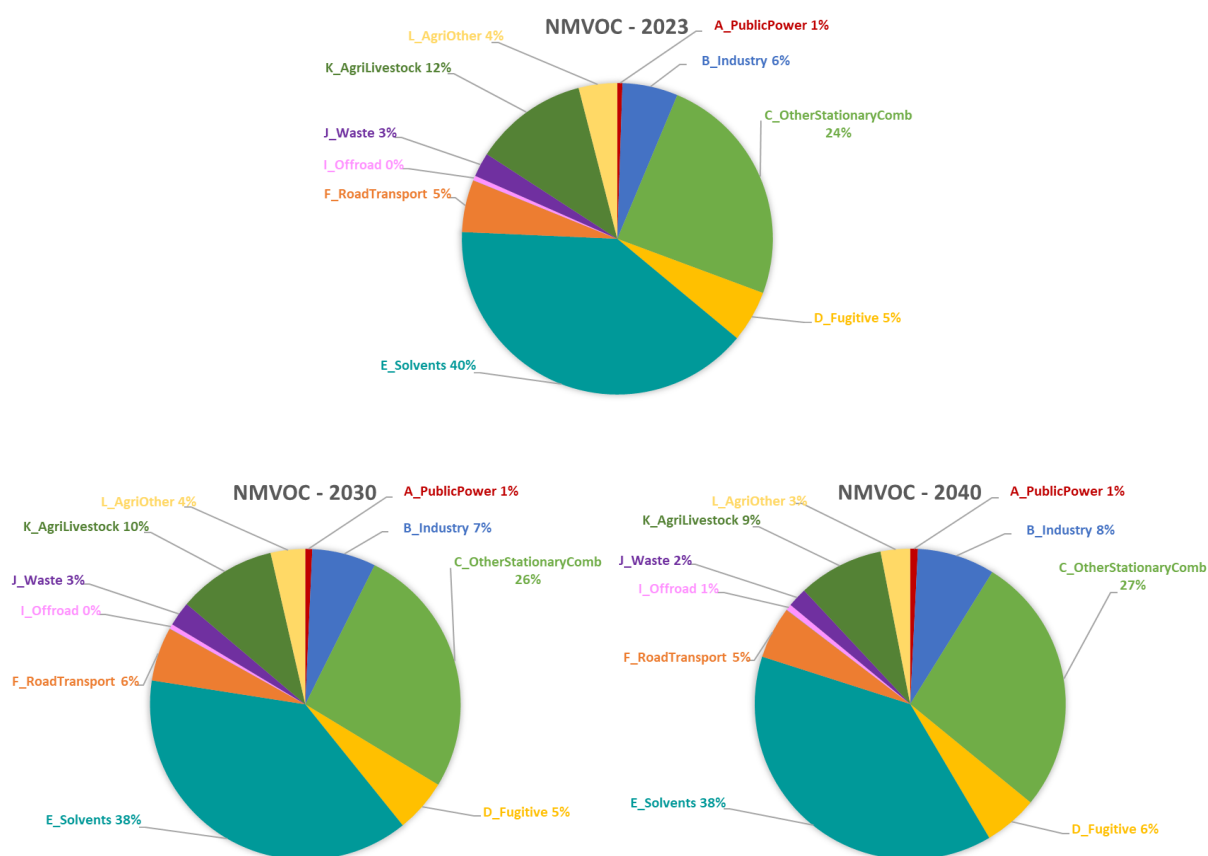


Figure 47 Pie charts with the national contributions of GNFR categories for the NMVOC emissions, for the years 2023, 2030 and 2040, for the WEM scenario

The sectoral structure of NMVOC emissions is characterised by a relatively diversified distribution across several key sources, with agriculture, solvents, and stationary combustion representing the largest shares.

In 2023, the largest contributors are wood residential combustion (NFR 1A4bi, 23.9%), followed by coating applications (2D3d, 20.3%) and domestic solvent use (2D3a, 15.0%). Together, these three categories account for almost 60% of total NMVOC emissions. Additional relevant sources include manure management (3B1a and 3B1b), coal mining (1B1a), chemical products (2D3g), and food and beverages production (2H2).

By 2030, the structure remains broadly similar, although a slight increase in the relative importance of 1A4bi (25.5%) is observed. Solvent-related emissions (2D3d and 2D3a) remain significant but show a gradual decreasing trend in absolute terms. Agricultural and waste-related sources maintain a stable contribution, while transport-related emissions continue to decline.

In 2040, the emission structure remains stable overall. 1A4bi remains the dominant source (26.2%), followed by solvent use (2D3d at 19.5% and 2D3a at 13.4%). Agricultural sources and manure

management categories continue to play an important but gradually decreasing role, while other sectors remain relatively minor contributors.

In terms of NFR sectors, the key categories for North Macedonia in the reference year and the projected years 2030 and 2040, for the WEM scenario, are as follows:

Table 284 Key categories for North Macedonia in the reference year 2023

| NFR | 2023 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 1A4bi | 4.149 | 23.9% | 23.9% | 1 |
| 2D3d | 3.517 | 20.3% | 44.2% | 2 |
| 2D3a | 2.605 | 15.0% | 59.3% | 3 |
| 3B1a | 0.929 | 5.4% | 64.6% | 4 |
| 1B1a | 0.799 | 4.6% | 69.2% | 5 |
| 2D3g | 0.579 | 3.3% | 72.6% | 6 |
| 2H2 | 0.576 | 3.3% | 75.9% | 7 |
| 3B1b | 0.497 | 2.9% | 78.8% | 8 |
| 3Da2a | 0.474 | 2.7% | 81.5% | 9 |

Table 285 Key categories for North Macedonia in the 2030

| NFR | | 2030 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|--|---------------------|------------------|-------------------------|------|
| 1A4bi | | 4.426 | 25.5% | 25.5% | 1 |
| 2D3d | | 3.314 | 19.1% | 44.7% | 2 |
| 2D3a | | 2.471 | 14.3% | 58.9% | 3 |
| 3B1a | | 0.710 | 4.1% | 63.0% | 4 |
| 2D3g | | 0.645 | 3.7% | 66.7% | 5 |
| 2H2 | | 0.587 | 3.4% | 70.1% | 6 |
| 1A3bv | | 0.440 | 2.5% | 72.7% | 7 |
| 3B1b | | 0.428 | 2.5% | 75.1% | 8 |
| 5A | | 0.418 | 2.4% | 77.5% | 9 |
| 3Da2a | | 0.400 | 2.3% | 79.9% | 10 |
| 1A2a | | 0.330 | 1.9% | 81.8% | 11 |

Table 286 Key categories for North Macedonia in the reference year 2040

| NFR | 2040 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 1A4bi | 4.528 | 26.2% | 26.2% | 1 |
| 2D3a | 2.324 | 13.4% | 39.6% | 2 |
| 2D3d | 3.368 | 19.5% | 59.1% | 3 |
| 2D3g | 0.738 | 4.3% | 63.4% | 4 |
| 2H2 | 0.609 | 3.5% | 66.9% | 5 |
| 3B1a | 0.577 | 3.3% | 70.2% | 6 |
| 1A2a | 0.488 | 2.8% | 73.1% | 7 |
| 1A3bv | 0.423 | 2.4% | 75.5% | 8 |
| 5A | 0.320 | 1.8% | 77.4% | 9 |
| 3Da2a | 0.315 | 1.8% | 79.2% | 10 |
| 3B1b | 0.311 | 1.8% | 81.0% | 11 |

10.8.3.3. Conclusion

Overall, NMVOC emissions in North Macedonia under the WEM scenario show a clear long-term decreasing trend followed by stabilisation at around 17.3 kt from 2023 onwards. The emission structure remains relatively diversified, with agriculture, solvent use, and residential combustion as the main contributing sectors.

Reductions in agricultural emissions and transport-related emissions are the main drivers of the overall decline, while solvent use and residential combustion remain relatively stable and limit further significant reductions. As a result, NMVOC emissions are expected to stabilise in the long term, indicating that additional mitigation efforts would be required in the solvent (implementation of IED) and residential combustion (replacement of old appliances and reduction of wood consumption) sectors to achieve further reductions beyond 2030.

10.8.4. Ammonia (NH₃) emissions

10.8.4.1. National trend

The following figure and table present the historical trend and projections of NH₃ emissions in North Macedonia under the WEM (With Existing Measures) scenario

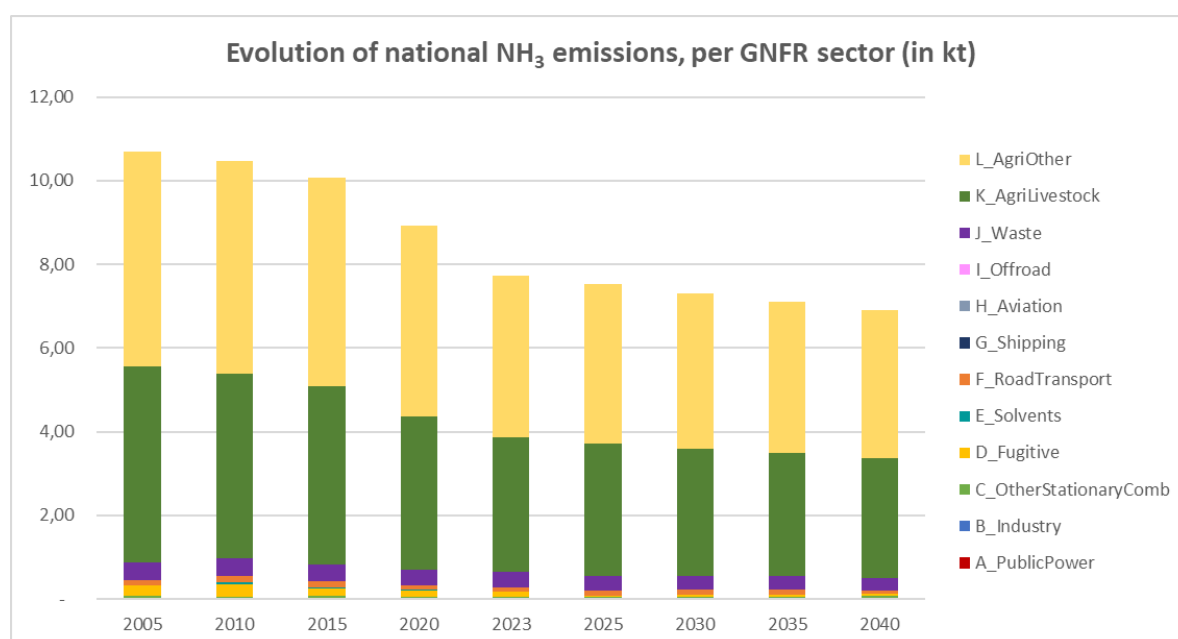


Figure 48 Trend of total emissions and projection of NH₃ emissions for WEM scenario

Table 287 Total NH₃ emissions (historical and projected) in kt, for WEM scenario

| Sector | | Historic emissions (kt) | | | | | Projected emissions (kt) | | | |
|--------|-----------------------------|-------------------------|------|------|------|------|--------------------------|------|------|------|
| GNFR | Name | 2005 | 2010 | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
| GNFR A | Public Power | - | - | - | - | - | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR B | Industry | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR C | Other Stationary Combustion | 0.07 | 0.06 | 0.08 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| GNFR D | Fugitive | 0.24 | 0.30 | 0.16 | 0.13 | 0.12 | 0.02 | 0.03 | 0.04 | 0.05 |
| GNFR E | Solvents | 0.01 | 0.04 | 0.04 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| GNFR F | Road Transport | 0.11 | 0.13 | 0.13 | 0.09 | 0.10 | 0.11 | 0.11 | 0.12 | 0.09 |

| | | | | | | | | | | |
|--------------|-----------------------|--------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| GNFR G | Shipping | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR H | Aviation | - | - | - | - | - | - | - | - | - |
| GNFR I | Offroad | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR J | Waste | 0.44 | 0.42 | 0.40 | 0.38 | 0.37 | 0.36 | 0.34 | 0.32 | 0.30 |
| GNFR K | Agriculture Livestock | 4.69 | 4.43 | 4.28 | 3.67 | 3.21 | 3.16 | 3.04 | 2.94 | 2.85 |
| GNFR L | Agriculture Other | 5.12 | 5.08 | 4.97 | 4.55 | 3.86 | 3.82 | 3.71 | 3.62 | 3.54 |
| TOTAL | | 10.69 | 10.47 | 10.06 | 8.92 | 7.73 | 7.54 | 7.30 | 7.10 | 6.90 |

Total NH₃ emissions show a gradual but consistent decreasing trend over the entire period. In 2005, emissions amounted to 10.69 kt, decreasing to 7.73 kt in 2023, which corresponds to a reduction of approximately 28% compared to the base year. In the projection period, emissions continue to decline steadily, reaching 7.30 kt in 2030 and 6.89 kt in 2040. Overall, this represents a long-term reduction of around 36% in 2040 compared to 2005 levels.

The decrease is mainly driven by reductions in agricultural emissions, particularly from livestock and manure management activities, which represent the dominant source category in the national emission inventory. Additional reductions from waste management also contribute to the overall downward trend, while transport and other sectors have only a marginal influence on total emissions.

10.8.4.2. National contributions

The following figure presents the contributions of the different GNFR categories in the national totals, in the WEM scenario, for the reference year and the projected years 2030 and 2040.

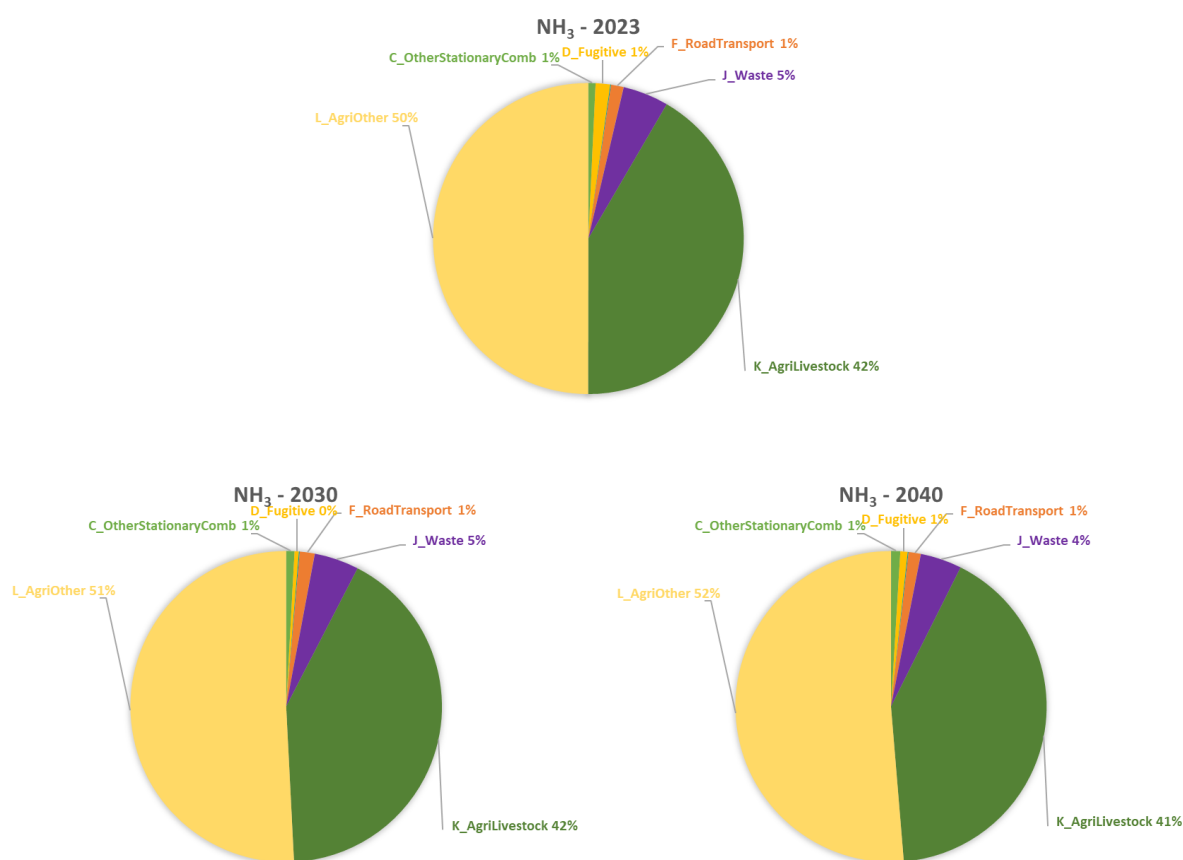


Figure 49 Pie charts with the national contributions of GNFR categories for the NH₃ emissions, for the years 2023, 2030 and 2040, for the WEM scenario

NH₃ emissions in North Macedonia are highly concentrated in the agricultural sector, which dominates the national emission profile throughout the entire modelling period.

In 2023, agriculture-related sources (GNFR K and L) account for the large majority of emissions, with livestock (GNFR K) and other agricultural activities (GNFR L) together representing more than 90% of total NH₃ emissions. The largest individual contributions come from livestock manure management and agricultural soil application.

By 2030, the sectoral structure remains largely unchanged, although a gradual reduction in absolute emissions is observed across most agricultural categories. GNFR K and GNFR L continue to dominate, together accounting for more than 85–90% of total emissions. Waste (GNFR J) remains the third most relevant sector, while all other sectors contribute marginal shares.

In 2040, the structure remains stable, with agriculture continuing to dominate the emission profile. However, a gradual reduction in livestock-related emissions leads to a slightly lower overall

contribution from agriculture compared to 2023, while relative shares of smaller sectors such as waste and transport remain low but slightly increasing in proportion.

In terms of NFR sectors, the key categories for North Macedonia in the reference year and the projected years 2030 and 2040, for the WEM scenario, are as follows:

Table 288 Key categories for NH₃ in the reference year

| NFR | 2023 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 3Da2a | 1.783 | 23.1% | 23.1% | 1 |
| 3B3 | 1.179 | 15.3% | 38.3% | 2 |
| 3Da1 | 1.152 | 14.9% | 53.2% | 3 |
| 3B1a | 0.715 | 9.3% | 62.5% | 4 |
| 3Da3 | 0.630 | 8.1% | 70.7% | 5 |
| 3B1b | 0.527 | 6.8% | 77.5% | 6 |
| 5D1 | 0.368 | 4.8% | 82.2% | 7 |

Table 289 Key categories for NH₃ for 2030

| NFR | 2030 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 3Da2a | 1.701 | 23.3% | 23.3% | 1 |
| 3B3 | 1.195 | 16.4% | 39.6% | 2 |
| 3Da1 | 1.160 | 15.9% | 55.5% | 3 |
| 3B1a | 0.618 | 8.5% | 64.0% | 4 |
| 3Da3 | 0.558 | 7.6% | 71.6% | 5 |
| 3B1b | 0.421 | 5.8% | 77.4% | 6 |
| 3B2 | 0.369 | 5.1% | 82.4% | 7 |

Table 290 Key categories for NH₃ for 2040

| NFR | 2040 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 3Da2a | 1.612 | 23.4% | 23.4% | 1 |
| 3B3 | 1.219 | 17.7% | 41.1% | 2 |
| 3Da1 | 1.172 | 17.0% | 58.1% | 3 |
| 3B1a | 0.502 | 7.3% | 65.3% | 4 |
| 3Da3 | 0.478 | 6.9% | 72.3% | 5 |
| 3B2 | 0.376 | 5.5% | 77.7% | 6 |
| 3B1b | 0.305 | 4.4% | 82.2% | 7 |

In terms of detailed NFR categories, NH₃ emissions are strongly dominated by agricultural sources, particularly manure management and agricultural soil application.

In 2023, the largest contributing category is 3Da2a (animal manure applied to soils), accounting for 23.1% of total emissions. This is followed by 3B3 (swine manure management, 15.3%) and 3Da1 (inorganic fertilisers, 14.9%). Additional important categories include 3B1a (dairy cattle), 3Da3 (grazing animals), and 3B1b (non-dairy cattle), confirming the strong dominance of livestock-related emissions.

By 2030, the structure remains broadly similar. 3Da2a remains the dominant source (23.3%), followed by 3B3 (16.4%) and 3Da1 (15.9%). A general reduction is observed in cattle-related categories (3B1a and 3B1b), reflecting declining cattle populations, while swine-related emissions (3B3) show a slight increase due to a marginal increase in livestock numbers.

By 2040, the same categories continue to dominate the emission profile. 3Da2a remains the largest source (23.4%), followed by 3B3 (17.7%) and 3Da1 (17.0%). While absolute emissions decrease in most livestock-related categories, the overall structure remains stable, confirming the long-term dominance of agriculture in NH₃ emissions.

10.8.4.3. Conclusion

Overall, NH₃ emissions in North Macedonia under the WEM scenario show a steady long-term decreasing trend, with total emissions declining by around 36% in 2040 compared to 2005. The emission profile remains highly concentrated in the agricultural sector, which is the dominant source throughout the entire period.

Reductions in livestock numbers and their associated manure management activities, in particular cattle livestock, are the main drivers of the downward trend, while smaller contributions from waste and other sectors remain relatively stable. Transport emissions show short-term variability but remain a minor contributor overall.

As a result, NH₃ emissions are expected to continue decreasing gradually, but future mitigation potential remains primarily linked to agricultural practices and livestock management improvements, given the very high dominance of this sector in the national emission profile.

10.8.5. Particulate matter – PM_{2.5} emissions

10.8.5.1. National trend

The following figure and table present the historical trend and projections of PM_{2.5} emissions in North Macedonia under the WEM (With Existing Measures) scenario.

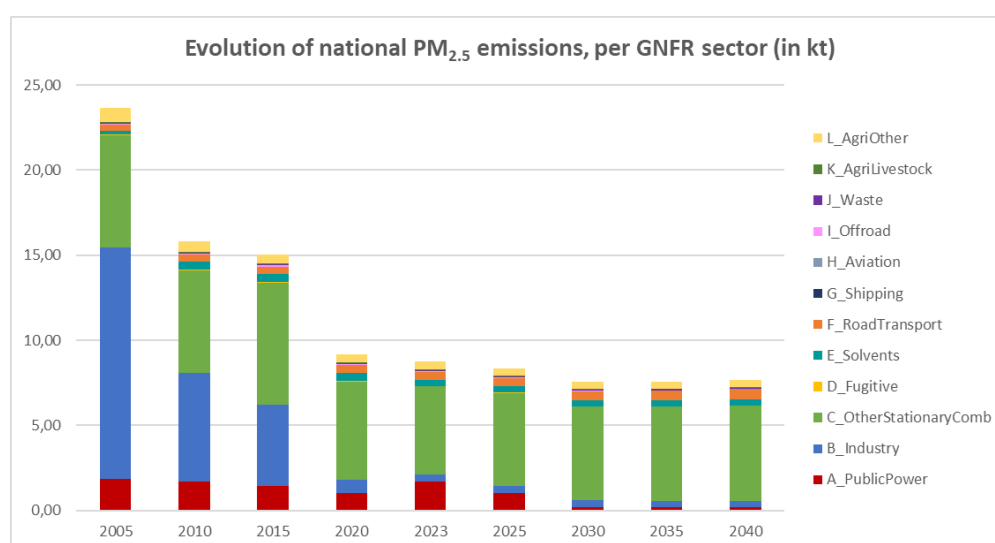


Figure 50 Trend of total emissions and projection of PM_{2.5} emissions for WEM scenario

Table 291 Total PM2.5 emissions (historical and projected) in kt, for WEM scenario

| Sector | | Historic emissions (kt) | | | | | Projected emissions (kt) | | | |
|--------------|-----------------------------|-------------------------|--------------|--------------|-------------|-------------|--------------------------|-------------|-------------|-------------|
| GNFR | Name | 2005 | 2010 | 2015 | 2020 | 2023 | 2025 | 2030 | 2035 | 2040 |
| GNFR A | Public Power | 1.83 | 1.70 | 1.42 | 1.02 | 1.70 | 1.02 | 0.18 | 0.18 | 0.19 |
| GNFR B | Industry | 13.64 | 6.39 | 4.81 | 0.78 | 0.43 | 0.38 | 0.40 | 0.36 | 0.37 |
| GNFR C | Other Stationary Combustion | 6.60 | 6.04 | 7.17 | 5.78 | 5.17 | 5.49 | 5.51 | 5.55 | 5.58 |
| GNFR D | Fugitive | 0.05 | 0.04 | 0.04 | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 |
| GNFR E | Solvents | 0.20 | 0.44 | 0.46 | 0.47 | 0.36 | 0.36 | 0.35 | 0.35 | 0.35 |
| GNFR F | Road Transport | 0.37 | 0.44 | 0.44 | 0.47 | 0.47 | 0.50 | 0.54 | 0.57 | 0.59 |
| GNFR G | Shipping | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR H | Aviation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GNFR I | Offroad | 0.03 | 0.05 | 0.06 | 0.04 | 0.04 | 0.02 | 0.01 | 0.01 | 0.01 |
| GNFR J | Waste | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 | 0.07 |
| GNFR K | Agriculture Livestock | 0.07 | 0.06 | 0.06 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 |
| GNFR L | Agriculture Other | 0.81 | 0.64 | 0.51 | 0.46 | 0.46 | 0.46 | 0.45 | 0.43 | 0.41 |
| TOTAL | | 23.65 | 15.84 | 15.02 | 9.16 | 8.74 | 8.36 | 7.57 | 7.58 | 7.65 |

Total PM2.5 emissions show a clear overall decreasing trend over the historical and projection period, with a substantial reduction compared to 2005. In 2005, emissions amounted to 23.65 kt, decreasing significantly to 8.74 kt in 2023, which represents a reduction of approximately 63%. In the projection period, emissions further decline to 7.57 kt in 2030, followed by a slight increase to 7.65 kt in 2040. Overall, this corresponds to a strong long-term reduction compared to the base year, despite the stabilisation in the final projection period.

The decline is mainly driven by significant reductions in industrial emissions and improvements in combustion processes in stationary sources. However, residential combustion remains the dominant source throughout the period, which is rather stable due to increasing biomass consumption and a slow replacement of old appliances, and limits further reductions in total emissions.

The following figure presents the contributions of the different GNFR categories in the national totals, in the WEM scenario, for the reference year and the projected years 2030 and 2040.

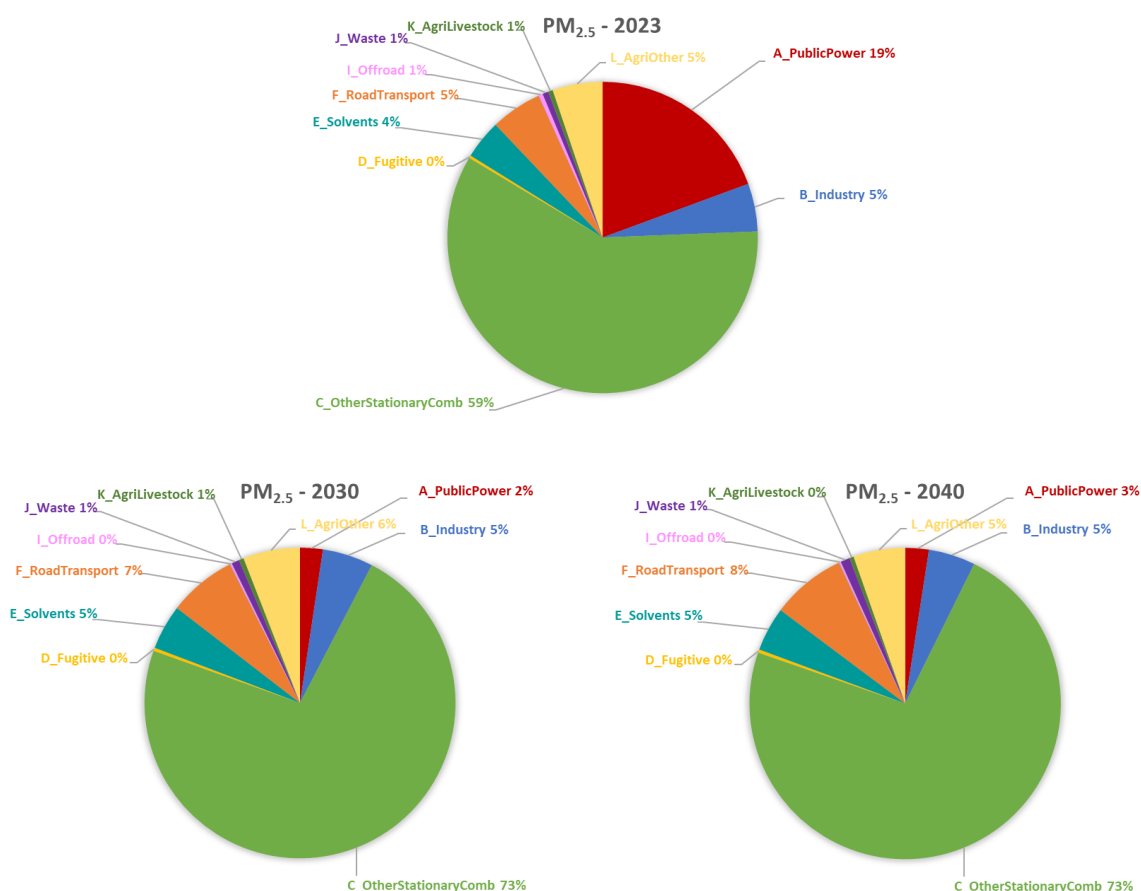


Figure 51 Pie charts with the national contributions of GNFR categories for the emissions of PM_{2.5}, for the years 2023, 2030 and 2040, for the WEM scenario

The sectoral structure of PM_{2.5} emissions is highly concentrated, with residential combustion representing the dominant source across all years.

In 2023, GNFR 1A4bi (Other stationary combustion – residential) is by far the largest contributor, accounting for 58.7% of total emissions. It is followed by GNFR 1A1a (Public power), contributing 19.4%, while other sectors such as agricultural residues burning (3F) and industrial processes contribute to the remaining shares.

By 2030, the dominance of residential combustion increases further, reaching 71.9% of total emissions. This increase is related to an increasing biomass consumption meaning the replacement of old appliances is slow, whereas other stationary sources are being equipped with abatement technologies and reduce their contributions. Industrial process and product use emissions (e.g. 2G) and agricultural burning (3F) remain minor contributors but become relatively more visible due to the strong decreases in other sectors.

In 2040, the structure remains stable, with NFR 1A4bi accounting for 72.2% of total emissions, followed by 2G (4.6%) and 3F (4.4%). All other sectors contribute only marginal shares, confirming the strong dominance of residential combustion in the PM2.5 emission profile.

In terms of NFR sectors, the key categories for North Macedonia in the reference year and the projected years 2030 and 2040, for the WEM scenario, are as follows:

Table 292 Key categories for PM2.5 in the reference year 2023

| NFR | 2023 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 1A4bi | 5.125 | 58.7% | 58.7% | 1 |
| 1A1a | 1.695 | 19.4% | 78.1% | 2 |
| 3F | 0.380 | 4.4% | 82.4% | 3 |

Table 293 Key categories for PM2.5 in 2030

| NFR | 2030 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 1A4bi | 5.440 | 71.9% | 71.9% | 1 |
| 2G | 0.354 | 4.7% | 76.5% | 2 |
| 3F | 0.373 | 4.9% | 81.5% | 3 |

Table 294 Key categories for PM2.5 in 2040

| NFR | 2040 emissions (kt) | Contribution (%) | Aggregated contribution | Rank |
|-------|---------------------|------------------|-------------------------|------|
| 1A4bi | 5.524 | 72.2% | 72.2% | 1 |
| 2G | 0.352 | 4.6% | 76.8% | 2 |
| 3F | 0.337 | 4.4% | 81.2% | 3 |

10.8.5.2. Conclusion

Overall, PM2.5 emissions in North Macedonia under the WEM scenario show a strong long-term decreasing trend compared to 2005, with emissions declining by more than 60% in 2023 and stabilising at around 7.6 kt in the long term. The emission profile remains highly concentrated in the residential combustion sector, which is the dominant source throughout the entire period.

While significant reductions are achieved in industrial and other combustion-related sectors, the relatively slow progress in reducing emissions from household solid fuel and biomass combustion limits further overall improvements. Transport emissions show a gradual increase, but remain a minor contributor compared to residential combustion.

As a result, PM2.5 emissions are expected to stabilise in the long term, and further reductions beyond 2030 will largely depend on targeted measures in the residential heating sector.

10.9. Conclusions for projections

Under the WEM (With Existing Measures) scenario, air pollutant emissions in North Macedonia generally show a decreasing trend over the projection period, with different sectoral dynamics shaping the overall evolution. The projections are based on consistent sectoral activity forecasts for

energy, transport, industry, agriculture and waste, combined with emission factor developments reflecting implemented and adopted policies up to the cut-off year.

NO_x emissions show a gradual decreasing trend over the projection period, from 20.66 kt in 2023 to 19.46 kt in 2030, followed by a slight increase towards 2040 (20.12 kt). The overall reduction compared to 2005 reaches 29% in 2040. The trend is mainly driven by reductions in the energy and transport sectors through efficiency improvements, gradual technological renewal and abatement technique implementation, while growth in activity in some subsectors slow further reductions in the long term.

SO₂ emissions show a very strong overall decrease compared to 2005, from 91.09 kt to 7.07 kt in 2030, remaining at similarly low levels up to 2040 (7.70 kt). This corresponds to a reduction of around 92% compared to 2005. The decrease is mainly driven by structural changes in the energy sector, including fuel switching and implementation of emission control technologies in large combustion sources.

NH₃ emissions show a continuous decreasing trend over the projection period, from 10.69 kt in 2005 to 6.90 kt in 2040 (–35%). Agriculture remains the dominant source, and the reduction is mainly driven by declining livestock numbers and gradual changes in manure management practices, while fertiliser use remains relatively stable.

NM VOC emissions remain broadly stable over the projection period, with a slight decrease from 17.33 kt in 2023 to 17.29 kt in 2040 (–30% compared to 2005). The main contributing sectors are solvent use, transport and agriculture. While transport shows gradual improvements due to technological changes, solvent-related emissions remain relatively constant and limit further reductions at national level.

PM_{2.5} emissions show a strong long-term reduction compared to 2005, from 23.65 kt to 8.36 kt in 2025, followed by a relatively stable trend up to 2040 (7.65 kt). This corresponds to a reduction of 68% compared to 2005. The main driver of emissions remains residential combustion, while reductions are mainly achieved through improvements in fuel use efficiency and gradual changes in combustion technologies.

Overall, the WEM scenario indicates that substantial emission reductions have already been achieved compared to 2005, particularly for SO₂, PM_{2.5} and NO_x. The energy sector is the main driver of reductions, especially for SO₂, while agriculture remains the dominant source of NH₃ emissions with gradual improvement over time. Transport becomes relatively more important for NO_x and NM VOC trends due to activity levels and slower mitigation effects in some subsectors. After 2030, emission reductions slow down for several pollutants, indicating a general stabilisation under existing measures.

Future improvements beyond the WEM scenario would require additional targeted actions, particularly in residential heating for particulate matter, in agriculture for ammonia, and in solvent-related NM VOC sources. Transport would also require further measures to sustain NO_x reduction trends in the long term. REPORTING OF GRIDDED EMISSIONS AND LPS

Republic of North Macedonia is regularly reporting data to fulfill the reporting obligation for gridded emissions and LPS. Last reported data was submitted in 2021 reporting year.

Following, a short description of the methodology for calculation of gridded emissions is presented.

Within a Twinning project, two expert missions on calculations of gridded emissions were carried out. It was decided to prepare gridded emissions for the new EMEP grid resolution (0.1°x0.1° long/lat). Within these missions several proxy tools were developed:

- DISTRIBUTE_MUNICIPAL_VALUES_via_PROXY_GRID.xlsm
- DISTRIBUTE_REGIONAL_VALUES_via_PROXY_GRID.xlsm
- DISTRIBUTE_TOTAL_VALUES_via_PROXY_GRID.xlsm
- LPS_to_GRID.xlsm
- Road_proxy_calculation.xlsm
- Farm_and_farmland_proxy_calculation.xlsm

A proxy map to distribute road transport emissions was derived from a road network map for Macedonia from “MapCruzin.com”. Therefore, the road network was intersected with the EMEP grid (by using “ArcGis”) to get the road share per cell. The length of these road fractions was then calculated within the GIS application.

The attribute table was exported from “ArcGis” and imported to Excel to proceed with the further steps. With the road type, which is an attribute of the road network map, additional weighting was implemented (e.g. motorways were weighted double in comparison with other roads and residential streets were weighted half). Then these fractions of proxy values, based on the road length and the type weighting, were aggregated to the 315 EMEP grid cells and multiplied with a population density proxy grid which was derived from SEDAC/CIESIN. The result is a proxy grid which considers the road network (including different road types) and the population density to distribute road transport emissions.

In addition, the population grid from SEDAC/CIESIN was adjusted regarding newer municipal population data from Macedonia.

A proxy map to distribute emissions from the agricultural sector was derived from a land use map for Macedonia from “MapCruzin”, Therefore the areas with the types “farm”, “farmland” and “farmyard” were intersected with the EMEP grid (by using “ArcGis”) to get the area share per cell. The attribute table was then exported from “ArcGis” and imported to Excel where these area fractions were aggregated to the 315 EMEP grid cells to get a distribution grid for agricultural emissions.

In addition, a tool was programmed, which was able to sum up the emissions from a list of large point sources to the allocated EMEP grid cells.

These tools were used by national experts to calculate emissions per grids. Furthermore, emissions from major installations for production of heat electricity and industry for production of cement were taken into account. Ferro metals and Incineration of medical waste as well as big swine and poultry farms were allocated in the grids according to their coordinates. Fugitive emissions were distributed using land cover and petrol and mines network.

Additionally, data for small emission was distributed using the population proxy calculations excluding households connected to district heating. Emissions originating from administrative capacities were included from the National cadaster database.

Population data was used to distribute emissions originating from the use of solvents and municipal waste. Emissions from aviation and national navigation are minor and were distributed according to

the location of airports and boat ports. For this year reporting calculation of emissions per grid from 2.K were added.

Currently, reporting for 2023 gridded emission data is under preparation, using the same methodology. Data report will be submitted with a certain delay, due to the time alignment with dedicated expert mission that is expected to provide assessment and improvement of the gridded emission reporting methodology. Provided expert mission assistance is part of current implementation of an IPA3 project related to support in the Implementation of Air Quality Directives. Expected improvement should involve assessment of the reporting methodology calculation, updating the proxy data used for emission distribution and improvement of the data acquisition.

The LPS report comprehensively details the methodologies for calculating emissions from ten distinct installations, encompassing both energy production and industrial processes.

Within the energy sector, there are five large combustion plants. REK Bitola and REK Oslomej, both major electricity producers utilizing lignite, employ different approaches. REK Bitola calculates SO₂, NO_x, CO, and TSP using implied Emission Factors (EFs) derived from historical measurements (2020-2022 data), and then estimates PM₁₀ and PM_{2.5} based on a proportion of TSP and Tier 1 EFs from the Guidebook 2023 for NFR category 1.A.1 Energy Industries (Tables 3-3 and 3-6). REK Oslomej, on the other hand, directly uses 2023 measurement data for these pollutants, similarly determining PM₁₀ and PM_{2.5} from measured TSP with proportionality and the same Guidebook Tier 1 EFs. Three natural gas-fired heat production plants—ESM-Energetika and ESM-Toplana Zapad—consistently apply Tier 1 EFs from the Guidebook 2023, NFR category 1.A.1 Energy Industries (Table 3-4) for all parameters. ESM-Toplana Istok is an exception, using 2023 measurement data for NO_x, while all other parameters follow the same Guidebook Tier 1 EFs. Lastly, TE-TO AD Skopje, a cogeneration plant, relies on 2023 measurement data for SO₂, NO_x, and CO, but utilizes Tier 2 EFs from the Guidebook 2023, NFR category 1.A.1 Energy Industries (Table 3-19) for NMVOC, PM₁₀, and PM_{2.5}, and Tier 1 EFs from the same category (Table 3-4) for heavy metals like Pb, Cd, and Hg.

The report also covers four manufacturing industries. Cementarnica USJE Skopje (cement production) primarily uses 2023 measurement data for SO₂, NO_x, CO, and TSP. PM₁₀ and PM_{2.5} are then derived from the measured TSP value using proportionality and EFs from the Guidebook 2023 for NFR category 2.A.1 Cement production (Tier 1, Table 3-1 and Tier 2, Table 3-2), while other parameters use Tier 2 EFs from NFR category 1.A.2 Manufacturing industries and construction (combustion), Table 3-25. Euronickel Industry Kavadarci (ferronickel production) and Makstil Skopje (steel production) both utilize 2023 measurement data for SO₂, NO_x, CO, and TSP. For PM₁₀ and PM_{2.5}, they apply proportionality to the measured TSP and Tier 1 EFs from the Guidebook 2023, NFR category 1.A.2 Manufacturing industries and construction (combustion), (Tables 3-2, 3-4, and 3-5), with Makstil additionally incorporating Tier 2 EFs from NFR category 2.C.1 Iron and steel production (Tables 3-19 and 3-22) for these particles and other parameters. Finally, Liberty Skopje (cold mill products) consistently uses Tier 1 EFs from the Guidebook 2023, NFR category 1.A.2 Manufacturing industries and construction (combustion), (Table 3-4) for all its parameters. This comprehensive approach, combining direct measurements with specific Guidebook EFs, ensures a robust calculation of emissions across the diverse industrial landscape.

11. ADJUSTMENTS

Executive Body decisions 2012/3 and 2012/12 concern adjustments to emission reduction commitments or to inventories under the 2012 amended Gothenburg Protocol. The decisions include the detailed lists of supporting information which must be provided in an IIR or in a separate report. Until now, Republic of North Macedonia did not apply for adjustment procedure.

IIR APPENDIXES

Appendix 1: Key category analysis

Appendix 2: Summary of whether source sectors use PM emission factors that include/exclude the condensable component

Appendix 3: Further elaboration of completeness, uses of NE & IE and (potential) sources of air pollutant emissions excluded

Appendix 4: National energy balance for 2024

Appendix 5: National totals and NFR sector emissions for 2024

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Table 296 Key source categories for emissions of NMVOC in Gg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|-------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A4bi | Residential: stationary | | | 3.75 | 23.9% | 23.9% |
| 2D3d | Coating applications | | | 3.26 | 20.8% | 44.6% |
| 2D3a | Domestic solvent use including fungicides | | | 2.55 | 16.2% | 60.9% |
| 3B1a | Dairy cattle | | | 0.87 | 5.6% | 66.4% |
| 1B1a | Coal Mining and Handling | | | 0.65 | 4.1% | 70.5% |
| 2H2 | Food and beverage industry | | | 0.59 | 3.7% | 74.3% |
| 2D3g | Chemical products | | | 0.57 | 3.7% | 77.9% |
| 3Da2a | Animal manure | | | 0.48 | 3.0% | 81.0% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1B2av | Distribution of oil products | 0.97 | 0.13 | 0.040 | 2.3% | 79.3% |
| 1A4bi | Residential: stationary | 5.63 | 4.13 | 0.250 | 14.6% | 54.4% |
| 2D3d | Coating applications | 10.43 | 3.52 | 0.135 | 7.9% | 62.3% |
| 2D3a | Domestic solvent use including fungicides | 2.43 | 2.60 | 0.259 | 15.1% | 39.8% |
| 3B1a | Dairy cattle | 1.45 | 0.82 | 0.049 | 2.9% | 74.3% |
| 1A3bi | R.T., Passenger cars | 7.65 | 0.40 | 0.424 | 24.7% | 24.7% |
| 2D3g | Chemical products | 0.02 | 0.58 | 0.092 | 5.3% | 67.6% |
| 5A | Solid waste disposal on land | 0.06 | 0.41 | 0.066 | 3.8% | 71.4% |
| 1A2gvii | Mobile Combustion in Manufacturing Industries and Construction | 0.79 | 0.03 | 0.045 | 2.6% | 76.9% |

Table 297 Key source categories for emissions of SO₂ in Gg

| Level Assessment 2024 | | | | |
|-----------------------|--|-------|-------|-------|
| NFR Code | NFR sector | 2024 | % | %cum |
| 1A1a | Public electricity and heat production | 44.83 | 97.9% | 97.9% |

| Level Assessment 2024 | | | | | | |
|----------------------------|--|-------|-------|--------|-------|-------|
| NFR Code | NFR sector | 2024 | | | % | %cum |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A1a | Public electricity and heat production | 99.29 | 54.04 | 44.825 | 97.9% | 97.9% |

Table 298 Key source categories for emissions of NH3 in Gg

| Level Assessment 2024 | | | | | | | |
|----------------------------|---|------|------|-------|-------|-------|-------|
| NFR Code | NFR sector | | | | 2024 | % | %cum |
| 3Da2a | Animal manure | | | | 1.69 | 21.4% | 21.4% |
| 3B1a | Dairy cattle | | | | 0.76 | 9.6% | 62.3% |
| 3Da3 | Urine and dung deposited by grazing animals | | | | 0.59 | 7.5% | 69.8% |
| 3B3 | Swine | | | | 1.09 | 13.8% | 52.7% |
| 3Da1 | Inorganic N-fertilizers | | | | 1.38 | 17.5% | 38.9% |
| 5D1 | Domestic wastewater | | | | 0.58 | 7.4% | 77.2% |
| 3B1b | Non-dairy cattle | | | | 0.47 | 5.9% | 83.1% |
| Trend Assessment 1990-2024 | | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum | |
| 3Da2a | Animal manure | 3.27 | 1.78 | 1.687 | 21.4% | 21.4% | |
| 3B1a | Dairy cattle | 1.26 | 0.72 | 0.760 | 9.6% | 62.3% | |
| 3Da3 | Urine and dung deposited by grazing animals | 1.78 | 0.63 | 0.589 | 7.5% | 69.8% | |
| 3B3 | Swine | 1.11 | 1.18 | 1.088 | 13.8% | 52.7% | |
| 3Da1 | Inorganic N-fertilizers | 1.17 | 1.15 | 1.382 | 17.5% | 38.9% | |
| 5D1 | Domestic wastewater | 0.51 | 0.37 | 0.582 | 7.4% | 77.2% | |
| 3B1b | Non-dairy cattle | 1.10 | 0.53 | 0.467 | 5.9% | 83.1% | |

Table 299 Key source categories for emissions of CO in Gg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|-------|-------|--------|-------|-------|
| NFR Code | NFR sector | | 2024 | % | %cum | |
| 1A4bi | Residential: stationary | | 25.52 | 62.3% | 62.3% | |
| 1A3bi | R.T., Passenger cars | | 3.17 | 7.7% | 81.4% | |
| 3F | Field burning of agricultural residues | | 4.66 | 11.4% | 73.6% | |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 38.33 | 28.04 | 25.516 | 62.3% | 62.3% |
| 1A3bi | R.T., Passenger cars | 68.79 | 3.17 | 3.167 | 7.7% | 81.4% |
| 3F | Field burning of agricultural residues | 9.74 | 4.69 | 4.660 | 11.4% | 73.6% |

Table 300 Key source categories for emissions of TSP in Gg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | 2024 | % | %cum | |
| 1A4bi | Residential: stationary | | 4.96 | 30.5% | 30.5% | |
| 1A1a | Public electricity and heat production | | 3.44 | 21.2% | 51.7% | |
| 3Dc | On-farm storage, handling and transport of agricultural products | | 1.94 | 11.9% | 63.6% | |
| 2A5b | Construction and demolition | | 1.73 | 10.6% | 74.2% | |
| 2A5a | Quarrying and mining of minerals other than coal | | 0.75 | 4.6% | 78.8% | |
| 2G | Other product manufacture and use | | 0.75 | 4.6% | 83.4% | |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 7.51 | 5.47 | 4.964 | 30.5% | 30.5% |
| 1A1a | Public electricity and heat production | 7.33 | 5.12 | 3.444 | 21.2% | 51.7% |
| 3Dc | On-farm storage, handling and transport of agricultural products | 2.06 | 1.95 | 1.937 | 11.9% | 63.6% |
| 2A5b | Construction and demolition | 1.24 | 1.57 | 1.728 | 10.6% | 74.2% |
| 2A5a | Quarrying and mining of minerals other than coal | 0.62 | 0.79 | 0.751 | 4.6% | 78.8% |
| 2G | Other product manufacture and use | 1.19 | 0.75 | 0.748 | 4.6% | 83.4% |

Table 302 Key source categories for emissions of PM2.5 in Gg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | 2024 | % | %cum | |
| 1A4bi | Residential: stationary | | 4.59 | 62.5% | 62.5% | |
| 1A1a | Public electricity and heat production | | 1.02 | 13.8% | 76.3% | |
| 2G | Other product manufacture and use | | 0.39 | 5.2% | 81.6% | |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 6.95 | 5.06 | 4.594 | 62.5% | 62.5% |
| 1A1a | Public electricity and heat production | 2.09 | 1.70 | 1.015 | 13.8% | 76.3% |
| 2G | Other product manufacture and use | 0.94 | 0.36 | 0.385 | 5.2% | 81.6% |

Table 303 Key source categories for emissions of PM10 in Gg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | 2024 | % | %cum | |
| 1A4bi | Residential: stationary | | 4.72 | 38.3% | 38.3% | |
| 1A1a | Public electricity and heat production | | 2.36 | 19.1% | 57.5% | |
| 3Dc | On-farm storage, handling and transport of agricultural products | | 1.94 | 15.7% | 73.2% | |
| 2G | Other product manufacture and use | | 0.69 | 5.6% | 78.8% | |
| 2A5b | Construction and demolition | | 0.52 | 4.2% | 83.0% | |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 7.13 | 5.20 | 4.717 | 38.3% | 38.3% |
| 1A1a | Public electricity and heat production | 4.99 | 3.58 | 2.357 | 19.1% | 57.5% |
| 3Dc | On-farm storage, handling and transport of agricultural products | 2.06 | 1.95 | 1.937 | 15.7% | 73.2% |
| 2G | Other product manufacture and use | 1.15 | 0.65 | 0.686 | 5.6% | 78.8% |
| 2A5b | Construction and demolition | 0.37 | 0.36 | 0.519 | 4.2% | 83.0% |

Table 304 Key source categories for emissions of BC in Gg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A4bi | Residential: stationary | | | 0.46 | 55.2% | 55.2% |
| 1A3biii | R.T.. Heavy duty vehicles | | | 0.05 | 6.3% | 73.8% |
| 1A3bi | R.T.. Passenger cars | | | 0.10 | 12.4% | 67.5% |
| 3F | Field burning of agricultural residues | | | 0.03 | 4.2% | 78.0% |
| 1A3bii | R.T., Light duty vehicles | | | 0.03 | 4.1% | 82.1% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 0.69 | 0.51 | 0.460 | 55.2% | 55.2% |
| 1A3biii | R.T., Heavy duty vehicles | 0.04 | 0.05 | 0.053 | 6.3% | 73.8% |
| 1A3bi | R.T., Passenger cars | 0.06 | 0.10 | 0.103 | 12.4% | 67.5% |
| 3F | Field burning of agricultural residues | 0.07 | 0.04 | 0.035 | 4.2% | 78.0% |
| 1A3bii | R.T., Light duty vehicles | 0.03 | 0.03 | 0.034 | 4.1% | 82.1% |

Table 305 Key source categories for emissions of Pb in Mg

| Level Assessment 2024 | | | | | | | |
|----------------------------|--------------------------------------|------|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | | 2024 | % | %cum |
| 2G | Other product manufacture and use | | | | 4.91 | 68.8% | 68.8% |
| 1A3bvi | R.T., Automobile tyre and break wear | | | | 1.01 | 14.2% | 83.0% |
| Trend Assessment 1990-2024 | | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum | |
| 2G | Other product manufacture and use | 3.42 | 4.76 | 4.91 | 68.8% | 68.8% | |
| 1A3bvi | R.T., Automobile tyre and break wear | 0.43 | 1.04 | 1.01 | 14.2% | 83.0% | |

Table 306 Key source categories for emissions of Cd in Mg

| Level Assessment 2024 | | | | | |
|-----------------------|------------|--|------|---|------|
| NFR Code | NFR sector | | 2024 | % | %cum |

| | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| 1A4bi | Residential: stationary | | | 0.09 | 32.9% | 32.9% |
| 1A1a | Public electricity and heat production | | | 0.05 | 18.6% | 74.7% |
| 2C1 | Iron and Steel Production | | | 0.04 | 14.2% | 88.9% |
| 3F | Field burning of agricultural residues | | | 0.06 | 23.2% | 56.1% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 0.12 | 0.10 | 0.087 | 32.9% | 32.9% |
| 1A1a | Public electricity and heat production | 0.11 | 0.06 | 0.049 | 18.6% | 74.7% |
| 2C1 | Iron and Steel Production | 0.02 | 0.04 | 0.038 | 14.2% | 88.9% |
| 3F | Field burning of agricultural residues | 0.13 | 0.06 | 0.061 | 23.2% | 56.1% |

Table 307 Key source categories for emissions of Hg in Mg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A1a | Public electricity and heat production | | | 0.08 | 44.1% | 44.1% |
| 2C1 | Iron and Steel Production | | | 0.02 | 13.6% | 77.1% |
| 2K | "Consumption of POPs and heavy metals | | | 0.02 | 10.4% | 87.4% |
| 1A2f | Non-metallic Minerals | | | 0.03 | 19.3% | 63.4% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A1a | Public electricity and heat production | 0.17 | 0.09 | 0.077 | 44.1% | 44.1% |
| 2C1 | Iron and Steel Production | 0.09 | 0.02 | 0.024 | 13.6% | 77.1% |
| 2K | "Consumption of POPs and heavy metals | 0.02 | 0.02 | 0.018 | 10.4% | 87.4% |
| 1A2f | Non-metallic Minerals | IE | 0.04 | 0.034 | 19.3% | 63.4% |

Table 308 Key source categories for emissions of As in Mg

| | | | | |
|------------------------------|--|-------------|----------|-------------|
| Level Assessment 2024 | | | | |
| NFR Code | NFR sector | 2024 | % | %cum |
| 1A1a | Public electricity and heat production | 0.38 | 87.9% | 87.9% |

| Level Assessment 2024 | | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|------|
| NFR Code | NFR sector | | | | 2024 | % | %cum |
| Trend Assessment 1990-2024 | | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum | |
| 1A1a | Public electricity and heat production | 0.84 | 0.46 | 0.382 | 87.9% | 87.9% | |

Table 301 Key source categories for emissions of Cr in Mg

Table 3-2 Key source categories for emissions of GHG

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A1a | Public electricity and heat production | | | 0.24 | 24.9% | 63.8% |
| 1A4bi | Residential: stationary | | | 0.15 | 15.9% | 79.7% |
| 1A3bvi | R.T., Automobile tyre and break wear | | | 0.38 | 38.9% | 38.9% |
| 2G | Other product manufacture and use | | | 0.10 | 10.0% | 89.7% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A1a | Public electricity and heat production | 0.54 | 0.29 | 0.243 | 24.9% | 63.8% |
| 1A4bi | Residential: stationary | 0.22 | 0.17 | 0.155 | 15.9% | 79.7% |
| 1A3bvi | R.T., Automobile tyre and break wear | 0.16 | 0.39 | 0.379 | 38.9% | 38.9% |
| 2G | Other product manufacture and use | 0.07 | 0.08 | 0.098 | 10.0% | 89.7% |

Table 310 Key source categories for emissions of Cu in Mg

Table 3.26 Key source categories for emissions of carbon dioxide

| Level Assessment 2024 | | | | | | |
|----------------------------|--------------------------------------|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 2G | Other product manufacture and use | | | 2.79 | 24.5% | 97.8% |
| 1A3bvi | R.T., Automobile tyre and break wear | | | 8.33 | 73.2% | 73.2% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 2G | Other product manufacture and use | 2.08 | 2.70 | 2.793 | 24.5% | 97.8% |
| 1A3bvi | R.T., Automobile tyre and break wear | 3.51 | 8.52 | 8.334 | 73.2% | 73.2% |

Table 311 Key source categories for emissions of Ni in Mg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A1a | Public electricity and heat production | | | 0.74 | 68.0% | 68.0% |
| 2C1 | Iron and Steel Production | | | 0.13 | 11.9% | 80.0% |
| 1A4ai | Commercial/Institutional: Stationary | | | 0.08 | 7.7% | 87.7% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A1a | Public electricity and heat production | 1.21 | 2.36 | 0.735 | 68.0% | 68.0% |
| 2C1 | Iron and Steel Production | 0.12 | 0.13 | 0.129 | 11.9% | 80.0% |
| 1A4ai | Commercial/Institutional: Stationary | 0.05 | 0.08 | 0.083 | 7.7% | 87.7% |

Table 312 Key source categories for emissions of Se in Mg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A4bi | Residential: stationary | | | 3.00 | 71.3% | 71.3% |
| 1A1a | Public electricity and heat production | | | 1.18 | 28.0% | 99.3% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 0.01 | 2.00 | 3.003 | 71.3% | 71.3% |
| 1A1a | Public electricity and heat production | 2.63 | 1.36 | 1.180 | 28.0% | 99.3% |

Table 313 Key source categories for emissions of Zn in Mg

| Level Assessment 2024 | | | | | | |
|----------------------------|--------------------------------------|------|------|-------|-------|------|
| NFR Code | NFR sector | | 2024 | % | %cum | |
| 1A4bi | Residential: stationary | | 3.44 | 42.5% | 42.5% | |
| 1A3bvi | R.T.. Automobile tyre and break wear | | 2.52 | 31.1% | 73.5% | |
| 2C1 | Iron and Steel Production | | 0.72 | 8.9% | 82.5% | |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |

| Level Assessment 2024 | | | | | | |
|-----------------------|--------------------------------------|------|------|-------|-------|-------|
| 1A4bi | Residential: stationary | 4.83 | 3.77 | 3.444 | 42.5% | 42.5% |
| 1A3bvi | R.T., Automobile tyre and break wear | 1.05 | 2.58 | 2.520 | 31.1% | 73.5% |
| 2C1 | Iron and Steel Production | 3.54 | 0.70 | 0.724 | 8.9% | 82.5% |

Table 314 Key source categories for emissions of DIOX in g I-TEQ

| Level Assessment 2024 | | | | | | | |
|----------------------------|---------------------------|------|------|-------|-------|-------|-------|
| NFR Code | NFR sector | | | | 2024 | % | %cum |
| 1A4bi | Residential: stationary | | | | 4.96 | 72.9% | 72.9% |
| 2C1 | Iron and Steel Production | | | | 0.94 | 13.9% | 86.7% |
| Trend Assessment 1990-2024 | | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum | |
| 1A4bi | Residential: stationary | 7.57 | 5.47 | 4.958 | 72.9% | 72.9% | |
| 2C1 | Iron and Steel Production | 2.66 | 0.91 | 0.944 | 13.9% | 86.7% | |

Table 315 Key source categories for emissions of PAHs in Mg

| Level Assessment 2024 | | | | | | |
|----------------------------|--|------|------|-------|-------|-------|
| NFR Code | NFR sector | | | 2024 | % | %cum |
| 1A4bi | Residential: stationary | | | 2.16 | 79.7% | 79.7% |
| 1A2gviii | Other Stationary Combustion in Manufacturing Industries and Construction | | | 0.16 | 5.9% | 85.6% |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 1A4bi | Residential: stationary | 3.38 | 2.38 | 2.165 | 79.7% | 79.7% |
| 5C2 | Open burning of waste | 0.21 | 0.16 | 0.160 | 5.9% | 85.6% |

Table 316 Key source categories for emissions of HCB in kg

| Level Assessment 2024 | | | | | | |
|-----------------------|-------------------------|------|--|-------|-------|--|
| NFR Code | NFR sector | 2024 | | % | %cum | |
| 5C1biii | Clinical waste | 0.01 | | 20.5% | 92.7% | |
| 1A4bi | Residential: stationary | 0.03 | | 72.2% | 72.2% | |

| Level Assessment 2024 | | | | | | |
|----------------------------|-------------------------|------|------|-------|-------|-------|
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 5C1biii | Clinical waste | NO | 0.01 | 0.010 | 20.5% | 92.7% |
| 1A4bi | Residential: stationary | 0.05 | 0.04 | 0.034 | 72.2% | 72.2% |

Table 317 Key source categories for emissions of PCB in kg

| Level Assessment 2024 | | | | | | |
|----------------------------|--------------------------------------|--------|--------|--------|-------|-------|
| NFR Code | NFR sector | 2024 | | % | %cum | |
| 2K | Consumption of POPs and heavy metals | 212.71 | | 88.5% | 88.5% | |
| Trend Assessment 1990-2024 | | | | | | |
| NFR Code | NFR sector | 1990 | 2024 | TA | % | %cum |
| 2K | Consumption of POPs and heavy metals | 202.80 | 211.71 | 212.71 | 88.5% | 88.5% |

APPENDIX 2: Summary source sectors use PM emission factors that include/exclude the condensable component (see below)

| NFR | Source / sector name | PM emissions: the condensable component is | | EF reference and comments |
|------|--|--|----------|--|
| | | included | excluded | |
| 1A1a | Public electricity and heat production | no | yes | The emission factors used for TSP, PM10 and PM2.5. that are calculating from direct emission for large point sources (LPS) and yearly taken from the EPR database. exclude the condensable component. Method used for PM10 emission measurement is gravimetric method and samples for it. need to be dry. Gravimetric method is in North Macedonian law. reference method for determination of mass concentration of floating particles. described with HRN EN 12341 standard for PM10 fraction. For non LCP sources. the emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions and are based on an defined ash content. |
| 1A1b | Petroleum refining | no | yes | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction) |
| 1A1c | Manufacture of solid fuels and other energy industries | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and the basis of these emission factors could not be determined in the reference. |
| 1A2a | Stationary combustion in manufacturing industries and construction: Iron and steel | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM |

| | | | | |
|---------|--|---------|---------|---|
| | | | | or total PM (filterable and condensable) emissions. |
| 1A2b | Stationary combustion in manufacturing industries and construction: Non-ferrous metals | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A2c | Stationary combustion in manufacturing industries and construction: Chemicals | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A2d | Stationary combustion in manufacturing industries and construction: Pulp. Paper and Print | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A2e | Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A2f | Stationary combustion in manufacturing industries and construction: Non-metallic minerals | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A2gvii | Mobile Combustion in manufacturing industries and construction: (please specify in the IIR) | yes | no | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors represent total PM emissions (filterable and condensable fractions). |

| | | | | |
|-----------|---|---------|---------|--|
| 1A2gviii | Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR) | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A3ai(i) | International aviation LTO (civil) | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2013 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3aii(i) | Domestic aviation LTO (civil) | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2013 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3bi | Road transport: Passenger cars | yes | no | The emission factors used for TSP, PM10 and PM2.5 are default ones from COPERT IV that is Tier 3 approach according to GB2019. According to GB2019, PM mass emission factors are considered to include both filterable and condensable material. The mass of particles collected on a filter kept below 52°C during diluted exhaust sampling. This corresponds to total (filterable and condensable) PM2.5. Coarse exhaust PM (i.e. >2.5µm diameter) is considered to be negligible. hence PM=PM2.5. |
| 1A3bii | Road transport: Light duty vehicles | yes | no | |
| 1A3biii | Road transport: Heavy duty vehicles and buses | yes | no | |
| 1A3biv | Road transport: Mopeds & motorcycles | yes | no | |
| 1A3bv | Road transport: Gasoline evaporation | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 1A3bvi | Road transport: Automobile tyre and brake wear | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3bvii | Road transport: Automobile road abrasion | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on |

| | | | | |
|------------|---|---------|---------|---|
| | | | | inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3c | Railways | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3di(iii) | International inland waterways | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3dii | National navigation (shipping) | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1A3ei | Pipeline transport | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 1A3eii | Other (please specify in the IIR) | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 1A4ai | Commercial/institutional: Stationary | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A4aii | Commercial/institutional: Mobile | IE | IE | IE: 1A4aii |
| 1A4bi | Residential: Stationary | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A4bii | Residential: Household and gardening (mobile) | yes | no | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these emission factors represent total PM emissions (filterable and condensable fractions). |

| | | | | |
|---------|---|---------|---------|---|
| 1A4ci | Agriculture/Forestry/ Fishing: Stationary | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions. |
| 1A4cii | Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery | yes | no | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these emission factors represent total PM emissions (filterable and condensable fractions). |
| 1A4ciii | Agriculture/Forestry/ Fishing: National fishing | IE | IE | IE: 1A3dii |
| 1A5a | Other stationary (including military) | IE | IE | IE: 1A4a |
| 1A5b | Other. Mobile (including military. land based and recreational boats) | IE | IE | IE: 1A4a. 1A3b(i-iv) |
| 1B1a | Fugitive emission from solid fuels: Coal mining and handling | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1B1b | Fugitive emission from solid fuels: Solid fuel transformation | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1B1c | Other fugitive emissions from solid fuels | NO | NO | This activity does not exist in North Macedonia. |
| 1B2ai | Fugitive emissions oil: Exploration. production. transport | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1B2aiv | Fugitive emissions oil: Refining / storage | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1B2av | Distribution of oil products | NA | NA | This activity does not result with TSP. PM10 and PM2.5 emissions. |

| | | | | |
|------|--|---------|---------|---|
| 1B2b | Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other) | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 1B2c | Venting and flaring (oil, gas, combined oil and gas) | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 1B2d | Other fugitive emissions from energy production | NO | NO | This activity does not exist in North Macedonia. |
| 2A1 | Cement production | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2A2 | Lime production | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2A3 | Glass production | NO | NO | This activity does not exist in North Macedonia. |
| 2A5a | Quarrying and mining of minerals other than coal | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2A5b | Construction and demolition | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2A5c | Storage, handling and transport of mineral products | IE | IE | IE: 2A1, 2A2, 2A3, 2A5a, 2A5b |
| 2A6 | Other mineral products (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 2B1 | Ammonia production | NO | NO | This activity does not exist in North Macedonia. |
| 2B2 | Nitric acid production | NO | NO | This activity does not exist in North Macedonia. |

| | | | | |
|-------|--|----|-----|--|
| 2B3 | Adipic acid production | NO | NO | This activity does not exist in North Macedonia. |
| 2B5 | Carbide production | NO | NO | This activity does not exist in North Macedonia. |
| 2B6 | Titanium dioxide production | NO | NO | This activity does not exist in North Macedonia. |
| 2B7 | Soda ash production | NO | NO | This activity does not exist in North Macedonia. |
| 2B10a | Chemical industry: Other (please specify in the IIR) | NE | NE | There is no emission factor for TSP, PM10 and PM2.5 in the GB2019. |
| 2B10b | Storage, handling and transport of chemical products (please specify in the IIR) | IE | IE | IE: 2B10a |
| 2C1 | Iron and steel production | no | yes | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction (European Commission, 2001)). |
| 2C2 | Ferroalloys production | no | yes | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction). |
| 2C3 | Aluminium production | no | yes | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions only (excluding any condensable fraction). |
| 2C4 | Magnesium production | NO | NO | This activity does not exist in North Macedonia. |
| 2C5 | Lead production | NO | NO | This activity does not exist in North Macedonia. |
| 2C6 | Zinc production | NO | NO | This activity does not exist in North Macedonia. |
| 2C7a | Copper production | NO | NO | This activity does not exist in North Macedonia. |
| 2C7b | Nickel production | NO | NO | This activity does not exist in North Macedonia. |
| 2C7c | Other metal production (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 2C7d | Storage, handling and transport of metal products (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |

| | | | | |
|------|--|---------|---------|--|
| 2D3a | Domestic solvent use including fungicides | NA | NA | This activity does not result with TSP. PM10 and PM2.5 emissions. |
| 2D3b | Road paving with asphalt | yes | no | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and these PM factors represent filterable PM emissions with Nnote that US EPA (2004) includes condensable PM emission factors and factors for controlled plant. |
| 2D3c | Asphalt roofing | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2D3d | Coating applications | NA | NA | This activity does not result with TSP. PM10 and PM2.5 emissions. |
| 2D3e | Degreasing | NE | NE | There is no emission factor for PM2.5 in the GB2019. |
| 2D3f | Dry cleaning | NE | NE | There is no emission factor for PM2.5 in the GB2019. |
| 2D3g | Chemical products | NA | NA | This activity does not result with TSP. PM10 and PM2.5 emissions. |
| 2D3h | Printing | NE | NE | There is no emission factor for PM2.5 in the GB2019. |
| 2D3i | Other solvent use (please specify in the IIR) | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2G | Other product use (please specify in the IIR) | unclear | unclear | The emission factors used for TSP. PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 2H1 | Pulp and paper industry | NO | NO | This activity does not exist in North Macedonia. |
| 2H2 | Food and beverages industry | NE | NE | There is no emission factor for TSP. PM10 and PM2.5 in the GB2019. |
| 2H3 | Other industrial processes (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 2I | Wood processing | | | There is no emission factor for PM10 and PM2.5 in the GB2019. |

| | | | | |
|------|---|---------|---------|---|
| 2J | Production of POPs | NO | NO | This activity does not exist in North Macedonia. |
| 2K | Consumption of POPs and heavy metals (e.g. electrical and scientific equipment) | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 2L | Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 3B1a | Manure management - Dairy cattle | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B1b | Manure management - Non-dairy cattle | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B2 | Manure management - Sheep | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B3 | Manure management - Swine | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4a | Manure management - Buffalo | NO | NO | This activity does not exist in North Macedonia. |
| 3B4d | Manure management - Goats | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4e | Manure management - Horses | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |

| | | | | |
|---------|--|---------|---------|---|
| 3B4f | Manure management - Mules and asses | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4gi | Manure management - Laying hens | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4gii | Manure management - Broilers | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4giii | Manure management - Turkeys | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4giv | Manure management - Other poultry | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3B4h | Manure management - Other animals (please specify in IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 3Da1 | Inorganic N-fertilizers (includes also urea application) | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Da2a | Animal manure applied to soils | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Da2b | Sewage sludge applied to soils | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Da2c | Other organic fertilisers applied to soils (including compost) | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Da3 | Urine and dung deposited by grazing animals | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Da4 | Crop residues applied to soils | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Db | Indirect emissions from managed soils | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |

| | | | | |
|--------|---|---------|---------|--|
| 3Dc | Farm-level agricultural operations including storage, handling and transport of agricultural products | yes | no | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information that the processes which result in particulate emissions are largely low-temperature mechanical activities, and emissions are unlikely to include substantial quantities of condensable particulate material. |
| 3Dd | Off-farm storage, handling and transport of bulk agricultural products | NE | NE | There is no emission factor for PM10 and PM2.5 in the GB2019. |
| 3De | Cultivated crops | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3Df | Use of pesticides | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 3F | Field burning of agricultural residues | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 3I | Agriculture other (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 5A | Biological treatment of waste - solid waste disposal on land | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 5B1 | Biological treatment of waste - composting | NE | NE | There is no emission factor for PM10 and PM2.5 in the GB2019. |
| 5B2 | Biological treatment of waste - anaerobic digestion at biogas facilities | NA | NA | This activity does not result with TSP, PM10 and PM2.5 emissions. |
| 5C1a | Municipal waste incineration | NO | NO | This activity does not exist in North Macedonia. |
| 5C1bi | Industrial waste incineration | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 5C1bii | Hazardous waste incineration | NO | NO | This activity does not exist in North Macedonia. |

| | | | | |
|---------|---|---------|---------|---|
| 5C1biii | Clinical waste incineration | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 5C1biv | Sewage sludge incineration | NO | NO | This activity does not exist in North Macedonia. |
| 5C1bv | Cremation | NO | NO | This activity does not exist in North Macedonia. |
| 5C1bvi | Other waste incineration (please specify in the IIR) | NO | NO | This activity does not exist in North Macedonia. |
| 5C2 | Open burning of waste | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 5D1 | Domestic wastewater handling | NE | NE | There is no emission factor for PM10 and PM2.5 in the GB2019. |
| 5D2 | Industrial wastewater handling | NE | NE | There is no emission factor for PM10 and PM2.5 in the GB2019. |
| 5D3 | Other wastewater handling (please specify in IIR) | NE | NE | There is no emission factor for PM10 and PM2.5 in the GB2019. |
| 5E | Other waste (please specify in IIR) | unclear | unclear | The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2019 and there is no information on inclusion or exclusion of the condensable component in PM emission factors. |
| 6A | Other (included in national total for entire territory) (please specify in IIR) | NO | NO | This activity does not exist in North Macedonia. |

APPENDIX 3 Further elaboration of completeness

No further info on this subject

APPENDIX 4 National energy balance 2023

Part 1

| | | Hard coal ['000 tonnes] | Coke ['000 tonnes] | Sub-bituminous coal ['000] | Lignite ['000 tonnes] | Total petroleum products ['000] | Refinery gas ['000 tonnes] | LPG ['000 tonnes] | Motor spirit ['000 tonnes] | Kerosenes, jet fuels ['000 tonnes] | Road diesel ['000] | Heating and other gasoil ['000] | Residual fuel oil ['000 tonnes] | Petroleum coke ['000] | Other petroleum products ['000] |
|--|-----------|-------------------------|--------------------|----------------------------|-----------------------|---------------------------------|----------------------------|-------------------|----------------------------|------------------------------------|--------------------|---------------------------------|---------------------------------|-----------------------|---------------------------------|
| Total primary production | 0 | 0 | 0 | 3227,017979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recovered products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Imports | 1,734817 | 0,89542 | 0 | 1046,179725 | 0 | 0 | 1227,77828 | 0 | 62,203347 | 0 | 117,3748 | 37,555683 | 781,401156 | 20,673492 | 68,133478 |
| Stock change | -0,235366 | -0,188676 | 3,99504 | 178,182 | 0 | 0 | 10,075154 | 0 | 0,166252 | 0 | -0,972041 | 0,047259 | -5,67993 | 0,63482 | 3,553448 |
| Exports | 0 | 0 | 0 | 0 | 0 | 0 | 108,674069 | 0 | 1,626554 | 0 | 3,969894 | 29,85602 | 41,855674 | 0 | 2,243768 |
| Gross inland consumption | 1,499451 | 0,706744 | 3,99504 | 4451,379704 | 0 | 0 | 1129,179365 | 0 | 60,743045 | 0 | 112,432865 | 7,746922 | 733,865552 | 21,308312 | 69,443158 |
| Transformation input | 0 | 0 | 0 | 4445,686 | 0 | 0 | 48,405 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48,405 |
| .. Public thermal power stations | 0 | 0 | 0 | 4445,686 | 0 | 0 | 48,405 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48,405 |
| .. Autoprod. thermal power stations | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. CHP plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Briquetting plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Biogas plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Refineries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Main activity producer heat plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transformation output | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Public thermal power stations | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Autoprod. thermal power stations | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. CHP plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Briquetting plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Biogas plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Refineries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Main activity producer heat plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Exchanges and transfers, returns | 0 | 0 | 0 | 0 | 0 | 0 | 0,1 | 0 | 0 | 0 | 0 | 0 | 0,1 | 0 | 0 |
| Consumption of the energy branch | 0 | 0 | 0 | 0 | 0 | 0 | 1,879515 | 0 | 0 | 0 | 0 | 0 | 1,747445 | 0,02207 | 0,11 |
| Distribution losses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Available for final consumption | 1,499451 | 0,706744 | 3,99504 | 5,693704 | 0 | 0 | 1078,994849 | 0 | 60,743045 | 0 | 112,432865 | 7,746922 | 732,218107 | 21,286242 | 20,928158 |
| Final non-energy consumption | 0 | 0 | 0 | 0 | 0 | 0 | 39,042881 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Final energy consumption | 1,499451 | 0,706744 | 3,99504 | 5,693704 | 0 | 0 | 1039,951968 | 0 | 60,743045 | 0 | 112,432865 | 7,746922 | 732,218107 | 21,286242 | 20,928158 |
| ...Industry | 1,499451 | 0,706744 | 3,99504 | 3,641 | 0 | 0 | 151,956733 | 0 | 13,366705 | 0 | 0 | 0 | 29,07799 | 8,496816 | 18,256472 |
| ...Iron and steel industry | 1,379451 | 0,688744 | 3,99504 | 0 | 0 | 0 | 0,84387 | 0 | 0,0547 | 0 | 0 | 0 | 0,775875 | 0,013295 | 0 |
| ...Non-ferrous metal industry | 0 | 0 | 0 | 0 | 0 | 0 | 1,1547 | 0 | 1,1321 | 0 | 0 | 0 | 0,0156 | 0,007 | 0 |
| ...Chemical industry | 0 | 0 | 0 | 0 | 0 | 0 | 0,507024 | 0 | 0,016723 | 0 | 0 | 0 | 0,078763 | 0,411538 | 0 |
| ...Glass, pottery and building materials | 0,12 | 0 | 0 | 1,022 | 0 | 0 | 97,838419 | 0 | 4,927698 | 0 | 0 | 0 | 2,596202 | 1,10817 | 6,447599 |
| ...Ore-extraction industry | 0 | 0 | 0 | 0,085 | 0 | 0 | 13,33958 | 0 | 0,03 | 0 | 0 | 0 | 13,30858 | 0,001 | 0 |
| ...Food, drink and tobacco industries | 0 | 0 | 0 | 0 | 0 | 0 | 16,213349 | 0 | 4,204083 | 0 | 0 | 0 | 0,609129 | 4,307745 | 7,092392 |
| ...Textile, leather and clothing industries | 0 | 0 | 0 | 2,534 | 0 | 0 | 3,280873 | 0 | 0,66062 | 0 | 0 | 0 | 0 | 0,674252 | 1,946001 |
| ...Paper and printing | 0 | 0 | 0 | 0 | 0 | 0 | 0,614996 | 0 | 0,15957 | 0 | 0 | 0 | 0,036026 | 0,097 | 0,3224 |
| ...Engineering and other metal industries | 0 | 0,018 | 0 | 0 | 0 | 0 | 2,634186 | 0 | 1,598806 | 0 | 0 | 0 | 0,382979 | 0,645401 | 0,007 |
| ...Other industries | 0 | 0 | 0 | 0 | 0 | 0 | 15,529736 | 0 | 0,582405 | 0 | 0 | 0 | 11,274836 | 1,231415 | 2,44108 |
| ...Transport | 0 | 0 | 0 | 0 | 0 | 0 | 835,378398 | 0 | 39,61429 | 0 | 111,994731 | 7,727653 | 676,041725 | 0 | 0 |
| ...Railways | 0 | 0 | 0 | 0 | 0 | 0 | 0,988 | 0 | 0 | 0 | 0 | 0 | 0,988 | 0 | 0 |
| ...Road transport | 0 | 0 | 0 | 0 | 0 | 0 | 826,634425 | 0 | 39,61429 | 0 | 111,966411 | 0 | 675,053725 | 0 | 0 |
| ...Air transport | 0 | 0 | 0 | 0 | 0 | 0 | 7,755973 | 0 | 0 | 0 | 0,02832 | 7,727653 | 0 | 0 | 0 |
| ...Households, commerce, public administration | 0 | 0 | 0 | 2,052704 | 0 | 0 | 52,616838 | 0 | 7,76205 | 0 | 0,438134 | 0,019269 | 27,098392 | 12,789426 | 2,671686 |
| ...Households | 0 | 0 | 0 | 0,653093 | 0 | 0 | 4,939323 | 0 | 3,036864 | 0 | 0 | 0 | 0 | 1,902459 | 0 |
| ...Agriculture | 0 | 0 | 0 | 0,721768 | 0 | 0 | 11,999869 | 0 | 0,821 | 0 | 0,438134 | 0,019269 | 6,717839 | 0,518747 | 1,647 |
| ...Other | 0 | 0 | 0 | 0,677842 | 0 | 0 | 35,677646 | 0 | 3,904186 | 0 | 0 | 0 | 20,380553 | 10,36822 | 1,024686 |
| Statistical difference | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Part 2

| | Natural gas ['000 mn3] | Geothermal heat ['000 m3] | Fuelwood ['000 m3] | Wood of fruit trees and oth. plant residues ['000M3] | Wood wastes, wood briquettes and pellets ['000 tonnes] | Hydro energy [GWh] | Solar electricity [GWh] | Solar thermal [TJ] | Wind electricity [GWh] | Biogas [GJ] | Biodiesel ['000 tonnes] | Derived heat [TJ] | Electrical energy [GWh] | Derived heat [TJ] | Total electrical energy [GWh] |
|------------------------------------|------------------------|---------------------------|--------------------|--|--|--------------------|-------------------------|--------------------|------------------------|-------------|-------------------------|-------------------|-------------------------|-------------------|-------------------------------|
| Total primary production | 0 | 0 | 0 | 1315,726578 | 862,164839 | 21,087882 | 29,931401 | 1366,396432 | 888,998699 | 145,675114 | 165,915474 | 939,558761 | 0 | 0 | 0 |
| Recovered products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Imports | 79,80608 | 60,630244 | 330724,254 | 0 | 4,13411 | 0 | 63,696729 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2066,597061 |
| Stock change | 12,38999 | -0,064644 | 3,307 | 0 | 6 | 0 | 1,413297 | 0 | 0 | 0 | 0 | 0 | 0,1 | 0 | 0 |
| Exports | 7,59944 | 21,522719 | 0 | 0 | 0,160559 | 0 | 0,13692 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1356,420061 |
| Gross inland consumption | 84,59663 | 39,042881 | 330727,561 | 1315,726578 | 872,13839 | 21,087882 | 94,904507 | 1366,396432 | 888,998699 | 145,675114 | 165,915474 | 939,558761 | 0,1 | 0 | 710,177 |
| Transformation input | 0 | 0 | 268503,9553 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 939,558761 | 0 | 0 | 0 |
| .. Public thermal power stations | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Autoprod. thermal power stat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. CHP plants | 0 | 0 | 242615,3643 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Briquetting plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Biogas plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 939,558761 | 0 | 0 | 0 |
| .. Refineries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Main activity producer heat p | 0 | 0 | 25888,591 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transformation output | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2082,772069 | 3883,206049 |
| .. Public thermal power stations | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2534,185219 |
| .. Autoprod. thermal power stat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. CHP plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1145,24 | 1289,51832 |
| .. Briquetting plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Biogas plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59,50251 |
| .. Refineries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .. Main activity producer heat pl | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 937,532069 | 0 |
| Exchanges and transfers, return | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1366,396432 | -888,998699 | 0 | -165,915474 | 0 | -0,1 | 0 | 2421,310605 |
| Consumption of the energy brar | 0 | 0 | 0 | 0 | 0,074 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,173997 | 407,381663 |
| Distribution losses | 0 | 0 | 3196,32134 | 176,273914 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 220,987734 | 991,666369 |
| Available for final consumption | 84,59663 | 39,042881 | 59027,28437 | 1139,452664 | 872,06439 | 21,087882 | 94,904507 | 0 | 0 | 145,675114 | 0 | 0 | 0 | 1859,610338 | 5615,645622 |
| Final non-energy consumption | 0 | 39,042881 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Final energy consumption | 84,59663 | 0 | 59027,28437 | 1139,452664 | 872,06439 | 21,087882 | 94,904507 | 0 | 0 | 145,675114 | 0 | 0 | 0 | 1859,610338 | 5615,645622 |
| ..Industry | 82,75875 | 0 | 49060,64814 | 0 | 12,0963 | 0 | 12,326739 | 0 | 0 | 0 | 0 | 0 | 0 | 17,72 | 1398,380952 |
| ...Iron and steel industry | 0 | 0 | 28350,84436 | 0 | 0,028 | 0 | 0,44892 | 0 | 0 | 0 | 0 | 0 | 0 | 17,72 | 271,335243 |
| ...Non-ferrous metal industry | 0 | 0 | 0 | 0 | 0 | 0 | 0,005 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14,630886 |
| ...Chemical industry | 0 | 0 | 2480,234228 | 0 | 0 | 0 | 0,025 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113,340555 |
| ...Glass, pottery and building m | 82,75875 | 0 | 3192,902455 | 0 | 0,101 | 0 | 0,03382 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 141,282215 |
| ...Ore-extraction industry | 0 | 0 | 34,263876 | 0 | 0,019 | 0 | 0,000779 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 209,196285 |
| ...Food, drink and tobacco indus | 0 | 0 | 8390,266711 | 0 | 7,604 | 0 | 8,53967 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 195,997209 |
| ...Textile, leather and clothing k | 0 | 0 | 149,216425 | 0 | 2,3505 | 0 | 0,39288 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51,397335 |
| ...Paper and printing | 0 | 0 | 620,171026 | 0 | 0,239 | 0 | 0,054 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22,865863 |
| ...Engineering and other metal i | 0 | 0 | 5070,148367 | 0 | 0,532 | 0 | 0,662032 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 251,161711 |
| ...Other industries | 0 | 0 | 772,600699 | 0 | 1,2228 | 0 | 2,164638 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 127,173651 |
| ..Transport | 0 | 0 | 3541,337368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,007397 |
| ...Railways | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,007397 |
| ...Road transport | 0 | 0 | 3541,337368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ...Air transport | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ..Households, commerce, pub. s | 1,83788 | 0 | 6425,298858 | 1139,452664 | 859,96809 | 21,087882 | 82,577767 | 0 | 0 | 145,675114 | 0 | 0 | 0 | 1841,890338 | 4217,257273 |
| ...Households | 0 | 0 | 220,672083 | 0 | 827,415807 | 20,973006 | 67,445386 | 0 | 0 | 130,250208 | 0 | 0 | 0 | 1450,133501 | 3150,348229 |
| ...Agriculture | 1,83788 | 0 | 0 | 549,189311 | 7,731392 | 0 | 0,0756 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37,165522 |
| ...Other | 0 | 0 | 6204,626775 | 590,263353 | 24,820891 | 0,114876 | 15,056781 | 0 | 0 | 15,424906 | 0 | 0 | 0 | 391,756837 | 1029,743521 |
| Statistical difference | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

¹⁾ Претходни податоци/Preliminary data

APPENDIX 5 Useful information- Nomenclature for reporting format (NFR)- Format for reporting under the UNECE/LRTAP convention for 2023

| MK: 25/04/202 5: 1996 | | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Othe r (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | | POP's (from 1990) | | | | | | | | Activity Data (from 1990) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | NOx (as NO ₂) | NMV OC | SOx (as SO ₂) | NH ₃ | PM ₁₀ | PM ₁₀ | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCD DU PCD F (dioxi n/ furan s) | PAHs | | | | | | | HCB | PCB s | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| MK: 20/04/202 8: 1996 | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Other (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | | POPs (from 1990) | | | | | | | | Activity Data (from 1990) | | | | | | | | |
|-------------------------------|----------------------------|---|---------------------------------|---------------------|---------------------------------|---------------------|-----------------------------------|---------------------|---------------------|---------------------|-----------------------------|--------------------------------------|---------------------|---------------------|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|--|---------------------|-------------------------|-------------------------|--------------------------------|---------------------|---------------------|-----|------------------------------|---------------------|------------|---------------------|--------------------|----------------------|--|---|----------------------------|
| | | | NOx (as NO ₂) | NMV OC | SOx (as SO ₂) | NH ₃ | PM ₁₀ | PM ₁₀ | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCD D/ PCD F (dioxin/ furan s) | PAHs | | | | | | HCB | PCBs | | | Liquid Fuel s | Solid Fuel s | Gaseous Fuel s | Biomass | Other fuel s (speci- fied) | Other Activity Units |
| | | | | | | | | | | | | | | | | | | | | | | | benz(a) pyrene | benz(b) fluoranthene | benz(k) fluoranthene | Indeno (1,2,3-cd) pyrene | Total 1-4 | | | | | | | | | | | |
| C_OtherSt ationaryCo mb | 1A4ai | Commercial/Institutional: Stationary | 0.275 0572 95 | 0.021 2788 28 | 0.010 3004 92 | 0.000 1611 93 | 0.014 2767 63 | 0.014 2767 63 | 0.014 2767 63 | 0.007 6484 45 | 0.138 2392 6 | NA | 0.000 2038 06 | NE | NE | 0.001 0190 28 | 0.034 6469 4 | 0.001 4266 39 | 0.000 2038 06 | 0.020 3805 53 | NE | 0.000 6114 17 | 0.001 0190 28 | NE | NE | 0.001 6304 44 | NE | NE | | IE | 870.3 5885 29 | IE | IE | NA | NA | TJ NCV | | |
| I_Offroad | 1A4aii | Commercial/Institutional: Mobile | 0.374 1450 3 | 3.751 0288 34 | 0.093 9252 65 | 0.051 049 | 4.594 3509 6 | 4.717 1889 6 | 4.963 5700 89 | 0.459 73 | 25.51 5854 29 | 0.182 3236 63 | 0.087 4102 23 | 0.003 8201 55 | 0.001 2960 61 | 0.154 7382 06 | 0.040 4967 31 | 0.013 5271 09 | 3.003 3715 83 | 3.443 5688 31 | 4.958 1039 | 0.757 9786 8 | 0.699 1718 4 | 0.264 0374 7 | 0.443 5743 6 | 2.164 7623 5 | 0.033 6181 | 0.001 2253 11 | | 381 | 5,000 0 | 7,549 6 | 6723 | NA | NA | TJ NCV | | |
| C_OtherSt ationaryCo mb | 1A4bi | Residential: Stationary | 0.002 309 | 0.010 5 | 0.000 0 | 0.000 0015 | 0.000 25 | 0.000 2499 | 0.000 25 | 0.000 013 | 0.296 2 | 0.001 6 | 0.000 0044 | NE | NE | 0.000 0 | 0.000 7 | 0.000 0 | 0.000 0044 | 0.000 4 | NE | 0.000 0 | 0.000 0 | NE | NE | 0.000 0 | NE | NE | | 18.25 0448 51 | NA | NA | NA | NA | NA | TJ NCV | | |
| I_Offroad | 1A4bii | Residential: Household and gardening (mobile) | 0.054 6145 62 | 0.024 2446 82 | 0.070 4642 44 | 5.339 036 05 | 0.017 7754 5 | 0.018 8942 72 | 0.019 7350 57 | 0.004 1091 16 | 0.102 1816 83 | 0.011 0800 67 | 0.000 8290 34 | 0.000 9317 86 | 0.000 8310 81 | 0.003 3310 09 | 0.001 8209 43 | 0.016 7142 81 | 0.000 4996 47 | 0.042 4996 02 | 0.019 1821 19 | 0.003 4672 91 | 0.004 6311 14 | 0.001 7949 82 | 0.001 4061 49 | 0.011 3217 36 | 0.000 1346 74 | 0.010 9622 36 | | 126.1 6 | 64.46 | NA | 53.39 | NA | NA | TJ NCV | | |
| C_OtherSt ationaryCo mb | 1A4ci | Agriculture/Forestry/Fishing: Stationary | 0.053 8194 39 | 0.005 8415 32 | 0.003 6092 24 | 5.357 36-05 | 0.001 8935 28 | 0.001 8935 28 | 0.001 8935 28 | 0.001 1957 57 | 0.043 6068 79 | NA | 6.717 846- 05 | NE | NE | 0.000 3358 92 | 0.011 4203 26 | 0.000 4702 49 | 6.717 846- 05 | 0.006 7178 39 | NE | 0.000 2015 35 | 0.000 3358 92 | NE | NE | 0.000 5374 27 | NE | NE | | 286.4 8773 29 | NA | NA | NA | NA | NA | NA | TJ NCV | |
| I_Offroad | 1A4cii | Agriculture/Forestry/Fishing: Off-road vehicles and other machinery | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | 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 | 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 | NE | NE | TJ NCV | |
| C_OtherSt ationaryCo mb | 1A5a | Other stationary (including military) | 0.020 4113 69 | 0.010 6431 43 | 0.000 4992 74 | NA | 0.001 1815 72 | 0.001 1815 72 | 0.001 1815 72 | 0.000 6616 81 | 0.557 7750 55 | NA | 5.664 3E-06 | NA | NA | 2.832 15E- 05 | 0.000 9629 31 | 3.965 01E- 05 | 5.664 3E-06 | 0.000 5664 3 | NA | 1.699 29E- 05 | 2.832 15E- 05 | NA | NA | 4.531 44E- 05 | NA | NA | | 46.87 2462 05 | NA | NA | NA | NA | NA | NA | TJ NCV | |
| I_Offroad | 1A5b | Other, Mobile (including military, land based and recreational boats) | NA | 0.645 4036 | NA | NA | 0.019 3621 08 | 0.125 8537 02 | 0.264 6154 76 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | Coal produced [Mt] | | |
| D_Fugitive | 1B1a | Fugitive emission from solid fuels: Coal mining and handling | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | Coal used for transformation [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 | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | Please specify and/or provide details in the IIR | | |
| 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 | NO | Crude oil produced [Mt] | | |
| 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 | NO | Crude oil refined [Mt] | | |
| D_Fugitive | 1B2aiv | Fugitive emissions oil: Refining and storage | NA | 0.135 4558 35 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | Oil consumed [Mt] | | | |

| MK: 20/04/202 8: 1996 | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Other (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | | POPs (from 1990) | | | | | | | | Activity Data (from 1990) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | NOx (as NO ₂) | NMV OC | SOx (as SO ₂) | NH ₃ | PM _{2.5} | PM ₁₀ | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCD D/ PCD F (dioxin/ furan s) | benz dia pyrene | benz o(b) fluoranthene | benz o(k) fluoranthene | Indene (1,2,3-cd) pyrene | Total 1-4 | HCB | PCBs | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| MK: 2004/202 S: 1996 | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Other r (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | | POPs (from 1990) | | | | | | | | Activity Data (from 1990) | | | | | | | | | |
|----------------------------|----------------------------|--|---------------------------------|---------------|---------------------------------|-----------------|-----------------------------------|------------------|---------------|--------------|----------------------------------|--------------------------------------|--------------|---------------|---|--------------|--------------|--------------|----|--------------|------------|--|---------------|---------------------|---------------------|------------------------|--------------|-----|----------|------------------------------|----------|----|----|---------------------|-------------------------|--|--------------------------------|---------------------------------------|----------------------------|
| | | | NOx (as NO ₂) | NMV OC | SOx (as SO ₂) | NH ₃ | PM _{2.5} | PM ₁₀ | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCD D/ PCD F (dioxin/ furan s) | PAHs | | | | | | | | PCB s | | | Liquid Fuel s | Solid Fuel s | Gaseous Fuel s | Biomass | Other fuels (type collected) | Other Activity Units |
| | | | | | | | | | | | | | | | | | | | | | | | benz(a)pyrene | benz(b)fluoranthene | benz(k)fluoranthene | Indeno(1,2,3-cd)pyrene | Total 1-4 | HCB | | | | | | | | | | | |
| 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 | Titanium dioxide 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 | Soda ash produced [kt] | | | |
| B_Industry | 2B7 | Soda ash production | NA | 0,000 9760 32 | NA | NA | 0,000 0508 35 | 0,001 0167 | 0,002 6739 21 | NA | NA | 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 | 2B10a | Chemical industry: Other (please specify in the IIR) | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | Please specify and/or provide details in the IIR | | | |
| B_Industry | 2B10b | Storage, handling and transport of chemical products (please specify in the IIR) | 0,040 9078 8 | 0,017 4528 26 | 0,018 8805 6 | NE | 0,006 6081 96 | 0,007 5522 24 | 0,021 1047 9 | 2,378 956 05 | 0,534 9492 | 0,472 014 | 0,037 7611 2 | 0,023 9153 76 | 0,002 5488 76 | 0,033 0409 8 | 0,006 2935 2 | 0,129 0171 6 | NE | 0,723 7548 | 0,944 028 | NE | NE | NE | NE | NE | 0,151 0444 8 | NE | 0,786 69 | NA | NA | NA | NA | NA | 8216 91 | Steel produced [kt] | | | |
| B_Industry | 2C1 | Iron and steel 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 | NA | NO | Ferrous alloy produced [kt] | | | |
| B_Industry | 2C2 | Ferrous 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 | NA | Aluminium produced [kt] | | | | |
| B_Industry | 2C3 | Aluminium production | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | Magnesium produced [kt] | | | |
| B_Industry | 2C4 | Magnesium production | NA | NA | 0,051 415 | NA | 0,000 0822 64 | 0,000 1645 28 | 0,000 2056 6 | NA | NA | 0,011 3113 | 0,000 5141 5 | NE | 0,003 0849 | NA | NA | NA | NA | 0,000 5141 5 | 0,032 9056 | NA | NA | NA | NA | NA | NA | NA | 26,73 58 | NA | NA | NA | NA | NA | 10,2 8 | Lead produced [kt] | | | |
| B_Industry | 2C5 | Lead production | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | Zinc produced [kt] | | | |
| B_Industry | 2C6 | Zinc 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 | NA | NA | NA | NA | NA | NA | NA | NA | Copper produced [kt] | | | |
| B_Industry | 2C7a | Copper production | 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 | NO | NO | Nickel produced [kt] | | | |
| B_Industry | 2C7b | Nickel production | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | Please specify and/or provide details in the IIR | | | |
| B_Industry | 2C7c | Other metal production (please specify in the IIR) | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | Amount [kt] | | | |

| MK: 2004/2002 & 1996 | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Other (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | POPs (from 1990) | | | | | | | | Activity Data (from 1990) | | | | | | | | | |
|----------------------------|----------------------------|---|--------------------------------|---------------------|-----------------|---------------------|-----------------------------------|---------------------|---------------------|---------------------|----------------------|--------------------------------------|---------------------|--------------------|---|---------------------|--------------------|------------|--------------|----|---------------------|--------------------------|---------------------|---------------------|---------------------|-------------------------|---------------------|-----|------------------------------|----|----|--------------|-------------|---------------|------------|--|--|----------------------|
| | | | NOx (as NO2) | NMVOC | SOx (as SO2) | NH3 | PM10 | PM10 | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCDD/F (dioxin/furan) | benz(a)pyrene | benz(b)fluoranthene | benz(k)fluoranthene | Indeno (1,2,3-cd)pyrene | Total 1-4 | HCB | PCBs | | | Liquid Fuels | Solid Fuels | Gaseous Fuels | Biomass | Other fuels (see use lists) | Other activity (specify code) | Other Activity Units |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B_Industry | 2C7d | Storage, handling and transport of metal products (please specify in the IIR) | NA | 2,551 9416 89 | NA | NA | NA | NA | NA | NA | 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 | 2D3a | Domestic solvent use including fungicides | NA | 0,013 5266 64 | NA | NA | 0,003 3814 16 | 0,025 3606 2 | 0,118 3495 6 | 0,000 1927 41 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA | NA | 8453 54 | Please specify and/or provide details in the IIR | | |
| B_Industry | 2D3b | Road paving with asphalt | NE | 0,002 9833 7 | NA | NA | 0,001 8359 2 | 0,009 1796 | 0,036 7184 | 2,386 7E-07 | 0,000 2180 16 | NE | NE | NE | NA | NA | NA | NA | NA | NA | NA | NE | NE | NE | NE | NE | NA | NE | NA | | NA | NA | NA | NA | NA | 22,9 49 | Please specify and/or provide details in the IIR | |
| B_Industry | 2D3c | Asphalt roofing | NA | 3,263 5789 87 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA | NA | 10,3 7351 | Paint applied [kt] | |
| E_Solvents | 2D3d | Coating applications | NA | 0,091 5387 6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA | NA | 128, 956 | Solvents used [kt] | |
| E_Solvents | 2D3e | Degreasing | NA | 0,016 1692 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA | NA | 40,4 23 | Solvents used [kt] | |
| E_Solvents | 2D3f | Dry cleaning | NA | 0,573 949 | NA | 0,000 0612 | NA | NA | 0,024 NA | NA | NA | NA | 0,000 0002 | NA | 0,000 001 | 0,000 012 | NA | 0,000 1 | 0,000 001 | NA | NA | NA | NA | NA | NA | NA | 0,005 1 | NA | NA | | NA | NA | NA | NA | NA | NA | Please specify and/or provide details in the IIR | |
| E_Solvents | 2D3g | Chemical products | NA | 0,019 801 | NA | NA | NA | NA | NA | NA | NA | 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 | 2D3h | Printing | NE | 0,030 2080 03 | NE | NE | 0,000 0533 1 | 0,000 0799 65 | 0,000 0977 35 | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | 0,000 1012 98 | 0,000 1012 98 | 0,000 1012 98 | 0,000 5045 8 | 0,000 8084 74 | NE | NE | | 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) | 0,005 6291 87 | 0,033 6148 27 | NE | 0,009 2234 83 | 0,385 3603 62 | 0,685 9070 82 | 0,747 9833 22 | 0,000 2700 37 | 0,167 2487 83 | 4,910 9761 11 | 0,009 2827 22 | 0,000 3572 7 | 0,008 3314 76 | 0,097 7191 78 | 2,793 2176 4 | NE | NE | NE | 2,222 53E-07 | 0,000 2467 | 0,000 1000 14 | 0,000 1000 14 | 0,000 1000 14 | 0,000 5467 41 | 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) | NO | NO | NO | NO | NO | NO | NO | NO | NO | 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 | 2H1 | Pulp and paper industry | NA | 0,586 5794 6 | NA | NA | NA | NA | NA | NA | NA | 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 | 2H2 | Food and beverages industry | NE | NE | NE | 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 | 2H3 | Other industrial processes (please specify in the IIR) | NA | NA | NA | NA | NA | NA | 0,000 1272 39 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA | NA | 0,13 | Please specify and/or provide details in the IIR | |

| MK: 2004/202 S: 1996 | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Other (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | | POPs (from 1990) | | | | | | | Activity Data (from 1990) | | | | | | | | | | | | | | | | |
|----------------------------|----------------------------|---|---------------------------------|---------------------|---------------------------------|---------------------|-----------------------------------|--------------------|--------------------|----|-----------------------------|--------------------------------------|----|--------------------|---|----|----|----|----|----|----|--|------|----|----|----|----|--------------|------------------------------|------|----|----|-----------------|----------------|------------------|---------|--------------------------------------|---------------------------------------|----------------------------|--|--|--|--|--|--|
| | | | NOx (as NO ₂) | NMV OC | SOx (as SO ₂) | NH ₃ | PM ₁₀ | PM ₁₀ | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCD D/ PCD F (dioxin/ furan s) | PAHs | | | | | Total 1-4 | HCB | PCBs | | | Liquid Fuels | Solid Fuels | Gaseous Fuels | Biomass | Other fuels (see use is) | Other activity (speci- fied) | Other Activity Units | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B_Industry | 2I | Wood processing | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | | | NO | NO | NO | NO | NO | NO | | | | | | | | | |
| B_Industry | 2J | Production of POPs | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.018 2261 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 212.7 132 | | | NO | NO | NO | NO | NO | NO | | | | | | | | | |
| B_Industry | 2K | Consumption of POPs and heavy metals (e.g. electrical and scientific equipment) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | | NE | NE | NE | NE | NE | NE | | | | | | | | | |
| B_Industry | 2L | Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR) | 0.041 3328 5 | 0.872 6923 19 | NA | 0.759 6373 18 | 0.020 0960 13 | 0.030 8752 4 | 0.067 4402 4 | 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 | | | | | | | | |
| K_Agr/Livestock | 3B1a | Manure management - Dairy cattle | 0.029 3938 | 0.475 5732 | NA | 0.467 3338 | 0.006 3388 | 0.009 5082 | 0.020 7771 | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NO | NO | NO | NO | NO | NO | | | | | | | | | |
| K_Agr/Livestock | 3B1b | Manure management - Non-dairy cattle | 0.007 9176 85 | 0.087 3948 32 | NA | 0.320 5417 66 | 0.005 1712 8 | 0.015 5138 4 | 0.036 1989 6 | 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 | | | | | | | | | |
| K_Agr/Livestock | 3B2 | Manure management - Sheep | 0.000 6110 | 0.120 6996 | NA | 1.088 3363 | 0.001 1534 | 0.025 7200 | 0.180 5752 | 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 | | | | | | | | | |
| K_Agr/Livestock | 3B3 | Manure management - Swine | 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 | NA | | | | | | | | | |
| K_Agr/Livestock | 3B4a | Manure management - Buffalo | 0.002 4151 78 | 0.053 0715 56 | NA | 0.077 5042 14 | 0.000 9791 8 | 0.002 9375 4 | 0.006 8542 6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | | | | | | | | | |
| K_Agr/Livestock | 3B4d | Manure management - Goats | 0.002 4175 63 | 0.060 8085 15 | NA | 0.065 5614 78 | 0.000 5470 5 | 0.000 8596 5 | 0.001 8756 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | | | | | | | | | |
| K_Agr/Livestock | 3B4e | Manure management - Horses | NE | NE | NA | NE | NE | NE | NE | 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 | | | | | | | | |
| K_Agr/Livestock | 3B4f | Manure management - Mules and asses | 0.015 0290 65 | 0.207 2037 | NA | 0.183 2892 44 | 0.003 7673 4 | 0.050 2312 | 0.238 5982 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | | | | | | | | | |
| K_Agr/Livestock | 3B4g | Manure management - Laying hens | 0.000 5545 3 | 0.008 0627 4 | NA | 0.011 0956 8 | 0.000 1493 1 | 0.001 4931 | 0.002 3862 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | | | | | | | | | |
| K_Agr/Livestock | 3B4gi | Manure management - Broilers | 0.001 5682 85 | 0.027 9292 35 | NA | 0.045 1183 41 | 0.001 1423 | 0.006 2826 5 | 0.006 2826 5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | | | | | | | | | |

| MK: 2004/202 S: 1996 | NFR sectors to be reported | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Other (from 1990) | Priority Heavy Metals (from 1990) | | | Additional Heavy Metals (from 1990, voluntary reporting) | | | | | | | POPs (from 1990) | | | | | | | | Activity Data (from 1990) | | | | | | | | | |
|----------------------------|----------------------------|--|--------------------------------|-------------|--------------------|------------|-----------------------------------|-------------|-------------|-------------|-----------------------------|--------------------------------------|-------------|-------------|---|-------------|-------------|-------------|-------------|-------------|-------------|--------------------------|---------------|---------------------|---------------------|------------------------|-----------|------------|-----|------------------------------|----|----|-----------------|----------------|--|--|-----------------------------------|--|----------------------------|
| | | | NOx (as NO2) | NMVOC | SOx (as SO2) | NH3 | PM10 | PM10-10 | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCDD/F (dioxin/furan) | PAHs | | | | | | HCB | PCBs | | | Liquid Fuels | Solid Fuels | Gaseous Fuels | Biomass | Other fuels (see note 1) | Other activity (specify in the IIR) | Other Activity Units |
| | | | | | | | | | | | | | | | | | | | | | | | benz(a)pyrene | benz(b)fluoranthene | benz(k)fluoranthene | Indeno(1,2,3-cd)pyrene | Total 1-4 | | | | | | | | | | | | |
| L_Agr/Oth | 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 | Please specify and/or provide details in the IIR | |
| L_Agr/Oth er | 3I | Agriculture other (please specify in the IIR) | NA | 0.4261 | NA | NA | 0.000029 | 0.000192 | 0.000407 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | 877,672 | Deposition [kt] | | |
| J_Waste | 5A | Biological treatment of waste - Solid waste disposal on land | NA | NA | NA | 0.00003816 | 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 | 0.159 | Organic domestic waste [kt] | | | |
| J_Waste | 5B1 | Biological treatment of waste - Composting | 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 | NA in feedstock [kt] | | |
| J_Waste | 5B2 | Biological treatment of waste - Anaerobic digestion at biogas facilities | NO | NO | NO | NO | NO | NO | NO | NO | 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 | 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 | Waste incinerated [kt] | | |
| J_Waste | 5C1b | 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 | Waste incinerated [kt] | | |
| J_Waste | 5C1bi | Hazardous waste incineration | 0.00013385 | 6.69249605 | 0.00013385 | NA | NA | NA | 4.78035605 | 1.09948606 | 0.0002677 | 0.006042362 | 0.000702711 | 0.000427363 | 0.000124289 | 0.000191214 | 0.000248578 | 0.000191214 | NA | NA | 0.013480587 | NA | NA | NA | NA | 3.82428609 | 0.0095607 | 0.00191214 | | | NA | NA | NA | NA | 0.095607 | Waste incinerated [kt] | | | |
| J_Waste | 5C1bii | Clinical waste incineration | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | | | NO | NO | NO | NO | NO | NO | NO | Sludge 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 | Corpses [Number] | | |
| J_Waste | 5C1bv | Cremation | NA | NA | NA | NA | NA | NA | NA | 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 | 5C1bvi | Other waste incineration (please specify in the IIR) | 0.04027 | 0.01558 | 0.001393112 | NE | 0.053064884 | 0.057117572 | 0.058763976 | 0.022287251 | 0.70706741 | 0.006205679 | 0.001266465 | NE | 0.005192507 | 0.000126647 | 0.00253293 | NE | 0.000886526 | 0.222011315 | 0.1266465 | 0.029508635 | 0.05863733 | 0.071935212 | NE | 0.160081176 | NE | NA | | | NA | NA | NA | NA | Please specify and/or provide details in the IIR | | | | |
| J_Waste | 5C2 | Open burning of waste | NA | 0.000496232 | NA | 0.5815584 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | NA | NA | NA | NA | NA | NA | 33082,153 | Total organic product [kt DC] | | |
| J_Waste | 5D1 | Domestic wastewater handling | NA | 0.011244075 | 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 | 749,605 | Total organic product [kt DC] | | |

| MK: 20/04/202 8-1996 | NFR sectors to be reported | | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Othe r (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) | NMV OC | SOx (as SO ₂) | NH ₃ | PM _{2.5} | PM ₁₀ | TSP | BC | | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCD D/ PCD F (dioxin/ furan) | benz ola pyrene | benz o(b) fluor anth ene | benz o(k) fluor anth ene | Inde no (1,2, 3-cd) pyrene | Total 1-4 | HCB | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | PAHs | | | | | | |
| J_Waste | SD2 | Industrial 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 | | NO | NO | NO | NO | NO | NO | Total organic product (kt OC) | |
| J_Waste | SD3 | Other wastewater handling | | NA | NA | NA | NE | NE | NE | NE | NE | NA | NE | NE | NA | NE | NE | NE | NA | NA | NA | NE | NA | NA | NA | NA | NA | | NA | NA | NA | NA | NA | NA | Please specify and/or provide details in the IIR | |
| J_Waste | SE | Other waste (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 | Please specify and/or provide details in the IIR | |
| M_Other | 6A | Other (included in national total for entire territory) (please specify in the IIR) | | 18,96 9734 3 | 15,71 3471 3 | 45,80 669 | 7,886 52 | 7,348 55 | 12,31 181 | 16,26 575 | 0,833 13 | 40,97 438 | 7,137 22 | 0,265 48 | 0,175 47 | 0,434 98 | 0,974 09 | 11,38 258 | 1,081 10 | 4,210 62 | 8,110 05 | 6,804 04 | 0,852 22 | 0,980 82 | 0,396 86 | 0,490 89 | 2,716 64 | 0,046 56 | 240,2 8680 | | | | | | | |
| | NATIONAL TOTAL | National total (based on fuel sold) | (a) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | NE | NE | NE | NE | NE | NE | 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 MCV | |
| | 1A3b(i) (fu) | Road transport: Passenger cars (fuel used) | (b) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | TJ MCV | |
| | 1A3b(ii) (fu) | Road transport: Light duty vehicles (fuel used) | (b) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | TJ MCV | |
| | 1A3b(iii) (fu) | Road transport: Heavy duty vehicles and buses (fuel used) | (b) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | TJ MCV | |
| | 1A3b(iv) (fu) | Road transport: Mopeds & motorcycles (fuel used) | (b) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | TJ MCV | |
| | 1A3b(v) (fu) | Road transport: Gasoline evaporation (fuel used) | (b) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | Mileage [10 ⁶ km] | |
| | 1A3b(vi) (fu) | Road transport: Automobile tyre and brake wear (fuel used) | (b) | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | Mileage [10 ⁶ km] | |
| | 1A3b(vii) (fu) | Road transport: Automobile road abrasion (fuel used) | (b) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | | NE | NE | NE | NE | NE | NE | | |
| | ADJUSTMENTS | Sum of approved adjustments (negative value) from Annex VII (CLRTAP) | | 18,97 | 15,71 | 45,81 | 7,89 | 7,35 | 12,31 | 16,27 | 0,83 | 40,97 | 7,14 | 0,27 | 0,18 | 0,43 | 0,97 | 11,38 | 1,08 | 4,21 | 8,11 | 6,80 | 0,85 | 0,98 | 0,40 | 0,49 | 2,72 | 0,05 | 240,2 9 | | | | | | | |

| MK: 25/04/2025: 1996 | NFR sectors to be reported | | | Main Pollutants (from 1990) | | | | Particulate Matter (from 2000) | | | | Othe r (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 ₁₀ | PM _{2.5} | TSP | BC | CO | Pb | Cd | Hg | As | Cr | Cu | Ni | Se | Zn | PCDDi PCDF (dioxin/furan) | benz o(a) pyrene | benz o(b) fluoranthene | benz o(k) fluoranthene | Inde no (1,2,3- cd) pyrene | Total 1-4 | HCB | PCBs | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | </ |

